Reweaving the Urban Landscape: Restoring Water Sustainability in the Laguna, Mexico

by

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Dedicated to my family, especially to my father, Sergio Guerrero, who is the source of inspiration in the pursuit of this thesis project.

Contents

Abstract

The Laguna, a semi-desertic region in northern Mexico, is an emblem of industrial prowess and economic development, yet one riddled by water inaccessibility. Torreon, the Laguna's hub, now dwells in the dichotomy of agricultural abundance and deepening water scarcity. The Nazas River, which previously crossed the city and replenished its aquifers, has been dry since the introduction of the Francisco Zarco Dam in 1968. Presently, most of the available water in the region is destined towards agricultural production, leaving the increasing population with an alarming water shortage.

This thesis explores the revival of the Nazas River as a method to achieve ecological recovery and support clean water accessibility in the Laguna. Working at three different scales, the design strategy investigates the integration of water infrastructure, urban landscape, and river-edge reactivation as a catalyst to the Laguna's water sustainability and the restoration of the region's collective memory of water.

Abbreviations

CCI - Consejo Civico de las Instituciones Laguna

CNA – National Water Commission

IMPLAN – Instituto Municipal de Planeación y Competitividad de Torreón

INEGI – National Institute of Statistics and Geography

LALA – La Laguna Group (Dairy Company)

RH36 - Hydrological Region 36

SIMAS – Municipal System of Water and Drainage

UN – United Nations

UNRISD – United Nations Research Institute for Social Development

WEC - Water Education Centre

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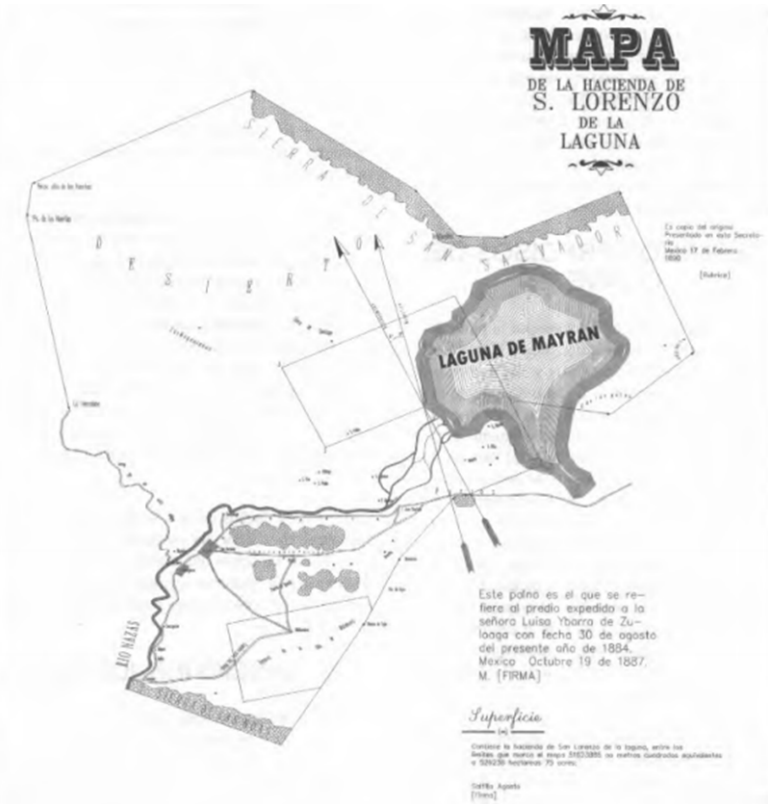
Chapter 1: Introduction

From an oasis of opportunity to an uncertain arid future, the Laguna [lagoon], a semi-desertic zone in the central region of northern Mexico, flourished and prospered largely due to the presence of the Nazas River. The strength and vitality of the waters of the “Father Nazas”, as the locals refer to it, nurtured agricultural production and fostered economic development; first, through the expansion of the cotton business, and subsequently with the introduction of an industrial dairy empire in the region, with Torreon at the center of its development.

The Laguna region in the national context. (Data from Google Earth 2020).

The fertile lands of the Laguna, watered by the Nazas River and the region’s aquifers, proved to be an ideal breeding ground for such agro-businesses. By the 1950s, the investment of the private sector towards forage production and cattle raising incentivized government-funded water infrastructure projects to increase irrigation capabilities in the region (Salas-Q 2011, 155). The federal government authorized the construction of one storage dam in 1946

One of the first exploration maps of northern Mexico depicting the extent of the lagoon system. (Urrutia and de la Fora 1769).



First scientifically traced map of the Laguna in 1887. (Guerra 2006, 33).

and a derivation one in 1968 in the Nazas River to fulfill the increasing demand for water dedicated towards agricultural production (Wolfe 2020; see Appendix I). The arrival of the dairy industry signified an economic boom and population growth for decades to come in the Laguna. However, the construction of the system of dams converted its endorheic lagoon basin system, including the Lagunas de Mayran, Viesca, and Tlahualilo, into deserts and depleted the ecosystems of the region. Additionally, the over-exploitation of the aquifers and the stored water at the dams have been progressively serving the dairy agro-industry over the years, to the point in which today there is a water supply shortage for families in the Laguna (Rodríguez 2019). On top of this, the scarce water supply has increased levels of arsenic contamination, leading to a rise in cases of cancer and diabetes in the region (ADN40 2019). Yet, concerns for carrying such unsustainable water practices in the Laguna have been thrown under the rug for over 50 years.

View of Torreon from the historical Puente Plateado [Silver Bridge], 1958; photograph from *Archivo Histórico del Agua.* (Salas-Q 2011, 142).

La Laguna living in an environmental paradox, a place where cows roam in the middle of the desert. (Photograph by author, 2021).

Thesis Question

> The Laguna's relationship to its largest river, the Nazas, is like Egypt's relationship to the Nile – the sustenance for human inhabitation in the region. (Wolfe 2017, 2)

As a Lagunero myself, and having lived the water shortages in my community in Torreon for years, my interest was sparked into researching potential ways of incorporating architecture as a means to achieving sustainable water practices, which led me to the following question - how can an architectural intervention support a balanced water resource system and help prevent further ecosystem disruptions in the Laguna region while reintegrating the community with its natural landscape?

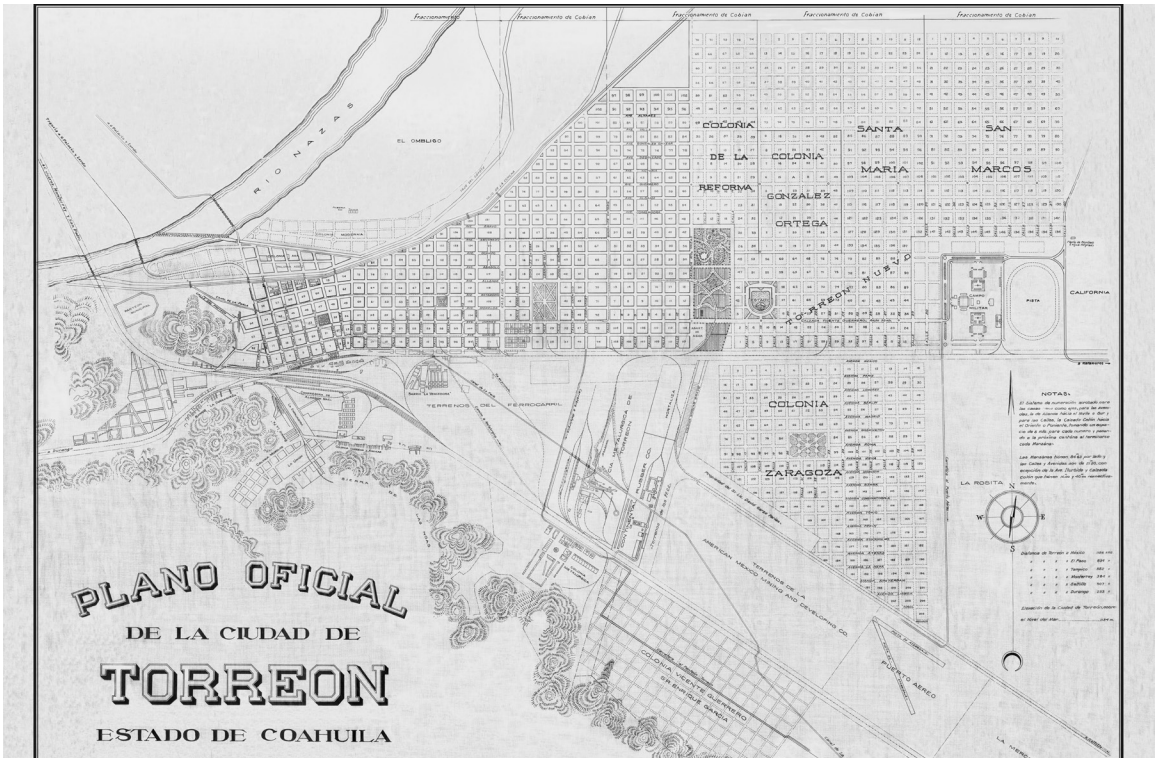
Ecology + Society + Economy

> They [researchers from the UNRISD] termed the Laguna's predicament a paradox of 'productive abundance' amid environmental deterioration and widespread poverty. (Wolfe 2017, 218).

This thesis examines the ecologic, social, and economic spheres of one of the most complex issues in the globe, water scarcity. A combination of factors, mostly driven by economic and political gain, have led the Laguna to a pressing situation in which urgent action is needed (Wolfe 2020; see also Appendix I). Through the ecological lens of the influential landscape architect, Ian McHarg, the project explores the interfusion of landscape as a method to achieve integrative open spaces for the population within urban developments (McHarg 1992, 57).

Through the social lens of the architect and urban historian, Dolores Hayden, this thesis aims to achieve an interweaving of public space, identity, and the personal and collective memories between the natural environment and the people in the Laguna (Hayden 1995, 9). The third scope will explore

the implementation of a method with sustainable economics for the region, as the livelihoods of the people of the Laguna cannot be ignored. Through the lens of hydrographic systems, the historical catalyst for economic development in the region, will be reimagined as a method to achieve ecological restoration through enhanced eco-efficiency (Gehl and Gemzøe 2000).



Plan of Torreón drafted by the urban planner, Federico Wulff in 1933. (Archivo Histórico Municipal de Torreón ‘Eduardo Guerra’ 1933).

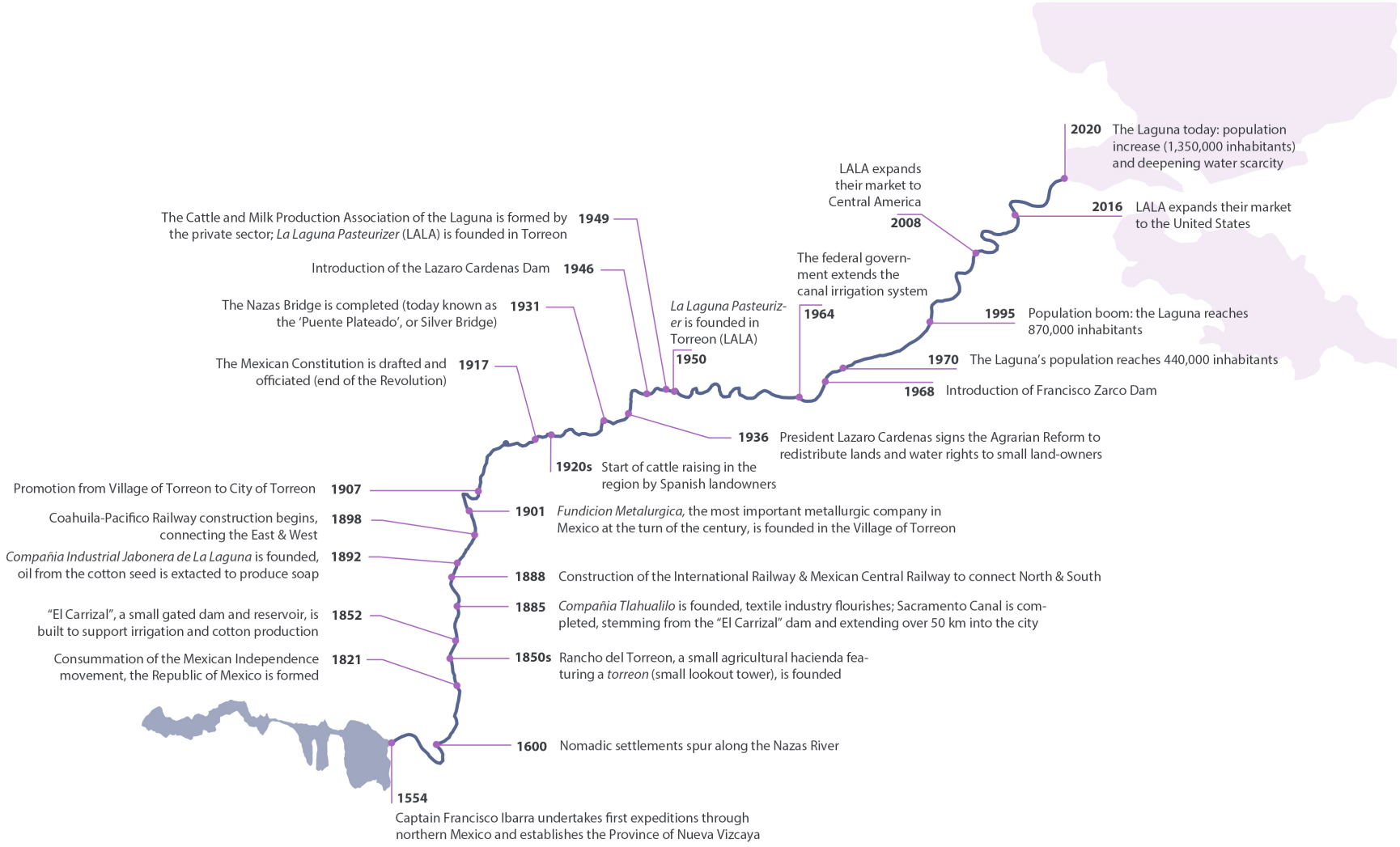
Chapter 2: History, Site & Context

Production and distribution of cotton thrived in the Laguna for decades at the beginning of the 20th century, n.d.a.; photograph from *Archivo Histórico Municipal de Torreón 'Eduardo Guerra'*. (Salas-Q 2011, 76).

The Laguna's History: A Region Intertwined by Water

The first known people native to the riverine edges of what today is known as the Nazas River were the nomadic tribes of the irritilas. The first written description came from the Spanish priest Geronimo Ramirez in 1594, who described them as a group of nomads who primarily subsisted from what was readily available to them from their surroundings, namely the fruits of maguey, mezquite, and cactus. Priest Geronimo Ramirez also noticed their main activities were fishing and hunting while traversing the river edges looking for food, with no indication of any settlement or form of agriculture (Maeda 1985, 1-2).

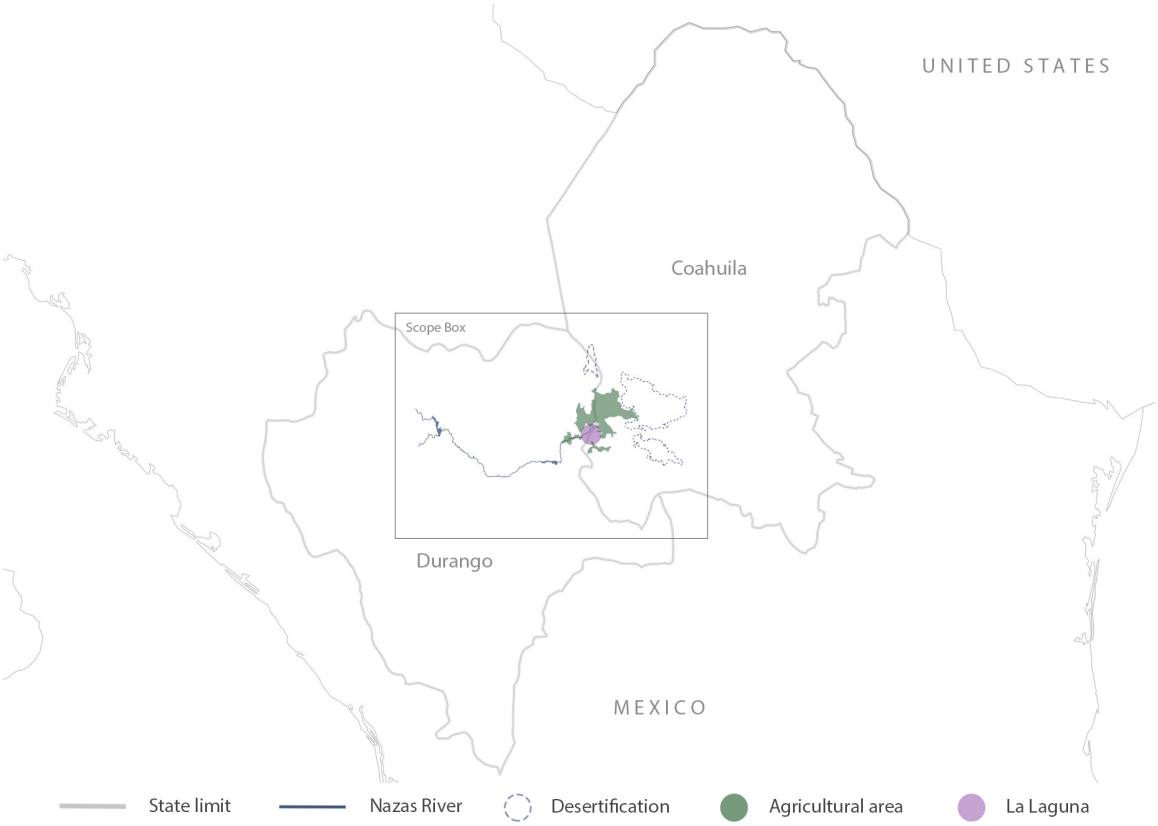
The presence of the Spanish became evermore influential in the region after the formation of the Province of Nueva Vizcaya in the mid-16th century, a northern jurisdiction of the Nueva España, primarily due to exploratory expeditions in search of mines. Towards the end of the 16th century, the advent of the expanding mining activity from Mexico's central region prompted the surge of religious missions in the Province of Nueva Vizcaya, as well as the search for more fertile lands for the growing agricultural needs of the mining population (Corona 2011, 22-23). The downstream region of what is today the Laguna, proved to be a prime agricultural production location, as the rich and fertile lands watered by the Nazas River provided the ideal conditions for farming. The first settlements along the Nazas riverbanks and its lagoon system followed at the turn of the 18th century, as small ranches and haciendas were founded to



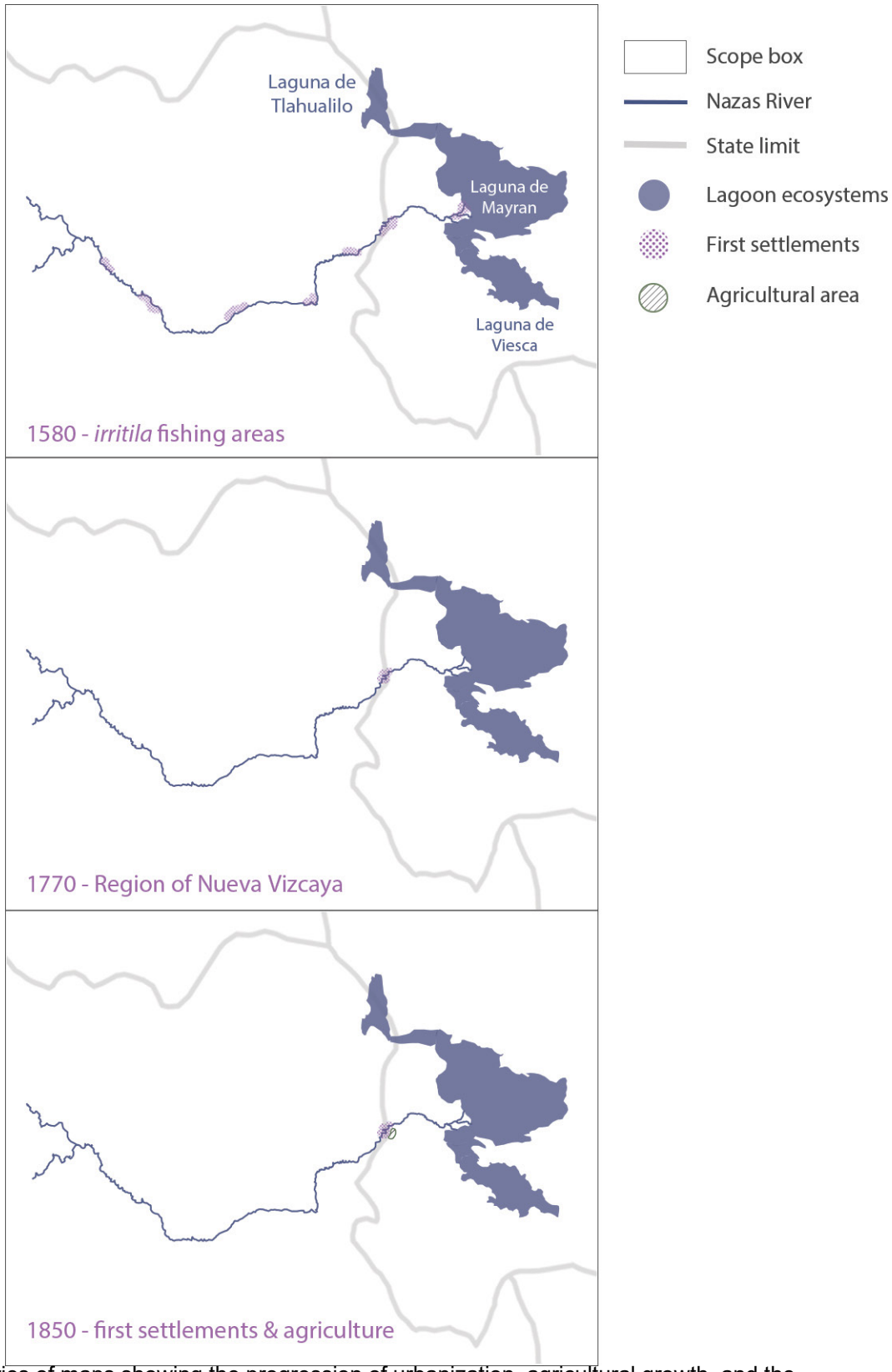
Historical timeline of the Laguna. (Data from Guerra 2006, Salas-Q 2011, and Wolfe 2017).

take advantage of the rise in the cotton industry (Maeda 1985, 11).

