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A comparative study of São Paulo and Mexico City

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ANNEXES

ANNEX A – LITERATURE REVIEW

Search term(s)	Period	Fields	Numbers of results
Integrated Water Resources Management	1970-2015	Title – Abstract – Keywords	1275 (271 with quotation marks)
Integrated River Basin Management	1970-2015	Title – Abstract – Keywords	487 (44 with quotation marks)
Integrated Urban Water Management	1970-2015	Title – Abstract – Keywords	349 (23 with quotation marks)
Sustainable Urban Water Management	1970-2015	Title – Abstract – Keywords	314 (17 with quotation marks)
Metropolitan Water Management	1970-2015	Title – Abstract – Keywords	113 (0 with quotation marks)

Source: Generated from ScienceDirect

ANNEX B – COMPREHENSIVE LIST OF POLICY INSTRUMENTS

	Regulatory	Economic	Infrastructure	Suasive
Water quantity	Water use permits Environmental flow standard (Mexico) Water abstraction restriction zones Transfer of water use permits between users Environmentally protected areas relevant for water resources Classification of water bodies	Water use fees (bulk use) Water tariffs (consumers) Electricity subsidies for irrigation pumping (Mexico) Sanctions for over-abstraction of bulk water Cross-subsidies in water tariffs at state level (Brazil) Metropolitan funds (FUMEFI in Brazil and Fideicomiso 1928 in Mexico)	Rainwater harvesting systems Water-saving technology Inter-connected regional water supply system Water metres Inter-basin transfers Artificial groundwater infiltration	Collection and publication of data on water availability within a basin or aquifer (Mexico) Registry of water use permits (Mexico) Water resources information system (Brazil)
Water quality	Wastewater discharge permits Quality standards for drinking water Quality standards for wastewater treatment Environmentally protected areas relevant for water resources Environmental licensing Classification of water bodies	Pollution fees/fines Payment for Ecosystem Services linked to water resources Financing of protected areas through various funding sources Environmental compensation mechanisms (Brazil)	Water recycling Treatment plants Water filters	Awareness campaign of pollution in the Tietê River (Brazil)
				Flood alert systems

Climate change adaptation	Environmentally protected areas relevant for water resources	Adaptation fund at city level (Mexico)	Basin-wide or regional cooperation on flood management	National climate change assessments
	Classification of water bodies	Adaptation fund at national level (Brazil)	Municipal, regional and national adaptation plans	
	Environmental flow standard (Mexico)	Fund for Natural Disaster Prevention (Mexico)		
	Water abstraction restriction zones (Mexico)	Payment for Ecosystem Services linked to water resources	River basin organizations	National Risk Atlas (Mexico)
		Financing of protected areas through various funding sources	National water resources plan	

ANNEX C – POLICY INSTRUMENTS SELECTED FOR ANALYSIS

Instrument	Selection criteria	Brazil	Mexico
Water use permits	Scope	Allocation of bulk water in and around the metropolis is a source of tension	
	Focus	Main focus on water quantity, but may link to water quality and climate change adaptation	
	Instrument goal	Inclusiveness and sustainability: Ecological → equitable access to/ownership of water resources and ecosystems' protection; Social → Guarantees water for small-scale farmers and preserves ecosystems for people's well-being; Economic → Crucial for industry, agriculture and energy generation; Relational → Criteria for granting permits that prevents power imbalances	
	Type of instrument	Regulatory instrument	
	Levels of implementation	State or federal level	
Bulk water use fees	Scope	(Differentiated) cost of water can lead to tensions between users	
	Focus	Water quantity focus	
	Instrument goal	Inclusiveness and sustainability: Ecological → May incentivize rational use; Economic → Rational use and reinvestment of funds; Relational → A regulated system prevents the richest and most powerful actors to grab all water resources	
	Type of instrument	Economic instrument	
	Levels of implementation	Basin level	Basin or aquifer level through regional organization
Water tariffs	Scope	Differentiated tariffs between and within municipalities and unpaid tariffs lead to tensions	Subsidized rates for public/urban use lead to problems with other users
	Focus	Water quantity focus	Water quantity focus with impacts on water quality
	Instrument goal	Inclusiveness and sustainability: Social → Subsidized tariffs for low-income households and cross-subsidies for state water company; Ecological → Scaled rates aim for rational use; Economic → Some tariffs are too low or not paid; Relational → Low-income and informal settlement residents have lower tariffs, but often sub-par access	

	Type of instrument	Economic instrument	
	Levels of implementation	Municipal or state level	Municipal level
Wastewater discharge permits	Scope	Contamination of water bodies affects communities and ecosystems downstream, causing tensions	
	Focus	Water quality focus	
	Instrument goal	Inclusiveness and sustainability:	
		Ecological → Reduces contamination by discouraging wastewater discharge without treatment;	
		Social → Low-income communities often most affected by contamination (e.g. waterborne diseases);	
		Economic → Preventing contamination is cheaper than fixing it or having to import water from further;	
		Relational → All polluters are held to these standards	
	Type of instrument	Regulatory instrument	
	Levels of implementation	State or federal	Basin or aquifer level through regional organization
Payment for Ecosystem Services	Scope	Preserving ecosystems and water resources for the city has an opportunity cost for landowners and municipalities in the rural hinterlands upstream	
	Focus	Water quality focus, but also relevant for water quantity and climate change adaptation	
	Instrument goal	Inclusiveness and sustainability:	
		Ecological → Incentivizes restoration/maintenance of crucial ecosystems. It also leads to climate regulation and protects habitats for biodiversity;	
		Social → Inclusion of rural communities and compensation for conservation efforts, possibly leading to poverty alleviation;	
		Economic → Loss of economic value in short-term but long-term benefits and cost savings;	
		Relational → Empowers rural landowners	
	Type of instrument	Economic instrument	
	Levels of implementation	Multiple possible levels, but mainly municipal	Federal or state level
Classification of water bodies	Scope	Defines restrictions on activities near water bodies and thus impacts economic development and environmental preservation	
	Focus	Water quality focus	
	Instrument goal	Inclusiveness and sustainability:	
		Ecological → Determines where more restrictive policies can be implemented to preserve water resources;	
		Economic → Restrictions affect economic activities;	

