MAINSTREAMING WATER RESOURCES MANAGEMENT IN URBAN PROJECTS: TAKING AN INTEGRATED URBAN WATER MANAGEMENT APPROACH

A GUIDANCE NOTE

WATER
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Acronyms

AWSB	Athi Water and Sanitation Board
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DRM	Disaster Risk Management
EAC	Equivalent Annual Costs
EU	European Union
FMDV	*Fonds Mondial pour le Développement des Villes* (Global Fund for the Development of Cities)
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographic Information System
GWP	Global Water Partnership
ICLEI	Local Governments for Sustainability
IEG	Independent Evaluation Group
IHA	International Hydropower Association
INSA	*Institut National des Sciences Appliquées* (National Institute of Applied Sciences)
IUWM	Integrated Urban Water Management
IWA	International Water Association
M&E	Monitoring and Evaluation
MOOC	Massive Online Open Course
NPV	Net Present Value
NRW	Non-Revenue Water
NWSC	National Water and Sewerage Corporation of Uganda
ODI	Overseas Development Institute
O&M	Operation and Maintenance
PCN	Project Concept Note
PPP	Public-Private Partnership
PSGS	Patel School of Global Sustainability
PSP	Private Sector Participation
QER	Quality Enhancement Review
TA	Technical Assistance

WASH	Water, Sanitation and Hygiene
WB	World Bank
WFD	Water Framework Directive
WHO	World Health Organization
WPP	Water Partnership Program
WRM	Water Resources Management
WSS	Water Supply and Sanitation

Foreword

In 2014, over half of the world's population was residing in urban areas. Continuing population growth and urbanization are projected to raise this to two-thirds, adding 2.5 billion people to the world's urban population by 2050, with nearly 90 per cent of this increase concentrated in Asia and Africa. With rapid urbanization, competition for water resources across all sectors will become fierce. At the same time, raw water sources risk becoming more contaminated through changes in land use patterns, poor solid waste and stormwater management, inadequate wastewater treatment, aging infrastructure, and unbridled formal and informal urban expansion. Climate change is adding more uncertainty and vulnerability to these challenges as water management has to take into account the additional stresses stemming from rising temperatures, changes in precipitation patterns and weather variability. Consequently, the quantity and quality of water available to cities for agriculture, energy, industry and human development needs is, and will remain, in constant flux. With many sectors relying on the same river basin, the competitive dynamics at play require a paradigm shift to an integrated approach to urban water management.

In response to these challenges, integrated urban water management (IUWM) aims to improve the way resources are managed across the urban water cycle by promoting resource diversification, system efficiency and conservation, while taking into account all water users in the city and in the wider catchment through broad stakeholder participation.

IUWM is an integral component of sustainable cities and metropolitan areas. The four dimensions of sustainability: clean and green, inclusive, resilient, and productive are inextricably linked to IUWM. Reducing pollution loads and making sure every drop of water is used in the most efficient manner are integral concepts of IUWM. Providing water services to excluded populations, and enhancing the resilience of cities to water disasters are key pillars of IUWM. Finally, competitive and productive cities not only need to provide water services for businesses and industries, but also need to be ready to deal with the extreme variability of water and the disruptions it can cause; water shortages and floods reduce the competitiveness of cities.

This Guidance Note was produced as part of the Water Global Practice's *Science of Delivery in Urban Water Supply and Sanitation* initiative, and under the auspices of the *IUWM Knowledge Silo Breaker* which is supported by the Urban, Environment and Water Global Practices. It aims to bridge the gap between knowledge and implementation by capturing tacit knowledge and facilitating World Bank teams' requests for practical guidance on how to engage with clients under an IUWM approach.

The Guidance Note is designed as a key entry document with links to existing and future material which provide depth of information on specific IUWM topics for development practitioners. It aims to be inclusive of perspectives from different water and urban sectors, including all aspects of urban water management as well as land use planning, social development, climate change, solid waste management, energy, flood control, drainage and the environment. The objective is not to add to the theoretical framework but to provide practical guidance, references and recommendations on IUWM for Bank practitioners and their government counterparts working in developing country cities.

The Guidance Note includes profiles from four cities that have taken an IUWM approach triggered by different factors: water scarcity in Windhoek, Namibia; flood protection in Rotterdam, the Netherlands; climate variability in Melbourne, Australia; and rapid, unchecked urbanization and upstream water quality challenges in Vitoria, Brazil. The latter case, in particular, demonstrates the nature and timing of World Bank investments in a series of operations over a sustained period which made possible the gradual transition to an IUWM approach. The examples highlight that there is no one way to transition to, and implement, IUWM. The Guidance Note nevertheless provides some practical steps and entry points for an integrated urban water management methodology, which is based on key drivers and on an appreciation of the institutional setting and the political economy of the cities where we work on these issues.

As our collective body of knowledge on IUWM continues to grow, we hope that this Guidance Note will provide a pragmatic and flexible tool for World Bank task teams and their counterpart stakeholders working on urban water management challenges in cities across the globe.

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Introduction

1.1 Objective and Structure

The objective of this document is to provide guidance for managing the urban water cycle in a sustainable manner, with a focus on cities in developing countries. In doing so, the Bank is promoting a paradigm shift to more holistic and sustainable management of urban and water resources by applying an Integrated Urban Water Management (IUWM) approach to the broad water challenges commonly faced in developing country cities around the world.

IUWM is not a new concept; its principles have been outlined elsewhere before and are refered to in a variety of ways (Cities of the Future (IWA) or Water Sensitive Cities (Wong 2009) and with different acronyms (Sustainable Drainage Systems (SUDS), in the UK, or Water Sensitive Urban Design (WSUD), in Australia). The objective of this Guidance Note is not to add to the theoretical framework but to provide practical references and recommendations for the Bank and for other development practitioners working on the issues of water in cities in developing countries. IUWM is multi-sectorial in nature, and this note specifically targets staff working in several Global Practices of the Bank: Water (particularly urban Water Supply and Sanitation (WSS) and Water Resources Management (WRM)), Urban (particularly urban services provision, Disaster Risk Management, and urban upgrading), Environment, and Climate Change, as well as Social and Environmental Specialists involved in the design and implementation of Bank projects. A separate version of the Guidance Note will be published for an external audience, aimed at Bank clients such as municipal, central and regional governments, water utilities, river basin authorities, urban planners, and other relevant stakeholders and decision makers.

After a brief introduction to the concept of IUWM (Section 1), this Guidance Note profiles the different IUWM approaches applied in three types of city: a water-scarce, fast-developing city (Windhoek, Namibia), an expanding city subject to climate extremes (Melbourne, Australia), and a dense, flood-prone city (Rotterdam, the Netherlands). It also profiles an example of Bank engagement under an IUWM approach in a fast-growing city in a middle-income country (Vitória in Espírito Santo, Brazil).

The final section of the Guidance Note showcases a potential methodology for applying an IUWM approach in a city, from the initial engagement and diagnostic phases toward the application of a full IUWM umbrella framework under which a program (or a series of operational loans and analytical activities) can be implemented.

Throughout this Guidance Note, we will refer to the city and the urban or metropolitan areas interchangeably—the area of interest being the urban agglomeration (including informal areas and other urbanized zones) rather than the jurisdiction of the city *per se*.

1.2 What is Integrated Urban Water Management?

Urban water management remains an acute challenge for local authorities and urban planners, with one quarter of the population in large cities worldwide currently experiencing water insecurity[1] due to geographic and economic factors; a situation which is further exacerbated by increasing urbanization, demographic growth, water scarcity and climatic variability (McDonald 2014).

1.2.1 Urban Water Management: Current Challenges

The main challenges for urban water management include:

- **Rapid and unplanned urbanization:** Currently, 54 percent of the world's population (i.e. 3.9 billion people) resides in urban areas; by 2050, 66 percent of the world's population is projected to be living in urban areas, with nearly 90 percent of this increase concentrated in Asia and Africa (UN 2014). Cities in developing countries already struggle to plan for and accommodate the current number of residents in a sustainable manner: unchecked urban growth has led to increased demand for infrastructure and resources (land, energy, water, transport) at suboptimal densities, which makes it less efficient to provide basic services in areas of urban sprawl (Prietoa 2010). Unplanned urban sprawl also reinforces social and economic inequalities, as poorer residents relocate to informal areas without access to basic services and often at risk of climate extremes, disasters or sea level rise (Revi 2014). The provision of basic services and the management of shared resources, including water, is also hindered by the need to coordinate across different service providers within a city, as well as across administrative boundaries, beyond the city's jurisdiction. In this context, growing demand for water supply and sanitation, and for related services such as drainage, access ways and solid waste manegement, when accompanied by unplanned land use in urban areas, leads to environmental degradation and to the contamination of surface and groundwater sources. These circumstances, in turn, further exacerbate the security of water supply, increase flood risks, and affect the quality of life and environmental health of the city and its current and future residents. Such deterioration in the urban fabric of developing world cities negatively impact their economic growth prospects and their attractiveness and competitiveness, at one end of the urban spectrum; at the other end, small and medium sized towns experiencing high population growth will likewise face increasing challenges to provide basic urban services in a sustainable way as they prepare to become the cities of tomorrow (Jacobsen 2012).
- **Inefficient water management:** Current approaches to urban water management remain sector-specific, lacking the necessary scope to adequately address cross-cutting, water-related challenges in developing world cities. Watershed approaches to urban water management, where they exist, are often fragmented and not well coordinated with urban planning and with the provision of other urban services. Local authorities may also lack information and experience on the technical options available for a more sustainable approach to urban water management. As a consequence, variations in the quantity and quality of water available to cities for drinking water, agriculture, energy,

[1] Water stress/insecurity defined in this reference as cities with a ratio of water use to water availability of higher than 0.4.

industry and the environment, exacerbate water insecurity, as competition for water between sectors increases, both within the city and between the city and other actors in the watershed, particularly when the quality of water is compromised.

- **Climate change adaptation:** Urban water management must take into account the increased variability in water resources availability stemming from the effects of climate change, including rising temperatures, changes in precipitation patterns, and climate variability. An estimated 150 million people currently live in cities with perennial water shortage; population growth and climate variability may increase this number to 1 billion by 2050 (McDonald 2011). Furthermore, most of the key climate risks are concentrated in urban areas, as high urbanization and rapid growth of large cities are accompanied by an increase in highly vulnerable urban communities, living in informal settlements, many of which are on coastal land at high risk from sea level rise, from extreme weather events, and from other climate change effects (Revi 2014). The level of vulnerability to the effects of increasing water insecurity and climate change differs across and within cities, and differences in adaptive capacity are to a large extent determined by poverty and inequality, as well as by access to infrastructure, institutions, and information. The urban poor are most vulnerable to these challenges, as they have less access to resources to cope with extreme weather events and are often marginalized from decision making, particularly when they reside in the informal settlements of growing urban areas in developing countries (Revi 2014).

The urban water management challenges described above pose a threat to the sustainable economic and social development of cities. The costs of inaction are significant but difficult to quantify: they range from the financial costs of recurrent water-related disasters (floods, droughts) that affect virtually all cities in developing countries and that are bound to increase, with or without the impact of climate change (Güneralp 2015), through the human and economic costs of the lack of universal water and sanitation services (Hutton 2004, WSP 2015), to the costs associated with environmental degradation, loss of ecosystem benefits, and lack of environmental health. To develop sustainably, cities such as Jakarta (Box 1) need to look for alternatives to the traditional approaches to urban growth and to service provision, given the acute pressures they face regarding the urban environment and the urban water cycle.

Box 1 ■ Jakarta: A City Faced with Multiple Urban Water Challenges

Jakarta suffers from many water-related issues, including chronic perennial flooding and extreme floods every few years. The 2007 flood alone affected 25 percent of the city and caused financial losses of US$900 million. Flooding has been blamed on deforestation in the nearby mountains, but the main causes lie closer to home: wetlands and rice fields have been paved over, in defiance of urban planning regulations; drainage canals are blocked by garbage, the result of an ineffective solid waste management system; and while the city confronts sea level rise of 60 centimeters or more over this century, unregulated and unsustainable groundwater extraction has already sunk coastal areas of the city by up to 4.5 meters over the past 50 years. Parts of the city could subside another 5 meters this century if groundwater extraction is not brought under control, and will likely sink a further 1.5–2 meters, even if groundwater use is curtailed by 2020. Jakarta is not alone in facing such challenges: such situations are also seen in Bangkok and in many other coastal or growing cities around the world.

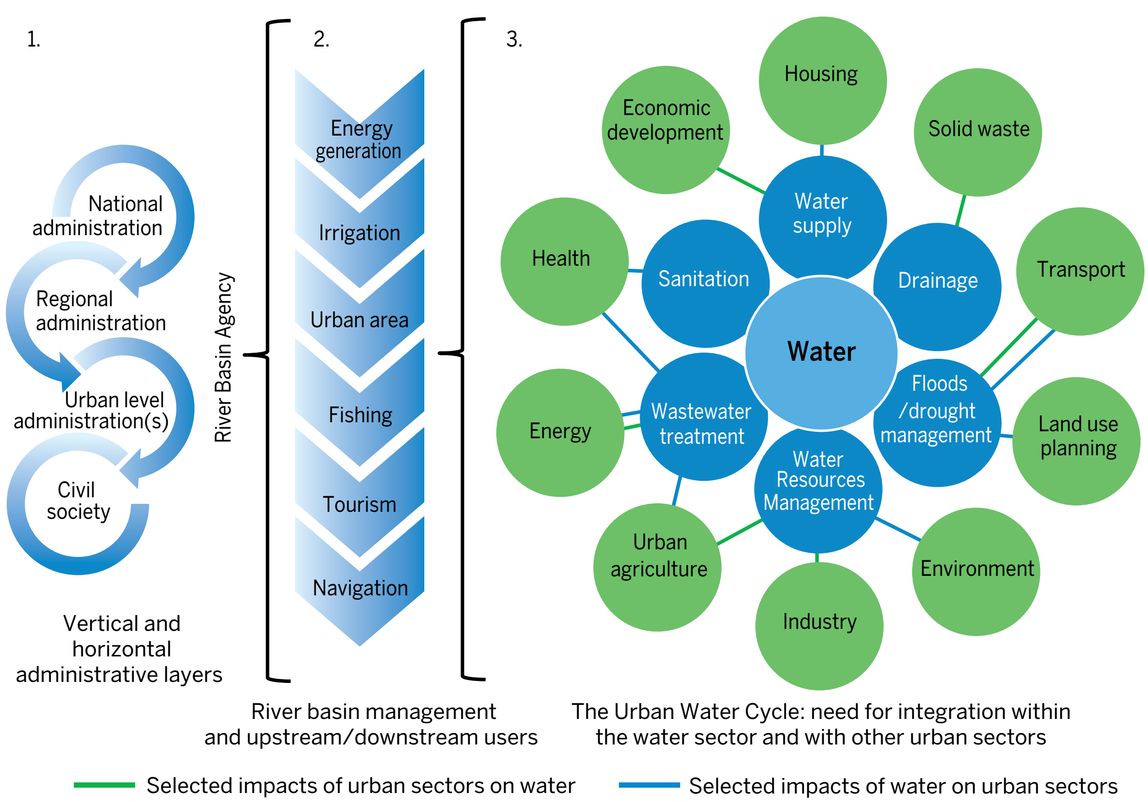
Source: (IEG 2011).

1.2.2 Key Principles of IUWM

IUWM offers a framework that can be used to complement traditional approaches to the challenges that affect the provision of water-related services in urban areas. It is underpinned by the idea that cities are fundamentally dependent on, and have an impact on, the wider watershed and consequently need to take into account all elements of the urban water cycle as they develop (Closas 2012). Under an IUWM approach, planning for the water sector is integrated with planning for other urban issues, such as land use, housing, energy, industry, and transportation, in order to overcome urban planning fragmentation, with the aim of improving system-wide performance (Maheepala 2010). IUWM also takes into account other users in the river basin, such as other cities and/or sectors with their different needs in terms of water quantity and quality (Figure 1), which may evolve over time. Last but not least, IUWM usually requires cooperation among several jurisdictions across which the urban area is spread, and with other users in the river basin, as well as coordination of the different aspects of urban water activities.

The World Bank defines IUWM as "a flexible, participatory and iterative process, which integrates the elements of the urban water cycle (water supply, sanitation, stormwater management, and solid waste management) with both the city's urban development and river basin management to maximize economic, social and

Figure 1. Multiple Layers of Integration



Source: Authors, based on (ICLEI 2011)
Note: An IUWM approach takes into account the needs of all users within the basin (2) while working across vertical and horizontal administrative boundaries (1) to overcome the traditional fragmentation of the Urban Water Cycle (3) and integrate interdependent sectors (urban (in green) and water (in blue)).

environmental benefits in an equitable manner" (World Bank 2012). IUWM offers a holistic way of strategic planning by managing competing water users at the level of the watershed, recognizing the needs of the city as well as those of upstream and downstream users (Figure 1).

An IUWM approach can yield multiple social, environmental, and economic benefits, among others, enhancing water security, health benefits, and climate adaptation strategies; reducing impacts on the environment; and improving overall system-wide performance. It also has the potential of bringing additional benefits through a focus on the long-term environmental, quality of life and health outcomes for urban residents, particularly the urban poor (Box 2).

The IUWM approach is based on a combination of principles aimed at optimizing the management of urban and water-related resources (Box 3). The key is to focus on the *outcomes* that the city aims to achieve rather than on the conventional means of providing WSS and related services provision. Through coordinated and flexible planning involving water actors and urban stakeholders, IUWM aims to optimize the sequencing of traditional and new urban infrastructure by using alternative management scenarios that leverage efficiencies and promote sustainability and resource conservation within the watershed.

IUWM represents a paradigm shift in how we manage water resources in the urban context; it is a way of thinking, not a methodology *per se*. It is an evolving science that requires a mindset in which all urban and water stakeholders recognize the issues and are determined to solve them in the long run, whether or not these issues affect their sector directly: for instance, housing regulations can be changed to solve run-off issues and mitigate flood risks, thereby directly benefiting one sector while forcing another sector to tackle an issue that does not directly affect it. The sustainable management of water resources, where even the smallest interventions can have a large impact, is one of the key principles of IUWM. In addition, an IUWM approach encourages nutrient, water and energy recovery from waste, including from wastewater, for reuse within, or close to, the city.

It is important to highlight that there is no one-size-fits-all model to an IUWM approach; rather, the mix of principles should be adapted to local socio-cultural and economic conditions (Bahri 2012). Even within a given city, some urban areas may apply different IUWM options to solve water and urban issues, depending on the local conditions. For instance, some areas within a city may be more prone to flooding than others, or may be growing faster than others, which will require a different set of options for IUWM within the city.

Box 2 ■ Integrated Urban Water Management Benefits the Urban Poor

Compared with the traditional benefits of urban WSS services, the additional contribution of an IUWM approach to poverty reduction and shared prosperity has been difficult to quantify. On the one hand, both share the health and economic benefits of improved access to WSS services; however, IUWM puts an additional focus on the environmental, quality of life and health benefits of integrated water supply, sanitation, drainage, urban planning and WRM, which translate into social, environmental, and economic benefits for the city in general and for its poorest residents in particular, who are often the ones most affected by water-related hazards. For instance, reduced water pollution through an integrated approach will benefit the health and living conditions of all urban residents; improved solid waste management, and special drainage and flood protection measures, will benefit the most vulnerable who live in informal areas most at risk of flooding. As 80 percent of all economic activities across the world are currently concentrated in cities, the provision of urban and water services and the preservation of environmental capital provide a foundation for shared prosperity now and in the future (McKinsey 2013).

Box 3 ■ Key Principles of IUWM

- IUWM recognizes the value of alternative water sources.
- IUWM differentiates the qualities and potential uses of water sources (and promotes the use of "fit-for-purpose" water sources, in terms of quality and quantity).
- IUWM views water storage, distribution, treatment, recycling, and disposal as part of the same resource management cycle.
- IUWM seeks to protect, conserve, and use surface water and groundwater (both in quality and quantity) at its source.
- IUWM accounts for nonurban users who are dependent on the same water source within the wider catchment.
- IUWM aligns formal institutions (organizations, legislation, and policies) and informal practices (norms and conventions) that govern water in and for cities.
- IUWM recognizes the relationships among water resources, land use, and energy.
- IUWM simultaneously pursues economic efficiency, social equity, and environmental sustainability.
- IUWM encourages participation by all stakeholders.

