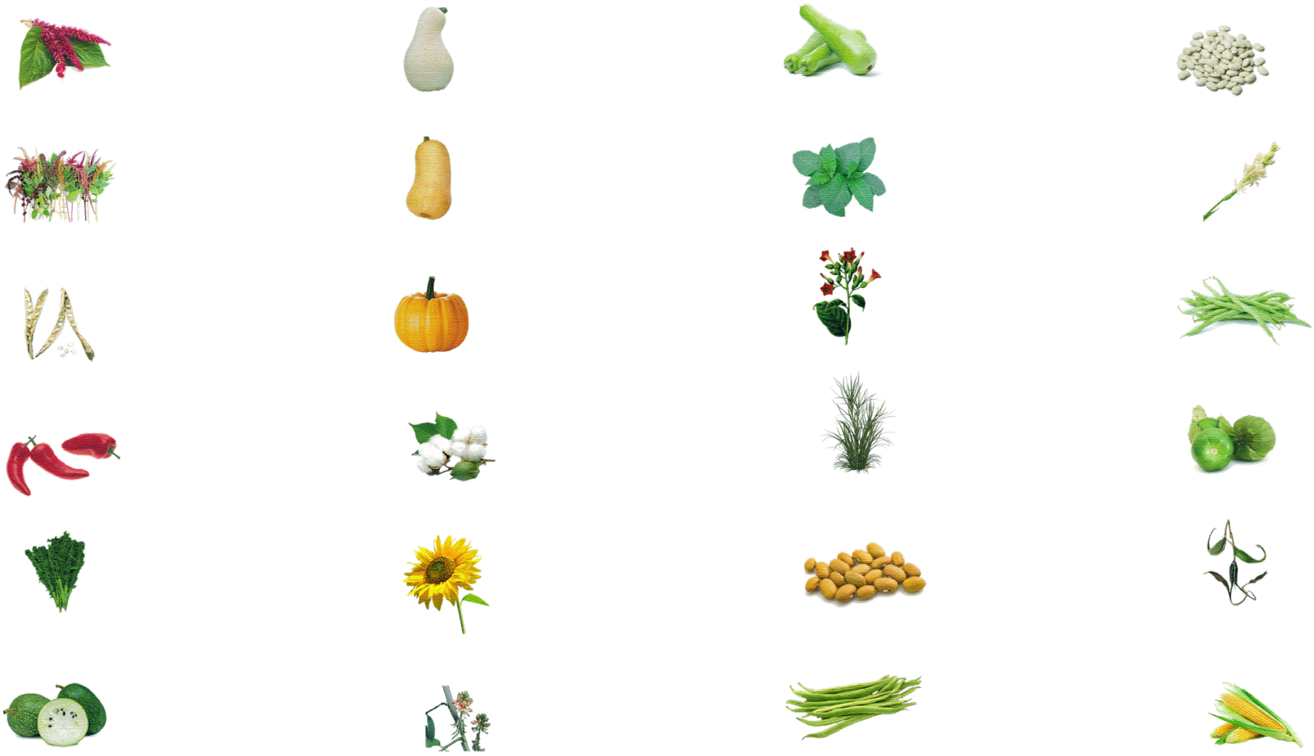
XĀM TĀP

Cultivated Connections

Developing an Integrated Foodscape Model
for the Metropolitan Area of Monterrey, Mexico



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Report 19/06/2024

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“No one will protect what they don’t care about; and no one will care about what they have never experienced.”

- David Attenborough, (2019)

I would like to extend my gratitude to the following organizations for making this research possible and for facilitating the site visit.

ABSTRACT

Monterrey (Mexico), situated in a semi-arid climate, confronts a several challenges because of rapid urbanization, such as droughts, floods, health issues and heat. The urban expansion resulted in higher vulnerability to climatic and political happenings. To navigate these multiple complexities, a comprehensive strategy is imperative. This study presents an integrative model of nature-inclusive urban agriculture, conceived to address the intricate interplay of ecological, water, and social dynamics within the urban fabric. Incorporating the implementation of heritage crops and techniques to strengthen the connection between humans, nature, and food production. The method used involves a multi-level approach, combining both bottom-up and top-down approaches. Through a case study in Monterrey, this model is refined into a more detailed toolbox, and applied in various locations across the city. Three distinct foodscapes are designed with the use of this toolbox, strategically positioned across the cityscape to maximize resilience. This toolbox goes beyond just geographical limits. It provides useful ideas and methods that can work for places dealing with similar challenges in (semi-)arid climates. By bringing together views from different regions and involving people at different levels, this approach helps communities adapt and become more resilient in changing environmental situations. This research doesn't just add to academic discussions but also gives real solutions that can have a big impact on making cities more resilient and sustainable in semi-arid areas around the world.

xām: to forget, to remember, memory, soul, house, home

tāp: world, earth, ground

(García, 2023)

The Coahuilteco language was used in regions such as Coahuila, Nuevo León, Tamaulipas, and Texas, spanning areas in both Mexico and the United States. It was spoken by nearly 200 semi-nomadic tribes across these regions. Many indigenous languages in this area disappeared rapidly, leaving their origins and full linguistic details largely unknown (García, 2023).

The words "Xam" and "Tap" are the guiding thread of this research.

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Introduction.

Problem Field

By mid-November 2022, the world's population had reached 8.0 billion individuals. Forecasts indicate that over the following three decades, the population will grow by an additional 2.0 billion people. This expansion is linked to factors like rising life expectancy, substantial urbanization, and intensified migration patterns (UNFPA, 2023).

The swift urbanization and population growth can directly result in a reduction of rural agricultural land and a growing urban population that needs to be fed. This, in turn, indirectly contributes to the prevalence of unhealthy dietary patterns and subsequent health problems like excess weight, obesity, and non-communicable diseases linked to diet. Simultaneously, the number of people experiencing food insecurity and malnutrition is increasing (FAO, 2019). The population growth of the Metropolitan Area of Monterrey is visible in Figure 1. This shifted urbanization and population growth resulted in an obesity rate of 41.6% in this area, due to the changing food industry, characterized by increased consumption of added sugars, fats, and refined grains (Scott et al., 2007).

The worsening effects of climate change, escalating health emergencies, and other unexpected disruptions have jeopardized the ability to maintain sustainable food production and deliver nutritious food to urban populations. This situation underscores the need to create more robust and environmentally friendly food systems capable of satisfying the growing need for safe and nourishing food in cities (Missing, 2020).

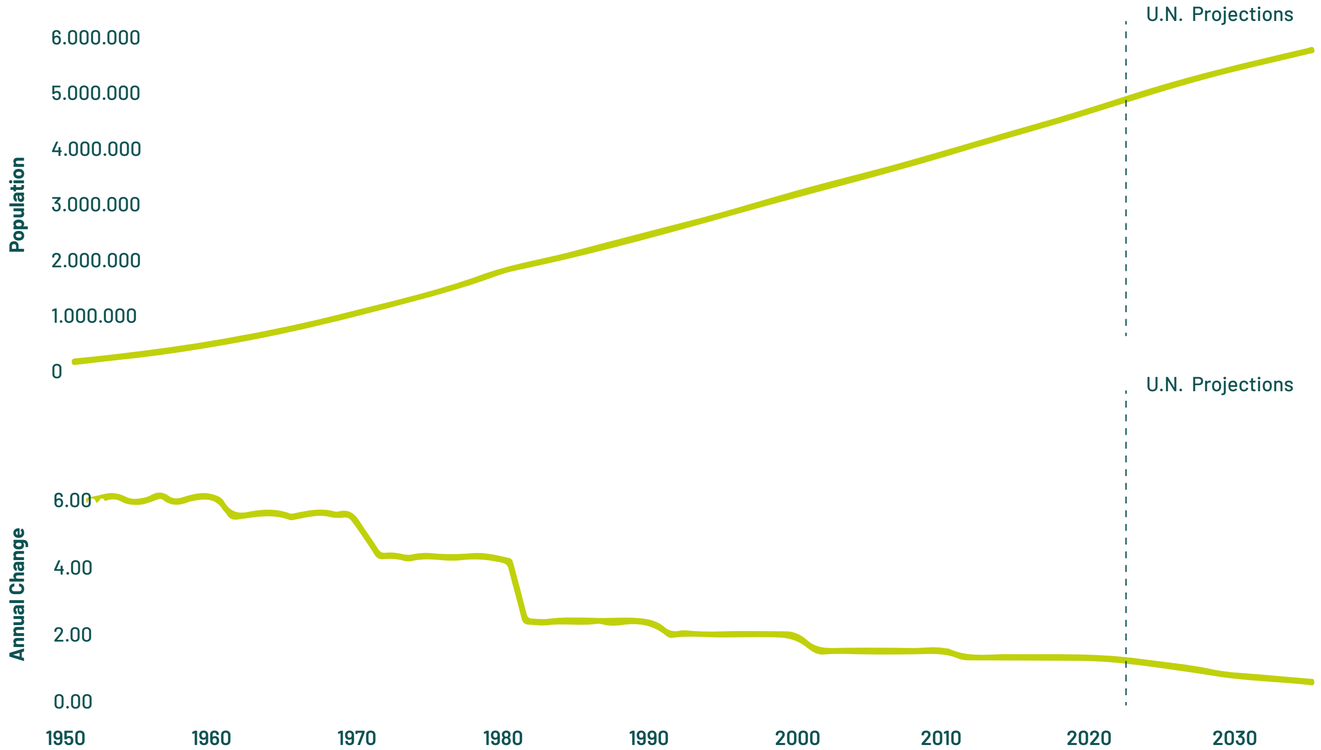

Figure 1: Population Monterrey, Mexico Metro Area 1950 - 2024. (Monterrey, Mexico Metro Area Population 1950-2024, n.d.)

Problem Field

For this thesis, the Monterrey Metropolitan Area serves as the design location. Monterrey is situated in the Mexican state of Nuevo Leon. In 2020, Monterrey had a total population of 5,341,177 residents, evenly split between genders, with 50% women and 50% men. The age groups with the highest population concentrations were individuals aged 20 to 24 years (470,536 inhabitants), 25 to 29 years (458,835 inhabitants), and 15 to 19 years (434,120 inhabitants). Combined, these age brackets accounted for 25.5% of the total population. Furthermore, it is the second most economically productive metropolitan area in Mexico, boasting a GDP (PPP) of US$140 billion in 2015 (Gobierno De Mexico, 2020).

Within the framework of this thesis research, there are instances where a broader perspective is taken, including an examination of Arido-America.
The term 'Arido-america' was introduced by American anthropologist Gary Paul Nabhan in 1985, building on prior work by anthropologists A. L. Kroeber and Paul Kirchhoff to identify a distinct cultural identity for the (semi-) arid region (Kirchhoff, 1954). When considering cultural and geographical aspects within the design, the broader context of Arid America is examined because of its relevance to these aspects.

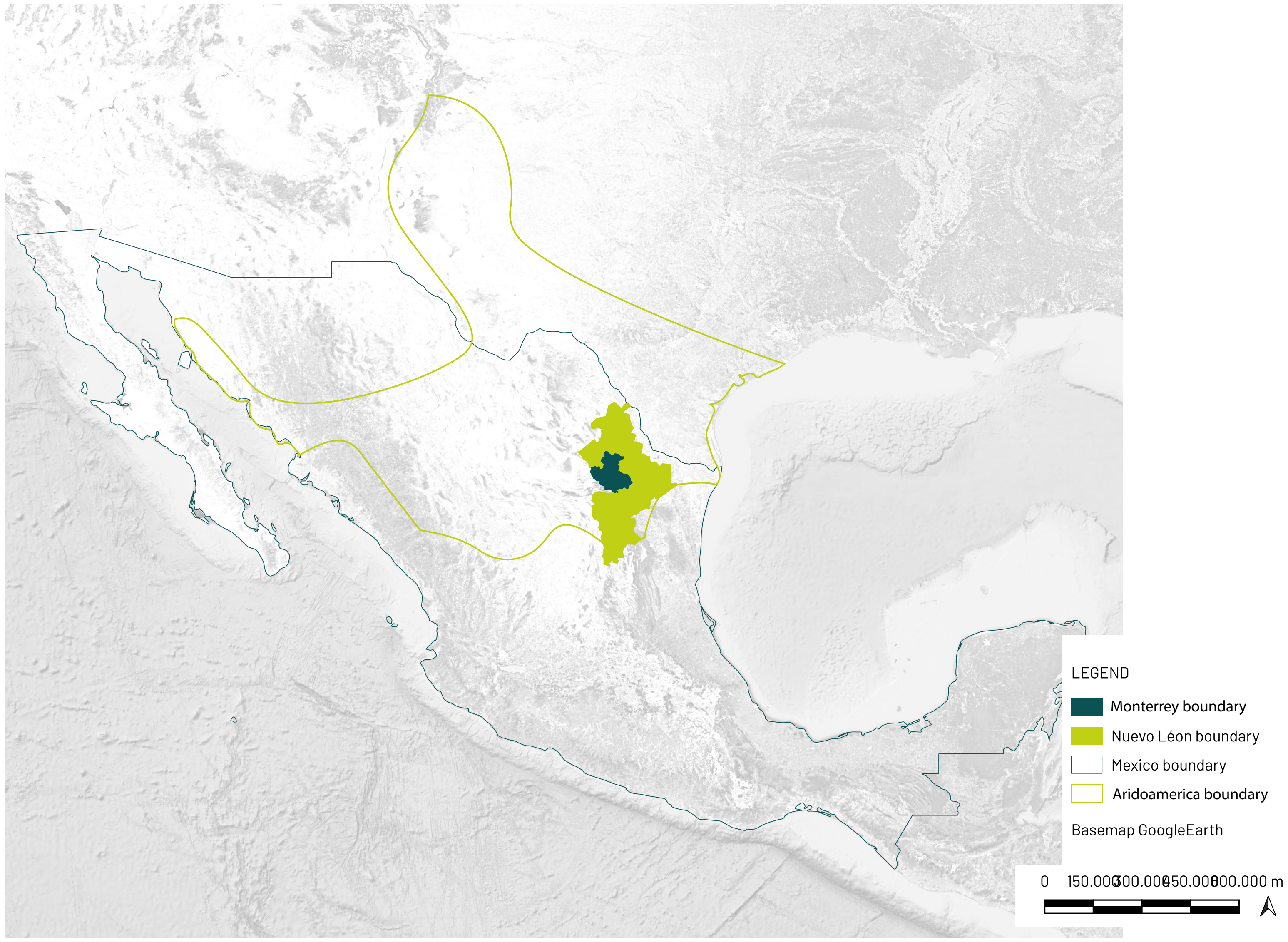

Figure 2: Location Monterrey. (QGIS.org, 2024)

Introduction.

Problem Field

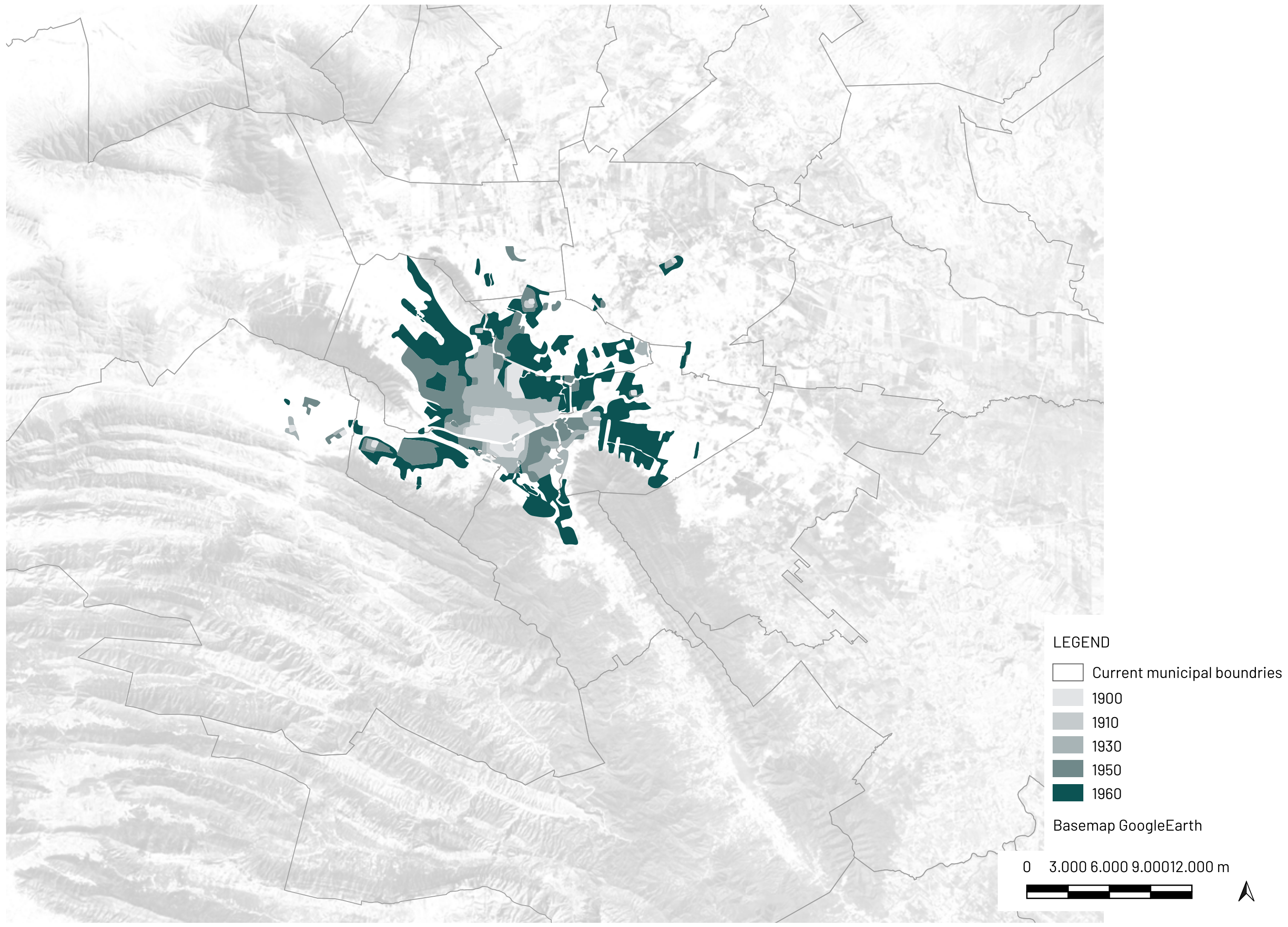

Figure 3: Urban Sprawl Monterrey, Mexico Metro Area 1900 - 1960. (Ward et al., 2014)(QGIS.org, 2024)

Problem Field

The link between humans and nature is lost as people migrate to cities. In Latin America, this migration is driven by various factors including socio-economic, environmental, and governance issues. This urbanization process has led to environmental and social problems, such as imbalances in atmospheric and hydrological cycles, increased pollution, and challenges in waste management. As a result, issues like inequality, poverty, traffic congestion, and crime rates have risen, threatening the sustainability of urban areas (López, 2019).

On the other hand, the emerging concept of "new rurality" recognizes the multifunctionality of rural areas beyond agriculture, promoting non-agricultural employment and income diversification. However, this shift has also led to a disconnection from nature, undervaluing agricultural practices and prioritizing urban lifestyles. This anthropocentric view has not only affected environmental protection efforts but also urban culture and identity (López, 2019).

Urban agriculture, particularly urban gardens, has emerged as a response to these challenges. They contribute to food security, provide recreational spaces, promote environmental education, foster community integration, and strengthen local economies. These gardens represent a multidimensional approach to development, addressing various social, economic, and environmental aspects within urban

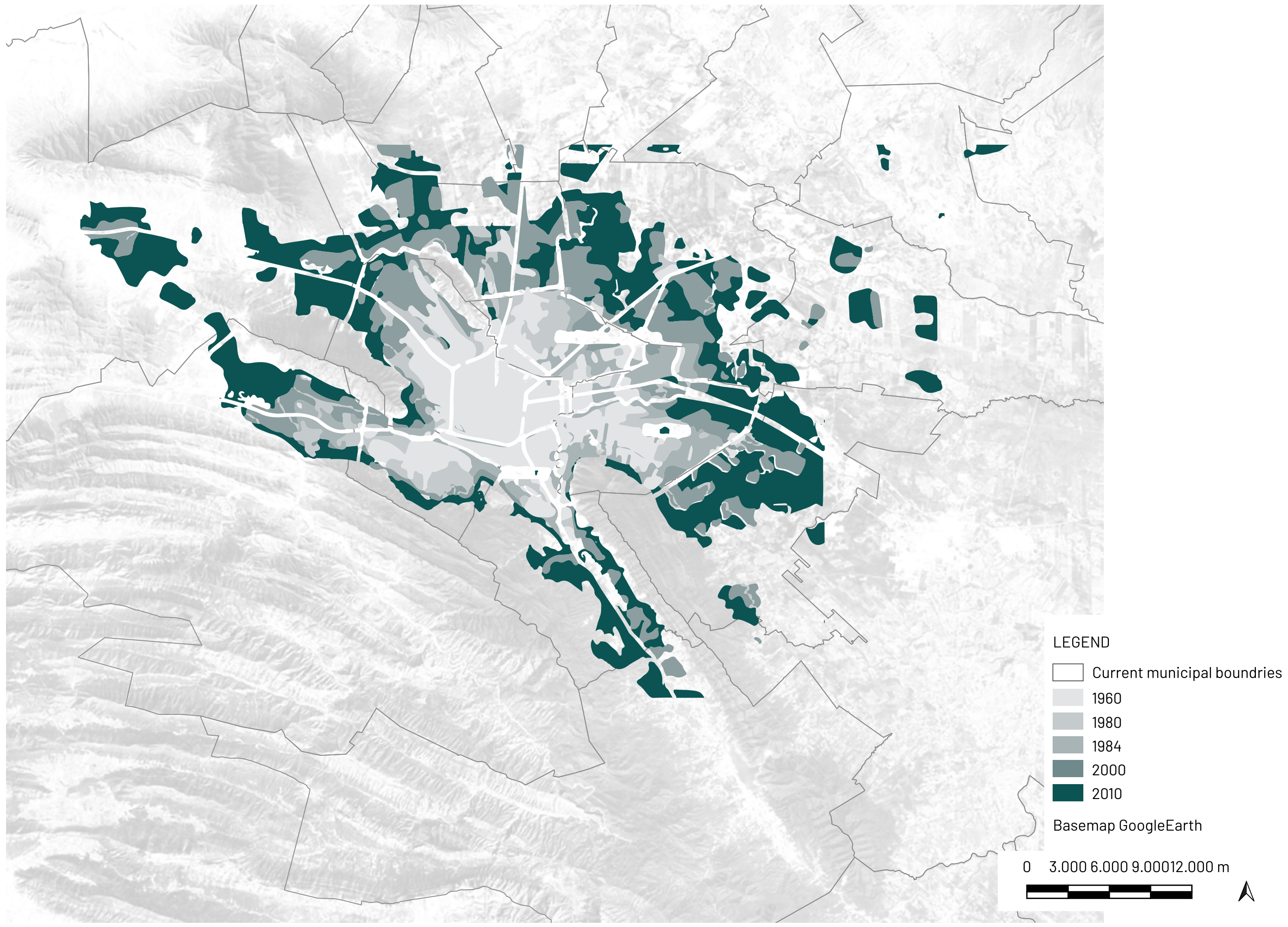

Figure 4: Urban Sprawl Monterrey, Mexico Metro Area 1960 - 2010. (Ward et al., 2014)(QGIS.org, 2024)

Introduction.

Problem Field

These events led to several extreme circumstances in the metropolitan area of Monterrey. For example, in July 2010, the Monterrey Metropolitan Area (MMA) was impacted by Hurricane Alex, leading to an estimated loss of 15 lives (Aguilar-Barajas & Ramirez, 2019).

As demand has surged, experts assert that inadequate rainfall and, notably, poor water management have precipitated one of the most severe droughts in the northern region of the country. With populations on the rise and temperatures climbing, accelerating evaporation from the land, the water challenges will exacerbate unless more effective adaptation measures are implemented (Patel & Tierney, 2022).

These industrial activities also affect the air quality and heat. Several studies have highlighted the adverse combined impacts of air pollution and heat on public health. Although

developed to communicate the risks of unhealthy air pollution levels and extreme heat to the public, there has been limited exploration of a combined index incorporating both factors (Fever et al., 2022).
Processed industrial foods lead to other health issues like obesity. An obesity rate of 41.6% in this area, due to the changing food industry, is characterized by increased consumption of added sugars, fats, and refined grains (Scott et al., 2007).

In 2010, Monterrey possessed 10.9 thousand hectares (kha) of tree cover, encompassing 25% of its total land area. By 2023, it experienced a loss of 12 hectares (ha) of tree cover, resulting in emissions equivalent to 2.20 kilotons (kt) of CO_2. The loss of vegetation leads to a higher vulnerability to political and environmental shocks (Vizzuality, n.d.).

Floods

Figure 5: Santa Catarina River during Hurricane Alex in 2010. (Aguilar-Barajas et al., 2019)

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Introduction.

Problem Statement

Before the industrialization of Monterrey, the city heavily depended on agriculture and cattle farming as its primary economic activities. Monterrey operated as an exporter, shipping corn and sugar cane to other regions of the country. While corn was the main agricultural product, sugar cane proved to be more profitable, particularly with piloncillo, a byproduct of sugar cane, being highly lucrative. Monterrey played a significant role in exporting this product nationwide. Additionally, cattle farming was a significant activity in the city, although it gradually gave way to agriculture over time (Vizcaya, 1968).

From 1950 to 2015, the population of Monterrey grew from 375,000 to 4,437,643 inhabitants, resulting in an expansion of the urbanized area from 4,032 to 75,424 hectares. The urbanized area per inhabitant changed from 93 to 59 hectares. This urban sprawl led to the loss of a significant amount of vegetation, with 23,393 hectares of vegetation being removed from 1990 to 2019, potentially reducing the absorption of 373,900 tons of CO2 annually. The current green space per inhabitant is 3.9, while the World Health Organization's goal is 9.0 (Carpio et al., 2021).

The rapid expansion of the built-up area resulted in several problems in the city, exacerbated by the NAFTA agreement. The North American Free Trade Agreement (NAFTA) between Canada, the US, and Mexico was introduced in 1994. This led to a substantial increase in Mexican immigrants to the United States, with numbers rising from 760,000 to 12.7 million from 1960 to 2008. It became more economical for Mexican citizens to import their food rather than purchase it from Mexican farmers due to subsidies received by wheat farmers in the United States, allowing them to sell their

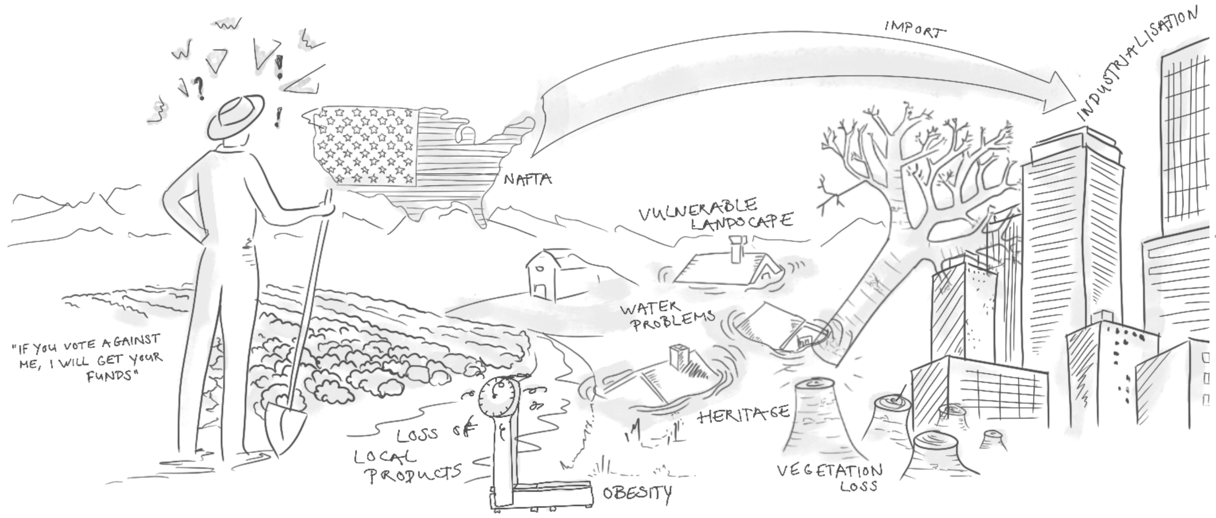


Figure 11: Problem drawing by author.

Problem Statement

The increase in imports has resulted in a loss of cultural (food) heritage. People have begun consuming more imported food containing added fats, sugars, and refined grains. Consequently, Monterrey now faces an obesity rate of 41.6% (Roggema et al., 2023).

Moreover, due in part to urbanization, Monterrey is confronting challenges related to climate change. By 2050 (from 2007), the temperature is projected to rise by 2 degrees Celsius, and precipitation is expected to decrease by 5.6% during the warmest season. This will lead to a 34% increase in agricultural droughts and a 29% increase in hydrological droughts. These droughts are anticipated to occur 74% more frequently. Additionally, twice as many people will be affected by river flooding due to climate disasters such as hurricanes and heavy rains. Consequently, there will be a reduction in agricultural productivity, resulting in significant socio-ecological impacts. The most vulnerable societies will bear the brunt of these effects (Roggema et al., 2023).

It is imperative to adopt a more sustainable land use approach that ensures adequate nutrition for the population through localized and nutritious foodscapes, thereby reducing emissions and increasing green space within the city. The revival of traditional dishes can play a pivotal role in achieving this objective. In this manner, the gap between climate policies, urban agricultural projects, disadvantaged communities, heritage cuisine, restaurants, and consumers is bridged. This approach leads to an enhancement of health through nutritious and nature-inclusive food production.

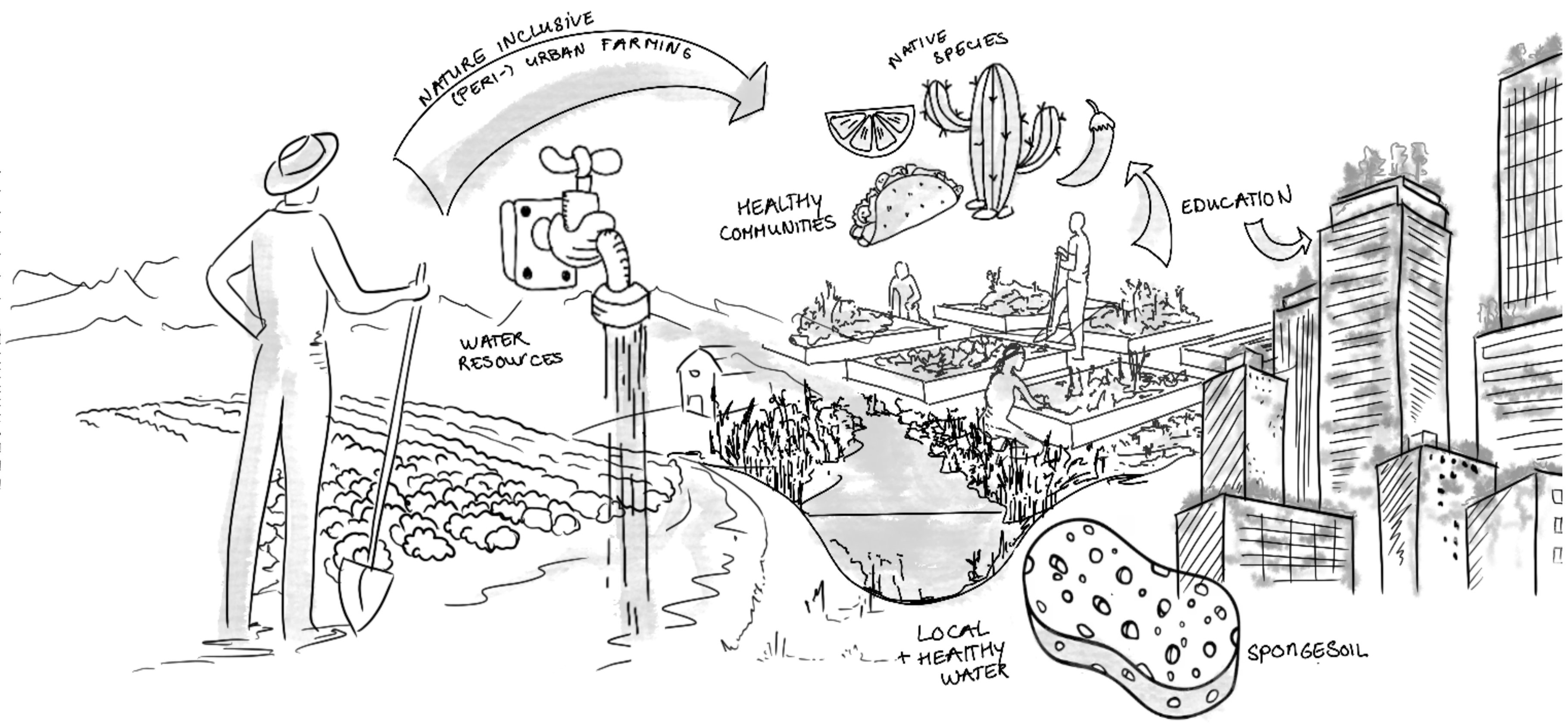


Figure 12: Result assumptions drawing by author.

Introduction.

Problem Statement

As historical context demonstrates, industrial agriculture presents numerous challenges and consequences. When compounded with escalating external influences, urban areas and their inhabitants become markedly more vulnerable, resulting in significant loss of vegetation and heritage. This loss is particularly acute in regions inhabited by the most vulnerable communities, leading to declines in both mental and physical health.

This report focuses primarily on these marginalized communities. By transitioning from industrial agriculture to a more nature-inclusive approach, complemented by the integration of local heritage practices, substantial benefits can be realized across various scales. This paradigm shift offers several advantages: it facilitates landscape adaptation to local conditions, revitalizes the cultural significance of the area, and fosters biodiversity. Similar positive outcomes are observed when employing nature-inclusive farming techniques, bolstering the resilience of urban ecosystems against prevalent droughts and enhancing carbon sequestration capabilities.

Beyond ecological benefits, there are notable social advantages as well. Enhancements in the food production experience not only improve mental well-being but also address physical health concerns effectively.

Problem Statement

Cultivating local food within urban areas addresses some of the challenges associated with industrial agriculture, which is heavily influenced by external factors. This approach can be implemented on both small and larger scales, including in peri-urban zones. In this way, the landscape with its communities will be more resilient.

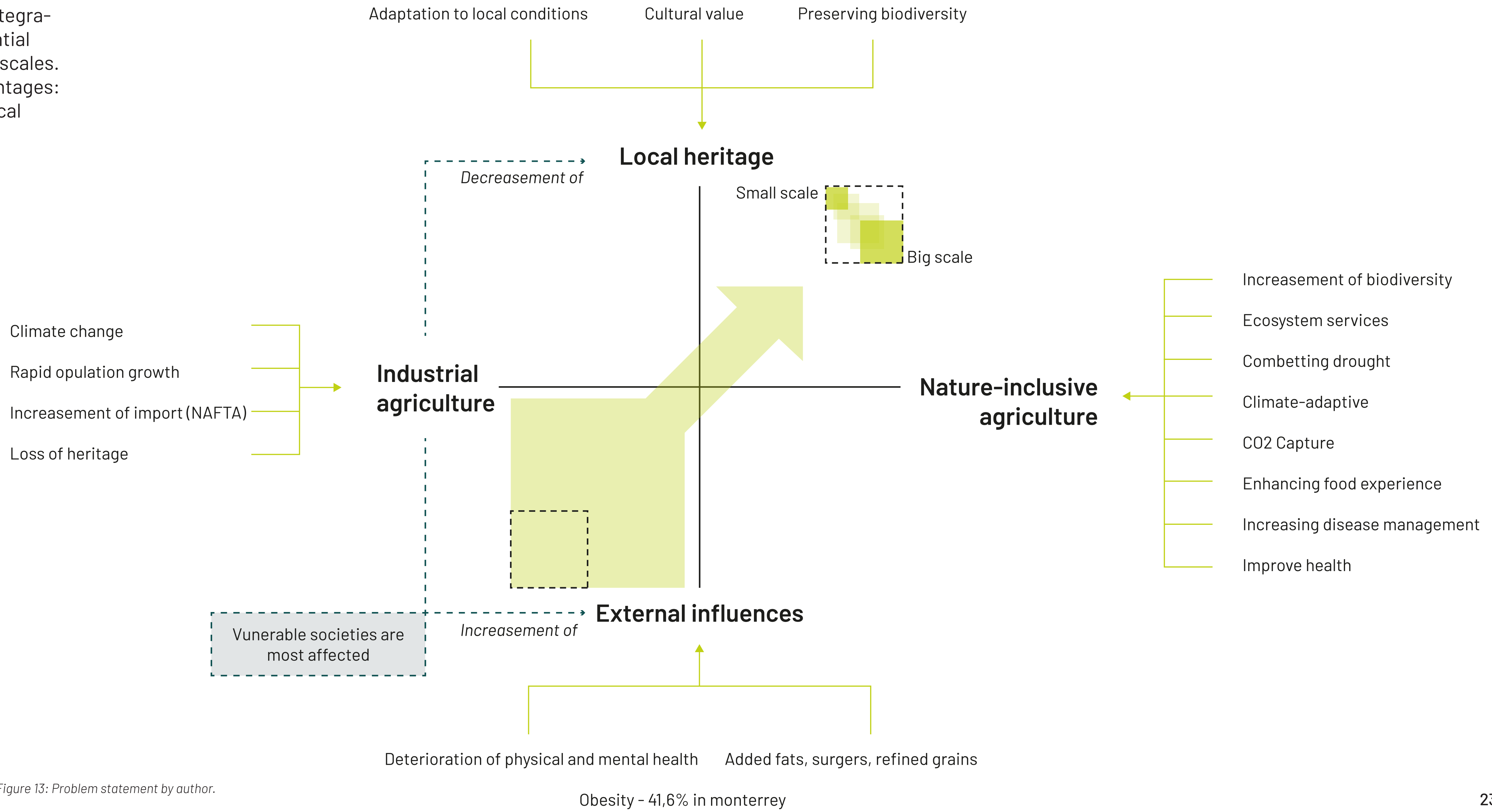


Figure 13: Problem statement by author.

2. Research approach

Research Approach.

Theoretical framework

The Sustainable Development Goals (SDGs)

Integrating the Sustainable Development Goals (SDGs) as a guideline in design offers a holistic approach to promoting sustainable development. Embracing the SDGs directs design processes to consider the various dimensions of sustainability, such as social justice, economic growth, and environmental protection. The design emphasizes the importance of connecting these objectives and addressing interdependencies to promote positive synergies and avoid conflicts. By utilizing the SDGs as a guideline, designers can strategically contribute to achieving global sustainability objectives and advancing an inclusive and resilient future.

Where there is a common ground for this design research with each goal, the primary focus lies on Goal 3 - "Good Health and Well-being," achieved by making healthy food accessible to all, thus inherently addressing Goal 10 - "Reduced Inequalities." Through the nature-inclusive approach to food provision, communities and cities become more sustainable, aligning with Goal 11. Goal 12 essentially encapsulates the project, as it aims to enhance the landscape and benefit residents by cultivating healthy and local produce, coupled with community involvement and education (Goal 4).

Integrated Global Goals

The Rockström and Sukhdev illustration serves as one of the foundational frameworks for integrating global goals and highlighting the interconnectedness of various sustainability objectives. This theory design principle emphasizes the importance of understanding the biosphere's role in achieving global sustainability and recognizes food as a crucial link to every aspect of these goals. By utilizing visual representations, such as the illustration provided by Rockström and Sukhdev, designers can effectively communicate complex concepts and promote holistic approaches to addressing sustainability challenges.

Figure 15: Integrated Global Goals. (THE 17 GOALS | Sustainable Development, n.d.)

Figure 14: The Sustainable Development Goals (SDGs). (THE 17 GOALS | Sustainable Development, n.d.)

Theoretical framework

Nature-Based Solutions

Nature-based solutions (NBS) represent innovative approaches to address contemporary environmental challenges while promoting sustainability and resilience. In the context of urban agriculture, integrating NBS principles with native crop cultivation can offer multifaceted benefits, ranging from enhancing biodiversity to mitigating climate change impacts. This theoretical framework draws upon the principles outlined in the report "Assessing the Benefits and Costs of Nature-Based Solutions for Climate Resilience: A Guideline for Project Developers" to elucidate the potential of NBS in fostering climate-resilient urban farming practices with native crops.
By embracing Nature-Based Solutions, urban agriculture can emerge as a vital component of climate-resilient cities, contributing to ecosystem health, social equity, and economic prosperity. Through rigorous assessment and strategic implementation, the integration of native crops with NBS practices offers a pathway toward sustainable urban development and resilient food systems in the face of climate change.

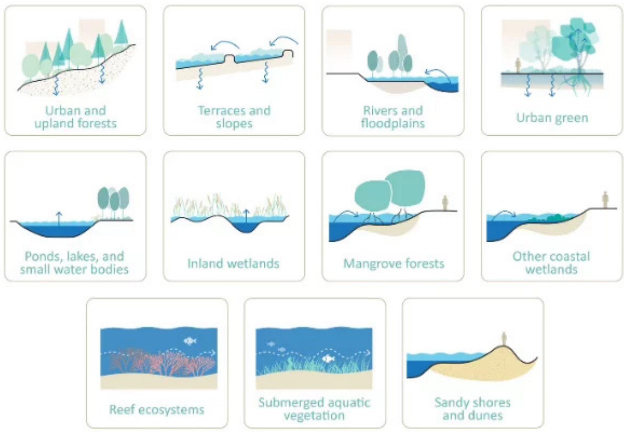


Figure 16: Nature-Based Solutions (NBS). (World Bank Group, 2023)

Bending the Curve

The accelerating loss of plant and animal species worldwide underscores the urgent need for holistic approaches that address both biodiversity decline and food system sustainability. This theoretical framework synthesizes the imperative for ambitious action to conserve biodiversity and transform the food system, highlighting the potential of nature-inclusive urban agriculture with native crops as a catalyst for positive change.

