Scalar mismatches in metropolitan water governance

A comparative study of São Paulo and Mexico City

van den Brandeler, F.A.

3. URBAN WATER GOVERNANCE

3.1 INTRODUCTION

This chapter explores the literature on urban water governance.[14] It addresses the secondary research question: What does the literature on urban water governance tell us about how to understand and address metropolitan water challenges? I address this question through a literature review and content analysis. First, I examine the evolution of urban water governance over time, in particular the paradigmatic shift towards more integrated and sustainable approaches to water management in cities (see 3.2.1). I then describe the main characteristics of Urban Water Management (UWM) (see 3.2.2), as well as the main drivers, institutions and instruments influencing this approach (see 3.2.3). Following this, I debate the strengths and weaknesses of UWM using as reference the reviewed literature (see 3.3). Finally, the chapter links back to the knowledge gaps identified in 1.2.3, and provides insights from the literature on how UWM can address metropolitan water challenges are discussed (see 3.4).

3.2 OVERVIEW

3.2.1 EVOLUTION TOWARDS MORE SUSTAINABLE AND INTEGRATED UWM

Urban water governance has undergone significant changes over the past decades, starting with the concept of Urban Water Management (UWM) and subsequently evolving to Integrated Urban Water Management (IUWM), Sustainable Urban water Management (SUWM), and a number of other concepts with overlapping goals.[15] During the 20th century, modernist visions of city planning rose to prominence around the world. This reshaped UWM to reflect a technocratic approach, aiming for controlling water flows, promoting public health, safety, and property protection, while ignoring environmental considerations (Kaika, 2005; Swyngedouw, 2006; Brown and Farrelly, 2009; Farrelly and Brown, 2011; Rauch and Morgenroth, 2013; Winz *et al.*, 2014). Actions focused on bringing water in and wastewater out of the city in a centralized, hierarchical and linear manner, with less attention to upstream and downstream linkages or longer-term environmental and social impacts (Engel *et al.*, 2011; Donoso, 2014; Winz *et al.*, 2014; Jacobi *et al.*, 2015). Scholars and policymakers considered that water should circulate constantly in the city, to wash it off waste and then leave it as sewage (Swyngedouw, 2006) – a process enabled through standardized and large-scale infrastructure and technological solutions (Farrelly and Brown, 2011; GTT, 2014; Winz *et al.*, 2014).

The modernist paradigm behind UWM reinforces dichotomies that separate the city and nature (i.e. human/non-human, urban/rural, culture/nature, centre/periphery) (Zimmer, 2010; Follmann, 2016). This transpires in practice through the drawing of boundaries between ontological spheres, giving order and a framework from where to proceed (Forsyth, 2003).

[14] This chapter draws heavily on Brandeler *et al.* (2019).

[15] Other concepts include Water-Sensitive Cities and Water-Sensitive Urban Design, for instance. The literature review found SUWM and IUWM to be the dominant concepts.

Land use planning institutionalizes boundary-making as it "formalizes the separation between nature and abstract space through the written codes of legal statute and professional conduct which impose a site-based, rather than system-based, narrative structure on its treatment of the environment" (Whatmore and Boucher, 1993: 169). While land use planning addresses the physical space, it often leaves out ecological processes and the fluidity of multiple relations between different spaces and places (Murdoch, 2006: 127).

The Political Ecology scholarship is critical of conventional UWM and highlights the tension between the 'modern' and 'non-modern' by arguing that the separation between the 'natural' and the 'social' will be undermined by ecological relations, as nature will eventually overcome human society and disrupt economic and social relations (Murdoch, 2006). It also illustrates how urban works and UWM create mechanisms of exclusion to access adequate quantities of potable water (Swyngedouw, 2006). This remains stark in cities of the Global South, where the urban elites often live in permanently irrigated tropical gardens, while the poor live in urban deserts.

Since the 1990's, the urban water literature has shifted towards a greater emphasis on social, cultural, environmental and economic aspects (Winz *et al.*, 2014). In recent years, the concept of Integrated Urban Water Management (IUWM) has emerged to help policymakers and local governments think about urban water. IUWM is nested within the broader framework of IWRM (Bahri, 2012), and is aligned with the 'sustainable development' paradigm formalized by Agenda 21 at the 1992 UN Earth Summit (Gabe *et al.*, 2009). IUWM is defined as a "participatory planning and implementation process, based on sound science, which brings together stakeholders to determine how to meet society's long-term needs for water and coastal resources while maintaining essential ecological services and economic benefits" (GDRC, 2015: 1).

IUWM promotes a holistic view of the urban water cycle, with a coordinated and flexible mode of strategic planning, and decision-making processes that must involve broad stakeholder participation (Brown, 2005; Varis *et al.*, 2006; Closas *et al.*, 2012). The participation of marginalized communities and the inclusion of gender issues aim to enhance equitable access to water (GDRC, 2015).

