TOWARDS THE BLUE-GREEN CITY:

Building Urban Water Resilience

Larry A Swatuk, Gregg Brill, Charon Büchner-Marais, Kirsty Carden, Ernst Conradie, Jenny Day, Joanna Fatch, Jessica Fell, Mafaniso Hara, and Bongani Ncube

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Editors:

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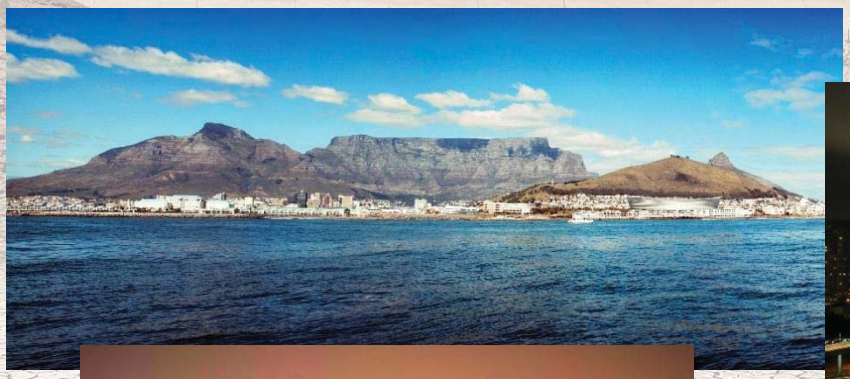

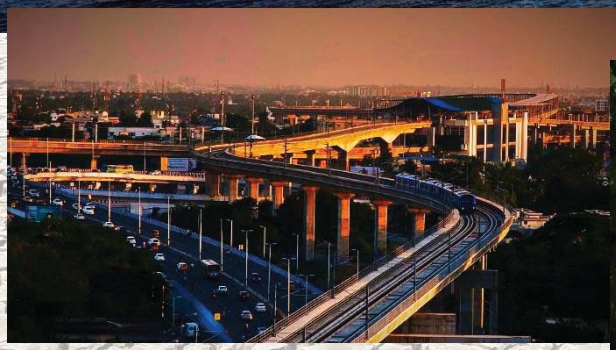

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Title page photographs:

In the background is the Leeu-Gamka Dam – the most important water source for Beaufort West, a town in South Africa – during the recent prolonged drought (photo: Styant 2017). The cities in the foreground have all been identified as being amongst the ten cities globally that are at greatest risk of reaching "Day Zero", when their taps run dry and the cities run out of potable water. These are (in clockwise order):
Cape Town (photo: D Van der Walt CC BY-SA 3.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Table_Mountain_from_Table_Bay.jpg), São Paulo (photo: Marcosleal CC BY-SA 3.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Ponte_estaiada_Octavio_Frias_-_São_Paulo.jpg), Mexico City (photo: J Peschard CC BY-SA 4.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Angel_of_Independence_Mexico_City.jpg), and Chennai (photo: Renh25 CC BY-SA 4.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Chennai_Interchange.jpg)

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FOREWORD

The world is urbanising at an astounding rate. According to World Bank data, the percentage of the world's total population living in urban environments grew from an estimated 36.5% in 1970 to 56.2% in 2020. While the percentage has increased dramatically, the absolute numbers are even more breathtaking: from around 1.3 billion in 1970 to close to 4.4 billion in 2020. A significant portion of this growth is occurring in the Global South, with countries across central, eastern and southern Africa having the highest rates of urbanisation in the world. By 2050, it is anticipated that Kinshasa will be the 10th largest city in the world. Understandably, there has been significant focus on the challenges facing megacities such as Delhi, Mexico City, Mumbai and Dhaka. Yet, one should not lose sight of the thousands of more moderately sized cities. According to the United Nations Department of Economic and Social Affairs (UNDESA), in 2018 while there were 33 megacities, there were 467 cities with 1 - 5 million inhabitants and 598 cities with populations between 500 000 and 1 million. Indeed, as the difficulties in dealing with the Covid-19 pandemic have revealed, significant challenges face cities of every size.

Water lies at the heart of urban well-being, prosperity, sustainability and survival. The most significant urban challenges are a function of water availability: ensuring that a diverse set of users have access to the right amount of water of the right quality delivered at the right time in an affordable and sustainable way is no small feat even for the most well-resourced municipality. Well-known water crises have recently plagued important global cities such as Barcelona, Cape Town, Chennai, Los Angeles and São Paulo. As urban growth outpaces municipalities' capacities to provide adequate services, a tendency toward uncoordinated 'self-help' results in a set of sub-optimal practices – from borewell proliferation to deforestation, from informal settlement expansion to land degradation – that worsen the urban environment while negatively impacting residents' quality of life. Globally, one in five urban residents lives in an informal settlement. The 2021 Sustainable Development Report shows that Sub-Saharan African countries average a score of 50 (out of 100) on SDG 6 (clean water and sanitation), with only the OECD countries scoring above 80. World Bank data shows that 86% of the world's urban population have access to safe drinking water while only 62% of the world's urban population have access to improved sanitation. Given that OECD countries have achieved almost universal access, one can clearly see the scale of the WATSAN challenge across the Global South.

Historically, meeting these challenges has fallen to city counsellors, urban planners and developers whose tendency toward 'command and control' seems only to have made matters worse. According to UNDESA, while the percentage of people living in informal settlements decreased by an estimated 6 percent over the period 2000-2014, their absolute number increased by some 75 million. Cities are organic entities, partially rooted but ever malleable,

simultaneously being preserved and destroyed, created and recreated by residents in line with their ideas, hopes and desires. New thinking builds on ideas of environmental sustainability and social inclusivity, locating the city within its built and natural environments, cognizant of the needs of changing populations and the limits set by the complex interplay of economic, technical, political, social and natural actors, forces and factors.

Realizing urban water security is not strictly a function of technical innovation combined with sufficient financial and human resources. Neither is it solely dependent upon satisfying the needs and interests of the most influential and powerful actors in society. Indeed, as described in several chapters of this collection, limiting the range of voices in decision-making exacerbates both social and environmental problems. As shown in this volume, building the water sensitive city requires a collective effort that marshals the insights, interests and resources of all stakeholders. It requires a significant behaviour change at all levels in the value and use of water. Given that water is valued in many ways – as a factor of production, a source of joy and spirituality, a component of leisure, a threat and an indispensable household necessity – reaching appropriate decisions in the service of all requires integrative, reflexive and flexible processes. Numerous case studies presented in this collection show how creative processes of collaborative governance that are cross-sectoral, collective and participatory contribute directly to broad-based urban water security. Without doubt, there continue to be as many setbacks as there are successes. Innovative concepts such as the hydro-social contract, water sensitive urban design, green infrastructure, sponge cities, and ecosystem services help us see challenges and opportunities differently, often more clearly. Yet, it is not all 'out with the old and in with the new.' We cannot neglect age-old indigenous wisdom. Seeing water as a sacred gift, a source of cleansing and of joy is essential to ensuring urban resilience. It must be emphasized that sustainable solutions require learning lessons from the past, listening carefully to all voices and respecting and accessing all forms of knowledge, be it indigenous and local or global and Western-scientific. Drawing on examples of best practice from around the world, the authors are cautiously optimistic. In their own words, 'While the vision of a water-sensitive city is a universal one, city managers will need to craft an approach that learns from their own successes and failures, and those of others in cities around the world, and establish an approach that suits their unique context.'

Jay Bhagwan
Water Research Commission Executive Manager: Water Use and Waste Management

PREFACE

Cape Town is not the only major city to have faced a serious water crisis. It is also not the first city to do so, or the last and its challenges related to water security are not necessarily worse than other cities. Nevertheless, Cape Town has become a global symbol for cities facing escalating water shortages, attracting attention from all over the world. At best, this symbol may be understood in terms of the remarkable way in which Cape Town's citizens altered their water usage to avert a worst-case scenario in 2018. Such compliance is indeed unprecedented and a story worth telling and reflecting upon.

In July 2018, Professor Philip Clayton (Claremont School of Theology), the President of the Institute for Ecological Civilization (EcoCiv), a California-based NGO promoting appropriate responses to long-term global challenges, approached Professor Ernst Conradie (Religion and Theology, University of the Western Cape, South Africa) to explore possibilities to host a major international conference on cities facing escalating water shortages. The assumption is that there are indeed many cities, all around the world, that are confronted with serious water shortages and that such challenges may well escalate over the long term (towards 2050) especially due to climate change, continued urbanisation and the deterioration of infrastructure. It may therefore advance the quest for sustainable forms of civilization if representatives from selected cities could gather together, preferably in Cape Town, to discuss best practice in addressing such challenges, lessons learned from mistakes made and to identify strategies in moving forward. The more ambitious aim for such a conference was to develop a "Water framework", namely a living document that can guide city officials and policy makers over the coming decades to address immediate water shortages and challenges with a long-term vision in mind.

In planning towards this conference, the need was recognised for a multidisciplinary approach to address such challenges in which a wide array of disciplines and stakeholders may each make a distinctive contribution while no one discipline has a complete overview. There is both a need for specialisation and for relating such perspectives with each other. Arguably, it is the failure to bring such perspectives together that poses the most serious challenge. Put differently, the question is whether basic assumptions on water security held in one sector may be in conflict with assumptions held in other sectors. This can only undermine an ability to address the challenges associated with escalating water shortages.

On this basis six task teams were established to each develop a position document on cities facing escalating water shortages, namely in the natural sciences, the social sciences, politics and governance, economics, the technical sciences and civil society. Each of these task teams had to be defined more carefully. Each included a cluster of sometimes overlapping disciplines. Each task team had to address a twofold question: What distinct contribution can

be made from the perspective of that particular task team that other disciplines cannot make to the same extent? And what transversals, or crosscutting themes, may emerge that need to be explored in conversation with other task teams? In other words, while the emphasis was on developing a common vision, the task teams simulated and explored underlying conflicts.

Each task team consisted of between 15 and 25 persons, including local scholars, stakeholders in business and industry, international scholars, representatives from international organisations, students and community activists. Each task team developed a position document that was circulated to participants and discussed in depth at the conference that was eventually hosted at the University of the Western Cape from 27 to 28 January 2020. The purpose of this conference was therefore a meeting of members of the six task teams in order to discuss their position papers and to develop an envisaged "Water framework". This document was subsequently produced in collaboration with the so called W12 Congress that was planned for the same week of 27 to 31 January but had to be postponed for logistical reasons.[1]

After the January 2020 conference the conveners of the six task teams continued to meet on a regular basis in order to further develop the position papers prepared for the conference. The set of essays included in this volume has to be understood against this background. They constitute insights gained from the multidisciplinary approach adopted for this conference and are made available here for a wider audience. While there are countless research contributions on water security that have been published from the perspective of particular disciplines in order to contribute to discourse in such disciplines, this set of essays represents a deliberate attempt to communicate across such disciplines and in such a way that this can come to the aid of practitioners engaged in urban water security. While urban water managers typically do have to juggle various perspectives and interest groups, such a multidisciplinary approach is not common elsewhere and constitutes the distinct contribution of this set of essays.

The set of essays includes an introduction that represents some of the common ground that was established across the various disciplines. This is followed by six essays that each offer perspectives on urban water security from a narrower set of disciplines in communication with other disciplines. Put simply, they each suggest non-negotiables for water security: if such perspectives are not taken into account collaborative efforts to address the long-term

[1] This document is available at https://usercontent.one/wp/www.w12-congress.com/wp-content/uploads/2020/05/W12-Framework-Final.pdf (accessed 6 August 2020). It includes the original position papers from the six task teams.

challenges associated with urban water security are likely to be undermined. These essays are followed by a concluding section that spells out a long-term vision for the future.

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The authors would like to thank all those who helped make this publication possible. In particular, we would like to thank all those who participated in the conference at the University of the Western Cape in January 2020. We would like to thank EcoCiv for their on-going financial, technical and intellectual support especially Philip Clayton, Jeremy Fackenthal and Ellie Leaning. Professor Burtram Fielding and the staff of the University of Western Cape offered vital administrative and logistic support. The John Templeton Foundation and the Prince Sultan bin Abdulaziz International Prize for Water (PSIPW) provided sponsorship without which the conference and also this publication would not have been possible. Finally, the W12 Congress and its staff hosted an opening event and a press conference in support of the conference.

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LIST OF ACRONYMS

ACDI	African Climate & Development Initiative
AGWA	Alliance for Global Water Adaptation
ATREE	Ashoka Trust for Research in Ecology and the Environment
BEE	Black Economic Empowerment
BGCMA	Breede-Gouritz Catchment Management Agency
CBO	Community-based organisation
CEO	Chief executive officer
CFR	Cape Floristic Realm
CMA	Catchment Management Agency
CoGo	Collaborative Governance Network for Water Security Co-operative
CoP	Community of Practice
COP	Conference of the Parties
Covid-19	Coronavirus 2019
CRCWSC	Cooperative Research Centre for Water Sensitive Cities
CRIDA	Climate Risk Informed Decision Analysis
DSM	Demand-side-management
DWA	Department of Water Affairs (South Africa)
DWAF	Department of Water Affairs and Forestry (South Africa)
DWS	Department of Water and Sanitation (South Africa)
FBO	Faith-based organisation
GDP	Gross Domestic Product
GIZ	Gesellschaft für Internationale Zusammenarbeit (German Society for International Cooperation)
GWP	Global Water Partnership
ICLEI	International Council for Local Environmental Initiatives
ICWE	International Conference on Water and the Environment
IIRC	International Integrated Reporting Council
IMF	International Monetary Fund
IoDSA	Institute of Directors of South Africa
IUCMA	Inkomati-Usuthu Catchment Management Agency
IWRM	Integrated Water Resources Management
Kl	Kilolitre
MAR	Managed Aquifer Recharge
MDGs	Millennium Development Goals
NatuReS	Natural Resources Stewardship Programme
NBI	National Business Initiative
NBS	Nature-based solutions
NCPD	National Council for Population and Development, Kenya
NGO	Non-Governmental Organisation

NPO	Non-Profit Organisation
NWRS	National Water Resource Strategy (South Africa)
OECD	The Organization for Economic Co-operation and Development
OSU	Ohio State University
PPP	Private-Public Partnerships
PUAs	Peri-Urban Areas
RSA	Republic of South Africa
RWH	Rainwater harvesting
SADC	Southern African Development Community
SAIRR	South African Institute for Race Relations
SALGA	South African Local Government Association
SANGOCO	South Africa Non-Governmental Organisations Coalition
SAW	as in “SAW Prophet Muhammad”: may the blessings and peace of Allah be upon [him]
SDGs	Sustainable Development Goals
SEBEI	Socio-Economic Benefits of Ecological Infrastructure
SES	Socio-ecological system
SISAR	Sistema Integrado de Saneamento Rural, Brazil
SRC	Stellenbosch River Collaborative
SSA	Sub-Saharan Africa
SuDS	Sustainable Drainage Systems
SUWI	Stellenbosch University Water Institute
SWPN	Strategic Water Partners Network
TCG	Transformative Collaborative Governance
TNC	The Nature Conservancy
UCT	University of Cape Town
UN	United Nations
UN habitat	United Nations Human Settlement Programme
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCC	United Nations Framework Convention on Climate Change
UNGC	United Nations Global Compact
USD	United States Dollar
UWC	University of the Western Cape
UWMTF	Urban Water Management Transitions Framework
VFT	Value-focused Thinking
VU	Vrije Universiteit
WBCSD	World Business Council for Sustainable Development
WBG	World Bank Group
WCC	World Council of Churches
WCWSS	Western Cape Water Supply System

WDM	Water-demand management
WEF	World Economic Forum
WINGOC	Windhoek Goreangab Operating Company
WRC	Water Research Commission, South Africa
WRG	Water Resource Group
WRI	World Resources Institute
WSC	Water Sensitive City
WSUD	Water Sensitive Urban Design
WUA	Water Users Association
WWC	World Water Council
WWTP	Wastewater treatment plant
WWTW	Wastewater treatment work
4IR	Fourth Industrial Revolution

CHAPTER 1

BUILDING URBAN WATER RESILIENCE

Larry A. Swatuk, Gregg Brill, Charon Büchner-Marais, Kirsty Carden, Ernst Conradie, Jenny Day, Joanna Fatch, Jessica Fell, Mafaniso Hara, Bongani Ncube

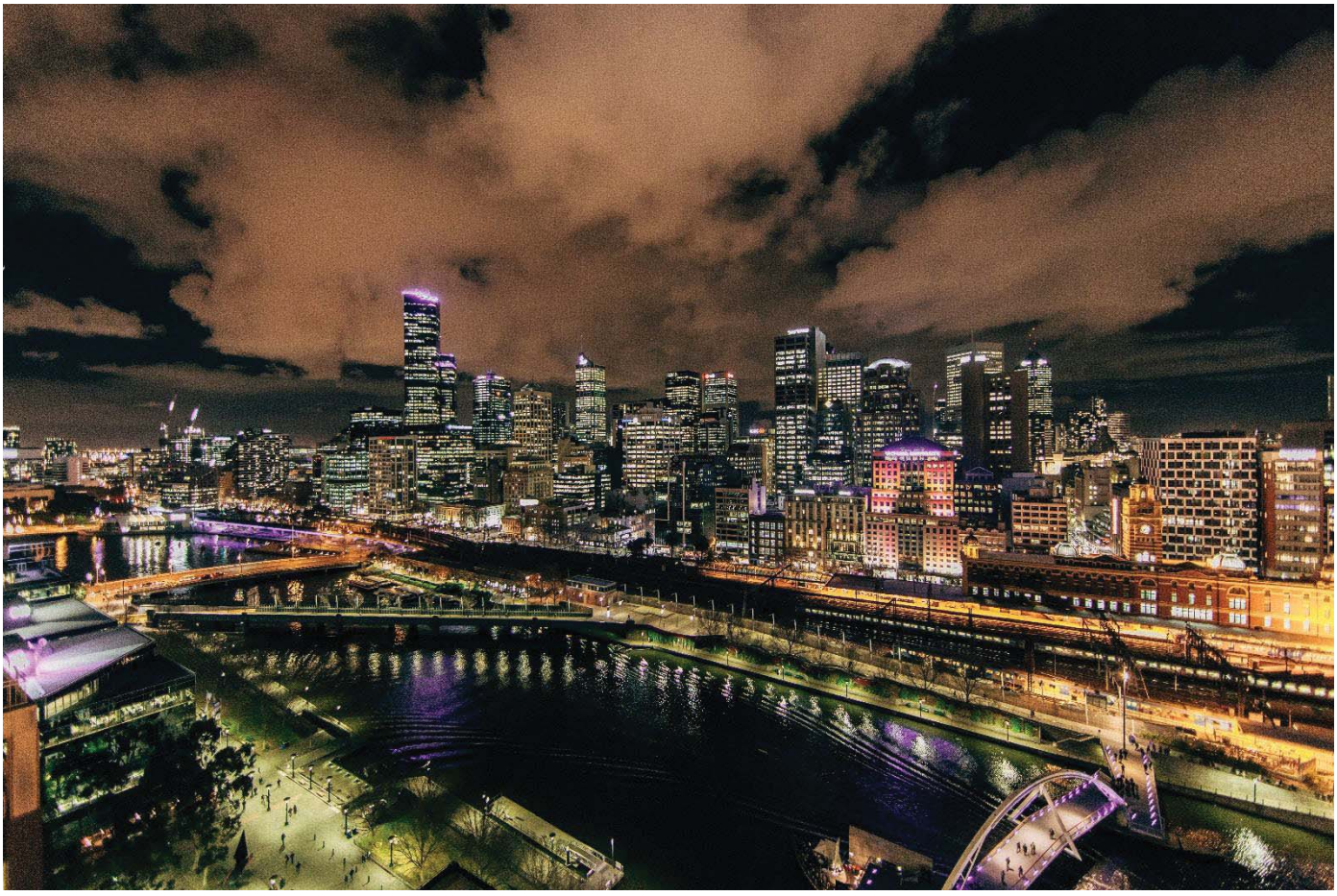

Figure 1.0 Melbourne has also been identified as one of eleven cities globally that are most likely to face 'Day Zero' and run out of water (photo: T McCartney timmccartney CC0 via Wikimedia Commons https://upload.wikimedia.org/wikipedia/commons/2/27/Urban_river_banks_%28Unsplash%29.jpg)

1.1 INTRODUCTION

'The world water crisis', said the Dutch King more than twenty years ago, 'is a crisis of governance'. This observation applies centrally to cities. Over the last several years, major cities such as Cape Town, São Paulo and Barcelona have faced 'Day Zero' scenarios, characterised by the very real possibility of running out of water. As the world continues its urbanising trend, there are important lessons to be learned from these water crises: why did they happen, what was the impact, and what was the response? These lessons will be central to tackling future urban-water-related risks and vulnerabilities especially given the uncertainties created by increased climate change and variability.

At the same time, Covid-19 has exacerbated many water-related impacts brought on by a changing climate and increasing urbanisation: water-related risks and vulnerabilities vary in relation to demographic factors such as race, class, age and gender. Similarly, densification in the face of inadequate service provision, including access to water and sanitation, results in inefficient responses. The coronavirus pandemic reveals how existing systems of service delivery reduce the risk of water insecurity for some but heighten it for others. However, this pandemic provides the opportunity and the incentive to build back better, ensuring a form of urban water resilience for the benefit of all.

According to Hoekstra et al. (2017: 7), 'For an understanding of the complexity and time dimension of urban water security, it can be helpful to adopt a system-dynamic perspective, acknowledging that many variables, causal mechanisms and feedback processes play a role.' They articulate a pressure-state-impact-response schematisation of 'social-environmental systems facing change'. Pressure involves the environmental and socio-economic drivers of change that stress existing systems. State of the water system refers to the natural (e.g. stocks, flows, and extreme events) and human-made factors that combine to determine the water balance in time and space. Impacts on water functions (the natural environment) and services (the built environment) result from pressure placed on the system. Responses include a wide variety of institutional and organisational actions taken to mitigate negative effects. These responses will either be effective (e.g. reducing pressures and negative impacts, increasing resilience and sustainability) or ineffective (e.g. exacerbating negative trends, decreasing resilience and sustainability), depending on a wide variety of social, political, economic, technological, and environmental variables. In this introductory chapter we adopt this schematic to illustrate the water security situation facing select cities from around the world.

In the same review article, Hoekstra et al. (2017) also delineate five different perspectives on urban water security: disciplinary perspectives; problem-oriented perspectives (i.e. quantity- and quality-related problems); goal-oriented perspectives (supply, sewerage, drainage, flood risk protection, recreation, navigation, aesthetics, and environmental integrity); perspectives on the type of integration, e.g. IWRM-oriented versus water-in-development or water-, energy-food (WEF) nexus types of perspectives; and perspectives on substance or process (i.e.

policy-analytical perspectives focused on the best instruments and solutions versus governance perspectives focused on the best processes and institutions). In this collection, whilst we organise ourselves across six key areas that more-or-less align with particular disciplinary approaches – politics and governance; social science; civil society; economics; technical sciences; and natural sciences – the argument that we favour is not disciplinary separation but rather integration.

Similarly, we argue that whilst it is both useful and insightful to focus tightly on urban water challenges through a particular disciplinary lens, analytical approach or focus area in order to ensure long-term urban water security – what we have termed 'urban water resilience'[2] – it is equally important to zoom out and take a holistic approach that integrates all of the different perspectives. What you will see here is a set of papers that share a common vision: to achieve a form of urban water resilience that is environmentally sustainable, socially equitable and economically affordable/efficient. We argue that it is necessary to move beyond the existing practices of urban water management toward fresh perspectives that begin with an understanding that many of the most pressing water-related challenges facing cities today emerge from a path-dependent resistance to change. Yet how do we move beyond these perspectives and practices? As we will illustrate in some detail below, amongst other things, we require:

- Forms of governance that acknowledge the deeply political nature of water access, allocation and management, and work to establish the processes and institutions that channel conflict and tension into progressive arenas and pathways for progress;
- Economic systems which incorporate the multiple values of water, and in which water is not treated as an ordinary economic good, subject simply to supply and demand;
- Revisiting and reflecting critically on our tendencies to rush toward technical solutions that are often too expensive and ill-suited to the specific socio-economic and socio-cultural context into which they are being introduced;
- A socio-ecological systems perspective that fosters green economies;
- The inclusion of all relevant forms of knowledge and the creation of appropriate platforms for effective citizen and stakeholder participation across the watersheds upon which these sprawling megalopolises depend;

[2] 'According to the working definition adopted by the CWRF, urban water resilience is "the capacity of the urban water system, including the human, social, political, economic, physical and natural assets, to anticipate and absorb, adapt and respond to, and learn from shocks and stresses, in order to protect public health & wellbeing and the natural environment and minimize economic disruption".' See https://www.siwi.org/what-we-do/city-water-resilience-pproach/#:~:text=According%20to%20the%20working%20definition,order%20to%20protect%20public%20health [Accessed on 19 February 2021].

- Meaningful narratives that capture the shared nature of a resource that too often divides us along so many lines: from consumers, producers and polluters, to farmers, industries, and squatters.

In summary, what we present here is a set of insights into the existing challenges facing cities, how these challenges are directly related to water resources, and how people have reacted (more or less successfully) to these challenges in time and space. Following the substantive chapters, we return, in the conclusion, to a set of principles and recommendations for practice that will help move the 21st Century urban space toward what Brown et al. (2009) have labelled the 'water sensitive city'.

We now turn to a brief overview of the state of the urban water crisis from a systems perspective.

1.2 PRESSURES (drivers of change)

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, São Paulo and Tokyo (https://www.bbc.com/news/world-42982959). A year later, an article in the U.S. News and World Report provided a slightly different list: Bangalore, Beijing, Cairo, Cape Town, Chennai, Jakarta, London, Melbourne, Mexico City, São 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. No city is wholly prepared to meet the interrelated challenges posed by environmental and socio-economic pressures such as climate change and rapid urbanisation.

In terms of socio-economic pressures, according to the United Nations Department of Economic and Social Affairs, Population Division (UNDESA/PD, 2019) '55% of the world's population lives in urban areas, a proportion that is expected to increase to 68% by 2050' (available at: https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html). As shown in Table 1.1 below, the world's largest cities are concentrated in Asia. Megacities are defined as those with populations greater than 10 million. In 2018, there were 33 megacities. The number of megacities is expected to rise to 43 by 2030 (UNDESA/PD, 2019). Notable in the table below is that Delhi will overtake Tokyo as the world's largest city, with Tokyo's population being predicted to decline by more than 1 million over the next decade. Several of these megacities are already facing similar 'Day Zero' scenarios and future megacities may not be spared the same fate.

Megacities are only one small part of the urbanisation phenomenon. It is estimated that, in 2018, 'there were 467 cities with between 1 and 5 million inhabitants and an additional 598 cities with between 500 000 and 1 million inhabitants' (UNDESA/PD, 2019). Without doubt,

providing adequate water and sanitation for the world's urban masses is perhaps the greatest challenge of the 21st century.

According to ICLEI, 'although only occupying 2 percent of the land, cities are responsible for 70 percent of global gross domestic product (GDP), greenhouse gas emissions (GHG), and global waste and over 60 percent of global energy consumption' (ICLEI, 2019 quoting UN-Habitat, 2016). Given our propensity to settle along water sources, climate change poses particular pressures on the urban environment. 'Of the 1146 cities with at least 500 000 inhabitants in 2018 … 59 per cent were at high risk of exposure to at least one of six types of natural disaster, namely cyclones, floods, droughts, earthquakes, landslides and volcanic eruptions' (ICLEI, 2019). These cities accounted for roughly 1.4 billion people in 2018. 'One hundred and eighty-nine cities – mostly located along coastlines – were at high risk of exposure to two or more types of natural disaster; 26 cities – including megacities Manila, Osaka and Tokyo – faced high risk of exposure to three or more types of disaster' (UNDESA/DP, 2019: 9). These cities accounted for roughly 1.4 billion people in 2018.

Table 1.1 The World's 10 Largest Cities (from UNDESA/PD, 2019)

The World's 10 Largest Cities in 2018 and 2030				
Rank	City	2018 Population (millions)	City	2030 Population (millions)
1	Tokyo, Japan	37.5	Delhi, India	39.0
2	Delhi, India	28.5	Tokyo, Japan	36.6
3	Shanghai, China	25.6	Shanghai, China	32.9
4	São Paulo, Brazil	21.7	Dhaka, Bangladesh	28.1
5	Mexico City, Mexico	21.6	Cairo, Egypt	25.5
6	Cairo, Egypt	20.1	Mumbai, India	24.6
7	Mumbai, India	20.0	Beijing, China	24.3
8	Beijing, China	19.6	Mexico City, Mexico	24.1
9	Dhaka, Bangladesh	19.6	São Paulo, Brazil	23.8
10	Osaka, Japan	19.3	Kinshasa, DRC	21.9

Socio-economic and environmental pressures compound each other. As cities grow, their ecological footprints grow, often far outstripping the biophysical carrying capacity not only of

the metropolitan area but of the entire country of which they are a part. For example, according to the Global Footprint Network, whereas Egypt has a natural biocapacity of 0.5 global hectares per capita (gha/cap), the country has an ecological footprint of 1.79 gha/cap, with the city of Cairo at 2.85 gha/cap – an astonishing 5.5 times Egypt's natural biocapacity.[3] Without doubt, a great deal of per capita consumption derives from imports. The impacts of the solid waste that result from such a consumption pattern are, however, entirely localised (see https://www.footprintnetwork.org/our-work/cities/). Angel et al. (2011), showed that the overall rate of geographical expansion of cities is double that of their population growth. Moreover, a great deal of urbanisation is unplanned, thus exacerbating environmental impacts such as water pollution, deforestation and related forms of resource degradation. Between 2000 and 2014, while the percentage of the world's population living in slums decreased by roughly six percent (28.4% to 22.8%), the absolute number of people living in slums increased from 807 million to an estimated 883 million (UNDESA/PD, 2019). According to Pandey et al. (2018: 379) 'slum dwellers typically lack durable housing, access to safe water, access to sanitation, sufficient living area and secure tenure. They are the most deprived of the urban poor and the most likely to suffer from disasters'. Without doubt, slum dwellers are highly vulnerable to the negative impacts of climate change and variability.

1.3 STATE OF THE WATER SYSTEM

While urbanisation and climate change are global phenomena, their impacts on cities and urban water resilience vary depending on the state of the natural and human-built water systems that are in place. If we take the cities listed in Table 1.2 for example, we see that there are similarities (5 coastal; 2 inland) and differences (average annual precipitation; built infrastructure systems) that result in different impacts on the city's capacity to deliver water security to all. For example, Cape Town has a winter rainfall regime delivering a limited amount of precipitation over the course of a year (roughly 515 mm/annum). This stands in sharp contrast to other coastal cities such as Chennai (Figure 1.1) and Jakarta, where the annual precipitation is approximately three times that of Cape Town but falls very intensively during

[3] The Global Footprint Network (GFN) measures Earth's biological capacity available per person. According to data for 2019, there were 12.2 billion hectares of biologically productive land and water on Earth which divided by 7.7 billion people equals 1.6 global hectares per capita. According to the GFN, 'this area also needs to accommodate the wild species that compete for the same biological material and space as humans.' See: www.footprintnetwork.or/resources/glossary/ (accessed 19 October 2020). According to the GFN, 'Global hectares are the accounting unit for the ecological footprint and biocapacity accounts. These productivity-weighted, biologically-productive hectares allow researchers to report both the biocapacity of the earth, or a region, and the demand on biocapacity (the ecological footprint). A global hectare is a biologically-productive hectare with world average biological productivity for a given year. Global hectares are needed because different land types have different productivities. A global hectare of, for example, cropland, would occupy a smaller physical area than the much less biologically productive pasture land, as more pasture would be needed to provide the same biocapacity as one hectare of cropland. Because world productivity varies slightly from year to year, the value of a global hectare may change slightly from year to year'. See: www.populationmatters.or/sites/default/files/SI_21_biocapacity_ecofootprint.pdf [Accessed on 19 October 2020].

the monsoon season. Melbourne is not much wetter than Cape Town overall, but has a much flatter hydrograph, with precipitation falling almost year round.

In contrast to the coastal cities, which are at the foot of watersheds, São Paulo lies at the top of its watershed, yet still faces challenges of supply despite the significant volume of precipitation that it receives on average every year.

All of the cities shown in Table 1.2 depend on significant, extensive systems of built infrastructure to ensure their supply.

1.4 IMPACTS ON WATER FUNCTIONS AND SERVICES

The nature, scale, intensity and frequency of the impacts of urbanisation and environmental change on cities' water resilience depends on numerous factors. Impacts take two forms, natural and human-made. Each reinforces the impact of the other. Natural biophysical impacts such as drought, flood, earthquakes, tropical storms and so on challenge even the best-run city. Droughts and floods are generally regular occurrences, so should be manageable. But as the recent droughts in São Paulo, Cape Town and throughout California showed, climate change-induced variability is making the prediction of precipitation, and hence our ability to determine the reliability of water supply more difficult. It is also calling into question orthodox, supply-side adaptation interventions, such as dam building and inter-basin transfer schemes. If no rain falls, the height of the dam wall matters not at all.

Figure 1.1 Floods in Chennai, India during the annual monsoons
(photo: Veethika CC BY-SA 4.0 via Wikimedia Commons
https://upload.wikimedia.org/wikipedia/commons/e/e1/Aerial_view_of_Chennai_during_floods.jpg)

As indicated in Table 1.1 above, vast numbers of people crammed into a geographically limited, albeit quickly expanding space almost guarantees problems with sanitation, disease, and pollution. As evidenced in top-of-watershed cities such as Mexico City, São Paulo, Johannesburg and Addis Ababa, seasonally dry river beds become *de facto* solid waste 'management' systems that flush clean during the rainy season(s), creating problems for the cities, farms and rural settlements further downstream. Bottom-of-watershed cities such as Alexandria, Chennai and New Orleans suffer from coastal zone pollution – only partly of their own making. Run-off from upstream agricultural enterprises releases phosphates and nitrates into the middle and lower reaches of rivers and thus into the sea through river mouths, creating extensive 'dead zones' that impact local livelihoods derived from fisheries and tourism, as well as impacting ecological and social health.

Existing governance and management capacities can exacerbate or alleviate these biophysical and human-induced pressures. Tokyo, for example, has an extremely robust system of governance and management, enabling the city to provide water of appropriate quality and quantity for all residents despite its status as the world's largest metropolitan area. As a world city located in one of the world's richest countries, it has sufficient financial, technical and human resources to maintain the system. In contrast, many of the world's largest cities are poorly governed, leading both rich and poor to pursue self-help approaches to water

security: from borehole development, to ‘poaching’ from the formal supply system, to buying bottled or bagged water or water from kiosks. None of these adaptive mechanisms enhance trust between citizens and the government or amongst the citizens themselves. Cities such as Lima and Cape Town are governed by representatives of political parties, so complicating decision-making by politicising service delivery. These examples raise the question of how to ensure “some water for all forever”, to quote the Department of Water and Sanitation in South Africa.

Table 1.2 Some Comparative Data on Cities Facing Day Zero Scenarios

City	Governance	City-proper Population (Millions)	Geography	Precipitation	Water supply	Issues
Cape Town	Party political	4.52	Coastal	515 mm/a winter rainfall (April-Oct)	Complex system of mainly surface water	Drought; Slums; Inter-basin transfers
Chennai	Municipal Corporation	4.64 7.09 in Greater Metropolitan Area (GMA)	Coastal (avg. 6.7 metres above sea level (MASL)	1380 mm/a 65% in monsoon season (Oct-Nov); Feb-Apr is dry season	Surface water reservoirs; desalination plants; high groundwater table	Flood; Drought; Slums; Downstream of agriculture
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 groundwater	Subsidence; Flooding; Slums; Low % of household connectivity; 9% green space; Sewerage covers 1.9% of total population; 4% of housing covered by WWTPs
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	600 mm/a Aug-Dec. but fairly stable across whole year	Elaborate surface infrastructure; 3000 km of sewerage lines; 1300 km of delivery; AUD3.1 billion desalination plants	Drought; Low-density (sub)urbanisation

Mexico City	Federal District; 13 boroughs; 'mayor' & directly elected reps (6 yrs/no re-election); party political; CONAGUA (Federal) + National Water Commission	8.84; 21 in GMA	Inland valley (drained lake bed; Lake Texcoco); 2240 MASL	846 mm/a (May-Oct)	Surface water 2/3; groundwater 1/3; long distance Cutzamate system; 11,900 km of pipes; elaborate drainage system	Flooding (17th C canals and tunnels); over-abstraction of groundwater; low recharge rate; subsidence (impacting wastewater management and runoff); deforestation; air pollution; unaccounted for water 36%
São Paulo	State-owned, publicly-traded, water and wastewater company, Sabesp, provides water & sewerage services in the city and across the state	12.18 22 in GMA	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; droughts; floods; Slums (20% of population); USD22 million in sediment management
Tokyo	Water managed by the 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 37.5 in GMA	Coastal	1530 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

1.5 RESPONSES

City responses to the pressures of urbanisation and environmental change vary dramatically across the urban landscape. In line with Sustainable Development Goals (SDGs) 6 (water and sanitation) and 11 (sustainable cities and communities), most of the plans, projects, programmes, laws, policies and new or reformed institutions that aim to shape a holistic response in support of sustainability, equity and economic efficiency are in place. However, a country-level survey of progress towards the establishment of integrated water resource management (IWRM) institutions across all national basins, shows limited success worldwide. According to UN Water, as of 2017, only five countries ranked as having achieved a 'very high' degree of IWRM implementation. On a scale of 0-100, these five score as follows: France, 100; Japan, 94; Denmark, 93; Netherlands, 93 and Austria, 91 (see https://sdg6data.org/indicator/6.5.1). Despite the similarity of pressures and impacts on urban water resilience in cities around the world, responses are highly uneven, as are outcomes. As illustrated below, activities can be *ad hoc* and short term, emerging as direct responses to natural (e.g. drought, flood) or human-induced (e.g. social protest) pressures. Responses can also be directed towards longer-term interventions and embedded in new structures of governance and management. In so doing, they lay a firm foundation for improved state-civil society relations in support of meaningful action. Most of the formal activity is, however, focused on the medium term, and is often designed to carry political parties through to the next election. After all, water is power, and rarely is there a government that fails to promise water to the people. Medium-term efforts are overwhelmingly supply-side in orientation and are focused on traditional infrastructure developments such as dams and pipelines. At best, their time horizon extends to 20 to 30 years. We turn to several examples to illustrate the range of responses.

1.5.1 Governance, Civil Society and Collective Decision Making

There are numerous positive examples of improved urban water governance that have involved civil society as a key actor in decision making. São Paulo, for example, has engaged in slum upgrading as a means of improving water quality through solid waste management. In Colombia, Medellín's "Mínimo Vital de Agua Potable" provides free basic water to its citizens, mirroring South Africa's national approach. Like São Paulo's slum upgrading scheme, the Colombian policy and resulting programmes help to build trust among state and civil society, a necessary bridge if long-term approaches to sustainability are to be devised and realised. Similarly, Los Angeles established the 'Save the drop' campaign in support of the policies that had been enacted to control demand during the prolonged drought of 2014-15, and these water demand management initiatives have continued as drought conditions persevered (Figure 1.2). By shaping the narrative in terms of a collective endeavour, the city aimed to build longer-term trust in government water management. Many of the positive short- and medium-term responses to urban water insecurity have resulted from pressure applied by civil society groups in support of their interests. Global governance frameworks such as the Sustainable Development Goals (SDGs), to which national governments have committed, provide the private sector and civil society with entry points for improving governance that

were previously closed off to them, suggesting that there are meaningful spaces and avenues for moving away from the *status quo*.

Figure 1.2 Water-saving kits were given away by Sonoma Water, California, at the Drought Drop By event in June 2021 in order to increase public participation and decrease water demand
(photo: Missvain CC BY 4.0 via Wikimedia Commons
https://commons.wikimedia.org/wiki/File:Drought_Drop_By_-_June_12_2021_-_Sarah_Stierch_01.jpg)

1.5.2 Technological Innovation

Many cities, especially coastal cities, have raced to adopt desalination technology as the 'permanent solution' to urban water shortages. This, of course, is a slightly misguided notion, as evidence from Melbourne shows that water savings realised from reclaiming sea water have been turned to supporting increased suburban sprawl, rather than contributing to environmental integrity. Many new technologies are affordable and can contribute significantly to reducing urban water footprints: from smart showers, to GIS-based remote borehole monitoring, low flow shower heads and low flush toilets. Implementing the use of such items is, of course, dependent on the financial resources of citizens, companies and cities.

1.5.3 Natural Systems and Bio-Mimicry

Source-water protection in cities as diverse as New York, Halifax, São Paulo and Tokyo aims to protect forests at the tops of watersheds. As water flows through urban settings, many city managers and urban planners have endeavoured to soften the soils to encourage infiltration. Miami's "million trees" initiative and the "sponge city" idea widespread across China also seek to turn nature to the advantage of cities, and to reconcile the built environment with the natural one. The construction of artificial wetlands to control flooding and purify wastewater is becoming common in many cities. As shown in several chapters below, nature-based solutions are increasingly central to urban water resilience planning.

1.5.4 Economic Innovation

Providing services in urban settings requires access to sufficient financial resources. A city such as Tokyo is able to provide services through an enormous tax base. In addition, this tax base serves as collateral should the city seek to borrow in support of proposed infrastructure developments. Few cities across the Global South have access to such resources through either taxation or borrowing.

Throughout the 1990s and the first decade of the 21st Century, in line with neoliberal thinking, many cities chose to privatise their water utilities and offload the responsibility of service provision to private companies (Furlong, 2010). The problems this approach created are well-known and well chronicled in the literature (Bakker, 2013). Throughout the second decade of the 21st Century, there has been a deliberate march back toward state-owned enterprises, and/or partnerships between private and public sectors, sometimes including community and civil society-based organisations. The lessons of the 'water war' in Cochabamba, Bolivia were hard won (McDonald, Spronk and Chavez, 2021). Recently, Quang Tri, a city in Vietnam, successfully pursued a form of blended financing for urban infrastructure involving both private sector and international financial institutional support. This is an increasingly common way of raising the capital necessary for the expansion of infrastructure, extension of services, and maintenance of operational systems. The City of Johannesburg established a private utility to deliver water services but with the City as the sole shareholder. In this way, the entity can operate with a blend of commercial (profit seeking) and social (equity seeking) goals. In Cuba, the city of Havana partnered with several universities to undertake the *Más Agua Para Todos* program. This project was funded by the Dutch and the European Union and sought to reduce the demand for fresh water by building new wastewater treatment and water reuse systems for households and industry. Evidence suggests that the program saves nearly 30 000 m^3 per day (UN-IHE, 2013). For more innovative ideas around funding and financing water, see Chapter 4.

1.6 OVERVIEW OF THE CHAPTERS

In Chapter 2 (Natural Sciences), Jenny Day, Gail Cleaver-Christie, Liz Day, Louise Stafford and Julia Wood examine the ways in which cities usually affect the natural environments in which they occur, the ways in which water stress, including drought and poor water quality,

affects cities and their non-human inhabitants, and the ways in which city managers respond to water stress. The chapter starts by describing the “services” provided by aquatic ecosystems (rivers, wetlands and aquifers). For example, they provide water, usually of suitable quality, in relatively predictable places and quantities. Wetlands tend to store water, dampening the effects of floods and droughts. By the nature of the microbiomes in their sediments they decompose organic waste and cycle nutrients, thereby cleaning the water passing into and through them. Rivers and wetlands support biodiversity and produce biomass in the form of building materials and food for humans, and grazing for cattle and other animals. Less obviously they are involved in the regulation of climate, both by contributing to the moisture in the atmosphere and by producing or absorbing climate-modulating gases. They also engage us with their spiritual, recreational, scientific and intellectual qualities.

The chapter focuses on Cape Town as a case study, illustrating the tensions between managing for biodiversity and conservation, and for the provision of water for a city’s human population. The severe drought of 2016-2017 reduced runoff into rivers and wetlands, thus lowering the water table and causing a die-off of water-sensitive species. This resulted in the pollution of watercourses due to an increase in sewage overflows and a decrease in dilution effects as watercourses dried out. Most significantly, the available water was diverted exclusively for human needs, at the expense of other users, including the environment. Water development schemes were fast-tracked, and went ahead without the regulations that normally protect the environment from damage during and after development. Similarly, detailed strategic investigations into their possible ecological impacts were short-circuited. In short, environmental considerations were virtually ignored at the very time when they should have been of greatest concern.

The lessons that were learnt from the Cape Town case study and other experiences are discussed, and include the importance of developing detailed, long-term (>50 years) strategic plans that include disaster management, the collection of long-term data, and the likely effects of changes in climate and demographics. Trust needs to be built between all groups of players, including citizens, water managers and politicians, by means of transparent decision-making and adequate communication.

The chapter emphasises that investing in the protection of naturally functioning ecosystems is the most cost-effective long-term solution for securing water. Some nature-based solutions require a fraction of the cost of engineered solutions such as desalination, groundwater exploration and water-reuse. Well conserved catchments provide both replenishment of groundwater and improved yield of surface water reservoirs, while increasing ecosystem resilience against climate change.

In Chapter 3 (Technical Sciences), Kirsty Carden and Jessica Fell provide a technical perspective on the issue of urban water resilience, with a discussion on moving from the ‘inherited wisdom’ of conventional centralised engineering approaches to a renewed approach

rooted in integration, with particular consideration given to the urban developing world. The concept of Water Sensitive Urban Design (WSUD) and the vision of a Water Sensitive City (WSC) form the framework for this renewed technical approach, offering a set of principles that underpin resilient, adaptive and sustainable urban water systems. The technical perspective provides a resounding call for the complete integration of sustainability elements – i.e. technical, social, economic and political – towards the design and delivery of integrated solutions.

Water scarcity is framed in terms of its availability or applicability (i.e. quality that is fit for purpose), thereby expanding the notion beyond that of a quantity issue to one that considers quality, productivity, attitudes and behaviours, as well as governance in a town or city. The challenge of the urban developing world is highlighted as the arena in which the battle for resilient and water sensitive systems will be won or lost. These areas present an opportunity for an approach that is centred on equity, sustainability and a strong commitment to context, where the developed world's conventional centralised model is not simply exported or duplicated.

A selection of principles and practices for Water Sensitive Cities, based on a renewed technical agenda, are presented: the urban water cycle as one integrated system; the urban water cycle is intrinsically connected to the catchment and its users; water supply diversification with fit-for-purpose water; monitoring and measurement for technical planning and communication; enhanced ecosystems and multi-functional green infrastructure; enabling governance, political and legislative elements necessary for technical interventions; and sufficiently capacitated multidisciplinary teams.

