Scalar mismatches in metropolitan water governance

A comparative study of São Paulo and Mexico City

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9. COMPARING SÃO PAULO AND MEXICO CITY: EVIDENCE OF SCALAR MISMATCHES

9.1 INTRODUCTION

This chapter compares the case studies of São Paulo and Mexico City to provide insights on how to best respond to water-related challenges in terms of quantity, quality and climate change, and through which policy instruments. First, it examines the two cases in terms of the drivers that shape their water challenges (see 9.2). It then analyses the organizational set up of the institutions that respond to these challenges in each case (see 9.3). Subsequently, it describes the policy instruments employed in the two case studies (see 9.4), and compares their effects on actors (see 9.5). This is followed by an evaluation of the instruments' effectiveness in achieving their stated mandates (see 9.6). It then compares recommendations for redesign in the two case studies and considers lessons that can be learned from each (see 9.7). Finally, the chapter summarizes the conclusions and introduces the concept of 'Scalar Mismatches', which, if unaddressed, impede sustainable and inclusive water governance in large metropolises (see 9.8).

9.2 COMPARING DRIVERS OF METROPOLITAN WATER CHALLENGES

Overall, similar drivers shaped water-related challenges in both São Paulo and Mexico City: Urbanization (associated with population growth), economic development and climate change.

Urbanization was the most influential driver for both case studies. Urbanization was characterized by nation-wide rapid although slowing rural to urban migration accompanying population growth especially concentrated in a few cities, and by the inability of cities to account for the daily influx of migrants. Unplanned urbanization has exacerbated inequalities, as informal, precarious settlements have mushroomed in peri-urban areas, leaving local authorities unable to cope with the high demand for affordable housing and related services. At regional level, urban expansion encroached on surrounding areas of springs or aquifer recharge. Repercussions include erosion and increased floods and mudslides, water degradation and increased water demand. At local levels, soil-sealing and the occupation of floodplains and steep hill sides, as well as inadequate sanitation and solid waste management (i.e. clogged drains, water-borne diseases), exacerbate flood risks. The type of housing and land tenure also affect residents' access to water services and exposure to risks. Moreover, water use was often unsustainable and inefficient, particularly in the MVMC, with heavy losses and excessive consumption in wealthier parts of the city.

Economic development is an important driver for both Mexico City and São Paulo as they are their respective countries' economic centres. At national and regional levels, policies have prioritized economic growth over environmental preservation, leading industrial, mining and agricultural development at local and regional levels. These sectors are important water users, thereby driving tensions around the allocation of limited water resources. Contamination remains a challenge and diffused pollution is particularly hard to address.

Climate variability and change, including global and regional processes (e.g. deforestation of the Amazon, El Niño) may have significant influence on extreme weather events experienced in Mexico City and São Paulo. Both cases record increases in extreme weather events and in temperatures in line with climate change forecasts. The size of the two megacities also contribute to strong heat island effects.

The combination of rapid, unplanned urbanization and a focus on spurring economic development have led Mexico City and São Paulo to grow into wealthy mega-cities with rampant inequalities – including in access to safe drinking water, safety from contaminated water, and protection from water-related risks. Climate change could act as a risk multiplier to the existing challenges.

9.3 COMPARING ACTORS AND INSTITUTIONS

9.3.1 INSTITUTIONAL CHANGES IN UWM AND IWRM/IRBM

Both Mexico and Brazil have made efforts to develop IWRM/IRBM over the last three decades, implementing water laws inspired by the Dublin principles. These legal frameworks recognize the multiple uses of water, introduce a multilevel governance system and create new policy instruments. IWRM is more advanced in São Paulo, where basin committees have broad representation, meet regularly, develop basin plans in a participatory manner and have budgets for projects within the basin. Even then, the ATB (Alto-Tietê Basin) Committee is often bypassed in decision-making processes, as happened during the 2013-2015 water crisis. In Mexico, basin agencies oversee WRM at regional level, but these are deconcentrated offices of CONAGUA and are thus government agencies that implement decisions in a top-down manner. Participatory basin councils exist on paper but represent a limited range of interests and lack resources and influence.

Regarding UWM, Wat&San responsibilities have been decentralized in both cases. Municipalities have been granted a wide range of mandates after Brazil and Mexico's democratic transitions, with a focus on land use, local environmental issues, drainage, urban planning and civil defence. At higher levels, however there is often a vacuum. In Mexico, there is no national level framework for Wat&San policy, which means states and municipal governments implement vastly different standards and goals. Brazil introduced a national Wat&San Law in 2007, but the role of states remains limited in the legislation, although the state water companies play a crucial role in the sector. Existing frameworks in both cases also do not specifically address metropolitan regions. A 2013 Supreme Court decision in Brazil has stated that, within metropolitan regions, functions of common interest, including Wat&San services, should be a shared responsibility between municipalities and the State. However, the decision does not clearly outline how this will take place and municipalities have since been struggling to turn this command into action. In the MVMC, stormwater and flood management are, to some extent, coordinated at metropolitan level by national and state-level actors.

9.3.2 THE INFLUENCE OF FEDERALIST STRUCTURES

Both case studies are in federal regimes. Mexico has more power concentrated at federal level, and Brazil at state level. Despite formal decentralization, local governments often lack financial and human capacity to implement adequate measures. Decisions at higher levels often bypass metropolitan/basin platforms and local actors, while local level decisions are often not coordinated between municipalities. This results in fragmented policies at regional level. In the MRSP, municipalities develop Wat&San plans separately despite interlinkages with neighbouring municipalities. This fragmentation has led state-level actors to take the lead. For instance, SABESP has developed its own planning and investment priorities as there was no Wat&San state policy and it operates in a majority of São Paulo State's municipalities. The dependence on external water resources strengthens higher levels of government in both cases. As the MVMC spreads across three states and imports water resources from even further, the involvement of federal actors is inevitable. State level actors are more prominent in the MRSP, as most water resources are contained within the state, but dependence on other states has increased as water supply systems have expanded following the 2013-2015 water crisis.