Parallel to IUWM, scholars also developed SUWM (Sustainable Urban Water Management), an approach that also departs from traditional UWM through a focus on the urban water cycle, emphasizing adaptation, decentralization, participation and integration (Brown and Farrelly, 2009; Daigger, 2011; Marlow *et al.*, 2013). SUWM considers water a central element of sustainable urban areas and a potential starting point for urban planning (Daigger, 2011). This requires that water professionals and urban planners become strategic partners. This view promotes a circular rather than linear approach to managing the urban water cycle, one where water is collected to respond to urban demands, treated to meet quality requirements, distributed to end users, collected again as wastewater and treated for reuse (Daigger, 2011). This combines large, centralized infrastructure with alternative, local and distributed technologies and participation (Van de Meene *et al.*, 2011; Younos, 2011; Closas *et al.*, 2012). However, the emphasis is particularly on local level, infrastructure-oriented initiatives (Marlow *et al.*, 2013; Rietveld *et al.*, 2016). Integrating infrastructure and biophysical systems (e.g. stormwater treatment and rainwater harvesting systems) requires considering social, economic, environmental and political contexts (Vlachos and Braga, 2001; Mitchell, 2006; Brown and Keath, 2008). In addition, it requires changing the existing (traditional) management structure, which will involve institutional reform (Daigger, 2011). The barriers to transitioning to SUWM are more often socio-institutional than technological (Brown and Farrelly, 2009).

Along with the shift from modernist to sustainable and integrated approaches to UWM, the end of the 20th century also experienced an evolution from state led UWM towards private management, inspired by neoliberal principles. Neoliberalism promotes a shift from "state responsibility for providing services to provision of services by private economic actors in which the role of the state is limited to enabling and regulating" (Ahlers *et al.*, 2014: 3). It is also associated with liberal notions of state reform, where decentralization reduces the burden of inefficient central bureaucracies and market incentives lead firms to incorporate the economic value of water into production costs (Abers and Keck, 2013: 50–51). Under this approach, UWM embraces full cost pricing, competition and privatisation (Bakker, 2002; Van de Meene *et al.*, 2011). Although there are claims that market governance aims to allocate resources efficiently and empower citizens (Pierre and Peters, 2000), this market-driven approach has also been criticized for leading to private monopolies, restrictive contracts limiting citizen access to previously accessible water resources and institutional fragmentation (Van de Meene *et al.*, 2011). In recent years, municipalities and regions have been re-municipalising water services in areas where these had been privatized (Parker and Sewell, 1988; Bakker, 2002, 2003; McDonald, 2018).[16] This trend is far from uniform however, with forms of re-municipalisation that are autocratic (i.e. aimed at enhancing control by a ruling elite), highly marketized (i.e. focused on market-based performance indicators), or observing social democratic principles (i.e. committed to promoting social and economic justice), among others (McDonald, 2018).

3.2.2 Main characteristics of UWM and IUWM/SUWM

UWM and IUWM/SUWM have similarities and differences in their goals, their scale of implementation, their approach to urban water, key actors and their mandates, water users, and what constitutes 'inputs' and 'outputs' of water. These are summarized in Table 3.1.

[16] Since the turn of the 21st century, France has shifted towards the re-municipalisation of water services, defined as the transfer of water services from private companies to municipal authorities, with Paris in 2010 as the most notable case (Pigeon *et al.*, 2012; Hall *et al.*, 2013). This was spurred by corruption between large private water companies and local politicians, and a report by France's public audit body highlighting widespread lack of transparency and overcharging in the water sector (Hall *et al.*, 2013). In Paris, re-municipalisation led to economic savings and a reduced water tariff (Pigeon *et al.*, 2012; Hall *et al.*, 2013). The focus is the shift from private to public management, rather than the territorial scale of this management.

Table 3.1 Main characteristics of UWM/SUWM/IUWM

Characteristics	**UWM**	**SUWM/IUWM**
Goals	Affordability, universalization and public health. Flood control	Also concerned with sustainability, adaptation, human welfare
Principle scale of policy implementation	Urban	Urban Sub-basin (within municipal boundaries)
Approach	Technocratic, centralized, sectoral, linear	Integrating grey and green infrastructure. Combining centralized and participatory, traditional and alternative technology, hard and soft measures
Actors	City departments, water utility/ies	City departments (including environmental department, transport), water utility/ies, civil society organizations, private sector
Mandates	Drinking water, sewage collection, treatment and disposal, stormwater management, flood protection and pollution control for diverse users (i.e. domestic, commercial, industrial) with divergent abilities to pay	In addition to conventional mandates, they strive for synergies with environmental management/ conservation and with other urban actors (e.g. planning, housing)
Users	All users within the urban area (mainly public/urban users)	All users within the urban area (mainly public/urban users)
Water 'inputs'	Blue water (i.e. groundwater from within urban area and surface water often imported from beyond urban area)	Blue water, including local water sources after rehabilitation and rainwater Greywater (i.e. treated wastewater)
Wastewater / stormwater 'outputs'	Expelled out of the urban area Focus on hygiene and controlling urban flood/mudslides risks	Recycled and reused or infiltrated Climate change adaptation increasingly considered