Source: Bahri 2012.

Engaging with all interested parties, including the public and the private sector, to agree on an IUWM framework for the city, and sustaining this engagement in the long term, is perhaps the most challenging aspect of an IUWM approach and involves a lot of time and effort for the relevant authorities. For this reason, an IUWM approach may not be suitable for all cities; for it to be successful, an enabling environment must be in place, which we will discuss in the next sections.

1.2.3 Where and how has IUWM been Implemented?

▸ For more details on international and World Bank experience of applying IUWM principles, and related resources, please refer to Appendix A.

International experience

An early champion of the IUWM approach was the EU-funded SWITCH project, which was implemented between 2006 and 2011 and researched IUWM approaches around several interrelated themes: water supply, stormwater, wastewater, planning for the future, engaging stakeholders, and decision-support tools. The research project engaged with 12 cities around the world, in developed and developing contexts, by empowering them to develop an integrated vision for water and urban development in their city. It has developed a wealth of resources, which are outlined in more details in Appendix A.

Another pioneer institution in the field of IUWM is the CRC for Water Sensitive Cities, which is based in Monash University, Australia. The CRC researches the themes of water-sensitive urban development and technologies, as well as IUWM adoption pathways; its research primarily aims to assist Australian cities in implementing innovative IUWM options. Australian expertise has also been used to develop a number of projects applying IUWM principles in Southeast Asia, in particular in Vietnam, through the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and AusAID (CSIRO 2012).

The International Water Association (IWA)'s "Cities of the Future Programme," coordinated by the University of South Florida, is a major avenue for knowledge exchange and dissemination on the topic of IUWM, with regular workshops and dedicated working groups on the topics of integrated engineering, planning, and institutions for cities.

Finally, the OMEGA project (*Outil Méthodologique de Gestion Intégrée des Eaux Urbaines*) is a recent collaboration between three French research institutes, a WSS utility (Lyonnaise des Eaux/Suez Environnement), and three French municipalities, which are acting as coordinators and serve as case studies for the implementation of particular IUWM options in France (Bordeaux, Lyon, Mulhouse). A practical output of this research project is a methodology for developing an integrated approach to urban water management, which can be of interest to French-speaking client countries.

Experience from the World Bank

From the early 1990s, the World Bank embarked upon a series of projects in Brazil, entitled 'Urban Water Pollution Control' projects, which included operations in São Paulo, Belo Horizonte, Curitiba and Vítoria, as well as diagnostic exercises for other rapidly urbanizing cities across the country. These operations were IUWM projects in all but name, as they addressed a suite of interrelated issues concomitantly, encompassing wastewater pollution reversal, stormwater and solid waste management, urban upgrading and green space development, and did so through the engagement of different local and state actors from the relevant sectors, and with an emphasis on improving the quality of life of the poor. Subsequent generations of projects in Brazil have futher built on these early IUWM experiences, notably in São Paulo, Vítoria, Betim, Uberaba and Teresina.

Furthermore, the Bank, with the support of the Water Partnership Program (WPP), has subsequently applied the concept of Integrated Urban Water Management in a more systematic way through regional engagements, particularly in Latin America, Europe and Central Asia, and Africa. The approach taken in each city and the level of engagement have varied, depending on local conditions, but have generally followed the transition pattern identified in Chapter 4 (engagement with the city, participatory diagnostic of urban challenges, and strategic planning for IUWM).

The Bank's 'Blue Water, Green Cities' initiative[2] focused on fostering a participatory approach in determining an IUWM framework in Latin American cities, as well as undertaking thorough diagnostics of a city's urban and water issues. More details are provide in Appendix A.

The Bank and the WPP also undertook technical assistance (TA) to develop an IUWM umbrella framework in Baku (Azerbaijan). The approach focused on a thorough diagnosis of urban and water challenges in Baku and an economic analysis of urban water management options, an assessment of the institutional framework for urban and WRM, and consultation with stakeholders.

In Africa, a number of analytical studies were undertaken by the Bank with the support of the WPP to look at the potential for an IUWM approach in the growing urban areas of Sub-Saharan Africa. Jacobsen et al. (2012) conducted an analysis of the urban and water-related challenges for 31 cities in Africa, with an in-depth diagnosis in several cities, including Nairobi (Kenya) and Arua and Mbale (Uganda). While city authorities expressed interest in follow-up in each of the three cities selected as case studies, Nairobi was the only one in which an integrated approach was applied as part of an ongoing World Bank investment project.

In East Asia, analytical work was also undertaken with the support of the WPP on the potential for an integrated approach (dubbed "Green Water Defense") for adaptive water management in cities (Li 2012). WB operations such as the Wuxikou Integrated Flood Risk Management Project and the planned Ho Chi Minh City Flood Risk Management Project in Vietnam also take an integrated approach, bringing together different sectors and stakeholders.

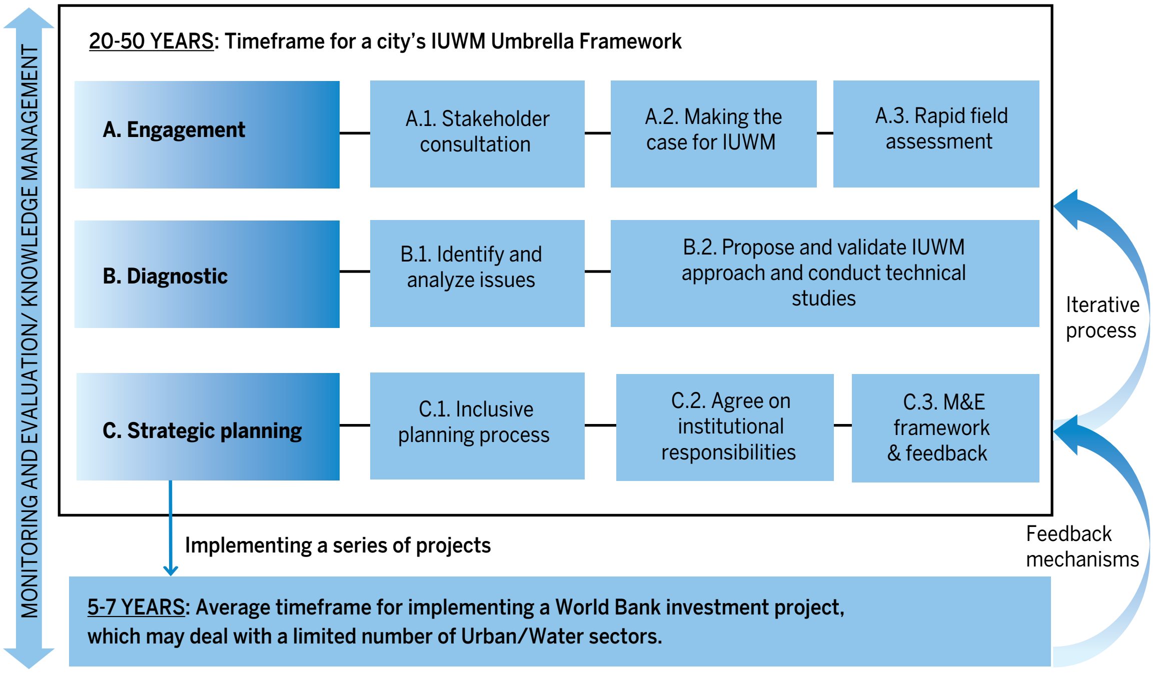
[2] http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/LACEXT/0,,contentMDK:22358351~pagePK:146736~piPK:146830~theSitePK:258554,00.html.

1.2.4 An enabling environment for IUWM

As outlined in Section 1.2.2, IUWM is a mindset that requires sustained, multisectoral coordination across a number of urban and water-related services as well as the participation of all stakeholders in the decision-making process for improved urban and water services delivery. As will be described in the following section, projects that apply the principles of IUWM do not need to deal with all of them at once, or engage with all of the relevant municipal sectors (some of which are identified in Figure 1). Rather, they should ultimately fit within an umbrella framework (Figure 2), which has been worked out and agreed with all relevant urban- and water-related stakeholders, and which is used to prioritize urban and water investments. This approach will ensure that all interventions or projects, however limited in scope, fit into an integrated approach with clearly defined objectives and outcomes, which can be monitored and reviewed regularly by city decision makers.

IUWM is not a particular framework or methodology that can or should be applied to all cities indiscriminately. For a city to benefit from an IUWM approach, it should normally (i) face multiple water-related challenges that can be solved through an integrated approach (e.g., water scarcity, flooding issues, drainage and/or pollution issues, etc.) and (ii) have strong governance and institutional capacity, and the necessary leadership, to drive the process forward (Jacobsen 2012). In this context, two crucial factors should be borne in mind. First, the linking of planning aspects across urban sectors and spatial scales while involving all relevant stakeholders is only feasible in institutional settings

Figure 2. Differentiating Roles and Timeframes of an IUWM Umbrella Framework from Projects



Note: The implementation timeframe of the IUWM umbrella engagement is long-term and inclusive of all relevant urban/water sector activities, while that of the project is short-term, with a more limited objective.

with relatively high capacity. Second, serious water-related challenges, such as water scarcity, flooding, or water pollution issues, provide an entry point or a "driver" for IUWM approaches to be considered by urban decision makers.

An IUWM approach is most effective if several of the issues identified are associated with water quality and quantity. As its implementation is usually lengthier than a traditional (i.e., single-sector) approach, it is best put to use in cases where a single solution is not possible. For instance, multiple water-related drivers propelled the adoption of an IUWM framework in Windhoek and in Buenos Aires, although they differed in nature; and, in practice, the enforcement of an IUWM approach was often (though not always) underpinned by regulatory, political, or legal drivers (Box 4).

An integrated approach also requires cooperation on, and coordination of, urban and water activities beyond the traditional boundaries of the city: this may encompass multiple jurisdictions of local governments over which the urban area is spread, as well as local or regional administrations in which upstream and downstream users are located. The IUWM approach calls for a change not only in terms of *how* urban water is managed, but also in terms of *who* manages it—the issues to be managed in the urban water cycle go beyond water services provision and the utility responsible for those services.

Key messages

Interventions that are based on an IUWM approach are found to work best in an institutional setting that already is, or that can be moved towards being:

- *Administratively vertically integrated*—that is, that involves the state, local, and municipal governments in the metropolitan region, as well as river basin authorities—given their different purviews regarding the necessary interventions;

Box 4 ■ Range of Drivers for Adopting IUWM As a Water Management Framework

Legal and water quality drivers: In Buenos Aires, the Supreme Court of Argentina ruled that authorities were responsible for controlling the environmental degradation of the Matanza Riachuelo River, and ordered an accelerated action program for the cleanup of the river, which provided an entry point for an IUWM approach supported by the Bank.

Water quality regulation and political drivers: Rotterdam turned to an IUWM framework as a means of complying with more stringent national and EU regulation for water quality, but also as a result of a strong political push at the municipal level to turn Rotterdam into a model "water city" and make it more attractive to potential residents.

Scarcity of water resources and governance drivers: Windhoek and Melbourne both took an integrated approach to dealing with water resources scarcity. In Melbourne, the water resources scarcity issue only arose in recent years, due to strong demographic growth, climate variability, and related extreme events; while in Windhoek, an integrated approach to water supply has been in place for half a century due to the arid climate. In both cases, municipal governance structures helped with the implementation of an integrated approach: Melbourne has the institutional and governance structure to veto development in areas of flood risks; and Windhoek has the authority to extend its municipal territory to prevent development in areas where aquifer recharge takes place.

Sources: (World Bank 2012, City of Melbourne 2009, City of Rotterdam 2007, Trepper 2012).

- *Sectorally horizontally integrated*—that is, that encompasses the basic key urban services (water supply, sewerage, drainage, wastewater treatment, solid waste management, and slum upgrading) as well as water resources (both groundwater and surface water, in quantity and in quality) and land use planning (ecological zoning, creation of green spaces, protected areas, public spaces, etc.);
- Backed by sustained *analytical work, data, and information* on the provision of urban and water services and hydrologic regimes, to help inform decision making and monitoring; and
- Underpinned by *strong governance and clear institutional mandates and capacity,* both in the urban and the water sector.

City Profiles

This chapter showcases cities in which an IUWM approach is being applied, to provide a reference point for Task Team Leaders looking for more context or examples of what has been done elsewhere. It also provides an illustration of the type of IUWM approaches that have been implemented in four reference cities:

- The water-scarce city, where water resource constraints have traditionally been the main driver for an IUWM approach (e.g., Windhoek, Namibia, with 322,500 residents)
- The city of extreme events, where resilience and adaptation to climate extremes are the main drivers for an IUWM approach (e.g., Melbourne, Australia, with 4.3 million residents)
- The coastal, flood-prone city, where managing water pollution and environmental health are the main drivers for an IUWM approach (e.g., Rotterdam, the Netherlands, with 625,000 residents)
- The case of the Bank's engagement under an IUWM approach in a fast-growing, developing city (Vitória, Brazil, with 1.7 million residents).

2.1 The water-scarce city: Windhoek, Namibia

Namibia is the most arid country in Sub-Saharan Africa, with a generally hot and dry climate, marked by sparse and erratic rainfall. The country has perennial rivers only on its very northern and very southern borders, respectively 750 and 900 km from the capital, Windhoek, which lies in the country's geographical center. In Windhoek, the average minimum and maximum temperatures range respectively from 6°C to 20°C in July (winter) to 17°C to 29°C in January (summer), the average annual rainfall is 360 mm, and average annual evaporation is 3400 mm (Lahnsteiner 2007).

2.1.1 Diagnostic

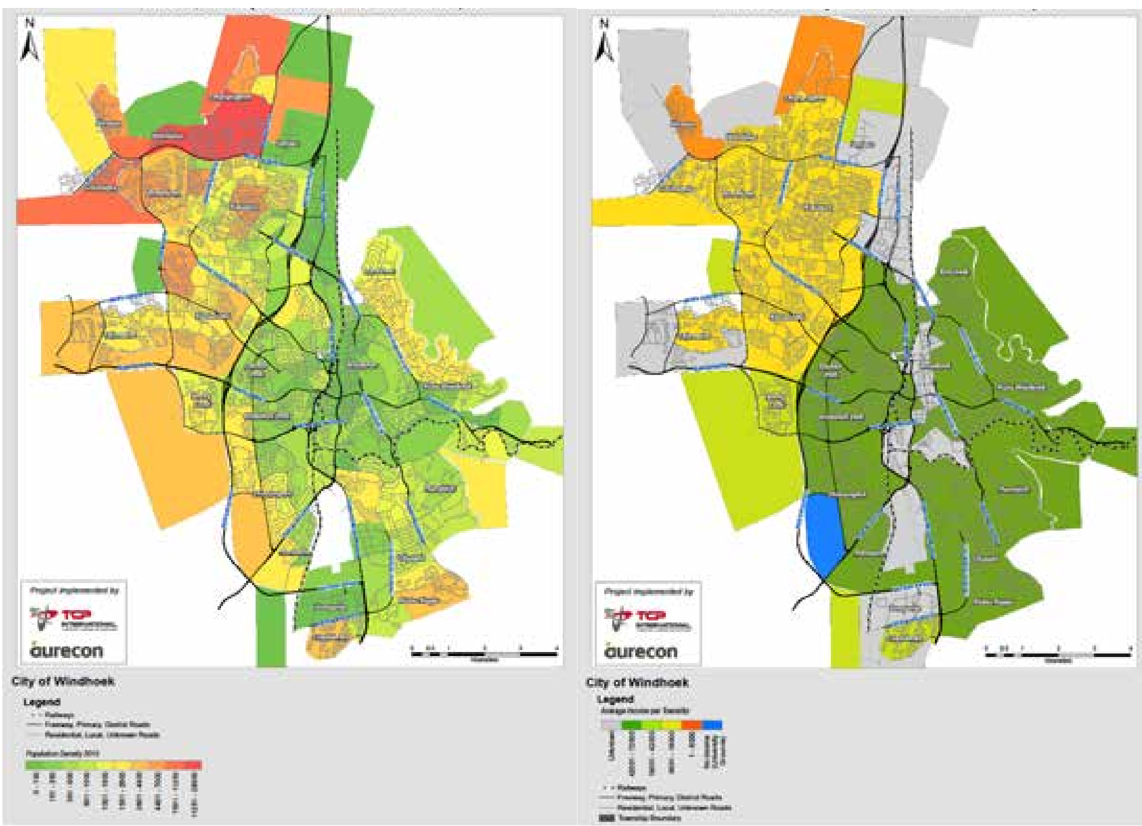
Windhoek has seen a major increase in population, with the number of residents increasing from 190,000 in 1990 to 350,000 today, and a current population growth rate of 5 percent per year. The city is governed by a municipal Council, which officially extended Windhoek's boundaries in 2011 to accommodate the vast number of people coming to the capital city and to regulate construction by developers of private residential areas outside the city's boundaries. Aside from a severe housing crisis that has pushed up house prices by more than 80 percent over the past five years and pushed out low-income earners to informal, densely populated townships, Windhoek faces WSS service delivery challenges, particularly to the informal settlements located on the outskirts of the city. Figure 3 clearly shows that the city's high-density areas correspond to the low-income townships. It is estimated that about 70 percent of Windhoek's residents have access to water supply. For those who are connected to the network, water supply is continuous and of good quality.

Extreme weather events have had devastating impacts on communities, infrastructure, and land in Namibia, including in Windhoek. Namibia experienced an unprecedented drought in 2013, which left the agricultural sector extremely vulnerable and threatened food security. The residents of Windhoek also experienced major losses from flash floods in the past decade, particularly in 2004 and 2009 when ephemeral rivers flooded, damaging residential areas and leaving many people homeless, particularly those living in the most vulnerable, informal settlements. As climate is highly variable in Namibia, it is difficult to detect and predict climate trends, though projections indicate an increased frequency of hot days, heat waves, and droughts (Republic of Namibia 2010).

2.1.2 Response and IUWM Framework

These climatic factors have forced the City of Windhoek to take the lead and invest in innovative methods to ensure water security. Windhoek is probably the leading pioneer in integrating the

Figure 3. Schematic of Windhoek's Urban Area



Source: (City of Windhoek 2013).
Note: High-density areas are shown in red and orange on the left; they match low-income townships on the right (in orange and yellow).

use of different water resources since the 1960s, long before the term IUWM had been coined. The City Council of Windhoek has championed this approach and in 1994 approved an integrated water demand management program that included policy matters, legislation, and education, as well as technical and financial measures (Lahnsteiner 2007).

Windhoek's IUWM response is based on the following principles:

- **Recognizing the value of alternative water sources** by increasing the share of aquifer management and wastewater recycling in water supply;
- **Differentiating the qualities and potential uses of water sources** with the use of '*fit-for-purpose*' water;
- **Protecting, conserving, and using water at its source** by managing water demand from residential and irrigation customers;
- **Encouraging participation** by all stakeholders.

Windhoek has historically depended on groundwater, which still remains a major source for drinking water supply; however, by 1957, the aquifer was overexploited. Between 1973 and 1990, the government built three surface reservoirs on ephemeral rivers, between 70 and 200 km from Windhoek. In the early 1960s, the possibility of reclaiming treated sewage effluent for potable purposes was explored, which led to the construction and conversion of the Goreangab Reclamation Plant. In 1968, the treatment plant was converted into the first commercial-scale direct potable reclamation plant, capable of supplying between 10 and 15 percent of the city's daily demand. In 2002, the facility was upgraded and currently it is managed under a PSP contract; the New Goreangab Reclamation Plant was completed with a capacity of 21,000m³ per day, and can supply up to 35 percent of the city's average daily demand. The plant is operated and maintained under a 20-year operation and maintenance (O&M) contract between the city of Windhoek and a consortium of three major international water treatment contractors.