Integrating nature-inclusive urban agriculture with ambitious conservation and food system transformation initiatives is essential for addressing the interconnected challenges of biodiversity loss and unsustainable food production. By embracing innovative practices, promoting policy coherence, and fostering multi-stakeholder collaboration, cities can emerge as incubators of sustainability, resilience, and biodiversity conservation in the Anthropocene era.

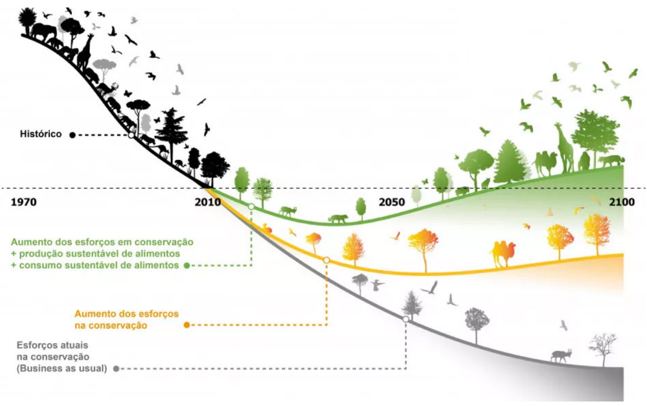


Figure 17: Bending the Curve. (Leclère et al., 2020)

Research Approach.

Conceptual framework

Similar to many instances, the diagram (depicted in Figure 4) positions the separate areas of exploration (the foundational elements) surrounding the central core, contributing their insights and resolutions to the cohesive inner circle. This inner circle comprises interconnected components that shape the unified entirety. No individual element can be isolated, as doing so would disrupt the continuous cycle. Ultimately, the model assumes an ongoing process, ranging from discovering conventional recipes to consuming nutritious meals. This cycle sparks further exploration for additional recipes and beyond. Its resilience strengthens with each successive completion of the cycle.

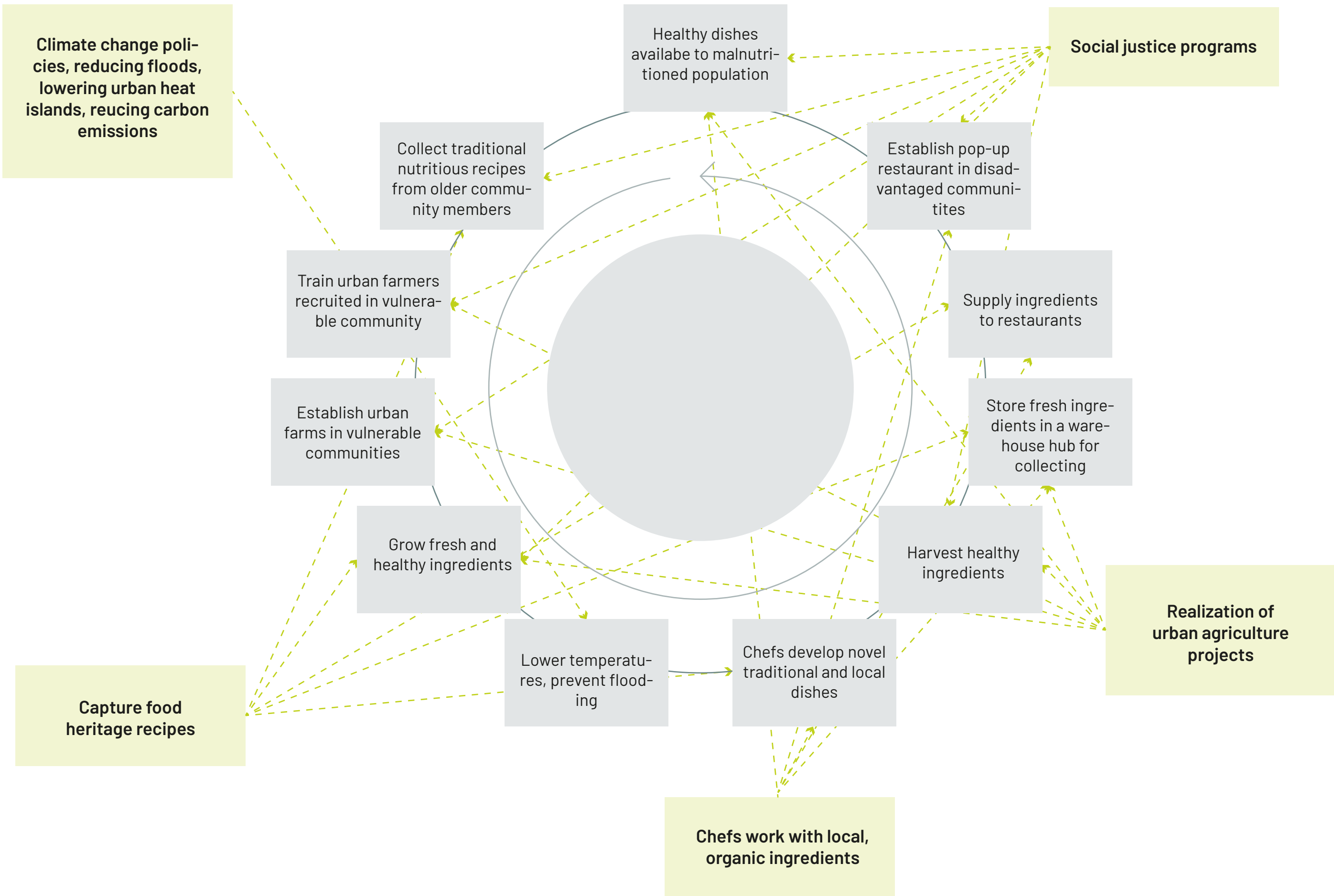


Figure 18: Conceptual Model of the Viruous Circle. (Roggema et al., 2023)

Research questions

After exploring the problem domain and delineating the problem statement, the research question has been formulated. The research question encompasses three types of inquiry:

Research for design
Research by design
Research through design

In the latter component, feedback is provided based on research for design.
The main research question of the study is as follows

How can the integration of **nature-inclusive agriculture** in the Monterrey Metropolitan Area contribute to the development of health-promoted **foodscapes**?

Sub-research question 1:
What specific nature-inclusive agricultural practices can be implemented in order to enhance biodiversity and ecosystem services in and around urban environments?

Sub-research question 2:
How can nature-inclusive agricultural interventions be spatially implemented within the Monterrey Metropolitan Area to contribute to the development of health-promoted foodscapes?

- What are the historical and current spatial characteristics and land use patterns within the Monterrey Metropolitan Area, and how do they impact the feasibility and implementation of nature-inclusive agricultural interventions?

- To what extent does the methodological design shape the investigation and outcomes of the research question?

3. RESEARCH FOR DESIGN

The term "urban agriculture" and the concept it represents gained widespread use relatively recently, primarily taking root during the 1990s. While there is no universally accepted definition of urban and peri-urban agriculture (UPA), it encompasses a wide range of agricultural activities conducted within or on the fringes of urban areas. These activities often compete for essential resources such as land, water, energy, and labor while serving various purposes to meet the needs of the urban population. Key UPA sectors include horticulture, livestock, fodder and milk production, aquaculture, and forestry. Non-wood forest products and ecological services offered by agriculture, fisheries, and forestry are also part of this framework (Nations et al., 2022).

From 1970 to 2008 the amount of immigrants from Mexico to the States grew from 760.000 to 12.7 million people. This is because a lot changed in the rural economy. It was cheaper to import from the United States than to buy food from Mexico. This had to do with the North American Free Trade Agreement which was introduced in 1994. The wheat farmers from The States received subsidies and could export their products for a better price to Mexico without any difficulties because of NAFTA. Wheat farmers from Mexico made too little money as a result (Roy Germano, 2022). This is also visible in the graphics below. After the introduction of NAFTA, there was a growth in imports of corn and soybeans by Canada and Mexico (Schnitkey et al., 2017).

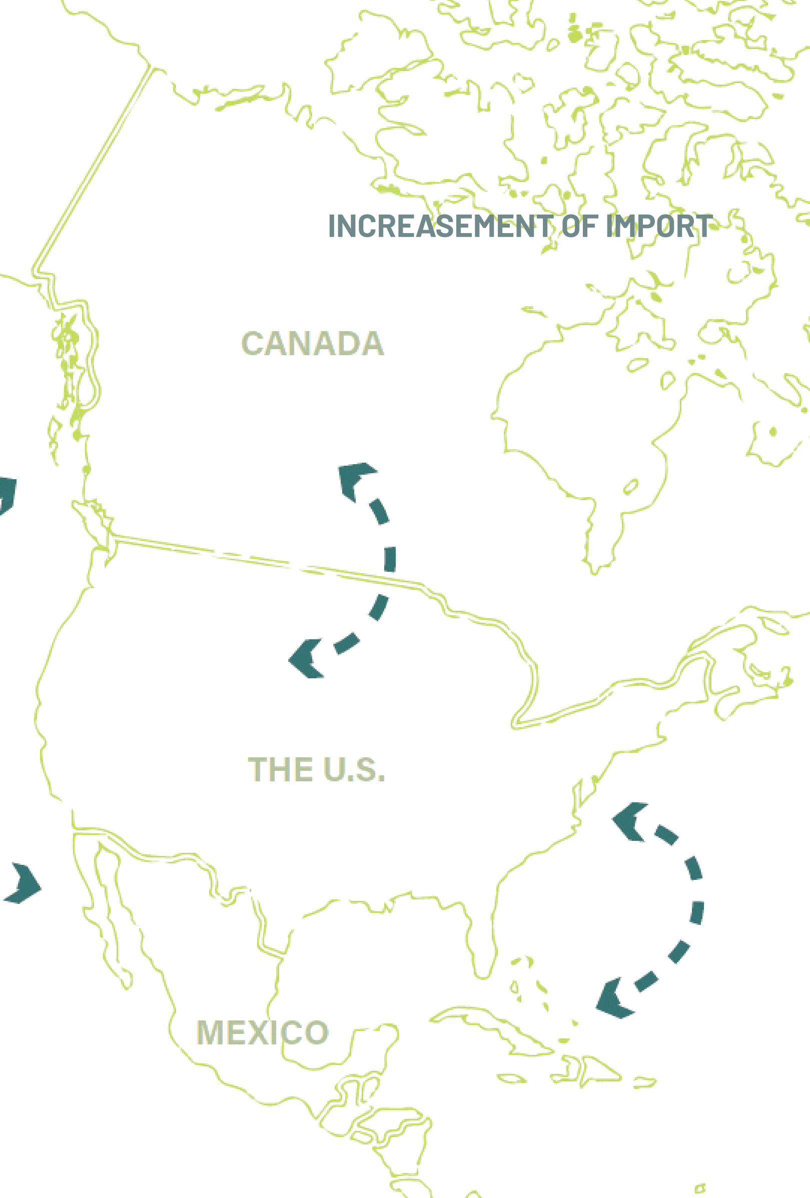


Figure 19: Involved countries NAFTA by author.

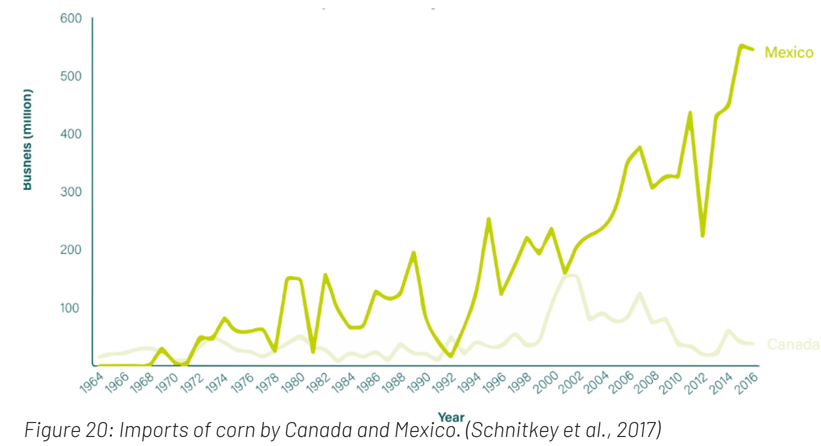


Figure 20: Imports of corn by Canada and Mexico. (Schnitkey et al., 2017)

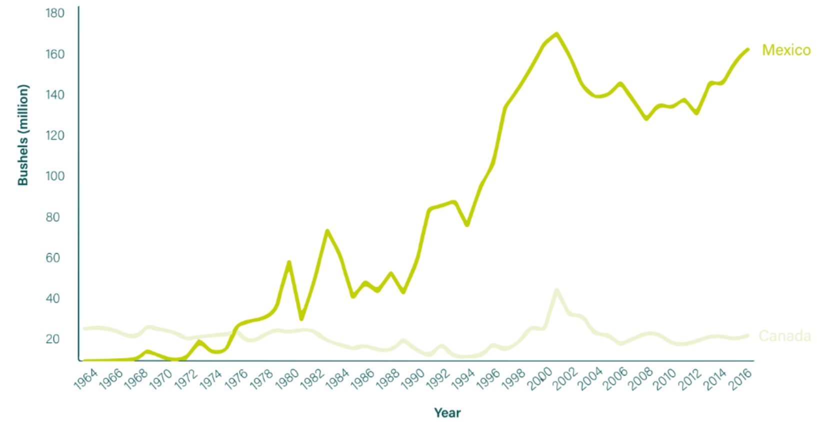


Figure 21: Imports of soy beans by Canada and Mexico. (Schnitkey et al., 2017)

The definition of nature-inclusive farming according to Natuurmonumenten Nederland is: "Nature-inclusive agriculture, in short, is a way of farming that benefits nature as well, working within the limits of the natural environment. It's farming that enhances biodiversity, increasing the richness of plant and animal life." (Natuurmonumenten, n.d.)

For enhancing biodiversity and ecosystem services, a different form of agriculture is needed, one that is not focused on maximum production, but on the quality of production factors such as soil, agrobiodiversity, and landscape. Nature-inclusive agriculture is an integrated approach where the farmer optimally utilizes and cares for the natural environment, integrating it into their operations (Portaal Natuurinclusieve Landbouw, n.d.). Nature-inclusive agriculture ensures a vital and resilient soil and the closing of cycles. It contributes to a greater supply of sustainably produced food (Provincie Noord-Brabant, n.d.).

A conceptual framework by the Louis Bolk Institute to provide guidelines for nature-inclusive agriculture includes the following points (Portaal Natuurinclusieve Landbouw, n.d.):

1) Soil and Functional Agrobiodiversity
a. Globally, 25% of our biodiversity
b. Sequestration of nitrogen and carbon
c. Plant Nutrition

Artificial fertilizers contribute to more aridity than soil without them. They enhance root development, soil openness, and consequently, soil retention.

2) Landscape Diversity
a. Feed for livestock
b. Insects contributing to pest control
c. Agrobiodiversity as flower strips

They also contribute to the ecological quality of, for example, birds and insects.

3) Local resources and connecting zones
a. Green/blue corridors create functional and deployable biodiversity sources
b. From regional scale to smaller scale

Grasslands, for instance, can add value and collaborate with the environment.

4) Specific Species
a. Preservation of certain species and landscapes
b. Social compensation

This enhances air quality, climate, and water quality, promoting ecosystem services. It also creates added value for the citizens (Portaal Natuurinclusieve Landbouw, n.d.).

Figure 22: The definition of nature-inclusive agriculture varies among different farmers. (Louis Bolk Instituut, 2020a)

Research for Design.

To make the new farming approach financially attractive for the respective farmer, two models have been developed.

1) Penalties
a. Making the old system more challenging.Higher prices for certain (non-nature-inclusive) practices

2) Rewards
a. Higher prices for consumers: bringing society closer to the farmer.

b. Alternatively, ecosystem services could be utilized. For instance, rewarding through contracts with the government for:
> Carbon sequestration
> Non-emission of greenhouse gases
> Scenic landscapes
> Water storage
> Retaining water in times of drought

This could involve short contracts. In the US, these contracts can extend for 15 or 30 years, allowing for the establishment of a real farm system.
When setting conditions it should be feasible for the farmer and a big plus for biodiversity as well as the landscape. For instance, with 6-meter field margins. Normally, liberalized leases are for 1 year, but the reward here could be a 6-year lease with a good rental price. This is also advantageous for the lessor since management does not need to be carried out with paid labor (Louis Bolk Instituut, 2020b).

Short-term investments are necessary, with long-term benefits anticipated. Improved indicators typically lead to increased societal benefits and reduced costs. Implementing multiple measures together can enhance outcomes synergistically. Nature-inclusive agriculture requires an integrated approach, and its attractiveness depends on various factors like size and socio-economic conditions. Learning from leading companies is crucial, and further quantification of measure effects is needed for a more comprehensive understanding (Erisman et al., 2017).

Based on the report from WUR, the following diagram has been developed. It illustrates the benefits and accompanying regulations (Erisman et al., 2017). Using the diagram below, a toolbox has been developed for implementing this in practice and for design purposes.

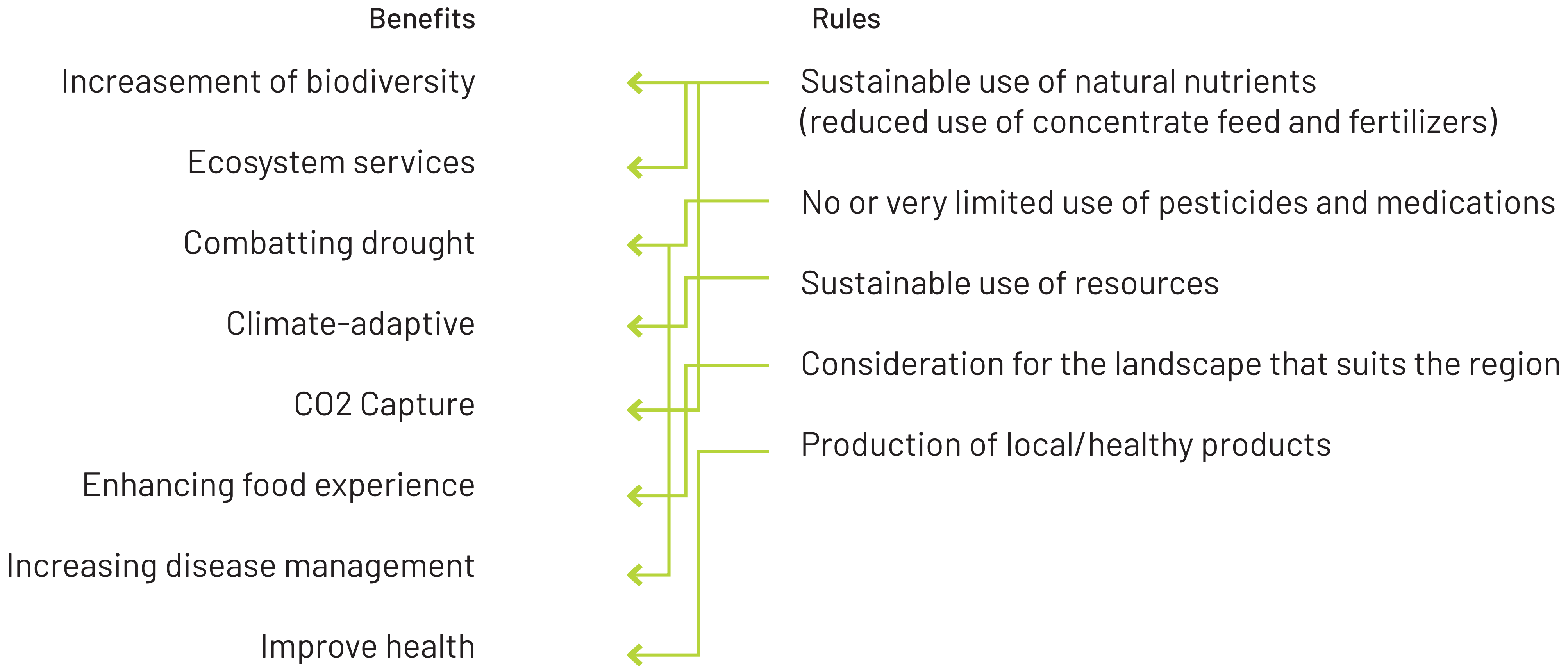


Figure 23: The benefits of nature-inclusive farming. (Erisman et al., 2017)

Research for Design.

In the design, focus is placed on various scales, ranging from regional to individual scale. It is neither a bottom-up nor a top-down approach, but rather a combination wherein the different scales constantly collaborate. The report first elaborates on the regional scale, followed by urban farms, community gardens, and green roofs and facades.

As a guide, the following toolbox has been utilized. The components of ecology, water, and social are the foundational design principles of this project. Tiles have been created to further elucidate these concepts. However, on different scales, certain tiles are more applicable than others. This does not imply that all these conditions are always met; it is site and scale-specific. This is further explained for each scale.

The goal of ecology is to elevate the organic value within the landscape, thereby enhancing its resilience. Water plays a crucial role in this endeavor, as without water, this is not achievable. To retain more fresh water in the soil, increased organic matter is required, thus perpetuating the symbiosis between these two components. Additionally, the social element must not be overlooked, as without people, nothing happens. Ultimately, they are the ones who will initiate the renewal.

Implement nature-inclusive agriculture practices

Bigger ecological impact

Scale

Bigger social impact

Nature-inclusive agriculture corridors

"Between urban, peri-urban, and rural areas, to connect ecosystems and create migration routes for wild animals. The corridors support food production and nature conservation. This will lead to greater resilience for the ecosystems.

Urban farms

Agricultural enterprise situated within a city environment, primarily dedicated to cultivating crops and raising livestock for the purpose of supplying fresh food to local communities

Community gardens

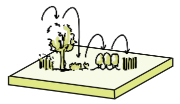
On unused urban spaces with suitable soil, community gardens can be established. These gardens not only provide food but also create a network, raise awareness, and foster a connection between local residents and the food system.

Green roofs and facades

Transform existing urban spaces for agriculture while enhancing biodiversity. This includes green roofs, rooftop gardens, and living walls, which provide food, habitat, and aesthetic benefits in cities.

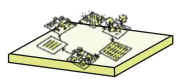
Figure 24: Toolbox by author.

Ecology *Increase organic matter*



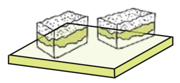
Natural pest management

Promoting practices such as minimal tillage, cover cropping, and the use of organic fertilizers, which enhance soil health and encourage the accumulation of organic matter through the decomposition of plant residues and organic amendments



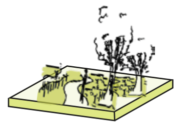
Crop rotation

Enhancing soil structure, nutrient availability, and microbial diversity, while also reducing soil erosion and pest pressure.



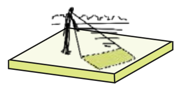
Utilizing compost

Adding organic material to the soil, which increases soil carbon content and promotes microbial activity. As compost decomposes, it releases nutrients and organic matter into the soil, improving soil structure, water retention, and nutrient availability.



Give 10% back to nature/landscape

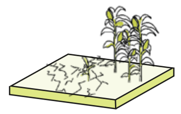
There will be a reduction of soil disturbance, and the vegetation grrowth is promoted. This will attract different species, like insects, and this will boost the natural ecosystem which is needed for cultivation.



Landscape adaptation

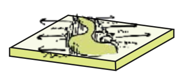
Encouraging ground cover with indigious species, minimizing soil disturbance, and enhancing biodiversity. Retaining water and promoting soil moisture contribute to slowing organic decay and enhancing soil organism activity.

Water *Retain fresh water*



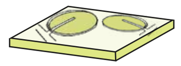
Soil moisture

By utilizing indigenous species that are well-suited to the soil, water infiltration can be enhanced. Additionally, planting trees or other vegetation aids in water retention. Therefore, it is crucial to preserve crop cover to maintain these benefits.



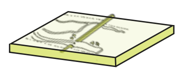
Groundwater storage

Groundwater can be captured in various ways, such as rainwater harvesting and improved infiltration through suitable crops. Circular thinking can enhance the system.



Surface storage

Surface water can be stored through the use of water reservoirs, minimal soil tillage, and vegetation buffer zones along waterways.



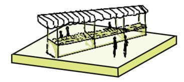
Improve waterquality

No pesticides, and the creation of vegetative buffer zones along waterways to filter sediment and nutrients from runoff. Through terracing and contour planting, soil erosion is reduced.

Social *Align stakeholders*

Organize workshops + (network) events

Fostering collaboration, knowledge exchange, and innovation among farmers, researchers, and policymakers, promoting nature-inclusive farming practices.

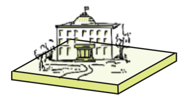


Access to market

Providing farmers with opportunities to sell their products (on local markets) encourages sustainable land management and biodiversity conservation.

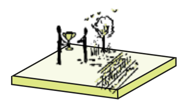
Education

Involve educational insitutes and other community initiatives wil raise awareness, providing training, and fostering collaboration among farmers, researchers, and policymakers.



Goverment involvement

Financial support and policies by the goverment incentivize and regulate nature-inclusive farming practices, promoting sustainability and biodiversity conservation in agriculture.



Rewards and recognition

It encourages widespread adoption of nature-inclusive farming practices, leading to improved ecosystem health and resilience in agricultural landscapes.

Research for Design.

In order to adapt the toolbox to the environment. Deeper research is done on the site. Based on this design the toolbox is later further developed and applied to two other locations in the city.
In the timeline, it can be observed what kind of development Monterrey underwent. It evolved from a place where 12 families lived into a large metropolis, reaching a population of 5,195,000 people in 2024 (Monterrey, Mexico Metro Area Population 1950-2024, n.d.-b). Over the years, certain events have had a significant influence on shaping the contemporary city. For example, the Spanish invasion placed pressure on the indigenous culture (Vizcaya, 1968).
The population growth is visible in the green

1612
The arrangement of the city was designed in compliance with the regulations outlined in the Spanish law governing the establishment of settlements in New Spain.

1600 — 1700

1596
Diego de Montemayor discovered the city "Ciudad Metropolitana de Nuestra Senora de Monterrey" consisted of 12 families.

1750
Population grew to 3000 inhabitants, but because of the coloniztaion of the Tamaulipas and a flood, the population decreased till 1000 people.

Figure 25: Development timeline of Monterrey. (Vizcaya, 1968)

End of 1800s
Many characteristics of the local identity and socio-spatial structures in the present have its toots in the pace set by the industrial activity that emerged in the end of this century.

1792
Adrès Ambrosio de Llanos y Valdes and French architect Jean-Baptiste Crouset made a city plan for the new distribution

1800-1850
The region was called "tierra de guerra viva" -a land of living war-, due to the regular attacks from
indios borrados, rayados, and chichimecas.
These tribes were hunted down and sold as slaves,
and in later years, they were imprisoned or forced to work as servants or into public works.

1853 - 1854
Between 1853 and 1854, the colonial settlement of tlaxcaltecas at the foot of the Loma Larga became a neighborhood for workers and immigrants called Repueble del Sur.

1800 — 1850

1875
The last registered confrontation of a tribe.

1842 - 1858
One of the largest projects at the time was an urban forest in the new northern expansion of the city: the Alameda. The local government bought plots of land for this project, extracted water, and acquires trees to be planted here.

1824
With the Consitutaion of 1824, the Nuevo Reino de León was declared a state. By then the city's population had doubled to 12282 people.

1803
The city cinsited of 6 blocks from north to south, and 12 blocks from east to west population by 6412 inhabitants

1853
The population of 26,795 inhabitants was mostly rural, depending on agriculture, cattle raising, and more importantly, commerce.

Sep 1846 - July 1848
Shortly after the annexation of Texas to the United States, the city of Monterrey was invaded by the North American army.

1890
Aguirre identified key factors contributing to the emergence of the bourgeoisie in Monterrey, Mexico:

1. US economic protectionism post-Civil War.
2. Porfirista policies favoring private capital.
3. Influx of foreign capital.
4. Tax exemptions under governors Reyes and Garza.
5. Capital accumulation during historical events.
6. Strategic location for trade with the US.
7. Growth of skilled labor and urbanization.

1892
Two of the most iconic public spaces constructed during that period were the Calzada Union and Calzada Progreso.

1910
Owners fled the country during the Revolution of 1910, and came back after the conflict calmed down.

1910
With 81,000 inhabitants by 1910, it became the fourth most populous city in the country.

1890s - 1910s
The city transformed with new buildings and improvements to landmarks, signaling a shift to urban life and dispelling the image of a small provincial town.

1910s - 1930s
Local government remodeled and maintained public spaces in middle class neighborhoods in the Primer Cuadro sporadically.

1930s
Strikes against the white syndicalism. 4 people were killed and dozens were injured by the industry owners. The owners where evacuated and protected by the police.

1930s
Industry owners created the Acción Civica Nacionalista with the goal of combatting communism.

1947
122,000 residents of the city were living without basic services such as water and drainage.

1950s
The city lacked well-maintained parks due to resource shortages, corruption, and authorities' indifference, especially in colonias populares.

1900

1950

1886
The Alameda, the city's urban forest, lost half of its surface due to the construction of the Penitenciaria, built at Reyes' behest in 1886, and also a part of the land was sold to private owners.

1850 - 1900
Progress in urban and economic development.

1900
The main economic activity shifted from agriculture towards industry and production of materials such as steel and glass.

1895
Crises in the neighboring mining states and the economic development of Monterrey attracted immigrants from San Luis Potosi, Coahuila, and Tamaulipas

1919
At the crossing, the monumental Arco de la Independencia celebrated the historic fight for independence, and showcased local craftsmanship and mastery of Neoclassical ornament. In spite of its symbolic purpose, the Calzada would remain unpaved until 1919.

1885 - 1909
Porfirian policy with Diaz's government. It pursued a Eurocentric modernization agenda for the country. Natives were prohibited from walking on main streets or sitting in public squares unless they adopted European attire, such as trousers and closed shoes, replacing their traditional cotton pants and sandals. The indio had no place -literally and figuratively- in the forward-looking project of a modern city.

1930s - 1950s
The elite's vision of the modern metropolis clashed with the challenges posed by extensive immigration, significant socio-economic inequalities, and the swift expansion of a burgeoning working class (Duhau & Giglia, 2016).

1946
In 1946 both the ITESM and the UNL opened their schools of architecture, and the first local generation of architects were active by the mid-50s.

1945
Local industries created educational institutions for their workers' children, from primary to vocational schooling. This influence was further solidified in 1943 with the creation of the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM).

1930s - 1940s
There was a massive development of neighborhoods for middle and upper classes. This took park in the western part of the city and eventually the south of the Santa Catarina river.

POPULATION

1940s - 1960s
The initial wave of metropolization was triggered by the housing crisis.

1940 - 1960
The era of industry-provided welfare between the 1940s and 1960s during which many families thrived is celebrated to this day.

1964
Constructed in 1964 as a response to the contemporary housing crisis, the Condominios Monterrey stands as the city's primary collective housing project, promoted by the federal government. In contrast to Mexico City, collective housing in Monterrey

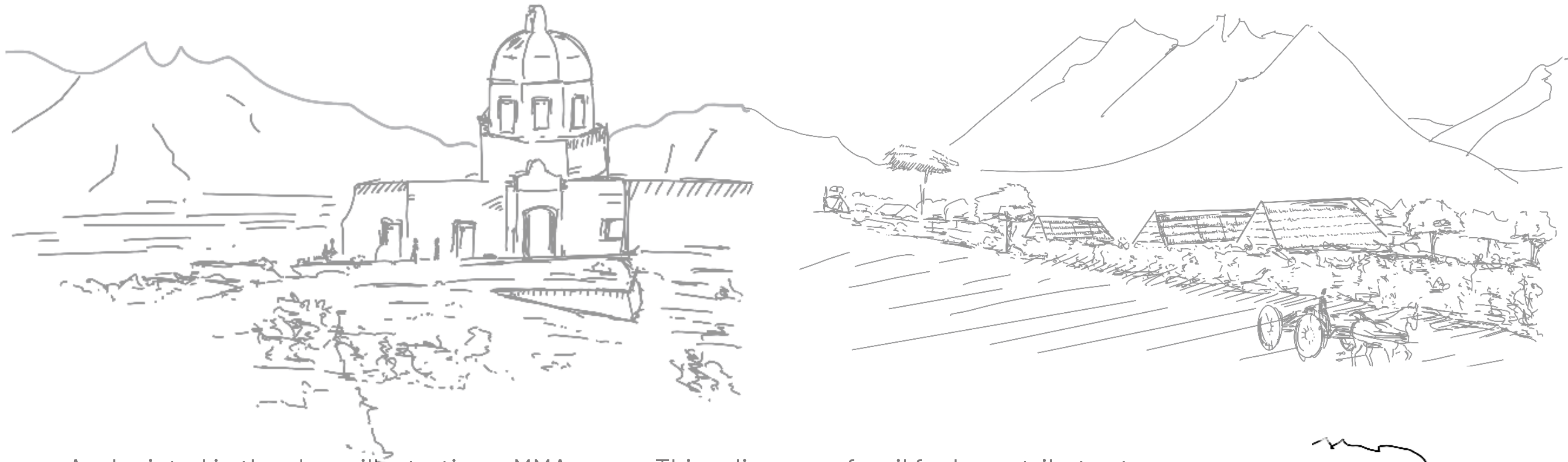
2000

1970
Monterrey had 1,600,000 inhabitants.
About 80% of the population of the entire state lived in the new Metropolitan Area.

1990s - 2000s
The city expanded northward, accommodating colonias populares for the lower classes, and southward, hosting neighborhoods for the elite. This distribution remained non-uniform, with socio-residential spaces in stark contrast to each other, persisting well into the 1990s and 2000s, as discussed by González & Villeneuve (2007).

1960s - 2000s
Economic activity shifted from industry to commerce and services

Figure 25: Development timeline of Monterrey. (Vizcaya, 1968)

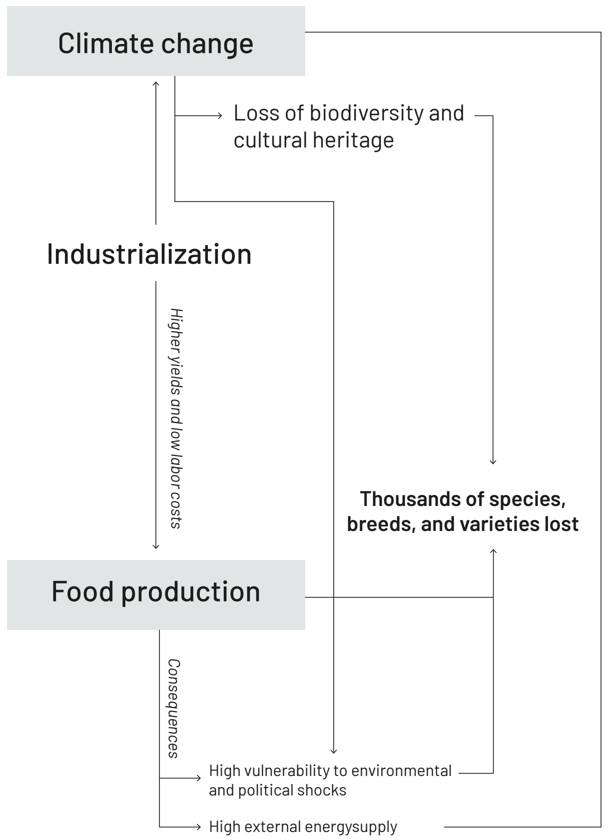


As depicted in the above illustrations, MMA has undergone significant transformation and heavy industrialization over the years. Industrialization has had a profound impact on food production, which in turn has had several consequences. Firstly, industrialization has led to large-scale agricultural practices, introducing mechanization, chemical inputs, and monocultures to enhance productivity. This shift from small-scale, traditional agriculture to large-scale farming operations has occurred.

However, these changes in food production have also exposed vulnerabilities (Altieri et al., 1984). For example, large-scale monocultures are more susceptible to diseases and pests, which can result in crop losses and food insecurity. Additionally, these industrial agricultural practices often rely on external inputs such as fertilizers and pesticides, which in turn depend on fossil fuels for production and transportation. This increases the dependence on external energy supply (Gerasimchuk et al., 2019).

This reliance on fossil fuels contributes to climate change through greenhouse gas emissions, which in turn has a cascade of effects. Climate change can lead to more extreme weather conditions, such as droughts, floods, and storms, which can affect food production (Kumar et al., 2018). Furthermore, climate change negatively impacts biodiversity, as some species are unable to adapt quickly enough to changing conditions or to follow migration patterns.

Figure 26: The relationship industrialization and food by author.



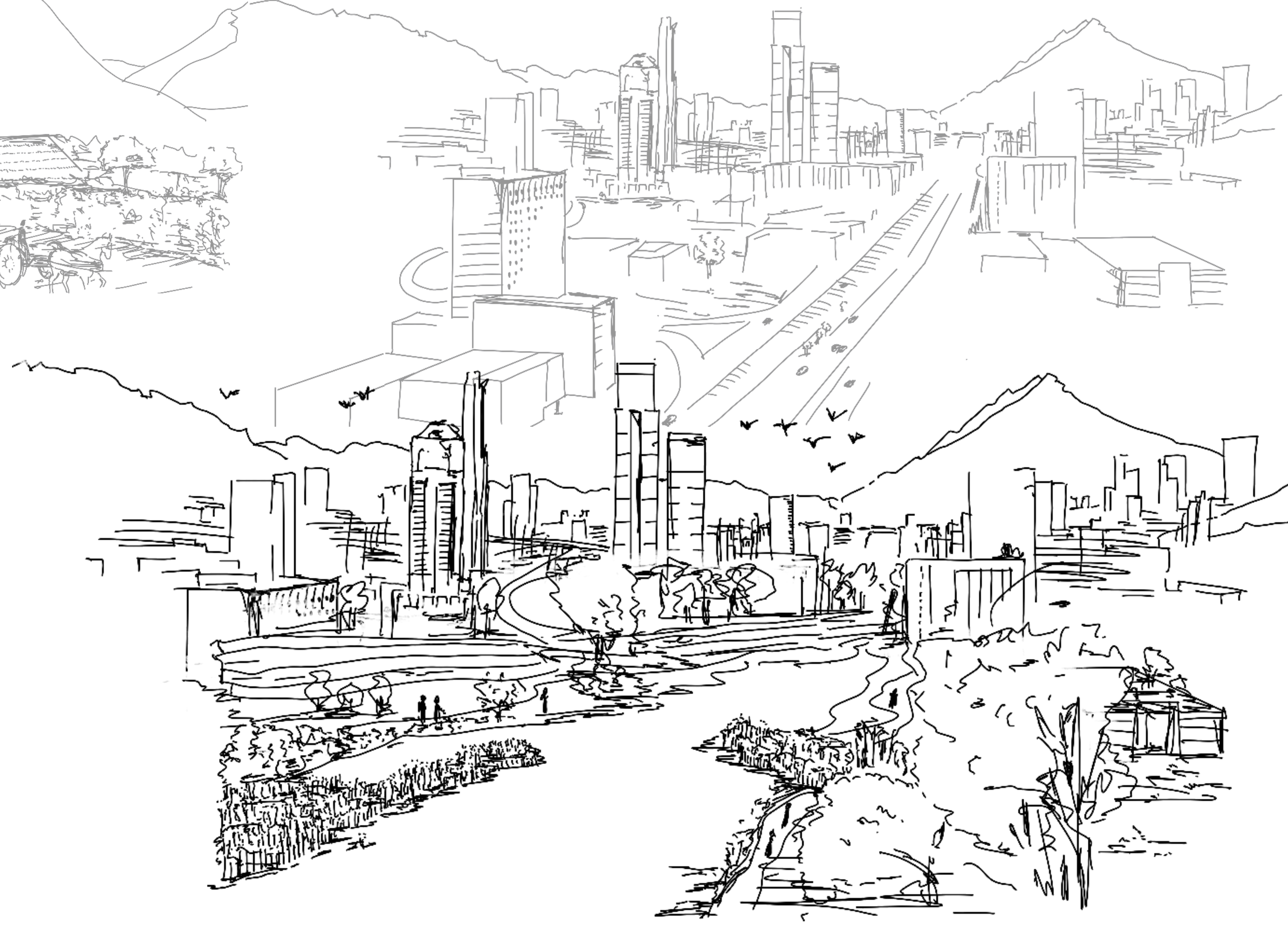


Figure 27: Drawings made by autor.

The loss of biodiversity has not only ecological consequences but also cultural ones. Many cultures are deeply connected to specific food crops and agricultural practices developed over generations. When these crops and practices disappear due to changes in food production and climate change, a piece of cultural heritage is also lost (Rotherham, 2015).

In summary, the link between industrialization, changes in food production, climate change, and the loss of biodiversity and cultural heritage is complex and interconnected. It illustrates how human activities at different levels and scales can have a domino effect that ultimately leads to significant ecological, social, and cultural changes.

Where the connection between humans (culture) and nature has gradually faded over the years, the aim is to rediscover this link. In highly urbanized areas, the appreciation of nature is being revived to rejuvenate cultural identity. This resurgence brings about a multitude of positive outcomes.

Beyond their reduced vulnerability to stress and diseases, there are other considerations regarding native crops in this cross-border region: Indigenous crops may be crucial for ongoing food production by indigenous cultures, especially on marginal lands where these crops exhibit superior adaptations to local climate and soil peculiarities (Toledo et al., 1981).