		Relational → All actors must comply to same standards	
	Type of instrument	Regulatory instrument	
	Levels of implementation	State or federal	Federal
Metropolitan-scale water management system (water supply)	Scope	Tensions on water sharing across metropolitan region and between basins	
	Focus	Water quantity focus, but also relevant for climate change adaptation	
	Instrument goal	Inclusiveness and sustainability:	
		Ecological → Rational use and conservation may be included	
		Social → May help overcome relative scarcity that affects marginalized communities	
		Economic → Guarantees supply for various users	
		Relational → Less powerful actors must have equal decision-making power	
	Type of instrument	Coordination instrument	
	Levels of implementation	State level	Federal level
Macro-drainage	Scope	Floods and related issues affect the whole basin and municipalities can aggravate effects downstream	Large volumes of wastewater, low levels of treatment and topography create risks for population and ecosystems. Floods affect all lower lying areas of the metropolis, but especially lower-income neighbourhoods in periphery
	Focus	Climate change adaptation focus	Water quality focus
	Instrument goal	Inclusiveness and sustainability:	
		Ecological → Ecosystem approaches, green infrastructure	
		Social → Marginalized communities should be main target	
		Economic → Cost must be compared to cost of inaction	
		Relational → Less powerful actors must have equal decision-making power	
	Type of instrument	Coordination instrument	
	Levels of implementation	Basin level (but municipal and state levels may also be involved)	Federal and state levels
Climate change	Scope		Climate change risks affect the MVMC as a whole, but poorer areas are more vulnerable

adaptation fund	Focus	Climate change adaptation focus (but also relevant for water quantity and quality)
	Instrument goal	Inclusiveness and sustainability: Ecological → Green areas, water saving, resilience Social → Reduce citizens' vulnerability, increase adaptive capacity and risk awareness. Economic → Economic benefits estimated to slightly outweigh costs in 6-year period Relational → Inclusive decision making
	Type of instrument	Economic instrument
	Levels of implementation	Federal District level

ANNEX D – INTERVIEW LIST

Code	Type	Level	Professional background	Country
Interview-M1	Government agency for environment and climate change	National	Climate change adaptation	Mexico
Interview-M2		National	Water management	Mexico
Interview-M3		National	Water management	Mexico
Interview-M4	National water agency	National	Water services policy	Mexico
Interview-M5		National	Water management/ basin entities	Mexico
Interview-M6		National	Hydrologist	Mexico
Interview-M7		National	Hydrologist	Mexico
Interview-M8		National	Executive advisor	Mexico
Interview-M9		National	Former high-level official	Mexico
Interview-M10	National Forestry Agency	National	PES programmes	Mexico
Interview-M11	National housing agency	National	High level officials	Mexico
Interview-M12	National Centre for Disaster Prevention	National	Extreme weather events expert	Mexico
Interview-M13	Basin management entity	Regional	Water supply infrastructure	Mexico
Interview-M14	Mexico City environmental department	Provincial	Climate change adaptation	Mexico
Interview-M15		Provincial	Environmental management, metropolitan planning	Mexico
Interview-M16		Provincial	Climate change adaptation	Mexico
Interview-M17	Mexico City conservation agency	Provincial	Environmental conservation	Mexico
Interview-M18	Mexico City Department of urban and land development	Provincial	Human right to water, urban water	Mexico
Interview-M19	Mexico City water and sanitation	Provincial	High level official	Mexico
Interview-M20	Mexico City government	Provincial	Metropolitan planning	Mexico
Interview-M21	Environmental regulator	Provincial	Environmental law	Mexico
Interview-M22	Environmental regulator	Provincial	Environmental law	Mexico
Interview-M23	CSO	Local	Political activist / Local leader	Mexico

Interview-M24	District level hydraulic department	Local	Hydraulic engineer	Mexico
Interview-M25	District level hydraulic department	Local	Geophysical engineer	Mexico
Interview-M26	District level urban development department	Local	Urban planner	Mexico
Interview-M27	Local water and sanitation utility	Local	Hydraulic engineer	Mexico
Interview-M28	University/ Research institute		Water governance	Mexico
Interview-M29	University		Ecosystem management	Mexico
Interview-M30	University		Ecosystem management	Mexico
Interview-M31	University		Basin management, agronomist	Mexico
Interview-M32	University		Hydrogeologist	Mexico
Interview-M33	University		Political scientist / water policy	Mexico
Interview-M34	University		Climate change adaptation	Mexico
Interview-M35	University		Water justice / climate change adaptation	Mexico
Interview-M36	University		Human right to water	Mexico
Interview-M37	University		Urban and environmental management	Mexico
Interview-M38	University		Water governance / social justice	Mexico
Interview-M39	University		Water management	Mexico
Interview-M40	University		Wastewater management	Mexico
Interview-M41	Private sector		Engineer	Mexico
Interview-M42	Private sector		Entrepreneur	Mexico
Interview-M43	Private sector		Commercial	Mexico
Interview-M44	Private sector		Commercial	Mexico
Interview-M45	International NGO		Soil and water conservation	Mexico
Interview-M46	International NGO		Environmental and urban policy	Mexico
Interview-M47	International - NGO		Environmental and social policy	Mexico
Interview-M48	International NGO		Environmental conservation	Mexico
Interview-M49	National - NGO		Executive / hydraulic engineering	Mexico
Interview-M50	NGO		Conservation biologist	Mexico