Furthermore, the three-layered structure of these federal regimes (i.e. federal, state and municipal) makes it more difficult to legitimize any intermediary governance level (e.g. metropolitan, basin) (see 6.3.4 and 8.3.4). As a result, institutions at such levels are mainly voluntary and rely on political will, consensus and alternative funding sources. Moreover, the MRSP is composed of 39 municipalities, and the MVMC of 60 municipalities and 16 districts in three federal entities, with vast differences in financial and human capacity. Differences in political party affiliations further aggravate fragmentation across the metropolitan region, as governments often take decisions based on political priorities and the interests of their jurisdiction rather than regional needs. Party politics may hinder horizontal coordination (i.e. between municipal governments), and vertically (i.e. between a local government and the state government).

Nevertheless, the two megacities have attempted to develop metropolitan initiatives related to water and other issues. In the MVMC, this takes a highly top-down form (e.g. metropolitan funds for mega-infrastructure), whereas initiatives in the MRSP are voluntary and often failed to materialize. Either way, developing a shared, metropolitan vision is challenging both in terms of structural design (how to create decision-making bodies) and in terms of resources to implement projects.

9.4 COMPARING INSTRUMENTS

9.4.1 INSTRUMENTS PER COUNTRY AND LEVEL OF GOVERNANCE

Table 9.1 lists the policy instruments selected in each case and the levels at which they are implemented. Brazil and Mexico have designed similar instruments, but sometimes at different levels. Unlike the MVMC, the MRSP has no (substantial) PES programmes. Suasive instruments, such as awareness campaigns for rational water use, exist in both cases but are considered of minor influence as they are generally implemented at a small scale and in a piece-

meal manner. Electricity subsidies for irrigation pumping exist in Mexico but have not been analysed as they are beyond the urban/metropolitan scope of this research. Relevant instruments that are absent from both cases include environmental taxes[87] and flood insurance[88].

Table 9.1 Instruments at multiple levels of governance in Brazil and Mexico

	Brazil	Mexico
National	Water use permits Wastewater discharge permits*	Water use permits Water use and wastewater discharge fees Wastewater discharge permits* Classification of water bodies* Metropolitan water supply system Metropolitan sewage and drainage system
State	Water use permits Wastewater discharge permits* Areas of Protection and Rehabilitation Macro-drainage plan Integrated Metropolitan System	Climate change plan and fund* Conservation Land
River basin	Water use and wastewater discharge fees Classification of water bodies*	Water use permits
Municipal	Water tariffs: Local governments are involved if the Wat&San services are provided by a municipal utility	Water tariffs
Other:	Water tariffs: Determined by the utility and the State regulatory agency	PES programmes: Multiple: Federal and State

Source: Author

*See Annex G – Additional instruments

9.4.2 EVALUATING AND COMPARING INSTRUMENTS IN TERMS OF DESIGN

Water use permits

In both countries, water belongs to the nation or state, which grants access to users under similar specific conditions. In the VMB (Valley of Mexico Basin), permits are issued by the national government, through the CONAGUA. In the ATB they are issued by the state government, through the DAEE, except for permits for water imports from basins that cross state borders (e.g. permit for imports from the Cantareira System) that are issued by the ANA.

[87] Brazil's National Water Law originally included compensation for environmental damage as an instrument, but this was later vetoed. In 2018, a federal law created a fund for compensation from environmentally damaging activities (MMA, 2018). This fund aims to support the management of Protected Areas.

[88] Flood insurance exists in both cases although it was not widely used. This research did not examine measures adopted at individual or household level.

Brazilian and Mexican water permits both aim to control water resources use. There were restrictions in the VMB on the granting of new permits because the Basin is in a low 'water availability zone', meaning that a user can only obtain a permit through a permit transfer. Such restrictions are not implemented in the ATB. On paper, the MVMC's water use permits system is therefore more adequate for water use management in a water scarce basin.

Water use fees

In both cases, water use fees aim to incentivise rational water use while financing WRM. In Mexico, fees are set at national level and differ according to the basin or aquifer's 'water availability zone', increasing as availability decreases; the MVMC's basin has the highest level of fees. In principle, this may encourage certain water users, such as industries, to move to areas where water is more affordable. In São Paulo, water use fees are set by the river basin committee through a participatory and deliberative process, and in consultation with its technical boards.

In each case, the fees are reinvested in different ways. In the MVMC, only fees from water utilities are collected and reinvested in drainage and sanitation infrastructure within the VMB. Investments are not returned to the donor basins to compensate users or invest in ecosystem preservation. Fees from other uses are collected by the Federal Treasury and are reinvested nationwide in the water sector as well as other programmes. Within the ATB, all collected water use fees are reinvested in projects within the basin that were defined in the basin plan.

Water tariffs

In Brazil, a national policy framework defines that water tariffs should support the universalisation of water services while allowing for financial sustainability. There is no overarching framework for water and sanitation in Mexico, but water operators in the MVMC share comparable goals. In São Paulo, water tariffs are approved by an independent regulator at state level[89], unlike the MVMC, where this is generally done by the State congress, making tariff-setting a political as well as a technical decision. In both cases, subsidies are provided to low-income households and different rates are charged for commercial and industrial consumers connected to the water utility. Tariffs rise exponentially as consumption increases, except for industrial and commercial users in the case of São Paulo. While some metropolitan municipalities had local utilities, most were serviced by a state-level utility.

Inter-basin transfers/Metropolitan water supply systems

Inter-basin transfers have been created to respond to the water demand in the MRSP and the MVMC as local water supply sources became insufficient or inadequate. For both cases, these supply-oriented approaches are core strategies for responding to water demand. The CONAGUA builds and manages these systems for the MVMC, with SACMEX's help. Both

[89] The design of tariff rates is nevertheless complex and lacks transparency.

national and state entities are involved in the ATB, depending on whether the imported water comes from a basin that is at least partly located in another state. In Brazil, basin committees are also involved in negotiations regarding these transfers, but ultimately limited with influence. In the MRSP, water is mainly supplied from surface water sources in large reservoirs within the ATB and beyond, through an inter-basin transfer. These systems are interconnected, forming the Integrated Metropolitan System, to create redundancy so that, if one system is dry, the area supplied by it can receive water from another system. Mexico City also relies heavily on inter-basin transfers, which import both surface and groundwater from other basins.

