Memories of Tlaloc:
Water as the Cultural Legacy in Xochimilco

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Memories of Tlaloc: Water as the Cultural Legacy in Xochimilco

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Abstract

Mexico City currently faces several challenges deriving from historical social inequalities and ineffective governance, which hinder equitable access to water. The centralisation of water supply and drainage systems has largely failed to address local needs, leading to the marginalisation of vulnerable communities, especially populations dwelling in areas ecologically essential to the functioning of the Basin.

This research argues for a renewed understanding of water's ecological and cultural importance in the city based on water's historical importance to Mexico and the modern misconceptions surrounding it.
In this context, this work analyses the potential of a park landscape intervention in Mexico City's cultural remains of Xochimilco, to explore new water management alternatives. Landscape architecture is presented as a critical strategy for fostering a renewed understanding and a medium-scale infrastructure based on circularity, while revealing layers in history. This thesis provides insights into how awareness, responsibility, and active engagement with water management can be promoted.

It proposes that collective engagement can restore essential components of Mexico City's hydrology, while mitigating some of the most crucial water issues, and inspire community-driven actions toward sustainable practices. Ultimately, the results put focus on the inclusion of local knowledge, strengthening the connection between people and water for an increasingly uncertain future.

Position

Landscape architecture is a critical strategy for managing our territories, offering a perspective on the interconnected processes of nature and its relationship to changing society. Landscape architects recognise that any intervention in the landscape must be approached with a deep a systematic understanding of these complex relationships.

In the context of this thesis, it is recognised that a collective understanding of the mechanisms of the endorheic basin of Mexico City is lacking. This gap can be partly attributed to the historical disconnect between water and the inhabitants of Mexico City. For the Mexica, the original inhabitants of the Basin, water was regarded as a sacred entity, valued for its life-giving properties but also recognised for its potential for violence.

Today, however, the perception of water has become ambivalent; it is seen as either absent or as a dangerous accumulation. This change is primarily due to the loss of critical spaces within the Basin that once facilitated natural water processes. It is imperative to promote the recovery of these essential components to effectively address the environmental crises facing the region (Zambrano, 2023).

While landscape architecture provides a foundational framework for development, other approaches can also help repair our relationship with water. Elizabeth Meyer argues that interaction with designed landscapes can become an active practice that embraces observation, exploration, and reflection on our surroundings, fostering a sense of responsibility. Thus, landscape architecture becomes a powerful tool for learning and internalising values related to our natural processes (2008).

Ultimately, this thesis argues that the human experience of designed landscapes in Mexico City can inform these processes and inspire meaningful action to preserve our precious water assets. Through this engagement, we can relink our connection to water.

fig 1. An aerial view of the Fountain of Tlaloc, a mural by Diego Rivera honouring the god of water in Chapultepec Park, Mexico City, Mexico.

(Photo: Carlos Jasso, Alamy Stock Photo/Reuters)

Context

Mexico City in the Global Context

Mexico City is located in South-Central Mexico, at a latitude of 19°25’10”, below the Tropic of Capricorn. It is within the Mexican trans-volcanic belt, surrounded by two mountain ranges: the Sierra Madre Occidental to the West and the Sierra Madre Oriental to the east. Its average height is 2,900 meters above sea level.

Due to the abrupt altitude differences in the area, its latitude, and its mild climate (subhumid temperate, Caw), as well as its water availability and rich soils, the city, particularly its southern municipalities, is home to over 11% of the country’s biodiversity.

Currently, the growth of Mexico City exceeds its political-administrative limits, which is why this area, comprising different administrations, is referred to as the Mexico City Metropolitan Area. This area has a population of 21,804,515 inhabitants. (INEGI, 2020)

fig 2. World map
Data: ESRI World Countries (2022)


0
100
200 km

Formation of the Endorheic Basin

The Basin of Mexico was formed after a long period of volcanic activity, during which the Sierra de Las Cruces to the west, the Sierra Guadalupe to the northwest and the Sierra de Rio Frio and the Sierra Nevada to the east were formed. During this geological stage, the Basin naturally discharged its waters to the south towards the Pacific. The appearance of the Chichinautzin mountain formation closed the natural water flow, transforming it into an endorheic basin with an extension of 9600 km (Breña Puyol et al., 2009).

The rivers and springs that flowed down from the higher parts of the sierras and hills were deposited in the lower part, progressively forming a large lake, which was reduced to five smaller lakes during the dry season (Breña Puyol et al., 2009).

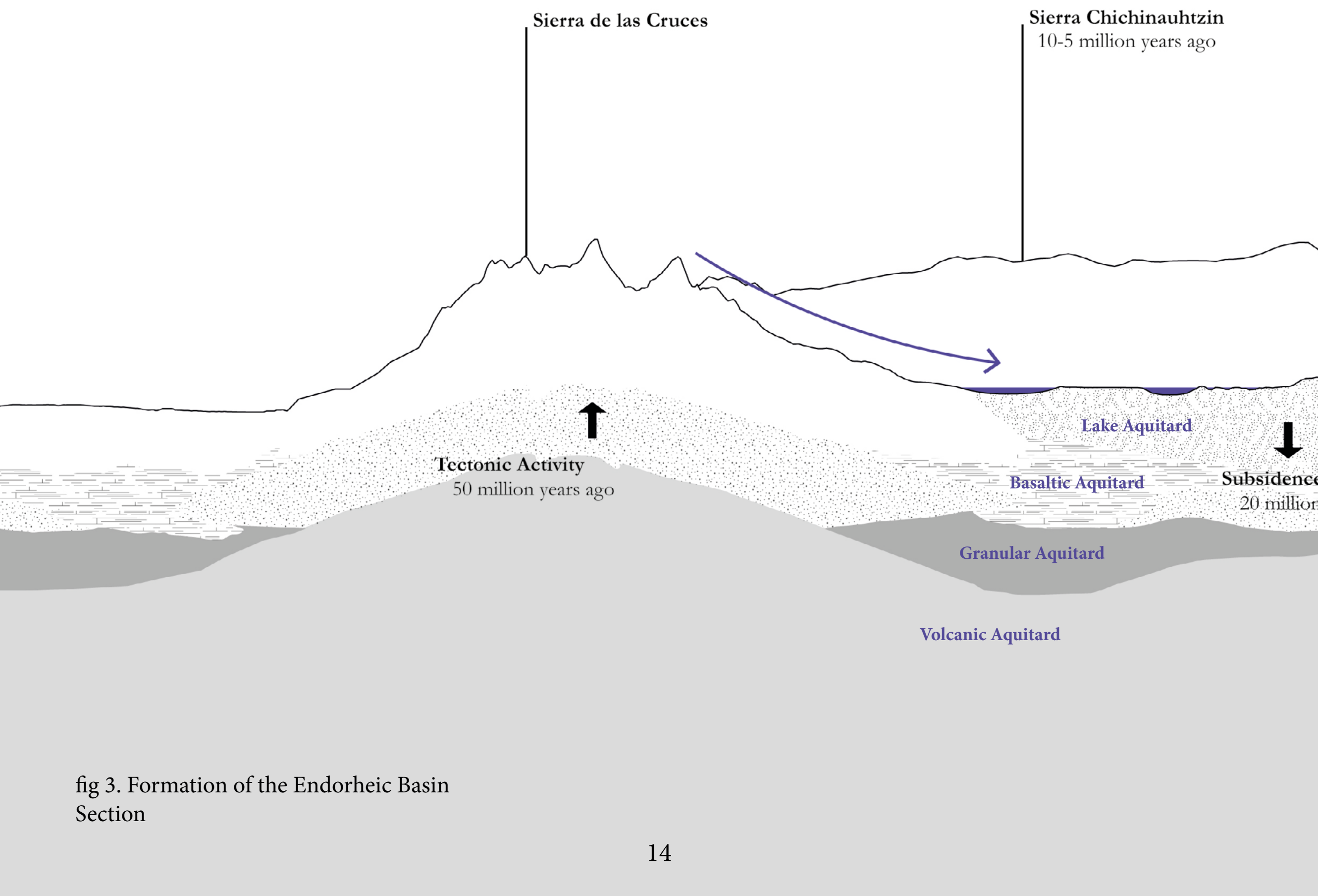
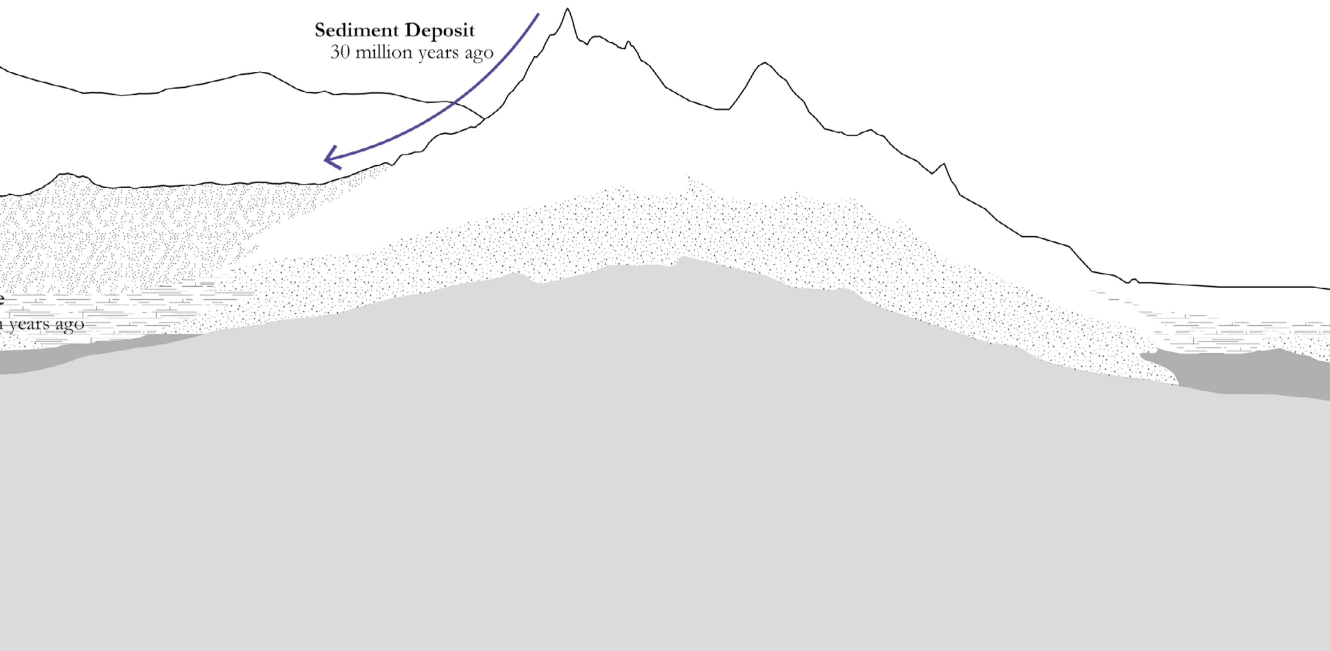


fig 3. Formation of the Endorheic Basin
Section

Over the years, a thick layer of clay, composed of fine material carried by rainwater from the surrounding mountains, has been deposited on the lake's bottom. This layer is approximately 40 metres thick, except in the southern part of the Basin, where it reaches depths of between 100 and 130 metres. It is particularly susceptible to compaction and cracking when moisture is lost (Breña Puyol et al., 2009).



Centralisation of the Mexico City Metropolitan Area

Mexico City is highly attractive, offering a wide range of job opportunities, access to commerce, healthcare services, education, culture, and more. The establishment of groups of people and the concentration of populations in urban areas in Mexico City was driven by the Industrial Revolution.

However, it faces complex challenges as it struggles to keep up with its high population density and ongoing horizontal expansion. Their infrastructure is inadequate, resulting in housing shortages, social inequalities, vulnerability to natural disasters, and insecurity. (Consejo Nacional de Población, 2024)

The concentration of population in the Mexico City Metropolitan Area has historical roots dating back to the founding of Great Tenochtitlan in 1325. Nevertheless, the centralisation of Mexico City has been consistent from the Spanish Conquest to the present day, when they established the capital of New Spain was established in this territory. The concentration of activities and government dependencies did not cease with Independence, the Mexican Revolution, or decades of neoliberalism. Today, the Mexico City Metropolitan Area remains the centre of political decision-making and a significant portion of economic activities. (Consejo Nacional de Población, 2024)

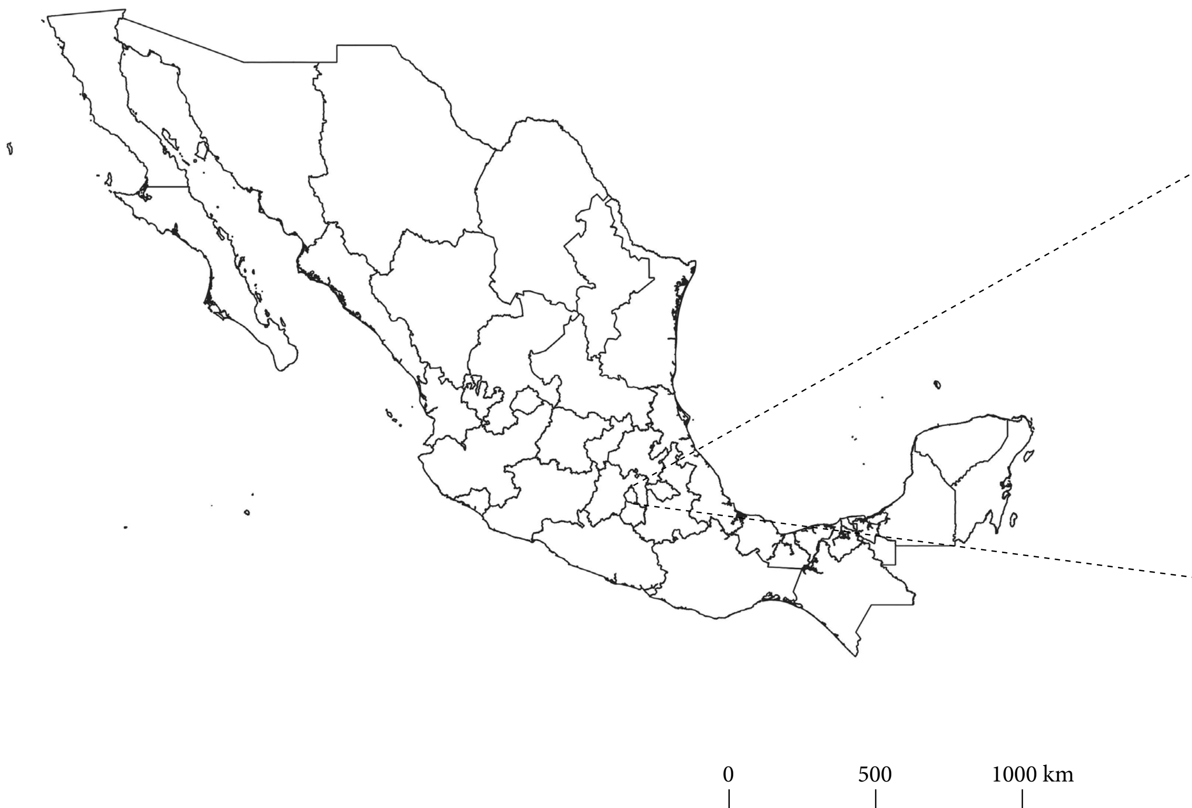


fig 4. Location of the Basin Area of Mexico City

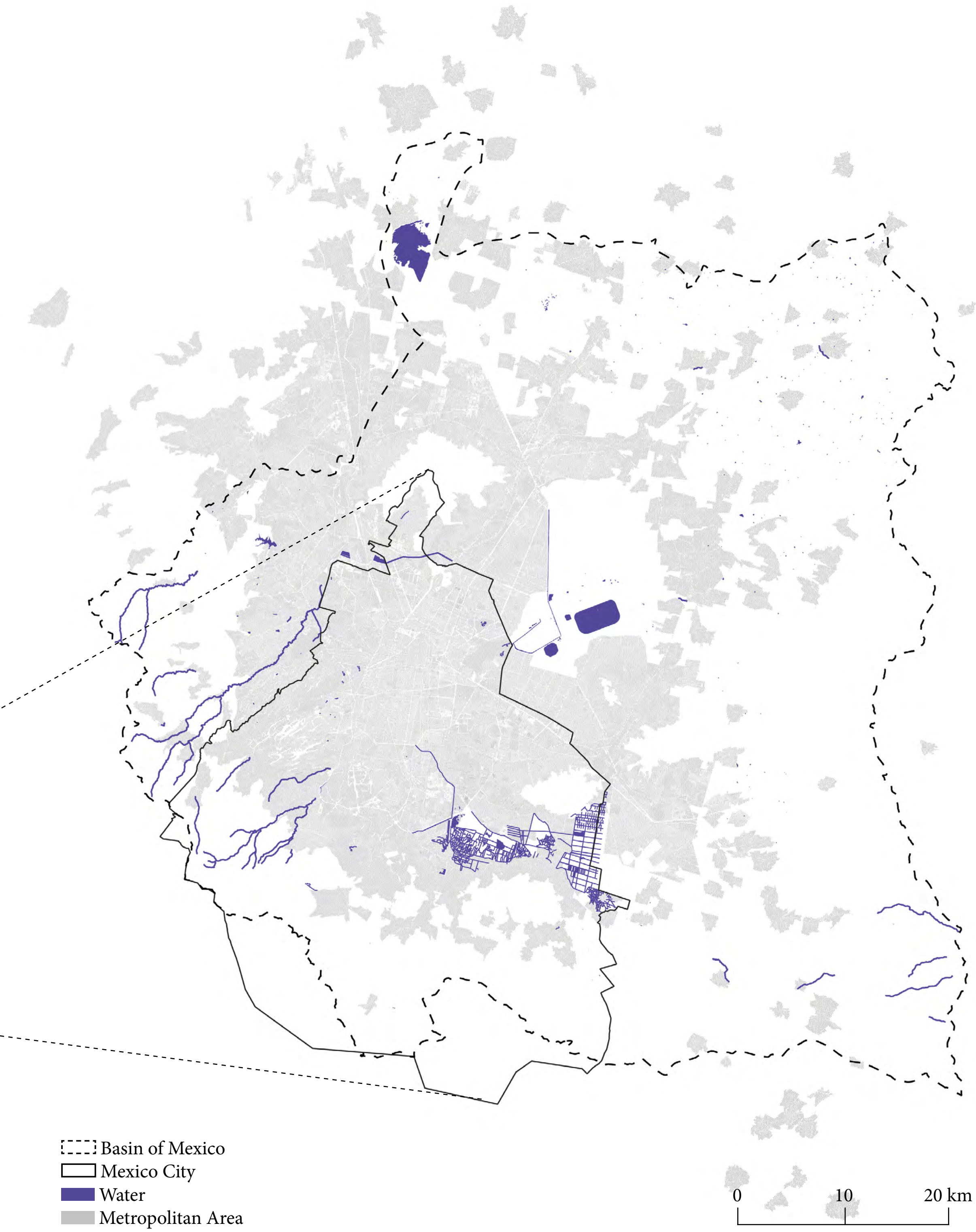

Basin of Mexico
Mexico City
Water
Metropolitan Area
0
10
20 km

fig 5: Horizontal sprawl of Mexico City
(Photo: Santiago Arau, 2018)

Average Annual Precipitation

Mexico City is situated at a tropical latitude but at a high altitude, ranging from 2,200 to 2,600 meters across its various districts. Rainfall occurs primarily during the summer months, exceeding 100 millimetres per month from June to September, with moderate rain in May and October, while the other months see minimal precipitation. The dry season is prolonged, lasting from November to April. *(Mexico City Climate: Weather by Month, Temperature, Rain,* n.d.*)*

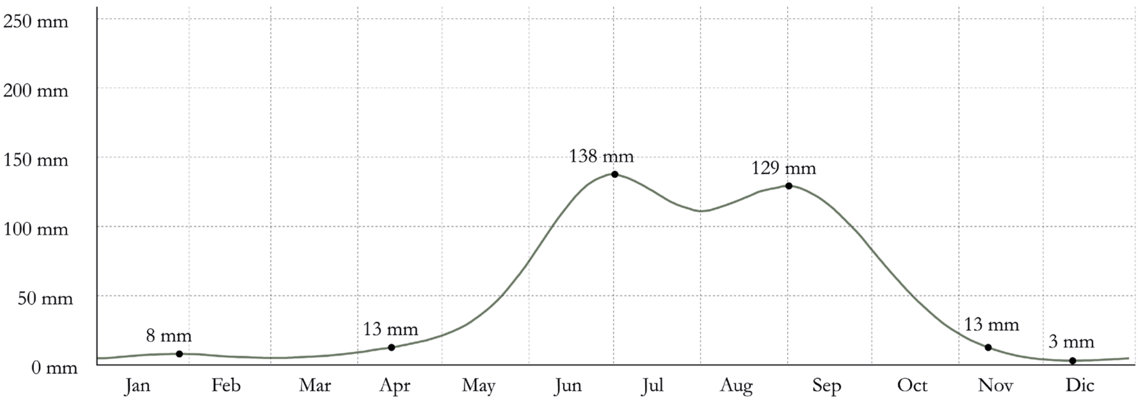


fig 6. Graph of average precipitation by month

Average Annual precipitation (mm)

Basin of Mexico
Mexico City
600-800 mm
800-1000 mm
1000-1200 mm
1200-1500 mm

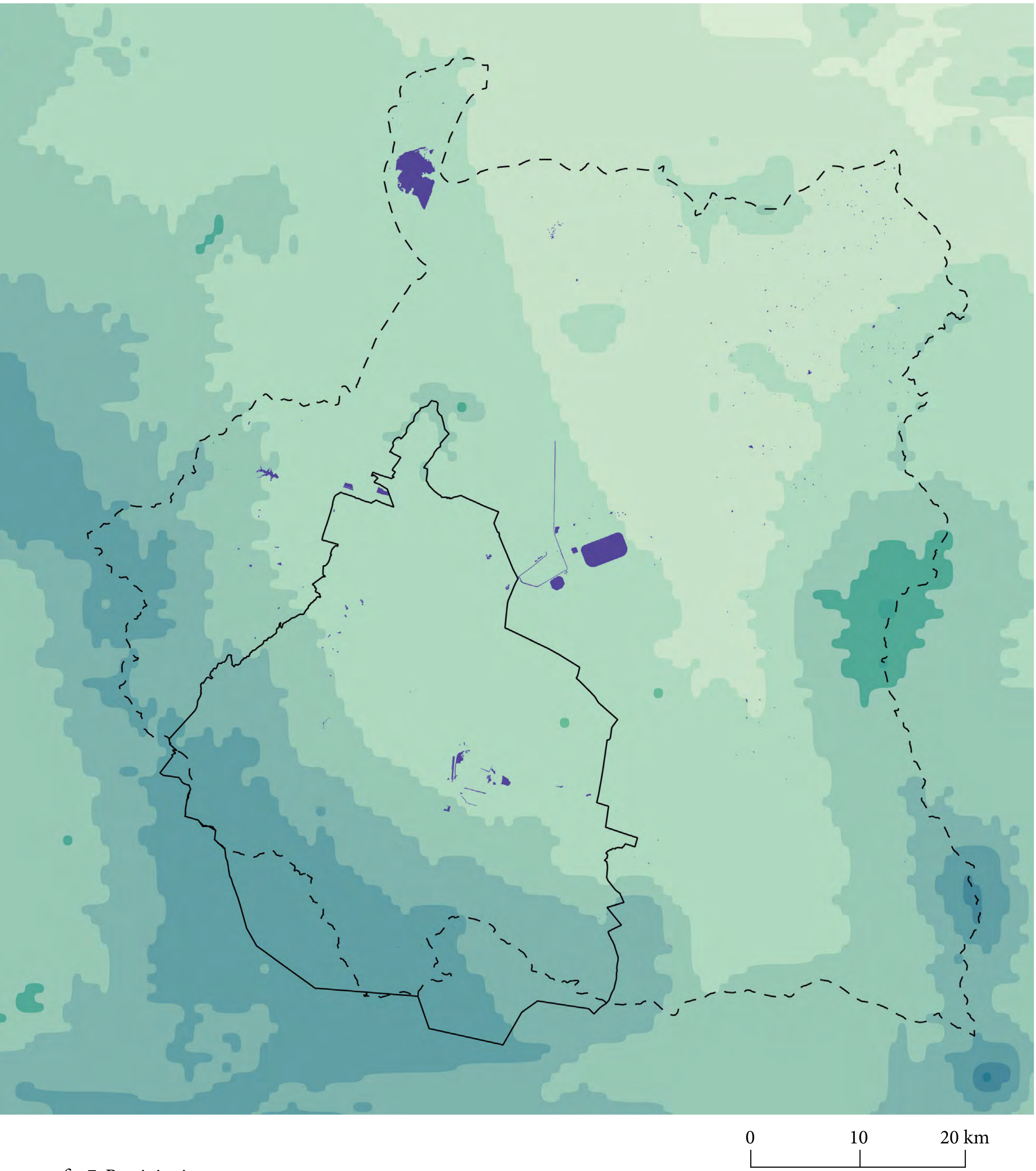


fig 7. Precipitation map

Average Annual Temperature

The warm season lasts 2.5 months, from March 22 to June 8, and is characterised by average daily high temperatures exceeding 26°C. May is the hottest month in Mexico City, with average highs of 27°C and lows of 13°C.
Conversely, the cool season lasts for 2.5 months, from November 19 to February 3, during which average daily high temperatures fall below 22°C. The coldest month is January, with average lows of 7°c and highs of 22°c. *(Mexico City Climate, Weather by Month, Average Temperature (Mexico)*, n.d.)

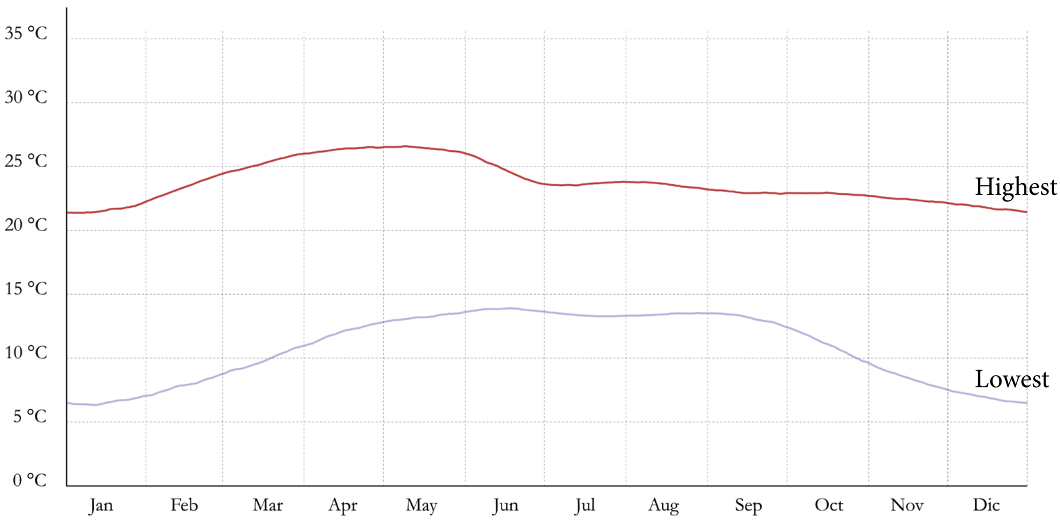


fig 8. Graph of average temperature by month

Average Annual Temperature (°C)

Basin of Mexico
Mexico City
8-10° C
10-12° C
12-14° C
14-16 ° C
16-18° C

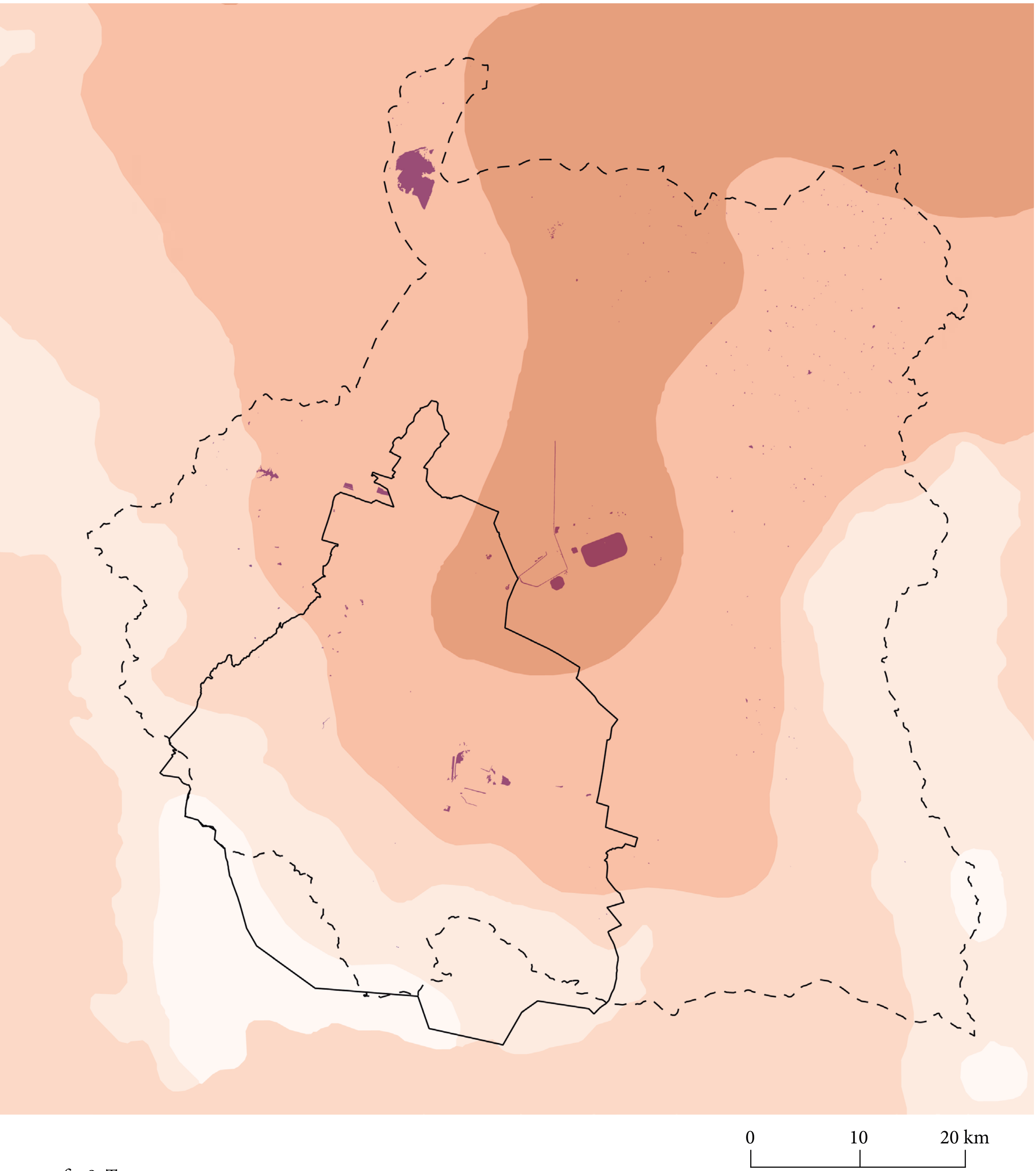


fig 9. Temperature map

Introduction

Subject

The element that gave life to the Basin on which Mexico City is built is no longer present. The wit and cosmotechnical expertise of the early inhabitants made it possible for them to live on water by finding ways to manage floods and provide drinking water to their residents.

After the conquest in 1521, the Basin began to be drained to become the new capital of New Spain. During the 20th century, especially between the 1940s and 1970s, there was significant population growth in Mexico City. "This happened arbitrarily, resulting in a series of contradictions and dysfunctions reflected in a complex urban structure that is highly disordered and expressly incomplete." (Marín Zamora, 2009)

Water is a persistent concern on the political agenda, and efforts have been made to address the issue by implementing large-scale infrastructure projects. However, mismanagement has led to an uncertain and intermittent supply, failing to meet the excessive demand for water, which has caused land subsidence and flooding. Furthermore, it has erased the collective memory of what the Basin once was.

However, certain voids become prominent. These are hydrological remnants, serving as the sole witnesses and final representatives of the city's lake-filled history. These voids are neither integrated into the city's vibrant life nor involved spatially, functionally, or socially. Marginalised, they are attached to the city, yet they remain disconnected. (Marín Zamora, 2009)

fig 10. Street Art depicting Tlaloc.
(Photo: Santiago Arau, 2021)

Problem Statement

Mexico City faces a multidisciplinary set of challenges that hinder sustainable development and quality of life for its inhabitants. The problem is rooted in its history, which has led to social inequality and poor governance. Centralised large-scale water supply and drainage systems have been implemented to tackle the population's demands; however, the dependence on this type of system has overlooked local needs. The effectiveness of this centralised approach is limited due to deficiencies and changing needs, and it does not offer everyone fair access to water.

Moreover, this mismanagement has exacerbated water scarcity and contamination, disproportionately affecting vulnerable populations. The lack of community awareness and improper urban planning heightens the pressure on essential spots for water processes, such as regulatory basins, which help mitigate urban flooding. It threatens them with polluted wastewater and irregular settlements. The spatial design challenge is integrating urban water management through innovative landscape design so that public spaces can solve water-related problems and improve urban livability. Nevertheless, managing water in this space is not a technical issue alone, but a task of reintroducing the ancient values of water back into the urban landscape.

How can historical water values in the Basin of Mexico be reintroduced to mitigate flooding, water scarcity, and pollution, enhance community awareness and engagement to conserve the unique endemic ecosystem in Mexico City, particularly in Xochimilco?

1. What are the indigenous values associated with water in the Mexico Basin, and what historical events have disrupted the relationship that modern inhabitants of Mexico City once had with it?
2. What are the characteristics of the centralised system in the Mexico City basin, and what implications does this system hold for the urban environment and daily life within the city?
3. Why is the conservation of Xochimilco important for the systemic functioning of the basin? What is the value of preserving this cultural landscape?
4. What are the viable alternatives to the prevailing model in Mexico City? In what ways can we inspire both the residents and visitors of Xochimilco to actively participate in water conservation efforts?

Defining the objectives

The objective within this thesis is to design a space that contributes to the marginalised water system of Xochimilco, as a way of preservation. The design of this space should consider the following aspects:

- The space should be accessible to people as a means to raise social and collective awareness about the cultural landscape conservation, the importance of the lacustrine ecosystem in Mexico City, and the contribution of Xochimilco to water metabolism in the Basin.
- The space invites visitors to reevaluate their relationship with the natural world, creating a more balanced and resilient future for both people and the planet.
- The space should include a circular and local water treatment system, which would utilise innovative technologies, such as wetlands, to treat and recycle water on-site. It should be designed to manage local water sources effectively.

Furthermore, the aim of this project in a larger scale is to explore an existing interdisciplinary network of projects addressing water issues in Mexico City, as a means of positioning the design to better understand the various approaches and collaborations sharing the same concern.

Approaches to Analysis and Design

Historical Analysis

- Review articles and reports that discuss the history to gain an understanding of the development of the Basin and the significant events that shaped the relationships between people and water.
- Visits to various museums, such as the Museum of Anthropology and History, to recognise the meaning of the Mexican cultural landscape and take a position as a designer for future developments.
- Review old cartographies and photographs.

Geospatial Analysis and Mapping

- Tools as mapping by using GIS (Geographical Information Systems) tools to understand water distribution, areas of vulnerability, and the relationship between social and spatial qualities.
- Studies on land-use changes, resource management, and ecosystem services.

Social-ecological systems analysis

- This analysis is a literature review on resilience, examining how communities and ecosystems respond to changes or shocks, including climate change, natural disasters, and social and political conflicts. Also, it assesses the role of policies, regulations, and governance structures in managing social-ecological systems.
- Conducting interviews with experts to gain insights into the challenges and opportunities related to the water system and its management.

Research on site

- Field observation and sketching to record actors' behaviours.
- Photographic documentation of the site's existing conditions.
- A collection of contextual information by visiting historical places.