Interview-M51	NGO		Economist	Mexico
Interview-M52	NGO		Basin management / activist	Mexico
Interview-M53	NGO		Water as a human right activist	Mexico
Interview-M54	NGO		Environmental policy	Mexico
Interview-M55	National - NGO		Basin conservation / Forest conservation	Mexico
Interview-M56	NGO		Engineer / water saving technology	Mexico
Interview-M57	Independent		Climate change adaptation / urban water	Mexico
Interview-M58	Independent		Engineering / water policy	Mexico
Interview-M59	Independent		Drinking water access activist	Mexico
Interview-M60	Independent		Drinking water access activist	Mexico
Interview-B1	National Water Agency	National	Water resources management / financial instruments	Brazil
Interview-B2	SABESP	State	Urban water and ecosystem conservation	Brazil
Interview-B3		State	Former high-level official of Tietê River Project	Brazil
Interview-B4		State	High level official	Brazil
Interview-B5		State	High level official	Brazil
Interview-B6	State Secretariat for Sanitation and Water Resources	State	Coordinator, bulk water supply / Representative in basin committee	Brazil
Interview-B7	State Environmental Department	State	Environmental Planning / Involved in basin committee	Brazil
Interview-B8	CETESB	State	Climate change division, Adaptation and vulnerability officer	Brazil
Interview-B9		State	Climate change Division, Mitigation officer	Brazil
Interview-B10	State Environmental Agency	State	Environmental management of metropolitan areas / Representative in basin committee	Brazil
Interview-B11	State Regulatory Agency for Water and Sanitation	State	Regulation specialist, Water and Sanitation Directorate	Brazil
Interview-B12		State	Regulation specialist, Water and Sanitation Directorate	Brazil
Interview-B13		State	Regulation specialist, Economic-financial Directorate	Brazil

Interview-B14	State Agency for forest conservation	State	Manager of conservation units in the MRSP	Brazil
Interview-B15	State Housing Agency	State	Architect / Representative in basin committee	Brazil
Interview-B16	Research institute (state-affiliated)	State	Researcher, hydrogeologist	Brazil
Interview-B17		State	Researcher on erosion, flood risks	Brazil
Interview-B18		State	Technical agent of FEHIDRO	Brazil
Interview-B19	EMAE	State / metropolitan	Environmental department / Representative in basin committee	Brazil
Interview-B20	Basin Agency	Basin	High level official	Brazil
Interview-B21	Municipal environmental department	Municipal	Official of environmental department	Brazil
Interview-B22	Municipal water and sanitation company	Municipal	Director of the Department of Planning and Projects	Brazil
Interview-B23		Municipal	Commercial / manager	Brazil
Interview-B24	Municipal department	Municipal	Drainage specialist	Brazil
Interview-B25	International - NGO		National Water Manager/ water activist	Brazil
Interview-B26	International - NGO		Activist, climate and energy	Brazil
Interview-B27	International - NGO		Water activist	Brazil
Interview-B28	NGO		Water services / Communications	Brazil
Interview-B29	NGO		Researcher focusing on water	Brazil
Interview-B30	NGO focused on river rehabilitation		Geographer, water and urban policy, public administration	Brazil
Interview-B31	NGO		Water quality and conservation, coordinator	Brazil
Interview-B32	NGO		Water resources and water services, urban environmental management	Brazil
Interview-B33	University		Water governance	Brazil
Interview-B34	Consultancy		Water services consultant	Brazil
Interview-B35	Lobby group		Industrial water policy	Brazil
Interview-B36	Water and sanitation workers union		Sanitation advisor	Brazil
Interview-B37	Low-income housing construction company		New real estate developments analyst	Brazil
Interview-B38	University		Spatial planning, environmental governance	Brazil

ANNEX E - MAIN ACTORS IN SÃO PAULO'S METROPOLITAN WATER GOVERNANCE

Scale level	Actor	Responsibilities
Global	World Bank	Grants loans and provides for projects and infrastructure in the water and sanitation sector.
	Inter-American Development Bank	Provides technical and financial assistance in the water and sanitation sector.
National	National Water Agency (ANA)	Regulates and issues permits for the use of national water resources.
		Carries out scientific studies and establishes an Information System.
		Acts as a conflict mediator (increased demand for water for diverse uses has increased conflicts (ANA n.d.).
	National Council on Water Resources (CNRH)	Highest organ of the SINGRH, and by nature normative, deliberative and participatory.
		Promotes the integration of the national and state government, users and civil society stakeholders in water management. However, it overwhelmingly represents government interests.
		Elaborates the National Water Resources Plan and deliberated on major issues and disputes.
		Determines the creation of river basin committees for rivers pertaining to the Federal Union
	Ministry of the Environment (MMA)	Promotes the integration of sustainable development in public policies, in a participatory and democratic manner at all levels of government and society.
		The Ministry of Environment coordinates policies related to fresh water, river basins (e.g. river revitalization programmes), aquatic biodiversity, water resources and coastal zones and oceans (OECD, 2015c, 64). It formulates policies in relation to climate change adaptation and the national policy on climate change (OECD, 2015c).
	Ministry of Cities	Develops urban development policy and coordinates with other government bodies on environmental sanitation (including water and sanitation).
	The River Basin Committees for rivers of federal domain (CBHs)	Approve the basin plan, arbitrate conflicts over water use, establish the values of bulk water use fees and more. They count on the participation of representatives of the States, municipalities, users, civil society and the Federal government.
Sub-national	DAEE	Manages water resources at state level. Grants water permits. Controls water use. Analyses proposed projects. Provides technical and administrative support to the CBHs.
	CETESB	Manages environmental concerns at state level. Issues environmental permits. Monitors pollution. Analyses proposed projects. Provides technical and administrative support to the CBHs.
	Basic Sanitation Company of São Paulo State (SABESP)	Responsible for water supply, and sewage collection and treatment in many municipalities of São Paulo State.

	State Council on Water Resources (CRH)	Multi-stakeholder council that oversees and regulates IWRM in the state (i.e. Discusses and approves laws related to the State Water Resources Plan, mediates conflicts between CBHs, classifies water bodies, etc). It is composed of 33 members, with equal representation from the state, municipalities and civil society (FABHAT, 2016).
	Secretary of Energy, Water Resources and Sanitation (SERH)	Formulates and implements the state policies on water resources and sanitation and integrates these with the state policies on the environment, health, urban development and more. DAEE and SABESP are subordinated to SERH.
	State Environmental Secretariat (SMA)	Establishes the State Environment Policy. The CETESB is subordinated to the SMA.
Basin	River basin committees	Approve and update Water Resource Plans. Deliberate on water-related decisions within the basin. Reduce conflicts among stakeholders. Define water bulk prices. The committee's creation is preceded by the elaboration of a basin Status Report that diagnoses its main challenges. The Alto Tietê basin committee is composed of state, municipal and organized Civil Society representatives, each with 18 seats[94]. As there are 36 municipalities in the basin, there is a representative and a substitute of each sector for each municipality. Representatives are elected, and each municipality is either directly represented or through a substitute, except the municipality of São Paulo, which always has a seat (Brandeler, 2013). The civil society bloc is composed of broad interests (e.g. industry and environmental preservation). The executive board is composed of a president, a vice-president and an executive secretary[95]. Meetings occur monthly and are open to the public, although the population is mostly unaware of the committees' existence (Interview-B31).
Metropolitan	Metropolitan regions	Regional units instituted by the States, formed by the grouping of neighbouring municipalities for integrating the organization, the planning and the implementation of "public functions of common interest" (Casa Civil, 2015). São Paulo State's definition of 'metropolitan region' is "a grouping of neighbouring municipalities of national prominence, due to high population density, significant conurbation, highly diverse urban and regional functions, socio-economic specialization and integration, requiring permanent integrated planning and joint action by the involved public entities" (State, 1994).

