The Challenge and its link to the SDGs

Introduction

The world is currently in the midst of an unprecedented transition from rural to urban areas, with 54% of the world's population currently living in cities and towns – human settlements collectively referred to as 'cities' herein. This number is expected to rise to around two thirds of the global population by 2050.[1] Further, cities around the world are grappling with complex and interrelated challenges including population growth, resource constraints, degraded environments and increasing climate uncertainty. Effectively addressing these challenges requires reforming the current urban water management approach, instead moving towards a framework that not only delivers essential water services but enhances the sustainability, resilience and liveability of urban areas more generally.

This alternative paradigm of water management has emerged in scientific, policy and practice domains and is embodied in concepts such as Integrated Water Cycle Management (IWCM) representing a vision for contemporary water servicing based on principles of flexibility, diversity and integration.[2] Related concepts include Water Sensitive Cities (Australia)[3], Low Impact Development (US), Sponge City (China), Active, Beautiful and Clean Water (Singapore) and Sustainable Urban Drainage (UK and Europe).

The IWCM vision is to provide long-term water security[4] via holistic socio-technical management of the urban water cycle, using an integrated mix of policies, community engagement, urban planning and centralised and decentralised infrastructure to deliver water services, protect and enhance the health of receiving waterways, reduce flood risk and create green public spaces that capture and clean water.

More generally, IWCM recognises that integrating water planning with broader urban planning and design of land development, and the principles of resource regeneration, can help deliver a range of objectives critical to the liveability of a city, including resilience to extreme events, mitigation of urban heat, increased biodiversity, public green space, healthy waterways and vibrant communities. The socio-technical dimension is fundamental to addressing challenges that are often referred to as 'wicked problems' - problems that are characterised by incomplete information, contradictory and changing requirements that are often difficult to recognise, and solutions often resulting in unintended consequences. The IWCM approach helps address broader issues critical to the SDGs, such as environmental stewardship, intergenerational equity, population health and wellbeing, and infrastructure and social resilience to climate change. This represents a significant departure from conventional urban water management approaches.

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1 United Nations, Department of Economic and Social Affairs, Population Division (2014), *World Urbanization Prospects: The 2014 Revision* (ST/ESA/SER.A/352).

2 OECD (2016), Water Governance in Cities, OECD Studies on Water, OECD Publishing, Paris; Pahl-Wostl, C. (2015), *Water Governance in the Face of Global Change*, Springer International Publishing, Switzerland; Prime Minister's Science Engineering and Innovation Council (2007), Water for Our Cities: Building Resilience in a Climate of Uncertainty.

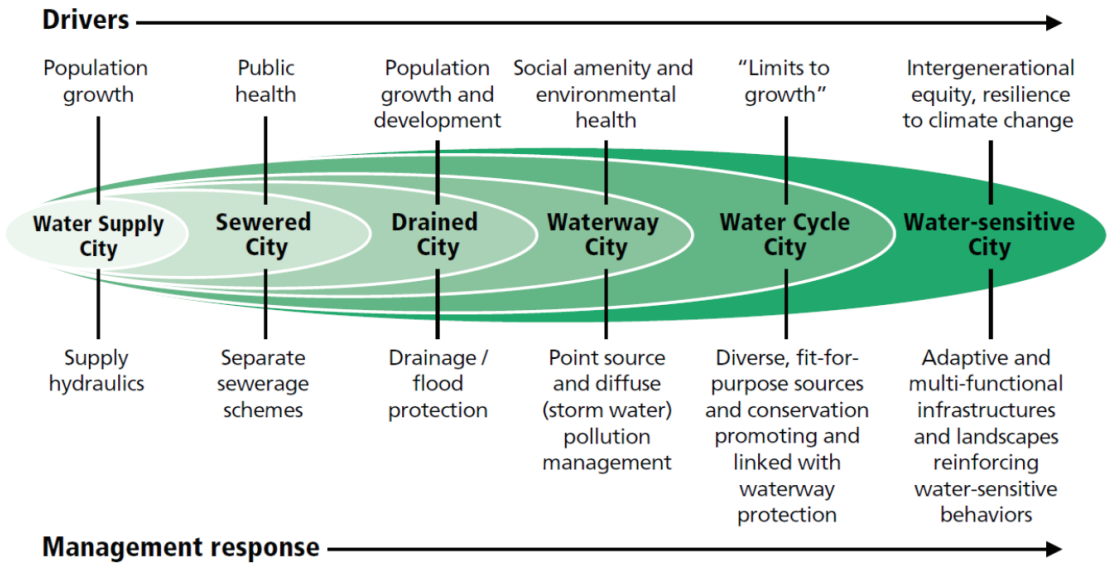
3 The National Water Initiative (COAG 2004) defines Water Sensitive Urban Design as 'the integration of urban planning with the management, protection and conservation of the urban water cycle that ensures that urban water management is sensitive to natural hydrological and ecological processes'. Water Sensitive Cities is the outcome of water sensitive urban design. http://www.coag.gov.au/meetings/250604/iga_national_water_initiative.pdf.