Design explorations

- Case studies analysing specific cases where decentralised solutions for circularity have been implemented in comparable urban environments.
- Research on Traditional Water Systems in the framework of the Circular Water Stories graduation studio, such as the East Kolkata Wetlands in India.
- Design thinking approaches to resilience, considering adaptation to changing conditions, such as drought and rain seasons.

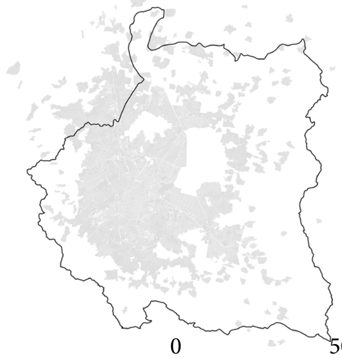
Design Assignment

To design a landscape that contributes to the marginalised system of Xochimilco, thriving in the ambivalent, wet and dry weather conditions of Mexico City, by incorporating water treatment. Similarly, the space should be accessible to the public to raise social and collective awareness about water conservation, the importance of the lake ecosystem in Mexico City, and the contributions of Xochimilco to the hydrological system. The challenge lies in weaving the timeless values and traditions of Xochimilco into a forward-looking vision for the future.

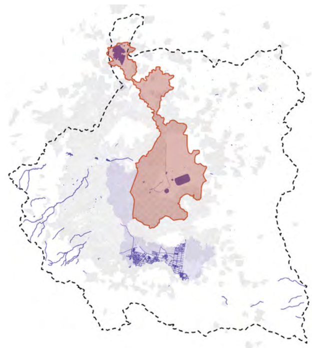
Design Framework

The framework for the design assignment is structured around three distinct scales that facilitate a comprehensive progression from a unified vision to the intricate details of design elements. The first scale encompasses the hydrological boundary of the Basin of Mexico, which serves as the context for water management and ecological considerations. The second scale focuses on Xochimilco's Conservation Land, allowing for the exploration of social practices in conjunction with the natural world. Lastly, the third scale delves into the Cienega Chica, a smaller, localised ecosystem where specific design elements can address environmental challenges and enhance community engagement.

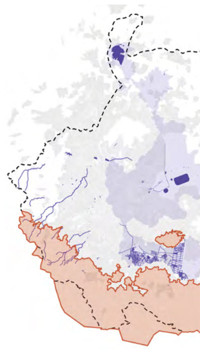
1. Basin of Mexico Hydrological Boundary



0 50 km

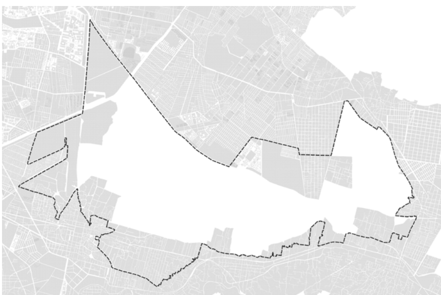


1. Retain and Store



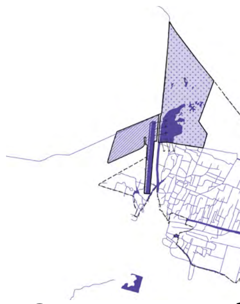
2. Infiltrate

2. Xochimilco's Conservation Land



0 5 km

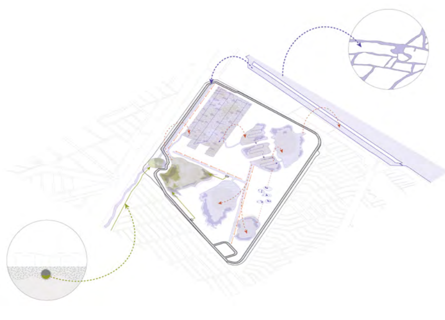
1. Creating an interconnected space for new ways of interaction



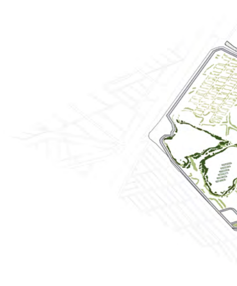
2. Connecting water and

3. Cienega Chica

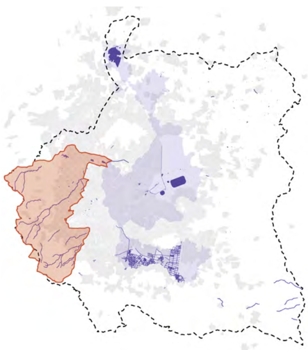
0 500 m



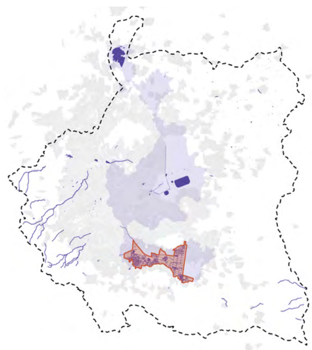
1. A New Cleaning System



2. Vegetation Restoration

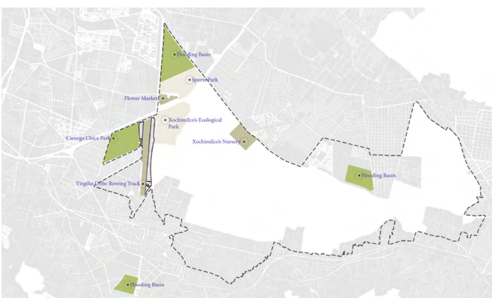


3. Delay and Infiltrate



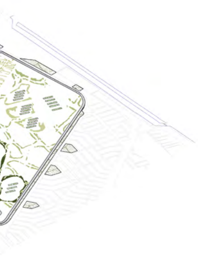
4. Clean

purification network



3. Repurposing urban infrastructure

4. Prioritising an ecological balance



n and Phytoremediation

3. Park Program Integration

Theoretical Framework

The theoretical framework exposes the positioning of this research concerning different principles that lead to the design choices in a landscape in disequilibrium. In this chapter, various concepts are introduced and defined as they are mentioned throughout this work.

Decentralisation

- In the context of Mexico City, it is necessary to find alternatives for the sustainable water management model, in which water has been a social segregator. In "Hydric Districts," Oficina de Resiliencia Urbana et al. examine the potential of a medium-scale approach to support the transition to a sustainable urban design and water management model in Mexico City. Unlike large-scale conventional grey infrastructure and small-scale green infrastructure, medium-scale redevelopment may present a more coordinated and informed opportunity to tackle the city's water crisis.
- In the work of Anna Lowenhaupt Tsing, she proposes the idea that landscapes are sites for more-than-human interactions. Therefore, they are radical tools for decentering anthropos. She states that landscapes are not backdrops for historical action, but they are active; watching landscapes in formation shows humans joining other living beings in shaping worlds.
- Tsing also claims that if we are interested in livability, impermanence, and emergence, we should observe the actions of landscape assemblages. (2015)

Palimpsest

- This passage argues that landscape architecture is not about creating something from scratch, but instead transforming what is already there. Landscapes are like palimpsests, reused parchments where old writing is scraped off to make way for new text. Even though the old text is partially erased, it still leaves traces. Similarly, landscapes are built up over time, with each layer of development leaving its mark. These layers tell a story about the political, cultural, and economic forces that shaped the land. The cool thing is that these layers can either reinforce or contradict each other, creating a complex and dynamic landscape. So, as landscape architects, we need to understand these existing layers before we can start to transform them. (Bobbink & de Wit, 2020)

Aesthetics

- The work "Design with Nature" by Ian McHarg proposes that designers should work in harmony with nature, not just on it. His approach is based on a deep understanding of ecological systems and landscape patterns. It also emphasises the importance of biodiversity and how design can foster rich and diverse environments. Furthermore, it seeks to align the aesthetics of the landscape with the natural beauty, creating pleasant spaces and encouraging a connection with nature.
- Elizabeth K. Meyer examines the role of beauty and aesthetics in the sustainability agenda. She argues that it takes more than ecologically regenerative designs for culture to become sustainable; therefore, what is needed are designed landscapes that provoke those who experience them to become more aware of how their actions affect the environment, and to care enough to make changes. So, this involves the role of aesthetic environmental experiences in transforming human consciousness from an egocentric to a more biocentric perspective. (2008)

Among the rushes and the reeds
Where the rock cactus stands
Where the eagle stops and rests
Where the eagle shrieks and pipes
Where the eagle relaxes and takes pleasure
Where the eagle dines and gorges itself
Where the snake hisses
And the fish glides
Where the blue-green and yellow waters
Merge and seethe
At the water's center
Where the waters enter.
Where the rushes and the reeds whisper
Where the white water-snakes
And the white frogs dwell
Where the white cypress
And the white leafy willow stands
There, it is declared
That sweat and toil have come to be known.

-Cantares Mexicanos

fig 11. El tianguis de Tlatelolco by Diego Rivera
(Photo: Jen Wilton via Flickr, 2012)

1. The historical legacy of water in Mexico City

Ancient Relationships with Water

The Basin has been inhabited for over 7,000 years, with early human settlements located near the lakes. Small kingdoms formed around these water bodies, and many migrations from various Mesoamerican groups to the Basin took place, including the Mexica, who settled on an island in the lake around 1325. Through alliances and conflict, they developed Tenochtitlan, a thriving hybrid city covering over 300,000 square kilometres by the early 16th century.

Tenochtitlan was an island city. The primitive settlement founded in the zone was described as a swamp and marshland near the western shore of Lake Texcoco during the first half of the fourteenth century. Residential space was created by the consolidation and partial drainage of higher ground or by the construction of artificial platforms, known as chinampas, for residential structures or as garden plots. (Calnek, 1972)
For the Mexicas, water was more than a resource to live; they believed in the concept of teotl, a "notion of a sacred quality, but with the idea that it could be physically manifested in some specific presence, a rainstorm, a lake, or a majestic mountain." (Townsend, n.d.)

The unusual watery environment of the Basin, within which Tenochtitlan was built, and the means of controlling it have been a source of wonder and puzzlement; the waterworks are the key to understanding the Mexica state. An organising principle of the city is visible: the mirroring of the human-made environment, its lived space, to that of the natural and therefore sacred one (Mundy, 2015).

Significant infrastructure projects were undertaken to manage water resources. One notable project is the Nezahualcoyotl dam, which spans over 16 kilometres and was designed to separate the saline waters of Lake Texcoco from the other lakes. Another important structure is the Ahuizotl dike, which was built to prevent flooding. (Corazón Capital, 2025)

When the Mexica first settled on the islands of the lake, they implemented the chinampa system to enhance the ratio of dry land to the lake and the limited space available on the islands. As their kingdom expanded along the shores and into the lake, intensive agriculture became a method of tribute for the communities in the southern lakes of Xochimilco, which were already engaged in chinampa agriculture due to the abundance of spring water in the southern area. In contrast, the northeast was richer in sediments, making it more challenging for agricultural use. (Bobadilla García, 2023)

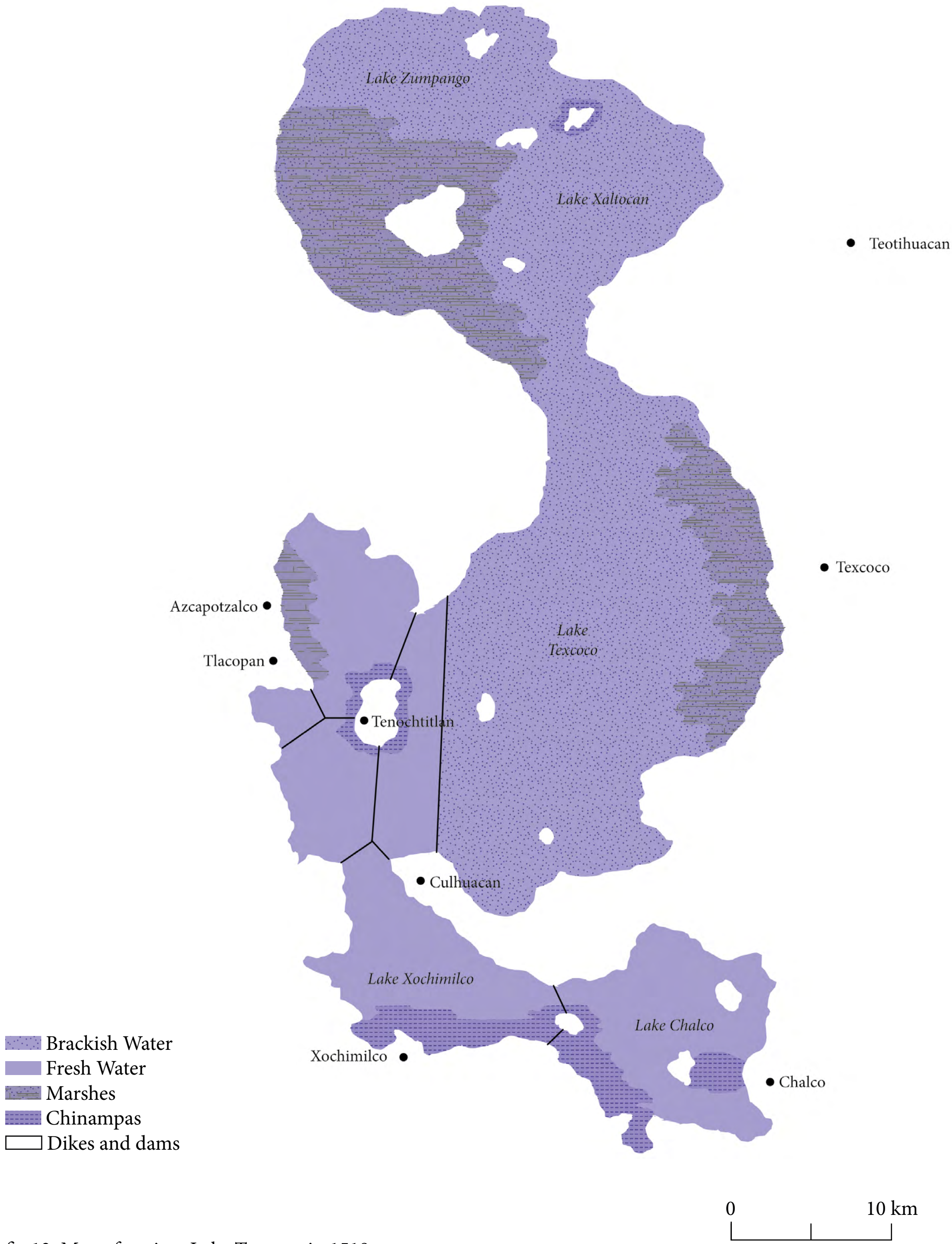


fig 12. Map of ancient Lake Texcoco in 1519

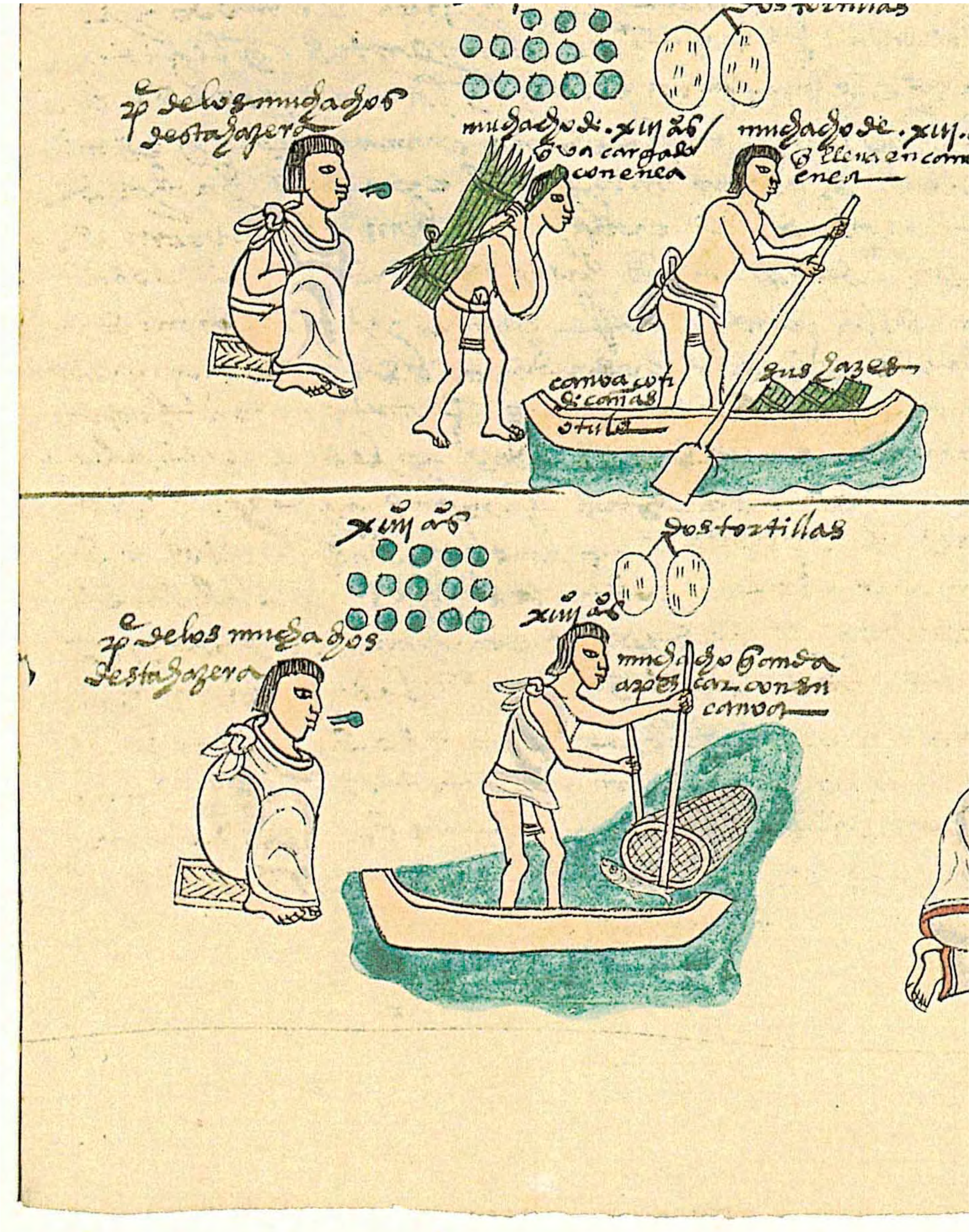


fig 13. Codex depicting the education of young Mexicas boys
(Source: Mendoza Codex, 1542)

fig 14. Mexicas building a Chinampa
(Source: mxc.com.mx, n.d.)

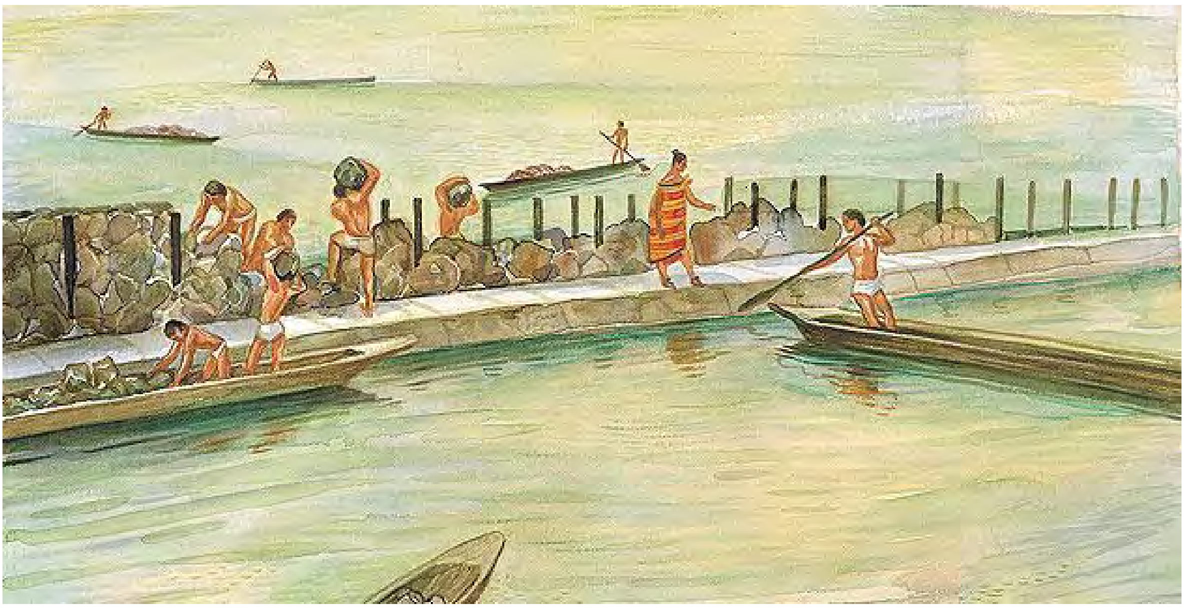


fig 15. Mexicas building the Nezahualcoyotl Dam
(Source: Mexico Desconocido, n.d.)

Drainage of the Lake

At the start of the 16th century, European forces conquered Tenochtitlan. The Spanish then built a new city on top of the ruins, repurposing its temples and government buildings. The disruption of Mexico-Tenochtitlan's water supply was a significant factor in the siege, contributing to its population decline.

Following the conquest, the city's urban layout and infrastructure were largely maintained, but the lakes' water was drained, and dirt was filled into central areas to expand the dry land. Indigenous people sought to preserve their water management knowledge to negotiate with the Spanish, who feared that control over water resources might lead to uprisings. (Bobadilla García, 2023)

After the conquest, a significant and lasting change occurred in the city's relationship with water. The massive floods of the early 17th century prompted the implementation of measures to control the lakes' water levels and quickly drain rainwater from the basin. Key projects included the San Lorenzo levee, the Great Ditch of Nochistongo, and the Huehuetoca drainage system. The rivers that were part of the lake system were tubed to create avenues and streets. Subsequently, the Great Drainage Canal was constructed, along with major infrastructure developments such as the Deep Drainage System and, more recently, the Eastern Emitter Tunnel (TEO). (Corazón Capital , 2025)

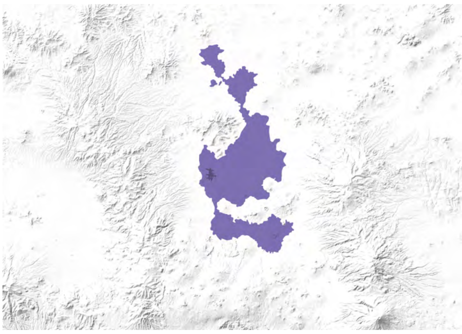
fig 16. Mexico City in the colonial era
(Source: www.nhmdemexico.colmex.mx, n.d.)

fig 17. The Great Nochistongo Ditch
(Photo: The New York Public Library, 1898)

fig 18. Deep Drainage System
(Photo: Fundación ICA, 1975)

From Origins to Present-Day Transformation

1500



1325
Tenochtitlan establishment

1521
Spanish conquest begins

1545
Mexico City establishment

1555

1580

1604 and 1607

1810-1821
Mexican Independence war

△ **1381**
Chapultepec aqueduct

1449
Nezahualcoyotl dike

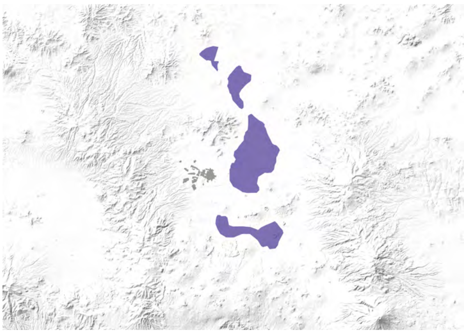
△ **1550**
Azcapotzalco aqueduct

○ **1789**
Drainage steering through mountains cut

fig 19: Chronological overview of waterworks, starting with Tenochtitlan's construction and ending with today's modern infrastructure.

- ● Flooding
- ✚ Earthquake
- △ Water supply
- ○ Sewage

1824



1929

1846
Mexico - USA war

1851

1864
Maximilian I Emperor

1880
Mexico City railway

1901

1910
Mexican Revolution war

1925

1825
Xola and Tacubaya rivers piping

○ **1865**
Large sewage channel
Culhuacan dike

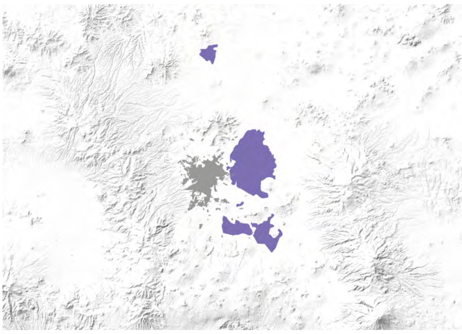
1888
First evidence of subsidence

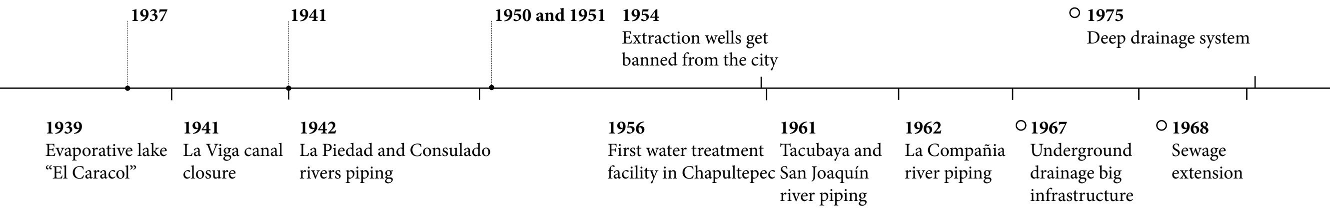
1904
Change of Churubusco river course

1913
Xochimilco aqueduct
Chapultepec water tanks

1928
Change of La Compañia river course

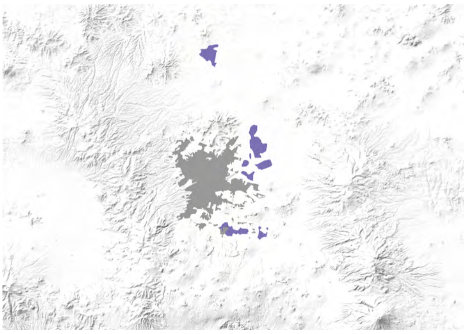
1950



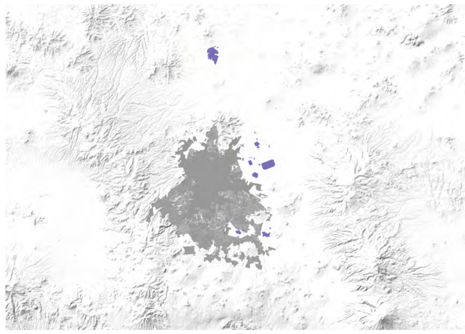

1937
1941
1950 and 1951
1954
Extraction wells get banned from the city
1975
Deep drainage system
1939
Evaporative lake "El Caracol"
1941
La Viga canal closure
1942
La Piedad and Consulado rivers piping
1956
First water treatment facility in Chapultepec
1961
Tacubaya and San Joaquín river piping
1962
La Compañia river piping
1967
Underground drainage big infrastructure
1968
Sewage extension

- ● Flooding
- ✚ Earthquake
- △ Water supply
- ○ Sewage

1980



2015



1985 ✚ · 2006 ● · 2009 ● · 2017 ✚

1971
Tizapan river piping

△ **1976**
Lerma - Cutzamala system

1977
Churubusco river piping

1980
Nabor Carrillo flooding plain

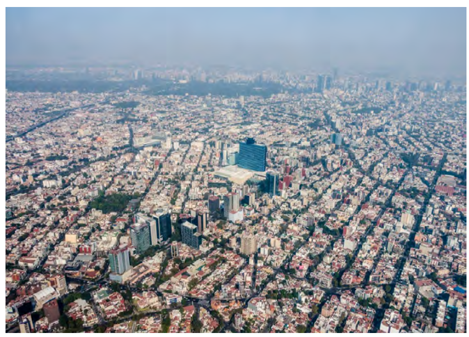
1992
End of sewage construction

2007
Atotonilco wastewater treatment plant

△ **2008**
Santa Catarina aqueduct

○ Sewage extension

○ **2016**
Chimalhuacan tunnel



Urban Expansion Timeline

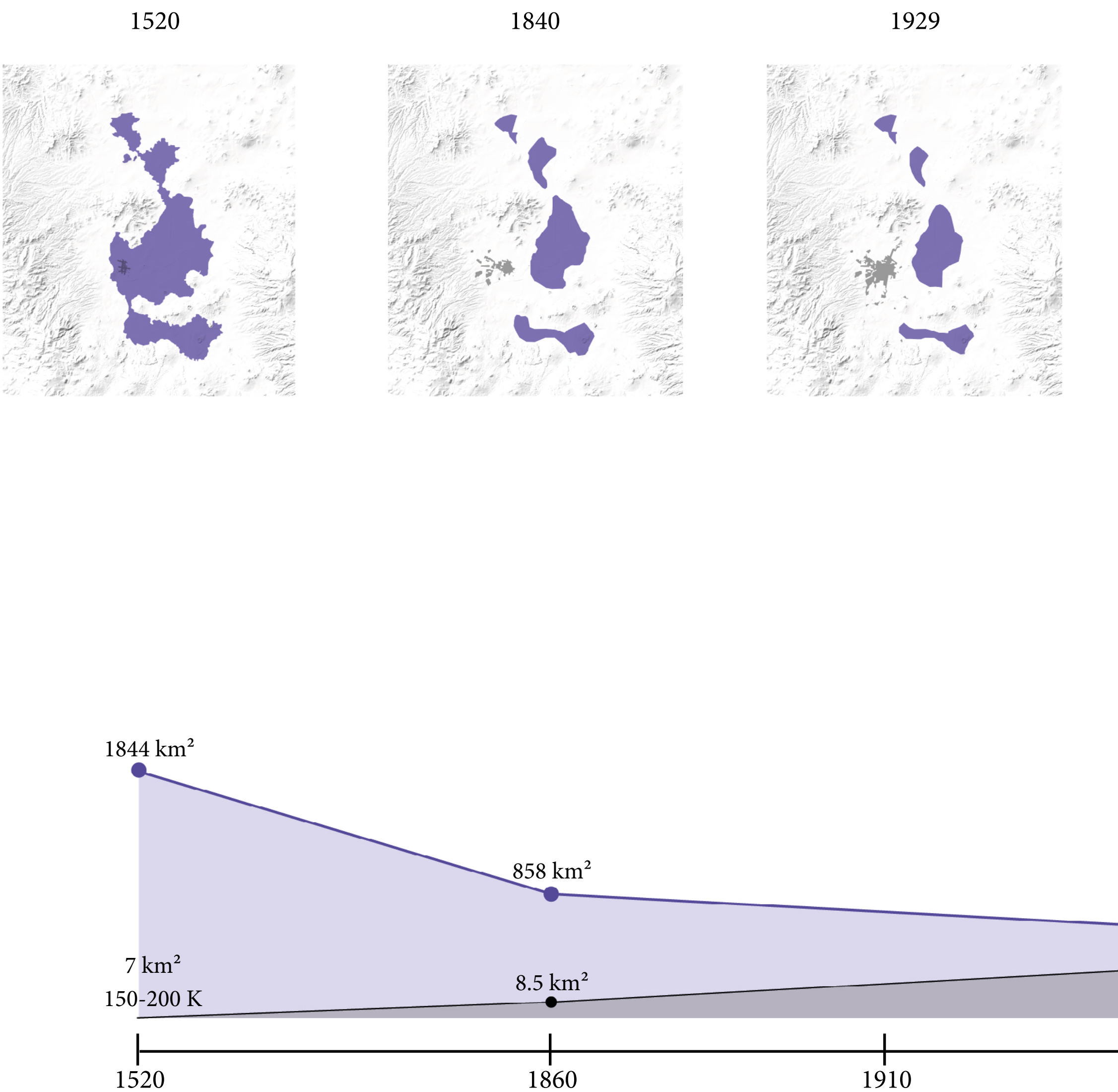
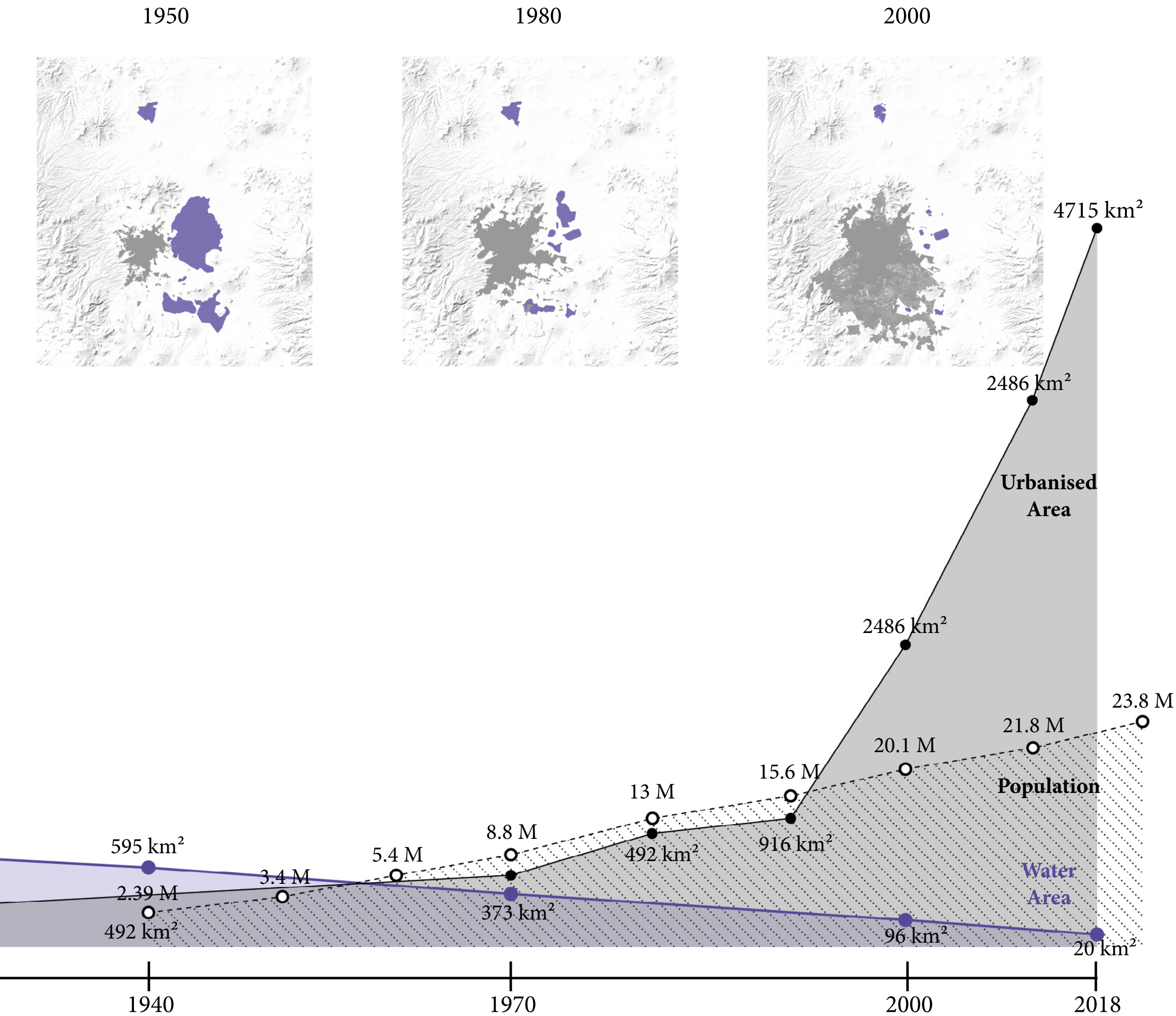


fig 20. Timeline of the relationship between the growth of urban areas, the presence of water bodies and population growth


1950
1980
2000
4715 km²
2486 km²
Urbanised
Area
2486 km²
23.8 M
21.8 M
20.1 M
15.6 M
Population
13 M
8.8 M
916 km²
595 km²
5.4 M
492 km²
3.4 M
Water
Area
2.39 M
373 km²
492 km²
96 km²
20 km²
1940
1970
2000
2018

Aquifers over-exploitation

It was in the middle of the last century that the formal intensive exploitation of the aquifer began, as the closest springs had already been exhausted by then. Water wells are spread all over the Basin of Mexico. (Marín Zamora, 2009)

The aquifers are geological formations permeated with easily extractable water. The alluvial deposits, composed of volcanic gravels and sands that surround and underlie the ancient lake bed, serve as the primary hydrogeological unit for extraction. This area intercepts the rainwater that falls on the surrounding areas, in addition to the water that reaches it through underground streams from the permeable mountains surrounding it.