[94] Civil society representatives embody organizations such as NGOs, user associations, neighbourhood associations, and business or industry associations. While SABESP is 51% state-owned, it represents the State's interests in the committee and not that of consumers (i.e. civil society) (Interview B35).

[95] The president is always a mayor, the vice-president is a Civil Society representative and the executive secretary is a State representative (from the DAEE or the CETESB). State representatives are technical experts and their leadership position in the execution of the committee's activities is based on the premise that they have more technical knowledge (Alvim, 2006, p. 163).

	EMAE (Metropolitan Company for Water and Hydropower)	Produces hydropower for the metropolitan region, through reservoirs and major engineering works that involved rectifying and reversing the Pinheiros River.
	EMPLASA (Metropolitan Planning Company of the State of São Paulo)	It is bound to the State Secretariat for Metropolitan Development. Formulates policies at the macro-metropolitan level on land occupation issues and compatibility with the region's sustainable development. EMPLASA aims to integrate sectoral, spatial and institutional projects and actions, and is focused on issues of mobility and logistics, environmental sanitation and housing. It has developed metropolitan plans for housing and urban development in the past, but they are not enforced (Interview B15).
Municipal	Municipal governments	Responsible for land use and soil occupation, water services, urban drainage, civil defence, micro-basins and areas of springs in their territory, and local environmental issues. The municipality of São Paulo's department of Works, which is responsible for drainage and flood control within the municipality, has the Emergency Management Centre that focuses on flood forecasts and triggers different alert levels. This centre is in close communication with the Civil Defence (Interview B24).

Source: Author

ANNEX F - MAIN ACTORS IN MEXICO CITY'S METROPOLITAN GOVERNANCE

Scale levels	Actors	Responsibilities
Global level	United Nations	Promoting global norms, standards and targets (Human right to water, MDGs targets for water and sanitation)
	World Bank and other IFIs	Providing financing to the water sector
National level	Federal government	Regulating the use of water resources Contributing to the financing of investments
	SEMARNAT	Establishes official norms in relation to water management Supervises enforcement of norms
	CONAGUA	Responsible for water resources management in Mexico, including: Granting of water abstraction and wastewater discharge permits Supplying bulk water to the Federal District and to parts of Mexico state through the Cutzamala and Lerma systems Water policy, planning, irrigation and drainage development, water supply and sanitation, and emergency and disaster management (with an emphasis on flooding).
	Inter-ministerial Commission on Climate Change (CICC)	Supporting collaboration among federal and regional agencies, minimizing conflicts among sectors, and maximizing the benefits of synergies for the integration of a climate change policy.
	SINAPROC (National Civil Protection Service System)	Informing authorities and society of imminent extreme events and risks, well as carrying out prevention signals, early warnings, evacuation procedures, providing provisional dwellings for affected people, damage control measures, thoroughly surveying damages and possible solutions for affected areas and helping the re-establishment of former living conditions (CONAGUA, 2011).
	CENAPRED (National Disaster Prevention Centre)	Develop risk reduction policies and coordinate information and warning systems.
State level / Federal District level	SACMEX	Providing residents of the Federal District with drinking water, drainage and sewerage services, as well as the treatment and reuse of wastewater, in adequate quantity and quality Operating, maintaining and building water infrastructure
	Mexico State Government	Planning, regulating and developing infrastructure for water resources Providing bulk water Treating wastewater Assisting municipalities in providing water and sanitation services

	Mexico State Water Commission	Buying bulk water from CONAGUA, transmitting it through its own bulk water infrastructure and selling it on to 57 municipalities (4.1million inhabitants) Monitoring water quality Providing technical assistance to municipalities in water disinfection and sewer cleaning Operating wastewater pumping stations and five wastewater treatment plants, emptying septic tanks Providing water in tankers in emergency situations Providing training and assisting municipalities in the establishment of municipal utilities
Basin level	Basin agencies (decentralized office of CONAGUA)	Formulating regional policy Designing programmes to implement such policies Conducting studies to estimate the value of the financial resources generated within their boundaries (water user fees and service fees) Recommending specific rates for water user fees and collecting them.
	Basin councils	Guiding, together with CONAGUA, the Basin Agencies' work. Coordinating government institutions Negotiating with water users and social organizations, with as main objectives the formulation and execution of programmes and actions to improve regional water management, support of hydraulic works development and related services, and preservation river basin resources.
City level	Municipalities	59 municipal governments in Mexico State, one municipality in Hidalgo State and 16 districts in Mexico City are responsible for the provision of drinking water, drainage, wastewater collection, treatment and disposal for their constituents, as well as the management of solid waste and the creation of environmental protection zones.
	Municipal utilities	Municipalities can delegate the provision of water and sanitation services to a municipal utility or to the state water commission.
Other	Irrigation districts	In Hidalgo state these oversee irrigation with wastewater from Greater Mexico City.
	NGOs	Focusing on social and environmental issues linked to water (Guardianes de los volcanes; UN Habitat, Isla Urbana, Agua Para Todxs Agua Para la Vida and more)

Source: Author

ANNEX G – ADDITIONAL INSTRUMENTS

CLASSIFICATION OF WATER BODIES IN THE MRSP

Description

According to the State Water Law (nº 7.633 of 1991), the State is responsible for the protection of aquatic flora and fauna and of the environment. This involves establishing priority uses for water and classifying water bodies in different categories according to their purpose for water users and the water quality levels required for these (Brazil, 1997). These are then submitted as proposals to the basin committees for discussion and approval (CEDE 2015). The aim is to ensure water quality compatible with the more demanding uses and to lower the costs of combatting water pollution through permanent, preventive actions (Brazil, 1997). There are five categories for surface freshwater resources and six categories for groundwater resources. Each category determines the level of protection by regulating the discharge of effluents and the licenses for activities with environmental impacts (PERH 2017). Water bodies that are deemed important for uses that require clean water or that are still well preserved, are typically classified within a category that involves more restrictions (CEDE, 2015). This instrument links with the granting of water use permits, the charging for bulk water use and environmental licensing (CEDE, 2015). This instrument can be considered a planning tool, as it not only looks at the current state of a water body but at the water quality it requires to respond to society's needs.