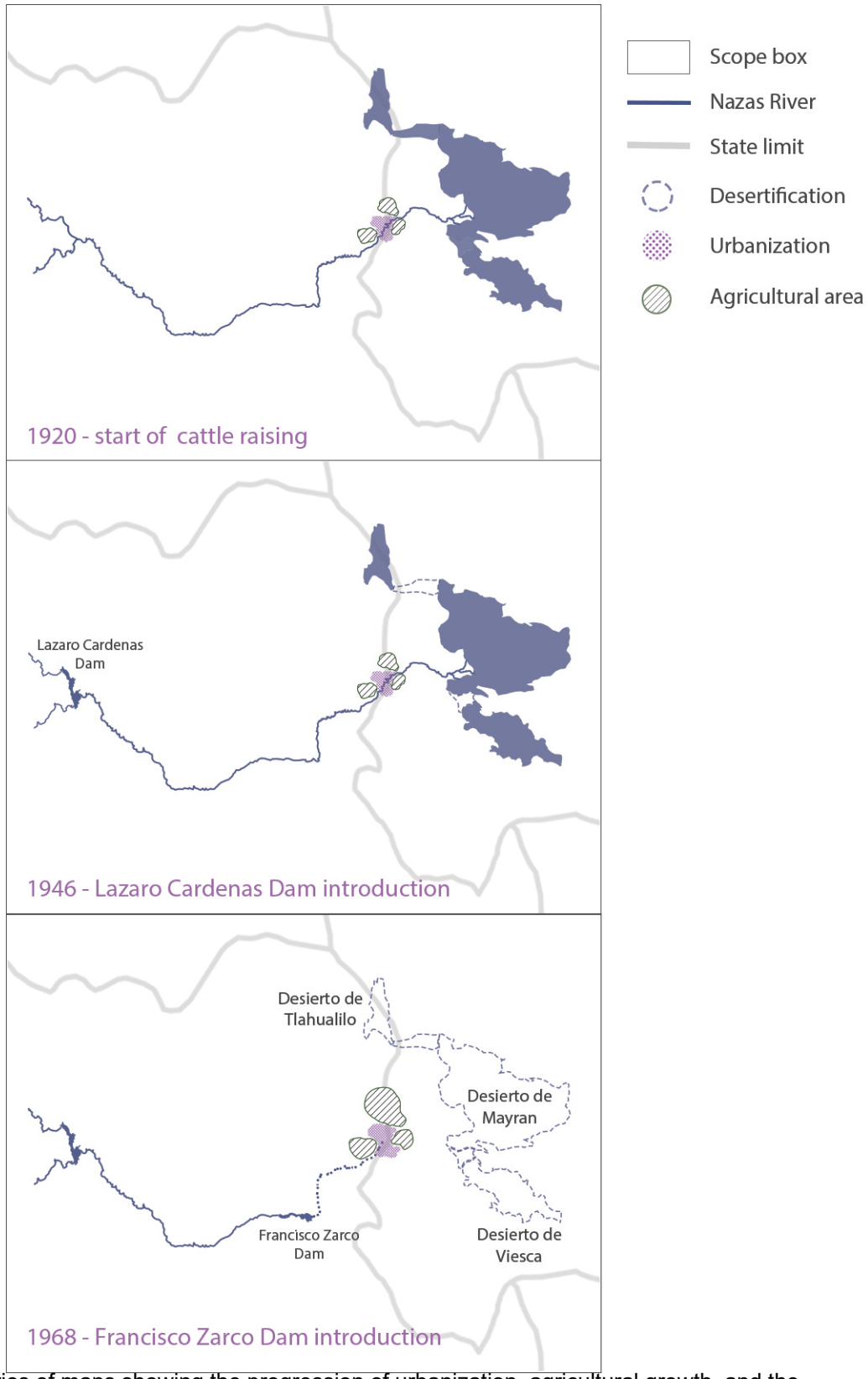
The haciendas flourished along the river-edges, as they incorporated a water collection system that used the diverted water from the Nazas River through an extensive use of canals and small dams. The first one was the El Carrizal Gates (today El Coyote Gates), constructed in 1851 by a local hacienda owner (Guerra 2006, 37). Soon, more haciendas and ranches would start featuring their own private system of dams, reservoirs, and canals to increase their yield in cotton production, making the Laguna a leading producer in the country. The advent of the Industrial Revolution and the introduction of the National Railway System in 1898 further catalyzed Torreon's prospect for industrial prowess, as it became a strategic point for distribution of goods and services



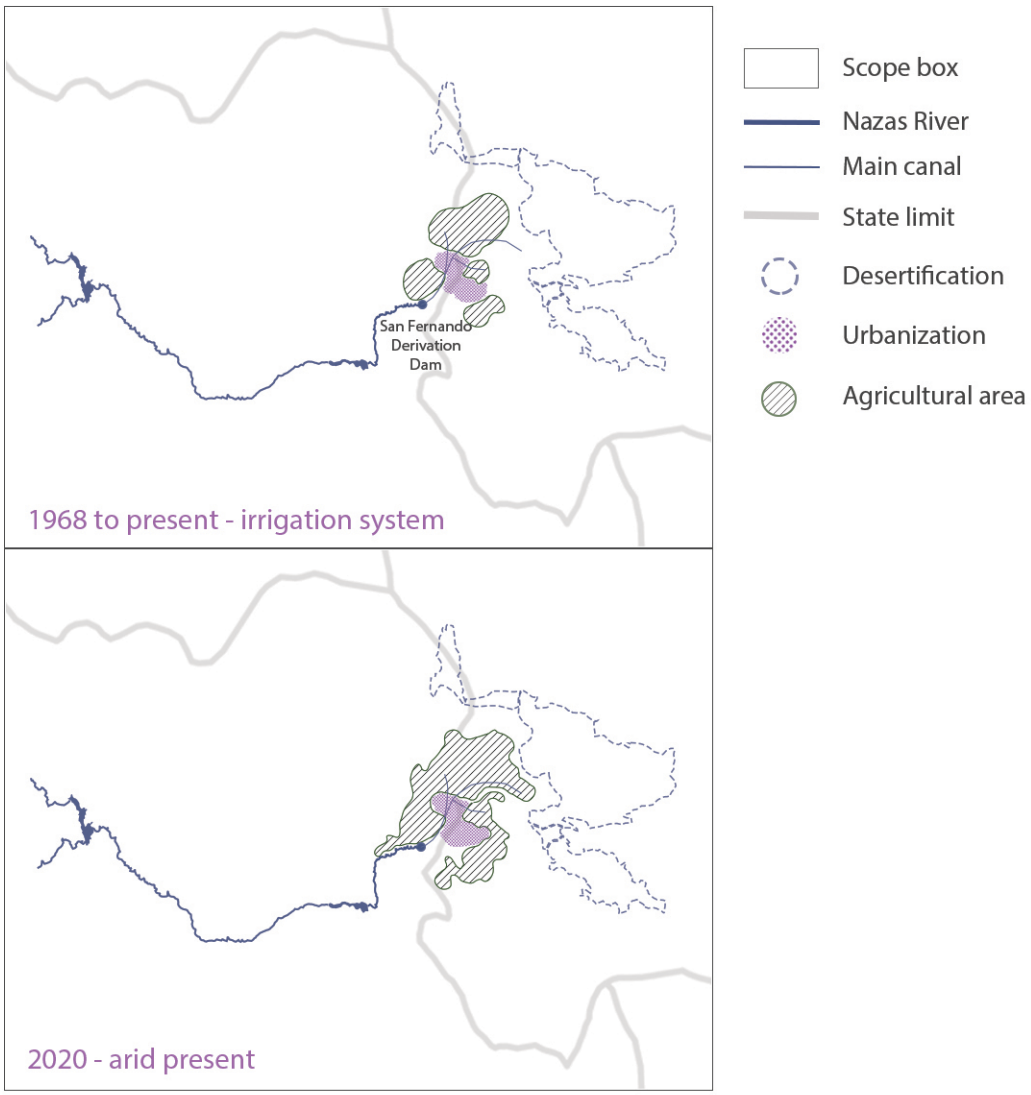
Map showing the desertification of the lagoon ecosystems in the Laguna region, in contrast to the expanding agricultural lands. (Data from Google Earth 2020).



Series of maps showing the progression of urbanization, agricultural growth, and the desertification of the lagoon system from 1580 to 1850. (Data from Corona 2005 and Guerra 2006).

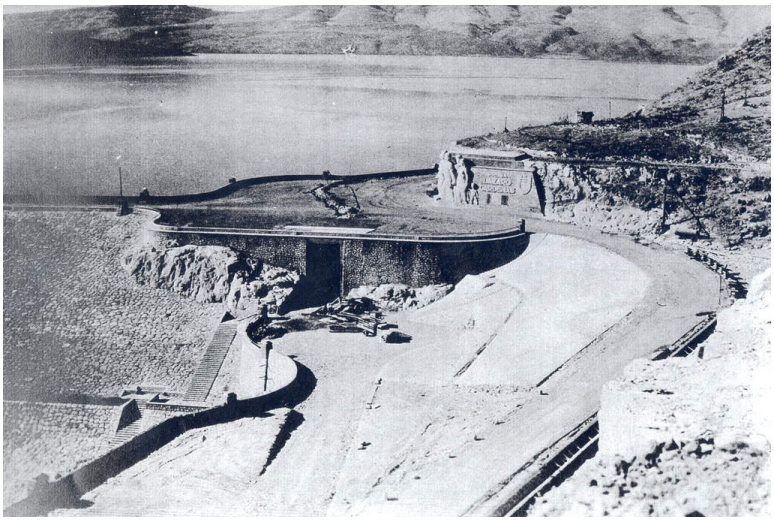


Series of maps showing the progression of urbanization, agricultural growth, and the desertification of the lagoon system from 1920 to 1968. (Data from Corona 2005 and Guerra 2006).

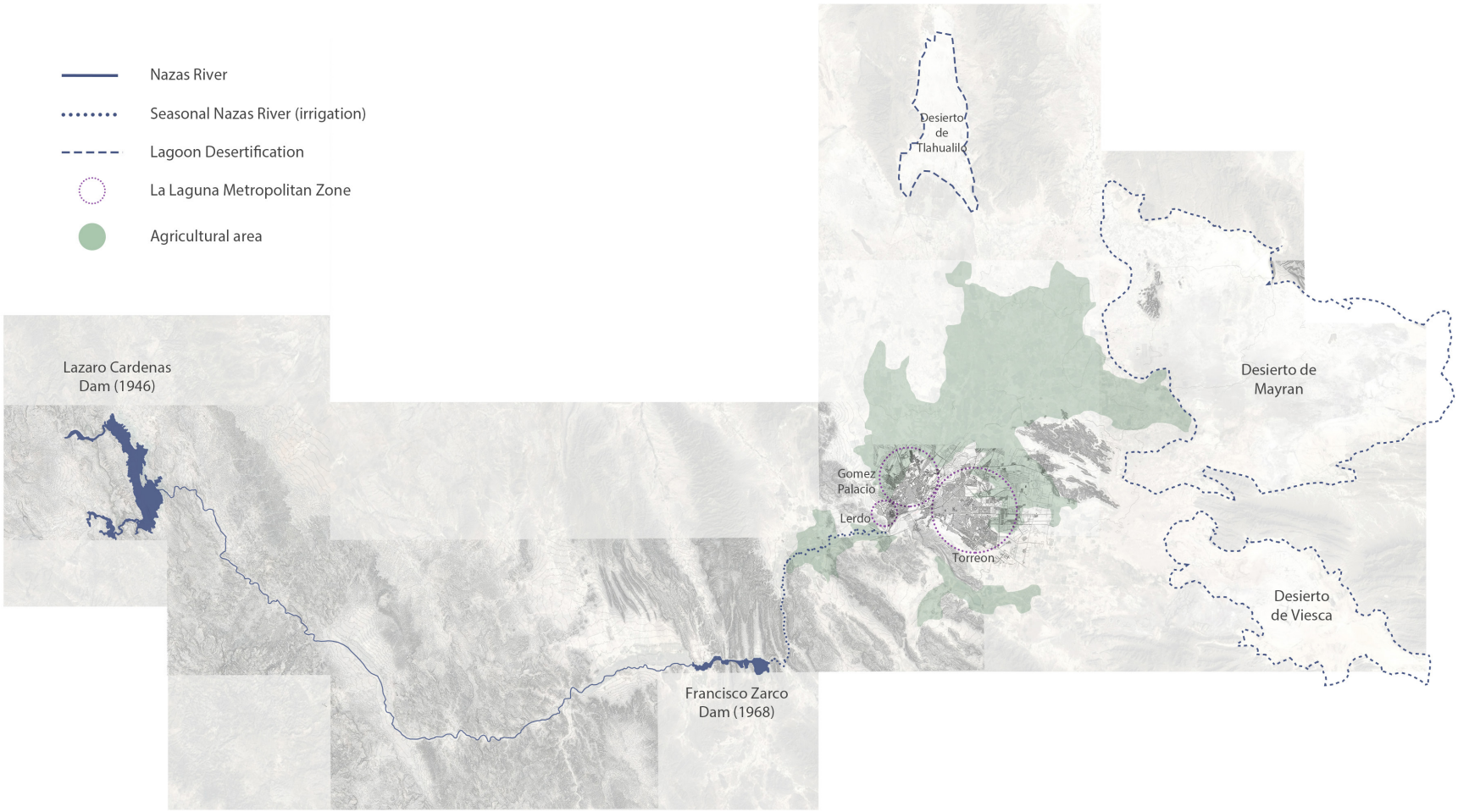


Series of maps showing the progression of urbanization, agricultural growth, and the desertification of the lagoon system from 1968 to present. (Data from Corona 2005 and Guerra 2006).

(Corona 2005, 17-46). By the turn of the 20th century, the founding of the Fundición Metalúrgica [Smelting Metallurgic Company, today Industria Peñoles] catapulted Torreon's status of village to being officially recognized as a city in 1907 (Guerra 2006, 77). The region's economical flourish was halted by the start of the Mexican Revolution of 1910. By the end, a new constitutional democratic government started in Mexico in 1917, and with this, changes in the law. By 1936, President Lazaro Cardenas implemented the Agrarian Reform to redistribute lands and water rights to small landholders, which brought about the unintended consequence of a 'water apartheid' effect that still ripples to this day. (Wolfe 2017, 4) Other changes from the Agrarian Reform brought the modernization of water management systems through the introduction of the Lazaro Cardenas Dam in 1946 and the Francisco Zarco Dam in 1968 to the Nazas River (Salas-Q 2011, 139, 143). Such system would prove to be the 'dam(n)ing' of the region (Wolfe 2017, 83).



Lazaro Cardenas Dam under construction in 1936. (Archivo 'El Siglo de Torreon' 1936).



The Nazas River hydrological system, as agricultural areas continue to expand and desertification intensifies. (Data from Google Earth 2020).

The Laguna and the Hydrological Region 36 (RH36) in the national context. (Data from Google Earth 2020).

Hydrology: Region 36

The Laguna lies within the Hydrological Region 36 (RH36), which forms part of the North-Central Basin Administrative Area of the CNA, encompassing the Nazas and Aguanaval Rivers. The RH36 is divided within three main areas: high basin, middle basin, and low basin. From the total watershed in the region, 85% is captured in the high basin area by the Sierra Madre Occidental mountain range where the Nazas River is born, 15% occurs at the middle basin area in between the Lazaro Cardenas Dam (LC) and Francisco Zarco Dam (FZ), and from to 0-5% is captured at the lower basin area where the Laguna is located (CNA 2014, 9-10; see also Descroix and Nouvelot 1997, 35).

Sharing the “same fate as its big sister, the Nazas River”, the Aguanaval River recently introduced a storage and regulatory dam in the neighboring state of Zacatecas in 2007 (Wolfe 2017, 228). The most significant source of surface water in the region comes from the Nazas River, which has a total dam storage capacity of 3182.2 hm^3, compared to the

144.9 hm³ from the Aguanaval River south of the Laguna (CNA 2014, 13).

Irrigation: District 17

One of the first pozos [wells] in the region of La Laguna, 1922; photograph from *Archivo Historico de la Universidad Iberoamericana.* (Salas-Q 2011, 169).

The Laguna forms part of the Irrigation District 017, a subdivision within the RH36, which encompasses the Nazas River and its LC-FZ dams, canals, and pozos [wells] (CNA 2018, 8-9). Total water usage in the Laguna in 2018 accounted for 1988.5 hm³, of which 1783.9 hm³ were distributed for agricultural production, 126.4 hm³ for domestic use, and the remaining 78.2 hm³ for industrial and other uses (CNA 2018, 30-33). Most of the water in the Laguna is sourced from the aquifers, as 54.8% of the total is drilled from the underground, and the remaining 45.2% is directly obtained from the Nazas River canal system (CNA 2018, 30). The LC Dam has an annual average water catchment of 1,000 hm³, which is then diverted into the FZ Dam to store and distribute to the Laguna (González, Descroix, and Sánchez 2010, 145).

To support the production of the more than 179,00 of hectares in the region, the CNA implements and oversees its Irrigation Calendar Plan, inclusive of its two seasonal irrigation schedules. The first schedule, Spring-Summer, is the most water-intensive one, as it features two auxiliary irrigation cycles that run for a total of 16 weeks (Solis 2020). The first cycle, called pre-siembra [pre-seeding], runs the entirety of April, while the second one runs from the last week of April through to the last week of July, delivering an average of 830 hm³ through the Nazas River canal systems to irrigate over 102,000 hectares, or 57.5% of the total annual production (Solis 2020). The second schedule corresponds to the Fall-Winter season; however, only 11.8% of the

annual crops are watered during this period. The remaining 30.7% are perennial crops, which receive irrigation from groundwater sources (Canedo 2020; see also Solis 2020).

A lush green field of alfalfa growing on the road towards the Desierto de Mayran zone. (Photograph by author, 2021).

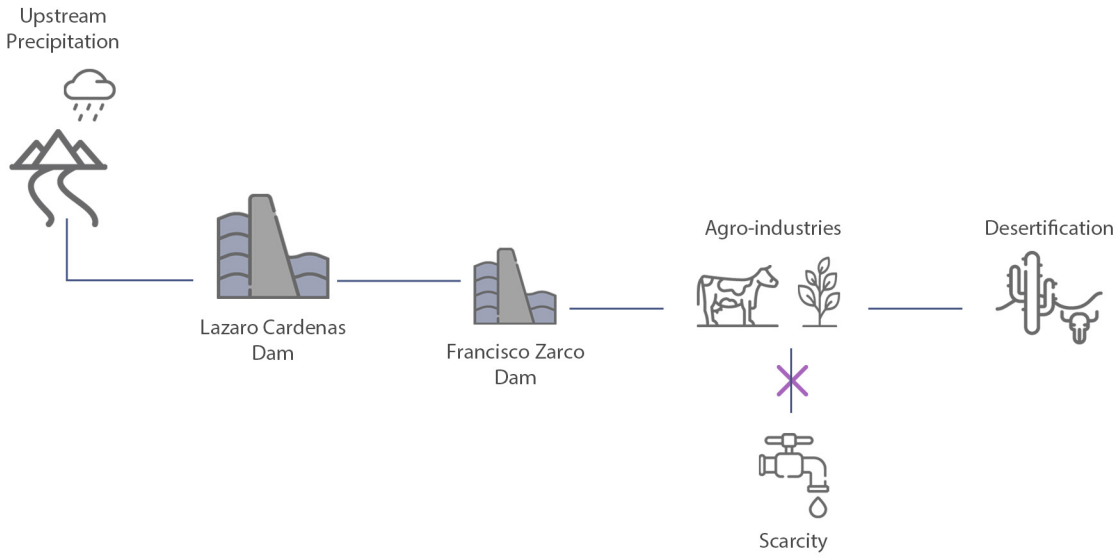
Ecosystem Disruption: Milking the Nazas River and Aquifers

The dairy agro-businesses have progressively eclipsed the rural landscape of the Laguna, as the introduction of the bovine industry now dominates the countryside. Since the 1950s, dairy production has increased exponentially: from a daily production of 33,000 liters of milk per day with a count of 4,000 cows in 1948 to an estimate of 7 million liters per day and 450,000 cows in 2019 (CNA 2014, 13; see also Salas-Q 2011, 158). The main dairy company in Mexico and the Laguna, LALA Group, holds 60% of the national market, and currently farms around 35,000 hectares of alfalfa, one of the most water-intensive crops, requiring around 61,200 liters a day for a single hectare (Canedo 2020; see also Salas-Q 2011, 155). Furthermore, it is estimated that 75% of all crops in the region are destined towards the dairy agro-industry (Salas-Q 2011, 98, 157).