The mountains surrounding the Basin slowly recharge water through their pores and fractures. The Chichinautzín and Santa Catarina mountain ranges have the highest infiltration capacity (Breña Puyol et al., 2009).

In 1952, the volume extracted, 22 m3/s, exceeded the volume recharged, 19 m3/s. In 2007, the extraction volume in the Basin was 59.5 m3/s, almost three times the recharge volume.

According to official figures, the extraction rate for the four principal aquifers in the Basin is currently nearly three times their recharge rate. (Breña Puyol et al., 2009)

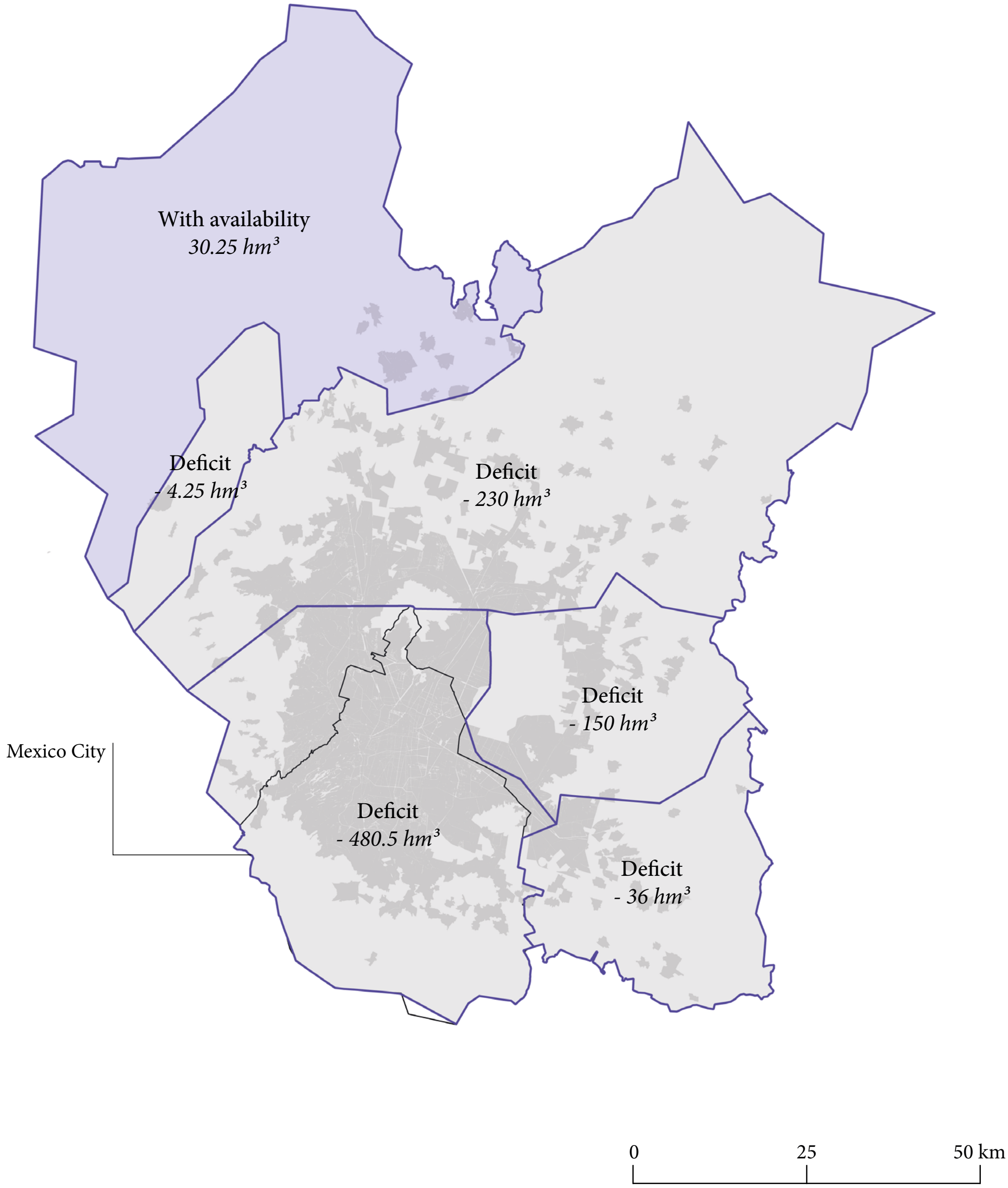


fig 21. Availability in aquifers surrounding the metropolitan area of Mexico City

fig 22. La Ciudad de México in 1949 by Juan O'Gorman
(Photo: Fundación ICA, n.d.)


VIVA MEXICO
METROPOLITAN
AQUI SE REPRESENTA EL CORAZON DE LA CIUDAD DE MEXICO
TAL Y COMO SE VE DESDE ARRIBA DEL MONUMENTO DE
LA REVOLUCION EN DIRECCION AL ORIENTE

2. Centralised Model

Lerma Cutzamala and the Deep Drainage System

The Cutzamala and Lerma systems were designed to replace water from overexploited aquifers with water imported from other basins. However, by not taking measures to curb urban growth, importing water from other basins did not reduce overexploitation rates.
The Lerma System, built to bring 15 m3/s to the Mexico Basin, had to reduce its flow to 5 m3/s, due to severe subsidence resulting from overpumping inflicted on the Lerma aquifers. The Cutzamala System, which brings water from the states of Mexico and Michoacán, has decreased its initial capacity from 20 m3/s to 15 m3/s. (Breña Puyol et al., 2009/2009)

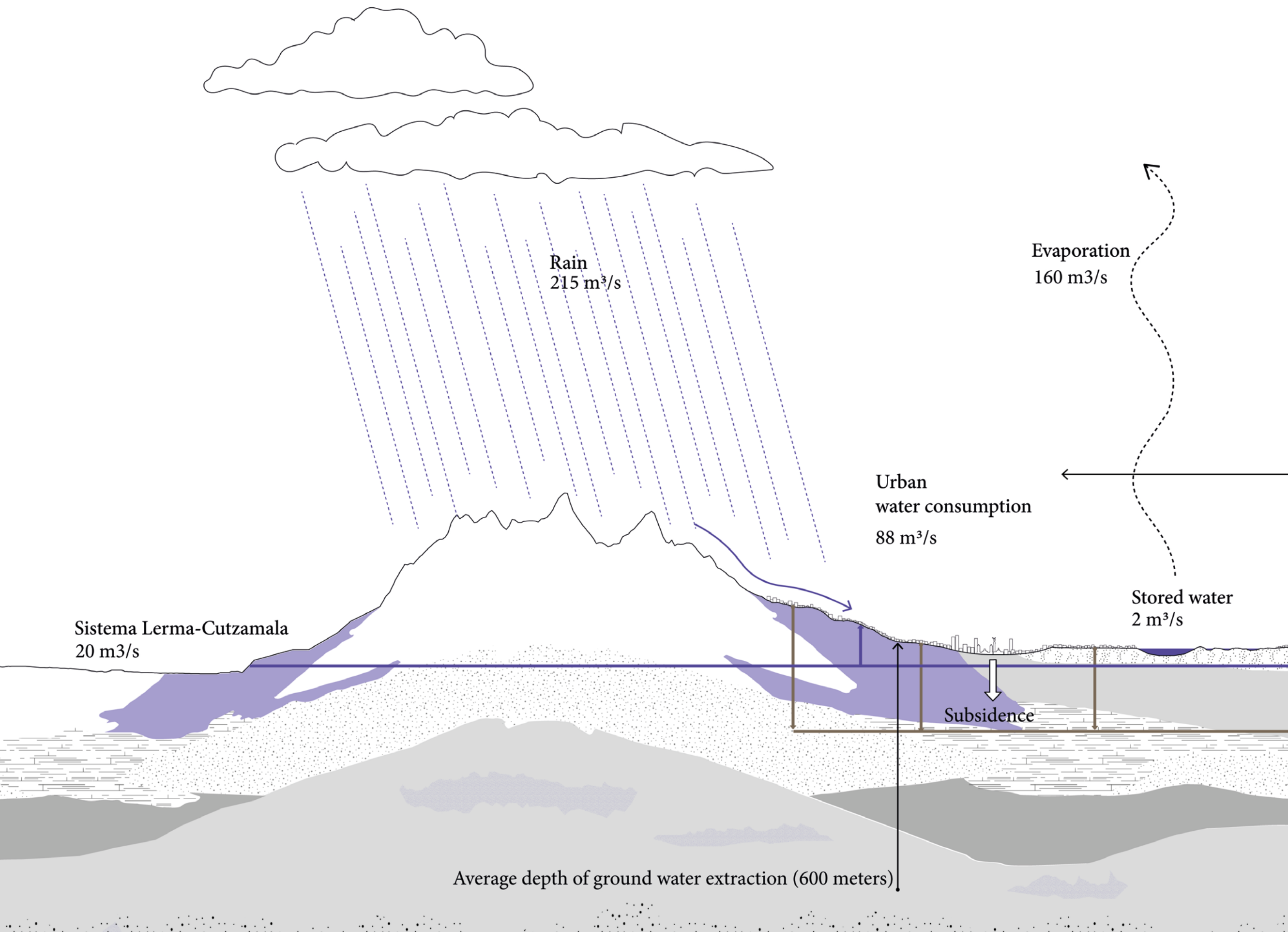
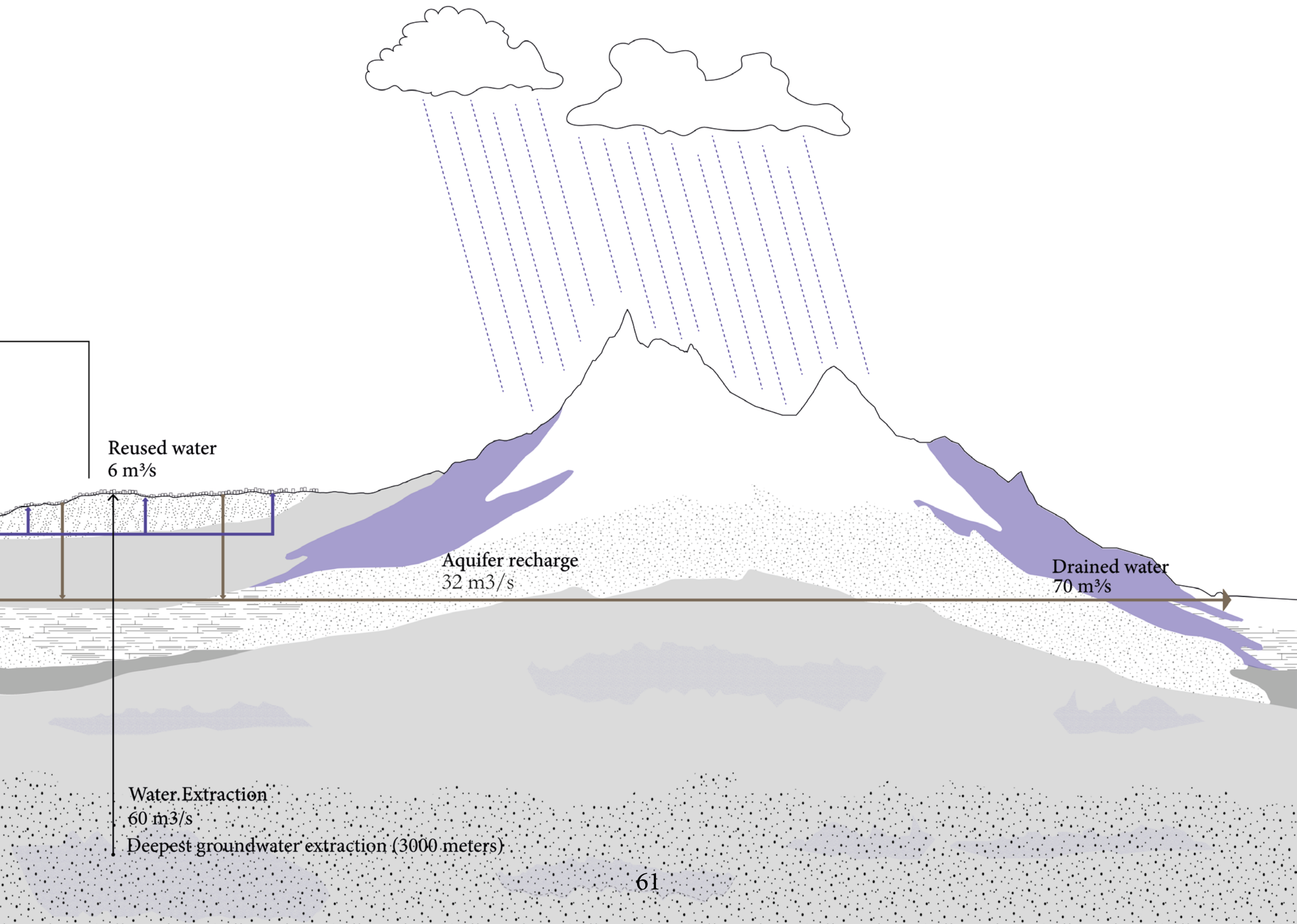


fig 23. Lerma-Cutzamala Hydroelectric System Section, groundwater Extraction and its disposal outside the Basin

As mentioned above, the Deep Drainage System is responsible for draining water during the rainy season and wastewater out of the basin, which corresponds to 70m3/s. In conceptual terms, the whole drainage system of the valley can be understood as an anti-natural system (against the natural slope of the basin) to try to maintain the water balance and avoid flooding in the city on the one hand, and on the other hand, to always carry and remove water to the north of the basin. (Barrón, 2022)



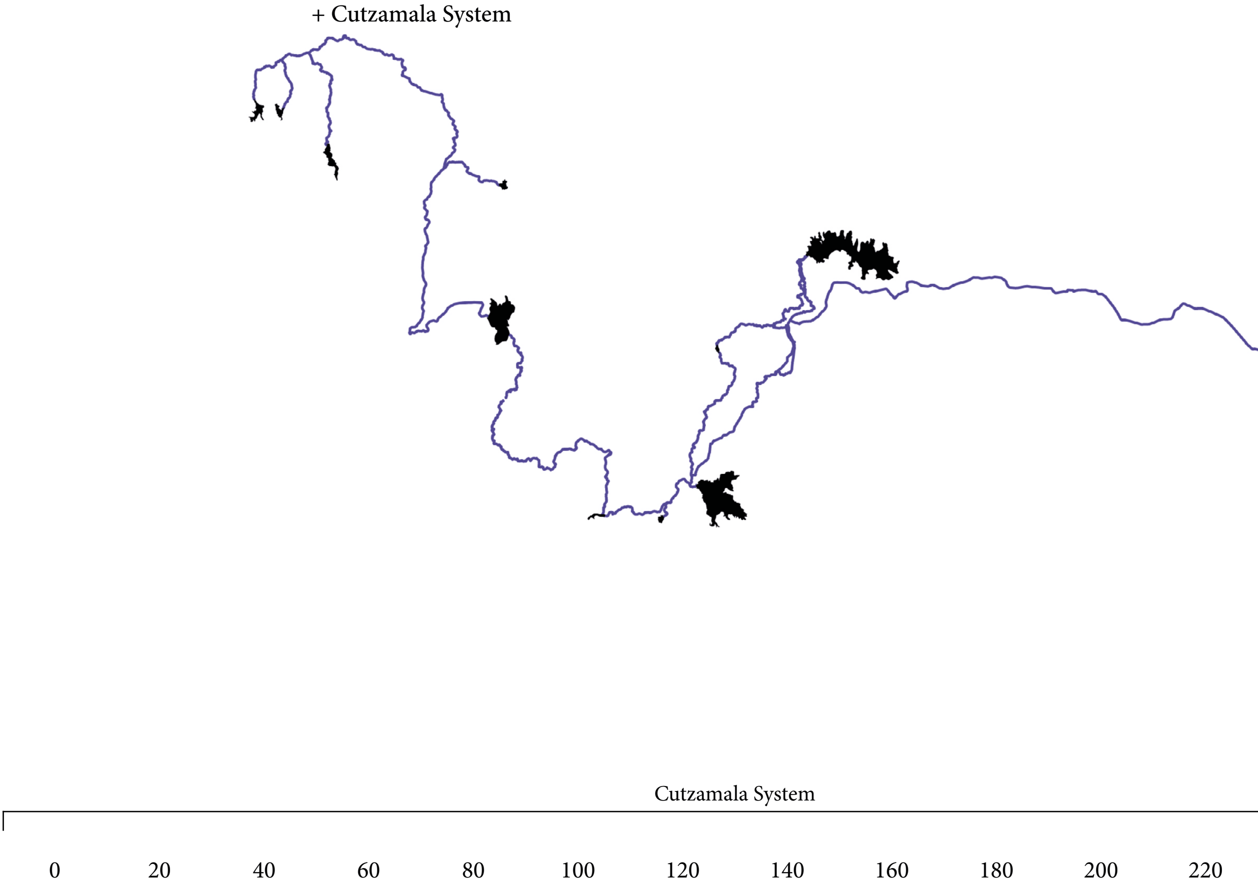


fig 24. The total system to supply the metropolitan area of Mexico City from the extraction of water to disposal in the Mezquital Valley.
(Source: Smith, 2024)


+ Mezquital Valley
0
25
50 km
Basin of Mexico
Mezquital Valley
240
260
280
300
320
340
360
380
400
420
460
480
Distance (km)

The Mezquital Valley has transformed into an agricultural region that supports three harvests each year. The sewer system of Mexico City provides it with more water than many of Mexico's major rivers, delivering an average of about 60 cubic meters per second throughout the year. (Smith, 2024)

fig 25. Flood irrigation in the Mezquital Valley.
(Photo: Rebecca Blackwell, n.d.)

Differential Land Subsidence

In the Basin of Mexico, groundwater is being extracted at such a high rate that Mexico City is sinking up to 20 centimetres per year (BBC, 2019).

The ongoing overexploitation of the aquifer beneath Mexico City has caused the dehydration of the clay layer, leading to land subsidence. This has resulted in significant damage to infrastructure, causing leaks, and required the installation of pumping stations throughout the city to manage wastewater and stormwater. (CDMX Resilience Agency et al., 2019)

In some parts of the city, subsidence has exceeded 10 meters in depth; however, subsidence is uneven, depending on hydraulic pressures and soil type. Differential subsidence and a lack of soil permeability cause flooding in certain urban regions. Subsidence is a progressive phenomenon. (Secretaría de Gestión Integral de Riesgos y Protección Civil de la Ciudad de México, 2023)

fig 26. Subsidence in downtown Mexico City
(Photo: Josh Haner, 2021)

Urban Floodings

The urbanisation significantly negatively impacted the Basin's ability to mitigate rainfall peaks. This transformation of the natural landscape disrupts the hydrological processes that previously allowed water to infiltrate the soil through agricultural and forested areas. As these spaces are replaced by impermeable surfaces, such as concrete and asphalt, rainwater that would typically be absorbed by the land now violently rushes towards urban areas. Consequently, this flow of water arrives with considerable force, carrying debris and waste, directly affecting the communities situated in the lower basin. The effects of this uncontrolled urbanisation become even more apparent during extreme weather events, which are increasingly common as a result of climate change. (Breña Puyol et al., 2009)

fig 27. Floodingd after heavy rains in summer
(Photo: Cuarto oscuro, n.d.)

Water scarcity

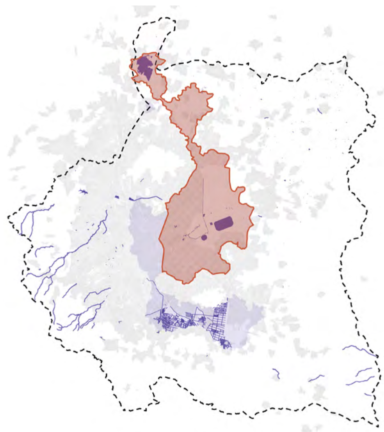
There is too limited drinking water to satisfy current and future demands, and, at the same time, torrential rainfall during the rainy season leads to frequent flooding. These problems are exacerbated by the unsatisfactory quality of drinking water, waste due to leaks, insufficient treatment, and the non-collection of rainwater. (Breña Puyol et al., 2009)

As Mexico City is one of the largest metropolises in the world, the growth of urban areas is accelerating, resulting in increased construction of new buildings and a corresponding rise in the population's demand for water. This generates a cycle of subsidence, flooding, puddles, and a drinking water crisis. We must understand that this phenomenon will continue as long as the wells in the Basin continue to be overexploited. (Secretaría de Gestión Integral de Riesgos y Protección Civil de la Ciudad de México, 2023)

fig 28. People filling containers during a public water distribution as more than half of Mexico faces moderate to severe drought conditions
(Photo: Daniel Becerril, 2022)

Strategies for the City

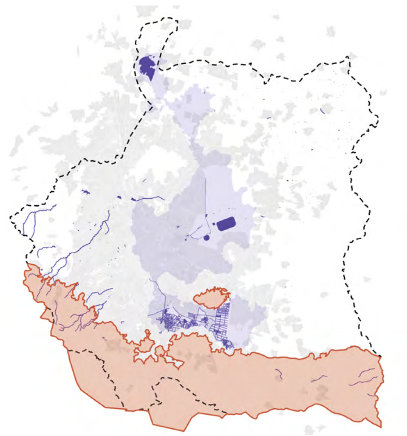
The maps presented below offer a comprehensive classification of strategies focused on water resource availability, tailored specifically to the various zones within the basin. This classification framework underscores the importance of developing diverse interdisciplinary projects that consider the geological, topographical, and climatic conditions within each section of the basin.



1

Retain and Store

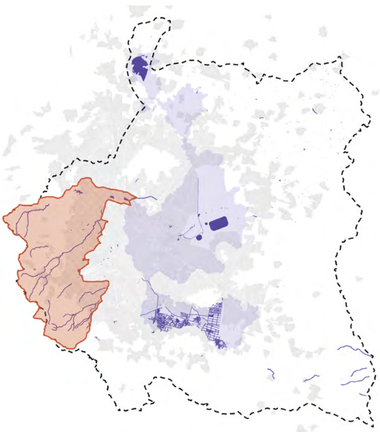
This area, corresponding to the former salt lake bed, has a semipermeable layer with a high clay content, which can maintain regular levels in water bodies. The strategy in this area is to store the water that falls during the rainy season for reuse in urban activities unrelated to human consumption due to its saline content. However, this would significantly reduce the pressure on groundwater extraction.



2

Infiltrate

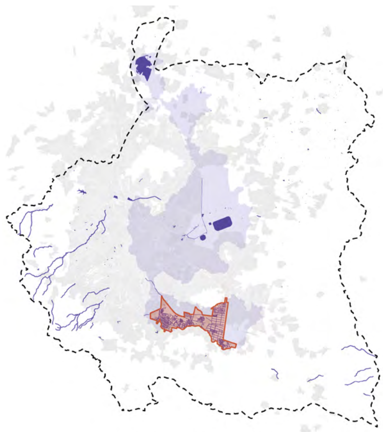
The Sierra de Chichinautzin, to the south of the Basin, is highly suitable for facilitating water infiltration and contributing to the recharge of Mexico City's aquifer. It is the region with the least urbanisation, low transpiration, and soils composed of volcanic rocks. Although basaltic rocks are not permeable, they contain many cavities and openings that allow water to pass through them. On the other hand, urbanised areas have minimal infiltration due to the large extent of paved surfaces and the impermeable clay layers covering the lakebed on which the city is built. (De Urbanisten et al., 2015) fig 29. Strategies in the Mexico City Scale



3

Delay and Infiltrate

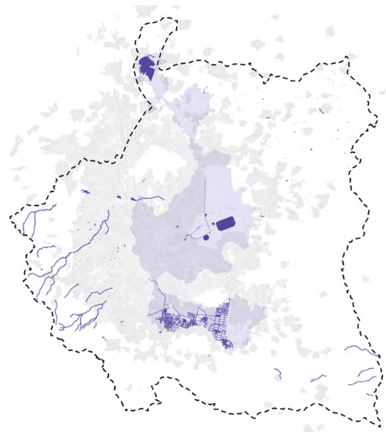
The western part of the basin is characterised by urbanised hillsides that create a predominantly impermeable surface. This lack of permeability significantly accelerates the speed of water runoff during periods of rainfall, which in turn exacerbates the risk of flooding in the lower-lying areas of the basin. To address this issue, the strategy implemented in this region focuses on slowing down the runoff through the creation of permeable spaces, such as green infrastructure features, to mitigate flooding.



4

Clean

Xochimilco faces serious problems related to water scarcity, exemplified by its canals increasingly drying up and suffering from severe pollution due to unregulated wastewater discharges. In the framework of this thesis, the strategy is to treat water through nature-based solutions such as wetlands. These wetlands can serve as natural filtration systems, improving water quality and providing a sustainable and regular water supply to address the ongoing issues.



5

Connect

Finally, the last strategy focuses on connecting these projects from a systemic perspective, utilising the network of canals (both open and closed) that still exists in the city. It is essential to implement recovery interventions for these canals, which should include the integration of vegetation and sanitation protocols to ensure that water can flow through them safely and effectively.

3. The last witness of Mexico City's lacustrine natural and cultural past

The place where flowers grow: Xochimilco

Xochimilco is a wetland located in southern Mexico City, covering an area of 120 square kilometres and a vast richness in its landscape. With 400,000 inhabitants, Xochimilco has a high population growth rate of 3.1%, primarily due to the migration of people from rural areas around the country seeking job opportunities, attracted by the supposedly available 'empty land' in this territory. Nevertheless, these spaces are part of an ecological reserve in the Basin of Mexico; however, due to a lack of political control, they are being urbanised either by informal settlements or by real estate developers. (Marín Zamora, 2009)

In contrast, in ancient times, Xochimilco was the garden of the civilisation, as it produced the most agricultural products. 'It was always developed as a sustainable and autonomous entity whose close relationship with the main city was essentially based on the exchange of goods.' (Marín Zamora, 2009)

Among the ecosystemic services that supply Xochimilco Lake are the recharging of subterranean aquifers, the regulation of the local and regional water flow, and the maintenance of biodiversity. Thanks to the physical and biological processes of Xochimilco Lake, there is flood control, a supply of oxygen, and the regulation of the local climate; thus, the lacustrine zone functions ecologically as a spacious wetland in the midst of an urban zone, which should be preserved due to its numerous benefits. (Domínguez Alfaro et al., 2023)

On the other side, the social identity of Xochimilco is rooted in the deep connection between the locals and their land and surroundings. Many of the contemporary traditions emerged during the Spanish colonisation, when local customs blended with those brought by the colonisers, resulting in a rich and diverse hybrid culture. (Marín Zamora, 2009)

Xochimilco is part of Mexico City's periphery and therefore possesses urban-rural characteristics. It is distinguished by its agricultural work, which contributes to preserving the cultural landscape and traditions, and is ideal for recreational, educational, and cultural activities. However, Xochimilco is not part of the city's dynamism, neither spatially, functionally, nor socially, and is therefore at risk of being absorbed by the city's peri-urbanisation process.

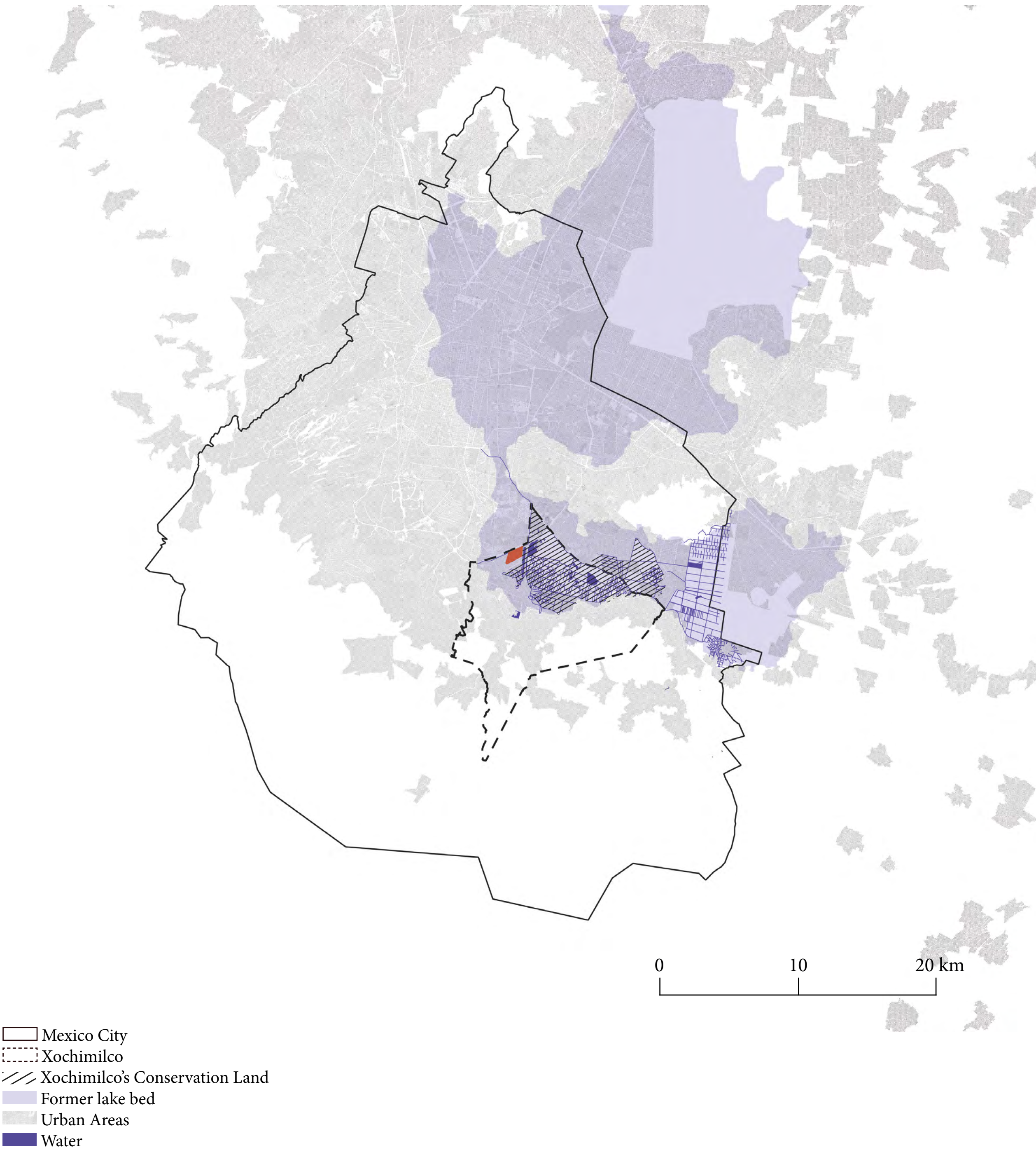
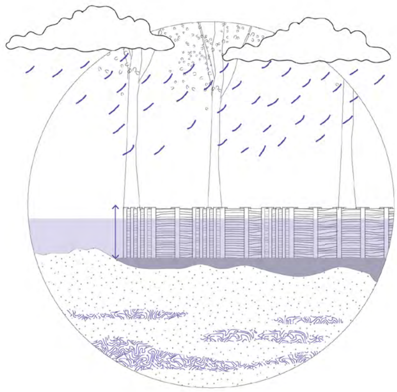


fig 30. Xochimilco's location in relation to Mexico City


fig 31. Aerial photo in Xochimilco
(Photo: Santiago Arau, 2017)

Xochimilco's Ecosystem Services



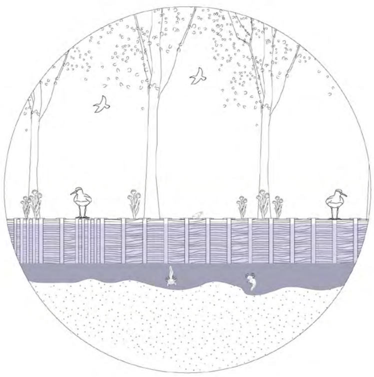
Regulation Services of the Hydrological Cycle

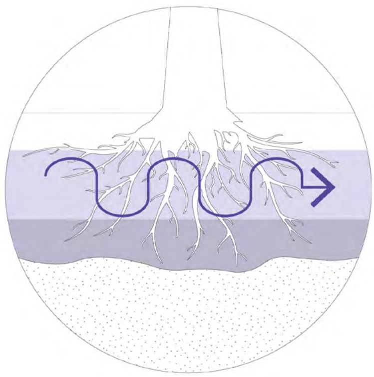
- Flood Regulation: The wetland plays a critical role in absorbing excess rainfall and mitigating the impact of floods.
- Microclimate Regulation: Influences local temperature and humidity levels, creating favourable conditions for various plant and animal species.
- Water retention: Involves the capacity of soils, vegetation, and wetland systems to absorb, store, and slowly release water.
- Infiltration into the aquifers: In Xochimilco, the wetlands and channels help facilitate the infiltration of surface water, contributing to groundwater recharge. This process maintains the water levels in aquifers, supporting local agriculture, ecosystems, and water availability for communities.

Cultural Services

- Recreation in cultural landscapes: These activities promote a connection to nature and contribute to positive social relationships between the diverse communities in Mexico City.
- Tourism: This activity has become an essential sector in Xochimilco, attracting visitors to unique ecosystems and cultural sites. This influx of tourism boosts local economies and encourages the preservation of natural and cultural heritage.
- Traditional Cultural Activities: Indigenous and local communities in Xochimilco engage in traditional practices, such as ceremonial events and sustainable harvesting practices

fig 32. Diagram of the different services that Xochimilco provides to the City





Preservation of Aquatic and Terrestrial Biodiversity

- Protection of Species: Xochimilco's conservation habitats support species like the axolotl.
- Healthy Ecosystems: Xochimilco provides vital services, including clean water, air purification, food resources, climate regulation, soil fertility, and pollination, which are essential for human well-being and environmental stability.
- Habitat for migrating birds: These ecosystems offer food, shelter, and breeding grounds that are crucial during migration periods. Many species of waterfowl, wading birds, and shorebirds use Xochimilco as a stopover during their seasonal migrations between North and Central America.

Water Quality Control

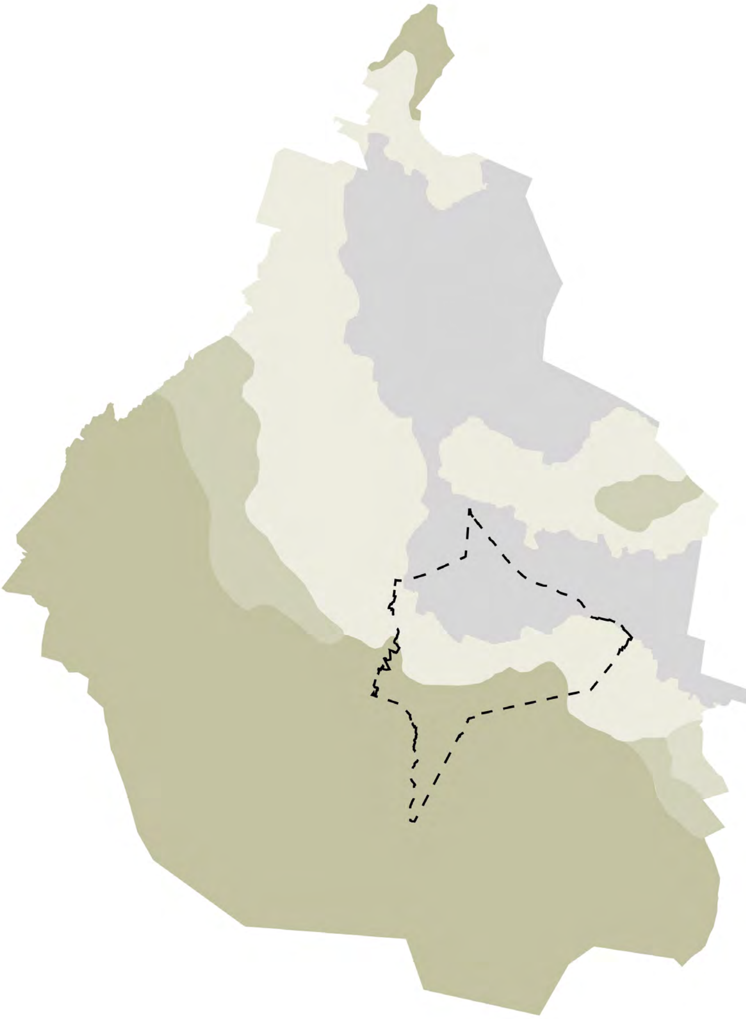
- Xochimilco's wetland acts as a natural filter, improving water quality by breaking down pollutants and sediment. This function ensures clean water supplies for both agricultural use and aquatic life ecosystems.