Chapter 4 (Economics) highlights the need for a new economic system in support of urban water resilience. Charon Büchner-Marais, Gregg Brill, Cathie Lewis and Martine Visser present a strong argument for alternative economic approaches and methods that support solutions to regenerate, restore and maintain water resilience as part of the commons. In an increasingly uncertain climate and in times of extreme events that can disrupt water services, with a specific case study focus on Cape Town, the authors present a long-term, holistically informed perspective arguing that:

- Water holds multiple values assigned to it, not just economic values;
- There is a need for a far more robust, equitable and inclusive water governance system in which all stakeholders and beneficiaries contribute towards decision making;
- Businesses are willing to play their part in approaches where they can address key priorities in order to support urban water resilience, collaboratively invest their resources and support relevant projects and programmes;

In their chapter, the Stellenbosch River Collaborative case is used to show how private companies (e.g. Distell) can commit to a collaborative investment to improve water quality in

local rivers. This investment informed Distell's behaviour and mindset, which allowed them to respond effectively to escalating water shortages and to build long-term economic water resilience.

In Chapter 5 (Politics and Governance), Larry Swatuk and Joanna Fatch focus on the politics and governance of urban water resilience. While politics involves contestation over a scarce resource, governance arrangements are key in ensuring equity, economic efficiency and environmental sustainability. Evidence from around the world shows, quite clearly, that existing governance arrangements lead to inequality, unsustainability, and wasteful economic practices. Since 2000, there has been an increasing global focus on policy, law and institutional reform. Different global governance settings have been created for collective learning among cities and other forces for positive change. Yet urban water crises and vulnerabilities continue to escalate. The social challenges are many and include unaccounted for water/piracy; unserved populations; non-payment/protests; corruption and many false promises. Orthodox approaches to service delivery have tended to ignore the deeply political nature of water provision. Because of this, approaches such as privatisation and other governance arrangements have resulted in popular push-back. Around the world, pressure from civil society and social movements have resulted in a trend toward remunicipalisation (McDonald, 2018).

Clearly, 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 learn from each other through global processes such as Agenda 2030 and forums such as ICLEI (Local Governments for Sustainability), Stockholm's World Water Week, and Amsterdam's and Singapore's International Water Week. These are collective social spaces occupied by national and local governments that are legislatively mandated to meet water and sanitation commitments; civil society organisations who share strategies and tactics on holding governments to account or taking the lead; and a private sector that competes for markets and contracts, promoting patent-protected technologies. It is these groups coming together who determine who gets what water, when, where and how. 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 towards money and power. Water provision and management decisions and outcomes are thus generally socially inequitable, environmentally unsustainable and economically inefficient. How to shift existing processes toward improved practices is not clear, but positive outcomes do exist. Swatuk and Fatch present evidence from a series of case studies showing that positive outcomes are possible when a series of key factors are in place.

In Chapter 6 (Social Sciences), Mafaniso Hara, Bongani Ncube and Darlington Sibanda build on chapters 5 and 7, adding both a theoretical and historical focus to urban water (in)security,

with a particular focus on African cities. The authors adopt the 'Hydro-social Contract' as their key conceptual framework for analysing and understanding the social issues around the provision of water and sanitation in cities. They use the City of Cape Town as a case study to demonstrate that 'scarcity' of water for the poor in cities is largely a social construct rather than a technical issue. The problem is therefore not only prevalent during times of acute water shortage – as was the case during the 2015-2018 extended drought – but rather an ever-present phenomenon. The key causes of the "social scarcity" of water are historic and economic dispossession, flawed governance of water provision, lack of recognition of the right to the city for the poor, and the politicisation of the hydro-social contract. The authors argue for an inclusive spatial planning approach by cities that takes cognisance of the importance of the Constitutional and human rights of the marginalised and vulnerable urban poor regarding access to the basic minimum required water and sanitation. As the saying goes: a chain is only as strong as its weakest link.

Among numerous global conventions, the SDGs require countries to address inequities and social exclusion from water and sanitation provision (SDG 6) which, if countries operationalised and achieved, could go a long way toward reducing the burden of water scarcity for the urban poor. The authors of this chapter propose a "water vision for cities": *Well-governed inclusive cities whose planning is human-centred with an ability to provide adequate water quantity and quality, and sanitation for the poor and marginalised*.

Chapter 7 (Civil Society), reflects on the critical role played by civil society in ensuring urban water resilience. Ernst Conradie and colleagues show that, throughout history, civil society has played a vital role in ensuring access to, if not equity in, urban services. After 1994, organised social protest helped pressure the newly-elected ANC government to provide free basic water – 25 litres per person per day – for all South Africans. Although the "right to water" is enshrined in the Constitution of South Africa, it was originally anticipated that citizens would pay according to their financial ability to do so. However, ahead of local government elections, in September 2000, "free basic water" was officially included as part of the African National Congress's (ANC's) elections programme. The policy followed shortly thereafter, in 2001. Thus, the main drivers in support of free basic water 'were political rather than technical; it was the product of political forces mobilised by the advent and evolution of a democratic government in 1994 rather than a technical response to the introduction of a Constitutional "right to water" in 1996' (Muller, 2008: 86). The city of Medellín, Colombia, has copied this approach, ensuring 2.5 m^3 of free water per household per month. More recently, social protest in Mombasa, Kenya, has resulted in improved access to water and sanitation for slum dwellers. Given global inequalities, it is clear that attending to the needs of the less-well-off will be a consequence of bottom-up civil action, not top-down government management. In Chapter 7, the authors map out the terrain for civil society engagement in ensuring urban water security for all. In particular they address several central questions, asking:

- What contributions from organisations in civil society are necessary for other sectors (especially politics, finance, business and industry) to be able to address escalating water shortages?
- What should organisations in civil society do if and when politics and economics fail to address escalating water shortages, which is likely to happen at least in some contexts in decades to come?
- What does civil society require from the other sectors in order to continue to operate at a minimal level, at least?
- What are the underlying weaknesses of civil society that may cause a failure to respond to escalating water shortages?

Chapter 8 reflects on the conclusions reached in the previous chapters and articulates a way forward for ensuring environmentally sustainable, socially equitable and economically affordable urban water resilience.

1.7 A SYSTEMS APPROACH

As stated, achieving urban water resilience requires a systems approach to water management. This means taking deliberate steps away from siloed approaches to resource access, allocation, use and management toward an integrated understanding of the many water-related challenges and opportunities that present themselves over the short, medium and long terms. While different lenses provide different insights and reveal challenges and opportunities particular to one perspective, sustainable, equitable and efficient resource use requires that these be brought together.

There are numerous, often unnecessarily complicated models attached to resource management (e.g. Geels and Schot, 2007). The literature is vast and replete with (sometimes useful) metaphors, but much of it is non-complementary, presenting highly contrary worldviews (Newell and Cousins, 2015). It is not our intention to add another model or metaphor here. Rather, it is our intention to highlight the possible benefits to be derived from a relatively straightforward, systematic process that is easily digestible for all relevant stakeholders, while recognising that the primary difficulty with achieving success lies in the political realm (see Figure 1.3).

The chapters are organised to illustrate this process, beginning with the natural environment and moving on to the technical, economic, political and social environments.

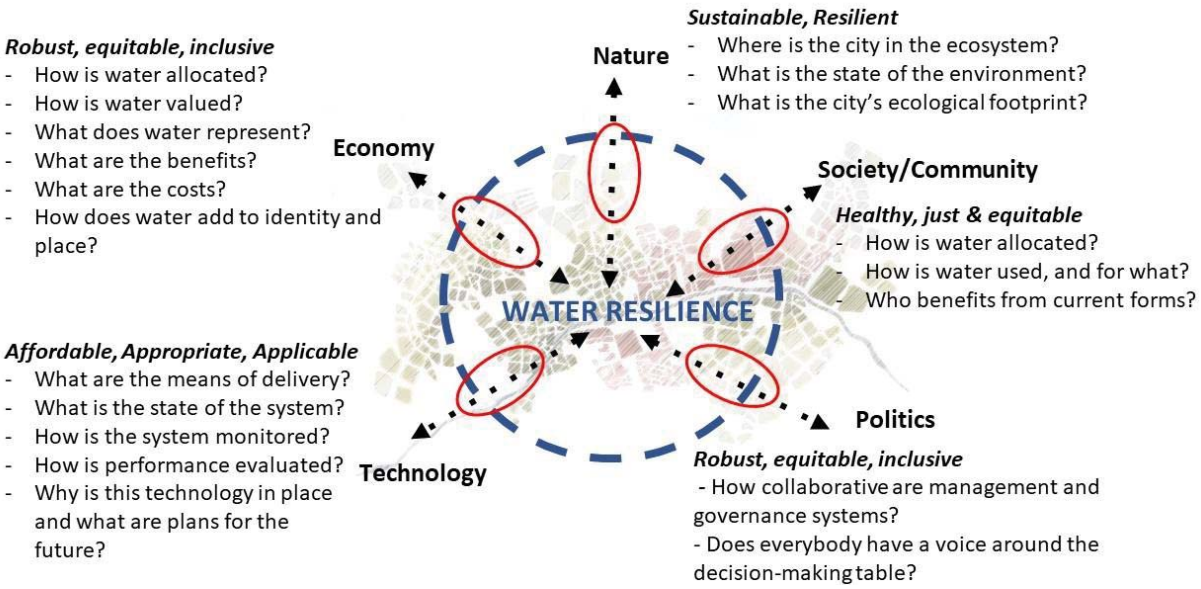

Figure 1.3 Water resilience for Blue Green cities

Building from Hoekstra et al. (2018), we argue that both the impacts of and responses to pressures on the water system are a function of the state of the broader social system. How the city is organised physically, including the character of the water system, reflects social relations within and beyond the metropolitan boundary. The character of the built environment gives rise to a set of interrelated questions: who has access to the resource and for what; how do use and management create economic winners and losers; how does the system of delivery exacerbate existing inequalities, or heighten or lessen the resilience of the natural environment; what are the benefits and costs of both the built environment and the decisions taken to sustain and expand it? The ability to answer these questions honestly, marks an important step toward achieving urban water security for all.

As illustrated in Figure 1.3, and as demonstrated throughout this collection, ensuring urban water resilience is a function of achieving four interrelated goals: (i) a sustainable and resilient natural environment; (ii) a healthy, just and equitable society; (iii) affordable, appropriate and applicable technology; and (iv) a robust, equitable and sustainable economy. Not one of these goals can be achieved in isolation. As the climate crisis illustrates, centering economic growth as the primary goal for society has resulted in numerous pathological outcomes across the other three issue areas. What, then, is to be done? Remember, the emphasis here is to support decision-making at the city level. In contrast to the current trends toward big infrastructure (e.g. pipelines; desalination plants), we argue that city planners must ask themselves a series of questions across five broad issues in order to determine the best path forward. These include:

In support of a sustainable and resilient natural environment

- Where is the city in the ecosystem?
- What is the state of the natural environment?
- What is the city's impact upon the environment (i.e. its ecological and/or water footprint)?

In support of a healthy, just and equitable society

- How is water allocated?
- How is water used and for what?
- Who benefits from current forms of water allocation and use?

In support of affordable, appropriate and applicable technology

- What are the means of delivery?
- What is the state of the delivery system?
- How is the system monitored?
- How is performance evaluated?
- Why is this technology in place and what are the plans for the future?

In support of a robust, equitable and sustainable economy

- How is water allocated?
- On what basis is allocation determined (e.g. economic cost, social need)?
- What are the benefits to the city's economy of these forms of allocation and use?
- What are the costs?

In support of a robust, equitable and sustainable process of decision-making

- How collaborative are management and governance systems?
- Does everybody have a voice around the decision-making table?

As illustrated in Figure 1.3 these questions are by no means complete; rather, they are indicative of the type of thinking required. Answers to these questions and others are provided throughout the ensuing chapters. Putting them all together into a coherent plan of action, however, is a process question. Given that water is in everything, is used differently across a highly varied range of stakeholders, is required in different amounts and to varying levels of potability by humans and nature, even broad agreement on the goals will not necessarily yield a set of priorities that is generally agreed upon. As access to sufficient amounts of water lies at the heart of social reproduction and wealth creation, who gets the resource, why and how is invariably a political question.

This brings us back to King Willem-Alexander's observation about the nature of the world water crisis being a crisis of governance. The chapters thus reflect upon appropriate decision platforms, arguing collectively that facilitating equality for all voices is fundamentally important to urban water resilience. As shown in Figure 1.3, urban water resilience is a function of an

integrated approach where nature, economics, technology, society/community and politics must be treated as equal partners in the decision-making process. Too often, politics or economics dominate the decision space at the expense of nature and (less powerful groups in) society. Granted, the nature of the urban political economy generates important questions: How to balance the needs and interests of state, private sector and civil society actors? How to ensure that different voices, expressing often contradictory viewpoints, are heard and that different valuations of water are meaningfully considered? How to balance the uneven resource capacities of the different stakeholders at the table? To arrive at suitable answers and mutually agreed upon ways forward is as much an art as it is science. At the same time, science, modelling and integrative analysis can only take us part of the way toward developing sustainable cities. Together they comprise the analytical 'tool-kit' that must be brought to the decision table. The rest of the way forward is unavoidably through political deliberation, contestation, and struggle. As suggested in Figure 1.3, any point on 'the wheel' provides an appropriate entry point for action. In order for that action to be supportive of urban water resilience, all elements of the wheel must be addressed. As shown in the chapters, the authors are in agreement that effective action in support of all citizens and residents of the city requires careful construction of inclusive decision-making platforms. These must include appropriate methods for conflict resolution and entry points for dialogue and contestation. Here you will find a familiar language of collaborative governance, the co-production of knowledge, the use of citizen science, of critical reflection and reflexive knowledge.

1.8 CONCLUSION

Effective urban water governance and management must reduce pressures, alleviate negative impacts, increase resilience, and strive for sustainability across ecological, social and economic systems. As highlighted above, this requires a no-nonsense approach to planning, meaning that planning for urban water resilience recognises the class, race, caste, gender and other divisions that characterise the early 21st Century city, and aims to accommodate diverse interests and capabilities in an integrated, holistic and collective fashion. How might this happen? While the vision of a water-sensitive city is a universal one, city managers will need to craft an approach that learns from their own successes and failures, and those of others, in cities around the world and establish an approach that suits their unique context.

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CHAPTER 2

WATER AND THE NATURAL ENVIRONMENT: BIODIVERSITY AND URBAN WATER MANAGEMENT

Jenny Day, Gail Cleaver-Christie, Liz Day and Louise Stafford

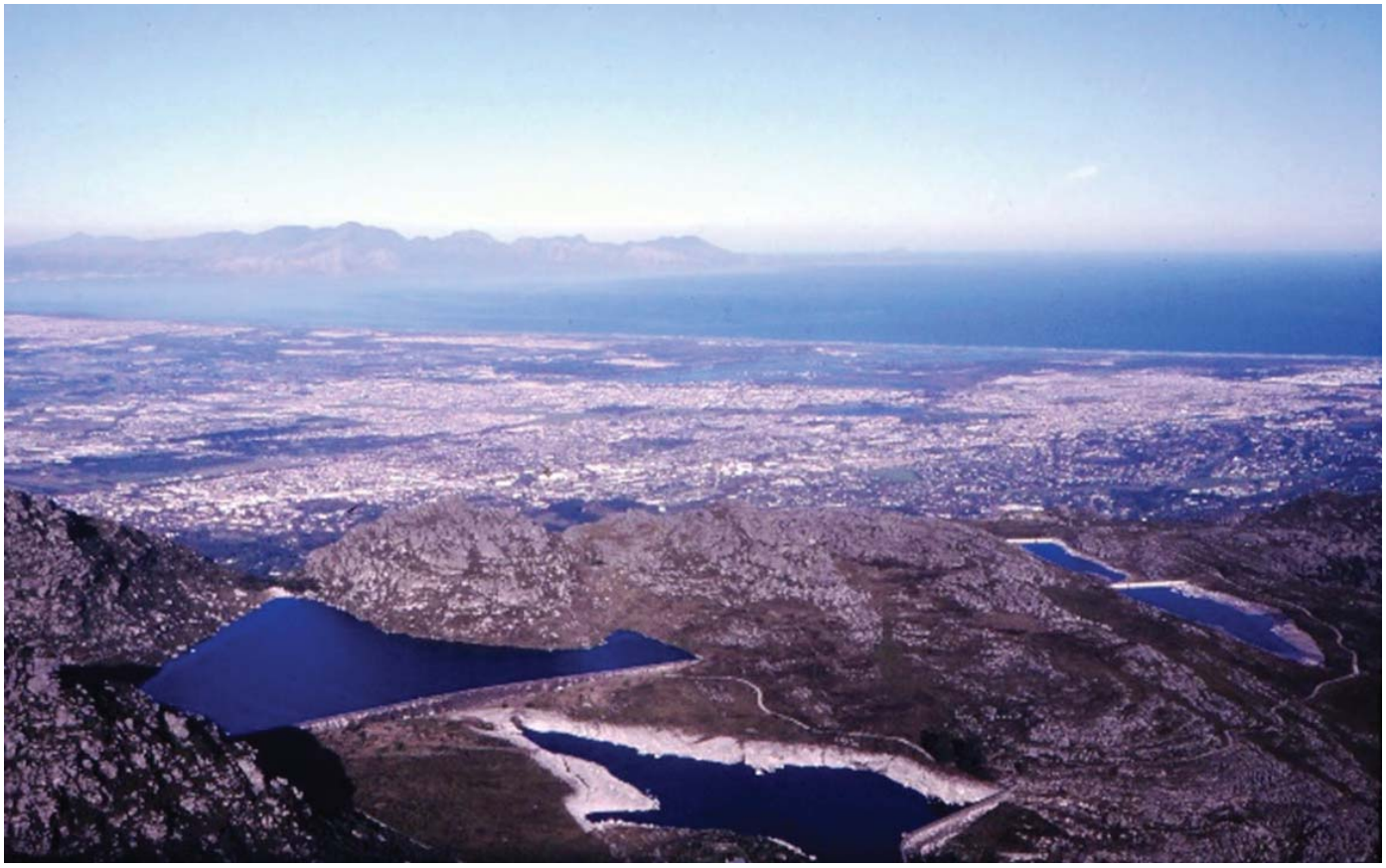

Figure 2.0 Small water supply reservoirs on the top of Table Mountain supply water to some suburbs of Cape Town
(photo: B Day 1997)

> *"Science and technology are what we can do; morality is what we agree we should or should not do."*
>
> EO Wilson, *The Future of Life* (1992)

2.1 INTRODUCTION

This chapter deals with the ways in which cities generally affect the natural environments in which they occur, the ways in which water stress, including drought and poor water quality, affect cities and their non-human inhabitants, and the ways in which city managers respond to water stress. We use Cape Town, said to be the World's most biodiverse city, as a case study illustrating the tensions between managing for biodiversity and conservation, and for water provision for a city's human population.

Water management traditionally involved only the supply of water (i.e. 'supply-side' management), with water users sometimes paying for the water they consumed, but at minimal rates. As the monetary value of water has increased, at least partly due to the cost of developing more and more sophisticated infrastructure, so the price has increased. Over time it has become obvious, though, that water is more than an economic good. It is the very essence of rivers, wetlands and aquifers, and removing water from them for human use both disturbs natural hydrological cycles and compromises the services that they provide to humans. The notion of rivers as "users" of water (and in some way therefore being in competition with humans) has gradually been replaced by the self-evident acceptance of rivers as "owners" of water in their own right and secondarily as providers of water to people. So, some years ago the idea arose of Integrated Water Resource Management (IWRM). IWRM is a concept designed to encourage water managers to consider environmental, as well as economic and social issues when planning and implementing water-supply systems. Clearly, tensions will arise when attempting to satisfy both the water demands of people and the needs of rivers and wetlands, particularly when people are able to voice their demands, and to pay for the water they use, while rivers and wetlands can do neither.

This chapter deals with the effects of water management on the natural environment in urban settings, particularly in the light of increased contestation as water becomes less and less available during times of increasing scarcity. We start with a brief description of the useful services that rivers and wetlands provide to the cities that have built up around them, and the ways in which cities affect the natural environments in which they occur, particularly under conditions of water stress. We mostly deal in very general terms with biodiversity, and the conservation of biodiversity in modern cities, emphasising the consequences of natural hydrological cycles on both terrestrial and aquatic ecosystems. We then outline the consequences for rivers and wetlands of reduced water availability resulting both from drought and from management actions, and describe the approaches to water management in various Mediterranean cities. Finally, we discuss lessons learnt from the Cape Town drought, describe some opportunities afforded by the drought conditions, and indicate potential ways of minimising the negative effects of water shortages in the long term.

2.2 ECOSYSTEM SERVICES PROVIDED BY RIVERS AND WETLANDS

It seems trite to say so, but aquatic ecosystems exist only because of the water held within their boundaries. They are of the right shape to hold water, and rivers are also of the right

slope to discharge water downstream. These systems are therefore *providers of water.* While rivers discharge water either downstream or into underlying aquifers, wetlands *store* water partly because of their topography but also because the peaty plant material that accumulates on the bottom acts as a sponge, retaining water. The result is that wetlands dampen the effects of floods and droughts, reducing the force of flood waters by slowing the rate at which water flows through them. Wetlands thus store water, as well as regulating the amount entering and leaving a river.

It is not only the amount of water that is regulated by wetlands, but also its *quality*. The purification of water, to the point at which it is safe to drink, is a service that has been provided by rivers and wetlands for as long as humans have existed. By the nature of the microbiomes in their sediments they decompose organic waste and cycle nutrients, thereby cleaning the water passing into and through them. People living in towns down the length of a long river may have drunk water that had been through the kidneys of five or six people before being consumed in downstream towns, and yet the water would have been of good quality. The river would have provided water to dilute the waste, while natural bacteria and fungi would have broken it down. This process continues to work very effectively where human populations are small but it doesn't work well in large cities, where the amount of waste generated overwhelms the cleansing abilities of natural systems. So today water is usually cleansed in technically sophisticated purification works (but using the same biochemical processes found in nature) before being distributed into the reticulation system and thence to our taps. Once used, the water is sent in sewers to wastewater treatment plants (WWTPs) to be cleansed – a task once performed by the rivers themselves.

Frequently the quality of water leaving a wetland is significantly higher than the quality of the water entering it, such as would have been the case for the wetlands shown in Figure 2.1. Wetland plants tend to act as filters, slowing down the flow of water entering the wetland, and causing particulate matter in the form of organic waste to settle to the bottom. Microbes in the wetland sediments break down the organic material (as they do in rivers) and large amounts of the released nutrients are adsorbed onto the sediment particles. Wetland sediments are even able to sequester certain toxins, making them unavailable and therefore making the water safe to use. Wetlands of this kind are essentially acting as WWTPs. It is no wonder, therefore, that water managers often emulate nature by creating artificial wetlands, particularly for improving water quality.

It goes almost without saying that well-functioning aquatic ecosystems provide biomass in the form of food from rice to fishes, building materials from reeds to timber, and grazing for cattle and other herbivores. The huge diversity of species supported by aquatic ecosystems also includes the microbes that cleanse the water and the terrestrial animals that drink it. As well as providing physical goods and services, rivers and wetlands provide less tangible benefits to us humans. They are involved in the regulation of climate, both by contributing to moisture

in the atmosphere and by producing or absorbing climate-modulating gases, and they engage us with their spiritual, recreational, scientific and intellectual qualities.

Figure 2.1 Many wetlands such as these at Kuilsrivier on the Cape Flats, near Cape Town, have been subsumed by urban development over the last 100 years. Their destruction has resulted in important ecosystem services being lost.
(photo: J Day 1976)

Many rivers are sacred to the people who live on their banks – think of the Ganges and the Jordan rivers, and Nyami, snake god of the Zambezi River; while Lake Funduzi in the north of South Africa is thought by local people to be home to the python god, who protects the lake (see, for instance, Mowat and Rhodes, 2020). The enthusiasm with which people holiday close to rivers and wetlands attests to their recreational importance as a sense of place, and the increased value of land along rivers, wetlands and estuaries especially in popular holiday resorts, as well as the income generated in these areas from holiday makers (for example Knysna, or Plettenberg Bay on the south coast of South Africa) indicates their economic value. They are also of huge value for scientific and intellectual enquiry.

A very simple example illustrates the monetary value of Mfuleni, a small, highly impacted wetland in Cape Town, by comparing it with Letseng-la-Letsie, a much larger pristine wetland in the highlands of Lesotho. For the local communities using the wetlands, the annual value of the Mfuleni wetland in 2008 was USD1 765 ha/yr, and that of Letseng-la-Letsie USD220 ha/yr. The average annual household income from the Mfuleni wetland was USD2 003 per year, and from Letseng-la-Letsie, USD66 per year (Lannas and Turpie, 2009). Globally, ecosystem services and goods provided by rivers have been estimated at an astonishing

USD4 000 per hectare per year, and wetlands far more, at about USD16 000 per hectare per year, for the year 2011 (Costanza et al., 2014). Costanza and his colleagues estimated that these values had decreased by about 3% since their previous estimation in 1997 (Costanza et al., 1997) as a result of ecosystem degradation and wetland loss.

Having described the value of wetlands and rivers as functioning ecosystems, we now turn to the effects of climate, and climate change, on them.

2.3 CLIMATE CYCLES AND THEIR EFFECTS ON THE NATURAL ENVIRONMENT

Cycles of wet and dry periods are familiar to us as seasonal rainfall, and as longer-term cycles of wetter and drier periods that may last for several years. Over the course of millennia the plants and animals native to any area will have adapted to the prevailing conditions of the biome, such as tropical forests or deserts or swamps, in which they live. Environmental conditions change over the course of time but generally the changes are slow enough that many of the species are able to adapt little by little to the changes, and therefore to survive. Species that are unable to adapt will become extinct. It needs to be remembered that over the course of the Earth's history, far more species have become extinct than are alive today, so extinction is natural and expected. A major aspect of current global warming, however, is the rapid rate at which it is happening – a rate much faster than the rate at which adaptation by natural selection acts on most species. Despite the desire by certain world leaders and other deluded individuals to believe that global warming is a myth, it is not. Every year new temperature records are broken. For example, in August 2020 a record high temperature of 54.4°C, was experienced in Death Valley National Park, in California in the USA (Redfearn, 2020). The more modest increases in temperature in many of the Earth's arid areas (like the Western Cape of South Africa) are expected to be accompanied by significantly decreased rainfall but significantly increased inter-annual variability, together with an increased likelihood of deep droughts and intense floods at unpredictable intervals. As we might imagine, all of these changes are likely to put far greater pressure on water resources than any we have experienced so far. Indeed, cities need to prepare in earnest for a drier, warmer future over the next decades. While there remains uncertainty in the details, the evidence for drying and warming is strong and planning that ignores this evidence poses a significant risk of water stress at some time in the future for both humans and the ecosystems on which they depend. An excellent source of information about climate change is the NASA website https://climate.nasa.gov/.

2.4 NATURAL CLIMATE CYCLES AND THE DEVELOPMENT OF CITIES

Until recently, with the advent of climate change, climate cycles were fairly predictable and could be used to estimate the amount of water available from season to season and from year to year. In conjunction with a knowledge of the water demand of a city, hydrologists and engineers would decide on the most suitable water sources to supply that demand. In mesic areas, where rainfall is consistently high, run-of-river water would be adequate, and small reservoirs would be constructed simply to allow ease of distribution of the water to reticulation

points for purification and distribution to water mains. In drier areas, larger reservoirs would be needed so that river water could be stored between rainy periods. The larger the population of a city, and the drier the region, the larger would be the reservoirs and the greater the effects on the rivers downstream. Where cities grew in regions with few rivers, or with inadequate sites to build reservoirs, groundwater has often been the major source of water for urban purposes. And, as climate change has kicked in, more and more ever-enlarging cities are facing challenges in providing sufficient water for their populations, even during periods of "normal" rainfall. Given that one of the consequences of climate change is longer and more frequent droughts, it is not surprising that several cities have faced, or are facing, critical water shortages.

On the other hand, capturing water in reservoirs alters the character, and sometimes the sustainability, of rivers and wetlands. It is fairly easy to see that removing water by pumping groundwater or diverting rivers will have consequences for the associated aquatic ecosystems, reducing their size and often changing the chemical nature of the water. What is less intuitive are the severe effects of damming on the nature of a river below the dam wall, reducing biodiversity and sometimes stopping the river from flowing altogether. The topic of 'environmental water requirements' is not dealt with significantly in this chapter but a good review of the topic can be found in King and Brown (2018).

2.5 THE EFFECTS OF CLIMATE CHANGE: SOUTH AFRICAN AND CAPE TOWN PERSPECTIVES

South Africa is not safe from the effects of climate change. In 2015, the country recorded its lowest annual rainfall since 1904. In the same year, Cape Town also recorded the highest temperature in the last 100 years at 42°C. The lack of rain, together with abnormally high temperatures, contributed to some of the worst fires the city has seen. And in 2017/2018, the Western Cape experienced its worst drought in decades, threatening water supply to its citizens. Climate scientists predict that the Western Cape will become drier and experience moderate to strong warming over the next 100 years. By 2050, the rainfall in the Western Cape is likely to have decreased by about 30% from current levels. The spectre of Cape Town as a perpetually water-stressed city is undeniable.

The Western Cape Government is playing its part in the global effort to reduce greenhouse emissions (Western Cape, 2014), especially since the Western Cape is one of South Africa's provinces most vulnerable to climate change. At city level, Cape Town has produced a Climate Change Response Strategy (Cape Town, 2017) and various players in the agricultural field have an implementation plan for the agricultural sector, better known as *SmartAgri* (Western Cape 2016). The *Smartagri* homepage on the GreenAgri website (https://www.greenagri.org.za/smartagri-2/smartagri-plan/) notes that

> [a]s our agricultural sector is vulnerable to changes in climate, it is vitally important to provide guidance to farmers and others in the sector on how to prepare for the impacts

of climate change in order to protect their livelihoods as well as food security. SmartAgri helps farmers from different parts of the Western Cape reduce their greenhouse gas emissions and protect their farms and businesses from the effects of climate change.

The remarkable action of a group of farmers near Cape Town should be recorded here. At the height of the drought, the Groenland Water Users Association, representing deciduous fruit growers in Elgin and Grabouw, donated approximately ten million cubic metres of water to the City of Cape Town (EWN, n.d.). Their generosity was astonishing, given the absolute dependence of farmers on adequate water for irrigating their own crops.

A further effect of human settlements on aquatic ecosystems is pollution, another topic that is dealt with only superficially in this chapter. It is important to note, however, that urban rivers and wetlands are commonly subject to reduced water quality because of sewer overflows resulting from blockages, power outages and poor maintenance, as well as organic waste coming from unsewered informal settlements. Furthermore, levels of pollution are likely to increase considerably under drought conditions because there is less water to dilute and flush away pollutants, and because wastewater treatment plants receive a much more concentrated "liquor" than normal, often resulting in inadequately treated effluents leaving the works. These effluents are discharged either to rivers or to the sea. It should be noted that water shortages in many rapidly growing cities (e.g. Nairobi, Bangalore) in the developing world are due as much to water pollution as to water scarcity. A relatively old but useful document, *The effects of water quality variables on aquatic ecosystems* (Dallas and Day, 2004), downloadable from the South African Water Research Commission's website, covers many aspects of water pollution.

2.6 EFFECTS OF URBANIZATION

The environmental setting in urban areas is, of course, much altered from conditions prevailing before urbanisation. Some of the most significant effects of urbanising environments are changes to the natural hydrological regime. Areas that were once wetlands have been drained and built on (e.g. the Kuilsrivier wetlands shown in Figure 2.1); rivers are often canalised and subject to increasing pollution, both chemical and in the form of solid waste; runoff from rainfall is directed into stormwater drains; temporary wetlands are made permanent, or obliterated. The overall effect is that less water is available in drier times, while flooding is becoming increasingly common. In summary, from the point of view of the plants and animals living in cities, the presence of water is less predictable, what water does occur is more polluted, and the quantity of water is often far greater or – more commonly – far less than in the past. The most appropriate goal of city managers concerned with the natural environment is therefore to maintain, as far as possible, the functions and services of ecosystems with minimal loss of diversity.

2.6.1 The Case of Cape Town, the World's Most Biodiverse City

Few cities can compete with Cape Town with regard to the natural beauty of its surroundings and the remarkable diversity of the plants that grow there. It is situated within the Cape Floristic Region (CFR), the smallest of the World's six Floral Kingdoms. This is a biodiversity "hotspot", covering an area of less than 80 000 km^2 but with the highest concentration of terrestrial plants in the world: about 9 500 species. More than two-thirds of these species do not grow anywhere else on Earth – i.e. they are endemic to the CFR. Because of the great importance of the CFR for biodiversity, the United Nations Educational, Scientific and Cultural Organisation (UNESCO) has declared various protected areas within the CFR as a World Heritage Site (IUCN, 2015).

Within the CFR, the City of Cape Town occupies an area of even more exceptional species richness and has therefore been declared by the UN's City and Biodiversity Outlook Project to be the world's most biodiverse city (Cape Town, 2018). Within its boundaries, including the Table Mountain National Park, the city hosts over 3000 plant species, of which about 200 plant species are endemic, being found only within the City boundaries. (The whole of the British Isles boast 52 endemic species.)

Figure 2.2 An example of the remarkable diversity of Fynbos vegetation
(photo J Day 2017)

In addition to its rich terrestrial biodiversity, Cape Town supports a variety of rivers and wetlands. Originally, many of these were naturally seasonal, particularly on the lowlands, where most rivers flowed for only a few months of the year, and retreated into seasonal pools that dried up in the summer. Once upon a time the lowlands supported hundreds of small groundwater-dependent wetlands that were seasonally inundated when the water table rose in winter. Many supported small, highly endemic aquatic invertebrates, particularly planktonic crustaceans. The City's rivers and wetlands have been highly modified by urbanisation, however (Figure 2.1). Many wetlands having been filled in or drained, while rivers have been canalised or channelised. Marshy seasonal wetlands are now rare. Nonetheless part of the False Bay Nature Reserve has been declared a Ramsar Wetland of International Importance for Waterbirds, and the City has very recently applied to become one of the first Ramsar Cities in the world. In addition, pollution – mainly by treated and/or untreated sewage effluent – has affected many of these systems. Both treated effluent from sewage works discharging into the rivers, and stormwater runoff, have led to many of the remaining systems receiving far more water than before, resulting in them changing from seasonal to perennial systems and leading to fundamental changes in ecosystem functioning.

As with other large metropoles, Cape Town has long since stepped outside its own water footprint. Most of the rivers that supply Cape Town with water lie outside of the City and, ironically, these too have been affected by large-scale abstraction and associated issues such as downstream salinisation. Until very recently, for its water supply Cape Town has been almost exclusively reliant on six rain-fed reservoirs (dams) located mainly outside the City's boundaries but part of the Western Cape Water Supply System (WCWSS). The City owns three of the six reservoirs, the others being owned by the national government's Department of Water and Sanitation (DWS). The WCWSS is managed by DWS in partnership with the City of Cape Town. Cape Town's Water Strategy (Cape Town, 2019) aims to develop diverse water resources, including groundwater, water re-use, and desalination because in the context of climate change, a mix of resources will be more reliable and more resilient than reservoirs alone. This topic is discussed more fully in Chapter 3.

2.6.2 The Effects of the 2016-2018 Drought on Cape Town

It is fortunate that the terrestrial vegetation of the Cape Town region is adapted to hot, dry, windy summers because the years 2016 to 2018 were the driest on record, and resulted in a major drought. The effects of that drought on terrestrial vegetation is currently being investigated (Jasper Slingsby and Martine Treurnicht, South African Earth Observation Network, pers. comm. 09.2020). At the same time, the severe drought reduced runoff into rivers and wetlands, lowering the water table and causing the die-off of drought-sensitive species. Pollution in watercourses resulted from an increase in sewage overflows and decreased dilution effects as waters dried up. Most significantly, available water was diverted exclusively for human needs, at the expense of other users, including the environment. The fast-tracking of water development schemes went ahead with vastly shortened processes that normally protect the environment from damage during and after development, and detailed

strategic investigations into possible ecological impacts did not occur. In short, environmental concerns were downplayed at the very time when they should have been of greatest concern. While this is understandable, it was indicative of a lack of adequate long-term planning. This, too, is understandable. The City was coming to the end of a 5-year Strategic Plan for Water (Cape Town, 2011) and had in 2015 been awarded the *C40 Cities Award*, which recognised the City's Water Conservation and Demand Management Programme at COP 21 (21st Conference of the Parties, Paris Climate Conference 2015). Almost immediately after this, though, the City was caught on the horns of two virtually unpredictable dilemmas. Firstly, the drought itself was the result of two successive years of unprecedentedly low annual rainfall – a phenomenon that had never been seen before. Secondly, key funding earmarked for water developments (such as increasing the capacity of one of the large dams supplying the City) by the national Department, then called the Department of Water Affairs (DWA), never materialised. A third, somewhat less consequential, challenge was the lack of cohesion between the DWA and the City in attempts to deal with the crisis, which resulted in an uncoordinated response at the beginning of the water crisis. The term "Day Zero" was coined to refer to the day on which the City's water resources would run dry.

As a result of severe water restrictions imposed on Cape Town's residents, and the associated major efforts made for on-site domestic recycling of water, less water flowed in the sewers than under non-drought conditions. They therefore became more vulnerable to blockages and on occasion sewage overflowed into stormwater systems, leading to the pollution of several watercourses. At the same time, the drought resulted in feeder streams being subjected to reduced flows from their respective catchments. Combined with the regular but unintended sewage spills and other factors leading to the on-going eutrophication of our watercourses, water quality in urban waterways was considerably compromised.

Ironically, reduced flows of treated effluent into downstream rivers, estuaries and wetlands as a consequence of increased water re-use might have been beneficial for systems that are naturally seasonal but that have been made perennial by stormwater and purified sewage return flows. At the same time, though, treated effluent was virtually the only water passing through some naturally perennial systems, some of which dried up. The increase in the re-use of effluent may thus have reduced the amount of water available for the lower river reaches and estuaries. Balancing these counter-impacts will continue to be a challenge for resource managers in cities facing reduced water availability in the future.

2.6.3 Water for People vs Water for the Environment: A Cape Town Predicament

As mentioned above, the City was caught off-guard by the combination of events that led to the drought of 2016-2018, even though its managers had developed a very effective water demand strategy (without which the consequences of the drought would have been far more devastating). As the drought deepened, the City's water managers were under greater and greater political and social pressure to find any viable sources of water. Often the easiest way to increase water supply is by exploiting groundwater. The Cape Town area is underlain in

parts by aquifers close to the surface and therefore easy to access, but potentially affected by the drought if recharge does not take place (as is likely in deep drought conditions). The City is also located on a series of major and very deep aquifers of the geological formation known as the Table Mountain Group (which, despite its name, extends for several hundred kilometres along the coast towards Port Elizabeth). Investigation into the potential use of the Table Mountain Group Aquifer by the City of Cape Town started in 2005, with various studies conducted to better understand both the geological and potential environmental impacts of large-scale abstraction of water from the aquifer.

With the drought, this precautionary approach was set aside. More than 200 potential borehole sites were identified by the City's geohydrologists for exploration and potential abstraction. A Directive was issued by the Province allowing the City to follow a shortened environmental assessment process in order to address the water shortage. Of the various focus areas that were identified for the development of a production wellfield, the one preferred by the geohydrologists falls within the Steenbras Nature Reserve (Figure 2.3), a formally recognised protected area and part of the core of the Kogelberg Biosphere Reserve (UNESCO, n.d.). Environmental Authorisations for activities in protected areas and biosphere reserves require approval by the National Department of Environmental Affairs (DEA). Authorisation was duly given because the area where drilling was to take place had been zoned within the Steenbras Nature Reserve management plan as a "utility zone". The City appointed specialists to assess areas of potential environmental concern and their surveys were used by the City to refine the placement of the boreholes. The concern is, however, that the real impacts of drilling in the Steenbras Nature Reserve, which is the core of the Kogelberg Biosphere Reserve, remain unknown.

Figure 2.3 Kogelberg biosphere Reserve – an approved site for potential groundwater abstraction – despite its immense significance for biodiversity
(photo: K Reid CC BY-SA 4.0 via Wikimedia Commons
https://commons.wikimedia.org/wiki/File:Kogelberg_Nature_Reserve_Path.jpg)

After consultation regarding concerns for potentially negative environmental consequences the City agreed to ensure that production boreholes remained in the utility zone. Due to the internationally recognised status of the CFR as a World Heritage Site, and the Kogelberg as a Biosphere Reserve, concerns were raised by citizens about the potential impacts of large-scale groundwater abstraction from the Table Mountain Group Aquifer. The DWA was questioned as to why a formally protected area of great biodiversity importance had been targeted for production wellfields. The dual issues of the disturbance of an important conservation area, and the wider effects of abstracting water from the TMS aquifer still need to be fully addressed.

It is with interest that we note that UNESCO (2019) has observed the threat posed to the World Heritage Site by the continued drilling of the wellfield. It is worth quoting part of the Decision:

> [UNESCO] notes with concern the reported emergency plans for water extraction from the Table Mountain Group Aquifer, due to drought conditions in the Western Cape Province, and further notes that the Province is no longer a National Disaster Area; also further notes that the reported emergency plans for water extraction, may have potential impacts on the property's Outstanding Universal Value (OUV). In the event that such

plans are developed, urges the State Party to assess the potential impacts on the OUV of the property; and in all proposed areas adjacent to the property before deciding to go ahead with these plans; and inform the World Heritage Centre of any major developments planned.

As of January 2022, despite good rains having fallen over the last couple of years, the wellfield development continues. An Environmental Monitoring Committee has been established by the City, and has designed a long-term monitoring programme for the Steenbras Nature Reserve wellfield and other sites in the Table Mountain Group Aquifer (Kleynhans et al., 2020).

In summary, natural systems were affected both directly and indirectly by the drought itself and by associated management actions. While the long-term effects of the drought on terrestrial plants is being monitored, the long-term effects of the drought on aquatic ecosystems within the City have not yet been studied.

The drought did have some positive aspects. For instance, managers were forced to find ways of undertaking operations with limited or even no potable water. For example, the planned burning of the native vegetation for control purposes now relies largely on non-potable water sources (although this water must still be drawn from some river or wetland, probably without consideration of the effects). Offices of the City's various nature reserves have become water-wise and in some cases have developed permanent ways of operating with the minimal use of water, and likewise, a multi-purpose centre currently being constructed at one of the City's Nature Reserves will recycle all of its water and may not need to rely on the municipal supply at all.

2.7 CASE STUDIES FROM OTHER MEDITERRANEAN CITIES

While every city is unique in its environmental challenges, some of those with the greatest challenges are "Mediterranean" (with a small "m", in that they have a typically Mediterranean climate of cool, wet winters, hot, dry summers, and declining mean annual rainfall). This combination of features makes them peculiarly at risk from climate change. The cities described below all have Mediterranean climates and all have experienced major climate-induced water shortages. Approaches to the management of aquatic ecosystems in these cities – Los Angeles, Santiago, Barcelona, Perth and Cape Town – are outlined here in an attempt to find common threads and to identify best practice with regard to water management. In all cases the cities draw water for domestic and other purposes from far outside the city limits, so it is sometimes difficult to discuss water management specifically within each city, rather than the wider catchments in which they fall.

2.7.1 Los Angeles

The city of Los Angeles is an integral part of Southern California, which is situated in a Mediterranean-climate region on the west coast of the USA. The area has a population of about 24 million, of which 12.5 million live in Los Angeles itself. The region has suffered severe

droughts within the last few years (e.g. Stokstad, 2020). Domestic water supply comes partly from local groundwater but most water is imported through the complex system of dams and pipelines of the California State Water Project and the Colorado River Aqueduct. (Needless to say, the once-mighty Colorado River virtually never reaches the sea these days.) Few wetlands of any size occur within the city limits, and the once significant Los Angeles River has been canalised and reduced to a drain (Figure 2.4). Management of the city's wetlands is highly contested between those wanting to redistribute water for agricultural and urban needs, and those wanting to improve conservation of the remaining aquatic ecosystems, which are under considerable threat from the decline in rainfall as well as water management activities. There are often no management plans in place for rivers and wetlands and planning for drought is inadequate, both for the provision of drinking water to rural residents and to prevent major losses of fishes, birds and aquatic ecosystems. California State has begun major reforms to reduce domestic water consumption and build drought resilience in the most vulnerable areas. The great wealth of both the State of California and the federal government is reflected in the fact that a fund for emergency ecosystem support was funded nationally in 2015 to the value of USD67 000 000, with a further USD66 000 000 coming from the State of California. A further USD104 000 000 has been provided by the federal government and an enormous USD2 609 000 000 by the state for what are called "Water System Investments", which are largely for engineering projects (Hanak et al., 2015). In short, Los Angeles has major problems in providing adequate water supplies for both citizens and the natural environment. Conflicts still arise between the two but it is a matter of will rather than resources that still prevents adequate attention to environmental requirements, particularly during periods of drought.

Figure 2.4 The once-mighty Los Angeles River, now reduced to a concrete drain (photo: C Cook CC BY 3.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Los_Angeles_River_(165940675).jpeg)

2.7.2 Barcelona

Barcelona is located on the north-eastern coast of Spain, and has a population of about 5.5 million. The city suffered a severe drought some years ago and still faces major water shortages, despite having one of Europe's largest desalination plants. It has been predicted that as a result of climate change, river flows are likely to be reduced to about 50% of virgin flow by the year 2050. *Rieras* – i.e. short, ephemeral streams that characterise so many Mediterranean cities – now experience extended periods of virtually no flow, interspersed with short-lived raging torrents. As a result of a particularly devastating flood in 1962, the floodplains of most of the rieras were channelised and their floodplains built on. Today, as we have described above for Cape Town, in dry periods the only water reaching the streams comes from wastewater treatment plants. In Spain much of the urban water is distributed by private utilities, which has caused considerable public uproar. Perhaps as a result of the commercial nature of these companies, environmental water allocations seem to have taken a back seat. Several studies (e.g. Crespo et al., 2019) have investigated the hydro-economic trade-offs between water for human use and for the environment and have concluded that well-functioning water allocation policies can be both economically efficient and socially acceptable, as well as being able to 'reduce the likelihood of failure of water reallocation to the environment' (Crespo et al., 2019: 2301). This remains to be seen in practice. In short, despite European directives regarding the environmental protection of urban as well as other

wetlands, inadequate attention is being paid to the water requirements of aquatic ecosystems, particularly during drought.

2.7.3 Santiago and Valparaiso

These are adjacent cities, housing nearly seven million people on the Pacific Ocean in central Chile. They have been in water deficit for many years, largely as a result of water legislation established during the Pinochet regime (OECD, 2015). Water rights are allocated almost entirely for agribusiness, to the extent that many small farmers have been unable to continue farming, and ordinary people have to pay highly inflated prices to the private companies that provide water to most of the citizenry. The situation is exacerbated by the fact that a considerable proportion of the water used by the city is derived from snowmelt, a resource that is reducing as climate change continues to escalate. Furthermore, funding of new water infrastructure is minimal. Although environmental water requirements are said to be taken into consideration in defining the available resource pool, environmental flows are not clearly defined even during periods where water scarcity is minimal. In addition, no account is given to water requirements for freshwater or terrestrial biodiversity. Calculations of quantities of water to be allocated are based on water availability and water rights (which are granted independent of land ownership). Discouraging news is that citizen protests against high water prices, shortages and poor water quality have not yet resulted in significant improvements. Encouraging news, on the other hand, is that The Nature Conservancy has established the *Santiago Water Fund* to protect wetlands and native vegetation in one of the catchments that provides much of Santiago's water (TNC, 2019b).