Metropolitan wastewater infrastructure

In both cases, metropolitan wastewater infrastructure centralizes the efforts to collect, treat and discharge wastewater, based on the premise of greater efficiency through economies of scale. It represents a conventional approach to UWM. Again, CONAGUA (national level) is directly involved in decisions and operations, whereas SABESP (State level) oversees this infrastructure in the MRSP. SABESP has developed an integrated system for sewage collection and treatment at the metropolitan scale, based on a few treatment plants, including one mega-plant. It takes an integrated view of the river basin and the metropolitan sanitation infrastructure and relies on cooperation from municipalities and industries to connect to the sewage network. In the MVMC, a giant sewage treatment plant was opened in 2017, thereby responding to the significant backlog in sewage treatment. It pumps sewage water out of the VMB, and discharges treated wastewater into the neighbouring Tula basin.

Macro-drainage plan of Alto-Tietê

The Alto-Tietê Macro-drainage plan, led by the DAEE, aims to mitigate flood risks through an IRBM approach and coordination with multiple actors. It is integrated with basin planning and the basin committee funds certain projects. As the Alto-Tietê Basin and MRSP almost overlap, this scale facilitates a regional approach to urban/metropolitan macro-drainage and flood management. Drainage districts are further delimited according to sub-basin boundaries. The plan combines cost-effective solutions that integrate hard and soft measures, including environmental rehabilitation. In addition, the plan emphasizes that flood risk management requires coordinating the urban drainage plans of all the municipalities in the river basin, acknowledging upstream/downstream interlinkages. Although the CONAGUA in the MVMC coordinates metropolitan-scale drainage infrastructure, this is not based on basin management principles or a regional plan but focuses on rapidly expelling excess surface water.

Environmental protection measures

In the MRSP, state legislation for APRMs regulates land use and development in areas crucial for water supply. The areas are delimited by sub-basin and aim to protect the springs while improving the living conditions in the area. Municipal governments are expected to control land use within their borders and therefore shoulder a large portion of the responsibility

regarding these laws. Within the MVMC, part of Mexico City proper, including the mountainous South that recharges the city's aquifers, is in 'Conservation Land', which restricts land use and development. The Mexico City government played a predominant role but depended on cooperation from district authorities. A limitation is that the ecologically valuable green region extends beyond the borders of Mexico City, but there is no regional or metropolitan land use planning for environmental conservation. While there are Protected Areas within Mexico City and surrounding states, these do not foster a regional approach to preserving water-relevant ecosystems. Environmental and urban policies within Mexico City are also not coordinated, leading to inconsistencies between sectoral plans.

PES programmes

Multiple PES programmes have been implemented in the MVMC, by different levels of government (e.g. federal government, Federal District, Mexico State) and with different strategies (e.g. strict rules on land use change or ability to develop sustainable activities, technical assistance, different payment frequency). They aim to protect ecosystem services, especially hydrological services, by supporting or compensating the providers of these services. As much of the land is communal, authorities must collaborate with and obtain consensus from a large number of individuals. No PES programmes are implemented within the MRSP. The PCJ basin applies some of the resources from water use fees in a PES programme that seeks to reforest areas around the Cantareira System.

9.4.3 INFERENCES

Most instruments were evaluated positively or as neutral in terms of their objectives. They emphasize environmental sustainability (e.g. preservation of minimum environmental flows, protection of green areas around urban areas) and social equity (e.g. subsidized tariffs for low-income households, compensation to landowners in the green belt). Although many instruments could be linked to climate change adaptation, this was generally not their primary goal. Moreover, the infrastructural and planning instruments are mainly implemented at the spatial scale of metropolitan region and/or basin, although they are managed at higher levels of government. Instruments focused on ecosystem protection are implemented at multiple levels, including through funding mechanisms, although their scope is local or regional.

Overall, responsibilities are often spread across multiple levels (e.g. legislation or policy framework at national or state level, land use management is a local responsibility, implementation and coordination takes place at regional level) and between actors with different interests. This has implications for how policy instruments are coordinated. Although the goals of UWM and IWRM/IRBM significantly overlap in both cases, they are managed separately. This is clearly illustrated by the absence of linkages between water use or discharge instruments (i.e. permits, fees) and water services instruments (i.e. tariffs), as IWRM/IRBM and UWM mandates and goals are designed at different spatial scales. Interactions between IRBM and UWM entities mainly focus on the management of large-scale infrastructure for water supply (e.g. the inter-basin transfers from the Cutzamala and Lerma systems and from

the Cantareira and São Lourenço systems) and drainage/flood control (e.g. deep drainage, canals and pumps to evacuate water from the VMB, and coordination between ATB municipalities that manage drainage systems and the DAEE that manages larger rivers).

9.5 COMPARING THE EFFECT OF INSTRUMENTS ON ACTORS' BEHAVIOUR

This step involved evaluating how effective the instruments were in achieving their stated mandates.

9.5.1 REGULATORY INSTRUMENTS

Water use permits

In both cases, water allocation through water use permits is based on water availability within basins and aquifers but decisions are made at state or national levels with little transparency. The possibility of transferring permits between users in Mexico has meant that these have changed hands over time from farmers to industries and real estate companies, as the city expanded. The value of these permits has spurred a black market that favours the highest bidders. These permit transfers, combined with weak enforcement of regulations regarding abstractions, have failed to reduce or even stabilize water use levels in the region. In fact, they enable unsustainable urban and industrial growth.

In the ATB, there are no restrictions for allocating additional water volumes, despite low water availability, and permits are granted through lax criteria, even though large volumes are imported from other basins. In both cases, no effective measures are in place to limit who can obtain permits, interlinkages with surrounding basins are ignored, and reliable groundwater extraction data is lacking. Moreover, the import of water from other basins corresponds to a reallocation of water resources from rural to urban areas. Through water use permits, these cities gain legal control over water resources and thereby over areas far from their borders.

Environmental protection measures

The enforcement of Protected Areas, with restrictions on land use and land occupation, has been ineffective due to a lack of monitoring and relies disproportionately on local governments in the periphery of the metropolises. The latter tend to be poor and lack capacity for monitoring and are under pressure from the local population to provide housing and urban infrastructure and services. In fact, informal settlements have multiplied around these areas, with reports of clientelism by local politicians, severely contaminating the springs that are crucial to the entire metropolitan region.