Productivity

- Water Resources for Agricultural Activities: The canals and wetlands supply water necessary for irrigating crops, particularly in traditional local agriculture, contributing to food security.
- Maintenance of Fertile Soils: Traditional agricultural techniques, such as those employed in chinampa systems, exemplify sustainable farming practices. These floating gardens not only optimise land use but also enhance soil fertility and productivity through crop rotation and the recycling of organic waste.

Xochimilco as part of Mexico City's Periphery

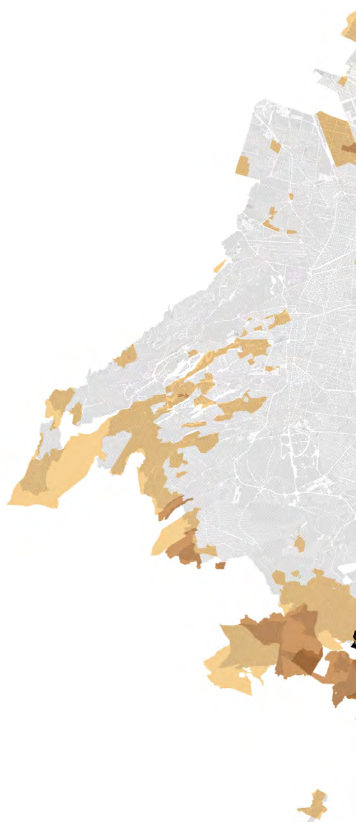
Geological Periphery



Geological Type

- Extinct lake bed
- Plain
- Hill top
- Mountain

Social Periphery

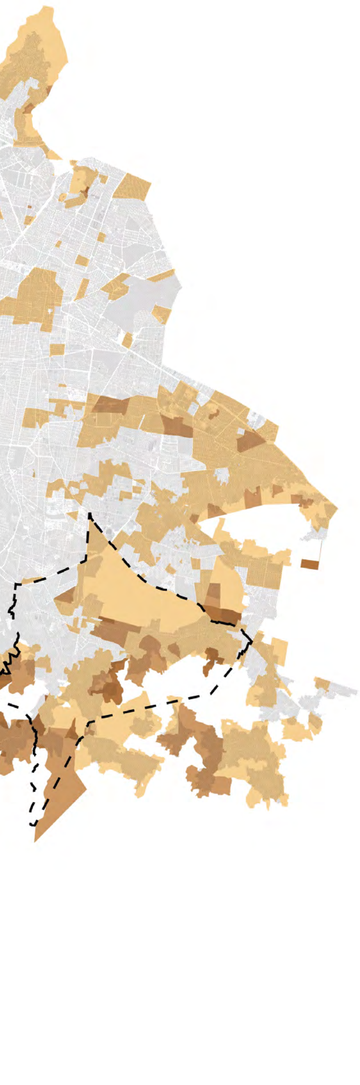


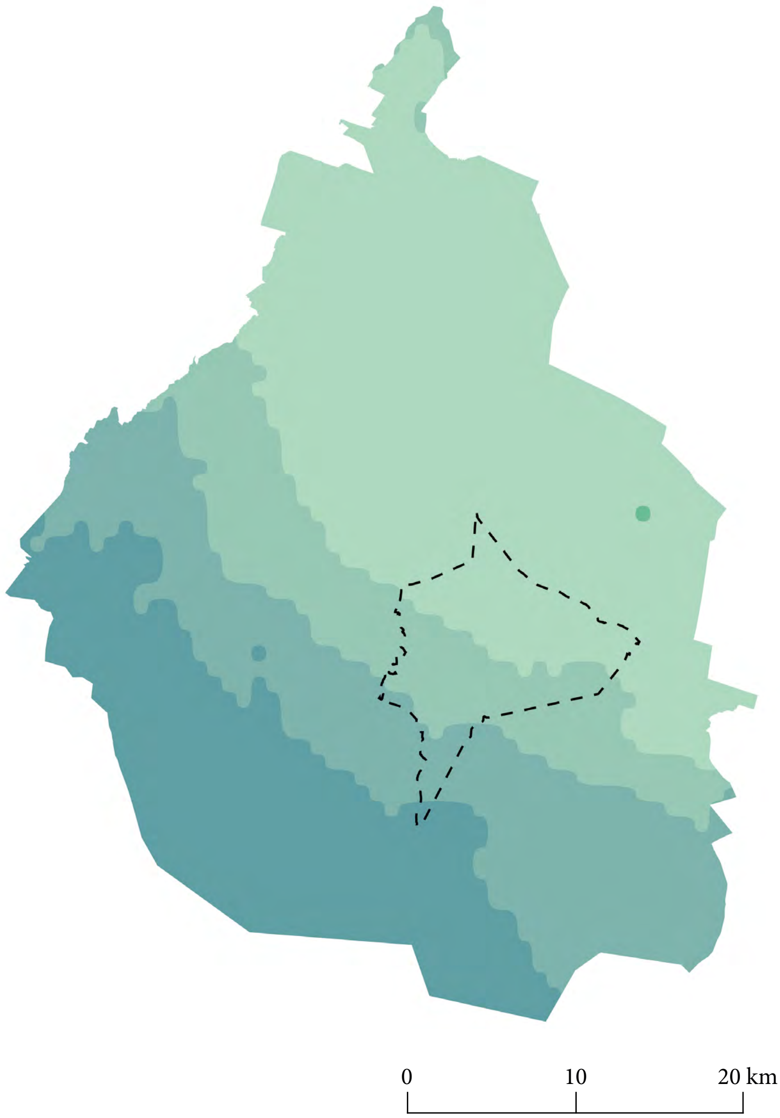
Urban Marginalisation Index

- Medium
- High
- Very High

fig 33. Maps of Peripheries

Precipitation Periphery





Annual precipitation (mm)

- 600-800 mm
- 800-1000 mm
- 1000-1200 mm
- 1200-1500 mm

Chinampas

'*Chinampa*' comes from the Nahuatl chinamitl, which means 'woven fence of canes'.

The *Chinampas* are a traditional system of land and water management created by the Mexica civilisation to support agricultural and territorial growth in the endorheic basin of the Valley of Mexico. This basin formerly featured a wetland ecosystem with interconnected lakes that are now extinct. (Rey-Hernández & Bobbink, 2022)

Chinampas are narrow, rectangular beds or platforms constructed by alternating layers of lake mud and thick mats of decaying vegetation over shallow lake bottoms or marshy zones (Calnek, 1972). Next, around the plot, they sowed willow branches with a slender crown, called ahuejotes (Salix bonplandiana). The plot was built to stand about 50 cm above the water table. Once the plots were constructed, irrigated agriculture was developed by subsurface irrigation. Their shape and dimensions varied; nevertheless, the most significant example is a rectangular islet measuring between 5 and 10 metres in width and extending over 50, 100, or even more metres in length. (Robles et al., 2018)

Under labour-intensive regimes, *Chinampas* are continuously cultivated and are characterised by exceptionally high yields per unit of land (Calnek, 1972). This traditional system is maintained by *Chinamperos*, local farmers. A system of narrow canals connected the Chinampas with more expansive waterways, facilitating navigation and irrigation. This is the final representation of what the lacustrine city of Tenochtitlan used to be like. (Robles et al., 2018)

Nonetheless, in the 20th century, the springs of Xochimilco and Chalco were redirected to provide drinking water to expanding residential areas; consequently, there was less water for the canals, and the *chinampas* area began to shrink.

Improvements to the sewage system accelerated the drying of the remaining lake areas, impacting the production and sustainability of the chinampa system as more significant regions were converted into urban neighbourhoods, thereby reducing the water supply for the remaining *chinampas*. (Bobadilla García, 2023)

In 1987, the CONANP (National Commission of Protected Natural Areas) declared *Chinampas* a protected area to conserve Mexico's biodiversity and heritage. This declaration involves regulations to protect the area's environmental and cultural significance while promoting sustainable practices. Local communities, NGOS, and governmental agencies are undertaking initiatives to revitalise and maintain the *Chinampa* system. These efforts include promoting sustainable agricultural practices, raising awareness, and improving water management in the region.

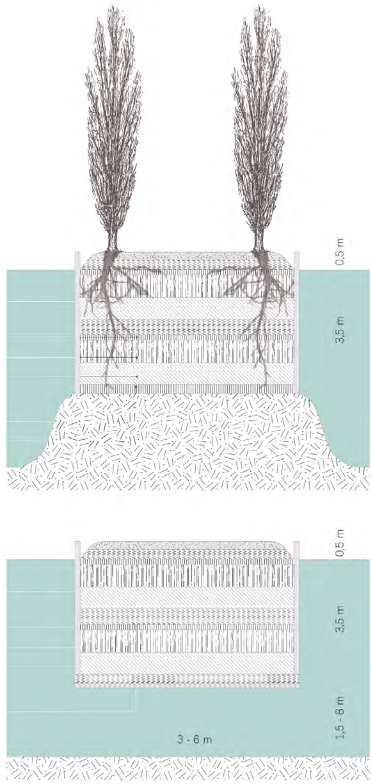


fig 34. Detailed plan and section of the Chinampas water system
(Source: Catalina Rey-Hernández, 2019)

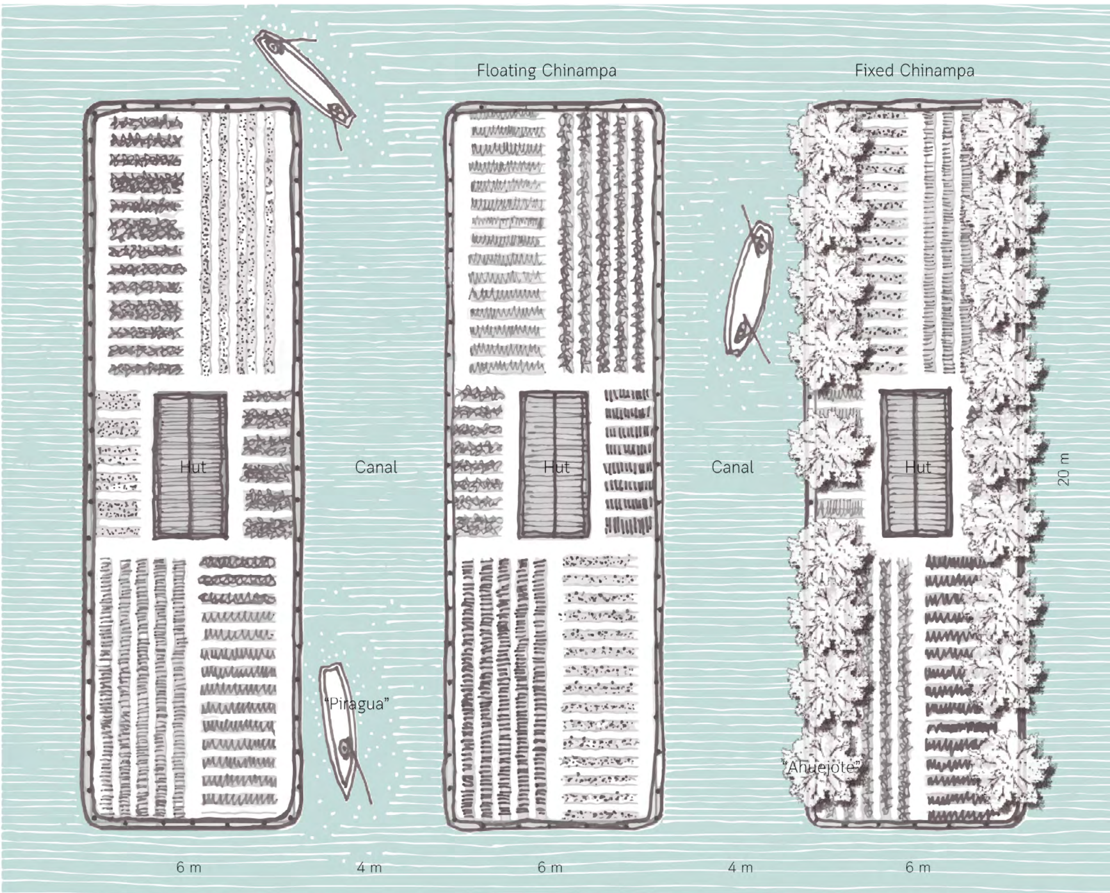

Floating Chinampa
Fixed Chinampa
Hut
Canal
Hut
Canal
Hut
20 m
"Piragua"
"Ahuejote"
6 m
4 m
6 m
4 m
6 m

fig 35. Cross-section of a Chinampa in Xochimilco
(Photo: Hugo Brehme, 1910)

Ecosystem Conservation

Conserving ecosystems requires focused management of various components, including soil, water flow, water levels, and forests. The soil within the *Chinampa* must be consistently replenished; this can be accomplished by incorporating organic matter derived from its lacustrine ecosystem, either by dredging mud from the bottoms of canals or by utilising plant residues from the surrounding area alongside manure.

Soil can be continuously cultivated by employing *almácigos* (nurseries), where seeds are planted using a base of canal mud and nutrient-rich compost. Additionally, the Chinampa functions as an agroforestry unit that incorporates ahuejotes (*Salix bonplandiana*). These trees, planted along the edges of the plots, help prevent the erosion of borders with their roots, which play a vital role in preserving forest biomass. (Robles et al., 2018)

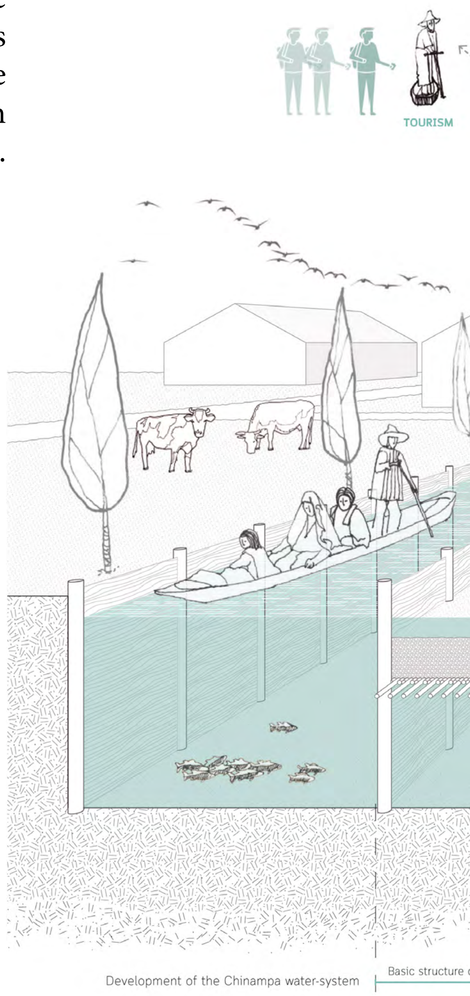
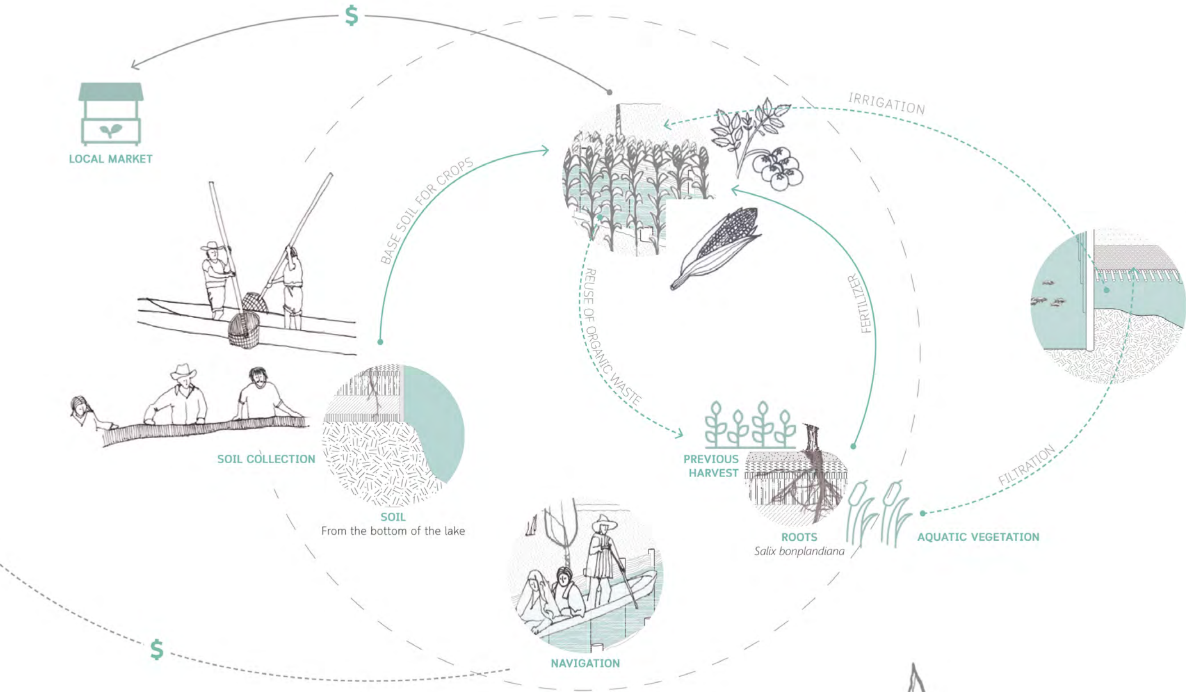


fig 36. Chinampas: Circularity of the system
(Source: Catalina Rey-Hernández, 2019)


$
LOCAL MARKET
IRRIGATION
BASE SOIL FOR CROPS
REUSE OF ORGANIC WASTE
FERTILIZER
SOIL COLLECTION
SOIL
From the bottom of the lake
PREVIOUS HARVEST
ROOTS
Salix bonplandiana
FILTRATION
AQUATIC VEGETATION
NAVIGATION
$

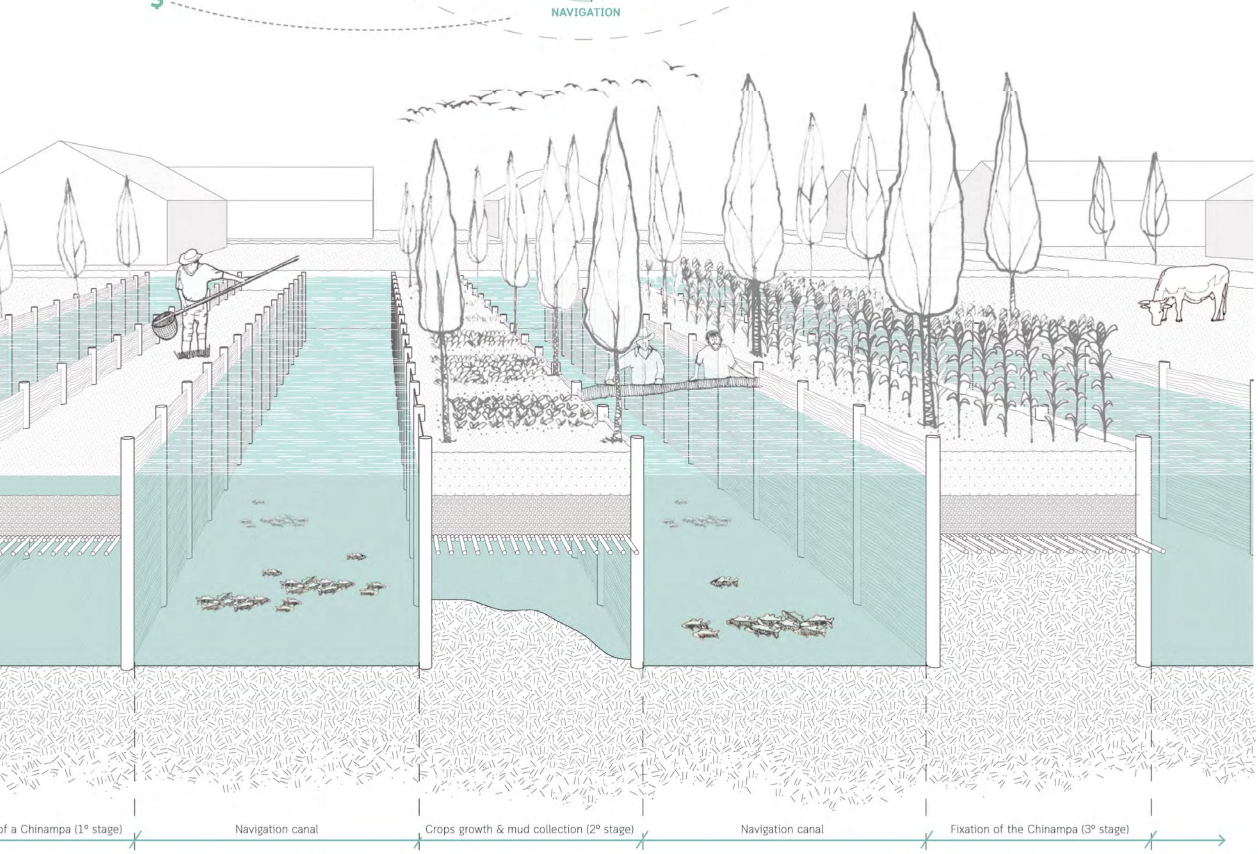
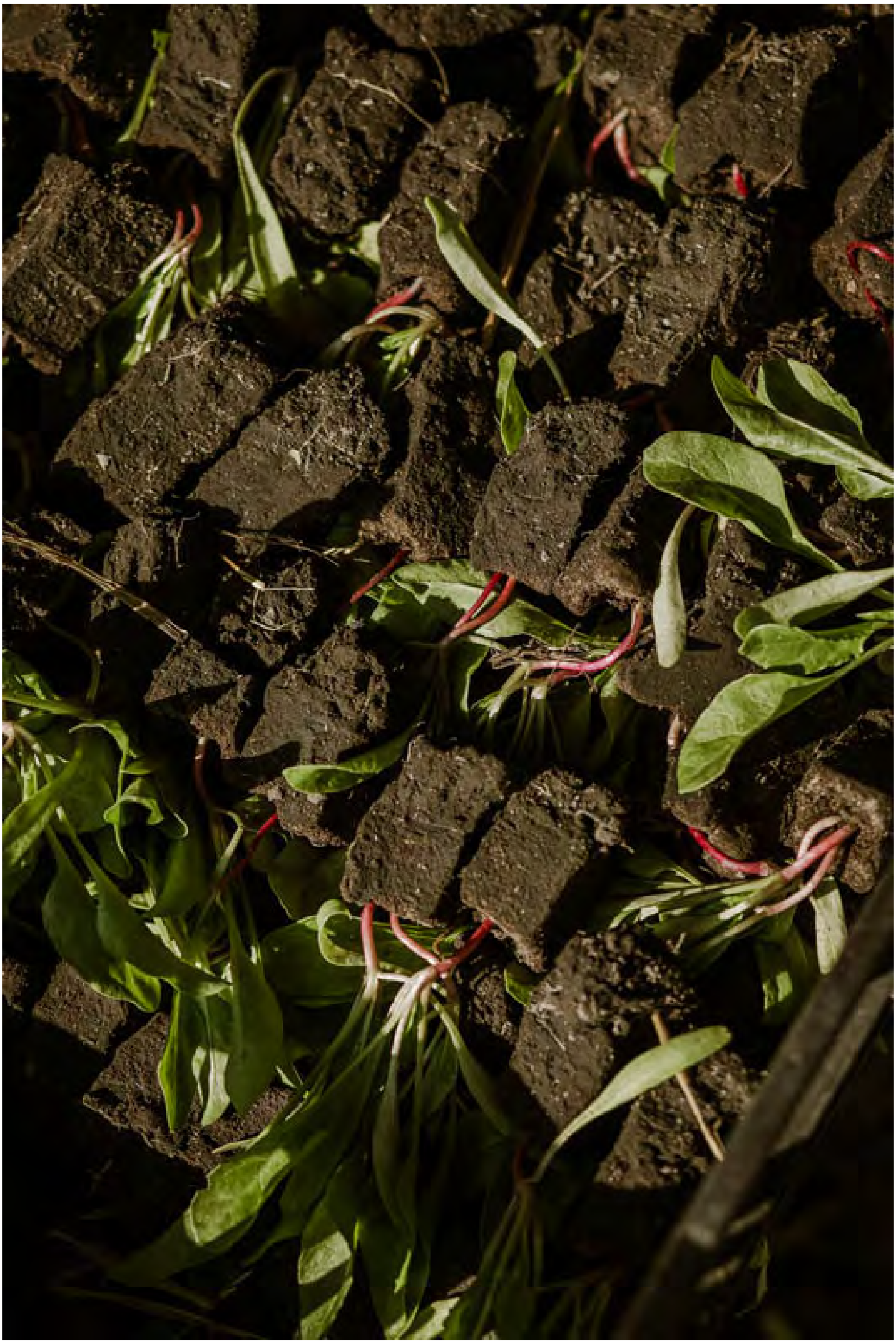

of a Chinampa (1° stage)
Navigation canal
Crops growth & mud collection (2° stage)
Navigation canal
Fixation of the Chinampa (3° stage)

fig 37. Chapin is an ancestral technique that is still used by producers in the Xochimilco chinampera area, as it is very effective for germinating seeds, and consists of making squares or small blocks of soil that are used to grow crops in the area.



(Photographs: Uta Gleiser, 2025)

Transformation from the lake to high urban pressure

Xochimilco is a clear example of a relationship in which humans managed to transform a seemingly inhospitable environment, such as wetland areas, into one that allowed them to extract resources for survival. This transformation was possible through technological innovation, specifically the chinampas, which originated in ancient times. Until the 1950s, there was a perfect harmony between the human community and the environment they had adapted to. (Santa María González, 2019)

The wetland was an essential part of the city for centuries, but has been dramatically reduced to less than half its original extent in the last decades. (Fernández et al., 2025)

The changes that have taken place since the end of the 19th century, when the springs of Xochimilco began to be channeled towards Mexico City, but above all with the urban and demographic growth experienced by the country's capital since the 1950s, have led all the wetlands that existed in this part of Mexico, and in particular that of Xochimilco, towards a highly complex situation in which not only could numerous species of endemic flora and fauna be irretrievably lost, but the hydrological stability of the Mexico City Basin itself would be put at risk, with all its implications for the quality of life of the citizens who live there. (Santa María González, 2019)

In 1900, the water systems of Xochimilco were still fed by rivers and natural springs. However, in the subsequent decade, the Grand Drainage Canal was opened. Porfirio Díaz's government initiated a project to finalise the drainage of the lakes in Mexico City, a process that had started during the Spanish colonial era.

The initial widespread drying of Xochimilco was recognised in the 1940s, and by the following decade, the springs that were being utilised had nearly vanished. To prevent Xochimilco from drying out completely, the authorities decided to pump treated water into the lake and its canals. (Torres, 2022)

Nowadays, the canals and lagoons are fed by the treated water of the 'Cerro de la Estrella' and 'San Luis Tlaxialtemalco' water-treatment plants, which supply 1 m^3/s and 0.225 m^3/s,
respectively. (Domínguez Alfaro et al., 2023)

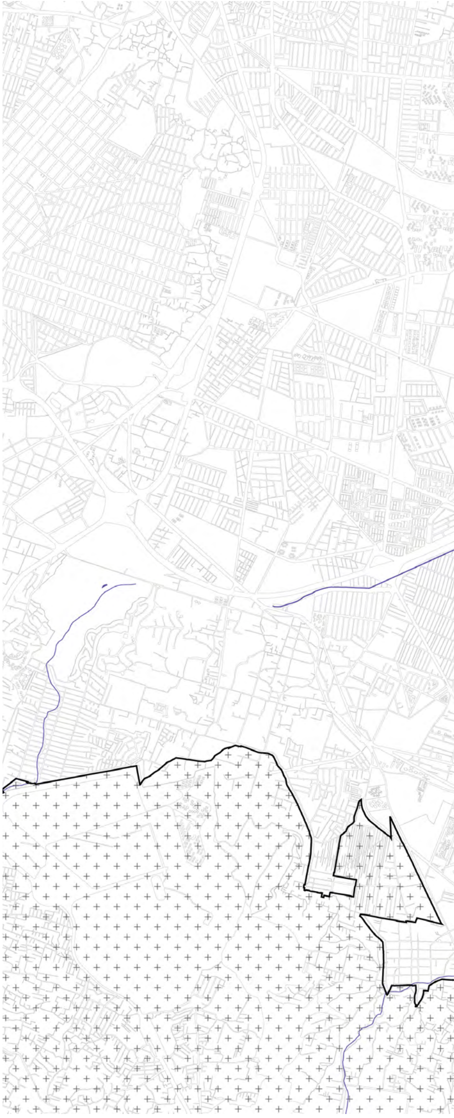
Miguel Ignacio Rivas, a biologist from Chinampa Refugio, a project dedicated to the conservation, recovery, and care of the fauna and flora in this lacustrine area, explains that what is happening in Xochimilco is a symptom of a systemic problem in the Basin of Mexico where as a result of the differential subsidence, some canals have ended up above the lake level and are now drying out. (Torres, 2022)

Urbanisation, water pollution, and the destruction of its environment are positioning Xochimilco in extreme vulnerability to the point of disappearance. Therefore, an urgent intervention is needed to save the last remnant of this cultural landscape.

Conservation Land

According to CONANP (National Commission of Protected Natural Areas) 'Protected Natural Areas (ANP) are areas of the national territory and those over which the Nation exercises sovereignty and jurisdiction, where original environments have not been significantly altered by human activity, or whose ecosystems and integral functions need to be preserved and restored. These areas will be subject to the regime established in this Law and other applicable regulations.'

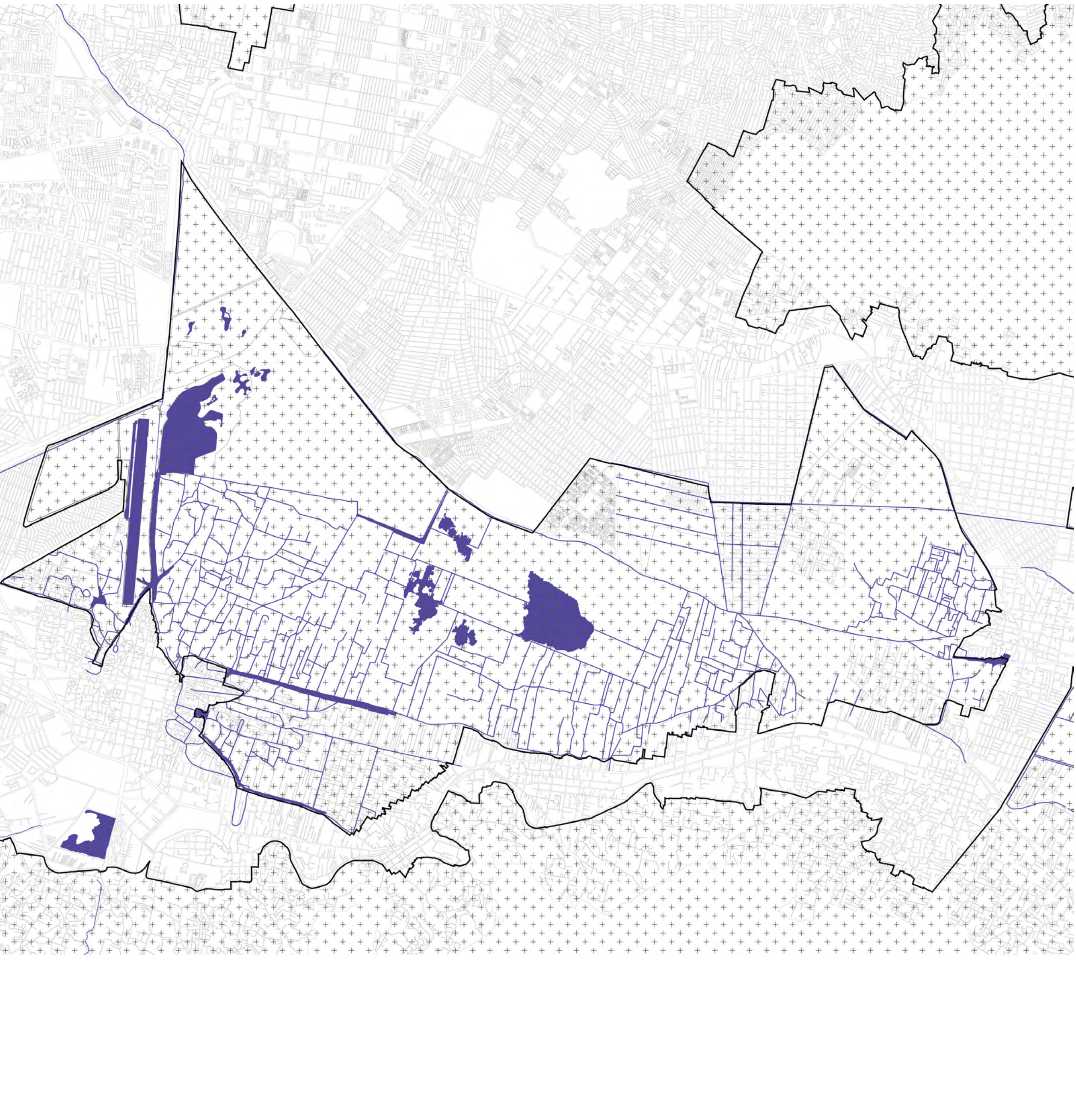
Nonetheless, these are areas of study involving multilevel stakeholders, illustrating the significant complexity of environmental management. Additionally, the relevant legislation offers a wide range of mechanisms for civic participation and public consultation. Furthermore, they are spaces of cultural diversity marked by notable asymmetries in access to power and resources (including technological, informational, economic, and legitimate resources) among the various actors. (Martínez & Espejel, 2015)



Xochimilco's Conservation Land

Water
Conservation Land

fig 38. Map of Conservation Land


0
1
2 km

Irregular Settlements

Xochimilco has the highest number of irregular human settlements located on conservation land. (Santa María González, 2019)

Peripheral municipalities of Mexico City continue to experience faster growth rates, particularly those in the southern part of the city that encompass the remaining conservation areas. This growth is mainly driven, though not entirely, by the persistent demand for housing among lower-income families in the form of informal settlements. Over time, this gradual pattern of settlement expansion has led to the fragmentation of conservation land, negatively affecting its ecological function. (Wigle, 2010)

The increasing level of human settlements and activity in conservation land in Xochimilco has also resulted in the loss of habitats, declining biodiversity and the contamination of water resources.

Furthermore, irregular settlements are a fundamental threat to the quality of life of the inhabitants of protected land, not due to the 'illegal' appropriation of these spaces but due to the systematic lack of services and vulnerability that these areas present. (Bobadilla García, 2023)

In this way, Wigle (2010) argues that the conservation land represents a 'test case' for preparing for more sustainable development in Mexico City. It highlights the fundamental challenges of balancing social and environmental considerations against urgent requirements, such as affordable housing. Furthermore, local municipalities with conservation areas, like Xochimilco, are likely to play a crucial role in addressing this critical planning and sustainability issue.