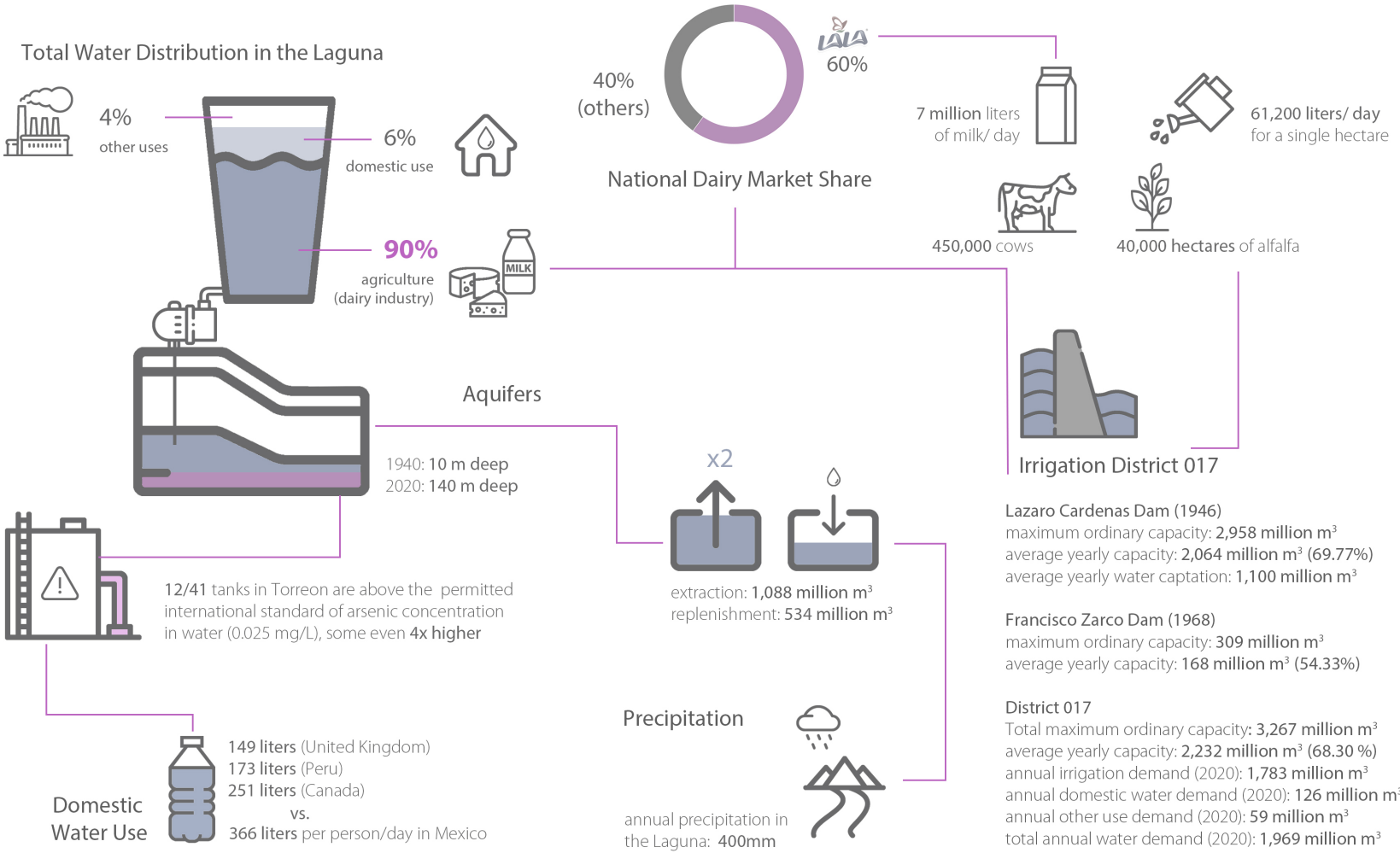
Water distribution in the region is far from equitable, as 89.7% of the total volume is destined towards agricultural production and a measly 6.3% is left for domestic use (CNA 2018, 30-33). Access to clean water, a fundamental basic human right, has been increasingly jeopardized in the Laguna by the agro-businesses, who privatize, trade and commodify a natural resource that should be accessible to everyone (Salas-Q 2020; UN 2010, 1; see also Appendix I). Increased demand for water from the agro-industrial sector has led to over-exploitation of the region's main groundwater source, the Principal Aquifer, which is being

exploited at more than twice the rate it is being replenished, as 1,088.5 hm³ are extracted annually, while only 534.1 hm³ seep back into the ground (CNA 2018, 30). Such demands lead every year to deeper drilling of the wells, some reaching 140 meters deep, compared to the 10 meters that were drilled back in 1940 (Salas-Q 2011, 175). Reaching such depths increases the risk of mineral contamination in the water, which is the case of wells and storage tanks in the metropolitan area of the Laguna. Of active wells, 33.7% (27/80) exceed the permitted levels of arsenic concentration in the water (0.025 mg/L), and from active storage tanks, 29.3% (12/41) surpass such norm, some exceeding more than four times the delineated standard (SIMAS 2019, 7).

The agro-industrial private sector from the Laguna has gained such influence within the national political spheres, that a former high-profile executive from the dairy giant, LALA, was appointed Director of all CNA operations in Mexico in 2006 (Wolfe 2017, 228). Water has become an aristocratic resource in a region where government institutions (like the CNA) have granted the agro-industrial sector a staggering



Water distribution is destined mostly towards agricultural production, which has resulted in desertification and lack of clean water accessibility in the Laguna.

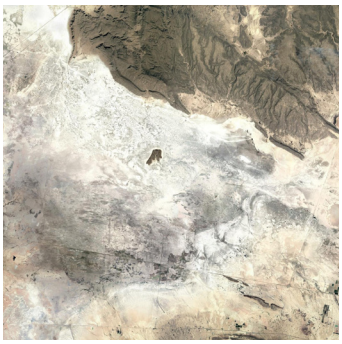


Several water distribution statistics that show the complex panorama of the region's water sustainability. (Data from Canedo 2020; CNA 2014; CNA 2018; Salas-Q 2011; SIMAS 2018; Valdelamar 2017; and Wolfe 2017).

84.8% of the total district's surface water and groundwater as concessions for extraction and private distribution, while granting only 8.1% for urban and domestic use (CNA 2014, 26). While the dairy industry and its subsidiaries continue to relentlessly milk the Laguna's water resources, a new paradigm needs to be introduced to address the ecological damage caused to the depleted region's aquifers and the today Desiertos de Mayran, Viesca, and Tlahualilo, as well as to avert further ecosystem disruptions (Wolfe 2020; see also Appendix I).

Agricultural crops north of the Laguna region. (Google Maps 2020).

Lush green fields of alfalfa at the outskirts of Torreon, featuring a cow farm in the background. (Photograph by author, 2021).



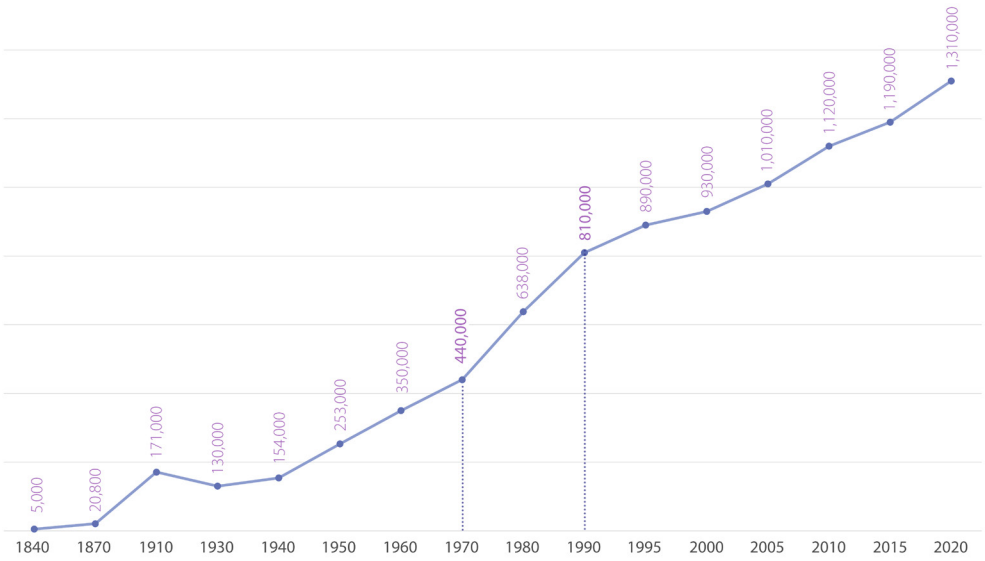
Satellite image of the extinct Laguna de Mayran. (Google Maps 2020).

Desertification of the extinct Laguna de Mayran; the aridness standing in stark contrast with the lushness of the agricultural crops. (Meza-F 2020a).

The Ongoing Water Scarcity

To contextualize the current alarming water issue in the Laguna through a global lens, the World Resources Institute has identified Mexico as one of the countries with highest water stress in the world, as it currently ranks 24th with a high 3.86 risk index, just below countries like Chile, Yemen, and Morocco (Willem-H, Reig, and Schleifer 2019). Water availability in Mexico has been distressingly decreasing over the last century; from an annual 31,000 m³/ inhabitant of available water in 1920 to 4,500 m³/ inhabitant by 2005 – compared to Canada's 91,600 m³/ inhabitant in 2005 (Carabias and Landa 2005, 17).

To further stress the demand of the already scarce water supply, there has been an exponential population growth in the Laguna over the last 50 years, as evidenced by the doubling of inhabitants from 1970 to 1990 (from 440,00 to 810,000 people) (Salas-Q 2011, 159). The last estimate from 2020 accounted around 1,380,000 people in the region, a 58.6% increase in 25 years (IMPLAN 2020).



Population growth in the Laguna since 1840. (Data from Salas-Q 2011 and IMPLAN 2020).

The average inhabitant of the Laguna consumes 350 liters/ day for personal use, which is 200 liters per day above the national average (Salas-Q 2011, 154). The increasing water allocation towards the agro-industries, coupled with its inefficient use has led to numerous protests in different areas of the region over the years, to the point in which organized demonstrations have blocked off streets to get the attention of the government (Iturriaga 2020; see also González 2021).

Drone image from the today Desierto de Mayran; a barren landscape that extends for kilometres. (Meza-F 2020b).

Chapter 3: A Region's Collective Memory

Traditional Water Collection Techniques

Historically, regions adjacent to the Nazas River, and in general in northern Mexico, implemented water storage collection systems to maximize water availability. In the Laguna, the cotton industry was the driving force for the construction of such systems in the mid-19th century, motivated by the prospect of increased production to their fields (Salas-Q 2011, 122). Most of the water was diverted from the main source, the Nazas River, through an extensive system of canals to then be collected in small dams and reservoirs. Most of the first attempts at these systems were successful in increasing production; yet, were inefficient due to their rudimentary nature (Castañón 2006, 14-17). One of these first primitive gated dams was that of El Carrizal in 1851 (previously mentioned), which was first erected with stone and gravel and destroyed within a year by a river surge. The gated dam was reconstructed with stone and limestone in 1853 to endure the weathering conditions of

Building of the canal system as part of the water infrastructure network by the turn of the 20th century, 1909; photograph from *Archivo Histórico Municipal de Torreón 'Eduardo Guerra'*. (Salas-Q 2011, 56).

the Nazas River and re-baptized to El Coyote Dam (Guerra 2006, 37-38).

Efforts to modernize the water systems were mostly privately driven, as the hacienda owners looked for efficient ways to draw water into their fields. Towards the end of the 19th century, a network of privately-owned canals was concluded with the construction of the concrete-lined Canal de Sacramento, which to this day stands as the region's main derivation canal (Salas-Q 2011, 125). Water management modernization continued through the beginning of the 20th century with the dawn of the Industrial Revolution and the enhanced railway systems. By 1932, there were a total of 12 small dams and reservoirs and more than 800 kilometres of canals stemming from the Nazas River (Salas-Q 2011, 125; see also Castañón 2006, 21).

Canal de Sacramento during its dry season (non-irrigation cycle), (Photograph by author, 2021).

However, the most significant (and disruptive) water technology implemented in the region around the 1920s was the introduction of pozos [wells] equipped with electrified or motorized pumps. The introduction of such systems would

allow hacienda owners and ranchers to draw water from the underground throughout the year (Castañón 2006, 21-23).

Photograph of the Francisco Zarco Dam's gates that control the Nazas River. (Yomontaño-W-S 2008).

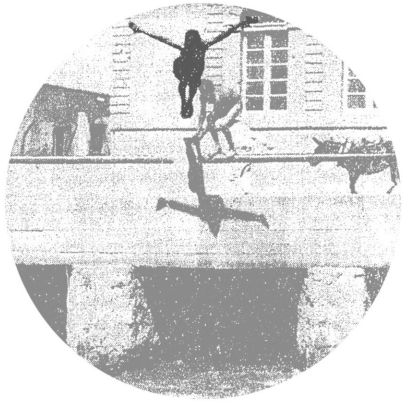
The introduction of the motorized pozos in the region allowed agricultural production to flourish beyond the Nazas River; therefore, increasing the potential for a new industry in the Laguna – that of cattle raising, a practice foreign to a semi-desertic region like the Laguna (Salas-Q 2011, 155). The rise in this new agro-industry brought a shift in the agricultural production in the Laguna, as more forage started being grown and cotton decreased in its production (Salas-Q 2011, 97-98). As mentioned before, the introduction of such a water-intensive crop like alfalfa increased the challenge for the growing agro-industry, which mounted pressure on the government to meet the demands of the private sector to irrigate their fields. The response from the Mexican federal government was to build the LC Dam in 1946 and its subsequent sister, the FZ Dam in 1968 to further continue the institutional technocratic mindset trend of conquering nature (i.e., the Nazas River) (Wolfe 2020; see also Appendix I). Nevertheless, it was the culmination of these two mega-infrastructure projects and the increase in groundwater drilling that radically shifted the scale of the local hydrographic system to the point in which it has become ecologically unsustainable and harmful to the lives of the people in the region (Salas-Q 2020; see also Appendix I).

Stranding the Social Life of the River

The Laguna was born from the vitality of the Nazas; a river that carried life and sustenance to an otherwise arid region. Yet, the advent of the industrialization movement in Mexico in the 1940s brought the introduction of intrusive infrastructure

1 - bathing

2 - canoeing



3 - taking a splash

4 - cooling off

5 - crossing

6 - gathering

7 - commercializing

8 - celebrating

The Nazas River fostering the sense of a collective identity by inviting people to experience water in their everyday urban landscape. (Photographs, in order, from Hernández 2016, 55; Dr. Samuel Banda Blogspot 1916; Dr. Samuel Banda Blogspot n.d.a., a; Dr. Samuel Banda Blogspot n.d.a., b; Salas-Q 2011, 142; Salas-Q 2011, 107; Salas-Q 2011, 70; Salas-Q 2011, 111).

that ultimately deprived the Laguneros of a social aspect of their everyday urban landscape (Salas-Q 2020; see also Appendix I). The bustling flow of the river that once crossed the cities of Torreon, Gomez Palacio, and Lerdo abruptly fell silent in 1968.

Since then, the gates of the Zarco Dam have been opened five times, allowing the Nazas River to reclaim its natural pathway. This event is a consequence of vast amounts of precipitation in the high basin area of the hydrological region, which lead to the system of dams reaching their storage capacity and releasing the excess water into the dry riverbed. The first time this happened was in September 1968, lasting for a period of three months. More than two decades later, in August of 1991, the gates opened again, allowing the water to flow for six months. The event has become more frequent over recent years, as the Nazas River has been revived in 2008, 2010, and 2016. These last three times, the water remained in the riverbed for an average of two months (El Siglo de Torreon 2017).

Before the introduction of the Zarco Dam, the Nazas River acted as host to the Laguneros' social gatherings; it was the main protagonist of the urban landscape in the region (Salas-Q 2020; see also Appendix I). The lushness that the river provided, in antithesis to the aridness that dominates the landscape, invited the people to gather by the riverside and enjoy the sound of the water (Hernández and López 2016, 54-55). The Nazas River fostered a sense of "collective identity" among the Laguneros, while functioning as the region's "scene of a cultural landscape" (Salas-Q 2011, 11). Beside hosting recreational and social activities, the Nazas River also presented the opportunity of small commercial activities, as people would gather by the riverfronts. Today,

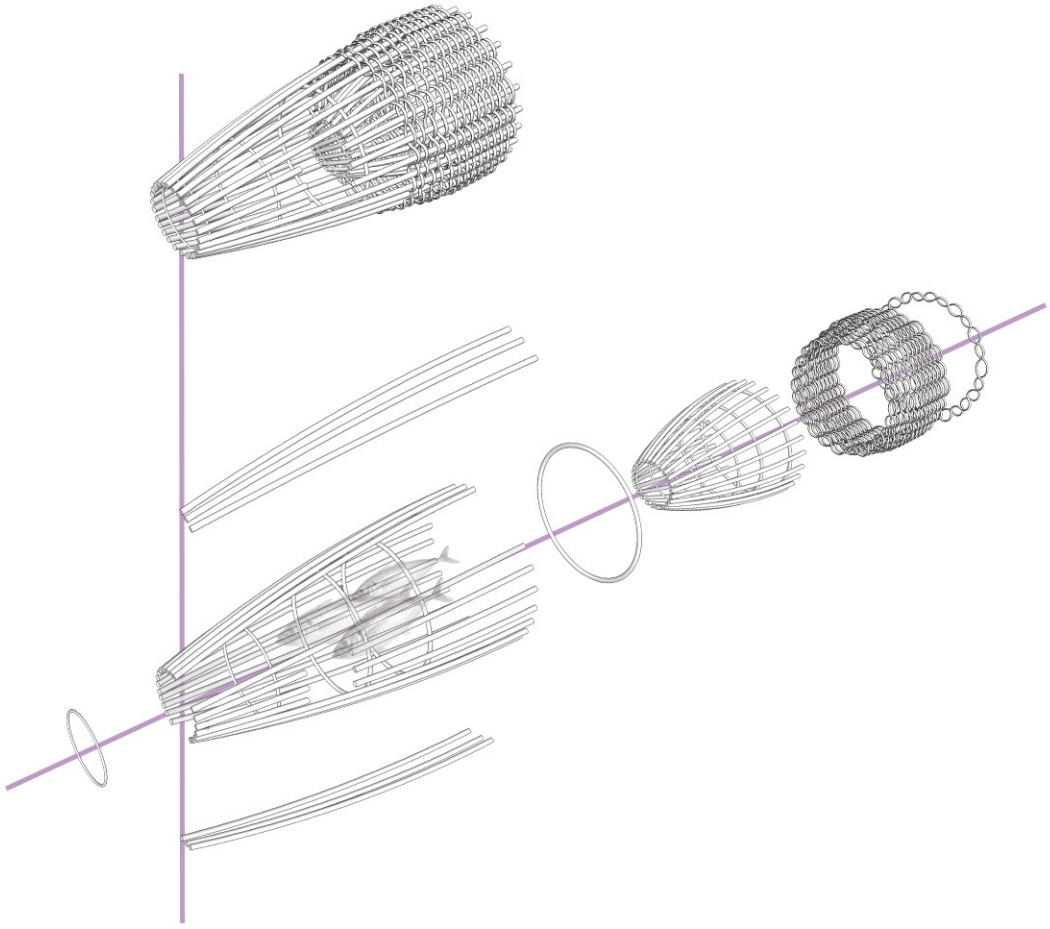
Photo montage showing the arid and wet conditions of the Nazas River during its flooding season and its current empty riverbed. (Images of Nazas River during flooding season from Yomontaño-W-S 2010a).

the Nazas River is nothing but a “social memory” of its urban landscape. A public identity that was once intimately linked to water is now one of nostalgia and scarcity (Hayden 1995, 9; Salas-Q 2020; see also Appendix I).

Art piece imagining the irritila tribes and their fishing traditions of the nasa baskets, 1985; portion of mural by Alberto Ruiz Vela. (Maeda 1985, 1).

The ‘Nasas’, a Fishing Tradition

The Nazas takes its name from an old fishing tradition, born from the same riverbanks where the irritila nomadic tribes found their sustenance and means of inhabitation (Salas-Q 2011, 12). The first known people to the region used a bait system which featured the use of the ‘nasas’, hand-crafted woven baskets thrown into the riverbanks, to lure the fish inside the device and capture it, holding up to three



The ‘nasa’, hand-crafted woven basket used for fishing by the locals at the Nazas River. (Graphic inspired by Revista Nomádica de Torreon 2012).

Replica of a nasa at the Lazaro Cardenas Dam Visitor Centre. (Yomontaño-W-S 2015).

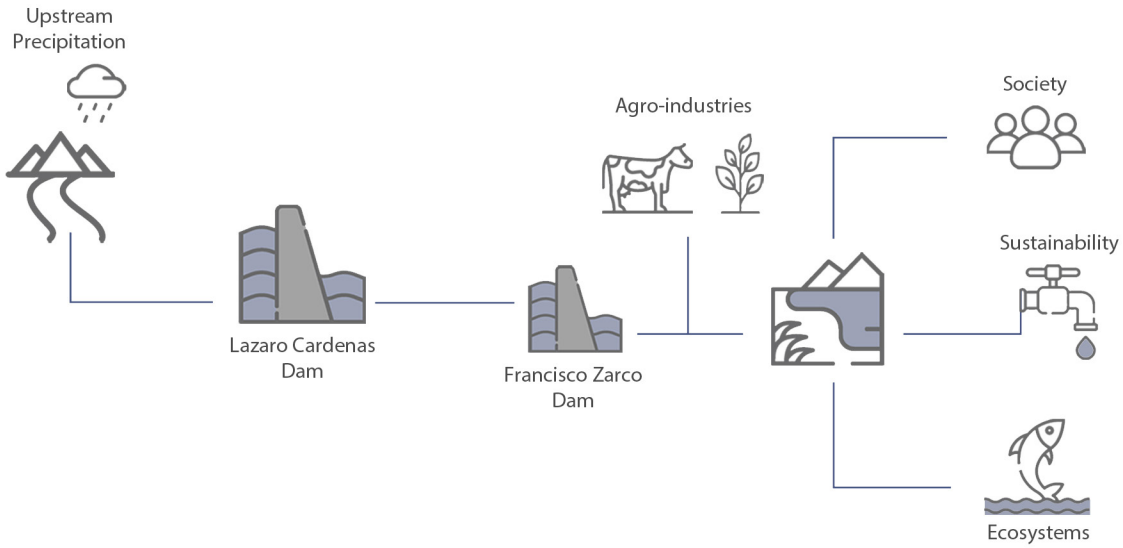
kilograms per try (Revista Nomádica de Torreon 2012). The Spanish explorers in the late 16th century noticed the ingenious fishing devices, which are still used to this day by the locals in some upstream areas of the river, and baptized it the ‘river of the nasas’ (Salas-Q 2011, 36). In homage to the collective memory tradition of the river and analogous to the weaving of the nasas, this thesis project aims to reweave the fragmented strands of the Laguna’s urban fabric to achieve ecological recovery and re-establish the symbiotic relation of the people and its water.