Indigenous cultivated plants in Aridoamerica, such as chili peppers, maize, and sunflowers, as well as certain wild crops like cotton and Hyptis, are facing the threat of extinction. In particular, local ecotypes of chili peppers, maize, and sunflowers are rapidly dwindling as they are being replaced by improved varieties. While other indigenous crops may not be directly endangered, they have certainly declined in abundance due to the replacement of indigenous mixed cultivation by modern profit-driven monocultures. Modern agricultural practices, such as intensive tillage and herbicide use in certain regions, are likely to diminish the possibility of crop introgression with wild species (Nabhan, 1985).

Erosion in these regions has primarily emerged in the last century due to a range of interrelated factors. These include the cultural shifts and abandonment of traditional farming practices by indigenous communities, economic transformations leading to urban migration, destruction of native agricultural habitats through human-induced environmental actions, encroachment upon traditional farming lands or water resources by external forces, and the transition from diversified small-scale farming to mechanized cultivation focused on a few (often non-native) crops (Nabhan, 1985).

In the future, the promotion of indigenous foods, seeds, and agricultural practices should be further encouraged as part of cultural revitalization movements, tribal health and gardening initiatives, and educational outreach programs. New cultural and economic incentives for diversified, regionally adapted agriculture should be considered, especially when existing incentives for growing specific indigenous crops are no longer effective (Nabhan, 1985).

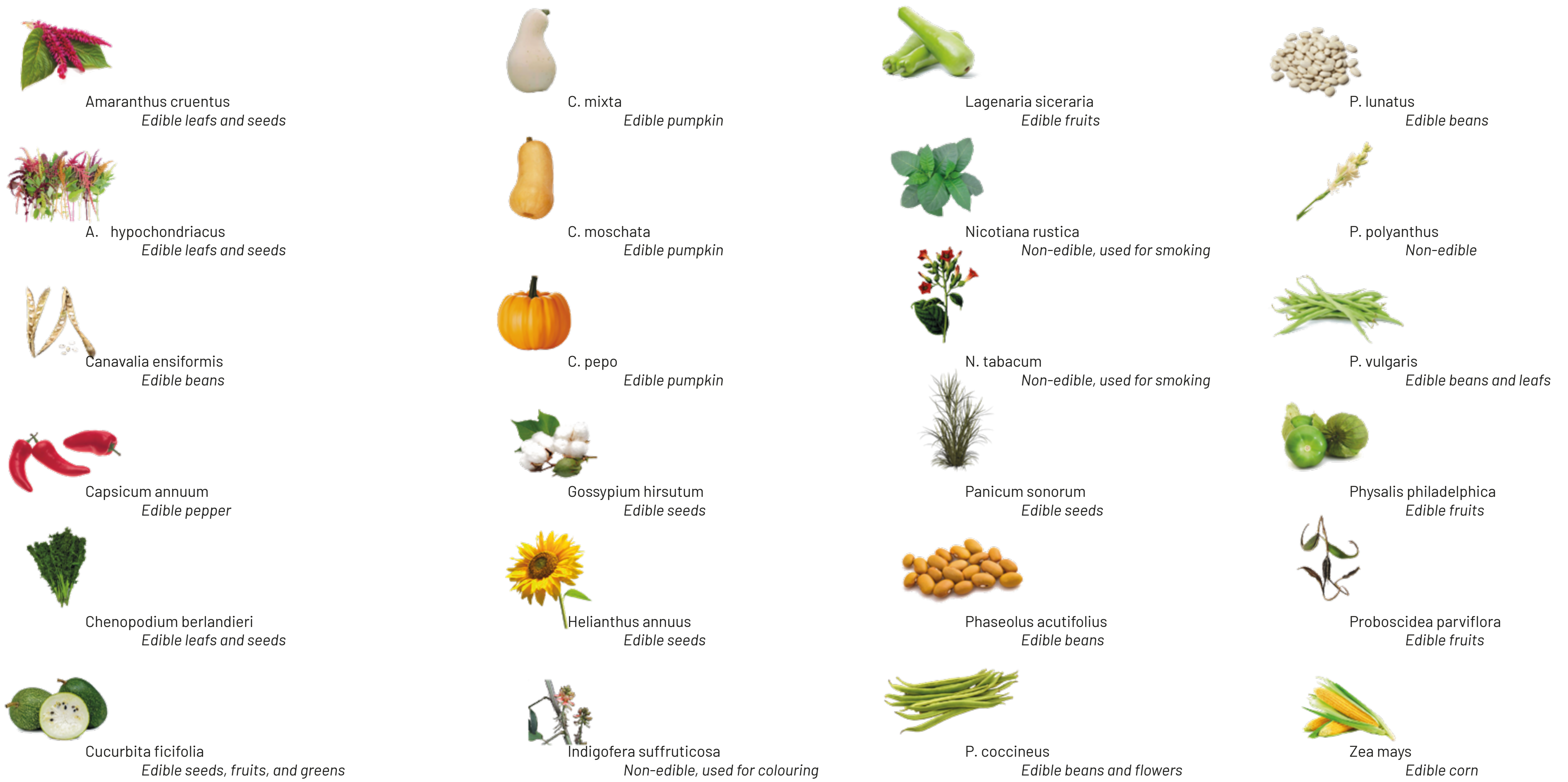


Figure 28: Plant species of Aridoamerica. (Nabhan, 1985)

NATIVE FOOD PROVISION

The attached image depicts the dietary patterns of the northern nomads throughout the year. Their sustenance relied on the crops and organisms that thrived with each passing season (Valdés, n.d.). These dynamics are pertinent considerations for the design plan to ensure a consistent food supply. During winter, food became scarcer, prompting the nomads to subsist primarily on seeds and limited animal resources. This awareness underscores the realization that food does not simply materialize in supermarkets.

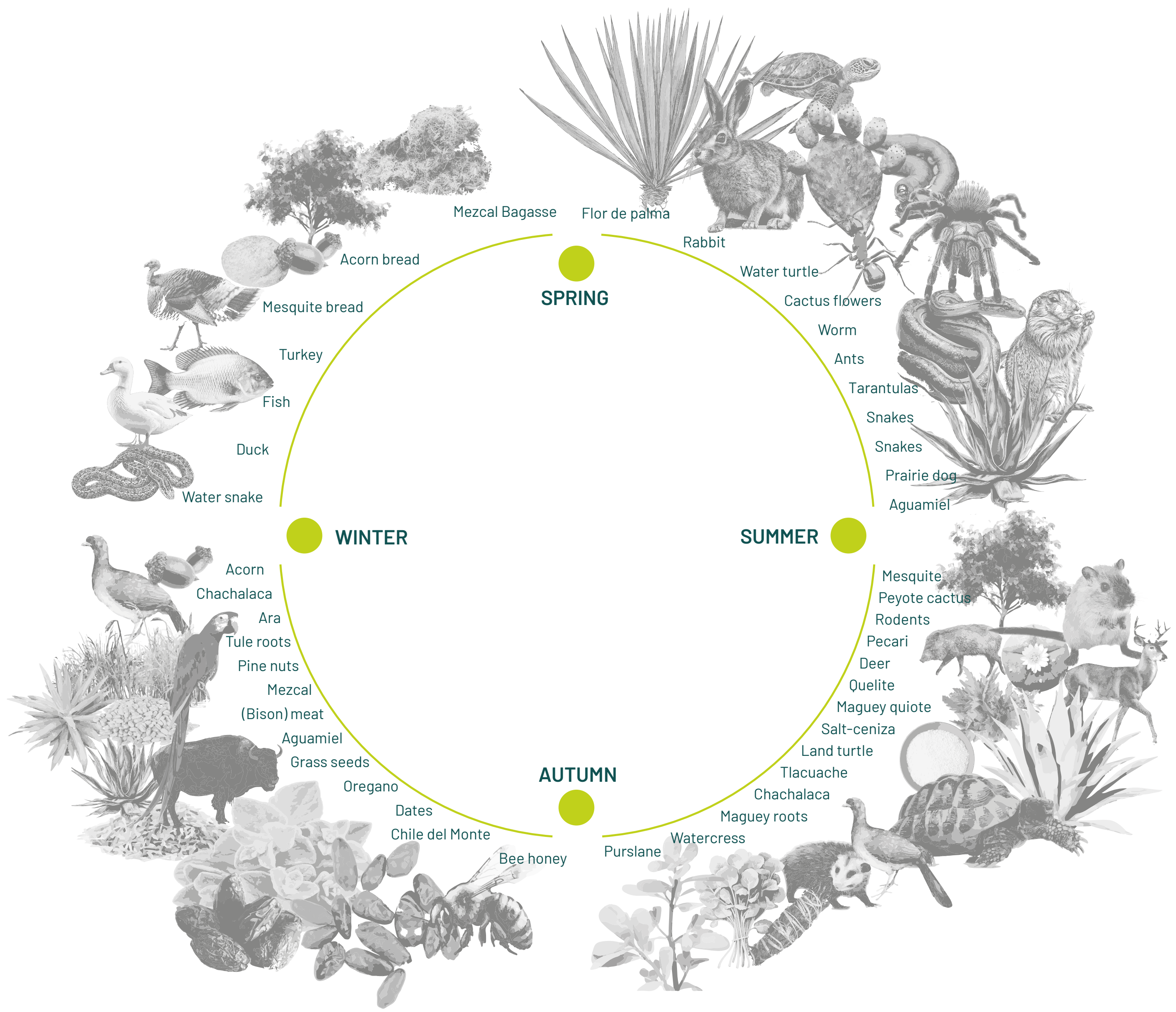


Figure 29: Food provision in Aridoamrica through seasons. (Valdés, n.d.)

Research for Design.

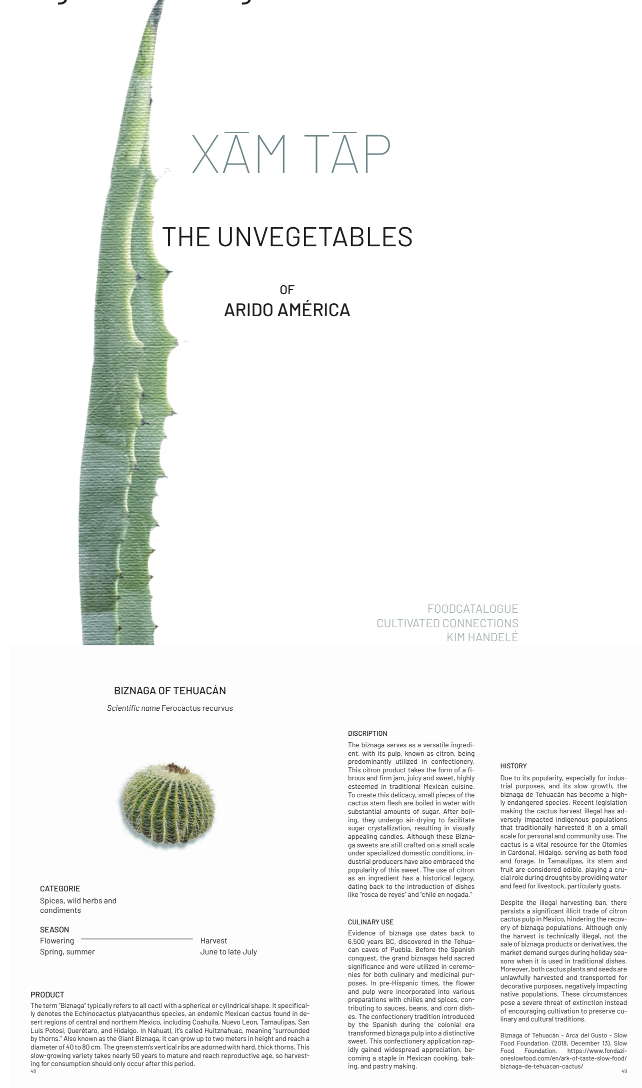
Site Analyses

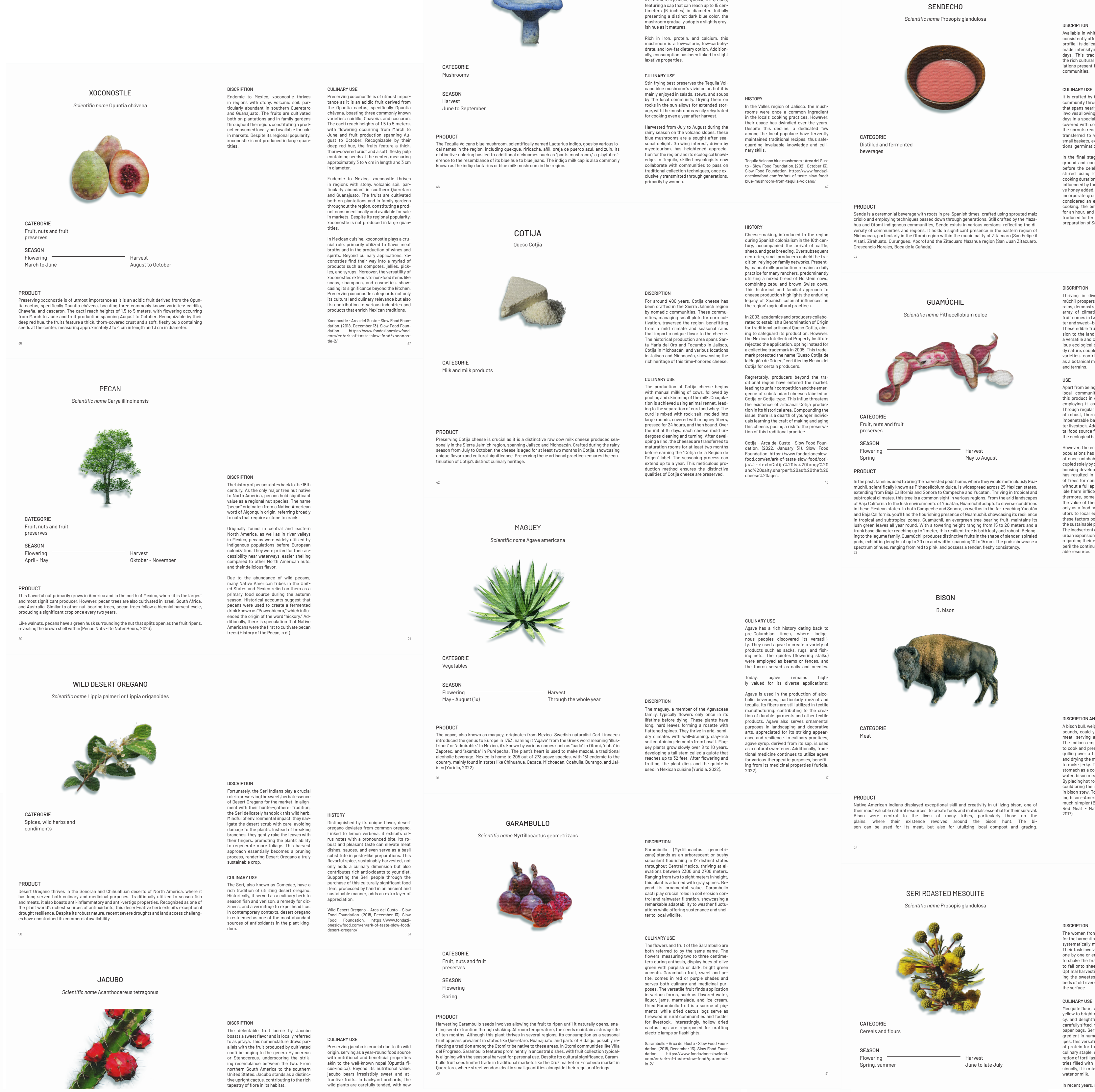
NATIVE FOOD PROVISION

To identify which crops naturally grew in Aridoamerica, the following food catalog has been compiled. By listing all the products in a catalog, it becomes easier to see which crops are involved.
The products come from the Taste of Ark by the Slow Food Network. Additionally, during the research and site visits, more valuable crops from the respective area were identified and included. The catalog provides details about the harvest season, a general product description, how it should be used culinarily, and the history of the product. Using native crops has both cultural and ecological value (Prodotti Dell'Arca Del Gusto in Mexico - Slow Food Foundation, n.d.).

Agro- and biodiversity are rapidly declining. Agricultural greenhouse gases contribute approximately 20 percent to global warming. The current conventional food and agriculture system produces junk food and snack moments at the expense of nature, animals, landscapes, farmers, and ourselves. The gap between production and consumption creates alienation among consumers and producers and does not enhance their food skills. On the contrary, it causes the few food skills they have to wither. It is common for food to travel 4000 kilometers across three or more continents before reaching your plate. During these transports and processes, the earth, climate, nature, farmers, and animals suffer (Karthals, 2021).

A distinction has been made between perennial crops and annual crops. This is because the different crops are applied in different ways in the design. The perennial crops are applied at a greater distance from the residents because they require less maintenance and can thus make a greater ecological contribution.





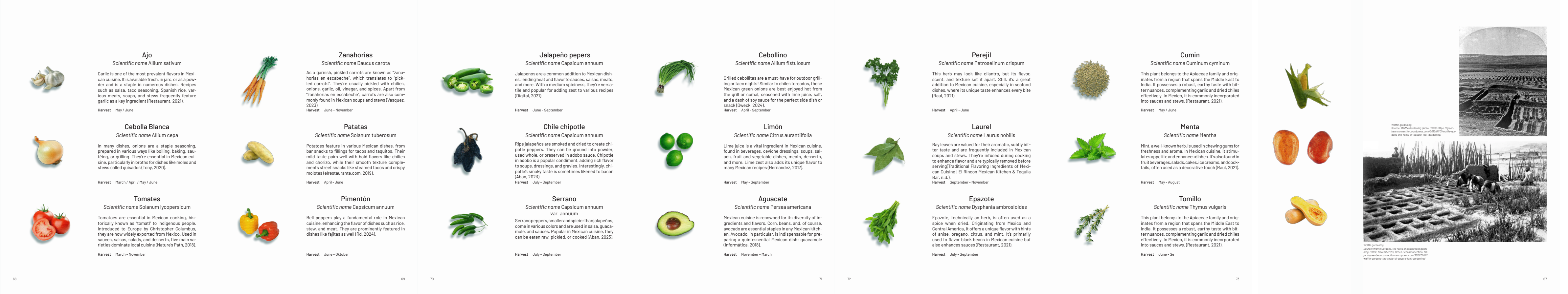


Figure 30: Food catalogue

Before the arrival of European settlers in North America, bison were the predominant grazers on the continent. While precise population estimates are uncertain, scholarly speculation suggests their numbers ranged from 30,000,000 to 75,000,000. Bison exhibited significant adaptability and occupied expansive territories, with their range extending across virtually every state in the United States, as well as regions in northern Mexico and western Canada (Arthun & Holechek, 1982).

Bison possess the remarkable ability to sustain themselves autonomously, requiring no external maintenance. They exhibit self-sufficiency by naturally reproducing without the need for supplemental minerals or salt, subsisting solely on grass without the administration of antibiotics or nutritional supplements (Food for Thought, 2024).

Indigenous communities assert that humanity's origins lie intertwined with these majestic creatures, as we emerged from the land of the buffalo: Pte Oyate. The cultural fabric, including dance, ceremonies, and familial structures, finds its roots in this connection. Oyate embodies a way of life, and teachings gleaned from these animals. Bison historically provided sustenance to the populace through their hides, skulls, meat, and organs. Reestablishing this bond, once lost, is paramount (Food for Thought, 2024).
Reintroducing bison-derived sustenance into cultural practices and ensuring its proper handling underscores the necessity of harvesting bison meat for the community's benefit and reintegrating it into the dietary regimen (Food for Thought, 2024).

In El Carmen (Coahuila), a 140,000-hectare reserve, dozens of American bison now roam freely after a century-long absence. Their return, initiated by Mexican multinational cement company Cemex in 2021, is vital for the region's fight against climate change due to the grasslands' carbon storage capacity. Starting with 19 bison, their numbers have since grown to almost 100, facilitating grassland vegetation regeneration and supporting various coexisting species.

Rurik List, an environmental sciences researcher at the Autonomous Metropolitan University (UAM) in Mexico City, explains that the bison's grazing habits enhance plant diversity and aid ecosystem regeneration by dispersing seeds in their dung. Additionally, their presence benefits other species, such as the Mexican prairie dog, by flattening the grassland to create predator-watch areas (Soriano et al., 2023).

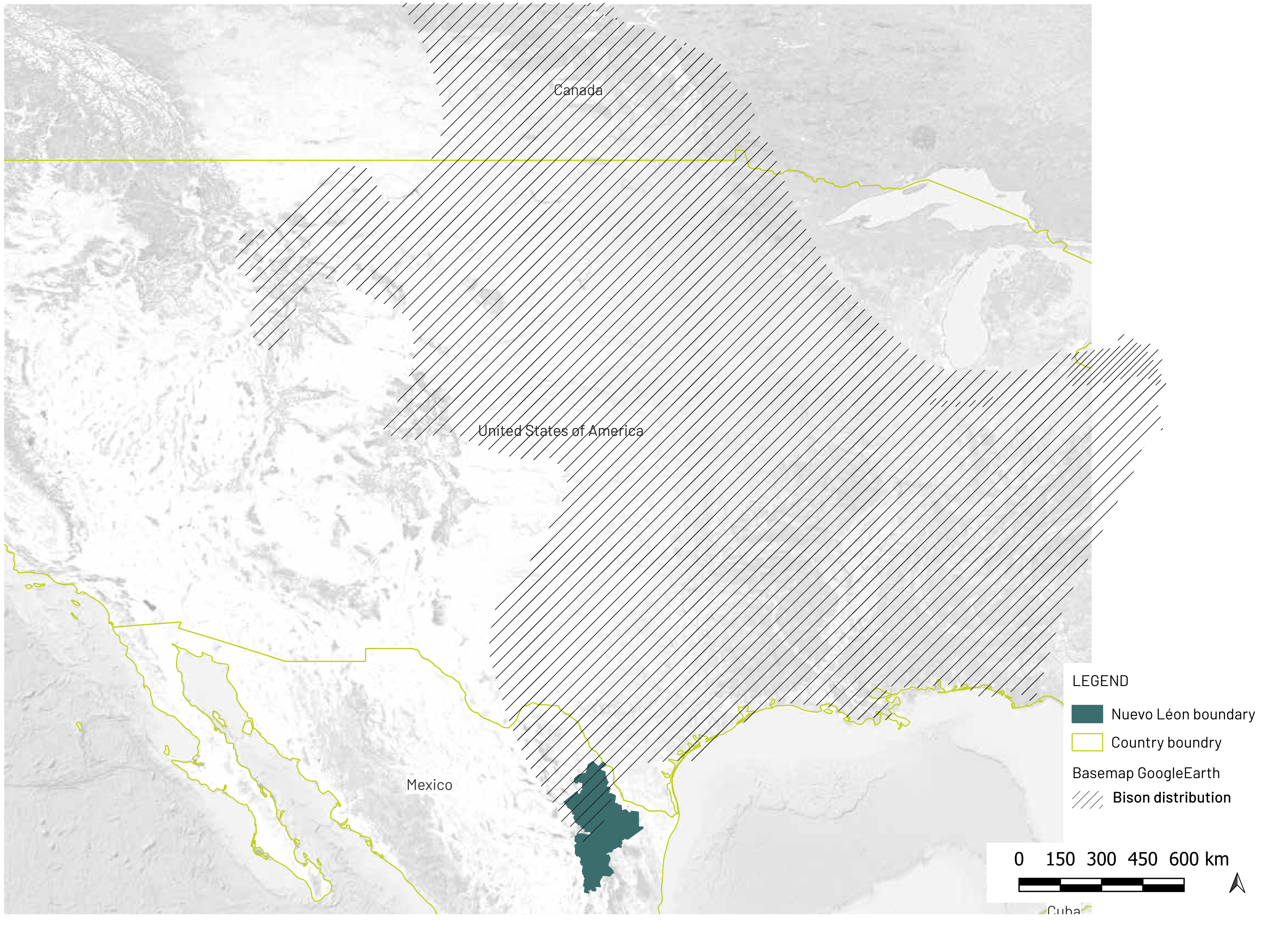


Figure 31: Bison distribution area 9000 BC. (Harper et al., 2000)

Community or public gardens are scarce in the MMA. Unlike school gardens, which can inherently be community-oriented, these are classified as a social activity distinct from education. The municipalities of San Nicolás de los Garza and San Pedro Garza García excel in such expressions due to their high-quality urban services, parks, and gardens. However, most of these gardens are subject to administrative changes or public maintenance (Lopez, 2019).

There are no policies promoting the establishment of community or public gardens from a social perspective. Rather, they arise as a civic demand to the government, and as long as social conditions do not generate a need for a garden, this service is generally not requested but offered. Community gardens are presumed to represent the final stage of structurally consolidated policy, as a significant number of beneficiaries turn to the subject through school gardens, subsequently transitioning to practices at home and proportionately to the establishment of community gardens. Their rarity as community gardens also indicates limited social integration in the city (Lopez, 2019).

(3) Family gardens are the second form most promoted by the government, primarily driven by the policies of SAGARPA in Nuevo León and the state's DIF. Municipalities focus mainly on family gardens from a forestry perspective. Both SAGARPA and the state's DIF have well-structured policies regarding timing and region. They allocate budgets to provide participants with seeds, workshops, and even infrastructure such as tanks, hoses, or vertical structures for vegetables, aimed at supporting those in vulnerable conditions. The primary objective of family gardens is mainly food security. SAGARPA is additionally concerned with social cohesion through women's empowerment and local economic development, while the state's DIF stated that the program also aims for "occupational therapy" and the promotion of healthier eating habits (Lopez, 2019).

Education in Nuevo León has been a priority area for several years. Therefore, it is not surprising that the expression of school gardens is one of the most common. Schools are the space where priority issues on the political agenda are addressed. The demand from the political agenda of the Secretaría de Educación Pública (SEP-NL) reflects the formative intention of the policy, whereby most social issues on the public agenda are primarily addressed through curriculum planning or extracurricular education promoted by educational institutions and their internal organization. Officials often state that students from primary and higher education show interest in gardens based on their experiences at school, thus influencing family and community (Lopez, 2019).

The form of agriculture provides a framework for the establishment of businesses offering products or services related to this activity. They find an emerging market in urban gardens. Some recently established and locally relevant businesses primarily focus on the production of organic food for marketing and distribution, alongside offering services and products for the design and maintenance of gardens, supplemented in some cases with introductory courses on urban gardening, vermicomposting, and hydroponics, providing participants with the opportunity to engage in recreational activities (López, 2019).
For further exploration of existing initiatives in the region concerning urban farming, the following study has been conducted. Several well-known urban farms have been assessed based on production quantity and techniques to determine whether they employ high- or low-tech methods and operate on a larger or smaller scale. By mapping this information, possibilities are revealed regarding the forms of urban agriculture present within the city. The existing farming initiatives are being examined and evaluated with the created toolbox. This involves distinguishing between small-scale and large-scale enterprises, as well as high-tech and low-tech production methods, to map out a diversity of approaches. We are considering methods of implementation and the underlying vision. This can serve as inspiration for innovation. Additionally, looking at local initiatives provides contextual relevance.

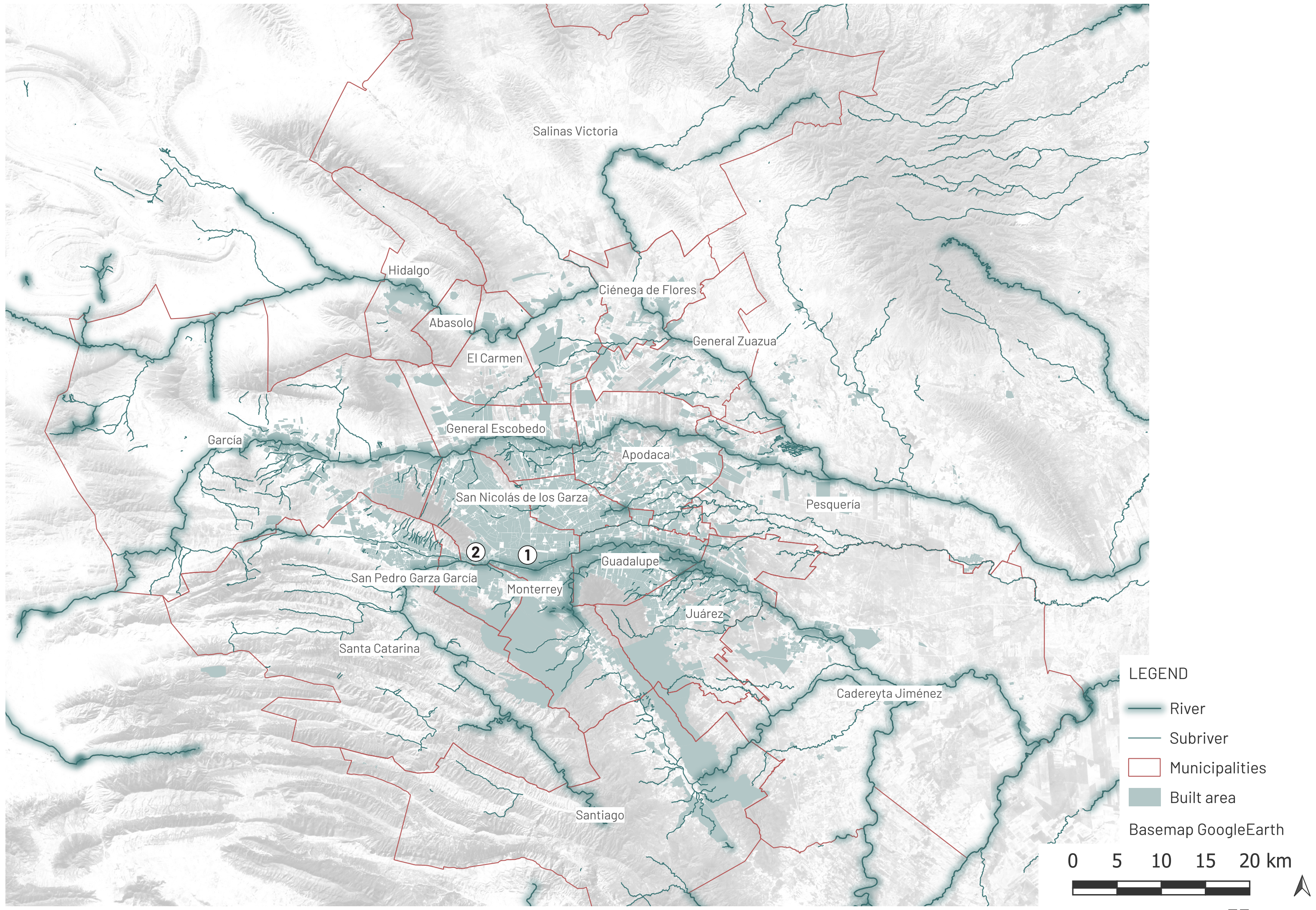


Figure 32: Two current urban farm initiatives (QGIS.org, 2024)

Site Analyses

CURRENT FOOD PROVISION

1) Ufarm

They describe themselves as:
"Our partners employ an organic and sustainable approach to harvesting, prioritizing the well-being of the land, water, and the environment, while also advocating for a fair economy to support those who cultivate our food.

All our offerings undergo a screening process to ensure they meet agroecological standards:
- Abstain from using pesticides
- No industrial fertilizers
- Utilize compost, ferments, or mineral broths
- Organic repellents
- Local inputs to minimize ecological impact
- Polycultures practices
- Harvesting involves local communities
- Competitively priced compared to certified organic alternatives, as certification is not required

(Nosotros – URBAN FARM MÉXICO, n.d.)

This business model offers several advantages, facilitating the sale of various ecologically impactful products. Ufarm serves as a bridge between farmers and consumers, ensuring that certain criteria are met to provide a valuable ecological and social contribution to the environment. Through this approach, farmers are allowed to access and improve market access. However, this results in limited product availability and seasonality.

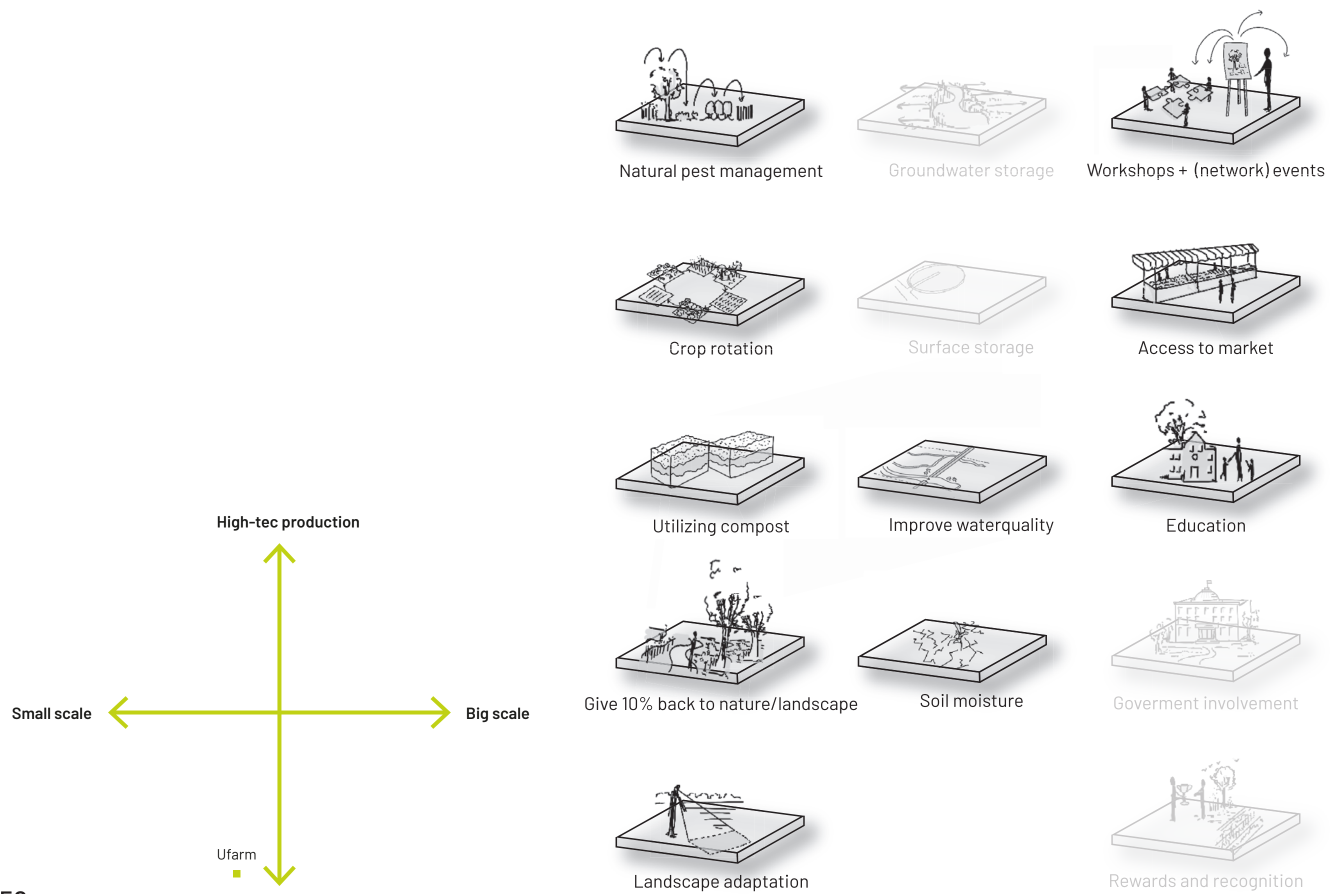


Figure 33: Urban farm matrix by author.

Site Analyses

NATIVE FOOD PROVISION

2) Karma Verde

They describe themselves as: "Karma Verde Fresh is a social enterprise working to incorporate Vertical Farms throughout Mexico and introduce products with high nutritional content and low impact on the environment into the market.
Our purpose is to transform the lives of individuals and communities through the creation of nutritious and accessible food options that have a friendly and positive impact on our environment." (Fresh, n.d.)

The advantage of this cultivation method in this highly urbanized area is that a variety of crops can be cultivated throughout the year, maximizing land use efficiency. In such areas, achieving high ecological yield in crop growth may not be feasible. However, localized cultivation of in-demand crops is achievable.
The enterprise can be enhanced by utilizing local and limited water resources, implementing green practices, and fostering community involvement to become more nature-inclusive.

Figure 35: Cultivated crops (Fresh, n.d.-c)

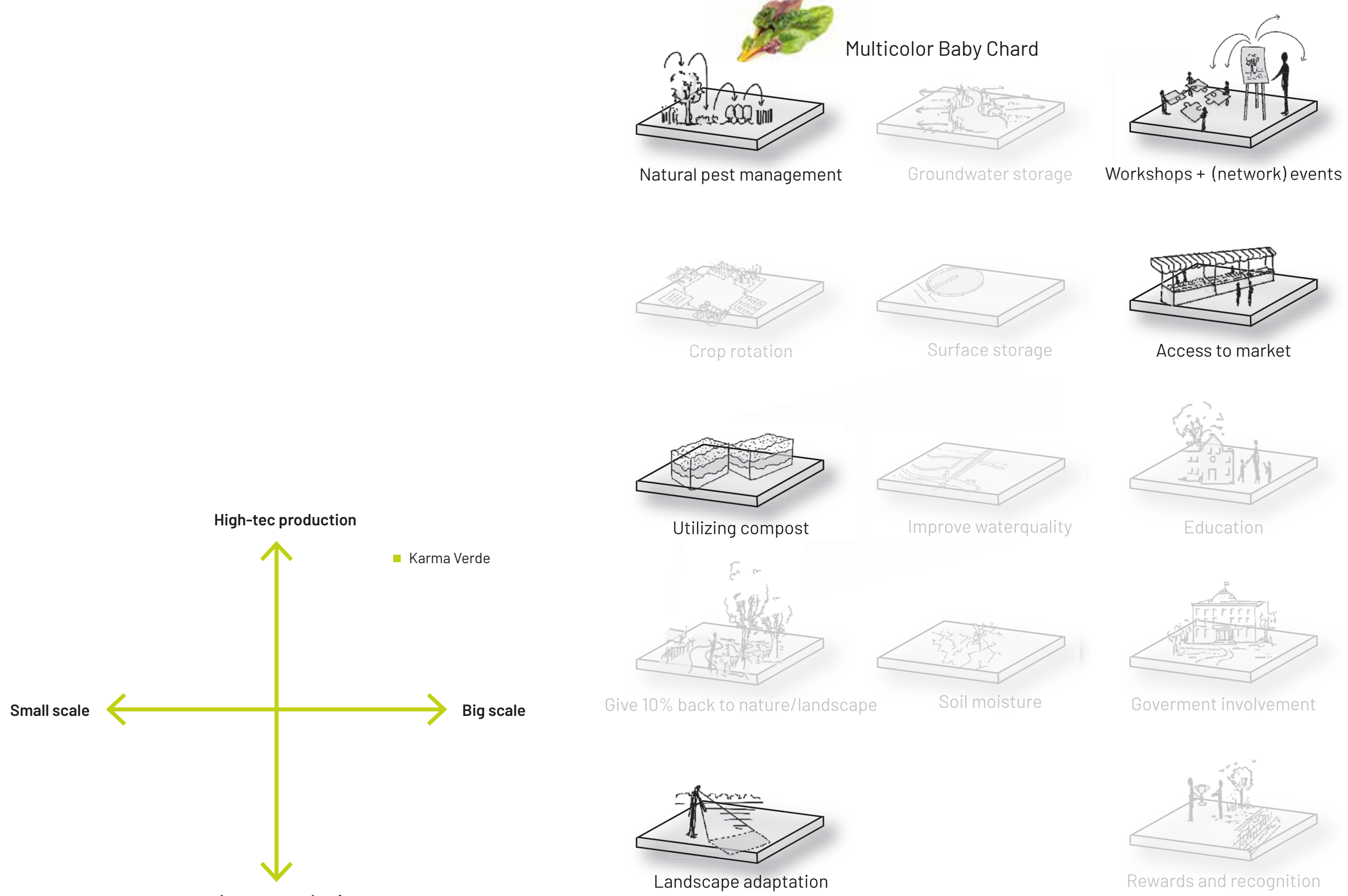


Figure 34: Urban farm matrix by author.

In the BRSJ irrigation district, farmers faced water supply issues following the construction of the El Cuchillo dam, which redirected water to Monterrey. Despite being directly impacted, farmers had limited influence on official allocation decisions, as decision-making processes largely excluded them. The conclusion suggests that involving farmers in water resource decisions should extend beyond observation to active participation, as outlined in Mexican water policy. Further research is needed to understand the reasons and consequences of limited farmer involvement in water allocation.

Compensation conditions were established for farmers in the Río San Juan situation, with Monterrey and Nuevo León investing in wastewater treatment. However, federal government intervention was required to compensate for water scarcity during drought. Farmers adapted by focusing on improving water productivity and irrigation efficiency, although the shift to maize poses production and economic risks due to limited rainfall and irrigation water scarcity.

Decision-making complexity in the Río San Juan case is exacerbated by USA-Mexico water sharing, with the Mexican federal government taking a primary role in water management. This diminishes farmer participation in decision-making, highlighting the need for alignment with legal and institutional frameworks.

Long-term challenges include determining suitable strategies for farmers facing a permanent transfer of water volumes, especially with Monterrey's planned second-stage diversion from El Cuchillo. Effective management of effluent flows to support transferred water-reliant farmers and address environmental and public health impacts requires careful negotiation and alignment with legal frameworks (Scott et al., 2007).