4 Water security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability. http://www.unwater.org/topics/water-security/en/

The Evolution of Urban Water Management

To effectively address the emerging challenges in water management in cities, it is instructive to first understand the historical evolution of urban water management regimes (i.e. infrastructure and institutions). Traditionally, urban water has been managed in a technocratic way, based on principles of predictability and control. Brown et al. (2009) investigated the evolution of urban water management in cities over the last 200 years and considered a series of sustainable futures perspectives.[5] As shown in Figure 1, they developed a typology of six dominant water management regimes that represent a nested continuum of socio-political drivers and service delivery responses, i.e. water supply, sewered, drained, waterways, water cycle and water sensitive cities. This framework has been used to inform the development of many urban water management strategies in Australia, (notably Water for Victoria[6], South Australia's Water for Good[7]), and internationally (e.g. Asian Development Bank (2013)[8]).

Figure 1: Evolution of Urban Water Management Regimes



(source: Asian Development Bank (2013) adapted from Brown et al 2009)

The first three regimes represent the historical development of water servicing in response to the need to provide (i) clean and reliable water supplies, (ii) better public health outcomes and (iii) protection from flooding. In these regimes, water services are provided through large, centralised infrastructure and the associated yet siloed administrative/governance systems managed on the community's behalf by utilities. The corresponding urban water infrastructure in almost all developed cities exhibit these characteristics, with low community water literacy[9] and urban water services largely invisible and typically taken for granted.

Managing the water cycle in this segmented and linear way, whereby wastewater and stormwater are swiftly channeled outside of the city and into receiving waterways, has given rise to a range of unintended consequences, including environmental degradation.

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5 Brown, R.R., Keath, N., & Wong, T.H.F. (2009), 'Urban water management in cities: historical, current and future regimes', Water, Science and Technology, 59(5), 847-855.
6 http://delwp.vic.gov.au/water/a-new-water-plan-for-victoria
7 www.environment.sa.gov.au/files/.../water/water-for-good-full-plan.pdf
8 http://www.adb.org/sites/default/files/publication/30190/asian-water-development-outlook-2013.pdf
9 http://watersensitivecities.org.au/are-australians-water-literate/

This overwhelming demand on natural capital has left many cities with a reduced environmental capacity to assimilate and process pollution, which in turn compromises water supply security (especially for downstream urban environments) and urban liveability. The existing legacy of environmental damage is especially problematic, with the majority of developed cities characterised by an ecological footprint much larger than the physical footprint of the city.[10] These challenges are further exacerbated by rapidly increasing urban population that is not well supported by aging infrastructure and inadequate ongoing investment in its augmentation, and the unpredictable and diverse nature of climate change impacts, causing drought in some places (e.g: many Australian, Indian and Brazilian cities etc in recent times) and severe flooding in others (e.g: the recent floods in Jakarta, Chennai, Houston, cities in Great Britain, just to name a few).

The next two regimes, the Waterways and Water Cycle cities, reflect the response of urban water systems (particularly in the developed world) to new challenges and socio-political drivers characterised by increasing community demand for enhanced liveability, the need for a more 'regenerative' response to water resources management in cities, and the emerging need for building stronger resilience to increasing uncertainties brought about by climate change and a shifting global economy.

In the Waterway City, cities improve environmental quality and the ecological health of waterways through initiatives such as restoring waterways from concrete drains to a more natural form (e.g. the naturalisation of a 3km section of Kallang River at Bishan Park in Singapore[11], and the 'daylighting' of the Cheonggyecheon Stream in Seoul, Korea[12]).

In the Water Cycle City, the emergence of "limits to growth" in terms of reduced water supply security and environmental assimilative capacity requires cities to diversify water resources and manage sources of environmental water pollution (wastewater and stormwater) as alternative resources (e.g. groundwater replenishment with treated wastewater for Perth[13], and stormwater harvesting for Los Angeles[14]). These solutions typically involve expensive infrastructure retrofits.

The Urban Water Management Challenge

In the face of increasing complexity and uncertainty, static water management and infrastructure planning approaches are no longer appropriate.[15] Many of the responses to emerging 21st century challenges are continuing to rely on the entrenched technocratic approaches of the 20th century, in many cases perpetuating existing institutional regimes and conventional water management approaches, rather than adopting more integrated, decentralised and innovative place-based options. Typically, many cities are simply expanding the capacity of existing water infrastructure to maintain levels of service for an increased population, as exemplified by the £10b Thames Water sewer tunnel upgrade.[16] Ironically, many cities in the developing world are striving to attain these outdated 20th century solutions, evident in the manner in which multilateral agencies typically structure water infrastructure loans.

Responding to current water management challenges while delivering increased sustainability and resilience in cities demands a shift to more dynamic, integrated, flexible and adaptive water management frameworks. The National Water Commission of Australia (2011) describes the future urban water sector challenge as enhancing the sector's "effective contribution to more liveable, sustainable and economically prosperous cities in circumstances where broader social, public health and environmental

10 World Wildlife Fund (WWF) (2014), Living Planet Report, WWF International, Switzerland.
11 http://news.asiaone.com/News/Latest+News/Singapore/Story/A1Story20120317-333972.html
12 http://www.preservenet.com/freeways/FreewaysCheonggye.html
13 http://www.watercorporation.com.au/water-supply-and-services/solutions-to-perths-water-supply/groundwater-replenishment
14 http://www.planetizen.com/node/86562/las-water-supply-increasingly-relying-management-stormwater
15 Milly et al (2008), Stationarity is Dead: Whither Water Management? Science Vol. 319, Issue 5863, pp. 573-574
16 http://www.theguardian.com/environment/2014/nov/27/london-super-sewer-branded-waste-time-money