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Achieving the Sustainable Development Goals: improving water services in cities affected by extreme weather events

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ABSTRACT

This article discusses how key risks from extreme weather events might affect progress towards meeting Sustainable Development Goals 6 and 11 in cities in developing countries. It outlines the magnitude of the existing shortfall in safe water and sanitation services, and how climate change will exacerbate existing problems. It argues that the performance of many governments thus far has lacked urgency and purpose. Unless governments in particular become more committed, with redoubled effort, the goals are unlikely to be achieved.

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Introduction

Only a well-functioning and corruption-free water sector will be able to overcome the enormous challenge ahead. (Water Integrity Network, 2016)

In the context of the evolution of urban areas in developing countries, this article discusses how key risks from extreme weather events might affect progress towards meeting the United Nations (UN) 2015 Sustainable Development Goals (SDGs) 6 and 11, and what can be done about it.

First, it outlines the two SDGs and the size of the task of meeting them. Second, it considers how extreme weather events and their future change in intensity fit into the mosaic of factors affecting urban water service provision. Third, it discusses the importance of solid information in judging how to move forward. Fourth, it considers a number of policy questions that national and city governments will need to grapple with if they are to address SDG 6 and 11 both now and in the face of emerging risks from the intensification of extreme events to water services and sanitation. This specifically includes the impact on the poor and vulnerable, few of whom currently have access to safe water and sanitation, and the large group of inbound migrants who will be in a similar position in coming years. The issues will be significant for some cities, including for many a need to fundamentally revisit governance arrangements.

Although this article focuses on cities in developing countries, there are important issues in many developed countries as well, in both urban and regional areas. In the US, Canada and Australia, for example, indigenous communities far too regularly must put up with poor

service provision and poor water quality (see e.g. Horne, 2018; U.S. Environmental Protection Agency & U.S. Department of Agriculture, 2014). There are also many developed-country delta cities, such as Rotterdam, New Orleans, New York and Tokyo, that anticipate heightened water-related risks resulting from more frequent and intense extreme weather events, particularly storm surges (Aerts, Botzen, Bowman, Dircke, & Ward, 2012). Nonetheless, this paper focuses on cities in developing countries, because this is where the bulk of effort relative to available resources must go.

The article is based on a large body of academic literature, reports by international organizations such as the OECD and UN agencies, and reports by advocacy groups and national water institutions that discuss the underlying issues. It also draws on discussion at two workshops held under the auspices of the Institute of Water Policy, Lee Kuan Yew School of Public Policy at the National University of Singapore during 2016 and 2017.

Achieving SDGs 6 and 11: the size of the task

Since the late 1970s, the UN and its member states have grappled with the provision of safe drinking water worldwide, and the diffusion of basic sanitation services:

The decade 1980-90 should be designated the International Drinking Water Supply and Sanitation Decade and should be devoted to implementing national plans for drinking water supply and sanitation in accordance with the Plan of Action.... Action must focus on promoting (a) increased awareness of the problem; (b) commitment of national Governments to provide all people with water of safe quality and adequate quantity and basic sanitary facilities by 1990. (United Nations, 1977)

Safe drinking water remains outside the reach of over 2 billion people, with a UN estimate that 600 million of that number are in urban areas. Two SDGs seek to address this massive shortfall. SDG 6 seeks to 'ensure availability and sustainable management of water and sanitation for all' (United Nations Development Program, 2016). SDG 11 seeks to 'make cities and human settlements inclusive, safe, resilient and sustainable'. See Box 1.

Box 1: SDGs affecting water services in cities

SDG 6: Ensure availability and sustainable management of water and sanitation for all.

Target 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all. (Indicator 6.1.1: Proportion of the population using safely managed drinking water services)

Target 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

Target 6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and increasing recycling and safe reuse.

Target 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity.

Target 6.5: By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable.

Target 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

Source: UNDP, 2016.