Effectiveness on actors in terms of mandated goals

All the waters of São Paulo state have been classified, which is not always the case in other states (CEDE 2015). The main challenges for the effectiveness of this instrument is the lack of adequate monitoring of water bodies and the need to calibrate cost estimates for the adoption of the measures to attend to the classifications (CEDE 2015). Nevertheless, in some basins, particularly those where the charging for the use of water is implemented, there are registration systems and monitoring networks (MMA 2010).

This classification significantly depends on the political will of a state or basin committee, as a more restrictive class means more restrictions on potential activities (CEDE 2015). The focus is on making water bodies meet the standards of their classification, which are sometimes very low, rather than promoting their preservation and restoration for purposes such as supporting aquatic life or improving the quality of life of riverside inhabitants.

Impact on inclusiveness and sustainability

Indirectly, besides a water quality instrument, this also represents a land use control mechanism as it restricts the installation of activities that would affect the quality of the water that a water body should maintain according to its classification (MMA, 2010). As many sources of water contamination are related to land use factors, such as informal urbanization, the implementation

of the regulations associated with this instrument has the potential to influence drivers of contamination.

The challenge is that contaminated water bodies often already have a lower classification, and therefore have weak regulations in place. Environmentalists criticize the category 4 class as so weak that it encourages the contamination of water bodies. In addition, the existence of the more permissive categories is at odds with the Law of Environmental Crimes that prohibits "pollution that results in damages to human health or that cause the mortality of animals or the destruction of significant flora" (Federal Law 9.605, 1998). This leads to legal ambiguity "where everyone does what they think is the right interpretation, or the most convenient". In the Alto-Tietê river basin, rivers in the urbanized areas fall under Class 4, the most permissive category, even when they are in still relatively good state, which reduces the incentive to reduce pollution.

Instruments	Effect on actors	Impact
Classification of water bodies	It has been implemented, although monitoring costs make it difficult to verify compliance.	Ecol: 0 Class 4 leads to tacit acceptance of "dead rivers" and does not encourage improvement. However, classifying rivers allows for differentiated and more realistic standards.

Redesign

This has the potential to influence land use management, as higher classifications restrict polluting activities near the water body in question. This instrument should be integrated with other planning instruments, so that discussions around it may include a broader range of actors, including the community to deliberate on what kind of river they want and what kind of river they can get. Informal settlements where sanitation cannot be installed remains a challenge and the solution must be negotiated with the housing and urban planning sectors, and with municipalities.

Some have argued that the most permissive class should not exist as it informally condemns the water body to remain in its contaminated state. However, eliminating it should be done within a longer-term planning horizon, so that current "polluters" have time to adjust.

Comparison in terms of design

In the case of São Paulo, the granting of a wastewater discharge permit depends on the classification of a certain water body. This classification ranks water bodies and waterways in terms of the level of restrictions and protections they require, and this depends on their condition and the type of use that is made from their water resources. Higher ranked water bodies, which may be well-preserved and used for water supply, therefore face more restrictions. While this protects these water bodies, it does not create incentives to reduce contamination in already polluted water bodies.

In the case of Mexico City, obtaining a wastewater discharge permit is also linked to the classification of the water body in question. The classification determines the water body's capacity to assimilate and dilute contaminants, the levels of contaminants that can be contained in discharged effluents and quality targets to be attained within specific timeframes. It is based on three quality parameters, which ignores other contaminants that can have harmful impacts and international recommendations on the number and types of parameters. Lack of compliance results (in theory) in a fee to be paid and that is (in theory) invested into the improvement of the appropriate infrastructure.

Comparison in terms of effect on actors

The classification of water bodies has meant that clean water bodies, sometimes used for water supply, had a higher ranking and thus level of protection. However, the responsibility to maintain these water bodies at those levels falls largely on local governments, which must enforce zoning laws and control land use around these water bodies. They typically lack the human and financial capacity to fulfil these expectations. Moreover, water bodies that are given low rankings – due to their current state of contamination – are condemned to remain as such, as the classification does not create incentives for improving the ranking. In addition, critics have claimed that water bodies have been downgraded in their classification in order to allow more (polluting) activities near them. In the case of Mexico, although included in the National Water Law, the classification of water bodies had not been implemented everywhere. Overall, the responses were that regulatory measures had not remedied the problem of sewage contamination in the country.

A stricter application of wastewater discharge fees and more restrictive classification of waterways would incentivize polluters to treat their sewage. This requires a basin view, more difficult to achieve with highly fragmented sewage management, and a regional approach to land use and the challenge of informal settlements.

WASTEWATER DISCHARGE PERMITS IN SÃO PAULO

Description

Wastewater discharge permits are the main instrument for water preservation (Brazil, 1997). They allow water users to discharge effluents into water bodies for dilution, transport or final disposal, and hydropower use. Together with water use permits, discharge permits are a prerequisite for obtaining an environmental license and a key step to realizing any activity that can pollute or cause environmental degradation (Brazil, 1981)[96]. Although environmental licenses are granted by the CETESB, wastewater discharge permits are emitted by the DAEE or ANA (depending on whether the water body is of state or federal domain) (Brazil, 1997 Art. 14). CETESB monitors the discharge of effluents at their source by collecting and analysing samples, and by verifying monitoring devices installed for this purpose (Interview-B7). The

[96] Licenses are renewed periodically, and measurements are taken to verify compliance (Interview-B10).

DAEE shares its database of water uses and permit-holders with CETESB, which then defines which use needs a license (Interview-B7).