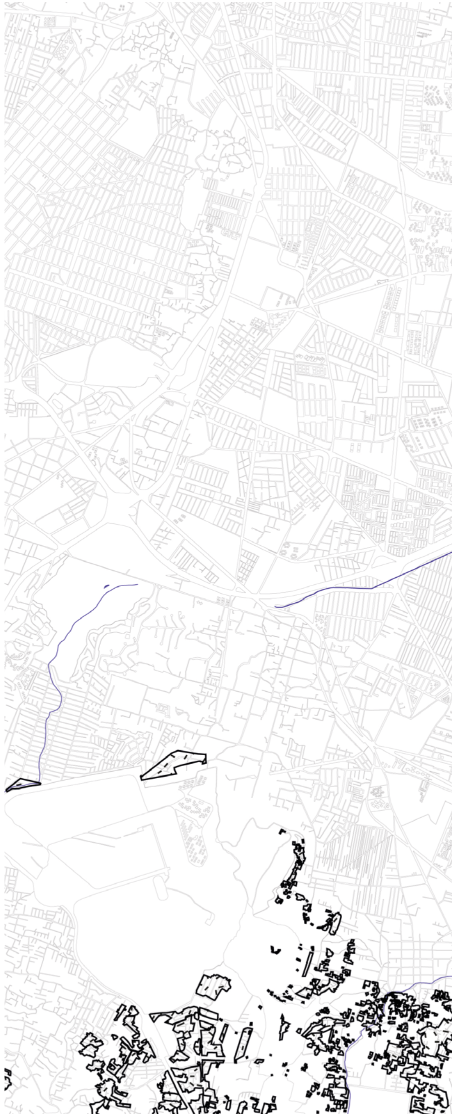


fig 39. Map of irregular settlements

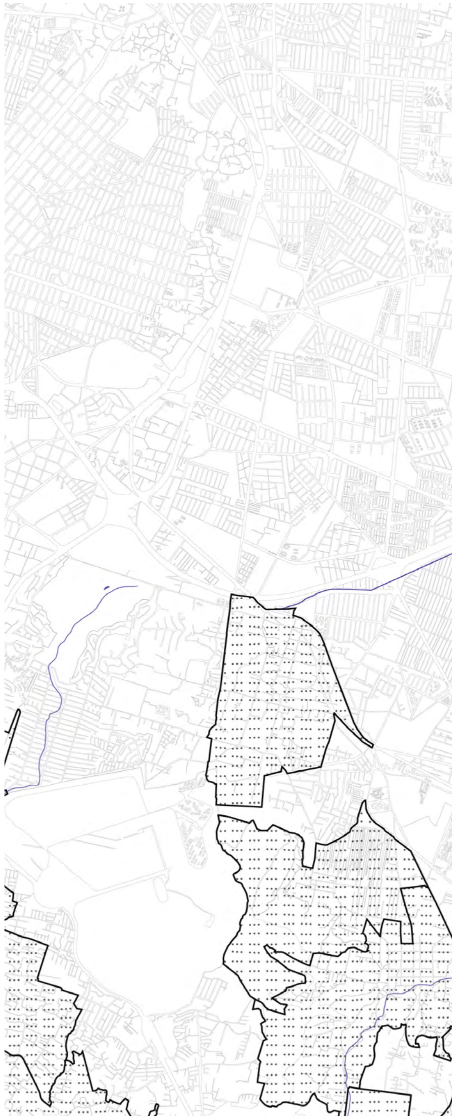

0
1
2 km

Pueblos originarios

Xochimilco's communities can be classified into three types: the urban communities located around the municipal centre and within defined urban areas; the mountain rural communities, which consist of towns and Pueblos Originarios in the southern hills, where agricultural traditions and festivals are more similar to those of other mountainous areas; and the riverside rural communities, which include Pueblos Originarios residing within conservation zones and the remaining wetlands. Despite the absence of significant ethnic distinctions among the populations, each exhibits unique economic pursuits and urban characteristics, which are influenced by their geographical context and positioning within the city. (Bobadilla García, 2023)

Pueblos originarios (indigenous people) are conceived as a heterogeneous group of individuals who can act as collective actors, with a historical origin predating the European colonisation process. These groups maintain certain communal relationships and recreate their connection with the territory, as well as construct their identity and territoriality based on elements such as ethnicity, language, customs, and traditions, all of which originate from their cosmology and their relationship with both the environment and the dominant society, in this sense. (Carmona Motolinia & Tetreault, 2020)

Nevertheless, the modernisation processes have resulted in significant changes in the communal living conditions of rural Mexico. Among the most notable are the effects on the collective forms of land and territory ownership of various rural communities and indigenous groups, which economic, socio-cultural, and political transformations have impacted. (Carmona Motolinia & Tetreault, 2020)



Location of indigenous communities

Water
Indigenous Communites

fig 40. Map of indigenous communities

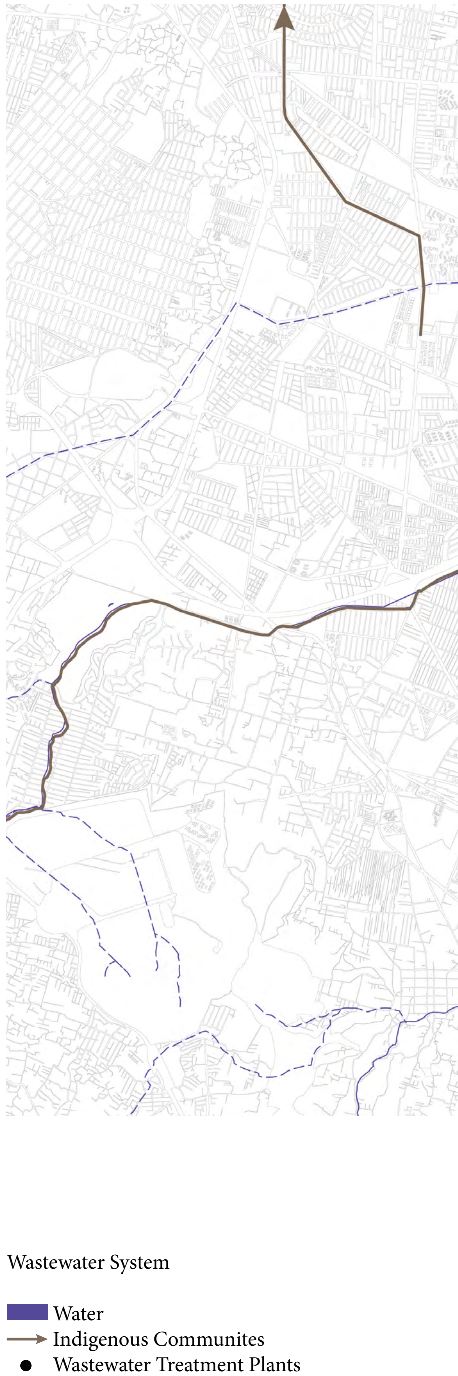

0
1
2 km

Current wastewater network

As mentioned above, as part of the metabolic functioning of the metropolis, Mexico City's wastewater is expelled to the Mezquital Valley. According to the Mexico City Water System (SACMEX), a city resident disposes of 70 litres of water daily at home. This use is divided as follows:

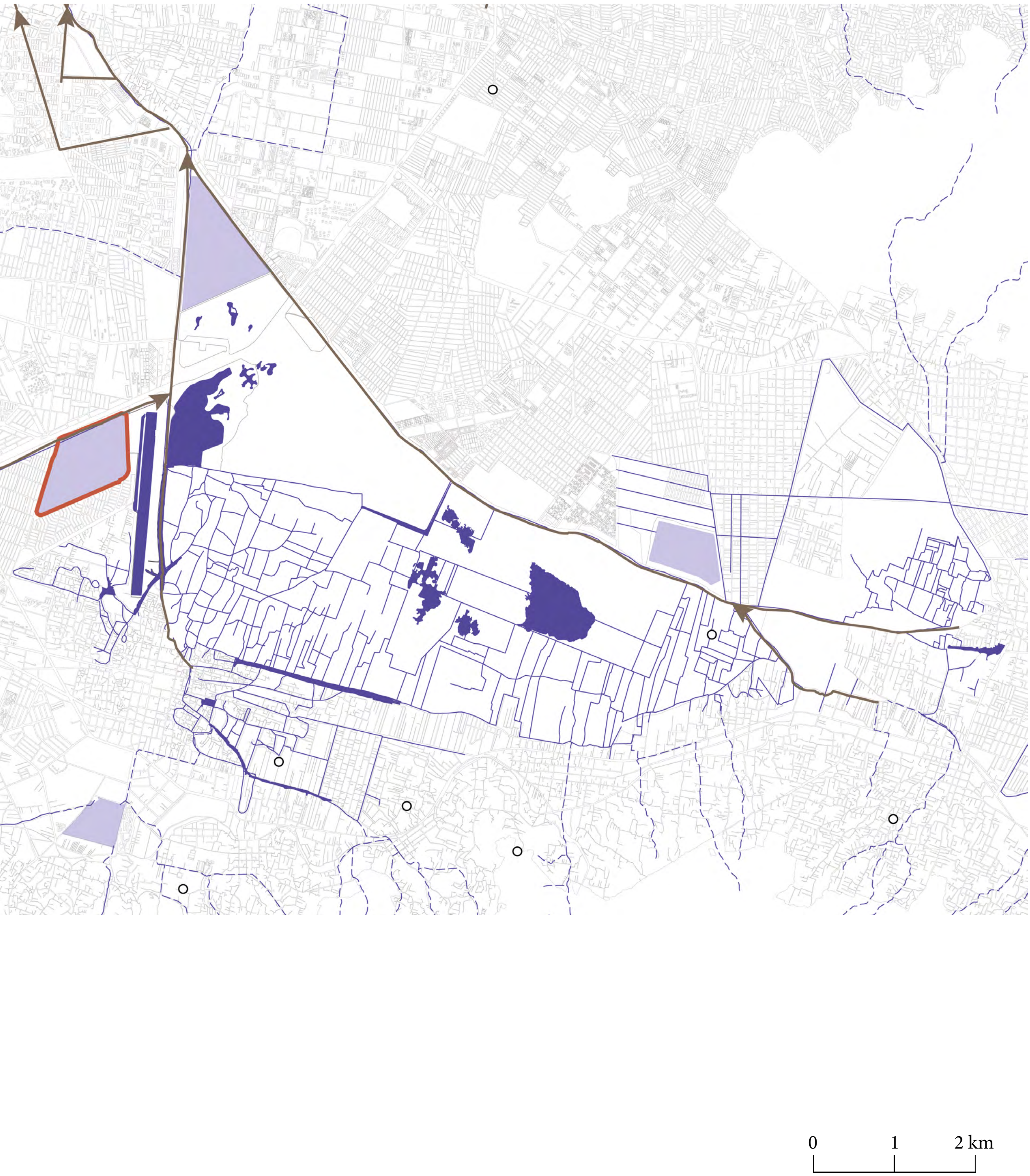
- Shower 60%
- Laundry 20%
- Dishwashing 10%
- Handwashing 5%
- Toilets 5%

However, some of this water ends up in the canals of Xochimilco, as informal settlements have been identified as a significant issue, leading to the illegal discharge of wastewater into the chinampa area. This situation has resulted in increased health risks, environmental degradation, and a substantial decline in agricultural productivity on the chinampas. (CDMX Resilience Agency et al., 2019)



Rowing track 'Virgilio Uribe'

fig 41. Current water network map


0
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2 km

The case of Cienega Chica

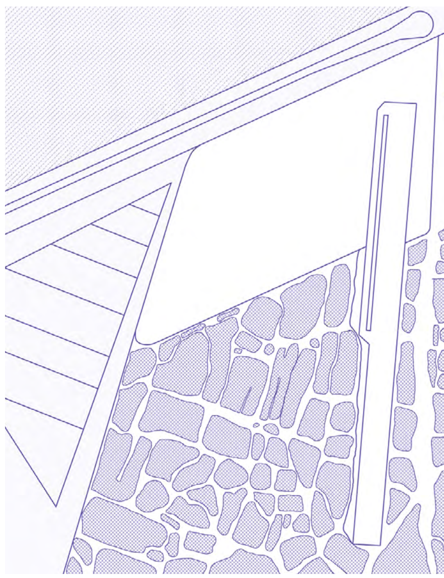
Cienega Chica was part of the Xochimilco wetland; therefore, within the framework of this research, it is assumed that it was also part of the chinampera zone. Nevertheless, in 1918, the restructuring of agricultural land was introduced as a key demand following the Revolution. As a result, regions like Cienega Chica were repurposed into agrarian areas. Later, in 1990, this land was expropriated to establish a regulating basin to alleviate water excess that could flood the Anillo Periférico. True to its name, the purpose of this basin was to capture, contain, and control water flows that naturally course through the Basin's topography; without such measures, it could lead to considerable damage to the surrounding settlements. (Kaye, 2023)

Nevertheless, over the years, it lost its ability to regulate water effectively and its connection to the drainage system that would subsequently manage these waters. Later, it became a space that only receives combined drainage water without any treatment, and being a clayey space, the only outlet of this water is evapotranspiration.

Nowadays, the Cienega Chica remains a void in the urban layout, a space littered with trash. Although there is no trace of the city's ancient vestiges, its layers and sediments speak of its history and transformation.

1521

1968



Cienega Chica's Location

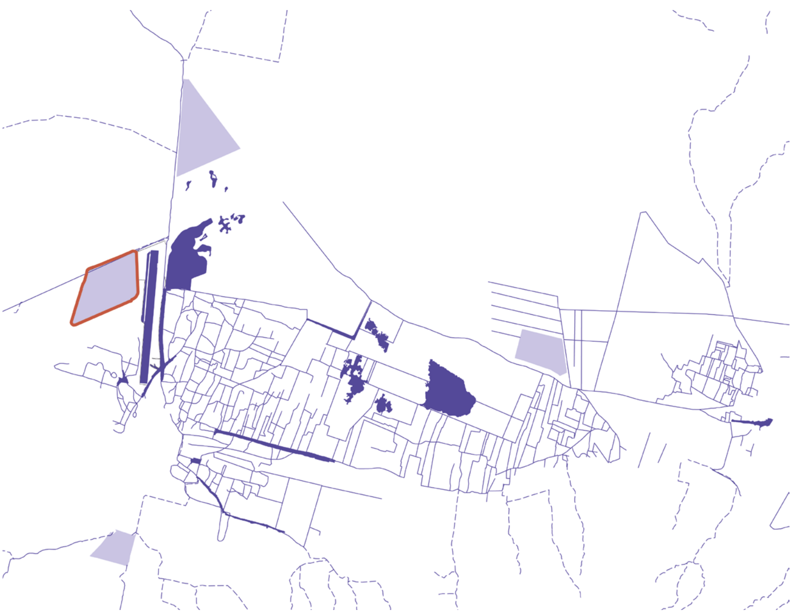
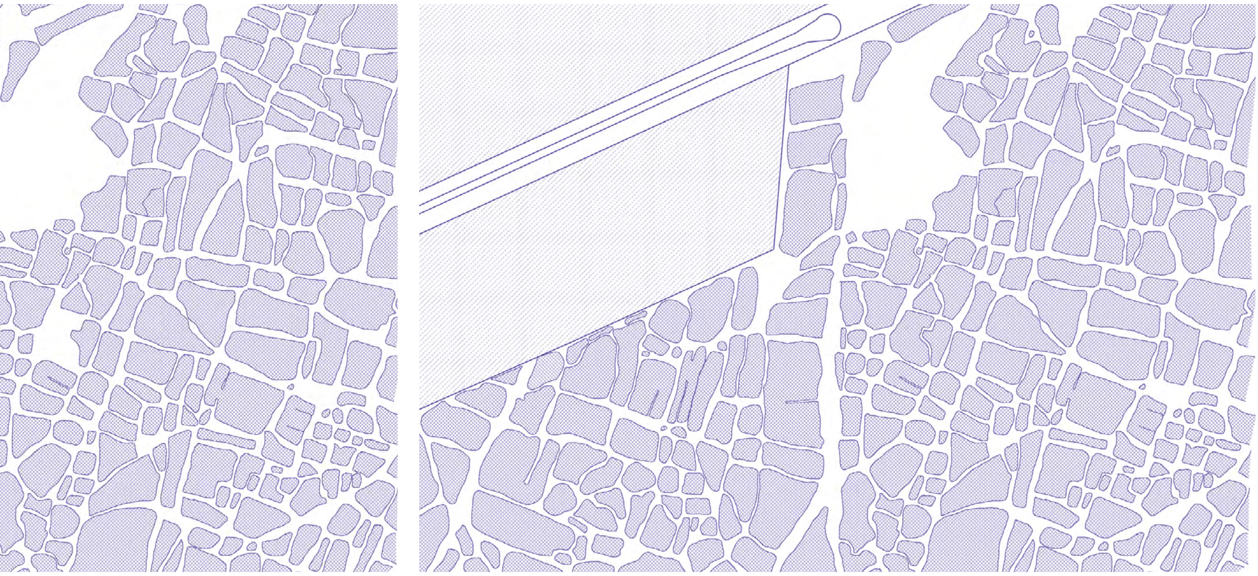
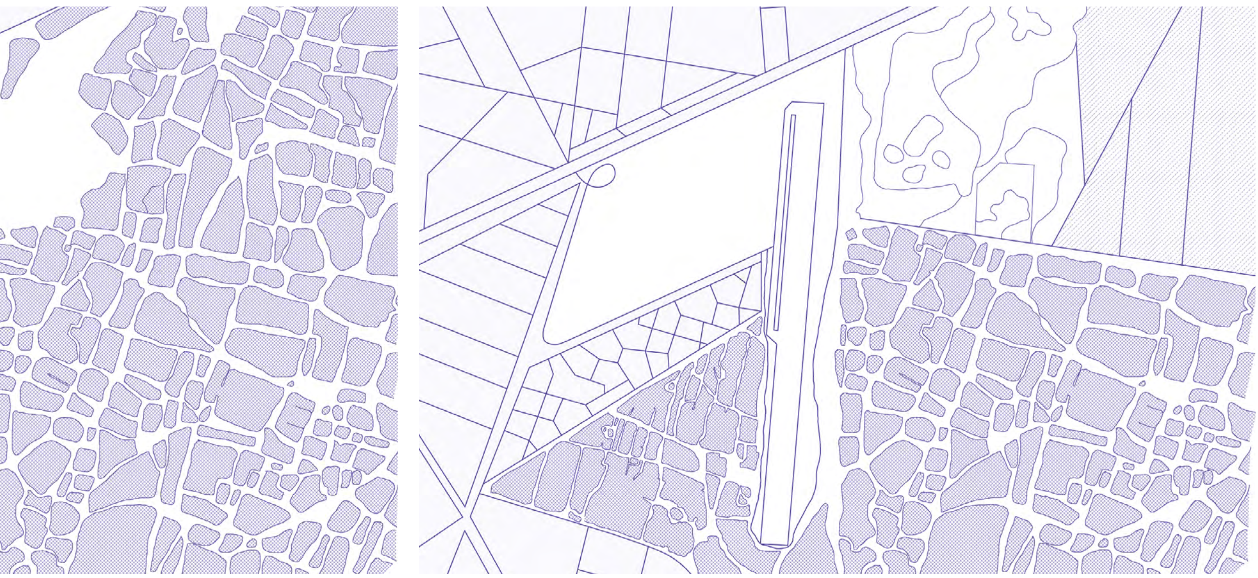


fig 42. Transformation of Cienega Chica from 1521 to the present day

1918



2025



4. Decentralisation as an alternative

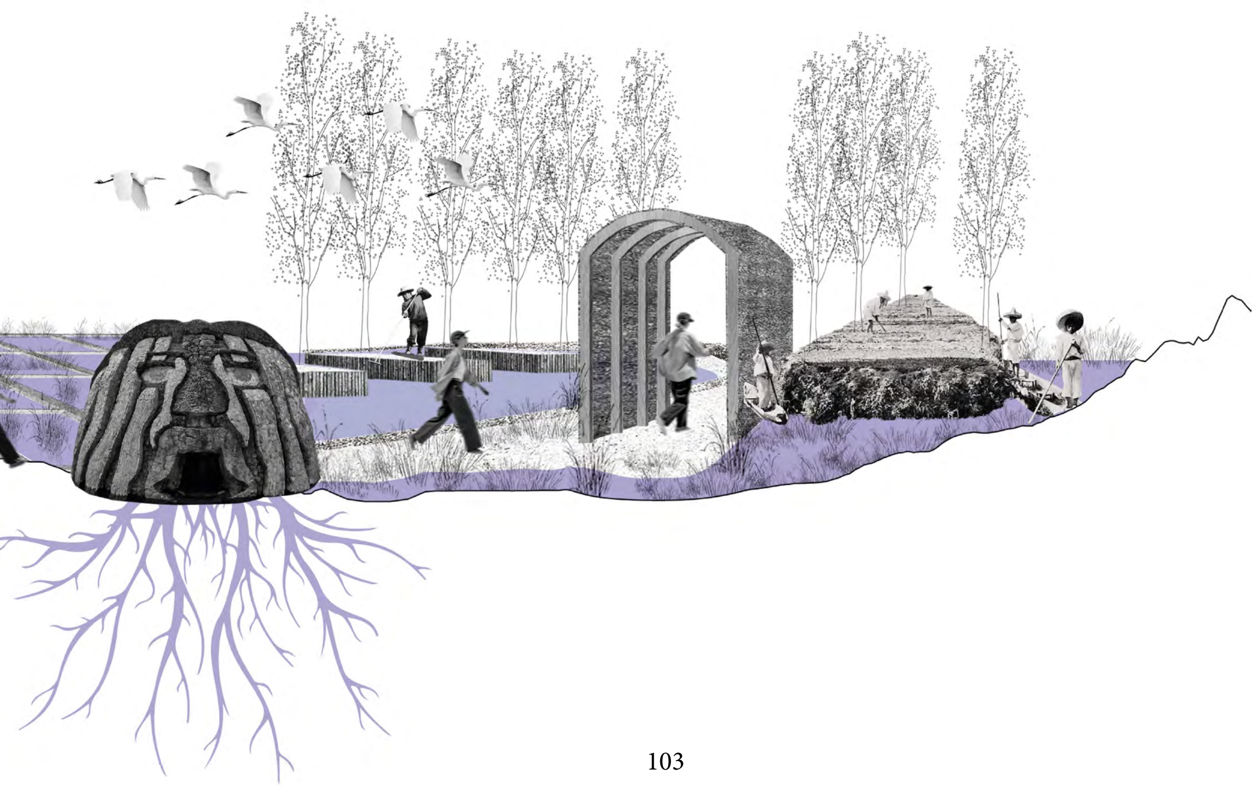
Make Every Drop Count

Wastewater is the only source that increases when demand grows. In the case of Mexico City, demand is expected to grow by 80% by 2050, which is also the case on a global scale, as more people will be living in cities.

(SECTEI, 2024), so this thesis proposes a confrontational approach, recognising that every drop of water available needs to be used as part of the urban infrastructure, rather than externalising the problem and its consequences elsewhere. This approach requires an interdisciplinary and decentralised lens of human autonomy, as it uses nature's processes and prioritises ecological balance.

Approximately 71,527 people live within a 1,000-meter radius of Cienega Chica, because of its high density, equivalent to 5,006,890 litres daily, which, in the case of this thesis, can be used to contribute to the conservation of the last living vestige of the Aztec civilisation, a symbol of culture throughout the country.

Apart from infrastructure, this proposed wastewater landscape becomes a park, inviting visitors to reflect and become aware of the importance of conserving this unique ecosystem and water resources.



Case Studies

Lankheet Park
Location: Landgoed Het Lankheet, Haaksbergen NL
Designer: Strootman Landschaparchitecten
Rural Context

fig 43: Lankheet's Reed Filtering System
(Source: Strootman Landschaparchitecten, n.d.)

Goals

The aim of the water purification park is to create reed beds that not only purify stream water but also produce biomass for renewable energy or fuel. This provides a platform for fundamental scientific research focused on the mechanisms of cleansing surface water using reed filters. In addition to its scientific purposes, the design of the park will also incorporate aesthetic elements, transforming the area into a poetic water spectacle that celebrates the beauty and functionality of natural ecosystems. (Lankheet Water Purification Park by Strootman Landscape Architects, n.d.)

What can be learn from it?

From this water purification park in Lankheet, I can learn that natural ecosystems, such as wetlands and reed beds, not only serve essential ecological functions but can also be designed and managed as integrated and visible systems that combine science, aesthetics, and utility.
This example demonstrates that a natural system can be transformed into a multifunctional space where water purification, the production of sustainable resources, scientific research, and cultural value converge in one location. Furthermore, by making it visible and accessible, the park educates and raises awareness in the community about the importance of ecosystems in environmental regulation and sustainability.

Bheri Wastewater Aquaculture Treatment
Location: Kolkata, West Bengal IN
Urban Context

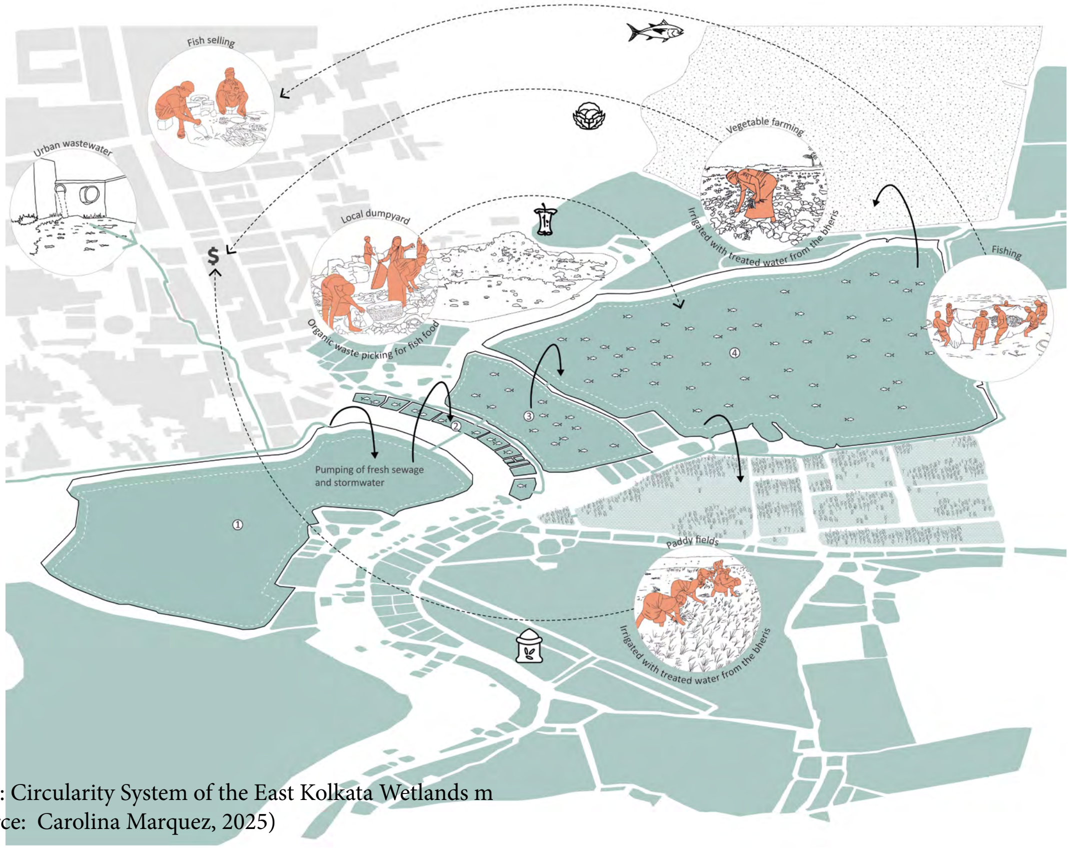


fig 44: Circularity System of the East Kolkata Wetlands m
(Source: Carolina Marquez, 2025)

Goals

Acting as a natural filtration system, the wetlands use aquatic plants and sediments to filter out pollutants, improving water quality and supporting biodiversity. The system promotes nutrient cycling, with organic matter from agricultural runoff enriching the water, benefiting both aquatic plants and fish populations. Moreover, aquaculture activities within the EKW support fish farming, providing food and income for local communities while helping to control algae and maintain water quality.

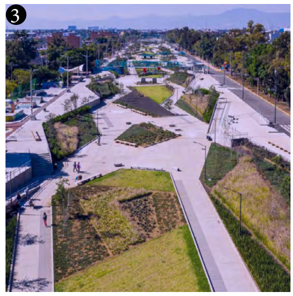
What can be learn from it?

From this system of wetlands and aquaculture activities, it can be learned that integrated ecosystem management can generate both ecological and socio-economic benefits for the communities involved.
Furthermore, the nutrient cycle facilitates the production of food and economic resources from agriculture and aquaculture, supporting food security and generating income for local communities.
This example shows that when communities engage in the conservation and management of these natural systems, a sustainable model is created that combines environmental protection with social and economic development. Active participation and local knowledge in the use of these ecosystems allow for the exploitation of their potential to improve the quality of life while protecting and conserving biodiversity.

Interdisciplinary cooperation

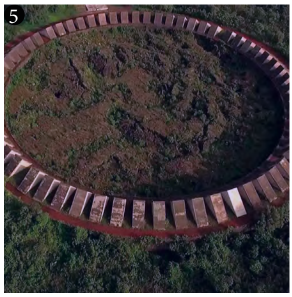
Bicentenario Park

Texcoco Ecological Park



Gran Canal Linear Park

La Quebradora Hydric Park



El Pedregal Protected Area

Xochimilco Ecological Park

There is no easy solution to Mexico City's water crisis, but perhaps it lies in communal and interdisciplinary cooperation. Efforts are being made in that direction, and various similar projects have emerged in response to this shared concern. This examination will help to learn from existing solutions and project a systematic collaboration among stakeholders who share the same goal.

In this map, the network of rivers and canals that could connect the water system is shown. This would involve restoring rivers that have had a significant influence on the morphological transformation of the city, as explained in previous chapters. They became the main avenues of the city and are frequently affected by flooding during rainy periods. Additionally, some voids in the city are identified as hydrological remnants, but they are not spatially connected to the city, transforming them into brownfields. And that is how I chose Cienega Chica in Xochimilco for this project.

This systemic approach allows the problem to be addressed from different perspectives through a comprehensive hydrological system recovery network in Mexico City. The network aims to promote sustainable practices, improve water quality, and effectively manage stormwater, ultimately contributing to a more resilient urban ecosystem.

De Los Remedios River

De La Piedad River

Churubusco River

San Buenaventura River

Cienega Chica - Proposed Site

750 km²

Basin of Mexico Hydrological Boundary
Water
Potential Projects
Ongoing projects
Strategic Reservoir for Conservation
Connecting Rivers
Recovery of Hydric Structure
Proposed Site
Green Areas

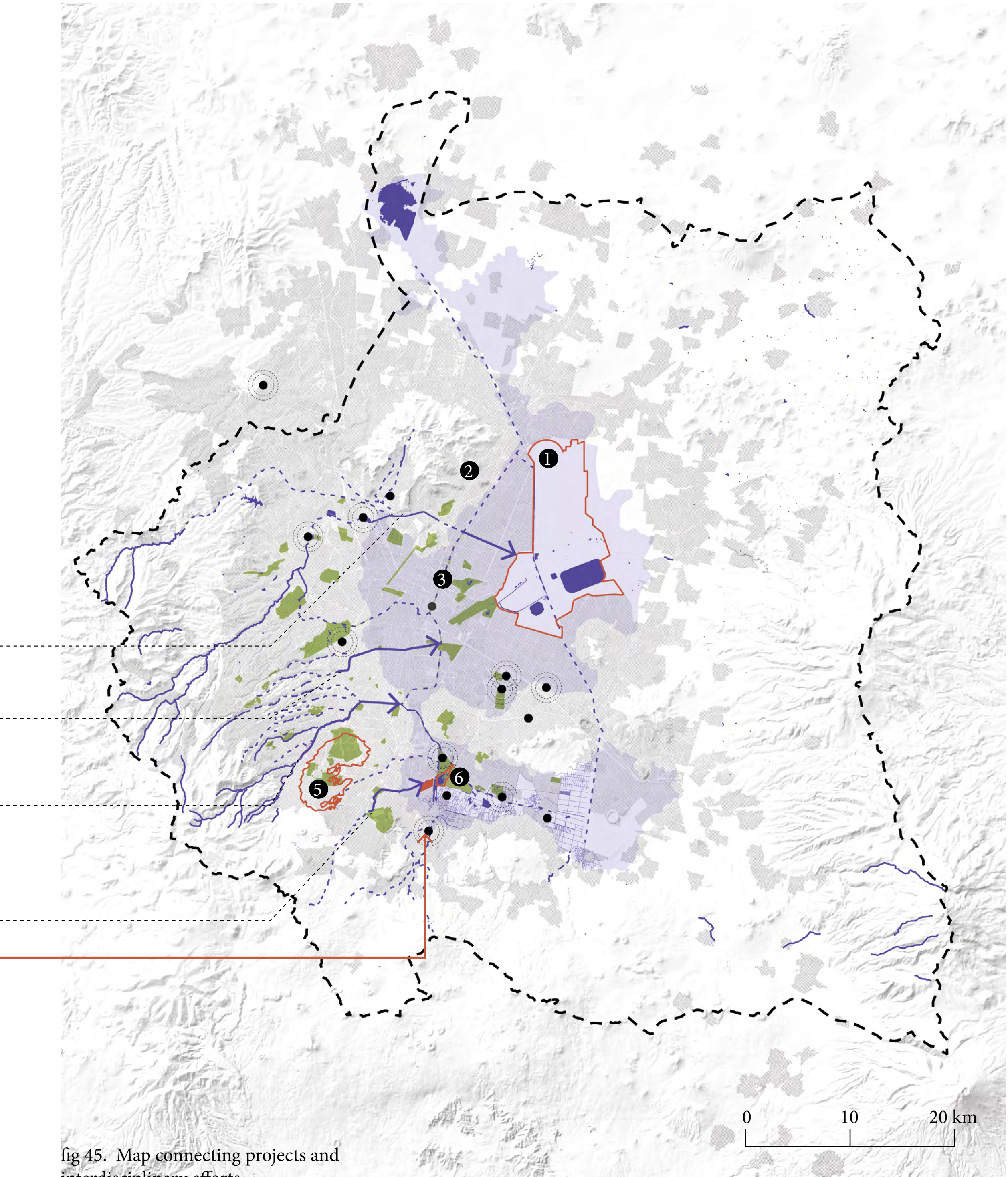


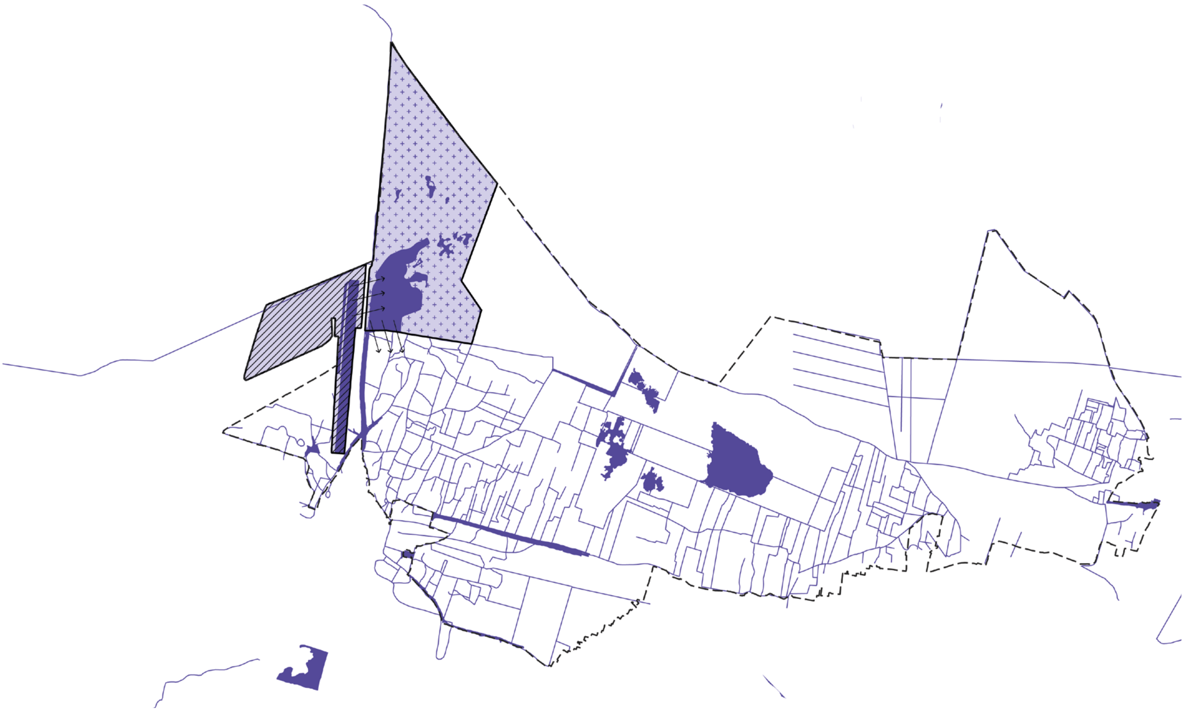
fig 45. Map connecting projects and interdisciplinary efforts

Strategies for Xochimilco's Conservation Land

1. Interconnected spaces for new ways of interaction
The Cienega Chica is envisioned as a transformative space where the communities of Xochimilco can engage in meaningful dialogue. This venue aims to bridge the gap between the indigenous inhabitants, who strive to preserve their customs and traditions, and the newer residents, often viewed as outsiders. By fostering this interaction, the Cienega Chica will serve not only as a community gathering point but also as an educational platform, allowing visitors to immerse themselves in the values and practices of the original local culture.