Chapter 4: Reweaving the Urban Fabric

Design Methodology: Nazas River, Threading the Landscape

In 2005, Danish architect Jan Gehl joined the Harbourscape Aalborg 2005, a design participatory workshop for the master-planning of the northern region of Denmark. The workshop focused on how to further link the cities of Aalborg and Nørresundby. Gehl and his team came up with a proposal to employ the Limfjord, the cities' linking body of water, as the metaphorical spine that would unify their waterfronts. By applying a pattern of 'reverse thinking', Gehl projected to generate space development by considering urban life first, followed by the rhythms of the region's urban spaces and the Limfjord's edges (Gehl and Gemzøe 2000).

Using Gehl's methodology as a guideline, this thesis focuses on the Nazas River as the metaphorical 'thread' that will interweave the urban landscape of the Laguna to restore the region's "historical identity and pride" and revitalize its



Following Jan Gehl's 'reverse thinking', this diagram reimagines the redistribution of water towards the ecosystems and the people first.

ecosystems (Smith and Garcia 2012, 123). Through the integration of spaces for the development of knowledge on water efficiency, this thesis aims to bring back a memory of the urban life of the Laguna by fostering education, collaboration, and social interaction. The project envisions a centre that helps raise awareness on water sustainability, as well as a space that invites people to interact with its riverine heritage within the urban areas of Torreon, Gomez Palacio, and Lerdo. With an increased awareness of water efficiency and a richer knowledge of its usage, this thesis envisions a hopeful future where the Nazas River regains its protagonist role within its hydrological region and reverses the desertification of its extinct lagoon system and urban landscape.

Social Thread

The nostalgic memory of a landscape vitalized by water is one that this project aims to address through the reintegration of a resource that has been stored and kept far away from the Laguneros. Going back to Hayden, even the storytelling of mundane urban artifacts that may not be obvious, like that of an abandoned canal, could evoke the collective memory of a region transformed by water (Hayden 1995, 227).

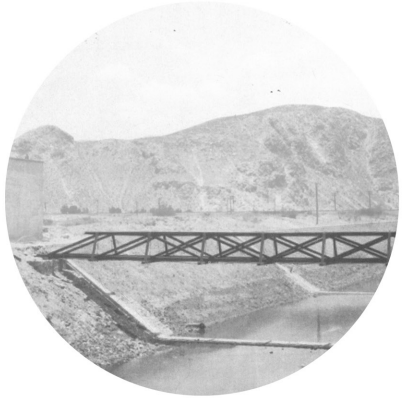
One of the main targets for this thesis project is to achieve accessible clean water for domestic use, so the architectural intervention should also reflect this ideal of water democratization, in the sense that the architecture should be able to reveal public accessibility and openness (Breen and Rigby 1994, 24). At the scale of the building and its community, the water educational centre will feature accessible spaces that invite the people to meander through the building, while interacting with the water and the dry

1 - *El Coyote* Gates

Traditional Systems

2 - hacienda *pozo* [well]

3 - Canal de Sacramento excavation



4 - Canal de Sacramento

5 - San Fernando derivation dam

Contemporary Systems

6 - *pozo* & pump

7 - storage tank

8 - concrete-lined Canal de Sacramento

Traditional and contemporary water collection systems used in the urban region of the Laguna, ranging from derivation dams to *pozos*, and an extensive canal system. (Photographs, in order, from Salas-Q 2011, 125, Salas-Q 2011, 169; Dr. Samuel Banda Blogspot 1923; Salas-Q 2011, 124; and photographs 5-8 by author, 2021).

riverbed, as well as re-inspiring the regional historical notions of the fishing traditions, the water collection systems, and the traditional building systems of the Laguna.

Ecologic Thread

As Jan Gehl concluded from his participation at the aforementioned Harbourscape Aalborg 2005 workshop, “life needed to be in focus from the beginning of the [design] process” (Smith and Garcia 2012, 123). Through Gehl’s lenses, this project places water in focus as the short, middle, and long-term solution to the heightening hydrological stress problem in the Laguna. The ecological thread of this thesis projects a process of water storage and distribution set to service the building’s needs in order to become sustainable, while also acting as an educational instrument and a catalyst for social interaction.

Long have institutions and the private sector promoted short-sighted development policies that have caused long-term detrimental consequences (McHarg 1992, 55-56). Governments cannot continue to make decisions without assessing environmental impacts. Man, and nature become one and the same; natural landscapes should be able to coalesce with people, as this relation is symbiotic (McHarg 1992, 197). The technocratic mindset humans have towards “domesticating” nature needs to be transformed (Salas-Q 2011, 122; Wolfe 2020; see also Appendix I). Hence, designing with the urban landscape and its continued sustainability takes paramount importance in the restoration of the Nazas River and its lagoons, as well as the replenishing of its depleted aquifers.

Water Recycling

One of the most successful water efficiency practices in the Laguna is that of residual treatment processes. The region hosts fourteen water treatment plants that are able to process up to 83% of the 95 million m³ of grey and black water every year. Most of the water that is recycled from these systems is reused and destined primarily for irrigation of green areas throughout the region. Several industrial parks like those of Peñoles Industry (metallurgic) and Modelo Group (brewery) have also incorporated in-house treatment plants to maximize their water efficiency and reduce their waste (Cuellar 2014; see also, IMPLAN 2018). This thesis projects explores the use of water recycling as a method to achieve water efficiency and supply the building's needs.

Image of treated water being reused in a fountain and green areas in Torreon. (Photograph by author, 2021).

Economic Thread

This thesis examines the economic thread of the region in relation to water sustainability. The introduction of a foreign, water-intensive practice into a semi-desertic region altered the balance in the hydrological system in the region; however, there might be alternatives that are able to integrate water sustainability into the current agro-

industrial practices. Perhaps one of those is the introduction of eco-efficient systems such as drip irrigation. This modern system has recorded a decrease in water usage of 13-27% in alfalfa crops in the southern United States, as well as creating a 20 to 35% increase in production (Ismail and Almarshadi 2013, 64; see also Aronson 2008, 117-120; Montazar et al. 2017, 1). Through infrastructure and architectural interventions in the Laguna, the introduction of new water systems will serve as an investment towards the region's sustainable future. The improvement in water quality will help reduce costs associated with water clean-up and treatments, while revitalization of waterfronts provides new economic opportunities for services, businesses, commerce, and housing. The introduction of green spaces and outdoor amenities promote ecotourism activities, which brings a potential influx of income towards the region. With such interventions, federal and state governments become more engaged and likely to invest towards the management and conservation of urban developments (Otto et al. 2004, 97-116).

Drip irrigation system used in the desertic region of Baja California, Mexico. (Virgen 2015).

Another potential angle to look within the scope of the Laguna's economic future, which translates to the livelihood

of the Laguneros' everyday life, is shifting to less water-intensive practices. There are other viable economic options to continue developing in a sustainably conscious way. The region is host to other substantial economic activities like commerce, services, and construction which account for roughly 26% of the total gross production from 2018 (CCI and Observatorio de La Laguna 2018, 6; see also CCI and Observatorio de La Laguna 2019). Some of the most profitable domestic companies in Mexico were born in the Laguna, three of them figuring in the top 50 of the "Top 500 Most Important Businesses in Mexico in 2020" (Soriana Organization, commerce; Modelo Group, brewery; Peñoles Industries; mining), while LALA Group figures 58th in the national rank (Patiño 2020).

Around 56.2% of all the water used in the region is destined for the dairy industry alone (CNA 2018, 30; González 2019). However, the dairy industry only accounted for 12.4% of the $ 351,982 million pesos produced in the Laguna in 2018,

Photograph of a cattle raising farm in the Laguna with the fields of alfalfa in the background,1972; photograph from *Archivo Histórico del Agua.* (Salas-Q 2011, 171).

while the booming manufacturing industry (basic metals, machinery, and transportation equipment) produced 47.0%, yet only consumed 0.9% of the total water in the region (CNA 2018, 30; González 2020; CCI and Observatorio de La Laguna 2018, 6; CCI and Observatorio de La Laguna 2019, 1; see also El Economista 2020).

As Dr. Wolfe pointed out, it is getting to the point in which the people from the Laguna should realize that an agro-industry like LALA should not be operating in the desert, unless they can find ways to innovate to reduce their water footprint in the region (Wolfe 2020; Padilla 2010, 294; see also Appendix I).

Urban site plan of the metropolitan zone of the Laguna, encompassed by the cities of Torreon, Gomez Palacio, and Lerdo, highlighting the San Fernando derivation dam. At this point the water from the Nazas River is diverted and channeled through the Canal de Sacramento during the irrigation cycles. (Data from Google Maps 2020).

1 - *El Coyote* Gates, the landmark entry point to the canal system in Torreon, built in 1852. (Photograph by author, 2021).

Chapter 5: Desert Waterscape

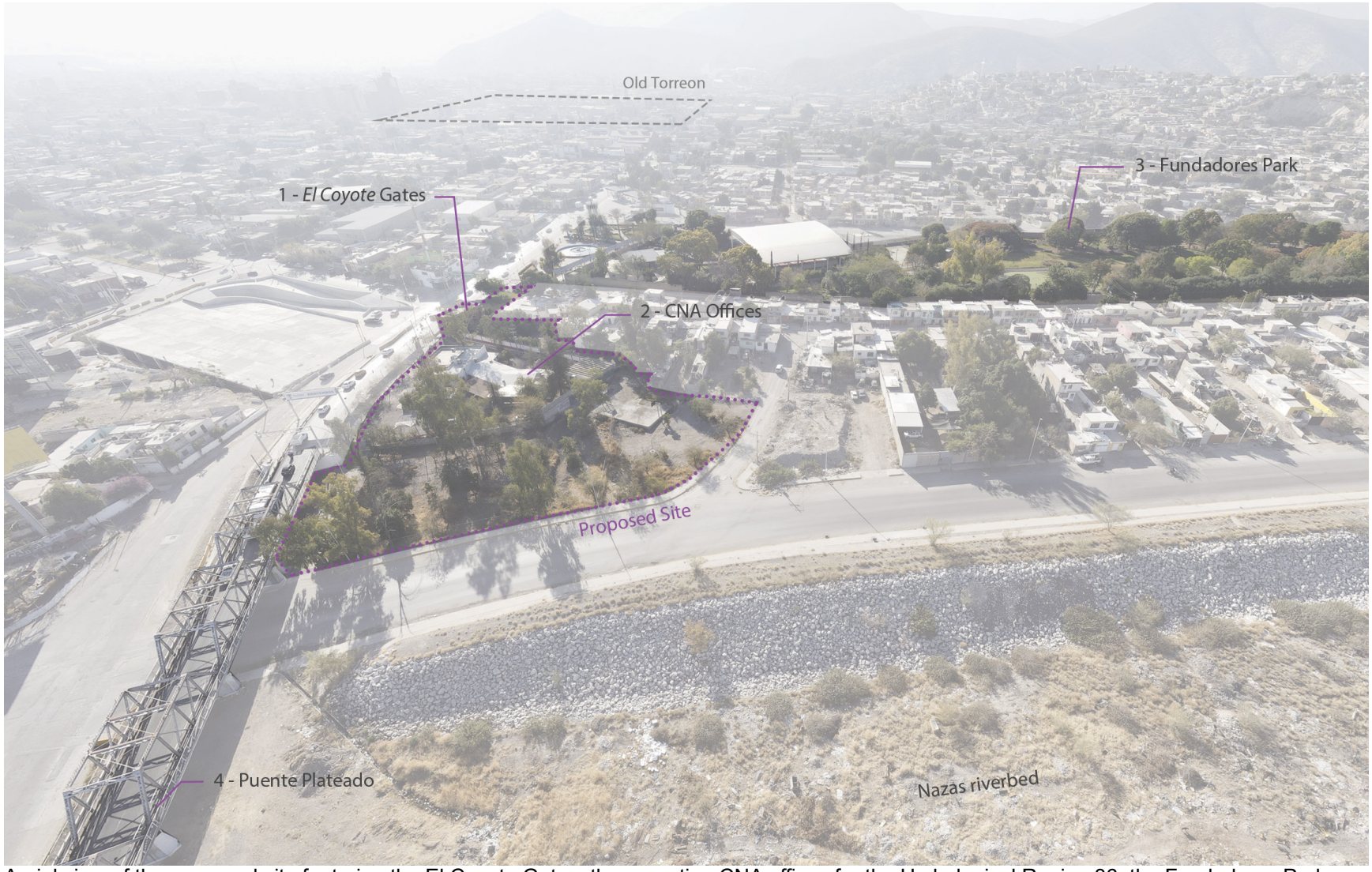
Proposed Site

The main architectural intervention of this thesis envisions the introduction of an educational centre that promotes water sustainability, while serving as a link between the people and their riverine heritage (Salas-Q 2020; see also Appendix I). The projected 'Centro Educativo del Agua', or 'Water Education Centre' (WEC), is set to be located by the 'Puente Plateado' [Silver Bridge], a historical linkage between the cities of Torreon and Gomez Palacio and the states of Coahuila and Durango. The proposed site features the historical landmark of the El Coyote Gates, the first gated dam and original entry point of the canal system into Torreon. The current operating offices of the CNA for the Hydrological Region (RH36) are also present at the proposed site, which presents the opportunity to further integrate the National Water Commission and a space for education and research. The site intends to function as the link between the adjacent Fundadores Park [Founders Park]

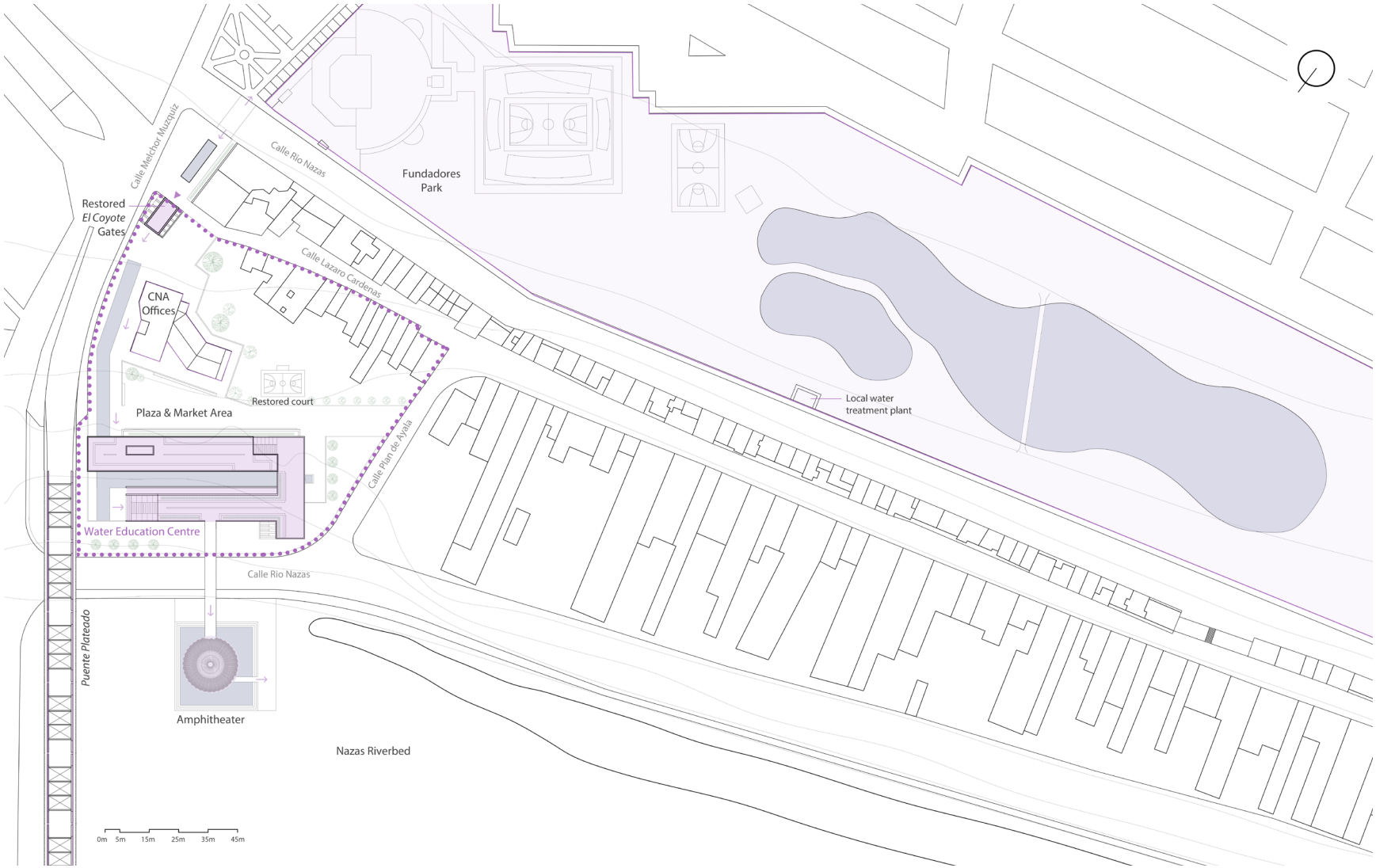
2 - Operating CNA offices for the Hydrological Region 36 (RH36). (Photograph by author, 2021).

3 - Use of recycled water at the neighboring Fundadores Park is a clear example of the success of treatment plants in the Laguna. (Photograph by author, 2021).

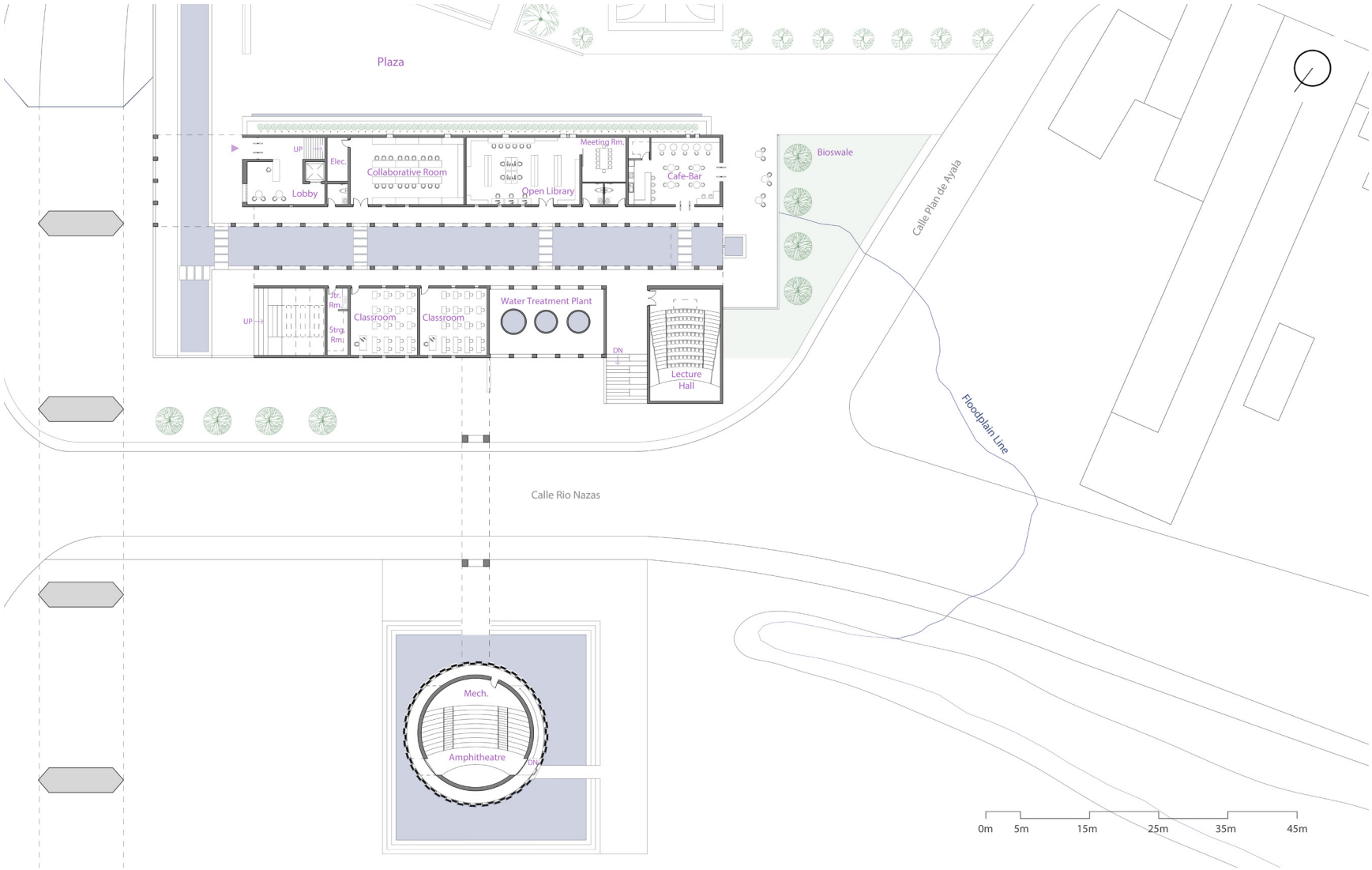
4 - The historical Puente Plateado [Silver Bridge] today, hovering over a dry riverbed. (Botello 2020).