2.7.4 Perth

Perth, which lies close to the Indian Ocean in south-western Western Australia, is a small city of nearly 2 million people. It once received an average of about 800mm of rain a year but this has steadily decreased, while the flow of water into Perth's water supply reservoirs has decreased to less than a quarter of what it was twenty years ago, meaning that evaporation from reservoirs can exceed inflows in very dry years (Heggie, 2019). Most water for domestic supply now comes from groundwater (39%) and desalination (43%), with reservoirs accounting for less than 20%. The region's aquifers also support groundwater-dependent ecosystems, including permanent and seasonal wetlands, springs and caves. According to WAWD (2011), 'Water allocation planning [in the Perth area] is focussed on optimising how water is taken to meet the needs of people and the environment in a time of changing climate and increasing water demand.' Water for the environment is managed according to local conditions so that, for instance, sufficient water is retained to maintain groundwater levels where groundwater-dependent wetlands are at risk. While methods used for assessing environmental water requirements are set out in great detail (e.g. WAWD, 2011), it is not clear the extent to which adequate water is actually allocated for environmental purposes, especially as climate change reduces water availability. We could find no indication as to whether or not EWAs are reduced or ignored during times of drought.

In summary, all the Mediterranean-climate cities discussed above have significant challenges in finding sufficient water for their populations, as well as for “nature conservation”, even though functional aquatic ecosystems provide valuable goods and services. The challenges include not only a reduction in the amount of water available, especially during ever-more-frequent droughts, but inappropriate legislation and/or a lack of political will to enforce environmental regulations. A last word: all of these cities rely (or will soon rely) very heavily on water from aquifers, but groundwater is not without limits. As more and more is used, particularly if it comes from ancient non-renewing sources, a stage will be reached at which it can no longer supply demand.

2.8 NATURE-BASED SOLUTIONS: WAYS OF EASING THE EFFECTS OF WATER SHORTAGES

We have shown above that functioning ecosystems provide goods and services of value to humans. Investing in ecological infrastructure (in other words, in these naturally functioning ecosystems) is the most cost-effective, long-term solution for securing water. Nature-based solutions require a fraction of the cost of engineering solutions such as desalination, groundwater exploration and re-use of water. Well conserved catchments provide replenishment of groundwater and improved yield of surface water reservoirs, while increasing ecosystem resilience against climate change (e.g. IUCN, 2020). Aspects of water-sensitive urban design and sustainable drainage systems are discussed in some detail in Chapter 3.

Water Funds are organisations that design and enhance financial and governance mechanisms which unite public, private and civil society stakeholders around the common goal of contributing to water security through nature-based solutions and sustainable watershed management (TNC, 2019). The Greater Cape Town Water Fund (GCTWF) was launched in 2018 by The Nature Conservancy with support from local partners, making the case for green (“ecological”) infrastructure in a clear and transparent manner. The GCTWF Business Case showed that investments in nature-based solutions, including controlling invasive alien plants and rehabilitating wetlands, can gain 55 million cubic meters of water per year within five years – equivalent to two months of Cape Town’s current supply needs – and 100 million cubic meters per year within 30 years. Such gains can be achieved at one-tenth the unit cost of alternative high-tech supply options and can create up to 350 jobs. Ensuring the sustainability of these activities through a clear, sustainable funding strategy will improve water security for the entire Greater Cape Town region and its 4.5 million people. The Nature Conservancy has initiated a similar Water Fund in Santiago, Chile (see above).

An important issue that has yet to be adequately discussed is the control of future development, so that the additional water resources freed up by more efficient water use and re-use do not simply lead to an expanded footprint of the City, with the result that there are no “additional” water sources to draw on in times of drought.

2.9 LESSONS LEARNT

We have learnt a number of important lessons from the drought itself, from the conference of January 2020, and from reading in preparation for writing this chapter. Some of these lessons are listed below, while others are common to several of the chapters and are discussed in the concluding chapter, Chapter 8. A far more thorough analysis of the lessons learnt from the Cape Town drought is to be found in Ziervogel (2019).

Planning

Long-term (>50 years) strategic planning is essential and needs to include detailed disaster management plans. A major reason for long-term planning is to prevent the need for "panic planning", leading to inappropriate actions, in the face of unexpected challenges.

Planning should ensure that environmental legislation is allowed to follow recommended time frames. In other words, good planning should prevent the need to shorten the time needed for studies to be done, since this could ultimately compromise our understanding of the very resource we are trying to protect in order to ensure a sustainable water supply. Plans need to be reviewed and updated every so often so that, for instance, new technologies can be assessed, and monitoring data can be incorporated into the plans.

After the crisis is over, stringent and timeous independent auditing is needed to review actions taken during the crisis and, where necessary, to reverse their effects. Well managed cities have an Environmental Management Strategy in place that sets conservation goals and is supported by appropriate by-laws.

Personnel

Establishing multidisciplinary planning teams (including, for instance, ecologists, geohydrologists, engineers and planners) before disaster looms, helps to solve problems. Building up trust between all groups of players, including citizens, water managers and politicians, obviates rumour-mongering and can be encouraged by transparent decision-making and rapid, clear communication.

Data

The availability of good data is crucial. The City of Cape Town had invested in the production of GIS datasets showing the extent and importance of remnant terrestrial areas as well as wetlands and rivers. Better spatial geohydrological data showing surface water/groundwater linkages would also have been useful.

Long-term monitoring information on aspects such as hydrology and water quality is important for ensuring that good decisions are made, and in minimising long-term risks which may have unintended consequences. Partners need to be prepared to share their data with others and all partners need to agree to use the data for the intended purpose.

Modelling the likely effects of changes in climate and demographics will assist in good decision-making.

2.9.1 Opportunities afforded by the drought in Cape Town

The drought provided an opportunity for Cape Town's 5-year Water Strategy (Cape Town, 2019) to incorporate lessons taught by the water crisis. (Further details on the Strategy are to be found in Chapter 3.) The City has also recognised the importance of owning water-providing catchments so that it is beholden as little as possible to other organisations. The City recognised skills gaps and has, for example, employed a geohydrologist in the Bulk Water Department, adding huge value to the team.

2.10 CONCLUSION

Climate change will ensure recurring droughts and therefore recurring periods of critical water shortages in cities throughout the world. At the same time, biodiversity in cities is threatened by the loss of habitat, pollution and other stressors. It is beholden upon city managers to recognise these threats and to plan for ways of protecting what biodiversity remains in their cities.

> "*This is the assembly of life that took a billion years to evolve. It has eaten the storms – folded them into its genes – and created the world that created us. It holds the world steady*."
>
> Edward O. Wilson, *The Diversity of Life* (2003)

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CHAPTER 3

A RENEWED TECHNICAL AGENDA FOR INTEGRATED URBAN WATER MANAGEMENT

Jessica Fell and Kirsty Carden

Figure 3.0 Water-wise indigenous landscapes reduce water demand and increase biodiversity and amenity value at the Vodafone Site Solution Innovation Centre building, Midrand, Johannesburg
(photo: D Ellis)

3.1 INTRODUCTION

The escalating water crises facing many parts of the urbanised world are an expression of the growing water turbulence of the Anthropocene (Rockström et al., 2014). Water scarcity, in particular, is becoming an increasing threat as a result of climate change impacts (changing rainfall patterns and rising temperatures) and increasing water demand. Humans are considered a primary driving force in this epoch, and a focus on coupled human-water systems that consider interactions, feedbacks and emergent patterns is needed to ensure a universal and sustainable supply (Sivapalan et al., 2012). If the increasing calls for a paradigm shift to resilient and water sensitive urban systems are to be realised, they will require a renewed technical approach to water management that is rooted in integration.

Symptoms such as dysfunctional or non-existent sanitation in urban slums, deteriorating river catchments and biodiversity loss are critical warning signals that conventional urban water management is ill-suited to this turbulent water era. Water management traditions entrenched in conventional, centralised engineering solutions are increasingly unable to provide water services in developed cities, much less to the already under-served and rapidly-growing urban centres in the developing world (Vörösmarty et al., 2015).

Water is a prerequisite for supporting economic and social development in urban contexts. A safe and secure water supply, along with drainage and sanitation for public hygiene and flood protection, have always ranked highly amongst the primary needs of urban dwellers. The pursuit and delivery of these needs over time has shaped the conventional centralised urban water systems that prevail today. These systems are dominated by ‘hard’ engineering and technical solutions (e.g. pipe networks, sewers, treatment works, etc.) which maximise access to water (Vörösmarty et al., 2010). This approach has been successful in delivering specific urban development and sanitation objectives and has brought benefits to massive numbers of urban dwellers (Gleick, 2003). However, as more technical solutions are employed to deliver water-based services, particularly focusing on securing more supply, natural systems are being pushed too far (see, for example Figure 3.1 of the Black River, in Cape Town. Once a seasonal river, it now flows permanently due to the inflow of treated sewage effluent from the local sewerage works). The pursuit of the engineered solution to exploit these systems is paradoxically coming at the expense of longer-term water security, particularly due to the impact of vast quantities of untreated wastewater entering the environment. Indeed, “nature talks back” when certain water-related planetary boundaries are crossed (Savenije et al., 2014). Along with the shortcomings associated with basic water service provision, conventional engineered approaches are failing to deliver on social, equity, environmental and amenity objectives. Moreover, they are excluding much of the urban developing world from access to even basic water services.

Figure 3.1 The Black River with Devil's Peak in the background, Cape Town
(photo: Cape Town Density Syndicate)

In urban areas, human-centred processes govern the water cycle (Vörösmarty et al., 2013). (It is important to note here that urban water use does not *consume* water but rather *pollutes* it (Harremoës, 2002)). Water scarcity can thus be framed in terms of availability or applicability (i.e. quality that is fit for purpose). This distinction expands the notion of water security beyond that of a quantity issue to one that considers quality, productivity, attitudes and behaviours and governance in a town or city. New ways of providing the same quantity of water for increased numbers of people with expanded needs, must be sought. As such, 'water security is not simply a state of adequate water but rather a relationship that describes how individuals, households, and communities navigate and transform hydro-social relations to access the water that they need and in ways that support the sustained development of human capabilities and wellbeing in their full breadth and scope' (South African National Planning Commission, 2019). Effectively managing the problem of water scarcity thus requires the inclusion of multidisciplinary perspectives in decision-making structures – including those of engineers, hydrologists, environmental and climate scientists, social scientists, policy experts, and more.

With this expanded view of water security and a recognition of the shortcomings of conventional centralised approaches, the question of what is wanted and needed from an urban water system must be considered (Brown et al., 2009; Chocat et al., 2007). Responses

will likely differ in developed and developing world urban environments. Cities in the developing world are arguably where the harder challenges lie, with many of the most vulnerable still having no access to basic water services. Furthermore, many of the urban areas of the future have not even developed yet, and will likely form in the developing world, particularly as slums. Whilst the challenge is significant, it also provides an opportunity for a renewed approach centred on equity, sustainability and a strong commitment to context. Given the context and the urgency in these areas, simply exporting the developed world's conventional centralised model is illogical at best and dangerous at worst, with significant implications for human rights (Vörösmarty et al., 2015). If a change is not made, the status quo will be entrenched.

The concept of Water Sensitive Urban Design (WSUD)[1] offers an alternative systems-based approach to conventional, centralised urban water management for the turbulent Anthropocene. WSUD offers a set of principles that underpin resilient, adaptive and sustainable urban water systems, and presents a framework for a renewed technical approach to water security, and the ultimate vision of a Water Sensitive City (WSC). A technical perspective such as this demands the complete integration of the technical into the social, economic and political – such that any technical solution has to be an integrated solution. In this age of uncertainty, the creation of WSCs moves beyond the goal of providing water services, to the creation of multi-functional water systems within liveable urban spaces. The technical elements of such systems present a significant departure from conventional approaches, and require new types of knowledge, expertise and resources. In this new system, the goal is not simply the use of water, but improved social and individual well-being per unit of water used (Gleick, 2003).

This chapter provides a technical perspective on the issue of urban water security, with a discussion on moving from the 'inherited wisdom' of conventional engineering approaches to a renewed technical approach, with particular consideration of the urban developing world. Our position within the paper is grounded on the very strong focus on water security that followed the 'Day Zero' crisis in Cape Town, South Africa. The ensuing discussions held at several stakeholder engagement sessions over 2019 and 2020 (as outlined in the preface to this monograph) have underscored the need for a different technical approach to water resource management. We therefore present here a selection of the various principles and practices for resilient, water sensitive systems using the framework of WSUD, and the vision of a WSC.

What is a Water Sensitive City?

The realisation of a Water Sensitive City (WSC) is an urban water management approach that delivers benefits that enhance sustainability, liveability and resilience. A WSC is based on the holistic management of the water cycle in order to deliver the basic services of supply and sanitation, while mitigating flood risks, and protecting and enhancing the condition of receiving waterways. It uses water management to deliver better health and wellbeing outcomes, and recognises that a water sensitive approach to urban development can deliver objectives critical to the liveability of a city, such as biodiversity, connected communities and cultural significance.

A WSC incorporates innovative infrastructure, design and governance solutions. Water recycling at different scales – through wastewater recovery and stormwater harvesting – provides a diversity of sources and improves the integrity of rivers, streams and wetlands by reducing pollution and impacts to flow. Nature-based infrastructure, meanwhile, is integrated into the landscape in order to offer hydraulic and water treatment functions, plus benefits such as an aesthetic environment, and mitigation of the urban heat island. Integrated and collaborative land use and water planning result in catchment scale approaches to flood resilience. Areas are also connected to create ecosystem and recreation corridors throughout the city.

3.2 EXPANDING THE TECHNICAL SCIENCES FOR INTEGRATED WATER SENSITIVE SYSTEMS: AN OPPORTUNITY FOR CHANGE

3.2.1 The flaws of 'inherited wisdom'

Water is a prerequisite for urban development. Historically, water services provision has been approached using the 'inherited wisdom' of conventional centralised and engineered systems, with infrastructure that has a long service life – thus locking in these approaches (Chocat et al., 2007). As Hohenberg and Lees (1985) note, 'urban structures are long-lived affairs'. For example, current conventional drainage and sewerage systems are based on principles developed in American and European cities in the early to mid-1800s[2], and include end-of-pipe approaches and large, mainly concrete-based infrastructure (Delleur, 2003).

From the late 18th century, science and technology were used to control and manage water resources for a stable supply (Savenije et al., 2014), as well as to divert stormwater discharges away from urban areas as quickly as possible. It was during this period that the rational method for calculating storm discharge from a drainage area, and Horton's work regarding the calculation of runoff emerged (Biswas, 1970). According to Molle et al. (2009), this pursuit, termed "the hydraulic mission", had the primary objective of "taming" nature and exploiting water resources for human use. The mission was marked by large-scale water resource developments such as dam and reservoir construction, diversion of rivers, and development of irrigation systems.

Conventional water systems developed and evolved in response to the normative and regulative underpinnings of a safe and secure water supply, and public health and flood risk protection from sewerage and drainage systems (Brown et al., 2009). In these systems, drinking water appears, and stormwater and wastewater disappears. A water supply usually relies on large, centralised infrastructure and a single water source, such as surface water. Drainage and sanitation similarly rely on large end-of-pipe infrastructure, taking the form of separate or combined sewers. These centralised systems depend on conservative hydraulic[3] engineering approaches and technocratic expertise, and use tried and tested technology with built-in redundancy, often at a large cost – financially, as well as environmentally and socially.

Conventional systems are generally focused on water resource efficiency under assumptions of stability and predictability (Rockström et al., 2014). In traditional hydrology[4], humans are often treated as a boundary, or considered as external forces in the water cycle, under the premise of stationarity; i.e. they are constant over time (Heine and Pinter, 2012, Remo et al., 2012; Di Baldassarre et al., 2013). Hydrology often analyses the catchment under idealised conditions, which is increasingly irrelevant in a changing world where the human hand is evident in nearly all aquatic environments (Wagener et al., 2010; Sivapalan et al., 2012).

The growth of urban areas results in changes to the physical properties of the land surface and is accompanied by a range of well-established hydrological challenges (Wong and Eadie, 2000; Schoeman et al., 2001; Butler and Davies, 2011; Baek et al., 2015). These challenges are primarily associated with the increase of impervious surfaces and the introduction of artificial drainage that reduces infiltration, and increases runoff and pollutant loads (Horner et al., 1994; Mckee et al., 2003). These impacts have multiple adverse effects on urban rivers in particular, a phenomenon termed the ‘urban stream syndrome’. Symptoms of this syndrome include increased flows, flashier hydrographs and elevated concentrations of nutrients and contaminants (Walsh et al., 2005). The traditional design of hydraulically efficient, concrete lined pipes is a principal cause of the syndrome as it results in higher flows of contaminated runoff transported to urban streams (Brown, 2005; Wong and Eadie, 2000).

The urban stream syndrome often manifests differently in developing countries because of differences in the patterns and histories of economic development and urbanisation (Capps et al., 2016). Urban streams in developing countries provide multiple uses such as ecosystem services, building materials, water for irrigation and households and as a drainage system for natural and anthropogenic (sewage, greywater and solid waste) inputs (Obrist et al., 2006; Armitage, 2011). Solid waste is a particularly prevalent problem in developing countries, and especially in informal settlements (Figure 3.2). For example, Armitage and Rooseboom (2000) estimated the potential annual cost of cleaning South Africa’s urban waterways of litter at approximately R2 billion in 2000. Litter decreases liveability of urban areas, poses a human health hazard, threatens ecosystem health and incurs significant clean-up operation costs. Poorly functioning solid waste systems coupled with limited wastewater treatment in

developing countries also highlight the issue of emerging contaminants (from pharmaceuticals and hormones, to personal care products and more) and their potentially harmful impacts on human health and the environment (Arukwe et al., 2012; Minh et al., 2006).

Figure 3.2 An example of a drainage channel being used as a conduit for solid waste in Masiphumelele settlement, Cape Town
(photo: N. Armitage)

Conventional centralised approaches have certainly provided immediate benefits for billions of urban dwellers by addressing a small number of targeted water problems, i.e. those of water supply, public health and flood risk protection (Gleick, 2003; Vörösmarty et al., 2004).This has, however been accompanied by many adverse social, economic and environmental consequences. Many of these consequences are externalised onto the environment and people, and are traditionally not included in narrow technical considerations (Hoekstra et al., 2018; Lloyd et al., 2002). Consequences such as the tens of millions of people displaced from their homes by water projects over the past century, flows in rivers such as the Nile, Amu Darya and Colorado not reaching their deltas, and highly compromised ecosystems below dams are not always considered in the cost of production for water supply systems (Gleick, 2003). Furthermore, the objectives of urban water systems have expanded far beyond the initial ones, to those relating to their resilience to a range of shocks and stresses[5], equity, amenity and long-term sustainability. Consequently, the ability of conventional centralised

approaches to respond not only to the expanded societal objectives for water systems, and mounting global pressures, but also to provide for the urban developing world, is increasingly and widely doubted (Brown et al., 2009; Rockström et al., 2014; Savenije et al., 2014; Hoekstra et al., 2018).

3.2.2 A renewed technical agenda

The growing acknowledgement of the flaws of 'inherited wisdom', coupled with the uncertainty characterising the Anthropocene has led to the need for a renewed technical agenda. It is now essential to expand on the specific engineering and technocratic knowledge and expertise required for conventional centralised systems. This agenda is rooted in 'new' urban water resource thinking that has broadened step-wise to a resilience-focused water sensitive approach (Figure 3.3). This visionary approach is largely still at the level of policy and academic rhetoric and the discussion below explores this new paradigm of water management, which can cater for the deep uncertainty of climate change and other risks.

New thinking and practice are being focused on managing blue (liquid stored in surface or groundwater) and green (infiltrated or evapo-transpired rain) water, with a broader focus on land-water ecosystem and cross-scale interactions (Gordon et al., 2005; Rockström et al., 2009). It represents a deeper social-ecological resilience-based approach to integrated land and water-resource management, where hydrological systems are the interface between the environment and society (Montanari et al., 2013; Rockstrom et al., 2014). This approach connects well to WSUD, with clear linkages to the WSUD principles of resilience, sustainability, source diversification and multifunctionality (Figure 3.3).

This integrated thinking has a long history, reaching back to the emergence of Integrated Water Resource Management (IWRM) in the 1950s, and its re-emergence in the early 1990s. Various other concepts and principles advocating resilience and sustainability exist, and have increased both in their frequency of use and application of principles (Fletcher et al., 2014). For example, concepts such as Low Impact Development, Sustainable Urban Drainage Systems and Integrated Urban Water Management emphasise the need for addressing uncertainty through building resilience into water management systems (through for example, diversifying water sources) and the need to plan for extreme events as a 'new normal'.

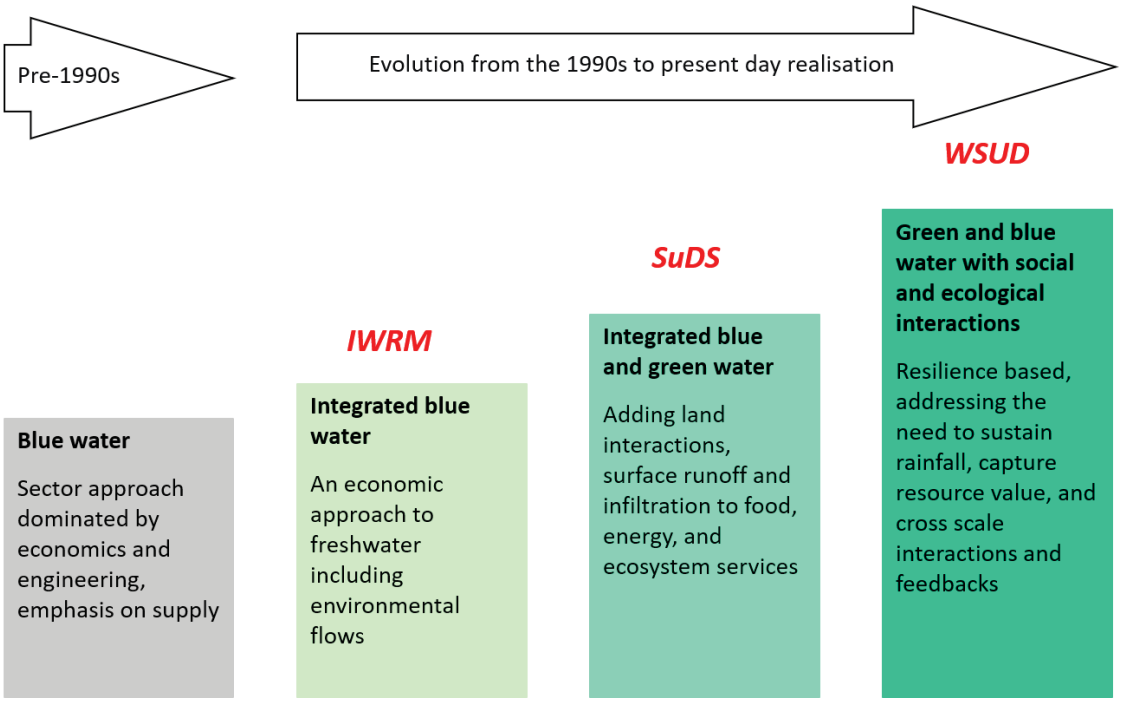

Figure 3.3 The evolution of water resource management (from Rockstrom et al., 2014)

It is increasingly held that the technical challenges of urban water management in the Anthropocene are largely related to socio-economic and governance issues. It is thus not likely that solutions will be found through the development of ever more sophisticated technical fixes. In fact, technical solutions already abound, with Chocat et al. (2007) noting that “we certainly have the technology to solve urban water management problems in a technocratic way”, especially if funding is not a problem. For example, polluted water can be treated to any degree of purity at an ever-increasing cost, and Fourth Industrial Revolution (4IR)-enabled technology such as real time control of stormwater ponds can be used to protect cities from flooding and to harvest stormwater.

However, can a continued technical approach tackle the increasing governance and socio-economic pressures? Harremoës (2001) asks whether the engineer is simply the instrument for "pursuance of the technical fix" and thus becomes an obstacle to addressing the basic causes which are socio-economic? Costly, ‘after-the-fact’ technological fixes just address symptoms and not underlying causes. With a renewed technical agenda, instead of being builders of pipes, dams and treatment works, technical personnel become central members of multidisciplinary teams guided by the vision of a resilient and water sensitive system for cities (Niemczynowicz, 1999); the notion that water problems will be solved by the construction of more infrastructure is abandoned (Gleick, 2003). This is exemplified in Table 3.1 that highlights some of the attributes of a WSC compared to one with conventional, centralised systems.

The grand scale and 'wicked' nature of the urban water challenges in the Anthropocene demand collaboration and resilience building (Montanari et al., 2013). With firm roots in multidisciplinarity and a strong commitment to integration, the technical elements of ensuring water security will be enriched and strengthened through the inclusion of other disciplines, rather than being diluted (Rockström et al., 2014).

Table 3.1 Attributes of a Water Sensitive City compared to current traditional regimes (Brown et al., 2016)

Attribute	Traditional regime	Sustainable regime
System Boundary	Water supply, sewerage and flood control for economic and population growth and public health protection	Multiple purposes for water considered over long-term timeframes including waterway health and other sectoral needs, i.e. transport, recreation/amenity, micro-climate, energy, etc.
Management Approach	Compartmentalisation and optimisation of single components of the water cycle	Adaptive, integrated, sustainable management of the total water cycle (including land-use)
Expertise	Narrow technically and economically focussed disciplines	Interdisciplinary, multi-stakeholder learning across social, technical, economic, design, ecological spheres, etc.
Service delivery	Centralised, linear and predominantly technologically and economically based	Alternative, flexible, decentralised solutions at multiple scales via a suite of approaches (technical, social, economic, ecological, etc.)
Role of public	Water managed by government on behalf of communities	Co-management of water between government, business and communities
Risk	Risk regulated and controlled by government	Risk shared and diversified via private and public instruments

A renewed approach will contribute to an 'expanded technical readiness' as described by Vörösmarty et al. (2018), through understanding and managing water as "a culturally, politically, and economically embodied resource necessary to human life" (Sivapalan et al., 2014). In this new paradigm, engineers and technical scientists need to consider building different types of redundancy into the planning of water management systems, to allow for increasingly unpredictable shocks such as the current Covid-19 global pandemic and changing population dynamics (as exemplified in the Water Strategy for the City of Cape Town

released in 2020, discussed in detail in the section to follow). This includes the consideration of nature-based solutions (NBS) and the implementation of decentralised green infrastructure options within the WSC approach that will require adapted governance processes and new knowledge for their maintenance and operation.

The new paradigm is thus likely to follow the 'soft path'; i.e. it will comprise hybridised systems with a mix of centralised and decentralised water services. Centralised, 'hard' infrastructure will be complemented with small-scale and decentralised 'soft' infrastructure, including blended 'grey' and blue-green approaches to water management (Table 3.1) that rely on the conjunctive use of traditional engineering and environmental services. Parts of the world have seen progress towards such an approach (see for example the work undertaken by the Technical University of Darmstad on the 'Semizentral' programme[6]), but it is often a patchwork of historical technocratic traditions and more sustainable and resilient management styles. The knowledge and skills, as well as the development of the appropriate supportive governance processes needed to manage these new hybridised systems, are in their infancy, specifically in developing countries such as South Africa (see text box for a description of WSUD / WSC in South Africa). This can make the transition from a traditional to a sustainable water management regime challenging and requires an ongoing consideration of interactions and feedback between the two as a means of addressing resilience.

Whilst the promise of a renewed technical agenda presents exciting prospects for the future of urban water management, caution needs to be exercised to ensure technical rigour. The significant risk of incorrect decision-making is not always appreciated as the hydro-social contract (the pervading values and often implicit agreements between communities, governments and business on the ways in which water should be managed) evolves, and water systems are expanded to include co-management and risk sharing, as well as diversification between the public and private (Table 3.1). Vörösmarty et al. (2018) reflect on this, expressing that "an expanded approach, that includes an admittedly more complex and unwieldy set of multiple perspectives that embody ecology, engineering, economics, governance, ethics and culture, will undoubtedly be a challenge for researchers and practitioners to achieve". Integrated, resilient and water sensitive principles are often embraced in theory, but face difficulties when it comes to implementation and/or practice. They should therefore be adopted in the context of developing resilient and water sensitive systems, with the acknowledgement that they may not provide an overall panacea.

WSUD and WSC in South Africa

The concepts of WSUD and WSCs emerged in Australia in the 1990s and were formalised in the 2000s through the Cooperative Research Centre for Water Sensitive Cities (CRCWSC), Australia. This approach is increasingly being adopted in South Africa, as evidenced by the Water Research Commission (WRC) publication in 2014 of a framework and guidelines for WSUD (Armitage *et al*., 2014). This was followed by the WRC's development of a WSUD Community of Practice and the establishment of WSUD as one of the WRC's five key research focus areas in 2015. WSUD is increasingly referred to as Water Sensitive Design (WSD) in South Africa, to allow for a broader focus on the development of not only urban and peri-urban communities, but also those in rural environments (Carden *et al.,* 2016).

As an example of the application of WSD at a city scale, the City of Cape Town has committed to becoming a WSC by 2040 in its new Water Strategy released in 2020 (City of Cape Town, 2020). This commitment was driven in part by the severe drought the city faced owing to below average rainfall received during the period 2015 to 2017. The drought highlighted the vulnerabilities in the system and the risk of resource path dependence wherein surface water is relied upon almost exclusively – see section below on the role of a strategy in driving a renewed technical agenda.

3.2.3 The role of an urban water strategy in driving a renewed technical agenda: Cape Town's Water Strategy

Cape Town, South Africa experienced one of the worst droughts on record linked to below average rainfall received from 2015 to 2017 (Wolski et al., 2020). The widely reported 'Day Zero' crisis, wherein the city faced the real possibility of running out of water, presented an acute shock to the urban water system. Cape Town relies largely on conventional centralised water management approaches, with water supplied mainly from the six largest dams that form part of the Western Cape Water Supply System, (WCWSS – described in a text box below). The crisis both highlighted and amplified the vulnerabilities in the system. The city is highly unequal and spatially segregated and faces challenges common to many developing countries such as weak governance and institutional capacity, limited funding and issues with services provision. Fifteen percent of the population currently live in under-serviced informal settlements, with communal, often dysfunctional water and sanitation facilities and limited drainage infrastructure. Whilst the 2018 rainfall season provided some immediate relief, the crisis exposed the larger need for a water system rooted in principles of resilience, equity, sustainability and water sensitivity. This imperative to build resilience that would enable the water supply system to respond to a range of shocks was further highlighted through the public outcry and citizen action around surface water quality issues in the City that arose during 2019, as well as the impacts that were felt in respect of health and the economy as a result of the Covid-19 pandemic during 2020 and beyond.

The City of Cape Town municipality has prioritised and actioned these principles of resilience, equity, sustainability and water sensitivity by developing a water strategy entitled *Our Shared Water Future: Cape Town's Water Strategy* (City of Cape Town, 2020a). The document provides a best practice example of the requirements necessary for the consideration and development of an enabling governance environment for a changed approach to urban water management. The strategy makes five strong commitments, covering issues of equity and inclusion, to its four million citizens 1) Safe access to water and sanitation; resilience to shocks, specifically drought, 2) Wise water use, 3) Sufficient, reliable water from diverse sources, 4) Shared benefits from regional water resources; and ongoing sustainability, 5) Transition to a Water Sensitive City. The strategy provides a high-level roadmap and outlines various roles and responsibilities, required capabilities, legislative elements and regulatory and financing mechanisms. The strategy expands the notion of water security beyond that of a quantity issue, and as such, integrated skills and knowledge from multidisciplinary teams are emphasised. Furthermore, while the acute shock of the water crisis was the primary driver of the strategy, it was also shaped and influenced by other chronic stresses and challenges such as persistent water quality issues, climate change, increased urbanisation concentrated in Cape Town's informal settlements and the citizens' distrust in the ability of the municipality to manage these challenges.

During 2020, the City of Cape Town took the first step towards operationalising the high-level strategy through a comprehensive, facilitated WSC transition planning process centred on co-creation and engagement with all relevant stakeholders. The well-established process involved benchmarking the current water sensitive performance of the city using the Water Sensitive Cities Index developed by the Cooperative Research Centre for Water Sensitive Cities (CRCWSC) in Australia (Rogers et al., 2020), curating a dedicated water sensitive vision for Cape Town and developing an implementation strategy. As the only South African city to date that has moved beyond a broad strategy towards the operationalisation of a WSC, the process in Cape Town provides a useful example of a systematic approach to building water resilience.

3.2.4 The challenge and opportunity of the urban developing world

The urban developing world is the arena in which the battle for resilient and water sensitive systems will be won or lost. The continued failure of governments to meet the basic water and sanitation needs for large parts of the world's urban population in developing countries highlights the urgency of this agenda. Much of the urbanisation of the future will occur in cities in developing countries, especially in peri-urban or urban slums. For example, Jacobsen et al. (2012) note "Africa's rapid growth means that half of the city of 2035 has not yet been built".

Exporting the developed world's conventional, centralised model is illogical and inappropriate in many of these contexts (Vörösmarty et al., 2015). Gleick (2003) notes that the assumption regarding the urban developing world is that per capita demand for water and related services

will reach that of developed nations. Given our current failure to provide water services, it is unlikely that conventional centralised and expensive water supply and treatment infrastructure will be able to meet the future demand. It is thus suggested that water systems in the urban developing world do not need to follow the trajectories of conventional systems and approaches from the developed world, or be burdened by legacy infrastructure. Instead, there needs to be a recognition that these water systems require a different approach due to the challenges that they face being different and often harsher; i.e. high population densities, lack of land tenure, unsuitability of terrain for water services, sub-standard housing and other infrastructure, and a lack of funds and municipal revenue. A renewed technical approach for the developing world must prioritise the principles of equity and dignity for dense and rapidly growing areas. There must also be a recognition that the 'conspicuous' consumption of water that takes place in the developed world is not likely to be sustainable in the long term.

When exploring possible trajectories in the search for resilient and water sensitive approaches for the urban developing world, the evolution of the hydro-social contract in the developed world is useful. The hydro-social contract[7] can be considered through three mutually reinforcing pillars of normative (values and leadership), regulative (administration, rules and systems) and cognitive (dominant knowledge, thinking and skills) dimensions (Brown et al., 2008). As the normative and regulative dimensions of the hydro-social contract in the urban developed world evolved, the cognitive response drove service delivery outcomes. Responding to the need for a secure water supply, drainage and sanitation, historically, the cognitive dimension employed a hydraulic engineering approach – which still predominates today. The Urban Water Management Transitions Framework (UWMTF) suggested by Brown et al. (2008) illustrates the cumulative socio-political drivers and the service delivery functions of the cognitive response, particularly prevalent in the urban developed world (Figure 3.4). This trajectory looks different for the urban developing world, however.

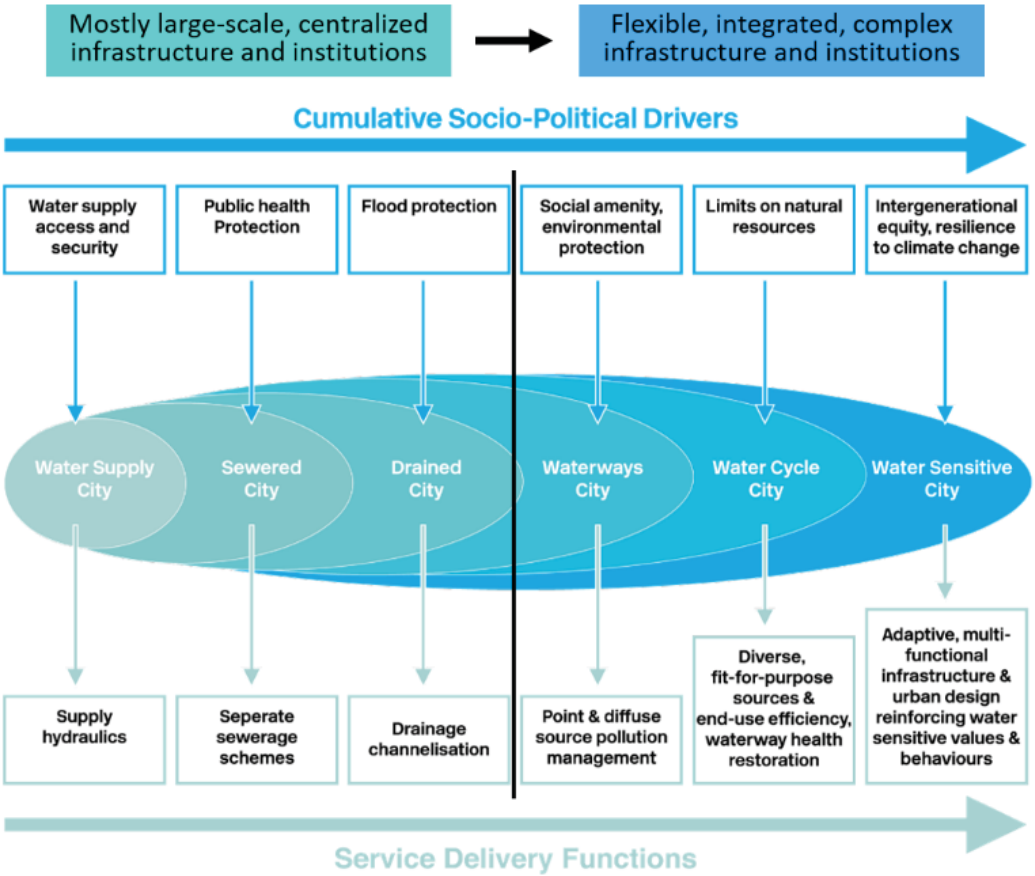

Figure 3.4 Urban Water Management Transitions Framework (from Brown et al., 2008)

The development of the UWMTF was largely based on Australian cities and was envisaged mostly for cities in developed countries. The framework has been adapted by Armitage et al. (2014) to include South African cities that have been shaped by the legacy of Apartheid and are characterised by both formal and informal areas with varying levels of urban water services (Figure 3.5). While the framework was adapted specifically for South African cities with their unique history, it has broader relevance for many other cities in the developing world, particularly relating to 'Informal areas'. Unlike cities in the developed world, early city states in developing countries are often not characterised by the provision of water, sanitation and drainage services via conventional centralised infrastructure, but rather by limited and ad-hoc service provision.

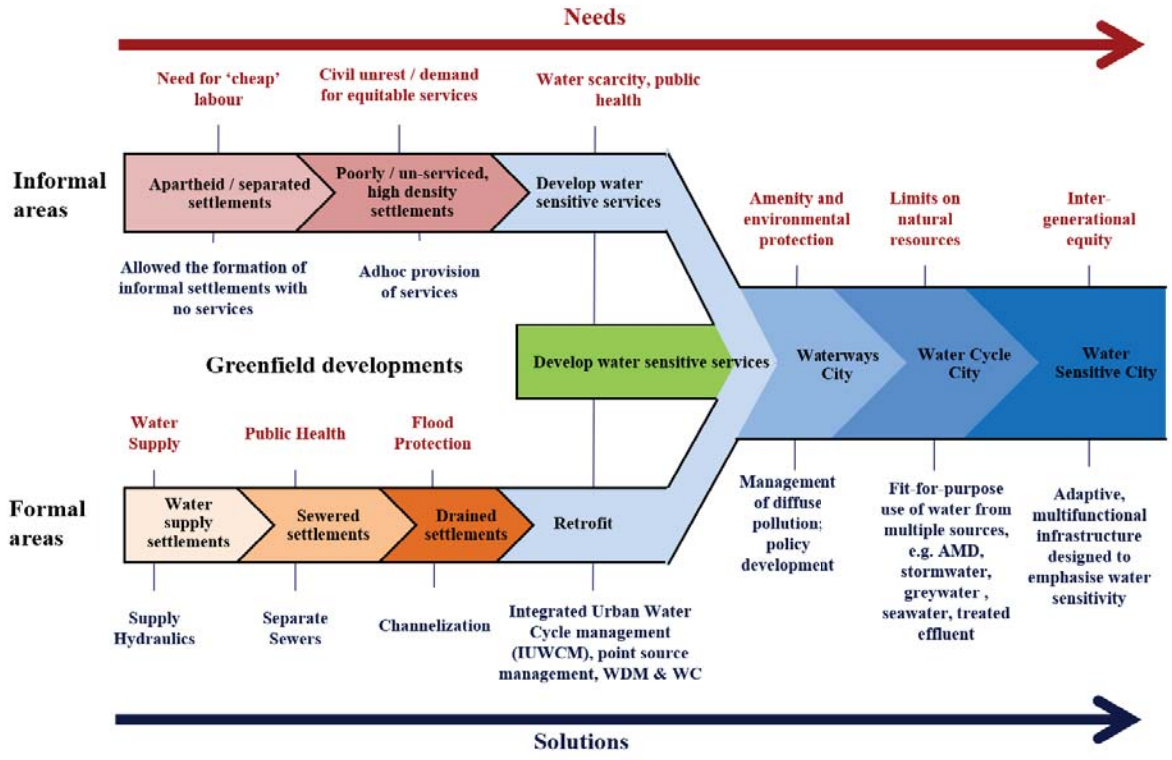

Figure 3.5 Transition framework for Water Sensitive Cities in South Africa (Armitage et al., 2014)

Given the fact that the first three city states for formal areas (i.e. Water supply, Sewered and Drained settlements) rely on centralised approaches to water management (as per Figure 3.4), the notion of 'leapfrogging' in developing countries is coming to the fore. In theory, leapfrogging is posited as a means of allowing developing country cities to skip these less desirable states and avoid making the mistakes that developed country cities have made in their pasts. Brodnik et al. (2018) state that "…the concept of leapfrogging suggests that undesirable conditions that increase levels of pollution and vulnerability can be bypassed to reach the more desirable sustainable and resilient conditions. Cities in developing countries are particularly well positioned to take these leaps forward because less resources have been invested in traditional urban water management infrastructure and institutions which makes them more receptive to water sensitive practices".

As cities progress along the UWMTF, the management of water quality, in the context of water sensitivity and security, becomes increasingly important, particularly in the developing world. The lack of basic service provision, and weak governance and institutional arrangements in developing cities mean that water quality problems abound, posing grave public and environmental health risks. Addressing water quality issues is highly complex and challenging, with lessons from the developed world indicating that response times to water quality problems are lengthy – seldom being less than a generation. For instance, in "Western Europe and

North America, it took more than 100 years for societies to first collect and then appropriately treat wastewater" (Rockström et al., 2014). Assuming this trajectory will continue, the urban developing world has a long path ahead.

Societies moving towards sustainability do so in cycles, with hydrological exploitation and infrastructure development followed by 'band-aid' solutions addressing environmental degradation, and only after that a push for sustainability (Vörösmarty et al., 2015) (Figure 3.6). Once again, the urban developing world must avoid this trajectory and learn from past mistakes, not least for the most vulnerable people living there. The water quality trajectories of a water body depend primarily on the country's stage of development; much of the developing world has not entered its peak and water quality will likely get worse before it gets better. Figure 3.6 represents a time-series of the development of human-water interactions in a developed country and/or the status of economic development and a gradient of impairment, with poor countries to the left and rich countries to the right. Stage one shows the early impact of humans on water systems, with stage two showing accelerated environmental degradation from urbanisation. The end of stage two sees a fork in the road between tolerating persistent impairment and commencing rehabilitation – both with different outcomes, depending on the availability of adequate finances and expertise to deal with ever more challenging water quality issues.

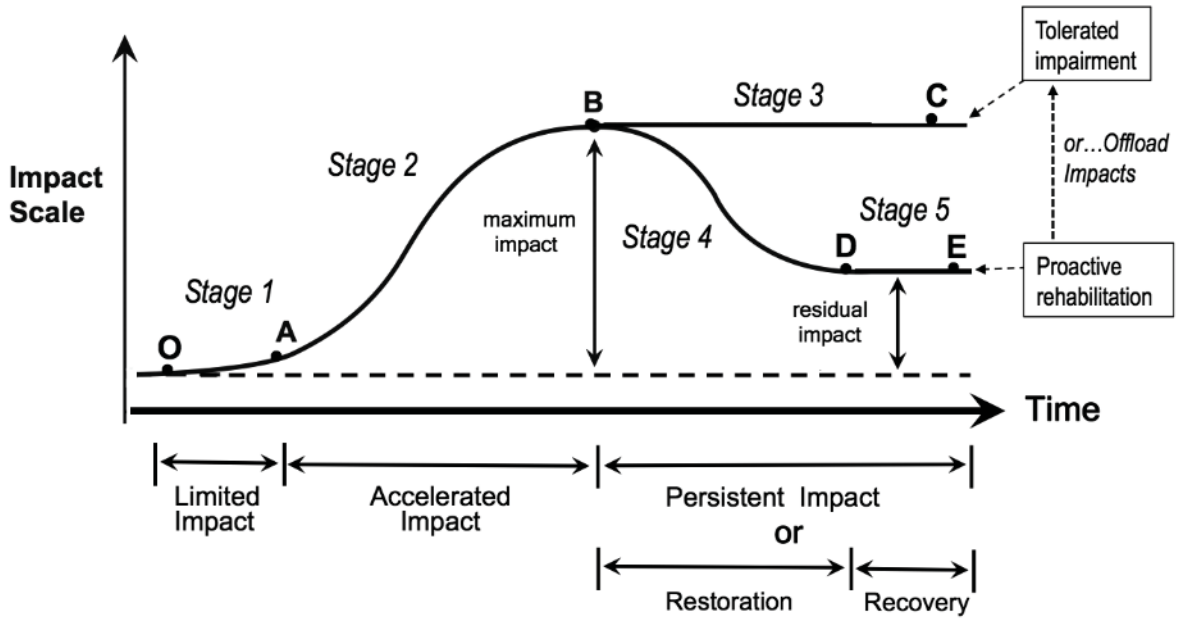

Figure 3.6 Typology of water system impacts and societal response to water-related environmental stress (Vörösmarty et al., 2015)

3.3 A TECHNICAL PERSPECTIVE ON INTEGRATED WATER SYSTEMS

This section provides a discussion on the knowledge, principles and practices of managing an integrated and water sensitive system from a technical perspective. As the technical sciences expand, elements such as governance and human behaviour, which were conventionally considered as beyond the technical realm, are incorporated. The principles and practices below do not form an exhaustive list, nor provide a commentary on context. In addition, some are universal while others are context-specific; however, they provide an overview of the important considerations for an integrated water management approach.

3.3.1 The urban water cycle as one integrated system

Water supply, sanitation/sewerage and stormwater are one interconnected system (see Figure 3.7). Each part cannot be viewed alone, and needs to be managed as part of the system. The three parts can interact with each other negatively, for example through the contamination of drinking water by poor sanitation, as well as positively, with wastewater and stormwater potentially providing a viable water supply (Jacobsen et al., 2012). All water sources (freshwater supply, rain, rivers, sea and wastewater) are interconnected with each other and other urban systems (parks, roads, energy, solid waste, etc.) so that efficiencies and synergies arise from a coordinated approach (International Water Association, 2016).