9.5.2 ECONOMIC INSTRUMENTS

Water use fees

Water use fees for bulk water are low and lacking in both cases (e.g. they excluded agricultural users, despite their heavy water use), discouraging actors from internalizing the real cost of bulk water supply – as discussed in the water tariffs section below. Low fees impact the effectiveness of the fees in both cases. However, water use fees in the MRSP have been reinvested within the basin where water was extracted, and according to the priorities defined by basin committee members. This gave users a sense of shared ownership and better acceptance of fees, meaning that a progressive rise in the fees' value and the inclusion of agricultural users was more likely to be accepted than in the MVMC. Industrial users in both cases are more likely to reduce use, due to the cost and the possibility of switching to recycled water and other water saving practices.

Water tariffs

Water tariffs for water supply services were considered relatively affordable in both cases, with subsidized rates for low-income households, and even for most residents in the case of Mexico City. However, the lack of an independent regulator in the MVMC politicized the design of water tariffs. Heavily subsidized water tariffs and fixed tariffs due to a lack of water metres have led to very high consumption rates. As a result, cost-recovery is low, and Mexican utilities depended on external funds. This hinders their ability to invest in the sector, including for reducing non-revenue water, such as leaks and water theft. This mainly affected low-income peri-urban residents who received subpar services or none at all. Informal settlements in the MVMC did not benefit from subsidized tariffs as they were not connected to the public network, and they often depended on water trucks that charged very high prices. In the MRSP, utilities such as SABESP had special programmes to provide drinking water services in informal settlements, although not all such neighbourhoods were included.

In the MRSP, significant funds are invested in expanding water supply infrastructure, and profits are also redistributed to shareholders. Critics argue that these profits are insufficiently reinvested in expanding wastewater services or reducing leaks. Nevertheless, SABESP's state-wide cross-subsidies have allowed it to expand access to peri-urban and rural areas, while applying the same tariff (including subsidized rates for low-income households) regardless of the cost of service provision. All in all, the lack of transparency prevents an in-depth evaluation, but this indirect evidence, when combined with high levels of water losses and the constant need to increase water supply, indicates that there is significant room for improvement in balancing the water use fee/water tariffs within SABESP.

Payment for Ecosystem Services

The value of the PES programmes in the MVMC is low compared to the opportunity cost for landowners to develop their land or log the wood. Nevertheless, at least around 2.5 million

hectares of forests have benefitted from the federal PES programme across Mexico. The Mexico State PES programme has stable funds as it receives part of the revenue from water tariffs, and this has also created a direct link between water consumption and WRM.

Although there is no PES programme in the ATB, the neighbouring PCJ basin has led to the reforestation of over 500ha out of 35,000ha needed. A challenge in both cases is cooperation with private landowners, as the economic benefits are minimal. As the pressure on landowners near springs in the MRSP is high, PES programmes or other economic instruments could incentivise adequate land use and environmental protection in these areas.

9.5.3 INFRASTRUCTURAL INSTRUMENTS

Inter-basin transfers

Inter-basin transfers and the interconnection of supply systems have ensured relatively stable water flow to both metropolitan regions, although marginalized communities still have precarious access, especially in the MVMC. The integration of systems may lead to greater resilience in the face of droughts. However, in both the MRSP and MVMC, inter-basin transfers are managed by higher-level actors in a top-down manner. The lack of transparency is more pronounced in the MVMC, as basin and local actors are not involved in discussions.

The focus on increasing water supply through inter-basin transfers (rather than reducing demand, rehabilitating local water sources or investing in alternative water supplies[90]) has increased dependence on bulk water suppliers, thereby further empowering these actors. Overall, residents have high levels of water access in both metropolitan regions.

Metropolitan wastewater infrastructure

Despite investments in large-scale sewage infrastructure in both megacities, sewage treatment remains low. Informal settlements are an obstacle for utilities to obtain and treat sewage (pipes cannot be installed due to lack of land tenure, and physical layout is a further obstacle for areas that are regularized).

In São Paulo, wastewater treatment plants are often running under capacity, due to the cost and practical challenge of transporting sewage through extensive piping networks. With fewer but larger plants, the networks need to travel longer distances and have a wider diameter to allow for a greater flow. Municipal treatment plants often perform worse in both cities, generally because they lack financial resources, cannot enjoy natural economies of scope and scale usually associated with these services and sewage treatment is not their priority. Neither

[90] In both cases, industrial users seemed more likely to invest in wastewater reuse technologies if there were sufficient incentives to do so. While cost through fees and environmental norms can push them in this direction, they also need security in knowing they will continue to have stable access to water. They can be reluctant to give up a permit for water use otherwise. In Mexico, respondents mentioned cases of industries or buildings switching to reuse/rainwater harvesting, but still being charged fees as they still had a water permit, and this can dissuade them from making these switches.

very large nor very small sewage treatment plants are optimal in the more urbanized areas, but local solutions were effective in sparsely populated peripheral municipalities of the MRSP.

However, the downstream location of both mega-plants prevents the reuse of treated wastewater within the metropolitan region or the replenishment of local waterways and aquifers. While it represents an effort to expand sewage treatment and reduce water contamination, this linear approach justifies the need to continue importing water from other basins and is not an ecologically sustainable path.

Macro-drainage plan (São Paulo)

Although this plan aims for a basin approach, the interactions between municipalities and the State (DAEE) are stronger than horizontal interactions (between municipalities). Tensions still occur between municipalities, especially those with rival political parties (e.g. construction of dykes that aggravate flooding for neighbouring municipality). Local mandates to address stormwater and flood challenges and different levels of financial and human capacity further prevent inter-municipal coordination. The plan mainly reinforces the DAEE's power and its vision of flood prevention through large, hard infrastructure, and does not substantially help foster changes in urbanization or land use. Nevertheless, it fosters a common vision of flood risks and priority areas in the basin. While the MVMC coordinates the discharge of sewage and stormwater between CONAGUA and the three state governments, this is limited to financial decisions and the operation of infrastructure and does not involve a multi-stakeholder basin-oriented planning process.