The importance of the SDGs is well established. These goals are characterized as global in nature and universally applicable, with targets being aspirational (United Nations General Assembly, 2015; UN-Water, 2017; World Bank, 2017). Key questions are how much progress is likely, and what the barriers are to that progress. The growth of informal settlements, despite their precarious legality and a very low level of infrastructure services, underscores the size of the tasks around SDG 6 and 11 (UN Habitat, 2016). Over the past decade the migration from rural to urban areas has been rapid, and this is expected to continue to 2030, in developing countries in particular. Four billion people inhabited urban areas in 2015, some 54% of the world's population. Despite the efforts of governments, international organizations and NGOs, the absolute number of people in informal settlements or slums has risen from around 689 million to 880 million, even though they have declined as a proportion of the total population (UN Habitat, 2016). Box 2 outlines some basic facts around access to safe water.

Box 2: Progress towards 'safe' water

Using access to 'improved water services' as an indicator of safe drinking water, the UN stated that the Millennium Development Goals Target 7c, to halve the proportion of the population without access to safe water and sanitation by 2015, had been met well ahead of time (WHO/UNICEF, 2015).

As WHO (2017) now states clearly, the notion of improved water services does not take account of 'location, availability, or quality of the water'. The lack of access to safe drinking water leads to nearly one million people dying annually from diarrhoea as a result of unsafe drinking-water, sanitation, and hand hygiene'.

Progress towards SDG Target 6.1 is being assessed using a much more appropriate indicator, access to 'safely managed drinking water services'. Using 2015 data, WHO suggests that 2.1 billion people, or 29% of the world's population, do not have access to safely managed drinking water services. And this is probably an underestimate, as, in 2015, estimates of safely managed drinking water services were only available for countries representing 35% of the world's population (WHO & UNICEF, 2017).

Many countries have openly acknowledged that achieving the target by 2030 is beyond their capability (UN-Water, 2017), with nearly one-third of countries not on track to achieve even 'improved' drinking water coverage by 2030 (WHO & UNICEF, 2017).

Against a background of urban migration and growth in area under urban settlement, water managers have been challenged to maintain and improve water quality and availability. Delivery of safe water and sanitation has declined in many urban areas across many countries. Even where everyday service fully meets expected standards, urban areas may be at risk from extreme weather events, including flooding from pluvial or fluvial sources, storm events (including cyclones or hurricanes) and drought. Over time the nature of these risks may change significantly. Growth in urban populations caused by natural growth and inward migration could push the footprint of many urban areas into increasingly marginal and risky areas, including the floodplain, and reduce the capacity of the city to maintain existing infrastructure as it grows or as the risks change. This ongoing change in footprint will be enormous. By 2030, it is projected that there will be 104 cities worldwide with a population over 5 million, compared to only 40 in 2000. In addition, there are projected to be 558 cities with a population between one million and five million (UN Habitat, 2016; Varis, Biswas, Tortajada, & Lundqvist, 2006).

As noted above, currently at least 600 million (or 15%) urban inhabitants do not have access to safely managed drinking water services. Given the large number of cities and smaller urban areas where water quality is currently not regarded as safe, and around 900 million people living in informal settlements, this figure looks like an underestimate. On its

own, securing access to safe water and sanitation for this current population is an enormous task. But the population of urban areas is projected to increase from 4 billion today to around 5 billion in 2030, with a major part of that increase located in African and Asian cities (UN, 2016). That is, at least 1.6 billion urban inhabitants will need new or upgraded water and sanitation services by 2030 if SDGs 6 and 11 are to be fully met.

The starting point for tackling the unserved population varies greatly between cities, as does the capacity of specific cities to provide modern water and sanitation services. In some important dimensions, making progress over the next decade will be even harder than it has been over the past decade. Urban population growth will inevitably be concentrated on more marginal land. Around half of the expansion in the footprint of urban areas is expected to occur in flood zones (Guneralp, Guneralp, & Liu, 2015). This poses massive challenges for large and small cities alike (Gu, Gerland, Pelletier, & Cohen, 2015; Hallegatte, Green, Nicholls, & Corfee-Morlot, 2013).

