HARVARD Kennedy School
JOHN F. KENNEDY SCHOOL OF GOVERNMENT

Navigating Water Scarcity: Climate Adaptation Solutions and Policies for Chile and Mexico

OECD's Action Plan: Climate Resilience and Neutrality Initiatives for Latin America

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1. Executive Summary

This research, conducted for the Organisation for Economic Co-operation and Development (OECD), delves into water management initiatives in Mexico and Chile, stemming from the "Action Plan Towards Climate Resilience and Neutrality in Latin America and the Caribbean (LAC)." Water is a focal point in this plan and requires a detailed analysis of impact, lessons learned, challenges, and policy recommendations to develop adaptation strategies for sustainable water management. Analysis and recommendations for both countries are grounded in a thorough examination of global best practices and successful local endeavors.

Chile and Mexico both grapple with water scarcity, pollution, and inefficient water management exacerbated by climate change. Mexico faces governance challenges stemming from fragmented regulatory frameworks and inadequate enforcement mechanisms. In contrast, Chile's water governance is hindered by historical water rights issues and limited institutional capacity. Both countries struggle with funding constraints, with Mexico lacking sustainable financing mechanisms and Chile facing difficulties mobilizing investment for sanitation services in rural areas.

While both countries face similar water management challenges exacerbated by climate change, their approaches differ. Mexico has made progress at the local level through stakeholder engagement, technical capacity building, and crisis responsiveness, fostering innovative projects like the Coapa Water District. In contrast, Chile has focused on institutional reforms, economic instruments, and trying to address equity considerations to optimize water use efficiency and support conservation efforts.

For Chile, recommendations include strengthening water governance frameworks, enhancing economic instruments, promoting conservation initiatives, and ensuring equitable access to water resources. Strengthening water governance frameworks would address the challenge of fragmented governance and improve coordination among stakeholders. Economic instruments such as water pricing mechanisms and subsidies would help address the undervaluation of water, incentivizing efficient water use and investment in water infrastructure. Likewise, promoting conservation initiatives, such as watershed management programs, would help protect ecosystems and enhance water security. Ensuring equitable access to water resources is crucial for addressing social inequalities and building resilience to water-related risks.

The recommendations for Mexico focus on key areas, such as enhancing water governance and management through updates to national water laws and alignment of urban development policies. Additionally, the empowerment of institutions like IMTA to spearhead innovation is emphasized, alongside the need for capacity building across diverse disciplines. Emphasizing financing mechanisms for the creation of new water assets. Furthermore, the report stresses the necessity of an integrated water management strategy, advocating for the incorporation of green infrastructure and conservation

practices to bolster resilience and ensure the long-term sustainability of water resources. Leveraging international agreements, fostering stakeholder collaboration, and incentivizing advanced technologies for real-time monitoring are also identified as key opportunities. Addressing equity concerns is also paramount.

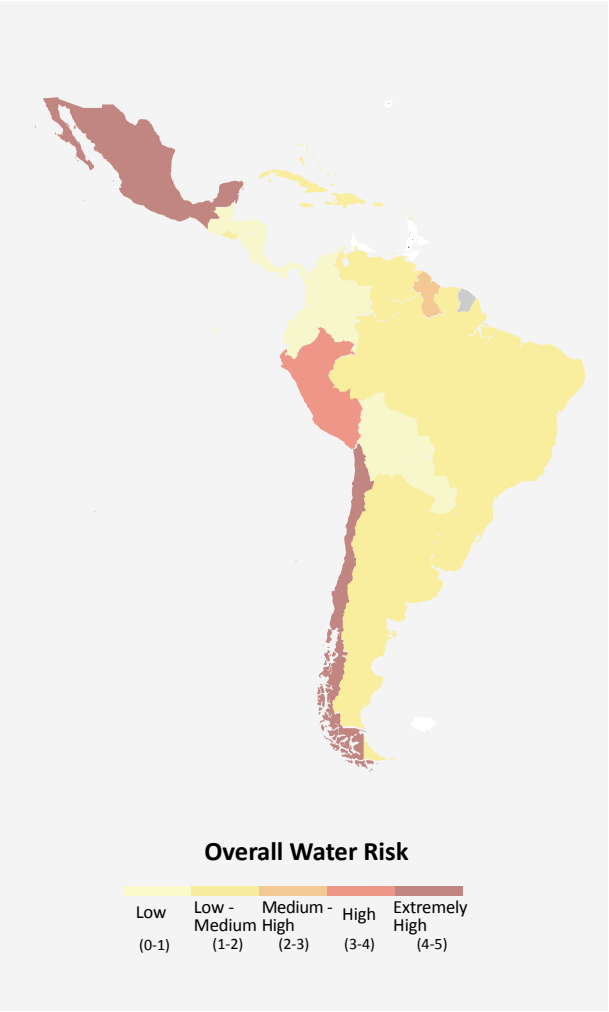
In conclusion, by addressing governance issues, enhancing regulatory enforcement, and promoting collaboration, both Mexico and Chile can overcome barriers to effective water management and build resilience to climate change. Continued international cooperation and knowledge sharing are critical for advancing sustainable water management practices and ensuring a water-secure future for Latin America. Through collaboration, innovation, and political commitment, both countries can strengthen resilience to water-related risks and contribute to sustainable development in the region, underscoring the importance of coordinated action and policy coherence.

2. Problem Description

Climate change poses a significant threat to water resources in Latin America and the Caribbean (LAC), exacerbating water scarcity, pollution, and drought frequency. As of 2019, approximately 150 million people in the region lived in areas with extreme water scarcity, with droughts causing an estimated US$24 billion in economic damage over four decades. These impacts extend beyond economics, straining water supply systems and disrupting sectors such as agriculture and energy. In response, some countries are forced to increase fossil fuel usage, compounding environmental challenges.

As shown in Figure 1, from the entire region, Chile and Mexico face the highest water stress. Addressing this urgent issue requires tailored adaptation strategies that not only mitigate short-term water scarcity but also build long-term resilience. Key questions revolve around how these nations can develop effective strategies amidst changing climatic conditions. By leveraging insights from their experiences, valuable lessons can be applied to accelerate the region's adaptation efforts and enhance water security.

Figure 1: **Water Stress in Latin America**
Source: (WRI, 2024)



Through robust adaptation measures informed by local contexts and international best practices, the LAC region can navigate the challenges posed by climate-induced water stress. By prioritizing sustainable water management, the region can mitigate risks, safeguard vital sectors, and pave the way for a more resilient and prosperous future.

3. Methodology

This project seeks to address water challenges in Chile and Mexico through case study research. We started with a comprehensive literature review and analysis to identify institutional strengths, weaknesses, and effective practices from global experiences.

We conducted stakeholder interviews in Mexico, engaging with over 20 experts from various sectors, including government representatives, the private sector focusing on water adaptation, think tanks like WRI, funds such as the FMCN, academia, civil organizations, basin council representatives, and local-level operators. In Chile, we interviewed over 10 experts from government departments, universities, Aguas Andinas, and specialized think tanks focusing on climate adaptation.

We analyzed investment trends and funding sources for adaptation projects to understand their assessment methods. Additionally, we used the OECD's assessment dashboard to track progress towards the 2050 climate resilience and neutrality goals, focusing on the water pillar, divided into four main categories: Dimension 1: Problem Diagnostic and Status Quo, Dimension 2: Enabling Factors for Adaptation Planning, Dimension 3: Financing Strategies, and Dimension 4: Maximizing Water Adaptation Projects: Metrics, Investment Strategies, and Success Stories.

Case studies

Analysis of Findings and Evidence - Chile

A) CHILE

Water scarcity is an urgent concern in Chile, particularly in the north of the country. Figure 2 shows the baseline water stress for the country and provides a comparison of the magnitude of the issue across the country's regions. Water quality and security are also jeopardized by contamination from industry, being urban and industrial wastewater, agriculture, fish farming and mining the main polluters, creating tensions over access and supply (World Bank, n.d.).

Chile has endured a "megadrought" for 14 years, having a disproportionate impact on vulnerable groups (OECD 2024). Likewise, intense droughts impact forest fires and electricity prices, with reduced hydroelectric output and higher fossil fuel usage. (World Bank, n.d.). Figure 3 shows government decrees for scarcity zones and affected provinces. Comparing years reveals more drought-affected zones. Moreover, current measures inadequately manage water sustainability. Instead of focusing mainly on increasing the supply, Chile should also look at the demand side to address the issue (OECD 2024).

Figure 2: Water Stress in Chile
Source: (OECD, 2024)

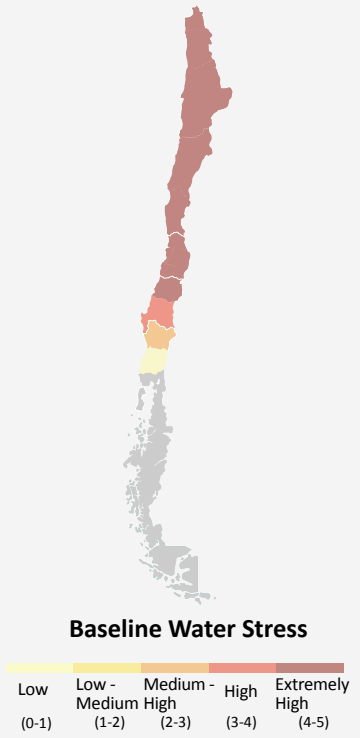
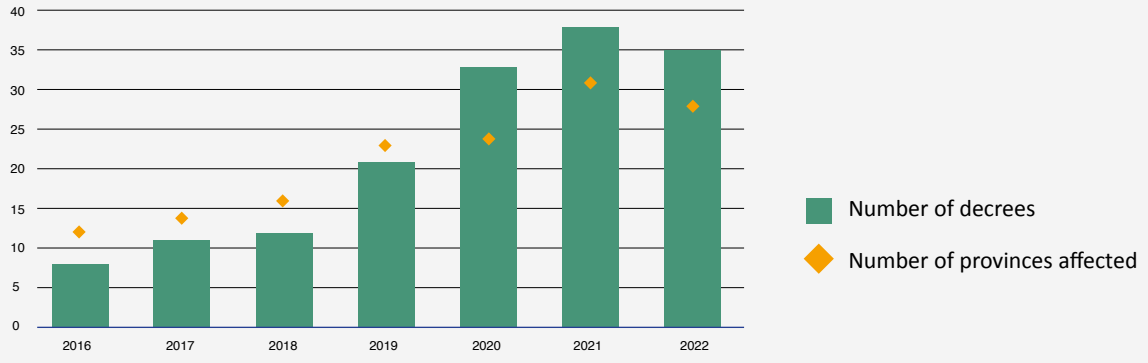


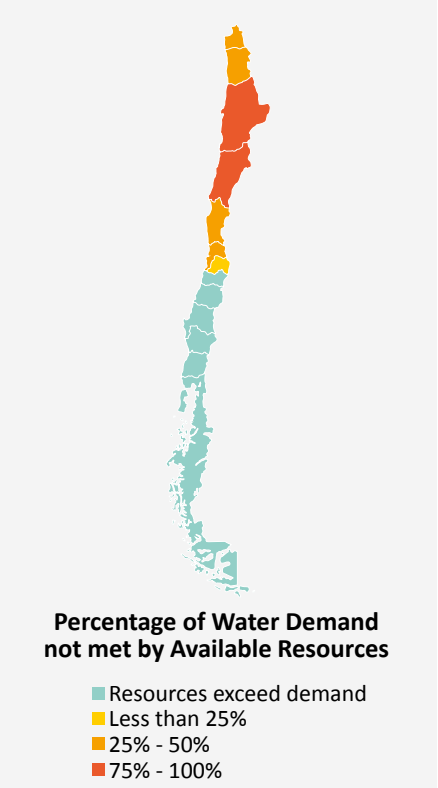
Figure 3: Chile's Rising Number of Scarcity Zones Reflects Extraordinary Drought Conditions. *Source: (OECD, 2016)*



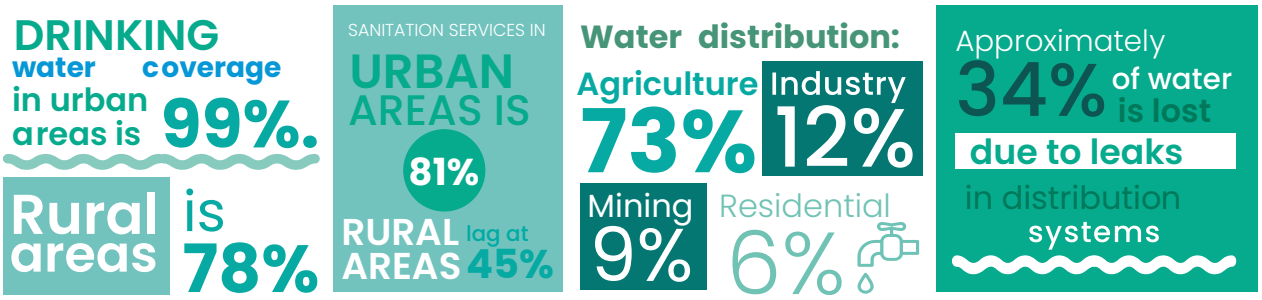
i) Supply and Demand Analysis of Water Resources in Chile

Eventhough Chile has one of the highest percentages of drinking water coverage among the OECD countries (urban areas in Chile have 99% coverage for safely managed drinking water, higher than the OECD average of 95%. However, rural areas lag at 78%.), the challenge for the country arises from the unevenly distribution of the resource, which combined with over-use, over-allocation and water governance challenges, leads to the country experiencing **a severe water crisis that requires coordinated action to improve water allocation and quality.** This challenge is shown in that the average water |availability in the arid region of the country (from the capital, Santiago, to the north) is below 800 m3/person/year. In contrast, to the south of the capital, the availability is approximately 10,000 m3/person/year (Easter and Huang 2014). Figure 4 shows the distribution of water resources, in contrast with demand to show the percentage of the demand that is not met by the resources available.

Figure 4: Chile´s Plentiful Water Resources are Unevenly Distributed Across the Country. *Source: (OECD, 2016)*

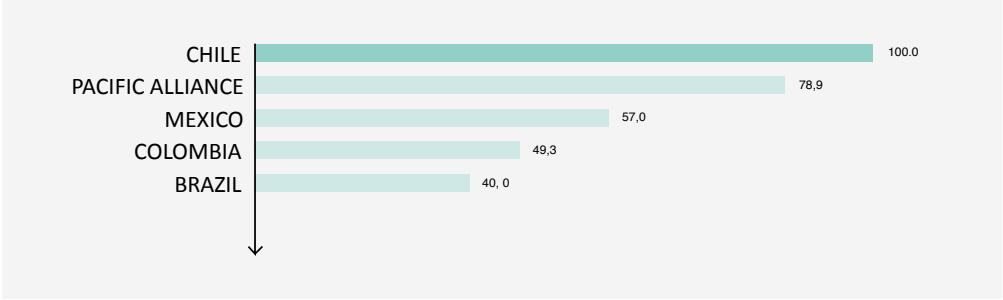


Regarding **water consumption**, in Chile, 73% of the consumptive water use is allocated to agriculture, a key sector of the country's economy, making up 7% of their export revenue and employing 9% of its workforce. The remaining portion of extracted water is allocated to industry (12%), mining (9%), and residential use (6%). For **water supply**, surface water represents 54% of the regional supply and sanitation, while groundwater represents 46%. From this, almost 50% of ground water use goes to agriculture, 35% to residential use and the remaining to industry. **Treated waters** are also key for meeting demand, as shown in the country's increase from 17% to 94.2% in the utilization of treated sewage waters between 1998 and 2011 (Easter and Huang 2014). This is currently 100%, and as shown in Figure 5, Chile is leading in this topic in Latin America.



Most greywater in Chile undergoes treatment in wastewater disposal. The law permits its use for urban, recreational, industrial, and environmental purposes, but not for drinking water. However, pending regulations hinder its implementation despite Law 21.075 addressing greywater collection and reuse. Challenges for greywater reuse in drinking water include high infrastructure costs compared to natural sources, along with necessary biological treatment and disinfection processes that may exceed current wastewater discharge standards and require skilled personnel (Mesa Nacional del Agua 2022).
Finally, Chile has **24 operational desalination plants and has 22 in construction**, and planning process. These are primarily located along the coastal regions of the country's central north and most of the projects are led by the copper mining sector, representing more than 70% of the country's desalination capacity. It is estimated that by 2030, approximately 93% of the water used in these operations will come from desalination (Instituto Milenio SECOS 2021).

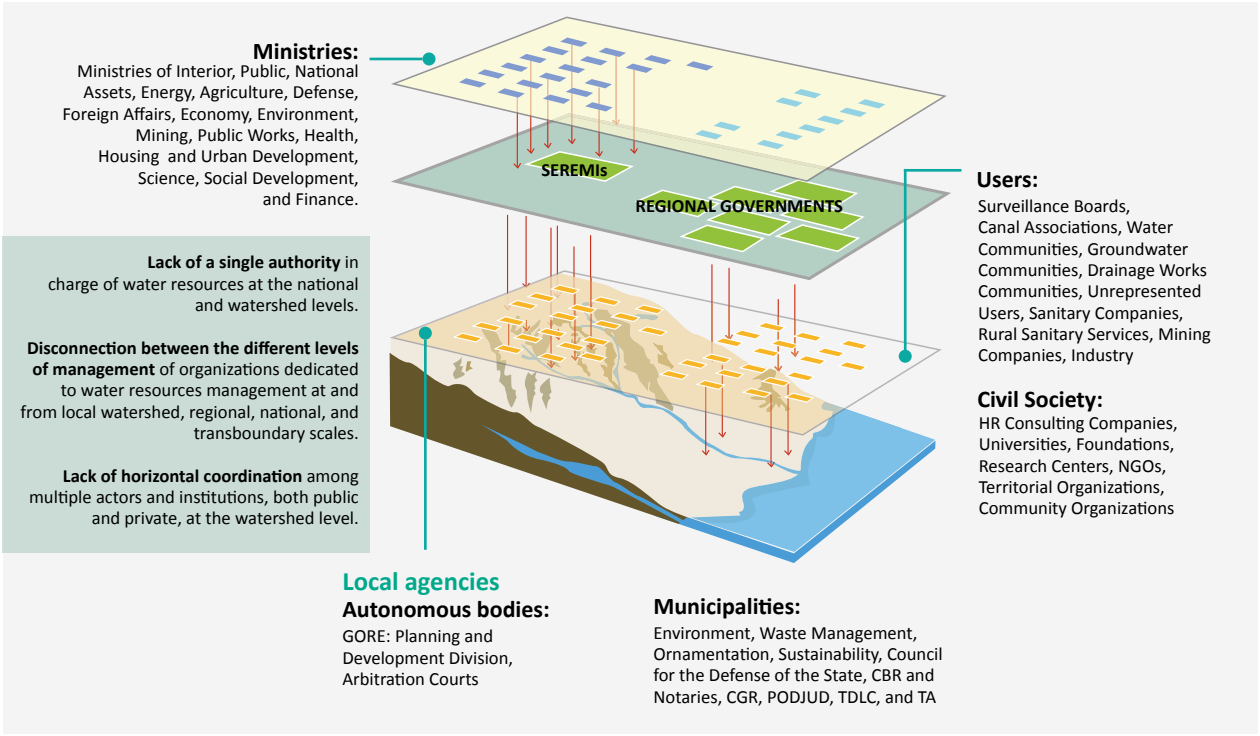
Figure 5: Comparison of Treated Urban Wastewater Among Latin American Countries
Source: (TNC, 2020)



ii) Current Governance Structure and Legal Framework

Water administration operates under a dual system: one centralized and the other decentralized. The centralized aspect is managed by the General Directorate of Water (DGA), a division of the Ministry of Public Works (MOP), responsible for granting water usage rights, maintaining records, and overseeing water resources. The decentralized administration involves various methods of organization and coordination among water usage right holders (Stubing 2021). The Hydraulic Works Directorate (HWD), also under the MOP, provides hydraulic infrastructure services, including projects such as reservoirs, rainwater collectors, river defenses, and alluvial control works (Minsterio de Obras Públicas 2018). Figure 6 shows the management structure.