Wastewater discharge permits are granted if the effluents meet qualitative requirements, or if the receiving water body has the necessary flow or volume to dilute the effluents so that it meets these requirements, thereby not compromising the water body's classification (CEDE, 2015). This classification determines different standards for different water bodies according to their current condition and the quality requirements of users that rely on it. Polluting effluents must therefore undergo adequate treatment prior to discharge (Conama, 2005). As with water use permits, a fee is charged for the discharge of effluents.

Effectiveness on actors in terms of mandated goals

Improvements in water quality may be attributed to water discharge permits, but the Tietê Project likely contributed by injecting large investments into SABESP's sanitation programmes. The difficulty of obtaining environmental licenses due to strict regulations may have curtailed the effect of discharge permits (Interview-B5/B37). The intended result (i.e. compliance with high standards and adjustment through stricter wastewater treatment processes) backfired and led to non-compliance (Interview-B5). The CETESB lacked the capacity to monitor potentially polluting activities, and although fines could be applied, in practice there was still a lot of impunity for polluters (Interview-B5). Meanwhile, the State Office of the Public Prosecutor operated in an isolated manner and presented polluters, such as SABESP, with billionaire fines rather than seeking comprehensive plans towards increasing sewage treatment (Interviews-B5/B22/B23).

Moreover, these permits are granted when pollutants can be absorbed without causing the downgrading of the water body's classification, but there are no requirements or incentives in place to improve the effluents' quality further (Interview-B5). This becomes a vicious cycle as polluted rivers are tacitly encouraged to remain so.

The effect of this instrument on industrial pollution is seen more positively than that on domestic sewage, which is partly explained by utilities' lack of financial capacity for their operations: In the largest wastewater treatment plant of the MRSP, "the pumping systems do not work and there are no interceptors, there is no maintenance" (Interview-B7). While the pressure is on sewage treatment plants and industries, diffused pollution from both urban and rural sources is left largely unaddressed.

Impact on inclusiveness and sustainability

Between 1990 and 2014, the length of the pollution slick in the Tietê River shrunk from 380 km to 70 km, although it returned to 130 km after the water crisis, as investments in sanitation were diverted to increase water supply (SOS Mata Atlântica, 2017). In addition, formal housing and commercial developments in areas that required higher levels of protection stopped, but irregular developments multiplied. This is particularly problematic in areas of springs, such as

the Guarapiranga dam[97]. By focusing exclusively on quantitative and qualitative impacts on water bodies, the licensing process ignores the factors leading to the pollution (i.e. lack of affordable housing, informal urbanization) (Interview-B5).

There is a disconnect between wastewater discharge permits, which are emitted at state or federal level (depending on the domain of the water body), and sanitation planning, which is a municipal responsibility and does not (necessarily) integrate basin considerations. This leads to tensions between zoning, and the developments sponsored at local level, and the protection of water bodies by basin and state entities. State-level respondents particularly emphasized the municipalities' inability (or unwillingness) to prevent occupations by new informal settlements.

Instruments	Effect on actors	Impact
Wastewater discharge permit	The lack of enforcement encourages non-compliance. Fines have been applied sporadically and without attempts at remediation. Sewage treatment plants lack resources, and fines will not help.	Ecol: - Discharge of untreated effluents remains high and cause water contamination. Soc: - Marginalized populations are more likely to lack sanitation and live near contaminated water. Econ: -- As local water resources are polluted, water imports become necessary. Costs are transferred from polluters to the State and donor basins. Rel: - Lack of coordination between sectors and levels of government has contributed to informal growth, but permits do not apply in these areas.

Redesign

First, compliance must be addressed. Environmental licenses should only be granted or renewed if it is verified that a wastewater treatment system is accounted for. Although constant monitoring is prohibitively expensive, sporadic inspections to a small number of permit-holders and the application of increasing fines (i.e. first-time offenders vs recidivists) can encourage compliance. Part of the value collected by the permits should also be allocated to monitoring and compliance schemes, creating a possible snowball effect.

To address the main challenge (i.e. informal settlements), it is necessary to increase coordination between local and state actors. Approval of water and wastewater discharge permits should be connected to the municipal master plan and Wat&San plan, and if sewage treatment facilities cannot comply (e.g. large investments still needed, informal settlements that are not connected to the network), they must work with local authorities towards a solution (e.g. regularization and upgrading of areas or relocation, alternative treatment options).

[97] Regulations in areas of springs aim to prevent housing densification by requiring a minimum surface area of 250m^2 per housing unit (Interview-B37).

Comparison in terms of design

In Mexico they are obtained together with water use permits. The classification of a water body determines the quality standards that the effluent must meet before discharge so that the water body concerned is deemed capable of assimilating and diluting the contaminants. In theory, a lack of compliance with these standards means that the polluter must pay a fee that is reinvested in the necessary sanitation infrastructure.

In Brazil, wastewater discharge permits are granted if the relevant authority (ANA or DAEE) estimate that the receiving water body has a volume or flow of water sufficient so that the discharge – together with the already existing discharges – do not affect water quality such that it would alter the water body's classification. Wastewater discharge permits are also necessary to obtain environmental licenses (for any type of potentially polluting activity). Similarly to Mexico, discharge permits require effluents to meet qualitative standards according to the classification of the water body.

In both cases, qualitative requirements tend to be stricter in areas further from the city, where water resources are better preserved. This instrument relies significantly on the classification of water bodies, and consequently so does its effectiveness.

Comparison in terms of effect on actors

In both cases, wastewater is still often discharged without treatment, due to a lack of treatment capacity or – more often – a lack of piping infrastructure connecting to a treatment plant. This also concerns "polluters" with wastewater discharge permits and leads authorities to turn a blind eye in many cases. Even when "polluters" could be connected to the wastewater infrastructure, the lack of monitoring did not incentivize them to do so. In the MRSP, utilities that do not treat sewage could face significant fines, and SABESP faced legal woes for its slow progress in sewage management.

Overall, in both cases, industrial users are more likely to comply (as they are easier to monitor and fine). For some, this has contributed to an incentive to treat and recycle wastewater, although this is still a minority.