Moreover, water and sanitation services to many existing and new urban areas will be even more vulnerable to extreme climatic events associated with climate change (McDonald et al., 2011). Water and sanitation infrastructure in delta cities, such as Guangzhou, Ho Chi Minh City, Mumbai and Jakarta, will be vulnerable to rising sea levels and storm surges (Aerts et al., 2012; Hallegatte et al., 2010). Greater preparedness is necessary in most cities. Preparedness for climate change can be in the form of continued diversification of water portfolios and managing infrastructure risk, as in the case of Singapore, a city that for decades has been trying to anticipate future conditions and plan the most appropriate response ahead of time (Chow, 2017; Tortajada, Joshi, & Biswas, 2013). Hong Kong provides a contrast (Hartley, 2017), where political complexity prevails and where diversification of water resources in the face of extreme events is not yet considered a priority.

Extreme events in the context of existing water service provision

Urban water managers have always had to manage climate variability (which is more of an issue in some regions than others). Looking forward, they are now required to routinely consider the impact of non-stationarity of climate (Milly et al., 2008). As is well recognized, a key feature of climate change is that in some areas it will result in higher intensity of extreme weather events, with magnified impacts that affect urban areas in new ways, well outside hitherto expected risk profiles in relation to pluvial and fluvial flooding and coastal storm surges (WHO, 2017). More frequent flooding, for example, will endanger an unquantified number of currently safe water services, particularly through increased likelihood of contamination of drinking water from sewerage overflow. On the other hand, extended drought conditions affecting the water supplies of large cities will cause major economic and social dislocation.

Climate variability will also result in hitherto unexpected floods in arid environments, which may result in infrastructure design being challenged and found wanting, and in the aftermath resulting in the spread of disease. Each year we see new records from extreme weather events, many affecting urban areas (Blunden & Arndt, 2017). Climate change is already having an impact, and will continue to exacerbate water-related problems in many areas (Hirabayashi et al., 2013), necessitating a city-by-city review of how these events are managed, both now and in the future. In Thailand, recurrent floods have affected almost all cities. Institutional fragmentation and politics have prevailed over holistic policy, exacerbating rather than solving problems (Lebel & Lebel, 2017).

In 2000 around 150 million urban dwellers faced perennial water shortages, and even more were exposed to seasonal shortages. With urban migration, the numbers facing perennial shortages are projected to grow to 1 billion by 2050. A further 100 million people will face water availability shortages as a result of climate change (McDonald et al., 2011). Water service providers will need to adapt or improve their infrastructure simply to maintain the level of services in the wake of new risks from more intense extreme weather events.

Within this framework, new and upgraded infrastructure can increase resilience in urban centres (Babovic, Babovic, & Mijic, 2017). Flood risk management agendas have traditionally sought improved drainage infrastructure to remove stormwater as quickly as possible. Developing new approaches to grey and green infrastructure to mitigate emerging flood risks is now becoming an important part of the urban water agenda (Richards & Edwards, 2017).

Meeting SDG 6 and 11 in a substantial way by 2030 will require a bundled response to many water-related challenges. Priorities will be different from urban area to urban area.

- *Standards not being met.* When there are inadequacies in water services, unrelenting urban growth, and the challenges of extreme weather events related to climate change, will service providers who even now cannot provide safe water services be able to move to a more satisfactory pathway?
- *Standards being met.* If services are currently meeting desired standards, will they be able to be maintained while putting in place new infrastructure services for new arrivals to the urban area, and also meet new challenges from more extreme weather events?

As many have commented, how cities – particularly large cities – perform in relation to provision of water and sanitation services over time depends on a range of factors, including size, importance in the domestic and regional economy, historical accidents around positioning, governance arrangements, migration flows, access to water supplies, the approach to charging for water and sanitation services, and likely impacts on existing services of changes in climate (IFRC, 2010; OECD, 2016; UN Habitat, 2016; UN-Water, 2017; Varis et al., 2006).