Figure 6: National Water Resources Management System *Source: (Escenarios Hídricos 2030 2021)*



Three main legal frameworks regulate water resources in Chile. First, the Law Decree 2.603 of 1979, which grants property rights over water, aiming to recognize traditional water uses deserving constitutional protection. The second framework, the Political Constitution of 1980, indirectly addresses three aspects concerning water resources: safeguarding ownership, categorizing rights, and implicitly acknowledging water as a public asset. Finally, the Water Code of 1981, designates water as a national public resource, allocated through usage rights and promoting efficient distribution through WR trading. It also separates water ownership from land ownership to facilitate trade (Stubing 2021).

Water Market in Chile. Under the 1981 Water Code, WR are legitimate claims granting temporary water use. These arise from a concession and can be obtained through two methods: registration processes outlined in the Code or purchasing them on the water market. The first method involves the DGA granting new WR through a free administrative action. Secondly, there is the process for regularizing existing rights. These must be recognized by civil courts if the applicant can demonstrate historical use and meets the requirements for creating new rights. Once granted or regularized, WR are registered in the general registry system, where market transactions like transfers, sales, and mortgages are also recorded (Melbourne Law School, Macpherson, and O'Donnell 2015). The code also distinguishes between surface and groundwater sources. It is necessary to note that surface WR were assigned by the mid-90s (Melbourne Law School, Macpherson, and O'Donnell 2015).

Regional water supply and sanitation is achieved through firms. Operating as private enterprises, these regional companies are predominantly owned by the state, with a significant stake held by the Corporation for the Promotion of Production (CORFO). Despite their private nature, these companies operate under national regulations to provide their services (Easter and Huang 2014). Regarding **price setting,** the Superintendence of Sanitary Services (SISS) supervises the process, which includes revising tariffs every five years considering long-term cost projections. Both water companies and the SISS play an equal role in the process. Moreover, companies are guaranteed a minimum annual return of 7% on their assets, and adjustments between tariff revisions are linked to inflation indicators. This framework ensures equitable and transparent adjustments while providing financial security for water service providers (Aguas Andinas 2024).

The primary challenge in adaptation is setting tariffs that efficiently provide distribution and sewage collection services while encouraging responsible consumption. Pricing based on long-term marginal costs ensures fairness for consumers, with adjustments to cover total costs for self-sufficiency. Chile addresses equity concerns by implementing targeted subsidies for vulnerable populations alongside this efficiency-focused system (Mesa Nacional del Agua 2022).

Table 1: Comparison of Drinking Water Management in Urban Areas and Rural Areas
Source: (Matus et al. 2020)

	Urban Areas	***Rural Areas***
Regulatory framework	General Law of Sanitary Services and Tariff Law.	Law regulating rural water supply and sanitation was enacted in 2017 but there is no enforcement regulation.
Structure	The SISS under the MOP, is the provider and regulator. SISS focuses on coverage of sanitary companies and establishment and oversight of development plans.	Rural Potable Water Systems (APRs) Program (active since 1964) aims to: provide drinking water infrastructure; rehabilitation, improvement, and capacity expansion considering population growth; develop and strengthen APR committees, which manage resource allocation once infrastructure is public; adaptation to new challenges (e.g. Comprehensive Water Supply Systems to provide energy autonomy to APR systems).
Operators	Private firms are the operators of drinking water distribution. These are required to have investment plans to address urban growth needs. Each addresses potable water supply and sanitation according to the specific needs of the area it manages.	Small operators, Rural Water and Sanitation Services (SSR), which are formed as cooperatives called APRs. Approximately 2,000 organizations, serving 2 million people. There are a thousand private sanitation systems serving productive activities and households in rural areas.

Water Code Reform 2022 and its Relevance for Adaptation Efforts

The reform in 2005 included for the first time the concept of minimum environmental flows. Article 129 bis in the Code mandated the DGA to establish minimum environmental flows every time it creates a new water right. The challenge is that these are fixed at the time WR are granted, and the holder of the WR can change the water use at any time, which may impact the calculation of these flows. Through Article 147 bis it also granted the President the authority to use a decree to partially decline a request for new WR when it is essential to preserve the resource for the population's water supply. However, across different administrations have had different views on the validity of this mechanism in terms of potentially overlapping rights (Melbourne Law School, Macpherson, and O'Donnell 2015).

In terms of environmental objectives, one significant constraint on these reforms is that **most of the Chilean water market was initially allocated to private owners without any historical allocation of water for environmental purposes.** By 2005, almost all of Chile's water resources had been allocated, limiting DGA's authority to set minimum ecological flows. Moreover, there hasn't been support for transferring water from extractive uses to environmental purposes (Melbourne Law School, Macpherson, and O'Donnell 2015).

In 2022, after an 11-year reform process, significant changes were implemented, including limits on water resource usage. Firstly, it established limits on the use of water resources, considering the public interest and recognizing that water, in any form, is owned by the nation and intended for public use. Secondly, it clearly recognized the human right to water, prioritizing access to clean water and sanitation as a fundamental and non-negotiable right guaranteed by the State. It also highlights that ensuring **access to water for drinking and basic needs takes precedence over other uses when allocating WR** (Libertad y Desarrollo 2022).

Thirdly, it set a 30-year limit for new water rights, tied to water supply availability or aquifer sustainability, aiming to diminish property rights over them. However, this presents challenges, as most water rights were allocated by 2005. Fourthly, the reform states that water rights will be partially or wholly extinguished if holders fail to effectively utilize them, as outlined in Article 129 bis 9 (Libertad y Desarrollo 2022).

The fifth change allows mining concessionaires to use water discovered during exploration and mining for mining activities, requiring them to report findings to the DGA within 90 days. This may challenge conservation efforts and impact social dynamics. The sixth reform addresses existing water rights and proposes indefinite increases in royalties every five years, potentially affecting sectors like hydropower. Furthermore, the Code now mandates every basin to have a Strategic Water Resources Plan to enhance water security in the face of climate change-related constraints. These plans must be publicly available and updated at least every ten years.

Additionally, the reform created a fund under the MOP's jurisdiction for research, innovation, and education in water resources to enhance capacity building (Libertad y Desarrollo 2022).

Finally, regarding the duration of the previously assigned WR, it mandated that those recognized or established before the reform, and those regularized by the competent authority under current legislation, remain valid and will only expire due to non-use (five years for consumptive WR and ten years for non-consumptive ones) (Libertad y Desarrollo 2022).

Challenges for Water Code Reform Implementation

The **2022 Water Code reform, responded to some of the main demands by prioritizing water supply for human use and introducing time-limited concessions for new WR.** Ongoing concerns persist regarding existing water rights treated as private property, distributed freely, and lasting indefinitely, along with worries about excessive allocation (OECD 2024).

Some of the challenges for its implementation are first, redistributing water across regions affected by water scarcity is affected by the lack of a comprehensive registry of WR issued by the DGA. There are different records kept by real estate conservators, land grant titles (which are those provided to indigenous groups), and the DGA's Public Registry. These are not combined so a there is no centralized registry of how many WR have been issued (Velásquez 2022).

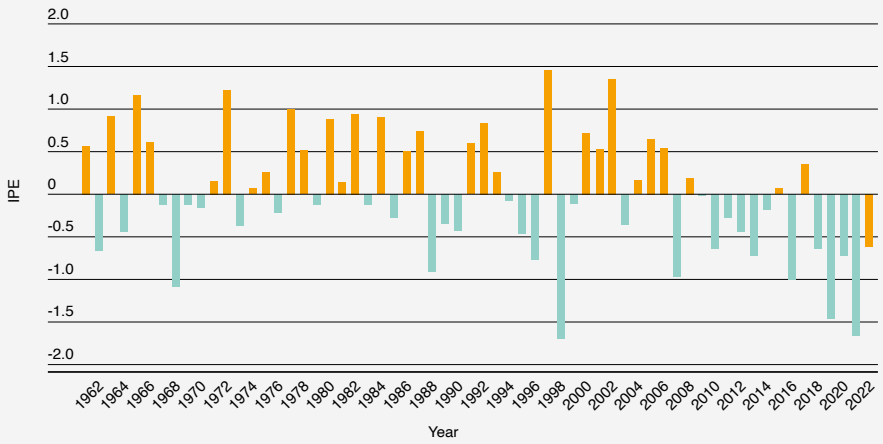
Likewise, the DGA's limited budget and staff, complicate the reform's implementation given that it affects its oversight capability. These limitations continue to exist despite the reform assigning it new responsibilities. Finally, and most importantly since it relates directly to one of the core demands, despite the new Water Code's focus on human consumption, oversight committees still include only rights holders, which are predominantly from sectors like agribusiness and mining (Velásquez 2022).

iii) Dimension 1: Problem Diagnostic Status Quo

1) Climate Change Challenges

Chile faces four main challenges related to climate change effects. Firstly, an increase in pollutants, including pesticides and nutrients related to agriculture activities. While pollution caused by urban sewage has been controlled wastewater, pesticides, and fertilizers are not subject to taxation or fees (OECD 2024). Secondly, droughts are a major concern for the northern part of the country. In terms of water management capacity, this is an issue because extended periods of drought are exposing vulnerabilities in water resource management systems within certain basins, affecting the ability to meet demand and causing severe economic impacts in specific regions, like Valparaíso and Coquimbo. Additionally, there are no financial mechanisms that protect economic activity from these effects and there is a lack of protective infrastructure, especially in cities (World Bank 2021). Figure 7 below shows the drought index from 1962 to 2022.

Figure 7: Drought Index (2022) *Source: (Ministerio del Medio Ambiente 2023)*



Thirdly, the country remains vulnerable to disasters from extreme hydrological events, particularly in cities at the Andean foothills intersecting sensitive basin waterways. While local interventions such as flood control structures have improved conditions, impacts are escalating due to economic growth. However, limited action has been taken due to high costs of protective measures and challenges in calculating related benefits. Investment often appears unfeasible based on economic and public investment methodologies (World Bank 2021).

2) Governance Structure Challenges

The water management system in Chile has been effective in enabling access to water resources by productive sectors in a structured, predictable manner and has favored private investment in initiatives dependent on water supply. However, given the intensive use of the resources and climate change effects, the system has key limitations in effectively managing integrated water resources (Easter and Huang 2014). Firstly, there are approximately 45 state agencies that have jurisdiction over water matters, hampering centralized decision-making and horizontal coordination (Velásquez 2022).

Likewise, Chile aimed to establish institutional frameworks where each economic sector operated under specific regulatory guidelines and incentives. However, this approach has complicated the management of complex interactions among public and private sectors. It has also led to the absence of a robust entity responsible for developing and implementing national water policies and ensuring coherence among agencies' actions (Easter and Huang 2014). This is worse given that the current system does not have planning mechanisms that allow for integrated coordination of both public and private initiatives in the medium and longer term (World Bank 2021).

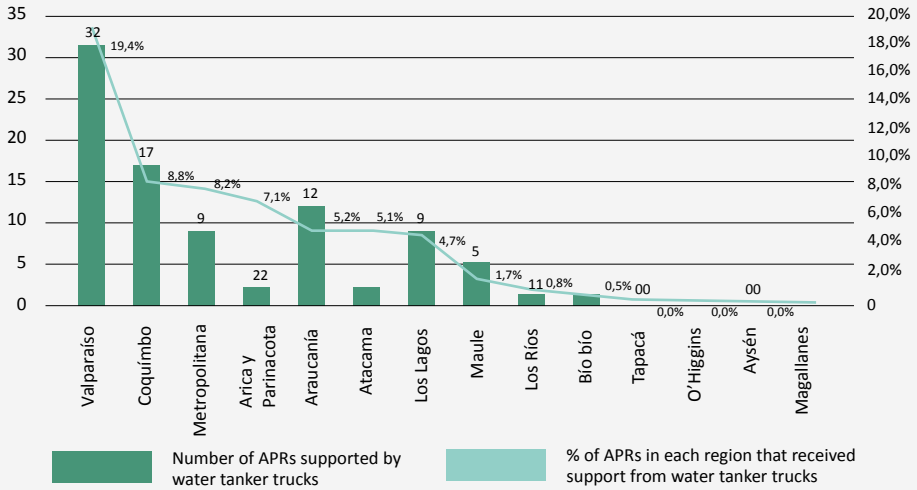
Furthermore, some interactions lack regulatory frameworks to prevent adverse effects on other users and the environment, leading to uncertainty about water availability and quality in the medium to long term. Additionally, there is a delay in modernizing canal systems, which would optimize water intake, conveyance, and distribution functions, thereby enhancing irrigation service efficiency and quality (Libertad y Desarrollo 2022).

3) Equity Challenges

Chile faces a significant challenge in providing sanitation services in rural areas. The coverage of these for urban areas is 81%, while for rural areas it is only 45% (Mesa Nacional del Agua 2022). One of the drivers for this is that the financial efficiency of rural service provision is poor because the tariff structure does not allow for cost recovery and there is a lagging tariff adjustment practice. As a result, most organizations (73%) impose tariffs with a fixed fee and a variable charge based on consumption and **only one out of every three organizations managing APRs recovers all their expenses** (operation, administration, maintenance, equipment replacement, and/or improvement and expansion) (World Bank 2021). This results in insufficient supply in these areas, necessitating supplementation by tanker trucks. One example of this unequal distribution is Petorca in the Valparaíso region, where about 10,000 people, constituting 20% of the population, rely on water delivered by tankers. Two main factors drive this situation: Petorca's location in one of the country's arid regions affected by the megadrought, and its status as the second-largest avocado-producing area in Valparaíso, contributing over half of the country's total avocado production. Due to the current water rights ownership structure, production often takes

precedence over human consumption (Laborde 2022). Figure 8 shows the distribution of water via tanker trucks per region.

Figure 8: Support of Water Tanker Trucks to APR Systems by Region, 2015 *Source: (World Bank 2021)*



4) Resources Challenges

Understanding available water resources is crucial for evaluating Chile's water governance effectiveness and identifying areas for improvement in managing evolving water challenges amid climate variability.

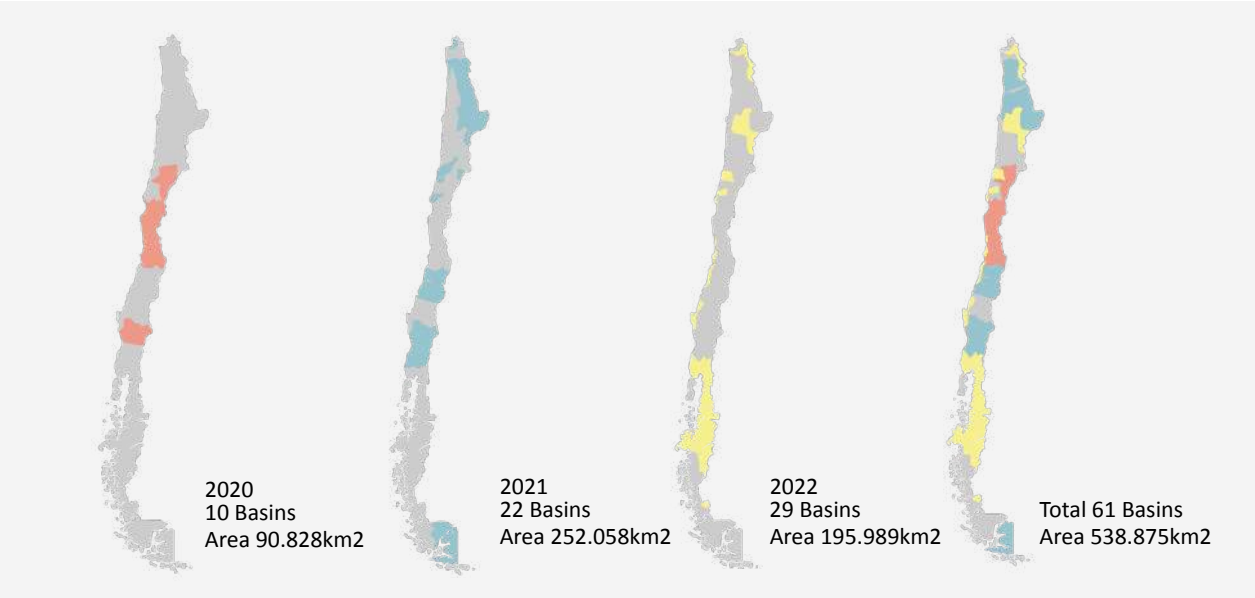
Table 2: Resources Challenges

Dimension 1	*Yes/No/Incomplete*	*Details*
Does Chile have detailed cartographic data on stress levels, availability, and user levels for watersheds?	Incomplete	Chile's legal framework mandates these requirements but lacks sufficient data on groundwater and surface water distribution, quantity, and quality. This affects monitoring efforts and understanding of environmental impacts, as information is scattered among government agencies, with limited data on water's effects on ecosystems, impacting environmental monitoring programs and policies (Mesa Nacional del Agua 2022)

Is ecological expenditure allocated to the main water bodies of the country (quantity and quality of water to sustain life and aquatic ecosystems)?	Incomplete	This is achieved with basin adaptation strategies, though some are ongoing. Article 13 of the Climate Change Law mandates Strategic Plans for Water Resources in Basins, focusing on managing water effectively for availability, climate change, and sustainability. These plans involve basin characterization, modeling, and resilience strategies, prioritizing human consumption and environmental conservation, with provisions for resource management and infrastructure (Nacional 2022) .
Is the legal framework and the tariff instruments for water updated to the scenarios of climate risk?	Incomplete	The Climate Change Adaptation Plan for Water Resources, currently in development, will address climate change impacts across sectors, communities, and regions. It will offer strategies to reduce vulnerability and enhance water resource resilience (Ministerio del Medio Ambiente 2023)
Do national accounts and water management incorporate the comprehensive valuation of the water resource?	Incomplete	The Climate Adaptation Plan for Water Resources will focus on understanding the hydrological cycle, implementing aquifer recharge, utilizing emerging sources like desalination plants, developing water infrastructure, and enhancing monitoring systems, including water quality and aquifer monitoring. Additionally, it will improve glacier inventory, monitoring, and research efforts (Ministerio del Medio Ambiente n.d.).

Chile is also developing Strategic Plans for Integrated Basin Management to efficiently handle water resources. These plans will provide solutions, including infrastructure, nature-based, and management strategies. By 2022, these plans covered 71.2% of the country's territory (Mesa Nacional del Agua 2022). Figure 9 shows progress on this area.

Figure 9: Progress In the Development of Strategic Plans for Integrated Watershed Management
Source: (Mesa Nacional del Agua, 2022)



5) Political Landscape for Climate Adaptation Policy Implementation

It is necessary to describe the political context in which the potential water reforms would take place. In 2019, Chile experienced intense social unrest, with people taking to the streets, one of the main demands was the need to address the fact that private entities were perceived as exploiting water resources in a way that led to depletion and shortages for the remaining population. These tensions, worsened by the impacts of the megadrought, happened during the discussions of reforming the constitution, which had been in place since Pinochet's dictatorship era (BBC News Mundo, n.d.)

Proponents of a new constitution pushed for explicitly declaring water a national asset for public use. However, the government contended that existing laws already established water as a public resource, attributing scarcity to natural causes and management inefficiencies. Likewise, businesses, especially in agriculture and industry, opposed changing the proposed reforms, arguing the risk of affecting their legitimate rights acquired under the existing system. These businesses, which have significant political influence, complicated efforts to reform Chile's water management (BBC News Mundo, n.d.).

iv) Dimension 2: Enabling Factors for Adaptation Planning

This section examines key questions about climate adaptation measures and regulations to evaluate their effectiveness in addressing climate change impacts on vulnerable resources and infrastructure.

Table 3: Enabling Factors

Dimension 2	*Yes/No/Incomplete*	*Details*
Is there an official National Adaptation Plan in place that government and financial entities are implementing?	Yes	NAP's objectives: Create the framework for adaptation. Establish the institutional framework for the operation of the National Adaptation Plan and sectoral plans. Identify and update sectors requiring adaptation plans and set criteria and guidelines for development and implementation. Define actions across sectors (Ministerio del Medio Ambiente 2015).
Is there a national regulation mandating the development of infrastructure in socioeconomic vulnerable areas, and do the construction codes at regional and local levels incorporate updates to meet climate adaptive needs?	Incomplete	The Water Infrastructure Plan for 2020-2050 aims to strategize for long-term water infrastructure, considering regional water availability, fairness in distribution, sustainability, and climate adaptation. It involves various projects and tools for economic and hydrological evaluation, aiming for basin-specific investment plans. These plans are currently being developed (Mesa Nacional del Agua 2022).