In addition, this water infrastructure was supported by other structural and nonstructural measures (Trepper 2012):

- In partnership with the bulk water provider NamWater, the city recently started to artificially recharge the Windhoek aquifer with a blend of surface water and recycled water. This enables the city to store sufficient water underground for up to two year's water demand. This also has the added benefit of reducing evaporation from the surface reservoirs, thereby making the city more resilient to long periods of drought.
- In 1993, a dual pipe system (total length 75 km, compared with approximately 1,800 km of water network) was introduced to supply municipal parks, landscaping, and sports fields with semipurified sewage effluent. This replaced about 6 percent of potable water supply with filtered sewage effluent
- In 1994, the city introduced a comprehensive water management strategy, which included the following elements: (i) permanent raise of block tariffs for all domestic users; (ii) mandatory covering of all private swimming pools, to curb evaporation; (iii) prescribing water efficient plumbing devices; (iv) introduction of watering bans when necessary; and (v) limiting water use for irrigation during certain hours.
- Furthermore, the city has introduced very strict urban planning measures aimed at protecting and conserving water resources first and foremost. Water-intensive industries are not promoted and not even permitted in areas crucial for groundwater recharge. The city has also proclaimed the recharge area of

the aquifer a conservation zone, thereby forfeiting large areas of developable residential land. To protect its aquifer, Windhoek plans to dramatically expand the city boundaries so that the town area will cover 5,000 km². This will make Windhoek the third largest city in the world by area, after Tianjin and Istambul, although the population density is only 63 inhabitants per km².

- A public awareness campaign around the use of recycled water was launched, which also targeted the education curriculum.

2.1.3 Lessons Learned

Efforts to introduce wastewater recycling for direct potable water supply have failed in many cities because of the perception that reclaiming drinking water from municipal effluent is generally unacceptable to the public. However, the experience in Windhoek showed that with persistent, well-designed, and targeted communication to the public, this perception can be changed. The people of Windhoek generally take pride in the fact that they are one of only a few cities in the world where direct potable water reuse is practiced. Furthermore, there is evidence to show that this is indeed a safe practice: in 40 years of recycling water for drinking water supply, the city has not had a single outbreak of waterborne disease linked to this practice.

The experience of Windhoek also proves that an IUWM framework is not incompatible with a city in a developing country context—quite the opposite, since Windhoek was actually one of the first cities to apply IUWM principles, before the term had even been coined.

2.2 The City of Extreme Events: Melbourne, Australia

Melbourne is the capital of the state of Victoria and the second most populous city in Australia.

2.2.1 Diagnostic

The Melbourne metropolitan area covers 7,694 km² (about the same area as the greater London area, or Los Angeles) and currently has a population of about 4.3 million. The Greater Melbourne area is undergoing unprecedented population growth, with the inner City of Melbourne (the business district, with a population of just over 127,000 residents) registering a growth rate of 10.5 percent in 2012–13. This trend is expected to continue over the next two decades as Melbourne is set to become Australia's most populous city by 2050 (City of Melbourne 2009). The Greater Melbourne area is spread over 31 municipalities and characterized by a large urban footprint and a low population density (430 residents per km²).

Melbourne Water, the main water authority, manages the Greater Melbourne's water supply watersheds, sewerage, rivers, and major drainage systems. Residential water supply services are provided by three major "retail" utilities, while Melbourne Water acts as a "wholesaler" water utility: it abstracts, treats, and transfers water to retail water utilities for further sale to residential customers, but remains a direct provider of sanitation services, removing and treating all of Melbourne's sewage. Melbourne Water's customers include the three major retail authorities (City West Water, South East Water, and Yarra Valley Water) as well as other water authorities, local councils, irrigators, and the land development industry. Melbourne Water is also responsible for protecting water resources, managing flood risks, and planning for water resources sustainability. It is owned by the State of Victoria and governed by an independent Board of Directors in conjunction with the Minister for Water.

Between 1997 and 2009, the State of Victoria experienced 13 consecutive years of drought (now known as the Millennium Drought), resulting in conditions below the threshold within which the water supply infrastructure and regulation were designed to operate (Li 2012) (Figure 4).

With the summer of 2012–2013 (including the hottest summer, hottest month and hottest day on record) having been linked to climate change in Australia (Herring 2014), climate adaptation is now a priority for the City of Melbourne. In its 2009 Climate Change Adaptation Strategy (City of Melbourne 2009), Melbourne identified the following priority climate risks, which have the potential to threaten the future of Melbourne and its economic attractiveness:

- Reduced rainfall and drought;
- Extreme heat waves and bushfire;
- Intense rainfall and wind storms; and
- Sea level rise.

2.2.2 Response and IUWM Framework

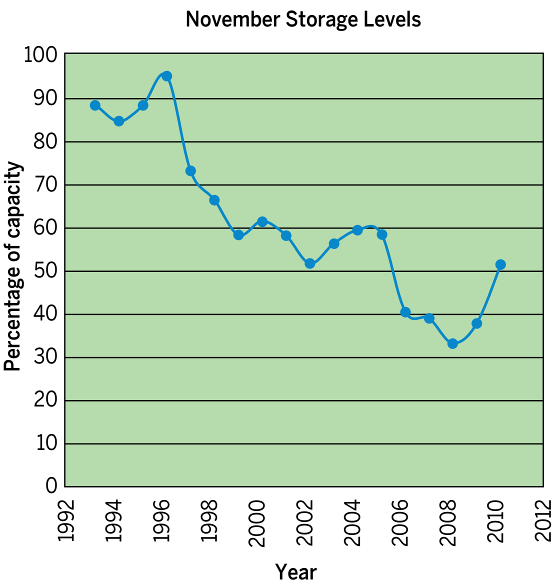
The adaptation response to these climate risks was largely driven by Melbourne Water, who championed an IUWM response in the midst of the Millennium Drought in Australia. Until then, water resource planners had not considered resilience an issue, as Melbourne's drinking water supply is provided by seven reservoirs, mostly in protected watersheds, which had been expected to guarantee high-quality and reliable drinking water and low-energy service thanks to gravity-fed water supply. Water resources planning had been based on historical trends; if Melbourne needed more water, the approach was to increase surface water storage capacity.

There was, however, little resilience to cope with the impacts of climate change on the water system and, by 2004–05, the shortage of storage water due to low rainfall, exacerbated by fire hazards in the forested catchment areas, started posing a major threat to the sustainability of water supply for the city.

The IUWM approach chosen by Melbourne was based on the following principles:

- **Recognizing the value of alternative water sources** by increasing the share of stormwater harvesting, aquifer management, wastewater recycling, and desalination for water supply;
- **Differentiating the qualities and potential uses of water resources** to introduce resilience in the water system with the use of fit-for-purpose water;
- **Viewing water storage, distribution, treatment, recycling, and disposal** as part of the same resource management cycle;
- **Protecting, conserving, and using water at its sources** by managing water demand from residential and irrigation customers;
- **Accounting for nonurban users** that are dependent on the same water source within the wider watershed, including the needs of the environment;
- **Encouraging participation** by all stakeholders.

Figure 4. Percentage of Melbourne Total Reservoir Storage Level, 1993–2010



Source: (Li 2012).

This approach was supported by a number of structural and nonstructural measures (Melbourne Water 2013):

- The construction/upgrade of two wastewater recycling plants in Melbourne, which supplied around 32 gigaliters of recycled water to irrigators, the tourism industry, municipal and environmental services, and to a small but growing number of residential developments equipped with dual piped schemes (where recycled water is used for toilet flushing, garden watering, streetscape, and open space irrigation). This recycled water is delivered via so-called "purple pipes" to ensure adequate use by the public and social acceptance of the use of reclaimed water.
- The construction of a large desalination plant (with a capacity of 150 gigaliters per year) to provide additional capacity in times of low storage levels, for which a Build-Operate-Transfer (BOT) contract was awarded in 2009 to a consortium led by Suez.
- The upgrade and reform of the irrigation district north of Melbourne, which brought annual savings of about 225 gigaliters—made available for increased environmental flows and irrigation, as well as for increased water supply storage for the city of Melbourne. All of this required a major expansion of the water distribution system to connect Melbourne's water system with the desalination plant and Northern irrigation upgrades.
- Managing aquifer recharge for the capture and use of treated stormwater or recycled water for later recovery and use, or for environmental benefit. Water deposits are made in times of surplus—commonly in winter—and extraction occurs during peak demand in summer, when traditional supplies struggle to meet demand. Multiyear balancing is also possible for long-term storage.
- Licensing stormwater harvesting in some watersheds. There are currently 32 active stormwater licences issued by Melbourne Water, mainly to councils and sports clubs, totaling 1.4 megaliters of water supply.
- The introduction of a planning amendment in a pilot watershed, to the effect that developers who increase impervious surface area by more than 10 m^2 have to treat runoff onsite through rainwater tanks, raingardens, or passive drainage, instead of letting flows enter the stormwater system. It has been designed as a two-year pilot to determine if this type of planning control is effective in reducing stormwater flows and improving urban waterway health.
- The introduction of permanent water demand management measures to encourage consumers to use less water through advertising, education, pricing, and appliance redesign.

Melbourne Water's approach includes collaboration with stakeholders, which extends across several dimensions:

- Engaging in long-term planning with stakeholders at the regional and municipal level to address the needs of a growing population and the forecast impacts of climate change and variability.
- Collaborating with the State of Victoria and retail utilities to develop regional integrated water cycle strategies to guide investment in water projects across Melbourne until 2050. These strategies consider the role of recycled water and stormwater harvesting to reduce potable water use and sewage discharges and to reuse urban stormwater. Melbourne Water also seconded an employee to work with one of the retail utilities to facilitate

integration of water management services at that level.

- Empowering communities to take local ownership of IUWM measures.

2.2.3 Lessons learned

Melbourne Water has done much to report and share the lessons learned from the past decade of implementing measures under an IUWM framework in the city. The lessons learned so far from this implementation experience (Melbourne Water 2013) are the following:

- It is of key importance to be flexible and outcome-focused by **adopting different approaches for different areas of Melbourne** so as to match local drivers and ensure the cost effectiveness of the proposed measures, as well as their affordability.
- It is crucial to **engage with the community** throughout the process of developing and implementing measures under an IUWM framework.
- There are risks and associated costs for the municipality or utility when shifting from input-based solutions to an outcomes-based mindset under an IUWM framework, as the increased complexity of the system requires a different skillset. In particular, the shift within utilities **from managing *assets* to managing *behavior* required new skills** and thus faced considerable resistance within the sector when first introduced.

With regard to the adoption of particular measures, Melbourne Water highlights the following challenges:

- Although Melbourne Water's capacity to supply recycled water is unaffected by weather and seasons, demand remains lower in wet years and higher in dry years, as the majority of customers are irrigators. This suggests the need to **diversify the customer base for recycled water** to ensure cost recovery and understand the changes in customer demand, depending on the availability of water resources.
- Similarly, it is particularly challenging to promote the integration of all sources of water to diversify supply and fit-for-purpose water supply in times of high rainfall.
- **Sharing the costs and benefits of integrated water cycle management projects across organizations remains challenging**, which has led Melbourne Water to consider developing a framework to clarify cost- and benefit-sharing.
- **Stormwater harvesting for domestic use had to be abandoned at some sites** as it turned out *not* to be the most cost-efficient option when the *full* range of costs and benefits were taken into account.
- Keeping pace with high demand while adopting an IUWM approach in areas of high demographic growth remains challenging.

2.3 The coastal city: Rotterdam, the Netherlands

Rotterdam is the second largest city in the Netherlands and home to Europe's main port. The city of Rotterdam has a population of 620,000 and is governed by a municipal council. Rotterdam is part of one of the densest and most populated urban areas in Europe, the Randstad, which comprises the four largest Dutch cities (Amsterdam, Rotterdam, The Hague, and Utrecht) and has over 7 million residents.

2.3.1 Diagnostic

Rotterdam is located in the delta of the rivers Rhine and Meuse. Because of its location, Rotterdam has had to adapt to the surrounding water for centuries; in fact, the city derives its name from the river Rotte, which it had to manage for survival. The water in Rotterdam comes from four sides: from the sea, from the river that flows through Rotterdam, as well as from above and below, in the form of precipitation and a high water table. Roughly a third of the municipality of Rotterdam, which covers 320 km², is made up of water.

Rotterdam has open waterways to the sea and is influenced by the tide. An ingenious system of dikes and barriers has kept the city safe from sea storms and floods for centuries. The city also has a system of canals, lakes, waterways, sewers, and pumping stations run by Rotterdam's Water Boards to regulate the water levels in the area protected by the dikes, which is well below sea level. The Water Boards are regional government bodies charged with managing water defenses and water bodies, as well as water quality and sewage treatment. A Water Board's territory is usually made up of one or more watersheds, and generally covers several municipalities. Water Boards hold elections, levy taxes, and function independently from other government bodies. Their executive board traditionally represents five types of water users: local residents, industry, municipalities, farmers, and public parks; the chair is appointed by the government for a period of six years.

Much of Rotterdam, including the main port, lies in outer-dike areas. If the region were to flood, the consequences for its residents and the city's economy would be disastrous. The city has already noticed the intensification of extreme events, which have also become more common in recent decades. Rotterdam has identified the following climate risks:

- Rise in sea levels
- Change in river discharges
- Longer hot and dry periods
- More intensive rainfall

Unlike Melbourne or Windhoek, high population growth is not a driver for the shift to an IUWM framework. The city is actually experiencing a stagnation of population due to the attrition of residents of working age. To a large extent, people leave because they cannot find the home of their choice in their preferred residential environment in the city. This is an important factor, which has made Rotterdam conscious of the need to offer its dynamic workforce a more attractive environment; Rotterdam is consequently actively seeking to improve its image by reinventing itself as a "water city of the future" (Mackenzie 2010). Rotterdam actually submitted its approach, incorporating water and spatial development for development, as an entry for the second International Architecture Biennale (under the name *Rotterdam Water City 2035*).

2.3.2 Response and IUWM framework

The adaptation response to these risks was driven by (i) the need for Rotterdam to comply with regional, national, and EU regulations on water management (particularly with the EU Water Framework Directive (WFD)) and (ii) the political will to tackle the issues of climate adaptation by incorporating them into the city's approach to urban planning.

The city presented its overall IUWM framework in its *Waterplan 2 (City of Rotterdam 2007),* which was the product of collaboration between the Municipality of Rotterdam (the Public Works Department, the Town Planning and Housing Department, and the Rotterdam Development Corporation) and the city's Water Boards. *Waterplan 2* also complements the *Rotterdam City Vision 2030* and aims to tackle the following issues:

- The effects of climate change on the city's water resources.
- Existing and new legislation and regulations on water quality and WRM (including the EU WFD

and the *National Policy on Water Management for the 21st Century*) and safety requirements for flood protection infrastructure.

These regulations require that Rotterdam's water system comply with new water quality standards by 2015, and that climate adaptation measures be in place by 2050. The implementation of the WFD is the joint responsibility of all water management authorities in the Netherlands. The IUWM approach chosen by Rotterdam focused on the outcome of meeting these ecological standards, and is based on the following principles:

- **Recognizing the value of alternative water sources and promoting the use of '*fit-for-purpose*' water sources** by separating clean rainwater—for recreational and environmental purposes—from the wastewater stream.
- **Viewing water storage, distribution, treatment, recycling, and disposal** as part of the same resource management cycle, through innovative water storage ideas, such as water plazas and multifunctional parking lots.
- **Encouraging participation by all stakeholders**, through extensive consultation as well as the innovative "*Paving out, Plants in*" campaign, through which the City of Rotterdam hopes to involve its residents in climate change adaptation and encourage them to replace paving in their yards with plants and vegetation.
- **Pursuing economic efficiency, social equity, and environmental sustainability** by improving the livability and environment for all residents.

The *Waterplan 2* emphasizes the need to provide for rainwater collection and storage. There is currently already a shortage of about 600,000 m³ of storage of water to cope with projected rainfall; the need for additional storage will become more pressing as climate change is expected to increase the intensity of rainfall. It is estimated that at least 80 hectares of open water bodies will be needed to address this shortage.

As space is limited in the city center, the focus is on alternative ways of retaining and harvesting rainwater, including the following innovative ideas:

- The city is studying possible locations for the construction of water plazas, which will fill up in a controlled manner during heavy rainfall and prevent the streets from flooding. In dry periods, these water plazas can be used as open public spaces for recreation. Rainwater will remain in the water square until it can be discharged into the nearest water body; in periods of drought and low river levels, the rainwater thus stored can also be used to "flush" water bodies and improve water quality. The Benthemplein is being developed into a large, multifunctional water square, which combines the collection of rainwater with a special, public outdoor area. A considerable number of stakeholders from the Benthemplein—including colleges, a church community, a youth theater, a sports school, and local residents—worked closely together to produce the final design.
- Another innovative idea is to build multifunctional parking garages, such as the new Museumpark garage in Rotterdam, which are equipped with an underground water storage facility. Whenever heavy rains threaten to cause the sewerage system in the center to overflow, within 30 minutes, 10 million liters of rainwater can be stored underneath the parking garage for further use, including later discharge into water bodies for ecological purposes in times of low river flow. Rotterdam is deploying projects like these to increase the storage capacity of the existing sewerage system and reduce

the stress on the current sewerage system, while also preventing wastewater from overflowing into open water bodies.

- The city of Rotterdam also promotes the installation of green roofs, which can act as a "sponge" and retain rainwater. It is mandatory for municipal properties, for example, to have a green roof. The installation of green roofs on third-party buildings, such as libraries and hospitals, is also encouraged. In 2008 and 2009, these efforts resulted in the installation of green roofs on the Municipal Archives, the Central Library, the docks, and Sophia Children's Hospital. The City of Rotterdam has also put in place a subsidy scheme where €30 is given for every square meter of green roof installed on privately owned buildings. As of 2015, Rotterdam had over 220,000 m^2 of green roofs.
- In 2012, work began on the construction of the Blue Corridor—a recreational, navigable route that provides clean water to the area, acts as a water storage facility, and forms an ecological link between a number of public parks. The route will significantly improve many aspects of the local environment. The project will take 10 years to complete and is divided into six subprojects. The scale of the project means that it can be especially effective in making the water system resilient to long periods of drought.

Additional structural and nonstructural measures included under the IUWM framework are the following:

- Safety projects: reinforcing flood defenses to protect against sea storms and expected sea level rise (as projected for 2050 and 2100) and to comply with new safety regulations.
- Projects to improve water quality: using stored rainwater to manage urban water quality and saline intrusion in groundwater, in particular during periods of droughts, which can lead to low river levels. The latter can favor saline seepage (as was the case during the dry summers of 2003 and 2006) and drying out of the peat soil, which poses a risk to wooden pile foundations and to peat dikes, and threatens the fauna and flora.
- Limiting development on the outskirts of Rotterdam to focus on improving the inner city area.

2.3.3 Lessons learned

The implementation of IUWM measures in Rotterdam is in line with the timeline of the regional, national, and EU regulations, which aim to improve water quality by 2015 and climate-proof WRM by 2015. Rotterdam has chosen to take a pragmatic approach to implementing structural measures under an IUWM framework by targeting specific areas, as each solution needs to be tailored to the water and urban condition of each area. This also aims to ensure economic efficiency: current water and wastewater assets should not be replaced until their lifecycle is over. IUWM measures should focus on the creation of added value through intelligent choices, such as the links to construction and development projects in the city (e.g., the Museumpark parking garage, which can be converted for water storage).

The city of Rotterdam has estimated that the total cost of these measures would add up to €400–500 million until 2030; it has developed a cost-sharing framework, whereby (i) accountability for a particular service or area determines the task owner, and (ii) the task owner pays for the project. The state, the province, the EU, and the private sector have all been called upon to provide financial support as well—an approach that has worked so far. Rotterdam should also be credited for getting many of its residents involved in the design and implementation of several of these projects (*City of Rotterdam 2007*).