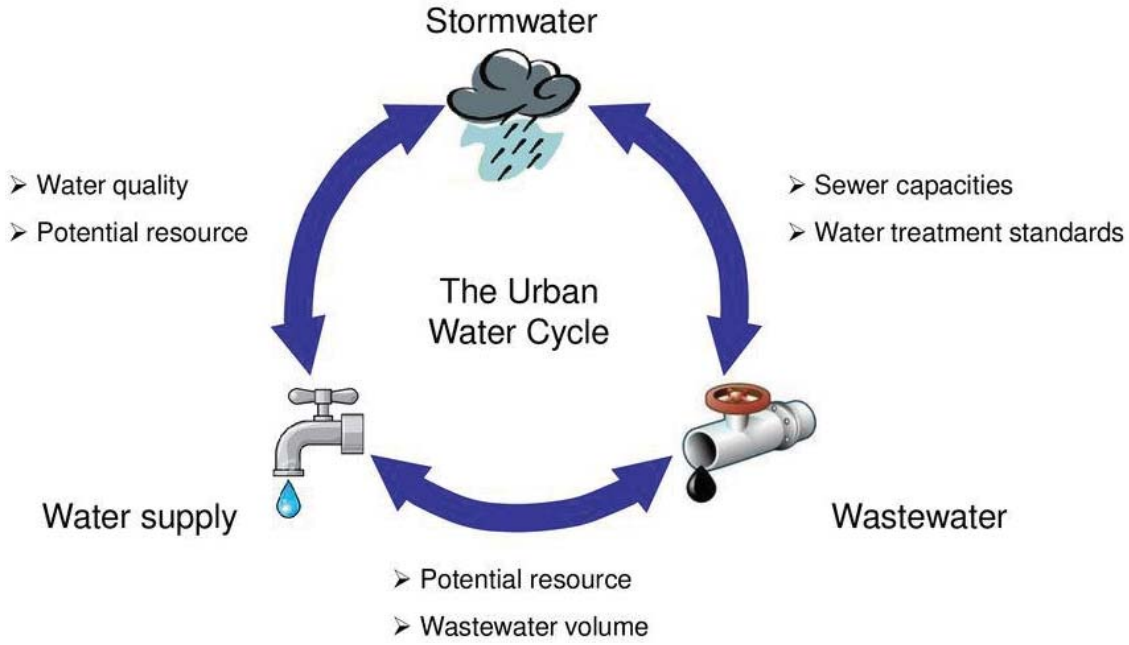

Figure 3.7 Linkages within the urban water cycle (Philp, 2010)

Western Cape Water Supply System, South Africa

The Western Cape Water Supply System (WCWSS) is a regional, integrated surface water system of six large rain-fed dams that provide water to urban and agricultural users in the Western Cape Province, South Africa. The users include the metropolitan municipality of Cape Town, which uses approximately 64% of the water for its citizens, the agricultural sector (29%), and smaller towns in the province (7%). The shared system is managed by the National Department of Water and Sanitation in partnership with urban and agricultural users. The system is facing multiple threats including invasive alien vegetation, allocation issues between the users, climate change impacts and deteriorating water quality from changing land uses. Managing these threats is key to ensuring adequate water for the economically important agricultural sector, as well as an appropriate supply to urban areas.

The impacts of climate change on the WCWSS were evident during the severe drought the Western Cape recently faced – and the associated 'Day Zero' crisis. The drought was the worst on record since 1904 and was largely as a result of below average rainfall over the period 2015 to 2017. As dam levels plummeted, WCWSS users were forced to take drastic measures in the face of the crisis. Cape Town focused largely on an expanded water demand management (WDM) programme, with stringent water restrictions and steep tariff increases. Daily restrictions dropped to a low of 50 litres per person per day (ℓ/c.d) at the most extreme. Interestingly, the restrictions also reiterated the plight of the 15% of Cape Town households living in informal settlements, already existing in a form of 'Day Zero' scenario. Water supply in these areas is through communal taps, and demand is consistently low (approximately 40 ℓ/c.d), limited by the volume of water that can easily be carried.

An intensive pressure management program was also employed, which made a significant contribution to water use reduction. The program was strengthened through a contract with the private sector to isolate the supply network into zones that could be pressure managed. Pressure in these zones was drastically reduced, with an estimated saving of 50 million litres per day during the first three months of 2018. Through this process, using both automatic pressure reduction valves as well as manual controls, the city was able to reduce water use at the same time as retaining a 24/7 pressurised system. The WDM efforts were highly successful, with a 40% reduction in water use achieved. In early 2016, before the drought, daily demand was over 1000 Mℓ a day and dropped to its lowest at just below the 500 M target in early 2018 at the height of the 'Day Zero' campaign.

Understanding and managing the urban water cycle as an integrated system also leads to the prioritisation of public health, environmental improvement and quality of life outcomes. In particular, the role of planning in the provision of public services is critical in ensuring the equitable provision of water-based services – specifically if it acts as a "cornerstone for service

management" (Heller et al., 2014). The Brazilian example of adopting multi-sectoral and holistic planning for water supply, sanitation, urban solid waste management and the management of urban stormwater as one integrated system – known as 'environmental sanitation' – provides a useful means of ensuring broader access to these services (Heller et al., 2014).

3.3.2 The urban water cycle is intrinsically connected to the catchment and its users

A city is dependent on, and intrinsically connected to the catchment of which it is a part, as well as other catchments with which it interacts through the abstraction of water and the generation of waste (International Water Association, 2016). Catchments outside of cities provide many ecosystem services, most notably in respect of water sources, that are often not understood or appreciated until these areas are degraded (see further details in this regard in Chapter 2). Catchments are often shared by multiple and conflicting users, particularly urban areas and agriculture (see text box on the WCWSS as an example). Thus, catchments need to be managed in concert with the other users that rely on them, and protected to ensure good water quality.

3.3.3 Water supply diversification with fit-for-purpose water

The conventional model of relying on a limited number of surface water sources to supply centralised systems leaves cities increasingly vulnerable in an age of uncertainty. Diversified water sources build in reliability, security and resilience. Groundwater, stormwater, greywater and blackwater can supplement surface water, and these resources can be used in a fit-for-purpose manner, i.e. matching water quality with its intended use (see text box for a best case example of this in Windhoek, Namibia).

The philosophy behind this principle speaks to improving the productivity of water, rather than seeking endless new supplies. Rather than delivering quantities of potable water for illogical uses (think waterborne sanitation), fit-for-purpose water delivers water services and qualities matched to users' needs. Whilst water 'consumption' is an accepted term as an indicator of demand, it implies that water is 'consumed' whereas it is not. Theoretically, almost all water that is used is available for re-use, indefinitely. The key consideration is therefore not so much water quantity but rather water quality. Given the adequate control of water quality, there is an adequate quantity of water for all, forever, through recycling.

By using alternative water sources, the WSUD concept of 'cities as catchments' can be practised – thus reducing our reliance on the importation of water sources from outside of city boundaries. In this regard, 'Sponge Cities' (Fuldauer, 2019) are designed to absorb large quantities of water and slowly disperse it back into the environment. Like sponges, they are made of porous surfaces and spaces capable of retaining water. Permeable roads and sidewalks, green roofs, wetlands and natural vegetation are all able to absorb, allow infiltration, store, purify, drain and manage rainwater. The system mimics the natural hydrological cycle in order to avoid flooding and is not only capable of dealing with a sudden excess of

stormwater but also reuses it to help mitigate the impact of droughts. A Sponge City is more than just its infrastructure; it is a city that makes urban flood risk management central to its urban planning policies and designs. There are planning and legal frameworks and tools in place to implement, maintain, and adapt the infrastructure to collect, store, and purify excess rainwater. The concept has been put into practice on a large scale in China where a Sponge City pilot project was launched by government during 2015, with 30 cities taking part. By 2030, the aim is that 80% of urban areas in China should absorb and reuse at least 70% of rainwater.

Wastewater reclamation in Windhoek, Namibia (Veolia, 2018)

"*In Windhoek, every drop of water counts*" – this is the motto of the Windhoek Goreangab Operating Company (Pty) Ltd. (WINGOC). It manages one of the few facilities in the world producing drinking water from wastewater. In 2001 the company signed an operating contract with the city of Windhoek that was aimed at improving wastewater treatment processes and increasing the site's production capacity. Recycling wastewater increases the amount of drinking water available, but also has a twofold benefit for the environment; it avoids tapping into natural resources and significantly reduces pollutant discharges.

Namibia is one of the most arid countries in Africa: the average rainfall is 250 mm per year, and the hot climate causes 83% to evaporate; only 1% of rainwater infiltrates into the ground. Consequently, the water supply of Windhoek – located in central Namibia – depends mainly on boreholes as well as three dams located 60 and 200 km away. To cope with shortages, the city has sought alternative solutions to secure its water supply. The various treatment processes associated with the direct reuse of treated wastewater, coupled with rigorous bio-monitoring programs, guarantee high quality, safe drinking water. The current system also allows for Managed Aquifer Recharge (MAR) processes to store (i.e. 'bank') excess treated water in the underground aquifer as a resilience strategy.

3.3.4 Monitoring and measurement for technical planning and communication

Access to quality data that are appropriate and timely is vital for driving a renewed technical agenda. Water monitoring provides information that is essential for guiding law and policy-making, understanding the effects of climate and land use change on hydrological systems and estimating hydrologic extremes. Without accurate data, the status of water resources cannot be sufficiently evaluated, effective water management and reuse programs cannot be executed, and the success of programs cannot be judged. Not only is access to data important, there is also a need to be able to process and transform the data into useful information, particularly for communication purposes.

Water resource managers cannot plan or site new water-related services effectively without detailed knowledge of the distribution and characteristics of existing infrastructure – both

natural and constructed. Such data limitations are a common problem in developing countries (Poustie et al., 2015). Monitoring networks are needed to help ensure that investments in protecting and restoring water resources are effective, which in turn can engender public confidence in the safety and reliability of their water supplies. To this end, it is important that there is an effective means of communication the right kind of data to the public. The Fourth Industrial Revolution (4IR) is an enabler when discussing the importance of data in water resource management and planning. It marks a new chapter in innovation for the water sector, with developments like the Internet of Things, artificial intelligence, blockchain and big data unlocking an abundance of previously inaccessible water data and opening up new ways of ensuring water security (World Economic Forum, 2018).

Four types of water data are particularly important for a renewed technical agenda:

1. Data on trends: for example, population growth rates and daily water demand
2. Predictive data on projected future changes: for example, decreases in net precipitation, population growth, information about surface water availability and increases in population
3. Monitoring data on the quality and quantity of water resources and water infrastructure: for example, groundwater abstraction volumes as well as pipeline monitoring for informed maintenance, and responses of wastewater treatment works (WWTWs) to reduced flows. Data can provide information on the types of alternative water resources as well as on water quality, thus providing an important public health function.
4. Smart meter data and resource monitoring data for communication

Data have a critical role to play in the communication processes necessary to build water sensitive communities. The availability of data helps promote collaborative decision-making, foster awareness and influence water use behaviours. This is particularly true in the context of a water crisis, where data can be used to navigate the complexity of crisis responses. For example, the City of Cape Town made extensive use of data in various forms to communicate with its citizens during the 'Day Zero' crisis, thus contributing to drastically reducing water demand. The City instituted a comprehensive and sustained communication campaign using various tools including (i) a novel Water Map that used different coloured dots to show water use per household for free-standing houses. The map helped citizens to see how their own water use was faring compared to the required restrictions, their neighbours and other homes across the city, and (ii) a weekly 'water dashboard' that provided information and projections on dam levels, water consumption and the progress of augmentation projects in a digestible graphic format (City of Cape Town, 2020b).

3.3.5 Enhanced ecosystems and multi-functional green infrastructure

Protected and enhanced ecosystems can provide services for both the natural and the built environment. Multi-functional green infrastructure[8] enhances liveability and amenity whilst also

providing other services such as flood protection – as exemplified in the 'Active, Beautiful, Clean Waters' programme that has been implemented in Singapore (see text box). Natural capital forms the building blocks of resilient water sensitive systems, with water-related ecosystem services providing water quality regulation and the moderation of extreme climate events, amongst other services (Vörösmarty et al., 2018). The IUCN (2018) defines nature-based solutions (NBS) as actions that may be taken to protect, sustainably manage, and restore natural or modified ecosystems; that address societal challenges effectively and adaptively and simultaneously provide human well-being and biodiversity benefits. NBS are a central focus of the 2018 UN World Water Assessment Program's report (UN-Water, 2018).

Kallang River Bishan Park, Singapore (Dreiseitl, 2012)

Bishan Park is one of Singapore's most popular parks and has more than 3 million visitors annually. As part of a much-needed park upgrade, along with other plans to improve the capacity of the Kallang River along the edge of the park, works were carried out simultaneously to transform the utilitarian concrete channel into a naturalised river, and to create new spaces for the community to enjoy. This project formed part of the 'Active, Beautiful, Clean Waters' (ABC Waters) Programme in Singapore, run by the Public Utilities Board that manages the country's water supply and drainage. The Programme is a long-term initiative to transform the country's water bodies beyond their functions of drainage and water supply, into vibrant, new spaces for community bonding and recreation.

At Bishan Park, a 2.7 km long, straight concrete drainage channel has been restored into a sinuous, natural river 3 km long, that meanders through the park. Sixty-two hectares of park space have been tastefully redesigned to accommodate the dynamic processes of a river system – including fluctuating water levels – while providing maximum benefits for park users. Three playgrounds, restaurants, a new lookout point that was constructed using the recycled walls of the old concrete channel, and plenty of open green spaces complement the natural wonder of an ecologically restored river.

The conjunctive use of traditional engineering and environmental services is required if a blended grey-green approach to water management is to be adopted in a WSC. Relying solely on grey engineered infrastructure is economically prohibitive for much of the urban developing world, and often has negative environmental consequences. However, drainage of stormwater, greywater and sewage is inadequate (or non-existent) in most informal settlements, and the ability to implement 'green' drainage solutions in these areas is often challenging, due to physical constraints as well as social challenges (Jiusto and Kenney, 2016). There is thus a need to develop relatively innovative, simple and practical drainage technologies that incorporate Sustainable Drainage Systems (SuDS) principles, in collaboration with local residents and stakeholders. Such a solution was highlighted in the Genius of Space project in Langrug settlement, Franschhoek, South Africa[9]. In this project, household-level greywater disposal points were installed using local materials. The wastewater drained into bioretention cells and tree pits throughout the settlement

(see Figure 3.7), resulting in reduced pooling of contaminated water, and an improvement in the quality of water being discharged to the downstream river system.

3.3.6 Enabling governance, political and legislative elements necessary for technical interventions

The complexities around technical water issues are often linked to the ways in which appropriate technical decisions and approaches can be made, and the supporting governance, political, and legislative environment that enables these actions. An enabling governance, political and legislative environment provides the framework for stakeholders to work together and facilitate a paradigm shift to a resilient water system.

The shift to resilient and water sensitive approaches requires a fundamental restructuring of the hydro-social contract. Such a system would include, inter alia, co-management between different spheres, the dispersed operation of and responsibilities for hybridised water systems, and shared risk. An enabling policy landscape that supports new ways of thinking and practice is also required. Strong inter-governmental relationships across national, provincial and municipal entities are necessary in order to provide the required support – both financial and technical – for water services provision.

Figure 3.8 Tree pit for the treatment of greywater in Langrug informal settlement, Franschhoek
(photo: J. Fell)

3.3.7 Sufficiently capacitated multidisciplinary teams

Implementing a paradigm shift in water resource management requires sufficiently capacitated, multidisciplinary management, planning and operations teams. Technical skills need to be embedded in an integrated interdisciplinary team where there is exposure to multiple disciplines daily. This is particularly important to ensure that technical decisions are socially just and environmentally sound, and that all geographic areas and socio-economic classes receive the same level of service. Interdisciplinary teams bring in multiple social, environmental, economic and political perspectives that enable the creation of resilient water systems.

Cities need to retain and nurture existing skills through policies and actions. Failure to ensure that there are adequate technical skill sets is one of the single biggest strategic risks to ensuring water security. In other words, there needs to be an increased focus on ongoing staff development and education, and on retaining skills, as well as on the development of technical capacity in institutions. Multidisciplinary management, planning and operations teams form part of water-wise urban communities – as outlined in the International Water Association Principles for Water Wise Cities (International Water Association, 2016). The principles specify that water-wise communities should consist of empowered citizens, professionals aware of water co-benefits, transdisciplinary planning teams, policy makers enabling water-wise actions, and leaders that engage with and engender trust in the public. Empowered citizens are an important component of water-wise cities, and are engaged, adaptive and water-wise in their behaviour.

3.4 CONCLUSION

As Rockström et al. (2014) note, 'the relationship between water and urban dwellers is more delicate today than ever', and the need for a new urban water resource management and planning paradigm has never been clearer. Engineering and technical approaches adopted to serve the water needs of early urban settlements have been carried forward, and still shape our systems today, despite their shortcomings. However, the mounting pressures of climate and population changes, resource pressures and water pollution – increasingly including disease outbreaks and pandemics such as Covid-19 – sound out the call for a renewed technical agenda and water sensitive approach. In particular, the under-served urban centres in the developing world require an urban water management approach that entrenches equity, sustainability and resilience, and this cannot be achieved by making the mistakes of the past.

The following five key lessons that emerged from the Cape Town water crisis (and were reflected upon at the 'Cities facing escalating water crises' conference that was held at the University of the Western Cape in January 2020) have been used as the framework for this paper:

1. Create water sensitive and resilient cities that include the concepts of 'the city as a catchment', water quality protection, liveability, and ecosystem protection
2. Practice integrated water planning and management that ensure sustainable and equitable water access
3. Build water smart cities that are connected with real-time relevant data and information that is shared widely
4. Ensure a collaborative and supportive governance environment to unlock synergies
5. Cultivate informed and engaged water citizens, and empower residents, government, businesses, NGOs, and the agricultural sector to make a difference

Using these lessons as a starting point for the discussion, this paper has presented a selection of principles and practices for Water Sensitive Cities based on a renewed technical agenda.

The principles emphasize the need to consider the urban water cycle as an integrated system that is intrinsically connected to the catchment and its varied users. Within a WSC, the practices centre on building a diversity of supplies that provide water that is fit for purpose, and that is underpinned by timely and actionable water data, not only for management purposes but to create ‘water-savvy’ citizens. The renewed technical approach speaks to the importance of multi-functional, blue-green infrastructure and enhanced ecosystems, and critical to this is an enabling governance, political and legislative environment led by multidisciplinary teams that facilitate and entrench equity, resilience and sustainability into day-to-day practices.

ENDNOTES

[1] "In its broadest context, WSUD encompasses all aspects of integrated urban water cycle management, including water supply, sewerage and stormwater management. It represents a significant shift in the way water and related environmental resources and water infrastructure are considered in the planning and design of cities and towns, at all scales and densities. WSUD is now often used in parallel with the term water sensitive cities (WSC). However, there is a subtle but important distinction between these two terms; WSC describes the destination (the objective), while WSUD describes the process" (Fletcher et al., 2014).

[2] For example, the city of London installed its first conventional sewerage system after 'The Great Stink' of 1858, https://www.historic-uk.com/HistoryUK/HistoryofBritain/Londons-Great-Stink/

[3] Hydraulics is a topic in applied science and engineering that deals with the mechanical properties of fluids and modelling flows.

[4] Hydrology is the study of the movement, distribution and management of water, including the water cycle, water resources and watershed sustainability.

[5]Johannessen and Wamsler (2017) identify three different levels of resilience (socio-economic, external hazard considerations, and larger socio-ecological systems) that need to be considered in any transition to sustainability.

[6] Semi-centralised supply and treatment systems for fast growing urban areas – www.semizentral.de

[7] the unwritten contract that exists between the public and the government…that comes into existence when the individual is no longer capable of mobilising sufficient water for their own personal survival, and that acts as a mandate by which government ultimately takes on and executes this responsibility. This hydrosocial contract thus acts as the basis for institutional development, and also determines what the public deems to be fair and legitimate practice such as the desire for ecological sustainability… (Turton and Meissner, 2002)

[8] "Green infrastructure is an approach that communities can choose to maintain healthy waters, provide multiple environmental benefits and support sustainable communities. Unlike single-purpose grey stormwater infrastructure, which uses pipes to dispose of rainwater, green infrastructure uses vegetation and soil to manage rainwater where it falls. By weaving natural processes into the built environment, green infrastructure provides not only stormwater management, but also multiple functions such as flood mitigation, air quality management, and much more" (Fletcher et al., 2014)

[9] https://www.westerncape.gov.za/eadp/news/watch-genius-space-grey-water-innovation

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CHAPTER 4

THE ECONOMICS OF WATER: VALUES AND GOVERNANCE PERSPECTIVES

Charon Büchner-Marais, Gregg Brill, Cathie Lewis and Martine Visser

Figure 4.0 Water bottling plants require water of a high quality and sufficient volume to run efficiently and effectively.
Source: https://www.dreamstime.com/modern-automated-mineral-water-bottling-line-plant-industrial-background-image140708976#

4.1 INTRODUCTION

Water holds multiple values to those who use, impact or govern the resource. In times of abundance, water, as part of the commons, is often taken for granted and is not always fully appreciated or valued appropriately (OECD, 2017). In view of increasing climate variability and uncertainty, competing resource usage across urban and agricultural sectors[4] (WEF, 2018; Liedtke, 2019), and growing demand for the resource from global populations, it is crucial for society in water-scarce regions to take a much more holistic perspective to water's full value[5] (Engineering News, 2019). This value needs to consider the critical role of water and its associated ecological infrastructure in enabling sustainable livelihoods, supporting just and equitable economic systems and ensuring resilient functioning of ecosystems (OECD, 2017; ACDI, 2019).

Inequalities in access to, and use of water, also need to become focal points in planning and governance processes in order to ensure societal and ecological justice and to meet the needs of both people and nature. The reasons for the systemic underappreciation or undervaluing of water need to be interrogated, analysed, and questioned critically so as to find different approaches based on different value systems and levels of consciousness (Beck and Cowan, 2005) to meet the needs of social and ecological systems, as well as of the economy.

Economics plays an increasingly fundamental role in finding sustainable solutions to water insecurity in towns and cities around the world (WWC, 2015). The global population is growing rapidly, with more and more people moving to towns and cities. It is projected that 70 percent of the world's population will live in urban areas by 2050 (Brears, 2017). With so much growth occurring in many of the world's large cities and metropolitans, and global water demand projected to exceed supply by 40 percent in 2030 (Brears, 2017), many of these urban centres are facing escalating water shortages (WRI, 2019).

This growth in population and economies will place significant stress on the existing infrastructure and capacity of governments and water authorities to fulfil their functions and mandates, adding to the economic costs of water (WEF, 2018) and exacerbating injustices in the unequal access to water by different users. Projections indicate that climate change could further exacerbate the water stress faced by hundreds of millions of people living in cities where demand for water outstrips the current supply (Winpenny, 2003). Even with large

[4] The agro-processing sector alone uses about 130 million kilolitres of water a year, of which animal slaughtering uses 26%, brewing and malting 17% and dairy 12%. https://www.engineeringnews.co.za/article/ifc-launches-study-to-improve-water-efficiency-in-agriculture-sector-2019-12-05/rep_id:4136 [accessed 22 September 2020].

[5] Total water withdrawals for all sectors in South Africa are forecast to 2035, with 2050 marking the point at which water supply vulnerability will play a larger role in climate change and medium population growth. https://www.engineeringnews.co.za/article/ifc-launches-study-to-improve-water-efficiency-in-agriculture-sector-2019-12-05/rep_id:4136 [accessed 22 September 2020].

investments being made in infrastructure to store, treat and distribute water, many cities could face a potential 'Day Zero'[6] scenario unless a fundamental shift is made in how we use, impact, value and govern water resources (Brill, 2017; Mbovane and Chirume, 2020)[7].

> In September 2015, the United Nations (UN) adopted a dedicated Sustainable Development Goal (SDG) on water. For years, water had been undervalued, under-priced and too often taken for granted, so Goal 6 on water and sanitation was a momentous recognition of water's crucial importance across ecological, social and economic systems. Though just one of 17 SDGs, this goal also sits at the heart of many of them: water is essential for food security, health, cities, sustainable consumption and production, and terrestrial ecosystems.
>
> Leflaive and Dominique, 2018

The key questions regarding the economics of water relate to how we value and cost water effectively, efficiently and equitably, while including the relevant economic, social and environmental considerations, as well as how we should determine and agree on what those considerations should be. This chapter will explore the different dimensions of the economy and values of water, discuss historical and contemporary value systems, propose new pathways for economic engagement, and consider the development of future systems which are more inclusive of the different dimensions of the economy.

4.2 HISTORICAL AND CONTEMPORARY VALUE SYSTEMS

Historically, the value we have assigned to water is often economic in nature (OECD, 2017). Economics deals with social practice and cannot be reduced to a pure economic theorem – it is neither free of social obligation nor value-free (Höver, 2004; Ulrich, 2010). In ancient times, economy used to refer to rules to manage a household (*oikonomos*)[8], also referring to household stewardship (Smit, 1992; Leshem, 2016). Today, the meaning of economy is shifting to a much broader description of the management of all resources on earth in a manner that aims to optimise societal welfare, build long-term resilience, and ensure well-functioning ecological infrastructure (Porter and Kramer, 2011; SEBEI, no date) based on how these different systems assign and derive value from water.

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[6] 'Day Zero' – the date when potable water will no longer be available from taps or pipes. Water will be provided at designated points of distribution (pods).

[7] See for example the water crises being experienced in the Eastern Cape in South Africa. https://www.news24.com/news24/southafrica/news/water-stricken-nelson-mandela-bay-hits-day-zero-20200908 [accessed 14 December 2021].

[8] Smit D (1992: 4-5) The word economy originates from Greek (*oikonomos*), meaning 'management' or 'stewardship' of a household.

Economics is central to our understanding of value systems and guides us to make informed choices and decisions around the allocation and use of scarce resources (Wadsley, 2020). An economy is influenced by the choices made in the production, distribution and consumption of goods and services, including natural resources like water (Atapattu, no date). In essence, economics involves the decisions and choices of all role players in the economic ecosystem regarding the ways in which their value systems, needs, interests and expectations can be fulfilled by using and valuing the resources available to them (Spit et al., 2018).

We need to review our concept of the value of water, by including broader systems of value too (Figure 4.1). In ethics, value refers to the degree of importance of a particular thing or action (Mintz, 2018), introducing the concept of the 'responsible society' (Niebuhr, 1978) as a framework to search for fitting solutions in response to the issue of sustainability (Gustafson, 1999). Boyer and Polasky (2004) propose an alternative eco-centric view in which other species or ecosystem processes could be considered sources of value, as opposed to the ways in which such species or ecosystems satisfy human wants and needs. They expand their view by proposing that, rather than valuing nature in monetary terms, we should frame choices alternatively, thereby making it possible for society to make clear trade-offs between various outcomes.

The traditional approach to economics defines the value of natural resources more in terms of commodification, and less with stewardship over ecological systems and water as a life source and limited resource (Figure 4.1). Adam Smith's (1776) 'invisible hand' guiding the maximisation of personal gains from extraction and resource exploitation comes at a significant cost to our natural environment, and overshoots important planetary boundaries and thresholds (Röckstrom et al., 2009; Hawken, 2010; Biggs et al., 2015). "The situation of the Anthropocene – where the biosphere is shaped by humanity from local to global levels – reinforces that there are no ecosystems without people and no human development without support from the biosphere, hence social-ecological systems." (Biggs et al., 2015: 19). In this light, water is impacted by everyone, and everyone is impacted by water.

4.2.1 Value versus Cost

The questions of how we value and cost water, inclusive of the relevant cultural, economic, social and environmental considerations, and how we determine and agree on what those considerations will be are both poignant and pressing. Understanding the importance of costing water to correctly reflect its intrinsic and extrinsic use values is becoming critical for South Africa's future in the context of increasing climate uncertainty and water scarcity. South Africa is characterised by extreme levels of poverty and income inequality (World Bank Group, 2018), with many individuals unable to pay for an amount of water that is deemed essential for human life. With both urbanisation and economic inequality on the rise, pricing water appropriately whilst still taking into account disparities in the ability to pay amongst different

user groups (Rijal, 2014) including social cohorts and economic sectors[9], is critical to creating resilient systems, societies and cities.

Water is generally costed via inclining block tariffs (Brick et al., 2017), where increasing volumes of water usage are priced at higher rates. From an equity perspective, the inclining tariff structure makes a basic amount of water affordable for all citizens, including free allocations to some households. Households living on properties valued below a certain threshold, or that can prove incomes below a certain bracket, are classified as indigent and receive water subsidies (Ziervogel, 2019). The inclining block tariffs also ensure that those who use more water, pay a larger proportion of the cost. While these are generally higher-income households (owning swimming pools and large gardens), in the South African context, however, it also means that multiple dwellings on a single property and larger households in lower-income areas may incur higher tariffs or water-related costs, which unjustly burdens the poor financially (Bruhl et al., 2020; Cook et al., 2020).

When creating water tariffs there needs to be a careful balance between generating enough income to cover the costs of supply and fund the investment in infrastructure, and ensuring that all individuals have access to affordable basic water services. Water tariffs are set based on the scarcity of the resource, fixed costs to install, operate and maintain the infrastructure, and the ability and willingness of users to pay for the resource (Zetland and Gasson, 2013). These pricing mechanisms therefore serve as a market mechanism to constrain demand rather than focus on cost-recovery[10], considering the natural cost structure of water supply infrastructure, which requires large capital investment and decreasing marginal costs (Correia and Roseta-Palma, 2012).

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[9] The increasing demand for water resources has implications for agriculture in particular. This is because water for human consumption and for industrial production are perceived as higher-value uses that require increased levels of supply assurance (Spit et al., 2018). The agriculture and agri-processing sectors are highly dependent on a consistent supply of water for the production of goods and services and are hence increasingly at risk (OECD, n.d.).

[10] Water tariffs are set based on the scarcity of the resource, fixed costs to operate and maintain the infrastructure, and the ability and willingness of users to pay for the resource. In some cases, water is valued at a premium, whereas in other circumstances, water is provided free of charge. This balancing act influences a government's ability to raise sufficient funds to cover the economic costs of water. In many cities and towns around the world, a poor rate of tariff collection results in a significant deficit in utility coffers. The lack of sufficient funds for water infrastructure and a lack of skills to operate and maintain these systems at the local, provincial, or national levels hampers the ability of governments to provide water of a sufficient quality and quantity to households and businesses, while still maintaining the ecological reserve. The increasing demand for water resources has implications for agriculture in particular. This is because water for human consumption and for industrial production is perceived as a higher value use of water that requires increased levels of supply assurance. The agriculture and agri-processing sectors are highly dependent on a consistent supply of water for the production of goods and services. This water needs to be of a high quality, and in many cases, the use of non-potable or low quality water is not permitted due to health and hygiene standards.

In addition, working at a price that only covers the cost of delivering the service to the city does not account for the risks associated with fluctuating water levels and water security. It does not incentivise investment in infrastructure and water saving; nor does it account for the effects of climate change on future water security.

In some cases, water is valued at a premium, whereas in other circumstances, water is provided free of charge. This balancing act influences a government's ability to raise sufficient funds to cover the economic costs of water. In many cities and towns around the world, where there are poor rates of tariff collection, or where a large portion of the water users do not or cannot pay for water, a significant deficit in utility coffers results. The lack of sufficient funds for water infrastructure and a lack of skills to operate and maintain these systems at the local, provincial, or national levels hamper the abilities of governments to provide water of a sufficient quality and quantity to households and businesses, while still maintaining the ecological reserve.

> "As a former Minister of Finance, I know all too well that lack of finance is often a consequence of an issue failing to get the attention it needs on the political agenda. This is certainly the case for water. The world failed to meet the Millennium Development Goal on sanitation by a wide margin, at least in part for lack of resources."
>
> Angel Gurría, OECD Secretary-General, 24 April 2017.

Increasing municipal debt and insufficient investment in infrastructure has shed light on the inadequacy of the traditional municipal revenue model for most of South Africa. In essence, the revenue model is not geared to ensure the longer-term, resilient management of water; nor does it enable the necessary longer-term investment in, or maintenance of infrastructure (Conradie et al., 2014). Inequalities in affordability are also being laid bare by large municipal deficits or debt, thereby exacerbating the financial burden of ensuring the sustainable supply of water for all (Breier and Visser, 2012).

4.2.2 Changing the system: reshifting the focus to the real value of water

Concerted action is needed to address the present trends of overconsumption, pollution and the rising threats from climate change and other extreme events. This action will require multiple actors across a broad range of agencies, sectors and institutions. More seats will be needed at the table for all to participate and take collective ownership of these challenges. It is time that the public, the private sector, governments, non-governmental/profit organisations (NGOs/NPOs) and academia collaborate to support initiatives in local communities, projects at national level, as well as plans and programmes at international level.

Four guiding principles, set out in the Dublin Principles during a seminal multi-stakeholder international conference on water in January 1992, propose recommendations for collective action at local, national and international levels (Brears, 2017). These principles proffer that:

1. Humanity should treat and respect fresh water as a finite and vulnerable resource that is essential to sustain life, economic development and the environment
2. Water development and management must be based on a participatory approach, involving users, planners and policymakers at all levels
3. Women must be included, and play a central part in the provision, management and safeguarding of water; and
4. We must accept that water is an economic good that has economic value in all of its competing uses (ICWE, 1992)

These principles set a course of action that will enable countries, corporations and citizens to tackle water resource problems head on. They are a call to re-examine how we value water as part of a broader, holistic approach that takes into account the social and cultural values and costs (considering that water and sanitation have been explicitly recognised as human rights by the United Nations General Assembly since July 2010), environmental values and costs (including the chronic and acute impacts of climate change on stressed ecosystems), and economic costs (revenue models that make provision for longer-term investment in infrastructure) of water.

By addressing these principles, we can support the following: alleviation of poverty and disease; measures that allow adaptation to, and mitigation against climate impacts and other natural disasters; water conservation and reuse; sustainable urban development; an enabling environment for agricultural production and rural water supply; protection of aquatic ecosystems; as well as the resolution of water conflicts – many of which further align with the SDGs.

4.2.3 Nudging water consumption behaviour towards responsible use and conservation

Introducing behavioural insights into the valuation, governance and consumption of water involves not only drawing on behavioural theories in the literature (Camerer et al., 2004) but also relies on engaging external players. Most notably those players include marginalised communities, the voices of women, low-income economic households, and indigenous populations. Understanding differential responses amongst groups is key to solving some of the most poignant theoretical and practical problems around water security.

Seeking behavioural change goes beyond just complying with government regulations, but instead relies on policy makers to draw on behavioural insights and implement tools, such as behavioural nudges, in conjunction with other traditional demand-side-management (DSM) measures in order to motivate compliance from citizens (Brick et al., 2019; Gaughan, 2019).

The role of behavioural economics and behavioural change in accompanying and refining the traditional toolbox of economic instruments (such as tariff increases and restrictions) in order to inform policy making, is becoming increasingly recognised by government think-tanks and research organisations across the world.

Demand management is also a crucial aspect of behavioural economics and is specifically centred around efficient water management and pricing systems that affect consumers' decisions regarding water use (Correia and Roseta-Palma, 2012). Increasing tariffs as a DSM instrument has the advantage that it incentivises individuals to save water, while also generating revenue for the utility, despite lower water consumption (Gaughan, 2019). However, increasing tariffs only when there is a lack of supply leads to a situation where the economic agents who use the water are wasteful in times of high supply and are then vulnerable to large increases in price and instability in supply during droughts, as recently observed in Cape Town. Focusing on behavioural change and habit formation linked to sustainable water consumption, alongside longer-term planning, should therefore be a priority for policy makers to ensure sustainable supply and access.

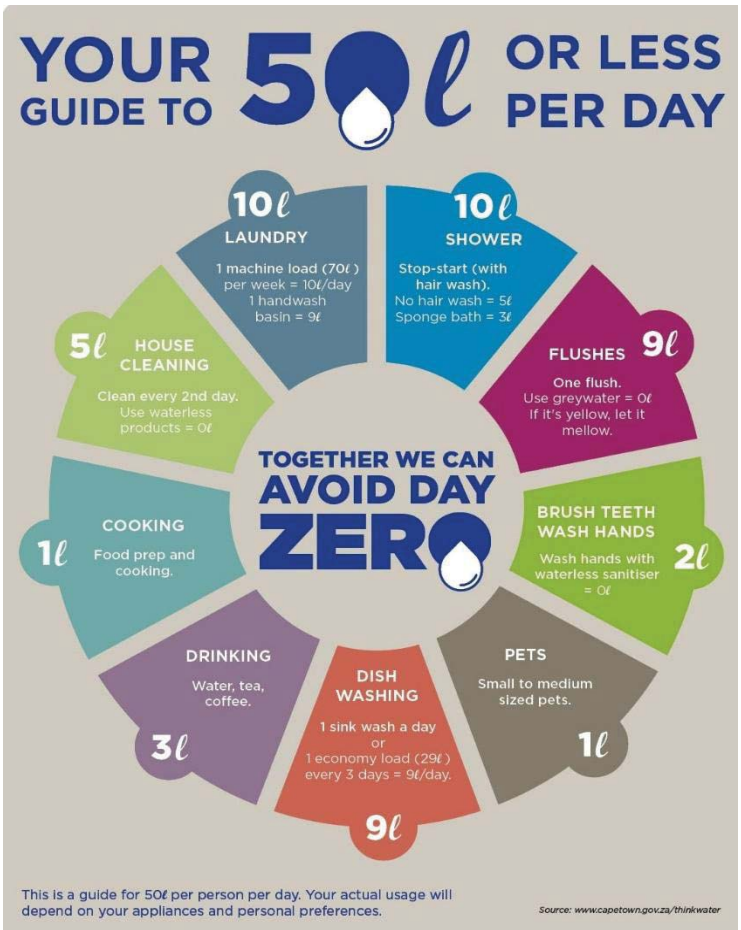

Figure 4.1 During the 'Day Zero' campaign, the City of Cape Town focussed on demand management, to great effect. The long-term impacts of the campaign still remain to be seen, however
(poster: Western Cape Government 2018)

In this regard, industrial and commercial users, often the largest water users in the urban water system, are stepping up to the plate. They are actively engaging in, and claiming responsibility for water stewardship as they start to see themselves as part of both the problem and the solution, thus helping to regulate the systems and build longer-term resilience (Shiao et al., 2020). While these water users made dramatic behavioural shifts in order to curb consumption as the Cape Town drought escalated, it is not clear if these changes in behaviour will be permanent or will apply solely under current or future drought conditions. It has yet to be seen whether households and businesses will resume previously wasteful patterns of water use, or continue to use their investments in water-augmentation or water-efficient technologies. Much has still to be done around cementing behavioural change, but perceptions and behaviours around collaborative governance and the sustainable use of water resources remain high on the agenda for many businesses and organisations (Bonthuys, 2019).

4.3 CREATING NEW PATHWAYS FOR ECONOMIC ENGAGEMENT

> "Improving water governance is a key topic in the political agenda worldwide. It is a prerequisite for sustainable and innovative water policies that can 'do better with less' and involve all relevant actors to achieve the Millennium Development Goals."
>
> OECD, 2011

Globally, it has been recognised that the global water crisis is not only one of scarcity but also of governance, institutional mismanagement, service delivery and a siloed approach across all levels and agencies of government (OECD, 2011; Olver, 2019). From a governance perspective, the economic and political systems are closely enmeshed, with the economy as the real shaper of social organisation. The economy is the ultimate rules-making system for the creation and maintenance of social order, frequently dictating political decision-making. It manages our lives as a system of rules that organise and distribute tasks and resources, with divided responsibilities to achieve social order (Fioramonti, 2017: 2, 31).

> "There is a new holistic paradigm emerging, putting us on a new playing field of collaboration, cooperation, and community."
>
> Lipton, 2009

In his seminal paper, Hardin (1968) proposed government ownership as the only way to overcome the Tragedy of the Commons. Ostrom (2014) counter-argued in favour of private ownership by means of a polycentric approach (Ostrom, 1999, 2009, 2010; Ostrom and Cox, 2010) as a more appropriate governance arrangement to avoid the Tragedy of the Commons and protect biodiversity and natural resources.

This implies an adjusted, inclusive, collaborative governance approach towards a circular economy, that boldly rethinks the purpose and role of the economic actors in the Commons (Aras and Crowther, 2008; Kacperczyk, 2008), and which includes the role of place (such as a catchment or river) (Lawrence and Dover, 2015) as a co-participant in the change-making process (Tihanyi et al., 2014*).*

The impact of such an approach is that the economic system becomes integrated with the social and ecological systems. The Dasgupta Review (2021) proposes that the economy must be understood to be embedded in the biosphere, not independent of it. This requires a broadening of the economic actors' understanding of how they can transition from a transactional firm-centric focus to a transformative collaborative focus that allows for a more stakeholder-centric approach in their relationships and engagement with, and impact on, the environment and society. The water mandate is now becoming part of this broader socio-ecological system, in which affected participants co-operate in partnerships in response to these governance challenges (UNGC CEO Water Mandate, no date).

4.3.1 Transforming economies for wellbeing: collaborative governance

Collaborative governance is conceptualised and implemented in different ways in the literature (Ansell and Gash, 2008; Emerson et al., 2012; Emerson and Nabatchi, 2015; Batory and Svensson, 2019; Rapp, 2020). We subscribe to collaborative governance as being a holistic approach that brings all the different representative voices to the table to deal with wicked problems in the Commons (Büchner-Marais, 2016), with a specific focus on economics.

Co-operation within partnerships is well-established in water governance. However, it continues to be institutionally dominated and embedded in a centralised top-down approach (Swarnaker et al., 2017). Water security needs to be considered as the collective responsibility of society, and decisions to organise and manage the shared use and value exchange of water distribution need to be viewed as an economic perspective on ownership, and how people interact with things of value. The ways in which we govern and manage water need to be reconsidered – we need to adopt a collaborative governance approach.

The issue of water security becomes a catalytic meaning-making objective in a social-ecological systems context. This objective accommodates connections and interactions in a cross-sector collaborative governance process at a transformative dimension (Guba and Lincoln, 2003; Denzin and Lincoln, 2005, 2011; Herr and Anderson, 2005; McLachlan et al., 2015). The economic collaborative governance framework is an enabling, self-organising process (Ostrom, 1999, 2009, 2010; Ostrom and Cox, 2010; McGinnis and Walker, 2010), defined by the different voices, and interactions that shape and influence the broader systems of value; reframing governance to connect human progress and economic growth to the biosphere and the life-supporting environment (Folke et al., 2011: 720; Dasgupta, 2021).

The eventual goal is to co-create sustainable, holistic water security solutions (Folke, 2006; Whiteman et al., 2013), which include water scarcity and quality, while specifically considering their economic aspects. Here, collaborative governance becomes the enabler of flexible decision-making that facilitates the process of self-organisation. Typically, this includes frameworks, processes and procedures to find and implement proper solutions to the risks of water scarcity aggravated by the effects of climate change. The approach will be predominantly climate risk informed decision analysis (CRIDA)-based (Mendoza et al., 2018) and will be influenced by a number of frameworks and theories including, but not limited to, complexity theory, systems theory, theory of system change and value-focused thinking (VFT) (Keene, 1992; Cilliers, 1998; Agranoff and McGuire, 2003). Case studies indicating successful inclusive community engagement include the Condominium Sewage (Melo, 2005) and SISAR initiatives in the Brazilian state of Ceará (Dos Santos Rocha and Salvetti, 2017).

4.3.2 The Role of Water in the Private Sector

After years of noting only incremental change to business-as-usual in the corporate response to mitigating and containing the risks of water insecurity (largely motivated through compliance requirements), there is an emergent shift towards the public and private sectors sharing the responsibility for water stewardship (NBI, 2019; UNGC CEO Mandate, 2020). Business and citizens alike are stepping up to build water resilience in cities (WBCSD, 2020) by supporting catchment management efforts, changing their perceptions and behaviour around water use and values, and making significant investments in water-efficiency, -reuse or -augmentation technologies. A further shift is towards working together and collaboration as opposed to in competition with one another (WBCSD, 2020).

> '...the new model for managing water is founded on the principle that there isn't one institution that can solve our water problems."
>
> Karin Krchnak, Project Manager, 2030 Water resources Group (WRG)

Economic sectors that are already experiencing the effects of climate change on their production and operations are becoming more vocal. The starkest impact of climate change is evident in the changes to the water cycle, and the phrase "If climate change is the shark, water is its teeth" being quoted as an analogy at business conferences (UNGC CEO Mandate, 2020). The insurance sector in South Africa confirms that some of these impacts are immediate (e.g. lower agricultural yields, declines in production and manufacturing due to less water supply/reduced water pressure), and is therefore something that businesses need to address in their current plans and strategies (NBI, 2018). This will require businesses to use different design and investment criteria, adapt their business models and adapt their organisations to be more responsive to variability and change in water security, thus ultimately become more economically resilient (Anderies et al., 2004; Steffen et al., 2004; Liu et al., 2007; Galaz et al., 2012; Whiteman et al., 2013; Fischer et al., 2015).

While some impacts of, and responses to strengthening economic water resilience are generic to all businesses and economic sectors, certain economic sectors are more intense water users, and therefore more vulnerable to water scarcity (Morrison et al., 2009). In this light, it is important to understand and reduce water-related needs and risks to existing businesses in those specific economic sectors in order to both reduce pressure on municipal water supplies and maximise opportunities for existing businesses and new investments in these sectors or sub-sectors (Morrison et al., 2009). This will not only enhance the water resilience of businesses, cities and towns (water-stressed or not) but will also increase the competitiveness of specific sectors and businesses and promote the transition to a greener, circular economy.

Additionally, when businesses start addressing their water-use issues, they invariably identify and address their own energy and materials use issues too, and positively impact their customers and other stakeholders (WEF, 2020). They start to view their business differently and become more aware of their resource use and wasteful practices, which often leads businesses towards improved resilience overall, not just water resilience. This practice of resource auditing increases efficiency and promotes greater competitiveness, which in turn may drive further innovation towards more efficient technology and practices, resulting in reduced demand for water and other resources (WEF, 2020).

Green, or circular economies provide global economies with pathways towards building resilience to these and other challenges and, in the process, have the potential to provide significant sustainable economic growth and development opportunities. This pathway toward a greening of the economy will only be possible with multiple, committed partners and stakeholders (Stafford and Faccer, 2014).

When considering that Earth Overshoot Day[11] was calculated as being on 22 August in 2020, despite the significantly reduced global economic activity because of the Covid-19 pandemic, it is clear that the move towards decoupling economic growth from increasingly degraded and scarce natural resources towards a circular economy is still a long way from being realised.

Refusing to embrace a transition to a green(er) economy is simply not an option for many local and regional economies in South Africa, given the increasing resource security challenges and costs, very high inequalities, increased urgency to mitigate and adapt to climate change and ongoing water crises. The National Business Initiative (NBI) (2019) highlighted the “perfect dust storm”, as alluded to by the South African Government in the National Water and

[11] Marks the date when humanity has exhausted nature's budget for the year. https://www.overshootday.org/ [accessed 20 September 2020].