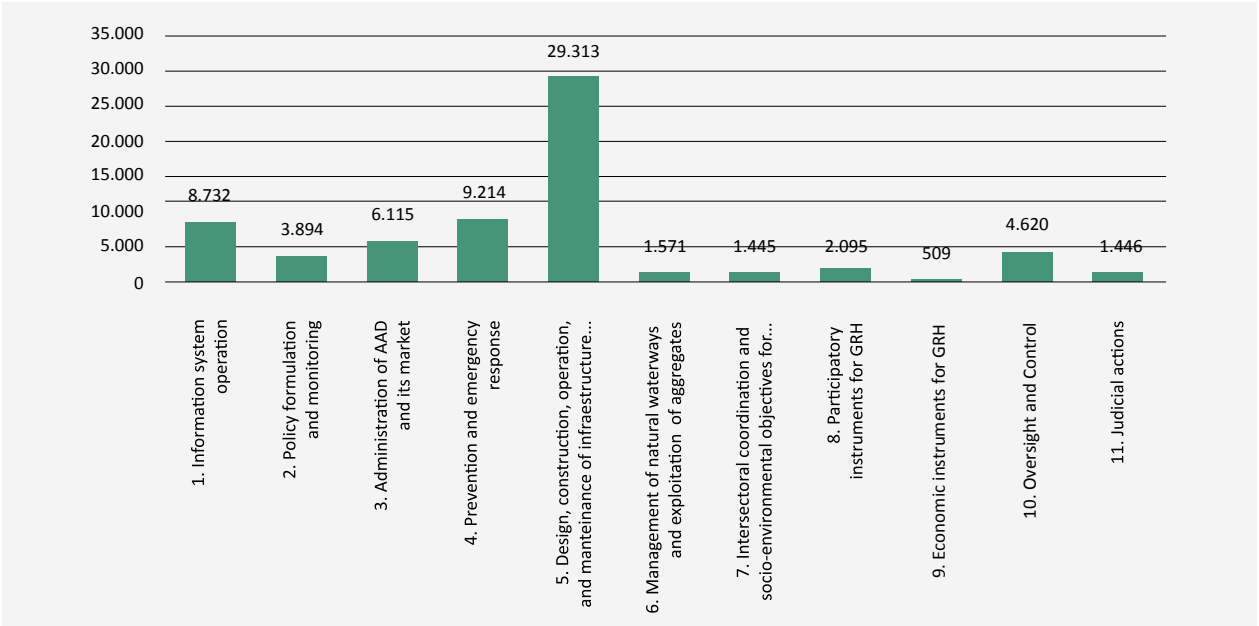
Chile's regulatory certainty benefits the private sector by offering confidence and clarity, reducing investment risks, and promoting long-term commitments. Public-private partnerships leverage both sectors' strengths, fostering collaboration and access to expertise and resources. Based on interviews with expert, private sector involvement brings substantial financial resources for adaptation projects, fosters innovation for sustainable water management practices, and prioritizes efficiency and effectiveness to optimize resource use and minimize costs, enhancing overall water management (Expert Interviews 2024).

An area for improvement in enabling factors is **enhancing the government's technical capabilities to facilitate water management adaptation projects.** Both central and local authorities need improved abilities, especially in watershed management. Challenges include expanding their roles in areas like water quality monitoring, enhancing technical skills, and adjusting regulations to increase representation, inclusivity, and accountability. There is also a lack of awareness among water users and municipalities regarding responsibilities and roles, alongside a notable deficiency in technical expertise (Mesa Nacional del Agua 2022).

iii) Dimension 3: Financing Strategies

As mentioned earlier, a challenge for implementing the Water Code reform is the limited funding and staffing of the DGA. It is crucial to evaluate available resources and financial strategies in this context. Annual funding for water management, separate from physical infrastructure, is approximately USD$71 million, with about 1,700 personnel involved in water management tasks. These resources primarily support large-scale hydraulic infrastructure design, mainly through the MOP's Hydraulic Works Department. However, key functions like operating the information system or supervision and control receive smaller proportions of total expenditure, at 13% and 7%, respectively. Disparities in funding and staffing persist within the DGA, affecting management and oversight. The organization's budget trajectory has remained relatively stable, except for a 28% increase between 2010-2011 (Mesa Nacional del Agua 2022). Figure 10 shows the distribution of the budget per function.

Figure 10: Public Budget ($MM) Allocated to the Development of Each Macro Function
Source: (Mesa Nacional del Agua 2022)



In addition to this allocation, other government ministries and public agencies involved in water management have established **specialized funding mechanisms** to support water infrastructure projects, addressing a wide range of needs. Financial tools have also been introduced to support projects aimed at improving water management, exploring new water sources, enhancing water quality, and promoting nature-based solutions (Mesa Nacional del Agua 2022).

Specific funding programs targeted at different population segments are managed by entities like the Agricultural Development Institute and the National Indigenous Development Corporation. These are complemented by regional development funds overseen by regional governments and municipal development funds. Private investment, particularly in projects led by established water user organizations, plays a significant role (Mesa Nacional del Agua 2022).

Regarding financial mechanisms, one important source are **sovereign green bonds.** In 2019, the Ministry of Finance issued its first sovereign green bonds, totaling US$2.377 billion. These are being used on projects targeting four climate objectives, including protection and sustainable use of water resources (Ministerio de Hacienda 2019). However, sustaining investment flow for this priority is challenging as recently issued bonds do not fund water management projects.

Another source comes from **CORFO**, investing through their **Green Credit**, operated through national banks, and funded by the Sustainable Productive Development Program led by the national government. An example is CORFO's US$35.9 million allocation to Banco BICE to aid in financing the Aconcagua project by Aguas Pacífico, which is the first desalination effort in Chile's central region (CORFO, n.d.). Additionally, Chile actively seeks funding from international cooperation organizations such as the World Bank.

Table 4: Financing Schemes and Policy Instruments

Dimension 3	*Yes/No/Incomplete*	*Details*
Do financing schemes prioritize public and private users under climate stress and risk conditions?	Incomplete	Legal frameworks, including Water Infrastructure Plan, seek to guide this process but in practice, there is not enough information or incentives in place to target investment.
Are there existing financial policy instruments that promote water adaptation projects?	Yes	Water Code reform created a fund for research, innovation, and education in water resources.

iv) Lessons Learned from Chile

a) Water Governance and Planning:

The lack of effective instruments and institutions for integrated management of water resources at the basin level, which should align individual and collective interests while maximizing water usage, acts as a barrier to efficient resource exploitation and contributes to conflicts that affect development. This is worsened when market incentives promote private utilization without regulations addressing externalities affecting all users. This is exemplified by the uncontrolled expansion of irrigated areas, resulting in the overexploitation of aquifers (World Bank 2021).

Chile's water management relies on a detailed legal framework that supports private sector involvement by providing certainty and clarity in processes. However, **the involvement of multiple stakeholders leads to inefficiencies and bureaucratic barriers due to unclear responsibilities.** This complexity particularly impacts rural areas, where emergency response and water access suffer. Simplifying coordination and defining roles among stakeholders is essential for effective water management and equitable access to resources nationwide (Expert Interviews 2024).

(b) Water Supply and Conservation

Effectiveness of allocating water resources to encourage investment among individual users: by leveraging market mechanisms to assess water utilization entitlements, Chile has facilitated a more efficient allocation system while also mitigating speculative activities through regulatory measures. The certainty provided by the water market has proven crucial in attracting private sector investment for sustainable, long-term planning initiatives.

(c) Equity

The unequal coverage between urban and rural areas, as illustrated by the situation in Petorca, shows the need for tariff adjustments to ensure sustainable operation and cost recovery for water services. **Combining fixed fees with consumption-based charges often leads to financial inefficiencies, preventing organizations from covering all operational costs.** This leads to many rural areas experiencing unmet demand, leading to the use of tanker trucks for water delivery. This dynamic shows the relationship between water scarcity, economic activity priorities, and human consumption requirements. Addressing these challenges requires an approach that considers both the socio-economic context and the WR structure to prioritize equitable access and sustainability.

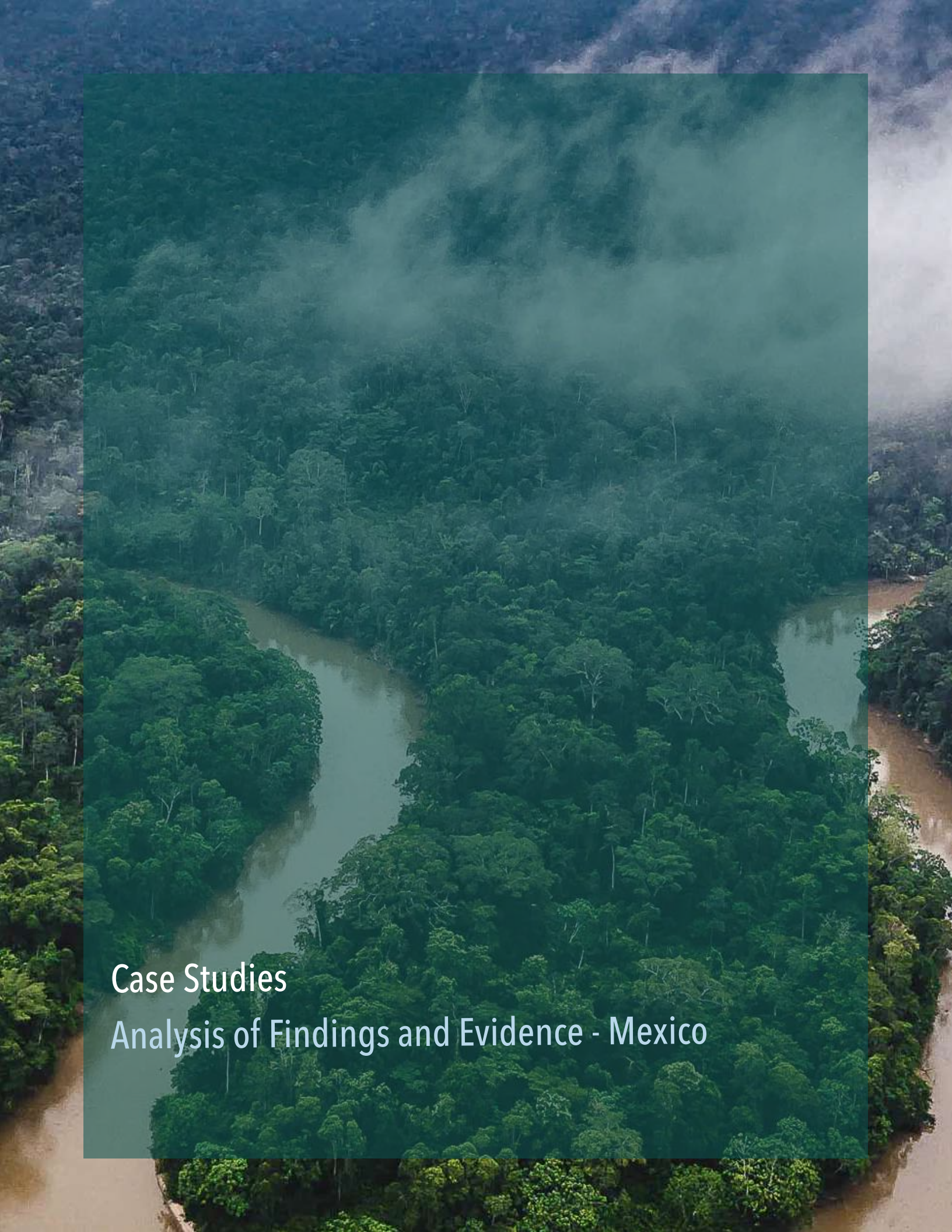
(d) Economic Instruments and Financing

Collaboration between public and private entities is key to advancing technologies linked to adaptation strategies, like desalination and sewage treatment systems. In Chile, where private firms lead urban water supply, the government plays a crucial role in driving innovation through direct investment. These collaborative models harness the strengths of both sectors to enhance water management efficiency and promote sustainable practices benefiting communities and the environment. Biofactoria La Farfana exemplifies this collaboration, showcasing how strategic partnerships can address water-related challenges and foster resilient water management in Chile. More detail on this model is provided in Box 1.

Box 1: Circular Economy: La Farfana Wastewater Treatment Plant in Santiago, Chile

La Farfana Wastewater Treatment Plant in Santiago, Chile, overseen by Aguas Andinas, is an example of how biosolids and biogas are effectively managed. This plant employs traditional methods to treat the wastewater from the city, which has a population of around 3.3 million, using activated sludge techniques. Within the plant, there are eight anaerobic digesters where sludge is separated from the wastewater and repurposed into biosolids for agricultural purposes. Additionally, the plant generates revenue by selling the biogas produced to Metrogas, a local company.

The utilization of biosolids and biogas has had financial benefits. For example, in 2017, these reached USD 5 million, which were attributed to improved energy efficiency, revenue from biogas sales, and the acquisition of carbon credits. Additionally, Metrogas, the gas distribution company, saved USD 1.6 million through reduced imports, while local farmers managed to decrease their fertilizer usage by 50%. Source: (TNC, 2020).



Case Studies

Analysis of Findings and Evidence - Mexico

B) MEXICO

i) Supply and Demand Analysis of Water Resources in Mexico

Population growth, urban expansion, inequality, inadequate zoning and planning, ecosystem neglect, and insufficient infrastructure have led to the overexploitation and contamination of water resources. These challenges are worsened by climate change, altering the hydrological cycle and causing more frequent extreme floods and droughts (Fernando González et al. 2022).
In Mexico, two-thirds of the territory is classified as arid or semi-arid, while one-third, in the southeast, is humid. Figure 11 shows the contrast between water availability and population distribution. In the northern and central regions, where 77% of the population lives and generates 83% of GDP, water availability is 33% (Fernando González et al. 2022).

Figure 11: Water Pressure by Administrative Hydrological Region *Source: (CONAGUA, 2019) (Fernando J González Villareal et al. 2022).*

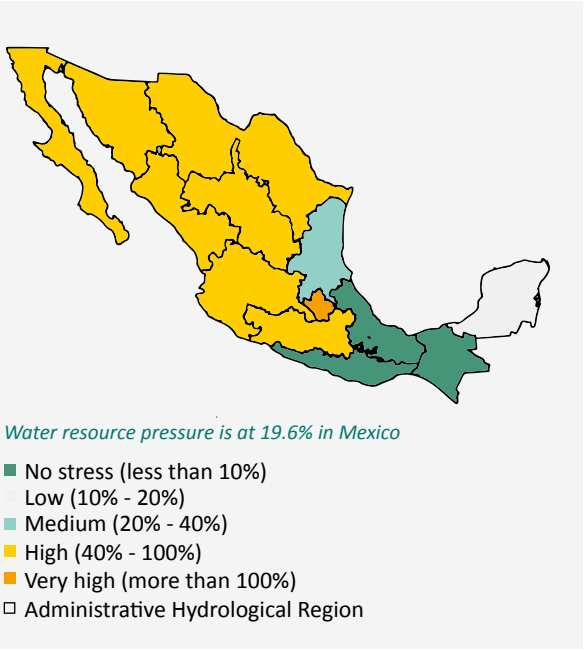


Figure 12: Evolution Annual Water Availability per Capita *Source: (CONAGUA, 2019) (Fernando J González Villareal et al. 2022).*

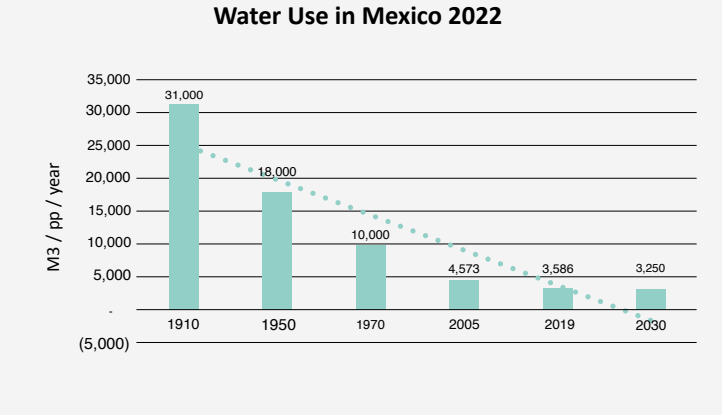
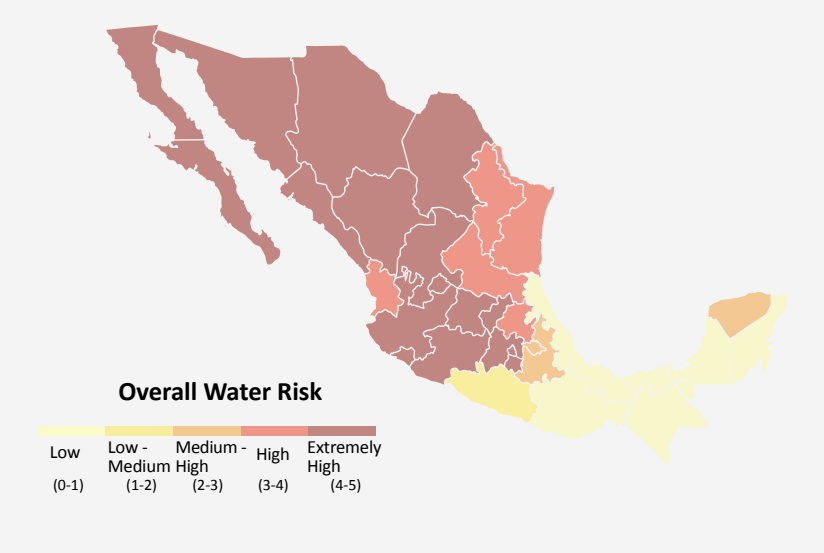
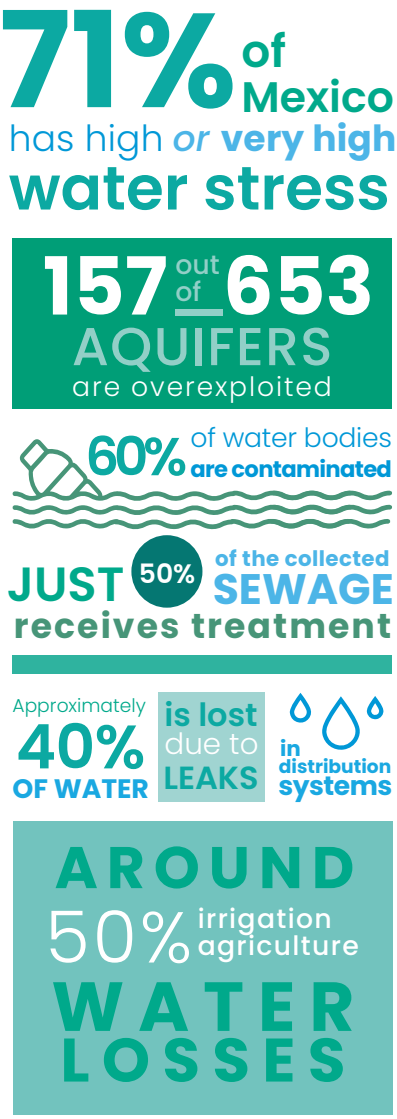


Figure 12 shows how Mexico's renewable water **availability** has decreased (SINA 2021). Likewise, surface water represents 80% of renewable water. There are 757 hydrological basins, from these, 649 have resources available (CONAGUA 2021). Concerning **groundwater**, Mexico established 653 aquifers in 2001, out of which 157 are overexploited (Fernando González et al. 2022). Also, 70% of the domestic urban supply comes from groundwater (UNESCO 2022). Regarding water **demand**, 76.29% is agricultural use, 14.84% urban public, 4.67% industry,

and 4.19% thermoelectric, refer to appendix 3 for more detail (SINA 2021). With urbanization rising, Mexico's population will exceed 130 million by 2030 and 148 million by 2050, further stressing water resources in main metropolitan areas, see appendix 4.