Source: Author

Goals: UWM's main goals are to address the need for drinking water, sewage collection, treatment and disposal, stormwater management, flood protection and pollution control for diverse urban users (i.e. domestic, commercial, industrial). Historically, UWM has focused on affordability (in some cases, recognizing diverging abilities to pay), universalization and public health. The shift towards alternative approaches such as SUWM/IUWM reflects a concern for broader social, economic and environmental outcomes than improving water quality and quantity (Gabe *et al.*, 2009; Maheepala, 2010; Daigger, 2011; Porse, 2013). This means recognizing the ecological functions of water, diversifying water sources, and promoting adaptation, health and human welfare, social and economic vitality, overall community improvement and stakeholder satisfaction (Maheepala, 2010; GDRC, 2015; Neto, 2016). Examples include improving urban biodiversity, exposing and rehabilitating urban water flows to create more 'liveable' cities, extending the life of urban water infrastructure, and developing green infrastructure that manages stormwater, removes pollutants and recharges aquifers (Gabe *et al.*, 2009). The IUWM framework also strives for optimizing the interface between urban water and other urban sectors (e.g. housing, transportation), as well as with relevant activities beyond urban boundaries (e.g. agriculture, downstream water use) (Brown, 2005; Varis *et al.*, 2006; Closas *et al.*, 2012; GDRC, 2015).

Spatial scale: Scholars (Niemczynowicz, 1996; Lee, 2000; Daigger, 2011) and practitioners (Bahri, 2012; OECD, 2015b) emphasise the local level as the most appropriate for managing urban water, particularly for water services and water-related risks. This involves municipal, district and lower levels, such as the neighbourhood and household. The form of urbanization, the type of urban planning and the demand for water in urban areas and its use and discharge, requires policies at the urban scale (Jha *et al.*, 2012). The shift to IUWM/SUWM leads to an emphasis on the use of small-scale infrastructure and technology (i.e. rainwater harvesting devices, smart water systems) and community infrastructure (Gabe *et al.*, 2009; OECD, 2015b).

Water-related risks may be addressed by local actors (e.g. municipal civil defence) but certain risks require interventions by higher levels of government or multi-level responses, when drivers of risk originate beyond the local level. Similarly, water distribution in cities can be entirely under the authority of local governments (e.g. groundwater extraction within municipal borders) but often involve higher levels of government as water must be transported from parts of the basin beyond the city. Moreover, cities lack authority over the ownership of water resources and their allocation as higher levels of government generally decide *who* owns water and *how* it can be allocated to different users.

Approach: UWM has historically been implemented through large-scale infrastructure and technocratic, centralized management (Farrelly and Brown, 2011; Rauch and Morgenroth, 2013). UWM promotes managing different steps of the urban water cycle separately, through sectoral entities that do not coordinate the needs for water supply, environmental quality and flood management (Niemczynowicz, 1999; Abdullah and Christensen, 2004; Brown, 2008; Daigger, 2011; GTT, 2014). The result is a linear approach of taking, using and rapidly discharging water (Kayaga *et al.*, 2007; Brown and Farrelly, 2009; Barraqué and Zandaryaa, 2011; Gregory and Hall, 2011; GTT, 2014). This approach reflects the human desire to control nature and translates into flood protection infrastructure (e.g. dikes, dams), long-distance transfers of water, elevation of water with pumps and a networked water distribution system (Barraqué and Zandaryaa, 2011; Nastar, 2014).

SUWM attempts to integrate infrastructure and biophysical systems (e.g. stormwater treatment and rainwater harvesting systems), thereby considering social, economic, environmental and political contexts (Vlachos and Braga, 2001; Mitchell, 2006; Brown and Keath, 2008; Brown *et al.*, 2008). It combines large, centralized infrastructure with alternative and distributed technologies and participation (Van de Meene *et al.*, 2011; Younos, 2011; Closas *et al.*, 2012). Similarly, IUWM uses structural and non-structural measures (e.g. new knowledge and information technologies, education programmes, water pricing and regulations) (Maheepala, 2010; Iacob, 2013). This shift in approach also emphasises coordination between government levels and between different types of actors (i.e. private sector, civil society, government, educational and research institutions) (Jha *et al.*, 2012).

Actors: UWM actors are generally centralized (at local or regional government level) and hierarchical (Elzen and Wieczorek, 2005; Saleth and Dinar, 2005; Farrelly and Brown, 2011; Porse, 2013), although in the Global South, informal, decentralized providers of water services also play important roles (Ahlers *et al.*, 2014), as do local and international NGOs (Brocklehurst, 2004). Higher levels of government generally design legal and regulatory frameworks and provide financing. SUWM/ IUWM promote decentralization, the devolution of administrative functions, inter-sectoral coordination, innovative funding solutions, co-management with communities and the private sector, and flexible institutional frameworks (i.e. public-private partnerships) (Bahri, 2012; Closas *et al.*, 2012; Whitler and Warner, 2014). Within the IUWM framework, local governments are seen as well-placed to oversee urban water programmes, in combination with top-down regulatory responsibility and bottom-up user needs and obligations (GDRC, 2015).

Mandates: The core UWM functions are drinking water supply, sewage collection and treatment, and urban drainage (Barraqué and Zandaryaa, 2011; Engel *et al.*, 2011), supplemented by flood mitigation and control of waterborne diseases (GTT, 2014). These are often the responsibility of local governments, although they may delegate certain functions to higher levels of government or private actors or call in help from outside (e.g. to deal with disasters) (Baud and Hordijk, 2009). However, local governments are rarely in the forefront of developing policies that address these challenges (Ibid). More recent approaches to UWM promote coordination between a wider range of stakeholders, such as urban planning, and in the Global South sometimes the development community (Whitler and Warner, 2014). The IUWM/SUWM literature further advocates broadening mandates to incorporate ecosystem health, basin management, biodiversity conservation, conflicts and competing water uses, wastewater treatment and disposal, risk prevention, and integrating all urban activities (Coccossis and Nijkamp, 2002; GTT, 2014).