Usable, timely information: a starting point

Good information is critical to assessing options for water management and water service provision in urban areas, to meet new demands and new risks to urban water assets from more intense extreme weather events. For example, in 2016, Australia completed the first upgrading in 30 years of 'Australian Rainfall and Runoff' (Ball et al., 2016; Horne, 2016), giving operators of urban water infrastructure (including stormwater) a much better sense of the likely impact of climate change on the urban landscape. Fit-for-purpose information is the first stage in developing a capability for water service providers and governments to undertake a systematic re-examination of likely impacts of extreme weather events on floods affecting urban water services, and an opportunity to consider priorities to strengthen key asset protections to minimize impacts on, for example, drinking water. Urban water service providers in advanced economies are now adopting a variety of approaches to address these issues (Heyn & Winsor, 2015).

Developing a strong water information base was seen as critical in the initial UN (1977) intervention into water matters. As acknowledged by the UN High Level Panel, it remains

highly relevant today (Bureau of Meteorology, 2017). Laudable progress has been made in countless areas, but the unevenness of the very large database of various UN agencies (WHO, & UNICEF (JMP), 2017; UN-Water, 2017) and individual country databases limits opportunities to draw out key conclusions in a granular and consistent way. African countries overall are very poorly placed to measure progress against the SDGs, as only 12 of 54 countries have autonomous statistical agencies, and coverage of indicators for SDGs 6 and 11 is particularly poor (African Union Commission, UN Economic Commission for Africa, African Development Bank, & United Nations Development Programme-Regional Bureau for Africa, 2017). The work of the IPCC (Revi et al., 2014), and the many other projects being undertaken around the world (WHO, 2017), provide a starting point to look at the impact of climate change in urban areas. However, in many of them, from the foundation work to establish baselines, to looking ahead to the impact on the urban environment and water service provision, the work is incomplete. In many urban areas, this prevents careful assessment of policy options and priorities going forward, and implementing policy, from investment to governance.

Urban areas need a range of information to address the water-related elements of SDGs 6 and 11. First, governments and water service providers need to understand accurately how inhabitants stand relative to SDGs 6 and 11. Baselines need to be established. Individual cities need a detailed spatial understanding of their existing drinking water and sanitation services. While clearly sensitive politically, at all domestic levels and internationally, this is a foundation stone for moving forward. The use of 'improved' to describe 'safe' drinking water in the Millennium Development Goals illustrated how political sensitivities can get in the way of devising robust policies. City and regional governments also need to understand the projected growth of the urban footprint, and the expected profile of new inhabitants to allow policies to be devised to prevent further growth in urban inhabitants without access to safe water and sanitation.

Second, information is required to understand whether unconnected households and businesses can be provided safe drinking quality water and sanitation services. If they can't, the issue is to work through the reasons for that, including the adequacy of governance arrangements, discussed later. In areas of a drying climate absolute water availability may be an issue, but effectively managing extremes, including floods, may be equally important.

Third, expanding everyday water service provision requires effective selection and management from a well-established list of demand-side and supply-side possibilities. Selection will reflect history, social norms, income levels and existing governance arrangements. Many past practices may need challenging and changing (for example, basing supply estimates or judgments around at-risk assets on historical records), simply to address current service inadequacies. The case for establishing new processes and practices requires data, and data are also required to assess the impact of new approaches. One way to address the problem of lack of data hampering a country's public policy responses is to collect pared-down, cost-effective data sets focusing on key issues.