Figure 13: Map on Water Stress Concentration by State
Source: (WRI, 2024)



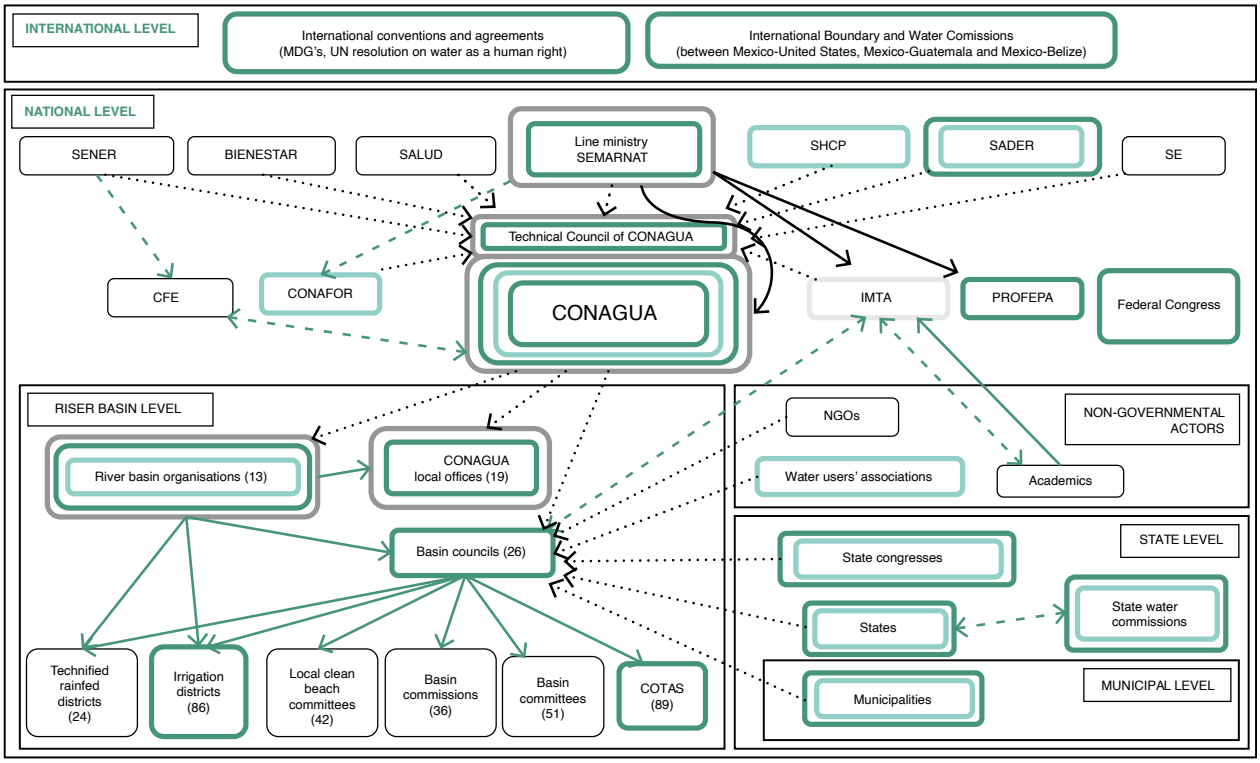


ii) Current Governance Structure and Legal Framework

Mexico's water governance is multilayered and multi-stakeholder to operate and supervise the different water uses like drinking water, irrigation, water for commerce and industry, hydropower, and environmental needs. There are multiple agencies at different levels involved in management and supervision at federal, state, municipal, and basin levels, creating a fragmented system with challenges in capacity coordination, especially for implementing changes in the systems. Thus, it is crucial to understand institutional responsibilities at each level (OECD 2013).

CONAGUA is the main actor in water policy. It is an administrative, regulatory, technical, advisory, and decentralized body of the Ministry of Environment and Natural Resources (SEMARNAT). Its main goal is to preserve Mexico's water resources and public assets, ensuring sustainable management and water security through collaboration among government levels and society (CONAGUA 2019d). See figure 14 for Mexico's Water governance map.

Figure 14: Mexico's Water Governance *Source: (OECD, 2017), (CONAGUA, 2024)*



ANEAS	National Association of Water and Sanitation Utilities
CFE	Federal Electricity Commission
CONAGUA	National Water Commission
CONAFOR	National Forestry Commission
COTAS	Technical committees for groundwater
IMTA	Mexican Technological Institute for Water
PROFEPA	Environmental Protection Federal Attor|ney Office
SADER	Ministry of Agriculture and Rural Development
SE	Ministry of Economy
BIENESTAR	Ministry of Welfare
SEMARNAT	Ministry of Environment and Natural Resources
SENER	Ministry of Energy
SHCP	Ministry of Finance and Public Credit

Hydrological Administrative Regions (HAR) CONAGUA established 13 to simplify water management; their boundaries are aligned with municipal limits and are managed through Basin Organizations, refer to figure 15 for the map (SEMARNAT 2024).

Figure 15: Mexico's Hydrological Administrative Regions
Source: (CONAGUA - SINA, 2012)

The following table explains the roles of different agencies at subnational levels.

Table 5: Water Management Roles at Sub-National *Source: (OECD, 2013)*

Level	*Role*
State	Plans, regulate, and develop water resource infrastructure, providing services to municipalities and creating state-level plans autonomously.
Municipalities	Provide water and sanitation directly or indirectly through legally separate entities. They grant concessions to private operators or state governments.
Water utilities	Manage service delivery autonomously under municipal oversight, occasionally involving the private sector.

State water commissions	Facilitate coordination between municipalities and the federal government, focusing on irrigation, water supply, sanitation, technical support to municipalities, and monitoring service provider performance.
State congress	Authorize tariffs and play a pivotal role in approving state water plans and allocating financial resources for water infrastructure.

The National Water Law stipulates that the water volumes concessioned to users are recorded in the Public Registry of Water Rights (REPDA), categorized into consumptive uses (agriculture, public supply, self-supplied industry, and thermoelectric) and non-consumptive uses (hydroelectric and ecological conservation) (CONAGUA 2019c). Mexico has multiple official water standards covering discharge limits, wastewater treatment, mangrove preservation, water availability, and infrastructure, alongside Ministry of Health regulations on drinking water quality, transportation, sampling, surveillance, and control. (CONAGUA 2019e).

Tariffs can be approved by the state congress, municipal governing body, operators' board of directors, or by the state water commission. Different rates apply to various user types residential, industrial, commercial, and services (CONAGUA 2019d). Mexican law states that, "water management must generate the economic resources needed to carry out its tasks, following the principle that water pays for water" (Congreso de la Unión México 1992). However, Mexico is not achieving this.

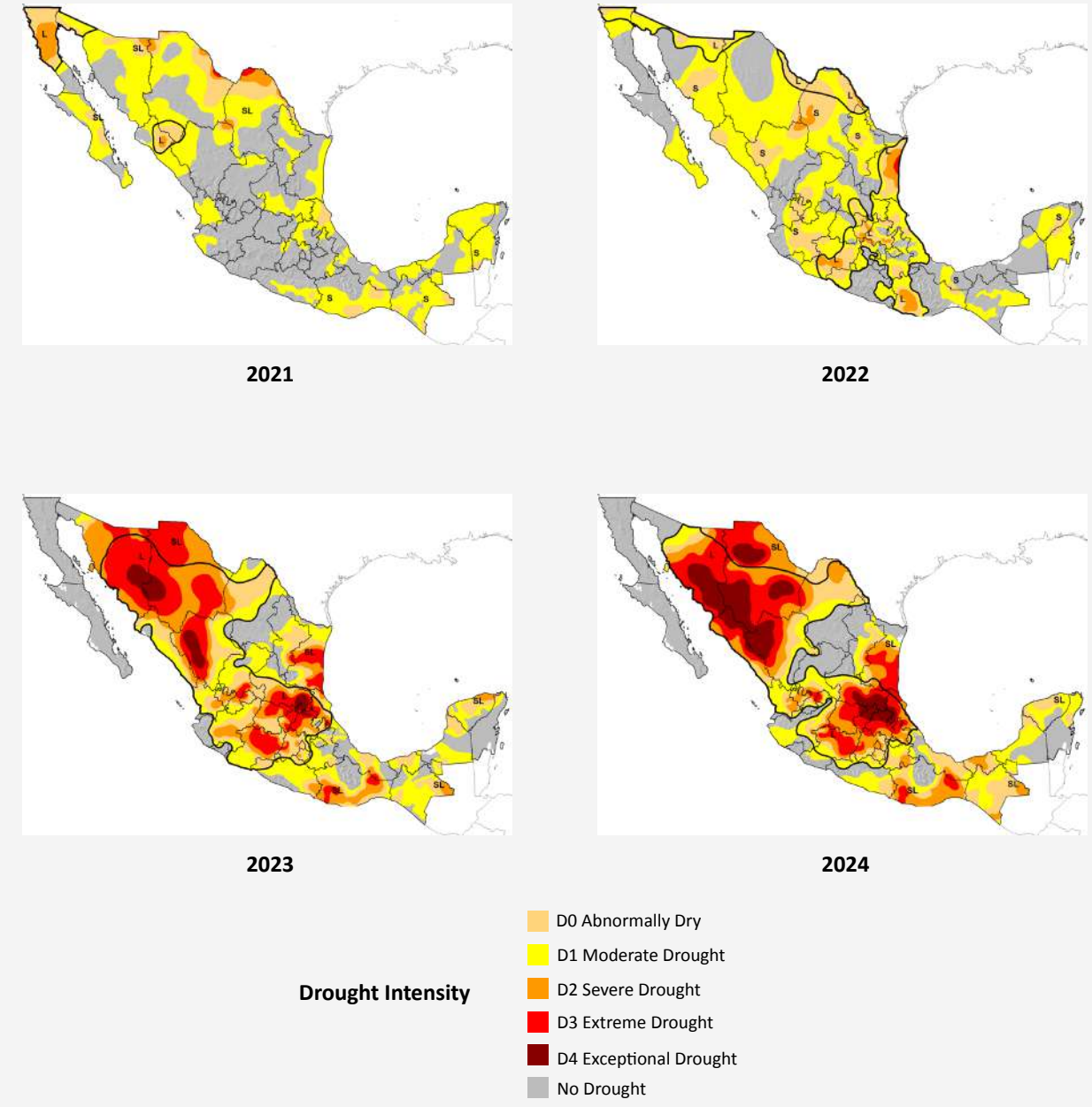
iii) Dimension 1: Problem Diagnostic and Status Quo

(1) Climate Change Challenges

Climate change poses challenges with rising temperatures and altered rainfall affecting water availability and quality. According to CONAGUA, 24% of Mexico's municipalities face high or very high climate vulnerability, with 106 being highly vulnerable to drought and 17 states (representing 62% of the population) being at risk of flooding. Review appendix 5 for Mexico's Climate Vulnerability map (Fernando González et al. 2022).

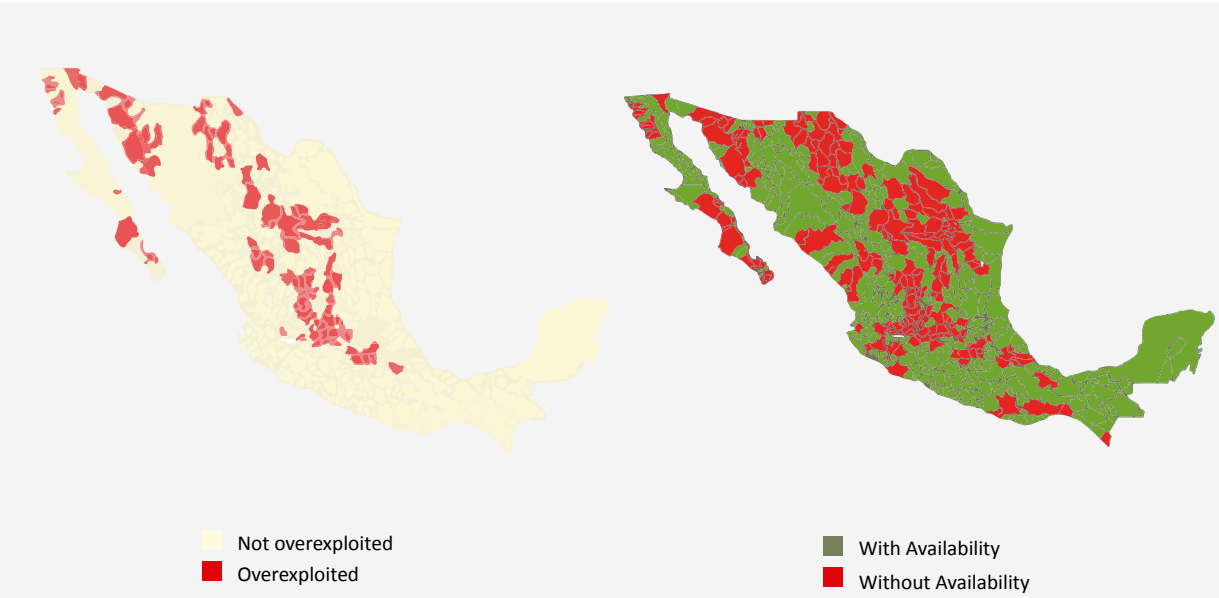
Moreover appendix 6 shows 50% of Mexico's territory has lost vegetation cover, impacting ecosystems and water sources. Likewise, Appendix 7 reveals Mexico's severe drought impact, affecting the economy and agricultural production planning due to changes in the rainy season (IMCO 2023c). Additionally, droughts jeopardize the country's environmental commitments by reducing clean hydroelectricity generation. Figure 16 Showcases Mexico's Droughts Evolution 2021 – 2024.

Figure 16: Mexico's Droughts Evolution 2021 - 2024
Source: (CONAGUA, 2024)



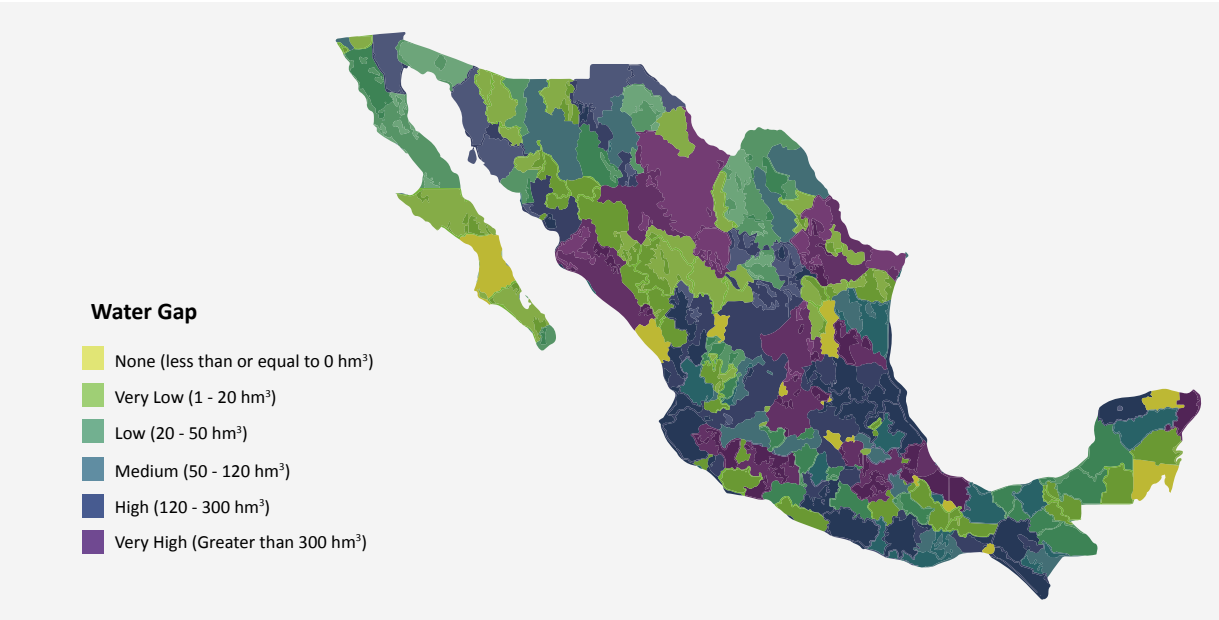
Furthermore, Mexican authorities lack a comprehensive understanding of groundwater dynamics, relying on outdated methods that assess hydric balance solely through surface hydrology. This approach overlooks the dynamic nature of aquifers, leading to erroneous evaluations (Carmona Lara et al. 2017). The country ranks 7th globally for groundwater withdrawal, alongside the USA. From this, 72% is used for irrigation, 22% for domestic purposes, and 6% for industry. Unlike other countries, Mexico lacks real groundwater tariffs due to monitoring challenges, enforcement issues, and agricultural sector influence (UNESCO 2022). See figure 17 for information on groudwater availability.

Figure 17: **Overexploited Aquifers and Availability of Groundwater**
Source: (CONAGUA, 2019)



Furthermore, decreasing precipitation levels, shown in Appendix 8, coupled with uneven rainfall distribution across Mexico where the southern region receives 280% more rain than the central-northern regions (Appendix 9), will worsen distribution challenges. CONAGUA predicts that about half of Mexican states will experience high to very high water deficits by 2030 see figure 18 (SINA 2021).

Figure 18: **Water Deficit by 2030 in Mexico**
Source: (CONAGUA, 2024)



(2) Challenges Related to Governance Structure

Despite a solid policy framework, Mexico struggles with effective implementation. River basin councils remain underutilized after 20 years, while fragmented drinking water regulation and harmful subsidies in energy and agriculture hinder policy objectives. Inadequate monitoring and enforcement exacerbate challenges like pollution and water discharge mismanagement, depleting water resources further (OECD 2013).

Political controversy hampers the update of Mexico's national water law. Despite 14 proposed revisions since 2012, none have succeeded due to opposition from civil society and political parties fearing privatization. Delays in modernizing water governance pose a significant challenge. Some issues include:

- **Obsolete concession provisions lead to a lack of transparency and accountability,** resulting in a black market for water, excessive extraction, and unauthorized use changes (IMCO 2023b). This hampers the state's ability to accurately determine extraction levels and identify responsible parties. Authorized concessions are irrevocable, hindering efforts to reduce overexploitation. Lack of retroactive regulations adds to this challenge. Moreover, high political costs deter regulatory changes, impeding efficient water management efforts (Expert Interviews 2024).

- **Concessions granted for agriculture are being misused** for industrial, commercial, or service activities to avoid water fees. This affects tariff-based financial sustainability, as different sectors pay varying fees despite similar water usage (CONAGUA 2019a).

- **Pervasive incentives,** 76% of concessioned groundwater is for to agriculture, exemptions for agriculture from payment under the Federal Law of Rights and energy subsidies for water pumping, encourage overexploitation of groundwater (SADER 2023).

- **Inadequate monitoring persists,** water usage permits recorded REPDA are not adequately supervised. In Mexico, 97% lack water meters, and 93% of those in place remain unverified, fostering excessive usage and clandestine taps, leading to a loss of up to 15% of potable water (El Economista 2023). Also, CONAGUA's in situ monitoring of water usage has declined by 67% during President López Obrador's administration (IMCO 2023b).