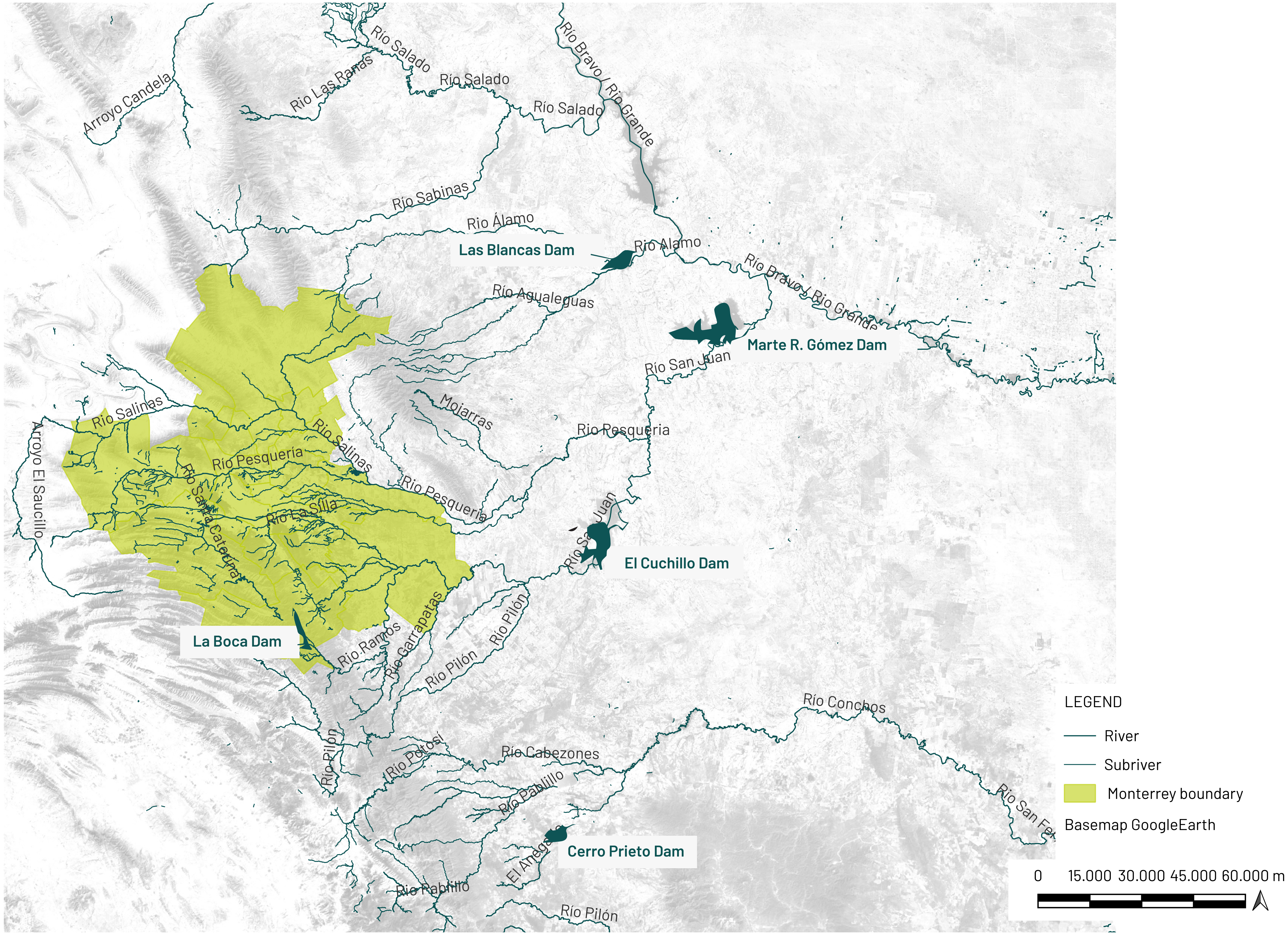


Figure 36: Watersystem Monterrey (QGIS.org, 2024)

Site Analyses WATER PROVISION

The model demonstrates the flow of water through the area in an abstract manner. Black dots indicate how the water flows to the lowest point between two higher elevations, showing how the landscape erodes as a result.

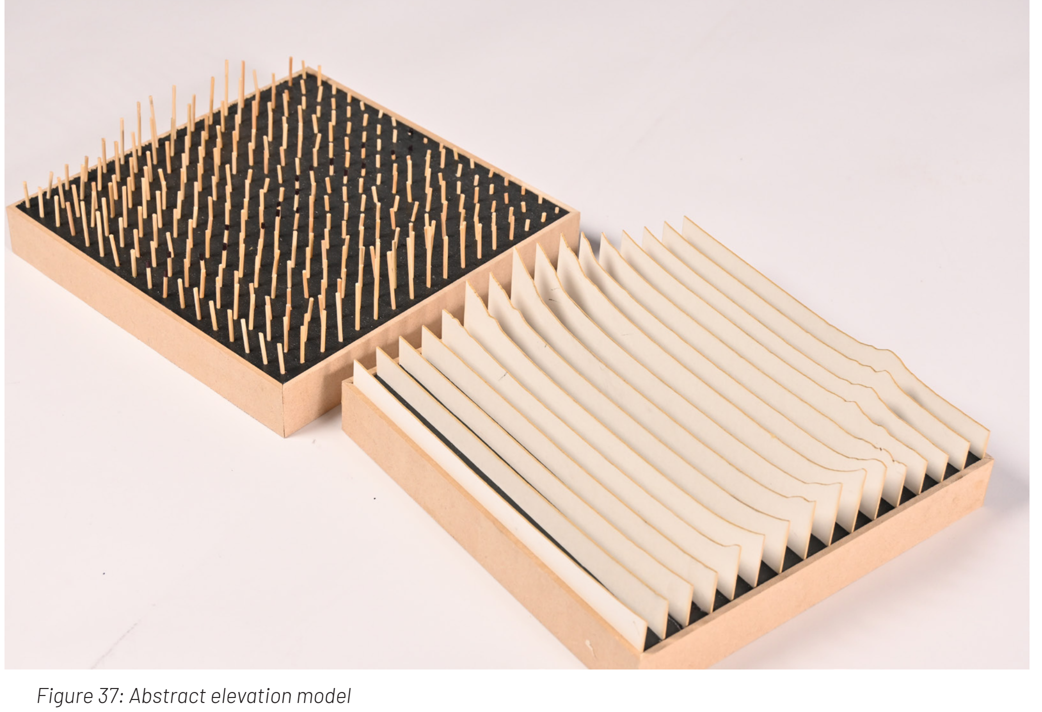
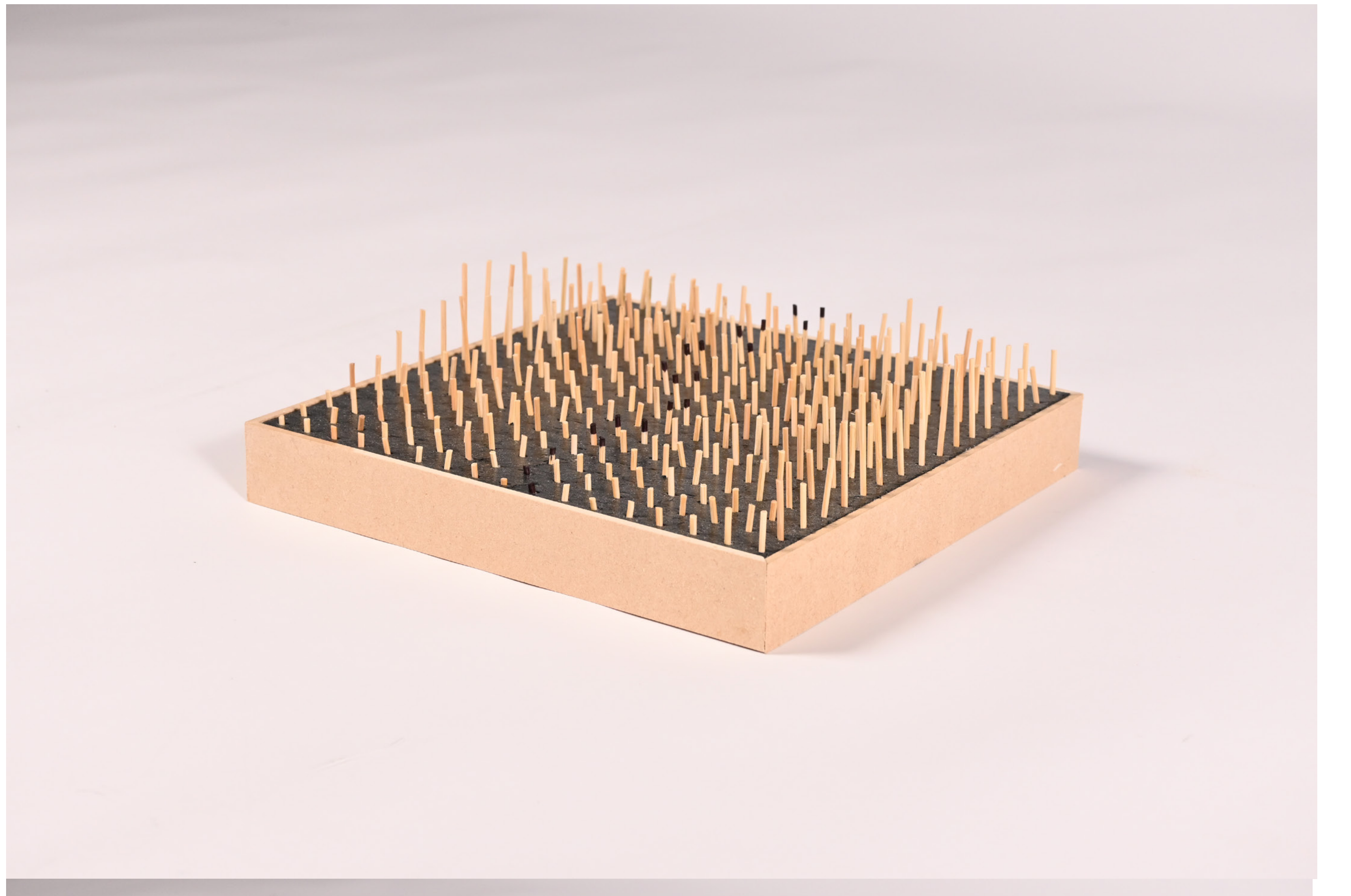
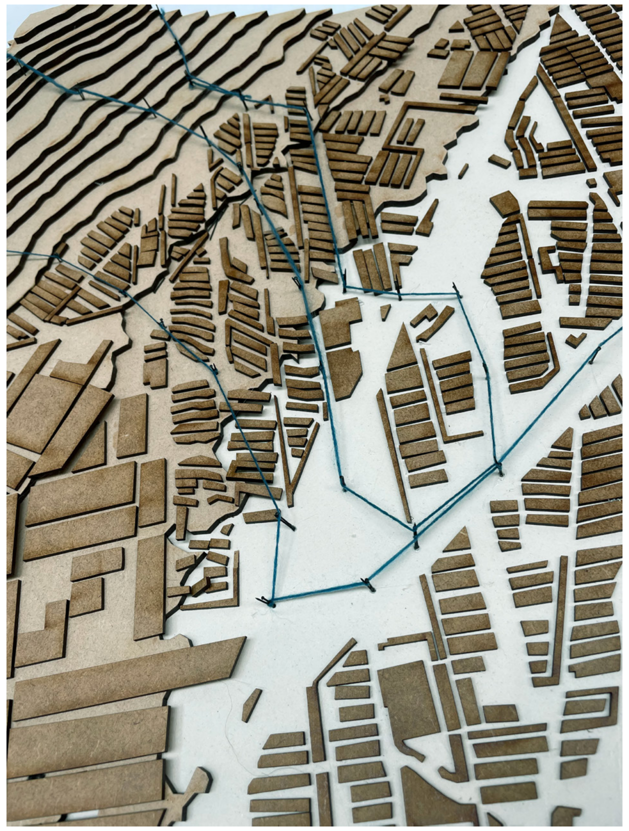


Figure 37: Abstract elevation model



Research Approach.

This model provides a more detailed representation of the area. It illustrates how water flows from the mountains and how potential runoff from an elevated urban area contributes additional water to the design location. This information has been used to analyze flooding and how current water flows can be transformed and utilized.



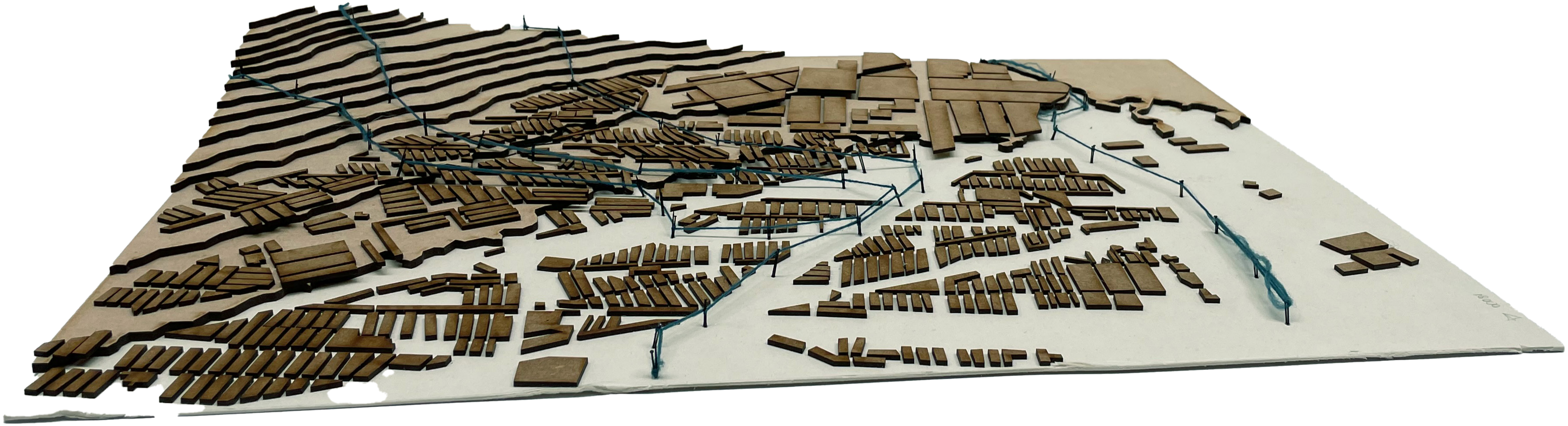


Figure 38: Pesqueria watersystem model

Kastanozem
Kastanozems are soils abundant in humus, initially covered by early-maturing native grassland vegetation, resulting in a distinctive brown surface layer. These soils are typically located in semi-arid areas with rainfall ranging from 200 to 400 mm (8-16 inches) annually, often adjacent to arid regions like southern and central Asia, northern Argentina, the western United States, and Mexico. Kastanozems are primarily utilized for irrigated farming and grazing purposes (The Editors of Encyclopaedia Britannica, 2000).

Phaezom
Phaeozems feature a top layer abundant in humus, naturally covered with lush grass or deciduous forest vegetation. These soils are highly suitable for cultivation and are utilized for growing crops like wheat and soybeans, as well as for grazing cattle. Additionally, they are utilized for wood and fuel production (The Editors of Encyclopaedia Britannica, 2000b).

Rendzina
Rendzina soils typically pose challenges for agricultural purposes. Their shallow depth inhibits effective mechanical tillage, while their limited soil volume restricts water storage and distribution capabilities. Moreover, these
soils frequently occur on sloped terrain, exacerbating the risk of erosion (Loveland, 2013).

Litosol
Because of their shallow depth or high rock content, these soils have good drainage, leading to low water retention. Lithosols or leptosols are limited in their agricultural use primarily due to their shallow depth and stony nature. Nevertheless, with appropriate management practices, they can be made productive for specific crop cultivation and forestry purposes (Castro, 2020).

Fluvisol
Fluvisols are commonly located in flat areas that experience occasional flooding from surface water or groundwater, such as river floodplains, deltas, and coastal plains. These soils are suitable for growing crops without irrigation or for cultivating rice, and they also serve as grazing land during the dry season (The Editors of Encyclopaedia Britannica, 2000a).

In the map below, the remaining soil composition is Rendzina. However, this has been omitted due to very limited options for cultivation and other activities due to high sensitivity.
The rest of the areas are very interesting. Along the rivers is particularly intriguing because there is no need for extra irrigation. This could contribute to addressing the water shortage in the city. The remaining soil types will likely require additional irrigation to grow crops. However, this depends on the type of crop. There are also opportunities for a nature-inclusive irrigation system.

Soil map

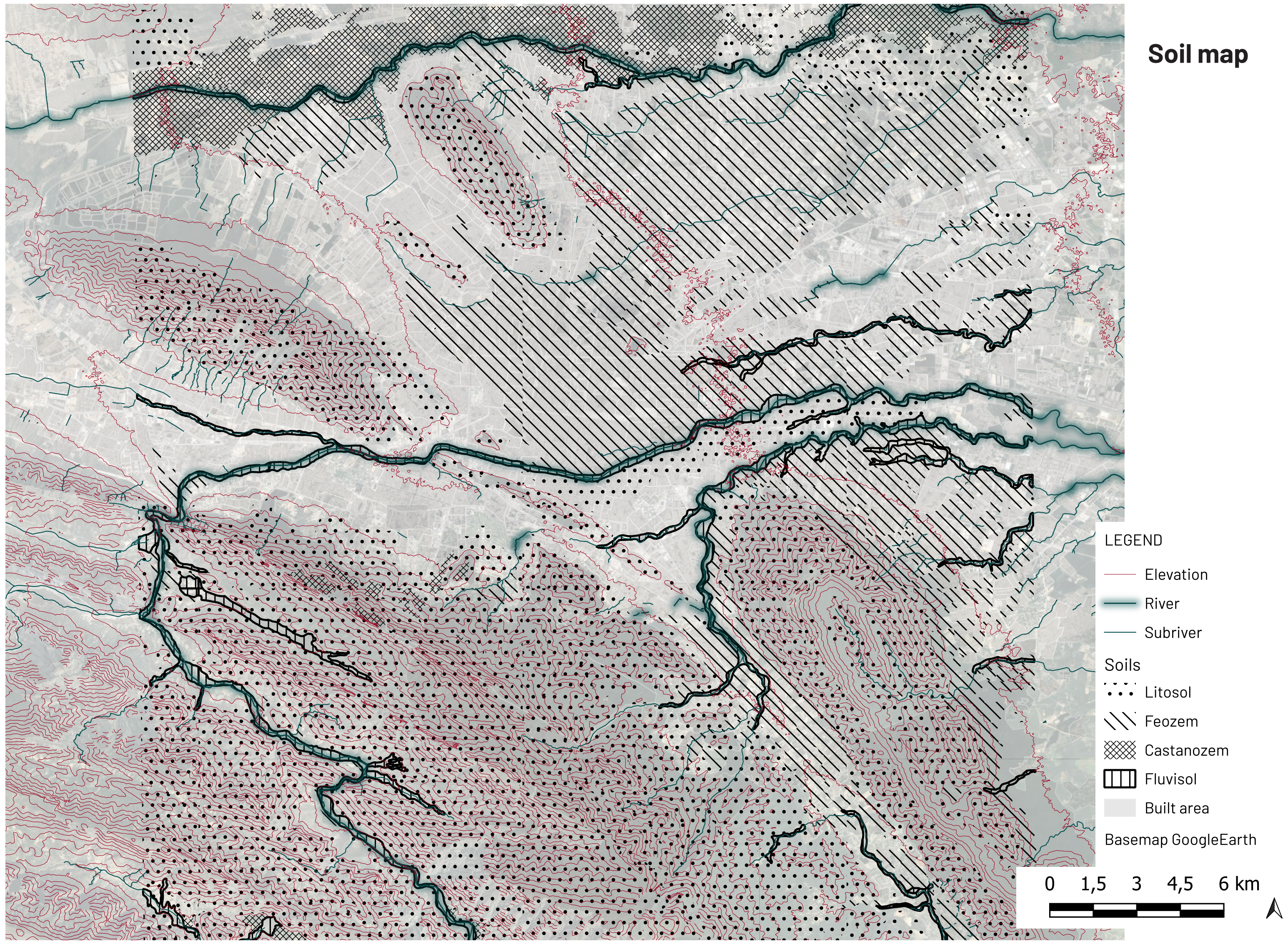


Figure 39: Soilmap Monterrey (QGIS.org, 2024)

Defining climatic zones is beneficial for understanding the relationship between climate and the distribution and behavior of plants and animals on Earth's surface. Various methods exist for establishing these zones, and the chosen method often depends on the specific goals of the study. These goals might include examining how climate impacts natural ecosystems, agricultural practices, or human activities (Bailey, 1979).

On a regional scale, various climates have been studied. Monterrey is situated in a climate that combines characteristics of regions 3 and 4. Region three exhibits features of shrublands found in hilly areas, occurring just below the mountains, often with smaller trees scattered across the landscape. Region 4, on the other hand, has a more forested character, encompassing both coniferous forests and mixed forests with oak and other deciduous trees, typically in mountainous areas.

Moving towards the northeast of Monterrey, the environment becomes increasingly arid, with dry conditions prevailing. Here, prickly plants, cacti, and other similar vegetation thrive. Water is scarce, and temperatures are high. Preserving this ecosystem is crucial for maintaining biodiversity.

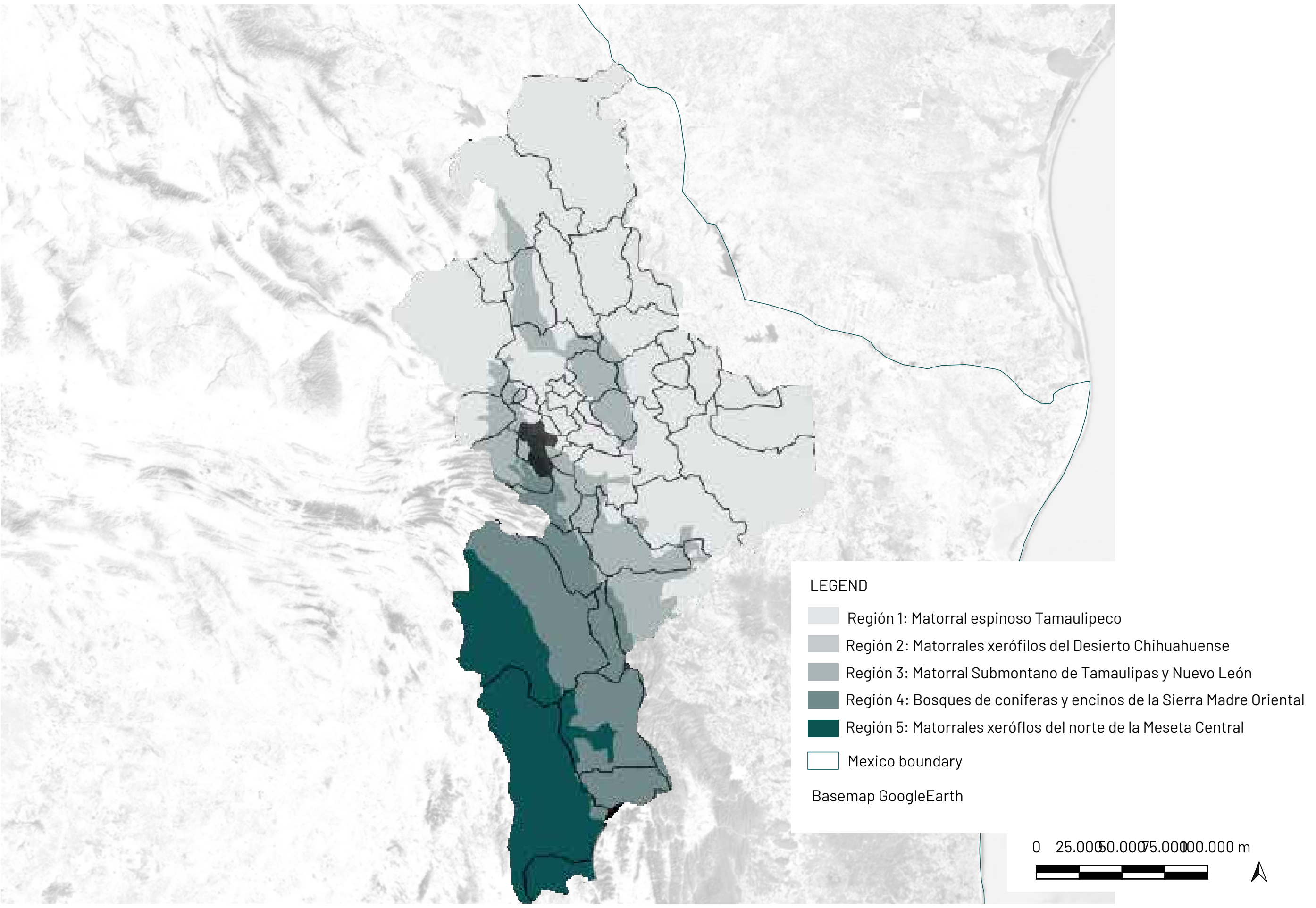


Figure 40: Climate zones Nuevo Leon (QGIS.org, 2024)

A further zoom-in reveals the various climates at the city scale. There is a combination of different types of arid climates in and around the city.

While it is true that even the driest regions receive some rainfall, albeit minimal and unpredictable, semi-arid regions generally experience significant precipitation for at least a few months each year. This amount is sufficient to increase soil moisture to levels that support the growth of grasslands or shrublands, resulting in a total biomass much greater than that found in arid regions (Richards et al., 1975).

Conversely, extended periods without sufficient rainfall are also characteristic of semi-arid climates. Even when precipitation is fairly evenly distributed throughout the year, prolonged dry spells of uncertain length and timing are a common feature of the long-term weather patterns in these regions (Bailey, 1979).

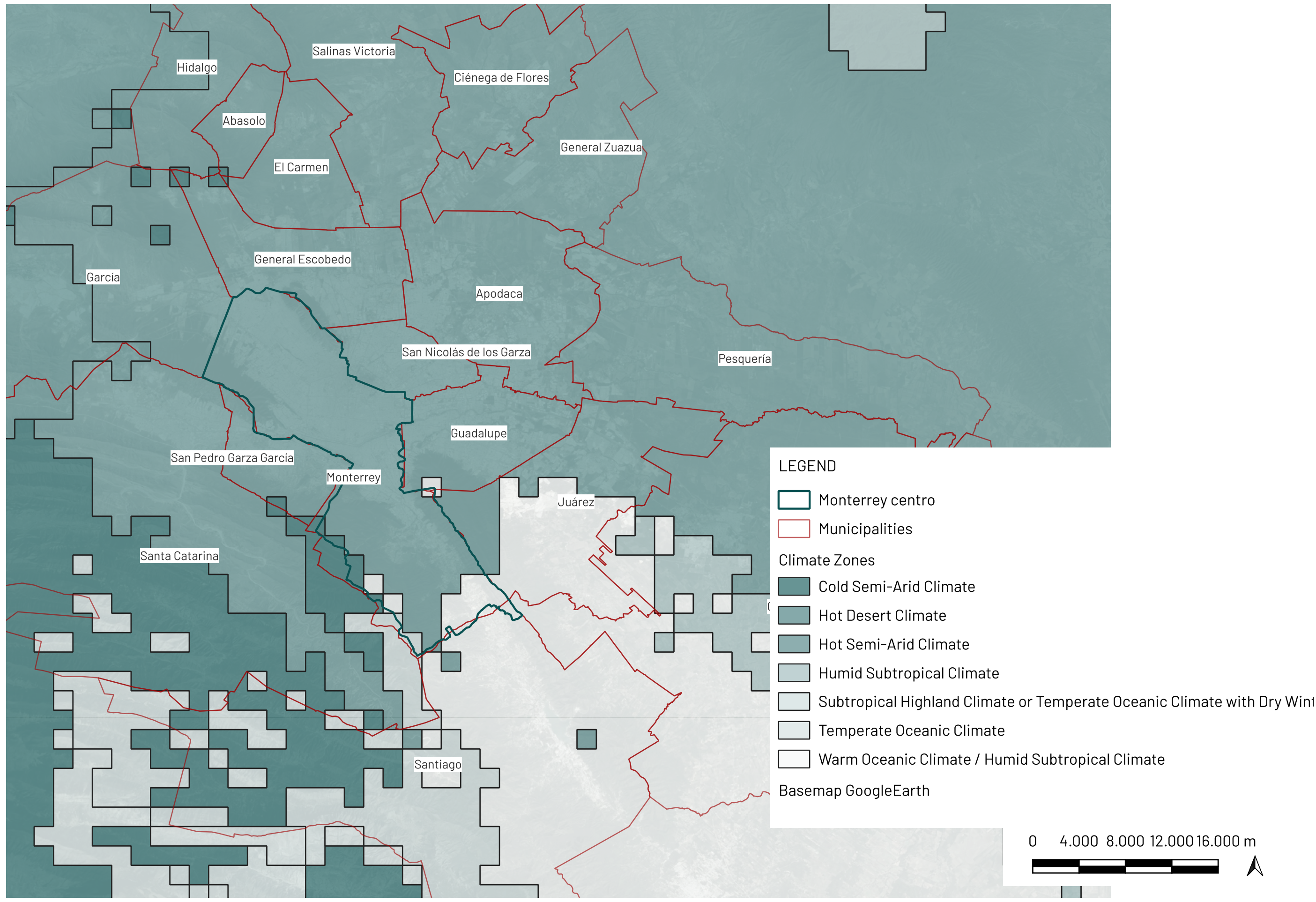


Figure 41: Climate types Monterrey (QGIS.org, 2024)

A solar study is crucial for designing vegetation in a densely populated urban environment for several reasons. Vegetation requires sunlight for photosynthesis, which is essential for plant growth and health. In an urban setting, buildings, trees, and other structures can cast shadows that affect sunlight availability. A solar study helps identify areas that receive adequate sunlight, allowing for the appropriate selection of plant species.

Urban areas can create microclimates where temperature, wind, and humidity can vary significantly over short distances. Understanding how sunlight varies throughout the day and across seasons enables designers to optimize microclimates for different types of vegetation, leading to better growth and plant survival.

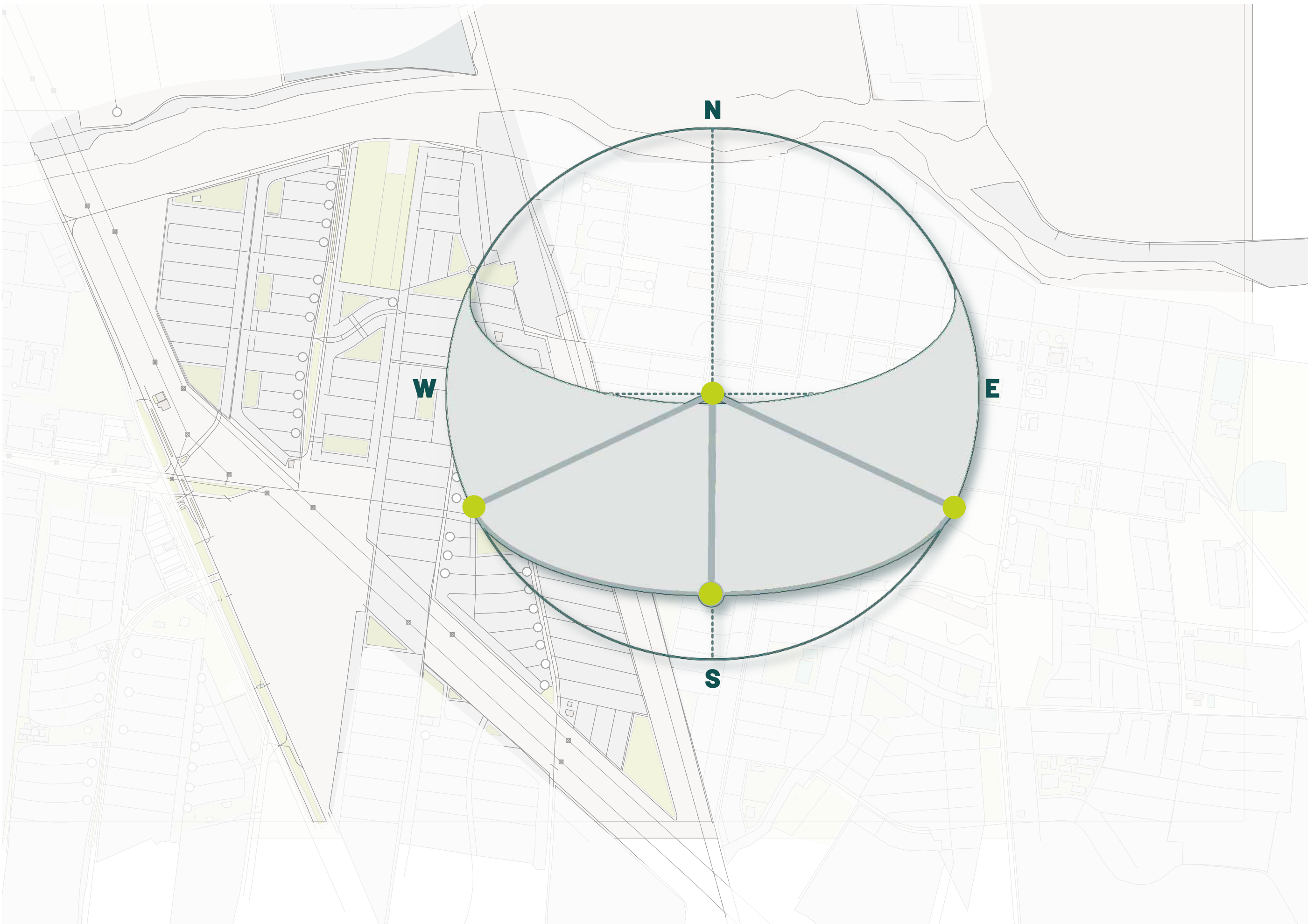


Figure 42: Sun study. (SunCalc Sun Position- Und Sun Phases Calculator, n.d.)

4. RESEARCH BY DESIGN

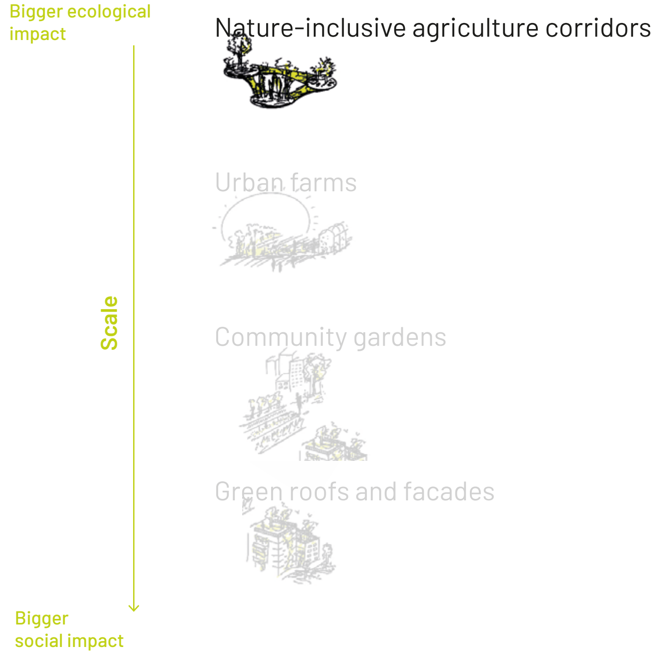
Research by Design.

In the design, focus is placed on various scales, ranging from regional to individual scale. It is neither a bottom-up nor a top-down approach, but rather a combination wherein the different scales constantly collaborate. The report first elaborates on the regional scale, followed by urban farms, community gardens, and green roofs and facades.

As a guide, the following toolbox has been utilized. The components of ecology, water, and social are the foundational design principles of this project. Tiles have been created to further elucidate these concepts. However, on different scales, certain tiles are more applicable than others. This does not imply that all these conditions are always met; it is site and scale-specific. This is further explained for each scale.

Toolbox regional focused

By author



The goal of ecology is to elevate the organic value within the landscape, thereby enhancing its resilience. Water plays a crucial role in this endeavor, as without water, this is not achievable. To retain more fresh water in the soil, increased organic matter is required, thus perpetuating the symbiosis between these two components. Additionally, the social element must not be overlooked, as without people, nothing happens. Ultimately, they are the ones who will initiate the renewal.

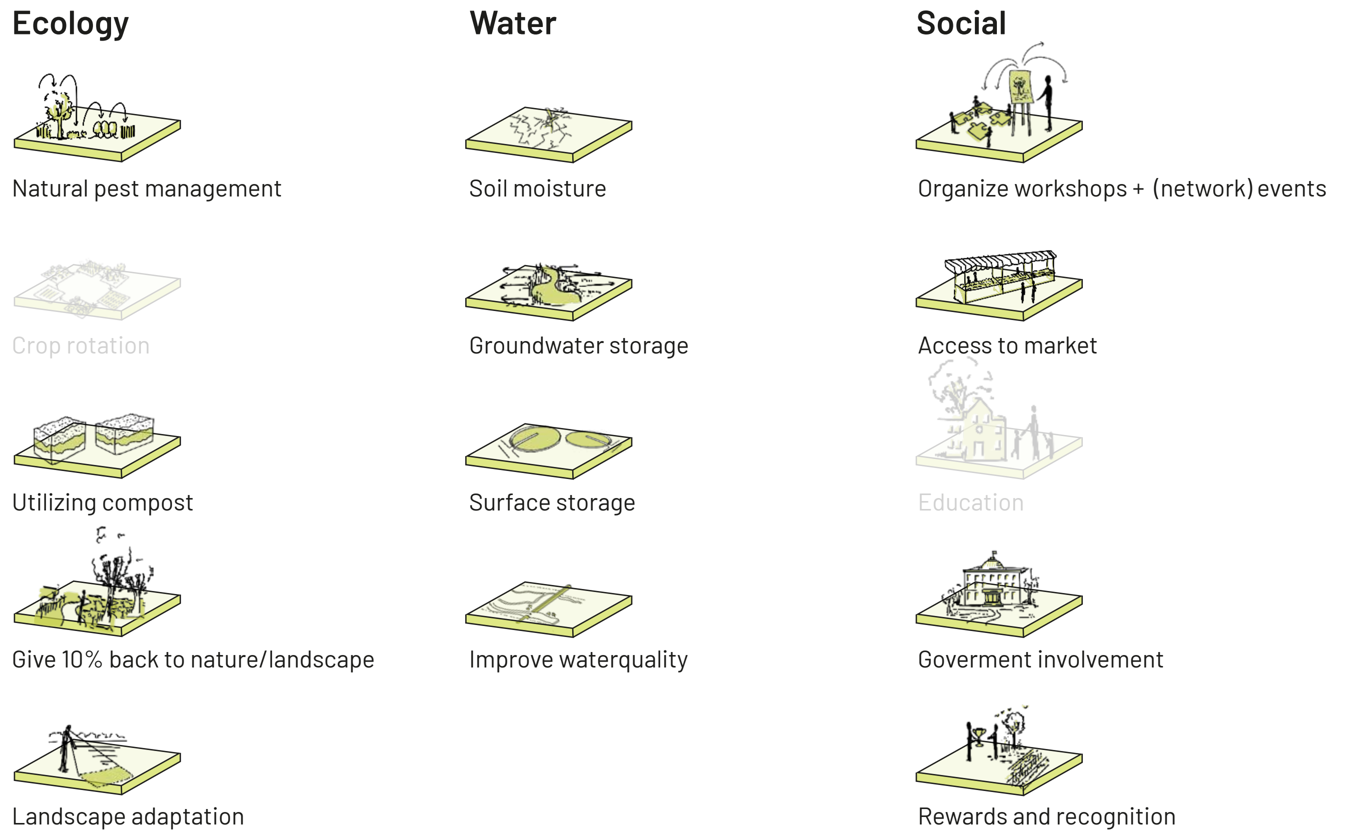


Figure 43: Toolbox Regional scale by author.

Regional scale
FOOD PROVISION

Connecting nature reserves to create a protected green belt around the city can significantly enhance its ecological value. This strategy addresses several important issues:

Address Urban Sprawl:
Establishing a green belt helps to control urban sprawl by limiting the spread of development and encouraging more sustainable urban planning.

Preserve Natural Landscapes and Green Spaces:
By protecting these areas, we can maintain the natural beauty and green spaces that are essential for the well-being of city residents.

Maintain Biodiversity:
A green belt helps preserve biodiversity by providing a variety of habitats that support different species of plants and animals.

Provide Habitats and Corridors for Plants and Animals:
These connected green spaces create continuous habitats and corridors that are crucial for the movement and survival of wildlife.

Improve Air Quality:
Green belts act as lungs for the city, absorbing pollutants and producing oxygen, thereby improving air quality.

Reduce Urban Heat Island Effect:
Green spaces help to cool urban areas by providing shade and releasing moisture into the air, thus mitigating the urban heat island effect.

By connecting nature reserves to form a green belt, we can create a sustainable and livable urban environment that benefits both people and wildlife (Hirt & Scarpaci, 2007).