In addition to promoting cultural exchange, this space will highlight the critical importance of water conservation. Ultimately, the project aspires to cultivate a sense of shared responsibility among community members and visitors alike, emphasising the necessity of safeguarding water for future generations.

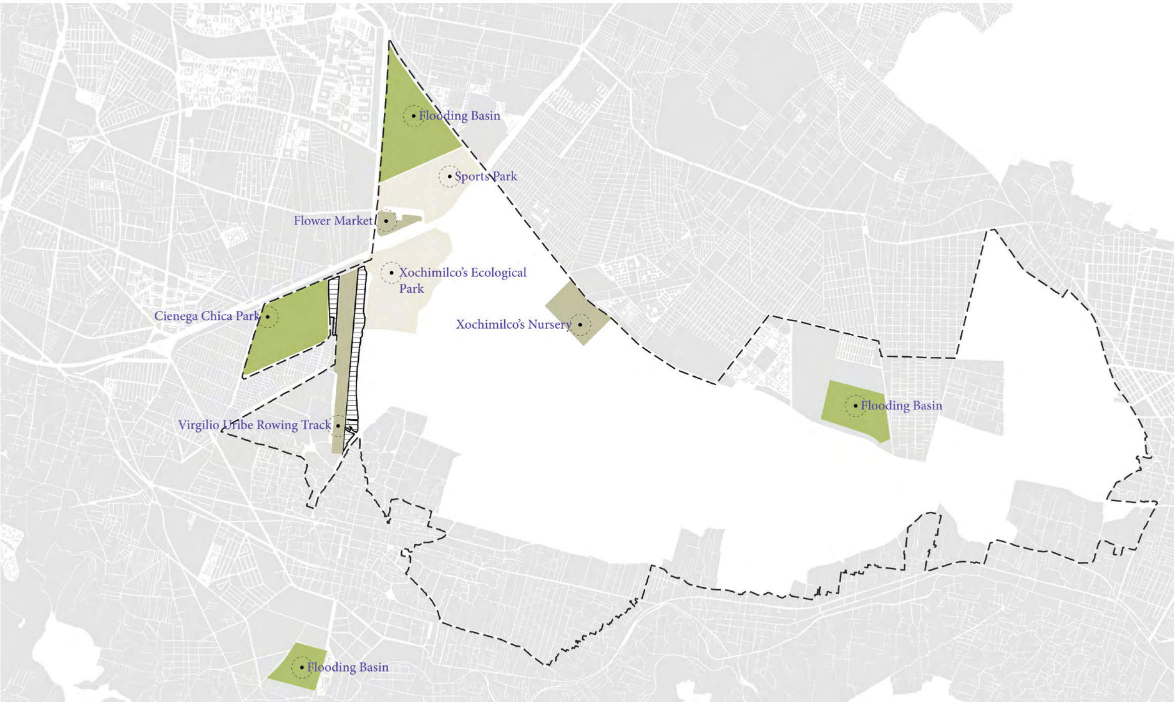
fig 46. Strategy Maps



2. Reconnected water purification system

The project focuses on recovering and reconnecting a water system that has been lost amidst Mexico City's development. Its goal is to enhance storage capacity by utilising all available water within the basin, specifically the wastewater from neighbourhoods surrounding La Cienega. Furthermore, the treatment of this wastewater will be conducted locally, eliminating the need to transport water outside the area. This approach aims to alleviate some pressure on the city's drainage system, potentially contributing to flood mitigation.

Additionally, the new system aims to nourish the canals of Xochimilco, which have become polluted due to desiccation. This desiccation is attributed to changing rainfall patterns and the melting of glaciers caused by global warming.



3. Repurposed urban infrastructure

Transforming spaces designated for infrastructure into accessible public areas can create a network of community spaces by strategically connecting urban facilities, such as Xochimilco's Ecological Park and the flower market.

Regulatory sites, like Cienega Chica and Cienega Grande, can be repurposed into urban parks for ecological renewal and conservation efforts.

This approach can significantly enhance the social fabric and economic vitality of local residents, fostering community engagement, supporting local businesses, and promoting sustainable practices. By prioritising accessibility and inclusivity, we not only encourage social interaction but also strengthen local economies, ultimately improving the quality of life for everyone in the community.

4. Prioritising an ecological balance

This project's significance is rooted in its role in preserving the rich cultural landscape of Xochimilco and its unique ecosystem. To safeguard this remarkable area from decline, it is crucial to foster a harmonious ecological balance among the local residents, the sustainable practices offered by eco-technologies like agriculture, and the diverse non-human stakeholders, such as the waterways and plant life in Xochimilco.

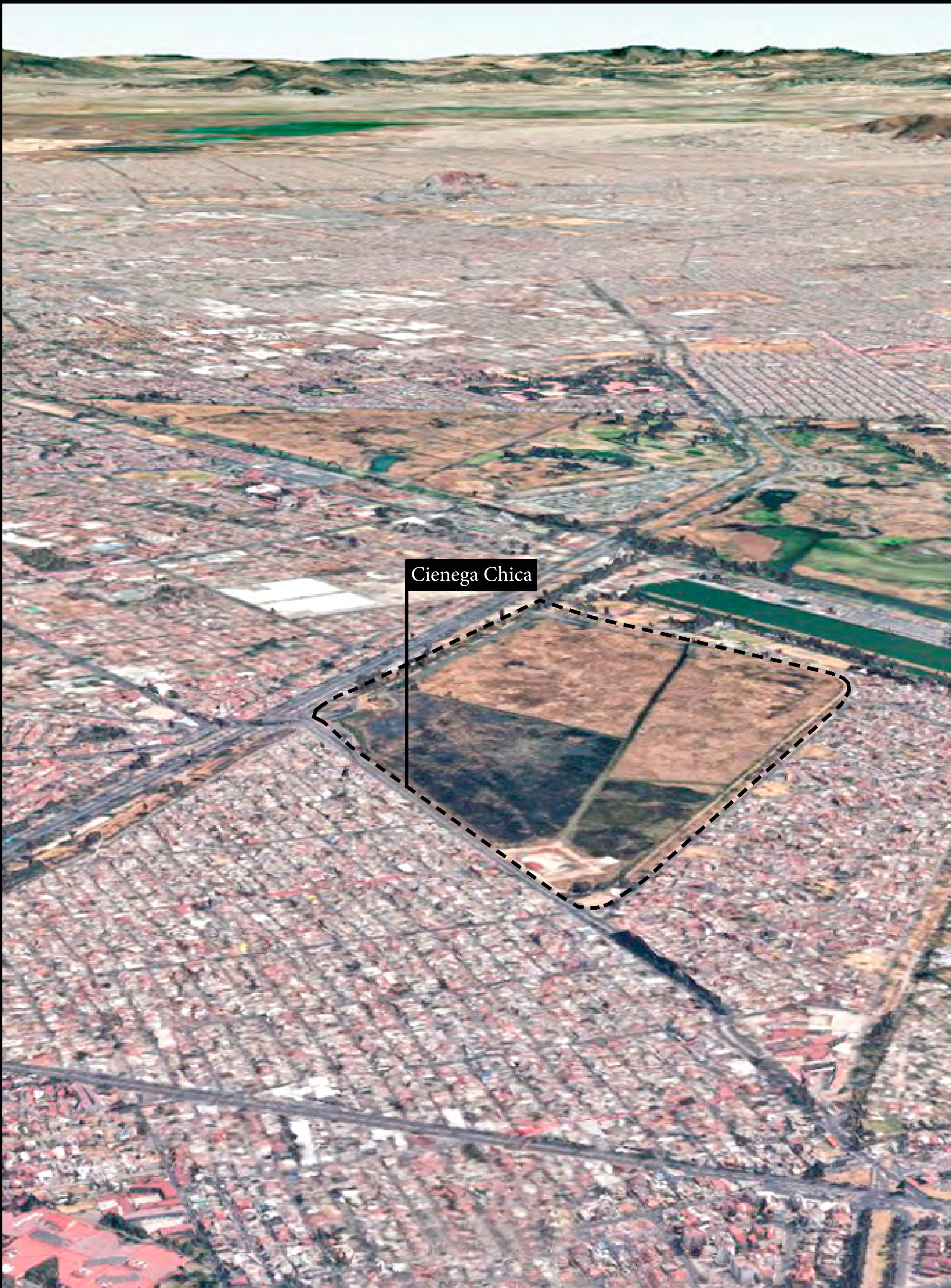


fig 47. Aerial view of Cienega Chica, the Xochimilco Ecological Park, and the chinampas cultural landscape
(Source: Google Earth, 2025)

Palimpsest of Water Flows

To implement the new purification system, an analysis of water flow patterns over the past 25 years was conducted, focusing on the complex network of waterways in the region. This study involved examining the microtopographies where water travels and collects.

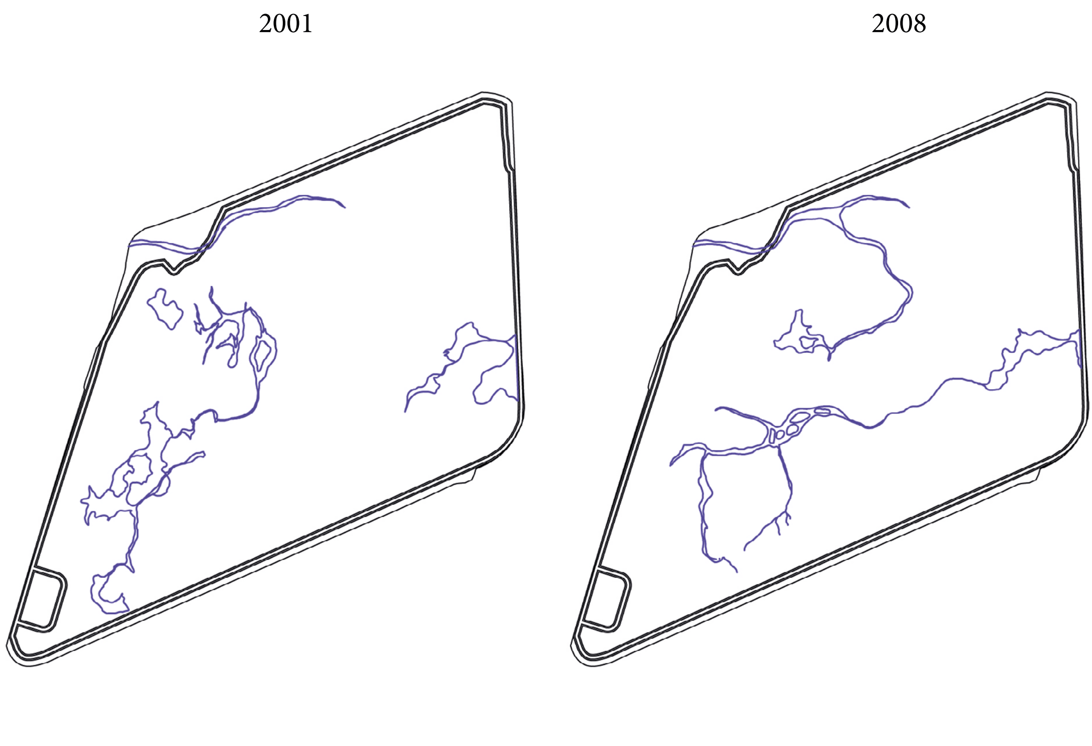
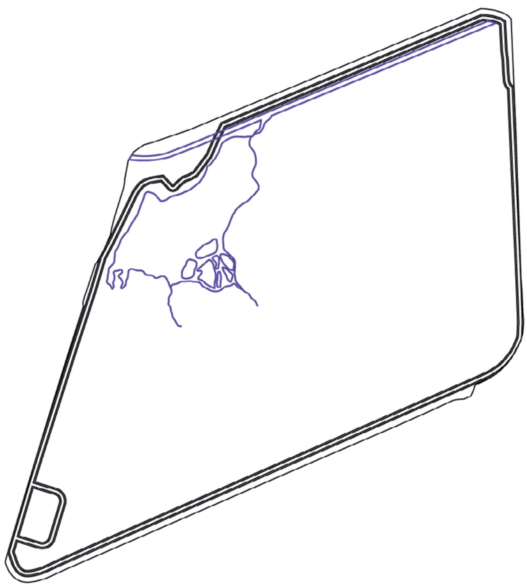
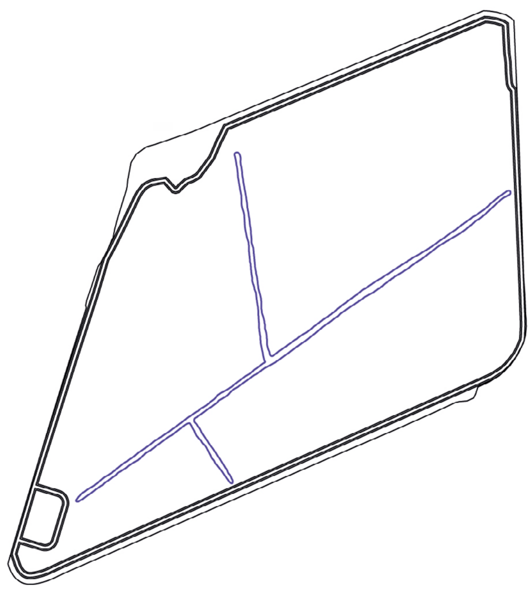


fig 48. Palimpsest of water flow directions over 23 years

2016



2023

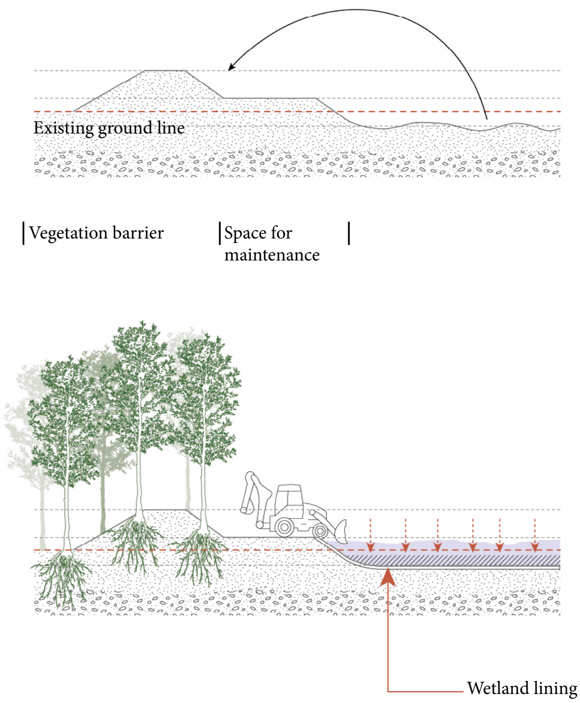


Building the Wetlands

Wastewater purification through constructed wetlands involves a carefully designed system that utilises varying depths and diverse types of vegetation to enhance the cleaning process at multiple stages. Initially, the construction employs an efficient cut-and-fill technique that meticulously balances the soil works. This method involves building dikes and ensuring that the natural contours of the landscape are preserved as closely as possible.

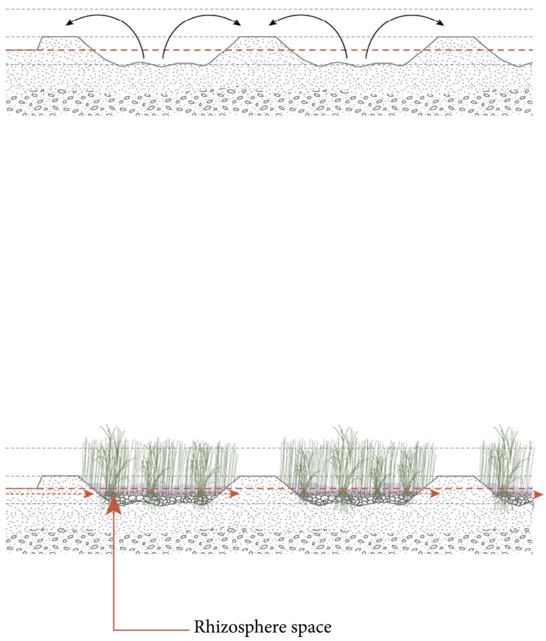
Different plant species are strategically integrated into the wetland system, each playing a unique role in treating wastewater by absorbing nutrients, filtering contaminants, and providing habitat for beneficial microorganisms. As water flows through these interconnected systems, the combined effects of natural filtration and biological processing contribute to an effective and sustainable method of wastewater management.

01 Sedimentation



The first step in the cleaning process is sedimentation, which takes place in a shallow wetland that requires ongoing maintenance. It is essential to leave designated space for this activity. This wetland is not open to the public, as it plays a crucial role in the initial stage of the cleaning process. A tree barrier helps to enclose this area and acts as a shield against unpleasant odours.

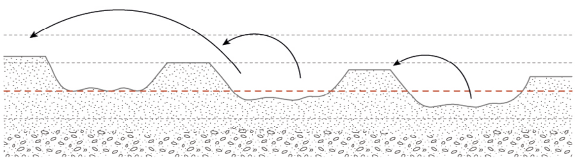
02 Reed Filtering

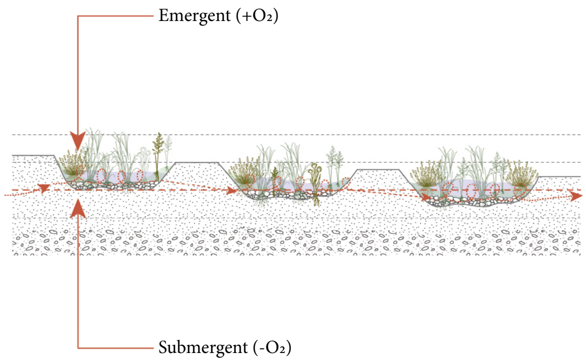


The next step features horizontal-flow reed filtering, a method in which water is guided through a series of interconnected pools. During this flow, water passes through the rhizosphere, the root zone. This space allows interactions between plant roots, soil microorganisms, and water. As the water travels horizontally, the reed cultivation absorbs nutrients and contaminants, improving water quality before it moves to the next pool.

fig 49. Cut and Fill Strategies Diagrams

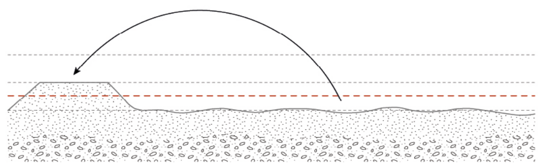
03 Anaerobic Treatment

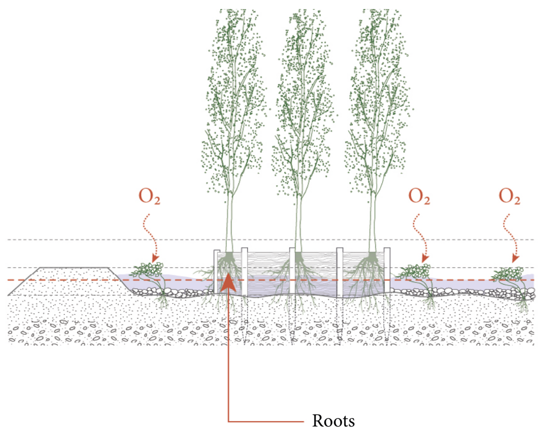




The third is a vertical flow system that operates anaerobically, meaning it alternates between areas rich in oxygen and those that are deprived. This unique characteristic creates varied environments that support a wide array of plant species, leading to greater biodiversity. In the oxygen-rich zones, photosynthetic organisms thrive, while the oxygen-poor areas provide habitats for specialised flora adapted to those conditions.

04 Facultative Treatment





The final stage is characterised by its heightened demand for oxygen and sunlight, which makes it accessible to people. The presence of aquatic plants plays a crucial role in oxygenating the water. Additionally, chinampas are introduced, which are populated with willow trees whose root systems significantly contribute to the oxygenation of the water. The synergistic relationships within the wetland reinforce the overall health of the ecosystem and improve aquatic habitats.

A New Cleaning System

The new proposal is a circular system that collects wastewater from surrounding neighbourhoods, with an estimated 71,527 people living within a 1,000-meter radius of Cienega Chica. This presents an opportunity to alleviate pressure on the current drainage system due to the park's storage capacity, while also providing an additional margin in the wetland capacity within the park, where rainwater could be stored to prevent flooding in Xochimilco.

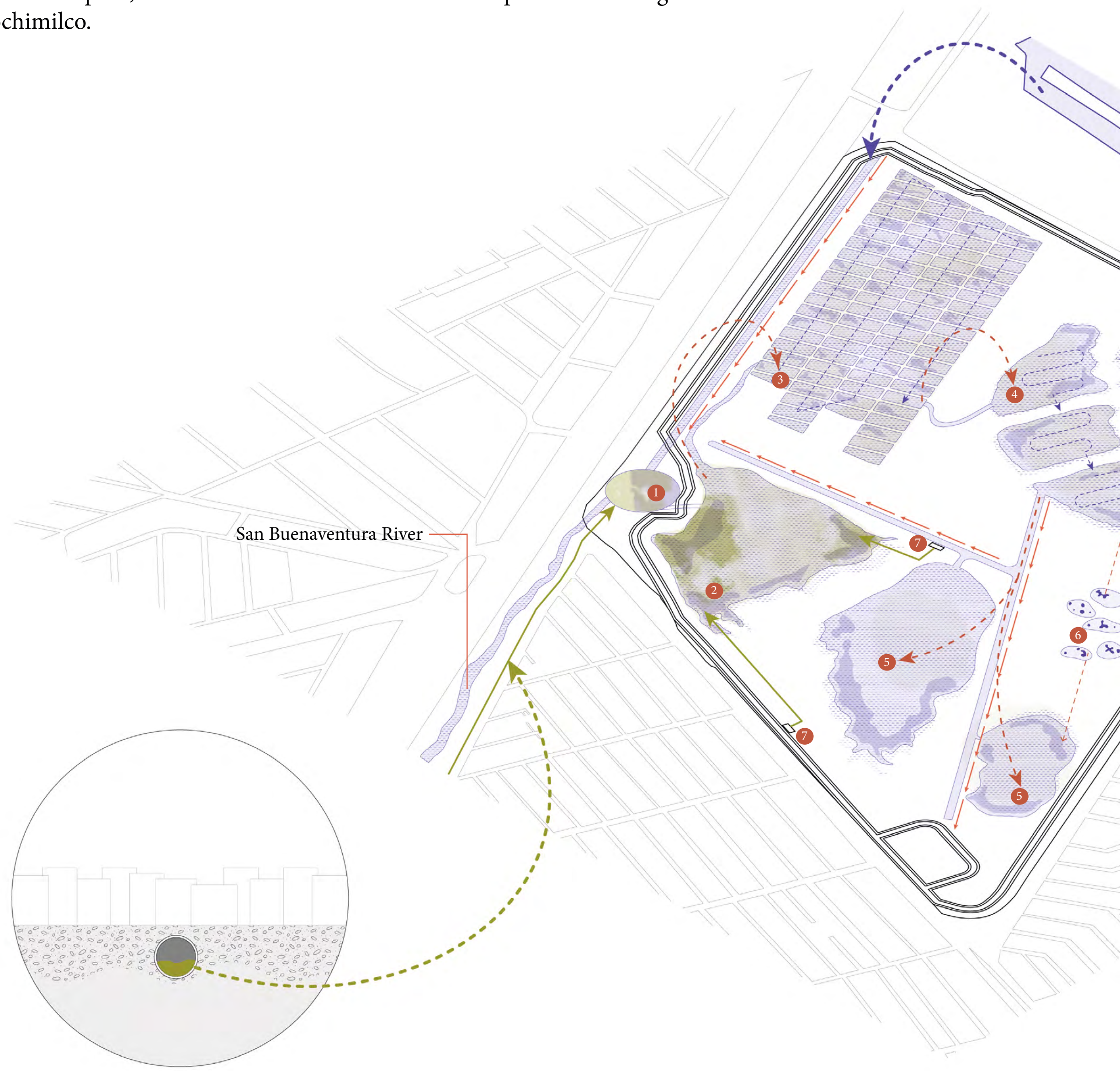
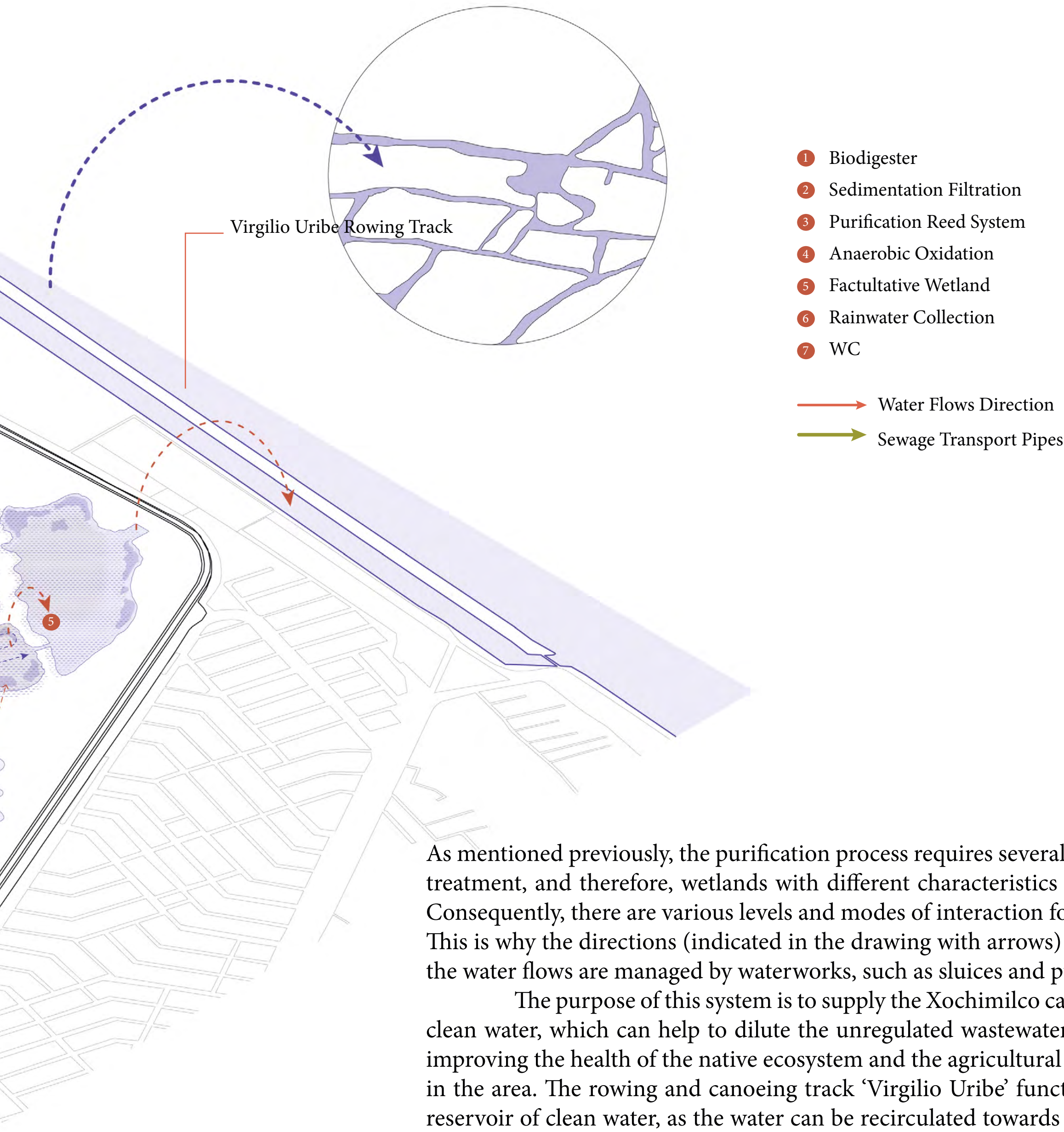


fig 50. Diagram with cleaning System

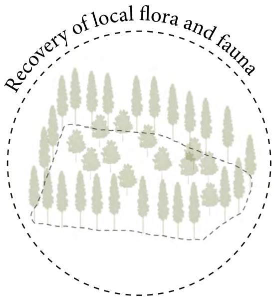


As mentioned previously, the purification process requires several stages of treatment, and therefore, wetlands with different characteristics are used. Consequently, there are various levels and modes of interaction for people. This is why the directions (indicated in the drawing with arrows) in which the water flows are managed by waterworks, such as sluices and pumps.

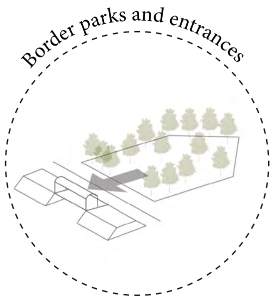
The purpose of this system is to supply the Xochimilco canals with clean water, which can help to dilute the unregulated wastewater, thereby improving the health of the native ecosystem and the agricultural activities in the area. The rowing and canoeing track 'Virgilio Uribe' functions as a reservoir of clean water, as the water can be recirculated towards the park, diluting the dirty water and helping the vegetation to recover.

Vegetation Restoration and Phytoremediation

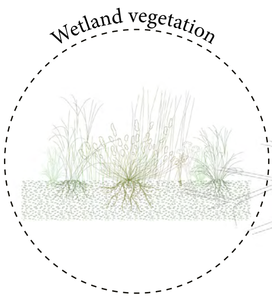
Spaces created by tracing the hidden geometries following the ancient channels of Xochimilco. In these spaces, a recovery process known as Ecological succession is employed (illustrated in more detail on the following page), in which pioneer species are introduced, progressing towards more complex and mature communities until they reach a state of balance.



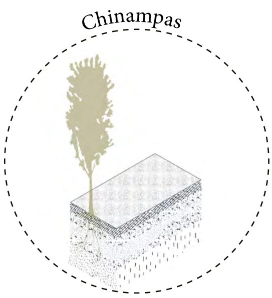
There is a significant opportunity to improve the park's accessibility by positioning the new entrances near the surrounding green areas. This strategic placement invites visitors to explore the landscape but also encourages a seamless transition from the housing environment into the park.



Utilisation of aquatic and sub-aquatic vegetation suited for each phase of the purification process and the specific characteristics of the wetlands.



Chinampas aid in water purification, assist in directing water flows, and serve as interactive and educational spaces, as well as habitats and refuges for endemic species.



Vegetation barriers are used to discourage visitors from entering certain areas of the park, such as wildlife recovery zones, wildlife refuge wetlands, and specific maintenance areas. These strategically placed barriers also serve to block unpleasant odours that may arise from the initial stage of water purification.