9.5.4 INFERENCES

Investing in large-scale infrastructure remains the preferred choice for state and national governments to address water quantity, water quality and climate change adaptation-related challenges. While this allows actors to (partly) fulfil their main goals (e.g. supplying drinking water, treating sewage), it also consolidates their monopolistic power and reproduces their linear approach of taking, using and expelling water, and provides little incentive for sustainable water use in the long-term.

Although regulatory instruments are crucial for better oversight of water resources and crucial ecosystems in and around the two metropolises, their enforcement is limited. In particular, they do not address the drivers of urban and economic growth.

In terms of economic instruments, water use fees are overall too low to incentivise users to reduce their use. When implemented, they seem more effective when the collected funds are reapplied in the region where they are collected, through an inclusive decision-making process. Even if the funds are dwarfed by those of other entities, it helps foster a basin-oriented approach. Regarding water tariffs, subsidized rates are not necessarily correlated with greater access to services for marginalized residents. With no cost-recovery, the quality of services of utilities tend to worsen due to the inability to invest. Funds such as the Fideicomiso 1928 and

the Metropolitan Fund only invest within the MVMC as the actors in charge of these do not have mandates to act outside its borders.

Suasive instruments play a minimal role. Since the 2013-2015 water crisis in São Paulo, there is greater awareness of the region's relative water scarcity and consumption levels are still below pre-crisis levels. The experience of the crisis and the application of bonuses and fines for reductions or increases in water consumption were more effective than awareness campaigns for water saving.

9.6 Comparing the impact on sustainable and inclusive water governance

In this step, I assessed the impact of instruments in terms of the four dimensions of sustainable and inclusive development, in the context of existing driving forces.

9.6.1 Ecological impacts

Environmental criteria are often unambitious or applied weakly. For instance, water use permits in São Paulo mainly rely on quantitative standards for surface water (i.e. the Q7,10), disregarding that large volumes of water within the basin are unavailable due to contamination and that significant groundwater is extracted. In Mexico City's case, there are restrictions on granting new water use permits but water has been over-allocated, and monitoring is lacking. Water use fees and water tariffs are disconnected from water availability levels in both cases, but especially in the MVMC, where drinking water tariffs are highly subsidized despite regional water shortages. Industrial plants continue to obtain permits, through permit transfers, to extract large volumes of water, for low fees, from over-exploited aquifers. Furthermore, utilities were often not allowed or able to provide Wat&San services in informal settlements. WRM and UWM actors have limited to no influence on land use management and land tenure. In addition, industrial contamination has decreased as industries have moved to nearby regions in both cases, but this transfers contamination to other basins, some of which supply the megacities through inter-basin transfers.

The current instruments focus on the symptoms of metropolitan water challenges, but fail to address their drivers, in particular uncontrolled urbanization and a constant push for economic growth at the expense of environmental sustainability. Both cases studies revealed that WRM is often disconnected from land use management, environmental protection and urban planning, in part because these are the mandates of actors at different governance levels. Ultimately, the instruments reflected a mismatch between where ecosystem services originate and where they are used, which promotes importing water from increasingly further away, and ignores high water losses, contamination and encroachment on surrounding green belts.

9.6.2 Social impacts

Water for human consumption is officially prioritized over other uses in both cases. Water tariffs are subsidized (significantly in the MVMC) for low-income households. Cross-subsidies

in the MRSP favour poorer, peri-urban municipalities. Nevertheless, marginalized residents in informal settlements lack access to sufficient drinking water, as the lack of land tenure sometimes leads to total exclusion from water services. During the water crisis in São Paulo, poorer households in the periphery experienced severe water shortages, while residents in central areas more rarely experience dry taps. This issue is more severe in Mexico City, where residents in peri-urban areas continuously struggle to access water and rely on water trucks, often paying much higher prices. Further from the metropolitan area, indigenous communities have seen their water sources become fenced off and inaccessible as these have been incorporated into the inter-basin transfers. Meanwhile, permits for other uses, such as industry, have still been granted in recent years, despite protests from surrounding communities whose drinking water comes from the same aquifer.

Similarly, instruments addressing water-related risks are mainly focused on technical and infrastructural fixes and do not address the greater socio-economic vulnerability of certain residents or uncontrolled urbanization that lead to the occupation of floodplains and hillsides.

9.6.3 Economic impacts

Water use permits grant users security and enable economic development. However, unsustainable water allocation harms the economic prospects of future generations and of the areas where more water is imported from. In Mexico City, land subsidence from over-drafted aquifers is also causing damages to buildings and infrastructure. Water availability and the risk of water depletion have not been effectively incorporated within a regional, long-term economic strategy.

Water use fees can redistribute gains across the basins and recognize the value of ecosystem services. In São Paulo, fees are reinvested within the basin where water is abstracted, in projects negotiated within the basin committees. In Mexico City, these fees disappear within a federal budget or are invested in large-scale infrastructure in the MVMC through a top-down process. The ineffectiveness of wastewater discharge fees has led to heavy economic costs due to reduced water availability and the potential waterborne diseases it can cause.

Regarding water tariffs, certain respondents in São Paulo argue that profits are redistributed to shareholders or invested in increasing water supply, rather than invested in reducing water losses or water contamination. In Mexico City, tariffs are too low for cost-recovery. The cost of mega-infrastructure for water supply is borne by taxpayers nationwide, while utilities cannot afford or do not prioritize measures such as reducing non-revenue water. The MRSP, on the other hand, de facto subsidizes many of the municipalities in the rest of São Paulo State.

Large infrastructure (e.g. mega-sewage plants, inter-basin transfers, flood management works) was often very costly. No comparative analyses are carried out (or disseminated publicly) to evaluate if these measures are the most economically efficient.