Since 1990, urban rivers have gained prominence in urban planning (Levin-Keitel, 2014) and urban river rehabilitation projects have multiplied (Deason *et al.*, 2010; de Haan *et al.*, 2015). Green infrastructure and Low Impact Development (LID) Best Management Practices (BMPs), such as infiltration basins, grass swales and green roofs manage stormwater runoff as close as possible to the source and reduce impacts on downstream receiving rivers (Jia *et al.*, 2013). However, such projects are usually municipal projects and rarely extend beyond city boundaries. While IUWM emphasises urban-rural relationships (Bahri, 2012), mandates are restricted to areas under the jurisdiction of the local authorities and/or water utility (Engel *et al.*, 2011). Overall, responsibilities often remain unclear, fragmented and overlapping, leading to tensions between professionals and politicians with different values and views (Brown, 2008; OECD, 2016).

Users: Water users within UWM are generally those who receive water from utilities for public/urban use, commerce, industry and other purposes, as opposed to users who are issued permits for water abstraction. In some cases, this may include informal users, for instance, residents of informal settlements, particularly where legal frameworks for water management have incorporated principles such as the human right to water (e.g. South Africa). In other cases, providers only serve registered consumers, as is the case of Hyderabad in India (Nastar, 2014), despite the growing recognition of the human right to water (Obani and Gupta, 2015). UWM generally prioritizes public/urban uses above other uses by higher levels of government, but this is not always accompanied by incentives at local levels for rational water use, even as urban water use has increased (Lee, 2000). Cities also attract industries and increase water demand for energy generation, recreation and irrigation in their surrounding rural hinterlands (Lee, 2000). This leads to an increase in the frequency of multiple and successive water uses, which affects river regimes and water quality (Lee, 2000).

While SUWM/IUWM highlight the need to consider upstream and downstream users, and non-urban users (Gabe *et al.*, 2009; Closas *et al.*, 2012; GTT, 2014), no specific instruments or arrangements are promoted to implement equitable water allocation among all users within a river basin. Additionally, SUWM/IUWM is increasingly recognizing ecosystems as water users, for instance through efforts to maintain the minimum ecological water requirement (EWR) (Jia *et al.*, 2011).

Inputs and outputs: UWM relies on a combination of surface and groundwater from within or beyond the basin, treating these as never-ending sources of water (GTT, 2014; Porse *et al.*, 2015; Conti, 2017), exhausting them until they dry up or are too contaminated for use due to inadequate pollution-control systems, and then turning to dams and inter-basin water transfers (Daigger, 2011; Richter *et al.*, 2013; OECD, 2015b). Large cities, due to their higher demand for water resources, frequently import water from sources beyond their watersheds and struggle to maintain a reliable flow (Barrios *et al.*, 2009; Daigger, 2011; OECD, 2015b). Meanwhile, IUWM/SUWM promote the use of alternative sources to water through decentralized infrastructure and technologies, such as rainwater harvesting systems and stormwater treatment, which can support aquifers, waterways and vegetation (Marlow *et al.*, 2013; GTT, 2014), and the reuse of greywater (Daigger, 2011). However, such initiatives remain scattered and limited in practice. Land use regulation and preserving catchment areas is needed for surface and groundwater sources to maintain sustainable flows, but this is less emphasized than in the IWRM/IRBM literature (see Chapter 4) (Bahri, 2012; Closas *et al.*, 2012). In part, this may be because urban water managers and city officials do not have mandates over these water producing areas.

Furthermore, grey and black waters have conventionally been seen as externalities that have to be rapidly expelled beyond the city to protect urban health, ignoring environmental sustainability, population growth, urbanization, industrialization and climate change (Kayaga *et al.*, 2007; Makropoulos *et al.*, 2008; Daigger, 2011). IUWM/SUWM approaches wastewater as an opportunity and a potential resource by including it into the urban water cycle through infrastructural and institutional integration and reusing it in industrial activities, urban irrigation and groundwater recharge (Jia *et al.*, 2005; Closas *et al.*, 2012; GTT, 2014). Wastewater can be used to extract heat and nutrients, and produce energy and soil-conditioning products (Daigger, 2011). This shift requires an overhaul of urban water and wastewater infrastructure and coordination between water resources management and urban planning (Daigger, 2011). However, combined sewers continue to affect human health and ecosystems (Porse, 2013), especially in megacities which concentrate humans and polluting activities.