WASTEWATER DISCHARGE PERMITS IN MEXICO CITY

Design

Wastewater discharge into national waters requires a CONAGUA permit (NWL, 2004). This permit is obtained simultaneously with the water use permit and is also registered in the REPDA. In issuing this permit, CONAGUA considers the capacity of the concerned water body to assimilate and dilute the effluents' contaminants. Depending on the water body's classification, the effluents must meet more or less strict quality standards (CONAGUA, 2015). More specifically, the effluents must comply with a series of indicators concerning water contaminating, the volume of wastewater and the pollutant load of the discharge (CNA-01-

001). CONAGUA may charge fees for lack of compliance investing the money into infrastructure improvement projects.

Effectiveness on actors in terms of mandated goals

Wastewater discharge permits are ineffective due to insufficient enforcement. There was little monitoring, the few discovered infractions rarely led to fines and, when they did, polluters may ask to commute the fine into reinvestments into a poorly monitored water pollution reduction initiative (Interviews-M5/M9/M40/M52/M58).

Most importantly, effective water preservations policies require a shared, long-term vision of the river basin, with consideration of upstream and downstream linkages, communication between municipalities and other stakeholders of the river basin (Interviews-M2/M9). This vision does not exist. For example, although a mega-sewage treatment plant has been built recently, there is no regional policy to prevent water contamination (see 8.4.3).

Impacts on sustainability and inclusiveness

Despite the emphasis on wastewater discharge on paper, in practice the large majority of wastewater effluents are discharged untreated and contaminated water bodies and agricultural fields beyond the VMB, affecting the health of locals and crops (Interview-M4/M9/M40/M50). Diffuse pollution and a lack of adequate solid waste management further degraded water quality and increased flood risks by clogging pipes and drains (Interviews-M5/M19/M50/M46). This was aggravated by informal urbanization as waste management services are not provided in these areas (Interviews-M5/M51).

The lack of domestic wastewater treatment and contamination from industrial activities, as well as soil subsidence – and the subsequent damage to piping – also threatened groundwater quality (Tortajada, 2008; Pina, 2011; Spring, 2015).

Instruments	Effect on actors	Impact
Wastewater discharge permits	No enforcement and no regional view of water contamination challenges	Env: -- Untreated sewage discharges pose risks to public health and food crops Soc: - Informal settlements are most affected

Redesign See the redesign of water use permits, as similar recommendations are valid.

CLIMATE CHANGE ADAPTATION PLAN AND FUND OF MEXICO CITY

Design

The SEDEMA coordinates a climate change adaptation plan, the Climate Change Action Programme of Mexico City (PACCM). The plan, first introduced in 2008, had a timeframe for 2014-2020. Its main objective was to increase quality of life and sustainable development with

low carbon intensity (SEDEMA, 2014). The Environmental Fund for Climate Change (FACC), managed by the SEDEMA, was created in 2015 to implement the plan (Interview-M16). It received contributions from the national and local governments, and from external sources such as international foundations (Interview-M16). The PACCM had three main axes: Mitigation, adaptation and communication/education. The adaptation axis, with a budget of approximately USD$ 160 million, consisted of 12 actions, including actions on sustainable housing, water saving systems, greywater reuse and energy saving systems (Interview-M14). Issues such as food security and water availability in adequate quantity and quality are emerging in discussions but not yet integrated into the plans (Interview-M14).

Effects on actors

Mexico City detailed climate change programme reflected a recognition within the administration of the need to address the climate crisis and its local effects. This was supported by a broader legal framework, including the National Law on Climate Change. However, the plan put much greater emphasis on mitigation than adaptation (Interview-M57). This could be explained by the synergies of mitigation actions with addressing the city's severe air pollution. Nevertheless, the plan adopted ambitious targets for both mitigation and adaptation. Despite the FACC, funding remained limited in comparison to the plan's scope (INECC, 2017).

Although all states and municipalities were supposed to prepare similar plans, many had limited or non-existent plans (OECD, 2013) (Interview-M16)[98]. Despite the shared challenges, adaptation measures were not coordinated with the MVMC's municipalities in Mexico State, beyond the coordination of macro-drainage (Interview-M14). Mexico City's districts were supposed to develop local plans, but differences in resources and political will led to important differences between them (Interview-M15). Some districts still lacked plans (SEDEMA, 2017).

Moreover, there are no clear coordination mechanisms between levels of government to ensure a coherent adaptation policy (Interview-M15). The Federal Climate Change Fund could strengthen institutional capacity for adaptation at state and municipal levels, but funds often remained at federal level (Interview-M15). Ultimately, state and municipal governments designed and implemented separate climate change programmes. The result was fragmented policies due to different budgets and political will, with the further marginalization of peri-urban areas. Political will was low in most jurisdictions as there was little pressure from civil society and government administrations (Interview-M15).

Impacts on sustainability and inclusiveness

There are no clear evaluation measures in place to verify progress on the PACCM. In fact, it may be almost impossible to isolate the effect of the plan and its fund, as they supported many

[98] As of early 2015, only 2.84% of municipal governments had a climate action plan (Delgado Ramos *et al.*, 2015).

existing initiatives managed by other actors. This further limited the ability to effectively communicate results to the public (INECC, 2017).

Instruments	Effect on actors	Impact
Climate change adaptation plan and fund	Ambitious targets despite focus on mitigation over adaptation. Disconnect between levels of government and across MVMC hindered coherence	Impacts are difficult to link to the plan, which mainly supported pre-existing initiatives. It raised awareness of the need for adaptation and strengthened capacity in sectoral departments

Redesign

It is necessary to design clearer evaluation methods, that can highlight which actions are effective. As many actions are implemented by sectoral departments or districts, this would require closer communication between entities.

All state had to develop such plans, but in the case of the MVMC this led to fragmented strategies and a loss of potential synergies and economies of scale. Mexico City, Mexico State and Hidalgo State should collaborate on a regional climate change plan (for mitigation and adaptation). This should be compatibilized with their individual plans and should not aim to centralize all efforts. Rather, this could help identify shared challenges and opportunities. This could include a regional approach to conservation and the preservation of ecosystem services that feed the basin's aquifers.