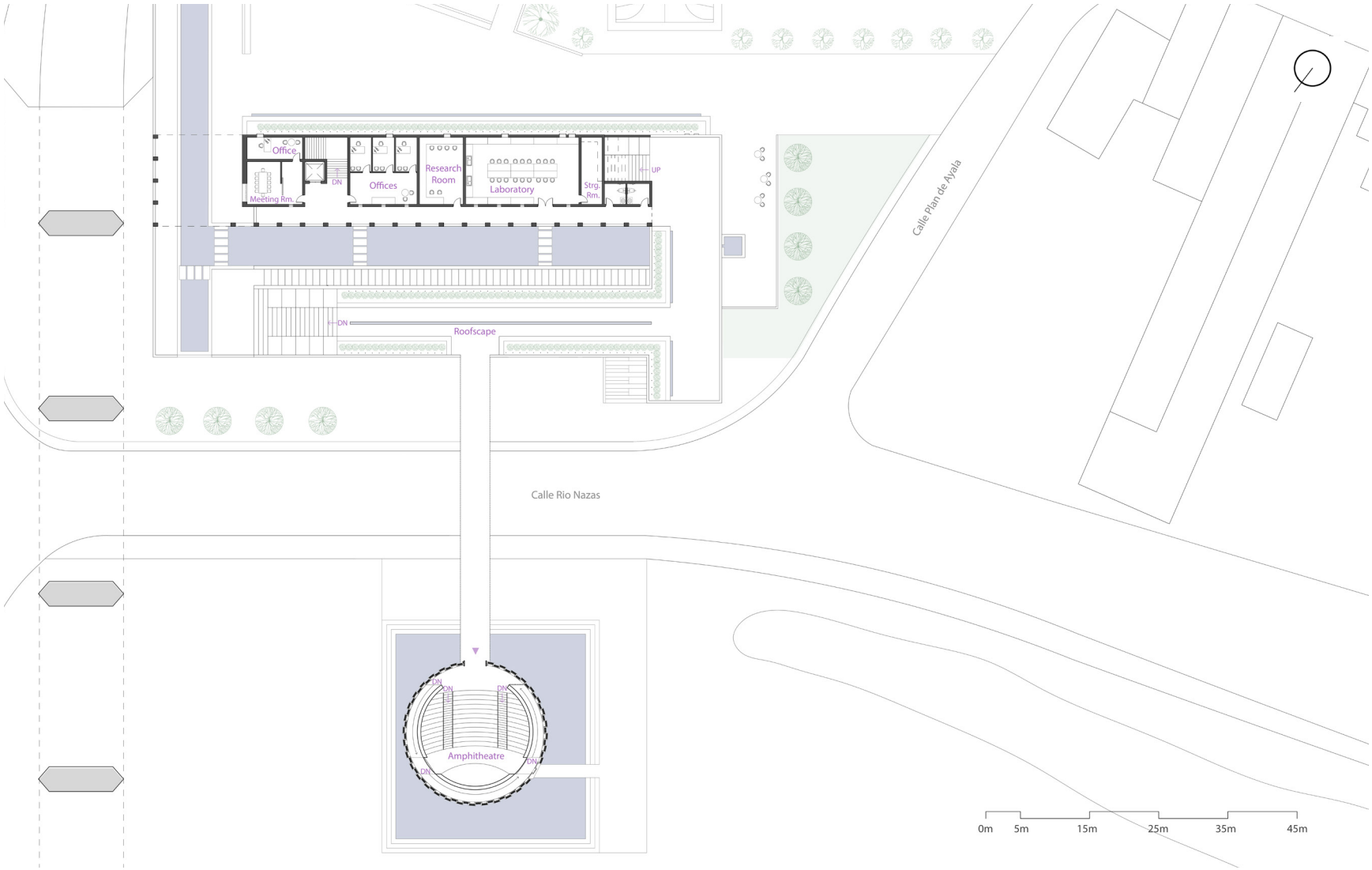
Aerial view of the proposed site featuring the El Coyote Gates, the operating CNA offices for the Hydrological Region 36, the Fundadores Park, and the landmark *Puente Plateado*. (Drone image by Yomontaño-Z 2021).



Site plan: the Water Education Centre and its site context.



Ground Floor Plan: educational facilities and social spaces all connected by the water mirror courtyard.



Second Floor Plan: research spaces and accessible roofscapes intend to bring the people together and invite them into the riverbed through the amphitheatre space.

and the Nazas riverbed. The park features six hectares of green areas and two small ponds that are supported by a local water treatment plant, making it a prime location for a sociocultural intervention. Additionally, the site currently lies within the river's floodplain, which presents the opportunity to engage with the landscape during its dry and wet seasons. Following Gehl's approach, the educational centre aims to allow "people, life, and vitality… to be the biggest attractions in the city" (Smith and Garcia 2012, 125).

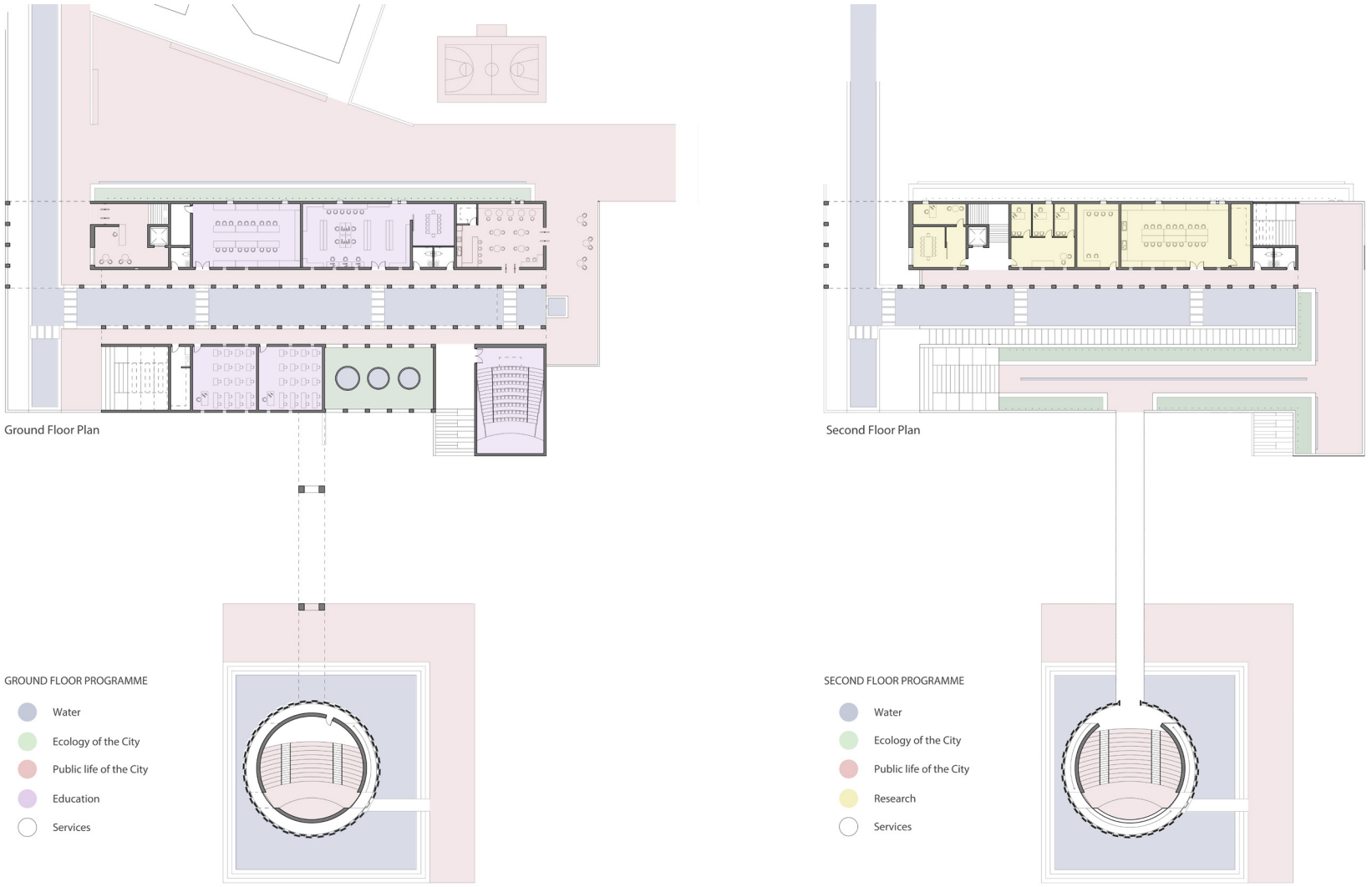
Water Education Centre

> Place memory encapsulates the human ability to connect with both the built and natural environments that are entwined in the cultural landscape. It is the key to the power of historic places to help citizens define their public pasts: places trigger memories for insiders, who have shared a common past, and at the same time often can represent shared pasts to outsiders who might be interested in knowing about them in the present. (Hayden 1995, 46).

The built and landscaped proposal from this thesis project aims to enhance the power of place, by reweaving the past, the present, and the future of the Laguna. It is then the Water Interpretation Centre's mission to serve as an agent of such experiences and a catalyst to community building in the Laguna.

Programme

Through multi-programming of the building's spaces, the WEC aims to interweave ecology, society, and economy to strengthen the urban fabric of the Laguna. The development is set to restore and adapt the abandoned El Coyote Gates (formerly the Museum of Revolution) to an interactive visitor centre that welcomes people and helps raise awareness on water sustainability from the moment you start your procession into the building. The gates are projected

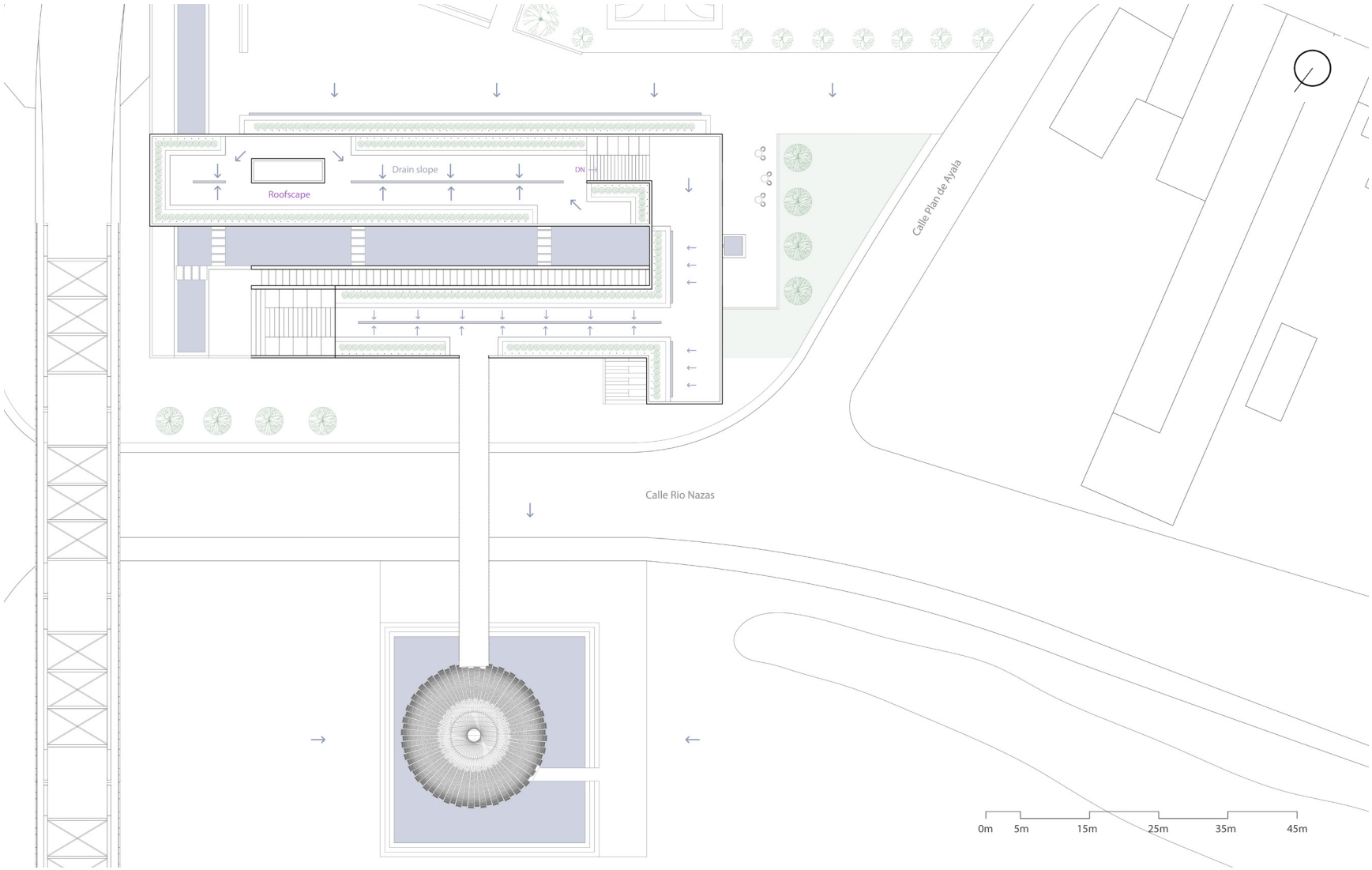


Programmatic floor plans, highlighting the water systems, as well as the ecologic, social, educational, and research spaces of the Water Education Centre.

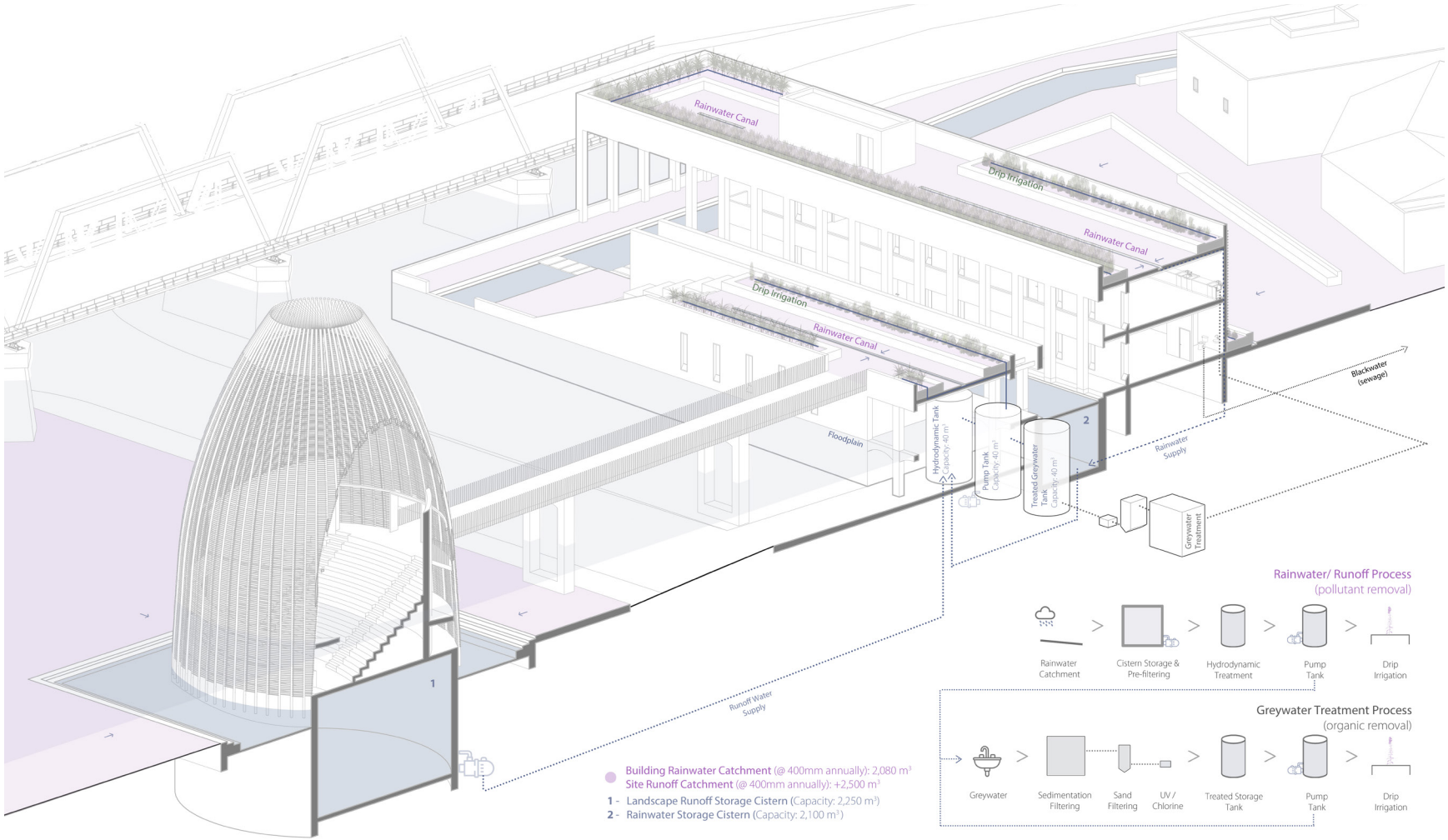
to act as the link between the Fundadores Park and the riverbed, inviting people to interact with their riverfront. A water mirror pathway will guide the people to walk beside the CNA offices and a small plaza area, welcoming them into the building. The centre aims to interweave the ecologic and public life of the city by integrating educational and research facilities. The spaces at the WEC are connected by a water mirror courtyard with the intent to recover the Laguneros' experience of water in their urban landscape (Salas-Q 2020; see also Appendix I). The educational facilities feature two classrooms, collaborative library spaces, meeting rooms, workshop spaces, and a lecture hall. The research centre on the second floor of the WEC includes a publicly accessible laboratory and research room open to investigators, scholars, industries, and the general public alike, as well as office spaces and a meeting room. To promote water sustainability in the city, the building incorporates the use of a local water treatment plant (similar to that of the Fundadores Park) to reuse the grey water and site's runoff, as well as displaying alternative irrigation methods through its accessible roofscapes. The courtyard, plaza area, café-bar, roofscapes, and the amphitheater by the riverbed intend to host the public of the life of the city, as the spaces foster social interactions and engagement with the site's surroundings.

Ecology of the City

To maximize the already scant available water, the Water Education Centre integrates several water collection techniques. The building aims to become self-sustaining by functioning as inhabitable water infrastructure. The WEC projects an in-house water treatment facility that can collect rainwater from the runoff landscape and its roofscapes



Roofscape Plan: roofscaped areas aim to invite people to interact with the drip irrigation as an alternative agricultural method for the Laguna, while providing the Laguneros with views of the riverbed and its surroundings (water collecting drainage highlighted).



Water Systems: isometric drawing depicting the water collection system from the site. A system of small canals and pools collect water from the building and landscape and store it in two *pozos*. The collected water is then pumped into an in-house treatment plant to undergo a hydrodynamic and organic processes. The treated water is then recirculated to supply the building's needs and to showcase the water mirror canal. (Data from Hilliges, Schriewer, and Helmreich 2013 and Lesikar et al. 2010).

during the dry season, as well as catching water from the Nazas River during its flooding season. The water collection system consists of two main pozos, or cisterns. The first one is located beneath the courtyard, collecting rainwater from the plaza and roofscapes through a system of small rainwater canals, and the other cistern is located beneath the amphitheater as it collects runoff water from the landscape.

The water collected in these cisterns is then pumped back into the in-house water treatment tanks in the building to be processed. Rainwater and landscape runoff water undergo a hydrodynamic process for pollutant removal (such as heavy metals), to then be recirculated to the building through a centralized pump tank (Hilliges, Schriewer, and Helmreich 2013). In a similar fashion, the WEC collects grey water from washroom and laboratory sinks for its reuse. The stored grey water from the building then undergoes a treatment process for organic removal through sedimentation, sand filtering, and chlorination. The treated grey water then passes through a storage tank, and then is recycled to the building through the centralized pump tank (Lesikar et al. 2010). The treated water from both these processes is then redirected back to the WEC to supply the building's water demand and to display drip irrigation as an alternative agricultural method for the region. To further showcase the ecology of the city, the water treatment tanks are left exposed and visible from the courtyard and riverbed to invite people to experience the water treatment process.

Public Life of the City

Just like the Nazas River acted as the host of social gatherings in the Laguna over half a century ago, the WEC taps into the collective memory of a lost urban landscape. The building

Entry vignette: view of the restored *El Coyote* Gates and a water mirror & small plaza to welcome people to learn more about the Nazas River and water usage.

Building entry vignette: view of the building entrance, featuring a small plaza and a green wall. The canal invites people towards the interior, as the guests enjoy a view of the riverbed, flanked by the *Puente Plateado*.

Courtyard vignette: view of the water mirror courtyard which invites people to gather and experience water. Glimpses of the vegetation from the roofscape hang towards the courtyard, creating an atmosphere of calm and tranquility.