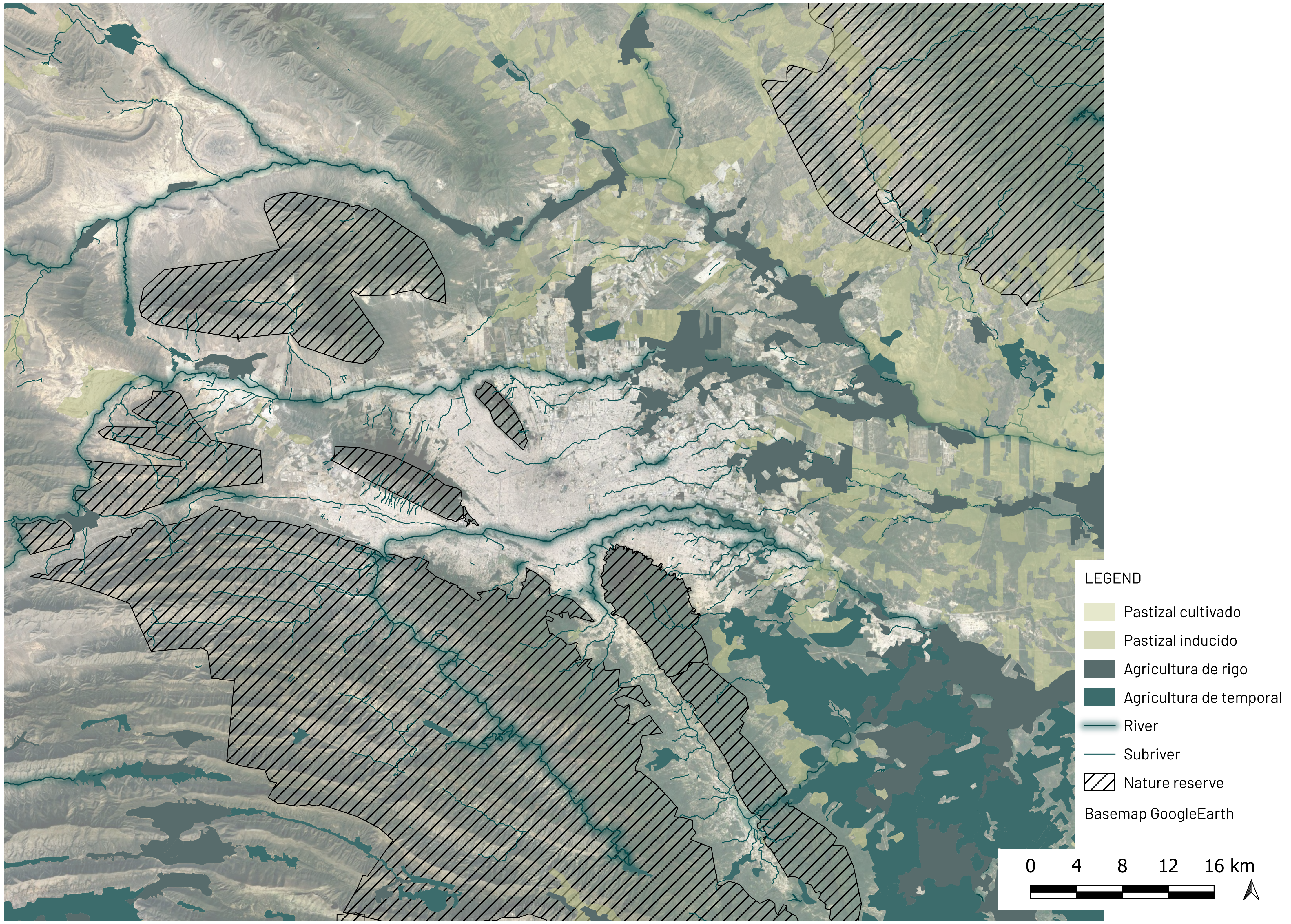


Figure 44: Nature Reserves Monterrey. (QGIS.org, 2024)

The maps below depict the impact of irrigated areas on the ecosystem, revealing how the built environment and agricultural activities in peri-urban zones significantly influence ecosystem dynamics. Protected areas emerge as havens with minimal human intervention, highlighting the potential for transforming peri-urban zones to mitigate environmental impacts.

This could, for example, be related to the irresponsible use of water resources or the application of pesticides.
Despite the advantages they offer in enhancing crop productivity, the widespread utilization of pesticides can result in significant adverse effects due to their tendency to bioaccumulate and persist in the environment. Various types of pesticides have the potential to contaminate the air, water, soil, and broader ecosystem, thereby posing substantial health risks to living organisms (Sharma et al., 2019).

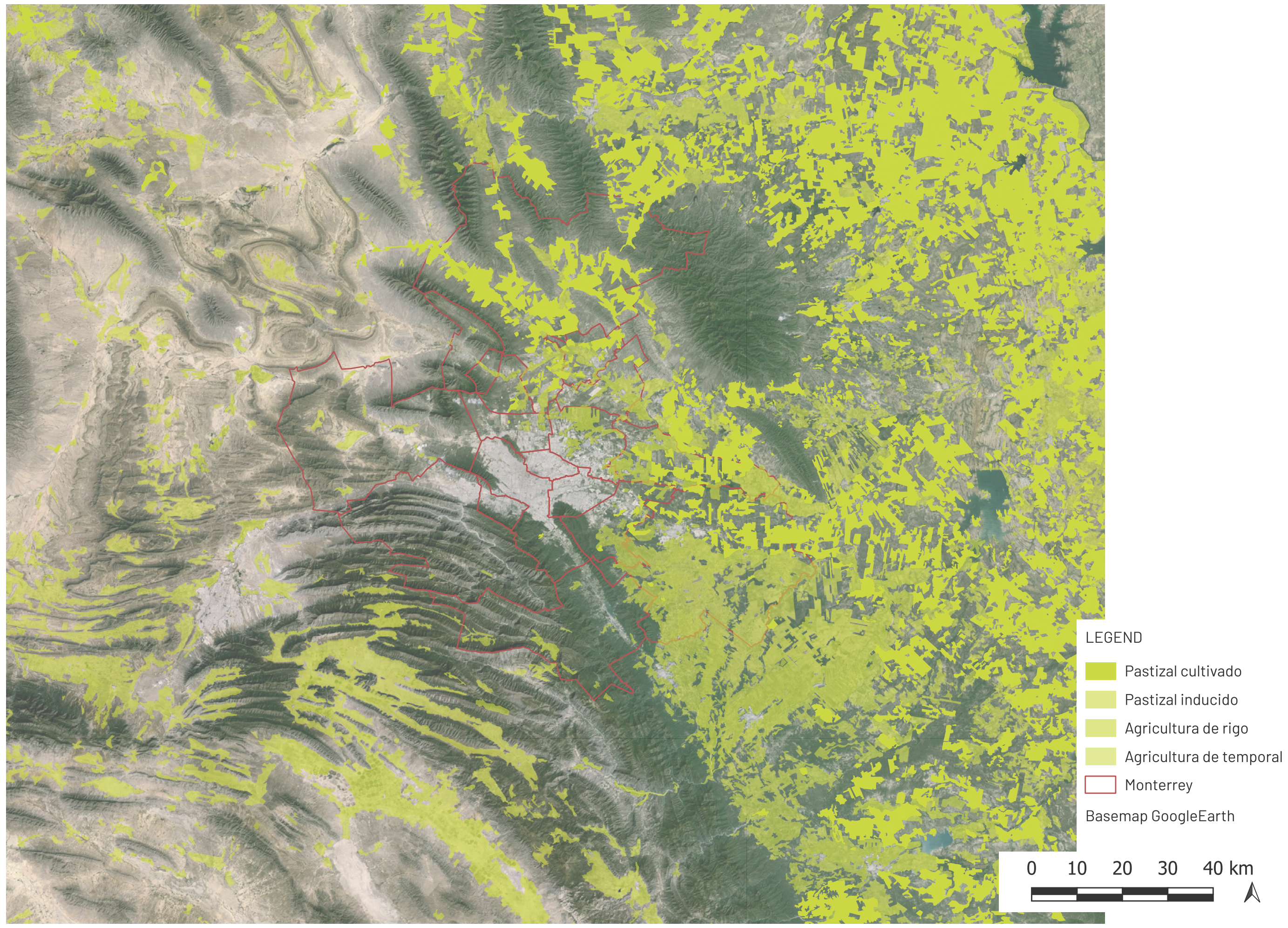


Figure 45: Regional irrigated areas. (QGIS.org, 2024)

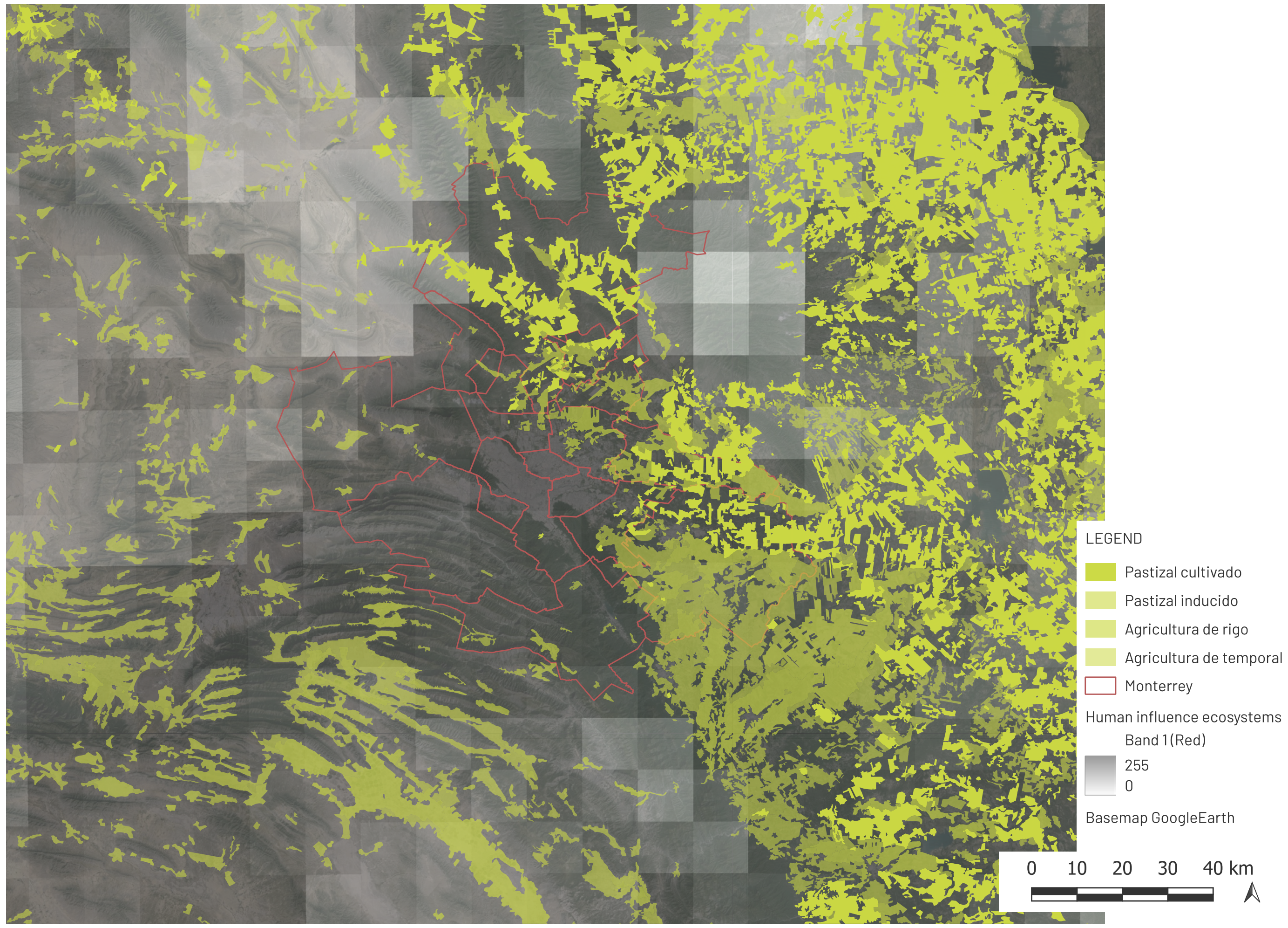


Figure 46: Ecosystem distruption by irrigation. (QGIS.org, 2024)

The approach will enhance the environment and benefit local communities. Here's how this can be achieved with the use of the toolbox:

1) Adapt to Local Resources and Landscape:
Utilize the unique characteristics and resources of the local landscape for sustainable development.

2) Give 10% Back to the Landscape:
Dedicate 10% of the land to natural elements to enhance ecological balance and biodiversity, like flowerstrips and other native vegetation.

3) Utilize Local Compost:
Use locally sourced compost to improve soil health and reduce waste, with for example the introducement of bisons.

4) Implement Natural Pest Management:
Adopt natural methods to control pests, reducing the need for chemical pesticides.

This can be achieved by transforming current agricultural lands and grasslands into diverse, ecologically rich habitats. Implementing water ponds will support local wildlife and improve water management. Using native plant species will maintain local biodiversity and ensure the success of the green belt. Additionally, integrating polycultures will promote greater biodiversity and soil fertility, increasing resilience to pests and diseases. Offering rewards for adopting nature-inclusive farming practices can provide short-term motivation and help ensure the initiative's success.

The current rivers running through the metropolitan area will be transformed into green and blue corridors, connecting different parts of the green belt. This transformation will also involve the community, as these rivers pass through densely populated urban areas. Engaging the local community in managing and maintaining these river systems will foster a sense of ownership, connectivity with natural systems, and responsibility.
By following these steps, a green belt can be established that supports ecological health and enriches the lives of city residents.

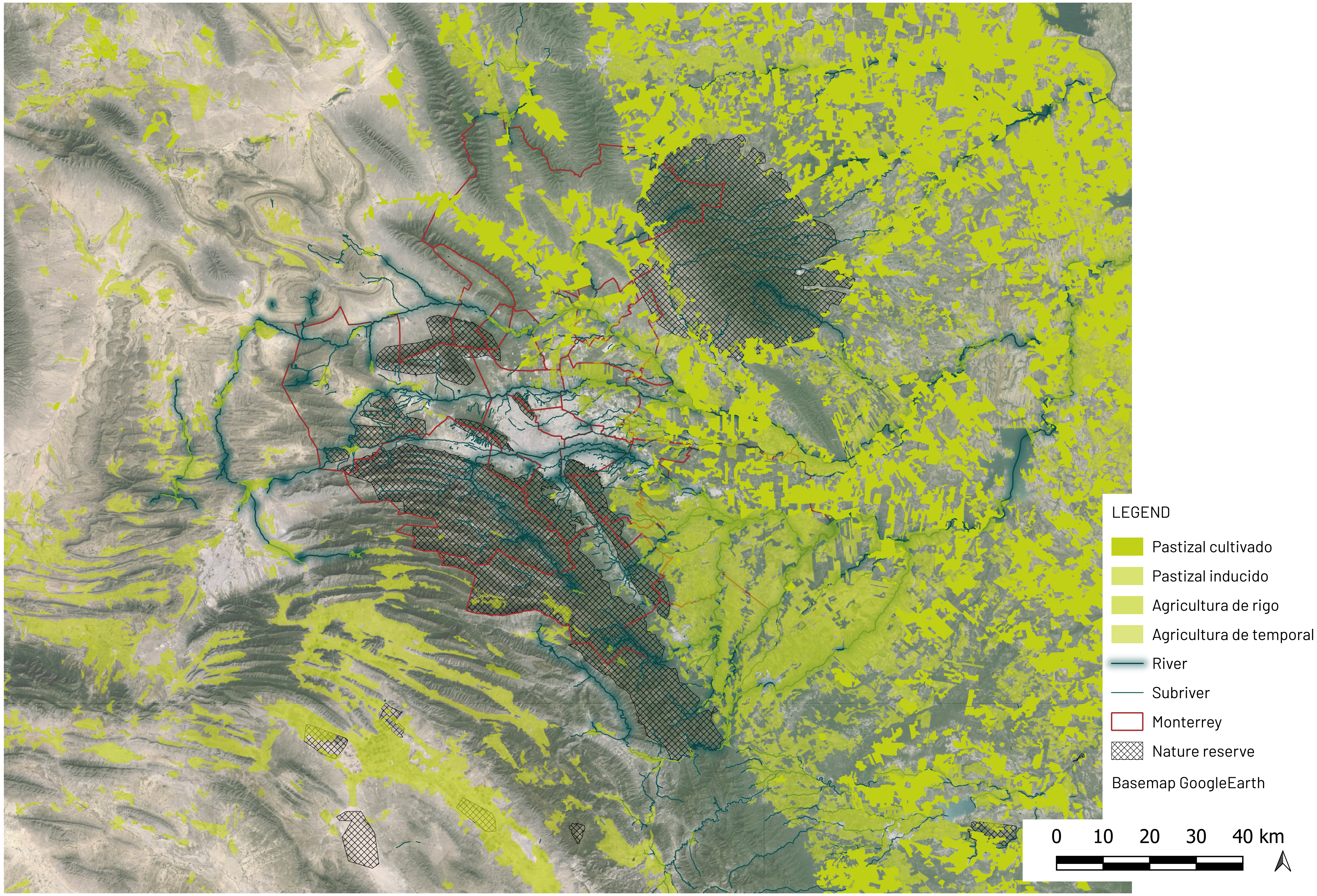


Figure 47: Integral regional map. (QGIS.org, 2024)

During the site visit, the farm Villa de Patos was analyzed. Located in a semi-arid area near Monterrey in a peri-urban environment, the farm spanned over 2000 acres and was owned by farmer Emilio Arizpe. He implemented buffelgrass (Cenchrus ciliaris) in combination with maguey (Agave spp.), resulting in a landscape where irrigation was no longer necessary. The maguey plants acted as sponges for the soil, significantly enhancing water retention and facilitating the sprouting and growth of other plants. Additionally, Arizpe utilized buffelgrass as nutritious feed for his cattle.

Beyond increasing soil moisture, Arizpe also used the maguey plants for consumption and CO_2 capture. The presence of maguey boosted the population of microorganisms in the soil and naturally attracted other grasses.

Figure 48: Villa de Patos Farm before introducing Maguey plant. (Google Earth, 2021)

Figure 49: Pictures by author during site visit.

Research by Design.

Regional scale

A maize farmer has transformed greater natural inclusivity. A water pond has been introduced to attract and stimulate various organisms. Additionally, native trees contribute to enhancing the farm's ecosystem. This initiative results in improved soil moisture, rendering the landscape more resilient against environmental shocks.

Before

Figure 50: Current farmland. (Google Maps, 2024)

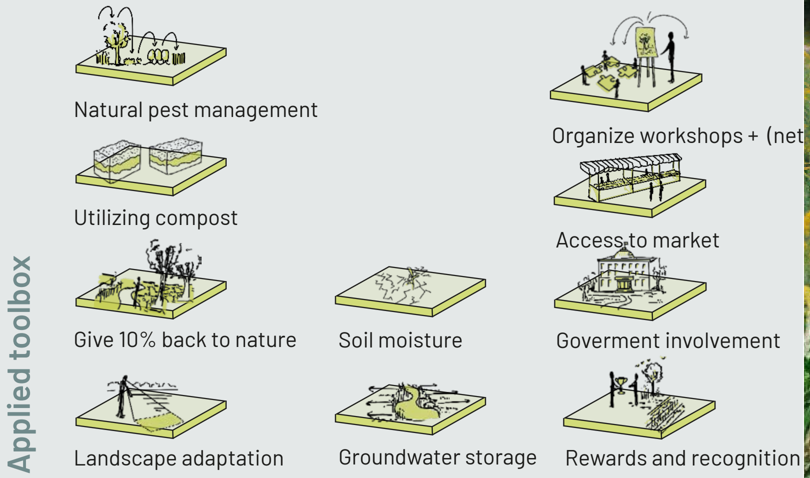


Figure 51: Impression Design Farmland by author.

Water reservoirs play a critical role in water management, energy generation, and environmental sustainability. Their strategic placement is essential to maximizing benefits while minimizing ecological disruption.
Reservoirs are indispensable in managing water resources. They retain excess water during periods of heavy rainfall, mitigating flood risks and ensuring a steady water supply during droughts. This functionality is vital for both domestic consumption and agricultural irrigation, contributing to food security and public health.

In addition to water management, reservoirs are pivotal in hydroelectric power generation. By harnessing the gravitational force of falling or flowing water, reservoirs convert potential energy into electricity. This method of energy generation is renewable, reducing reliance on fossil fuels and decreasing greenhouse gas emissions.

The strategic positioning is based on three primary strategies:

1) Placing reservoirs upstream:
Establishing reservoirs in upstream areas is another effective strategy. This placement allows for the early capture and storage of water, reducing the risk of downstream flooding. They can ensure a more consistent and controlled supply for downstream areas. Additionally, by capturing water at higher altitudes, these reservoirs can further enhance hydroelectric power generation due to increased gravitational potential energy.

2) Utilizing natural elevation
Natural elevation differences are used to store the water. In this way, the construction can be minimal and thus have a smaller impact on the local ecosystem.
3) Aligning with existing waterways:
Constructing reservoirs along existing streams and rivers optimizes the use of current hydrological systems. This strategy not only improves water management and energy generation but also supports the health and functionality of river ecosystems by maintaining natural water flow patterns.

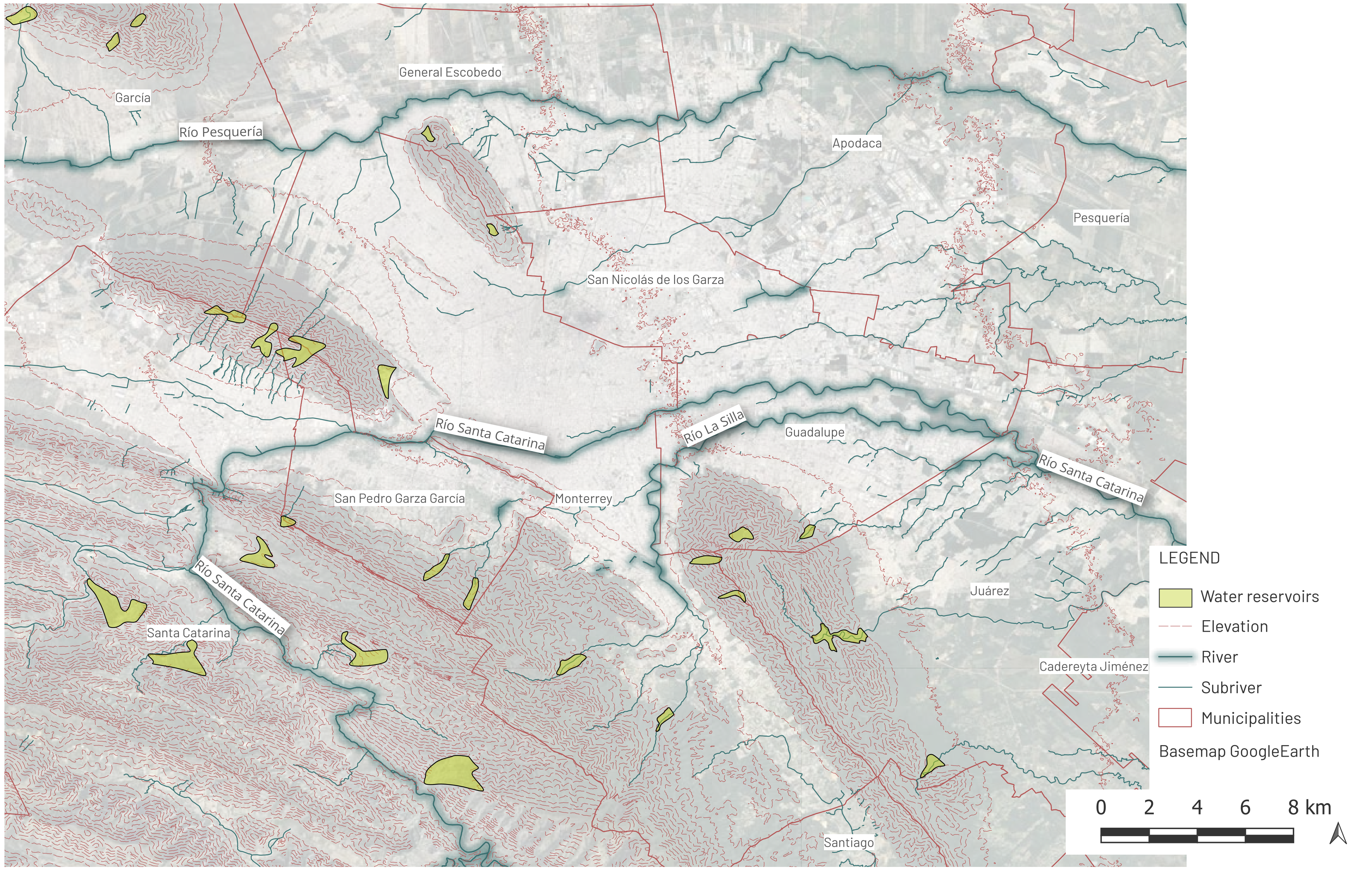


Figure 52: Reservoir localization (QGIS.org,2024)

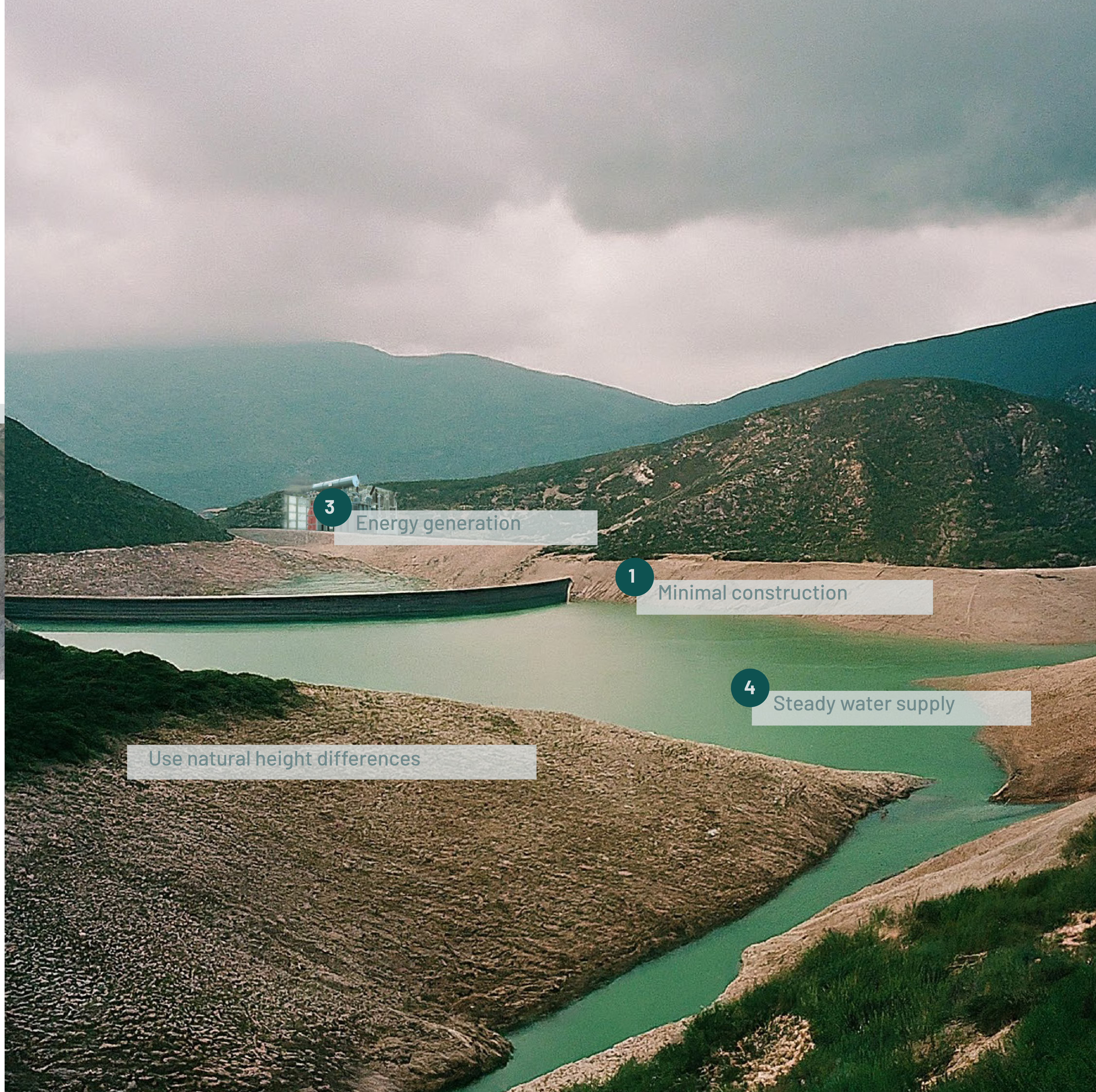
Research by Design.

Regional scale

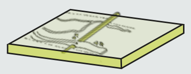
This illustration demonstrates how a minimal construction upstream can retain water in a reservoir. During heavy rainfall, the water can be captured and subsequently released during dry periods as clean drinking water and for irrigation. This ensures a steady water supply for the city throughout the year.

Before

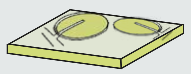
Figure 53: Current situation upstream. (Google Maps,2024)



Applied toolbox



Improve waterquality



Surface storage

Figure 54: Impression upstream reservoir by author.

Research by Design.

Foodscape Rio Pesquería

The regional research is used for the design of the first zoom-in. At this location, the toolbox is applied along the Rio Pesquería. The focus here is on closing the neighborhood loop through the use of local resources. Subsequently, reflection on the toolbox occurs, further development takes place, and it is reapplied to the two other foodscape locations.

The evolution of numerous food environments stems from indigenous concepts and grassroots efforts. The notion of foodscapes exemplifies bottom-up approaches, emphasizing the role of local communities in shaping their surroundings. Planners often encounter the reality that "you can't plan everything; it's the people who drive change." Roberta Sonnino also recognizes this phenomenon, questioning how these inherently viable urban food strategies can be expanded and standardized. There exists a challenge in effectively identifying and implementing local initiatives, as well as in connecting them to enhance their collective impact (Morgan & Sonnino, 2010).

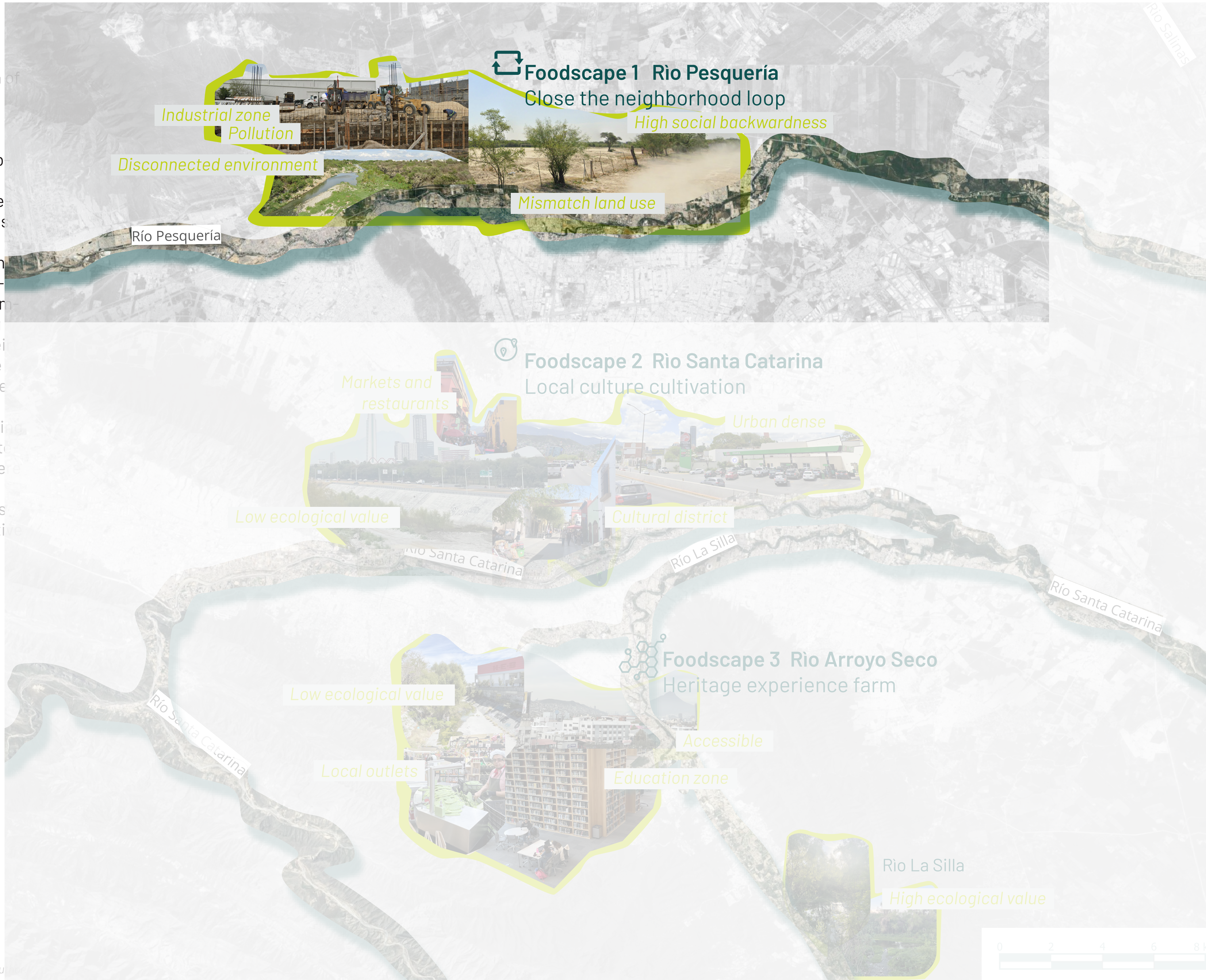


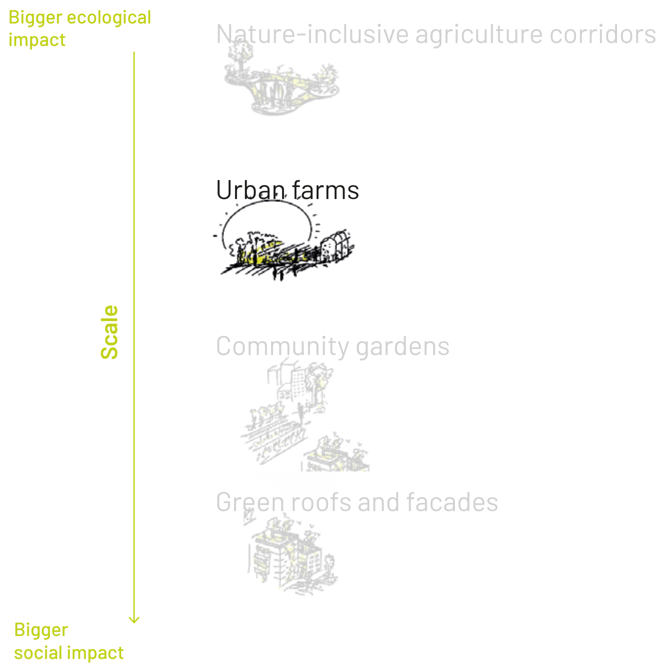
Figure 55: Identity drawing Pesqueria River by au

Research by Design.

At this scale, urban farms are designed using previous research conducted at the regional level. Here, further, detailed design and investigation can be conducted to determine the ultimate influence on larger systems. Given its application at a smaller scale, greater attention can be devoted to details, such as exploring methods for composting within the respective area. Additionally, natural pest management and crop rotation are essential for enhancing the ecological value of the area. The guideline of returning 10% back to the landscape is also maintained through the incorporation of native plants, trees, and/or flower strips. Given the diversity of land use in the city, deeper research must be conducted to ensure that the design is firmly grounded. Collaboration between ecology and water management is also present at this scale. The presence of vegetation will increase soil moisture, while the establishment of a water buffer as surface storage aims to mitigate peak water flow events.

Given that this scale is applied to neighborhoods, residents must be engaged. Indeed, they will participate in maintenance and further development efforts. This approach provides people with better access to healthy food and education on crop cultivation, necessitating the establishment of a local sales outlet.

A location along the Pesquería River is selected, representing the most challenging ecological, water, and social aspects. Successful implementation here would pave the way for similar initiatives in other areas along the river.



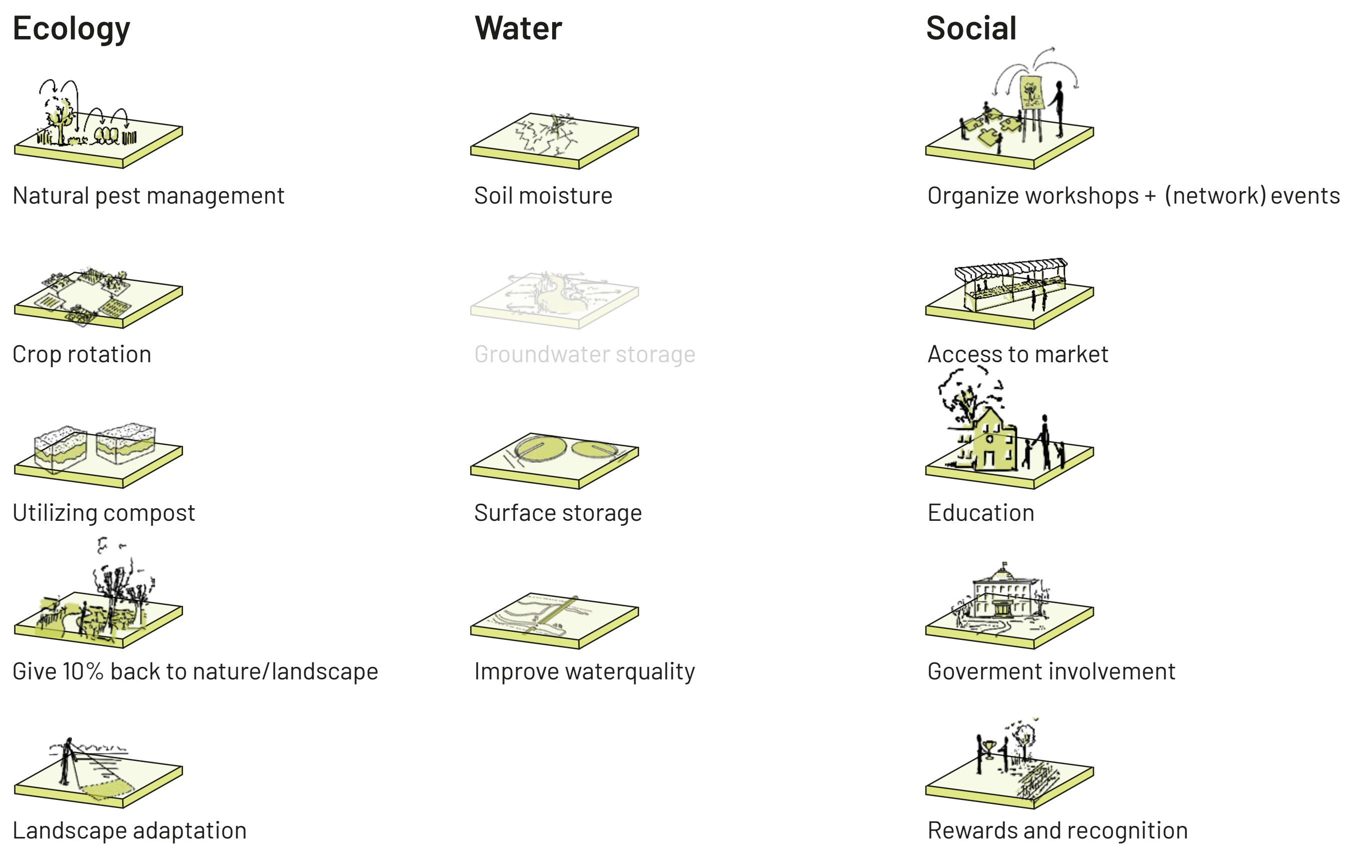


Figure 56: Toolbox Urban Farms by author.

The region presents several key factors that must be addressed in the development planning process. Firstly, ensuring adequate water access is crucial, with both the Pesquería River and the Topo Chico Mountain serving as significant water sources (1). Additionally, attention must be given to areas with high social backwardness, focusing efforts on the most vulnerable communities (2).

Geographical features offer both opportunities and challenges. Leveraging elevation and integrating developments into the existing ecosystem are essential considerations (3). Surrounding land use requires careful management, with the transformation of agricultural lands and collaboration with industrial activities being pivotal for sustainable development (4).

Soil suitability is another critical aspect, with Feozem soil offering favorable conditions for cultivation, particularly in agricultural endeavors, while Fluvisol along riverbanks presents unique opportunities for specific types of cultivation (5).

The region currently suffers from a low ecological value, characterized by a lack of greenery and concrete riverbanks. Addressing this issue will be fundamental to enhancing the environmental quality and resilience of the area (6).

Finally, transportation infrastructure plays a vital role, with access to the rail network and connectivity with the rest of the city being essential for economic development and social inclusion. Integrating these considerations into the planning process will be crucial for fostering sustainable and equitable development in the region (7).