2.4 WB Engagement under an IUWM approach: Vitória, Brazil

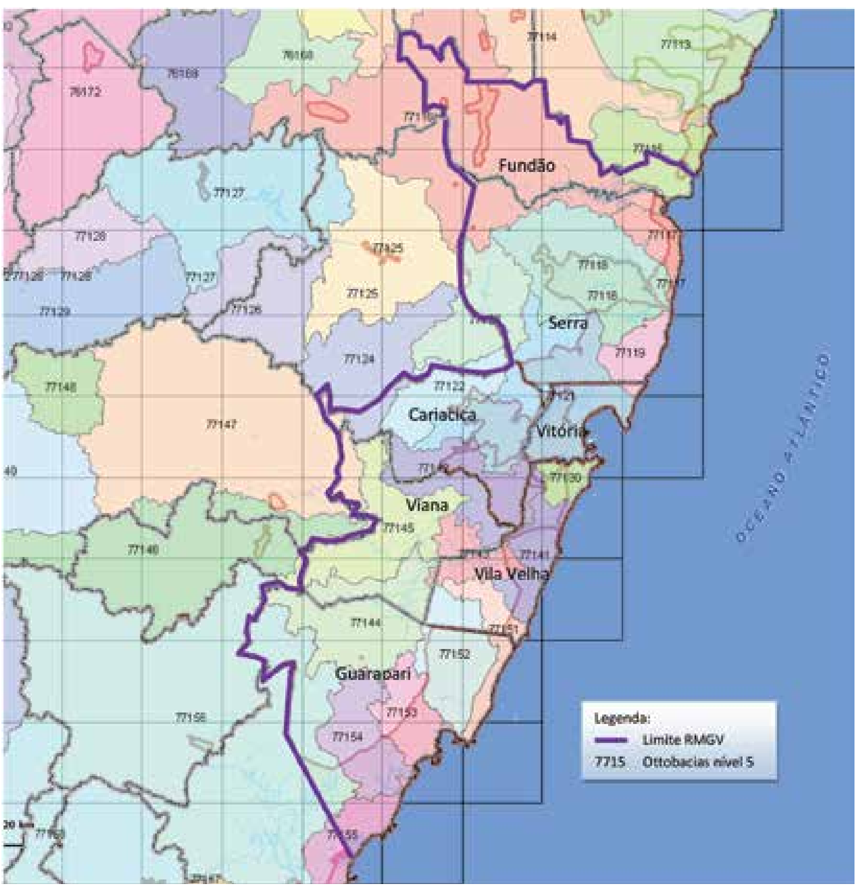
Vitória is the capital of the state of Espírito Santo in Brazil's Southeast region, and is located in a delta on the coast; the city has a population of 350,000 residents. The Greater Vitória Metropolitan Region (GVMR, Figure 5)—comprising the municipalities of Vitória, Cariacica, Fundão, Guarapari, Serra, Viana, and Vila Velha—holds close to half of the state's 3.5 million residents.

2.4.1 Diagnostic

Between 2000 and 2010, the GVMR's population increased rapidly, its density increasing from 620 inhabitants per km² in 2000 to 728 in 2010.

The rapid urbanization process in the GVMR has been largely unplanned. Urban population growth has increased pressure on the state to provide adequate access to WSS services and to ensure the quality of water resources serving the city, which are threatened by high levels of erosion and by insufficient coverage of sewage collection and treatment, particularly in the catchment areas upstream of the GVMR (World Bank 2014). Extensive environmental degradation over the past 50 years has put additional stress on the quantity and quality of water resources: the loss of forest coverage has led to the reduction in groundwater recharge and increased the velocity and quality of surface runoff. Land use patterns upstream of the GVMR have resulted in severe

Figure 5. The Greater Vitória Metropolitan Area and its Municipalities



Source: (State of Espirito Santo 2011).
Note: The purple lines represent the boundary of the GVMR.

erosion, substantially increasing sediment loads and reducing the quality and delivery of water supplies to the residents of the city (World Bank 2014). The quality of water resources in the watershed is of vital importance not only for drinking water supply in the GVMR but also for hydroelectric power generation.

The state of Espírito Santo has also experienced an increased intensity and frequency of extreme events in recent years (World Bank 2014). Of a total of 376 extreme events in the past decade, 276 were related to flash floods and landslides, and 69 to droughts, exacerbating water scarcity in some of the state's municipalities. In 2013, heavy rainfall resulted in the worst floods to hit Espírito Santo in 90 years, causing more than 20 deaths and displacing 70,000 people. Since early 2015, the state has been coping with its worst drought in 40 years. These extreme events have accentuated the conflicts between different water users in the watershed.

The state water and sanitation company, CESAN, is a public WSS service provider, established in the late 1960s, with the mandate to provide WSS services in the state of Espírito Santo. CESAN is mostly owned by the state of Espírito Santo and is a service provider in 52 of the state's 78 municipalities, including all 7 municipalities in the GVMR. While sewerage coverage in Vitória, under the management of CESAN, has increased from 20 to 60 percent between 2004 and 2012, municipalities upstream of the GMVR have inadequate wastewater collection and treatment services and, as a consequence, environmental degradation continues to affect the quality of the water downstream as well as that of coastal areas (World Bank 2014). The technical agency responsible for water quality planning and control in the state of Espírito Santo is the *Secretaria de Estado do Meio Ambiente e Recursos Hídricos* (SEAMA, the State Secretariat for the Environment and Water Resources) and its subordinate, the State Environmental Institute (IAMA). SEAMA's functions include the enforcement of environmental regulations, the inventory of pollution discharges, the licensing of new industries, and monitoring the water quality of state rivers.

2.4.2 WB engagement

The Bank's partnership with the state of Espírito Santo and CESAN has been particularly strong since the mid-1990s. When the latest Bank-supported project is due to close, in 2021, the World Bank will have invested close to US$377 million over 27 years in CESAN, which has been transformed from an underperforming public utility into one of the most advanced utilities in the country.

When the Bank initiated its engagement with CESAN in the 1990s, urban water supply coverage was already quite high in the state (at 87 percent), despite the rapid urbanization and relatively high urban growth rate of the previous decades. However, less than 11 percent of the urban population of the state was connected to a sewerage network, and less than 9 percent of total collected wastewater was being treated. These low figures degraded the water quality of raw water sources and resulted in widespread coastal pollution, with significant health and economic repercussions. The key challenges CESAN faced at the time also included operational and commercial inefficiencies, which resulted in financial difficulties for the service provider, as well as poor governance and customer services.

The Bank has been active in Espírito Santo's water sector for the past two decades through four successive operations (Table 1).

The Bank's engagement, through the Espírito Santo Water and Coastal Pollution Management Projects "*Projeto Aguas Limpas I* and *II*" (columns (1) and (2) in Table 1), initially sought to achieve triple objectives in water and sanitation:

Table 1. World Bank Engagement with State of Espírito Santo in the Water Sector

Project name	(1) Espírito Santo Water and Coastal Pollution Management Project "Projeto Aguas Limpas"	(2) Espírito Santo Water and Coastal Pollution Management "Projeto Aguas Limpas II" (AF)	(3)EspíritoSanto Biodiversity and Watershed Conservation and Restoration Project	(4) Espírito SantoIntegrated Sustainable Water Management Project
Date approved	06/28/1994	07/01/2004	11/18/2008	02/26/2014
Date closed	06/30/2003	09/30/2011	12/31/2015	04/30/2021
Project ID	P006522	P087711	P094233	P130682
Project cost (Million US$)	182.9	107.5	12	323
Bank Loan (Million US$)	112.5	36	4	225
Instrument	SIL	SIL	SIL	SIL

Note: AF = Additional Financing. SIL = Specific Investment Loan. Projeto Aguas Limpas = Clean Waters Project.

Table 2. Focus Areas of World Bank Cooperation with Espírito Santo in GMVR (1994–2021)

	(1) "Projeto Aguas Limpas"	(2) "Projeto Aguas Limpas II" (AF)	(3) ES Biodiversity and Watersehd Project	(4) ES Integrated Sustainable Water Management Project
Integration within the water sector				
Access to WS	✓	✓		
Access to SS	✓	✓		✓
Reliability of WSS services	✓	✓		✓
Affordability of WSS services	✓	✓		
Efficiency (incl. NRW reduction)	✓	✓		✓
Financial sustainability	✓	✓		✓
Environmental Sustainability of WSS services		✓	✓	✓
Customer orientation		✓		
WSS sector reform		✓		
Integration with other sectors in the watershed and the city				
Agriculture			✓	✓
Land use			✓	✓
Environment and natural resources		✓	✓	✓
Health	✓	✓	✓	✓

Note: WS = Water Supply; SS = Sanitation Services; WSS = Water Supply and Sanitation; NRW = Non-Revenue Water; AF = Additional Financing; ES = Espírito Santo.

(i) environmental quality for residents in low-income areas; (ii) environmental quality for surface water; and (iii) improved efficiency of the utility.

The Bank's engagement gradually moved from WSS access provision to improving the environmental sustainability of services and integrating WRM into other related sectors. Table 2 outlines the evolution of the Bank's engagement with Espírito Santo.

2.4.3 Response and IUWM framework

The response to these risks through the aforementioned projects was driven by: (i) the political window of opportunity provided at the federal and state levels for improving water and environmental resources management;[3] (ii) improved governance mechanisms, which made the state and the WSS utility more accountable to the public; and (iii) extreme events, in particular flash floods and droughts, which affected many municipalities in the state.

The IUWM approach followed by Espírito Santo was based on the following principles:

- **Taking into account the non-urban users who are dependent on the same water source within the wider catchment**, including farmers and hydroelectric power plants;
- **Pursuing economic efficiency, social equity, and environmental sustainability** through the promotion of sewerage connections in low-income areas to improve environmental health;
- **Seeking to protect, conserve, and use surface water and groundwater**—both in quality and quantity—at its source, through an innovative '*Payment for Environmental Services*' scheme as well as through 'upstream pollution and downstream impact' decision making analyses;
- **Encouraging participation by all stakeholders**.
- **Recognizing the relationships between water resources, water quality and other sectors**, in particular land use and agriculture.

Integration of sectors and issues around an IUWM framework was incremental in Espírito Santo and in the GMVR, and is still a work in progress. While the first project initially aimed at improving traditional WSS services, in later stages of engagement the Bank focused on improving the environmental quality for residents in slums and low-income areas, and on restoring the quality of surface water through wastewater treatment and sewerage connections through the *Aguas Limpas* projects in the GVMR. The current project (2014–21) continues with this approach in municipalities upstream of the GVMR to improve water quality both locally and downstream in the GVMR; it also aims to improve the coordination between water subsectors at the metropolitan level, particularly the management of stormwater, which relies on drainage master plans developed independently and with little intermunicipal coordination and thus proves problematic when managing land use evolution and flood impacts on the entire metropolitan region. It is worth noting that the GMVR is currently designing its IUWM umbrella framework document; integration until now had been incremental in nature and paved the way for a wider IUWM approach under the present project.

Key to the Bank's approach was to work through several implementing agencies: the WSS utility and the state's environmental agencies. SEAMA and its subordinate, IAMA, initially did not benefit from any of the planned

[3] Brazil passed the Federal Water Resources Law (9433 of 1997), which advocated an Integrated Water Resources Management approach at the basin level; in 2006, Espírito Santo's '*Vision 2025*' plan declared that the state intended to be "*a national reference [...] for the consistent promotion of sustainable development*" (World Bank 2008).

improvement activities proposed under *Aguas Limpas*. Under *Aguas Limpas II* and thereafter, however, the Bank projects targeted SEAMA and IAMA for institutional capacity building and strengthening through the implementation of project activities. Institutional performance in the areas of WRM was improved and, as a result, the number of environmental licenses issued by SEAMA/IAMA increased almost threefold (from 599 in 2003 to 1,628 in 2011), with a peak of 2,111 environmental licenses issued in 2010. SEAMA and IAMA are now both strong champions of an integrated approach to WRM in Espírito Santo.

While the legislative framework for an integrated approach to WRM existed in principle, it only became implemented in practice after the state's environmental institutions had been strengthened. In 1998, State Law 5818 introduced the state's first policy framework specifically meant for the management of water resources. It defined the principles of WRM integrated with other sectors, such as WSS and agriculture, and established the Espírito Santo Integrated Management and Monitoring System for Water Resources. However, the state of Espírito Santo only began implementing the system after improving the institutional governing structure and capacity of the state's Water Basin Committees and of SEAMA.

Agricultural practices upstream of Vitória, combined with climate change and population growth, led to the adoption of innovative approaches, including *Payment for Environmental Services* (PES) and IUWM in the basin. Under the Espírito Santo Biodiversity and Watershed Conservation and Restoration Project, an innovative PES approach[4] provided monetary incentives for farmers upstream of the GVMR to adopt sustainable land use practices in two critical watersheds. The Espírito Santo Integrated Water Management Project scaled up this approach through its support of the broader PES program *Reflorestar*, which was launched in 2012. Espírito Santo was the first state in Brazil to adopt an explicit PES law in 2008. The state has also established a Water Fund (*Fundagua*) to finance PES in the state, partially funded by oil royalties.

Strengthening the demand side of good governance and improving the accountability of public services, combined with a solid communication strategy, were key to the success of these measures. Under *Aguas Limpas*, CESAN still suffered from political interference, which limited the impact of measures designed to improve its governance. Under *Aguas Limpas* II, the institutional strengthening measures targeting CESAN followed a different approach: making the company accountable for results to its customers, improving governance structures, and enhancing the transparency of the WSS sector overall. CESAN now reports every six months on indicators related to the company's operational performance and the quality of its service provision (through its website and in the media). Furthermore, CESAN publishes its results statewide twice a year, to enhance public accountability. In addition, since 2003 CESAN has been tracking the level of its clients' satisfaction regarding the services it provides, through annual opinion surveys in which a representative sample of clients are asked to rate the quality of the services received.

As for the environmental agency IEMA, it monitors water quality and coastal pollution on a weekly basis, through a water quality sampling network in the main hydrographic basins of the state and a coastal pollution sampling network covering 46 beaches along the state coast (totaling 71 sampling locations). The results of this analysis are posted online on a monthly basis in

[4] For more details on the Payment for Environmental Services approach used under these two projects, please refer to Sossai et al. (2012) *Florestas para a Vida* Project in Espírito Santo, Brazil. PES Learning Paper 2012–1, World Bank, Washington, DC.

a user-friendly format to inform the population about water quality at each beach, as measured by the fecal coliform index.

2.4.4 Lessons learned

An integrated approach in a city and its basin, with several sectoral implementing agencies, can be effective at tackling urban poverty and improving WRM without falling into a "*Christmas tree*" project syndrome.[5] As described in IEG's evaluation of *Aguas Limpas*, lessons learned from earlier multisectoral urban projects tended to discourage integration, as "*few [urban] institutions were capable of coordinating many agencies and complicated problems such as incomplete legal instruments, disparities in income of customers, and asymmetrical political power in governance*". The engagement of the World Bank in Espírito Santo and with other Brazilian cities shows that integration can be done, and that it is more effective than a sectoral approach at meeting the combined goals of improving WSS services and improving the quality of life in slums. The *Aguas Limpas II* Project, for instance, highlighted the need to involve the municipal government in the provision of WSS services, as it has the mandate for enforcing sewerage connections.

While the Bank engaged at the state level, the federal government's support for an integrated, basin-wide approach must not be underestimated. Brazil's Federal National Water Agency, ANA, demonstrated an innovative approach by offering cities grants that were proportionate to the reduction of pollutants in certain water bodies. This provision radically changed the behavior of state and local officials: rather than maximizing the costs of treatment plants for which mayors sought financing from federal authorities, mayors were incentivized to minimize pollutants reaching the water bodies in order to access the pollution reduction grants. This led mayors to take an integrated approach to WRM, focused on environmental outcomes rather than on standard processes and approaches.

Finally, and as noted above, the GMVR did not have a formal 'umbrella framework' for IUWM (though it is designing one under the current project), but did have a broad agreement on the definition of the problem and a collaborative working environment that allowed complex technical issues to be addressed. This allowed an incremental integration of water with other sectors as well as with other water users in a given catchment, and paved the way for further integration under the current project.

[5] A 'Christmas tree' being the term coined for a project in which everything is included under its design such that it ends up being too unwieldly and complicated to effectively implement.

Transitioning to an Integrated Urban Water Management Approach in a City

International and World Bank experience shows that the transition to an IUWM approach in a city is often an incremental process, usually triggered by one or several drivers, be they social (such as rapid urbanization, as in Vitória), economic (such as increased demand for a "liveable" space, as in Rotterdam), or environmental (such as water quality issues, water scarcity or climate extremes, as in Melbourne and Windhoek).

In OECD countries, ageing infrastructure, extreme weather events, and national laws and regulations are the main drivers affecting the governance of urban water management (OECD 2015). Daniell et al. (2015) define more broadly the following factors as potential drivers for transition to an integrated approach to urban water management (see Box 4 for more examples of drivers to IUWM):

- Population growth, demographic change, and increasing urbanization, all adding to growing demand for water supply and sanitation/wastewater treatment services, as well as changes in the hydrological cycle at the local level, as seen in Espírito Santo.
- Increasing resource scarcity, including water (both in quantity and quality), as seen in Windhoek;
- Technological innovation including, among others, smart grids and ICT tools;
- New water governance approaches and systems, such as the public's higher demand for citizen participation and transparency;
- Changing water values and cultures, resulting in higher demand for environmentally friendly approaches, as seen in Rotterdam;
- Climate variability and global changes, which require decision making for long-term urban investments under increasing uncertainty, as seen in Melbourne;
- Ecosystem degradation and the growing awareness of the need to protect river ecosystems in urban environments; and
- Political ideology and development of international norms (such as the "green growth" movement).

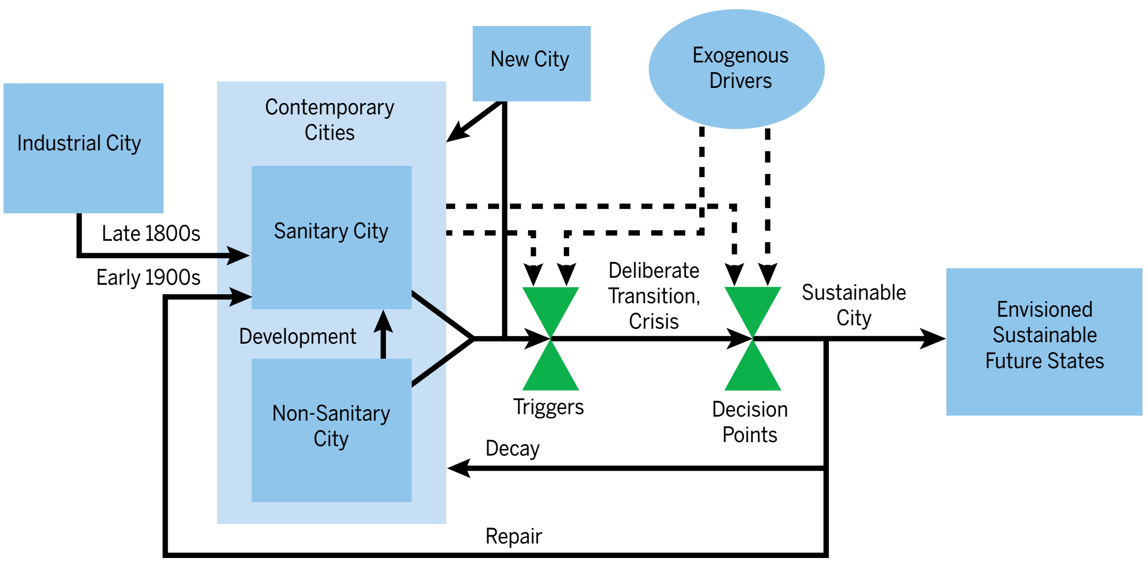
Virtually all of the world's cities are subject to such economic, social, and environmental changes, so why is it that only a handful have started to transition to an IUWM approach to tackling them?