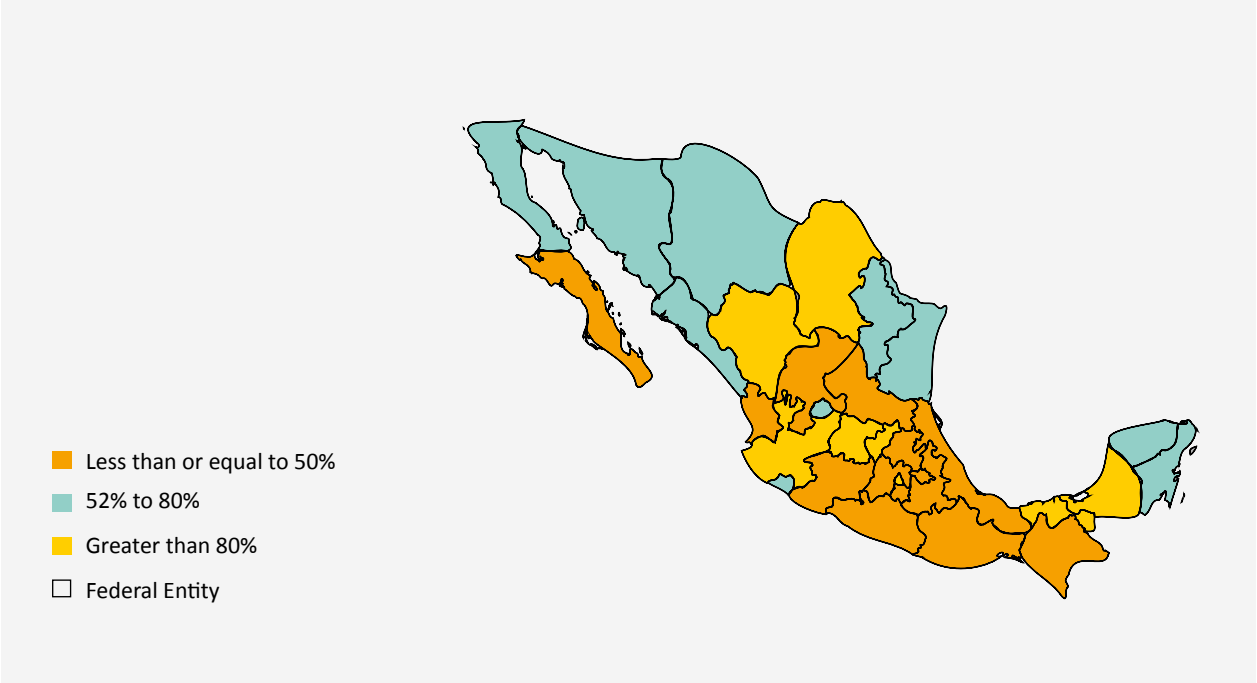
As in the case of Chile, one of Mexico's main water management challenges is the abundance of water-related authorities which complicates responsibility definition, leading to fragmented policymaking. Short-term planning and reactive crisis responses hinder long-term water management strategies. Experts stress the absence of incentives to establish realistic water distribution tariffs and emphasize the need to strengthen regulatory bodies (Expert Interviews 2024).

Current planning heavily prioritizes traditional gray infrastructure, overlooking climate change strategies for integrated water management. Additionally, there is insufficient coordination between national policies and urban, agricultural, and industrial development plans, impeding effective water conservation efforts. Furthermore, municipalities, tasked with water supply but operating within narrow mandates, lack incentives to adopt innovative water conservation solutions (Expert Interviews 2024).

(3) Equity Challenges

Article 4th of the constitution establishes the Human Right to Water. However, as shown in figure 19, this has not been achieved for more than half of the population.

Figure 19: Population with Daily Water and Improved Sanitation by State.
Source: (CONAGUA, 2019) (Fernando J González Villareal et al. 2022).



Currently, water rates are heavily subsidized, but primarily for higher income segements of the population. In Mexico, the poorest quintile pays proportionally more for water than the richest quintile. This must change through infrastructure improvement and water reuse (Ríos 2023).

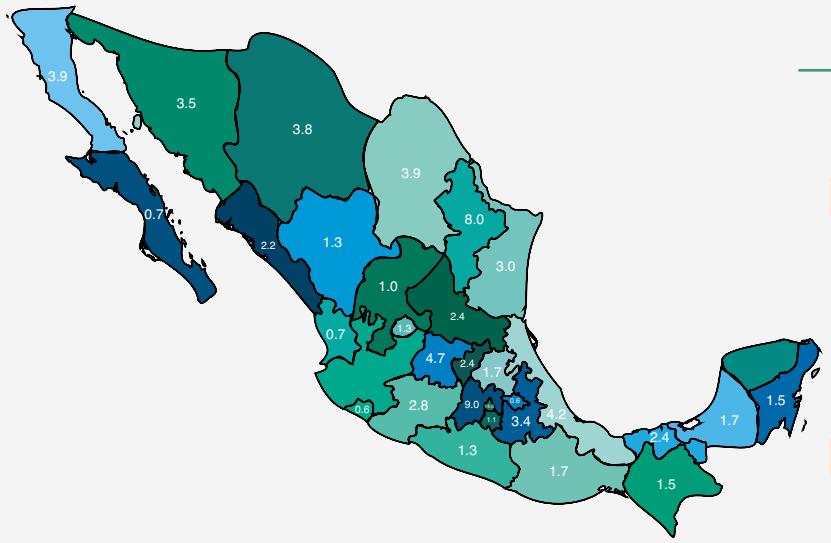
In Mexico City, 12 municipalities connected to the Lerma Cutzamala system face a 50% water supply reduction due to scarcity. The government's free water tank provision is a short-term fix, hitting lower-income neighborhoods hardest. Typically, local governments react rather than proactively respond to crises, leaving households without water and sewage connections, lacking a crucial amenity for dignified living (CONEVAL 2022).

Each city's context is shaped by its size, governance, maturity (technical and financial), and climate change vulnerabilities. Therefore, a uniform approach to funding criteria and norms for development projects is impractical. As a result, utility operators and the National Association of Water and Sanitation Entities (ANEAS) advocate for customized programs and requirements that match the unique characteristics of cities across these categories (Expert Interviews 2024).

(4) Resource Challenges

Mexico faces the opportunity of nearshoring, nonetheless water scarcity is frequently cited as a major obstacle for investment, alongside unreliable energy security, widespread insecurity, and a fragile rule of law (Bloomberg 2024). Figure 20 highlights the mismatch between water resources and economic activity. While the south and southeast regions have 67% of water resources, they contribute only 17% to the GDP. In contrast, the north and central regions, which have 60% of the workforce and contribute 70% to the GDP face the highest water stress in the country, show in appendix 10. This shows the challenge of aligning economic activity with water resource distribution in Mexico (SEDATU 2021). Finally, the national strategy for economic development lacks integration of climate change, risks to vulnerable communities, conservation and development, and specifically water stress considerations (Bloomberg 2024).

Figure 20: Mexico's National GDP Distribution per State 2022
Source: INEGI 2022, (Fernando J González Villareal et al. 2022).



National average

3,982 m³/habitant/year

Center-North

1,650 m³/habitant/year

Renewable water	33%
% Population	77%
GDP Share	83%

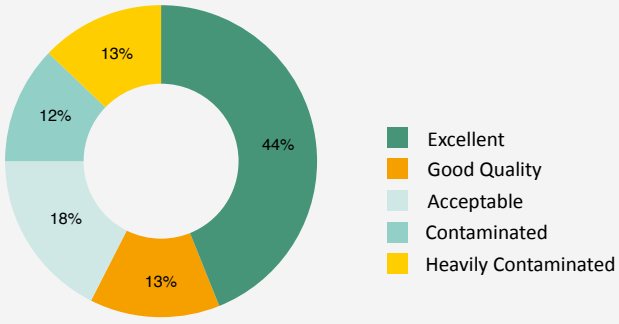
South-Southeast

11,768 m³/habitant/year

Renewable water	67%
% Population	23%
GDP Share	17%

In interviews with ANEAS experts and operators, one of the main challenges identified is outdated infrastructure and inefficiency, with leakage losses often exceeding 40%. Compounded by insufficient capital and financially unsustainable utilities, operators struggle to invest in essential maintenance projects (Expert Interviews 2024). Additionally, ANEAS highlighted as a key challenge the high national director turnover rate of 1.3 per year. This impedes long-term planning, crucial for success, and increases challenges for water operators. Also, operators struggle with groundwater overexploitation, leading to poor water quality. Despite this, treatment methods remain unchanged. Water quality variability complicates regulation compliance, especially during scarcity. This is troubling in Mexico, where 25% of available water is contaminated see figure 21 (CONAGUA 2021).

Figure 21: National Average Water Quality and Pollution Percentage in Mexico, 2019-2020
Source: (CONAGUA, 2021)



Additionally, out of Mexico's 3,960 wastewater treatment plants, 1,330 are non-operational due to municipalities lacking electricity payment capacity. Consequently, two-thirds of Mexico's water treatment infrastructure is not functioning properly, resulting in only 32% of water being treated (Forbes 2023). According to INEGI, only 41% of municipalities provide some extent of wastewater treatment services, with 58.0% (953 municipalities) lacking these services (INEGI 2022). Additionally, figure 22 illustrates the level of treated water utilization.

Figure 22: Municipal Wastewater Treatment Plants in Operation in Mexico 2020, By Type of Reuse
Source: (INEGI, 2023)

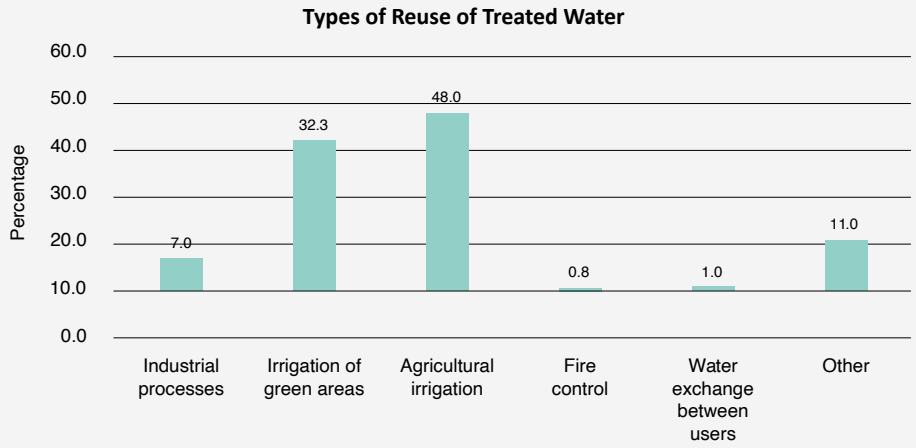


Table 6: Resources Challenges *Source: (OECD, 2013)*

Question	*Yes /No/Incomplete*	*Details*
Do countries have cartographic data on stress levels, availability, user levels for watersheds? Do water management incorporate the comprehensive valuation of water?	Incomplete	Mexico struggles to accurately measure and monitor water resources stress levels and availability. The REPDA registers various user types but overlooks clandestine withdrawals and black market concessions, especially evident in groundwater due to flawed calculation methods (Carmona Lara et al. 2017).

Is ecological expenditure allocated to the main water bodies of the country (quantity and quality of water to sustain life and aquatic ecosystems)?	Incomplete	As of 2018, Mexico had 147 restricted zones. In 2013, 333 agreements for aquifers suspended unrestricted extraction. 275 of 757 basins lacked regulation, 288 had exclusive reserves, 153 had restrictions, and 41 had multiple regulations. However, enforcement incapacity often renders regulations ineffective (CONAGUA 2019d).
Is the legal framework and the tariff instruments for water updated to the scenarios of climate risk?	No	Potable water rates vary by municipality and user, influenced by state legislation. However, CONAGUA's latest report lacks mention of climate risk scenarios or water stress in tariff formulation (CONAGUA 2022a).

(5) Political Landscape for Climate Adaptation Policy Implementation

Most interviewees identified political will as the primary factor determining whether a project can progress or not. This highlights deficiencies in strategic thinking and priority setting, as well as a lack of technical or data-driven approaches in developing water management plans. Additionally, there are few incentives to expand and maintain infrastructure, particularly for underground projects due to their lack of political visibility (Expert Interviews 2024).

Therefore, priorities are driven by political agendas, leading to short-term visions and misallocation of resources. Uncertainty in capabilities, designated officials, and priorities hinders long-term planning and private sector involvement. Finally, politicization of water leads to a lack of trust in utility operators, prompting the creation of tools like the Water Transparency Barometer by the Mexican Institute of Water Technology (IMTA) to assess various aspects of water management, including budget management, civilian participation, incorporation of external recommendations, procurement, operation, and results (Expert Interviews 2024).

iv) Dimension 2: Enabling Factors for Adaptation Planning

Experts agree that Mexico's adaptation strategies have overlooked the ecological system context. The primary emphasis has been on meeting increasing water demand with technical solutions, neglecting potential ecological, financial, and feasibility consequences (Expert Interviews 2024).

Table 7: Governance Enabling Factors

Question	*Yes /No/Incomplete*	*Details*
Is there an official National Adaptation Plan (NAP) in place that government and financial entities are implementing?	Incomplete	The Law for Climate Change highlights the need for adaptation. Yet, this was formulated by the previous administration, and there is no progress (SEMARNAT 2013). However, CONAGUA started working on water management adaptation criteria for the Hydric National Program (PNH) (KfW and CONAGUA 2024)
Is there a national regulation mandating the development of infrastructure in vulnerable areas, Do regional and local construction codes address climate adaptive needs?	Incomplete	PNH priorities aim to tackle equity issues in water access and maintain the integrity of the water cycle. Priority 1, managed by the PROAGUA program, has not alleviated water scarcity, as mere system connections no longer ensure full access. Priority 4 seeks to reassess water availability but lacks construction codes adaptable to diverse local challenges. (CONAGUA 2019b)

(1) Adaptation Plan for Water Resources for Mexico

Hydric National Program (PNH)

The PNH serves as the foundational document for water-related policy and management. It outlines five priority objectives, these shape policy strategies within the National Development Plan (PND) 2019-2024 framework (CONAGUA 2022b). These are:

1. **Access to potable water and sanitation services is insufficient and inequitable.**
2. **Inefficient water use, which affects both the population and productive sectors.**
3. **Reducing vulnerability and addressing the impacts of floods and droughts, particularly among marginalized groups.**
4. **Preserving the integrity of the water cycle to ensure the hydrological services provided by basins and aquifers.**
5. **Improve conditions for water governance to strengthen decision-making and combat corruption.**

Based on the PNH, hydrological regional plans are formulated, outlining priority projects for each area. However, local stakeholders seek more tailored approaches based on regional or city-specific needs. Revitalizing basin councils as a platform for cross-level communication can inform regional hydrological plans, unlocking their full potential.

CONAGUA is developing **climate change adaptation criteria, focusing on water resources.** This involves integrating adaptation criteria into planning instruments such as the National Water Program 2020- 2024 (PNH), guidelines for Regional Water Programs (PHR), and Specific Actions defined by CONAGUA in the Special Climate Change Program (PECC). This effort is facilitated by an international cooperation agreement with Germany, including a Policy-Based Loan (PBL). Collaboration involves the Ministry of Finance and Public Credit (SHCP), SEMARNAT, and CONAGUA, with technical assistance provided by KfW, the German Development Bank (KfW and CONAGUA 2024).

The following table analyzes the gaps identified through expert interviews regarding the technical capabilities of government agencies.

Table 8: Findings on Enablers for Water Projects

Multi-stakeholder Engagement	*Technical Capacity and Knowledge*
- *Community participation and buy-in* are essential for rain harvesting project success, relying on beneficiaries' effective system management. This reinforces project goals and stability through government transitions, fostering collaborative efforts for tailored success and sustainability. - *Technical Stakeholder coordination,* Engaging academia, private sector, and financing institutions aids project scalability and showcases early successes for wider adoption.	-*Accessing technical support from international organizations and academia* for diagnosis and project planning, enhances governmental capabilities and credibility. - *Developing additional capacities and multidisciplinary groups* to propose innovative solutions beyond traditional gray infrastructure, including experts in decarbonizing water supply. - *Utilizing predictive tools* like the or the IMTA water management models to understand supply and demand dynamics, especially in the context of climate change, guiding policy decisions and priorities.

Incentive Alignment	*Crisis Responsiveness*
- *Fiscal incentives,* such as tax credits, drive local infrastructure development for water recycling. - *Projects tied to economic* objectives enhance adaptation or resilience initiatives. - *International agreements,* like CONAMP and biodiversity agreements, inform national policy actions, as emphasized by FMCN.	- *Officials must explore innovations* under PPP models like rain harvesting to tackle challenges, benefiting communities with shortages or limited access to systems. - *Innovations require cost-benefit* analyses to surmount government resistance. Contrasting innovative projects with alternatives like water tank trucks highlights the latter's inefficiency, resulting in no long-term solutions, discontent, increased emissions, and higher costs.

v) Dimension 3: Financing Strategies

(1) Current Funding Sources

According to the OECD, countries should allocate 1% to 2% of their GDP to water supply and sanitation to achieve universal access to water as defined by the SDG6 (OECD 2022). Nonetheless, Mexico invests 0.8% of its GDP on water (El Economista 2024). Figure 23 illustrates a 12.6% decrease in the 2024 budget compared to the budget allocated in 2023, which creates uncertainty about covering water infrastructure capacity (IMCO 2023a).

Figure 23: **Evolution of Budget for Water Management in Mexico 2010 – 2022 in Thousands of Millions of Pesos of 2024**
Source: (IMCO, 2024), (SINA, 2024)

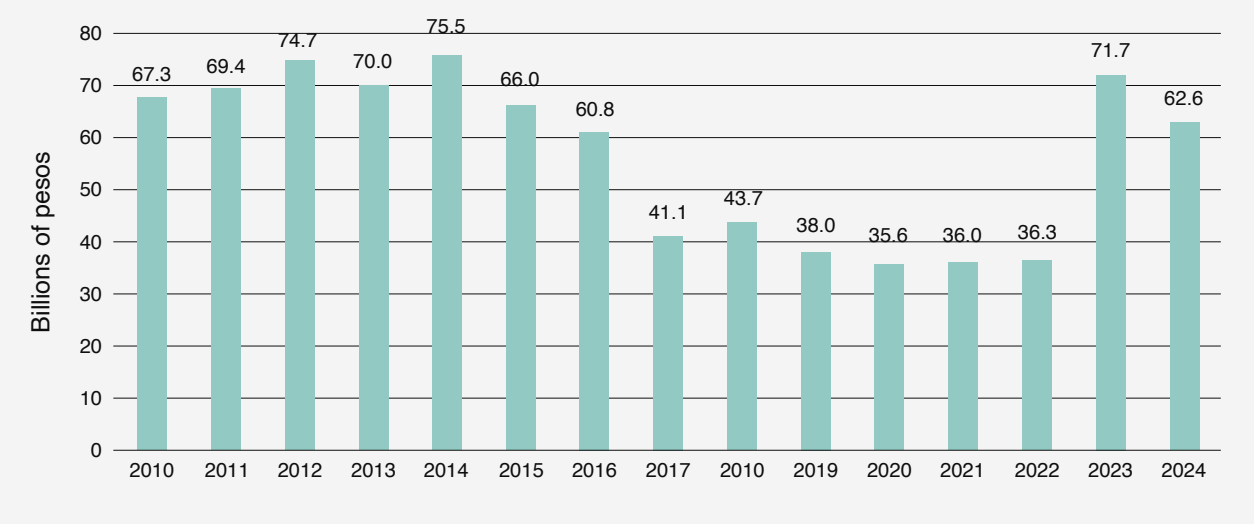
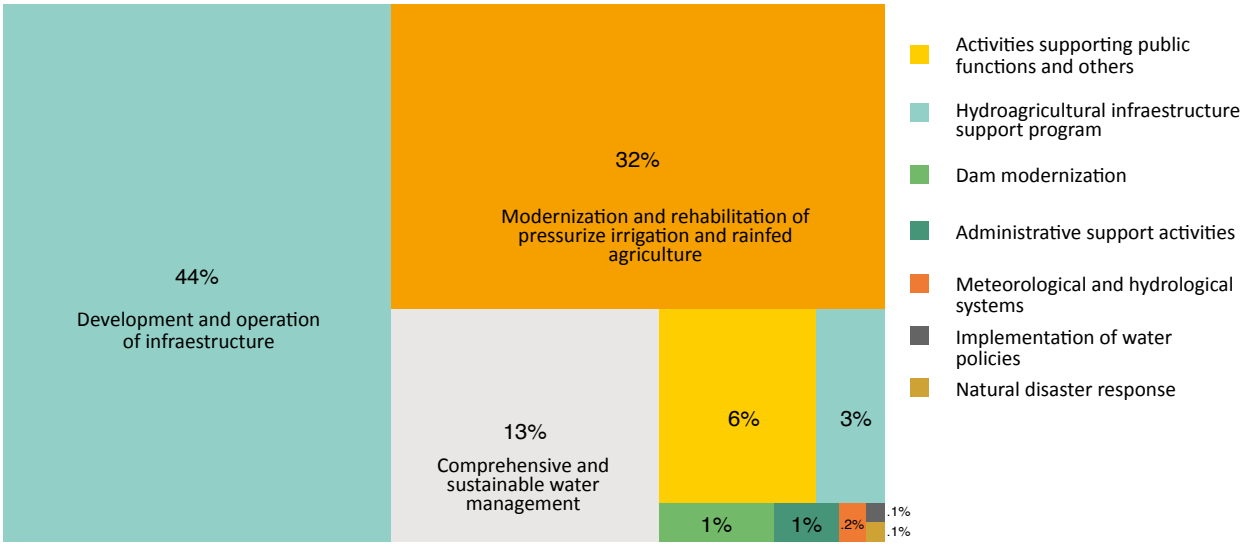


Figure 24 outlines CONAGUA's 2024 budget allocation, 44% is allocated for development and infrastructure operation, covering water distribution and sanitation. Modernization and rehabilitation of pressurized irrigation represents 32% of the budget. However, integrated water management and public functions underwent a 8% decrease in comparison with 2023. This decline is concerning given that includes monitoring, planning, protection, conservation, legislation, regulation, and research. This budget allocation indicates CONAGUA's continued focus on traditional infrastructure, overlooking broader water management needs (IMCO 2023a).