A part of this set of issues is the information needed to effectively manage extreme events that occur today, or are projected to occur in the future. The pertinent question is: How is the impact of intensified extremes incorporated into service provision? In a critical sense, understanding the strengths and weaknesses of the existing system is a precursor to understanding the impact on management of future water services of demand growth and changes in extremes. Each part of this exercise requires basic information. How countries

and urban areas should respond to their information needs will vary greatly from country to country and urban area to urban area (Bureau of Meteorology, 2017). Many cities and urban areas are well advanced in incorporating new requirements into everyday practice (ARUP, 2017; Horne, 2016; WHO, 2017; World Bank, 2016), but, as with overall service provision, many remain underprepared or unprepared, and some are not yet focusing on the core vulnerabilities. Water safety plans provide a well-articulated starting point (see e.g. WHO, 2017).

Key policy issues

Existing policy issues

Initially putting management of intensified extreme events to one side, city managers need to address the routine and currently unmet demand for safe water and basic sanitation. Issues include:

- Governance arrangements within the urban water sector, including issues such as corruption and fraud, relationships between the community and the water service provider, and relations between different levels of government;
- Capacity and willingness to address slums and informal settlements via land-use planning, regulation, and investment in water infrastructure for water service provision;
- Financial weakness of water service providers that undermines their capacity to deliver needed services – related issues include the need to expand revenue water (reduce water theft and leakages and increase revenue to bolster the robustness of the water supply network), set sustaining water tariffs and improve operating efficiency;
- Robust monitoring of water quality – linkages with health outcomes to drive upgrading of monitoring and regulatory frameworks;
- Water demand management in urban systems as a whole to drive water availability to new customers and the politics of equality; and
- Water safety plans, including basic information gathering and risk management around disaster management versus continuity of safe drinking water supplies.

We focus below on the first three issues. The others are very important but for reasons of space are not discussed here in detail.

Water governance

A core issue in water service provision is the quality of governance arrangements. It has been the focus of much valuable work by the OECD and others (see e.g. IWA, 2015; OECD, 2015, 2016, 2017; World Bank, 2017). However, while there is some evidence and examples of improved governance (UN-Water, 2017) it is not yet clear that sufficient progress has been made to drive the desired results. Corruption remains endemic in many countries, and will certainly undermine efforts to achieve SDGs 6 and 11 (UN Habitat, 2016; Water Integrity Network [WIN], 2016) unless addressed more fully, particularly with the overlay of intensifying extreme events.

Water governance is a means to an end. Effective governance will help ‘manage “too much”, “too little” and “too polluted” water in a sustainable, integrated and inclusive way, at an acceptable cost, and in a reasonable time-frame’ (OECD, 2015, p. 5). It will help to address

the breakdown within 2–5 years of their construction of 30–50% of new water supply projects in developing countries (United Nations World Water Assessment Programme, 2015). Adequate maintenance of capital-intensive wastewater treatment plants is necessary to sustain sought-after improvement in health outcomes and in the quality of life in urban settlements. It will help to engage the extreme poor in informal settlements in discussions on how to deliver safe and effective outcomes for clean water supply and sanitation. It will assist in developing a consensus between governments, business and communities on how the real value of water can become a central element in realizing sustainable outcomes.

The Water Integrity Network (involving UNDP, GWP, Transparency International, SIWI, UNDP Water Governance Facility and many national partners) connects, enables and promotes the work of organizations and individuals who recognize the impact of corruption (especially on poor and disenfranchised communities). Its *Water Integrity Global Outlook 2016* provides an overview of the costs of corruption flowing from inadequate water governance, and a toolbox of strategies whose implementation would go a long way towards addressing many of the key water issues. This is an endemic problem in many cities. Without this issue being addressed, the massive expansion in infrastructure funding that is required by many urban areas will not be forthcoming.

One of the more complex policy problems for governments, water service providers and communities is to shift policy approaches and tools from ex post disaster management towards active management of extreme risk events before they occur. Advanced countries find this a difficult issue, even with their comparative wealth of resources, so it should not be a surprise that cities with a massive capital shortage find it even more difficult (Horne, 2016). Fundamental reassessment of governance arrangements is necessary to ensure that this shift in focus happens, with international organizations leading the way in establishing case study exemplars. Good governance is never a default position, and maintaining it requires ongoing effort. This includes the role of governance arrangements to move from coping with extreme events to being resilient in the face of them.