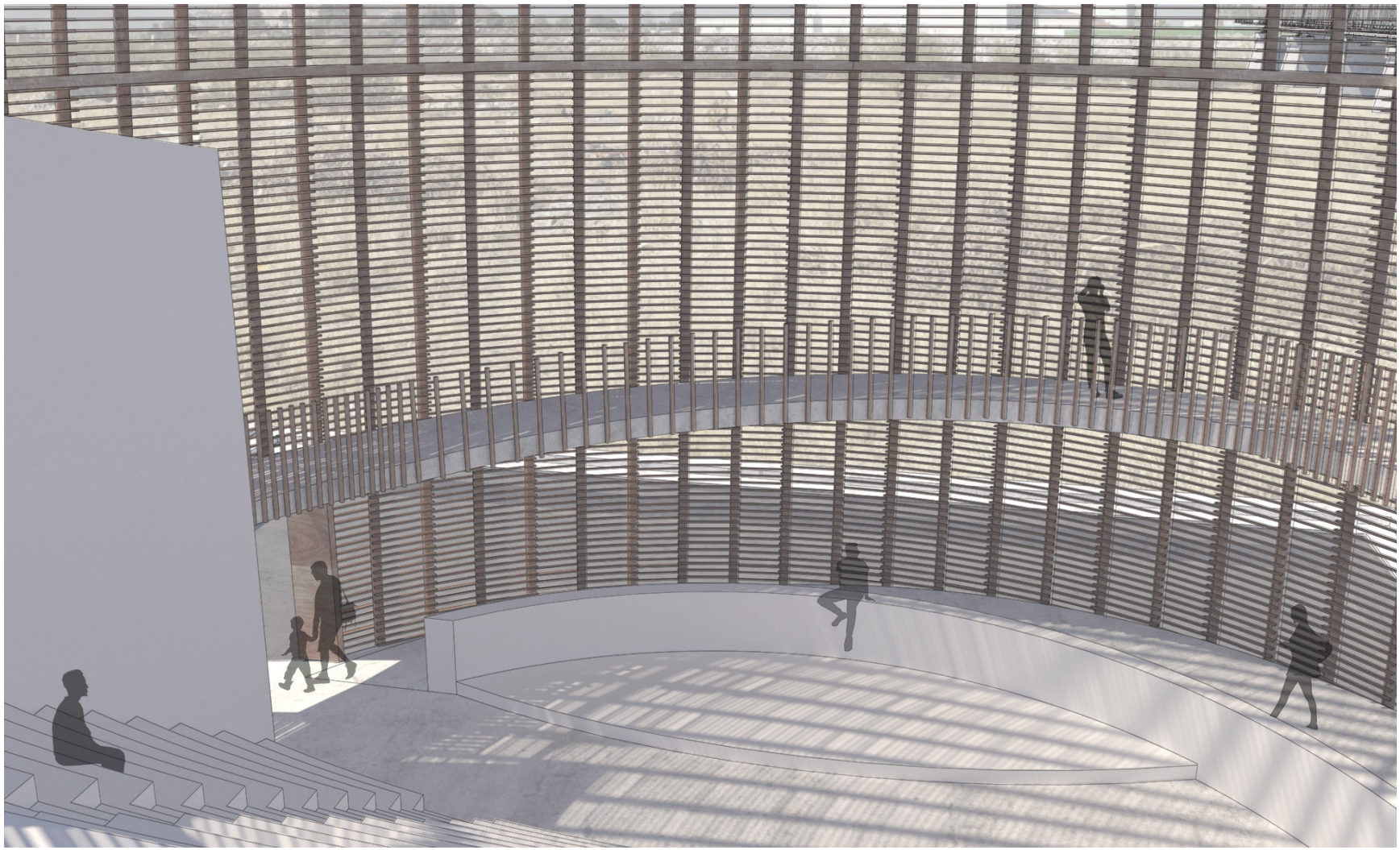
Classroom vignette: interior view of the classroom, a space which fosters community engagement and the spread of knowledge of water and its uses.

invites the Laguneros to learn more about their past and present, with the goal to be a driver for change towards a water sustainable future. By restoring the abandoned El Coyote Gates, the project aims to reopen the historic landmark and invite people to visit the educational facility. The restored gates function as a visitor centre, immersing the guests with the architecture of the nineteenth century, while displaying archival photographs of the Nazas River. The visitor is then guided by the water into the educational centre, as the water mirrors throughout the facility reference the history of the extensive canal systems in the region.

Passing through the operating CNA offices, the visitor is greeted by a lush green wall and a plaza area with planters and seating areas. Following the water mirror canal, a courtyard flanked by a colonnade welcomes people to engage with the water, while functioning as a shaded space to cool off from the heat. The educational facilities and café-bar on the ground floor invite people to learn about their riverine culture, while fostering a sense of community and social interaction. The center welcomes people to meander though its spaces any time of year, as its accessible roofscapes invite people to meander while experiencing different viewpoints of the site. The roofscapes feature planters that display the drip irrigation system with recycled water from the site, while also inviting people to sit and enjoy a view of the riverbed.

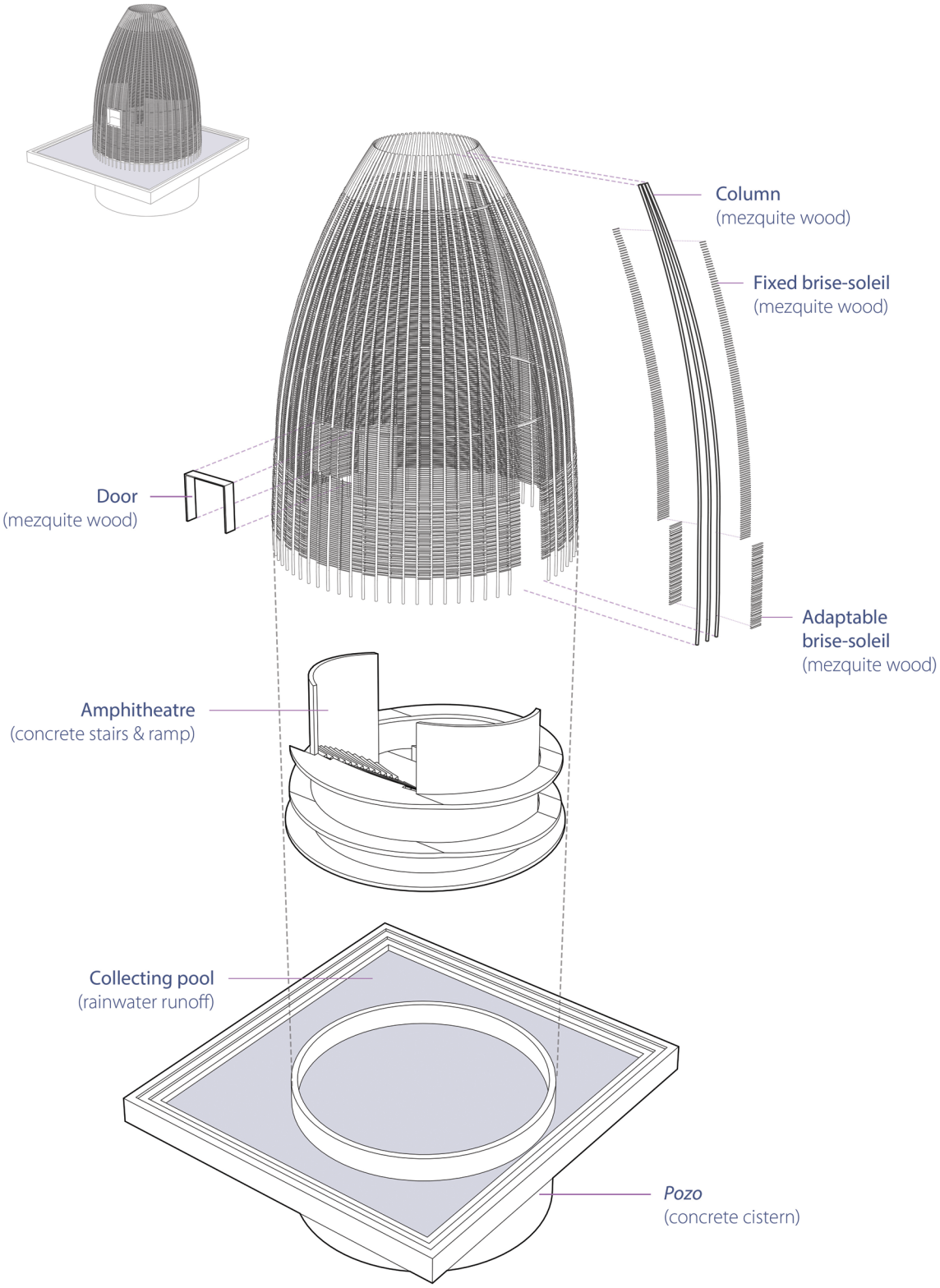
The open-air amphitheater by the riverbed further draws people to cross the bridge to engage with the river landscape. A structure, inspired by the nasa irritila tradition rises from the riverbed, hosts a seating area and stage, as well as a set of stairs and accessible ramps that take people into the riverbed during the dry season. Inside the amphitheater, the visitors get glimpses of the Silver Bridge and its surrounding

Roofscape vignette: view of the roofscape with the *Puente Plateado* on the background. The accessible roofscapes feature planting and seating areas that showcase drip irrigation as an alternate agricultural method. The roofscape invites people to meander and enjoy views of the Nazas River, while fostering social interaction.



Amphitheatre vignette: view of the open-air venue, with glimpses of the riverbed in the background and the water collection system underneath.

Riverbed vignette: view of the amphitheatre and the Water Education Centre from the riverbed.



Inspired in the structure of the *nasa*, the amphitheater functions as a space that collects rainwater, but also as a social area that invites people into the riverbed. The venue integrates the use of concrete and mezquite elements to withstand the dry and flooding seasons.

Traditional building method in concrete framing, infilled with adobe blocks and covered in cement parging.

Brick masonry is also a commonly used material in the Laguna.

Stone masonry and cement parging widely used for canal lining and foundations.

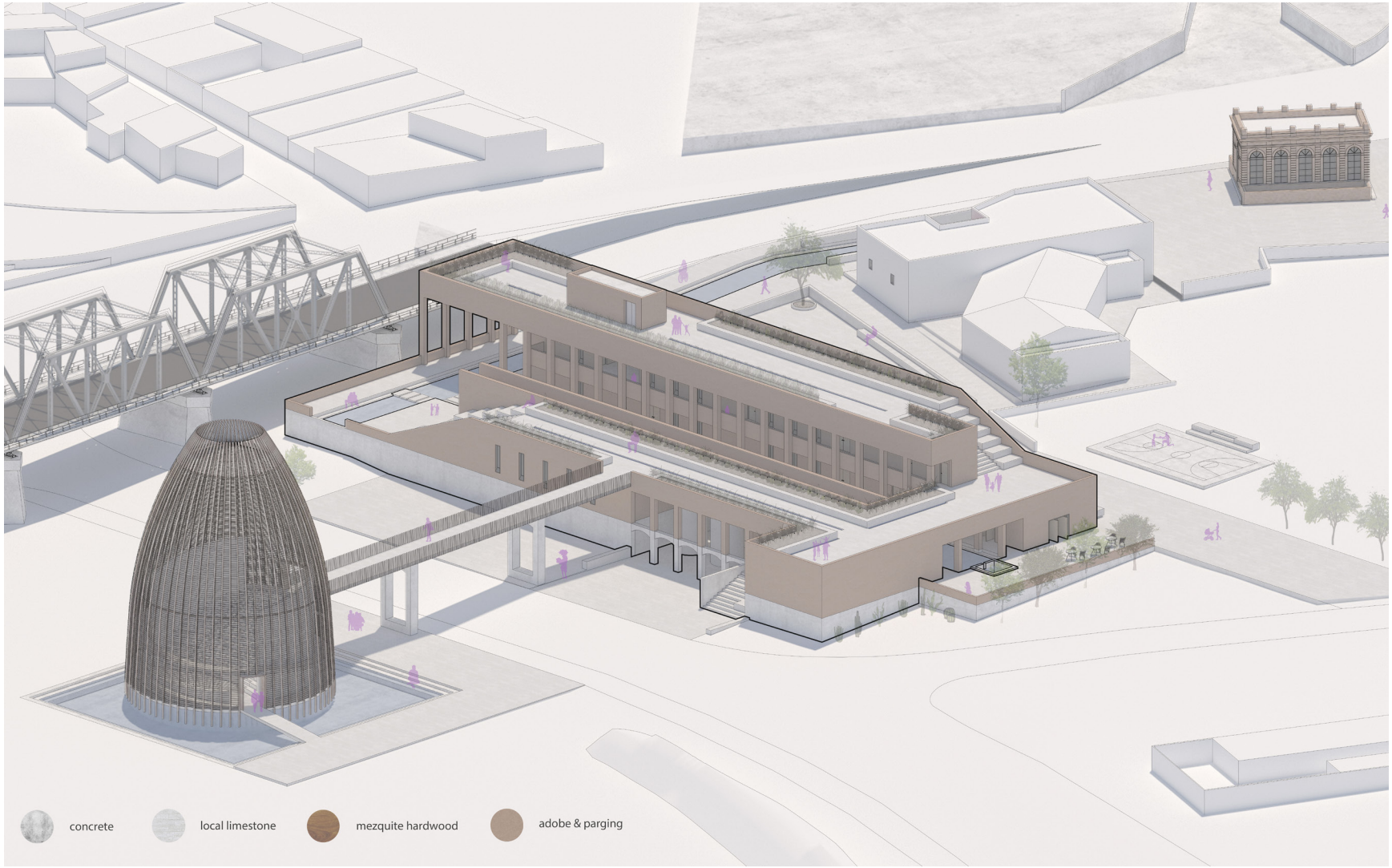
Concrete is now widely used for contemporary water collection systems.

landscape. A film of water surrounds the structure, contrasting the elements of the desert with that of water. To further protect the people from the heat, the structure's envelope is interwoven with mesquite wood elements that function as a brise-soleil. The upper brise-soleil is set to be fixed to block the sunrays, while the bottom elements are able to rotate and engage with the water fluctuations from the river during its flooding season.

To further emphasize the spirit of democratization and openness of the project, all spaces within the WEC are accessible and open to the public, fostering the spread of knowledge and community interaction. The site also envisions a space open for recreational and commercial activities, just like the Nazas once did. The open plaza by the entrance presents the opportunity for local vendor interaction, or perhaps a small farmer's market area. Similarly, the restored court beside the plaza area invites people to engage in recreational activities, such as a game of basketball or soccer in the spirit of community building.

Materiality

Inspired by the attention to harmony and place of Luis Barragan's architecture, this thesis project seeks to reflect the identity of the Laguna through the integration of the contrasting elements of the desert and its water (Salas-P 1992, 14-17). The WEC incorporates the use of locally sourced earthen materials, referencing the traditional building methods of the region. To express the soil conditions of the land, the building features the use of adobe blocks and parging for the walls. These act as thermal masses that help regulate the temperature of the interior spaces. The building's foundations and the amphitheatre by the



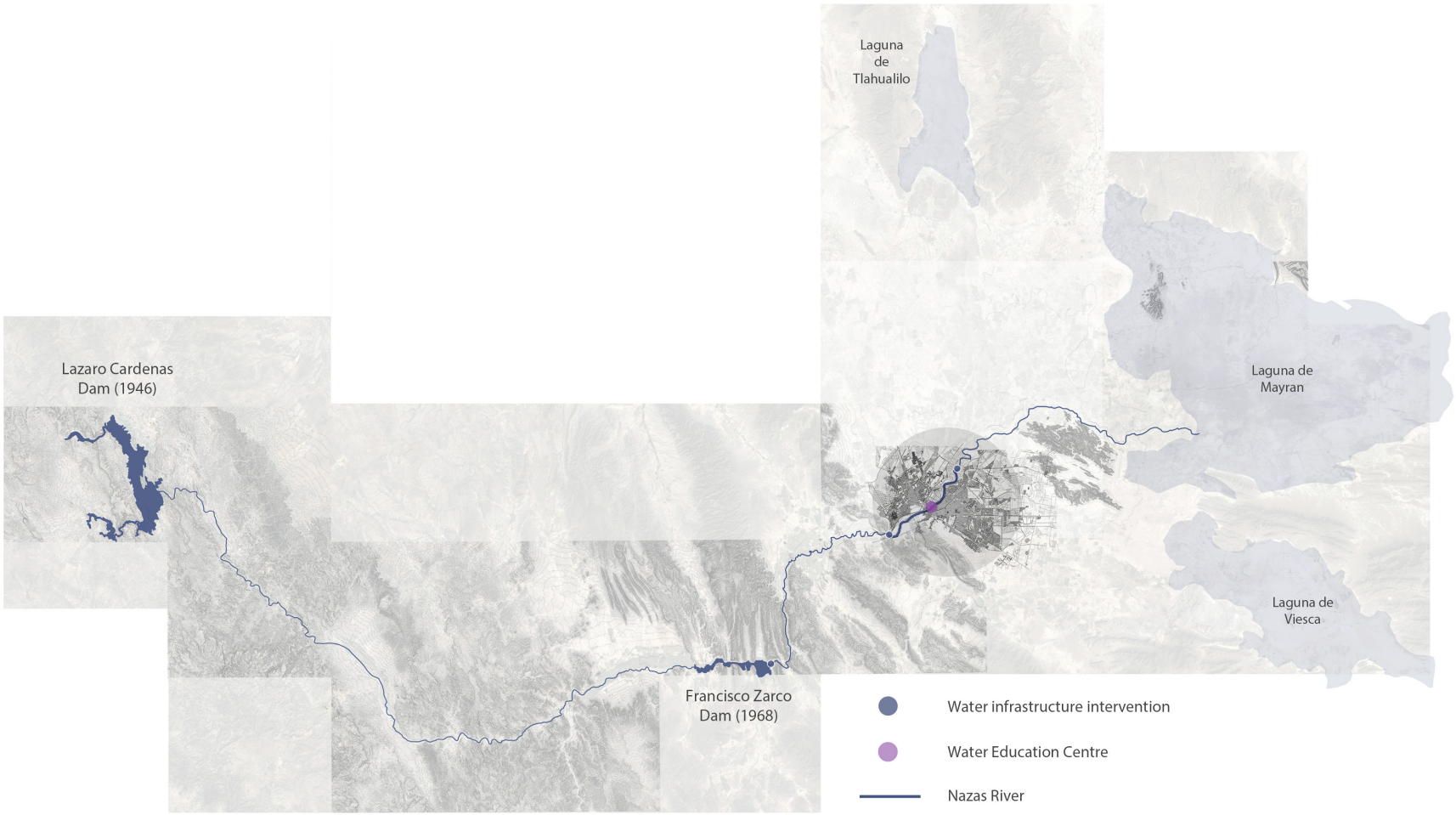
Aerial view of the site during its dry season, highlighting the materiality of the building and amphitheatre. Locally sourced materials feature in the Water Education Centre, such as the mezquite wood, adobe bricks, and limestone.

Aerial view during its wet season, as the water trickles into the building and interacts with the amphitheatre in the riverbed. The Water Education Centre is projected to be resilient to the changes during its dry and wet seasons, as the concrete foundations act as the floodplain’s datum.

riverbed introduce the use of more resilient materials, as these must be able to withstand the dry and wet conditions during the dry and flooding seasons of the Nazas River. The foundations feature the use of concrete, while the outdoor floors and planters incorporate local limestone. The use of the resilient mezquite wood found in the Laguna becomes a perfect material for the amphitheater's envelope and the building's doors, beams, and interior furniture.

Water, Community Catalyst

Water was once the element that brought people together in the Laguna. The Nazas River acted as that catalyst for social interactions, inviting people to go by the riverbanks to gather and celebrate. For the Laguneros, to be able to see water in their urban landscape was profound and hailed as a source of "life, cleanliness, and productivity" (Salas-Q 2020; see also Appendix I). Hence, it is the water of the Nazas River, the needle of this architectural reweaving, that will aim to interweave the Laguna's collective memory of the past, its experiential moment of the present, and its prospect of a sustainable future. Thus, the water not only becomes a functional element to the system, but an agent of celebration and a protagonist of social interaction within its spaces.



A hopeful future where the Nazas River reclaims its natural pathway, as it crosses through the urban center of the Laguna once again, and restores its lost lagoon ecosystems. (Data from Google Earth 2020).

1 - San Fernando Derivation Dam. (Photograph by author, 2021).

2 - The abandoned Calabazas Derivation Dam. (Google Street View 2021).

3 - Puerta de Torreon, a regional landmark by the Mexican sculptor Enrique Carbajal. (Yomontaño-W-S 2010b).

4 - Riverbed contamination at Santa Rita (Photograph by author, 2021).

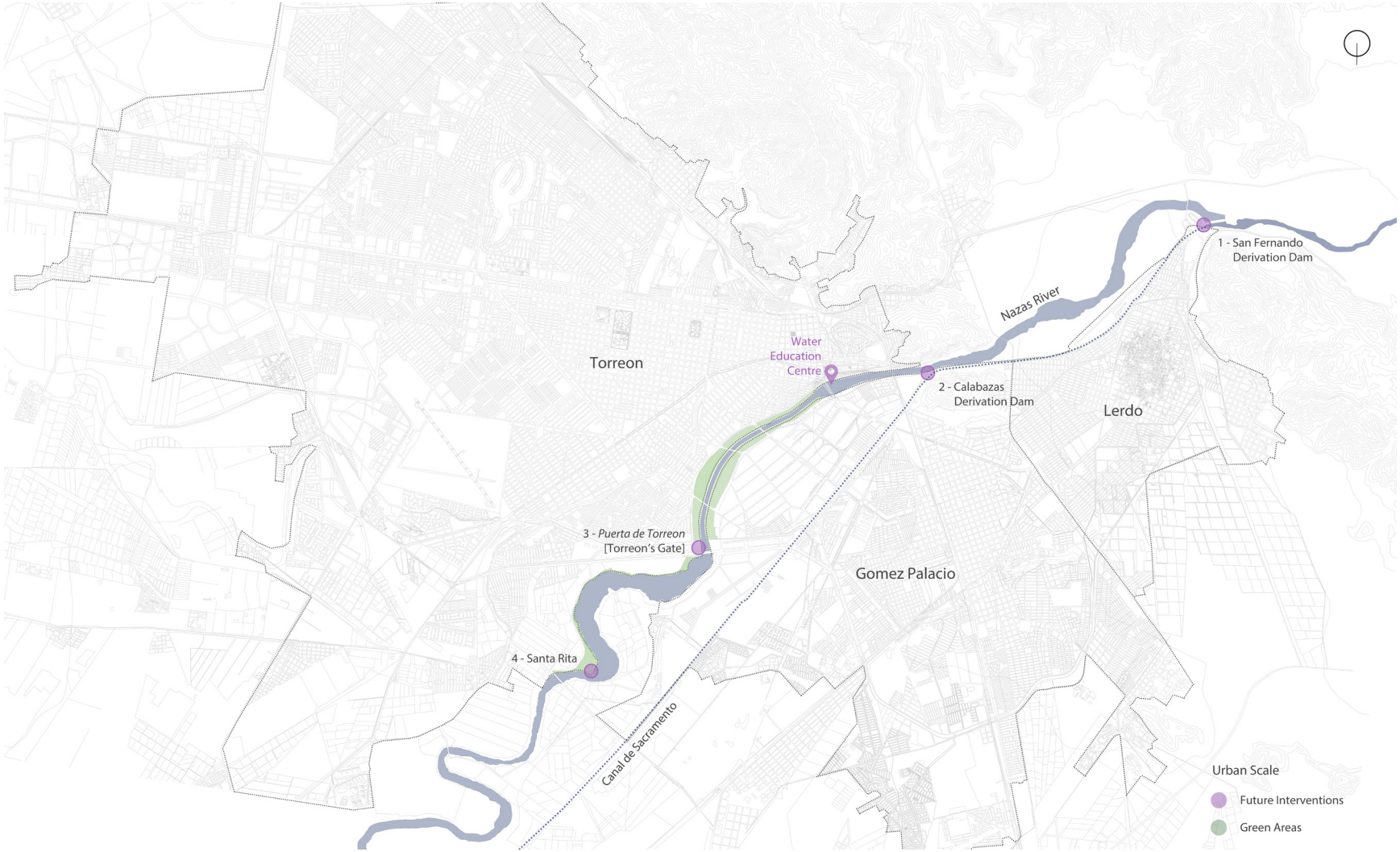
Chapter 6: Conclusion

A Hopeful Future

Urban Scale

This thesis project envisions the recovery of the Nazas River to be gradual. For this reason, this project looks forward to a hopeful future in which society, ecology, and economy function in a symbiotic relation. The Water Education Center aims to serve as the catalyst and prototype of further interventions happening at the urban scale by bringing back the balance to our hydrological region. Reimagining a sustainable urban landscape for the Laguna, the gradual progression could see architectural interventions throughout the metropolitan zone that invite people into the river, while harnessing rainwater collection and reusing it.