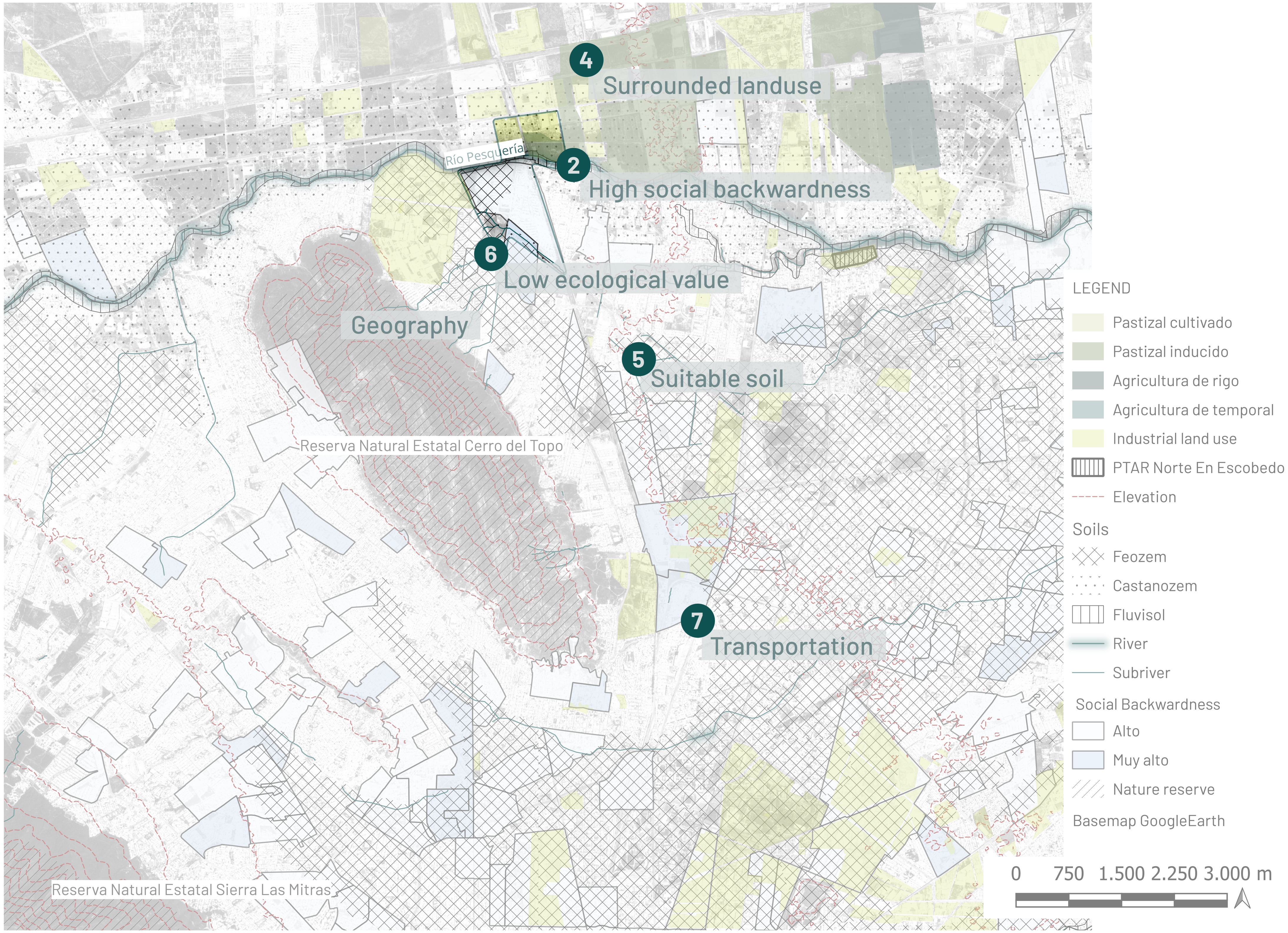
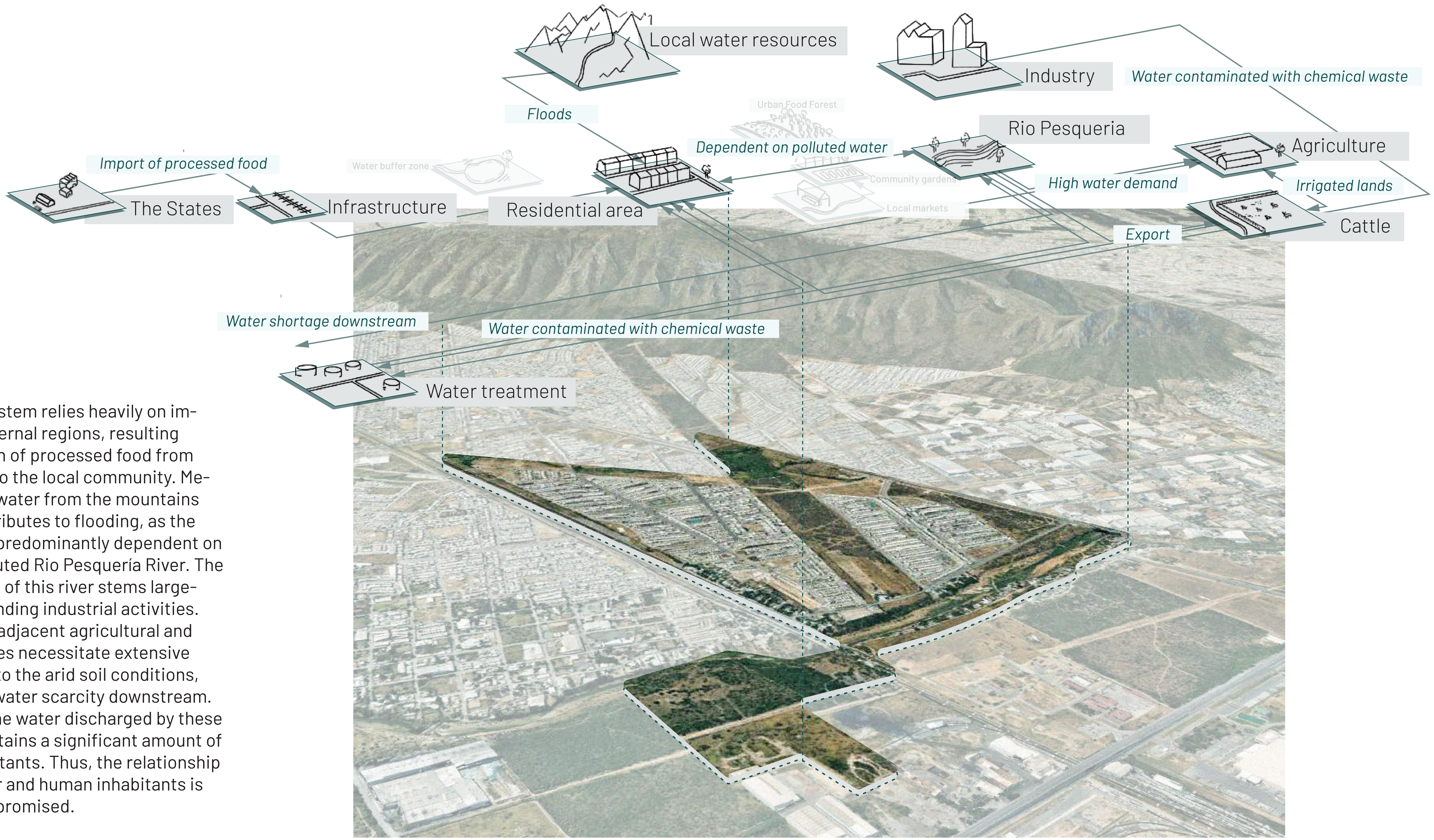
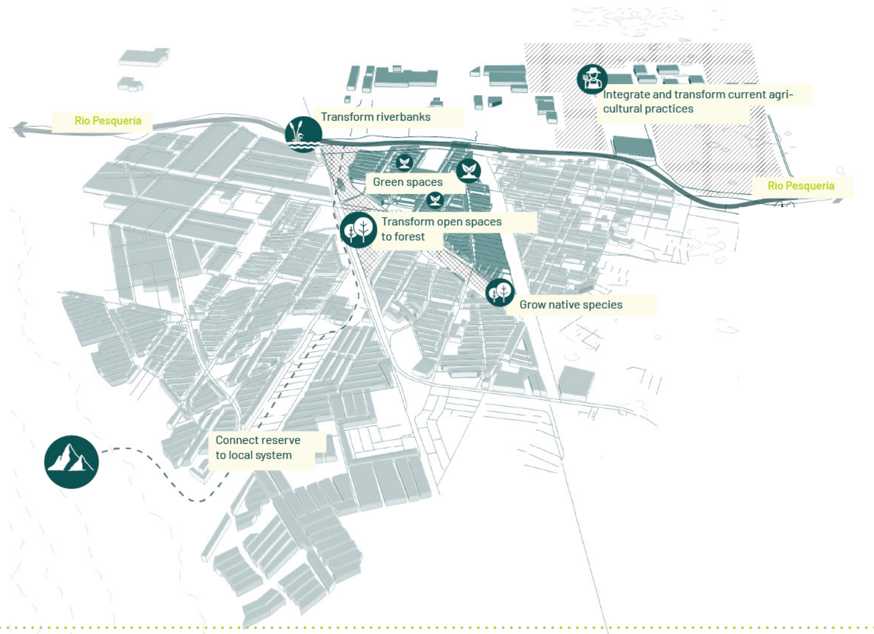


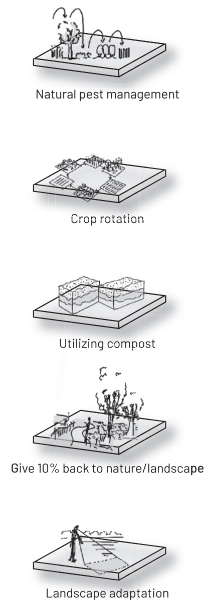
Figure 57: Localization Foodscape 1. (QGIS.org, 2024)



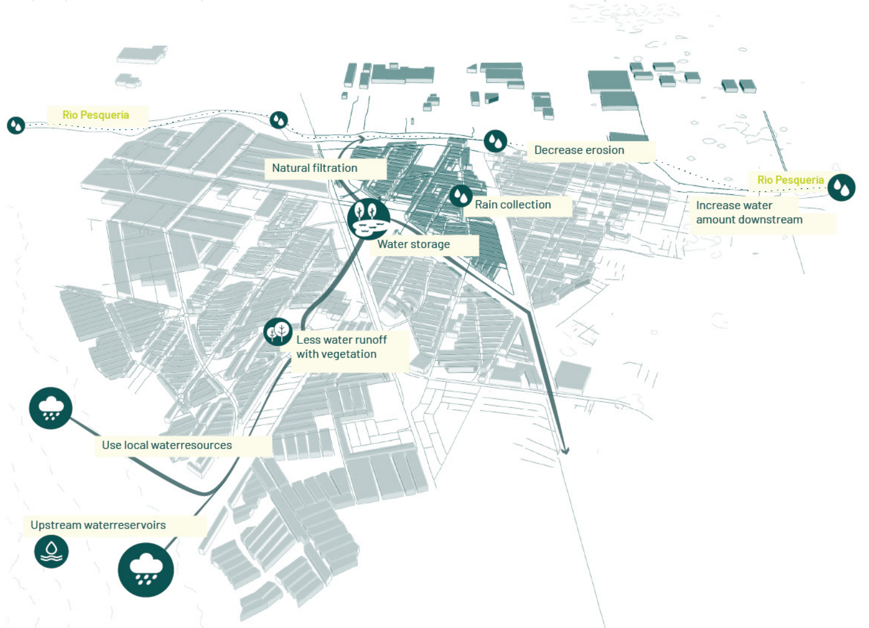
The current system relies heavily on imports from external regions, resulting in the provision of processed food from distant areas to the local community. Meanwhile, local water from the mountains primarily contributes to flooding, as the community is predominantly dependent on the highly polluted Rio Pesquería River. The contamination of this river stems largely from surrounding industrial activities. Moreover, the adjacent agricultural and cattle industries necessitate extensive irrigation due to the arid soil conditions, exacerbating water scarcity downstream. Additionally, the water discharged by these industries contains a significant amount of chemical pollutants. Thus, the relationship between water and human inhabitants is currently compromised.

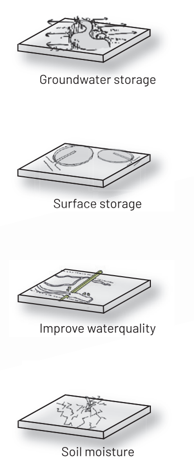
Figure 58: Current system by author.



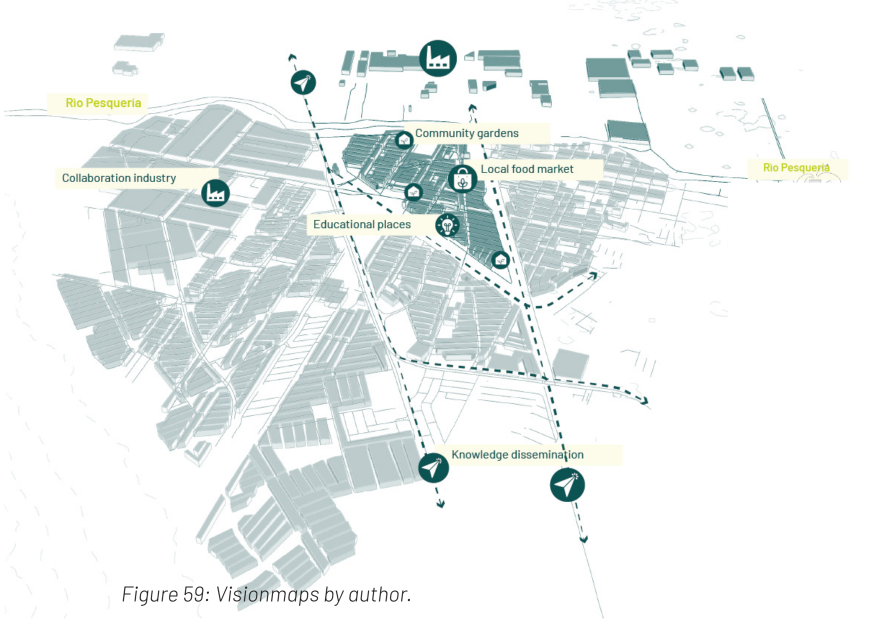


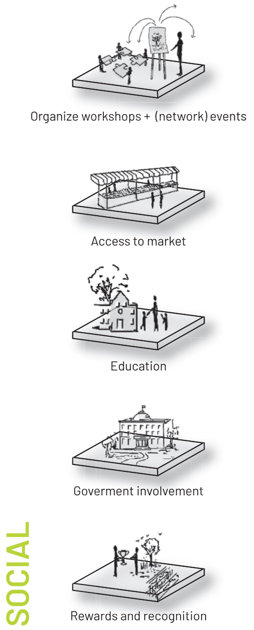
ECOLOGY





WATER





SOCIAL

Figure 59: Visionmaps by author.

The design focuses on ecology within a disadvantaged neighborhood, aiming to enhance connectivity between a local natural reservoir and the rest of the design. Transforming a large public urban space into a forest featuring native species such as pecan trees is proposed. Additionally, the riverbanks, currently of low ecological value and in some parts made of concrete, will be revamped. These riverbanks hold significant potential for addressing erosion and other challenges.

Each block within the neighborhood hosts numerous public spaces, a requirement stipulated by regulations dictating that 17% of developers' space allocation must be designated for public use, such as parks, trees, playgrounds, etc (Ley de desarrollo urbano del estado de Nuevo León, 2009). However, these spaces often remain underutilized. They present prime opportunities for the cultivation of green areas featuring native species, managed by the respective blocks.

Existing grasslands north of the design site will transform, becoming more nature-inclusive and integrated into the neighborhood's system. This approach ensures alignment with the site's characteristics and promises to enhance both ecological and social values.

To render the land suitable for cultivation, water is essential. Soil quality plays a crucial role, wherein ecological design interventions and the utilization of local water sources complement each other. During periods of heavy rainfall, water can be captured upstream in the Topo Chico mountain, adjacent to the site. In times of extreme drought, this stored water can be utilized within the vicinity. The elevation and choice of crops contribute to a functional water management system. The presence of roots and vegetation reduces water runoff, allowing the soil to function akin to a sponge, thus minimizing the need for irrigation. Excess water flows downhill to a water wetland located at the neighborhood's periphery. Through natural filtration provided by the forest, this water can be filtered for local usage. By relying on local water sources and native plants instead of irrigation systems (including for larger-scale grasslands and agriculture), more water will be available downstream. This is particularly significant as local farmers often face water scarcity due to extensive water usage along this stretch of the river. Due to limited rainfall and irrigation water scarcity resulting from the transfer, the irrigation district may be moving towards a system where crops rely more on rainfall supplementation (Scott et al., 2007). Hence, local interventions have broader implications on a larger scale.

Without considering the social component, ultimately there are no individuals who make the difference. Hence, educational spaces are established within the vicinity. These are community gardens where individuals learn about cultivating native crops. Workshops and events can be organized, allowing residents to learn about crops and ecology. Children play a significant role in this regard as well. They can discover the essence of food cultivation playfully amidst greenery. Through hands-on experience in the gardens, individuals gain insight. Additionally, access to a local market, currently absent, is provided. This enables locally grown produce to be traded within the community.

To the west of the neighborhood lies an industrial area. Collaboration with various entities could prove beneficial, such as in the reuse of byproducts or joint water management. By incentivizing or supporting involved industries and nature-inclusive initiatives through subsidies, this form of collaboration is encouraged.

Over time, local knowledge and vision will spread across a broader area, influencing other locations as well.

The drawings below represent studies on the spatial arrangement of the river (left) and the community gardens with local sales points (right). On the right, water is used as a barrier, whereas on the left, it is integrated to enhance connectivity with the river.

Figure 60: Sketch study Pesqueria

Figure 61: Sketch study Community Garden

Research by Design.

The total number of households in Monterrey is approximately 3370. According to data from Statista in 2023, the average number of individuals per household in Monterrey was reported to be 3.5 people. Thus, calculating the total population based on this average reveals that Monterrey is home to an estimated **11,795 people**.

Furthermore, the areas designated for development are identified with the grey areas. Currently, these areas consist of either abandoned open spaces or greener environments with untapped potential.

Figure 62: Measurements and amounts design area by author.

Referring to a similar project in Curitiba, Brazil, covering an area of 177,000 square meters (equivalent to 17 hectares) and comprising 147 urban gardens, food production reaches 160 tons per month, as documented by the AIPH in 2024.

In the given context, calculations indicate that 17 hectares of land are capable of yielding 160 tons of food per month. Breaking this down, it can be deduced that 1 hectare yields approximately 9.4 tons of food, equating to 9,400,000 grams of food per month.

Considering the minimal consumption recommendation for vegetables, as stipulated by the Voedingscentrum, at 250 grams per person per day, it amounts to 7,625 grams of vegetables per person per month. With a population of 11,795 individuals within the design area, the total vegetable requirement is calculated to be 89,936,875 grams or 90 tons.

Since 1 hectare yields 9.4 tons of vegetables, a total of 9.6 hectares of land is necessary to meet the vegetable consumption needs of the entire designated population, ensuring a daily intake of 250 grams of vegetables per person across the area.

On a larger scale, **29 hectares** at the edges of the neighborhood are available for crop cultivation.

! Note
This area excludes pathways, waterways, and other vegetation. Therefore, a minimum of one-third of this space must be allocated for growing vegetables.

Figure 63: Cultivation design area by author.

Foodscape Rio Pesquería WATER PROVISION

For the location of an appropriate location for the water pond for water storage within the design site, current conflicts and challenges are assessed. As depicted on the map below, to the south of the design area lies a location prone to puddling and flooding during heavy rainfall. This leads to soil erosion because of not enough absorption by the ground. However, it also signifies a significant influx of water to this area, thus indicating its potential for a wet habitat. Presently, the area remains unused and is characterized by open space. This creates an opportunity to create a moist environment.

Besides creating different microclimates in and around the pond, with terraces and vegetation types, another goal is to help residents feel connected to the area. The pond is meant to be an accessible place for recreation and education. There will be pathways around it, as well as observation platforms and informational signs, to encou
appreciate the aqu

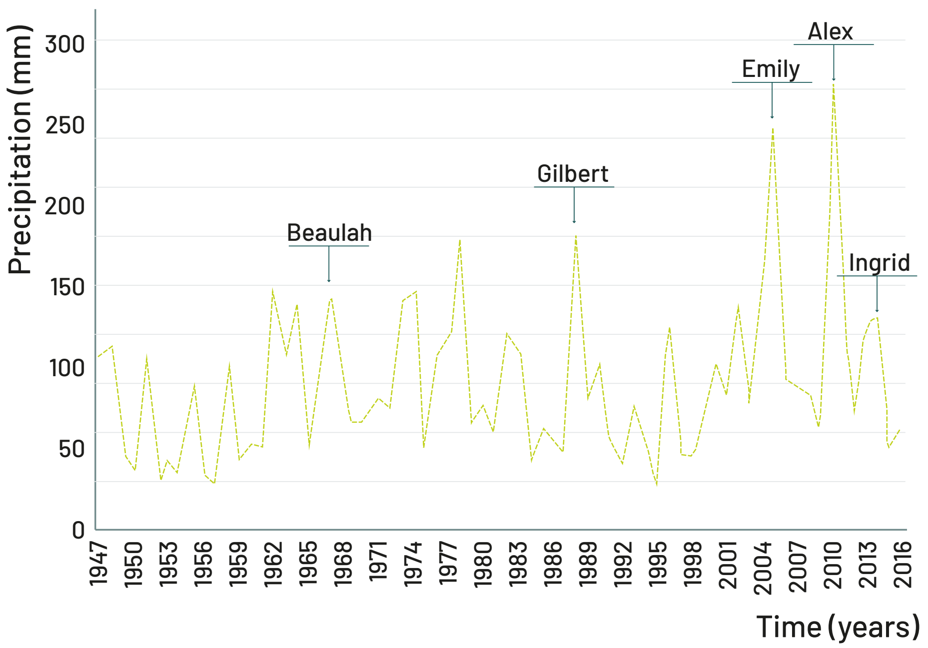


Figure 64: Maximun precipitation within 24 hours (MMA). (Aguilar-Barajas & Ramirez, 2019)

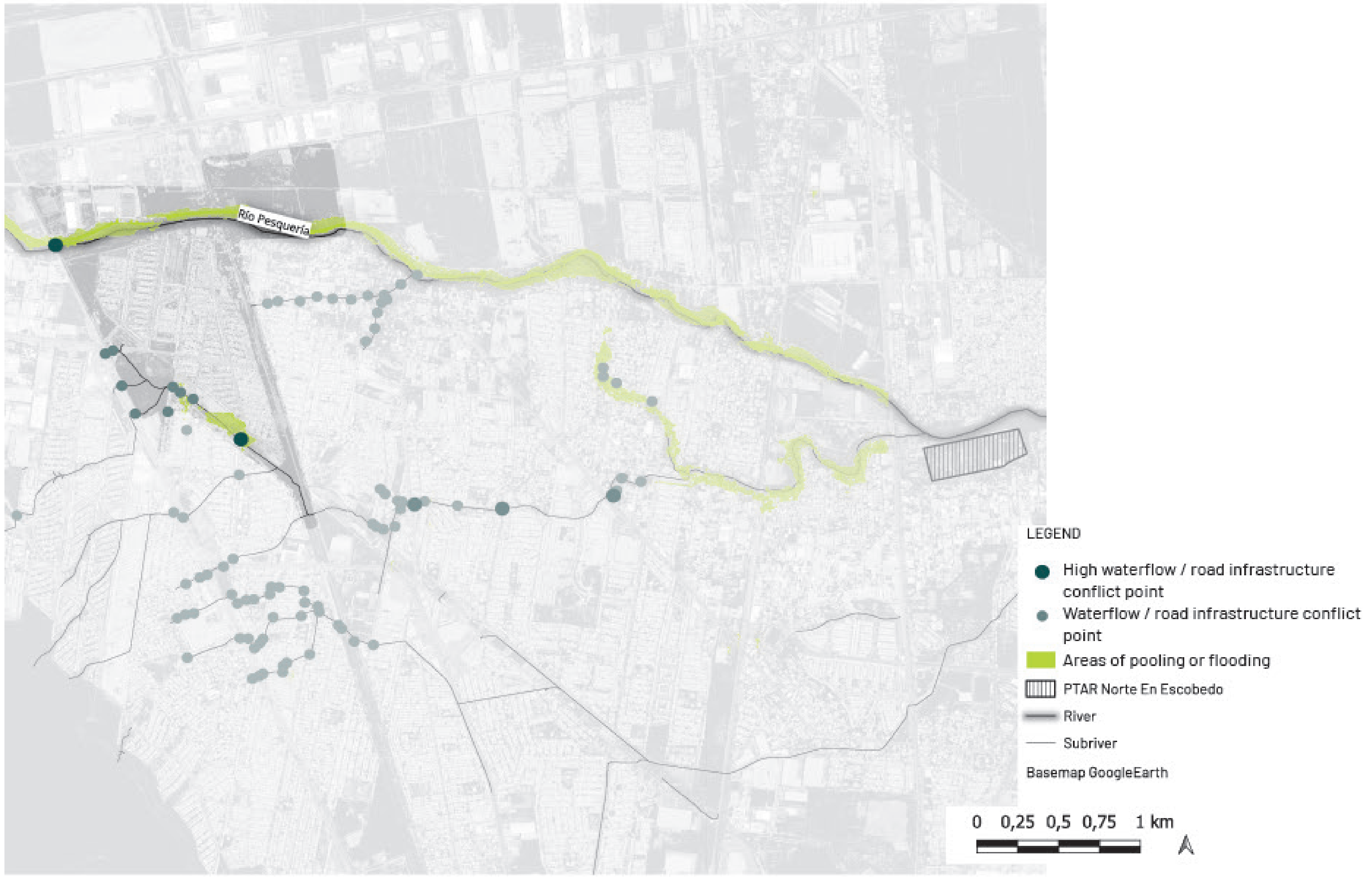


Figure 65: Waterflows and floods. (Atlas Riesgos : NL, n.d.)

During periods of intense precipitation, such as heavy rainfall events, the accumulation of up to 280 mm of rainfall within a month has been documented, as shown in the previous page (Aguilar-Barajas & Ramirez, 2019). To mitigate the formation of standing water and potential flooding in the respective area, an assessment is conducted to determine the necessary size of a water pond capable of capturing and containing this rainfall.

The built-up area comprises approximately 1.030.000 square meters, equating to a catchment area of roughly 103 hectares. A runoff coefficient of 0.85 is applied to account for the impervious surfaces within this area, based on guidelines provided by the State Water Resources Control Board (State Water Resources Control Board, 2011), considering a composite of concrete streets and roofs. Additionally, there exist approximately 58 hectares of industrial land. For this area, a runoff coefficient of 0.70 is utilized State Water Resources Control Board, 2011).

The estimation of runoff volume is computed as follows:
Runoff volume = rainfall intensity (in meters) * catchment area * runoff coefficient.
For the built-up area: (280 mm / 1000) * 1030000 m^2 * 0.85 = 237.550 cubic meters
For the industrial area: (280 mm / 1000) * 580000m^2 * 0.70 = 114.800 cubic meters
These values are summed to obtain a total volume requiring containment:
237.550 + 114.800 = 352.350 cubic meters
Considering an average depth of 3 meters for the pond, accounting for variations in depth ranging from 0 to 3 meters at the edges and increasing towards the center of the water surface, the calculation yields.

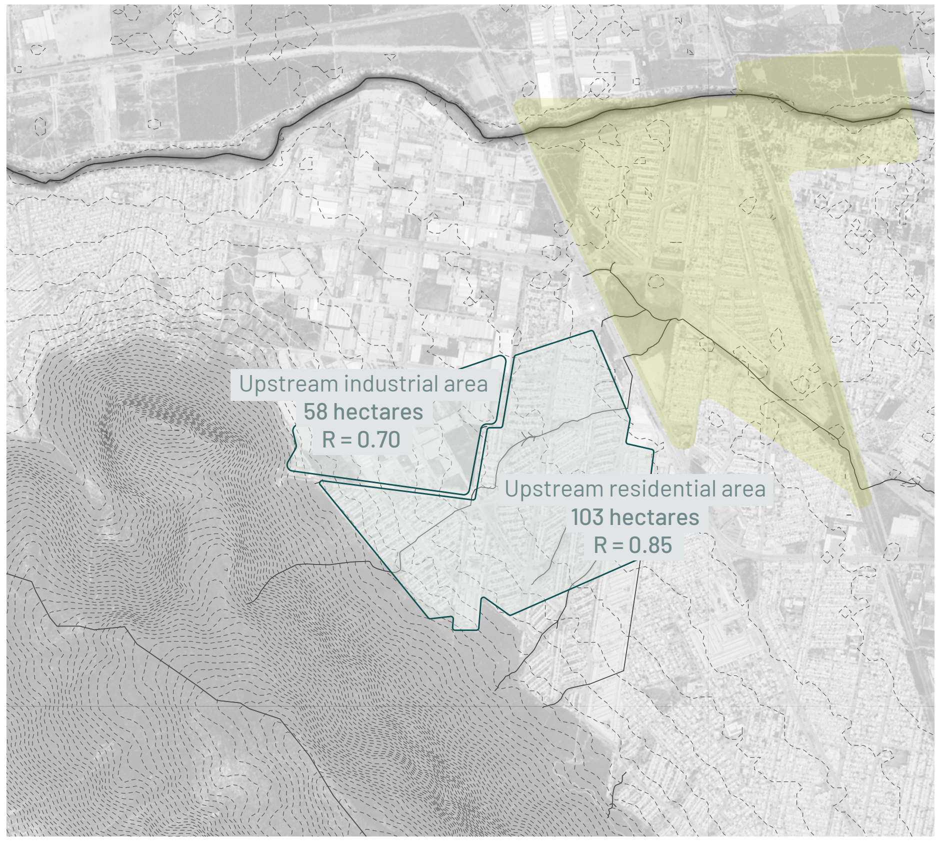


Figure 66: Upstream areas. (QGIS.org,2024)

The depth of the water ponds mustn't reach the groundwater level to safeguard the existing water supply and maintain environmental and ecological stability. Since 2008, no groundwater depth exceeding 10 meters has been recorded (De León-Gómez et al., 2021). Therefore, the depth of the pond should not exceed 10 meters under any circumstances.

352.350 cubic meters / 3 meters depth = 117.450 square meters of water surface area (= 11.7 hectares) required to effectively capture and manage the influx of rainwater during intense precipitation events in the designated area. During periods of anticipated heavy rainfall, adjustments to the water level can be made using a standpipe, allowing the pond to function as a storage reservoir for stormwater runoff.

Figure 67: Waterbuffer design area by author.

Foodscape Rio Pesquería
INTEGRAL PLAN

Main structure is based on

1. Following current forms
2. Connecting surrounding infrastructure
3. Analysis of existing informal routes
4. Sunlight study for the optimal amount of light
5. Differences in elevation in the landscape
6. Paths oriented towards residential areas

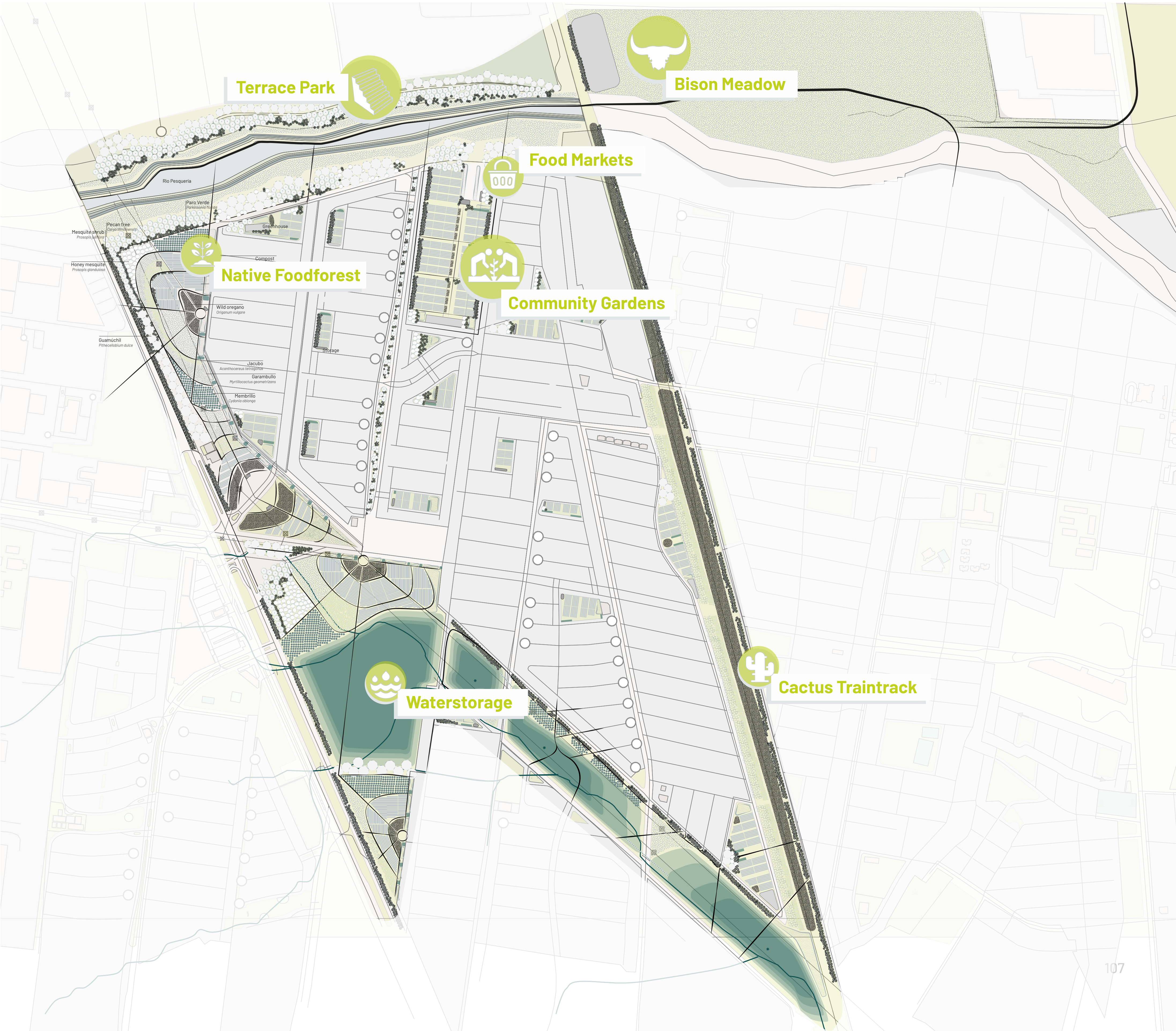
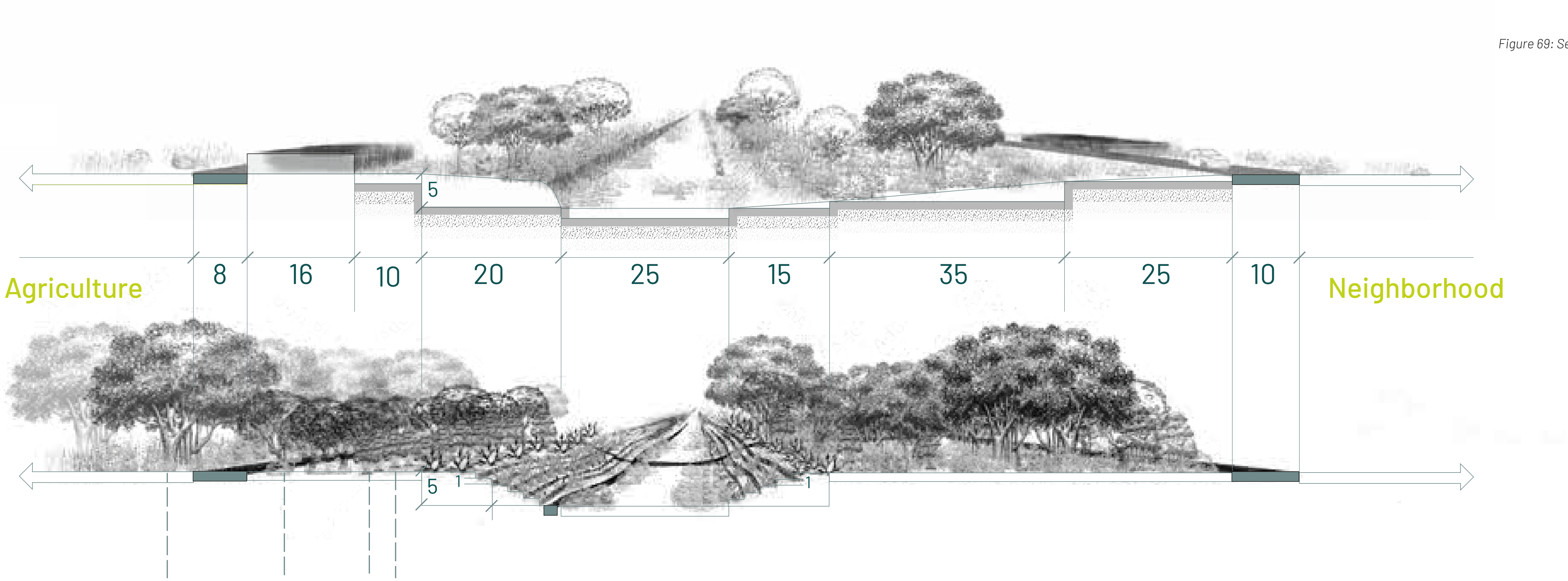


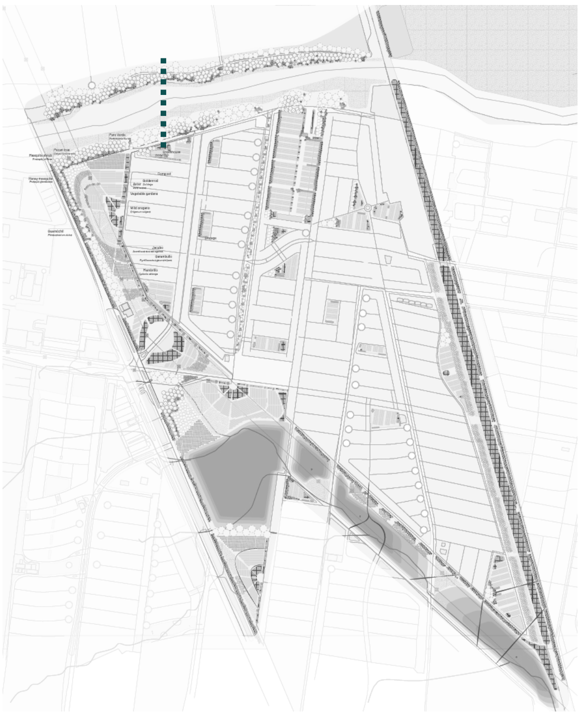
Figure 68: Integral design map by author.

Before



After

Figure 69: Sections Terrace Park by author.



This initial section covers the Pesquería River, both before and after the design implementation.

The implementation of terraces offers several benefits, including suitability for soil utilization, water retention capabilities, reduced erosion, enhanced organic matter content, and the creation of a microclimate conducive to agricultural productivity (Holzer, 2011).

The application of native species serves multiple ecological functions within the designated area. By incorporating native flora, water retention is enhanced, thereby reducing runoff and mitigating erosion. Furthermore, the introduction of native species promotes biodiversity, contributing to a healthier ecosystem overall. Additionally, the presence of native vegetation fosters microclimate regulation, adapting to varying weather conditions and providing stability to the local environment.

Furthermore, native species play a crucial role in rainwater filtration, improving water quality within the ecosystem. Additionally, certain native species can serve as food sources for livestock, such as buffalo, thus promoting sustainable agricultural practices and supporting local food systems (Nabhan et al., 2022).

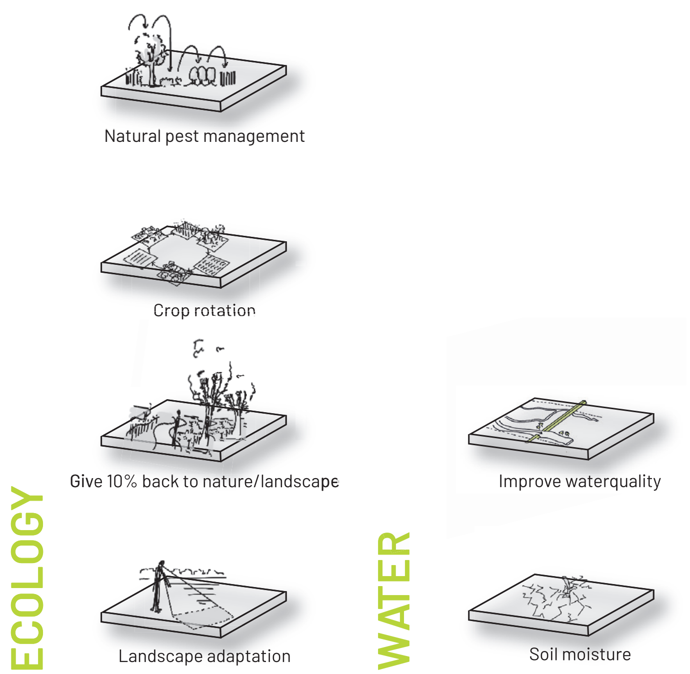
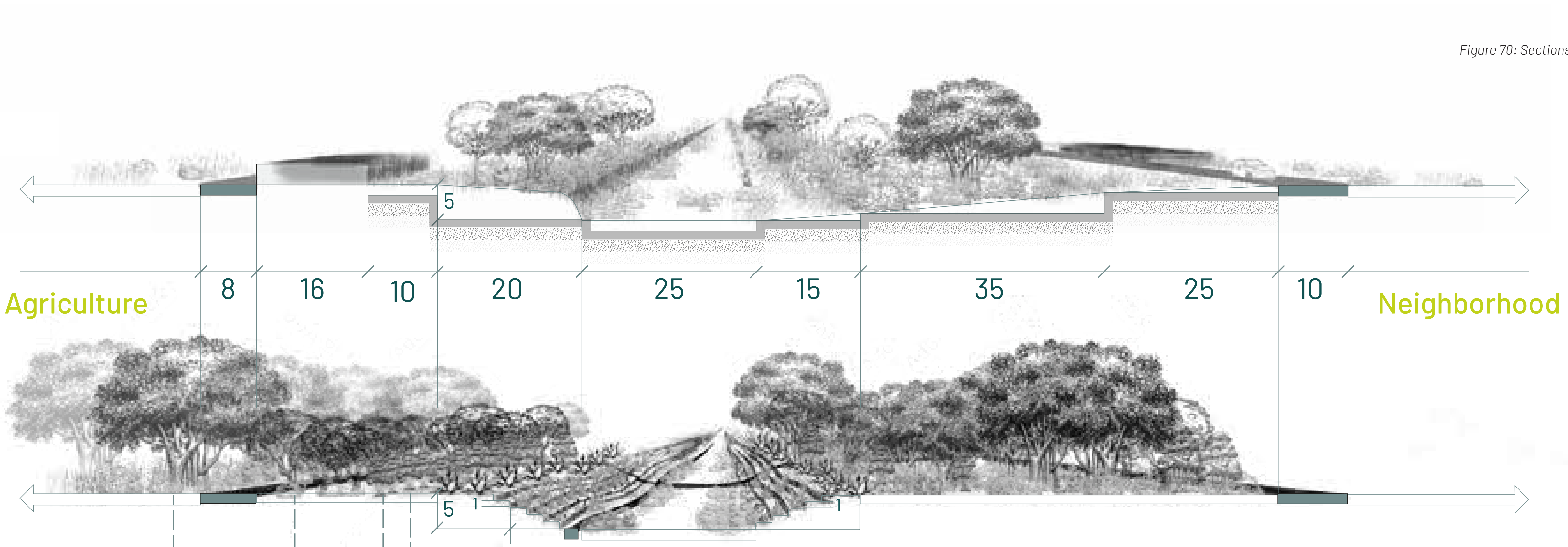


Figure 70: Sections Terrace Park with vegetation by author.