3.2.3 *DRIVERS, INSTITUTIONS AND INSTRUMENTS*

A number of drivers shape urban water challenges, such as population growth and concentration, leading to rising demand for water for residential, agricultural and industrial use within and around the city (Lee, 2000; Darrel Jenerette and Larsen, 2006; Maheepala, 2010; Gregory and Hall, 2011; Van de Meene *et al.*, 2011). Whereas countries in the Global North face aging populations and migration from abroad, countries in the Global South have rapidly growing populations and rural-urban migration (Neto, 2016). Urbanization without proper sanitary infrastructure leads to environmental degradation and public health risks (Lee, 2000; Van de Meene *et al.*, 2011; Neto, 2016). Moreover, agricultural, urban and industrial activities that pollute supply catchments also threaten urban water (Maheepala, 2010). Meanwhile, droughts and heat waves caused by climate variability or climate change, are likely to reduce water supplies and affect water quality (Maheepala, 2010; Van de Meene *et al.*, 2011).

UWM institutions have been designed at multiple levels to address the provision of urban water services and promote measures against water-related risks. Legislation, regulatory frameworks and norms are often set at higher levels of government. However, these have not always accompanied the rapid changes and complex challenges facing urban water management (Lee, 2000). They must keep up with new developments in innovation, technology, science, and changes in mandates and policy (Farrelly and Brown, 2011). Local governments and citizens play an important role in implementing national and international legislation that shape and regulate urban water governance (OECD, 2015b).

Part of the UWM scholarship argues that institutions can only effectively address urban water challenges if users and polluters pay “adequately and justly for the services they enjoy from the water resource” (Lee, 2000: 77). This perspective grants a greater role to the private sector in the provision of urban water services, claiming that removing decision-making from political arenas will allow for more competent water and sanitation (Wat&San) utilities (Lee, 2000).

Historically, UWM was associated with “the strong professional identities and powerful elite cultures that co-evolved with water systems and flowered in isolation from other professions and society” (Sofoulis, 2011: 807). Shifting towards IUWM/SUWM also requires that institutions can evolve in contexts of rapid changes and uncertainty, and function in an integrated fashion (Porse, 2013; GTT, 2014; Braga, 2016). This involves flexible institutions and institutional arrangements that enable multiple actors to collaborate and meet a variety of objectives (Niemczynowicz, 1999; Brown and Farrelly, 2009; Floyd *et al.*, 2014; GTT, 2014). Flexibility and collaboration are crucial for large cities facing water-related challenges that are multi-dimensional, multi-sectoral and multi-regional (Tortajada, 2008). Resulting redundancies in institutional structures sometimes increases complexity, but may also lead to enhanced resilience (Lebel, 2005).

Furthermore, other institutions relevant for UWM involve laws and regulations on spatial planning and land use, such as construction, zoning, land use parcelling, sanitary control and environmental conservation (GTT, 2014). Rules regarding the delimitation and amalgamation of administrative regions also have important implications for the allocation of roles and responsibilities and the spatial scale at which urban water is managed (OECD, 2014). In addition, informal institutions may play an important role at household and community levels, especially in cities of the Global South where formal institutions are absent in certain areas or highly bureaucratic (Jha *et al.*, 2012). This can involve flood adaptation measures such as building structures around houses to block flood waters, raising the house's floor, moving furniture to higher floors, helping more vulnerable neighbours, or unclogging drains in surrounding streets (Simarmata, 2015; Hordijk *et al.*, 2016).

The institutional setting determines the instruments of UWM. Table 3.2 provides an inventory of commonly used instruments in UWM/IUWM/SUWM. Economic and suasive instruments are often targeted at the level of the individual, household, or municipality, and aim to change behaviour through incentives or persuasion. Many of the UWM instruments are biased towards the economic and social dimensions of sustainability and inclusiveness (e.g. financial incentives or educational measures to reduce water consumption), and to some extent towards relational dimensions (e.g. subsidies, differentiated tariff systems that address urban inequality). More recently, environmental concerns have led to an increase in instruments that promote sustainability (i.e. wastewater reuse, protected areas).

Table 3.2 Types of instruments of Urban Water Management

Types of instruments	UWM
Economic	Water tariffs (user pays principle); Water metering (linked to tariffs); Subsidies for connecting to the piped network; Sewage tariffs (polluter-pays principle); Financial incentives for water/wastewater reuse; Subsidized retrofits; Fines for improper solid waste disposal
Regulatory	Quality standards (minimum standards for drinking water quality); Access to sanitation with minimum standards; Zoning restrictions in flood prone areas; Stormwater ordinances; Ordinances for source water protection
Suasive	Water saving campaigns; Education programmes for promoting culture of civil protection; Flood risk warnings
Coordination	Flood control plans; Climate change adaptation plans

Source: Author

3.3 UWM FOR SUSTAINABLE AND INCLUSIVE DEVELOPMENT

3.3.1 STEPS FORWARD

While conventional UWM is supply-oriented, adjusting infrastructure to meet water demand, IUWM/SUWM aims to manage water demand to better match water availability (Maheepala, 2010; Gregory and Hall, 2011; GTT, 2014). This is crucial as urban water demand is increasing not only in absolute volume (as cities grow) but also per capita, as urban dwellers in the Global South become more affluent. Increasing competition between users adds stress, pollution reduces water availability and extreme weather makes future availability less predictable (GTT, 2014; OECD, 2014). In the Global North, population ageing means water demand could decrease, with implications for infrastructure investments and potential risks of bacterial after-growth in drinking water (Hummel and Lux, 2007). Therefore, flexible approaches to UWM can help reorient investments in infrastructure according to demand (Neto, 2016). In addition, IUWM/SUWM seeks to diversify water sources (i.e. wastewater reuse, rainwater harvesting), further providing water security (Maheepala, 2010).