The potential future interventions could make use of existing landmarks along the Nazas River's edges within the urban landscape of the Laguna. I envision the San Fernando Derivation Dam, the current entry point to the extensive canal system of the Laguna, as a strong candidate to integrate the existing water infrastructure into a landmark that invites people to interact with the river. Similarly, the historic Calabazas Derivation Dam could benefit from a restoration project, as it currently lies abandoned. Like the El Coyote Gates, the Calabazas Dam could be reprogrammed to act as a visitor centre that welcomes guests to learn more about the region's water infrastructure. The Puerta de Torreon [Torreon's Gates] is another significant landmark that could host such activities. The gates are currently a touristic destination and lie within one of the main arteries that connect Torreon, Gomez Palacio, and Lerdo. Finally, the



Urban site plan of the Laguna depicting potential architectural interventions for a sustainable future. Such interventions would invite people into the river and support rainwater collection. In a hopeful future, the interventions and pockets of green spaces would reweave the urban landscape of the Laguna, allowing people to experience water once again. (Data from Google Earth 2020).

site of Santa Rita could be another potential destination for a water infrastructure intervention. The location is currently in a state of decay, as the adjacent industrial parks dump toxic waste into the riverbed. This site would be a prime location to transform and recover, as the river continues to heal the urban landscape of the Laguna.

Hydrologic System Scale

The Laguna poses a unique case study, as it possesses the tools to revert the ongoing situation. The abuse of our landscape and the mid-20th century technocratic mindset of domesticating nature (the Nazas River) has gradually depleted our ecosystems and brought thirst to our communities, taking away the access to a fundamental human right, water (SalasQ-2020, Wolfe 2020; see also Appendix I). The goal of the Water Education Centre is to start a process of ecological recovery for the Nazas River and its lagoons, as well as achieving clean water accessibility for communities throughout the region that do not have access to the vital liquid. By raising awareness and educating the people about efficient water usage, it leaves the door open for a hopeful future in which alternative agricultural methods, like drip irrigation, could be considered for agro-industrial practices.

At this hydrological system scale, I reimagine a future in which agriculture is part of the solution and not the problem. I reimagine a future in which the deserts of Mayran, Tlahualilo, and Viesca are revived, and its lost flora and fauna is able to repopulate. I reimagine a future in which the water flows back through its natural path and the region's aquifers replenish at healthy rates. I reimagine a future in which we do not need to depend on contaminated wells,

and we see less cancer and diabetes cases. I reimagine a future in which communities do not have to wait weeks to get running water in their households. I reimagine a future in which education and community building help in the restoring of a water sustainable future. I reimagine a future in which we are able to reweave the urban landscape of the Laguna, Mexico.

Collage illustrating the past, present, and potential future of the Laguna with the river interweaving all of the moments.

Appendix I: Interviews

Interview with Dr. Hernán Salas Quintanal

Hernán Salas Quintanal, Ph.D. in Anthropology, Professor of Anthropology at the Universidad Nacional Autonoma de Mexico (UNAM). Author of *El Rio Nazas: La Historia de Un Patrimonio Lagunero (2011)*.

This interview was carried out remotely via video call and recorded on October 20, 2020. Dr. Salas Quintanal received a transcript of the interview via email to review. The transcript below was approved and revised by the interviewee.

> The value given to heritage is guided by the way a region is built, in which it is necessary to choose specific ways of incorporating the past into the present. Heritage corresponds to these cultural resources that represent the collective memory of the communities that gave rise to a region and a sense of identity and belonging to a territory; however, cultural, economic and legal policies, within the possibilities of development, have reduced the value of heritage to what is significantly necessary to justify the present. (Salas-Q 2011, 11).

Interviewer (I): Do you think this collective memory of the Nazas River and its passage through the Laguna has been lost? If so, how can we restore it?

Dr. Hernán Salas Quintanal (HSQ): I believe that the collective memory of the Nazas River is not lost, yet it is weakening. On the contrary, I believe that the Nazas River is always very present in people's lives - not the river as we always imagine a river, which is a place where water runs. Laguneros have a special love for history, although the new generations I would not dare say it. As for the more adult generations, I think they do have a very special love for knowing their history and preserving their memory. I remember talking to many people in the Laguna, from

Torreón, Gómez Palacio and Lerdo, who talk to you about history with great passion. They retell facts of the past, they retell characters and anecdotes; especially with reference to the Nazas River.

Most people know the basics of the river - they know that the water is stored away in the dams, they know why the water does not run there, they know more or less about the droughts. If we go to the area of Lerdo, the river is much more present, because there are still lagunas [lagoons] and there are times of the year where there is a lot of humidity there. Of course, we are in a semi-desertic area, so any little water that generates green areas become very attractive to the population.

Regarding memory, I believe it has been weakened, but this has more to do with institutional policies that do not make reference to the collective memory. Collective memory is a memory that people maintain, it is a memory that people have and that they are transmitting from one generation to another. This transmission and its memory is always selective. It was very helpful to me when I made the book of the Nazas River to talk to the ejidatarios [landowners], who had used water directly from the river. The older people remembered when the water passed through its localities and through the city, the floods, and the Cotton Fair. I think the Fair is no longer done, as cotton is not a widespread crop in La Laguna anymore. They had many memories, even before the time of livestock, talking about mid-20th century. They remembered the agricultural Laguna more than the livestock Laguna, which is what it is now, a dairy basin. They had many memories that had to do with the landscape, which is one of the concepts you are working on, in the sense that for them to see water was important.

Not knowing it exists and it's in a dam, everyone knows that, but seeing it was part of her everyday landscape. Seeing the floods, even the floods that became very catastrophic in Torreón, are remembered with some nostalgia, as something that brought life, cleanliness, and productivity. I believe that in this collective memory there is a very important, very significant agricultural culture. So I believe that collective memory is not lost, that is why I speak of the Nazas River as a cultural heritage, because I believe that the people of La Laguna feel the Nazas River as theirs, as if it is one of them.

Heritage is not only personal and private, but also a collective heritage that belongs to us because we are Laguneros, because we are from this region. People are very clear when they say that La Laguna has life because there is a river, even if the river no longer passes by. Therefore, I believe the collective memory is not completely lost; however, it is selectively transmitted and sometimes can be weakened. We should see this perhaps in the younger generations, who knows how much importance they give to it, to see how much they value their heritage.

Regarding the second question, we enter more into the political realm, rather than the cultural one. As others and I investigate, I try to recapitulate how the Nazas River became an instrument of negotiation and political action in the nineteenth century and with much more force after the Mexican Revolution at the stage of the Agrarian Reform and land redistribution. Subsequently with the conversion to livestock, the river becomes no longer managed by the Laguneros but rather by institutional policy. The Nazas River was used as an experiment to research river water generation as a water management model, which was

then applied in other basins and irrigation water districts in northern Mexico with similar agro-ecological characteristics.

To restore the collective memory as such, no, because memory is created and recreated every generation; however, what can be restored is that benchmark. I did a quite hopeful exercise in the book, showing how water would be seen from the air in the Laguna if the river circulated again in its natural pathway, and of course it would be a very different city. It would be a radically different city if the water flowed again by - the vegetation, the walkways. It would change many things in the daily life of the Lagunero.

I: How can the new generations avert the loss of the collective memory of the Nazas River, even when there is no water running down the riverbed?

HSQ: I am a university professor and an important topic for me is education. Before I did this book, I did another investigation back in La Laguna with the ranchers and ejidatarios. I had the feeling I owed them something because I always received hospitality from the Laguneros. There was a lot of openness when I did my fieldwork. I remember walking from one ejido [agricultural land] to another, walking beneath the burning sun, but people were always very generous to me. I felt in debt and wondered if I could do something that would interest the Laguneros, and that's when I started thinking about this book.

I had known the Torreón Historical Archive in the 1990s and realized that the archive was not well organized, yet I found wonderful photographs that no one knew of. Today they already appear on many websites and social networks, and I wondered why don't we let people know through photographs? We can revive that memory through images,

maps, and cartography. And I think I fell very short in the book because there is plenty of material in that Archive. I remember telling the Historical Archive that this material had to be disseminated for people to know, so that children could experience it, so that it could be disseminated in schools. People must know what La Laguna was like a century ago. Torreón just turned one hundred years old as a city recently, and I'm not quite sure people know.

How many times did the river take the whole city down and had to be rebuilt? Anyway, these are very entertaining stories, so on the one hand we have to spread the history and that historical and cultural heritage that is in the Archives, but that is also in families, in those previous generations. I was able to interview some older people who knew a lot and some who were even been part of the Revolution or when the cows first arrived to Torreón. I believe that the dissemination of heritage is very important, as is education. That's why I made this book, and I do not think it has been print in La Laguna as much and I am sorry about that, but what I wanted is for everyone to know it. Not for my own protagonism, but really to showcase the Nazas River as the protagonist of this story and for people to know its history. When people cross the bridges every day or even neighbors of surrounding colonies, they know it was a river and that there would be nothing there if it were not for the river. A lot of people do not know that, and think it has always been like this.

> Stemming from the interest of social sciences in environmental problems, nature-society symbiosis, which had traditionally been regarded as an opposition, must be reconsidered and rebuilt as a single object of study. (Salas-Q 2011, 12).

I: What do you think was the inflection point that broke that symbiotic nature-society relationship in the region?

HSQ: I think this was gradual, maybe there is not a single inflection point, but several. I talked about the artificialization of the region. In the twentieth century, La Laguna was a wonderful place for agricultural production. Despite being a semi-arid place, it has a land of excellent quality, precisely because they were lands that were flooded in an epoch, which brought a fertility to the soil. Water has never been scarce in La Laguna, on the contrary, there were floods that became lagoons, since it was an endorheic basin. A lot of people do not understand that, it used to be like a big casserole.

This land has a vocation for agricultural production, which brought great wealth to La Laguna. That wealth was better distributed in the past. We can even see this in photographs from the urban development of Torreón. You could see it in the architecture, the layout of the city, the festivities, you could even see the wealth that cotton produced in the nineteenth century, which called to remain as an agricultural basin.

If there is a strong turning point, it would be the process of cattle raising that occurs around the 1950s, which certainly has to do with a national development model. It was not something of the Laguna alone, but rather a movement for industrialization in the whole country. Here are several factors: the industrialization that was sought in the post-war era and the capitalization of the countryside. This idea that the countryside was not only a place where food was generated, but also a place where wealth was generated. There was a proposal for economic development closely linked to this business logic, and that became a point an inflection point in the region.

That is where the cattle raising comes in. At first the ranchers, ejidatarios, and small owners from the Laguna did not believe in livestock. I interviewed some founders of LALA who had been agricultural worker in their past. When they were invited to raise cows, some were even afraid of them because they did not know how to treat them. They did not know if they were dangerous animals or how to handle them, but they were willing to learn. The first generations of livestock and milk producers suffered greatly with the transition from agriculture to livestock. Here we see this process of artificialization because it was artificially sought to convert that agricultural region into a cattle raising region which would have consequences in this nature-society relationship because that relationship shifts more towards water distribution. The use of water was prioritized towards the production of forage for livestock and the attempt at industrialization. The mining is also part of this attempt at industrialization in the region. It seems to me that the water problem in the Laguna is the concentration of some activities that have focused on the use of water, either through law or facts. Water use has been prioritized in mining, in more extractive activities, or in the same production of forage and livestock.

I do not understand when people say there is no water and it is going to end. The water does not have to end up in the Laguna. The water is there, but what needs to be done is to distribute it and manage it better so that everyone has access to water, whether for domestic, industrial or agricultural use. I believe that this artificialization, or this break between nature-society, meant that some groups appropriated water. This is not just coming from me, there are studies that have pointed it out. If there is an appropriation of water, that is

the break between this relationship of mutual cooperation between nature and society - what we need of nature to live and society to maintain nature so that it can continue to provide us with what is necessary to continue living as humanity. I think this relationship has been broken down. This is what generates environmental problems, which at the same time become social problems. It has led to scarcity, pollution, and disease. We know of groundwater with arsenic concentration. It has generated poverty, injustice, social conflict, and violence.

I: Do you think the identity of the region has been fundamentally damaged by the introduction of the Francisco Zarco Dam?

HSQ: I would not talk about identity damage, but about a transformation of this identity. It is hard to tell if an identity is better or worse than before. For this we may need more elements with which criteria to judge this. I think there has been a transformation because society builds its identity based on its surroundings, or its landscape, as the architects would call it. It is not always a physical landscape, but it is how we look at that landscape. The new generations are building an idea of what their environment is without water, based on scarcity. I insist on this – it is not a shortage problem, it is a water distribution problem. If the water was managed well, there would be enough for everyone.

Now, the specific dam has been important in preventing flooding. The original idea of dams, as much as the Francisco Zarco and Lazaro Cardenas dams, was precisely to have a good distribution of water. It was so that the water would not be lost, that it did not flood urban areas, so that it could be controlled to make efficient use and fair distribution. This

has generated an identity that was more balanced with the use of natural resources.

I: How do you think water use can become efficient?

HSQ: I think the State should take matter into action. It must return to the idea that the water is of the Nation, the water is of the Mexicans, the water is of society, not of an individual or of a group of individuals. Water cannot be sold or bought; water cannot be a commodity that is freely commercialized in markets. Water must be a fundamental good for the livelihood of individuals, families and society. There must be a higher entity that knows all the needs of the sectors of society and can distribute with justice and equality, with a view to a sustainable future, not only thinking what we will eat today, but also tomorrow. The State should take a more leading role and not leave this in the hands of the market alone. When I talk about the State, it is not the government in particular; there has to be agreement between various sectors of the population. The State as rector, and entrepreneurs, local politicians, producers, and the civil society that all need this vital liquid for domestic use. Laguneros are very rational, educated and cultured people and could come to terms if there was a willingness to find way to use water and think of the next generations.

I: What do you think of the federal government's proposal to implement the "Agua Saludable para La Laguna" [Healthy Water for La Laguna] project?

HSQ: I am not a specialist on the subject, but I believe that the problem of distribution should not be what is intended for the industrial, agricultural, and domestic sectors. I think the distribution should be that there is always enough for everyone. The agricultural sector will always occupy more

water than the others; however, the fact that it occupies more water does not mean that other sectors should run out of it. Finally, the economic part, the Laguna has an economic livelihood based on agricultural, industrial, mining, and commercial activities.

There is another problem, which I do not know if this project takes into account, which is that not only is much of the water allocated to the agricultural sector, but that this small sector has greatly enriched because of it. There comes a time when it is not only thinking about water redistribution, but also wealth redistribution. Water and wealth have been concentrated. This may be very ideological of me, but that is why I think the State should have a more powerful intervention because there is no way that there is such socio-economic inequity. We see it in the Laguna, and unfortunately in other regions of the country too. There is a small group that enjoys great wealth, yet a large sector of the population is living in poverty. People who do not have jobs, who do not have water. How is it possible that there are urban populations that do not have water? With everything this means, not only material poverty, but also a deterioration in quality of life, health, hygiene, in the ability of children to feed themselves and be good students, for example. This inequity has many consequences.

This “Healthy Water for La Laguna” project seems to have good intentions, hopefully they can do it. The issue of reloading aquifers also has to do with load capacity. The problem is that they have overexploited aquifers for many decades now. This is where the arsenic problem arises. Water is being consumed so deep that it brings contaminants. Speaking a little bit of the landscape, studies have probably been done to determine how far the water can go, but I think

the water should be able to be channeled so that the urban landscape can be transformed.

May the urban landscape not be of dryness, which it is not throughout the city - even in this there is inequity! There are areas of the city that are better irrigated and with more humidity. You can even see how the trees grow with an impressive vitality. When talking about the domestic urban use of water, there should be consideration to have more parks and green areas, especially in these areas of the country where industrial or chemical pollution is not so strong. I believe the Peñoles mining company is no longer at the core of Torreon anymore. Until just a few years ago, it was there at the center of the city generating environmental pollution, noise, and garbage. This part of the city became degraded with all the surroundings, and it is just a few blocks from the Historic Downtown.

These projects should be comprehensive in that regard; consider the economic part, but also the social one. Economic indices must be balanced so that there is no extreme poverty or extreme wealth. Also take into account the cultural part of the identity of a city with a history where water is a more vital element than elsewhere. Cities that have a river crossing through them almost always have an identity in relation to water. It provides them with more than a pleasant landscape that generates other benefits from cultural, which can also be economic, as cities become more touristic.

Interview with Dr. Carlos Cháirez

Carlos Cháirez, Ph.D. in Rural Development Studies. Author of several academic publications on traditional irrigation techniques in the Laguna.

This interview was carried out remotely via phone call on November 4, 2020. Dr. Cháirez received a transcript of the interview via email to review. The transcript below was approved and revised by the interviewee.

Interviewer (I): What is the most efficient way to recharge the Principal Aquifer?

Dr. Carlos Cháirez (CC): The most efficient way is to recharge it through the natural riverbeds, the vega [low fertile land] channels, and agricultural land parcels.

I: Can the ecosystem, its flora and fauna, recover if the waters of the Nazas River were allowed to flow through its natural pathway?

CC: Of course - the conditions to be reproduced are in the existing section between the Francisco Zarco Dam (FZ) and the San Fernando Reservoir.

I: What is the solution to the scarcity and contamination of water for domestic use?

CC: Scarcity, like groundwater contamination, has as its source the overexploitation of the aquifer. The solution is to recharge the aquifer and control extractions, as well as reducing the number of active wells.

I: How can an ecological, social, and economic balance be achieved in terms of water management in the Laguna?

CC: Through water laws and regulations, for times of scarcity as well as for those of relative abundance.

I: How can the traditional practice of the aniego [parcel flooding] be applied to current irrigation practices?

CC: The aniegos are typically practiced for torrential downpours; however, it can also be practiced with controlled waters such as those of the Nazas River.

Notes on Nazas River Sustainability

Text received via WhatsApp from Dr. Carlos Chairez, November 3, 2020:

1. To reduce the 475.69 million cubic meters (Mm^3) lost in the Lazaro Cardenas – Francisco Zarco (LC-FZ) dam system vessels:

a) Discharge the waters collected from August to January of each year and allocate them to the planting of various crops and orchards of melon and watermelon,

b) Use the water collection from February to July for the application of relief irrigation and the planting of summer fodder (forage maize),

c) Modernize the instrumentation metric tools to avoid losses from unquantified extractions, losses from administrative faults in the irrigation area of the Rodeo I and Nazas II irrigation modules, as well as for driving losses in the section between the Francisco Zarco Dam (FZ) and the Los Angeles hydrometric station.

2. To improve water management efficiency at the Irrigation District 017 (DR017), a joint management of surface water must be carried out (from the Nazas River basin), underground and meteoric. This would involve DR017

taking over water from the Nazas River, deep wells and meteoric water in its area of influence; therefore, only areas with irrigation rights that were provided in 1936 must be watered (not indicated areas and surfaces dominated by deep wells).

This would also involve removing some water rights or closing some pumping wells, the former being used for artificial recharge and the latter to keep groundwater protected in the subsurface, as a reserve for contingency times.

3. Carry out the Regulation for the management of surface, underground, and meteoric water.

4. Create water banks where the rights to use, operation and management of water, both for surface water and groundwater, can be transparently auctioned.

5. Perform geo-hydrological balances at the hydrological micro-basin level.

6. Implement water harvesting methods for domestic and human consumption use, reuse wastewater, etc.

7. Perform constant artificial recharges in the area of the main aquifer and Nazas River.

Interview with Dr. Mikael D. Wolfe

Mikael D. Wolfe, Ph.D. in Latin American History, Professor of History at Stanford University. Author of *Watering the Revolution: An Environmental and Technological History of Agrarian Reform in Mexico (2017)*.

This interview was carried out remotely via video call and recorded on November 24, 2020. Dr. Wolfe received a transcript of the interview via email to review. The transcript below was approved and revised by the interviewee.

Interviewer (I): In your opinion, what would be the single-most important historic event that caused the disruption of the ecosystem in the Laguna?

Dr. Michael D. Wolfe (MDW): If you are asking about technological intervention as the single-most important historic event, I would say it is the combination of the two large dams and the groundwater pumping. It was all kind of one package over time, the large dams, the groundwater, the electric or motorized groundwater pumping and the paving over the earthen canal system. Even though earthen canals were not the most efficient, they allowed the water that flowed through them to seep back underground and to replenish the aquifer. When the government paved them over with concrete to try to make water flow more efficient, it really disrupted the hydrological cycle.

> Prevailing envirotechnical paradigms of invasive hydraulic infrastructure building and agricultural chemicalization encouraged by Green Revolution policies provided short-term relief, even as they worsened conditions in the medium and long run. (Wolfe 2017, 191).

I: What role did politics/ economics play in the introduction of the Francisco Zarco Dam to the Laguna?