Figure 24: CONAGUA's Allocation Budget for 2024 by Project. From the budget 44% will be assigned to development and operation of infrastructure *Source: (IMCO,2024), (Transparencia Presupuestaria, 2024)*



CONAGUA experts highlighted the **challenge of integrating climate impact data into existing systems,** essential for accessing international funding, which necessitates improved technical capabilities. Other challenges include excessively high targets set by international funds, complex financial schemes, and project bankability, particularly affecting water adaptation projects (Expert Interviews 2024). The focus on traditional industries is also shown in Mexico's prioritization of the oil industry. While Mexico's national oil company (PEMEX) received $80.5 billion USD in capital injections and tax breaks from 2019 to 2023, CONAGUA faced budget cuts. Moreover, the estimated allocation needed to solve water scarcity in Mexico City is estimated to be 7% of the government's contributions to PEMEX across 5 years (Bloomberg 2024).

The **main federal program** that provides funding is PROMAGUA, administered by National Infrastructure Fund (FONADIN). Its objective is to incentivize the development of projects under public-private partnership schemes that allow for increasing levels of coverage and quality of drinking water and sanitation services, as well as efficiency levels in operating entities, see appendix 11. FONADIN and private investors co-fund projects, choosing providers is based on technical and economic merit to boost

socioeconomic gains. FONADIN's role reduces local financial burdens and bolsters project stability for quality services and maintenance (BANOBRAS and CONAGUA 2019). However, evaluating the program's impact and state benefits is difficult. Moreover, its criteria highlight Mexico's limited water management focus, neglecting broader ecological solutions like water harvesting and nature-based approaches.

The **fund for Adaptation to Climate Change,** which aims to support vulnerable communities, is implemented by IMTA and receives funding from two main sources. First, 2% of Certified Emission Reductions (CERs) generated by Clean Development Mechanism (CDM) projects, and from other sources (INECC 2024).The fund invests in projects in Mexico and globally but lacks transparency in project oversight and stakeholder access. Experts note underutilization of funds despite a decade of existence, not meeting intended mandates (Expert Interviews 2024). Finally, the involvement of multilateral development agencies such as the World Bank, IDB, international cooperation agencies such as GIZ, and multiple green funds like the GFC and FMCN are main players of providing the financial resources to develop projects.

A notable success story in diversifying revenue streams involves the implementation of a **climate change water tax,** approved by local congress. Guanajuato state in Mexico enacted Decree 111 on June 1, 2023, introducing "Ecological Taxes for Environmental Remediation," including a carbon tax, a water pollution tax, and a waste disposal tax. Of particular importance is the "Tax for Environmental Remediation due to the Emission of Pollutants into Soil, Subsoil, and Water." This tax targets individuals, legal entities, or economic units operating within the state and aims to generate additional financial resources for climate resilience projects (SMAOTG 2023).

Table 9: Financing Schemes and Policy Instruments

Question	*Yes /No/Incomplete*	*Details*
Do financing schemes prioritize users, public and private, during climate risk?	No	No, because there is no measurement or requirement to provide this information to access to capital (CONAGUA 2022).
Are there existing financial policies that promote water adaptation projects?	Yes	The Climate Adaptation Fund, PROMAGUA, the carbon tax, are some of the instruments listed above (BANOBRAS and CONAGUA 2019).

Is climate risk assessment mandatory in financial institutions for water projects?	Incomplete	Despite having an Environmental Impact Statement, the country lacks risk assessment for vulnerability conditions. Experts stress the need for government training in climate language and technicalities (Expert Interviews 2024).

iv) Lessons Learned from Mexico

This section will analyze four cases related to incentive systems for private sector investment, leveraging international finance for capacity building, financial sustainable operators and basin council governance. Review appendixes 12 and 13 for more success cases.

Box 2: Water Districts – Coapa, Mexico City
Implementor: ORU and WRI
Client: Agua Capital (Mexico City's Water Fund), Tecnológico de Monterrey (ITESM)

This aims to foster a unified water vision among stakeholders within (ITESM) CDMX campus district. It serves as a planning tool, integrating urban and environmental development with water sensitivity, resilience, and adaptation to climate change effects on water resources. Operating at a local, decentralized level, it promotes sustainability and circular economy principles within a specific area comprising shared identity traits among neighborhoods or communities.
Objective: Improving flood control, water consumption management, aquifer recharge, treatment and reuse, and water storage to enhance the area's water balance. Success was achieved by diagnosing the campus water balance, integrating gray and green infrastructure, collaborating with stakeholders, innovating water reuse systems, and promoting water conservation alongside economic development goals. Review appendix 14. *Source: (ORU 2022), (Expert Interviews 2024). See appendix 20.*

Box 3: National Program of Water Reserves
Enhancing Adaptation Strategies to Combat Climate Change
Implementor-Funding: CONAGUA, WWF, Fundation Gonzalo Rio Arronte, and the IDB.

A water reserve is an early adaptation initiative aimed at conserving water for the environment and future generations. It aligns with Mexico's Water Agenda 2030, focusing on balanced watershed management and preserving natural heritage. The outcomes include:

- Creation of NMX-AA-159-SCFI-2012 for environmental flow determination
- Capacity building enhanced ecological water management, prioritizing adaptation strategies, involving 58 institutions and 138 experts.
- First executive order in 2014, established water reserve for 11 basins supporting biospheres, outlining usage reserves for 50 years with set authorization conditions.

- By 2018, previous administration's reserved water in 295 basins, 38% of total. Currently, they've reached 396 basins, 88% of their goal.

International impact: A proactive approach to meeting legal obligations and international agreements regarding water allocation for the environment. Recognized as a vital action for climate change adaptation within water policy. Starting to be replicated in Guatemala, Colombia, Bolivia and Peru. Refer to appendix 15 for illustration.

Source: (CONAGUA 2022a), (IDB 2015), (Secretaria de Economia 2012), (WWF 2024) (Expert Interviews 2024).

Box 4: City of Leon SAPAL

The SAPAL Advisory Board, ensures governance with external validation, comprised of city officials, the private sector, academics, civil society, and government representatives, it mandates a long-term vision essential for the sector, based on the city's needs and growth. León boosted water delivery efficiency from 41% to 70%, in contrast with the national 40% average. The change is attributed to technology integration and constant infrastructure monitoring, to minimize leaks. Despite a threefold increase in the population efficiency led to a water extraction reduction.

Ensuring continuous water service and engaging consumers is crucial for building trust, resulting in an impressive 95% commercial efficiency. Approximately 85% of the projects are self-funded, with a 5% federal contribution. This financial independence allows investment in sustainable water management, alleviating a major constraint for water utilities. Consequently, SAPAL has earned a AAA rating from Fitch Ratings. Inspiring citizen confidence, staff tenure at SAPAL is notably high, with the director serving over 25 years, compared to the national average of just 1.3 years for water utility directors.

Increasing value of different types of water: Leon treats 100% of its water, with 85% reused. SAPAL prioritizes investing significantly in drainage to ensure wastewater reaches treatment plants for reuse. This approach benefits both financially and environmentally, meeting norms while reducing the climate impact of extracting more water from the aquifer.

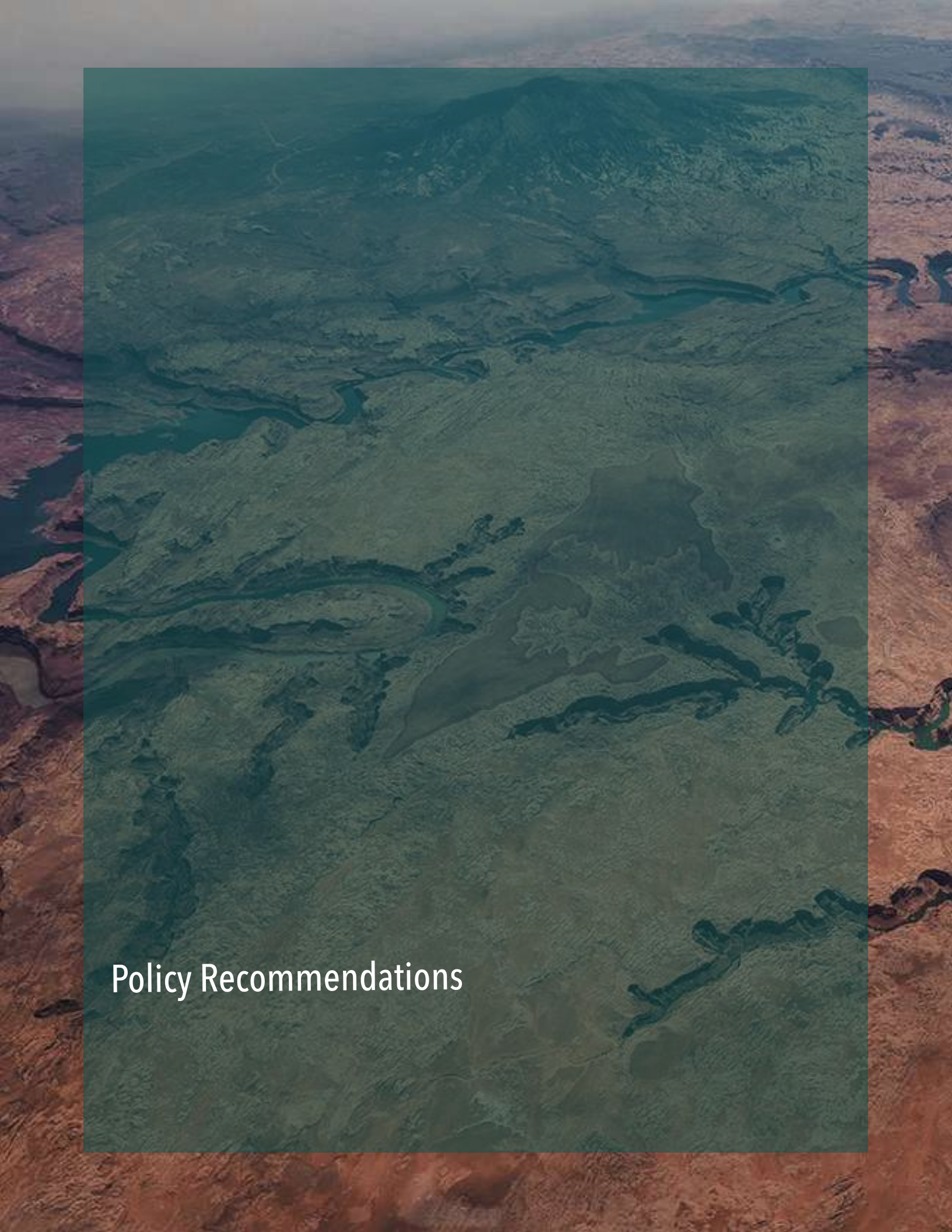
Innovation to face crisis: SAPAL's innovation department adopts global best practices, aiming for savings through clean energy, and co-generation projects, to improve services and revenue, assessing their scalability, while pioneering nanotechnology wastewater treatment methods inspired by Texas.
Source: Interviews with SAPAL officials, (SAPAL 2023), (Expert Interviews 2024).

Box 5: Basin Councils, Decree Lerma-Chapala 2014

The Lerma-Chapala basin supplies water to 16 million inhabitants, supporting around 20% of the country's GDP,. Extensive agriculture, urban growth, and excessive water demand have depleted both surface and groundwater, leading to water scarcity and quality degradation.

Basin Councils coordinate actions among the National Water Commission, government agencies (Federal, State, and Municipal), and basin users to manage water efficiently, develop infrastructure and services, and conserve basin resources. The Lerma-Chapala Council comprises five governors, seven federal ministries, and representatives from industry, civil society, including users, agricultural interests, and academia.

Supports conflict resolution as it oversees six major dams storing key water resources. In 2004, the council established an agreement with a surface water distribution model crafted by the IMTA among the five states. The 2014 national decree stemmed from the initial agreement, highlighting the success of localized solutions. Basin councils serve as policy hubs, facilitating the scaling of policies to the national level through effective implementation.
Source: (FAO 2014), (Expert Interviews 2024).



Policy Recommendations

Recommendations for Chile

1) Water Management and Planning:

Unify, streamline, and standardize water data collected from various sources to ensure easy access for the public. There are many sources of information gathered by different water stakeholders that, if consolidated, would provide valuable insights into water quantity and quality. Key challenges include incentivizing reporting to authorities, standardizing data, and establishing accessible public information systems. This requires a national water information policy to align needs with data generation capabilities (Mesa Nacional del Agua 2022).

Leverage technology and innovation to bridge information gap. Using digital platforms can streamline operations and incorporate socioeconomic and environmental variables, facilitating impact evaluation. This can strengthen water governance by analyzing interconnected factors, promoting coordinated planning, and dealing with informal practices and legal compliance that require robust monitoring mechanisms (Matus et al., n.d.).

Generate incentives to promote the reduction of water usage and the implementation of environmental controls, both through legislation and via the water market. This question addresses the need to explore strategies for encouraging sustainable water management practices, including the development of regulatory frameworks and market-based mechanisms aimed at fostering responsible water usage and environmental protection. As mentioned above, in Chile, most of the WR were fully allocated by 2005. Thus, the Australian water market, as described in Box 6, can provide lessons learned since it enabled the growth of dynamic water markets and the introduction of environmental WR, despite the full allocation of WR already in place.

Box 6: The Victorian Environmental Water Holder (VEWH) and Australian Water Market.

Australia's Victorian Environmental Water Holder (VEWH), operating as a state-level corporation, aligns well with a market-based system due to its focus on WR, resembling to private WR. The VEWH determines water resource usage and can utilize the water market to achieve its objectives. Although accountable to Victoria's Minister for the Environment, the VEWH is shielded from ministerial interference in its water resource decisions. Legislative provisions ensure VEWH's independence by establishing it as an autonomous entity and limiting the Minister's authority to issue directives. To enhance water management flexibility and efficiency, VEWH can utilize the water market to sell surplus water and acquire additional water as needed. Consequently, two key recommendations could be adopted for Chile. Firstly, ensuring that the water market operates to safeguard the environment. Secondly, safeguarding the authority's role from political interference. For effective operation within a market-driven system, those responsible for water management need access to water rights (WR).

This necessitates three provisions: Firstly, they must hold legally recognized WR, formally acknowledging their entitlement to access and utilize water resources within established laws. Secondly, these WR should be legally designated as property rights, resembling to those held by private entities, necessitating a clear legal framework to define and protect these rights. Finally, individuals engaged in water management need the legal capacity to both hold and transfer WR, allowing them to manage these resources effectively within the established legal framework.
Source: (Melbourne Law School, Macpherson, and O'Donnell 2015).

2) Water Supply and Sanitation:

Facilitate greywater reuse for drinking water purposes: Expedite the enactment of pending regulations under Law 21.075 and establish specific guidelines for treatment, quality, and monitoring. Additionally, increase investment in infrastructure, including allocating funds for the development of cost-effective greywater treatment technologies suitable for potable water reuse. To encourage adoption, provide financial support such as subsidies for installing greywater treatment systems in residential, commercial, and industrial settings, especially in water-scarce regions. These measures will streamline greywater reuse processes, ensure compliance with health and safety standards, and contribute to sustainable water management.

3) Water Policies and Allocation:

Bridging the gap in coverage and investing in piped water systems to ease financial strain on households lacking access, who currently rely on alternatives like tanker trucks, another adaptation measure is introducing rain harvesting models used in Mexico City and rural communities. Furthermore, water quality often deteriorates in such situations. The benefits of expanding access to clean water and sanitation far outweigh the costs—by approximately 2.4 times for water and 7.3 times for sanitation. Chile should prioritize these investments as they offer a more efficient and sustainable solution compared to current methods. Mobilizing resources requires both national and international financing, along with improved public policies to optimize service delivery and budget allocation efficiency in the sector (Matus et al. 2020).

4) Equity:

Enhance financial efficiency in the provision of water services in rural areas by encouraging the consolidation of rural water providers. In addition to establishing appropriate tariffs aligned with the systems operated by the SISS in each context, the government could initiate pilot projects promoting collaboration or clustering of rural water systems. Collaboration becomes increasingly relevant now that organizations managing these systems will also oversee sewerage services, which are managed jointly in some regions.

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Develop a system for generating data on the rural subsector to inform optimal tariff decisions and infrastructure investments, thus enabling Chile to meet its sustainable development goals by 2030, particularly in rural sanitation (World Bank 2021).

5) Economic Instruments and Financing for Water Management:

Diversify financing mechanisms from the government allocations, including expanding the use of climate financing instruments such as the green bonds.

Recommendations for Mexico

Drawing from extensive interviews with experts and literature review of international best practices, alongside successful cases in Mexico, this section discusses crucial factors that enable success in water management projects: 1)Multi-stakeholder engagement, 2) Technical capacity, 3) Incentive alignment, 4) Crisis responsiveness, 5) Sustainable and constant access to finance (Expert Interviews 2024). Highlighting which projects have success potential for regional scaling and on what the OECD can advise Mexico to prioritize.

1) Water Governance and Planning:

Update National Water Law: this includes modernizing concessions, improving monitoring, and addressing budgetary and financing needs for water infrastructure (IMCO 2023a). The Supreme Court mandated the Congress to enact a General Water Law by August 2024, underscoring the urgency to guarantee future water access in Mexico.

Alignment of SEDATU's urban development policies and CONAGUA's PNH, integrating water management into urban planning to mitigate environmental impact. This includes regulating urbanization to protect natural water sources and incorporating water management provisions (rain harvesting, and flooding areas) into construction codes. SEDATU is working on green construction standards, which could be further supported through initiatives like the Improvement Urban Program (PMU).

Empower IMTA to lead innovation and technology efforts, bridging capacity gaps and integrating solutions into water management strategies. As an expert in water information management, IMTA ensures transparent decision-making, fosters accountability, and promotes a service-oriented culture within CONAGUA. IMTA's leadership is crucial for Mexico's water policy transition, particularly in advancing adaptation projects and accessing climate funds.

2) Economic Instruments and Financing for water Management:

Water New Assets for Climate and Financial Resilience: The GCF explores unconventional water sources such as wastewater as new asset classes for climate adaptation. Affordability and bankability present significant challenges for water utilities. Leveraging the GCF's push for a low-carbon, climate-resilient water security paradigm shift could improve credit and financing in Mexico. Blended finance approaches, outlined in appendix 16, combining commercial and concessional finance, could facilitate new water asset projects. The focus on adaptation efforts could introduce a new asset class in sanitation and water reuse, with substantial potential in Mexico and Latin America. Cases like Leon and Celaya (Box 4) demonstrate opportunities for private investment in wastewater facilities, aligned with ESG impacts and SDGs (Elmahdi and Wang 2022).

Assess all water-related subsidies and their impacts through collaboration with relevant institutions. Especially, coordinate with SADER to ensure long-term water availability for irrigation and sustainable food production. Work with Federal Electricity Commission (CFE) who administers the federal electricity subsidy for rural users (Tarifa 9), to incorporate the real cost of water and address climate vulnerabilities. Prioritize water allocation to higher-return activities, mirroring Chile's approach to ensure access during water scarcity.

3) Water Conservation and Supply:

Leveraging international agreements: Mexico committed to the UN Fresh Water Challenge, to restore 300,000 kilometers of rivers and 350 million hectares of wetlands by 2030, aligned with the commitments in the Montreal Global Biodiversity Framework. Mexico and local stakeholders must utilize these pledges to integrate ecological understanding into water management.