First of all, it is important to highlight that there is not one single pathway to transition to a more sustainable and integrated approach to urban water management. Some researchers view the transition to IUWM in cities as similar to technological transitions, with sequential phases of take-off, acceleration and, eventually, stabilization under more sustainable management (Figure 7). Others (Childers (2014)) see "tipping points" in the transition from the existing, prevailing model of "sanitary" or "sewered" city (Appendix B) to sustainable cities, which can be caused by a combination of the aforementioned drivers, or simply reflect deliberate decisions aimed at making cities more sustainable. In this model, transitions are not meant to reach a static point but rather to remain in a state of flux, adaptable to changing objectives of sustainability (Figure 6). In this framework, as described in Wong et al. (2009), cities in developing countries have the advantage of being able to '*leapfrog*' to more holistic and integrated urban water management by avoiding the loss of environmental capital that developed cities are now trying to correct, or by facing the challenges of retrofitting existing infrastructure to evolving pressures (OECD 2015) (see Appendix B for more details).

In both models, sustained political leadership on the one hand, and broad institutional and social support on the other, are seen as critical for transitioning to more integrated approaches on a regulatory, institutional, technological, and/or social level.

- **Examples**: The SWITCH Transition Manual gives examples of cities (Figure 7) that are in the process of transitioning to a more integrated approach of urban water management (Accra, Ghana; Belo Horizonte, Brazil; and Łódź, Poland) and

Figure 6. Possible Transition Pathway to an Integrated Approach to Urban Water Management



Source: (Childers 2014).
Note: Solid lines represent city state transformations or state changes; dashed lines represent influence. The model accommodates the transformation of contemporary cities, in both "sanitary" and "non-sanitary" states, toward being sustainable cities, as well as new cities, that may transition to being "sanitary", "non-sanitary" or directly toward sustainability as they develop and grow.

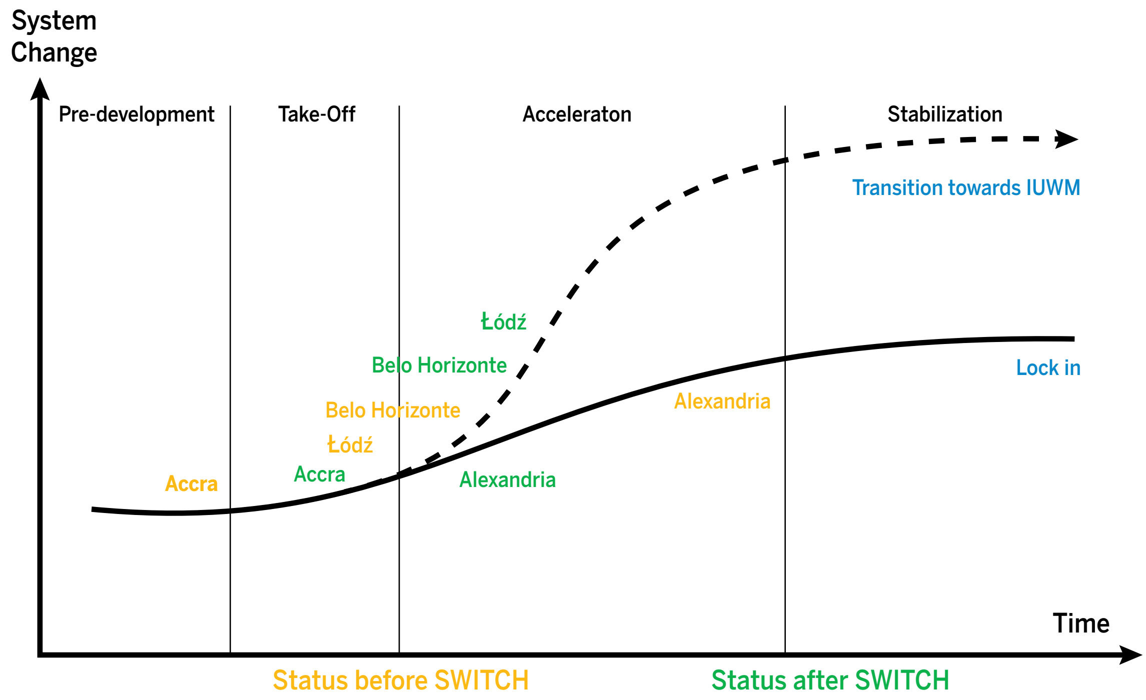
one city that has failed to transition to a more integrated approach (Alexandria, Egypt). The failed transition was due to "extremely long established and rigid institutions which are set up to restrict integration and innovation, [which] was highlighted by two sectors preparing [two] separate visions [for the city]" (SWITCH 2011).

Key References:

- A clear and practical, step-by-step manual to accompany a city in a strategic IUWM planning process and to move toward defining a transition agenda can be found in Frantzeskaki et al. (2012), with reference to the case of Melbourne.
- A summary of current research on transitions in urban water management can be found in Daniell et al. (2015) and de Haan et al. (2015).

The next chapter outlines a possible methodology for assessing whether to engage in an IUWM approach, and how to develop an IUWM approach thereafter. This methodology is based on the experience of the cities profiled earlier and on research undertaken by the Global Water Partnership (GWP), the University of South Florida and the International Water Management Institute (IWMI) (forthcoming), Frantzetzaki et al. (2012), Closas et al. (2012), Tucci (2009), INSA Lyon (2014), and Marino (2014).

Figure 7. Four Cities Transitioning under the SWITCH Program



Source: (SWITCH 2011).

Applying an IUWM Approach in a City

This chapter aims to give practical guidance on the kind of activities that may be considered when engaging with a city under an IUWM approach, and referencews supporting material and resources for Bank task teams and their city counterparts. The activities listed *do not* represent a checklist—not all of the activities below need to be implemented, nor do they have to be undertaken in the order suggested here. Each project's specific approach will vary depending on local conditions and drivers, as well as on the experience of the city in applying an integrated approach, the length of the Bank's prior engagement in the relevant sector(s), and the client's interest and capacity.

Table 3. Possible Building Blocks of an IUWM Approach

Phase	Objective	Steps	Resources
1. Engagement	Determine (i) whether an IUWM approach is appropriate to deal with the city's challenges and development goals and (ii) if there are drivers and an enabling environment for IUWM.	a. Conduct a desk review of the urban and water sector in the city. b. Identify stakeholders and analyze the political economy. c. Make the case for an integrated approach. d. Conduct a Rapid Field Assessment of urban and water challenges.	Section 4.1
2. Diagnostic	Analyze urban and water challenges and propose a set of options to solve these challenges under an integrated approach.	a. Conduct technical studies, including economic and financial analyses of IUWM measures. b. Identify nonstructural measures. c. Identify structural measures.	Section 4.2
3. Strategic planning: developing an umbrella framework for IUWM	(i) Validate the proposed IUWM umbrella framework; (ii) Clarify institutional responsibilities and mechanisms for application.	a. Inclusive planning: determining outcomes, activities, and options for an integrated approach. b. Agree on institutional responsibilities and cost sharing. c. Design M&E framework, feedback and revision mechanisms, and knowledge management.	Section 4.3

Resources

Undertaking analytical work, a technical assistance (TA) program, or preparing for an investment project will require staff time, technical capacity, and funding, all of which are normally limited. Cofinancing with other donors may be a good way to secure additional funds and technical support, as well as to pave the way for a coordinated approach among donors.

If cofinancing is not possible, financial and/or technical support may be available from development partners. It is worth exploring the possibility of joining forces with organizations that support city climate adaptation finance, disaster risk management (DRM), or urban development initiatives—some of which are listed in Table 4. *Pro-bono* technical support may also be available from a number of these organizations: for instance, *100 Resilient Cities* offers funding to hire a Chief Resilience Officer for the city to help develop a resilience strategy (Table 4).

The integration of the urban water cycle at the city level also needs to be reflected in the skill mix of the Bank team. The following skill set may be useful for involvement and/or consultation in a project applying IUWM principles, particularly including Bank staff and consultants with knowledge of the local context:

- Urban WSS Specialist
- Urban Specialist
- Social/Gender Specialist
- Financial Specialist
- Economist
- WRM Specialist
- Environmental Specialist
- DRM Specialist
- Governance Specialist
- Energy Specialist
- Transport Specialist
- Climate Change Specialist

4.1 Engagement

The objective of this first phase should be to engage with urban stakeholders to answer the following questions together:

1. Is an integrated approach appropriate to deal with the city's challenges and the development goals that the city has set itself?
2. Are there drivers for adopting an IUWM approach? Is the social and institutional context conducive to an IUWM approach?

Table 4. Potential Financial and Technical Support Sources for Bank IUWM Initiatives

Potential financing sources and partners	Online resources
The Water Partnership Program	http://water.worldbank.org/wpp
The Water and Sanitation Program	http://wsp.org
Cities' Alliance	http://www.citiesalliance.org
GFDRR	https://www.gfdrr.org
The Climate Adaptation Fund	https://www.adaptation-fund.org
The GEF (Sustainable Cities Program)	http://www.thegef.org
Korea Green Growth Partnership	http://www.worldbank.org/en/topic/sustainabledevelopment/brief/korea-green-growth-partnership
C40	http://www.c40.org
100 Resilient Cities	http://www.100resilientcities.org
ICLEI	http://www.iclei.org
UCLG	http://www.uclg.org
FMDV	http://www.fmdv.net
The Governance Partnership Facility	http://bit.ly/1cpLGv0

4.1.1 Conduct a data review of the urban and water sector in the city

Background data needs to be collected to gain a better understanding of the city profile and the potential urban and water issues:

- **Urban space and planning**: urban area and population, population density and growth rate, and percentage of informal areas;
- **Economic and social activity**: GDP, social distribution of income (e.g., Gini indicator for the city), watershed in which urbanization is taking place, and percentage and location of informal areas;
- **Access to basic services**: water supply and sanitation coverage and reliability in the area of interest and the city as a whole; electricity coverage and reliability; solid waste coverage and disposal; drainage/stormwater management infrastructure and mapping of flood-prone areas; wastewater treatment and environment impacts;
- **Water resources**: watershed and climate data such as temperature and rainfall; raw water supply sources, including groundwater; climate change impacts; description of extreme events, drought, and frequency of floods; people affected by extreme events and water- and excreta-related diseases; water uses and main environmental assets;
- **Urban and water institutions**: urban governance system, accountability and inclusiveness; mapping of service providers (water supply, sanitation, drainage, solid waste, etc); watershed organizations; water user groups; civil society organizations; nongovernmental organizations; participation and citizen feedback;
- **Previous projects** that have taken place in the urban and water sector (government, Bank and external) and lessons learned;
- **GIS maps** of the city/watershed;
- **Hydrometeorological data** (e.g., forecasts for rainfall, stream flow, and tropical cyclones);
- **Data** on climate impacts (rainfall, temperature) as well as estimations of sea level rise for coastal cities.

The data collected can be collated in GIS layers for spatial analysis or in Excel for further analysis.

- **Example**: For an illustration of urban and water data that can be collected through a desk review (and their sources), see the raw data (http://data.worldbank.org/data-catalog/african-cities-diagnostics) for the urban water diagnostic for 31 African cities from Jacobsen et al. (2012) as well as the resulting city profiles (with maps) (http://water.worldbank.org/gis_map/abi) and the companion volume (http://documents.worldbank.org/curated/en/2012/01/17046599/future-water-african-cities-waste-water-diagnostic-urban-water-management-31-cities-africa-companion-volume). Information on climate change impacts (by country and/or basin) can also be accessed through the Climate Change Knowledge Portal; note that all of the climate data featured on the Climate Change Knowledge Portal (http://worldbank.org/climateportal)has been published as open data resources.

4.1.2 Identify stakeholders, analyze institutional framework and political economy

Given the multisectoral nature of IUWM, and the localized use and effects of water, the range of formal and informal institutions and stakeholders[6] involved may be varied and remains context-specific. Key institutions and stakeholders that may need to be engaged can be categorized as follows:

- The national government and its representation at the local level;
- State/provincial/regional governments where they have roles at the city level
- Municipal governments and metropolitan/city-wide governments/entities;
- Community associations;
- Beneficiaries and communities affected by potential project measures;
- River basin agencies; water user organizations; water services providers;
- Water and sanitation service providers; entities responsible for planning/providing related service such as drainage, solid waste management, land use planning, etc;
- Hydro and meteorological agencies providing forecasting for water-related events;
- Private or public sector companies working in the water and urban sector, or that are large water users/consumers (e.g., mining, agriculture, energy, industry);
- NGOs, community-based organizations;
- Universities and research institutes;
- The media and general public;
- Other stakeholders from relevant sectors that may be implicated in an integrated approach, for instance industry, agriculture, environment, energy, fisheries, and transport.

Mapping the institutions involved and their relationships can be a useful output of this exercise and will give the team an idea of the formal and informal relationships between institutions:

- Review the institutions involved in making decisions with regard to water and urban resources (river basin agencies, national or local water utilities, etc.), as well as the extent of public participation in these sectors.
- Assess the current mandates, priorities, and decision-making processes for investment in WSS, WRM, DRM, urban planning, solid waste management and stormwater management, and other relevant sectors.
- Assess the performance of existing *formal* institutions and determine whether they have the capacity to enforce existing formal rules and coordinate activities with other agencies when necessary.
- Map out *informal* institutions in the urban water sector and their connections and influence on formal institutions or agencies.
- Assess whether the regulatory and legal framework is adequate to respond to identified priorities.
- Map out all relevant stakeholders implicated under the local/national authorities' and utilities' water policies and practices, including those that are not currently implicated but might have a stake in the development of the sector.
- Determine whether stakeholder participation and accountability mechanisms are part of the current framework, and whether there are opportunities to strengthen the demand side of governance (through mechanisms to disseminate information to the public and

[6] Stakeholders here are defined as "persons or groups who are *directly or indirectly* affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either *positively or negatively*. Stakeholders may include locally affected communities or individuals and their formal and informal representatives, national or local government authorities, politicians, religious leaders, civil society organizations and groups with special interests, the academic community, or other businesses" (IFC 2007). Institutions are defined as "sets of rules—in this case in the urban water sector—that entail mechanisms which govern how and by what means the rules should be dealt with, and [...] that identify, define and regulate relationships between actors in the urban water sector" (GWP, PSGS, and ICLEI (forthcoming) 'IUWM Toolbox: Institutional Analysis Module').

promote the accountability of those being regulated).

- Consult stakeholders on current challenges and needs, and on what has and has not worked in the past.

> **Key resources:** SWITCH (2010) has developed a methodology for institutional mapping for IUWM (available at http://www.switchurbanwater.eu/outputs/pdfs/WP6-2_BRN_Institutional_mapping.pdf). The Bank's Social Analysis Sourcebook (available at http://siteresources.worldbank.org/INTTSR/Resources/SocialAnalysisSourcebookFINAL2003Dec.pdf) is also a reference for conducting institutional and social analysis as part of project design. Finally, as part of the IUWM Toolbox prepared by the GWP, ICLEI, PSGS and the World Bank (forthcoming), there is an institutional analysis module specific to IUWM.

This analysis should also assess the institutional and regulatory framework for urban planning, WSS, and WRM, and identify whether there are institutional or political economy issues that might arise if there is a change to an integrated approach. The corollary—whether institutional, regulatory, or political economy arrangements are favorable to an IUWM approach—should also be highlighted.

> **Key resources**: The Bank's *Governance Partnership Facility* provides funding for governance and political economy analyses, including for the water sector. For a full methodology of how to conduct a political economy analysis in the urban and water sector, you can refer to: World Bank (2011) *How-to Notes: Political Economy Assessments at Project and Sector Levels* (available at http://www.gsdrc.org/docs/open/pe1.pdf) as well as Manghee and Poole (2012) Approaches to Conducting Political Economy Analysis in the Urban Water Sector (available at http://documents.worldbank.org/curated/en/2012/09/17181109/approaches-conducting-political-economy-analysis-urban-water-sector), and ODI (2012) Political Economy Analysis for Operations in Water and Sanitation: A Guidance Note (available at http://www.odi.org/publications/6454-political-economy-analysis-operations-water-sanitation-guidance-note).

4.1.3 Engage stakeholders and make the case for an integrated approach

Sustaining the effective engagement of stakeholders is key to the implementation of IUWM strategies in a city: stakeholder engagement helps build public trust by enabling more transparent decision making in the urban water sector. Participation in decision making around urban water governance is the key to sustained stakeholder engagement. The IUWM Toolkit developed by the GWP, IWMI, PSGS and the World Bank (forthcoming) includes a identify the following guidelines for effective stakeholder engagement in an IUWM approach:

- The engagement process should be driven by clear objectives, identified at the outset; these should be discussed and agreed upon by all stakeholders.
- A stakeholder/institutional analysis should be done to ensure that the appropriate stakeholders are represented in the engagement

process; special attention should be paid to ensure the inclusion of marginalized groups.

- The effectiveness of the stakeholder engagement process should be monitored to ensure that the process is reaching its identified objectives;
- The results of the stakeholder engagement process should be documented and disseminated to all agencies involved in the process.

Since IUWM is a way of thinking that is relatively new, it may be necessary to "make the case" for an integrated approach with the city's relevant stakeholders. This can be done by:

- Showcasing the economic, social, and environmental benefits of integration through the implementation of a project that brings together several related sectors, with the aim of demonstrating that the benefits of an integrated approach outweigh those of traditional urban water management;
- Exposure to cities that have implemented, or are in the process of implementing, an IUWM approach;
- Learning alliances (e.g., twinning or networks of cities);
- Capacity building, for instance, through some of the following activities:
    - Knowledge exchange between city/water/river basin stakeholders with other cities that have applied IUWM approaches;
    - Knowledge exchange through dedicated professional networks;
    - Capacity-building activities (workshops, webinars, MOOCs).

Through capacity-building activities, urban water stakeholders can be trained to become "champions" of an IUWM approach, which will help move the process of strategic planning forward and ensure the sustainability of the approach. This could include, for instance, workshops that facilitate South-South or North-South knowledge exchange and bring together several cities/countries that have implemented IUWM, and key stakeholders from other cities/countries that are good candidates to implement IUWM. This would be an efficient way to stimulate clients' thinking about, and acting on, IUWM. One such workshop was organized by the WPP in 2012 in LAC, and more recently by the African Development Bank and GWP in Côte d'Ivoire (workshop summary available at http://www.gwp.org/en/GWP-SouthernAfrica/GWP-SA-IN-ACTION/News/AWF-GWP-hold-capacity-building-workshop-on-Integrated-Urban-Water-Management/).

At this stage, it would be important to engage stakeholders around potential shared benefits or outcomes for the city as a whole, as well as mandates and responsibilities for action. For instance, rainwater harvesting can help produce multiple benefits by mitigating flood risk, decreasing stormwater runoff, and managing water demand through the provision of residential lawn or garden irrigation; but who should bear the cost of the residential rainwater harvesting "hardware" and its maintenance, or the cost of promoting the use of rainwater for residential gardens? Should it be the water utility, which gains from a reduction in water demand? Public or private property owners, who gain from decreased flood risks? Or residential households, who benefit from a sustainable system for irrigating their yards?

It will also be important to highlight the difference between an IUWM approach and common practices in developing countries, for instance, the cascading reuse of wastewater for irrigation, which is not safe and increases public health risks. An IUWM approach in this context should explore solutions for safe cascading use of wastewater (e.g., through sanitation safety plans).

- **Key resources:** In addition to resources from the World Bank and from the partners listed in sections 1.2.3, the Bank's *South-South Knowledge Exchange Facility* may be able to facilitate knowledge exchange between cities. In addition, the World Bank's 2014 webinar on IUWM (available at http://www.podcastchart.com/podcasts/world-bank-s-open-learning-campusvideo/episodes/integrated-urbanwater-management) and Monash University's Massive Online Open Course on Water for Liveable and Resilient Cities (available at https://www.futurelearn.com/courses/liveable-cities) may provide useful introductions to the topic for city officials and other stakeholders.
- The IUWM Toolkit developed by GWP, IWMI, PSGS and the World Bank includes a Stakeholder Engagement Manual, which provides guidance on what is required to develop and manage a stakeholder engagement process for IUWM (forthcoming).