9.6.4 Relational impacts

Decision-making on UWM and WRM lacks transparency, prioritizes short-term political and economic interests and reproduces the exclusion of marginalized communities through policies and actions focused on importing water, exporting storm and wastewater and ignore issues of environmental preservation or land tenure. It has led to conflicts with indigenous communities and users in donor basins, who have neither voice nor vote in the process. Besides water tariffs, most instruments do not aim to put the needs of the most vulnerable first, but even subsidized tariffs often fail to benefit marginalized residents. Clientelism is common between local politicians and residents in the case of Mexico City and between municipal utilities and residents in the MRSP. In Mexico City, CONAGUA's control over water use and wastewater discharge permits and fees hindered involvement of more local level actors and bottom-up knowledge integration. Participatory river basin planning is virtually absent. In São Paulo, basin and local actors have more influence, although ultimately, state-level actors dominate decision-making processes. Partly, more advanced implementation of IWRM/IRBM may be due to the near overlap of the ATB and MRSP's territories and being contained within one state, creating fewer coordination challenges. In addition, water use fees increased the ATB committee's budget and thereby its potential for effective IRBM.

Mega-infrastructure for water supply, sanitation and stormwater play prominent roles in both cases and reinforce the power of state and national actors, legitimized by the concept of water security. Some respondents argue that mandates and funds should be transferred to local level actors, but besides the lack of technical capacity, it is not clear how the collective water-related challenges highlighted in this thesis can be addressed in that manner.

9.6.5 Inferences

Overall, instruments applied in the MRSP performed better in terms of design, effect on actors given their mandates and impacts on inclusive and sustainable development than in the MVMC, although there is room for improvement in both cases. Social inclusiveness is greater in the case of the MRSP, which has high levels of access to the piped water network and cross-subsidies that support poorer municipalities. However, in both cases, the patterns of economic growth that reproduce socio-economic inequality and unequal exposure to water-related risks remain unaddressed. Negative ecological impacts are clear in the MRSP through the contamination of local water sources, and in the MVMC through land subsidence from groundwater over-exploitation. Even instruments specifically designed to address this, such as PES programmes or environmental protection areas are mostly ineffective. In particular, such instruments do not address the root causes of environmental degradation, namely informal urban growth that leads to encroachment on green areas and a lack of basic infrastructure and services such as sewage and solid waste collection. In terms of economic impacts, many instruments favour short-term outcomes and supply-focused approaches disregarding the (not-so-distant) future economic consequences. They are often economically inefficient, preventing cost-recovery, or with a budget too low compared to the needs (i.e. PES programmes). The financial gains benefit a small number of private sector actors and, sometimes, corrupt

politicians, excluding marginalized peri-urban and rural communities. Finally, power largely remains in the hands of state or national level actors. Table 9.2 provides scores based on the evaluation of Mexico City and São Paulo's instruments in terms of their design (see 9.4), their effect on actors' behaviour (see 9.5) and their impacts in terms of sustainability and inclusiveness (see 9.6).

Table 9.2 Evaluation of the effectiveness of instruments in the MRSP and MVMC

	Brazil			**Mexico**		
	Design	Effect on actors	Impact on Sust&Incl	Design	Effect on actors	Impact on Sust&Incl
Water use permits	+	-	Ecol: - Soc: - Econ: - Rel: -	+ +	-	Ecol: - - Soc: - - Econ: - Rel: - -
Water use and wastewater discharge fees	+ +	+	Ecol: + Soc: + + Econ: + Rel: + +	0 / +	-	Ecol: - - Soc: - - Econ: - - Rel: - -
Water tariffs	+	+ +	Ecol: - - Soc: + + Econ: - Rel: -	0	0	Ecol: - - Soc: 0 Econ: - Rel: -
Metropolitan water supply	0	+	Ecol: - - Soc: + Econ: - Rel: - -	0	0 / +	Ecol: - - Soc: - - Econ: - - Rel: - -
Metropolitan wastewater infrastructure	+	0/+	Ecol: - Soc: - Econ: - Rel: -	0 / -	0	Ecol: - Soc: - Econ: - - Rel: -
Macro-drainage	+ +	0 / +	Ecol: - Soc: - Econ: - - Rel: -	-	-	Ecol: - Soc: - Econ: - - Rel: -
Environmental protection areas	+	0	Ecol: + Soc: + Econ: + Rel: +	+	0	Ecol: - Soc: 0 Econ: - Rel: 0
PES programmes				+ / + +	0 / +	Ecol: - Soc: 0 Econ: + Rel: +

Relative assessment scores: ++ Very positive; + Positive; 0 Neutral; - Negative; -- Very negative (See 2.4)

9.7 COMPARING REDESIGN

Finally, based on the instruments' effects on actors and impacts in terms of sustainability and inclusiveness, I conclude about the lessons that each city can learn from the other in terms the (re)design of policy instruments within urban water and river basin governance regimes.

9.7.1 MACRO-DRAINAGE

A participatory, basin-scale plan such as the MRSP's Macro-drainage Plan, which has strengthened metropolitan-wide collaboration and more context-appropriate responses in the MRSP, could benefit the MVMC as the current focus on expelling storm and wastewater ignores basin considerations and local interests. However, the MRSP's plan mainly focuses on hard infrastructure, and more emphasis could be shifted to drivers of vulnerability such as land use, land tenure, affordable housing and climate change. Green infrastructure is rare despite its potential for flood mitigation and other co-benefits (e.g. leisure, climate regulation, groundwater recharge). Its relatively low-cost warrants further consideration. In the MVMC, small-scale infrastructure to infiltrate or harvest rainwater is more common. These measures mitigate flood risks and help retain water within the basin for reuse or aquifer recharge, alleviating the pressure on over-drafted aquifers and external water resources. While aquifers are not under similar pressure in the MRSP, retaining stormwater through green infrastructure would alleviate over-burdened grey stormwater infrastructure during heavy rains and reduce diffused pollution in waterways. Scaling up these measures, in both cities, could involve incentives and the revision of norms, combined with risk assessments.

Moreover, the MRSP's Macro-drainage Plan has not increased coordination between municipalities. This could be addressed if local governments adjust their stormwater plans to be coherent with the macro-drainage plan. As an incentive, this can be a pre-requisite for local governments to apply for funding from the basin committee for stormwater and flood management-related projects. In the MVMC, three state governments and the federal government coordinate infrastructure across the metropolis, but as in the MRSP, municipalities did not coordinate among each other. Regional, long-term strategic planning that includes local authorities, metropolitan infrastructure and basin hydrology could better integrate underlying and localized vulnerabilities. As was learned from the Brazilian experience, this is more effective if local governments are incentivized or required to make local stormwater and flood mitigation plans coherent with regional planning. Measures can be implemented at sub-basin level (as in MRSP) to adjust to local needs and return surface runoff to streams rather than funnelling it downstream.