Slums and informal settlements

Slum growth in sub-Saharan Africa accounted for over half of the growth in slum populations between 1990 and 2014 (UN-Habitat, 2016). Much peri-urban expansion over the coming decade, particularly in many of the large cities of Asia and Africa, is most likely to focus on marginal land and slums and informal settlement. Much of this will be in 'environmentally and geographically hazardous urban areas... The impact of living in these areas, whose vulnerability is often exacerbated by climate change, is continually life threatening as no alternatives are provided' (UN Habitat, 2015, p. 6). Water issues are but one of a host of challenges facing governments and communities in these slums and informal settlements. Thoughtful, timely, forward-looking land-use planning principles and building regulations (and much more) are essential (Johnson & Blackburn, 2014), but in many countries, the existence of these settlements is not even acknowledged by government (Subbaraman et al., 2013; WIN, 2016). If governments are serious about SDG 11, a key policy issue for them is where to focus scarce infrastructure spending, in a real world of weak governance and strong competition from corruption (WIN, 2016). City and national governments are often reluctant to provide long-term infrastructure, including adequate water infrastructure, to slum settlements, but without it, SDGs 6 and 11 will not be met. Few major urban areas in Asia and Africa have a clear idea of the long-term shape of the urban landscape (Yu, Shannon,

Baumann, Schwartz, & Bhatt, 2016), and few have instituted approaches to inward migration that focus on accommodating the poor and disenfranchised and providing them with basic, safe and affordable water services.

Land-use planning has been notably ineffective in many cities and in their hinterlands in the face of massive inward migration, and interests in those cities seeking to maximizing development without full recognition of flood risk. A result has been significant settlements in flood-prone areas, with slums and informal settlements occupying the least desirable real estate in cities in many developing countries.

Upgrading of water quality in slums and informal settlements from 'improved' to safe requires a determined attitude to water quality and approaches to expand water distribution systems, and an equally determined approach to the whole of the infrastructure sequence to tackle sanitation. Superficial approaches, such as increasing the number of toilets, will not address the core issues set out in SDGs 6 and 11. But what will drive it? It requires a package of policy actions implemented simultaneously. That will not happen unless upgrading slums becomes a central goal in city planning. Given the experience of the past several decades, there are few reasons to expect wide progress. Unless the intensification of extreme weather events itself becomes a driver of reform, outcomes seem more likely to deteriorate than to improve.

Financial weakness undermines capacity to deliver needed services

A third issue relates to the availability of financial resources to undertake the transformation being discussed. Many factors undermine the financial strength of urban water service providers and hence their ability to provide desired services, which in turn undermines their capacity to deliver the outcomes sought under SDGs 6 and 11. This vulnerability will be tested further by the expected impacts of population growth and urban spread, and the impacts of intensified weather events.

Expanding revenue water. Given a massive scarcity of both capital and operating funding, increasing the proportion of revenue water by reducing leakage and increasing numbers of paid connections is critical to funding new infrastructure and its maintenance. The 2016/17 GLAAS survey reports that for the largest suppliers in many developing countries, non-revenue water still exceeds 30%. It also notes that the Japanese International Cooperation Agency has focused technical cooperation on this issue, with good results (UN-Water, 2017). For apparent affordability and political reasons, water tariffs have regularly been set at levels that do not cover operating costs, let alone capital costs at any time (Independent Evaluation Group, 2010). As a dead-weight cost, this suggests that increasing the proportion of non-revenue water is critical, and unless it is addressed adequately, it is difficult to see water service providers being able to maintain infrastructure in the longer term, or progressively expand their own service-providing networks.