4.1.4 Conduct a rapid field assessment of urban and water challenges

The objective of the rapid field assessment is to engage with stakeholders and refine the desk review analysis to gain a better understanding of the water challenges the city faces and the processes in place for dealing with them.

Identify and analyze urban water issues in consultation with stakeholders

The identification of issues can be done through: (i) interviews with stakeholders and residents; (ii) household surveys; and/or (iii) a participatory workshop, moderated by the Bank team (CSIRO 2012). Appendix C provides a standard questionnaire that can be used when meeting with urban water stakeholders to determine current urban water challenges and needs. The desirable outcomes, and related issues/causes, can then be prioritized—using green for low priority, yellow for medium, and red for high priority, for instance. As assigning priority levels is very subjective, it should be done in consultation with stakeholders.

- **Example:** In Can Tho, Vietnam, stakeholders at a participatory workshop (CSIRO 2012) mapped issues related to: (i) aquatic ecosystems; (ii) flooding; (iii) groundwater; (iv) water infrastructure; (v) access to water supply and sanitation; and (vi) water quality. A Feasibility Assessment Workshop was organized subsequently to enable the stakeholders to identify key criteria for the chosen options to be successfully implemented. The CSIRO team was then able to undertake some more detailed feasibility studies based on this ranking of options and feasibility criteria suggested by stakeholders.
- **Key resources**: The IUWM Toolkit developed by the GWP, IWMI, PSGS and the World Bank (forthcoming) includes a Water Balance Model Tool, which performs analyses of different scenarios for the urban water system under an integrated approach at three levels (household, cluster, and city). It is a scoping tool, which is relatively easy to understand and which can be used for engaging stakeholders around water-related issues at the city level (but not for detailed technical studies).

Figure 8. Participatory Mapping of Water-Related Issues in Can Tho, Vietnam

Source: (CSIRO 2012).

4.2 Diagnostic

Based on the data gathered and the stakeholder consultation carried out during the engagement phase, the objectives of the diagnostic phase are to:

- Determine which urban sectors are currently facing challenges or likely to face challenges in the future, as this could drive an IUWM approach;
- Analyze links between water use in the watershed and other sectors (e.g., agriculture/irrigation, industrial water, energy sector, pollution control, and disaster and risk management) as well as related urban services (solid waste management, sanitation, stormwater, urban planning);
- Consider existing integrated practices, as well as areas of duplication that might contribute to poor water and urban management;
- Assess the resilience of the urban water sector to future demographic change, water resources constraints, and climate change impacts.

There may be dozens of measures that could be of relevance to a proposed outcome. Therefore, it is important to validate the proposed measures and the scope of the technical studies with the stakeholders identified in the engagement phase, as the feasibility of some options will differ between cities and even within a given city, depending on the local conditions. A second engagement phase with decision-makers and end-users may be needed once the diagnostic phase has been completed. User-friendly Decision Support Systems (DSS) tools can help decision makers assess the benefits and issues associated with alternative approaches.

- **Key Resources:** An interactive, analytical decision support tool was used to guide SEDAPAL, Lima's water utility, into making long-term water resources management investments under uncertainty for a range of future scenarios. The tool is available at https://public.tableau.com/profile/david.groves1600#!/vizhome/SEDAPAL_PDT-2015_05_10_0/SEDAPALPDT (for more information, see Kalra et al. 2015).

In this context, it will be important not only to look at data but also at the modus operandi of the institutions, in particular the processes and practices in place for:

- Bridging the supply-demand gap for urban water;
- Increasing the resilience of the urban water supply to extreme events and climate change;
- Determining the most appropriate supply-side investments or demand management activities for urban water supply;
- Managing conflicts in time of water supply shortage.

4.2.1 Technical studies, including economic and financial analysis of IUWM measures

The objectives of the technical studies of IUWM measures are the following:

- Determine whether the proposed IUWM measures make economic and financial sense;
- Assess the financial feasibility of solutions identified as suitable during the diagnostic phase (e.g., wastewater reuse, solid waste management improvements, stormwater management);
- Identify the resulting structural and nonstructural IUWM measures to be implemented.

A number of technical studies will be required to inform strategic planning and implementation of the proposed measures, among others:

- **A baseline measurement of the water and urban system**, focusing on measuring progress to reach the proposed outcomes of the IUWM umbrella framework, which can also be used for monitoring and evaluation (M&E).
- A **water balance assessment** to assess current water demand, availability, and depletion of water resources, both in terms of water quantity and quality. The nature of contamination/deterioration of water quality and source and nonpoint source contaminants should also be identified. Projected demand for the city for the next 25–50 years (depending on the timescale chosen for the IUWM strategic plan) should be based on a number of scenarios to be validated with stakeholders, and take into account the impact of climate change on water resources and uncertainty associated with each scenario/proposal.
- The **feasibility of structural measures** (i.e., "hardware") that can be implemented by the city to reach the proposed outcomes, including engineering, economic and financial analysis, environmental and social analysis, risk analysis, etc. This should also include an inventory of regulatory and financial incentives, subsidies, and PPP schemes that may favor (or discourage) an integrated approach.
- The **feasibility of nonstructural measures** (i.e., "software") that can be implemented to reach the proposed outcomes, including policy and institutional options, as well as regulations, incentives for behavior change, urban planning control, education, and capacity building. This should also include an inventory of regulatory and financial incentives, subsidies, and PPP schemes that may favor (or discourage) an integrated approach.
- An **environmental and social evaluation** of the impacts of the proposed measures.
- An **evaluation of climate change risk/vulnerability/resilience assessment** for the proposed measures.

- **Key Resources:** the Climate Change Decision Tree (available at https://openknowledge.worldbank.org/handle/10986/22544) is a useful reference; it provides guidance for assessing an urban water scheme's vulnerabilities to climate change (Ray and Brown 2015).
- **Key Resources:** The World Bank's Global Knowledge Silo Breaker in Solid Waste Management has put together a useful compendium of resources for managing solid waste in an urban context, and sharing experiences and resources to learn from waste projects across the World Bank Group. This compendium includes key experts, project examples, and case studies and key documents; it can be found

at http://iteam.worldbank.org/connectlcr/lcrsd/LCSUW/URBAN/swm/KeyTopics/Drainage_Resources.aspx (accessible only through the Bank intranet).

Most of the above technical studies are not very different from the type of studies carried out for a conventional urban and/or water project. However, the economic and financial analyses of IUWM measures deserve particular attention.

Economic viability refers to the need to generate a net benefit to society once all economic, social, and environmental costs and benefits have been factored in. The identification of potential benefits for each proposed IUWM option as part of the framework requires an understanding of all capital and operational expenditures and their links, as well as a complete assessment of current and future alternatives to WRM. These economic assessments will allow the decision makers to form an idea of the financial capacity of institutions and the benefits to be derived from implementing the proposed activities, as well as the timeline and funds needed.

- **Key resources:** For an example of an economic assessment of an IUWM umbrella framework developed in Baku, Azerbaijan, refer to Scandizzio and Abbasov (2012).

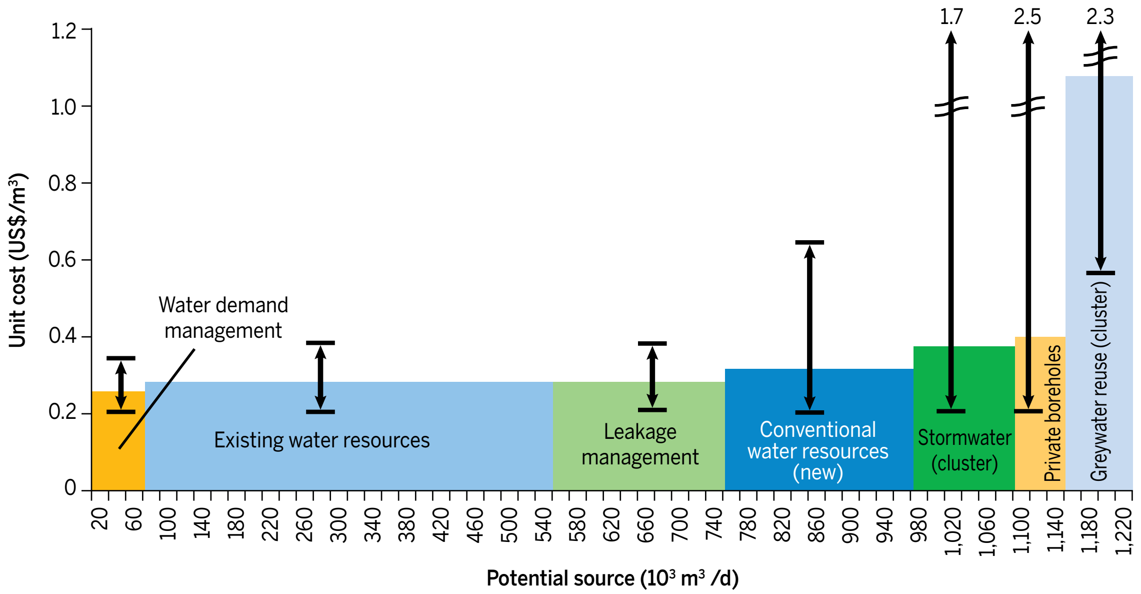
Cost-benefit analyses can help determine the economic viability of IUWM measures by quantifying all of the costs and benefits of a project in monetary terms, including items for which the market does not provide a satisfactory measure of economic value. Cost-benefit analyses should consider a number of options for development, including the "no project" option and the option of approaching the challenges in a conventional, non-integrated, way. They should be done at two levels:

- At the *city* level, under the IUWM umbrella framework planning process: this will allow decision makers to understand the economic costs and benefits of an integrated approach compared with business as usual, and get a sense of the timeline and level of funding needed to reach the proposed objectives;
- At the *project* level, to determine whether the project is actually economically viable.

- **Example**: For the economic analysis carried out in Nairobi, Kenya, the economic costs of conventional water supply for the period leading up to 2035 were compared with the costs of providing water under an IUWM framework (Figure 9). The economic analysis of the options proposed under the IUWM approach was carried out for high, medium, and low scenarios of urban water demand for the period leading up to 2035. It highlighted the fact that some options—such as water demand management and leakage management—could be more affordable than the development of conventional water resources (such as surface water storage and transportation). However, the variation in the range of the costs of development of stormwater harvesting, greywater reuse, and private boreholes was much higher, highlighting the need to look at these options on a case-by-case basis and at different scales. The methodology used in this evaluation is outlined in Jacobsen et al. (2012) and Eckart et al. (2012).

Financial viability addresses both access to finance and the ability of a project to generate financial returns (if relevant). As is the case for conventional urban water projects, applying

Figure 9. Economic Analysis of IUWM and Conventional Options for Water Supply in Nairobi, Kenya



Source: (Jacobsen 2012).
Note: The range of unit costs (vertical lines) are based on the technologies and approaches used. For example, unit costs for water demand management depend on the quality and type of water saving devices; leakage management costs depend on the cost of water production and leakage control strategies; greywater costs depend on the treatment choices; stormwater costs depend on whether structural and/or nonstructural measures are applied; rainwater harvesting costs depend on whether simple storage tanks or pumping to elevated reservoirs are required. For cost assumptions and calculations, see Eckart et al, 2012. (10^3 m^3 /d = 1,000 cubic meters per day).

an IUWM framework requires significant levels of funding for both capital and O&M costs. For countries with a limited ability to invest in IUWM structural measures, strong institutions and governance are needed to raise the necessary funds, from the public or the private sector, as well as from donors where appropriate. Similarly to conventional urban water projects, financially attractive schemes may be implemented in partnership with the private sector, while schemes that are not financially viable or considered too risky by the private sector may need to be undertaken by the public sector and financed through a sustainable combination of the three "Ts" (taxes, tariffs, and transfers) (OECD 2009).

The particularity of IUWM is that financing needs and returns are shared among public and private stakeholders. Moreover, it will not always be those stakeholders who benefit from a scheme who will pay for it. Particular attention needs to be paid to institutional responsibilities and cost sharing in the design of financial models for IUWM schemes (Section 4.3.2). Innovative financing models have emerged recently that could be applied in cities of developing countries, provided the right enabling environment is in place (Box 5).

4.2.2 Structural measures

An IUWM approach may call for nontraditional measures to reach the proposed environment and social outcomes the city aspires to. Table 5 outlines some of the differences in structural ("hardware") and nonstructural ("software") measures between a conventional

Box 5. ■ DC Water's Clean Rivers Project: encouraging private adoption of natural systems for improved water quality

Driven by the need to comply with regulatory demands for improved water quality, DC Water (the water and sanitation utility of the District of Columbia in the United States) has been implementing the Clean Rivers Project since 2007. This US$2.6 billion project aims to decrease the volume of combined sewers overflow (CSO) by 96 percent for all of DC's waterways—the Anacostia and Potomac rivers as well as Rock Creek. In May 2015, DC Water announced an agreement with the District of Columbia, the Environment Protection Agency, and the Department of Justice, which modifies the terms of the project to include the use of some IUWM options instead of only constructing underground tunnel systems to control CSO. These IUWM options include natural systems such as green roofs, porous pavements, and rain gardens, to treat stormwater prior to discharge, as well as rainwater harvesting. The Project has been given a 7-year extension to allow for the additional time needed to encourage the construction of green infrastructure and is now expected to be completed by 2032.

The success of DC Water's amended Clean Rivers Project rests on convincing both private and public land owners to construct green roofs, porous pavements, and rain gardens, and encourage the uptake of rain barrels. DC Water's tactics includes partnering with nonprofit groups to raise awareness and increase uptake of these systems, as well as coordinating with the District of Columbia—the primary public landowner in the area—and particularly its environmental regulator, the District Department of the Environment (DDOE).

Since 2013, and as part of the Mayor's Sustainable DC Plan, DDOE has been running the RiverSmart Program, which provides financial incentives to help District land owners install the green infrastructure DC Water is planning for, such as rain barrels, green roofs, rain gardens, and permeable pavements. Financial support from DDOE includes rebates and subsidies for construction of green infrastructure, as well as discounts on environmental pollutions fees. A number of targeted areas of importance to the watershed are given additional incentives to encourage private uptake of stormwater management. Furthermore, DDOE regulation requires new development and large renovations of properties in the District to install stormwater pollution control measures. DC Water is also running an extension of the DDOE's RiverSmart program, by providing their customers with a discount on the impervious area charge if they have taken stormwater management measures.

In 2013, DDOE also launched an innovative Stormwater Retention Credit Trade, which is the first of its kind in the United States. Private property owners can generate Stormwater Retention Credits (certified by DDOE) by installing green infrastructure that captures and retains stormwater runoff; these Credits can then be sold in an open market to buyers who can use them to meet DC's regulatory requirements for retaining stormwater for new building or major renovations.

Source: ddoe.dc.gov (DC Water 2015).

approach to urban water management and an IUWM approach. In practice, structural and nonstructural measures are often used in combination under an IUWM approach. Prioritization of outcomes, as part of the strategic planning process, will determine the type of interventions that should be investigated.

Structural measures include any type of infrastructure that is considered to meet water demand, improve water quality, and improve the sustainability of urban water management. They include decentralized WSS systems, rainwater harvesting, wastewater and stormwater recycling, and natural systems such as wetlands. Chapter 2 outlines some of the structural measures used under an IUWM approach in Rotterdam, Windhoek and Melbourne, and highlights the fact that each measure implemented

Table 5. Differences Between Conventional and IUWM Approaches

	Conventional approach	IUWM approach
Infrastructure planning and development	• Water supply infrastructure developed first, followed by sewerage and drainage. • Further action aims to rectify damage caused by earlier infrastructure development. • Centralized systems for water supply and wastewater management are generally preferred.	• Planning for all urban water components carried out simultaneously. • Synergies between interactions are extracted and used for better planning. • Both centralized and decentralized systems for water supply and wastewater management are considered.
Choice of infrastructure	• Infrastructure is made of concrete, metal, or plastic.	• Infrastructure can also be green, including soils, vegetation, and other natural systems.
Water sources	• Water is supplied from traditional sources such as rivers, lakes, and aquifers.	• Water is supplied not only from traditional sources but also from alternatives such as rainwater harvesting, aquifer storage, and stormwater and wastewater reuse.
Water supply	• Complex and expensive treatment and distribution technology is preferred, despite being prone to inefficiency. • Deteriorating water quality is addressed by investments in treatment technology. • Increasing demand is met by developing new resources and expanding the existing treatment and distribution infrastructure.	• New water distribution systems are designed based on zoning principles, leading to a more efficient system. • Water resources are protected from pollution (including from industrial and agricultural sources) through upstream watershed management. • Increasing demand is managed through water efficiency measures, effective leakage control, and pricing tools.
Sanitation	• Centralized wastewater treatment is the preferred solution, despite the high costs of construction and operation.	• Wastewater and sludge are managed through centralized and decentralized approaches (such as condominial sewerage, decentralized wastewater treatment plants, and septic tanks), thereby enabling separation, treatment, and disposal of the different types of waste streams and reducing the wastewater load. • Wastewater and sludge are used as resources rather than treated as waste, with options for nutrient and energy recovery.
Urban drainage and solid waste management	• Urban drainage is planned based solely on the objective of flood protection. • Solid waste is to be collected and disposed in a landfill.	• Urban drainage is planned based on flood protection, potential collection and reuse of stormwater, recharge of groundwater, and the enhancement of urban biodiversity. • Natural systems such as wetlands, rain gardens, or green roofs are used to treat stormwater before discharge to the receiving water body. • Solid waste management considers the 3R principles (reduce, reuse, recycle).

(continued on next page)

Table 5. Differences Between Conventional and IUWM Approaches *(continued)*

	Conventional approach	IUWM approach
Institutional arrangements	• Different urban water components are planned independently by the different responsible institutions in a silo structure.	• Institutional integration is actively promoted through coordinated management of different urban water components. • All relevant stakeholders are represented in urban water decision-making processes. • Decentralized governance structures create an enabling environment for private sector involvement. • Large water consumers and polluters become part of the solution.

Source: Authors, adapted from (Eckart 2012).

was dependent on the city context as well as the specific area within the city. For instance, normally some areas of the city experience higher population growth than others (e.g., the suburbs) and may be suited to new, decentralized WSS services while others are already well-served by centralized systems.

- **Example:** In Melbourne, using recycled water to supply water to fast-growing suburbs turned out to be more affordable than extending centralized water services to these areas; this was assessed by taking a life cycle approach that included not only the traditional costs of supplying water but also environmental externalities (e.g., energy costs and resulting carbon and greenhouses gas emissions as well as nutrients discharged into the environment from wastewater effluent). This may, however, not have applied to other areas in the center of the city, where centralized water services could have been supplied at a lower cost. This underscores the need to look at the local conditions within the city to determine the most applicable IUWM options.

Greenfield investments may also be financially more attractive than retrofitting of existing infrastructure. For instance, in Rotterdam, the choice was made to design new infrastructure under an integrated approach, on a case-by-case basis, but not to retrofit existing assets to ensure economic efficiency: current water and wastewater assets should not be replaced until their life cycle is over, as such an approach would generally not be economically optimal. In Melbourne, however, new assets are being retrofitted onto existing and new residential developments (such as the purple pipes for "recycled water") but, in this case, economic efficiency is assessed on an area-by-area basis.

Unlike conventional approaches, IUWM recognizes the important role of green infrastructure in addressing a city's water needs, which can provide a broad range of ecosystem services such as preserving biodiversity, decreasing flood risks, improving water quality, and mitigating the urban heat effect. This can be done through the creation of new green infrastructure (e.g., the green roofs of Rotterdam or the RiverSmart program in Washington, DC) or through restoring riparian ecosystems.

- **Key Resources:** The IUWM Toolkit developed by GWP, IWMI, PSGS and the World Bank includes a Technology Catalogue (forthcoming), which provides a useful compendium of technology options available under an IUWM approach, as well as a Technology Selection Tool that can be used to inform stakeholders on the potential technologies available to manage urban water supply.