IUWM/SUWM has the potential to reduce negative environmental impacts by considering upstream and downstream impacts and the basin as a whole (Closas *et al.*, 2012). This can be through protecting green areas, including native flora and fauna in urban waterways and estuaries and around urban areas (Maheepala, 2010).

Decentralized, collaborative and participatory forms of water management, promoted by IUWM/SUWM, are also more inclusive of different views, interests and environmental values (Brown, 2008; Maheepala, 2010). Deliberation and decision-making processes are iterative, long-term and consider the total water cycle rather than one-time, localized processes (Closas *et al.*, 2012).

3.3.2 Lingering obstacles

Despite the paradigm shifts towards greater sustainability and integration, the water sector's path dependent nature means that the shift towards IUWM/SUWM is slow. Retrofitting existing infrastructure and technology involves high transitioning costs and can lead to stranded assets (Brown and Farrelly, 2007; Brown, 2008; Closas *et al.*, 2012; Marlow *et al.*, 2013; OECD, 2015b; Bos and Gupta, 2018). Investment and technological 'lock in' delays the uptake of alternatives (Marlow *et al.*, 2013). Local governments often lack the necessary funds or capacity to leverage capital investments, and they remain dependent on higher levels of government (Closas *et al.*, 2012). Water management institutions tend to be resistant to change and have low adaptive capacity (Van de Meene *et al.*, 2011; Marlow *et al.*, 2013). Transitioning to IUWM/SUWM also relies on a change in values throughout society (Gabe *et al.*, 2009). It is mainly pushed for by social groups with more inclusive views regarding UWM (Gabe *et al.*, 2009; Winz *et al.*, 2014). Moreover, switching to new infrastructure and processes may involve trade-offs that require careful consideration. For instance, SUWM encourages innovative solutions that may be energy-intensive (e.g. desalination, pumps for rainwater tanks) or risky (e.g. wastewater reuse) (Marlow *et al.*, 2013).

The IUWM/SUWM literature remains largely prescriptive, and the few empirical studies available reveal a failure to go beyond ad hoc demonstration projects (Harding, 2006; Mitchell, 2006; Brown and Farrelly, 2009). Learning experiments and innovation at local and basin levels are not easily transferred to urban decision-making processes and policy (Pearson *et al.*, 2010; Farrelly and Brown, 2011). Such knowledge transfers require adequate social learning mechanisms and coordination mechanisms (e.g. bridging organizations), long-term strategic planning and the identification of new solutions through the inclusion of research and development partners in key projects (Farrelly and Brown, 2011; Van de Meene *et al.*, 2011; Colenbrander, 2018). Limited human and financial resources, a lack of available information, a lack of industry-wide experience and knowledge, a lack of monitoring and evaluation and poor communication processes further represent obstacles to the implementation of SUWM/IUWM (Brown and Farrelly, 2007; Adank *et al.*, 2011).

Institutional inertia further represents a barrier to the implementation of SUWM/IUWM, in particular for proactive responses to increasingly complex urban water challenges (Lee, 2000; Brown and Farrelly, 2007). This includes over-centralisation, bureaucratic inefficiencies and lack of sustainable finance, inconsistent regulatory approvals processes, conflicting or unclear mandates amongst organisations, institutional and sectoral fragmentation (despite the aim to integrate the total urban water cycle), unproductive intergovernmental relations and poor collaboration, limited data sharing, unclear property rights and lack of authority of operational organizations (Lee, 2000; Brown and Farrelly, 2007; Adank *et al.*, 2011). The result is often inadequate, fragmented planning and a lack of enforcement of existing plans (Adank *et al.*, 2011). While it is increasingly recognized that institutions contribute to the slow pace of change, there is little understanding on how to overcome this (Brown and Farrelly, 2007, 2009).

Moreover, IUWM/SUWM does not address power relations, nor implementation challenges resulting from a lack of political will, political leadership or political incentives to do so (Brown, 2008; Pearson *et al.*, 2010; Van de Meene *et al.*, 2011). While IUWM promotes local governments' participation in basin-wide planning spaces, these usually lack decision-making powers (Vlachos and Braga, 2001). Community participation is often considered inadequate and expert knowledge tends to dominate decision-making to the detriment of local, lay knowledge (Brown and Farrelly, 2007; Van de Meene *et al.*, 2011; Brandeler *et al.*, 2014). IUWM/SUWM also mainly applies to formal settlements, and its references to informal settlements focuses on the need for land use management and land tenure (Porse, 2013).