Before



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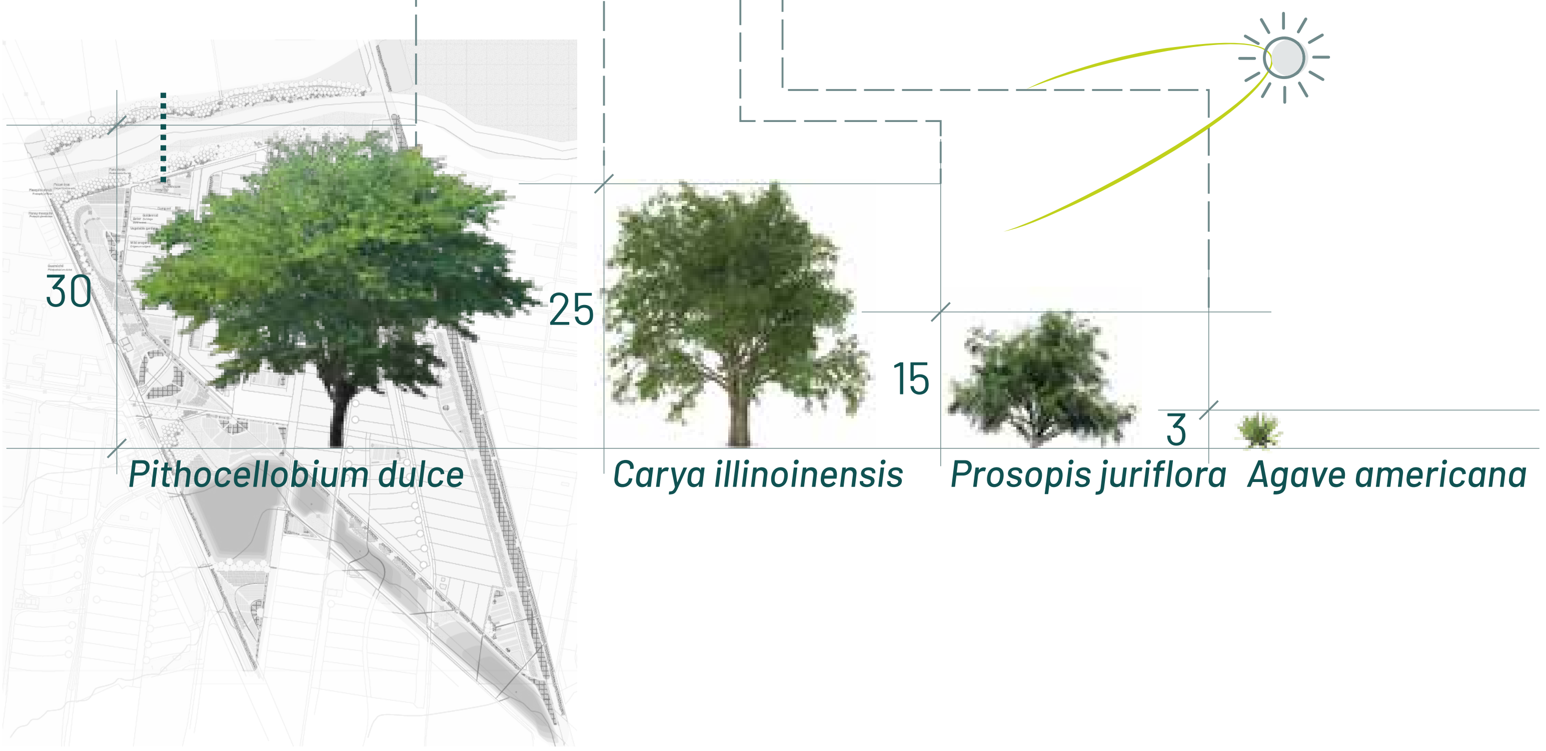


Cooperative plant interactions involve fostering symbiotic relationships among various species, and optimizing sunlight exposure to maximize growth potential. This strategy entails selecting plant species that complement each other's growth patterns and thrive when cultivated together. Pioneer species, known for their adaptability and resilience, are particularly valuable in initiating and maintaining plant communities.

Moreover, the incorporation of both fast-growing and slow-growing species allows for a dynamic and diverse ecosystem, accommodating different harvest seasons and ensuring a continuous supply of produce throughout the year.

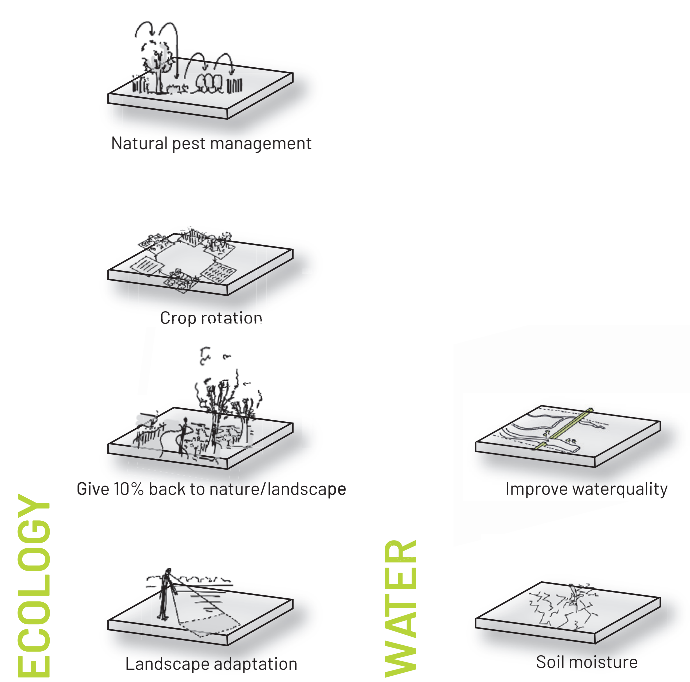
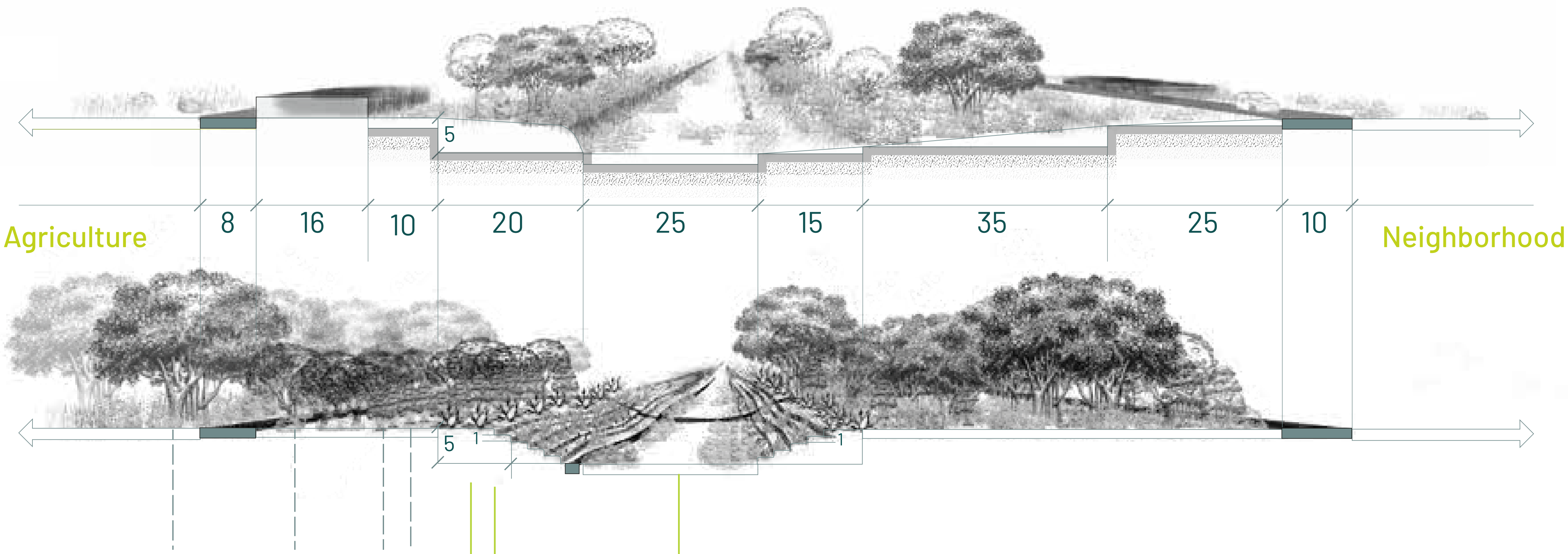


Figure 71: Sections Terrace Park with materialization by author.

Before



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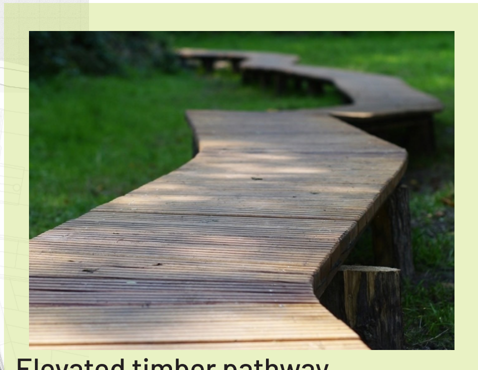
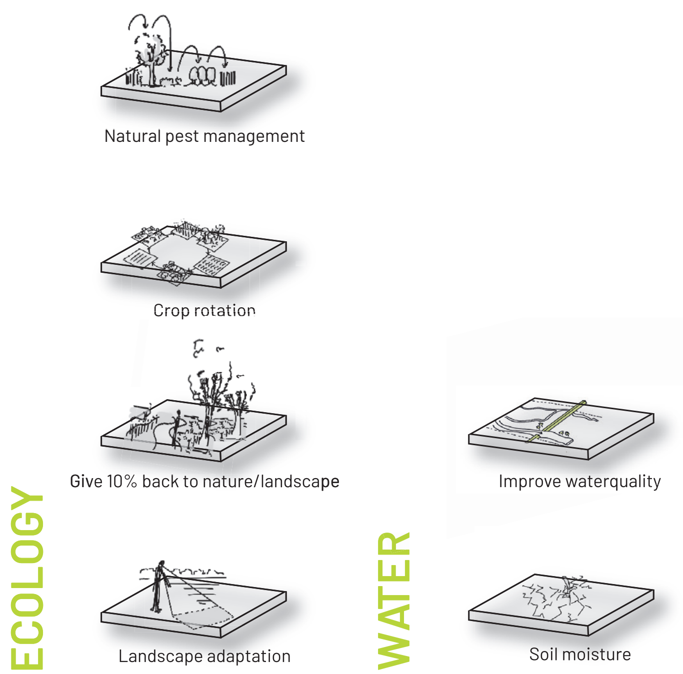


Elevated timber pathway of re-used trees
Data source: Admin. (2022, March 9). Tuin op het noorden. Hovenier Tuinier. https://hoveniertuinier.nl/tuin/tuin-op-het-noorden/

Wooden terrace structure of re-used trees
Data source: Peaceofearthfarmalbany. (2017, September 14). event – Peace of Earth Farm. Peace of Earth Farm. https://peaceofearthfarmalbany.wordpress.com/tag/event/

As a materialization strategy, elevated timber has been used to create pathways. This timber is sourced from trees currently standing along the river. The pathway runs alongside the river to facilitate direct interaction between people and the water. Various crossing points provide access to the opposite side of the river, and the recreational route extends to the bison meadow.

Additionally, the trees are repurposed for other functions, such as forming terrace structures along the river for cultivation. This approach not only repurposes materials for new uses but also creates space for other vegetation to flourish.



Research by Design.

Foodscape Rio Pesquería

Bison meadow with an elevated visitor path. The pathway is made of cut trees on site. Native maguey plants are introduced to stimulate the soil moisture and let grasses grow naturally. In this way the the bison are able to live independently here.

Before

Figure 72: Current Grasslands. (Google Maps, 2024)

Figure 73: Impression Bison Meadow by author.

Research by Design.

Foodscape Rio Pesquería

The design along the Pesqueria River includes terraced cultivation to mitigate erosion. A riverside pedestrian pathway facilitates connectivity between humans and the design. The verdant riverbanks create various microclimates, which results in healthier water. Additionally, a communal cottage is situated for shared use by the community.

Before

Figure 74: Current riverbanks of Rio Pesqueria. (Google Maps, 2024)

Figure 75: Impression of Terrace park by author.

WATER PROVISION

The construction of an additional waterway aims to provide the area with a stable water supply without the need for pumping. By utilizing the natural elevation and implementing upstream storage, this system ensures a consistent and sustainable water source.

On-site, drip irrigation will be employed to promote water conservation and efficient usage. This method allows for precise delivery of water to plants, minimizing waste and optimizing resource management.

Figure 76: Introduced waterflow from upstream reservoir.

The larger scale of the supplying water reservoirs has been visualized in a 3D model to effectively illustrate where the water accumulates.

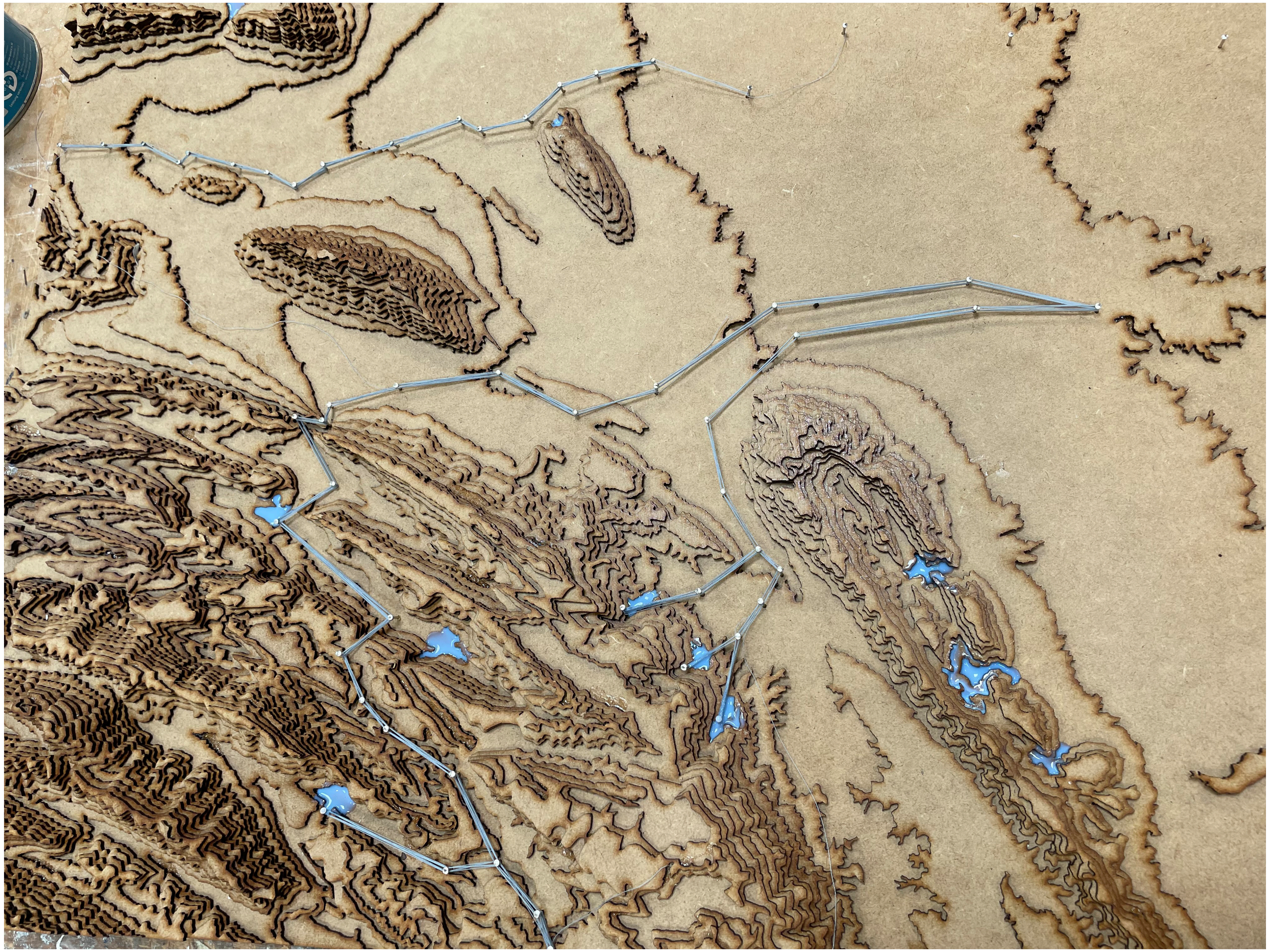
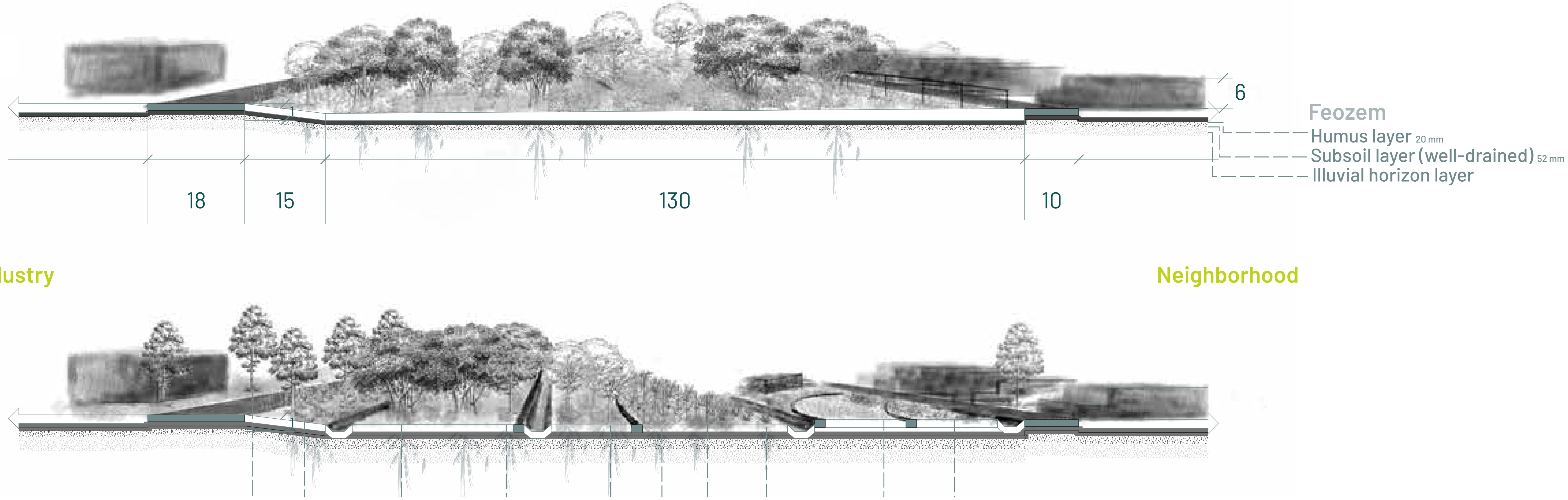


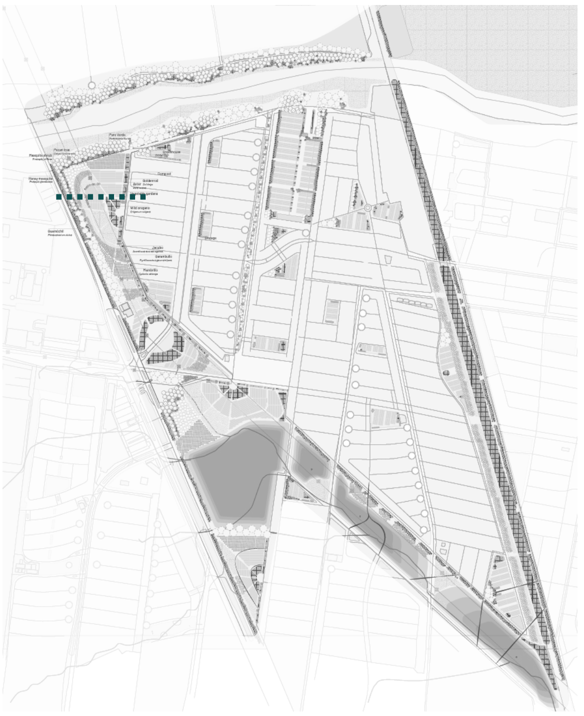
Figure 77: Big scale water reservoir model

Figure 78: Sections Food Forest by author.

Before



After



This initial section introduces the establishment of a food forest at the edge of the neighborhood. It utilizes the newly established water flow from Topo Chico.

The selection and implementation of vegetation in the area will be tailored to suit the soil conditions, enhancing water retention and contributing to the adaptability of vegetation to various land uses. This approach will increase the organic matter in the soil, improve the microclimate, and support higher biodiversity. Additionally, the involvement of the community in vegetation efforts will be encouraged, fostering a sense of ownership and participation in environmental stewardship.

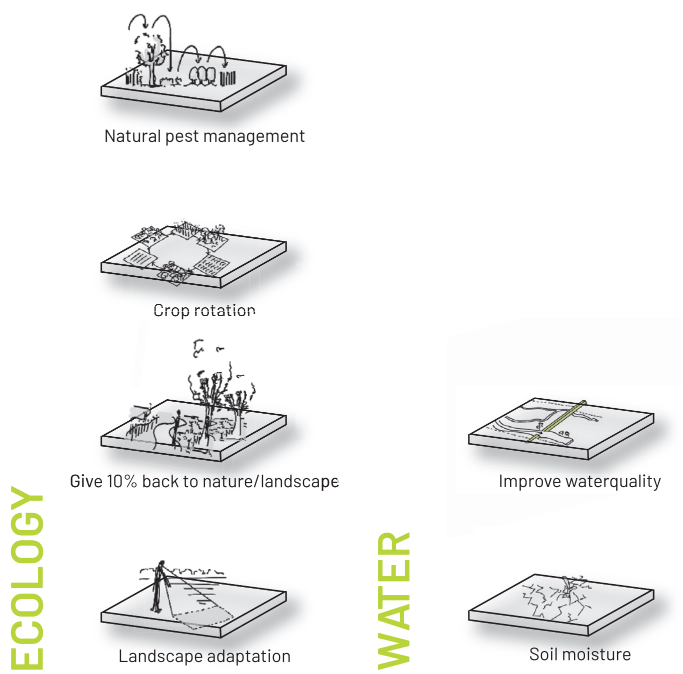
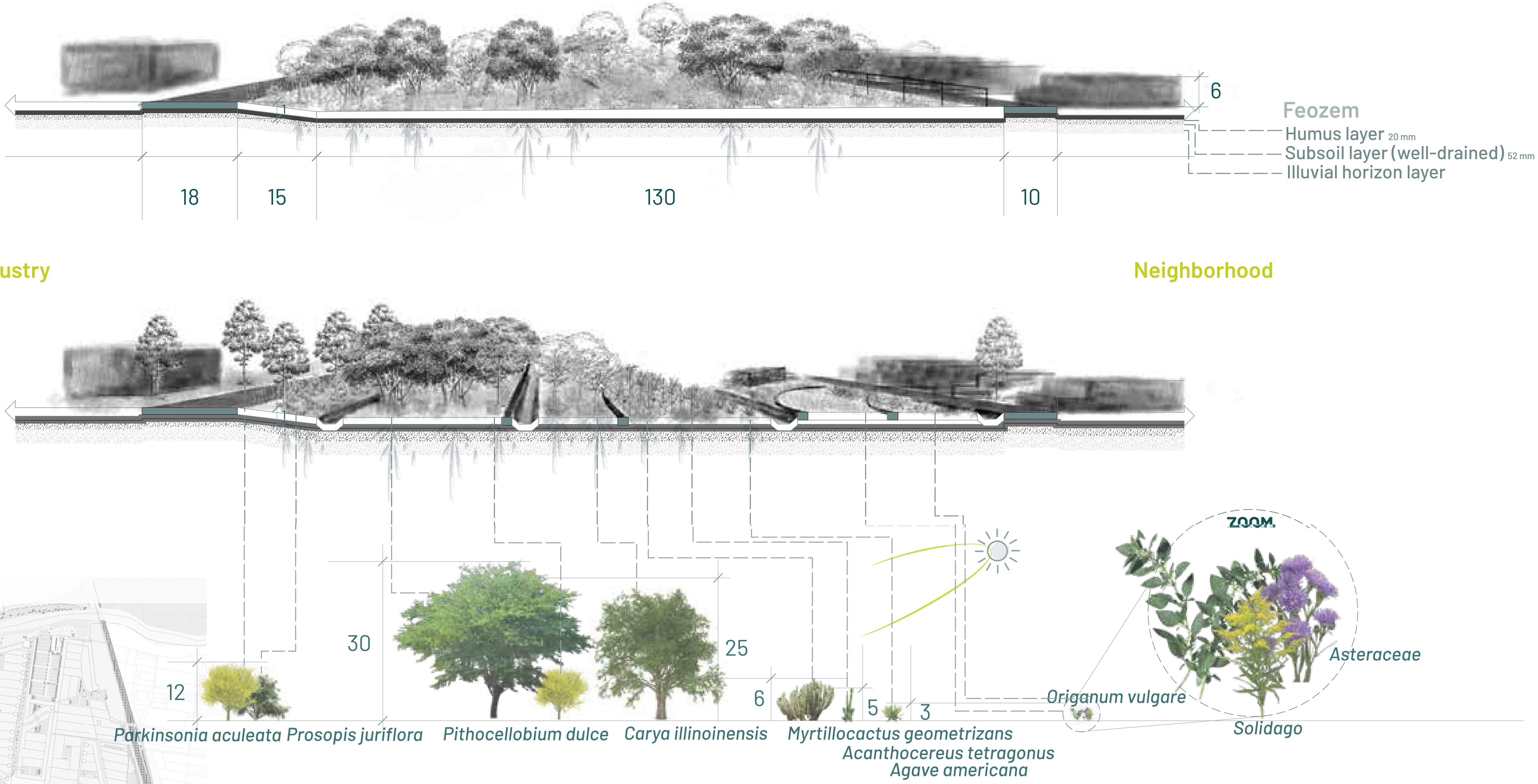


Figure 79: Sections Food Forest with vegetation by author.



Parkinsonia aculeata
- Native plant
- Leguminous crop next to road
  - *- nitrogen fixation*
- Pioneer species
- Bright yellow color

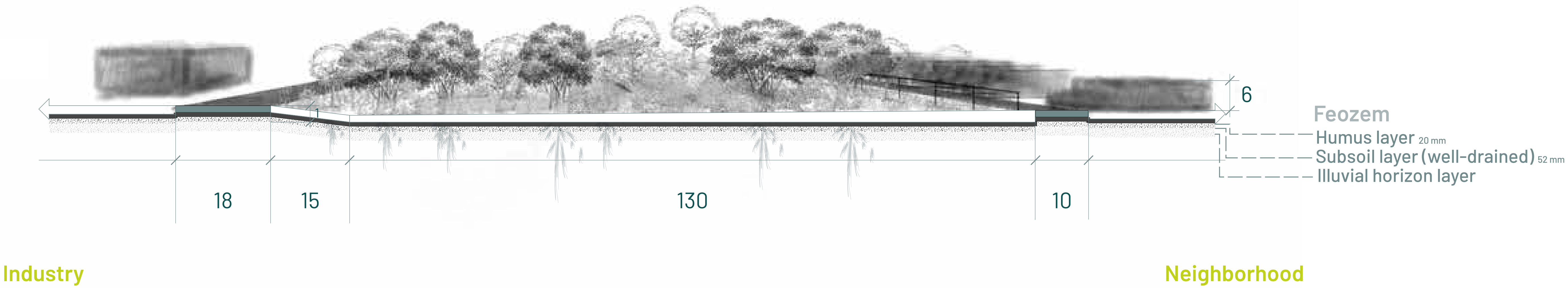
Proposis juriflora
- Native plant
- Prickly dense plant (natural fence)
- Edible
- Pioneer species

The structure of the food forest is designed to vary in maintenance intensity, ranging from low to high for residents. Vegetation is arranged from high to low along the sun path to maximize sunlight exposure. Native species are prioritized to ensure ecological compatibility and resilience.

The design allows for harvest possibilities throughout the year, supported by water streams that follow the natural elevation of the landscape. Leguminous trees are included as companion plants to enrich the soil with nitrogen and support the growth of other species.

Figure 80: Sections Food Forest with materialization by author.

Before



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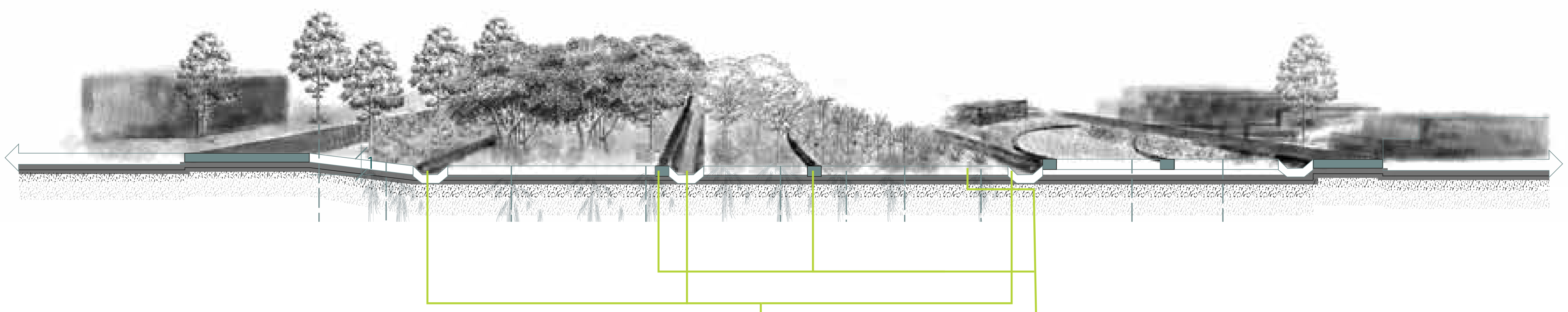
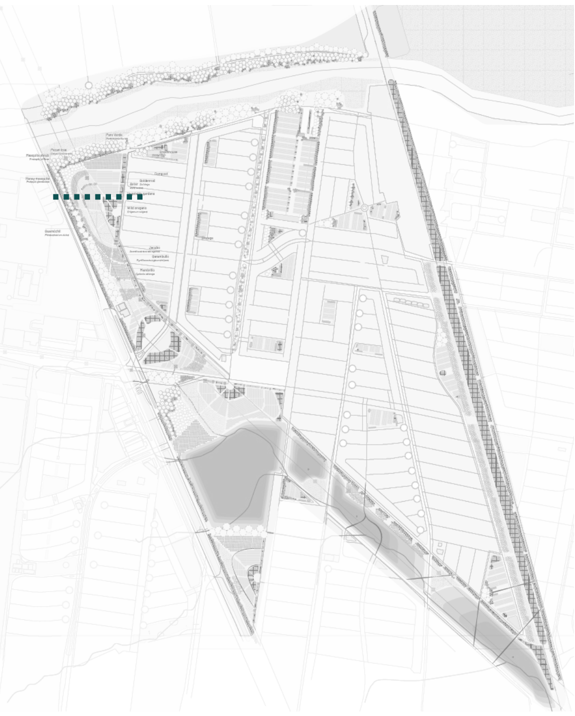




Waterflows through the foodforest connected to drip irrigation system

Data sources
a. Watering of agricultural crops, countryside, irrigation, natural watering, village. (n.d.). Depositphotos. https://depositphotos.com/photo/watering-of-agricultural-crops-countryside-irrigation-natural-watering-village-188051868.html
b. Demo druppelirrigatie bij Waterwijs Boeren-tuinder Gert Smits. (2020, July 21). Deltaplan Agrarisch Waterbeheer. https://agrarischwaterbeheer.nl/nieuws/demo-druppelirrigatie-bij-waterwijs-boeren-tuinder-gert-smits

Wood chip pathways through the foodforest

Data source: Tuinadvies. (2015, January 30). Alternatieve 'verharding' in de tuin. https://www.tuinadvies.nl/artikels/oplossing_voor_waterschaarste_met_alternatieve_verhardingen

Wooden agricultural beds of re-used trees

Data source: MAKE. DO. GROW. (2022, March 26). Building RUSTIC Raised Beds from Fallen Pine Trees - #5 [Video]. YouTube. https://www.youtube.com/watch?v=fhNvTTeiZ34

Wood chip pathways are utilized for the roads to ensure good water permeability. The water flows through the food forest are connected to the drip irrigation system throughout the forest. Raised beds made from reused trees from the area are used for growing vegetables.

Research by Design.

Foodscape Rio Pesquería

This impression illustrates how the arid landscape is transformed into a thriving area of native vegetation through the implementation of a food forest. The up-stream reservoirs ensure a steady supply of fresh water, and the vegetation is arran-ged from high to low to optimize sunlight exposure.

Before

Figure 81: Current open urban space. (Google Maps, 2024)

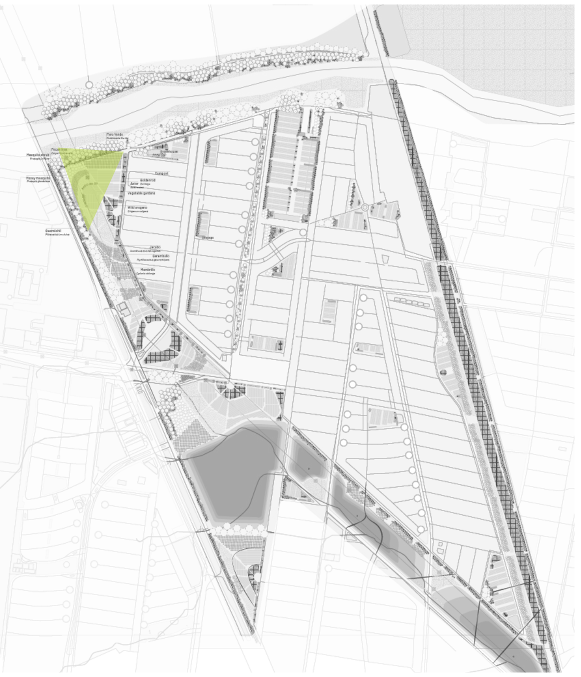
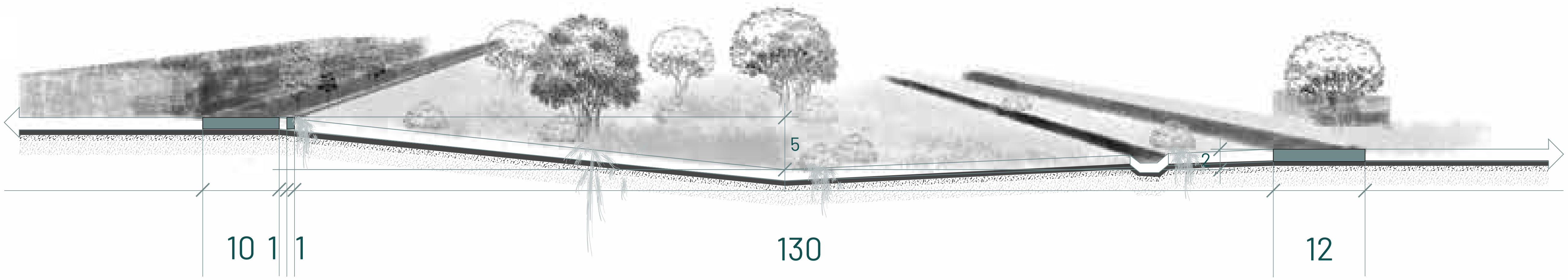


Figure 82: Impression Food Forest by author.

Figure 83: Sections Water Buffer by author.

Before



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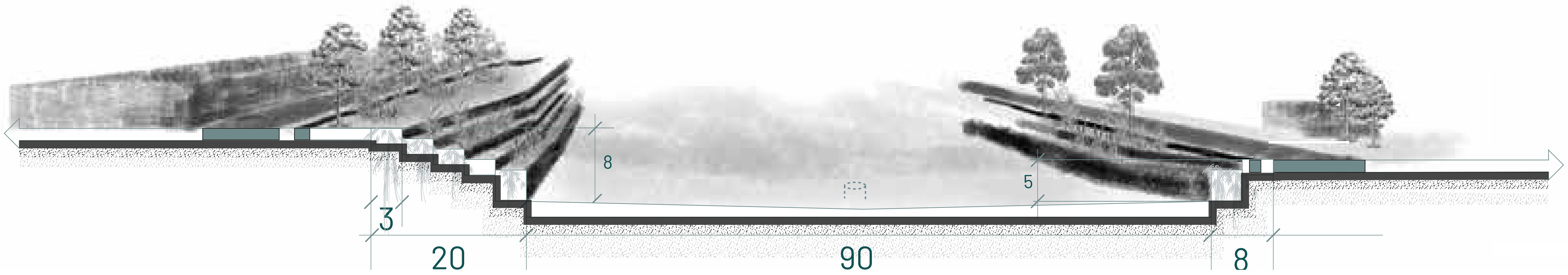
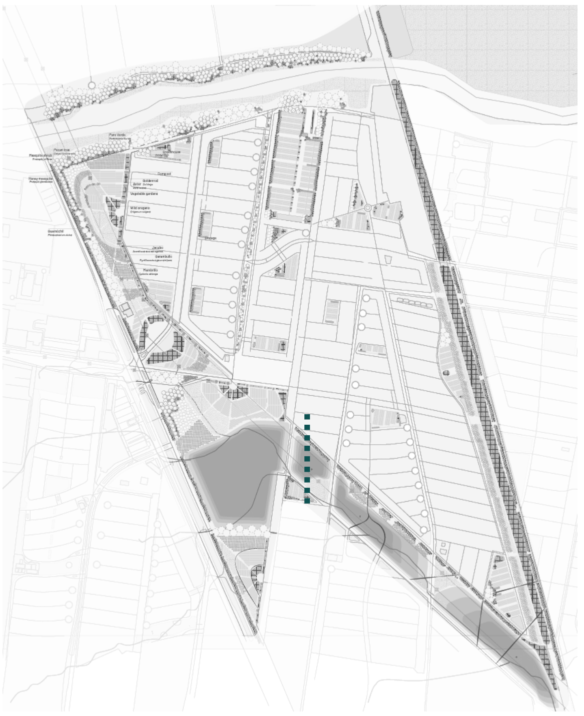
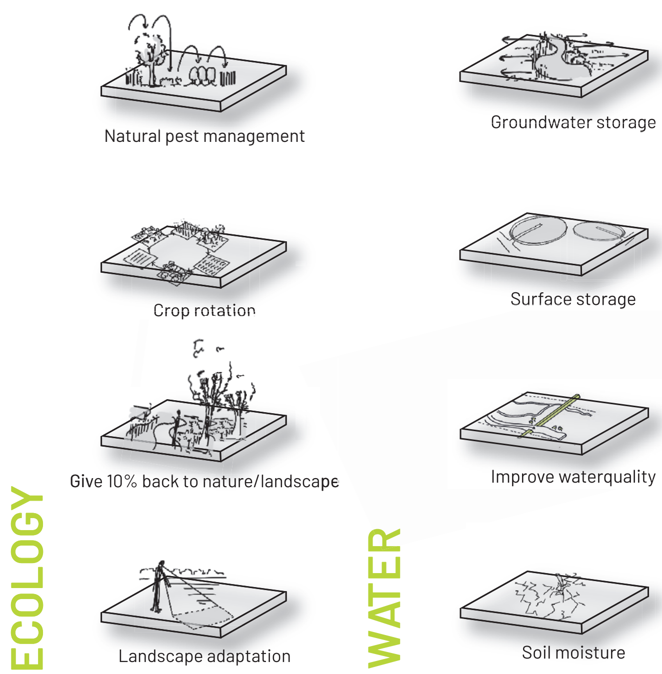




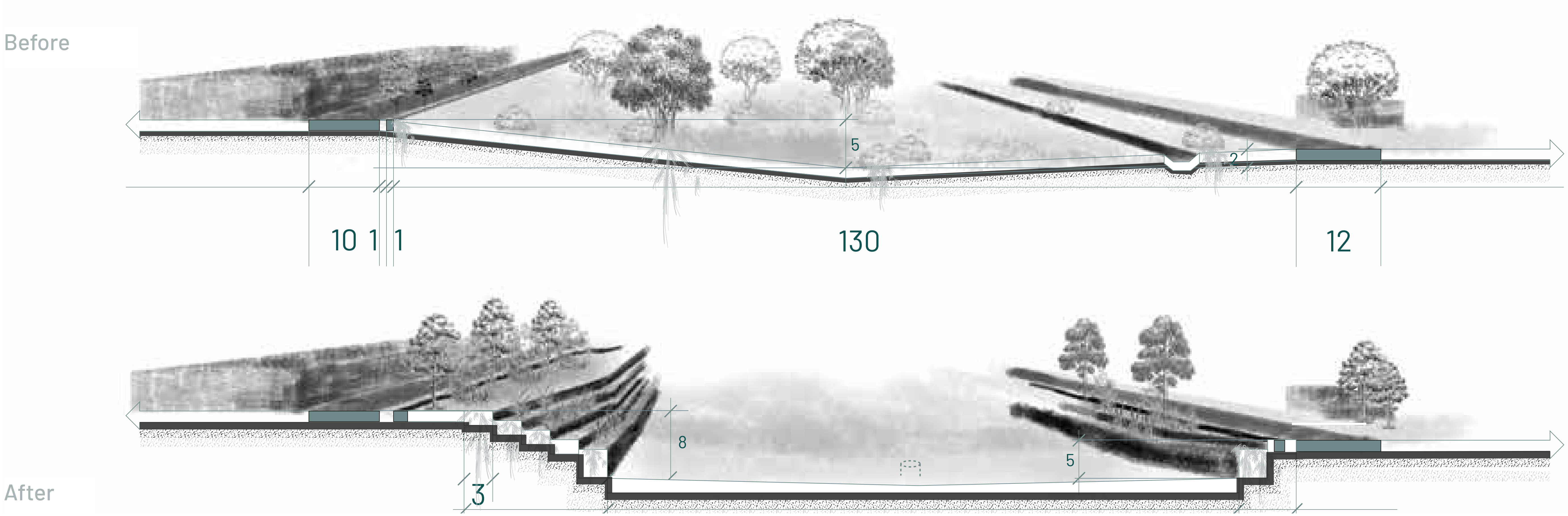
This initial section introduces the establishment of a water buffer zone at the edge of the neighborhood. It can collect all the upstream run-off water.