- **Training**: In the United States, DC Water and the WEF have launched the development of a national Green Infrastructure Certification Program, which will look at how to install, maintain, and inspect green infrastructure systems (to start in early 2017). This will include rain gardens, pervious pavements, rainwater harvesting, and green roofs. In the United Kingdom, HR Wallingford offers courses in Sustainable Drainage Systems (SuDs), which cover many aspects of green infrastructure.

4.2.3 Nonstructural measures

Nonstructural measures are designed to manage behaviors, examples of which include:

- Regulations for water use to manage water demand, or command and control legislation (such as the Water Framework Directive in the case of Rotterdam);
- Prices or taxes (e.g., the "polluter pays" principle on activities that affect water quality);
- Environmental levies (e.g., on water abstraction);
- Economic and market-based instruments (e.g., appliance rebates on rainwater harvesting systems, or Payment for Ecosystem Services schemes as used in Espírito Santo);
- Urban planning control and land use planning (e.g., to manage flood risk)
- Education and capacity building;
- Public disclosure, legal actions, and formal negotiation.

All of the above nonstructural measures can be used very effectively in combination with structural measures or on their own, to reach specific social, environmental, or economic outcomes. For instance, land use planning best serves IUWM purposes when municipal/city governance structures have the authority and the will to use them, as well the capacity and budget to enforce them. These measures must be above political interference and can take the following forms:

- Development zoning and prohibition of development in water-sensitive areas;
- Investment and use of weather and climate data to best determine flood risks;
- Flood protection infrastructure, including drainage channels; and
- Green corridors for flood protection, for instance, wetlands, water-sensitive gardens, and river flood plains.

- **Example:** Melbourne and Windhoek (Chapter 2) both have strong municipal governance and institutional structures, which has enabled Melbourne to veto development in areas of flood risks, while Windhoek has widened its municipal territory to prevent development on areas where aquifer recharge takes place.

4.3 Strategic Planning: Developing an Umbrella Framework for IUWM in the City

The objectives of the strategic planning process are to:

- Validate with stakeholders the proposed IUWM umbrella framework and options considered and establish a formal or informal platform for further engagement;
- Clarify institutional responsibilities for implementation of the proposed solutions going forward;
- Ensure there are mechanisms in place for managing and sharing data across sectors and institutions;
- Develop and apply an appropriate M&E framework for the strategic plan.

4.3.1 Inclusive planning: determining outcomes, activities, and options for an integrated approach

Assuming that stakeholders have decided to move forward with an IUWM approach, and based on the prioritization of issues and desirable outcomes identified at the engagement and diagnostic stage (e.g., aiming to improve the environment, social, livability, or health in the city), a vision for the long-term integration of urban water management in the city can be developed.

The IUWM umbrella framework should include the following:

- Agreement on a set of proposed outcomes for the city;
- Milestones for implementation of activities to reach the proposed outcomes;
- Mechanisms for review, monitoring, and incorporating residents' feedback; and
- Capacity for revision and amendment based on implementation experience.

For this process to succeed, it is important that stakeholders have ownership of the development of the proposed measures and outputs. This may require a convening authority (a so-called "city champion") to chair the process of developing an IUWM framework. A formal or informal platform inclusive of all stakeholders should be set up for consultation, reporting, and feedback. The strategic planning process needs to be technically advised by the Bank team during the design phase so that stakeholders can make informed decisions to reach the proposed outcomes. The process should be inclusive and reflect the diversity of stakeholders identified during the engagement phase.

- **Key resource:** SWITCH (2010) Facilitating Conflict Management and Decision Making in Integrated Urban Water Management: A Resource and Training Manual (available at http://www.switchurbanwater.eu/outputs/pdfs/W6-1_GEN_MAN_D6.1.4_Conflict_resolution_-_Training_manual.pdf).

Stakeholders may also have to set criteria for prioritizing the different activities needed to reach the proposed outcomes for the city under an integrated approach.

- **Example**: In Rotterdam, the following criteria were used to prioritize projects under the IUWM umbrella framework: (i) projects that were already underway and could be readily integrated; (ii) projects that contributed to the realization of multiple outcomes (e.g., water quantity and water quality); (iii) whether the project was a question of "now or never"; and (iv) whether it was a demonstration project that could guide future investments (City of Rotterdam 2007). As a result, a phased implementation plan—specifying clear roles for each objective, as well as individual and joint objectives across institutions to ensure sustained cross-sectoral collaboration—was developed to guide the first two phases of implementation (2007–12 and 2012–15). The city also set up a structure to facilitate and sustain cross-sectoral collaboration: a project office, a steering committee, workgroups around specific outcomes, and regular management meetings.

During this phase, it is important to ensure that institutions have the capacity to manage and share data across and within sectors; this is particularly critical for the success of flood or drought management activities, where information needs to be shared in a timely and usable manner. Experience has shown that most cities lack the technical capacity for basic information and data management, which in turn limits their ability to apply such information in multisectoral planning and operational decision-making. The key here is moving past the idea that such planning should be done only once every 10 to 20 years but, instead, offering an approach where the process becomes a dynamic tool to help a city manage its resources and provide public services.

4.3.2 Agree on institutional responsibilities and cost sharing

Clarifying and agreeing on institutional responsibilities is perhaps the biggest challenge of designing and implementing an IUWM framework. Indeed, an integrated approach presupposes that an institution may be mandated for an activity that actually has an impact on another sector altogether. For instance, changes in land use practices can increase water quality and have multiple benefits for residential and industrial water use, but who should implement, pay for and monitor these practices?

The initial step in assigning institutional roles and responsibilities is for all stakeholders to agree that the IUWM umbrella framework actually furthers the overall goals for the city's urban development and for the management of its water resources. These benefits can translate into better outcomes for the urban or the water system, and/or can result in reduced costs for the package of measures to achieve the expected outcomes.

There is no correct answer for determining institutional responsibilities for applying an IUWM approach and for sharing costs: the optimum answer will depend on local context, the actors, and the outcomes of the IUWM framework. Indeed, the costs and effectiveness of interventions vary not only between cities but also within a city. Once it is determined and agreed by all partners that the overall costs for IUWM measures are lower—or the benefits for the system are higher—than traditional water management practices, an agreement must be reached on cost sharing. Several principles for cost sharing can be applied:

- The "polluter pays" principle;
- The stakeholders who benefit pay a larger share;
- The stakeholder who is responsible for implementing the proposed option pays;
- Cost-sharing follows the regular legal responsibilities of each partner.

Cost-sharing mechanisms can also be used to manage behavior within the water system. For instance, the introduction of a groundwater abstraction tax can lead to higher demand for the water provided by utilities or increased use of reclaimed water. However, groundwater regulation may be the responsibility of a different institution than the utility, which is why a common agreement about the overall objectives of the IUWM umbrella framework is of paramount importance.

Nonstructural measures (Section 4.2.2), including pricing instruments and financial incentives like rebates, subsidies, discounts, audits, and seasonal and zonal pricing, can also be used to shift some of the costs of higher levels of consumption or quality to users. Schemes under the "polluter pays" principle, in which charges relate to the effluent generated, can improve the cost effectiveness of treatment and reuse, and even fund the capital and/or operational expenditure of new infrastructure.

IUWM therefore requires governing bodies to adhere to adequate pricing mechanisms if costs are to be shared with other institutions. Tariffs for water supply or a pricing mechanism for wastewater need to be appropriate such that they can recover costs sustainably to fund schemes proposed under an IUWM framework.

- **Example**: In Rotterdam, it was decided that accountability for a particular outcome should determine who the task owner should be—and who should pay. For city-wide studies, which benefited all stakeholders equally, the allocation of expenditure was partially borne by the city (40 percent) and by the three Water Boards (25, 25, and 10 percent respectively) *(City of Rotterdam 2007)*.

4.3.3 M&E framework and knowledge management

M&E framework

An appropriate M&E framework should be in place for the IUWM umbrella framework to facilitate its implementation and provide mechanisms for review and progress monitoring. Its objectives are to:

- Establish a rigorous M&E framework to assess an intervention's impact on the environmental, financial, economic, and social aspects of the urban environment;
- Capture knowledge from project implementation for management and dissemination.

After ensuring that the city's senior management is committed to the design and implementation of M&E for the IUWM umbrella framework, it may be useful to go through the following questions to help guide the development of the M&E framework (SWITCH 2010):

- What will the M&E system be used for: for reporting, implementing and/or planning? If reporting is the purpose, will the indicators be aggregated at the subnational, national, or international level?
- What are the outcomes that have been formulated in the strategic planning process?
- What is the level of effort that the city is willing and able to commit to, in terms of staff time and budget, to design and update the M&E framework?
- What is the capacity of the city to collect and analyze primary or secondary data, to maintain databases, and to communicate the results to target audiences?

Each proposed **outcome** should come with a set of indicators with which to monitor its progress. The stakeholders' first task is therefore to translate the proposed outcomes of the IUWM umbrella framework into indicators. For each proposed outcome, stakeholders can derive a long wish-list of indicators. Models have been used to simplify the complex interactions between factors, such as the DPSIR (Driver/Pressure/State/Impact/ Response) framework, which was proposed by the European Environment Agency in 1998 to monitor and evaluate environmental policies in the EU. For instance, if one of the proposed outcomes is the improvement of water resources quality, the following indicators could be derived:

- **Drivers**: Indicator related to socio-economic forces, economic activities, etc (e.g. demographic growth);
- **Pressure**: Stress that human activities bring onto the environment (e.g. % wastewater collected but not treated);
- **State**: Environmental conditions (e.g. water quality indicators);
- **Impact**: Effects caused by the degradation of water quality (environmental impacts, health impacts, etc);
- **Response**: Society's response to the situation (e.g. regulation, master plan to improve water quality, etc).

Based on the long wish-list of indicators and the city's level of capacity, it would next be helpful to next do a "reality check" in order to identify those indicators that will be available, understandable to the public and updatable in practice. Doing so will help narrow down the list of indicators to an implementable M&E framework. The main questions that should drive this process are:

- Are the relevant institutions and stakeholders able and willing to supply the data for the indicators at the desired frequency?
- Is it possible to carry out additional data collection and maintain that activity over the years?
- Are the reliability and accuracy of the data for a proposed indicator adequate? (Decision makers need to be aware of uncertainties associated with the proposed indicators.)
- Does the institution in charge have the capacity to manage the data and share them in a usable and timely manner with others?

- **Example**: Stakeholders in Melbourne designed an iterative and flexible M&E system for transition to a Water Sensitive City, with objectives and indicators for a range of development scenarios for the city, as well as regular milestones to reflect and adapt the transition strategy as needed. A critical path to transition was thereby developed, specifying short-term and medium-term objectives for Melbourne (Ferguson 2012).

"Hard" data (i.e., published and available to all stakeholders) should be used as much as possible; "soft" data (i.e., indirect evidence or the informed opinion of experts) should be avoided and only used as a last resort. Indicators can then be used to present to decision makers the state of, and pressures on, the urban water system of the past and the system's evolution leading to the present. The indicators will show the impact of IUWM measures and whether those measures are fully, or only partly, successful. The target audience and purpose of the M&E framework will also determine the frequency at which the indicators must be reported on.

It may also be necessary to perform a **baseline assessment** for those indicators for which no data are available at the time of the IUWM umbrella framework design.

- **Example**: in Rotterdam, one of the main objectives of the IUWM umbrella framework is to comply with the requirements of the EU Water Framework Directive in terms of water quality. A baseline assessment of the city's water system was therefore performed in 2003, focusing on the water quality. The analysis showed that the water was rich in nutrients, contaminated by heavy metals, and that the condition of the flora and fauna was substandard. The second comprehensive water quality and ecological monitoring exercise was conducted in 2010, with a 2015 deadline set by the EU WFD for improvement of the ecological conditions of water bodies. As part of the IUWM umbrella framework, a progress report is made public every year, recording progress on the implementation of the umbrella framework. Progress is measured both in *physical* terms (project implementation) and in *financial* terms, and makes the link with progress on the environmental indicators (e.g. for water quality) chosen to monitor outcomes.

Knowledge management

As IUWM is a relatively new concept, it is crucial to ensure knowledge amassed during the design and implementation of an IUWM program in a city (including failures and lessons learned) are shared beyond the city, to inform similar initiatives elsewhere.

Having common and standard metrics for urban areas and urban water initiatives is extremely important and helpful in the long run for cities and can enable benchmarking and knowledge sharing between cities. Established platforms for urban service indicators can enable comparison and aggregation of specific indicators for benchmarking and/or reporting at the national and international level.

- **Key resources**: Benchmarking tools with indicators that may be used for knowledge management and M&E of urban water systems include IB-NET (http://www.ib-net.org) and the Global City Indicators Facility (http://www.cityindicators.org).

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Global Experience and Resources Related to IUWM

Global experience

International and WB initiatives	Online Resources
The Blue Water, Green Cities initiative	worldbank.org/laciuwm
The WPP Cross-regional IUWM initiative	water.worldbank.org/iuwm
The EU-SWITCH project	switchurbanwater.eu
CRC for Water Sensitive Cities	watersensitivecities.org.au
OMEGA — *Méthodologie pour la Gestion Integrée des Eaux Urbaines* (*in French*)	omega-anrvillesdurables.org

An early champion of the IUWM approach was the EU-funded SWITCH project, which was implemented between 2006 and 2011 and researched IUWM approaches around several interrelated themes: water supply, stormwater, wastewater, planning for the future, engaging stakeholders, and decision-support tools. The research project engaged with 12 cities around the world, by empowering them to develop a vision for water in their city 30 to 50 years into the future, and to think of an integrated approach that might benefit them. These cities included Accra (Ghana), Lima (Peru), Bogota and Cali (Colombia), Alexandria (Egypt), Tel Aviv (Isreal), Łódź (Poland), Beijing (China), Belo Horizonte (Brazil), Birmingham (UK), Hamburg (Germany) and Zaragoza (Spain). A useful resource is the SWITCH Training Kit, which contains several modules that can be used to organize a workshop and explore IUWM options. The SWITCH project also documented case studies of cities that had made progress in transitioning to various stages of sustainable urban water management, including Berlin, Seoul, and London.

- All documentation from the SWITCH project, including diagnostics of urban and water challenges for the above cities, training resources, case studies, and IUWM knowledge base can be found at http://www.switchurbanwater.eu/index.php.
- The SWITCH Training Kit can be accessed at http://www.switchtraining.eu/trainer-materials/ and includes the following modules: (1) Strategic Planning – Preparing for the Future; (2) Stakeholders – Involving All the Players; (3) Water Supply – Exploring the Options; (4) Stormwater – Exploring the Options; (5) Wastewater – Exploring the Options; and (6) Decision-Support Tools – Choosing a Sustainable Path.

The tangible outcomes for the cities involved in the SWITCH project are quite difficult to assess, as the processes and outcomes related to the transition to an IUWM mindset varied between the cities approached, depending on the urban- and water-related challenges and the drivers for the transition.

In Belo Horizonte (Brazil), SWITCH focused on the development and uptake of more natural and environmentally friendly approaches to urban drainage to minimize flooding risks while also improving river corridor habitats. Outcomes included commitment by the Municipal Parks Foundation to scale up rainwater harvesting and a start by the city's participatory budgeting committees on implementation of alternative and more sustainable drainage solutions.

In Alexandria (Egypt), by contrast, activities focused on developing an integrated urban water management plan and demonstrating how urban slum communities could be served with the existing water supply and be given capacity to manage their sanitation system (Howe 2012).

However, not much information is available on what has happened in these cities since the end of the SWITCH project in 2011, and whether this introduction to IUWM paved the ground for implementation of IUWM frameworks. It is encouraging to see that the SWITCH Training Module has since been adapted for more cities, in particular in India, and is currently being applied in Jaisalmer and Kishangarh, in Rajasthan and Solapur States, and Ichalkaranji in Maharashtra State (ICLEI 2014).

The lessons learned from the SWITCH experience include the following (Howe 2012):

- The large number of organizations involved in the urban water sector in most cities was challenging and led to ambiguity in responsibilities, complicated by a lack of incentives for particular areas or institutions to work together.
- A lack of expertise in integrated urban water management in planning organizations (both at city and national level) limited the cities' ability to engage with the technical organizations and provide leadership or coordination.
- It was difficult to agree on common, city-wide M&E indicators for integrated urban water management, relying instead on a collection of indicators for various technical areas.
- The short- to medium-term focus of water management organizations, in accordance with political and funding cycles and priorities, made it difficult for the cities to plan for a 30–50 year timescale;
- Water organizations generally had stronger expertise in design and construction using conventional technologies than in holistic water management and planning and in unfamiliar technologies such as sustainable urban drainage, natural treatment systems, and demand management;
- It was difficult to get groups like energy providers, developers, and architects involved in the process and, as a result, these issues were generally represented by urban planning organizations.

Another pioneer institution in the field of IUWM is the Cooperative Research Centre (CRC) for Water Sensitive Cities, based in Monash University, Australia. The organization groups a number of lead thinkers and academics around the transition to Water Sensitive Cities. Their research is based on the Australian experience of dealing with water resources scarcity in urban areas, and is organized around four aspects of the transition to IUWM: (i) society (including the economic aspects of transition); (ii) water-sensitive urbanism (including urban design and flood resilience); (iii) technologies (for water reuse and fit-for-purpose water use in particular); and (iv) adoption pathways (including capacity building and M&E). The CRC is a leader in cutting-edge research on the above themes, which primarily aims to assist Australian cities in implementing innovative IUWM options. The CRC also runs a seven-week long Massive Open Online Course (MOOC) entitled "Water for Livable and Resilient Cities," led by Professor Rob Skinner (Monash University), which is a great resource for capacity building and can be accessed remotely through online videos.

- The CRC for Water Sensitive Cities and Monash University MOOC *Water for Liveable and Resilient Cities* are available at https://www.futurelearn.com/courses/liveable-cities.

In addition, the International Water Association (IWA) launched a "Cities of the Future Programme" which focuses on exchanging knowledge in the water sector to address the challenges of urban water management in an integrated manner. The program established voluntary working groups composed of utility practitioners and thought leaders, who tackle key areas required for an IUWM approach. The program is centered around the following themes: Engineering, Planning, and Institutions and Foundation, and is coordinated by the University of South Florida. The results are documented in discussion papers and publications (including an IWA Cities of the Future Water Wiki) and are debated at Cities of the Future workshops and events. The working groups are complemented by Cities of the Future networks on global, regional, and national scales as well as alliances between cooperating cities and academia. However, the publications listed on its website were not publicly available at the time of writing and the IWA Water Wiki dedicated to the "Cities of the Future" scheme appears to be dormant, as no new publications or updates have been listed in the past couple of years. Nevertheless, the IWA Cities of the Future initiative remains a major avenue for knowledge exchange and dissemination on IUWM, with regular workshops held several times a year.

- IWA Water Wiki "Cities of the Future": http://www.iwawaterwiki.org/xwiki/bin/view/Organizations/+Cities+of+The+Future
- Cities of the Future Program website: http://psgs.usf.edu/cof/

Finally, another initiative that may be of particular interest to task teams working in francophone client countries is the OMEGA project (*Outil Méthodologique de Gestion Intégrée des Eaux Urbaines*), which aims to develop a methodology for assisting municipalities in overcoming current difficulties linked to urban water management and in implementing an integrated approach to urban water management. It is the product of a collaboration between three French research institutes, a WSS utility (Lyonnaise des Eaux/Suez Environnement), and three French municipalities, which are acting as coordinators and serve as case studies for the implementation of particular IUWM options (Bordeaux, Lyon, Mulhouse). A very interesting and practical output of this research project is a methodology for developing an integrated approach to urban water management in French cities. An abridged version of the methodology is available publicly, while the full version is available upon request from Lyonnaise des Eaux/Suez Environnement.

- Information on the OMEGA project (*in French*): http://www.omega-anrvillesdurables.org/
- OMEGA abridged methodology for IUWM (*in French*): http://www.graie.org/OMEGA2/IMG/pdf/OMEGA_livrable_L2b_L1b-Guide_methodologique-1p.pdf.

Bank experience

- **Key resource**: An overview of World Bank and WPP interventions in IUWM and their conclusions can be found in Closas et al., 2012.