Setting sustaining tariffs. No matter how difficult for affordability and political reasons, setting water tariffs to recover operating and maintenance costs will be critical to ensure that infrastructure can be operated effectively over its whole life, rather than services being undermined by maintenance issues early in the life of an investment (van den Berg & Danilenko, 2017; Rouse, 2014). Subsidies and reduced tariffs for some groups is a common policy approach in many countries to enhance affordability, but some well-documented

cases suggest that the least able to pay are sometimes the least protected (McKenzie & Ray, 2009; UN-Water, 2017). Water service providers in many countries fail to cover even operating and maintenance costs, which clearly will have an impact on a service provider's ability and willingness to expand services.

Operating efficiency. Equally, issues abound around operating efficiency (see e.g. African Union Commission et al., 2017; UN-Water, 2017). Underperforming entities, which abound, are undermining the efforts to achieve the SDGs. Much of this goes back to governance, but culture, lack of training and lack of resources are contributing factors.

Managing intensified extreme weather events

Effectively managing the impact of intensifying extreme events will be a part of the challenge of meeting SDGs 6 and 11. In many urban areas, it may be a relatively small part of the problem of advancing universal service provision, swamped by the influx of population and internal population growth. But in other areas it will be an increasing part of the challenge. The evidence thus far is not compelling, but there are dangers policy makers need to be alert to. Assessing the relative importance of contributing factors can only be determined on a city-by-city basis. One recent publication argues that large rainfall shocks impact economic outcomes in cities, particularly for vulnerable communities; smaller events have little impact (Damanian et al., 2017). Health impacts are also acknowledged, but their size is not estimated. There are already over 150 million urban dwellers facing perennial water shortages, which will increase with population growth. Larger extreme events in future will have more substantial impacts, and these will inevitably reduce the likelihood that the SDGs are met.

Governance arrangements will need to manage changing risks to the roles of emergency management institutions and key service providers. This will go to issues like bidding for budgets to finance new infrastructure versus expenditure on operations and maintenance in the context of intensifying extreme events. The location of infrastructure will need scrutiny, as will the continued usefulness of existing methodologies and technologies. In some cities it will require fundamental changes to the level of cooperation needed between service providers for electricity and water. It will require a re-examination of the systemic weaknesses in managing safe water and sewage. In areas where flooding is more prevalent, the issues around land-use regulation will need to be further examined and, even more importantly, acted upon.

Today, there are numerous cities where inaction is more conspicuous than action. Thailand is an example where experience does not seem to have permeated the glass ceiling of politics (Lebel & Lebel, 2017). The notion that governance needs adjusting if the cost of inaction is too high is not one that can be relied upon, as vested interests rather than the common good are more likely to prevail. A systemic approach to new challenges is required. Just what it looks like will depend upon the arrangements that constitute current governance, how effective they are, and whether there is a political will to implement change if that is required.

With changing patterns of extreme events, disadvantaged groups in these cities will likely be put in even greater peril, along with the meagre services they currently enjoy. But an intensification of extreme events could also expose new parts of a city to higher risks, even in cities with established planning processes. Recalibration of basic parameters such as the

100-year flood line and the likelihood of high-intensity rainfall events will affect the capacity of established infrastructure to deliver safe water and sanitation services, particularly to low-income sectors in urban areas. The concept of sponge cities (Dai, van Rijswijk, Driessen, & Keessen, 2017; Xia et al., 2017) is designed to address aspects of this issue. The new 'normal' will require considerable adjustment by many cities in how they operate. Even if there is a good conceptual understanding of the issue, there is no guarantee that a societally optimal outcome will emerge. Higher intensity of extremes will require re-examination of the optimal characteristics of water and sanitation assets. In many cities more decentralized solutions may increase the likelihood of consistent services.

The Netherlands is one of only a few countries that have aggressively responded to the new risks from extreme weather events, building resilience to floods in terms of policies, institutions and infrastructure (Dai, Wörner, & van Rijswijk, 2017). On a much larger scale, China has a significant exposure in urban areas to extreme events and is investing in responses to these new challenges (Cai, Kumm, Niva, Guillaume, & Varis, 2017), but institutional frameworks still require strengthening (Moore, 2017).