MDW: I think they had everything to do with it. The Zarco Dam of the late 1960s was almost the initial, original proposal that Francisco Madero had back in 1906 in terms of the location of the first proposed high dam on the Nazas. There were already small diversion dams in and around Torreon of course. In some ways, a dam had always been planned where the Zarco is now, but the engineers who studied Madero's proposal in 1909 thought it was not feasible because the geology of the region could not withstand that much concrete and that much pressure. They needed to find a different place way upriver, and that is where they ended up with the location of the Lazaro Cardenas dam. My book is largely about the politics and economics of that dam, the arguments about whether it was economical and what its social purpose was, namely, is it to help landowners in the region or would it help facilitate an agrarian reform, which is what Cardenas wanted the dam to be for.

As engineers started building the Lazaro Cardenas upriver in Durango in the late 1930s they realized that they were probably going to need a second dam at some point because the first dam was insufficient to regulate the Nazas flow. As a result, the Zarco completed in 1968 was essentially an extension of the first dam completed in 1946. In some ways, the Zarco fulfilled Francisco Madero's original proposal, which I found historically very interesting . The other thing I found interesting about the Zarco Dam was that there was not as much controversy about it. The Lazaro Cardenas Dam, which was also known as the El Palmito Dam because it is next to the little village of El Palmito, was very controversial. A majority of landowners did not want that dam built because they actually liked the free-flowing Nazas and the irrigation system that depended on it, even though

it was unpredictable because you never knew how much water you were going to get from year to year. That was the entarquinamiento or aniego [parcel flooding] system of irrigation, which floods your lots of cropland to retain in the ground as moisture and then goes back underground and helps replenish the aquifer after which you have water to pump. Of course, that was not sustainable for very long once motorized or electrified groundwater pumps burgeoned. There was a potential for an ecologically sustainable system before the dams were built. The dams predictably disrupted that process, which is was what the landowners feared .

By the 1960s when the Zarco Dam was built, the technocratic mindset of engineers was dominant at all levels of government. There was not as much fear about the radicalization of technology as there had been with the first dam in the 1930s when conservatives were alarmed that Cardenas wanted to redistribute land and the dam would help him do that by redistributing water. By comparison, the Zarco Dam was not that controversial, since it was an add-on to the first dam and a part of the rehabilitation plan to pave over the canals and rehabilitate the agricultural economy.

I: Do you think society would have been okay with it, seeing it as an extension of the Lazaro Cardenas dam to capture water and redistribute it?

MDW: Yes, from what I could tell from my research, most Laguneros had already accepted the first dam, as if it was part of the landscape. Even though it did not live up to the expectations that three Mexican presidents set for it (Cárdenas, Avila Camacho, and Aléman), I think it was seen as necessary, playing a very important role in regulating the river while there was a terrible drought across northern

Mexico that hit right after the dam came online in 1946 and persisted into the 1950s. So, nature played a role, too. There are a lot of farmers in the area who felt they needed the dam because otherwise they never knew when they could get water. They thought they needed the dam for water to be more equitably distributed and a lot of them probably did not know about the ecological problems.

One thing I did in the book was to uncover how much the engineers understood the adverse environmental consequences of their technical interventions, yet were not publicly saying much about it. They corresponded with each other, which you can find in the Archives and occasionally in the newspapers, but this was not a time when people were thinking environmentally. We forget that the environmental movement is relatively recent in human history, which started pretty much in the 1960s. It is not that people did not care about nature before that, but in terms of a real global movement, the environmental movement did not exist as such before the 1960s, and certainly not in Mexico. It took until the 1970s and 1980s before there was something called an environmental movement in Mexico. So, I think all these combinations of factors are the reason why the Zarco Dam was really not controversial.

> Researchers working with the United Nations Research Institute for Social Development … termed the Laguna's predicament a paradox of productive abundance amid environmental deterioration and widespread poverty. (Wolfe 2017, 218).

I: What is the main lesson to be learned by the Mexican government to prevent another "water apartheid" from happening?

MDW: You need to make sure that technology truly serves human well-being. It should be designed to be as equitable

as possible and it needs to have popular input, too. The government should not impose or try to co-opt people into getting behind it, which is what happened for decades. Instead of asking what people thought about it and inviting them to participate in the planning process, they sought to overcome the opposition. Contrary to what a lot of people think, the Mexican government was not a totalitarian government - it was authoritarian, but it still had to worry about public opinion. Sometimes it would use force, but it could not use force the way Stalin did in the Soviet Union. Its use of force was very selective because it preferred co-optation, or buying people off. That is the way the PRI [Institutional Revolution Party] governed for decades. That was still a very top-down system, unfortunately, and even after 2000 after the PRI was voted out in a relatively free and fair election, the system has persisted.

There is a flood control dam on the Aguanaval River that was rammed through, as well, without a proper environmental impact assessment. The government was able to split the opposition by proposing different configurations of the dam, and some people were for it, some were against, and others were for parts of it . In some ways, the government learned to be even more cunning than it had been under authoritarian PRI rule to defuse opposition. Even though there was a lot more environmental awareness in the 2000s, even though the laws were better about environmental impact assessments, the old habits of governance persisted even with electoral alternance. Even with the PAN then back to the PRI now to Morena, unfortunately, this technocratic mindset just has not gone away in Mexico. So, I think the technocratic mindset is really what needs to be overcome to get rid of “water apartheid” in the region and all over Mexico.

When I was in the Laguna in the mid-2000s, I heard a lot of proposals, and I think yours is great, too. Raising awareness and increasing education are important, but you also have to have enforcement of the law. You are not supposed to be able to deplete an aquifer. If you look at Mexico's water laws, they are very progressive, about which I published an article in the Washington Post a couple of years ago. Mexico's water laws are even better than the United States' in my opinion. The problem is you do not have enforcement or compliance.

Back when I was in the Laguna and thereafter keeping track of the water news there, I read and saw how people could just drill a well and suck up as much water as they wanted. Of course, the people that can do so are the people with the most resources, such as obviously the LALA dairy company and subsidiaries, whereas poor ejidatarios can not. They do not have the money, or the credit. There was a dramatic picture that I took when I visited an ejido outside of Torreón. This old ejidatario there who could actually remember way back to the building of the first dams took me out and showed me his defunct well, this pozo that was completely dried out full of weeds surrounded by parched soil with nothing growing in it. He pointed just half a mile away to a small landowner who was working for LALA whose field was green, lush green! It was growing beautifully with all this alfalfa. I asked, what is going on here? He answered: "that guy has a well with a motor and he can suck up all the water he wants. No one does anything about it." I read and heard about the urgent need for medidores, or meters in the wells to measure how much water people were withdrawing. But nothing really happened. The aquifers just keep being depleted. Now, this is not a problem unique to the Laguna

or Mexico, by any means. One thing I am very careful about, both in the book and whenever I present on this topic, is that there is nothing uniquely Mexican about this. It is not part of the culture of Mexico. You can find similar problems in California, Texas, India, Pakistan, and places all over the world. Rather it reflects a universally extractivist mindset; thinking the future is not my problem, I need the resource right now. I think that is common all over the world. We have to get over that mindset and say the future is very important and you just cannot keep extracting as if there is no tomorrow.

> With agrarian reform jettisoned for nearly a generation, whether such organizations can reverse the regulatory capture of the CNA [National Water Commission] and other government agencies by private industry so that they will consistently act in the public interest – and therefore fulfill the promises of the Mexican Revolution for complementary development and conservation of water and other natural resources – remains to be seen. (Wolfe 2017, 228-229).

I: If Mexico were to aim for a water revolution and draft a new Agrarian Reform, what would be some crucial items to include?

MDW: Oh, so you are asking a historian what future policy should look like!

I wish the law would be implemented and people would comply with it. Laws are not perfect, and they always have to be adjusted in some way or another, but I do think, as I said before, that Mexico has really good, progressive water laws. If you could just get the institutional capacity, as well as public trust and confidence in institutions to be able to follow the law, I think that would improve things.

I am not necessarily for an Agrarian Reform again like the 1930s because the Laguna has changed too much. Back In the 1930s, still half the region was agrarian, and it was

a different time period. You just could not implement an Agrarian Reform like that anymore. Now it is mostly urban, and people produce very different kinds of crops. The demand structure is very different. There are still ejidos and people obviously farming. There are a lot of things that can be done, but I am really not familiar with all the details. I know the eijidatarios I talked to feel very neglected by the government. They feel the water situation is very unfair. They feel they are only pawns, only useful when elections come around. Otherwise, they are just forgotten.

There needs to be more attention paid to what is going on and how people are suffering and how the power of some of these agribusinesses can be curbed. That is a tough thing to do. Again, it is not a problem unique to Mexico. I would have to do more research again to tell you what kind of Agrarian Reform should be implemented. In terms of the water, they really should not be producing milk in a desert region like the Laguna. That is a hard thing to say because LALA is such a wealthy company and is one of the biggest milk producers in Mexico, but it is just ridiculous, for it is an arid region! You should not have water intensive agriculture in arid regions where water is scarce. It just does not make any sense ecologically.

I think the engineers there are very talented and if they were allowed to do work in the public interest, they could come up with good solutions. It would mean accepting the reality that you should probably not have a company like LALA in the desert or try to get LALA to do something different, or really implement water conservation measures. Again, I am not the person to talk to you about that, since I am not up on the latest technologies and policies. I can tell you historically,

however, that lack of law enforcement and compliance is what has been lacking the most.

> An editorial in July 1929 titled “The Very First Flow of the Laguna Nile” described the river’s social, economic, and ecological importance to the region in such reverential terms… (Wolfe 2017, 133).

I: How can agriculture bring society, economy, and ecology together to achieve sustainable development in the Laguna?

MDW: I think people could better appreciate what the Nazas River did for the region and how it was revered before all the technological changes: damming the river, sucking up the groundwater, and paving over the canal systems. People could just look back a century and realize the Laguna was almost defined by the Nazas and it was part of a natural hydrological cycle that people learned to adapt to and appreciated, as you can see in that editorial before any of the dams were built. Groundwater pumping was starting to become more prominent but had not yet started to boom. People just realized water was nature’s bounty and appreciated when it flowed down and gave them their economic livelihoods and made life possible in the region, based on agriculture, which was the main economic engine back then. It would be great to have that kind of appreciation again in our current post-industrial society that we take for granted.

> The overexploitation was primarily due to an agricultural sector that consumed more than 90 percent of their water while accounting for only 30 percent of the regional economy. As the region’s lifeblood, the Nazas stood at the center of every discussion… (Wolfe 2017, 226).

I: Plenty of protests have sparked in the last few years in the Laguna due to a lack of water availability for everyday domestic use. Do you think the water scarcity issue in the Laguna could be solved through envirotechnical means? Or

is the presence of the agro-industry in the Laguna destined to be a perennial political influence?

MDW: Once again, you are asking the historian to predict the future through a crystal ball!

Envirotechnical is more of an academic term, it means that our technologies are inseparable from the environment in which we embed them. It does not necessarily mean a more sustainable means of resource management. But it can mean that. There are actually companies called “Envirotech” that like to say they produce clean energy. Academically, that is actually not what it means. If you are asking me, is there a more ecologically sustainable technological means of dealing with this issue? I think yes, absolutely. There are many more sustainable irrigation technologies all over the world that are much more efficient. A lot of Laguneros are familiar with them. Israel has done a lot with drip irrigation, for example. I read in El Siglo de Torreon how Israeli engineers and technicians visited the Laguna and gave advise. I always look at the comments of those articles online and I noticed one person posted: “Enough of studies, we do not need any more studies. We know what to do here, we need action.” That was interesting, as they were not very impressed with the Israelis coming over to tell them how to manage their water.

I think the knowledge is already there. I talked to this engineer [Dr. Carlos Cháirez], who I cite a few times in my book, and he did this ethnographic research about the aniego system of irrigation. I used his thesis a lot because he did all this research that I was not able to do for various reasons. I thought it was fascinating, you could still find remnants of this old way of irrigating, especially in the Aguanaval River.

I do not know if there is anybody still doing it now, it has been 15 years since I talked to him. I think it would be great if there was more education and awareness about how the old system worked, even if no system is perfect. That is one thing I tried to show in my book: there were trade-offs. I do not want to romanticize what existed before, there were very good reasons why people would want the dams to be built on the rivers because their flows are unpredictable. If you want to run a business with agriculture and be able to sell your goods, one thing that is extremely important in business is certainty and predictability. You just could not have that if you tried to rely on the Nazas' natural flow. I think this is the mindset we need to change, this business of trying to control nature and turn it into a machine is not working for us. We can see that with climate change. So, where is the balance? We need a new paradigm.

I would agree, agro-industry in the Laguna, as long as it can keep taking the water without any consequence, will have a big political influence in the region. I think at some point there is not going to be enough groundwater left. It is an exhaustible resource. It differs from oil and gas. There are plenty of reserves of oil and gas with the fracking revolution, etc. If you are concerned about climate change and sustainability, it is not a good idea to say we are going to run out of oil and gas. Maybe, but it will take another century at least. We do not have a century to reduce our greenhouse emissions. It is absolutely going to be catastrophic; it is already terrible with the changes in the climate. A better argument is we have to get off oil and gas, leave it in the ground, and use different technologies which are booming such as solar, wind, geo-thermal, and other types of clean energy. In the case of water, you can actually make the

argument we are going to run out of this resource, especially if we keep contaminating it. So, we can use both arguments; we are reaching peak groundwater AND we need a new technological-economic paradigm. What kind of economy are we going to have in this fragile, arid region?

I: What are some examples of successful agricultural technologies used in Latin America where they have similar conditions to that of the Laguna?

MDW: I think there are, but they are very small scale. Martin Sanchez and Jacinta Palerm are both very knowledgeable about the more sustainable pequeño riego [small-scale irrigation] systems around Mexico. I would defer to them, in terms of what kind of models exist in the country. There are much more sustainable systems throughout the world. I think the issue, though, is that they cannot be scaled up very easily. Since the Industrial Revolution of the early nineteenth century, capitalism has been able to scale things up by making nature into a seemingly inexhaustible resource. It took over a century to realize that this is just not the case. So, how do you scale things back? How do you get people to realize endless consumption should not be an end in itself? That is a much bigger problem.

You can find small-scale systems that produce food for home consumption very well, and even have some surplus for local markets. If you are talking about a system that could sustain agribusiness and industrial scale agriculture, I do not think there is one. To overcome that, we would have to accept that we cannot keep living the way that we do. We live in very unequal societies, so I am not talking about everybody of course.

I: Regarding the “Agua Saludable Para La Laguna” [Healthy Water for the Laguna] Project:

MDW: It is a great start; you need a pilot program and to demonstrate to people it could actually work and then you build from there. I think in Mexico City, too, there are similar projects of trying to restore natural flows.

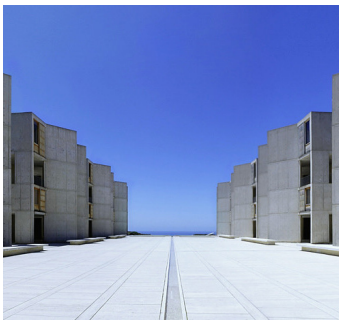
Torreon is a very urban region now. Half of my book is about when it was more of an agricultural region, but I did not really research the urban side of it. I recognized that by the 1950s or so, the story of the region is how it urbanized. I was still much more focused on the agricultural side and I had good reason to, as much of the water is still used by agriculture. Yet, the urban story is hugely important because that is where most people live. I think there have been people who have written about that.

I: Regarding the agency of CNA (National Water Commission, CONAGUA) within government:

MDW: It is an interesting agency; it is not like it is the enemy. It is a regulatory agency, and it is a big one, so there are a lot of people who work for it. It still tends to have this technocratic mindset, but it is open to different views and many engineers working there are trying to do their jobs the best they can. It is not like they want to screw things over for people, it is just that they have all these pressures put on them. In the case of the flooding problem in Mexico City in particular, you cannot control the flooding, you need to disperse it. So, of course, where do you release the floods? You release them in the poor neighborhoods because they have no political influence. Can you imagine if they released floodwaters into the rich neighborhoods like Santa Fe or Polanco? It is like this flood disbursal system has become naturalized. Many

poor and middle-class people do not realize that the flooding can be dispersed in a controlled way. They just think it is an act of nature, but the government is not helping them enough. I am sure it’s very similar in Torreón and other cities throughout Mexico.

Appendix II: Case Studies



Courtyard at the Salk Institute, a project by Louis Kahn. (Yusheng 2006).

Centre Culturel Jean-Marie Tjibaou, a project by Renzo Piano Building Workshop. (Waters 2003).

- Khaju Bridge by the Safavid dynasty (Iran, 17th century)
- Las Arboledas by Luis Barragan (Mexico, 1961)
- Salk Institute by Louis Kahn (United States, 1965)
- Centre Culturel Jean-Marie Tjibaou by Renzo Piano Building Workshop (New Caledonia, 1998)
- Museum of Modern Literature by David Chipperfield Architects (Germany, 2006)
- Santa Lucia Riverwalk (Mexico, 2007)
- Desert Interpretation Center by Emilio Marin + Juan Carlos Lopez (Chile, 2015)
- Museo Internacional del Barroco by Toyo Ito (Mexico, 2016)

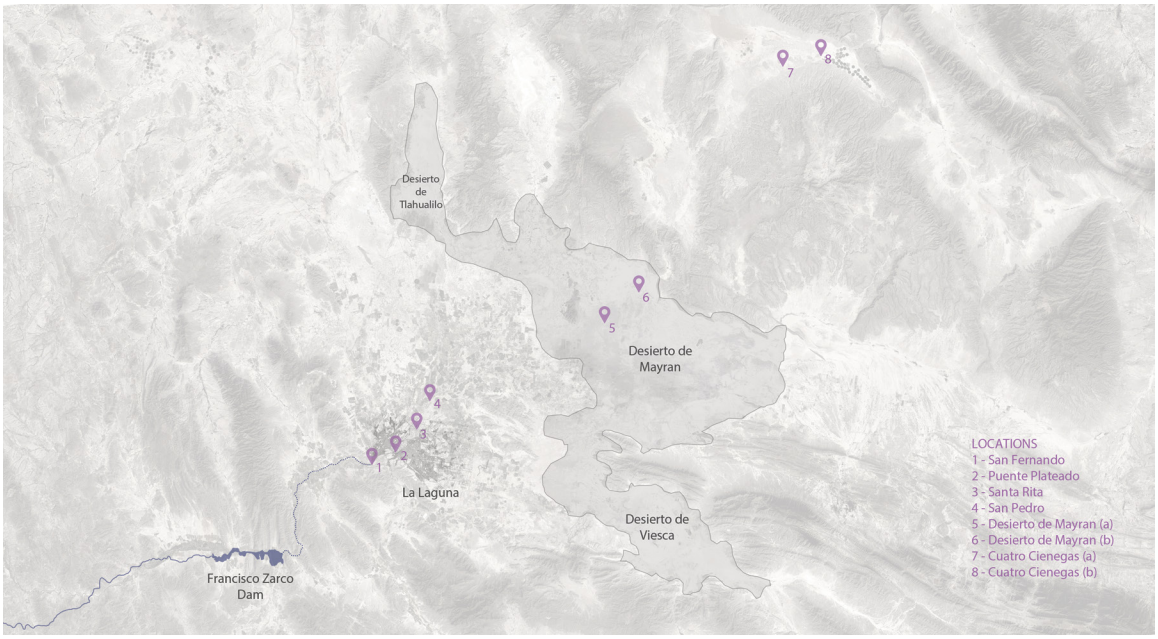
Fuente del Bebedero at Las Arboledas , a project by the Mexican architect Luis Barragan. (Dika Estudio 2020).

Appendix III: Earth Experiment

The colors and textures of the Laguna's different kinds of soil and sand.

To further showcase the richness of the Laguna's earth, I embarked on a small rammed earth wall experiment. I proceeded to collect soil and sand from eight different locations within the hydrological region to display the variety of the region's landscape.

The eight different soils and sands were filtered to remove rocks and waste. In a separate container, each one was mixed with sand and cement (80% earth, 10% sand, and 10% cement). Water was then added until the blend would reach a texture similar to paste. The earth paste was then placed inside the acrylic formwork and compacted. This process was repeated for all the eight different soils, layering one on top of the other. The composition was left to dry for 24 hours and then the formwork was removed. The final composition revealed a variety in colors, as well as subtle difference in textures (see image on the left).



Map showing the locations where the soil and sand was extracted. The soil was collected in January 2021. (Data from Google Earth 2020).

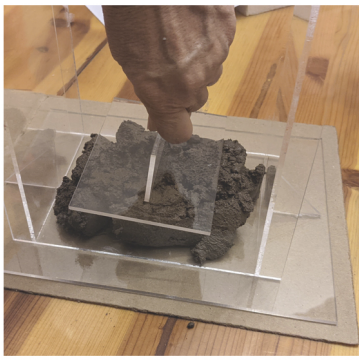
Formwork and earth compactor

1 - Filter the earth to remove rocks and waste.

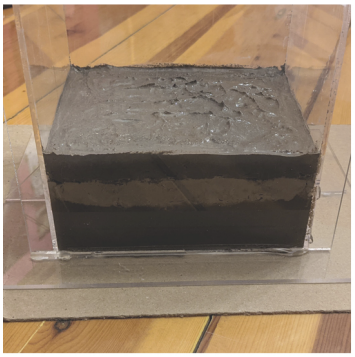
2 - Filter the sand to remove rocks.

3 - Mix the filtered earth with filtered sand and Portland cement (80% earth, 10% sand & 10% cement).

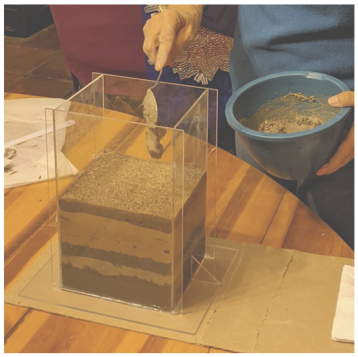
4 - Add water and mix to reach a texture similar to paste.



5 - Place mix inside the formwork and compact.



6 - Repeat steps one to five and continue adding layers.



7 - Continue adding layers.

Final composition consisting of eight different layers.

Series of images that illustrate the earth experiment's process (experiment done in collaboration with Carmina Aguirre).

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