Establish mechanisms for stakeholders to launch pilot projects in monitoring, efficiency, harvesting, and recycling water to test scalable solutions. While Mexico has seen success in conservation, scalability remains a challenge. Leveraging programs like the "National Program for Water Reserves (Box 3)" and "Cuencas y Ciudades" can expand water reserves effectively. Collaboration with CONAFOR is vital for reducing soil erosion in upstream river basins, ensuring water security.

Leverage Mexico's norm, NMX-AA-179-SCFI-2018, and **IMTA's technology**, like satellite monitoring and sensors, to enhance real-time water resource monitoring. Collaboration among CONAGUA, IMTA, and PROFEPA enables effective leakage detection and maintenance, improving water resource management.

4) Equity:

Develop expertise in crucial water management fields such as hydrogeology, urban planning, biology, public policy, and management. Partner with IMTA to incorporate cutting-edge technical advancements into education for a comprehensive approach to water management. Embrace design as a catalyst for change and involve multidisciplinary experts in reimagining spaces for sustainable water management, exemplified by Parque La Quebradora (Appendix 12). (Expert Interviews 2024).

Enhancing water quality requires a multifaceted approach. Firstly, identifying pollution sources and assessing technical solutions' feasibility is essential, alongside determining necessary local government support. Secondly, strengthening PROFEPA's regulatory capacity under the updated NOM-001-SEMARNAT-2021 standard is crucial. Collaboration with IMTA can integrate monitoring technology for better regulation. Additionally, using behavioral science, to incentivize pollution reduction among industrial polluters, while using ecological education to emphasize the impacts of pollution.

6. Dimension 4

Maximizing Water Adaptation Projects: Metrics, Investment Strategies, and Success Stories

Some of the financial barriers for water management strategies include undervaluation of water as a public good, which leads to underpriced services; capital-intensive infrastructure with long pay-back periods; difficulty monetizing benefits; context-specific projects increasing transaction costs; and poor business models hindering operational efficiency and sustainability (Elmahdi and Wang 2022). The analysis of Chile and Mexico shows that both countries face these financial challenges, at the national and local level, hampering their capacity to innovate or implement long-term integral management planning because the operators are always in crisis.

Increasing investment for water adaptation projects at scale requires a paradigm shift regarding how we define, develop, and finance water assets. Thus, to revolutionize water security in infrastructure, both countries must manage water resources holistically, encompassing supply treatment, distribution, and wastewater handling. This requires creating an environment for credit enhancement and blended financing through alternative funding methods, while ensuring fair financing via tariffs (OECD 2019). Box 7 provides an example of a project that effectively gathers funding for long-term planning.

Box 7: National Project Cuencas y Cuidades

Status: Since 2004, new phase 2022 and 2025.

Implementor-Funding: FMCN, Foundation Gonzalo Río Arronte.
Allies: Cervecería Colima, UN Environment, and the U.S. Forrest Service.

Objective: Support institutional coordination for better basin management and water governance, to reduce hydric stress and vulnerability of cities in Mexico. It is a project incubation and acceleration model, includes developing pilot conservation models and implementing long-term financial mechanisms. The new phase will enhance water resilience in cities and their watersheds through NBS for climate adaptation. By *integrating green and grey infrastructure, attracting public and private investments, and strengthening local stakeholders' technical and financial capacities.*

Accomplishments: In total, 12 local initiatives have benefited over 16,000 families from 192 communities. Additionally, 3,134 people receive compensation for environmental services, and 55,421 hectares are under conservation and restoration schemes. This project serves as a valuable repository of knowledge, learnings, and insights into hydrographic territory management in Mexico. It has facilitated holistic water management by engaging various stakeholders, including landowners, urban water users, and government authorities at different levels. (FMCN 2021).

7. Conclusion

The OECD's "Action Plan Towards Climate Resilience and Neutrality in Latin America and the Caribbean (LAC)" identifies key water priorities, including effectively managing water demand to address scarcity, emphasizing the value of water, evaluating conditions for financing, and promoting sustainable investments in water security. Chile and Mexico are at different stages in reaching these objectives. Chile has advanced in valuing water and employing economic policy tools, such as public-private partnerships and efficient water markets. In contrast, Mexico has relied on basin councils and multistakeholder projects like hydric districts and agricultural digitalization for water management. However, both countries must diversify their investment to include green infrastructure and innovative technology for better monitoring and enforcement of water consumption.

Both Mexico and Chile have established regulatory frameworks at national and local level, yet they grapple with coordination issues and scaling up successful approaches. Likewise, Mexico faces hurdles such ass limited access to capital and political transitions which hamper long-term planning. On the other hand, Chile has leveraged public-private partnerships and sustainable tariffs to bolster its main water operators, however, it faces equity challenges, which have led to social unrest. Both countries could benefit from having a centralized body that enhances coordination and accountability, given the responsibilities fragmentation present in these countries.

Moreover, there is an urgent need for a paradigm shift in how we define, develop, and finance water assets. While Chile has been more successful in effectively leveraging private funding for water distribution at the urban level, both countries need to strengthen the enabling environment for credit enhancement and blended financing through alternative funding solutions to scale local solutions and improve resource allocation efficiency. This involves establishing water reuse and sanitation infrastructure as new water assets by defining their investment value and creating the necessary financial and institutional framework to attract private market investors, as Chile has done, and Mexico can improve upon.

Nonetheless, the crisis situations in both countries can serve as a window of opportunity. The convergence of crises, policy initiatives, public awareness, and political attention has elevated water management to a priority, emphasizing the crucial need to translate these discussions into tangible actions. This requires setting goals, allocating appropriate budgets, and implementing a comprehensive water policy strategy. The lessons learned from Chile and Mexico can also provide valuable insights for other countries in the region to move forward with adaptation strategies that help navigate water management challenges.

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9. Appendix

Appendix 1: Abbreviations and acronyms

ANEAS	National Association of Water and Sanitation Utilities Asociación Nacional de Entes de Agua y Saneamiento
APRs	Rural Potable Water Systems
BANOBRAS	National Works and Public Services Bank. Banco Nacional de Obras y Servicios Públicos
BIENESTAR	Ministry of Welfare
CFE	Federal Electricity Commission / Comisión Federal de Electricidad
CONABIO	National Commission for Biodiversity, Knowledge and Use
CONAFOR	Comisión Nacional para el Conocimiento y Uso de la Biodiversidad National Forestry Commission
CONAGUA	Comisión Nacional Forestal/ National Water Commission Comisión Nacional del Agua
CONEVAL	National Evaluation Council of Social Development Policy Consejo Nacional de Evaluación de la Política de Desarrollo Social
CORFO	Corporation for the Promotion of Production
COTAS	Technical groundwater committees Comités Técnicos de Agua Subterráneas
CSADER	Ministry of Agriculture and Rural Development Secretaría de Agricultura y Desarrollo Rural
DGA	General Directorate of Water
FGRA	Fundación Gonzalo Río Arronte Mexican Fund for Nature Conservation
FMNC	Fondo Mexicano para la Conservación de la Naturaleza
FONADIN	National Infrastructure Fund
GCF	Fondo Nacional de Infraestructura
HAR	Green Climate Fund Hydrological Administrative Regions
HWD	Regiones Hidrlógicas Administrativas Hydraulic Works Directorate
IMTA	Mexican Institute of Water Technology Instituto Mexicano de Tecnología del Agua
INEGI	National Institute of Statistics and Geography (Instituto Nacional de Estadística, Geografía e Informática)
MOP	Ministry of Public Works

NAP	National Adaptation Plan
NbS	Nature-based solution
NWL	National Water Law (Ley de Aguas Nacionales)
OECD	Organisation for Economic Co-operation and Development
ORU	Urban Resilience Office / Oficina de Resiliencia Urbana
PEMEX	Mexican Petroleum / Petróleos Mexicanos
PMU	Improvement Urban Program
PNH	National Hydric Program Programa Nacional Hídrico
PROFEPA	Federal Attorney for Environmental Protection (Procuraduría Federal de Protección al Ambiente)
PROMAGUA	Program for Water Supply, Sewerage and Sanitation in Urban Areas Programa para la Modernización de los Organismos Operadores de Agua
REPDA	Public Registry of Water Rights Registro Público de Derechos de Agua
SDG	Sustainable Development Goal
SEDATU	Ministry of Agrarian, Territorial and Urban Development Secretaría de Desarrollo Agrario,Territorial y Urbano
SEMARNAT	Ministry of Environment and Natural Resources Secretaría del Medio Ambiente y Recursos Naturales
SHCP	Ministry of Finance Secretaría de Hacienda y Crédito Público
SINA	National Water Information System Sistema Nacional de Información del Agua
SISS	Superintendence of Sanitary Services
SSR	Rural Water and Sanitation Services Autonomous Metropolitan University
UAM	National Autonomous University of Mexico Universidad Nacional Autónoma de México
UNAM	Victorian Environmental Water Holder
VEWH	Water Rights
WRI	World Resources Institute
WWF	World Wildlife Fund

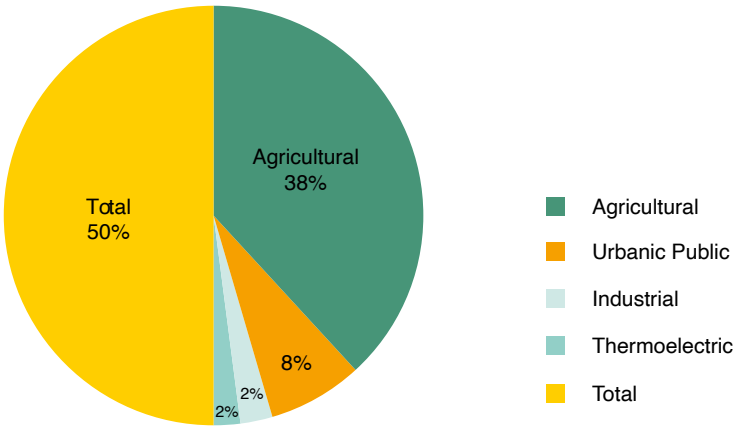
Appendix 2: Expert Interviews

Water management expert interviews for Chile and Mexico will only list the organization's name to maintain interviewee anonymity.

SECTOR	ORGANIZATION
	MEXICO
Academia	UNAM - National Laboratory for Sustainability Sciences (LANCIS)
Academia	UNAM – Engineering Institute
Academia	UAM – Growth and Environment Economics Department
Academia	UNAM – Hydrogeology Department
Academia	University of Texas – Hydric Security at the Border
Civil Organization	Consejo Consultivo de Agua
Civil Organization	ANEAS - National Association of Water and Sanitation Utilities
Government	CONAGUA - International Finance
Government	Leon's Water Utility Operator
Government	Celaya's Water Utility Operator
Government	ITMA – Hydric Security
Government	CONAGUA – Hydric Planification
Government	SINA – Intelligence Unit
Government	INECOL – Ecology Institute
Multilateral	OECD - Global Relations Regional Program for LAC
	LAC Environment Department
Private Sector	CAPSUS
Private Sector	ORU – Urban Resilience Office
Private Sector	Isla Urbana
Private Sector	FMCN – Mexican Fund for Nature Conservancy
Private Sector	Taller Capital
Private Sector	Celeste
Think Tank	WRI – Water and Infrastructure Mexico WRI
	CHILE
Academia	Chile Hydrology Expert
Academia	Universidad Católica Center for Global Change
Government	MOP - Ministry of Public Works
Government	DGA – General Waters Directorate
Government	MOP – Former advisor
Private Sector	Aguas Andinas
Private Sector	Biofactory "La farfana"
Think Tank	Center for Climate and Resilience Research (CR2)

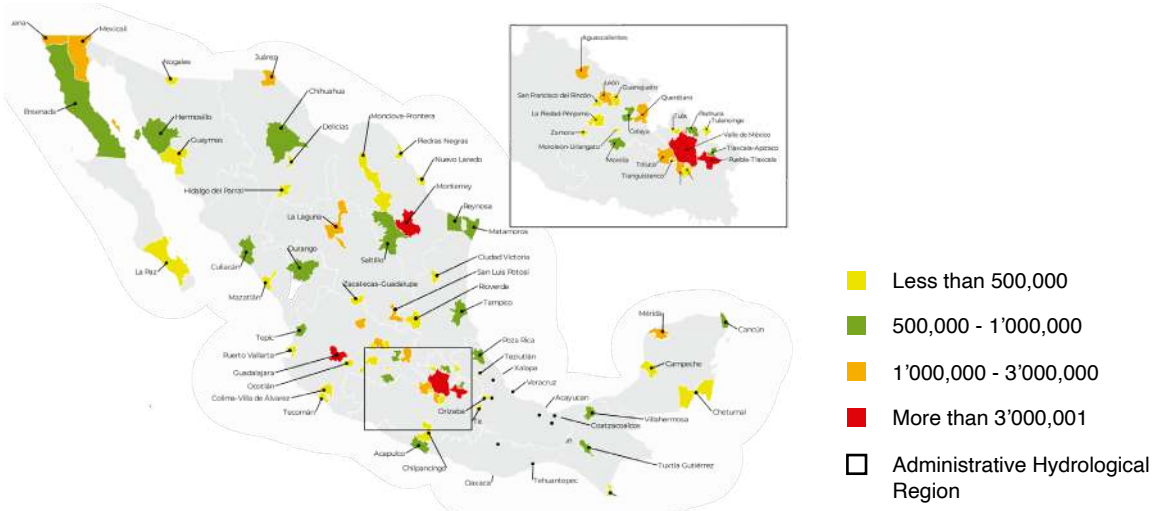
Appendix 3: **Water Use in Mexico 2022**

Source: (SINA, 2021)

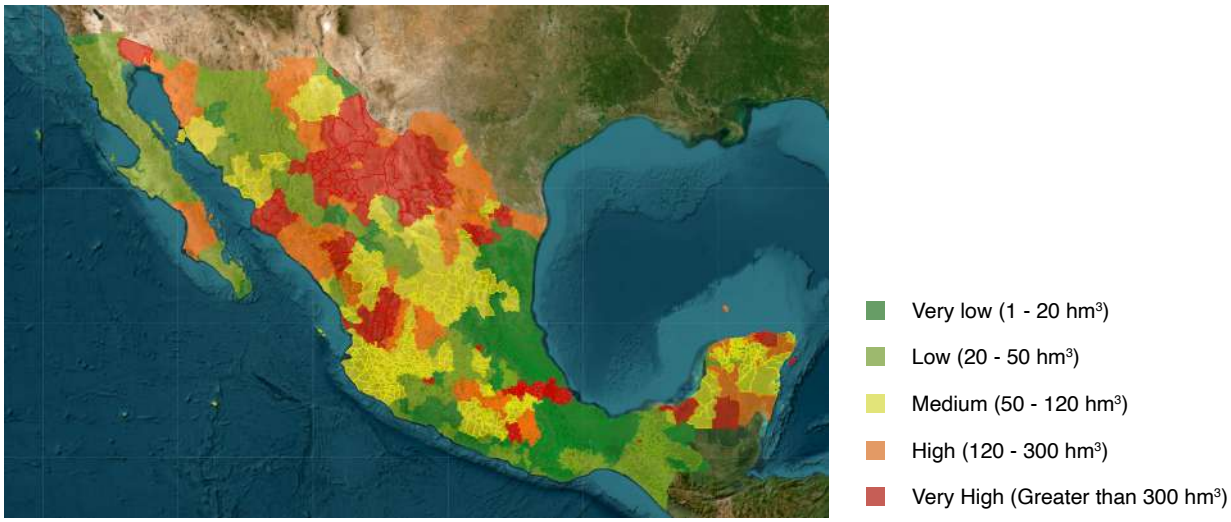


Appendix 4: **Urban Growth: Population in metropolitan areas by 2030**

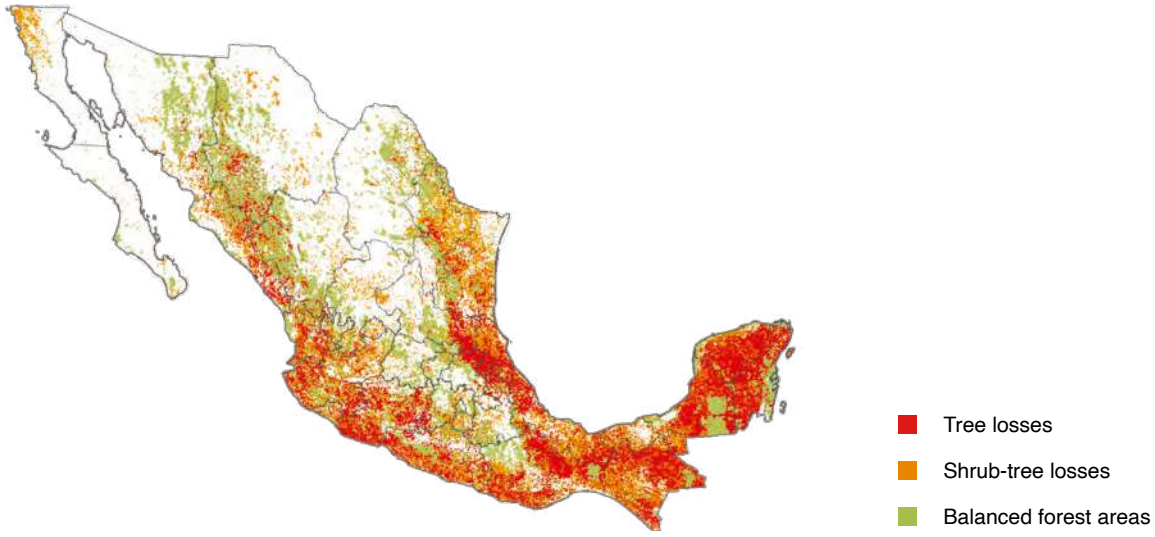
Source: (CONAGUA, 2019)



Appendix 5: Mexico's Climate Vulnerability
Source: CONAGUA, SINA 2012.

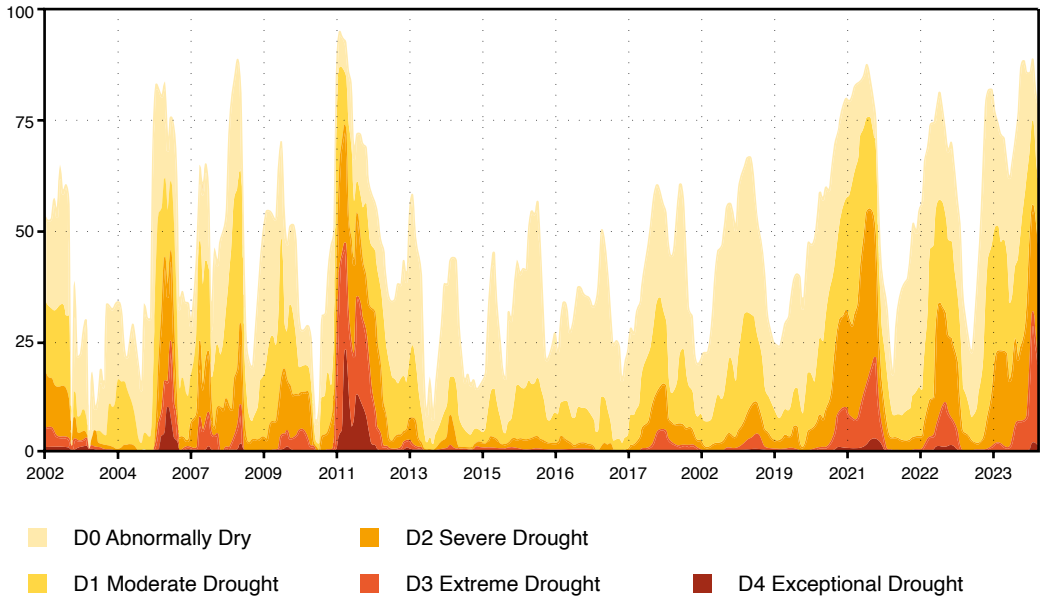


Appendix 6: Deforestation in Mexico 2022
Source: Cruz-Gaistardo Et Al. Atlas Nacional de Mexico 2022. Instituto de Geografia, UNAM. (CONAGUA, 2019) (Fernando J González Villareal et al. 2022).