The Bank's work on IUWM encompasses three regions and has looked into different aspects of IUWM, from dealing with water scarcity to improving water quality and climate resilience. Implementation of IUWM interventions has been undertaken under a number of pioneering operations in Brazil (Box 6). Elsewhere the Bank's efforts have focused on conducting urban water diagnostics and designing umbrella frameworks for IUWM. Capturing the lessons learned from the implementation of these projects is critical to understanding what conditions the success (and failure) of IUWM initiatives.

Latin America

From the early 1990s, the World Bank embarked upon a series of projects in Brazil, entitled 'Urban Water Pollution Control' projects, which included operations in São Paulo, Belo Horizonte, Curitiba and Vítoria, as well as diagnostic exercises for other rapidly urbanizing cities across the country. These operations were IUWM projects in all but name, as they addressed a suite of interrelated issues concomitantly, encompassing wastewater pollution reversal, stormwater and solid waste management, urban upgrading and green space development, and did so through the engagement of different local and state actors from the relevant sectors, and with an emphasis on improving the quality of life of the poor (Box 6). Subsequent generations of projects in Brazil have futher built on these early IUWM experiences, notably in São Paulo, Vítoria, Betim, Uberaba and Teresina. Subsequently, with the support of the Water Partnership Program (WPP), the Bank has applied the concept of Integrated Urban Water Management through the Blue Water, Green Cities initiative in several cities in Latin America, including Bogotá (Colombia), Buenos Aires (Argentina), São Paulo and Rio Grande do Norte (Brazil), in Uruguay and Panama. The program finances diagnostic studies of urban water challenges for the above cities, which represents a necessary first step when considering whether an IUWM approach may be suitable for solving urban and water-related issues, prior to project identification. The Blue Water, Green Cities initiative focuses on fostering a participatory approach in determining an IUWM framework in Latin American cities, as well as undertaking thorough diagnostics of the urban and water issues being faced. The resulting documentation provides a template for the type of issues that should be covered in urban water diagnostics and is available at http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/LACEXT/0,,contentMDK:22358351~pagePK:146736~piPK:146830~theSitePK:258554,00.html.

Europe and Central Asia

The Bank and the WPP also undertook TA to develop an IUWM umbrella framework in Baku, Azerbaijan. The approach focused on identifying the main urban and water challenges in Baku, assessing the institutional framework for urban and WRM, and having consultations with stakeholders. Based on this, the Bank team developed an umbrella framework for IUWM in Baku, which included structural and nonstructural IUWM options, which took into account future urban and water development scenarios, and which was aligned with Baku's Strategic Development Plan. The team also conducted some studies to prepare for potential investment lending by donors, including a financial analysis, as well as an environmental and social analysis, and a risk assessment for various IUWM options. (Marino 2014).

Box 6. ■ Developing an IUWM Approach in Brazil: an overview of Bank support in São Paulo, Paraná and Espírito Santo

An IUWM approach has been adopted in a number of water and urban projects in Brazil over the past two decades. The information below refers to the following Bank-funded projects implemented between 1992 and 2007: the Water Quality and Pollution Control Project in São Paulo and Paraná, and the Water and Coastal Pollution Management Project in Espírito Santo (World Bank 2007).

- The overarching objective of these projects was to preserve and improve water quality; poverty alleviation was also central to these projects, as the choice of target areas coincided with poverty alleviation and watershed management strategies.
- The São Paulo Water Quality and Pollution Control Project (the 'Guarapiranaga' project, 1994–2000), a US$ 387 million project cofinanced by the state government, the state water utility, the municipality of São Paulo and the Bank, initiated the study of the Guarapiranga watershed, strengthened the institutional capacity to manage the watershed in an environmentally sustainable manner, and improved the quality of life of the watershed's slum dwellers by providing them with water supply, sanitation and related services. The achievements of the Guarapiranga project included reversing the pollution of the Guarapiranga reservoir, used as a potable resource fo the city of São Paulo, and improving the quality of life and environmental health of a large number of slums surrounding the reservoir. The project also contributed to increased community awareness. Project outcomes were reflected in the enhanced level of respect for public areas, equipment and amenities, in the concomitant upgrading of housing with residents' own funds, and in the overall post-program increase in real estate values. Guarapiranga also helped show how to integrate interventions within a complex institutional framework involving different levels of government (state and municipal) and myriad service providers.
- In Paraná, the objective was to rehabilitate and maintain the river and its larger watershed as a reliable water source, and to promote flood control and rehabilitation of flooded areas in Curitiba.
- In Espírito Santo, the objectives were to improve the efficiency of the state water company and provide appropriate water and sanitation infrastructure to low-income urban areas of the capital city, Vitória.

Research conducted during the implementation of the projects generated evidence that the problem of water quality was not just caused by *industrial* waste, as was initially thought, but mostly by *domestic* wastewater. These findings confirmed the importance of including the upgrading of informal settlements to include adequate wastewater, stormwater and solid waste management in them as a way of reversing broader water quality challenges in the cities; they also highlighted the importance of undertaking strong monitoring and data collection.

An IUWM approach has been adopted by follow-up projects in Brazil, notably in São Paulo, Espírito Santo and Teresina.

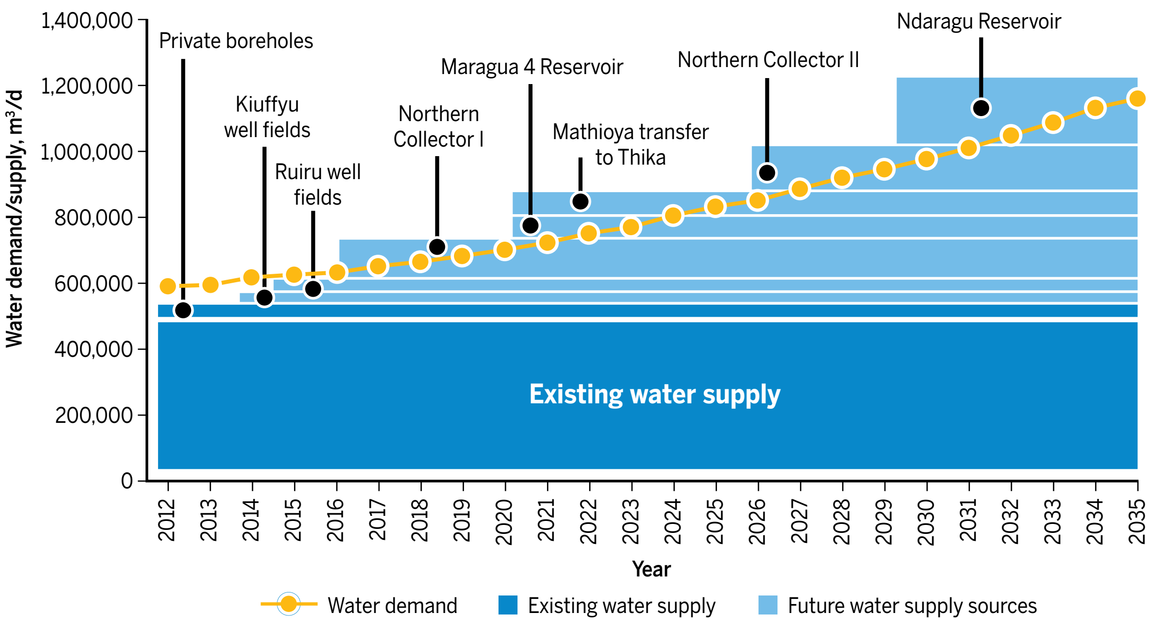
Source: World Bank (2007); www.worldbank.org/laciuwm.

Africa

The Bank with support from the WPP conducted a number of analytical studies to look at the potential for an IUWM approach in the growing urban areas of Sub-Saharan Africa. Jacobsen et al. (2012) analyzed the urban- and water-related challenges of 31 cities in Africa, based on an in-depth diagnosis in several cities, including Nairobi (Kenya) and Arua and Mbale (Uganda).

In the case of Nairobi, the urban and water diagnosis was based on a range of scenarios for future urban water use until 2035 and proposed an array of IUWM options to plug the growing gap between urban water supply and demand.

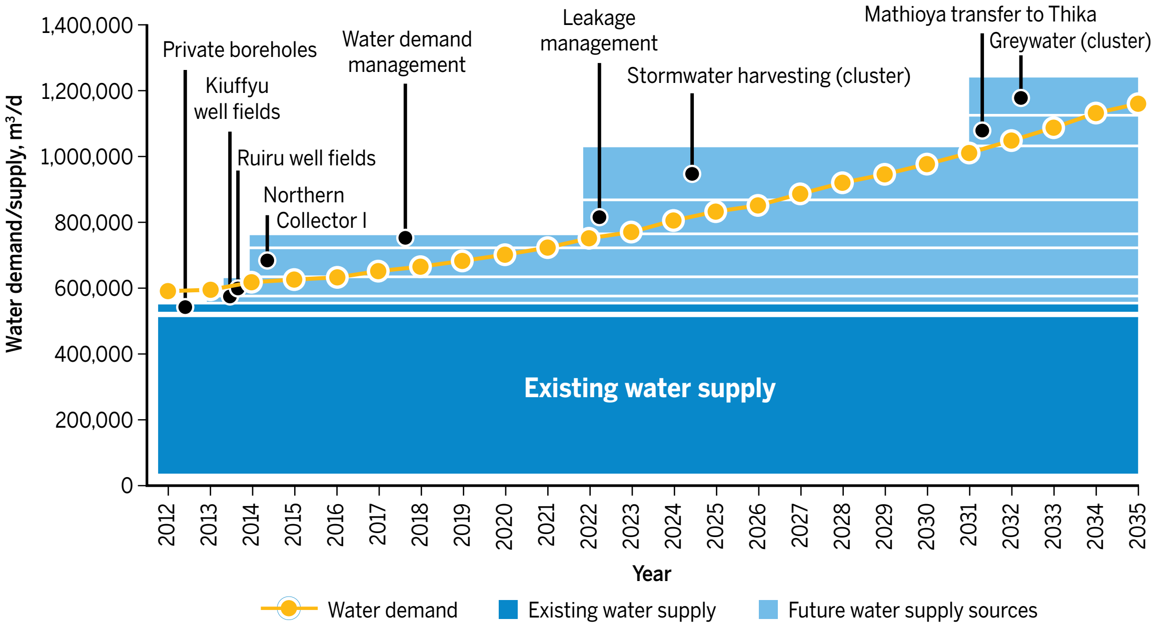
Figure 10. Conventional Development of Water Resources for Nairobi, Kenya (2010–35)



Source: (Jacobsen 2012).

Figure 10 shows the conventional water supply options (from storage and transfers of surface water) that were being considered by Nairobi to meet the growing water supply gap in the coming years, while Figure 11 shows how the demand for water can be met more efficiently by diversifying water sources and considering the use of fit-for-purpose water sources—under an IUWM approach. While city authorities expressed interest in following-up in each of the three cities selected as case studies, Nairobi was the only one in which an integrated approach was applied as part of an ongoing Bank investment project: a Water Master Plan was developed, which served as an umbrella framework for IUWM and considered IUWM options through multicriteria analysis. These options included demand management and loss reduction, groundwater sources, stormwater storage and reuse, wastewater recycling, and greywater reuse. The scale of the Water Master Plan was the metropolitan region (not just the city), which ensured that communities situated where the raw water sources are located were also included in the process of developing the framework.

Figure 11. Staged Development of Water Resources for Alternative IUWM Approach for Nairobi, Kenya (2010–35)



Source: (Jacobsen 2012).

Appendix A

Appendix B

Literature Review: The IUWM Paradigm

Tucci (2007) argues that there are three sequential stages in the development of urban water services in developed countries, namely:

- Interventions prior to the 1970s, concerned with public health;
- Urban water management from the 1970s to the 1990s, concerned with corrective measures to improve water quality and quantity;
- From 1990 onward, a paradigm shift to sustainable water management.

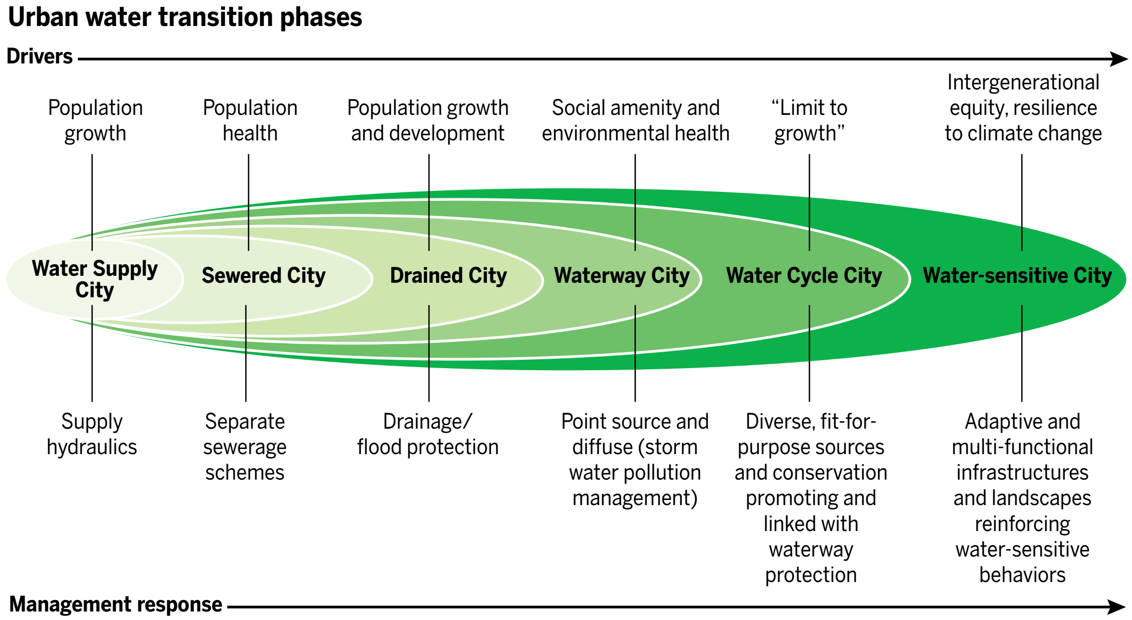
The Water Sensitive Cities Framework (Wong 2009) has also been used to describe the stages in a city's development and urban water management (Figure 12). More specifically, it describes the various stages that developed cities have historically taken to develop, and the drivers that have pushed for paradigm shifts in urban water management. While most cities in the developed world by the early 20th century had gone through the first phases and have recently begun to shift from the concept of "drained city" to that of "environmental city," only a few have started to transition to the stage of the "water cycle city", while the "water sensitive city" remains an aspiring concept that has yet to be translated into reality.

The advantage of this framework is that it gives a historical perspective to the development of urban water management in cities and underpins the potential for cities in developing countries, which may be at the "water supply" or "sewered" city stage, to 'leapfrog' across several stages to that of a "water sensitive" city by avoiding the loss of environmental capital that developed cities are now trying to correct/reverse.

However, it may also be difficult to characterize developing cities using this framework, as it may be too monolithic in practice: a developing city may exhibit aspects of the waterway city in some areas (e.g., the business district), of the drained city in others, of the sewered city or the water supply city elsewhere, or have no services at all in informal areas. For instance, a city like Nairobi may provide water supply, sewerage services and drainage to parts of its city, but some areas may not benefit from any of these services at all—therefore making its insertion with this framework more problematic.

A more pragmatic approach was chosen by Jacobsen et al. (2012), who emphasized the need to analyze the institutional capacity of cities as well as their water-related challenges when considering an IUWM approach in developing countries. These criteria make sense in a developing context and have been emphasized earlier in this guidance note (Section 1.2.4): an IUWM approach may

Figure 12. The Water Sensitive City Framework



Source: (Wong 2009).

be more suited to cities with strong capacity (characterized as a mix of governance, accountability, institutional strength, and economic opportunities) and with many water-related challenges (including water scarcity, flooding, droughts, climate extremes, sea level rise, solid waste management, and sanitation-related challenges).

Checklist for Rapid Urban and Water Diagnostic

This questionnaire can be used when conducting a participatory workshop with stakeholders to determine current city and water-related challenges and needs.

Sector	Challenges
Urban planning	What are the main causes of population change?
	What are the trends of urban expansion or change?
	What is the percentage of informal areas/slums in the city? Where are they located? How are they currently serviced and by how much?
	Are there any ongoing urban development programs/plans?
	Are there any challenges linked with enforcing urban planning and related regulations?
	Is there an urban plan for the next decade? What is the process of urban planning—who is involved?
	How is urban development financed?
Water resources	Is there a watershed management organization and management plan? What is the process of managing water in the watershed?
	Are water sources contaminated? What are the sources of contamination (point and non-point sources)?
	How is water quality monitored? Does it comply with existing regulations?
	How is groundwater managed and monitored (quantity and quality)?
	Are there periodic or ongoing water scarcity issues? Have there been shortages of water in the past? How are those shortages managed?
	How is water allocated between users in the watershed? Do the rules differ in times of drought? Have there been conflicts?

(continued on next page)

Sector	Challenges
Water supply	What percentage of the city's population is connected to the water supply network? What percentage does not have access to water supply?
	What are the sources for water supply and where are they located?
	Are raw water sources for water supply subject to seasonal /climate variability? Are they subject to contamination and, if so, what are the sources of this contamination?
	What is the level of NRW/losses in the network in the city?
	Is water supply intermittent? If so, how is it managed?
	What is the cost of the services? Is it affordable? Are there any direct or indirect subsidies for water supply? Are there informal water supply service providers? How much are there services?
	Is the utility financially sustainable?
	Is there a water supply plan for the next decade? What is the process of planning for water supply?
	Who regulates water supply quality and costs?
Sanitation	Who is in charge of sanitation? Same entity as water supply?
	What is the percentage of the population: with septic tanks? connected to the sewerage network? with other forms of onsite sanitation? without access to improved sanitation?
	What is the percentage of fecal waste that is adequately collected, treated and disposed of/reused?
	Are sanitation facilities frequently blocked by solid waste? What problems does this cause?
	What is the percentage of collected wastewater that is treated?
	What is the level of treatment and its efficiency?
	Does the water body have the capacity to receive wastewater effluent?
	What are the standards for water quality and the environmental indicators used?
	What is the cost of sanitation services? Are there any subsidies?
	Is the entity in charge of sanitation financially sustainable?
	Is there a sanitation plan for the next decade? What is the process of planning for sanitation?
	Who regulates sanitation services and costs?
Stormwater	How is drainage infrastructure maintained? How is it planned for?
	Does the city's urban development have an effect on stormwater flow/velocity?
	Are there frequent floods in the city? Why?
	Are drains frequently blocked by solid waste? What problems does this blockage cause?
	What is the population's perception of stormwater management?
	What is the budget for stormwater and drainage management and how is determined? Who pays for it? Is the population charged?
	Is there a stormwater management plan for the next decade? What is the process of planning for stormwater management?

(continued on next page)

Sector	Challenges
Solid waste	What entities are involved in solid waste collection, and what percentage of the city is covered?
	What is the percentage of solid waste produced that is collected?
	Is there a program of minimizing and recycling/reusing solid waste?
	Is there an adequate solid waste disposal site? Is it managed sustainably?
	What percentage of solid waste produced is disposed of adequately?
	What is the coverage and frequency of street cleaning?
	Who is in charge of cleaning drains, canals, or urban water bodies?
	What is the cost of solid waste services? Who pays for it?
	Is there a solid waste management plan? What is the process of planning?
Governance	Is there an independent body in charge of regulating water?
	Is there an entity in charge of WRM? Water licensing? Is it integrated with urban water/ stormwater management?
	How are conflicts between water users managed during droughts or shortages?
Economic impacts	What is the impact of floods? Their frequency and severity?
	Are there landslides? What is their impact, frequency, and severity?
	What is the prevalence of water- and excreta-related diseases (e.g., vector-borne diseases such as malaria)?
	Do water bodies meet water quality standards? How often is their quality assessed?
	What economic services do water bodies provide? (e.g., tourism, fishing, ecosystem services)
	How is urban/water infrastructure financed?

Source: Authors, based on Tucci, 2009.

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