Sanitation Master Plan, which states that 'South Africa is facing a water crisis caused by insufficient water infrastructure maintenance and investment, recurrent droughts driven by climatic variation, inequities in access to water and sanitation, deteriorating water quality, and a lack of skilled water engineers. This crisis is already having significant impacts on economic growth and on the well-being of everyone in South Africa' (South African National of Department Water and Sanitation, 2018: 1).

4.3.3 Driving Corporate Water Stewardship

The approaches described above align closely with the United Nations Global Compact (UNGC) framework guidelines (UNGC, 2016), which encourage businesses to adopt sustainable and socially responsible policies and to report on their implementation. This framework is a call to action for companies to align their strategies and operations with global principles that will advance societal goals. Moreover, the United Nations Sustainable Development Goals (SDG) framework was developed to guide governments towards sustainable development. Many in the corporate world have also embraced this SDG framework as part of their strategic processes, evidenced in their integrated reporting (IIRC, 2013), which dovetails well with the King IV framework in South Africa (IoDSA, 2016).

There is a growing insight that issues related to water and climate change cannot be solved by governments (top-down) alone, but also require partnerships with non-state actors, of which industry is a significant contributor. In this regard, the annual water stewardship event convened jointly by the Strategic Water Partners Network (SWPN), the Natural Resources Stewardship Programme (NatuReS), the National Business Initiative (NBI) and the Royal Danish Embassy is a good example of a multi-stakeholder collaboration to explore strategies and find wicked solutions to wicked water security problems (5th Annual Water Stewardship Event, 2019).

Drought and declines in rainfall, as well as pollution of our freshwater systems are ubiquitous and are a complex challenge (Kings, 2017; Lindow, 2018) in the Commons. These challenges require rallied action, and initiatives to partner and cooperate to manage water security. There is a desperate need for a multi-actor, cross-sector collaborative governance network that can access and allocate funds to implement and sustain bottom-up, stakeholder-driven solutions within communities (Felix, 2017; Smit, 2019). An example of such a partnership is that between Distell, Stellenbosch River Collaborative (SRC) and the Collaborative Governance Network for Water Security (CoGo). The SRC is the result of a doctorate research collaboration (Büchner-Marais, 2016).

4.3.4 Case study: The Stellenbosch River Collaborative (SRC) and CoGo (Collaborative Governance Network for Water Security)

The SRC formulated an inclusive bottom-up collaborative governance framework within which the wider group of stakeholders from multiple sectors can create collective, fair and equal value through enabling transformational partnerships in a non-competitive and non-

threatening space. This collective draws on its broad range of skills, expertise, and combined resources, using sound research and science, to identify critical thresholds and vulnerabilities in, and drivers of change for the ecosystem.

The private sector actors frame their responses in terms of inward-focused water-related risk mitigation and compliance to sustain business. The state and relevant government agencies also frame their responses to issues arising in terms of risk mitigation, with an emphasis on mandate, control, and sanction rights, which translates to punitive or higher tax rates, crisis management, costly public relations events and media releases, re-prioritising election undertakings and re-allocating budget and supply – all of which are not conducive to mutually respectful relations.

The SRC was formed based on common values of caring for and protecting the rivers in the Eerste River catchment. Framing the catchment and its rivers as a biosphere-based understanding of sustainability, enabled the actors from both the public and private sectors to collaboratively develop a governance response that draws on social-ecological systems (SESs) thinking and complex realities.

Figure 4.2 The Eerste River, Stellenbosch, South Africa – one of the rivers in the Eerste River catchment that is the focus of rehabilitation and protection by the Stellenbosch River Collaborative (SRC)

(photo: HelenOnline CC BY-SA 3.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Eerste_River_from_De_Oewer.JPG)

Since the establishment of the SRC, Distell, as one of the founders, has undergone several shifts in its approach towards and response to the wicked problems in the Commons experienced by all (see, e.g., Distell, 2021). The severity of the water crisis emphasised the limitations of the existing formal governance structures to engage people more deeply in sharing a collective sense of responsibility for water. They have realised that as a corporate citizen within a greater ecosystem, problems beyond their organisational boundaries impact them equally severely as those within their boundaries. This leads to a step-change approach from being purely transactional and firm-centric to that of being part of a conglomerate of equals within a non-threatening, non-judgemental and non-competitive space.

Since its launch, the SRC has increased its efforts, not only to drive river rehabilitation with research projects, but also to transform relations through research projects between government agencies and communities at Stellenbosch University. This led to the launch of

the Collaborative Governance Network for Water Security in conjunction with the Stellenbosch University Water Institute in November 2018.

CoGo, as catalytic agent, navigates a convening space, bridging the divides between affected stakeholders and brings them into a network of trust, paramount for transformational relationships (Büchner-Marais, 2016; Rapp, 2020).

Such relationships facilitate and encourage all participants to be considered equals, removing power inequalities and creating social capital, which leads to decision-making consensus to address water issues in our river catchments (Ansell and Gash, 2008). Other key drivers of CoGo include science-based learning platforms for the development of actionable research and knowledge and a Community of Practice (CoP) framework for prototyping and improving solutions (Harris et al., 2017).

Since CoGo is focused on creating water security within a specific river catchment area, their ambition includes the expansion of the unique collaborative governance approach to many other river catchment areas, which will result in the organic growth of the CoGo model and the establishment of further CoGo's in regions across South Africa, and potentially wider.

4.4 BUILDING FUTURE-PROOF SYSTEMS

> "People come to me and say that 'water should be free because it falls from the sky, it is a gift from God'; I say, 'tell that to the fisherman who puts fish on your plate'"
>
> Wadsley, 2020.

It is apparent that the current system of economic water valuation does not fully embrace broader value systems (Audouin et al., 2013) (see Appendix A). There is therefore an urgent need to realign current economic systems with the value systems, needs, interests and expectations of society and the environment (Folke et al., 2002; Folke, 2006; Adger, 2006; Whiteman et al., 2013; Capra and Luisi, 2014). Long-term holistic financial planning of water supply, investments in grey and green infrastructure, inclusion of operational and maintenance costs in budgets, as well as water demand management are imperative considerations in creating a resilient framework for future water management and governance (Grey and Sadoff, 2007; Schäffler and Swilling, 2013; Sahin et al., 2016). The reality of future water-provision frameworks is going to have to deal with how to fund and provide water more broadly.

4.4.1 Costs and Control

Many developing countries need water infrastructure in order to improve the livelihoods and quality of life of their citizens. While rain and water from lakes and rivers may be free, water infrastructure is not. This infrastructure is typically financed by consumers through water tariffs.

These tariffs are based on the fixed costs of the system (capital, operational and maintenance costs) as well as overhead costs like the salaries of those who manage the water-supply systems (Babak, 2002). These costs are seldom spread equitably across users, with some carrying more of a cost burden than others. Future tariffs and water costing systems should look at creating a system where no cohort is unfairly discriminated against by higher tariffs or costs.

The cost of water is often dictated by government actors. In the majority of cases, the entire water- and wastewater systems in cities are fully centralised (i.e. government owned and operated) and thus government agencies or municipalities receive the revenue from tariffs, but are also responsible for their design, construction, operation and maintenance (Babak, 2002). In countries where there is a high level of corruption, or perceived corruption, it makes sense for tariffs to be paid directly to water providers (either public or private), depending on whether these funds are ring-fenced to be used specifically for water. However, if such providers are from the private sector, the tariffs are often associated with high profits for these companies, which can lead to distrust and discontent by the public.

In many parts of the world, there is a significant shift to decentralise water and wastewater systems, or parts thereof, in order to build resilience at more localised scales (Ostrom, 1999, 2009, 2010; Ostrom and Cox, 2010; Anderies and Janssen, 2012) such as at a suburb or community level, and to reduce the fixed costs of the water-supply systems (Sharma et al., 2010; Quezada et al., 2016). These fully, or partially off-grid systems allow the users to invest in a solution that works for them, and which can be scaled up or down depending on current and future needs (Ostrom, 2010). This investment comes with a considerable capital cost, as well as operational and maintenance costs, but these investments become assets to those who have invested in the technology. Additionally, this infrastructure is often better performing and maintained than government alternatives (Schäffler and Swilling, 2013). This model has proved both popular and successful in communities around the world, ranging from Australia to Scandinavia. This model could also be a possible solution in areas where governments or utilities are simply not able to, or capable of, making further investments (covering capital, operational or maintenance costs) in water and wastewater systems, or where the costs of connecting a community to the existing infrastructure network are prohibitive or where financing cannot be secured.

4.4.2 Funding and Financing Future Water Systems

There are numerous permutations by which water infrastructure can be funded or financed (see Appendix A). Actors within local, provincial, and national governments will have to investigate the feasibility of funding and financing current and future water infrastructure urgently. This will have to include alternative technologies such as desalination, investments in ecological infrastructure, decentralised water systems and wastewater systems, and the reuse of treated effluent, among other options.

Options around whether funding and financing will come from development agencies, national or provincial budgets, municipal utility income, public-private partnerships or elsewhere, will need to be adequately explored and costed. Funders or financiers will have different priorities, mandates, investment objectives, risk appetites and liquidity needs (Kaminker and Stewart, 2012). For efficient planning of the flow of finance into water security investment, the source of capital, the level of investment, the different stakeholders at different stages of investment and the different channels through which investment in water security infrastructure may be accessed must all be identified (OECD, 2018).

Innovation in financing is needed to bridge the water sector investment gap and to accelerate action to scale financing that contributes to water security and sustainable growth (OECD, no date). This includes building and expanding on proven approaches, as well as finding innovative solutions.

4.4.3 Going Green

The current economic climate, coupled with an abundance of international capital earmarked to address water-, sanitation- and health-related issues associated with the Covid-19 pandemic, provide significant means to scale up water-related infrastructure investment that will contribute to sustainable growth, in addition to meeting key health needs. In many advanced economies, interest rates are close to zero, increasing the fiscal space available for governments to support investments (IMF, 2020). Mainstreaming water considerations into development finance portfolios in energy, transport, health, agriculture and climate would provide additional resources needed to reduce vulnerability to water risks and enhance resilience and adaptive capacity (Leflaive and Dominique, 2018). This mainstreaming of investments aligns closely with the 2030 Development Agenda, whereby the global community is striving to translate the aims of the Paris Agreement into financing flows and investment (Partnership for Green Growth and the Global Goals 2030, no date; Strategic Partners Network, South Africa, no date).

There are various instruments available to fund or finance current and future investment in water security (see Appendix A), with green bonds being one of the most common mechanisms. Green bonds are like regular bonds but are specifically reserved for investment in projects or assets with environmental or climate-related benefits. Water is expected to be a key investment area for green bonds and the market for green bonds relating to water management has been growing rapidly. Globally, some USD 30 billion of green bonds related to sustainable water management were issued in 2018, compared to USD 12 billion in 2016 (AGWA et al., 2018). The first green bond that was issued in South Africa was in the City of Cape Town in response to the recent water crisis and included funding for emergency water-supply schemes designed to address water security, support climate change objectives and build long-term resilience.

Investments in nature-based solutions (NBS) are also gaining traction (Schäffler and Swilling, 2013; Seddon et al., 2020). New business models can convert investment benefits into revenue streams, thus improving the risk-return profile of water investments. For instance, investments in floodplains or wetlands could be financed by capturing some of the value NBS provide surrounding properties through flood protection. The multiple benefits that accrue from investing in NBS also meet broader sustainability and water stewardship goals (Shiao et al., 2020). These investments often appreciate in value as the solutions mature and yield more benefits over space and time, as opposed to depreciating grey infrastructure which requires costly maintenance to yield a limited number of benefits (Schäffler and Swilling, 2013; Lafortezza et al., 2018) (see Technical Sciences, Chapter 3). Water management and governance actors should therefore consider nature as part of their asset register and invest in the restoration, management and protection of watersheds accordingly (Abell et al., 2017).

4.4.4 Corporate Clout: Blended Finance Opportunity for Water Investments

Blended finance which strategically combines development funds and financial instruments to mobilise private investment towards sustainable goals is a promising way to leverage contributions from different sources of finance with different risk appetites to make projects more bankable (see Appendix B). Blended finance can play a critical role in mobilising commercial finance and strengthen the financing systems on which water and sanitation investments rely. By deploying development finance in a way that addresses the investment barriers that prevent commercial actors from providing capital, blended finance operates as a market-building instrument, able to be a bridge from the reliance on grant and other donor funding and financing to crowding in commercial finance over the long term. This option of finance allows the corporate sector to also have a say in how capital is spent on infrastructure and could open the door for a more collaborative relationship between the public and private sectors, and one in which more voices are heard, and a broader perspective of the water system can be considered (see governance: Chapter 5).

4.4.5 Factoring in the Full Picture

Although funding and financing investments in water infrastructure are major considerations in addressing long-term water security, these investments may not consider the full suite of costs once construction has been completed (Ruiters, 2013). It is paramount to factor in operational and maintenance costs when undertaking infrastructure costing and cost-benefit analyses, to ensure that the long-term sustainability and functionality of current and future infrastructure is considered appropriately (see Chapter 3). Not all costs and benefits that are relevant can be counted, and neither do all elements that can be counted add benefit. The value of water is closely related to risk, and poor households are often more vulnerable to water scarcity than other stakeholders (Wadsley, 2020). Yet, their ability to pay hampers the potential for cost recovery. Further considerations will therefore need to centre on how water will be costed to cover the bill of those who cannot afford to pay – a growing proportion of those living in cities and towns in many parts of the world, including South Africa (Engvist and Ziervogel, 2019).

4.4.6 Access and Equitability

Equitable access to water and payment thereof is a key feature of how water as a basic need and human right must be supplied across urban centres in South Africa and beyond. Ensuring fair distribution and use of water resources that do not marginalise the poor even further, nor inadvertently discriminate against lower-income groups with large households and multiple dwellings per property, will need to be a priority of urban utilities (see Chapter 6). However, the sustainability of the model for provision of free water to indigent households will need to be explored, as greater numbers of rural migrants enter towns and cities annually in search of social and economic opportunities, appreciating the "most fundamental form of moral common sense" that "water provision has to be paid for, somehow" (Skeldon, 2017; Wadsley, 2020: 679). Therefore, the confluence of access, equitability and affordability of water needs to be fully understood and addressed or redressed.

Figure 4.3 The costing of water will need to include the provision of 'free water', such as is provided here at a communal tap in Soweto, South Africa
(photo: SuSanA Secretariat CC BY 2.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Communal_tap_(standpost)_for_drinking_water_in_Soweto,_Johannesburg,_South_Africa_(2941729790).jpg)

In parallel with fair distribution of resources amongst water users, government actors and other stakeholders also need to ensure adequate provision and safeguarding of water resources for the environment, to ensure the functioning of ecological infrastructure, as enshrined in the National Water Act, 1998 (Angelstam et al., 2017). Investments in ecological infrastructure and NBS have been shown to be more affordable and yield better returns on investment over the long-term than those in grey infrastructure (TNC, 2019), and accrue significantly more benefits and co-benefits across ecological, social and economic sectors (Shiao et al., 2020). Ensuring that both ecological infrastructure and the ecological reserve are restored and maintained will be a critical shift in both policy and practice (see Natural Sciences, Chapter 2), and an important factor in an optimal water resource management framework for the future.

4.4.7 Changing Perceptions and Behaviour

Key to future planning and policy formulation is the need to embed positive behavioural changes and a shift in perceptions (Eggert et al., 2018) about the value and availability of water amongst all its users. This will require a broadening of the traditional toolkit of economic policy instruments to include behavioural insights and mechanisms, such as green nudges, to facilitate a sustained change in behavioural patterns around water use (WCG and OECD, 2018). For example, management and governance actors will need to focus on behavioural insights targeted at shifting public perception regarding the use of “recycled” water. A lack of knowledge about the quality, and risks related to the reuse of water, such as treated effluent, are major obstacles in shifting public perceptions around recycled water, and need to be addressed skilfully (Dingemans et al., 2020). The ‘reuse’, or ‘recycling’ of water several times before its ultimate disposal is going to be a necessary adjustment in both households and businesses, as water demand continues to outstrip supply, and the cost of water continues to increase with demand (Ahmadi et al., 2020). These costs, and access to water by households, businesses and the environment will be critical considerations for all government actors as well as broader water users.

4.4.8 Building Capacity and Sharing Knowledge

Apart from building institutional knowledge of the financial and behavioural components of future water systems, capacity building and knowledge sharing among all actors in the water management and governance system need to be developed and implemented. Without an adequate understanding of all the components of the water-resources system across social, economic and environmental sectors, it will become increasingly difficult to address the critical considerations around economics and value systems. This understanding of system dynamics should be both practical and theoretical, and amalgamated with local and institutional knowledge to ensure that all values are considered, consulted and incorporated into decision-making processes and activities.

4.4.9 The primary take-aways

- Water holds multiple values, and these are not just economic. Historically we have valued water from a cost perspective. Going forward, we should include the multiple

values assigned to it, whilst engaging effectively with different stakeholders and beneficiaries to ensure this happens.

- There is a need for a far more robust, equitable and inclusive water governance system, in which all stakeholders and beneficiaries contribute towards decision making.
- Businesses are willing to play their part in approaches where they can address key priorities, collaboratively invest their resources and support relevant projects and programmes. This can be done by engaging government, businesses, academia, NGOs and civil society in a middle-out approach (connecting top-down and bottom-up approaches.
- The Stellenbosch River Collaborative case shows how private companies (e.g. Distell) can commit to a collaborative investment to improve water quality in local rivers. This investment informed their behaviour and mindset, and allowed them to respond effectively to escalating water shortages and to build long-term economic water resilience.

4.5 CONCLUSIONS

It is becoming increasingly clear that we must reconfigure everything we know, understand and do regarding the economics of water. Our transactional approaches are failing us in addressing the persistent challenge of governing the Commons. The old ways and systems of managing and governing resources no longer work. Water is finite and we need to value it accordingly. This calls for a shift from the historical principles of top-down command and control governance to a more inclusive collaborative governance approach. Balanced and fair decision-making that considers the needs of all affected stakeholders in a holistic way, including the natural ecosystem, will contribute towards achieving the ultimate aim of sustainable funding and provision of water for all.

Globally, the magnitude and complexity of climate change are amplified by rapid population growth, rampant environmental degradation and deepening social and economic risks that are widening the inequality gap. These challenges all pose significant risks to water quantity, quality and access, and freshwater ecosystems, and are escalating existing and potential water crises globally (Bŭchner-Marais, 2019). Addressing these challenges through positive behavioural change, and collaborative action, that includes civil society, investors, innovators, entrepreneurs, corporations, and progressive state and government actors, is clearly needed.

These emerging institutional forms are neither market-centric nor state-centric and tend to be more inclusive of broader stakeholder and system dynamics. These initiatives will need to be diverse and initiated by various parties, with the private sector emerging as a key participant. All parties, however, have a duty to recognise and embrace water's economic, social and ecological values, reconcile these values and build trust, protect resources, change perceptions and behaviours and invest and innovate. This way everyone can play their part in building long-term economic water resilience.

As a final note, it is pertinent to state that the economic position taken in this chapter is not necessarily the best fit for every city, but it is a step in the right direction for the Western Cape and other water-stressed regions in South Africa. The chapter proposes what the next steps could be, given the pressures we face, to develop a new economic approach to water through the lens of broader value considerations and collaborative governance. It is only by developing these more inclusive, collaborative systems around the economics of water that we may address long-term economic water resilience.

Figure 4.4 Fresh fruit and other agro-processing products are often transported on a conveyor belt using high quality water
(Source: https://www.dreamstime.com/clean-fresh-gala-apples-conveyor-belt-fruit-packaging-warehouse-presize-image145716611)

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4.7 APPENDIX A: FINANCING OPTIONS FOR WATER INFRASTRUCTURE

There are numerous permutations by which water infrastructure can be financed. Table A4.1 below illustrates nine ways through which water infrastructure can be financed.

Table A4.1 Funding alternatives in South Africa (Ruiters, 2013)

Funding model	**Evaluation criteria**					**Impact on funding and project delivery: Drivers and principle**
	Efficiency	Effectiveness	Equity	Appropriateness	Sustainability	
National Revenue Fund (NRF) (on budget)	Not efficient in setting price signals for best value infrastructure provision.	Simple and effective to manage as part of the funding (MTEF) measures.	Assumes the funding of a wholly public good and not a shared private benefit.	Well suited to fund components of the water infrastructure value chain.	Long-term sustainability impacts on the integrity and functionality of the water infrastructure.	Unlikely to be sufficient funds for socio-economic needs.
Conditional grants: Water services infrastructure	Not efficient in setting price signals for best value infrastructure provision.	Simple and effective to manage as part of the funding (MTEF) measures.	Poor linkage and interface between payment and infrastructure.	Broadly understood and supported mechanisms but depend on political trade-offs with core other public services or extra funding from the NRF through taxation foreshadowed.	Non-payment for water infrastructure service provision a major risk.	High dependency on the NRF.

Balance-sheet funding (tariff model)	Country-wide model more efficient due to targeted benefit areas and users paying into a hypothecated fund (or paying an infrastructure bond). Disconnected from price signals since it is not efficient in ensuring that the right assets are delivered at the right price.	If the appropriate water tariff is set at the new water infrastructure value, it would be sufficient to fund the water infrastructure and surrounding land needed. Difficult to implement water-use charges for historically disadvantaged and/or poor communities at a local scale.	Contributions of infrastructure in poor communities or slow growth areas, where funds are not necessarily spent in a manner that recognises a spatial or temporal nexus, must view as a social infrastructure provision.	Especially appropriate where dispersed but identifiable beneficiaries are likely to achieve a windfall gain from water infrastructure. Well suited to be locked into funding a securitised cost and revenue stream. Appropriate as a distinct element of the funding mix, and support the recurrent costs associated with the use of the water infrastructure being charged.	Long-term sustainability to secure the integrity and functionality of the water infrastructure.	Unlikely to be a dominant part of the development water infrastructure mix but plays an important role in funding recurrent costs and costs mostly linked to the water user. NT enabling the project to be implemented via SPV through explicit government guarantee.

II. New paradigm: Alternative and innovative water infrastructure funding models						
Financial markets (off-budget)	Debt underwritten by NT can use very low interest rates.	Potentially able to raise large funds subject to fiscal management (NT) imperatives of the country (appropriate ratings). Effective controlling of the risks, including interest rate costs and levels of debt.	Sharing of costs over time amongst contemporary and future-generation beneficiaries.	Appropriate where supported by a secure revenue stream from a funding source.	Non-payment for water infrastructure service provision a major risk.	Operates subject to securing a revenue stream (e.g. water tariffs, water-use charges). Charge commercial tariffs, and/or block tariffs as allowed for in the raw water pricing strategy.
Public-private partnerships (PPPs)	Can optimise provision of water infrastructure and land by having the party most suited to manage the risks. Enables private innovation on delivery of needed infrastructure projects according to	PPP binds all the parties to their agreed responsibilities, especially where agencies or parties expected to make long-term infrastructure funding commitments. PPPs for infrastructure	Most equitable where an agreement also ties down arrangements for the broader community to contribute to any public good being produced by the infrastructure development.	Agreements needed to clearly describe how they fit with other related funding arrangements (cf. NT 2000).	Reduction of water infrastructure risk management.	NT's risk on providing the guarantee is limited to periods of shortfalls and not full exposure of the loans.

	agreed specifications.	development are complex and place a burden on the government and the agencies involved.				
Private sector markets (built-own-operate and transfer – BOOT)	Most efficient where cost of managing risk does not exceed benefits of getting access to private infrastructure funding capital.	Able to access large infrastructure funds but at higher interest rate costs.	Spreading of costs amongst the different water users.	Appropriate where risks are to be manage by the private sector, otherwise require significant government underwriting (surety) and contractual controls.	Operations and maintenance to be planned and implemented on a long-term period and sustainable benefits to beneficiaries.	Not a funding source but a model, a financial management tool to smooth out peaks and troughs in costs and revenue and ensure that costs are spread out a longer period of time.

Demand (market) risk funding	High-cost scheme due to complexity. Not efficient as a funding mechanism due to potential high revenue risks.	Unlikely to be sustained for long term or diffuse water infrastructure period. Effective at delivering outcome where strategic water infrastructure assets are acquired and/or developed.	Payment unlikely to be equitable where beneficiaries are remote and where levels of payment are not sensitive to benefit received or capacity to pay (e.g. flat rate for agriculture water-use across the country, etc.).	Useful in establishing a new or independent source of targeted funds to achieve a specific result. Especially valuable to fund regional benefits without upsetting other funding regimes (e.g. De Hoop Dam; Mokolo-Crocodile water projects for Eskom; Lesotho Highlands Water Project, etc.). Contribute to broadening funding base by directly targeting raw water user and land value.	Long-term sustainability impacts on the integrity and functionality of water infrastructure, e.g. frequent disruptions in supply, etc.	May have role to fund backlogs and network connections (regional bulk infrastructure) or specific programme with measurable results. Most value as a supporting measure to lock in place outcomes as well as incidentally earned return on investment.
Special banks or financial institutions	Efficient means of providing of infrastructure demands.	Least effective where fund accrues at a slow or irregular rate, not well-matched with expenditure needs. Least effective where funds are exposed to escalation risks.	Equitable where contributions plan establishes reasonable nexus and accurately apportions costs between new and existing water infrastructure developments.	Appropriate to deliver local water infrastructure in high growth areas with high water demands for socio-economic developments where new developments are greatest beneficiaries and where contributions income is most predictable.	Long term viability of built-own-operate and transfer (BOOT), i.e. economic viable projects.	Preference shares issued by development finance institution(s), i.e. IDC, DBSA, etc. to address cash flow mismatches. Provide comfort and support to the issuer in terms of the PFMA due to the strategic nature of infrastructure projects. Preferably debt or quasi debt instruments can be offered with clear redemption strategies

4.8 APPENDIX B: INTERPRETATIONS OF VALUE

Table B4.1 below illustrates the various interpretations of value. While acknowledging the value of water to the environment and society, revenue is mostly based on the economic value only. Economic value is a limited view of the broader construct of value, as illustrated in the table below. Of importance in this view is the incorporation of common goods, and public benefit and access to safe water as a human right in the description of value.

Table B4.1 Comparison of value-related terminology (Volschenk, 2016)

	Categories of value	Description	Total economic value	Common goods	Socio-environmental value (a public good)
Use value	Direct use value	Value of provisioning services such as the actual use of the produce of nature (water, fish, timber, etc.).	X	X	
	Indirect use value	Ecosystem functions that provide value in the form of regulating services (flood control, disease control) and supporting services (nutrient cycling and habitat provision).	X		X
	Option value	The willingness of an individual to pay to safeguard an environmental resource for using it in the future.	X		

	Categories of value	Description	Total economic value	Common goods	Socio-environmental value (a public good)
on-use value	Bequest value	The benefit accruing to any individual from the knowledge that others might benefit from a resource in future. This may include the value of spiritual, recreational, aesthetic benefits (cultural services).	x		x
	Existence value	Value deriving from a person's concern for simply the existence of any particular environmental asset, for instance the African Rhino, although they have never seen one.	x		x
	Intrinsic value	The value of a species or nature when there is no one to do the counting.			x

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CHAPTER 5

REFLECTIONS ON THE POLITICS AND GOVERNANCE OF WATER: LESSONS FROM CASES

Larry A. Swatuk and Joanna Fatch

Figure 5.0 Newspaper headlines and posters during the 2018/2018 'Day Zero' crisis in Cape Town, South Africa
(photo: City of Cape Town 2019)

5.1 INTRODUCTION

The human world is increasingly urban. Cities are expanding in size and reach. Even where population increase is slowing down, the ecological footprint of cities continues to hold steady or rise (Elmqvist et al., 2017; UNDESA, 2018). '[T]oday, 55 percent of the world's population lives in urban areas, a proportion that is expected to increase to 68 percent by 2050 … with close to 90 percent of this increase taking place in Asia and Africa' (UNDESA, 2018). Cities expanded most rapidly across the Global South between 1970 and 1990 and have slowed down ever since, with key exceptions in parts of Sub-Saharan Africa (SSA), South and East Asia (see data and maps at UNDESA available at https://population.un.org/wup/Maps/).

Even a cursory review of the 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, São 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, São 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 organisations such as UN-Habitat 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 for immediate action.

Cities concentrate wealth, power and privilege. They account for approximately 75% of global GDP. Cities, especially the primate mega-cities of the Global South, are magnets of perceived

opportunity, annually drawing millions of people from the surrounding countryside. Whilst migration similarly followed industrialisation in the global north, the pace of growth (including job creation) in the Global South is slower than the rate of migration, especially in SSA, resulting in widespread unemployment and urban poverty (Adetunji, 2019). Because of this, roughly one in seven urban residents currently lives in slums and informal settlements. This situation, in which existing power and privilege reside alongside perceived economic and social potential, generates a powerful political dynamic. It is a modern-day 'tale of two cities': the well-serviced city of ratepayers, who are few in number, and the haphazardly-serviced city of the marginalised, who are many in number, and their interrelationships in shared physical and temporal space (Haase et al., 2018).

In this chapter, we interrogate these relationships and examine their potential for generating positive outcomes that may help achieve Sustainable Development Goal (SDG) 11 (making cities and human settlements inclusive, safe, resilient and sustainable), and SDG 6 (sustainable water and sanitation provision). We focus primarily on the political economy of water and sanitation service delivery, arguing that positive outcomes in this key area can help build trust across urban class, race, caste and gender divides. The chapter neither ignores nor downplays the numerous challenges that we will face while achieving SDGs 6 and 11 (see Chapter 1 for an overview). Indeed, inequality of access not only to water and sanitation, but to the city itself is the norm (UNC, 2017). With regard to water and sanitation, the struggles of urban dwellers, particularly the poor, in Cochabamba (Assies, 2003), Durban (Bond and Mottiar, 2018; Bond, 2020), Johannesburg (Macdonald and Ruiters, 2004) and Cape Town (Robins, 2014) are well-known and well-chronicled in the literature. The lessons from these cases are clear: where relations between the state and civil society are fraught with conflict, questions of service delivery become highly politicised confrontations about much more than just the service in question. These contestations are as much about social inclusion, justice, and the right to the city as they are about potable water and improved sanitation. These 'water wars' or 'toilet wars' are really proxies for deeply entrenched class-, race- or gender-based conflicts, and the resolutions achieved through conflict and confrontation are generally temporary and rarely sustainable in the long run (Robins, 2014; Sitrin, 2015). At the same time, if questions regarding water and sanitation services serve as proxies for state-civil society conflict, might they not also serve as proxies for cooperation? Put differently, where advances in service provision are made, and where they are undertaken in an inclusive way, might they help build trust across the urban divide and thereby improve state-civil society relations? (See also the chapters by Conradie et al. and Hara et al. in this collection for further discussion on this topic.)

Holding these well-known cases and their lessons constant, in the balance of this chapter we focus on cases where success is evident and seemingly long-lasting. We interrogate the factors leading to such success. The chapter presents evidence from a desk study surveying more than 30 cities around the world. It will be shown that where outcomes toward SDGs 6

and 11 are positive, interventions tend to have resulted from one, or a combination of the following four factors:

- they are collective, cross-sectoral and participatory;
- they are framed in a deliberately non-political way;
- there is influential third-party involvement; and
- government policy and practice is shaped by enlightened leadership.

The chapter proceeds as follows: in the next section we discuss politics and place urban water resources access, use and management in political and historical contexts. This is followed by a presentation of the case study findings. The penultimate section discusses the case study findings in terms of the four factors highlighted above. Lastly, in the conclusion we make several recommendations regarding lessons learned and ways forward.

5.2 POLITICS AND THE POLITICS OF WATER

Politics has been described as 'the art of the possible'. In particular, it centres on the authoritative allocation of scarce resources, i.e. who gets what, when and where, and the contestations amongst groups and individuals to which these resource use decisions give rise. In the context of cities, politics generally manifests as a consequence of decisions that affecting:

- Land use and land use change
- Infrastructure development
- Service delivery
- Urban planning and design

In the context of water resources, the allocation decisions pertain either directly or indirectly to the resource. Each decision context generates political dynamics. By 'direct effects' we mean those decisions that impact the hydrology of the basin directly (or, in the case of interbasin transfers, also the basin from which the water originated (i.e. both the originating and receiving basins)). For example, dams and canals move water from point A to point B, possibly creating 'winners' at point B and 'losers' at point A. The displacement of millions of people by the creation of the Three Gorges Dam is one such example. By 'indirect effects' we mean changes to the built environment that were made without due consideration for the hydrology. Urban expansion is a good example, whereby the hardening of surfaces creates the perfect context for flash flooding and the uneven impacts of flood events.

We are aware that it is not possible to separate 'politics' from either economics or ecology. Decisions that affect 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?). Recognising the interrelationships among the social, economic and environmental factors, in the case studies we focus our attention on the political impacts and implications of eight key questions regarding urban water security:

- 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 fresh water 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 are the impacts (social, environmental and, economic) of the overall system? (the sustainability question)

Embedded in the answer to each question are trade-offs, compromises, and the exercise of influence – in other words, the social relations of power. Urban water systems, like cities themselves, are organic, and evolve over time. While linked to the past through fixed capital and the built environment, challenges and opportunities arise to encourage and foster change. To paraphrase Robert W. Cox (1987), the constellation of social forces within cities changes as the actors, forces and factors change across the global political economy. New challenges and opportunities arise; new decisions are taken; changing pressures release new forms of institutional, material and ideational power in the world. Cox argues that in order to effectively meet these challenges, actors across society must be ready to pursue clinical, as opposed to cynical politics. This requires strategy and tactics prior to deliberate action.

5.3 THE GOVERNANCE CHALLENGE

When the King of the Netherlands, Willem-Alexander, declared the '*world water crisis*' a '*crisis of governance*' at the second World Water Forum held at The Hague in 2000, he was, in effect, attempting to set a discursive boundary around the abiding problems regarding access to, and the allocation, use and management of water. Scarcity, he was suggesting, is more a consequence of social relations than of biophysical conditions. Water, as the key input into all productive processes, is an unavoidably contested resource. Water is power. It drives industry. Its delivery to people wins elections, enhances authority, and builds legitimacy. Historically humans moved towards water and settled around water sources – at the mouths of rivers; in mid-stream, and around lakes, springs and wetlands. Over time, however, humans have managed to reverse this flow, so much so that people seldom move towards water sources, and water no longer runs along its hydraulic gradient; rather, it flows toward 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: 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, the other 90 percent went to the elite. 'Public basins

and fountains used freely by ordinary people … received only 10 per cent of total aqueduct water' (Solomon, 2010: 87). Nevertheless, that 10 per cent was more than enough to ensure the political legitimacy of the Empire's ruling class.

In targeting 'governance' as the primary source of water insecurity, the Dutch King was shining a spotlight on those abiding organisational forms of decision making that were sub-optimal in terms of social, economic and environmental outcomes primarily because they:

- served special interest groups;
- were based on outmoded understandings of water in nature and society; and
- were set up to reflect the past, not anticipate the future

In other words, water crises would persist and conflicts would worsen if the political and economic decision making around water was not channelled through appropriate institutional forms. The early 1990s global commitment to IWRM (Integrated Water Resources Management), now embedded in SDG 6: Target 6.5.1, entails the creation of an entirely new 'water architecture' (Swatuk, 2002), that includes new laws, policies and basin-based organisations. The Global Water Partnership (GWP, 2000) defines IWRM as 'a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.'

For nearly half a century, through global, regional and national governance networks and processes, stakeholders have sought to reshape global thinking regarding appropriate ways and means of addressing society's water-related needs and interests. Governance may be defined as '[t]he use of political authority and the exercise of control over society and the management of its resources for social and economic development' (Serageldin and Landell-Mills, 1991). In 2003, Rogers and Hall defined water governance as '[t]he range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services at different levels'. As Conca (2006) highlights, IWRM-based water governance marked a shift from (i) the sovereign state to the river basin as the physical basis for decision-making; (ii) the government to basin-level stakeholders as the authoritative actors in decision making; and (iii) expert (political, economic, technical) knowledge to all appropriate forms of knowledge and ways of knowing, including indigenous knowledge.

There have been numerous metrics developed in order to measure and monitor the progress of countries towards 'good water governance'. In the UN's second World Water Development Report (UN, 2003), ten elements of good water governance were articulated:

1. participation
2. transparency

3. equity
4. effectiveness and efficiency
5. rule of law
6. accountability
7. coherency
8. responsiveness
9. integration; and
10. ethical considerations

These were designed to address the social (equitable use), environmental (sustainable use) and economic (efficient use) aspects of sustainability. In 2005, following limited progress toward either IWRM or good water governance, a fourth component was added to these three 'dimensions of water governance', namely the political dimension (equal democratic opportunities) (Tropp, 2005). It was quite evident that institutional power was insufficient to alter the status quo of access to, use and management of water around the world. The new water architecture, far from altering past practice, rather provided a new context in which the power politics of water could play out (Swyngedouw, 2015).

Power resides with institutions, to be sure. But institutions vary and, even where mandated, the new river basin organisations remain far down the hierarchy of national, regional and global financial and political power. Power also takes on material and ideational forms. The ideas of IWRM and good water governance – along with many others such as 'water stewardship', 'water diplomacy', 'water justice', 'stakeholder participation' and 'lowest appropriate forms of governance' – continue to run up against the material and institutional power of those with vested interests. These include mining, manufacturing, farming, finance, cities and their political supporters. An important complicating factor in relation to urban water security, is that cities are generally considered to be one unified 'stakeholder' in the new water architecture. Often cities, and some private sector industries, buy their water directly from bulk providers and thus consider themselves exempt from basin management processes. Where cities require more water, they then generally bypass the new water architecture and approach higher levels of government directly (Garcia et al., 2019).

Water for cities is generally understood to be 'small water' – at least relative to the 'big water' required for agriculture – and delivery is complicated by financial, technical, social, political and bio-physical factors (see the other chapters in this collection). Also, whilst water for cities may be small, demand is constant. Users require water in an amount and of a quality that satisfies their needs throughout the day, every day of the year. Given the multifold challenges faced by cities (see Chapter 1), water resources management is but one among many. Similar to global water governance, cities have their own SDG 11, and emergent management architecture through organisations such as ICLEI, C-40 Cities and UN-Habitat. Like global water governance, urban governance frameworks and approaches present a variety of ideas designed to reign in politics and channel it through sustainability, equity and efficiency

narratives (Simon et al., 2018). As with water as a resource, so with cities as built environments: good governance requires transparency, accountability, stakeholder participation and so on. Despite their built boundaries, cities are themselves organic and contested social spaces sprawling into once considered peri-urban and rural areas. Chicago was once deemed ‘the city that works’ largely due to what is called ‘machine politics’ wherein corruption and patronage are key factors driving functionality and development. Most Global South megacities are rife with mafias, gangs, and black markets that occupy what can be called ‘self-governed’ spaces – spaces that city managers consider to be ‘ungoverned’, largely due to their inability or unwillingness to bridge the formal-informal divide.

Arguments made in support of participation are obvious. Inclusive stakeholder participation will lead to:

- more successful projects in terms of scale, design, operation and maintenance;
- improved cost recovery;
- enhanced revenue generation and financing;
- protection of environmental resources;
- protection of and respect for cultural and human rights;
- coordination of interests and improved conflict resolution; and
- increased transparency and accountability in decision-making (UNESCO and UN Water, 2006).

Challenges are equally well-known. For example, participation does not always achieve consensus. Intra-urban class, caste and race-based conflicts over various aspects of service delivery are common, so effective arbitration processes and conflict resolution mechanisms are needed. Government intervention is needed in order to create an enabling environment for marginalised social groups (e.g. the poor, indigenous people, the elderly and women). These same groups require support in order to participate effectively. Where environmentally sustainable, socially equitable and economically viable urban (and) water governance and management are concerned, ‘[t]he world needs leadership, long-term sustainable policies, robust legal and regulatory systems, strong institutions, and services that are reliable and provided irrespective of the circumstances’ (Biswas and Tortajada, 2019). Yet, according to Biswas and Tortajada (2019), ‘at least four billion people do not have access to water that is safe to drink, or that it is perceived as not safe to drink without point-of-use treatment systems; in the entire South Asian region of over 1.7 billion people, one will be hard-pressed to find even one city, town or village where the majority of the people think the tap water is safe to drink, without any health concerns. It should be noted that “nearly drinkable” water is in fact not drinkable’; and ‘this includes developed countries, ranging from France to the United States, where fewer and fewer people are drinking water directly from the tap because of quality concerns and sociocultural conditions’.

Think of governance as the design phase of a project and management as the execution phase of the same project. The two are related in terms of performance through feedback loops, reflection, policy reform, and so on. So, who gets to design how water resources are used? Historically this has been elite-driven and has served the political and economic interests of the elite, i.e. water for the production of energy, food and agriculture, mining and manufacturing. Given water's pivotal role with regard to political and economic power, especially in the post-colonial era, to the power of the central state, management systems have largely been command-and-control, and sector-oriented. Such short-sighted actions, intended for very specific (narrow) outcomes, have created wonders of the built environment and we humans have reaped many benefits from this historical approach to the governance and management of water and land. This approach is, however, both unsustainable and does not serve the needs of the majority. Finally, the impact of neoliberal globalisation has simultaneously widened the gap between rich and poor and heightened the politicisation of services through deregulation; desubsidisation; and privatisation (Bakker, 2010; Boelens and Zwarteveen, 2005, Joy et al., 2014). Structural adjustment conditionalities combined to undermine development as a social project in favour of profit and shareholder value. In the water world this meant, among other things, the privatisation of public utilities and services, the appearance of pop-up infrastructure such as water kiosks based on user-pay principles,

Figure 5.1 Civil society, social activist groups and academics demonstrating in the 2003 World Social Forum, Porto Alegre, Brazil due to the privatization of water and sanitation services

(photo: WATERLAT GOBACIT/Flickt www.flickr.com/photos/125391306@N03/with/48238418671/)

private providers serving the urban poor with expensive water of generally poor quality, the proliferation of non-governmental organisations (NGOs) and community-based organisations (CBOs) in place of government offices and services, and large, technically complex and economically expensive infrastructural projects (e.g. desalination plants and water transfer schemes) designed not to unite cities around a collective challenge such as climate change or unequal access, but to maintain the status quo.

Big infrastructure attracts not only powerful actors but acts as a diversion from the deeper issues of divided societies. The challenge is to bring this fractured world together – not just to talk about a pro-poor agenda or a triple-bottom line but to actually follow through on commitments. Is there evidence of this to give us hope? As will be shown below, it is clear that positive outcomes emerge under a combination of particular factors. We identify nine key factors that seem to contribute to shuttling urban water politics along a positive pathway. We have already highlighted four: (1) collective, cross-sectoral and participatory decision-making; (2) actions that are framed in a deliberately non-political way; (3) projects that are underpinned by influential third-party involvement; and (4) efforts that are supported by government policy that has been shaped by enlightened leadership. To these four, we add an additional five: (5) shared need; (6) sufficient available capital; (7) respect for people; (8) relatively equal vulnerability; and (9) the presence of an effective regulator. From the case studies, it appears to us that the first four are most important, while the last five may help compensate for the absence of one or more of the first four.

We turn now to a presentation of the case materials. These cases are meant to be indicative of possible solutions, rather than definitive. They suggest strategic and tactical interventions that not only facilitate enhanced urban water security but encourage better governance through interventions with clear multiple benefits for stakeholders across the urban environment.

5.4 CASE STUDIES

5.4.1 Collective, cross-sectoral and participatory

With regard to cross-sectoral, collective and participatory action, there are numerous examples of slum upgrading as a means of improving urban governance, the livelihoods of poor people, and water security. In city's as diverse as Cape Town, Karachi, Johannesburg, Manila, Mombasa, Nairobi and São Paulo, municipal government actors took it upon themselves to improve slum dwellings. This is not to suggest that it was a top-down effort. On the contrary, in each of these cases civil society actors organised and pressed for attention to their interests. The common, historical, global response has been for city authorities to stigmatise slum dwellers and to seek their removal at all costs. In these particular cases, however, the outcome was quite different – smart partnerships were created by state, CBO, NGO, and private sector actors in support of the upgrade. In the São Paulo case, the focus was on wastewater and solid waste management in the favelas. Most favelas across the São

Paulo metropolitan area have access to water (either illegally or legally), but almost none have access to formal sanitation. As a result, the outflow from the favelas creates significant pollution problems for those downstream in the Guarapiranga basin. In 2005, São Paulo's Social Housing Department, supported by a loan from the World Bank, undertook a massive slum upgrading intervention. The most important aspect of these projects is that the City committed to acknowledging slum dwellers' rights, not only to the city but also to the land they were occupying. This was an important step toward making slum dwellers willing partners in the exercise (Tshabalala and Mxobo, 2014).

The Lusaka Water Security Initiative, initiated by the city of Lusaka in Zambia offers a good example in which all stakeholders were equally affected by the contamination of groundwater in the shared Kafue catchment area. In the Lusaka case, the intervention was initiated by Zambia Breweries – a private sector company dependent upon high quality groundwater. The company brought its financial capabilities into alignment with government authorities, by way of the Water Resource Management Authority, who sought assistance from the GIZ Water Stewardship Program in devising a strategy for the management of the Kafue groundwater supply. More than 70 stakeholder groups participated in a series of workshops, resulting in a government-supported, multi-stakeholder initiative involving approximately twenty partners from civil society, the state and the private sector: e.g. Zambian Breweries, Coca-Cola, Lusaka City Council, and Women for Change. At present the initiative is engaged in four projects: wellfield protection, a water security action and investment plan, Lusaka clean green and healthy schools project, and the implementation of the Alliance for Water Stewardship project.

Two water conservation exercises in Chennai and Bangalore, India, offer slightly different examples. Chennai and Bangalore are at opposite ends of their respective hydrological systems, with the former located at the top, and the latter at the bottom end of the watershed. This presents significantly different challenges to sustainable water management in these Indian cities. Following significant drought in the early 21st Century, the state of Tamil Nadu, where Chennai is located, mandated that rainwater harvesting (RWH) systems were compulsory. This decision was driven in part by the influence of the Akash Ganga Trust, a private trust that has long been involved in RWH and which, in 2002, established the Chennai Rain Centre. All new buildings in Tamil Nadu are required to have RWH infrastructure. In addition, the municipalities provide inducements and penalties to incentivise the uptake of RWH across these large urban spaces. According to Durga (2016) and Holand-Stergar (2018), groundwater recharge and household well levels have improved significantly.

The rapid expansion of India's tech industry is centred in Bangalore. As a result, there has been rapid urban expansion, encompassing areas that were previously rural. Many of these rural areas are dotted with a complex system of tanks (i.e. small artificial impoundments, similar to lakes) designed initially for irrigation and village water supply. The urban footprint has come to include these tanks as desirable settlement sites, though many have fallen into disrepair. The Jalaposhan Trust emerged to 'adopt' one of the tanks – Jakkur Lake – and

undertake its rehabilitation. Today this civil society organisation, in cooperation with a number of other groups, e.g. Satya Foundation, ATREE, the Horticulture Department of Bangalore, and the Fisheries Department, has taken a collaborative approach to rehabilitation. The lake now provides aesthetic value, serves as a small fishery, and operates as a wetland helping to improve water quality and lessen flood impacts in the area.