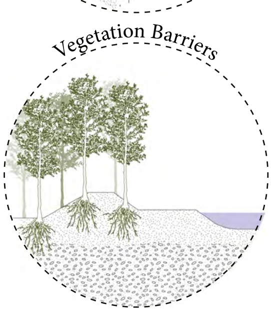
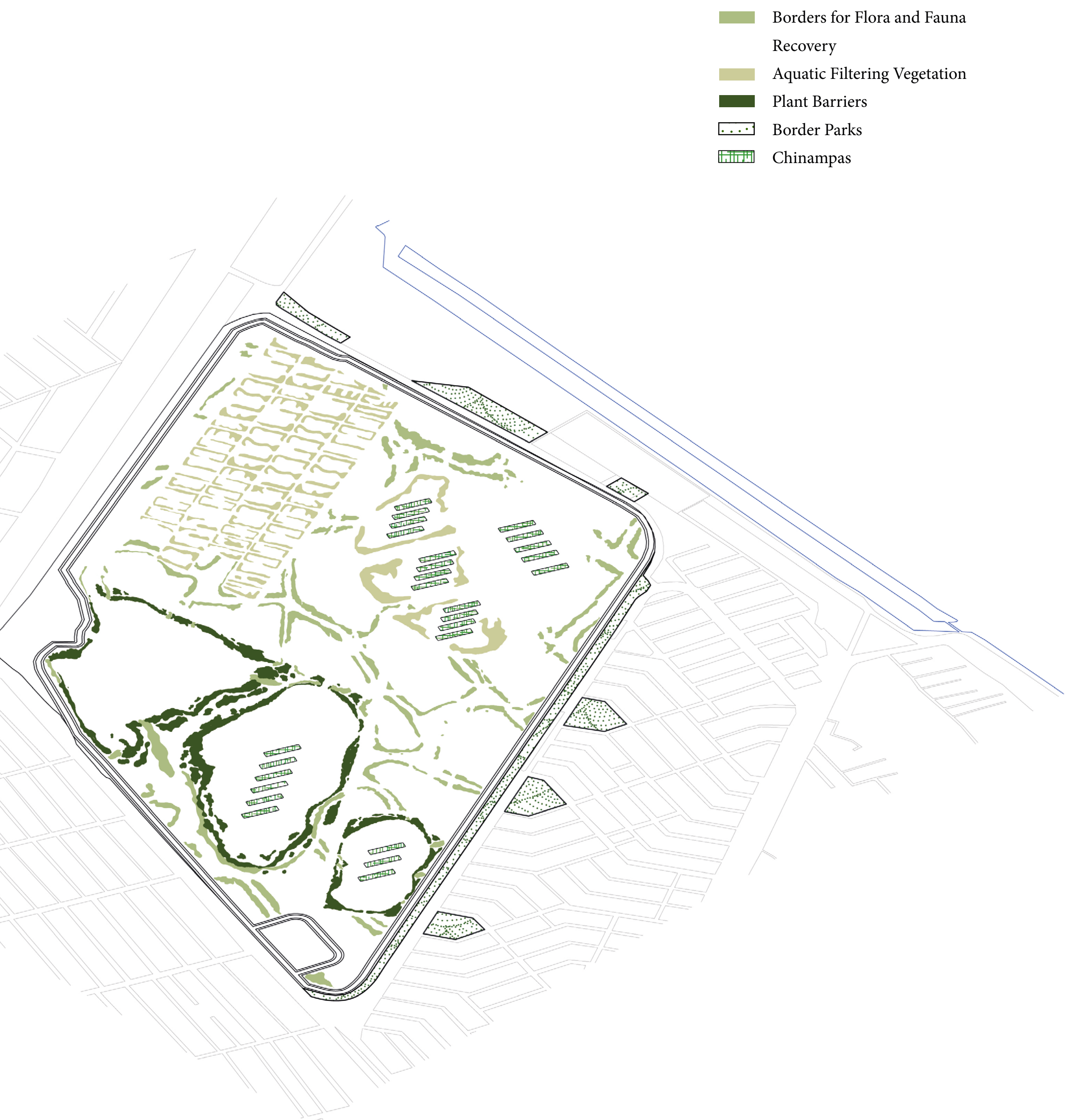


fig 51. Strategies for Managing Vegetation


Borders for Flora and Fauna Recovery
Aquatic Filtering Vegetation
Plant Barriers
Border Parks
Chinampas

Ecological Succession

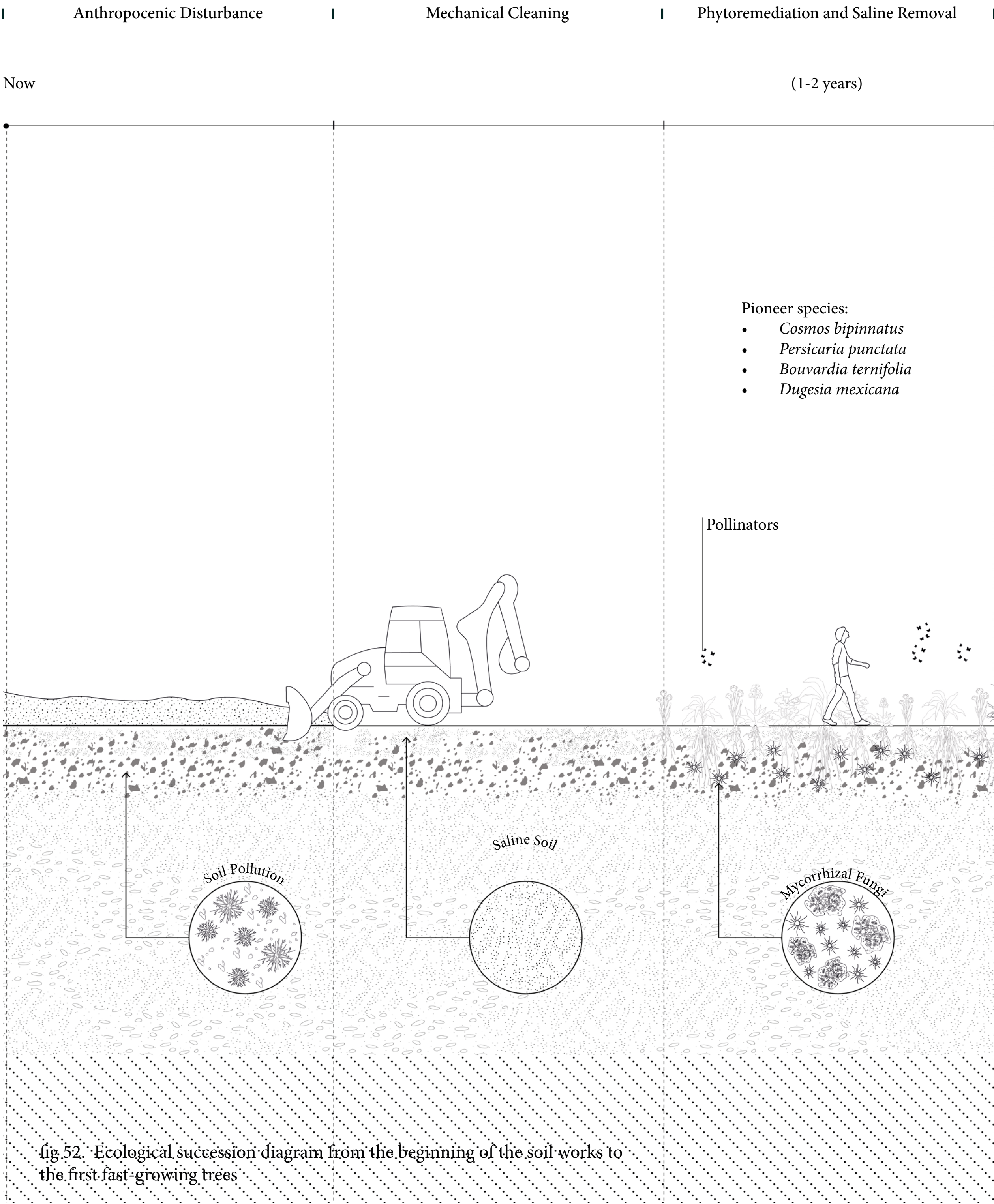


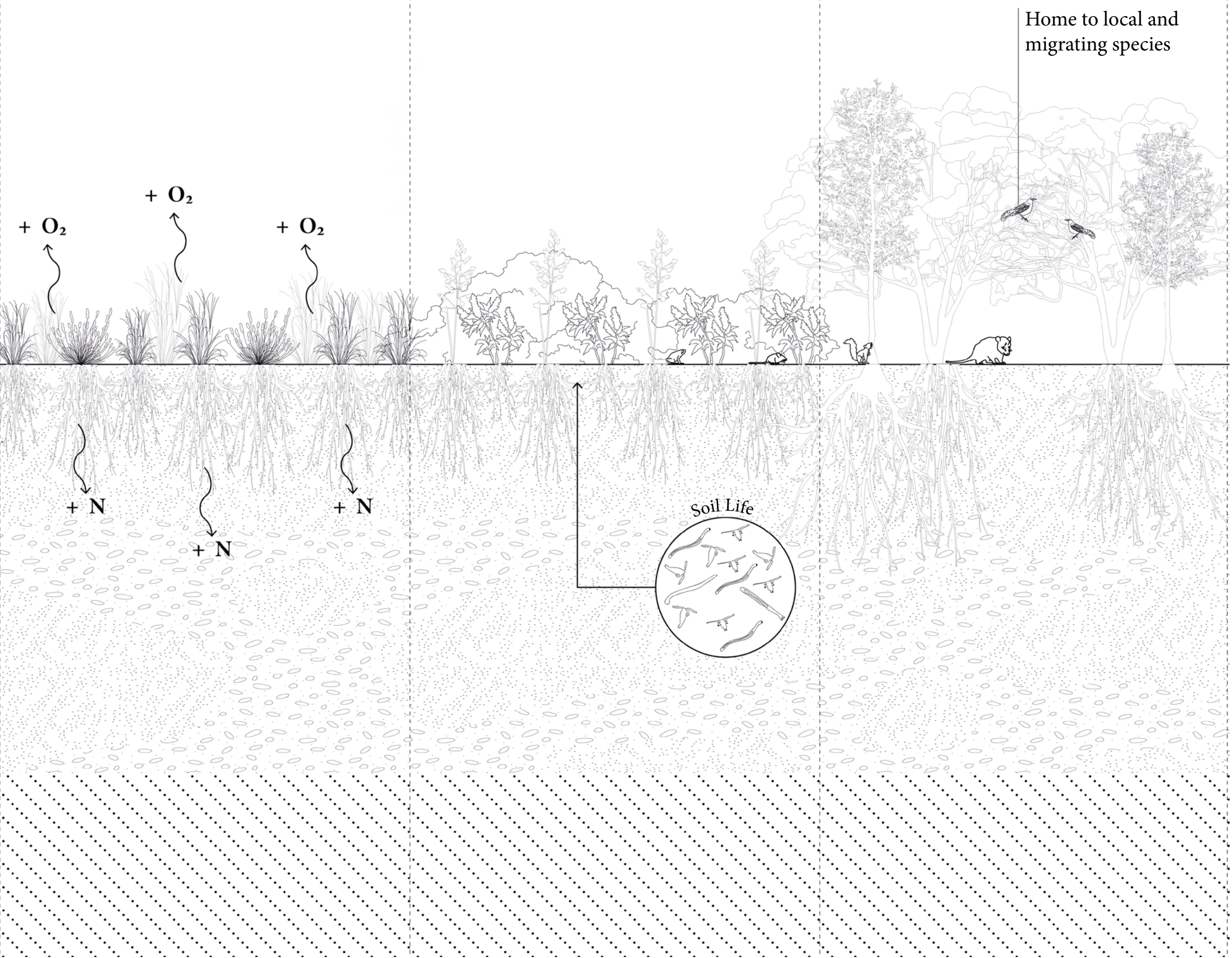
fig 52. Ecological succession diagram from the beginning of the soil works to the first fast-growing trees

Grasses and Perennials	Shrubs and Woody Pioneers	Fast Growing Trees
(3-4 years)	(5 years)	(10 years)

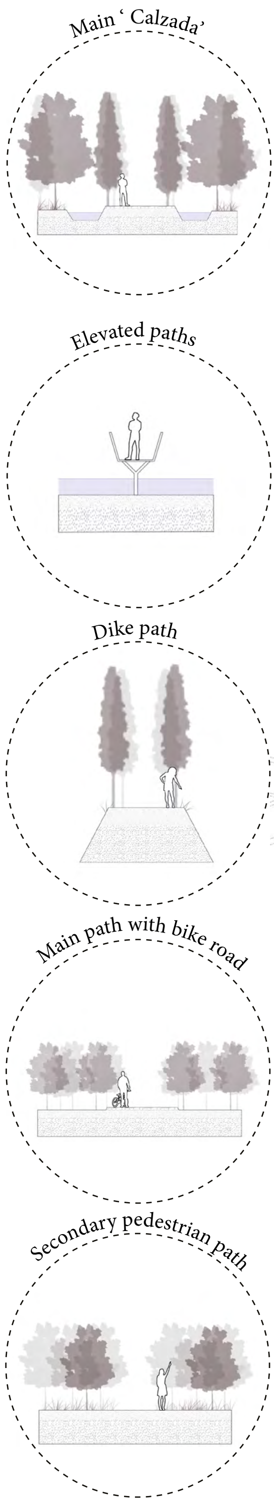
Pioneer species:
- *Metastelma spp.*
- *Dalea spp.*
- *Eryngium foetidum*
- *Andropogon gerardii*

Pioneer species:
- *Tithonia tubiformis*
- *Mirabilis jalapa*
- *Buddleja cordata*

Pioneer species:
- *Handroanthus chrysanthus*
- *Argemone mexicana*
- *Hippocratea excelsa*
- *Bursera spp.*



Park Program Integration



In Mexico-Tenochtitlan, a calzada was a raised road connecting the city to nearby areas. In this park, an existing water-filled ditch serves as a path and visual element to create a calzada. Made from earth and stone, the park's calzada uses materials that match the original, preserving its historical and cultural significance while enhancing the landscape. This design highlights the connection between water management and cultural heritage.

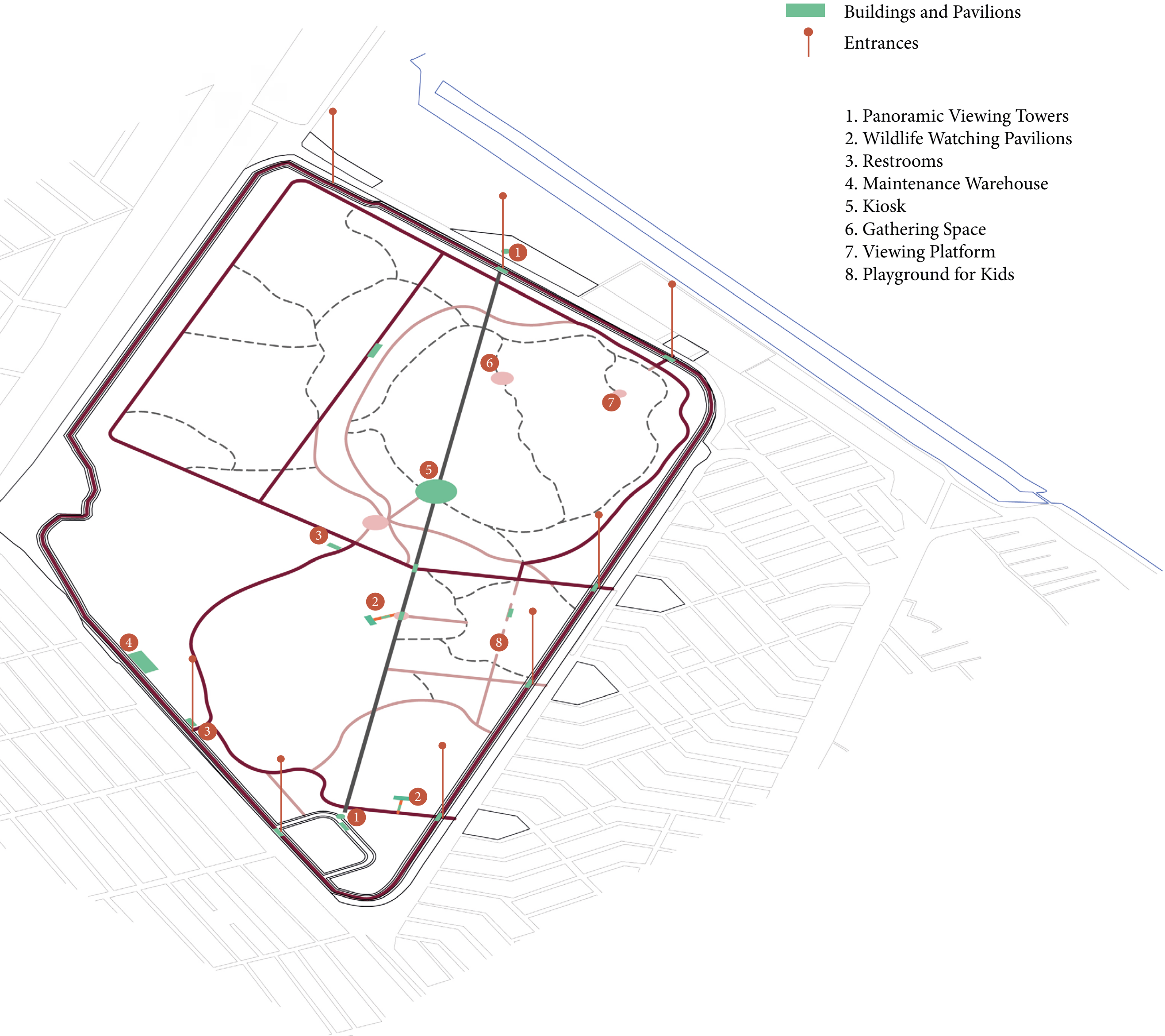
Elevated platforms are designed to enhance the visitor experience with the wetland landscape, providing a unique point for observing the diverse flora and fauna. This allows guests to connect more wetland the ecosystem as they gain a deeper understanding of the ecological significance of wetlands and the importance of preserving them.

A dike surrounds the entire perimeter of the Cienega Chica. Currently, it is access to space. In the context of the park, this passageway is preserved, and, as it is the highest dike, it serves as both a panoramic path for the park and a point for observing the park context.

To enhance the park experience, a network of bike paths has been established. These paths are shared by cyclists and pedestrians, which requires a wider pathway. The primary goal of these bike paths is to facilitate easy navigation throughout the park, with a specific route designed for cyclists. Additionally, these paths connect to routes outside the park, providing access to various points of interest in Xochimilco.

For pedestrians, there are designated routes that encourage exploration of various areas and interaction with the landscape at a slower, more thoughtful pace. These paths provide visitors with a more educational experience, allowing them to stop and engage with the park's features.

fig 53. Strategies for the park's program and paths



Main ‘Calzada’
Main Road with Bike Path
Secondary Pedestrian Path
Meandering Path
Elevated Walkway
Open Spaces
Buildings and Pavilions
Entrances

1. Panoramic Viewing Towers
2. Wildlife Watching Pavilions
3. Restrooms
4. Maintenance Warehouse
5. Kiosk
6. Gathering Space
7. Viewing Platform
8. Playground for Kids

Experiencing the Park

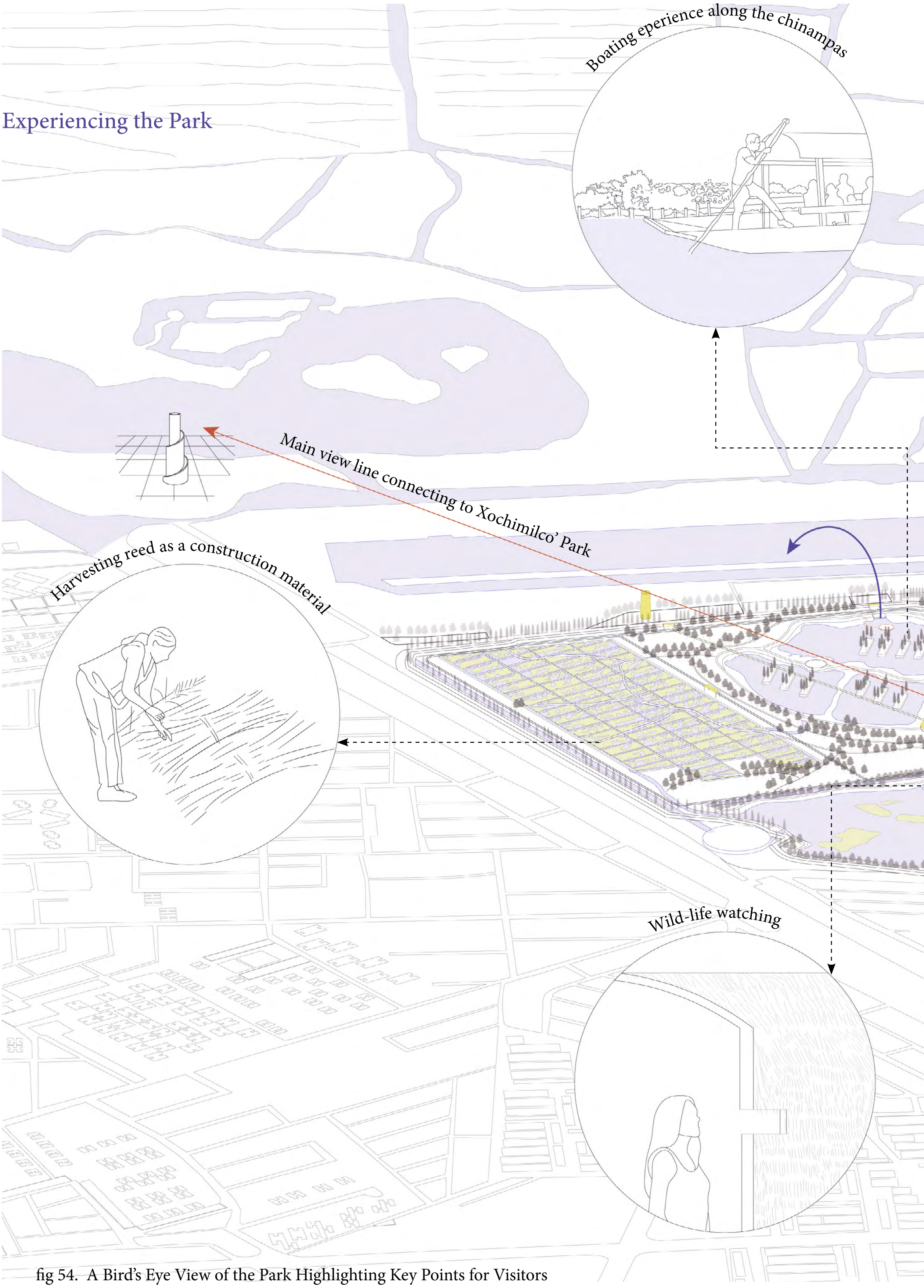
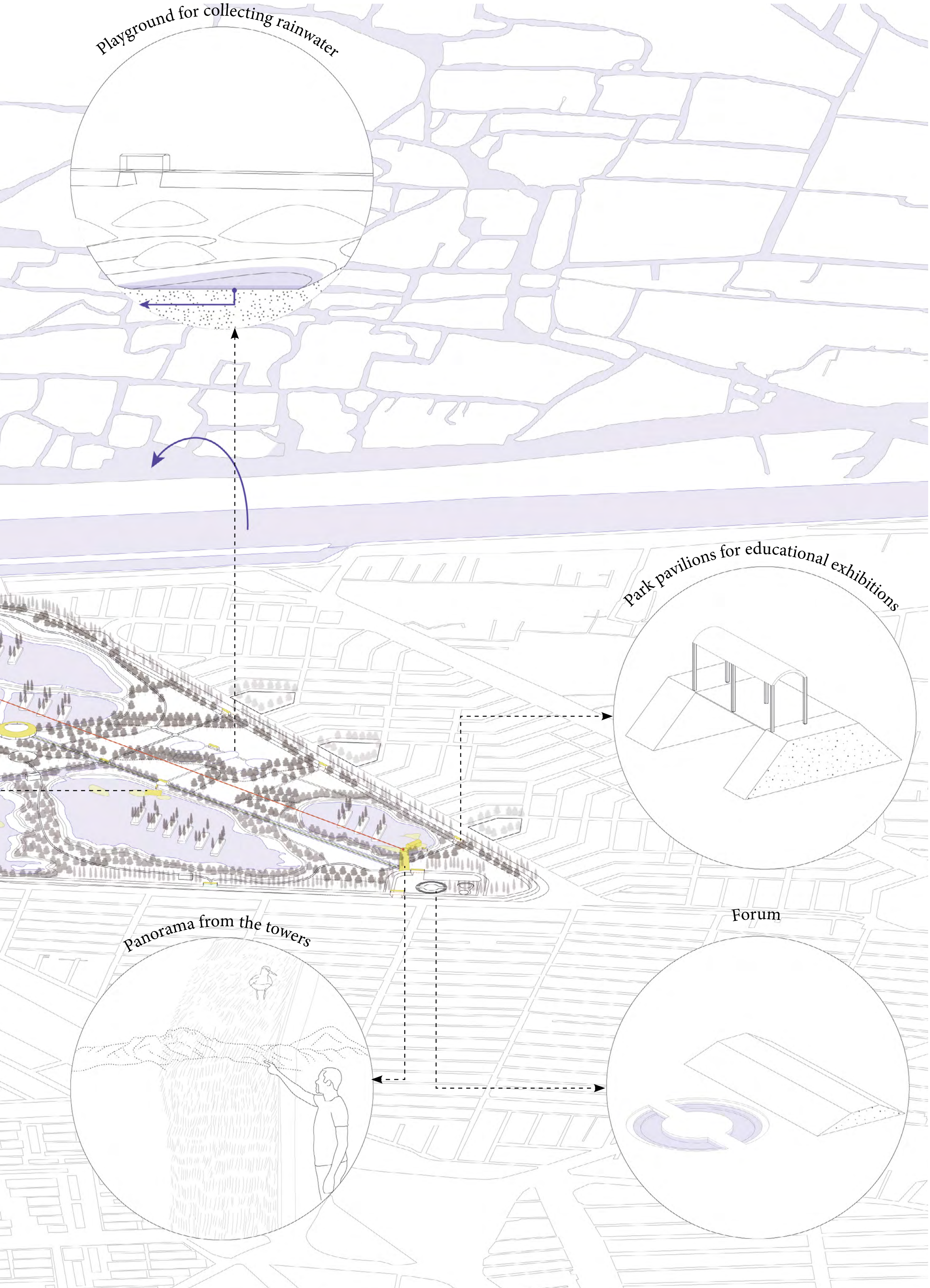


fig 54. A Bird's Eye View of the Park Highlighting Key Points for Visitors


Playground for collecting rainwater
Park pavilions for educational exhibitions
Panorama from the towers
Forum

Accessibility and Routing

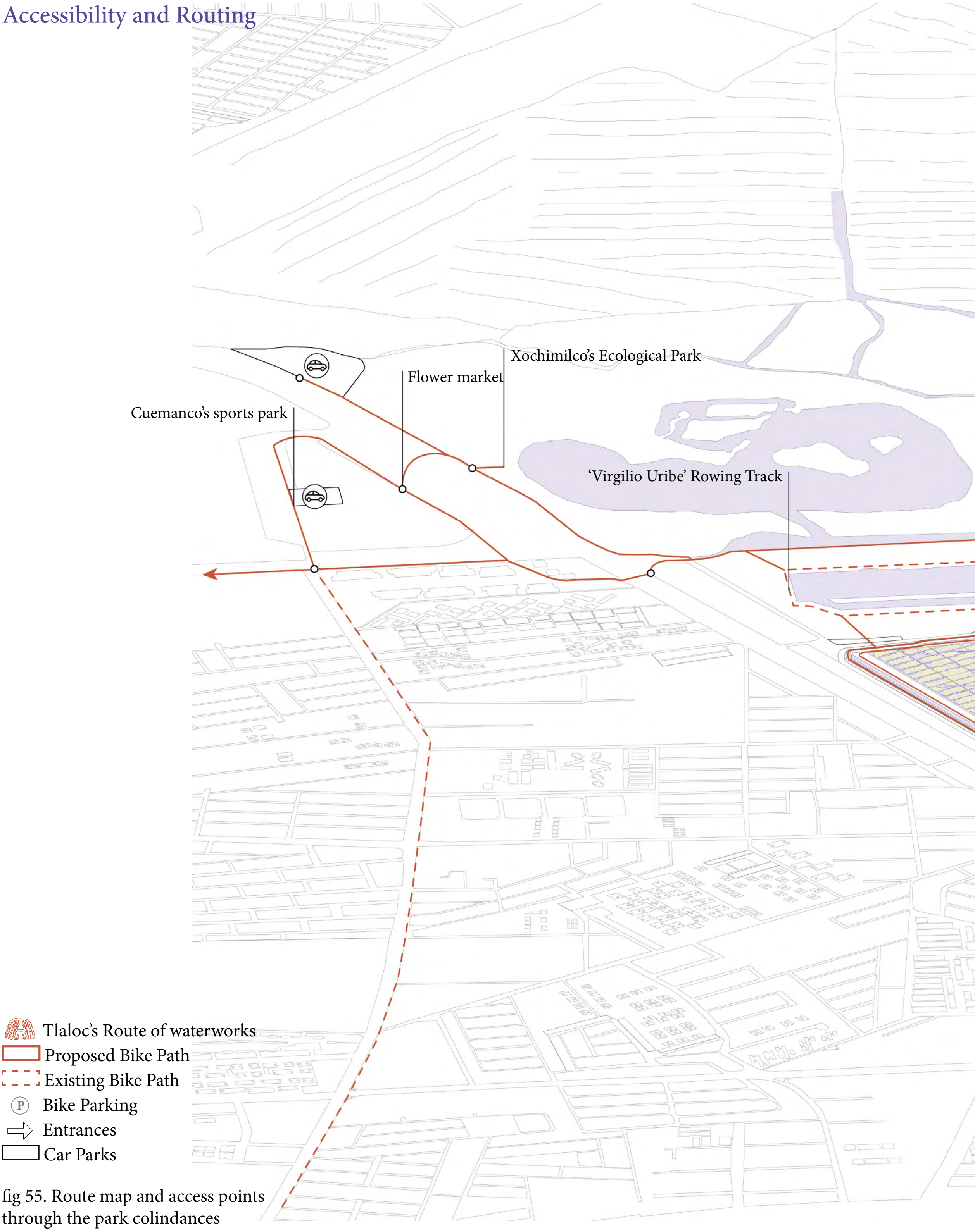
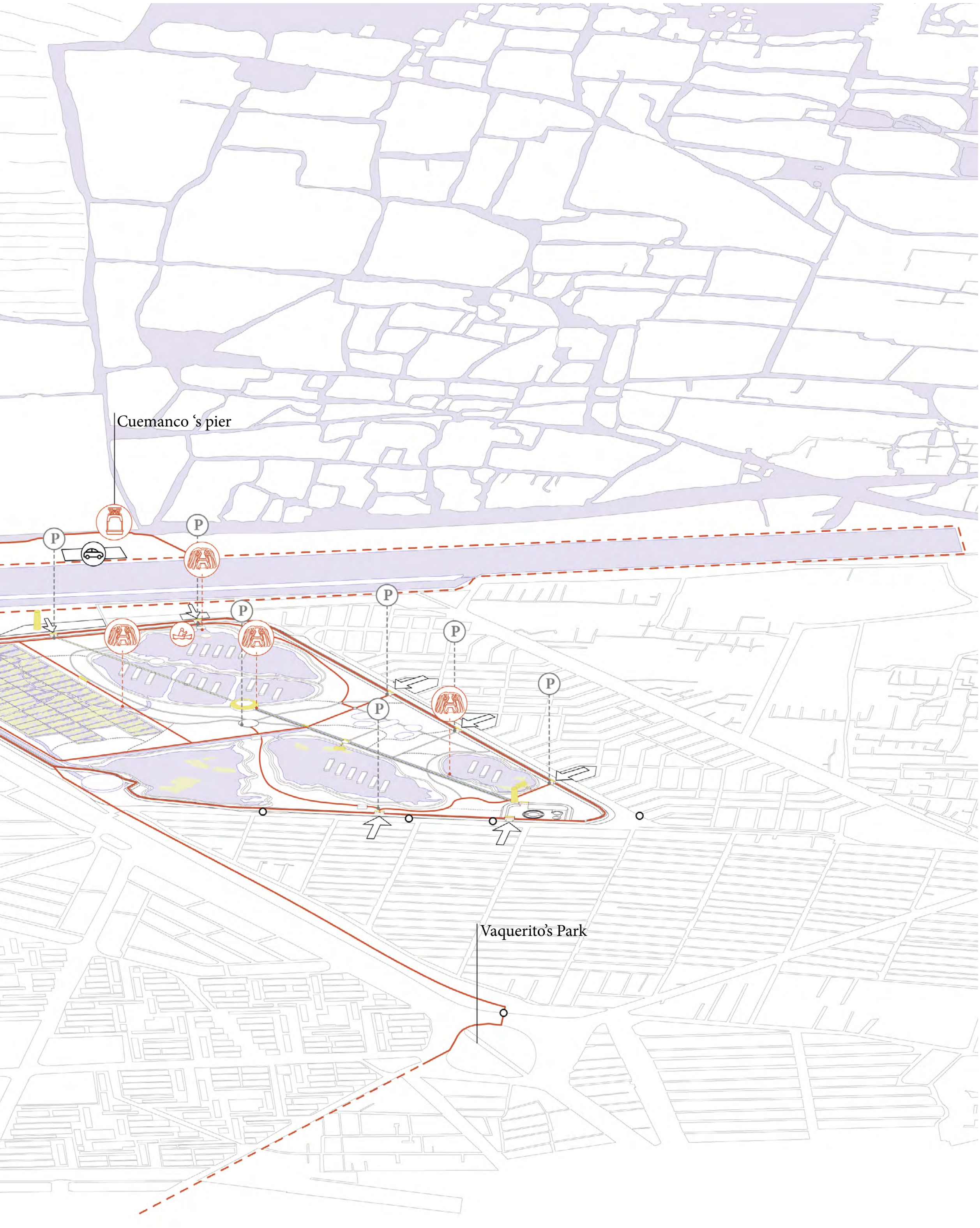


fig 55. Route map and access points through the park colindances


Cuemanco 's pier
Vaquerito's Park

Transforming a once dysfunctional infrastructure into an entrance point

Before

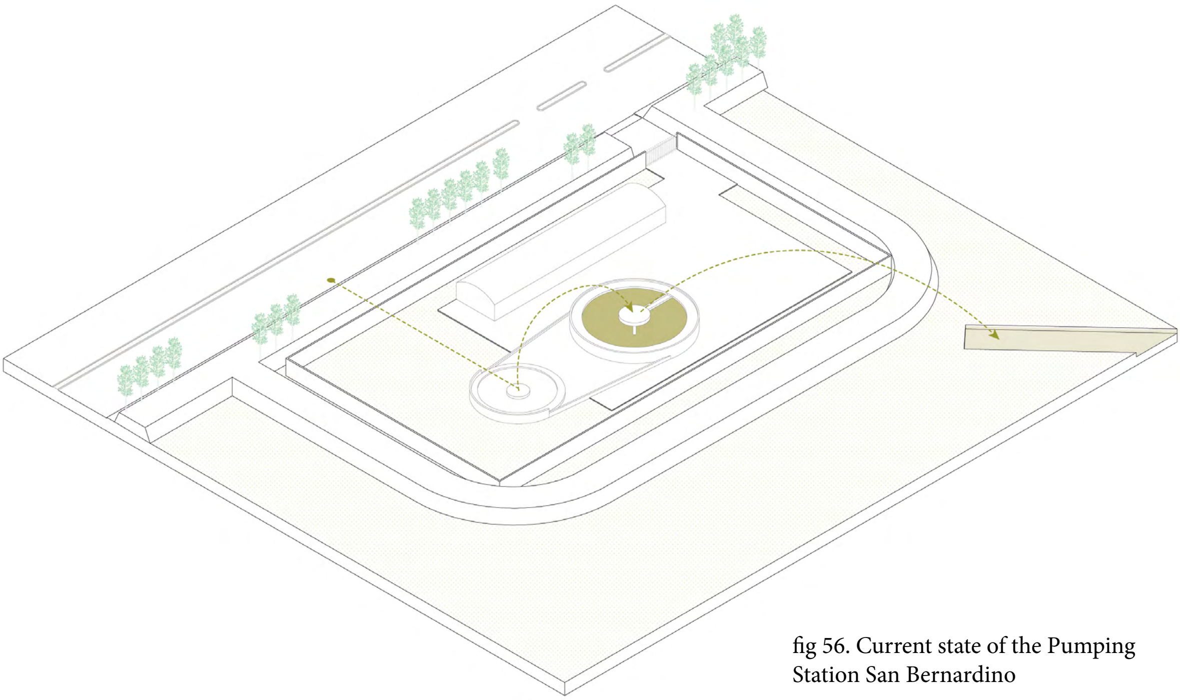


fig 56. Current state of the Pumping Station San Bernardino

The case of the combined water pumping station in San Bernardino was built after the establishment of the flood basin in Cienega Chica, around which a dike and a wall were constructed, reinforcing the notion of inaccessibility. The original idea of this infrastructure project was to pump greywater and drainage from the branches of the drainage system and connect it to one of the main lines for subsequent discharge outside the City.

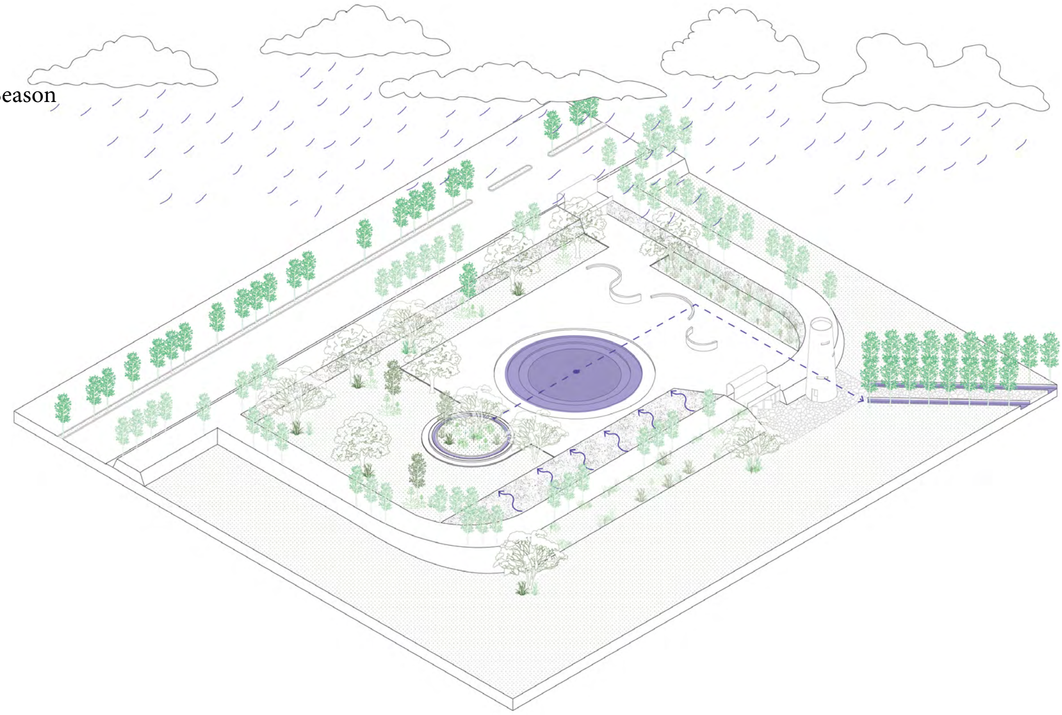
However, this pumping station lost its connection to the main channel, so it currently remains unused. The little water it pumps is stagnant in Cienega Chica, and most of it is evaporated through evapotranspiration.

What is proposed is to give this infrastructure a new purpose, one that is public, recreational, and accessible to the public. Since this is the turning point of the current dike, it is proposed that this be the entry point and serve as an intermediate space between the streets of Mexico City and the park.

The infrastructure is replaced by public space; during the rainy season, the central space becomes a floodable area, while in the dry season it can serve as an outdoor forum. This is why the dike is designed to soften the slope, creating a space where visitors can sit around the central area.

It is proposed that this space be flexible and able to host travelling educational exhibitions, from which people can learn about the ecosystem and elements of the park before embarking on the route within it.