9.7.2 METROPOLITAN WASTEWATER SYSTEMS

Despite relative water scarcity within the ATB, there are few efforts to promote recycling and wastewater reuse. Treated wastewater is reused more extensively in the MVMC, for urban and rural agriculture, industrial use and the replenishment of canals. This can reduce pressure on

(blue) water systems. However, the downstream locations of mega-sewage plants in both cities disincentivizes measures to retain treated wastewater within the basin for reuse or replenishing streams (or aquifers through artificial groundwater infiltration), thereby reducing dependence on external water sources. Promoting (treated) wastewater reuse in the MRSP may be easier as wastewater treatment plants are more decentralized than in the MVMC, with large and small treatment plants are distributed according to population density and managed at sub-basin level. This reduces wastewater transportation – and thus overall – costs. Many smaller wastewater treatment plants in the MVMC operate under capacity or are abandoned. As sewage collection and treatment does not reach all households, especially those in informal settlements, these smaller plants could support wastewater recycling and reuse.

Many sewage plants in the MRSP also operated under capacity due to legal and physical limitations to connect households in informal settlements to the sewage network. This was particularly true for the mega-sewage plant, surrounded by informal settlements. Expanding sewage treatment services is now less an issue of treatment capacity but of connecting households in informal settlements and installing sewage mains. This requires utilities to coordinate with local governments, responsible for land use and housing. The latter need greater support in enforcing land use restrictions and in upgrading informal settlements. Within the APRMs, municipalities could receive technical and financial support for the upgrading of settlements from the basin committee, conditional on their harmonization of local plans with the basin or regional Wat&San plans. Expanding decentralized wastewater treatment – and therefore reuse – in the MVMC is also more likely to succeed if utilities and local governments are coordinated within a regional wastewater management plan.

In addition, water users in the MVMC were often reluctant to take the risk of switching their water supply system to treated wastewater. Large users such as industries could receive incentives, such as lower water use fees, easier access to water use permits or a water allocation guarantee (e.g. if the alternative system was inadequate for a user's needs, they can reclaim their permit for bulk water supply within a set deadline).

9.7.3 WATER TARIFFS

In both cities, water tariffs are overall affordable and promote equity and the inclusion of low-income residents through block rates and subsidized tariffs. In the MRSP, water tariffs still allow for cost-recovery. However, subsidized tariff rates in the MVMC were granted to most households, including those with the capacity to pay full rates, which crippled utilities' revenues and ability to invest in the services. It has also led utilities to depend on federal funding, meaning taxpayers subsidize water services in the country's wealthiest region. Adjusting eligibility criteria for such tariffs will allow utilities to better recover costs and encourage more rational water use and the installation of water metres. Additional revenue could further support leak repairs or service expansion to areas currently relying on water trucks. The MVMC could learn from the MRSP, which has legal frameworks at national and state levels to promote minimum standards and goals for access to drinking water and an independent regulator. In addition, programmes for informal settlements in the MRSP have

expanded access to drinking water and reduced commercial water losses. This could also be implemented in the MVMC through collaboration between local authorities and utilities. In addition, coordination between utilities and local governments regarding land use and land tenure could facilitate the identification of settlements to be legalized, upgraded or serviced through alternative means.

Furthermore, SABESP applies the same tariff rates and subsidies in all the municipalities it operates in through cross-subsidies, enabling service provision in unprofitable areas. However, the tariff structure does not consider water availability within the basin or aquifer. The exception was when bonuses and fines were applied during the water crisis of 2013-2015 to incentivize water saving. In addition, local water utilities that obtain bulk water from SABESP do not always pay for this and are likely to disregard water availability in the broader basin when setting their tariffs. This disconnect by SABESP and local utilities from the water resources that they depend on could be addressed by incorporating environmental impact criteria and compensation mechanisms into tariff-setting.

The tariff design in the MVMC also ignores water availability within the basin, the cost of importing water and the effect of low tariffs on water demand. The State Congress is not accountable to the basin and is incentivized to apply widespread subsidies as a political tool. A more independent process of setting tariffs (e.g. through a regulator) could improve cost-recovery for utilities and increase investments, but also incentivize rational water use and better match the reality of the basin.

9.7.4 WATER PERMITS

Water permits in both metropolises prioritize water for domestic consumption and preserve minimum environmental flows. In the MRSP they are a pre-requisite for obtaining an environmental license and in the MVMC they require an environmental impact assessment. In the MVMC, there are stricter regulations than in the MRSP for obtaining a water permit as a restriction zone across the basin imposes a moratorium on the granting of new permits. Nevertheless, permits in the MVMC can be transferred between users. The introduction of a moratorium on new water permits could be considered for the MRSP, but the case of the MVMC highlights the importance of an accountable regulatory system. Unregulated permit transfers and weak land use and building regulations allow for continued urban expansion in peri-urban areas, increasing water demand. This shows a disconnect between WRM at basin or aquifer level and urban planning at local level. In some cases of over-allocation, it may be preferable for the relevant authority to terminate a permit rather than to allow its transfer to another user. If a transfer is allowed in a water scarce area, guaranteeing priority uses is necessary – although not always sufficient – to achieve sustainability and inclusiveness.

In addition, water-centric Strategic Environmental Assessments could help decision-makers identify where new projects are viable without causing environmental or social impacts. This would go beyond current Environmental Impact Assessments as it would allow region-wide impacts in a continuous manner and support sustainable planning processes. Such

regional planning that includes stakeholders from the multiple basins inter-connected in metropolitan water use, the water allocation authority, users and local governments could lead to concerted action to ensure that urban and economic growth considers resource limitations and benefits local residents. More groundwater data and knowledge and the integration of groundwater into participatory basin management could also ensure more adequate responses to current groundwater use.