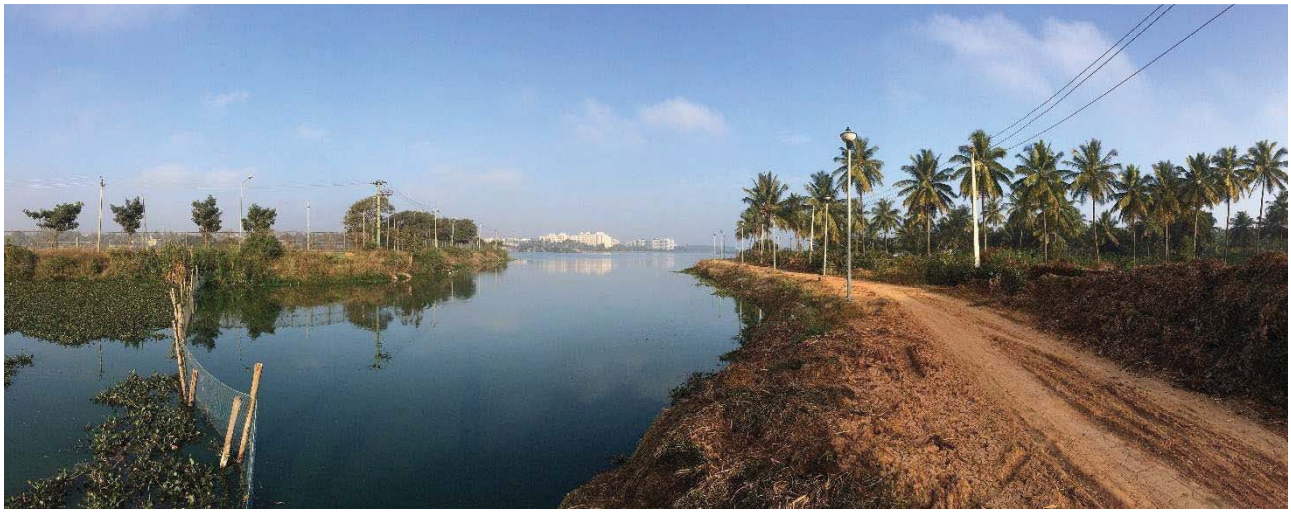

Figure 5.2 Jakkur Lake, Bangalore, India
(photo: Manu.mohan CC by 4.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Jakkur_lake.JPG)

5.4.2 Deliberately non-political

The city of Miami is vulnerable to a variety of climate change factors such as increased numbers of intense seasonal storms, saltwater intrusion, and flash flooding. Like any other city, Miami is home to rich and poor alike; each group being vulnerable to these extreme events in different ways, but all vulnerable nonetheless. Moreover, these events are worsened by the nature of the built environment. Enter the Miami-Dade County Neat Streets' 'Million Trees' initiative. Neat Streets is a Miami-Dade County Board under the jurisdiction of the Miami-Dade County Parks, Recreation and Open Spaces Department. Their goal is to increase tree canopy coverage by 30% in order to help address the negative effects of extreme weather events. This initiative has led to other tree-planting initiatives in the City, such as the Growing Green Playgrounds and Growing Green Bus Stops programs. Singapore has launched a similar initiative.

If Miami's nature-based solutions initiative is recent, Tokyo's nature-based solution – the water conservation forest – is more than a century old. The Bureau of Waterworks has managed the 23 000 hectares of forest in the upper catchment of the Tama River since 1901. Since the early 2000s, the Bureau has sought to rehabilitate forest on private lands within the Tama River basin.

Figure 5.3 Water conservation forest in the headwaters of the Tama River, Yamanashi, Kanagawa

(photo: 雷太 CC BY 2.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Tama_River,_Japan;_August_2016_(01).jpg)

Green infrastructure and nature-based solutions are popular as they reduce the cost to governments of creating similar infrastructure. The Olentangy Wetland, located on the campus of Ohio State University in Columbus Ohio, is an artificially created wetland that has since been designated as the 24th Ramsar Wetland of International Importance in the United States. It serves to filter water flowing to, and through the OSU campus, thereby providing important ecosystem services to the university and the city.

5.4.3 Influential Third-Party Involvement

Most of these case studies have included influential third-party involvement: in Lusaka it was GIZ and in São Paulo it was the World Bank. These are typical water influencers, whose involvement is often controversial. In Rwanda, the Kingdom of the Netherlands supported the development of the Upper Nyabarongo Catchment Plan that was designed to help the country transition toward IWRM while also improving water security for the primate city of Kigali. The World Bank also supported an Output Based Aid project in Jakarta, Indonesia in which the contracts of private providers Suez and Thames Water were tied to specific outputs geared towards pro-poor water access. As is well known, privatisation was rightly criticised on a number of fronts, one of which was that it enhanced services for those already empowered, and further marginalised those without services (and unnecessarily enhanced the political nature of water delivery). In this particular case, the unexpected outcome of privatisation was

conflict with existing small-scale private providers. Ultimately, CBOs were enlisted to participate in billing and collection. While a convoluted and controversial case study, the Jakarta example demonstrates that in many mega-cities, the poor are completely left to their own devices and it is only through innovative projects such as this one that civil society is better able to represent its interests to government.

5.4.4 Enlightened Leadership

There is no substitute for effective leadership. Examples are numerous where city managers, often supported by higher levels of government, and in league with civil society organisations, achieve significant outcomes in urban water security. These vary dramatically in form and content from government support for crop-switching within the watersheds serving Beijing, China, to Rotterdam's collectively designed Climate Proof Urban plan, or the development of multi-use systems for surface and groundwater that serves Mexico City as well as the farmers upstream and downstream of the city. The drought in California during the mid-2010s resulted in the development of a meaningful water conservation policy in the City of Los Angeles. This included not only environmental education within schools and communities, but also innovative approaches to encourage both public and private shifts towards indigenous landscaping (such as the removal of temperate zone grasses, for instance, from parks and lawns). Mimicking South Africa's basic water law, Medellín, Colombia instituted a minimum water provision guaranteeing households 2.5 m^3/month of free water.

In our view, remunicipalisation and corporatisation of urban water utilities reflect enlightened government leadership. Paris is an example of the former, and Johannesburg is an example of the latter. Each of these large cities face challenges not only related to serving growing numbers of customers, but in maintaining existing infrastructure. In the case of Paris, the City decided in 2008 to remunicipalise the water utility at the completion of the private contracts it had signed with two private providers, Suez and Veolia. The municipal provider, Eau de Paris, was consequently created in 2010. The situation in Johannesburg was more complicated. Following the end of apartheid, the municipal boundaries were redrawn so as to include the previously marginalised townships of Alexandria and Soweto. The question became one of how to extend infrastructure to those most in need but with the least ability to pay. Private providers, beholden to shareholders, were prone to 'cherry picking', i.e. only providing to those who could pay. Corporatisation would allow the City to operate along business/for profit principles, but with social and environmental objectives as well.

The reliable delivery of potable water to millions of people, many of whom have limited means to pay for services, and who have long been marginalised from the system is no small success. To be sure, civil society has played a central role in driving government performance. The relative success of Johannesburg stands in stark contrast to the negative social, economic and environmental outcomes of privatisation in Cochabamba, Bolivia and Jakarta, Indonesia.

Increasingly, municipalities have realised that public-private partnerships (PPPs) are not enough, and that communities must be directly involved through, for example, civil society organisations. In highly unequal societies, such as South Africa or Brazil, with gini coefficients of income inequality nearing 0.6, differential service delivery is regarded by the poor as a continuation of neglect and disrespect. Without community involvement then, it is not possible to achieve their buy-in regarding the possibilities for expansion and delivery (see Chapters 6 and 7 on social science and civil society).

While there are many issues related to under-performing utilities, it seems clear that both 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 – have 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. When it goes right though, as seems to be the cases in Medellín and Johannesburg, success tends to breed success as the state and civil society move closer together in building trust and social capital. One must remember, however, that 'success' is not a result of 'enlightened government' alone, but also of civil society pushing for its interests, often using the power of disruption in order to shift governments in directions they would otherwise not have gone (Bond, 2008; Macdonald and Ruiters, 2004; Robins, 2014; Rodina, 2015; and see also Chapters 6 and 7 in this collection). Moving toward the successful delivery of water and sanitation services thus 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, questions regarding whether expansion will include networked or non-networked systems, prepaid meters with automatic shut-off points, 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 when 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 (Robins, 2014).

Table 5.1 summarises the findings from the cases that have been discussed. As may be seen, no initiative includes all nine criteria. All show at least two of the first four criteria (see key to table below), with all cases being framed in non-political ways – in other words, they are framed as fulfilling a government mandate through service provision. Several would clearly not have succeeded without influential third-party support, especially in the form of financial backing. This is particularly the case with the slum upgrading exercises and with Jakarta's improved water provision to the poor. These are also the cases where 'respect' for the poor is an issue (7), vulnerability is highly uneven (8) (except in the case of São Paulo where slum

locations impact wealthy and empowered downstream users), and corruption is an on-going problem (9). Are these initiatives sustainable and replicable? They are certainly replicable – slum upgrading schemes have worked at small scales around the world – but sustainability is another matter. Where citizens have been empowered as partners (i.e. in the Karachi case), it seems to us that there is hope for both sustainability and replicability of the project. In the cases of purely technical and/or nature-based-solution approaches, there seems to be a great deal more potential for improved state-civil society relations, as evidenced in the cases of Miami, Los Angeles and Tokyo.

Table 5.1 Case Study Summary

City	**Intervention**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Comment**
São Paulo	Slum upgrading	x	x	x	x		x		x		Dependent on capital
Mombasa	Slum upgrading	x	x	x			x				Dependent on capital
Karachi	Slum upgrading	x	x	x			x				Dependent on capital
Cape Town	Slum upgrading	x	x	x	x		x				Dependent on capital
Nairobi	Slum upgrading	x	x	x			x				Dependent on capital
Lusaka	Integrated planning	x	x	x	x	x	x	x	x		All actors vulnerable to groundwater contamination
Chennai	Rainwater Harvesting Systems	x	x	x	x	x	x	x	x		Citizen mobilisation with strong third party
Bangalore	Urban wetland rehabilitation	x	x	x	x	x	x	x	x		Citizen mobilisation with strong third party
Miami	‘million trees’ initiative	x	x		x	x	x	x	x	x	Citizen mobilisation with government support
Tokyo	Upper catchment management		x		x	x	x	x	x	x	Strong regulator with adequate finance and shared vision
Columbus, Ohio, USA	Urban wetland construction	x	x		x	x	x	x		x	Citizen initiative supported by government
Kigali	IWRM catchment plan		x	x	x	x	x	x	x		Powerful third party support

City	Intervention	1	2	3	4	5	6	7	8	9	Comment
Jakarta	Output-Based Aid		x	x			x				Dependent on finance and external influence
Rotterdam	Climate Proof Urban Plan	x	x		x	x	x	x	x	x	Mutual vulnerability
Mexico City	Multi-use system	x	x	x	x	x		x	x	x	Clear benefits to be shared
Los Angeles	Water demand management	x	x		x	x		x	x	x	Mutual vulnerability with reasonable sacrifices
Medellín	Free basic water	x	x		x	x		x		x	Citizen mobilisation with strong government commitment
Paris	Remunicipalisation	x	x		x	x		x		x	Strong leadership and capacity for delivery
Johannesburg	corporatisation	x	x	x	x			x		x	Strong leadership and capacity for delivery

Key: (1) collective, cross-sectoral and participatory; (2) framed in a deliberately non-political way; (3) underpinned by influential third party involvement; (4) supported by government policy shaped by enlightened leadership; (5) need is shared; (6) capital is available; (7) people are respected; (8) vulnerability is relatively equal; (9) where an effective regulator is in place

5.5 THE POLITICS OF WATER IN CITIES

Urban water security may be defined as both the citizens' freedom from want (i.e. having adequate amounts of water of an appropriate quality for daily consumptive (household, economic) and non-consumptive (e.g. recreational, spiritual) needs, and the citizens' freedom from undue risk due to natural hazards 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:

(i) 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)

Figure 5.4 Unequal access to services such as refuse removal and sanitation leave slum dwellers at risk in places such as Jakarta
(photo: J McIntosh CC BY 2.0 via Wikimedia Commons
https://commons.wikimedia.org/wiki/File:Jakarta_slumlife15.JPG)

(ii) Reducing vulnerability through appropriate individual and collective action

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

As shown above, there are many examples of 'better practice' across the world's cities. These include low impact development and nature-based solutions, community-centred approaches to service delivery, public-private-community partnerships and infrastructure upgrades. In relation to the politics of water for cities, our chapter also 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. Improvements can be made, however.
- As cities continue to grow, there will be no substitute for supply-side solutions to scarcity and uncertainty. At the same time, there is great potential for nature-based-

solutions to bring together otherwise divided citizens (as shown in the Bangalore and Miami cases).

- Demand-side management, as well as improvements to existing supply systems can greatly enhance the urban water endowment. These are politically sensitive, however, especially when asking citizens – some of whom already have limited access – to 'want less'. Nevertheless, if shaped creatively, as in Los Angeles, significant improvements can be made.
- Authoritarian/Totalitarian political systems (where civil society is weak) provide equal space for misguided projects (e.g. Three Gorges Dam and Ilisu Dam) and creative innovation (e.g. large-scale desalination and '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, and less-influential groups, in particular the poorest citizens, are squeezed out
- 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.

5.6 CONCLUSION

It is clear 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 towards improved practices and outcomes? Since 2000, there have been concentrated efforts along two fronts: first, improved governance (including exposing and rooting out corruption, updating water laws, and developing strategic plans for water resource development and management), and second, improved management (specifically IWRM with a focus on river basins as the geophysical units 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 privatisation of urban water systems being the prime example (Bakker, 2010). Urban water governance has proceeded in a similar fashion, with similar pressures for change.

There is no escaping the politics of water. It is manifest in decisions regarding reforms to governance and management, and it is manifest in decisions regarding appropriate technologies. Some regard the widespread turn toward desalination to be a consequence of the endless ocean waters not being 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 also has ecological consequences, which will no doubt have socio-political and economic consequences as well. Cities, through global processes such as Agenda 2030 and UNFCCC COP, learn from each other. Moreover, these

are collective social spaces occupied by civil society organisations who share strategies and tactics, and the private sector, who compete for markets and contracts. It is these groups coming together that will determine who gets what water, when, where, and how (Bond, 2008, 2013). It is our job as academics to understand why, and as activists to fight for the outcomes we believe in. We believe that we have illustrated the potential and possibility for positive change through our short case studies. At the same time, we are well aware of the challenges presented by a constellation of social forces determined to maintain their power and privilege at whatever cost.

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CHAPTER 6

SOCIAL INSECURITY OF WATER IN (SOUTH) AFRICAN CITIES

Mafaniso Hara, Bongani Ncube and Darlington Sibanda

Figure 6.0 Khayelitsha, an informal settlement in Cape Town, South Africa
(photo: O Ernst CC BY-SA 4.0 via Wikimedia Commons
https://commons.wikimedia.org/wiki/File:Khayelitsha,_Baden_Powell_Drive_(South_Africa).jpg)

6.1 INTRODUCTION

Urbanisation is a growing challenge all over the world. In former colonies (Africa, Southeast Asia, and South America), cities are increasingly attracting people from rural areas who come in search of jobs in the formal economy, better economic opportunities, and improved lifestyles. In South Africa, the removal of the apartheid era influx controls has meant that black South Africans are no longer temporary residents in cities, but citizens who have equal rights to cities and therefore have greater degrees of freedom to establish their own homes within or outside of the ambit of the state and/or the residential property market in cities (Bhan, 2016, Napier, 2013, Royston, 2013, Thompson and Tapela, 2018). The implications and consequences of this have been an increased number of households in urban areas and a hyper-growth in the demand for housing and social services. The state (particularly municipalities and local government), as a result, struggles to deliver services to meet these burgeoning needs and demands. In South Africa, the net effect has been an increase in backlogs of historically disadvantaged individuals/households trapped on waiting lists or databases awaiting service delivery or state-funded housing, and/or dependent on informal rental and tenure markets. For example, Thompson and Tapela (2019) point out that between 2001 and 2011, formal dwellings increased from 68% to 78% and informal dwellings decreased only slightly from 16% to 14%. On the other hand, the South African Institute of Race Relations, (SAIRR, 2017) argue that informal dwellings also increased from 1 453 018 in 1996 to 2 193 968 in 2016, a growth of 51%. Bore-Saladin and Turok (2013) point out that 1 in 5 households in metros live in shacks, and the Cape Metro (Cape Town) had the biggest increase (53%) in such informal dwellings followed by the Johannesburg Metro (17%). These figures mask the actual prevalence of informality, with regard to access to services such as water and sanitation that are linked to dwellings in urban areas, due to rapid urbanisation.

While metros show the greatest increase in the informality of housing and tenure, findings show that this urbanisation trend is spreading to non-metropolitan cities and towns and smaller towns across South Africa (Thompson and Tapela, 2019). Once people move into urban areas, the next step is trying to “move up the ladder”, which includes access to free government housing, informal settlement upgrades, formalisation of tenure and tenure security (Hornby et al., 2017). For residents living under informal tenure, infrastructure upgrades provide the opportunity to link housing upgrades with secure and improved water and sanitation as part of a progressive realisation of their Constitutional (human) rights to secure access to water and sanitation services. Unfortunately, the reality is that cities find themselves continuously struggling to provide space and services. In a study on the impacts of urban land use planning for climate adaptation, Anguelovski et al. (2016, 336) found that ‘in a comparison of eight cities land use planning interventions for adaptation can disproportionately impact low income and minority groups by creating or exacerbating different forms of socio-spatial inequality.’

During times of drought and water stress the poor and vulnerable communities are usually the hardest hit. We argue for the importance of a spatial planning approach that takes cognisance

of the importance of the rights of the urban poor, marginalised and vulnerable citizens in terms of addressing their rights, tenure and access to water and sanitation by decision-makers in cities.

6.1.1 Water Insecurity and Our Assumptions

Our contention is that the problem of water insecurity for the urban poor is a social issue. The problem, therefore, is not only prevalent during times of water shortages in cities, but is ever-present. Thus, the adage of "social scarcity of water" (Tapela, 2012) is an apt descriptive reference for this existing situation regarding water for the poor in cities. The disjuncture between people's basic water requirements and the inability of water service agencies (e.g. local government) to fulfil this basic requirement for the poor is largely a social-political product and governance issue, the result of which is the social exclusion of the marginal urban populations. This exclusion is influenced by the political, economic, and power dynamics underpinning the institutions that structure social relations, rights, and access to water. Thus, water social insecurity revolves around issues of inequality (social, economic, and political), governance and governing systems (formal and informal), markets, transparency and accountability, and systems of rights and tenure.

We base our arguments mainly on the political economy of access to water and water provision services in cities, particularly in developing countries. We use the City of Cape Town in South Africa, where water scarcity and the threat of 'Day Zero' recently made global headlines, as our case study. Generally, it is useful to look at what drives the water insecurity for the poor in post-colonial cities, and the persistently skewed spatial planning and resource allocation related to water and sanitation. What role does policy play in the provision and distribution of water in cities, and who meaningfully participates in policy development and water governance? What role can regional and global conventions (e.g. SDGs, and the Southern African Development Community (SADC) water protocol) play in national policy development processes and equitable access to water?

6.1.2 Policy and Legislation for Water Provision in South Africa

One of the key aims of South Africa's flagship National Development Plan (2012) was to eliminate poverty and reduce inequality. Access to water and sanitation were important factors contributing to the achievement of these aims. With the recognition of the need to address inequality, South Africa also revised the National Water Resource Strategy 2 (NWRS2 2013) with the major focus on 'sustainable, equitable and secure water for a better life and environment for all.' Unfortunately, the NWRS2 also failed to bring water to those who are resource-poor (Hedden and Cilliers, 2014). The government then came up with a Water and Sanitation Master Plan (2019) which is a "Call to Action" document that sets out the critical priorities to be addressed by the water sector in the period from 2018 to 2030. The "Call to Action" provides the basis for, and a more detailed analysis of, the key issues and Schedule of Actions. Water experts believe, though, that the government and stakeholders in the water

sector cannot achieve the plan alone, nor by trying to manage the proposed actions in the traditional top-down approach.

The provincial government of the Western Cape developed its own Western Cape Sustainable Water Management Plan (2017-2022). Unfortunately, the 2014-2018 drought left the Province and the city of Cape Town reeling under severe water shortages. One of the glaring causes for the failed management of the water shortage crisis was the lack of integrated planning between the provincial government, the city and the national government (Enqvist and Ziervogel, 2019). The result was a blame game that remains unresolved, although efforts were made to find joint solutions when the Department of Water and Sanitation (DWS), in partnership with the Western Cape Government, hosted a high-level Water Indaba in 2017 (GreenAgri, 2017). After the drought, the City of Cape Town became more aggressive in dealing with water issues. The Strategic Water Vision for the City states that 'Cape Town will be a water sensitive city by 2040 that optimizes and integrates the management of water resources to improve resilience, competitiveness and liveability for the prosperity of its people' (City of Cape Town, 2019).

While the principles spelt out in the City of Cape Town's Water Vision mention 'inclusivity' and 'work together across boundaries' explicitly, the city remains starkly divided (Enqvist and Ziervogel, 2019). Access to services such as water and sanitation remain heavily skewed, with informal settlements and backyard dwellers at the bottom of the water ladder. The big question, therefore, is: What mechanisms, regarding access to water and sanitation services (within the mix of formal and informal tenure arrangements) in cities, will ensure that the urban poor and marginalised are included?

6.1.3 (Global) Water Vision for 2050

Global effort towards addressing access to water and sanitation, and ensuring sustainable development, has been ongoing for several decades. The United Nations (UN) declared the period 1981-1990 as the International Drinking Water supply and Sanitation Decade. In 1987, the United Nations Commission on Environment and Development defined sustainable development as "development that meets the needs of the present while safeguarding Earth's life-support system, on which the welfare of current and future generations depends" (UNCED, 1987, 16). This subsequently led to the Millennium Development Goals (MDG) whose water aspects were based on the Dublin Principles (Brown, 2010). Water and sanitation were embedded in MDG 7 (Ensure Environmental Sustainability) with the main target being to reduce by 50% the proportion of people without sustainable access to safe drinking water and basic sanitation.

The year 2015 saw the commissioning of the 2030 Agenda for Sustainable Development, with the goals for water and cities being entrenched in SDG 6 (Clean Water and Sanitation) and SDG 11 (Sustainable Cities and Communities). An important fact raised by the United Nations Development Programme in South Africa (UNDPSA) is that SDGs are integrated, meaning

that they recognise that action in one area will affect outcomes in others and that development must balance social, economic and environmental sustainability (United Nations no date). Goal 6 of the SDGs seeks to ensure the availability and sustainable management of water and sanitation for all. Goal 11 also seeks to make cities and human settlements inclusive, safe, resilient, and sustainable. In addition, Goal 5 (Gender Equality) and Goal 16 (Peace, Justice and Strong Institutions) are also central to the way that communities live. All these goals underpin the importance of involving everyone, including the urban poor and women. Both the MDGs and SDGs emphasised poverty eradication, access to clean water and inclusion of the urban poor. The MDGs showed that a goal-setting approach raised both public and policy support and channelled funds effectively towards urgent global problems, but the challenge was to encourage politicians to have the political will to go beyond the goals that had been set (Griggs et al., 2014). The SDGs are included in most national governments' policies, including South Africa. Nations are required to report on their achievement of the targets and indicators in the goals (Global Change, 2014).

6.1.4 Conceptual Framework

We use the 'Hydro-social Contract' (Lundqvuist et al., 2001) (Figure 6.1) as the key conceptual framework for analysing and understanding the social insecurity issues around the provision of water and sanitation in cities.

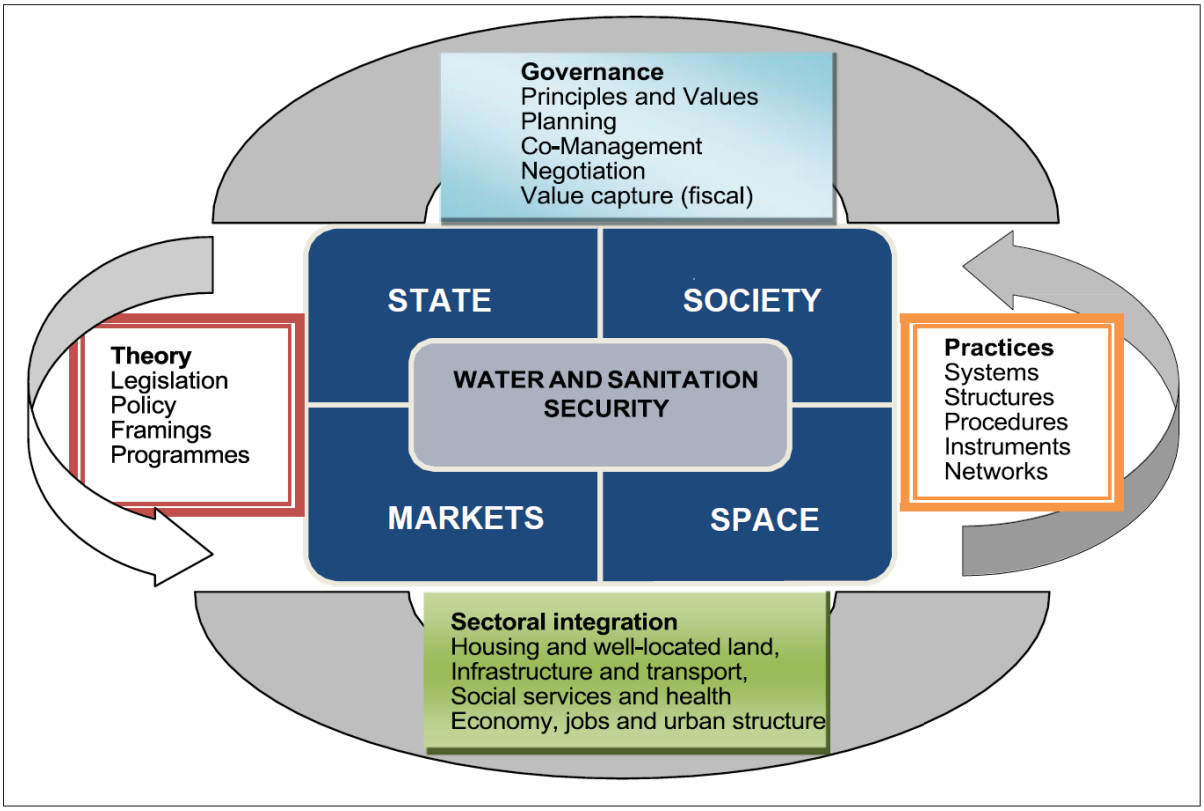

Figure 6.1 The Hydro-social contract (adapted from Lundqvuist, 2001)

A 'hydro-social contract' refers to an implicit contract that exists between the State, Society and Markets (Lundqvuist, 2001). The term refers to the pervading values and often-implicit

agreements between communities, governments and business on how water should be managed for the benefit of everyone. Turton and Meissner (2002, 2) define the hydro-social contract as:

> The unwritten contract that exists between the public and the government that comes into existence when the individual is no longer capable of mobilizing sufficient water for their own personal survival, and that acts as a mandate by which the government ultimately takes on and executes this responsibility. This hydro-social contract thus acts as the basis for institutional development, and also determines what the public deems to be fair and legitimate practice such as the desire for ecological sustainability, to which politicians react.

For South Africa the right to minimum basic water and sanitation are enshrined in the Constitution (Republic of South Africa, 1996) and the National Water Act (Republic of South Africa, 1998), thereby actualising the hydro social contract in law. The hydro-social framework is useful in defining the key elements that require scrutinisation when analysing the social-political issues in relation to water and sanitation delivery for the poor and marginalised in urban societies. It is, however, important to note that the framework assumes de-politicisation of the issues and the implementation approach, which is far from reality. For example, the South African hydro-social contract is certainly not neutral – having been moulded by a racially-based historical political economy that governed resource allocation (Thompson and Tapela, 2019). Therefore, historical water provision for blacks under apartheid was not apolitical or de-politicised. In effect, the black democratic government had also to try to deal with the backlog in the provision of water and services for blacks who had been marginalised, thereby also politicising the "contract". Given this political history, the complexity of dealing with equity in water allocation and service delivery should not be under-estimated. Equally, the colonial history in most developing countries has resulted in class stratification, which also politicises and skews resource allocation and service delivery in urban areas. In this chapter, the conceptual point of departure in understanding the hydro-social contract is that there are unequal power relations underlying the exercising of rights and responsibilities, and also that the framework is not value-free in terms of ethics, principles, ideologies, interests and motivations. The hydro-social contract is transacted through the socio-ecological fabric of space through time. Space, in this context, refers to the linkages between land, housing, water resources, water and sanitation infrastructure and social-economic-political institutions that are crafted by the state, markets and society (Thompson and Tapela, 2019; Cleaver, 2012). Recognition of tenure is key-most among the common denominators that determine the patterns by which citizenry practically negotiates and attains (or does not attain) secure access to water and sanitation services (Thompson and Tapela, 2019).

6.2 METHODOLOGY AND APPROACH USED

This chapter uses a case study approach so as to understand the challenges of water provision for the poor within cities. Cape Town City is presented as the key case study. We

also use three other African cities, namely Harare, Lusaka and Nairobi to draw lessons from the African context. The summary case study texts of the four African cities are given below. We also draw lessons from these case studies, and provide recommendations at the end of the chapter.

6.3 CAPE TOWN

Cape Town is located in the Western Cape Province, South Africa. Like most urban areas in South Africa, Cape Town was faced with two main challenges after 1994: to overcome spatial divisions created during the colonial and apartheid era, while at the same time addressing the endemic poverty that these divisions had produced for over three centuries (Swilling and de Wit, 2010). According to Swilling (2010), nearly half of Cape Town has been built in the last 25 years. This is despite the fact that there is a huge challenge regarding '*availability of and access to, suitable and well-located land for integrated human settlements*' (City of Cape Town, 2013/2014: 18).

The population of the City grew by almost 30% in a ten-year period from 2 893 240 in 2001 to 3 740 026 according to the 2011 Census (Statistics South Africa, 2011). Recent estimates by the City of Cape Town indicate that the population may reach 4 232 276 by 2023 (Western Cape Provincial Government, 2017). A significant portion of population growth is attributed to in-migration from other provinces as well as other countries (Statistics South Africa, 2019). Access to water services has improved for most of the population in the city. For instance, the 2011 Census indicated that 75.8% of the population had access to water inside their houses, which was a growth of 5.7% from the 2001 Census. Unfortunately, the lack of accurate data and the complex mushrooming of informal settlements paints a different picture of the real situation on the ground (Sibanda and Tapela, 2016).

Access to water services remains skewed due to the legacy of racial inequality (Enqvist and Ziervogel, 2019). Informal settlements remain sites of deprivation, despite the fact that their inhabitants use fairly small quantities of water compared to other water users. Table 6.1 shows water usage in the City of Cape Town by category in 2017.

Even at the height of the drought, informal settlements used only 3.6% of all water supply in the city. The bulk of the water was used by formal settlements (houses), followed by retail and offices.

Table 6.1 City of Cape Town water use in 2017 (City of Cape Town 2017)

CATEGORY	2015/2016%	2016/2017%
Houses (formal)	55.6	55.0
Flats and complexes	9.2	9.5
Domestic other	1.8	1.8
Informal settlements	4.7	3.6
Retail and offices	11.0	12.8
Industry	3.9	4.2
City-owned facilities and departments	5.2	4.9
Government	2.5	2.2
Other	6.2	6.0

6.4 HARARE

According to the 2012 population census, Harare, the capital city of Zimbabwe, had a population of 2 123 132 people residing in the city (Zimbabwe National Statistic Agency, 2012). The population with access to safe drinking water was pegged at about 94% during the census. However, the situation on the ground paints a completely different picture. In 2008, Harare was struck by one of the worst cholera outbreaks ever recorded in the city. Studies in 2015 revealed that the outbreak was explicitly linked to 'an array of socio-material processes (particularly the collapse of Zimbabwe's public health and hydraulic infrastructures); the failures of urban governance; the electoral violence of 2008; economic strategies of survival; and to the arbitrary, spectacular and violent actions of the state' (Chigudu, 2019, 182). A number of alternative water sources were provided to combat the cholera outbreak. However, Manzungu and Chiroreso (2012), found that the water sources used by a household were related to the household's socioeconomic status, with low-income households using less expensive sources of water like shallow and deep wells that were largely unprotected and unsafe.

Harare, like other major urban centres in Zimbabwe, has a history of evictions and the demolition of informal settlements, which has resulted in citizens being moved to what are termed 'emerging settlements.' A case in point is Hopley Farm in the city, where residents, especially the poor, are described as 'the underclass who are denied their right to the city through displacement, dispossession of their land, and exclusion in accessing formal service' (Matamatanda, 2020, 485). The settlement lacks running water and sanitary services. Residents improvise in order to access water, resorting to unsafe water sources such as shallow wells. In some instances, access to clean water is charged at USD1 per day, an amount that the poor cannot afford to pay (Matamatanda, 2020, 480).

6.5 LUSAKA

Lusaka Province, in which the capital city of Zambia (Lusaka) is located, had a projected population of about 3.36 million by 2020 (Zambia Central Statistical Office, 2012). The increase in the population has been accompanied by an increase in water demand, as in any other big city. In the late 1980s, Zambia implemented reforms for the commercialisation and privatisation of water and sanitation services. Families in low-cost housing were to pay less than those in higher-income housing. However, the unintended consequences of this were that, although the water tariffs were low, they were still unaffordable for the majority of the residents. As a result, the quality of water and access to safe water in the urban sector has declined. Poor households rely on public taps, boreholes, and wells rather than water supplied through residential pipes (Dagdeviren 2008). Most of the residents depend on the shallow wells because of their proximity and lower costs. As a result, there are increased incidences of water-borne diseases among residents who use such water (Levy et al., 2017). Poor sanitation is also directly related to poor water quality. For example, Kennedy-Walker et al. (2015) found that 'the level of sanitation access, safe management of excreta, sanitation service provision and associated knowledge in Peri-Urban Areas (PUAs) of Lusaka was poor.' Sixty percent of the population resides in these areas, and 90% of them use pit latrines (Kennedy-Walker et al., 2015).

Since the late 1980s and early 1990s, Zambia has embarked on water sector reforms to 'address a number of challenges including the poor institutional and legal framework, deterioration of water and sanitation services, inadequate human resource capacity, low coverage of water and sanitation services, inadequate stakeholder and community participation, limited and ever-decreasing capital investments, and the need to adapt to emerging international trends in water management' (Chitonge, 2011, 3). The Zambian water governance system has remained highly sectorial however, with insufficient institutional and legal frameworks and mechanisms to ensure the equitable provision of water and sanitation. The structure is centralised and lacks effective stakeholder participation (Uhlendahl et al., 2011), resulting in large sections of the population remaining without safe water and sanitation services.

6.6 NAIROBI

Due to rapid urbanisation, the City of Nairobi is expected to spill into neighbouring peri-urban areas thereby becoming a metropolis. Nairobi is an economic hub for East Africa and had a population of 4.7 million in 2020. The population is growing rapidly at over 3.5% annually[12] due to rural-urban migration. It has the largest population density in Kenya at 4 515 per square kilometre (National Council for Population and Development NCPD, 2013). Besides the major water supply deficit, Nairobi faces unpredictable droughts and flooding. According to the Smith School of Enterprise and the Environment (2014), the city's current water supply is 23% lower

[12] (https://www.macrotrends.net/cities/21711/nairobi/population

(170 000 m^3/day) than water demand, and this is expected to increase to a 63% deficit by 2035. Non-revenue water is as high as 42% due to aging infrastructure and illegal connections (Smith School of Enterprise and the Environment, 2014). Due to the insufficient and unreliable supply, most households and enterprises invest in alternative sources of water supply. Estimates indicate that of the over 3 500 boreholes located in Nairobi County in 2014, less than half (47%) had abstraction permits, nearly two thirds (63%) were unmetered, and four in five (78%) users did not pay for water (Smith School of Enterprise and the Environment ,2014). In addition, because of informal settlements relying on pit latrines, groundwater is contaminated and largely unsafe for domestic use.

Figure 6.2 Shared pit latrines such as this one in Mathare, Nairobi are often sources of groundwater pollution

(photo: SuSanA Secretariat CC BY 2.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Shared_toilet_facility_in_Mathare_(Nairobi)_(5163671304).jpg)

Nairobi has also seen a proliferation of informal water markets. A recent study found that more than half of the residents in Mathare, a large informal settlement, accessed water from informal water vendors and about 36% of households depended exclusively on them. Unfortunately, the water quality was inconsistent, and the water sometimes tasted bad (Sarkar, 2020)

6.7 CAUSES OF WATER SOCIAL INSECURITY

The causes of water insecurity in cities such as Cape Town (and most other African cities) are the result of historical and economic dispossession, governance problems, informal economies, lack of recognition of 'the right to the city' for the poor, and unfulfillment of the hydro-social contract.

6.7.1 Historical Socio-Economic Dispossession

The perpetuation of social, economic and political inequality in South Africa is a result of the colonial past, apartheid and neoliberal policies post 1994. Here, we draw on Marxist (Marx 1867) ideas and notions of "accumulation by dispossession" in our analysis of water governance regimes (e.g. Bond, 2012 and Loftus, 2007 for South Africa, and Swyngedouw, 1997 more generally). The apartheid regime was based on policies that dispossessed the rights and resources of blacks for accumulation by whites. This was on a grander and more brazen scale than the colonial project. Although a lot has been achieved in terms of water delivery for the poor since the institution of democracy in 1994, the continuation with neoliberal policies after 1994 has resulted in stalled progress and an increase in problems of service delivery. Policies such as "full cost recovery" and, "ring-fenced financing" have prevented the achievement of the government's policy on free basic water for all, which was based on progressive social protection thinking. This has resulted in the state's inability to deliver on its Constitutional obligations (Republic of South Africa, 1996) and legislative mandate (National Water Act 1998). As Linton and Budds (2014) remind us, 'water flows towards power and money', and even more so under globalisation and 'economic efficiency' principles. The poor cannot compete with the well-to-do and politically powerful on equal terms, especially in South Africa, which is one of the most unequal societies in the world. According to Li (2009), the current policies in South Africa amount to '*let live and let die*' and limit our ability to think differently about water security and how best to achieve sustainable, equitable and efficient water access for every citizen in the whole society.

There is a need to understand how we got to the current situation. On the eve of the first non-racial democratic elections in 1994, an estimated 1.06 million households, comprising 7.7 million people, already lived in informal settlements. The socio-political control wielded through state-driven, racial discrimination under apartheid firmly entrenched the underlying South African urban structural form. The apartheid era policy implications weigh heavily on the current relationship between the state, citizenship and space (Robinson, 1997). The unequal access to water services was inherited from colonialism and apartheid. The hastened urbanisation post-1994 only reinforced and made worse a situation that was already bad as a result of the spatial segregation ruthlessly instituted and enforced under apartheid (OECD, 2011). Davis (2006: 60-61) postulated that Malan (2000) had painted a bleak and rather pessimistic picture of the rapid rate of urbanisation in Cape Town soon after 1994, and how this related to the provision of water and other services:

> After…the hated pass laws were scrapped, it was as if a distant dam had broken, allowing a mass of desperate and hopeful humanity to come flooding over the mountains and spread out across the Cape Flats. They came at the rate of eighty, ninety families a day, and built homes with their bare hands, using wooden poles, tin sheeting, bits and pieces of trash rescued from landfills and plastic garbage bags to keep out the rain. Within two years, the sand dunes had vanished under an enormous sea of shacks and shanties, as densely packed as a mediaeval city, and populated by fantastic characters-bootleggers, gangsters, prophets, Rastafarians, gun dealers and marijuana czars, plus almost a million ordinary people.

Another dimension which has seen tremendous growth in South African cities, and to some extent other African countries, is the backyard housing sub-sector. The 2011 national census indicated that the proportion of backyard renters grew by 32% between 2001 and 2011, to constitute 25% of all households (SALGA, 2013). Given this massive and unplanned growth in informal housing and demand for water, sanitation and other services, the number of people utilising toilets, taps, drains and cooking facilities on specific sites across neighbourhoods can stretch the carrying capacity of the existing infrastructure. Here, as in any informal urban setting, the importance of informal water economies becomes obvious. Thus, self-dug wells/boreholes, informal vendors and sharing of water become important in the provision of water. The numbers and proportions of people joining this informal water economy are therefore bound to have increased massively with increased urbanisation. It is no wonder then, that the last decade has seen growing unrest and violent demonstrations against the lack of, and/or poor service delivery in South Africa (Tapela et al., 2015, Sibanda, 2018). Despite the aforementioned, formal households used the lion's share (55%) of the water in Cape Town in the 2016/2017 financial year. Retail businesses and offices were the second-biggest water consumer at 12.8%, and informal settlements used only about 3.6% (see Table 6.1).

Research findings by Sibanda (2018) indicated that informality leads to poor access to water and sanitation services. This is because the 'package' of services is normally linked to formal property titles. In some cases, municipalities do not provide services to informal settlements on private land or disputed tenure settlements (Sibanda, 2018). The quality of water services is also affected by the geographic location of some of the informal settlements. Taing's (2017) research in Cape Town showed that officials preferred providing informal settlements with un-sewered sanitation because the conditions of the ground on which the settlement is located were not ideal due to various reasons. Among these reasons were the high capital costs for construction of new sewer and treatment plants, and the fact that informal settlement occupants might interpret this as the granting of official tenure rights. This is also the case with water services.

The blanket approach to water and sanitation services delivery which the state followed after 1994 ignored serious pertinent issues for people in different tenure arrangements (Sibanda, 2018). It is important to address questions such as: how do the rights to adequate housing,

water and sanitation coalesce or contradict each other? And, given that tenure arrangements are fluid and complex in urban and rural settings, how do they impact other rights such as basic services?

In other African cities, for example, Harare, Lusaka and Nairobi, the growth in the number of self-dug wells/boreholes is a response to a deepening water crisis (Manzungu and Chioreso, 2012). The ability of households to respond to these dire situations is however dependent on the socioeconomic status of the households, which means that the situation for poor households is usually very precarious. Lack of basic services has sometimes been blamed on the 'informality' of informal settlements in regard to the legality (or illegality) of such dwellings. For example, for Kibera, one of the largest informal settlements in Africa, Mutisya and Yarime (2011: 203) state that "the Kenyan government owns all the land on which Kibera stands, though it continues to not officially acknowledge the settlement, no basic services, schools, clinics, running water or lavatories are publicly provided. The services that do exist are privately owned." For the government, the whole settlement is 'illegal'.

Even beyond the problematic land-water legalities, strict legal approaches and policy formulations on water service delivery easily result in criminalization that hits the poor hardest. The question becomes: 'What forms of policy review and (gendered) government support could stimulate whatever works, and prevent negative excesses in water governance and service delivery?' Royston and Narsoo (2006) allude to this fact by stating that invisibility and lack of recognition carry the risk of side-lining many vulnerable people, households, and communities from development opportunities.

6.7.2 Governance Challenges

Governance is overwhelmingly viewed as the exercise of political, economic, administrative and legal authority in the management of a nation's affairs (World Bank, 1994, Killian, 2020) or the politico-administrative way of public policy-making, reforming and organising (OECD, 2019, Bang and Esmark, 2013). African cities are dynamic and therefore need adaptive governance to accommodate rapid urbanisation and population growth, so as to enable 'social mobility' among the poor (Turok, 2012). In addition, in the context of shared water sources – as is the case in informal settlements in most cities in South Africa and most African cities – the issues and questions are: 'What type of access rights exist?', 'Who controls access?', 'What are the rules for access?', 'Who makes and changes the rules?', 'How are the rules enforced?', etc. Although boundaries (physical, social, economic, political, etc.) influence and determine who can access a particular service and at which times (Ostrom, 2013), the role of unwritten socioeconomic boundaries is far more important in informal settlements (Manzungu and Chioreso, 2012, Cleaver, 2012). In some instances, access to water for tenants renting in someone's house might depend on the rules that the landlord put in place (Sibanda, 2018). Sharing water points such as community standpipes can involve a complex mix of rules and processes, with control to some standpipes exercised by the use of a lock that indicates restricted access, or some form of access arrangements (Sibanda, 2018, Tapela et al., 2015).

After 1994, South Africa embarked on legislative and policy reviews, resulting in instruments such as the National Water Act (1998), the Water Services Act (1997), the National Water Resource Strategies 1 (2004) and 2 (2013) and water allocation reforms (2008 and 2011). The main objectives of these instruments were to give mandate and effect for water governance that culminated in the Water and Sanitation Master Plan (2019), which provides for:

- Universal and equitable access to reliable water supply and sanitation services;
- Protection, management and development of the nation's water resources in a manner that supports justifiable and ecologically sustainable economic and social development; and
- Transformation of access to water to redress the racial imbalances created by apartheid.

Figure 6.3 Issues of access to, and control of shared water resources in informal settlements – such as this community standpipe in Khayelitsha, South Africa – are often complex
(photo: Justmee3001 CC BY-SA 4.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Washing_clothe.jpg)

Despite all of these internationally acclaimed policies and legislative instruments, South Africa is still struggling to provide equitable water and sanitation services to the poor, in both the rural and urban areas. The Water and Sanitation Master Plan (2019) proposes a paradigm shift that includes the recognition that, in order to achieve water security, there will be a need to "ensure equitable access to the limited water resources and to deliver reliable water and sanitation services to all." According to Winter (2019), the master plan unfortunately does not go far enough to address the impending water crisis, and he further stated that 'the DWS and stakeholders in the water sector cannot achieve the plan alone or by trying to manage the proposed actions in the traditional top-down approach. The challenge is too big'.

The Policy Draft for the City of Cape Town (2013) acknowledges that, 'although the City has made good progress in decreasing the service delivery gap in informal settlements, the organic growth and form of informal settlements, makes it difficult to provide municipal utility services such as water, sanitation, electricity and waste removal at the required minimum basic national standards'. In addition, the City claims that 'informal settlements are characterised by lack of formal tenure, lack of public space and public facilities, inadequate access to municipal services, and non-compliance with planning and building regulations'. The situation is similar to cities such as Lusaka, Harare and Nairobi, although the historical and political narratives may be different (Enqvist and Ziervogel, 2019).

One of the problems in South Africa is the dual, overlapping and sometimes unclear governance mandates for water resources and water and sanitation services. These cause persistent confusion between the national Department of Water and Sanitation and the cities. For example, water resources management is a function of the national government, while water services provision is a function of municipalities (and cities) and local government. The Cape Town Water Supply Systems are located outside the jurisdiction of the city since the system is governed by the DWS. In times of crisis like the recent 2017/18 drought, the DWS response was slow and while the City of Cape Town might have needed to take greater responsibility for urgent action, they were limited by their legislative mandate (Ziervogel, 2019). Thus, during the threat of Day Zero in Cape Town, 'officials' frustration with DWS included delayed responses including announcements of restrictions and delays in funding infrastructure projects as well as national government's lack of leadership on the drought' (Ziervogel, 2019, 12). Other areas of confusion include unclear regulatory and governance mandates for alternative water sources, such as the authorisations required for boreholes and rainwater harvesting.