The importance of impacts from the changing nature and frequency of extreme climatic events will vary from city to city. Income levels are highly relevant, but well-performing cities such as Phnom Penh provide evidence that income levels are far from the sole determinant of strong performance (Biswas & Tortajada, 2010). The potentiality of flood-related weather events raises more immediate issues (and accounts for the majority of immediate disaster-related costs), whereas the impacts from drought are likely to be more insidious (Damania et al., 2017).

Cities in advanced countries typically have more options, including stronger revenue capability and the ability to address emerging issues; better developed emergency management capacity; and greater capacity to upgrade infrastructure in the short-to-medium term to manage emerging risks; and are more likely to have a regulatory framework that reduces urban expansion in flood-prone areas and improves their ability to manage drought restrictions. They also have more measurable assets at risk. Many cities in developing countries (particularly in Asia and Africa) face growing risk from rapidly increasing population, juxtaposed against a shortfall of municipal revenue and absence of a regulatory framework aimed at inhibiting, for example, expansion into flood-prone areas. Demand management in many cities in arid regions of developing countries is often rudimentary.

In the real world of policy change, any options analysis will need to incorporate the expected impact of future extreme events on the capacity to deliver safe water and basic sanitation services, covering all at-risk assets. This goes beyond water assets, as water delivery security will be affected by secure power availability, as illustrated by the lengthy impact in 2017 of Hurricane Maria on Puerto Rico's water supply (FEMA, 2017). Critical to this analysis will be an understanding of how risks to safe water supply will change with the intensity of extreme climate events. Also critical will be strategies to secure at-risk assets, or reduce their vulnerability to extreme events. Much of the unsatisfied demand for safe water and access to sanitation services already reflects the impact of 'routine' extreme weather events. Addressing risks to existing services from these events remains a major problem in many urban areas in developing countries. New technologies may play a role, but that is not yet evident, suggesting they are unlikely to have a major impact over the next half-decade at least.

In every case, there are better and worse ways to handle risk. Understanding key risks and the suite of options available to address them is a good place to start but requires an effective and fair process to develop such understanding. This applies to the performance of the existing water delivery systems and ways to improve the performance and resilience of the systems as the intensity of extreme events changes, and the interaction with other factors, such as the location of new settlements. But understanding the options does not guarantee being able to implement actions.

Managing risk in the face of intensifying extremes will require simultaneous progress in dealing with many existing problems, often with new dimensions that make achieving SDGs 6 and 11 even more difficult. A key starting point is having a framework to manage new and changed risks while seeking to achieve the desired outcomes.

Conclusion

The challenge of successfully implementing SDGs 6 and 11 would be daunting even if the problems to be addressed were limited to urban migration, natural population growth and the growth in area under urban settlement. But they are not: the impact of intensifying extreme weather events will make this task even more daunting.

Many countries have openly acknowledged that achieving the targets embodied in SDGs 6 and 11 is beyond their capability. Delivering them in a substantial way will require a bundled response to water-related challenges from individual country governments, city administrators, local communities, NGOs and international institutions. Priorities will need to be different from urban area to urban area. A useful starting point will be developing pared-down, cost-effective data sets focusing on key issues.

From a policy perspective, significant issues around governance, including corruption and fraud, a capacity and willingness to address slums and informal settlements and a willingness to expand revenue water and financial sustainability will need to be effectively addressed. Understanding the key risks and the suite of options to address them, in the context of a fair and effective process, is necessary but not sufficient for progress. Implementation will be critical.

Overall, the performance of many governments in working towards SDGs 6 and 11 thus far has lacked urgency. Unless governments in particular become more committed, with redoubled effort, the goals are likely to remain aspirational rather than having any genuine prospect of being achieved.

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