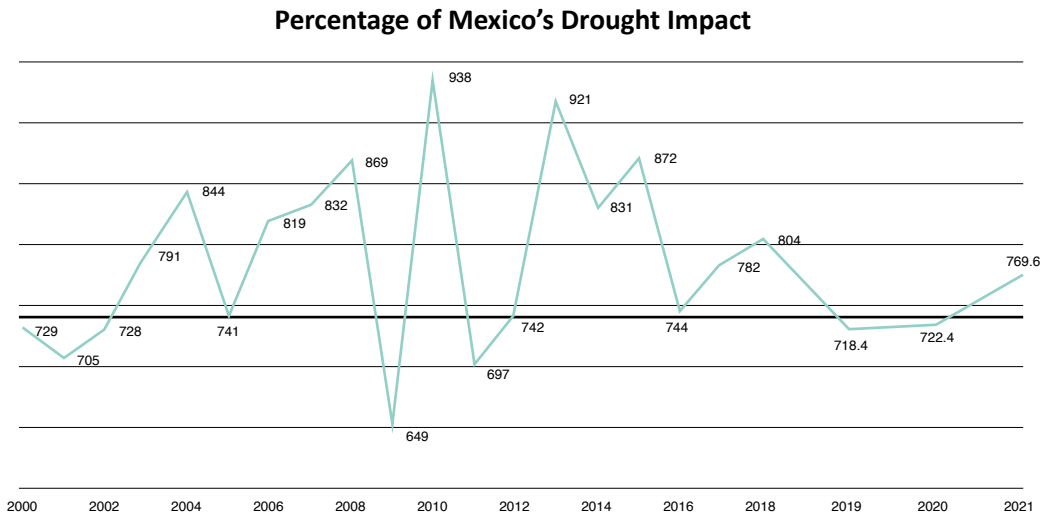
Appendix 7: Percentage of Mexico´s Drought Impact

Source: (CONAGUA, 2023)



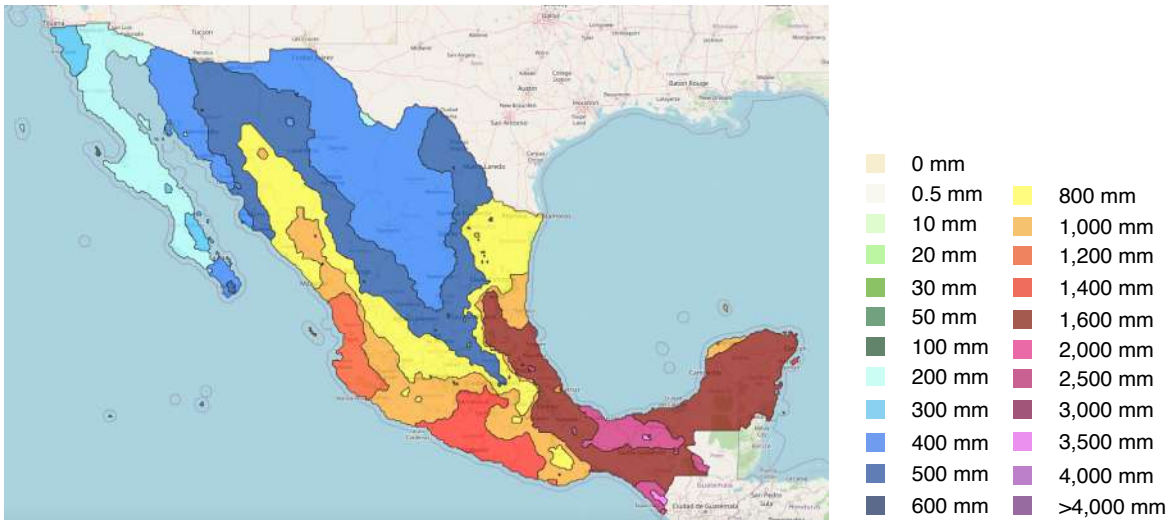
Appendix 8: Rain Precipitation from 2000 to 2021

Source: (CONAGUA, 2021)



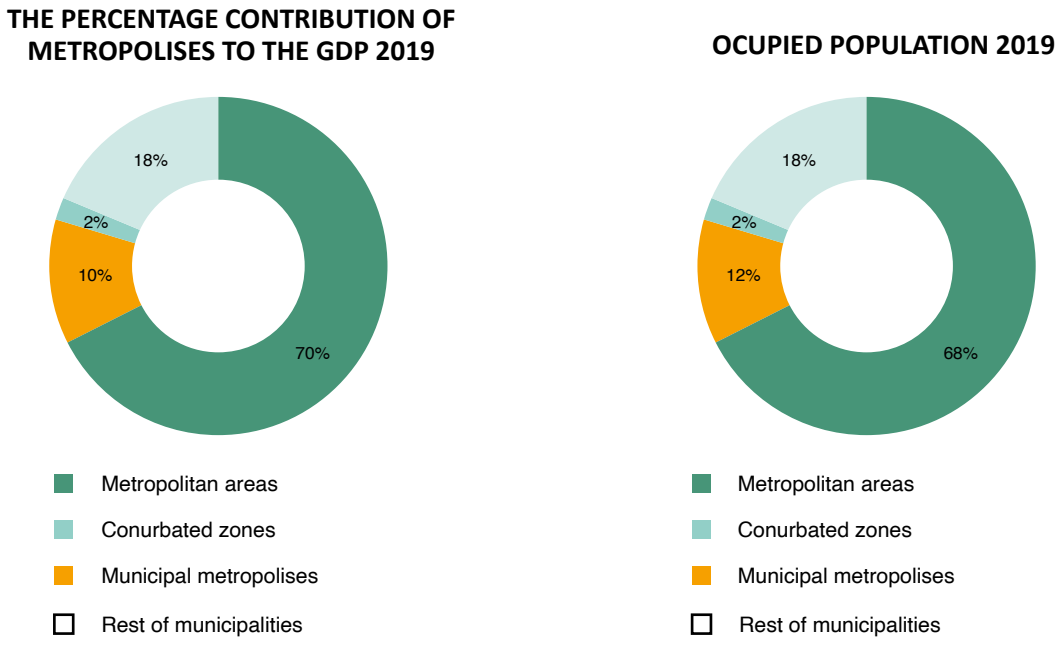
Appendix 9: Distribution of Normal Precipitation 1991 - 2020

Source: (CONAGUA, 2021)



Appendix 10: The Percentage Contribution of Metropolises to the National Economy, and Occupied Population 2019

Source: SEDATU, 2020



Appendix 11: FONADIN: PROMAGUA

Source: BANOBRAS, CONAGUA, 2019

Funded Studies	Funded Water Projects	Maximum Percentages
Comprehensive Planning Diagnostics	Aqueducts	Up to 50% for the development or updating of studies.
Basic Engineering	Desalination Plants	Up to 50% of the cost of strategic consultancy for the bidding and financial closure of the project.
Socioeconomic Evaluations	Wastewater Treatment Plants (WWTP)	Up to 49% of the total project cost
Feasibility Analysis of a PPP	Operational and Financial Sustainability	
Strategic Consulting		

Appendix 12: Parque La Quebradora

Parque La Quebradora

Transforming sustainable water management into a spectacle for the population.
Location: Itztapalapa, Status: Concluded in operation Executor: UNAM, Iztapalapa Municipalty, Mexico City Water System. Funding: A trust has been designed for operation and maintenance.

Objective: Highlighting natural infiltration possibilities and implementing water treatment and reuse systems demonstrate alternative resource management in Mexico City. Noteworthy for its location in a densely populated marginalized area grappling with water scarcity and periodic flooding, this initiative directly benefits 28,000 residents by addressing flood mitigation, producing treated water, and providing public spaces.

La Quebradora exemplifies resilience amid government transitions. Despite facing a construction stop due to the change in government in 2018, the project was revived thanks to the community support, involvement by experts, and international prices recognition. With backing from the new municipal administration and the Mexico City Water System, construction resumed in July 2019, adhering to the original UNAM criteria.
Source: (FAO 2023), (Expert Interviews 2024).

Appendix 13: South-South Cooperation
Digital Transformation and Innovation in Agriculture

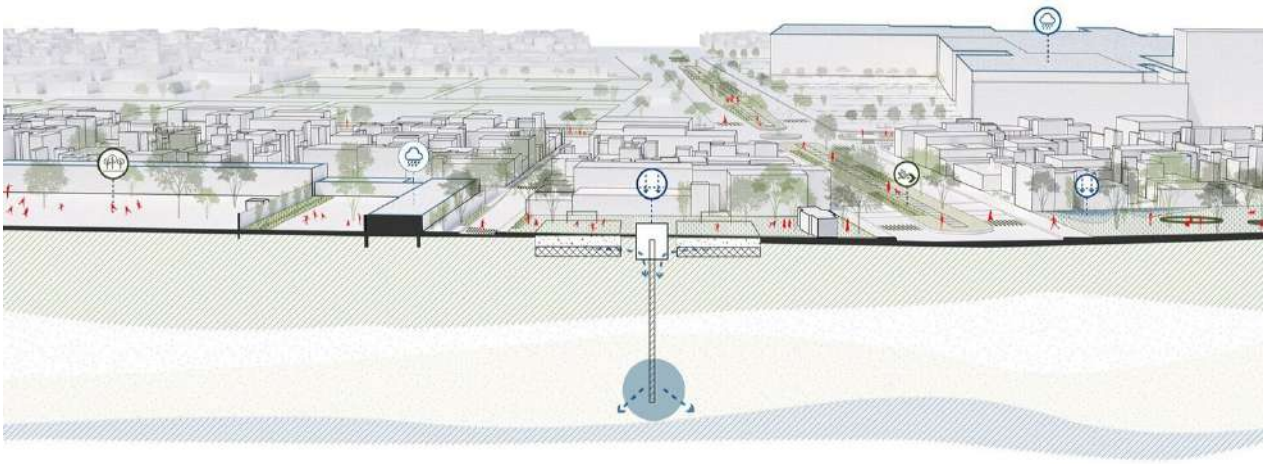
Location: Michoacan, Mexico. Status: in operation since 2023
Executor: FAO China CELAC, SADER Michoacan, CONAGUA, IMTA.

Objective: Financial-technical support for rural digitization pilot plans, to aid small-scale producers with relevant information for decision-making, and optimizing water, soil, and resource usage.

The challenge: Historically, agriculture lacked technification and faced challenges with law enforcement on tariff payments due to data unavailability. However, this project tackles the issue by introducing a digital system that makes decisions on irrigation usage and optimization leading to agricultural savings of approximately 25% without extra investment.

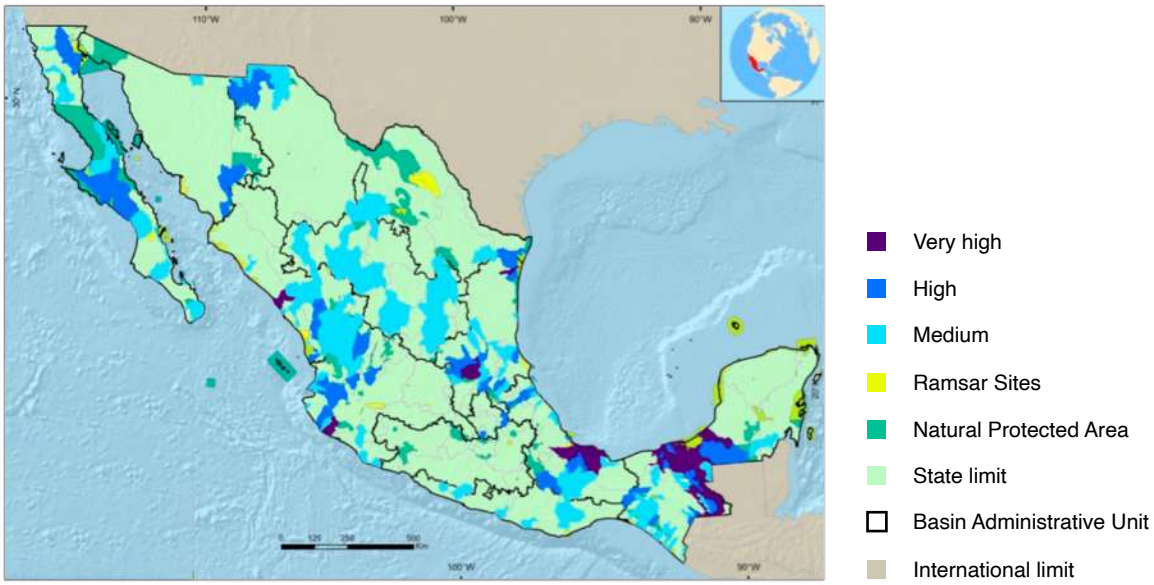
Recognizing that agriculture is the primary consumer of water in the country, accounting for over 70% of usage, enhancing the sector's efficiency must be a government priority. The challenge for such projects remains securing initial funding and building technical capabilities, leveraging both international innovations and local support.
Source: (FAO 2023), (Expert Interviews 2024).

Appendix 14: Hydric Districts
Source: Oficina de Resiliencia Urbana (ORU), 2020.



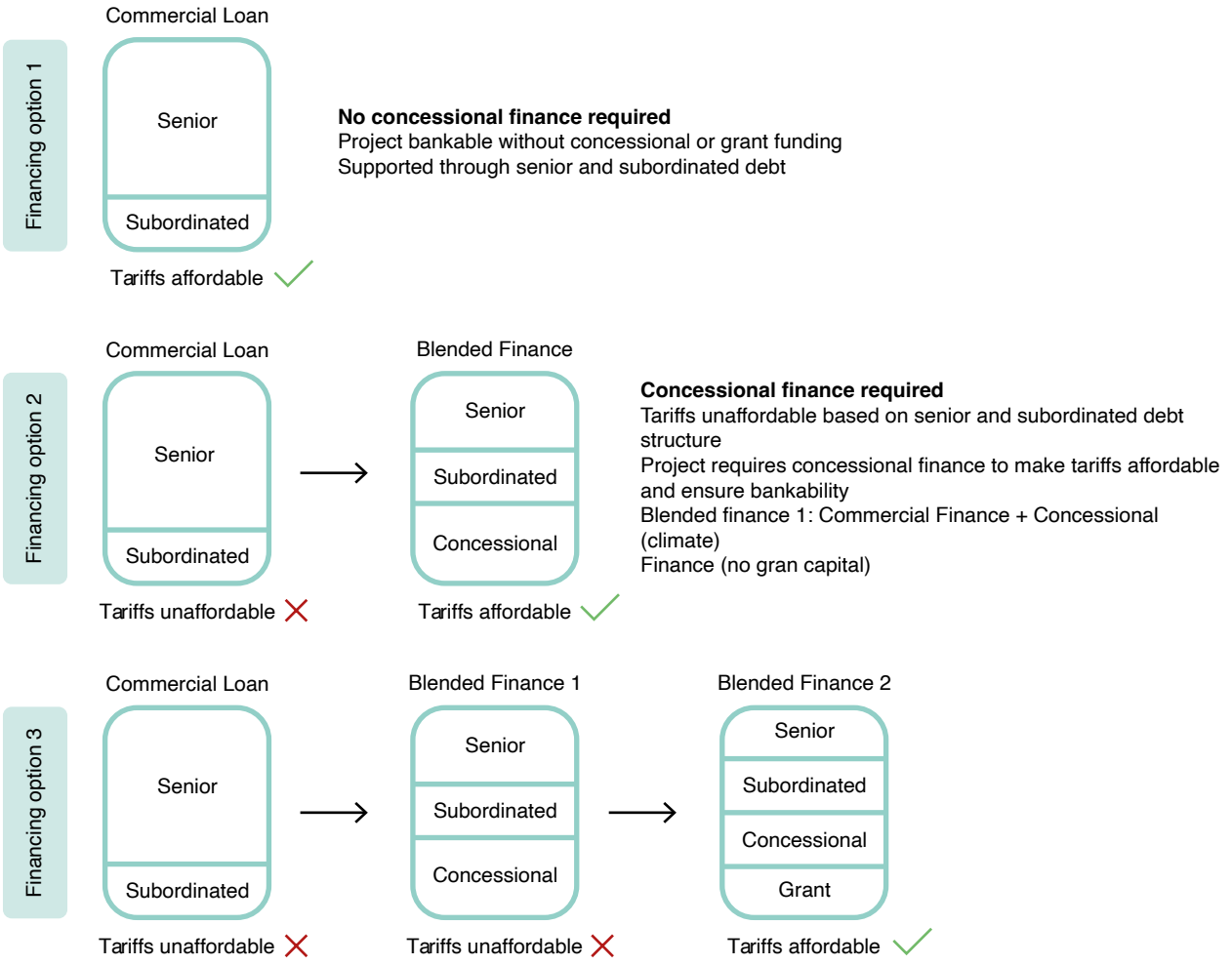
Appendix 15: **Potential Water Reserves for the Environment in Mexico and Eco-systemic or Environmental Services**

Source: (BID, 2015)



Appendix 16: Financing Options and Affordability, second picture shows the Key Characteristics of the New Asset Class

Source: (Amgad Elmahdi, et al; 2022)



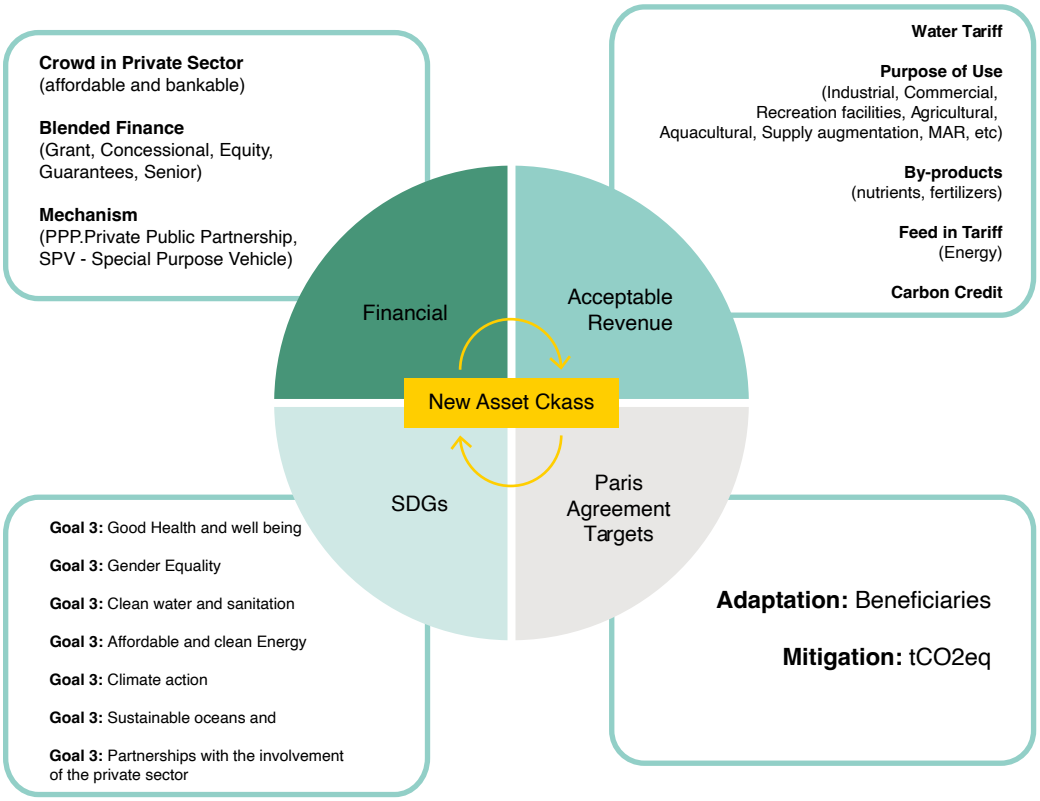
Concessional finance and infraestructure fund (SA Government) great funding required to make tariffs affordable and ensure bankability required

Tariffs unaffordable based on senior and subordinated debt structure as well as concessional funding

Great funding required to make tariffs affordable and ensure bankability (Great funding to be provided by SA Government infraestructure fund)

Blended finance 1: Commercial Finance ´Concessional (climate) Finance + Grant Fund (SA government infraestructure fund)

Key Characteristics of the New Asset Class
Source: (Amgad Elmahdi, et al; 2022)



Appendix 17: **Project Cuencas y Cuidades - Hydrography of an Alliance**
Source: (FMCN,2021)