9.7.5 WATER USE AND WASTEWATER DISCHARGE FEES

Although they promote rational water use and consider water availability, the value of water use and wastewater discharge fees in the MRSP remains low. In part this is because they were only introduced in 2013 and the basin committee plans to raise them progressively. Increasing these fees, at least for certain larger users, will help reduce water demand and increase the basin committee's budget for basin-wide projects. In Mexico, these fees are set at national level and vary per 'availability zone'. The value of fees in the MVMC is also relatively low, despite its location in a low availability zone. Requiring the use of water metres for bulk water users could increase rational water use and the revenue collected. Applying sanctions to users who lack metres or use water illegally would also incentivize compliance (as non-compliance is now met with virtual impunity) and finance intermittent inspections. Although water for public supply is the largest use, incentives for farmers to switch to more efficient irrigation systems could reduce water use in the MVMC's rural hinterlands and reduce pressure on aquifers.

In the MRSP, bulk water use and wastewater discharge fees are returned to the committee of the basin where they were charged. With the implementation of these fees, the ATB committee's budget increase. This has led to renewed stakeholder interest and involvement due to a greater capacity to invest in projects of basin relevance. This system of keeping fees within the river basin and involving users and other stakeholders has potential for the MVMC. Currently water use fees for water resources used within the MVMC are either reinvested in stormwater and sanitation works in the metropolis, even when these water resources were imported from other basins, or they are absorbed by the Federal Treasury. The MRSP's system increases willingness to pay of users and stakeholder engagement, leading to more sustainable and inclusive outcomes at basin level.

9.7.6 INTER-BASIN TRANSFERS

For both the MRSP and the MVMC, inter-basin transfers have been key to responding to rapidly growing water demand, and due to the heavy reliance on donor basins it is unrealistic that either city could stop importing water in the short to medium term. Nevertheless, the focus on inter-basin transfers as the main strategy to achieving water security has disincentivized water demand management in both cases. As both cities are reaching the limits of the economic viability of importing water and as climate change forecasts indicate an overall decrease in

precipitation, cost-benefit analyses could reveal the economic advantages of investing in water demand management.

In both cases, water imports have transferred externalities to donor basins. In the MRSP, this has led to tensions with the PCJ committee and its reluctance to renew transfer agreements. In the MVMC, there have been conflicts with indigenous communities who lost access to nearby water resources without prior consultation or any form of compensation. Basins exporting water to the MRSP receive compensation through water use fees. However, these fees do not fully compensate for externalities. Cancelling the discount on inter-basin transfer fees from the Cantareira System to the MRSP would more fairly reflect the costs transferred onto the donor basin. This could be done progressively to allow time for users to adjust (e.g. by investing in water saving technology). The additional funds could be reinvested in preserving the Cantareira System and sustainable activities around it, thereby economically supporting the donor basin and ensuring the preservation of ecosystem services that benefit the MRSP. In addition, actors within the PCJ basin, or other basins that export water to the MRSP, could be given a greater role in basin transfer negotiations through a platform at a larger spatial scale, such as the Integrated Urban Development Plan.

In the MVMC, bulk water use fees are not returned to donor basins and subsidized drinking water tariffs reduce incentives to reduce water consumption at household level. Returning water use fees to donor basins, eliminating subsidized water tariffs for those who have the capacity to pay, improving billing by installing water metres where they are absent and incentivizing investments into water saving and recycling technologies at local levels could reduce water demand and the pressure on donor basins. Returning water use fees to basins could also strengthen basin councils and give stakeholders in donor basins a stronger voice in negotiations.

9.7.7 Environmental protection measures

In both cases, environmental protection measures have been characterized by sectoral fragmentation and a lack of coordination between local governments and across levels of governments. APRMs in the MRSP require coordination between local, basin and state-level authorities. They involve participatory planning and basin considerations. Although APRMs are managed by sub-basin committees, their main struggle is informal urbanization; and land use management and housing are primarily municipal mandates. It is therefore essential that the sub-basin committee, municipalities, state entities and Wat&San utilities coordinate their actions and goals and develop coherent planning. Municipalities that update their Wat&San plans to align with the basin plan could receive points in the FEHIDRO system, increasing their qualification for funds from the basin committee. Coherent plans would facilitate coordination between utilities and local governments regarding land use limitations for service provision to find solutions, when possible, for service provision in informal settlements.

As in the MRSP, the preservation of Mexico City's Conservation Land involves multiple local governments (i.e. districts), but the green belt expands far beyond the Conservation Land

and there is no inter-state cooperation. A regional vision and plan that englobes the MVMC's green belt has been designed by NGOs but has failed to attain broad government support. However, such a plan could guide investments for PES programmes and from revenue generated by water use fees, as well as facilitate coordination between state conservation programmes. As in the MRSP, managing funds and coordination activities could be the responsibility of a regional body (e.g. a basin organization or an inter-state conservation body). Although PES Programmes still have relatively small budgets, they can support over-burdened local governments and strengthen collaboration across administrative boundaries.

9.8 INFERENCES

In both case studies, rapid and unplanned urbanization, economic development prioritizing the interests of industry and the economic elite and extreme weather events aggravated by climate change are the major drivers of metropolitan water challenges. Developing coherent UWM and IWRM/IRBM that leads to changes in actors' behaviour and that impacts inclusive and sustainable development is challenging in both the MRSP and MVMC. In part this is due to the multitude of jurisdictions involved and the need to align mandates at different levels, spatial scales and sectors (e.g. preservation involves land use management at local level, environmental policies at state level, basin management, etc.). Instruments are sometimes disconnected from the water cycle (e.g. water tariffs focusing on affordability but ignoring water availability) or fail to include already marginalized communities within or outside the metropolis. Many suggestions for redesign therefore relate to the spatial scale of instruments and the challenge of overcoming mismatches between the scale of their design and the scale of their impacts. Harmonizing plans at different levels and between sectors is crucial in that regard. Importing water from other basins remains necessary in the short and medium term but externalities could be accounted for through regional planning that incorporates inter-linked basins and gives a voice to all stakeholders, and through compensation mechanisms, which would also incentivize implementing more water demand measures. Drainage and wastewater management require a metropolitan plan for interlinked infrastructure, but stormwater and wastewater can often be managed at sub-basin level, retaining water closer to its source. Although the MRSP's river basin and urban water governance regimes are overall more effective in terms of inclusiveness and sustainability, policy redesigns are recommended for both cases and each has relevant lessons for the other.