In Zimbabwe, the provision of water services in cities was a traditional function of municipalities, but political play started to interfere with the systems. Manzungu and Chioreso (2012: 121-122) reiterate:

> Because national government wanted to take over control of revenue from the profitable water account, it (the central government) took over the provision of water

and sanitation services in local authorities in the early- to mid-2000s. The decision by the government to return water and sanitation to local authorities in February 2009, provided yet another twist in the relationship between central and local government. The new councils that were elected in March 2008, found themselves saddled with a giant malfunctioning water and sewer reticulation system.

Thus, the political play between the central government and municipalities has resulted in the total destruction of the water and sanitation system and has led to untold suffering, especially for the poor and marginalised. The Zimbabwe Peace Project Fact Sheet 2 (2019) says SDG Goal 6 'remains a pipe dream unless there is more commitment and political will on the part of local and central government to improve the situation.'

6.7.3 Need to Recognise Informal Water Economies

In cities, it is the poor who are affected most by continued water insecurity. It is important to start recognising the growth in informal water economies in any urban setting. Self-dug wells/boreholes (Figure 6.4), informal water vendors and sharing of water could well provide for more than half of all users, certainly for those without proper access to public supplies (and those who cannot easily afford public water). Both these numbers and the proportions are bound to continue to increase with the growing and projected future urbanisation. In Harare for instance, the failure by the City to provide portable water has resulted in many households drilling their own boreholes and selling water to those who are in need, and can afford it (Nhapi, 2009, Manzungu and Chioreso, 2012). Similar examples are found in Dar es Salaam (Smiley, 2013), Nairobi (Smith School of Enterprise and the Environment, 2014) and Lusaka (Dagdeviren, 2008).

For Cape Town, Ziervogel (2019) argues that a 'systems approach' is required. For instance, during the drought in Cape Town 'many citizens and organisations installed their own "micro"-water sources, including boreholes, rainwater tanks and greywater systems' (Ziervogel, 2019: 17 and Figure 6.4). Even beyond the problematic land-water legalities, strict legal approaches on water service delivery easily end up in criminalisation that hits the poor hardest. A good example is the need to register boreholes in the City of Cape Town as well as the national Department of Water and Sanitation (2018) guidelines for all borehole and WellPoint use gazetted and effective from 12th January 2018. The question therefore remains – what forms of (gendered) government support could stimulate whatever works and prevent excesses?

Figure 6.4 An advertisement painted on a wall in Khayelitsha, Cape Town gives evidence for the informal water economy in informal settlements
(photo: K Day 2021)

6.7.4 The Right to the City

The Lefebvre (1995) 'right to the city' discourse proposes the development of a platform for the masses to claim the enjoyment of full rights in urban spaces like anybody else. This also plays into water issues, particularly in the context of water insecurity, as the poor would continue to view this as a denial of access to adequate supply and quality of water. Those who perceive themselves to be excluded from such citizens' rights have different ways of expressing their need for their rights to be recognised. In South African cities, protests have happened in various ways. McFarlane and Silver (2016) argued that rallying around the poor sanitation issue and responding to this through throwing human waste in public spaces such as Cape Town International Airport, as happened on 25th June 2013, becomes '*poolitics'*. This means that services such as water and sanitation cease to be just tangible and physical elements but start representing other ways of 'seeing' (McFarlane and Silver, 2016) and become sites of contestation and symbols upon which the excluded rally to demand their rights.

Thompson and Tapela (2019) argue that institutional and governance issues are compounded by the analytical/ideological bias in policy analysis towards 'Cities without Slums', rather than the 'Rights to the City' approach. The authors provide the example of the City of eThekwini

(South Africa) where this ideology found concrete application in the Slum Eradication Policy. Another example is 'Operation Murambatsvina' ('Drive out the rubbish' or 'Restore Order')', implemented by the Zimbabwean government in 2005. According to Potts (2006), the campaign 'was designed to eradicate 'illegal' housing and informal trading'. Unfortunately, the results were that the livelihoods of 'hundreds of thousands of poor urban residents' were impacted negatively. The author further points out that some of the root causes of the campaign were 'an ideological adherence to modernist planning and the associated image of a 'modern' city; and a desire to decrease the presence of the poorest urban people, by driving them out of the towns, because of an incapacity to provide sufficient and affordable food and living space for them'.

The policies around slums and informal settlements in cities across the world, therefore, need to be rethought, and require legislators to grapple with the best ways to realise the political content and promise of the hydro-social contract. The problem is how to shift the narrative and discourse toward inclusion. In South Africa, this seems a contradiction in context, given that the National Water Act (1998) and various policies, including the Water and Sanitation Master Plan of 2019, confirm and reaffirm the hydro-social contract by providing for free basic water for every citizen. The question becomes: 'Why has the fulfilment of the NWA only partially succeeded?'

6.7.5 The Politicised Nature of the Hydro-Social Contract

While municipalities and local governments in South Africa generally claim to be addressing the backlogs to water and sanitation, housing and infrastructure provision, such pronouncements need to be viewed through the analytical lens of the 'hydro-social contract' and the reaffirmations of this by the Constitution (Republic of South Africa, 1996) and the National Water Act (Republic of South Africa, 1998). Contrary to the assumptions that the framework should be 'apolitical', in reality, there are always politics around the provision of water to the poor. Implementation of the 'contract' is not value-free and is constructed through the socio-ecological fabric of space through time.

Thus, despite South Africa's progressive national legislation and policies that re-affirm the hydro-social contract, neoliberal and market-led policies, (for example those under the Democratic Alliance-led Western Cape province and Cape Town City) have led to lukewarm support for, and implementation of measures to fulfil the free basic water provisions for the poor, thereby reinforcing the structural inequalities. Thus, in refusing to provide water and sanitation services for Marikana, an informal settlement on privately owned land in Philippi, and Drift Sands, an informal settlement built on a wetland within the Drift Sands Nature Reserve, the City of Cape Town argues that it cannot build infrastructure for these informal settlements until the legal issues of the illegal land occupations have been resolved (pers. Comm, City of Cape Town Official, January 2020). In this context, the dual economy (formal and informal economic sectors) policy lens fails to take cognisance of the fact that the vast majority of the marginalised poor are not so much excluded, as included on highly adverse

terms (Thompson and Tapela, 2019). The problem is more often, not that the poor are excluded from particular institutions, resources or larger processes, but that they have been included on inequitable or invidious terms. This is because institutional arrangements and governance practices politicise and marketise 'the contract' – in effect failing to sufficiently deal with, and address the underlying historical structural distortions. Boelens (2008) and Goldin et al. (2016) suggest that, contrary to the apolitical assumptions of the hydro-social contract, water rights are in most instances generated, constituted and distributed according to the prevailing economic policies, the governing class and gender.

6.8 LESSONS AND GENERAL RECOMMENDATIONS FOR AFRICA

In this chapter, we argue that the recognition of the urban poor should take cognisance of the importance of addressing their rights, tenure and access to water and sanitation. While the Hydro-social contract provides a framework for analysing these issues, the de-politicisation of the framework is not usually practical or realistic. Also, water problems faced by most cities have a lot to do with distorted and disjointed policy and legal frameworks that persistently fail to address historical imbalances and inequities at the expense, or detriment of the poor.

African governments need to consider some of the strategies that are required in order to solve water problems as a matter of urgency. The 2020 Covid-19 pandemic has further exposed shortcomings in water and sanitation provision in many cities. There is a need to develop more permanent solutions to the problems of water and sanitation for cities. Some areas that need urgent attention are described below.

6.8.1 Water Governance and Legislative Reforms

African countries need to revise or update water legislation. South Africa launched the National Water and Sanitation Master Plan in 2019 for addressing the long-standing water issues. The plan outlines 'a plan of action that needs to be implemented by the entire water sector in South Africa to achieve government's goals and objectives.' There is an urgent need to create enabling processes such as hastening the passing of the Water and Sanitation Bill and the implementation of the National Water and Sanitation Resource Strategy in reaction to the pandemic. Similarly, other countries need to address the issues of equity and access to water and sanitation for marginalised communities.

6.8.2 Achieving the SDGs

All countries that are signatory to Agenda 2030 are involved in tracking the implementation of SDGs. South Africa uses the StatsSA Goal Tracker, which is a robust system of tracking and reporting on the SDGs. The system shows positive outcomes in terms of South Africa's progress on Goal 6 (Clean Water and Sanitation), although the Covid-19 pandemic could reverse or slow the gains. For countries such as Zimbabwe, Mozambique and Malawi, Covid-19 came at the back of drought and Cyclone Idai disasters, due to which so many people were already struggling to rebuild their lives (Oxfam, 2020). It is even more critical for these countries to have accurate data beyond statistics that will enable them to solve long-standing

and growing problems, such as the practical complexities of access to water and sanitation for townships and informal settlements.

6.8.3 Informal Arrangements

Informal arrangements with regard to water and sanitation are likely to be with us for a long time to come. While there is a need to try and provide adequate water and sanitation for all citizens, there is also a need to recognise informal tenure and find strategies for allowing these to exist and making them work parallel to formal tenure systems. As already seen, cities like Nairobi are putting these systems in place. As governments and all stakeholders work on strategies, they need to include ways of improving various tenure systems so that they work for the benefit of improving water and sanitation for people using them.

6.8.4 Transparency and Accountability

There is a need for governments to instil accountability and integrity in the water sector. During disaster periods such as the Covid-19 pandemic, systems might slip as people focus on addressing the challenges at hand, while other people might simply want to make quick money out of such misery. The report by Corruption Watch and the Water Integrity Network in March 2020 on South Africa (titled '*Money down the Drain: corruption in South Africa's water sector'*), is an example of the problems of corruption and maladministration in the water sector, which in the end hurt the poor the most. It is therefore important that governments remain alert to some of these malpractices and build systems and institutions that are accountable to communities and society.

6.8.5 Community Engagement

There is a need to engage communities through social structures and civil society in order to create genuine dialogue in water service provision. For example, questions regarding where to locate communal taps and toilets and how to manage and maintain these. A lot of decisions that hurt the poor are taken without community engagement. The Harare Hopley Farm is a case in point (Matamanda, 2020). There is also the issue of the relocation (de-densification) of people from some townships and informal settlements as a way of dealing with problems of social distancing – as announced by the Minister for Human Settlements in South Africa at the start of the Covid-19 pandemic. Media reports indicated clear signs of a lack of consultation with affected communities. Community engagement can create trust between communities and the government and could lead to workable solutions for the provision of water and sanitation, particularly during disaster periods.

6.8.6 Effective Intergovernmental Cooperation and Partnerships

Water and sanitation management cannot be effectively implemented without collaboration between the different government departments and the private sector. Having human settlements and water and sanitation under one ministry was a step in the right direction in South Africa. However, the roles of other large water use ministries such as agriculture and mining are critical. The private sector must also be an important player in this process.

6.8.7 Funding Mechanisms for Water and Sanitation

The South African National Water and Sanitation Master Plan recognises that 'Without sufficient revenue from transfers and tariffs the sector will be unsustainable'. Dealing with pandemics such as cholera and Covid-19 requires other emergency sources of funding. While the governments are scrambling to find funding for dealing with the various issues such as health infrastructure and equipment, there could be a role for water-based private companies and philanthropies. This type of funding is likely to require fewer conditionalities and more flexibility in terms of using such funds for dealing with emergencies arising from the disasters.

Figure 6.5 Access to clean water is severely limited in Hopley Farm, Zimbabwe (photo: Majuru 2018)

6.8.8 Service Provision, Municipalities, and Covid-19

Municipalities are responsible for service provision, including water and sanitation services. However, many municipalities are struggling to carry out their mandates effectively and efficiently, as evidenced by the growing service delivery protests in South Africa. In Zimbabwe water services in cities have been destroyed by political interference (Manzungu and Chioreso, 2012), leading to a total collapse of water supply systems in some cities. It is high time that local governments and the water sector ministries find common ground in water and sanitation service provision and how these could be improved. Particularly at times of emergency, such as the Covid-19 pandemic, ratepayers and communities need efficient and effective water and sanitation services.

6.9 CONCLUSION

This chapter has shown that urbanisation is a growing problem all over the world, as a result of cities increasingly attracting people from rural areas in search of employment, better economic opportunities, and improved lifestyles. This has resulted in the mushrooming of unplanned informal settlements and high-density residential areas, with the attendant problems of poor infrastructure and inadequate services. For the poor in these marginalised areas, access to adequate water quantity and quality is one of the most critical problems. We adopted the 'Hydro-social Contract' as the key conceptual framework for analysing and understanding the social issues around the provision of water and sanitation in cities. We used the City of Cape Town to demonstrate that water insecurity for the poor in cities is largely a social construct rather than a technical issue. The problem is, therefore, not only prevalent during times of water shortages, as was the case in 2017-2018 in Cape Town when the city suffered a water crisis, but that this is an ever-present phenomenon. The key causes of water 'social insecurity' are historical and economic dispossession, water governance problems, lack of recognition of 'the right to the city' for the poor and the politicisation of the hydro-social contract. We argue for the importance of an inclusive spatial planning approach by cities that takes into cognisance the importance of the Constitutional and human rights of the marginalised and vulnerable urban poor regarding access to the minimum basic required water and sanitation. There are also global conventions and Sustainable Development Goals that require all signatory countries to address inequities and social exclusion to water and sanitation. If countries operationalised and achieved these goals, it could go a long way in reducing the burden of water insecurity for the urban poor. Thus, Agenda 2030 recognises the need to address equity and social inclusion in the provision of adequate quantity and quality water for all citizens. Based on this, our view is, therefore, that the water vision for global cities (especially African cities), should be:

> *Well-governed inclusive cities, whose planning is human-centred, with an ability to provide adequate water services and sanitation for the poor and marginalised*.

This global water vision will place the poor at the centre of water provision while ensuring inclusivity through effective engagement and participation. We believe this can be achieved if cities like Cape Town can lead the way in adopting water sensitive planning that includes the environment and all its people.

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CHAPTER 7

URBAN WATER RESILIENCE: PERSPECTIVES FROM CIVIL SOCIETY

Ernst Conradie (lead author) with Jeremy Fackenthal, Ridtwaan Gallant, Jan Jorrit Hasselaar, David Jalajel, Rachel Mash, Job Matenda and Clive Pearson

Figure 7.0 Water is a source of great joy, especially for children like these boys playing after the rains in Khayelitsha, South Africa
(photo: Mazin m CC BY-SA 4.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Two_boys_playing_in_water.jpg).

7.1 INTRODUCTION AND METHODOLOGICAL CLARIFICATION

This chapter is based on a report from the "civil society task team" that was established in planning towards a conference held on "Cities Facing Escalating Water Shortages: Lessons learned and strategies moving forward", hosted from 27 to 28 January 2020 at the University of the Western Cape. Details on this conference and the multidisciplinary approach that was adopted towards that conference are provided in the preface to this volume. This chapter cannot be understood on its own, outside of the critical interactions with the five other task teams, namely the natural environment (Chapter 2), the technical sciences (Chapter 3), economics (Chapter 4), politics (Chapter 5) and the social sciences (Chapter 6). In the multidisciplinary approach adopted here, the aim is not to address civil society itself or to disciplines typically associated with it, but to address disciplines outside of civil society, and to city managers in order to inform them as to what they should take into account about civil society.

The question that is addressed in this chapter is this: What perspectives can civil society contribute that should be taken into account by all other spheres of society when addressing issues around urban water resilience? From the way this is phrased it should be clear that this is not merely an open question but is constrained by the multidisciplinary approach that was adopted. Put differently, the question is not merely what civil society can contribute but what would go wrong in *other* spheres and discourses if these perspectives are not recognised sufficiently.

The notion of civil society will be discussed in more detail in the following section, but provisionally one may say that this chapter draws especially from academic disciplines in the arts and humanities such as philosophy, ethics, religious studies, Islamic Studies and Christian theology. The full range of creative and performing arts is certainly also relevant here but plays a lesser role, purely due to the backgrounds of the authors who contributed to this chapter.

The task team that was established raised the following four questions for discussion amongst participants:

- What contributions from organisations in civil society are necessary for the other sectors (especially politics, business and industry) to be able to address escalating water shortages? "What is it that you cannot do without us?!"
- What would organisations in civil society do if, and when, politics and economics fail to address escalating water shortages, which is likely to happen at least in some contexts in decades to come? "What will we do when you fail, which we think may well happen?"
- What does civil society require from the other sectors in order to continue to operate at least at a minimal level? "What can't we do without you? / What do we need from you?"

- What are the underlying weaknesses of civil society that may cause us to fail to respond to escalating water shortages? “What makes it difficult for us to get our own act together?”

Through ongoing discussion and reflection amongst participants, including participants from around the world, a number of parameters were identified and described in response to these questions. These will be discussed in the third main section below. This will be followed by a discussion of the different roles that organisations in civil society play in relation to urban water resilience, and some examples of best practice in this regard. A few concluding recommendations will follow on a vision towards 2050.

It should be obvious that this essay draws mainly, but not only, from organisations in civil society in and around Cape Town. While such organisations are often well-networked internationally, they have to maintain a local footprint in order to remain relevant. The members of the civil society task team (on whose work this chapter is based) therefore reflect a Cape Town orientation although efforts were made to draw in expertise from elsewhere in the world. In the words of Rachel Mash, the rapporteur for the task team and co-author here, ‘The lessons learnt from Cape Town are a gift from us to the world to share with other cities facing their own day zero. What we did right, the mistakes that were made may help other cities in similar situations.’ Obviously, similar lessons learned could be gathered from elsewhere in the world.

7.2 THE TERM “CIVIL SOCIETY”

The term civil society is constructed in different ways, depending on the context.[13] It is typically clearly distinguished from government, business and industry, but also from jurisprudence, formal education, the health sector, the media and the arts in any pluralistic society. Although individual citizens and households may be included in civil society, it may be best to focus on the ways in which people organise themselves around particular social goals, and institutionalise such efforts in organisations that cannot be included under any of the above categories. At the same time, inasmuch as civil society is comprised of citizens, it may be said that civil society underlies all other sectors.

From the above it should be evident that one may adopt a broader or a narrower notion of civil society. The broader notion would exclude only government, business and industry; thus including trade unions and labour-related movements that set themselves up in opposition to industry. During the apartheid years in South Africa an example would have been the broad-based United Democratic Front that was instrumental in inducing political transformation. Where trade unions become successful, they tend to represent the interests of the middle class or the “working class” – rather than the unemployed, the unemployable and others

[13] For a discussion, see the essays in Welker et al. (2017).

marginalised from the formal economy. Trade unions can also become related to government, as is the case with the tripartite alliance in the South African context. If so, a narrower notion of civil society may be adopted to refer to non-aligned social movements that may become the "carriers" of social transformation. A much narrower notion would reduce civil society to little more than social clubs and special interest groups, often related to arts, culture and religion.

For the purposes of this chapter a middle way is adopted in which we focus on a set of organisations in civil society that are orientated towards the common good (instead of narrow group interests) and would therefore tend to address challenges associated with urban water security. From inside civil society a distinction is typically made between non-government organisations (NGOs), community-based organisations (CBOs) and faith-based organisations (FBOs). From the perspective of government, such structures are typically referred to as non-profit organisations (NPOs) to distinguish that from business organisations for tax purposes.

NGOs are sometimes quite large and internationally deployed, with extensive budgets and staff and are therefore vulnerable to fluctuations in funding sources. CBOs are typically much smaller and operate at a local level. They are often dependent upon outside funding but may also be more resilient, given their roots in local communities. FBOs have typically been initiated from within faith communities but then became independent as the institution grows and specialises. This also allows registration as an NPO. Their staff are often highly committed and some draw on volunteer work. One may distinguish such FBOs from organised religious groups and institutions (churches, mosques, synagogues, temples, monasteries), since these operate also as voluntary associations and contribute to civil society on this basis. These local religious communities typically, but not necessarily, form part of national denominational structures and sometimes of global ecumenical networks.

In addition, there are also broad social movements that form part of civil society initiatives. These may be well organised but not necessarily institutionalised. One example is the widespread student protests on climate change such as "Fridays for the Future" and "Extinction Rebellion". Such activist groups tend toward a flatter organisation model, with or without official designation as an NPO. Nevertheless, some such groups contribute widely to the advocacy-type work of civil society.

The activities of such organisations cover a very wide array of initiatives – in the fields of food security, education, health care, various other forms of caregiving, education, arts and crafts, environmental concerns and so forth. Not surprisingly, there is then a need to engage with the relevant formal sectors but there may well be resistance against being taken over by the formal sector, given their perceived needs and strengths. In some contexts, where challenges become overwhelming and government services break down, there is a need for emergency services and disaster relief. This is often done with the help of large global organisations operating in civil society.

Such an emphasis on voluntary associations leaves aside the role of "influencers" in a society, that is, the media, artists and other opinion-makers. There is also the so-called "fifth estate" (social media) which can easily be reduced to an "echo chamber", but at the same time it possesses the capacity to carry the ideas and aspirations of a less formally organised citizenry.

The roles of citizens as scientists, of the media to disseminate reports, and of opinion makers should not be underestimated, even if their engagements are not well coordinated. The evidence, information and opinions circulated in civil society, and also through social media, may be anecdotal but can still become highly influential. Readers of public media reports participate in the public sphere in the midst of those whom Parker Palmer (1983) describes as a "company of strangers". These lines of relationship work together to form networks of thin (not thick) trust which are more casual, occasional and not bound by other ties of association.[14] It is sometimes said that the quality of a civil society depends upon the quality of its thin relationships. The presence and engagement of an active citizenry is a necessary condition on which any attempts to address concerns over urban water resilience depends. It forms a pool of experiences, observations, insights, moral sensitivities, awakenings, and reflections from which all other sectors necessarily have to draw.

For the purposes of this essay the term civil society will include NPOs, NGOs, CBOs, and FBOs but will also consider perspectives from the various arts – music, drama, literature, poetry, puppetry, the visual arts and the like. Reference will be made to ordinary households of different shapes and sizes, but rather from the perspectives of citizens and not from the perspective of social sciences.

The term civil society is sometimes used in a normative sense, i.e. to refer to civil virtues, civil rights or civil duties. This then stands over and against "uncivil" behaviour, for example stealing water, conflict over water, or wasting fresh water. The term civil society will not be employed in this way here, although moral issues will indeed have to come into play. Inversely, notions of being "civilised" or "civilisation" may be employed by a dominant society to impose an order upon another society – as is the case in any colonial context. Moreover, the term civil society can sometimes be used in a way that excludes those who are not citizens and thus players in electoral processes. This raises complex issues over what it is that one is a citizen of (contested notions of nation states), how one becomes a citizen (raising debates on migration, refugees, and asylum seeking), civil rights (given notions of "second-class citizens") and civil responsibilities. In response, the category of "the common good" has been used in order to avoid narrower notions of what the "civil" in civil society may mean.

[14] The distinction between thick and thin trust, or thick and thin relationships, is most commonly associated with the work of Robert Putnam (2000: 136-137, 142-144, 147).

It is widely recognised that organisations in civil society have considerable strengths but also specific weaknesses. Organisations in civil society have ready access to grassroots needs and sentiments, are able to reach ordinary citizens on a regular basis, can draw on volunteer support and tap into community-based sources of inspiration, including sacred texts, indigenous wisdom, myths and rituals. A diversity of conflicting interests is seen as a strength from the inside even where this presents a lack of consensus from the outside (not speaking with one voice).

On the other hand, organisations in civil society can also be divided amongst themselves, are often prone to in-fighting, can be subject to political divisions, are sometimes administratively weak, can become undemocratic, can be led astray by charismatic leadership, can be prone to corruption if not well resourced, are vulnerable to funding constraints, and so forth.

7.3 SOME BROAD PARAMETERS FOR ENGAGING WITH URBAN WATER SECURITY AND RESILIENCE

The following parameters for urban water security and resilience may be offered from the perspective of civil society, as circumscribed above. These are perspectives that arguably have to be taken into account in all the other sectors that address challenges associated with urban water resilience, and certainly by urban water managers. A failure to do so will undermine their efforts. The point of the multidisciplinary approach adopted here is not merely to explore what perspectives civil society can contribute to solve multi-dimensional problems. It is to address assumptions held somewhere and disputed elsewhere that can lead to miscommunication and hence a failure to confront such challenges. Put provocatively, the perspectives offered below claim a veto right, i.e. if these are not taken into account, strategies to address the challenges associated with urban water resilience are unlikely to be successful over the long term. The same would apply to perspectives offered from within other sectors.

7.3.1 Rights and justice

Citizens, households and organisations in civil society tend to treat access to clean water as a right. They assume that water is not a commodity (except for bottled water) or a utility.[15] They believe that water does not belong to the municipality and that access to water cannot be privatised by any company (see Anderson, 2007). They would regard water as part of nature's bounty, as God-given, sacred, or as belonging to the whole community of life, including plants and animals. The right to clean water and proper sanitation became especially

[15] See the comment by Leonie Joubert and Gina Ziervogel (2019:11): 'The City's choice of wording in this ad campaign shows up one of the fault-lines in the municipality's efforts to meet its service delivery need across one of the most socially and economically unequal cities in the world: some see water as a 'commodity', a product to be bought and sold by those with the means to trade in it; but many others see it as a basic human right and part of a common good resource, something that we need to share fairly, regardless of who has the means to buy it and who doesn't.'

important during the Covid-19 pandemic, given the recommendation for the frequent washing of hands to counter the spread of the virus. As the World Council of Churches observes, 'Besides the health and sanitary aspects of it, the lack of access to clean water in homes is putting women and children in even more vulnerable situations'.[16]

Such rights not only include the rights of citizens (e.g. access to potable water), but, following an ecocentric approach, also the rights of non-human animals and of ecosystems (rivers, mountains, lakes, wetlands and so forth). Access to water is therefore often a matter of struggle and of justice, especially distributive justice.[17] As the Prophet Muhammad (SAW) declared: 'Excess water must not be withheld so that the growth of herbage may be hindered' (Muslim, 1993: 38).[18] Groups in civil society view water scarcity accordingly.[19] In other words, a lack of access to water is a matter of unequal distribution and not in the first place, a limit imposed by nature. Civil society therefore tends to attribute a lack of access to water to poor governance, management and unequal distribution.

It is therefore appropriate that South Africa's Department of Water and Sanitation in its National Water and Sanitation Master Plan adopts as a masthead the motto "*Water is Life;*

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16 See https://soundcloud.com/worldcouncilofchurches/wcc-Covid-19-support-episode-3-the-human-right-to-water [Accessed on 6 October 2020].

17 This emphasis on justice is often found in environmental ethics but especially in theological ethics. See e.g. John (2007), Rawlins (2007), Kim and Gorsboth, 2014), Marais (2017), Zenner (2018), Issac (2019).

18 This tradition refers to someone preventing the use of surplus water from their private well for people grazing their livestock on adjacent public pasture, in order to prevent them from being able to use that public pasture on account of their livestock's need for water. The rationale is that the water in the area is needed by the public if they are to avail themselves of the pastureland and preventing the sharing of the water prevents their use of that pasture. Al-Nawawi (2002: 1197) explains that the well owners 'are required to make that water available to the cattle free of charge and they are prohibited to sell it.'

19 The South African National Water Security Framework recognises this by adopting the following definition of water security: '…water security is less about obtaining water, and more about fostering human capabilities as they relate to water... We thus ask: What are the social, cultural, and political relationships with water resources and flows that advance a life that fosters human dignity? And, how are those relationships secured to facilitate the freedom to achieve wellbeing, fulfilling social arrangements, and human flourishing? … water security, then, is not simply a state of adequate water – however defined – to be achieved, but rather a relationship that describes how individuals, households, and communities navigate and transform hydro-social relations to access the water that they need and in ways that support the sustained development of human capabilities and wellbeing in their full breadth and scope.' See the Draft National Water Security Framework Version 0.5, 15 January 2019, Executive summary at https://www.nationalplanningcommission.org.za/assets/Documents/Frameworks/NWS%20Framework%20Public%20Version%200.0%2011%2006%202019.pdf [Accessed on 5 August 2020].

Sanitation is Dignity". It bases this on the values embedded in South Africa's Constitution, with specific reference to human dignity, the achievement of equality and the advancement of human rights and freedoms. It derives from that an emphasis on the right to dignity (section 10), the right to an environment that is not harmful to one's health or well-being (section 24) and the right to sufficient food and water (section 27b). It adds that 'Access to sufficient water is a basic human right enshrined in the Constitution of South Africa. Access to adequate sanitation services is a critical element of the right to dignity' (SADWS, 2018: 156).

In civil society such an emphasis on human dignity is taken for granted and serves as the source of inspiration for many organisations. There is admittedly much less clarity on the question as to why humans have such dignity and how that relates to other animals. Africans can refer to the much-debated notion of Ubuntu while faith-based organisations can, and do refer to religious sources of inspiration (e.g. being created "in the image of God"). However, since these are contested elsewhere there is a surprising lack of clarity on the very notion of dignity. It may suffice to say that while dignity is hard to define, the violation of such dignity may be much easier to recognise. A lack of access to sanitation is an obvious example (Figure 7.1). This is what prompts advocacy work in civil society. In the words of Rachel Mash, the rapporteur for the civil society task team:

> The principle of justice demands that we stand in solidarity with the most vulnerable. We recognise that many citizens of Cape Town live day zero every day. They have to carry water every day. Going to the toilet involves a trip to filthy communal toilets with the risk of sexual harassment or rape. The principle of justice demands that we protect our water sources for the generations to come. We cannot accept short term solutions from politicians who are looking at a four year election cycle. Our aquifers, rivers and wetlands are a legacy that we must protect.[20]

7.3.2 Different perspectives on such rights

Households and organisations in civil society will express this right to water in very different ways, depending on their socio-economic positions. The affluent may be willing to pay for the right to water their swimming pools, while the desperately poor focus on access to clean drinking water. All would recognise the need for water for personal hygiene (washing one's body, sanitation, clothes) and to grow food. The right to potable water may be absolute but the expression of such rights remains relative. How to allocate and quantify access to water given the many claims in this regard – from agriculture, industry, households, government and sport and recreation (the ubiquitous golf courses!) – is of course a thorny issue. Civil society does not have the final say here since this is a matter of policy making and politics, but would

[20] This is a transcript from the press conference held on Wednesday 28 January 2020 after the conference on "Cities Facing Escalating Water Shortages".

at least insist that decisions in this regard, especially in times of drought, be made in consultation with local communities and in a transparent way.

Figure 7.1 Few would question that a lack of access to clean water and sanitation – such as is seen by a young boy washing in a highly polluted river in Jakarta – is a violation of human dignity
(photo: Jonathan McIntosh CC BY 2.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Jakarta_slumlife14.JPG).

7.3.3 A sense of responsibility

In the context of water scarcity most households would recognise the need to use water responsibly, even if some individuals, households, companies and organisations do not always act accordingly, and even if water allocation may be disputed. Using water responsibly is not the same as reducing water usage: for the sake of basic human dignity some need to use more water than they do, others less.

The phrase “using water” is admittedly awkward: within the earth’s atmosphere water cannot be created or destroyed, consumed or used up. Water is therefore not like some other

commodities that can be used only once. Using water responsibly therefore concerns the flow of water. It concerns a particular time period within that flow (e.g. when it flows through one's own body, household, industry or farm). The question is what the impact of "using water" during this period is on its continued flow. Can the same water be "used again" and how soon can it be used again for similar purposes (e.g. drinking water). It may be hard to avoid the term "use" here, but those with a sense of responsibility would welcome connotations such as "channelling", "stewarding" or "integrating" water's flow within the non-water environment.

Without this common sense of responsibility any political, economic, or engineering efforts to address water scarcity will be futile. Organisations in civil society can play a vital role in cultivating such a sense of responsibility by strengthening the moral fabric of society. Religious traditions can also play a crucial role here, not least given their long-term history and vision.[21]

Such a sense of responsibility is typically undermined through apocalyptic worse-case scenarios, for example the images associated with a "Day Zero" when taps will run dry.[22] Such imagery leads to either moral paralysis (fear), or opportunism (fending for oneself), and at worst to violent conflict over water. The role of an attractive guiding vision towards the future is crucial in this regard.[23] As has been remarked, "Martin Luther King did not say, '*I have a nightmare*'. He said, '*I have a dream*', and he created a movement."[24]

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[21] The so-called Böckenförde principle (named after the German Constitutional judge Ernst-Wolfgang Böckenförde is relevant here. It holds that the moral fibre of modern (Western) societies relies on moral sources that such societies cannot themselves guarantee or sustain. The moral fibre may be explained in generic categories (values, virtues, visions, and duties) but the sources of inspiration behind them are particular. They are typically embedded in the archetypes, symbols and belief systems of religious traditions and cannot be captured through a generic sense of religiosity. To sustain such moral sources, the particularity of such traditions therefore has to be taken seriously.

[22] See Joubert and Ziervogel (2019: 20): 'With hindsight, it's clear that this was a double-edged sword: on one level, it stoked public panic, which drew some criticism as a communications strategy; but at the same time it did drive down daily water use drastically.' They add: 'With hindsight, it turns out that the release of the disaster plan became the single biggest catalyst for change in water users' behaviour. But with it came the use of the term 'Day Zero', which was controversial. There was a swell of alarmism, panic, and distrust, reflected in an ever-more shrill mediascape. Would these water cut-offs result in outbreaks of violence at water distribution points? What would happen if the sewage system shut down? What about outbreaks of diseases, and death?' (2019: 25-26).

[23] Jonathan Sacks argues that the biblical stories highlight an attitude of *emunah* (trust), hope (as a journey) and *hesed* (love). Hope here highlights the crucial role of time. Complex issues, that involve primarily, a change of the way we look at the world, require time for the process of transformation. A key question then is how not to get lost while being on the way, how to keep the candle of hope burning. The Exodus-narrative emphasises the crucial role of the institution of a public Sabbath or Utopia Now here (Hasselaar, 2020).

[24] Quoted by Maarten Hajer, former director of Netherlands Environmental Assessment Agency (PBL) (2011: 28).

There is also a need to recognise limits to responsibility. One can only take responsibility for what is within one's locus of control. This differs significantly depending upon the positions of power in a household, a community, a business and an organisation. A burden of responsibility should not be placed upon those who cannot, and do not exercise such responsibility. The danger here is that this will infer a false sense of guilt that precisely undermines the exercising of responsibility. This is obviously important in contexts with high degrees of inequality, especially in the Global South.

7.3.4 Fostering a sense of responsibility

Given disputes over water allocation and, depending on the severity of water shortages at different times, it remains necessary to mobilise citizens, households and organisations around responsible water "use". It matters how this is done. For citizens it all too often sounds as if strategies are devised to change their behaviour without recognising that citizens are moral agents and should be respected as such. At the peak of the Covid-19 pandemic, in an article for *The Conversation,* Steven Friedman (2020) recognised the significance of this insight. He argued that addressing the pandemic was not merely a matter of technical know-how, but concerned the relationship between the governed and those who govern. He observed that 'The governors see the majority of the governed as people who must be told what to do and controlled if they do not listen. Working with the majority to fight the virus isn't possible when they are seen as "backward".' This clearly also applies to responsible water use.

Theories of moral formation are relevant here. Three strategies may best be used in public campaigns, as these can complement each other.[25]

- With classic deontological ethical theories it is possible to emphasise rules and regulations and therefore the duties of citizens to comply with those. Authoritarian rules will be less persuasive than rules where citizens can explain to themselves what is right. Failure to abide by such rules can then be subjected to penalties, but fear of penalties without understanding why such rules matter, will not suffice.[26] Again the micro-management that characterised the government regulations during the

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[25] See also the discussion in Ziervogel (2019).

[26] This is well illustrated by the novel by John Irving *The Cider House Rules*, and the film based on the novel. See also the comment by Joubert and Ziervogel (2019: 28): 'Through the course of the drought, the City used a few carrot-and-stick approaches to get people to be more water-wise: price hikes for the bigger water users, restrictions, installing water shut-off devices in the homes of bigger residential users who were ignoring restrictions, fines, the threat of naming-and-shaming greedy water users, and behavioural 'nudging' messages through the City's utility billing system.'

lockdown period as a result of the Covid-19 pandemic illustrates this very well. One may also suggest that oftentimes individuals distrust messages from municipalities because they may not support the political party in power. By contrast, they may be more inclined to trust messages from a faith leader.

- With classic utilitarian ethical theories it is also possible to emphasise the common good, the well-being of all citizens, and indeed of all living creatures. Individual actions then need to be aligned with the common good and need to avoid common ills (Figure 7.2). The "Day Zero" strategy used in Cape Town in early 2018 was effective because citizens recognised the need to avoid a common catastrophe and collectively aligned their actions accordingly.[27] By contrast, those affluent households who found alternative access to water (e.g. through drilling new boreholes) may not have recognised the common good, since water in aquifers cannot be "owned" privately.
- Another approach is to emphasise and cultivate virtues, and to counter vices. The four "cardinal" virtues of wisdom, justice, courage and especially temperance are all relevant for water usage. Considerable wisdom is needed in allocating water justly to different sectors. A sense of habitual justice (distributive and contributive justice) is required at all levels, including households who had to restrict water usage to 50 litres per person per day. The need for courage is perhaps less obvious but this comes into play when long-term considerations have to be weighed up against short-term gains. The need for temperance is obvious in the sense of frugality.[28] The issue is not merely

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[27] See again the comment by Joubert and Ziervogel (2019: 28-29): 'One of the key take-home messages is that if people know their efforts to save water are working, and that their small efforts are contributing toward a greater good, they'll be more likely to do that than to 'free ride' at other people's expense and selfishly use up the resource … If the media keeps pushing the message that residents are selfish in their water habits, … it's more likely to trigger panic and selfish hoarding behaviour. If people feel that their small daily efforts are actually making a difference, and are helping to save water to the benefit of their fellow citizens, they're more likely to keep working towards this shared common good.' They add: 'The concept of 'Day Zero' slipped into everyday language in October 2017 when the City released its Critical Water Shortages Disaster Plan, which spelled out clearly what the emergency rationing measures would be if the dams ran down to that critical threshold of 13.5 percent of usable water. This disaster plan turned out to be the single most effective intervention to bring about behaviour change from water users, as dam levels ran perilously low. Spelling out the urgency of the drought, and how imminent the emergency really was, seemed to send a shock wave through communities, and people were compelled to change how they used water.' And 'Theories from the field of economics, about what drives behaviour, supports the idea that if people have clear information about how serious a threat is, but still have a sense of agency in terms of knowing what they can do to help tackle the problem, they're more likely to act' (2019: 39). Such comments emerging from the discipline of behavioural economics may be helpful from a managerial perspective. However, a civil society perspective would be "from within", not treating water users as customers to be managed, or as masses to be brainwashed through advertising campaigns, but as citizens with rights and responsibilities.

[28] There are several important manifestations of temperance See Conradie et al. (2006: 69):

- *Simplicity* and satisfaction (the Latin *satis* means enough), being content when one has had enough, instead of greed – to know when enough is enough;

limiting the use of water but using water frugally. It should be clear that temperance is crucial in many spheres of life. Many social and personal problems (overindulgence, abuse of alcohol, anger, gossip, assault, sexual harassment) are related to a lack of temperance. It certainly also plays a role in using water responsibly. One may add the role played by the (theological) virtue of hope – which may be contrasted with optimism, pessimism and cynicism (Hasselaar, 2017). One may also recognise the roles of kindness, hospitality, generosity and so forth in providing access to water for others who are in need of water.

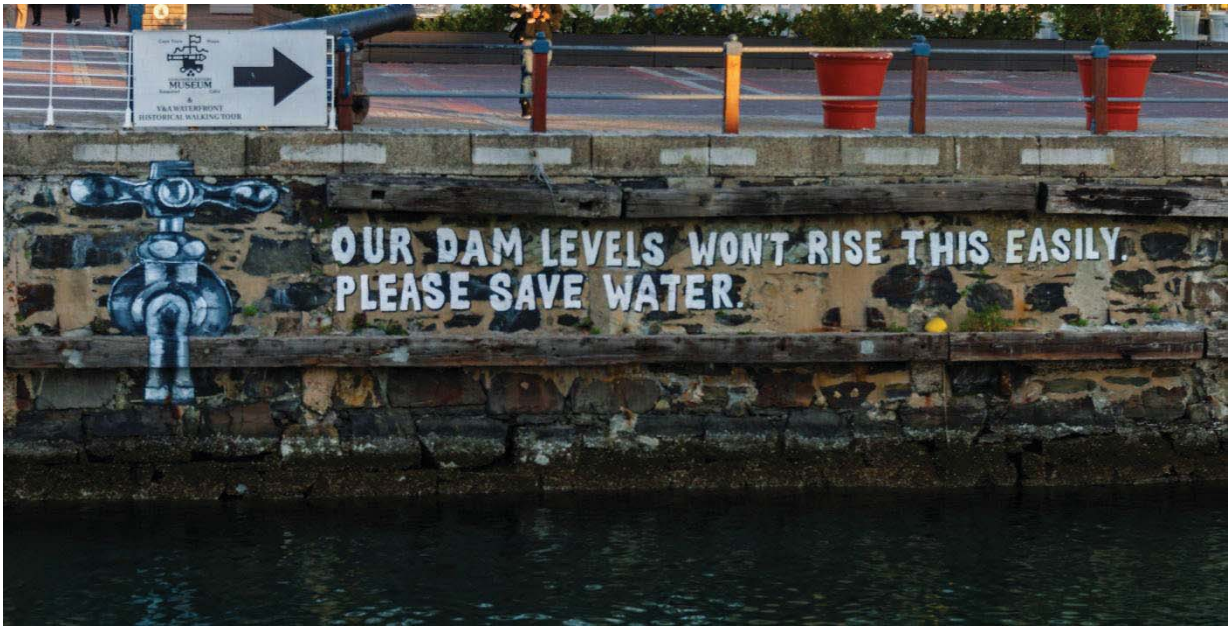

Figure 7.2 A plea to water users on the harbour wall in the Waterfront, Cape Town, used art and humour to appeal to individuals to do the 'right thing' during the drought, whilst emphasizing the common good

(photo: D Case CC BY-SA 3.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Water_conservation_message_on_retaining_wall_at_Cape_Town_waterfront.jpg).

This task of moral formation takes place in households, in moral communities (including schools) and in faith communities. The arts and culture also play a vital role. Moral formation

- *Moderation* instead of allowing oneself to indulge in an immediate satisfaction of bodily drives: eating too much, drinking excessively (consider alcoholism), sexual license;
- *Gratitude* for what one has received instead of consumerist greed;
- *Patience* and tolerance instead of unbridled anger;
- *Humility* instead of pride;
- *Gentleness* and kindness, being benign instead of showing aggression, the ability to control one's temper.

cannot rely on information and education alone, since moral leadership, examples, a sense of belonging to communities, role-plays, regular exercises incorporating feedback, stories, songs and proverbs are all required to cultivate such virtues over a longer period of time. These are typically culture-specific, but commonly appear across a wide array of cultures and traditions.

It may be taken for granted that traditionally Western, Eastern, and indigenous virtues can all contribute uniquely to such moral formation. Without the assumption of such virtues, any call for responsibility will fall on deaf ears. The cultivation and expression of such virtues follow a different rationality to the instrumental logic with which water-related issues are typically managed. African traditional societies, for example, place a very high premium on communities. Obligations to family and wider community (clan or tribe) supersede personal needs. Major decisions are made communally. Individualism is despised. The value of an individual is in the community.

At the same time, the possibility of malformation should be taken into account. Often moral disintegration follows the fragmentation of moral communities – e.g. due to high levels of crime, corruption and gangsterism. This is a pertinent problem on the Cape Flats due to the long-term consequences of colonialism, subjugation and apartheid, but is also easily applicable elsewhere. This can easily lead to vices such as negligence, wastefulness, theft or sabotage (e.g. stealing copper water pipes that leads to water spills and leakages). Faith communities, on the other hand, have resources that cultivate a respect for water (e.g. Muslims through prayer, Christians through baptism). The sacredness of water can therefore be emphasised when cultivating appropriate virtues. To reiterate the point: moral formation is not the task of government and cannot be legislated. However, without moral formation in moral communities, governance would be impossible. Governments rely on moral sources that they cannot provide or guarantee.

7.3.5 Factors that undermine a sense of responsibility

The role of deep divisions in society has to be recognised when fostering such a sense of responsibility; not least given the long-term impacts of slavery, imperialism and colonialism. These manifest themselves in the form of inequality in terms of class, race, gender and culture, and also in terms of access to, and the use of water, and especially access to adequate sanitation. Alongside such access to water, vulnerability to fire and flooding also has to be recognised. In some societies this is exacerbated by the role of the military, by state security mechanisms, by surveillance, by gangsterism, by caste systems and the like.

In such situations an emphasis on responsibility will lie with those in relative positions of power and this is indeed appropriate. Everyone exercises some degree of power and has to exercise decision-making within their locus of control. It does not, however, make sense to call for a sense of responsibility where something is beyond a person's locus of control. The same applies to education and awareness-raising campaigns. The danger here is that some citizens

are treated merely in an instrumental way by those in positions of power. When this is internalised, citizens tend to see themselves as passive victims of unequal social conditions. They then regard themselves as moral patients (on whose behalf others, including government officials, have to act) and not as moral agents in their own right. Where some political awareness is raised, such citizens then tend to emphasise their rights and underplay their responsibilities. This leads to a culture of entitlement, with devastating consequences for the social fabric and for a sense of contributive justice, where everyone has to contribute to the common good according to their ability.

7.3.6 The role of worldviews and cosmologies

Moral traditions are themselves embedded in more encompassing views of the world. Differences regarding moral judgements, not least about the use of water, are typically shaped by different worldviews. For example, those who inhabit the "liquid continent" – viz. Oceania, water, land/is-land, moana/sea, wave, tide – create a worldview that can emphasise ideas of liquidity and mobility.

The relative influence of science and of indigenous knowledge systems play a crucial role here. Citizens who have embraced modern science are in danger of adopting a mechanistic and often reductionist view of the world. Inversely, citizens who maintain a more traditional cosmology recognise a tension between their view of the world and modern artefacts to which they may or may not have access. Likewise, economic systems shape the way we view the world. Water sources are treated in very different ways if they are regarded as sacred, or as a mere utility to be used for optimal economic benefits. This shapes public engagements, educational activities, art and sport alike.

The role of worldviews is especially important in the African context. The African traditional line of thinking is that soil, water, forest, wildlife and the whole environment was the common asset of the local people bestowed by God to be managed as a "*trust*" (Maake and Kaya, 2012: 52). Water and soil, the basis of human existence, are so valuable that they are associated with sacredness, which is why water features large in rituals, both as an instrument of healing and cleansing and as a symbol of divine blessing (Müller and Kruger, 2013). There is a recognition of the interdependencies between humans and nature and a giving of respect to non-humans in a symbiotic relationship if humans are to receive benefits. In African traditional worldviews, there is strong emphasis on harmony between humans and the environment through a complex metaphysical belief system transmitted through folklore, taboos, and traditional knowledge (Taringa, 2006). Thus, the African worldview is integrated with three basic parts namely: the spiritual world, the world of human beings and the natural world. Taringa (2006) notes that water bodies, including wetlands, are sacred, and they are closely related to abstinence. This means that people should approach sacred water bodies carefully and observe taboos.