3.4 Scalar limitations of urban water governance paradigms

3.4.1 Metropolitan areas have unique challenges and opportunities

A limitation of UWM, and the more recent SUWM/IUWM paradigms, in the context of metropolitan water challenges is their lack of consideration for the spatial scale of the metropolis. The limited MWM literature covers principles of water management for the metropolitan context, and the expansion of decision-making structures and urban water networks to suburban constituencies or peripheral municipalities (Kallis and Coccossis, 2002; Keil and Boudreau, 2006) – topics left unaddressed by the IUWM/SUWM literature. However, inadequate UWM can lead to externalities across a metropolitan region that are difficult for UWM actors to address unilaterally. For instance, a lack of sanitation infrastructure in one metropolitan municipality may affect the neighbouring municipality downstream, through the health risks of contaminated water and the reduced available water for consumption. It can also lead to externalities in the broader basin (i.e. between a municipality and the basin). For instance, high urban water demand means that there is less water available for the basin's other users, such as farmers. Aquifers within metropolitan regions are affected by land use and inadequate wastewater management (Foster and Ait-Kadi, 2012). Metropolitan regions are therefore not just large urban areas, but experience water-related problems of a different nature than smaller urban areas. Peripheral metropolitan municipalities often face greater water challenges and have fewer capacities to address these alone.

Megacities and large metropolitan regions also present a number of opportunities due to their size (economies of scale), their greater capacity (financial, human) relative to smaller urban or rural areas and the markets (for jobs, products) that they provide for the broader region (GTT, 2014; Kraas *et al.*, 2014; UN-HABITAT, 2016). The resulting "fragmentation of policy making among multiple governmental units diminishes problems of concentrated powers and can promote competition and innovation" (Feiock, 2009, p. 356). Their unique position also makes them centres for research and innovation, including on environmental practices (GTT, 2014; Kennedy *et al.*, 2015). These elements bring significant advantages for facing a range of challenges, including those relating to water.

On the other hand, responsibilities for water distribution, wastewater collection, drainage and flood management often remain at local levels, involving a large number of local governments and private utilities within megacities. Municipalities, the administrative units that form a metropolitan region, are frequently the level at which policy is implemented, but they are often arbitrary and reflect ancient patterns (OECD, 2015b). This can result in incoherent and even contradictory water management practices, as well as inefficiencies, as decisions by one municipality may impose positive or negative externalities on others (Richardson, 1989; Feiock, 2009; OECD, 2011; Sorensen, 2011; Li *et al.*, 2015). It may also hamper the capacity of cities to build the necessary coalitions of actors or structures of governance (Aguilar, 2008) and to foster productive cooperation (Kim *et al.* 2015). Metropolitan regions often experience governance fragmentation, through "overlapping or disconnected institutional structures, national government intervention overpowering local authorities, and disconnections between land and water sectors" (Li *et al.* 2015: 603) and environmental planning and resource management (Kim *et al.* 2015). Local governments within the same metropolis may be affiliated to different, even rival, political parties. They often struggle to develop cohesive responses to shared challenges due to the inconsistency of available data, data dispersion across agencies and the lack of information-sharing mechanisms (OECD, 2016).

The growth and multiplication of metropolitan regions and megacities puts pressure on service delivery and infrastructure development, as well as on adequate management (Vlachos and Braga, 2001, p. 4). Municipalities within a metropolitan region often share water resources, and their water-related activities affect each other (e.g. lack of sewage treatment upstream, deforestation around areas of springs), but due to their politically fragmented nature, they struggle to develop coherent policies and plans to address these shared concerns. An exclusive focus on local practices in urbanized basins leads to water resource degradation, irrational investments and sector-oriented management (Toledo Silva and Amaral Porto, 2003; Foster and Ait-Kadi, 2012). This is even more complex in metropolitan regions with large numbers of jurisdictions within the urban area. Moreover, many of the world's largest cities are located in the Global South, in areas particular vulnerable to climate change, they hold pockets of extreme vulnerability and lack coping mechanisms (Kraas *et al.*, 2014). They often experience rapid growth, especially on their margins, challenging an already fragmented institutional set up and further weakening regional planning and coordination (Adank *et al.*, 2011).

3.4.2 UWM IGNORES THE LINKAGES TO THE RIVER BASIN

The mismatch between the spatial boundaries of institutions (with administrative functions) and the biophysical systems they are dealing with (river basins and aquifers) can be an obstacle for addressing urban water challenges (Abdullah and Christensen, 2004; Cumming *et al.*, 2006; Young *et al.*, 2008; Salzman *et al.*, 2014; OECD, 2015b).[17] UWM focuses on urban (often municipal-level) concerns and needs and does not address those of the river basin and the links between the two spatial scales, which hinders sustainable and inclusive policies (Brown, 2008; Van de Meene *et al.*, 2011). The scholarship on IUWM and SUWM does so to a greater extent, by highlighting the importance of urban-rural relationships (Pearson *et al.*, 2010; Bahri, 2012) and advocates for broadening mandates to incorporate ecosystem health, basin management, biodiversity conservation, conflicts and competing water uses, wastewater treatment and disposal, risk prevention, and integrating all urban activities (Coccossis and Nijkamp, 2002; GTT, 2014). This is evidenced by the increased prominence since the early 1990's of water and rivers in urban planning (Levin-Keitel, 2014). As water resources become scarcer, interlinkages between urban and rural areas need to be better understood (Pearson *et al.*, 2010). However, although more projects incorporate basin considerations, they usually are municipal projects with strong technical components and they rarely extend beyond city boundaries to focus on the interaction between people and the natural environment (Neto, 2016).