Comparison in terms of design

This plan represents a political recognition of the threat of climate change and a comprehensive strategy to address it in Mexico City. Multiple actions and a sizeable budget are dedicated specifically to adaptation, although mitigation is the plan's main focus. The actions are diverse, including actions related to housing, water saving systems, wastewater reuse, and more. The cost-benefit analysis suggests that water-related measures will bring more benefits than costs. The plan includes attempts to better integrate urban and environmental policies, in particular in the Conservation Land, which is crucial for climate regulation and aquifer recharge. In terms of extreme weather events, it only addressed risks from heavy precipitation (as opposed to droughts, forest fires, and other risks). In addition, while the plan recognizes that vulnerability aggravates risks, it does not specifically attempt to address or reduce drivers of vulnerability.

Another drawback is that, as the plan is developed by the Federal District, it does not include the rest of the metropolitan region. Many of the poorest areas, and those most vulnerable to the effects of climate change, are thereby excluded, and urbanization of the green belt is also an important factor aggravating risks for the entire MVMC. Neighbouring states, such as the State of Mexico, have climate action plans, as the General Law on Climate Change specifies that federal entities must develop their own actions. However, the State of Mexico's plan is focused on general guidelines rather than concrete actions, with timeframes and cost estimates.

	Brazil	Mexico
Wastewater discharge permits	0	0
Classification of water bodies	+	+
Climate change plan and fund		+

Comparison in terms of effect on actors

While all federal entities must design a climate change action plan and fund, according to the Federal Climate Change Law, these have been slow to comply. In the case of the Federal District, there is a climate change mitigation and adaptation Law, which makes the implementation of the Plan and Fund mandatory. The higher level of human and financial capacity may further explain its greater progress. However, an effective climate change adaptation strategy was hindered by several elements. The plan lacked data and information to develop a baseline and specific indicators for adaptation, which led to mainly generic guidelines. The plan significantly depended on international funding, and resources are limited in comparison to the ambition of the plan. Many of the actions are the responsibility of different departments and the plan served more to put these existing actions under one umbrella, which did not give additional support to these existing actions. In addition, the plan only concerned the Federal District, and neighbouring municipalities of the MVMC did not have similar plans. Moreover, there was also no vertical coordination mechanism with the Federal government, to ensure coherence of measures. For some actions, isolated, local actions work well, as each district can focus on those that are most relevant. Addressing issues such as air pollution and water-related risks would benefit from a more regional approach as causes and effects spread across borders.

In the case of the MRSP, there is little official recognition of climate change risks and there is no specific strategy at city, metropolitan or basin levels. Climate change concerns could be incorporated into the basin plan and serve to reinforce existing measures that constitute win-win strategies (e.g. drought or flood prevention measures). Overall, climate change was still a taboo subject and many respondents argued that it is not clear whether the water crisis was linked to climate change or climate variability.

ANNEX H – WATER TARIFFS

- *MRSP: SABESP'S TARIFFS*

Normal residential tariff		**Water**	**Sewage**
0 to 10	Reais/per month	26.18	26.18
11 to 20	Reais/ m3	4.1	4.1
21 to 50	Reais/ m3	10.23	10.23
above 50	Reais/ m3	11.27	11.27

Social tariff		**Water**	**Sewage**
0 to 10	Reais/per month	8.88	8.88
11 to 20	Reais/ m3	1.53	1.53
21 to 30	Reais/ m3	5.43	5.43
31 to 50	Reais/ m3	7.74	7.74
above 50	Reais/ m3	8.55	8.55

Favela tariff		**Water**	**Sewage**
0 to 10	Reais/per month	6.77	6.77
11 to 20	Reais/ m3	0.77	0.77
21 to 30	Reais/ m3	2.56	2.56
31 to 50	Reais/ m3	7.74	7.74
above 50	Reais/ m3	8.55	8.55

Source: (ARSESP, 2019)

- *MEXICO CITY: SACMEX'S TARIFFS*

Normal residential tariff		Minimum rate	Additional fee per m3
0 to 15	Pesos	497.17	0
<15 to 20	Pesos	497.17	33.15
<20 to 30	Pesos	662.89	33.15
<30 to 40	Pesos	994.31	33.15
<40 to 50	Pesos	1325.76	33.15
<50 to 70	Pesos	1657.19	40.34
<70 to 90	Pesos	2464.18	43.95
<90 to 120	Pesos	3343.23	58.36
< 120	Pesos	5094.06	90.79

Middle residential tariff		Minimum rate	Additional fee per m3
0 to 15	Pesos	162.13	0
<15 to 20	Pesos	162.13	20.9
<20 to 30	Pesos	266.59	22.87
<30 to 40	Pesos	495.29	27.08
<40 to 50	Pesos	766.02	29.18
<50 to 70	Pesos	1057.76	32.26
<70 to 90	Pesos	1703.07	43.23
<90 to 120	Pesos	2567.67	57.66
< 120	Pesos	4297.36	90.79

Popular residential tariff		Minimum rate	Additional fee per m3
0 to 15	Pesos	43.23	
<15 to 20	Pesos	43.23	
<20 to 30	Pesos	61.96	
<30 to 40	Pesos	121.3	
<40 to 50	Pesos	242.45	
<50 to 70	Pesos	419.22	
<70 to 90	Pesos	945.85	33.38
<90 to 120	Pesos	1613.4	57.66
< 120	Pesos	3343.1	90.79

High residential tariff		Minimum rate	Additional fee per m3
0 to 15	Pesos	194.54	0
<15 to 20	Pesos	194.54	21.9
<20 to 30	Pesos	304.01	24.48
<30 to 40	Pesos	548.78	29.06
<40 to 50	Pesos	839.29	31.04
<50 to 70	Pesos	1149.58	33.25
<70 to 90	Pesos	1814.66	43.23
<90 to 120	Pesos	2679.26	57.66
< 120	Pesos	4408.95	90.79

Low residential tariff		Minimum rate	Additional fee per m3
0 to 15	Pesos	49	0
<15 to 20	Pesos	49	8.36
<20 to 30	Pesos	90.79	11.25
<30 to 40	Pesos	203.28	15.95
<40 to 50	Pesos	362.75	22.38
<50 to 70	Pesos	586.51	28.3
<70 to 90	Pesos	1152.69	34.62
<90 to 120	Pesos	1844.97	57.66
< 120	Pesos	3574.66	90.79

Source: (Mexico City Government, 2018)