7.3.7 The symbolic power of water

In civil society attitudes towards water cannot be reduced to matters pertaining to rights and responsibilities. The symbolic role of water needs to be recognised. Failure in other sectors to do so, for example by treating water purely as a commodity or a utility, to treat water in terms of mere quantities, or to put a price on water, is imprudent because it will meet with some resistance in the end.[29] It sometimes seems that what economists cannot count does not count, while from a civil society perspective the most important things in life cannot be counted, for example life itself, health, family, marriage/partnership, friendship, and time and opportunities to express one's various talents. Despite disputes over water, water is shared communally so that rich and poor drink from the same sources. Not surprisingly, water is closely related to hospitality, and also to strangers.[30] In the words of rapporteur Rachel Mash, 'For us water is not a commodity to be sold and bought. It is a fundamental human right which must be shared equitably. It is the heritage of our children's children which must be treasured. Water is sacred. Water is life.'

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[29] See the following comment by Issac (2019: 73): 'Privatization of natural resources which nourishes life is a serious crime and unforgivable sin in the cosmotheandric lenses of orthodoxy.' See also the comment by Rasmussen (2013: 282): 'Every good ethic includes a description of what is. At present what is, in the case of water, is a resource and commodity in the service of the irrational exuberance of the post-1950 global economy … a natural resource at the ready. That use-relationship, so "natural" to us, frames water and its value in our way of life and erodes the mythic, poetic, and esthetic understandings of water. When water is a market commodity in a plastic bottle piled on supermarket shelves, it is no longer sacramental. This loss of sacred meaning in turn affects our moral sense: It's "just water".'

[30] There is ancient wisdom from all religious traditions in this regard, especially from arid regions where travellers needed water to drink. For example: 'The Buddha encouraged his disciples to plant shade trees along roads, construct bridges, dig wells and build rest houses for the benefit of travellers, and to provide water for wayfarers.' See https://www.bhantedhammika.net/like-milk-and-water-mixed/i-was-a-stranger-and-you-took-me-in [Accessed 7 of October 2019]. Such practices continue to exist also in cities where private households have access to wells and use them for hospitality.

The symbolism of water is expressed in multiple ways through art, culture, drama, puppetry,[31] painting, music, literature, film,[32] rituals, myths and religion[33] alike. Such symbolic expressions should speak for themselves, but it is possible to discern especially four aspects of the symbolic meaning of water that resist any easy quantification:

[31] See www.cradleofcreativity.co.za. The production "River and Redfin" is representative here. The blurb for this performance reads: 'River & Redfin is a puppet performance that uses live music, masks and visual performance. The performance is set in the Klein Huis River. This performance celebrates and reclaims the power, mythologies, and significance the river holds for the people and animals of this scenic and fertile part of the Langeberg. It brings awareness to the way water has been used to divide the community and people…'.

[32] See the short film "Black River" (*Agua de Río*) from Argentina, which deals with the pollution of a river, the direct impacts on the surrounding communities, and how the communities respond in order to reclaim their right to access clean water. See also the documentary feature film *The Whale and the Raven* by director Mirjam Leuze, which tells the story of indigenous peoples in northwestern Canada who must face the competing interests of industrial uses for the channel through which whales migrate. The film raises questions regarding rights and access to sacred waterways and uses of the sea that disturb both humans and animals alike. See https://filmsfortheearth.org/en/films/the-whale-and-the-raven.

[33] See the volume of biblical reflections produced by the Ecumenical Water Network, *Reflections on Water* (WCC, 2014), with reflections entitled, "Drip, Drip, Drip", "Waters of Baptism, Water of Life", "Wells of Quarrel – Space for Peace", "Thirst for Water – Thirst for Life", "Sister Water or Blue Gold", Give me Water … The Living Water", and "We Need to Wash our Dirty Feet".

Water as a gift of life

To say that water is a source of life is commonplace given the way rain replenishes plant growth. 'It is He Who sends down water from the sky; and with it We produce vegetation of all kinds…' (Qur'an 6, 99).

Water may indeed be regarded as a gift. There is a deep-seated recognition, often expressed in religious terms, that water precedes life. It gives, yields, and bears life. Water brings forth new life, also and especially in arid conditions.[34] Our bodies are water-based. We cannot exist without it. The blue planet has life because it has water. Put differently, to say that humans "need" water or "use" water does not capture what is at stake. To some extent we humans simply are water, part of the flow of water. If so, there would be some resistance to seeing water merely as a utility, and even a commodity.

This gift is threatened by the absence of water. This may be the result of climate change, of water monopolisation, or of the pollution of fresh water through commercial agriculture, mining, fracking, industry or sanitation infrastructure. Wherever that is the case, resistance is to be expected on the basis of such fundamental sensitivities. The absence of rain also evokes religious sensibilities – hoping, indeed praying for rain.[35]

Water as a threat

That water is a threat is widely recognised by citizens in civil society all over the world. In our times such threats are associated with rising sea levels, the salination of fresh water, hurricanes, flooding and so forth. One example is the devastation wreaked by hurricanes in Mozambique in 2019. One other example may suffice: a report from Clive Pearson (a member of the task team) observes that people in Sydney are being warned about possible floods and loss of soils/slips through landscapes denuded by fire. One disaster leads to another: too little water compounds the likelihood of too much water delivered, in volume, over too short a period.

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[34] See the following quotations from the Qur'an: 'And Allah sends down water from the skies, and gives therewith life to the earth after its death…' (Qur'an 16, 65) '… And you see the earth barren and lifeless, but when We pour down water upon it, it is stirred (to life) and it swells, and it puts forth every kind of beautiful growth (in pairs) (Qur'an 22, 5)…and He (Allah) sends down water from the sky and with it gives life to earth after it is dead…' (Qur'an 30, 24) '… And We send down pure water from the sky, – That with it, We may give life to a dead land, and slake the thirst of things We have created, – cattle and men in great numbers.' (Qur'an 25, 48-49).

[35] Note the question mark in the collection of essays edited by Chitando and Conradie (2017) entitled "Praying for Rain? African perspectives on Religion and Climate Change".

By its nature this threat cannot really be removed except by its inverse, i.e. the absence of water. It is nevertheless dangerous to underplay such deep-seated fears related to water. Cities need to do what can be done in this regard but also recognise their limited power in the face of the ominous power of nature. Cities therefore need to build networks with other cities and promote international treaties that address major global challenges around nuclear weapons, ozone depletion, climate change, the loss of biodiversity, ocean acidification and so forth. Although humans have become a "geological force of nature" (as is widely recognised in discourse on the Anthropocene), we are not able to determine the physical and chemical laws of nature (including gravity!) that both sustain and threaten us.

Water as a source of cleansing

The cleansing ability of water is obvious to all concerned – in terms of bathing / showering, sanitation, washing clothes and washing dishes. Not surprisingly, such cleansing is metaphorically extended towards medical and psychological healing, towards a sense of cleanliness (as in Muslim cleansing rituals[36]), but also to cleansing from various forms of guilt (as in Christian rituals around baptism).

The cleansing ability of water is obviously threatened when water is itself contaminated. The problem is not merely dirty water but toxic water. What, then, would purify the impure? How could water cleanse if it is not clean (Conradie, 2020)? And even if the water is clean, mere rain and washing cannot cleanse everything in societies that are riddled with injustices.

Water as source of joy

Water is not merely a scarce resource or a utility; it is a source of exuberance, of pleasure, of fun, of play, of sport (Figure 7.0). This attitude towards water is expressed by rain making rituals in many indigenous cultures but also by dancing in the rain after periods of extended drought. There are, of course, many water-based sports – swimming, diving, canoeing, sailing, surfing – you name it. But these pale into insignificance compared to childrens' exuberance when water is available. Grown-ups may be concerned about "wasting water" while children are rightly having fun (Figure 7.0).

Strangely, water as a source of joy is not easily threatened by water scarcity. In fact, such scarcity may provoke creative responses. This may be counter-intuitive but there is evidence from around the world that making fun with water is vital in times of scarcity. One example

[36] See the following: 'O you who believe! When you intend to offer As-Salât (the prayer), wash your faces and your hands (forearms) up to the elbows, rub (by passing wet hands over) your heads, and (wash) your feet up to ankles. If you are in a state of Janâba (i.e. had a sexual discharge), purify yourself (bathe your whole body).' (Qur'ān 5, 6).

may be the New Year festival in Myanmar where dumping anyone in the streets with a bucket of water is permissible amidst high temperatures and water scarcity. Another is the multiple jokes around Day Zero that abounded in Cape Town in the summer of 2018.

7.4 FORMS OF IMPLEMENTATION IN CIVIL SOCIETY: EXAMPLES OF BEST PRACTICE

It is important to recognise that organisations in civil society play a diversity of roles in responding to urban water resilience. There may be a tendency in some government circles to regard civil society as "making trouble" through protest action over service delivery, which sometimes becomes violent. One example of such protest is the Cochabamba water war, a series of protests that took place in Cochabamba, Bolivia, between December 1999 and April 2000 in response to the privatisation of the city's municipal water supply company SEMAPA. Another example is the "poo protests" that erupted over inadequate sanitation in Cape Town around 2013. Such protests may at times be justified, but do not define the full spectrum of engagement with water resilience in civil society.

It is possible to cluster together civil society initiatives under the following four rubrics:

- *Food security projects and their related water needs:* There are numerous community-based organisations all around the world that focus on sustainable livelihoods, and urban agriculture and their related water-requirements. These are examples of civil society initiatives where people take responsibility for addressing their own immediate needs. Organisations in civil society often develop partnerships with other sectors, especially local and regional levels of government, to assist with service delivery in the fields of food security, health, various forms of caregiving, and so forth.
- *Education and awareness raising:* The role of civil society in cultivating virtues has been mentioned above. In addition, numerous organisations in civil society, including those not directly involved in urban water resilience, play a crucial role in explaining the implications of the virtue of frugality amidst water stress. The awareness-raising campaigns of government (through the media, placards, and posters) are unlikely to be successful if not reinforced through such education and raising of awareness. In addition to literature-based resources (books, articles, and pamphlets), one also needs to mention the role of the performing arts, including drama and puppetry.
- *Hospitality, charity, and care-giving:* Civil society organisations often accept a role in offering hospitality, e.g. to travellers, strangers, and visitors. Amongst the urban poor, especially in arid areas, this obviously include the need for potable water, cooling down, sanitation, washing feet and refreshment. This should not be reduced to the hospitality industry – which is often perceived to place additional burdens on an already water-stressed city. In addition, charity organisations help in distributing water to

wherever it is most needed. Amidst the regular droughts in South Africa there are remarkable stories of individual citizens or organisations who were willing to come to the aid of others. Not surprisingly, such initiatives also become ritualised in the form of rituals around cleanliness, foot washing and sharing water.

- *Monitoring, advocacy and policy making around water resilience:* Larger non-government organisations are also able to play a role in research, monitoring, policy making and advocacy on a range of social issues, including water resilience. One may mention here the role of the Institute for Ecological Civilization, the Ecumenical Water Network, Oxfam, Bread for the World and numerous other initiatives. In the Cape Town area one may also mention the Alliance for Water Stewardship.[37] Such organisations in civil society can, and do, hold policy makers and institutional service providers accountable regarding the ways in which they proclaim and implement policies related to water conservation and use. Community-based organisations typically have first-hand experience with those most affected by water crises and can, therefore understand, and raise the issues that need to be addressed over the longer term. Because they are not tied to (or by) policy or regulations, civil society organisations are often able to think more creatively and flexibly about ways to re-evaluate and reshape systems and structures for a more generative and secure future for all.

The task team on civil society whose work forms the basis of this chapter, collected the following examples of best practice related to urban water resilience. These often touch on more than one of the rubrics identified above. They remain arbitrary in the sense that other examples could easily be mentioned, but these are derived from the experience of the co-authors and so merely remain suggestive.

- *Social justice coalition pushing for access to clean water and sanitation in Khayelitsha:* They identified that, although the municipality was paying small BEE companies to do the cleaning of toilets, it was often not being done. They also push for toilets to be put in where not present. The Asivikelane project has been doing a great job during COVID making sure that people get access to clean water and that communal toilets are cleaned.
- *Anglican Church's Lenten campaign around water:* This campaign started with spirituality – sermon materials and liturgies were developed for each Sunday of Lent. "If water is sacred we must preserve it" – 'green' Anglicans ran a competition on who could reduce their water usage the most and the prize was a Jojo tank (donated by Mica, a local hardware chain). Two water conferences were held to discuss the various issues around water (sanitation and biodiversity). A water expo was held at St

[37] See its Water caucus manifesto at http://www.emg.org.za/programmes/climate-change/35-uncategorised/43-sa-water-caucus [Accessed on 21 October 2019].

Margaret's church, Parow, Cape Town, with talks being presented, and all kinds of water saving products on display.

- *Blessing of the springs:* When the new spring at Newlands was opened (a new tap was fitted as an outlet at a natural spring coming off Table Mountain), the faith communities were asked to come and bless it by the city of Cape Town.
- *Princess Vlei campaign*: The Princess Vlei (a wetland) on the Cape Flats, Cape Town was threatened with the construction of a shopping mall. Schools, local community organisations and faith groups protested. It was then declared a sacred space by the Khoisan and the development was stopped.
- *Public Sabbath*: Imagine a regular water festival to celebrate an inclusive water sensitive city, and to recall that the city is not determined by its past. Such a festival should be shaped by the people involved, but here are some suggestions that were recognised for the city of Amsterdam. The now famous canals in Amsterdam were treated as a garbage dump and sewer for hundreds of years. Amsterdam's canals remained polluted well into the 20th century. Today the canals are cleaner than ever. The Amsterdam City Swim, launched in 2012, demonstrates the potential of clean canals every year. In 2012 Princess Maxima, now Queen Maxima, took the plunge, swimming two kilometres to raise money for charity. Paddling into the future, as expressed in Cape Town's 'Peninsula Paddle: journey of hope' (Figure 7.3), organised by the University of Cape Town, might be Cape Town's alternative to swimming into the future, as it is not (yet) possible to swim in the waterways. Other elements of a public Sabbath, like a safe space for discussing conflicting views, might be better expressed in the Courageous Conversations, an interfaith initiative in South Africa introduced by amongst others, Archbishop Thabo Makgoba (Anglican Archbishop of Cape Town) (Hasselaar, 2020b).

Figure 7.3 Peninsula Paddle 'Journey of Hope' is an annual event that draws attention to the environmental condition of Cape Town's waterways, and encourages civic associations and City departments to take action (photo: EGS 2020)

- *Retrieving the Hensbeker tradition*: Civil society can also contribute to the development of rituals in order to stimulate cooperation on water issues. See for example the Dutch "Hensbeker" from the year 1717. This cup and related tradition were reinvented during the Amsterdam International Water Week and the Water Symposium Amsterdam (November 2019) to celebrate and seal the cooperation between business, religion, academia, NGOs and the cities of Jakarta, Cape Town and Amsterdam.[38]
- *A Covenant of Hope*: The multidisciplinary symposium "Water in Times of Climate Change: A Values-driven Dialogue", held at the Vrije Universiteit Amsterdam on 6-7 November 2019, had a focus on three major urban areas: Cape Town, Jakarta and Amsterdam. During a ceremony in the closing session of the symposium, the Covenant of Hope, expressed as an Amsterdam Agreement of the Amsterdam International

[38] See https://www.agv.nl/geschiedenis/historisch-archief/parels-uit-ons-archief/hensbeker-300-jaar/ [Accessed on 5 October 2019].

Water Week 2019, was signed by representatives of, for example, the Ecumenical Patriarchate, water utilities in Amsterdam, Jakarta and Cape Town, dredging company Van Oord, the United Nations Environmental Program, ABN AMRO, the Old Catholic Church, Tear, Deltares, the Water Institute Cape Town, the Netherlands-Indonesian Consortium for Muslim-Christian Relations and the Amsterdam Sustainability Institute (VU Amsterdam). In 2020 a bilateral project on "water sensitive cities" was formulated between Cape Town and Amsterdam as an outcome of such a covenant.[39]

- *Water for Dignity*: Water for Dignity is a township-based civil society organisation that was established in 2013 as a form of citizen science in response to increasing water supply and management problems in Makhanda (formerly Grahamstown), the main urban centre of the Makana Local Municipality in the Eastern Cape province of South Africa. They used a social learning approach and integrated water resources management to offer participatory experiences to citizens in order to teach them how they could claim rights to water. At the same time they engaged them on how they also need to choose and meet the corresponding responsibilities of water wise usage. Weaver et al. (2019) report that, through social learning, this initiative enabled Water for Dignity to engage effectively on general water knowledge, water conservation

[39] The text of this covenant adopted at this conference (see Hasselaar and IJmker 2021: 122-123) reads as follows: 'Water: source of life, symbol of purity. But also threatening force of nature that humans have to struggle with. Life-giving friend, life-taking foe. Since time immemorial and across the globe this ambiguous relationship with water has resonated in religious narratives and technological innovations alike. Today it resonates also in several of the Sustainable Development Goals, the umbrella to address the challenges of our times.

Securing our existence and the future of our children has become more than navigating ambiguity. Water in times of climate change has become a radical uncertainty, key to the most compelling challenges of our societies. Rising sea levels, drought and desertification, shortage of drinking water and sanitation, shapes and forms our struggles with water that will be crucial to the sustainability and viability of the earth.

We can respond in various ways to this radical uncertainty and ambiguous complexity. Reckless denial ignores all the warning signs and postpones all action so that the next generation will suffer the consequences. Helpless despair lets itself be overwhelmed by the dreadful consequences so that we lose the power and courage to act. Thoughtless self-confidence believes that our technological ingenuity will suffice so that we risk overlooking moral dimensions and yet unseen complexities.

Our response is a fearless hope that acknowledges uncertainty and complexity. Hope balances the imperfections and failings of the present with the promises and possibilities of the future. Hope builds the bridge between the "what is" of reality and the "what if" of our visions. Hope is the contrary of denial, of despair, and of the self-confidence that easily turns into a new escapism. Hope is the engaged and engaging response of the people of today to the calling from the future.

This covenant of hope invites us to respond to that calling. It brings together all those of good will, ready to share our insights, visions, resources, and capabilities. The covenant respects the dignity of our differences and the responsibility for joint action. The covenant seeks to bridge our practical, technological, legal, economical, and spiritual understandings of our predicament. Together we will take the small steps needed today to reach our rich vision of living sustainably on this earth, living with water as our dangerous friend.'

practices, best-practice for safely storing water, personal water rights, and citizen responsibilities with regards to water. Through structured citizen engagements, informal conversations, and face-to-face engagements as a form of social learning, they managed to induce behavioural change (e.g. adopting water conservation practices) and active citizenship (e.g. reporting water leaks to the municipality). These are the first steps towards a community transforming to an improved state.

7.5 A VISION FOR THE FUTURE

It is unlikely that organisations in civil society will ever agree on a common vision for the future. This is not a sign of failure but of vibrancy, as the process of discussing a vision is more important than agreeing on any one formula. To discuss such a vision is crucial, as this prevents people from seeing water challenges merely in terms of technical management rather than in terms of values that are based on who they are, and what they want their city to be.

Nevertheless, participants in the civil society task team on whose work this chapter is based found the vision of a "blue-green city" attractive. This is defined in the following way: 'A Blue-Green City aims to recreate a naturally-oriented water cycle while contributing to the amenity of the city by bringing water management and green infrastructure together. This is achieved by combining and protecting the hydrological and ecological values of the urban landscape, while providing resilient and adaptive measures to deal with flood events.'[40]

From the perspective of civil society, a vision for urban water resilience towards 2050 should include at least the following four dimensions:

1 Participation in public decision-making processes

From a civil society perspective, water is not merely a resource to be managed, a utility to be utilised or a commodity to be traded. It is also a basic human need, a gift, a right, and a responsibility. Organisations in civil society need to participate as stakeholders in public decision-making processes in order to promote their visions for water resilience, for example in terms of the notion of blue-green cities. It would want to make an impact on such decision-making processes as policy making and policy implementation. This can be done through participating in public hearings, ratepayers associations, research foundations, etc. Inversely, it is important for local government to involve its citizens in policymaking from the start – and to ensure that stakeholder dialogue takes place within communities and not in hotels!

Although organisations in civil society are active in this regard already, they often do not have the impact that they desired or envisaged, because of a lack of coordination. This is because

[40] See http://www.bluegreencities.ac.uk/about/blue-greencitiesdefinition [Accessed on 7 August 2020].

civil society comes up with conflicting and diverging perspectives that government and industry find difficult to engage with. Although such a diversity of opinions is one of the strengths of civil society, some degree of coordination is necessary in order to be effective. In South Africa the role played by the South Africa Non-Governmental Organisations Coalition (SANGOCO) may serve as an example.

2 Education and awareness raising processes

Civil society would want to see that citizens are educated through awareness-raising programmes, conscientisation and changing perceptions, especially in five areas that are pertinent to water security, namely:

- To know the water footprint of each consumer product (from bottled water to a loaf of bread and a motor vehicle). The water footprint is the amount of water needed to produce a consumer product while taking the whole value chain into account. Such a water footprint needs to be indicated on the label of any product alongside its price, ingredients, and carbon footprint.
- To advocate the role of citizen science at a local level, in order to maximise participation and awareness raising. Students and retired teachers may play a role here, for example to monitor water pollution (to ensure the principle of “The polluter pays”) and water leakage.

Figure 7.4 Students being taught about wetland ecology and introduced to citizen science at Mfuleni wetland, Cape Town, on World Wetlands Day
(photo: Sutherland no date)

- To see and use sewage not merely as a waste product but as a valuable resource, e.g. for energy production and fertilisers.
- To recognise that flush toilets are not the only appropriate norm for adequate sanitation but that a fuller spectrum of options are available and may be used as appropriate in different local contexts.
- To conscientise people through the cleaning of rivers and wetlands. This plays a significant role in education: once one has seen the garbage in rivers one recognises the need to do something about that. This may include banning the plastics that accumulate in river systems.

Such awareness raising can be done in multiple ways, e.g. in faith communities, in clubs and by using the performing arts

3 Becoming water-wise: Exercising responsibility in households

Civil society also includes households of various shapes and sizes. In order to achieve water resilience, it is necessary for citizens in such households to exercise responsibility regarding

the use of water. One cannot be responsible for what is beyond one's locus of control, but some aspects fall within the locus of control of every household. These include the following:

- Cultivating the virtue of frugality and avoiding the vice of wasting potable water.
- Cultivating the virtue of care and avoiding the vice of polluting fresh water in various ways
- Developing innovative forms of water storage appropriate to the nature of the household and its geographical location.

Becoming water-wise is a virtue that has to be cultivated over the long-term. Role players in this regard include schools, the media, NGOs, FBOs and local faith communities.

The vision for 2050 at this level would be to ensure that the overriding majority of households exercise such responsibility. This requires a first generation of innovators – a group of early adapters – in order to reach a critical threshold where the majority of households will follow the desired trend.

4 Recognising the role of activist movements

There are a number of serious threats to water security as a result of the contamination of water, e.g. through mining, industry, energy generation, agriculture, and waste management. In response, movements in civil society emerge to address such contaminations. Such movements are not always institutionalised but are nevertheless effective in resisting threats to water security. They encourage vigilance and engage in activities such as monitoring, information gathering and dissemination, awareness raising, storytelling, lobbying, advocacy, training, organised protests, and networking with similar movements elsewhere.

There is no need to promote such movements as they typically emerge spontaneously in response to local needs. As a vision towards 2050 it is only important to recognise the role played by such movements, to promote checks and balances and to encourage networking and coalitions between local interest groups.

The role of civil society in addressing concerns over urban water resilience need not always be well-coordinated in the same way that planning and organisation are required by government to become effective. What may be a weakness elsewhere may be a strength in civil society. Especially in times of crisis, when planning breaks down, there is a need to cope with what is "unprecedented", for example when droughts, storms or fires that are supposed to happen only once in a hundred years occur far more frequently. There is then a need for resilience; first an opportunity to express shock and dismay, and then to search for a way forward to cope with severe water shortages. This applies equally to severe flooding or the

contamination of existing water supplies.[41] This can only happen where people live and work. The role of a vibrant civil society therefore remains vital in order to face the expected future challenges associated with urban water resilience.

[41] These observations are derived from Clive Pearson (Charles Sturt University, Sydney), one of the task team members and co-authors. He reported on 15 January 2020: 'We are experiencing an absence of water in Sydney; It hasn't really rained for such a long time: we are due to get some storms this week as cyclones have begun to move over the west coast of Australia and this excess of water raises different problems, including contamination of water and loss of soils on denuded landscapes. But the thing which strikes me is this: we cannot separate our talk about water from our talk about fire (and heat), and quality of air (we are now all talking about 2.5mm particulates in the air which hardly any of us knew existed before). We are seeing how this "element" (water) is inter-related with fire and air and land. We are seeing how these things working together compromise our "creatureliness" through so many animals / insects lost through fire (extraordinary numbers): our connection with plant life is not what it was (how do you manage a garden: which plants do you choose to keep alive?). Our normal language of environment, sustainability, responsibility perhaps is giving way to "emergency services", "disaster relief", a lostness for words. Yesterday we saw a blue sky for the first time since late November, but even so the sun this morning rose orange and who knows what it is "hidden" and "unseen".'
Upon further reflection he reported on 22 August 2020: 'Since the drought and terrible fires we have had excessive rain and unusual storm systems called "east coast lows". There are two challenges before us now – saltwater and freshwater. Climate change is leading to more regular one in 10 year storms, one in one hundred year storms, etc.: it is amazing how quickly these centuries are coming round now. The east coast lows are causing storm surges which are eating away at beaches / cliffs and making (often high end) property vulnerable. It provokes debates over responsibility – is it the local authority, the owner, or the state government? Acts of water-borne nature seep into the fractures of the democratic process. It raises questions over insurance: will property be covered – or not? Our dams are now full: there is risk of flooding on built floodplains. What is more of a worry is that the quality of the water in the dams can no longer be guaranteed because of the fires earlier in the year: there have been plumes of fire ash washed into the dams. So there is a lot of water (where there was none) but what about its quality?'
And on 27 August 2020: 'In Sydney we have many reports about water, fire, our vulnerability – but what transpired through the fires, heat and drought was not really planned for. The anecdotes are the witnesses of experience and shock – and the breakdown of planning. The term that we have become so familiar with is "unprecedented". It is as if we move from one crisis to another despite all the good energy and planning. It can feel like being exposed to a series of apocalyptic-like tremors.'

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CHAPTER 8

CONCLUSION: TOWARDS THE BLUE-GREEN CITY

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Figure 8.0 A success story: London Wetland Centre is a rehabilitated urban wetland, created by the Wildfowl and Wetlands Trust, and forms part of London's Blue-Green strategy towards urban resilience

(photo: Patche99z CC BY-SA 3.0 via Wikimedia Commons)
https://commons.wikimedia.org/wiki/File:London_wetland_centre_764r.jpg

8.1 INTRODUCTION

The vision we present in this collection of essays is in support of what we term the “blue-green city”. The blue-green city aims to recreate a naturally-oriented water cycle while contributing to the amenity of the city by bringing water management and green infrastructure together. This is achieved by combining and protecting the hydrological and ecological values of the urban landscape while providing resilient and adaptive measures to deal with extreme events such as drought, flood and heatwaves. Moreover, such a city, constructed in line with water-sensitive urban design (WSUD), is a well-governed inclusive city whose planning is citizen-centred, with an ability to provide adequate water services for the poor and marginalised. Such a city is a ‘good citizen’ within its catchment, actively contributing to the success of the UN Agenda 2030 for attaining the Sustainable Development Goals (SDG)s.

While the evidence provided by the authors in this book illustrates many examples of improved performance and best practice, it also illustrates how far there is still to go. While standing in the shadow of the climate crisis, the Covid-19 global pandemic reveals only too clearly the extent to which embedded systems of governance, management, production and consumption are ill-suited to positive collective action. While cities share all of the pathologies leading to ill preparedness, their spatial scales and central importance to human well-being require pathways for positive action. Moreover, we believe that the indispensability of water to human existence provides a common focus for action in support of sustainable urban design.

Recently, the global consulting company Arcadis published the *Citizen Centric Cities: 2018 Sustainable Cities Index* wherein 100 cities were examined closely across the three well-known pillars of sustainability: people (society), planet (environment) and profit (economics). This is a follow-up to their highly regarded *Sustainable Cities Index 2016* report wherein thirty-two indicators across 20 categories were used to assess city performance. In relation to the 2016 report, the authors state, ‘Cities are under pressure from all angles. Some pressures can be modelled and forecasted, such as population growth and mobility needs, but others, political uncertainty or flash floods for example, are more difficult to predict. Balancing the immediate needs of today without compromising the needs of tomorrow is at the heart of being a sustainable city’.

The 2018 update analyses data across 48 indicators within 31 categories. Their findings are important for us in a number of ways. For example, on a scale of 0 to 100, only five cities score above 70. The top ten, in order, are London, Stockholm, Edinburgh, Singapore, Vienna, Zurich, Munich, Oslo, Hong Kong and Frankfurt – all long-established cities located in the richest parts of Europe and East Asia. What is notable from the findings is that the top 60 cities all scored only adequately on environmental (planet) indicators. Their higher rankings were largely due to economic robustness and the health and wealth of the citizenry. Put differently, all cities undervalue the natural environment in the design and performance of the built environment. Twenty-five cities’ overall scores were less than 50. Most Latin American cities

scored in the range of 40. Canadian and Australian cities ranged around 60, while the world's largest metropolis – Tokyo – scored 59.

Many Latin American, Asian and African cities scored poorly overall (Cape Town ranked 97th with a score of 30/100; Johannesburg (Figure 8.1) was 92nd with a score less than 40), and especially in relation to both the people and profit categories. Cape Town, Johannesburg and Nairobi ranked 98, 99 and 100 respectively in terms of 'people' – which should come as no surprise given the vast numbers of urban poor. Right alongside them are Jakarta, Kolkata, Salvador, Mumbai and Manila. Unsurprisingly, the top and bottom deciles are populated by the same cities, with cities such as London and Stockholm performing reasonably well across all categories, and cities such as Nairobi and Kolkata performing exceedingly poorly across all categories.

Figure 8.1 Johannesburg (including Soweto), South Africa scored very poorly on the Citizen Centric Cities: 2018 Sustainable Cities Index
(photo: Matt-80 CC BY 2.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Soweto_township.jpg)

There are two key messages to be derived from this short summary. One, "sustainable" cities require a combination of healthy citizens and robust economies – which are in short supply across the Global South. Two, the natural environment is under great stress across all urban

spaces and, until very recently, has been significantly undervalued as an “asset” in sustainable urban design.

Keeping these messages in mind, this final chapter reflects on the lessons learned in each substantive chapter, and draws some conclusions regarding appropriate analytical tools that may allow decision makers to think through context-sensitive courses of action in complex urban water situations. The concluding chapter also makes recommendations regarding appropriate first steps to tackle the challenges and opportunities that have been raised in this book. As hinted at above, it is our belief that improved state-citizen relations and a concentrated effort in nature-based solutions have created great opportunities to meet the challenges, not only of water security, but more broadly, of urban sustainability.

8.2 TECHNOLOGY MATTERS, BUT NATURE MATTERS MORE

Water managers worldwide are assuming that humans can ultimately solve the problem of deteriorating quality and inadequate quantities of water largely through a combination of technological innovation and adequate finance. Without doubt, this will yield improvements, but to think that these problems will be solved in this way is misguided. With increasing global warming, an increasing world population, and intensification of urbanisation, there is a real probability that (lack of) water will be the limiting factor in cities and indeed in human populations. As noted in the chapter by Carden and Fell, with regard to Africa’s urban growth trajectory, ‘half of the city of 2035 has not yet been built’. Added to this, the fact that all forms of pollution will skyrocket under such circumstances, means that current challenges will worsen. What does this mean for urban planners, city engineers and politicians? In terms of technology there are five key points to keep front of mind:

- The pursuit of conventional engineered solutions to exploit natural systems for high-quality water supply comes at the expense of longer-term water resilience, particularly as a result of the impacts of untreated wastewater entering the environment. Renewed, IWRM-oriented technical and planning approaches are therefore required.
- WSUD offers an alternative, systems-based approach to conventional centralised urban water management, with the ultimate goal of creating multi-functional water systems within liveable urban spaces (Water Sensitive Cities).
- Water systems in the urban developing world do not need to follow the trajectories of conventional systems and approaches from the developed world, nor be burdened by legacy infrastructure.
- Investing in ecological infrastructure for the purposes of maintaining or rehabilitating naturally functioning ecosystems and devising nature-based solutions (NBS) is a significant long-term solution for securing water.
- A collaborative and supportive governance environment is needed in order to unlock the transition to WSCs.

The shift to resilient and water sensitive approaches requires a fundamental restructuring of the hydro-social contract. Such a system would include, amongst other things, co-management between different spheres, the dispersed operation and responsibilities of hybridised water systems, and shared risk. An enabling policy landscape that supports new ways of thinking and practice is also required. Strong intra-governmental (department to department) and inter-governmental relationships across national, provincial and municipal entities are necessary in order to provide the required support, both financial and technical, for water services provision. This leads us to five key recommendations regarding technology:

- Create water-sensitive and resilient cities – including the concept of the 'city as a catchment', water quality protection, liveability, and ecosystem protection.
- Practice integrated water planning and management that ensure sustainable and equitable water access. This means that cities must also be aligned with SDG 6, Target 6.5.1, that addresses functional Integrated Water Resource Management.
- Build water smart cities that are connected with real time relevant data and information which is shared widely.
- Ensure a collaborative and supportive governance environment to unlock synergies.
- Cultivate informed and engaged water citizens; empower residents, government, businesses, NGOs, and the agricultural sector to make a difference.

As shown in the chapters by Day et al. (Chapter 2) and by Carden and Fell (Chapter 3), there is significant benefit to be derived from a focus on NBS. What the many different urban water crises are teaching us is that the rush to established technologies (e.g. boreholes, pipelines, dams, and desalination plants) in the name of 'crisis' is not only expensive but constitutes sunk costs that create new path dependencies as well as possible financial disasters. When it comes to crises, we often see 'nature' depicted as a 'user' who is competing with 'humans' and the 'built environment' for a scarce resource. To the contrary, as illustrated in the chapters above, there are numerous possible long-term gains to be derived from a commitment to NBS. In addition, a sunk cost is better when it creates 'built infrastructure' that mimics the cleansing, cooling, purifying and infiltrating processes of the natural system.

In Chapter 2, Day et al. recommend the following:

- Deliberate and focused long-term planning: well-managed cities have in place an environmental management strategy that sets conservation goals and is supported by appropriate by-laws.
- The establishment and cultivation of teams of appropriate personnel: establishing multidisciplinary planning teams (including, for instance, ecologists, geohydrologists, engineers and planners) helps to solve problems before disaster looms.
- The building up of trust between all groups of players, including citizens, water managers and politicians. This obviates rumour-mongering and can be encouraged by transparent decision-making and rapid, clear communication.

- Gathering of data: the availability of good data is crucial. Long-term monitoring information on aspects such as hydrology and water quality are important for ensuring that good decisions are made and in minimising long-term risks, which may have unintended consequences. Partners need to be prepared to share their data with others and all partners need to agree to use the data for the intended purpose.
- Modelling, monitoring and evaluating consistently: modelling the likely effects of changes in climate and demographics will assist in good decision-making. Such modelling can assist with consistent monitoring and evaluation of projects and performance.

These recommendations complement those made in Chapter 3 by Carden and Fell, and fit well with the 'new' ecological economics (see also Wheeler, 2013) proposed by Buchner-Marais, Visser and Brill in Chapter 4. So, to the above we add:

- Development of an appropriate budgetary model: Too often environmental spending (e.g. green space development) is regarded as "unaffordable" in light of the pressures for improved service delivery. Ecosystem services analysis and an ecological economics approach will help align these interests.

We acknowledge the difficulties that exist when shifting toward new models of finance for urban sustainability, particularly as municipal governments everywhere tend to practice what Wassmer (2002) termed the "fiscalization of land", where too often decisions on land use are taken based on their potential to generate revenue, and little else. Nevertheless, as shown above, there are numerous examples of creative co-funding, participatory budgeting, full cost accounting (including environmental services) and so on. Moving to new forms of economic and technical thinking and practice requires deliberate attention to the decision-making processes. It will, without doubt, require us to create new habits that are aligned with our new ways of thinking about what water is, and what it is for.

The hard path of supply-side infrastructure will only take us so far, particularly if we are interested in sustainable urban design. Working with nature is generally regarded as 'the soft path', as it aims to minimise the urban ecological footprint. The soft path places an emphasis on demand management, but this too will only take us so far. A compromise is necessary. However, in terms of implementation, the hard path is easier for politicians, as it requires no alignment of interests between the empowered and marginalised within the socially divided city. It is also tried and tested and all policies already consider these options the *status quo*. Like neoliberal economics, the hard path imagines a 'trickle-down' effect of enhanced access to, and use of, new supply. The evidence in support of this perspective is weak, however. As shown above, without deliberate engagement across class, race, caste and gender lines, water continues to flow toward the powerful. Importantly, such an outcome worsens, rather than enhances state-civil society relations. There is thus an urgent need to create institutional structures that promote collaborative governance, allowing all stakeholders in the water

system to shoulder the burden, share ideas and plot a sustainable path forward. Beyond the technical and economic aspects of creating the blue-green city, careful attention is required to politics and governance, i.e. the social and civil side of the city.

8.3 GOVERNANCE MATTERS MOST

As illustrated in Chapter 6 by Hara, Ncube and Sibanda, municipalities across the Global South are plagued by inadequate institutional responses to rapid urbanisation and mismatches and contradictions remain at all levels of governance. Skewed spatial planning – the result of the fiscalisation of land – continues to perpetuate uneven access to water and sanitation services. Also, global efforts such as the Millennium Development Goals, Sustainable Development Goals, continental and regional agendas and national plans that prioritise access to water and sanitation, remain unrealised for many, in particular those residing in informal settlements in African, Asian and Latin American cities. Despite decades of discussion regarding 'good water governance' and IWRM, policies continue to perpetuate exclusion, especially for the poor and marginalised. This has resulted in informality and insecure tenure that contributes to social water scarcity in cities. For example, evictions, displacements, and denial of 'right to the city' for the poor are common in African cities. The poor have resorted to informal sources of water such as boreholes and wells that are unsafe in many instances. In addition, there has been an increase in non-revenue water due to ageing infrastructure and illegal connections. Water has also been commodified, and at times this has resulted in the proliferation of expensive informal water markets that the poor cannot afford.

How might we bridge the gap between the formal and well-serviced side of the city and its informal, ill-serviced counterparts? Chapter 7 by Conradie et al. provides several important insights in this regard. While the impacts of the recent Cape Town, Los Angeles and São Paulo water crises are unevenly felt between rich and poor, evidence shows that they presented important opportunities to build trust across the urban socio-economic divide. Too often, citizens are generally regarded and treated as customers to be served, or threats to be disciplined, or dangers to be controlled, or objects to be educated, or agents to be manipulated through appropriate media messages. In other words, they are objects rather than subjects of urban governance. To move toward the blue-green city, citizens and organisations in civil society must be treated as partners, and work together to address the challenges. Admittedly, such partnerships are often troubled, for instance by angry protests, but equally, where civil society is dysfunctional and leads to the disintegration of communities (illustrated by gangsterism, but also a range of other issues). As illustrated in several of the chapters, in the Cape Town, Los Angeles and São Paulo water crises, bridges were built between these different sectors, admittedly a bit rickety but nonetheless they constitute a necessary starting point.

Perhaps the crucial insight here is how moral formation takes place in households and organisations. For city managers, if the message to citizens only focuses on one strategy for compliance, this may well fail in the long run. An emphasis is needed on:

- Appropriate values and goals, given a sense of the common good and common threats (Day Zero-talk);
- Duties and rules (enforced compliance, fines), rights (distributive justice) and responsibilities (contributive justice); and
- Fostering appropriate virtues.

In ethical theory these notions are often in direct conflict with each other (rivalries between the utilitarian, deontological and virtue ethics approaches). Nevertheless, in the South African Constitution both what is right (the Bill of Rights) and what is good (the preamble to the Constitution) are addressed in necessary tension with each other. In the case of Cape Town's recent water crisis, the utilitarian message around avoiding a common disaster was hugely successful, but it was supplemented by an emphasis on duties and rules (the water restrictions). What is typically ignored or taken for granted is the formation of virtue. Nothing can work in society without it, but this is also something that cannot be addressed by politicians, economists, engineers or scientists, except insofar as they are also citizens. As the saying goes "virtue cannot be taught", certainly not by municipalities.

Civil society and social movements play a crucial role in improving urban governance. The challenge for city managers is to begin to regard these groups as assets rather than liabilities, and to see their actions and hear their interests as a kind of litmus test of the health of the polity. Conradie et al. present a series of examples of best practice, focusing on food security and urban agriculture, education and awareness-raising, hospitality, charity and care-giving, as well as monitoring, advocacy and policy making. Each of these provides different ways of improving state-citizen relations, partly by performance but importantly through inclusive narratives regarding the symbolic nature of water – as a gift of life, as a threat, as a source of cleansing, and as joy. Each of these suggests ways of bringing people together in common cause and moving beyond instrumentality.

Water is in everything. As such, it is simultaneously a resource to be managed (in cities and municipalities, as well as for agriculture), a utility to be governed (in industry), an asset/commodity to trade (in business), an allotment to use responsibly (which differs from one city to another), a gift to be treasured (recognised in religious communities), a threat to be feared, a source of play and fun (children understand that better than grownups), an entity in its own right, part of a living system, and an aesthetic complement to daily life. Reconciling these different interests, each of which requires water in different amounts, of different qualities and at different times, is inevitably a political matter.

As suggested above, achieving urban sustainability requires improved governance. The characteristics of this governance are well known and have been described in different ways in most of the chapters above. If there is any river that needs to be tamed and channelled in water resources governance and management, it is the political river. Chapter 5 by Swatuk

and Fatch suggests nine criteria that are necessary for channelling politics toward the common good:

- Collective, cross-sectoral and participatory decision-making;
- Actions that are framed in a deliberately non-political way;
- Projects that are underpinned by influential third-party involvement;
- Efforts that are supported by a government policy that has been shaped by enlightened leadership.
- Shared need;
- Sufficient available capital;
- Respect for people;
- Relatively equal vulnerability;
- The presence of an effective regulator.

Granted, the evidence from the cases that have been presented across all chapters, though systematically collected, is not comprehensive. It is nevertheless indicative of the criteria that are necessary for shifting cities away from "business as usual" toward more inclusive, sustainable and resilient planning and practice. More research is required to determine, for example, if all or only some of the nine criteria must be present for enabling and ensuring best practices toward WSUD. For example, adequate finance is necessary, but the relative meaning of "adequate" will depend on the intervention that is collectively agreed upon. In our view, it is the method of decision making that matters most of all. Attaining urban water security through sustainable urban design can only be successful if it is as a result of an inclusive and collective process.

8.4 CONCLUSION: SYSTEMS AND STEPS

This overview brings us back to the systems approach we highlighted in Chapter 1. It is clear that each chapter provides a unique entry point into the complex world of urban water resilience. At the same time, and as illustrated above, all chapters emphasise the importance of an integrated approach to knowledge gathering, information sharing and decision making. One method for keeping disparate groups and conflicting interests together is through a shared conceptual lens. Here we argue that the most appropriate lens is WSUD. In Chapter 1 we identified a number of goals that are driving action for urban water resilience:

- a sustainable and resilient natural environment;
- a healthy, just and equitable society;
- affordable, appropriate and applicable technology;
- a robust, equitable and sustainable economy; and
- a robust, equitable and sustainable political process.

A systematic analysis of the city, in line with each of these goals, is a necessary first step toward achieving WSUD (see Chapter 1).

The technical, human and financial tool-kit necessary for achieving these goals contains many instruments. We have described several in this volume and the reader will no doubt know of many more. In our view, the choice of tools will depend not only on how the socio-ecological landscape has been analysed, but where people and nature feature in the hierarchy of values. As stated at the outset of this chapter, technology matters but nature matters more. How then can we arrive at a robust decision in support of the common good? As we say above, governance matters most of all. Each chapter makes a case for developing the appropriate values and goals, cultivating a cohort of informed and engaged citizens, building trust, and engaging in collaborative and supportive forms of governance in the context of transparency and accountability. Technical tools can assist in this process, namely: data gathering, modelling, monitoring and evaluation, appropriate budgeting and resource acquisition.

We hope that this volume provides insights appropriate not only for city managers, but for all of those interested in building urban water resilience. While we counsel the need for a systems approach to urban water security, we resist any effort to build a mechanistic model to be applied across all cases and places. While we feel strongly that a deep and reflective analysis of the natural, economic, technical, social and political nature of the urban environment is necessary, we also recognise that the influence of different elements will vary depending on context. In the end, achieving urban water resilience will require a creative, collaborative coalition of actors who are continually engaged in open dialogue. As we stated earlier, this will be as much about art as it will be about science. Nevertheless, and in conclusion, we offer three universal first steps that are necessary for cities to move away from business as usual toward new thinking and action for urban water resilience.

1. Adopt a water accounting approach, utilising the insights and methods available to all relevant stakeholders (from earth systems observations to citizen science). Managers must understand how their city fits within the hydrological cycle(s) of the river basin(s) from which they derive their water, and into which they introduce their waste.
2. Conduct a forensic analysis of water governance and management. Poor performance is attributed to a variety of factors, and these need to be interrogated without fear of retribution.
3. Hold a series of stakeholder forums. There is great potential to learn from each other, build social capital, and increase trust among state, private sector and civil society actors through a series of meetings devoted to, among other things:
    i. Exploring the value of water (its meaning to, and place within the lives and livelihoods of all users across the city and the catchment)
    ii. Sharing examples of best practice in WSUD, green infrastructure, and so on (this may be preceded by the commissioning of research conducted primarily by the ‘next generation’ of water managers, i.e. students at all levels of education)
    iii. Investigating creative means of financing water service delivery with an explicit focus on matching needs with appropriate technology and affordability

Figure 8.2 Our ultimate goal – urban water resilience – that provides sustainable, clean, potable water for all
(photo: JJ Harrison CC BY-SA 3.0 via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Water_Dolphin.jpg)

Together, these three actions constitute the foundation upon which to build urban water resilience. Put differently, in order to realise the goals of “some water, for all, forever”, it is imperative that we understand:

- how much water we have, where it comes from, when and why;
- what we do with it while we have it, and what happens to it once we dispose of it;
- how decisions are made regarding its access, use and management;
- why outcomes match or do not match expectations; and given (1)-(4), how we can best move forward through consensus.

How we prepare for 2050, moreover, should also help build resilience in the face of the unfolding climate crisis.

8.5 REFERENCES

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