IUWM/SUWM actors also do not interfere in water allocation, which is typically the mandate of higher levels of government. Local governments have limited (or no) mandates on how water resources are used outside their borders, even if these resources are part of the same basin (e.g. in irrigation or hydropower), which may have enormous implications for water availability (Maheepala, 2010). They also generally do not focus on managing surface and groundwater systems within their borders, reducing evapotranspiration and preserving environmental flows (Pearson *et al.*, 2010). In addition, responsibilities for urban water are not clearly coordinated with basin actors. Rather, mandates are often unclear, fragmented and overlapping, leading to tensions between professionals and politicians with different values and views (Brown, 2008; OECD, 2016; Brandeler *et al.*, 2019). As decisions within the river basin are (mainly) made by different actors than those within UWM, learning is not easily transferred between the two scales (Pearson *et al.*, 2010).

Urban areas depend on biodiversity and ecosystem services (BESS) or nature's contributions as they are currently referred to, which can be produced within their borders, but more often in their rural hinterlands, or further away (e.g. virtual water through food imports). These ecosystem services play essential roles for the sustainable and inclusive development of cities, and cities can have profound effects on them. Ecologists have only recently started to show interest in urban areas and how to address urban environmental problems (Grimm *et al.*, 2008). Urban water scholars and urban planners also increasingly recognize the benefits of BESS within cities (e.g. urban forests can reduce stormwater runoff (Xiao and McPherson,

[17] This issue is also referred to as "hydro-administrative mismatch" by the OECD (2013).

2016) and prevent pollution in urban waterways and groundwater resources (Livesley *et al.*, 2016)) and those from the wider watershed (e.g. protecting upstream areas for urban water supply and water purification services (Kenny, 2006)). However, despite this convergence between scholarly disciplines, cities continue to create externalities related to their management of water resources and related ecosystems (i.e. contamination from sewage affecting communities downstream, high water demand requiring reallocation to urban uses from other uses, soil sealing affecting infiltration and aggravating risks within the city and downstream). Conflicts between environmental sustainability and the right to housing agendas are common at the urban/rural interface of large cities, as low-income populations are pushed to the margins through a real estate driven process of social-spatial exclusion and occupy watershed areas (Refinetti, 2006; Klink, 2009).

3.5 INFERENCES

This chapter reviewed the urban water management literature to gain insights on how it understands and addresses metropolitan water challenges. It explored this in relation to two knowledge gaps identified in 1.2.3, namely (a) how the literature relates to the river basin context and conceptualizes urban/rural relations, (b) how the literature relates to the metropolitan context as a multi-jurisdictional and often heterogenous urban environment. Multiple factors were identified by the UWM literature review that may facilitate or hinder sustainable and inclusive development. In conjunction with these factors, the research examined whether political fragmentation within metropolises and the lack of mandates over rural areas of their basin also play a role in determining the effectiveness of UWM institutions and instruments in terms of sustainability and inclusiveness.

UWM elements for Sustainable and Inclusive Development

The literature review highlighted a shift from conventional approaches towards paradigms such as IUWM and SUWM, which embrace sustainable and inclusive development principles. These principles are promoted through institutions and instruments that implement water demand management, diversify water sources, protect valuable ecosystem services, foster decentralization and participation and facilitate social learning. Common obstacles that hinder effective implementation are path dependency, a focus on technological fixes, the difficulty to scale up local initiatives, rapid demographic changes (shrinking cities in the Global North and rapid, unplanned urban growth in the Global South), limited local budgets (especially in the Global South) and a lack of knowledge sharing. The empirical chapters evaluate whether such measures are part of the responses to metropolitan water challenges, and if so, how effective they are.

Political fragmentation within metropolitan areas

Metropolitan regions tend to be composed of multiple local governments that have more or less autonomy in decision-making. However, UWM is normally restricted to the mandates of local level actors, which means that metropolitan regions can concentrate a significant number of UWM actors. IUWM and SUWM embrace decentralization and participation, which may ensure more context-relevant policies and social and relational inclusion, particularly in highly unequal metropolises of the Global South. However, a constant prioritization of local interests, policies and practices can lead to political fragmentation within the metropolitan area. Localism could further create difficulties in addressing shared problems, as actors have no incentives or authority to spend resources beyond their jurisdiction's boundaries. This may be aggravated when there are strong political differences in metropolitan regions. Affiliations with different political parties can lead to tensions between metropolitan municipalities and a lack of political will to coordinate actions on UWM. Differences in human and financial capacity, and power relations, also shape the ability of different local governments to coordinate on an equal footing. Based on this framework, the empirical chapters explore the coherence of UWM across the metropolitan regions in terms of characteristics identified in 3.2.2 (i.e. goals, mandates, approaches, users), and how the shortcomings of this framework increase shared water challenges.

Urban dependency on rural areas

Large cities often rely on areas that provide water resources and other ecosystem services beyond their boundaries. There is growing recognition of the importance of preserving these areas, particularly as cities expand. However, UWM actors do not have mandates to do so directly, in particular when these areas fall outside the borders of their jurisdiction. Urban water governance regimes therefore generally fail to recognize these dependencies and address drivers that affect water resources and ecosystem services at the adequate level. This research therefore explores the coherence of UWM across the urban/rural interface, in terms of characteristics identified in 3.2.2 (i.e. goals, mandates, approaches, users), and its implications for addressing shared water challenges.