Wet Season



Dry Season

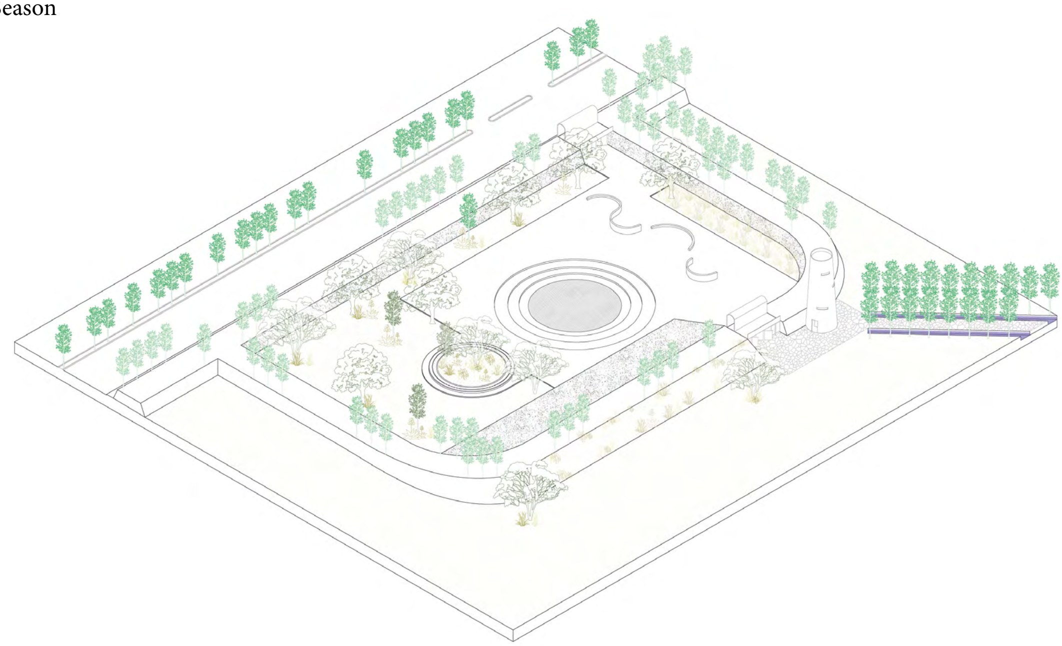


fig 57. The new entrance of the park in the wet and dry seasons

Welcome to the Place Where Flowers Grow

fig 58. A new welcoming space in the Cienega Chica's park

Wildlife Watching

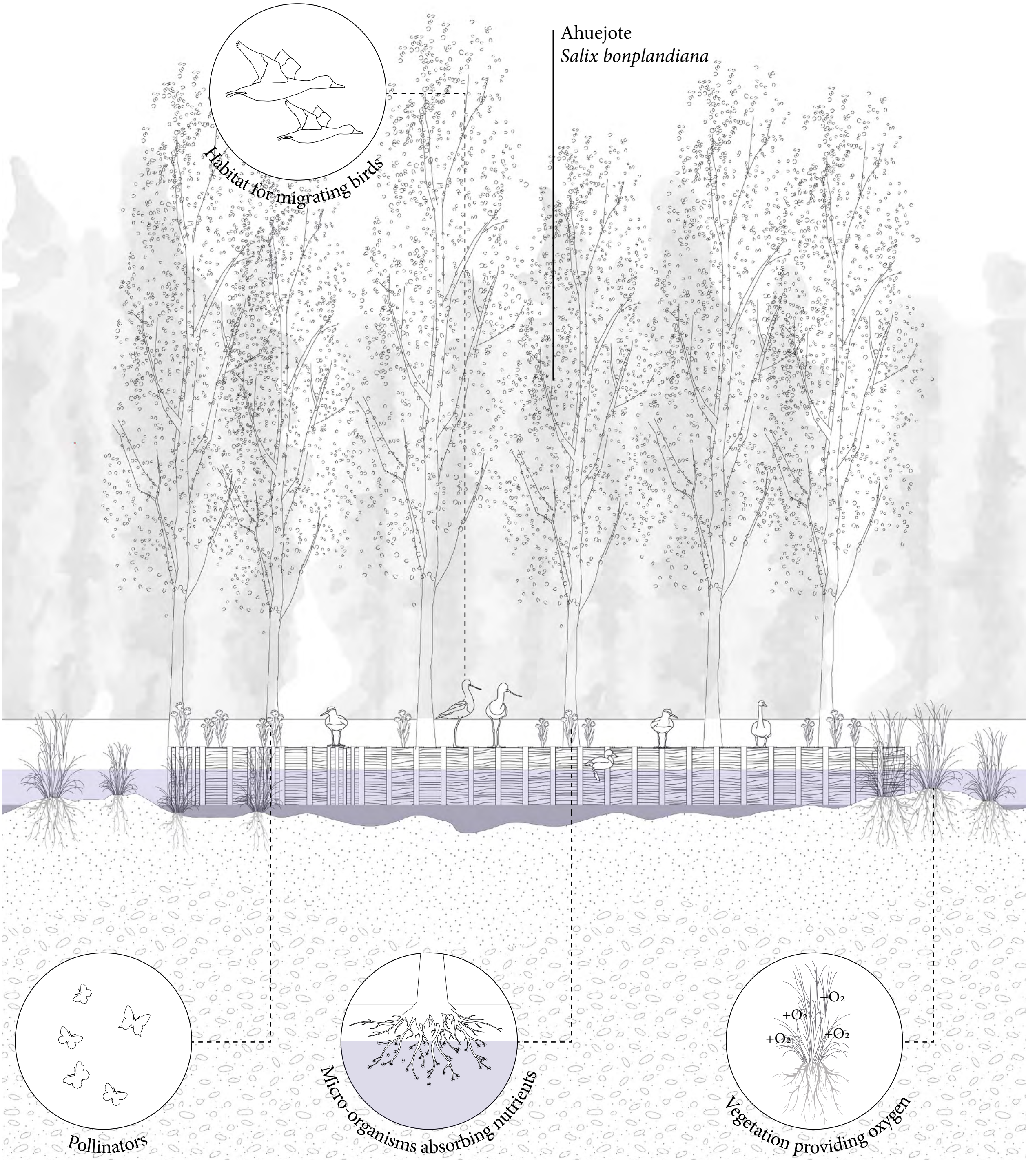
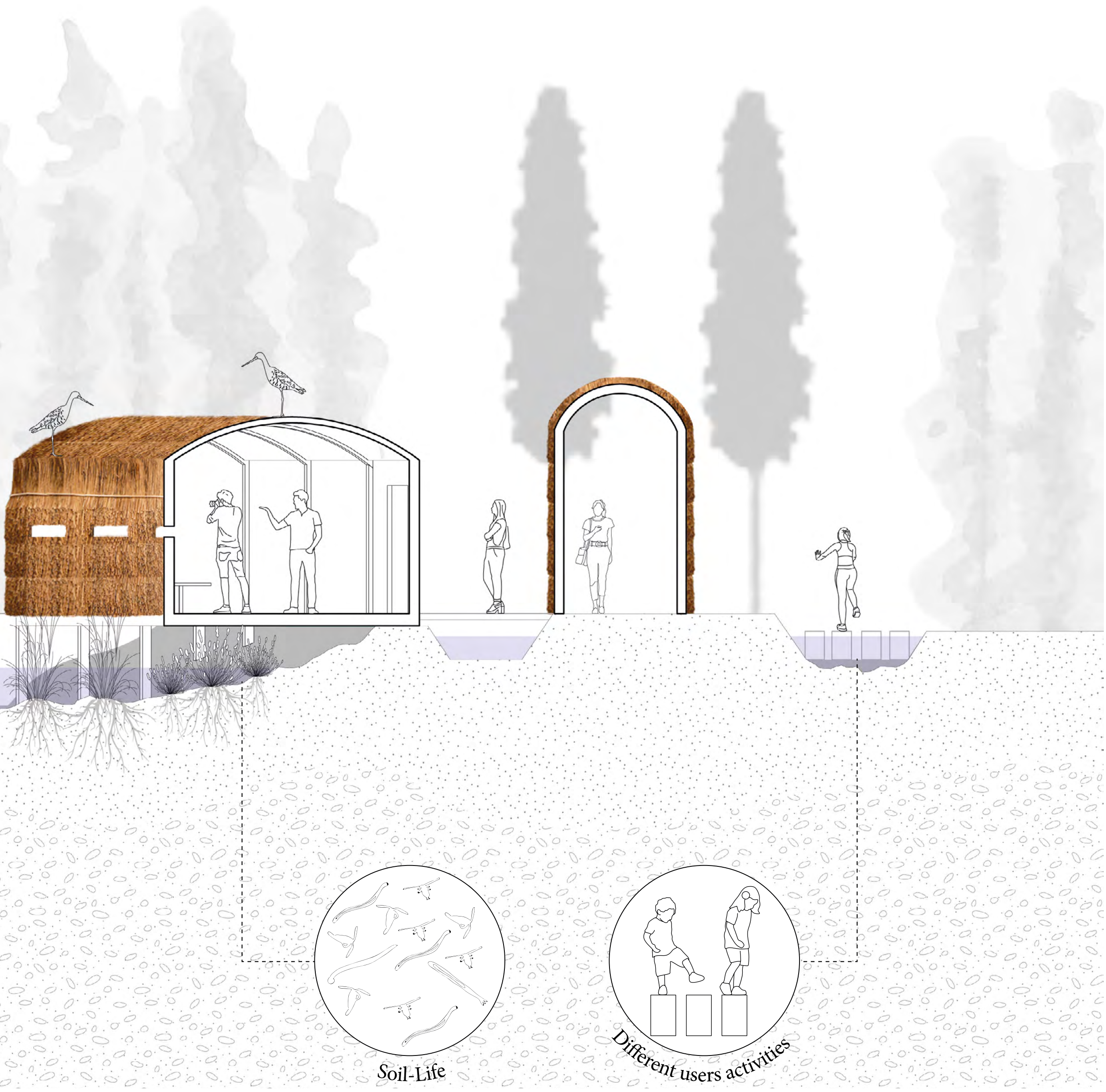


fig 59. Section of a wildlife watching pavilion in a facultative wetland

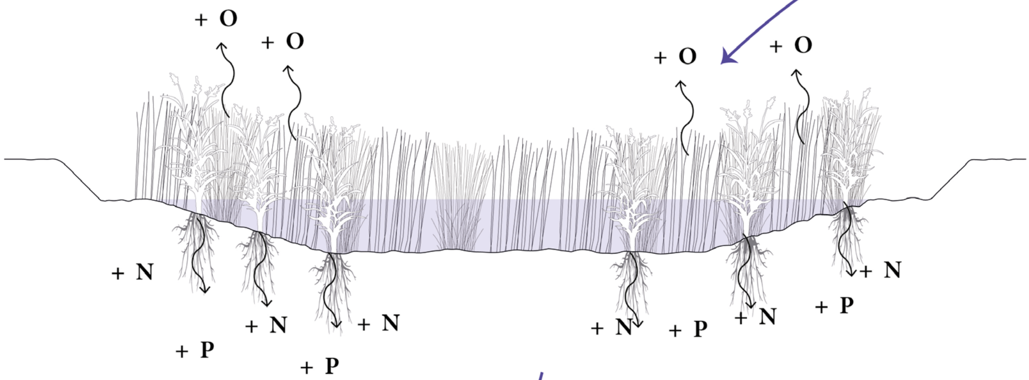


A Living System to Explore and Learn

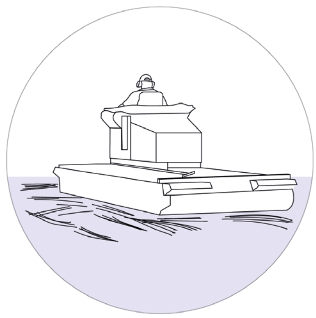
fig 60. Reed filtering field and a Tlaloc sluice

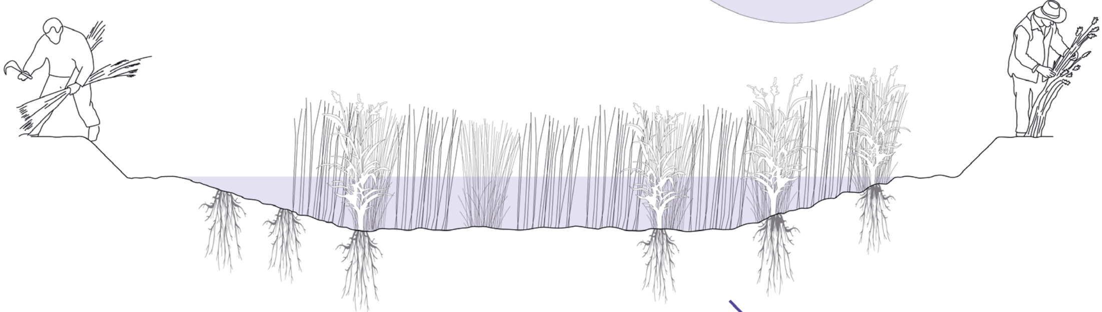
Reed Life-Cycle

Translocating Phase
(August – October)



Harvesting Phase
(October)





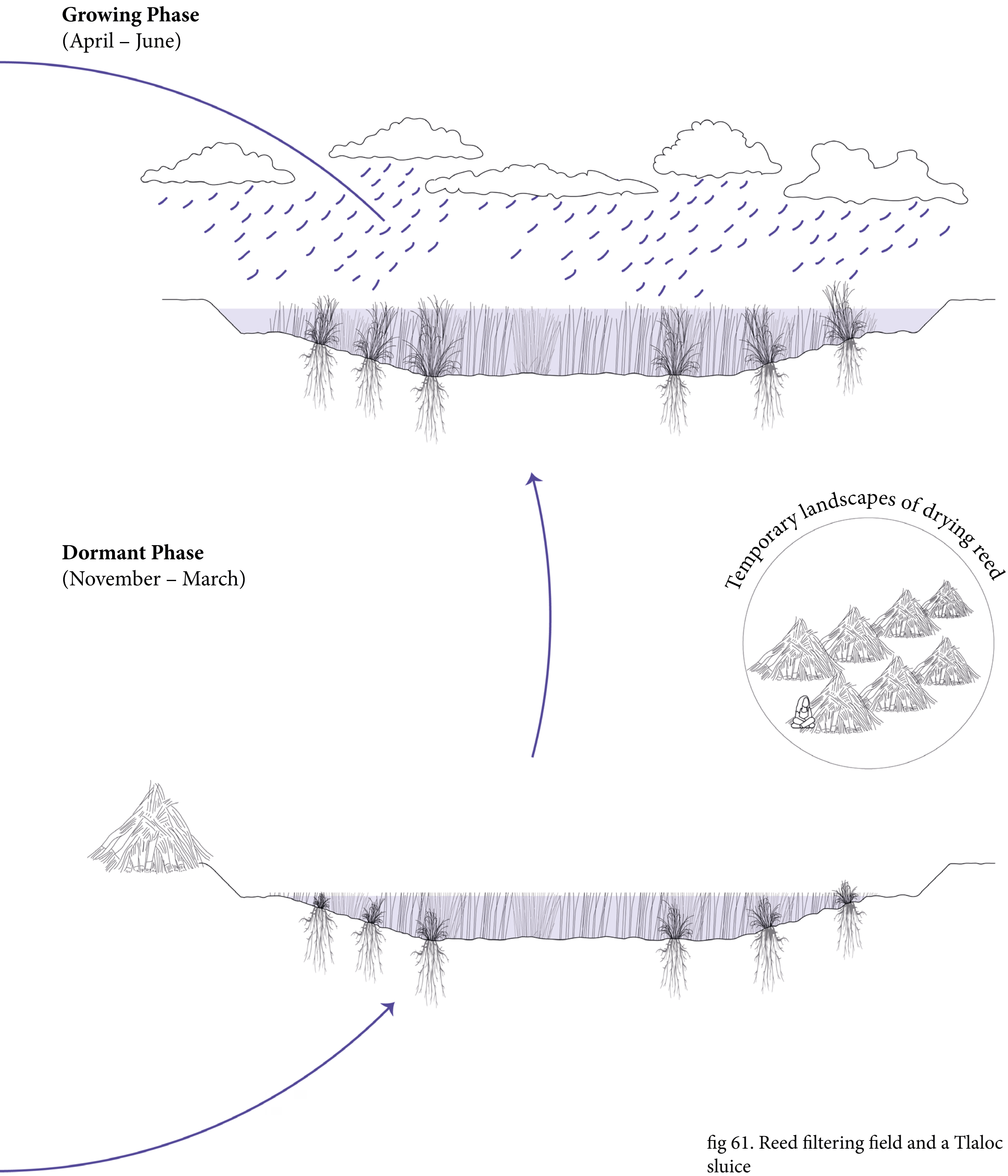
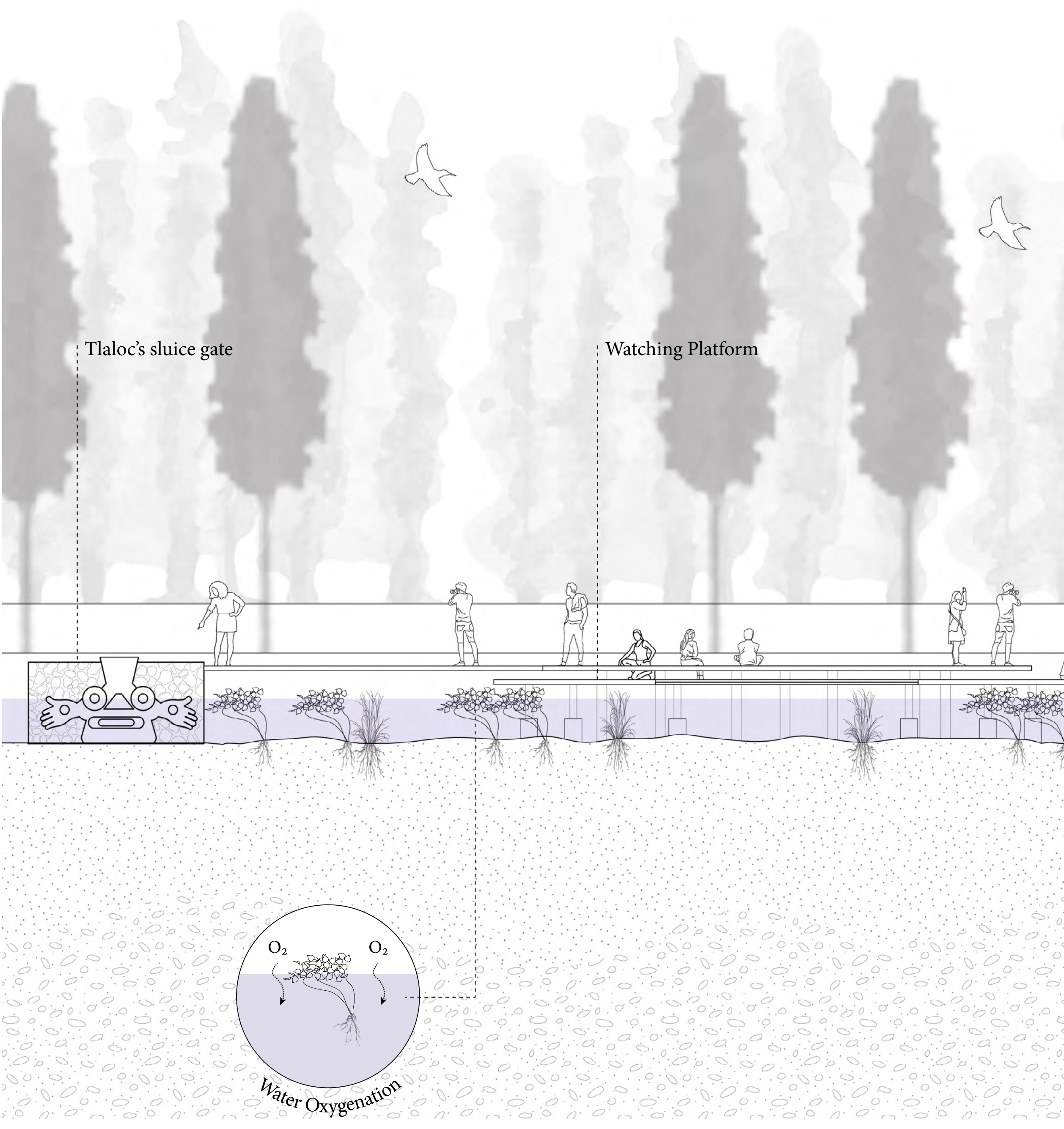


fig 61. Reed filtering field and a Tlaloc sluice


Tlaloc's sluice gate
Watching Platform
O_2
O_2
Water Oxygenation

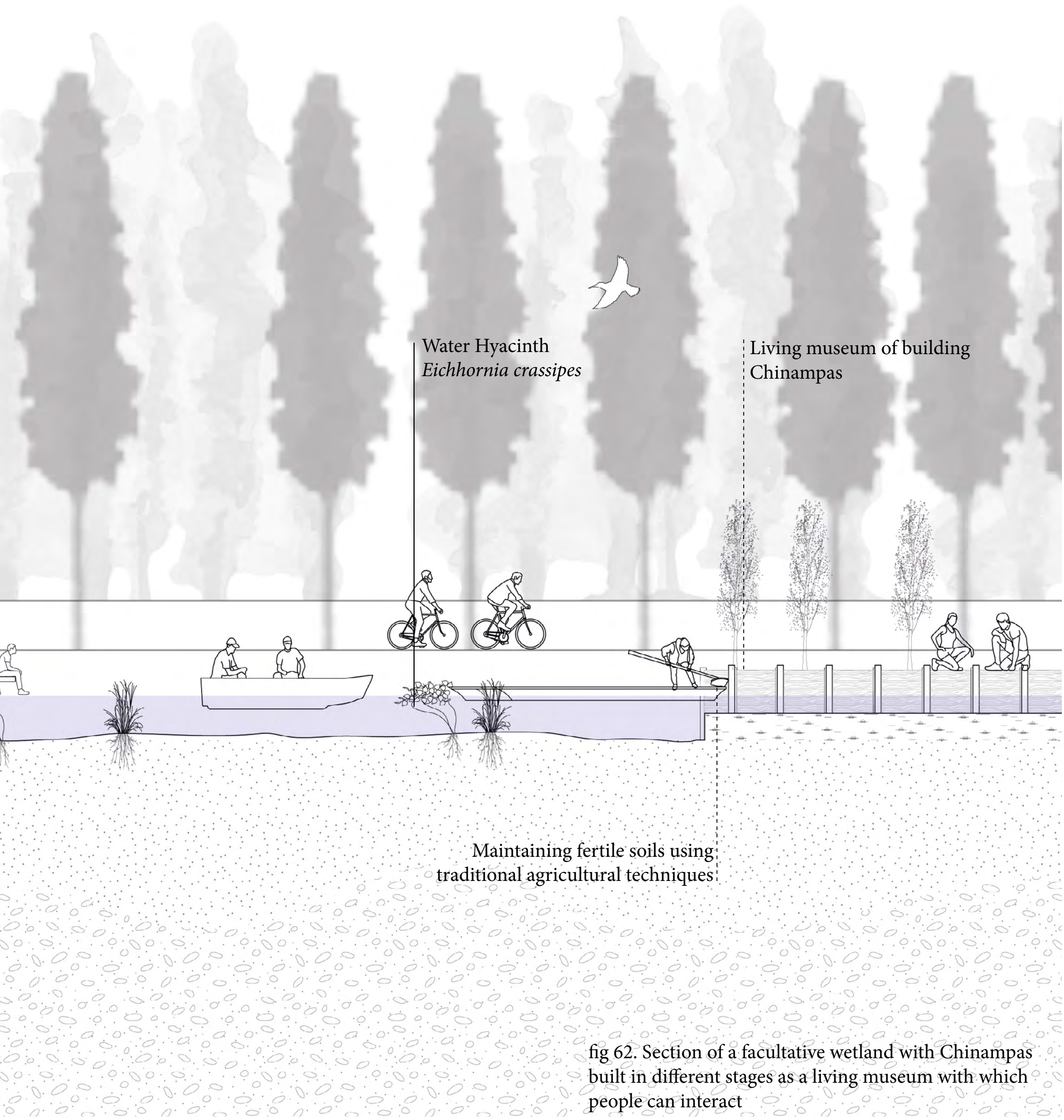


fig 62. Section of a facultative wetland with Chinampas built in different stages as a living museum with which people can interact

Socio-Ecological Relationships

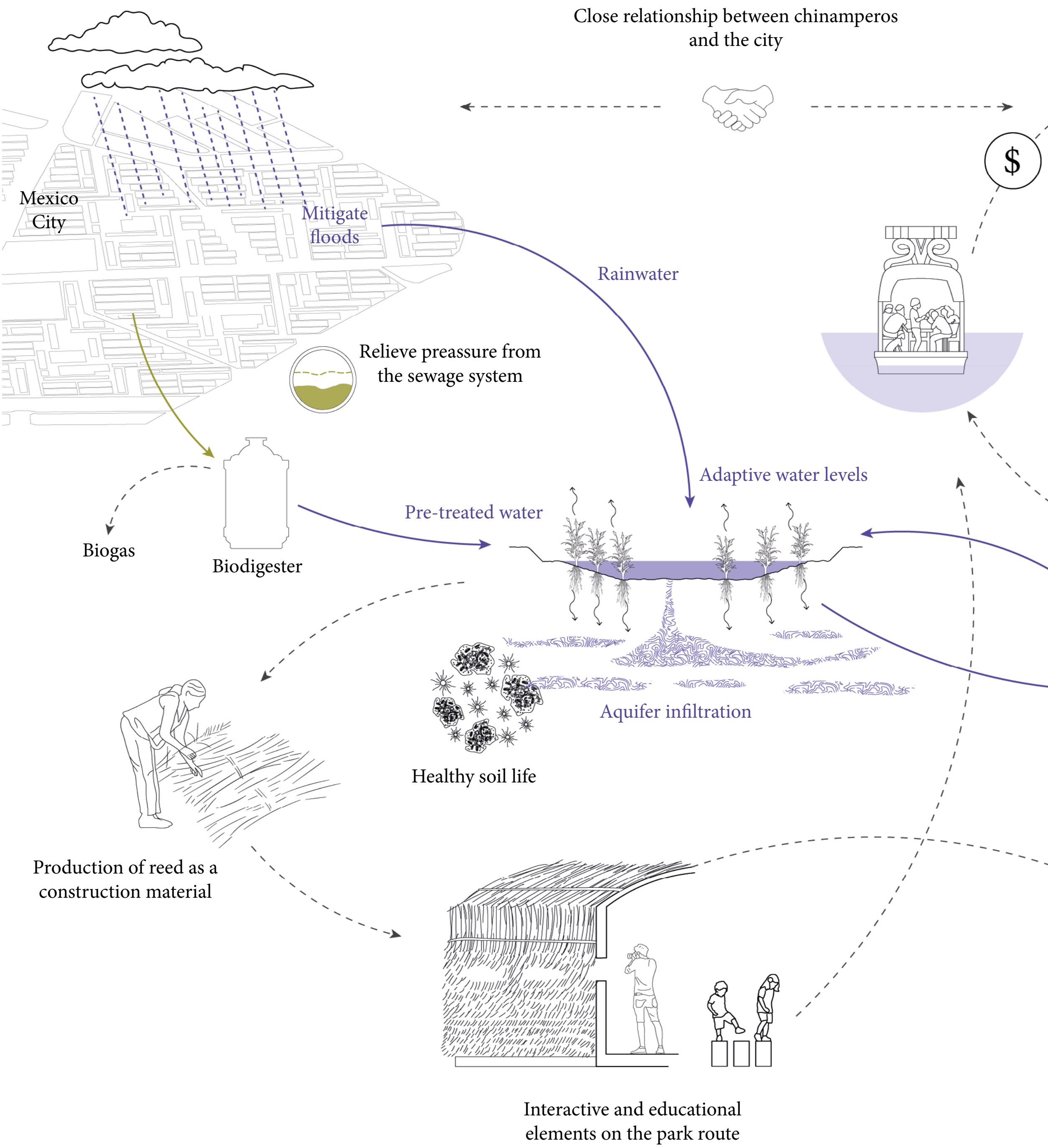
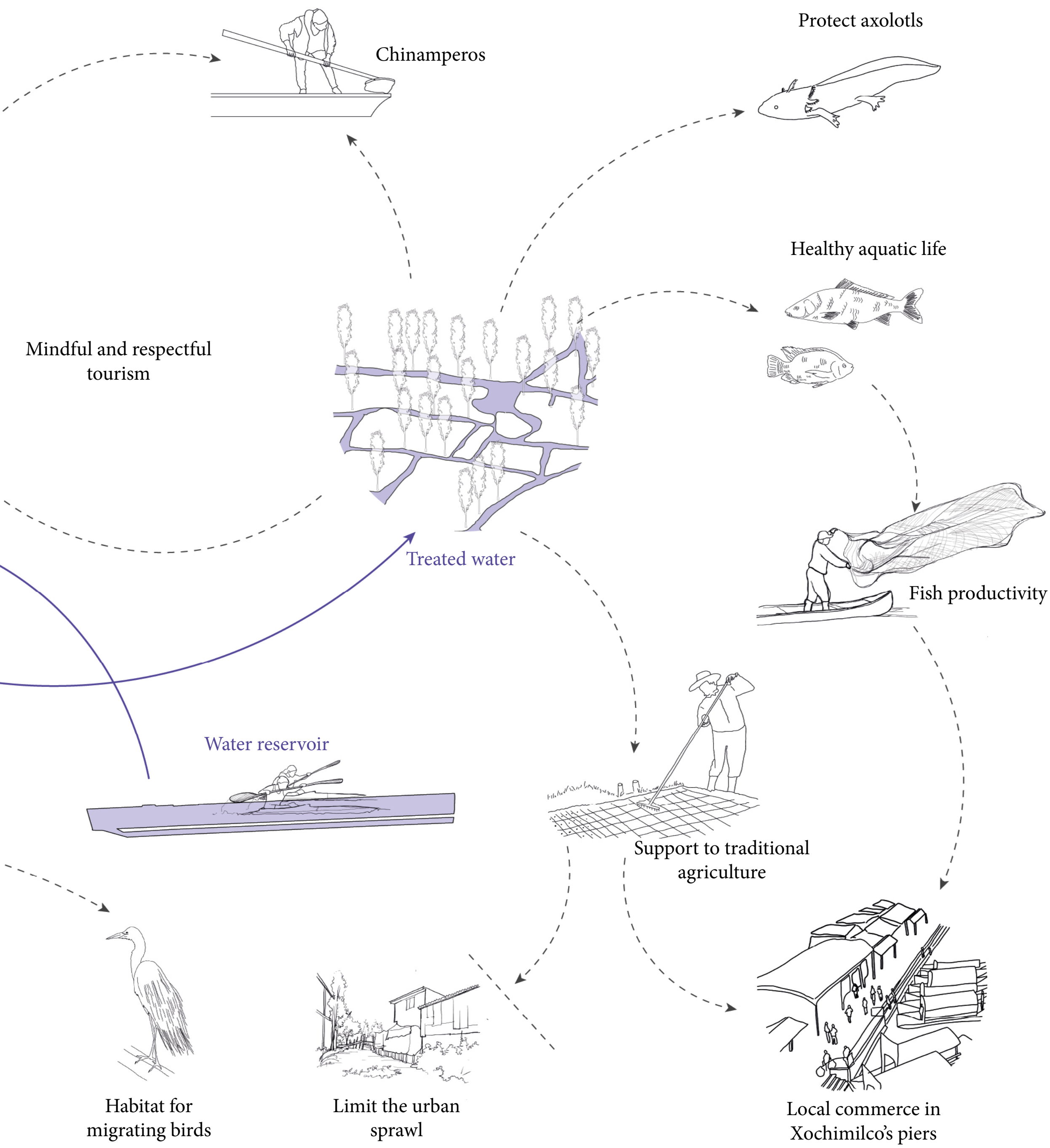


fig 63. Socio-ecological relationships fostered by the new elements and spaces in the Cienega Chica Park



Conclusion

The water crisis in Mexico City

Regarding the issue of the water crisis in Mexico City, it can be concluded that a significant part of the problem lies in a centralised system that attracts a massive number of people to concentrate in a single location, and with this number, the demand for water also increases, which has so far been addressed with an extractivist approach to water.

The perception among the population of the City towards water tends to be negative, as the issue of water scarcity is a daily concern, exacerbated by the extreme weather conditions during the rainy season, which increases susceptibility to flooding.

Systemic Approach

Numerous initiatives and projects have been launched in response to the escalating water crisis in the City. While these efforts demonstrate commendable intentions, they often operate in isolation and fail to generate a substantial, lasting impact on the local population's daily lives. The disconnection between these projects limits their overall effectiveness and prevents a unified strategy from taking shape. To address the water crisis more effectively, it is essential to adopt a systemic approach that integrates these diverse solutions.

Cultural Impact

Public space projects have the potential to serve multiple functions, transforming urban areas into informative but also playful and recreational spaces. By integrating educational elements, this project can engage residents and visitors alike with a deeper understanding of environmental issues. Moreover, these initiatives can make natural processes more visible to the community, allowing individuals to witness firsthand the relationships within their environment. This visibility can play a crucial role in shifting attitudes and mentalities towards preserving natural resources. As people come to appreciate the beauty and importance of their local ecosystems, they may become more motivated to participate in conservation efforts, creating a more sustainable and environmentally conscious community.

Challenges

The challenges of this project are multifaceted, arising from the fact that the systems in Mexico City are highly complex, encompassing both governmental aspects and social dynamics, as well as the water systems and infrastructure. Similarly, a significant complexity is the population growth and the search for new sites to build housing developments, which has been eating up green spaces with infiltration capacity, thereby exacerbating other effects of the water crisis, such as subsidence.

Opportunities
The opportunities emphasise the critical importance of preserving essential areas that support hydrological functions, such as Cienega Chica. These natural spaces play a vital role in maintaining ecological balance and water management. It is crucial to protect them from the threat of urban sprawl, which can disrupt their functionality and the delicate ecosystems they support. Safeguarding these areas is not only imperative for preserving the hydrological cycle but also for ensuring the survival of various non-human species that inhabit Xochimilco.

The role of Landscape Architecture
The role of a landscape architect in this project is to provide functional and cultural meaning that contributes to the preservation of the ecosystem and natural resources. In the case of this project, it becomes a living system in which social ties and interactions are necessary to keep it functioning, thereby building a relationship between the urban and rural sectors of Mexico City.
In this way, the park project in Cienega Chica becomes a support for both human and non-human communities, contributes to the preservation of Xochimilco as a cultural landscape and pre-Hispanic heritage, and becomes part of a system that helps to mitigate the effects of the water crisis improving the quality of life for the vast population of Mexico City.

Reflection

Historical analysis has led me to conclude that the development patterns of Mexico City are often driven by economic growth that does not incorporate sustainable practices for managing the area's limited natural resources. Furthermore, the social landscape in Mexico is characterised by inequality, which affects decision-making processes that tend to prioritise immediate relief for vulnerable populations over long-term strategies.

While water has historically played a crucial role in supporting the Basin of Mexico, the lake ecosystem now exists primarily as a concept in the collective memory of the Mexican people. This disconnection from natural water sources contributes to a significant challenge: a lack of environmental awareness.

During the course of this thesis, I faced several significant challenges in the decision-making process. One of the main difficulties was narrowing down my focus within the broader scope of water-related issues in Mexico City. The complexity of the water crisis means that there is no single solution, resulting in slower-than-expected progress, as I needed additional time to refine my focus.

This may have been more effective if I had worked within my design framework and defined my scales in a timely manner, but I believe it was more due to project complexity than a lack of planning.

Reflecting on the two years I spent studying the Dutch landscape, I learned about various methods and technologies for water management. Despite the differing contexts, I noticed similarities in certain elements, such as dikes, levees, and the construction of polders. What I hope to replicate in Mexico is making water more visible through landscape strategies rather than just through pipes.

Ultimately, I aimed to centre my work on indigenous cosmovision and its ecological perspective, which extends beyond human considerations. I sought to reintroduce this worldview through spatial elements. My goal was to integrate a water treatment infrastructure within a culturally rich landscape, thereby creating a meaningful connection between ecological practices and the heritage of the area.

As a landscape designer, my perspective after completing this project emphasises the importance of understanding water systems on a regional scale. This requires a systematic vision that encompasses interconnected spaces. It is equally essential to develop experiences that resonate with people, promoting an approach that extends beyond human-centred perspectives. I envision this project as a stepping stone rather than an endpoint, and I am looking forward to continuing my exploration of decentralised alternatives in my professional journey.

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