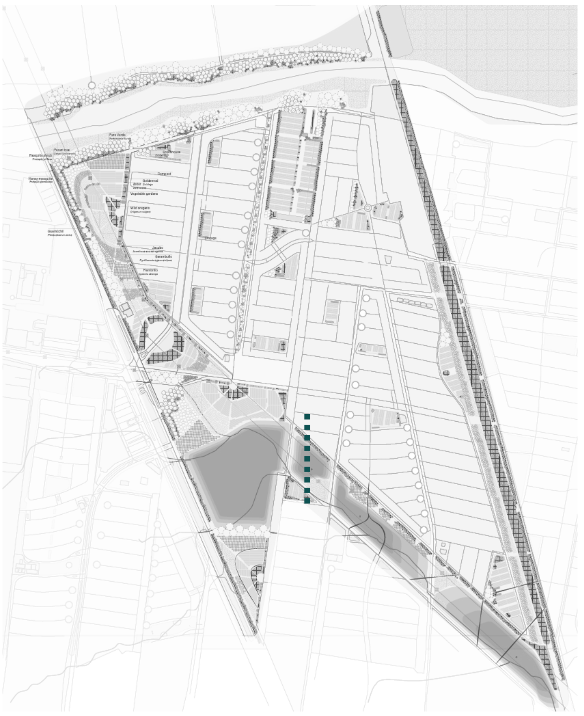
The waterbody structure is designed based on natural elevation and existing water flows. It is capable of preventing floods caused by upstream water runoff. Terraces are incorporated to create different micro-climates, with strict height differences serving as barriers to prevent overgrowth. Native species are planted to increase organic matter, biodiversity, and cultural heritage. Water levels are regulated with a standpipe at the deepest point, and excess water is directed to the Pesquería River using an overflow pipe.



Foodscape Rio Pesquería INTEGRAL PLAN

Figure 84: Sections Water Buffer with process by author.





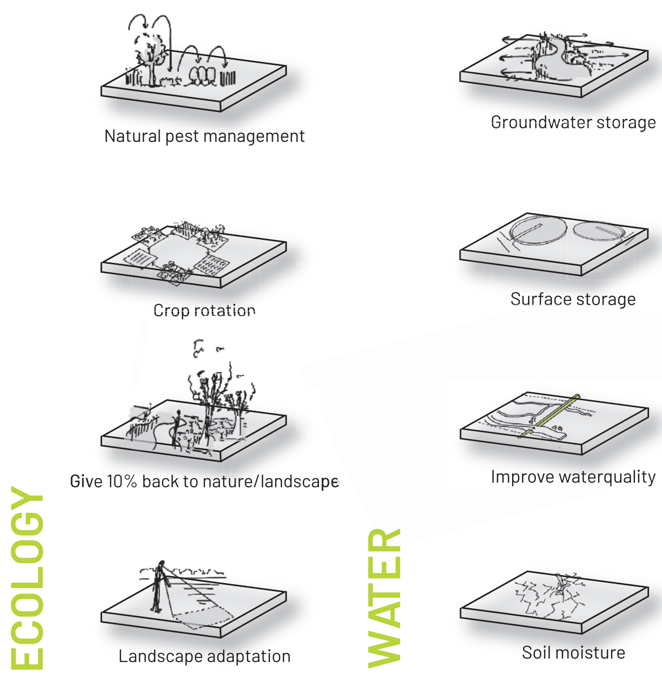
Water serves as both drinking water and a source for pools and water gardens. Moist habitats, water gardens, and ponds can provide habitats for numerous beneficial creatures such as snakes and amphibians. These organisms play a crucial role in pest regulation. Additionally, larger water bodies mitigate temperature fluctuations in the surrounding areas by reflecting sunlight and releasing stored heat. This increases soil moisture, creating favorable microclimatic conditions (Holzer, 2011).

Identifying naturally wet areas is imperative. The form should mimic natural conditions as much as possible. It is essential to ensure a well-structured environment encompassing both shallow and deeper zones. This facilitates the development of a functioning ecosystem, as different plants and animals require diverse habitats (Holzer, 2011).

Step 1 Dig!
Fine excavated material:
Creating barriers and terraces from the finely excavated material, in compacted layers of 30-50 cm thick.
Coarse excavated material:
For the transition from the slope to the bank edge and for securing the walls.

Step 2 Densify!
To make it watertight, let the surface fill with water to a depth of 30 to 40 cm. Then compact it with a dredge level.

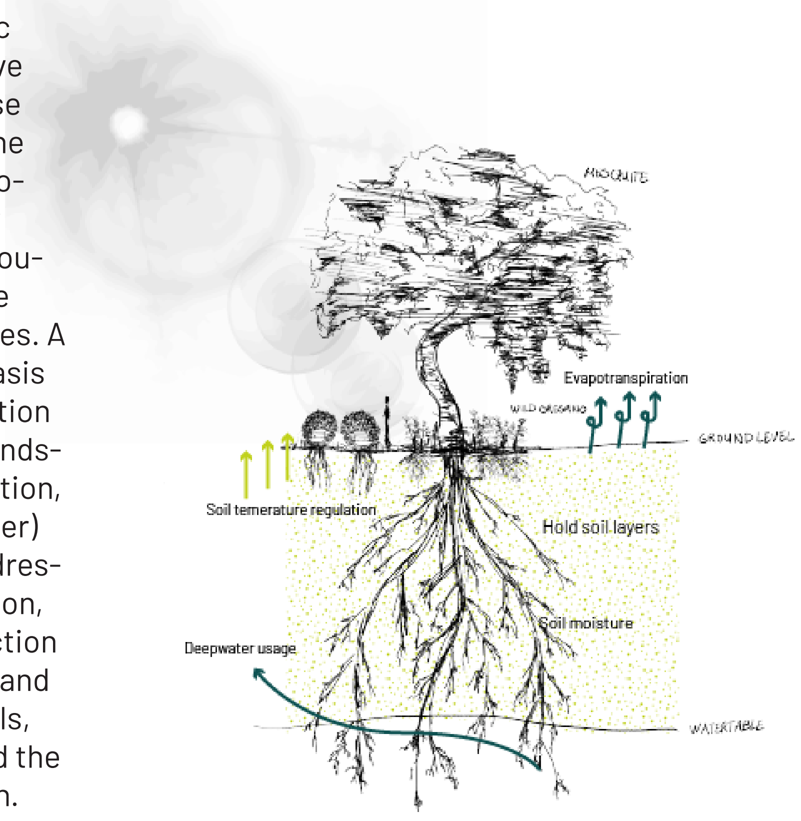
Step 3 Drain!
At the deepest point, a standpipe is installed to regulate the water level. Excess water is conveyed to Rio Pesqueria through an overflow pipe (Holzer, 2011).



The drawing depicts the profound impact of integrating native species into our landscapes, highlighting the symbiotic relationship between nature and design. It emphasizes how strategic interventions can not only enhance the aesthetics but also foster healthier ecosystems and communities, while mitigating environmental challenges.

The drawing unfolds over a year, reflecting the fluctuations in temperature and precipitation that plays a crucial role in shaping the broader landscape.

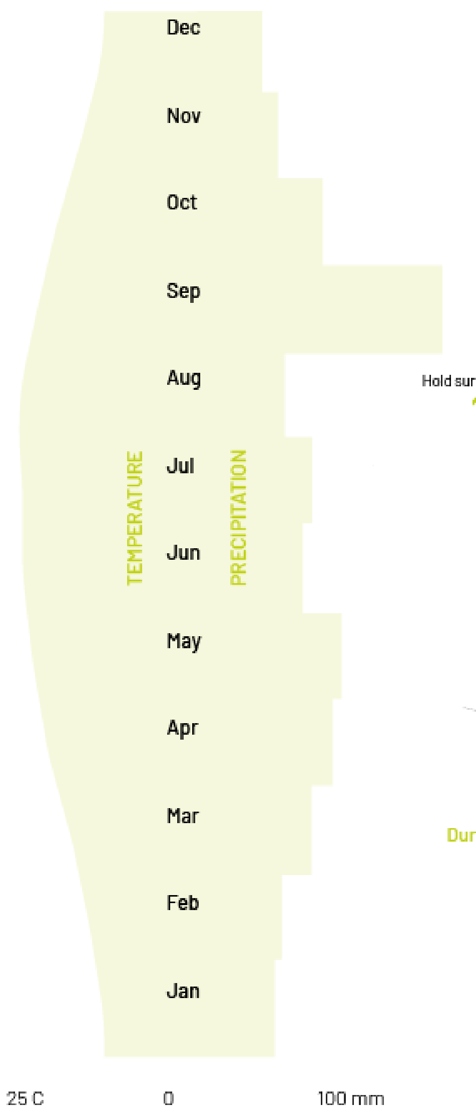
At its core, the drawing portrays a dynamic landscape where the strategic use of native species is central to its functionality. These plants not only add more green space to the environment but also serve essential ecological purposes, promoting biodiversity. By prioritizing native species, the design encourages a sustainable approach to landscape architecture, rooted in ecological principles. A notable aspect of the drawing is its emphasis on water management. Through the selection and placement of native vegetation, the landscape demonstrates improved water retention, minimizing runoff, and promoting (rainwater) infiltration. This resilience is crucial in addressing challenges such as flooding and erosion, exacerbated by climate change. The depiction of a buffer forming during wetter periods, and gradually releasing water during drier spells, underscores the adaptability of nature and the efficacy of using indigenous flora in design. Furthermore, the drawing suggests broader implications of these interventions, extending beyond environmental benefits to encompass habitat restoration and support for local ecosystems. It signifies a shift towards more sustainable land management practices, echoing the values of conservation and stewardship. The drawing serves as a poignant reminder of design's potential for a more harmonized relationship between citizens and nature.



During droughts / high temperatures

The drawing suggests the potential of incorporating native species into landscape architecture, but also signals the need for further exploration (see system drawing on the next page). Future research will examine broader implications, including cultural heritage revitalization and community health.

It will investigate the influence of native species and sustainable water management on the environment, communities, and landscapes. This expanded approach aims for a holistic and resilient landscape designs, prioritizing sustainability and human well-being.



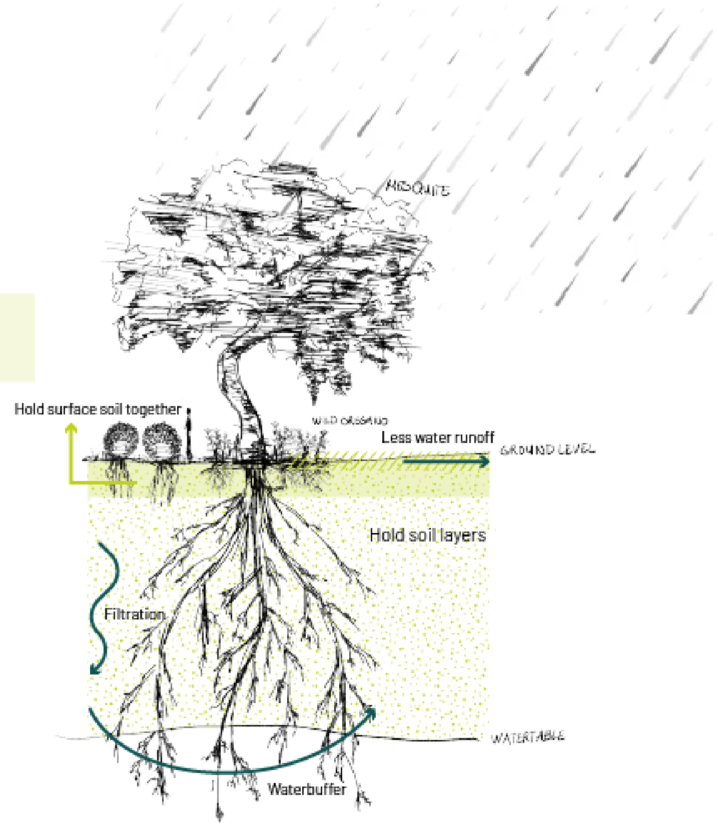
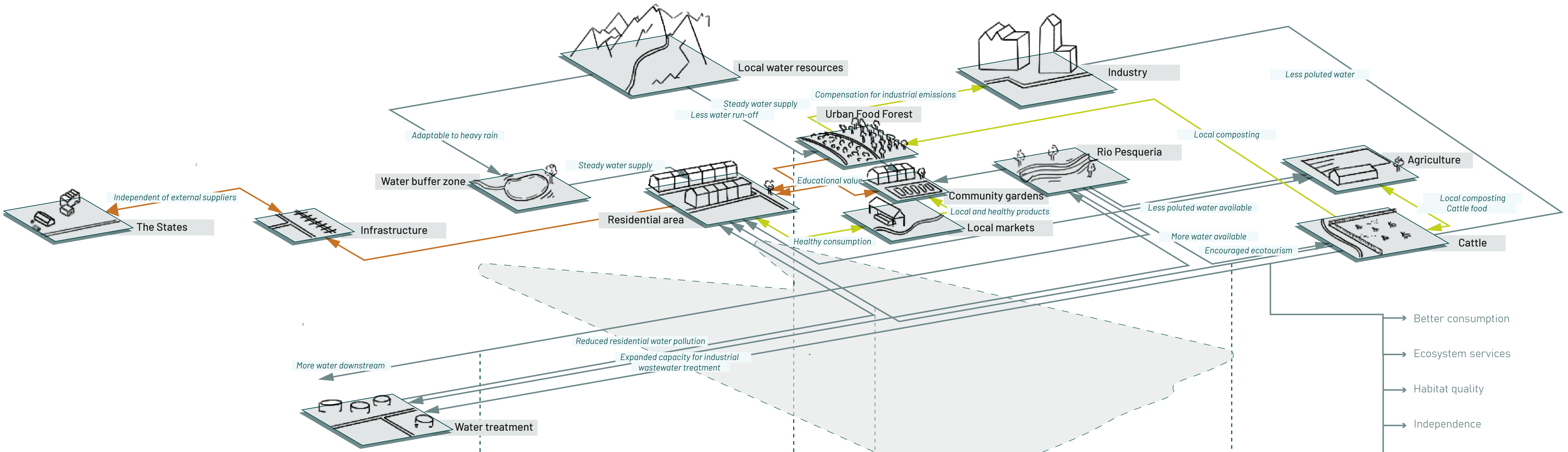
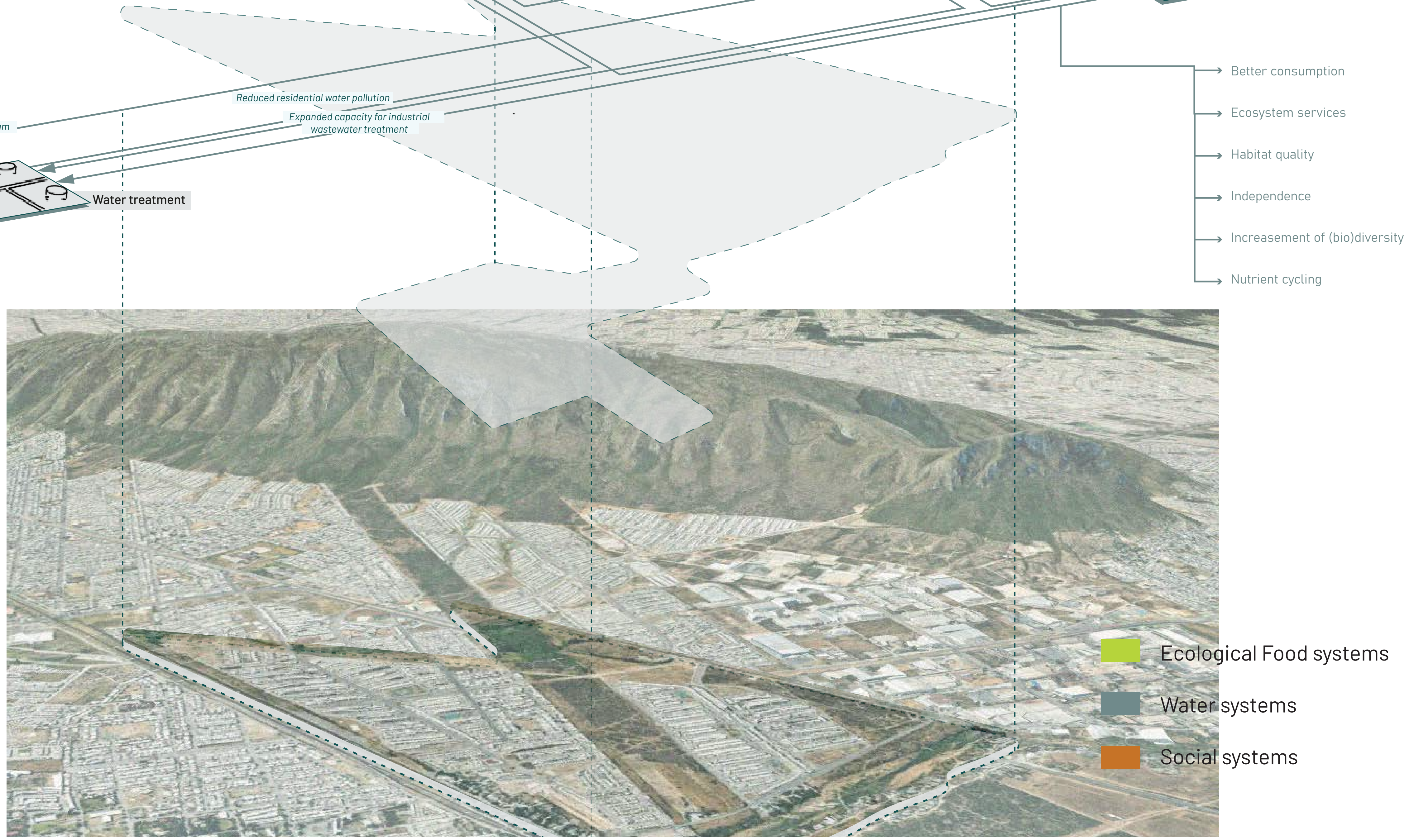


Figure 85: Drawings systems by implementation of native plants by author.

During (heavy) rainfall





In the newly introduced system, it becomes evident how the neighborhood is capable of capturing excess water and growing healthy, local crops. This enhances the neighborhood's resilience against environmental shocks. Additionally, it has a broader impact on the larger scale. By utilizing local water sources, reducing water runoff through improved soil moisture, and employing more efficient irrigation systems, more water will be available downstream.

It also becomes apparent how the ecological food systems interact with the water systems and social systems. Everything influences each other, highlighting the importance of this integrated approach. Ultimately, it leads to improved consumption patterns, enhanced ecosystem services, better habitat quality, increased self-sufficiency, and an increase in (bio)diversity with improved nutrient cycling.

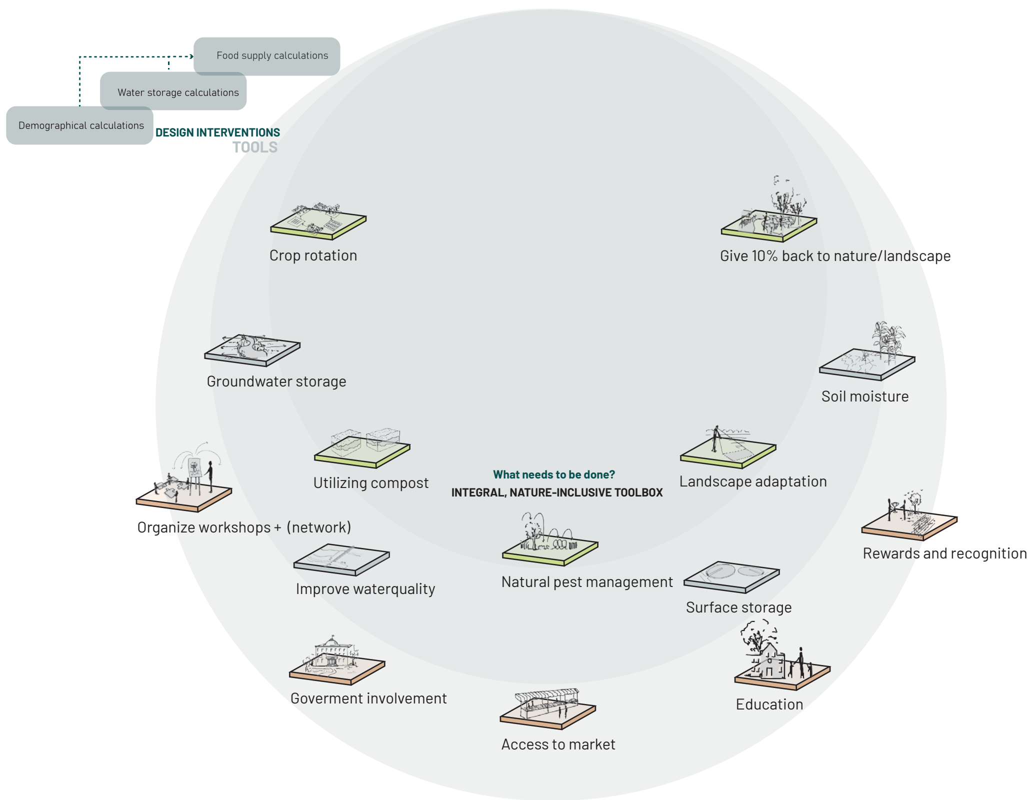
Figure 86: Influence on systems by author.

5. RESEARCH THROUGH DESIGN

Toolbox reflection

ADVANCED TOOLBOX

Based on the design research conducted, progress has been made in further developing the toolbox. An integrated approach also needed to become more evident in the design of the toolbox. This ensures that the various layers of the system (ecological food provision, water supply, and social provision) are more interconnected. Additionally, calculations form the basis of spatial designs and structures. Therefore, demographic calculations, as well as water storage and food supply calculations, are conducted to create more resilient designs.



Toolbox reflection

ADVANCED TOOLBOX

Furthermore, the various components are mapped out to illustrate how they can be effectively implemented. These components are interconnected with the previously mentioned tools and collectively influence larger systems, referred to as achievements. These achievements represent the systems impacted by the application of the different components. These new systems have a significant impact, addressing the problems and challenges outlined in the problem analyses. They encompass large-scale regulations such as improved accessibility to healthy food, urban cooling, drought mitigation, vegetation growth, flood resilience, and purified air.
In this way, the ultimate goal is achieved: greater resilience in the landscape and for the people living within it.

The updated toolbox is derived from the expanded design of the foodscape along the Rio Pesquería. This updated toolbox is applied to the two other foodscapes to assess whether systems can be similarly adapted to enhance resilience in those areas as well.

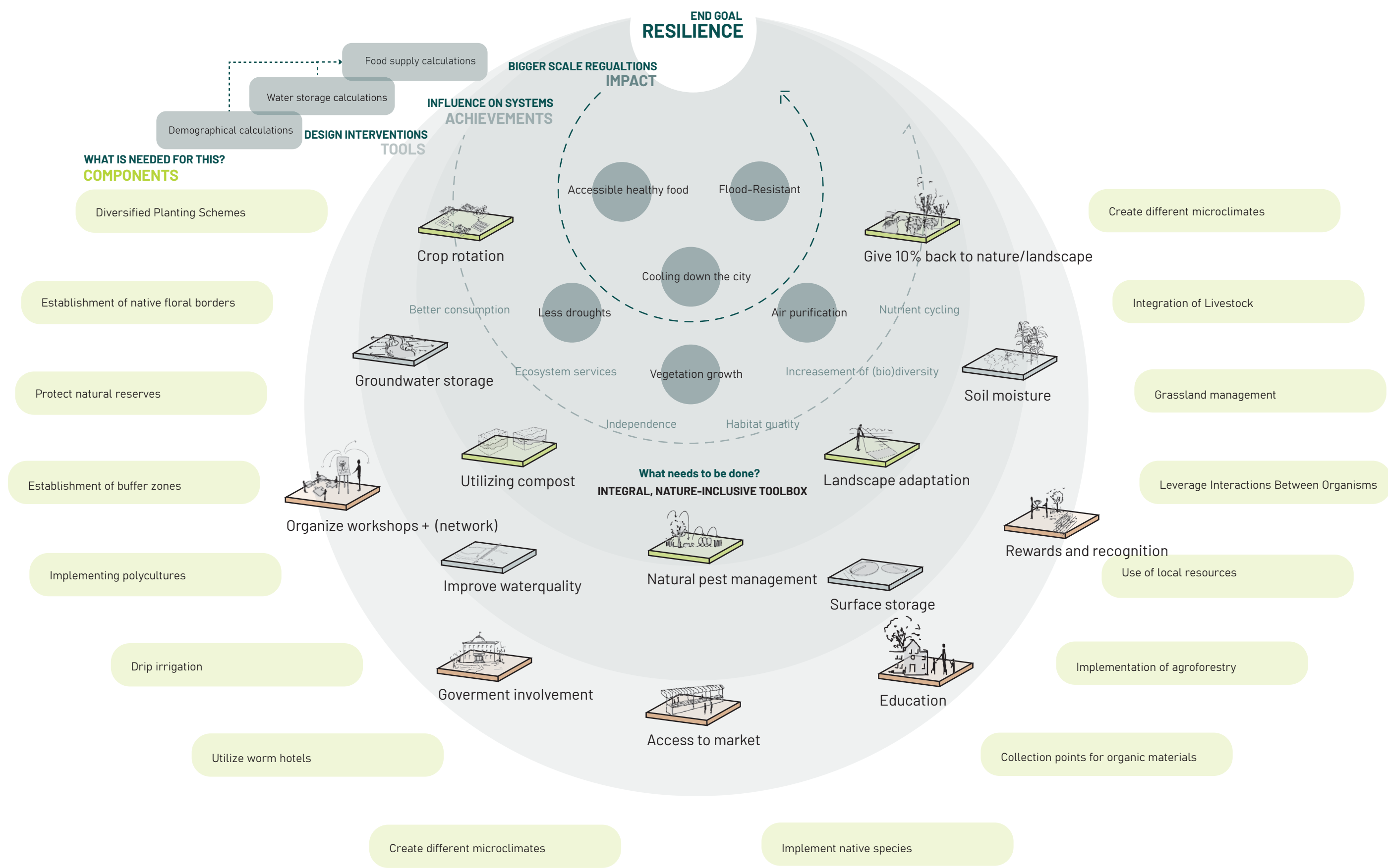


Figure 87: Advanced toolbox by author.

The updated toolbox is first applied to the se cond foodscape along the Rìo Santa Catarina. This river flows directly through the city cen- ter, resulting in dense urban development ar numerous cultural amenities such as market restaurants, and museums. The river has low ecological value due to concrete riverbanks, and there is minimal investment in the river due to the risk of destruction during heavy rainfall. Therefore, the design needs to antic pate these factors.

Figure 88: Identity of Rio Santa Catarina by autho

Foodscape 2 Rio Santa Catarina IDENTITY

Available selling points

Santa Catarina

Cultural institutes

Design location

Figure 89: Pictures by author.

On this location, water access potential is primarily identified in the utilization of rooftops (1), since there is almost no water flow in the Rio Santa Catarina. However, the region contends with significant social disparities, particularly evident in its most vulnerable areas (2). Positioned at the nucleus of the cultural center are pivotal establishments such as restaurants, museums, and markets, pivotal not only for cultural enrichment but also for the distribution and supply of crops (3).

Regarding land utilization, the area comprises a blend of open urban spaces interspersed with abandoned buildings (4). Soil analysis reveals the presence of Fluvisol along the rivers, offering promise for cultivation endeavors (5). However, the ecological integrity of the area is compromised by a paucity of green spaces and the prevalence of concrete riverbanks (6).

Infrastructure within the vicinity is characterized by fragmentation, notably adjacent to an 8-lane highway and connected to an indefinite walking bridge. These infrastructural nuances significantly influence the spatial and socio-economic fabric of the region, shaping its developmental trajectory (7).

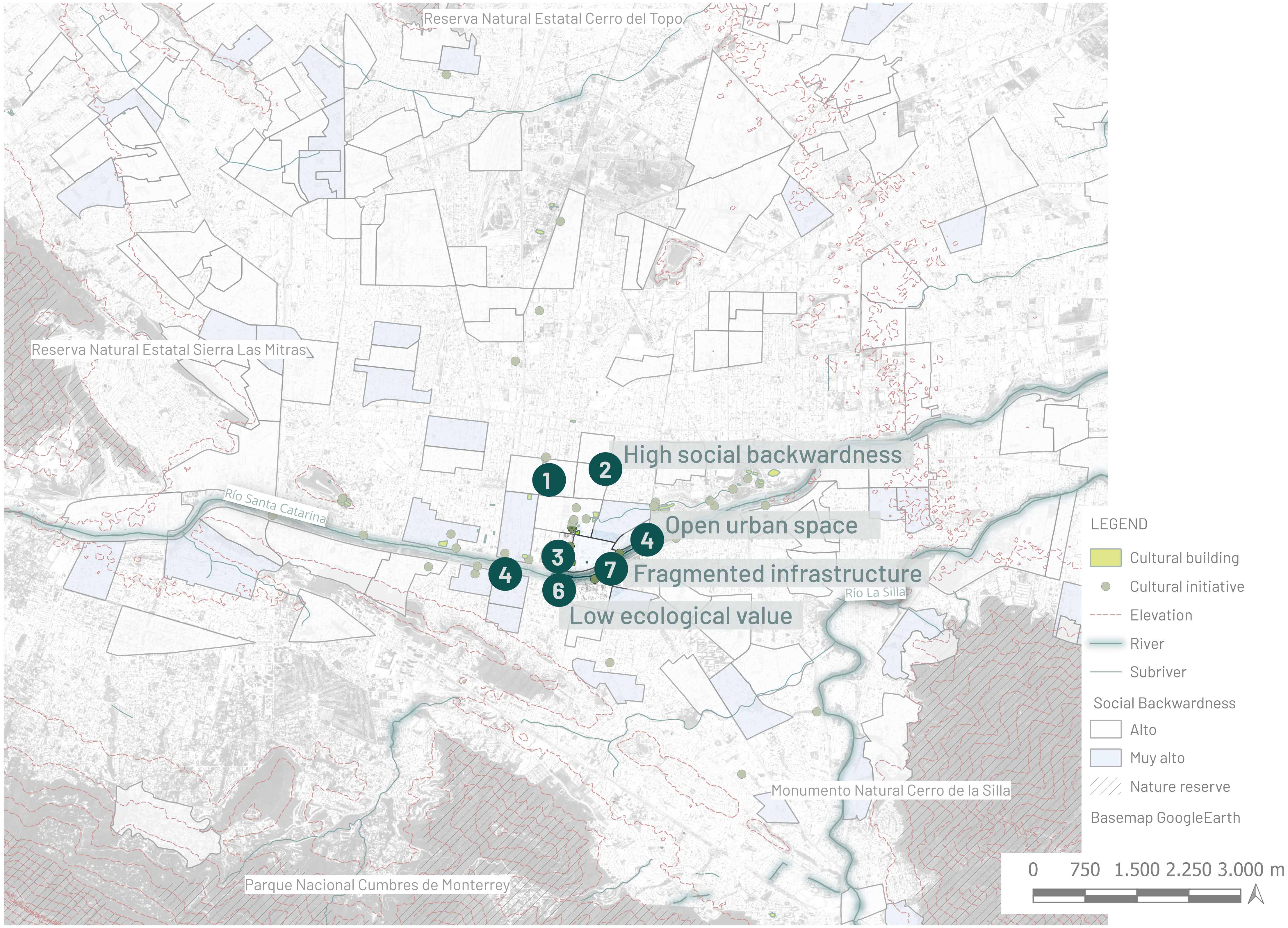
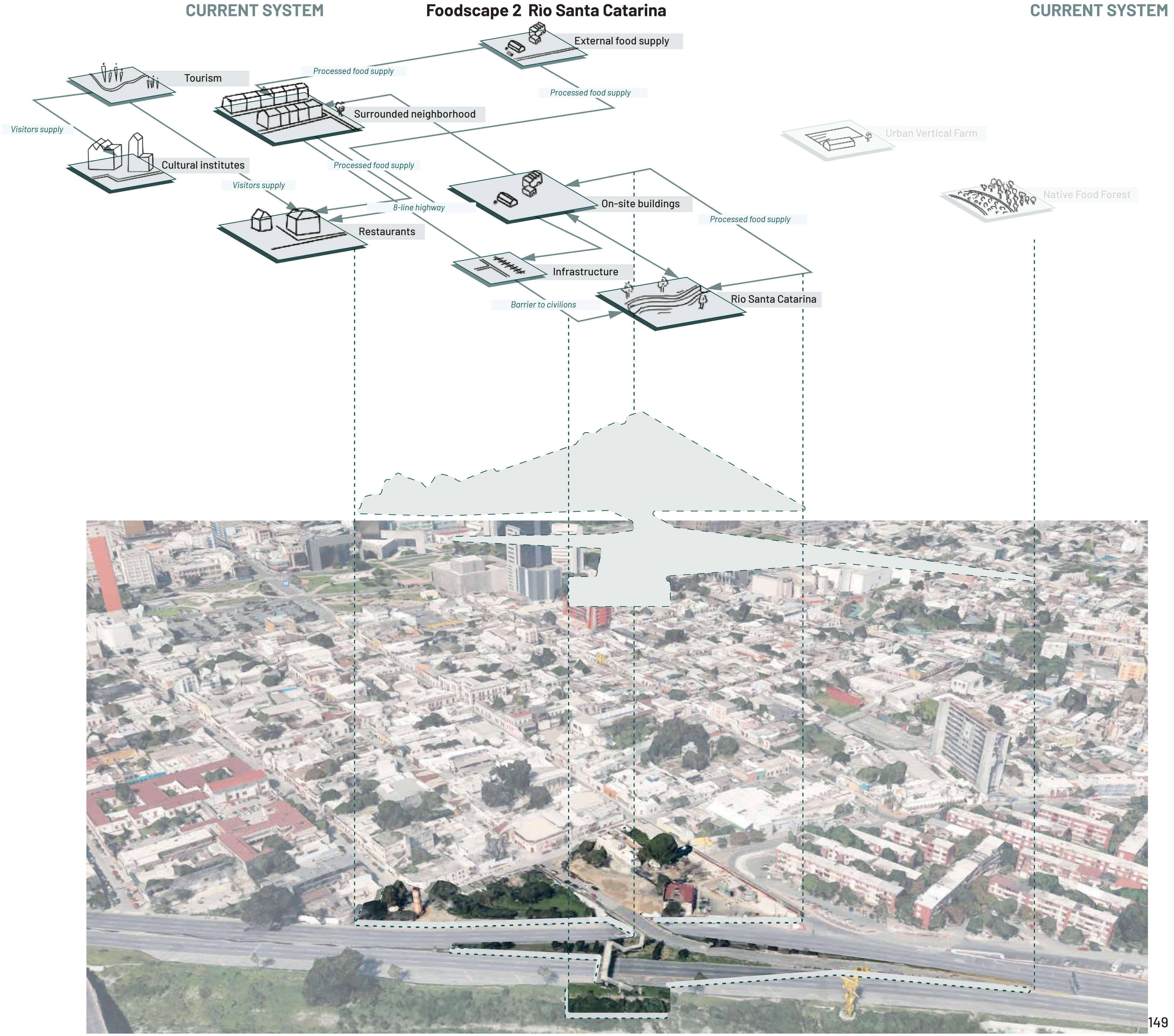


Figure 90: Localization Foodscape 2 by author.

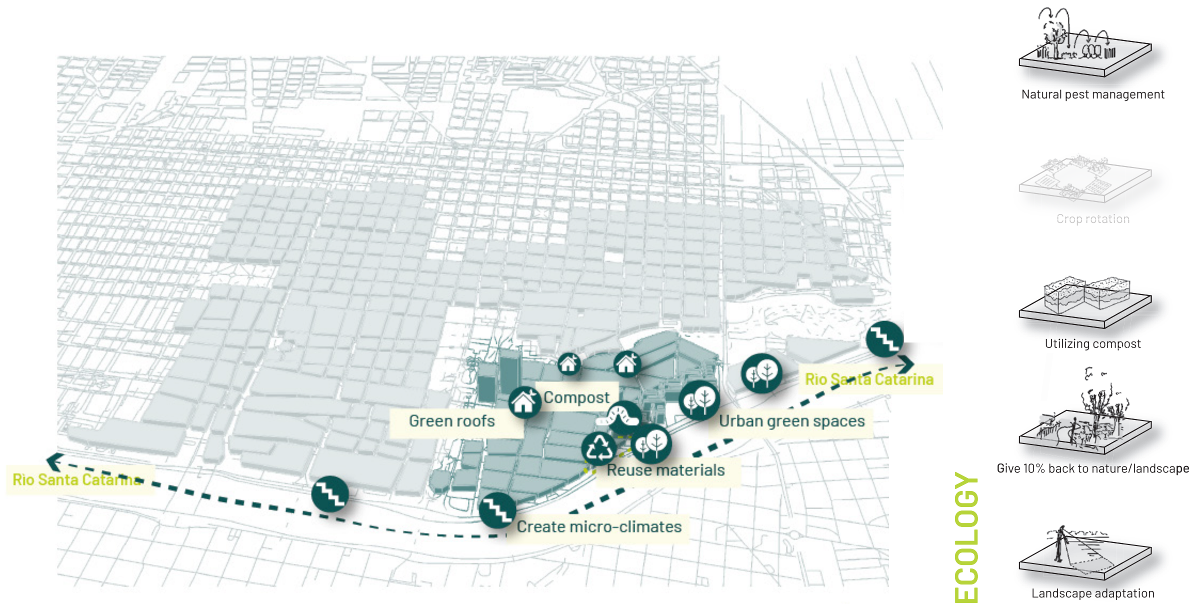
Research through Design.

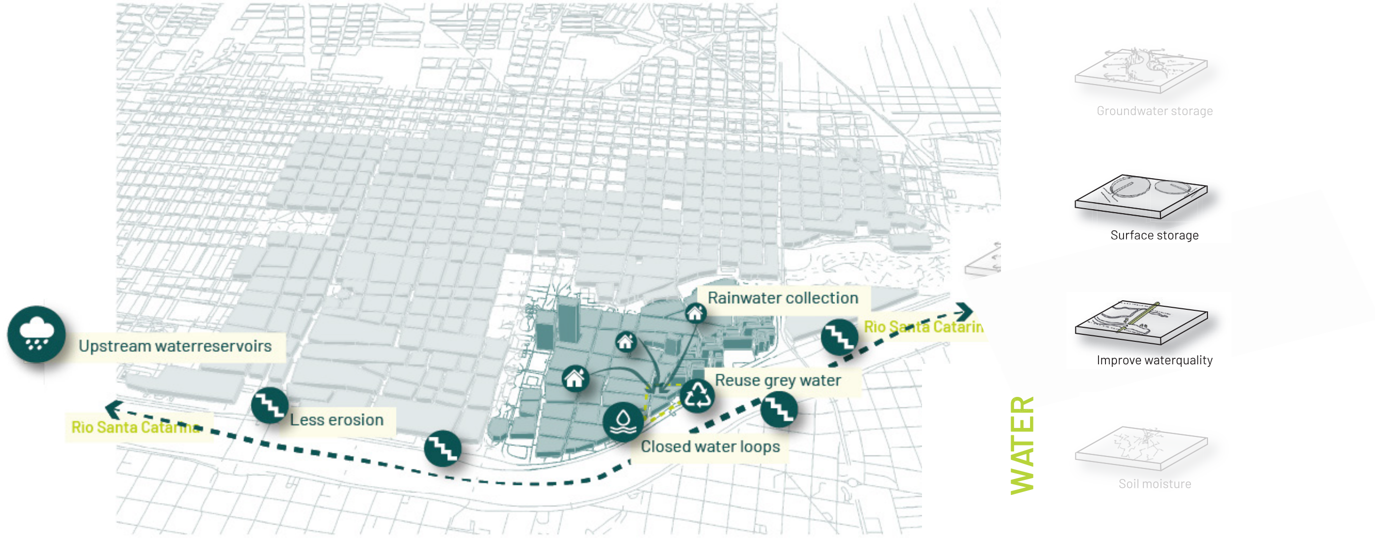
Foodscape 2 Rio Santa Catarina



In the current system of the area situated adjacent to the Rio Santa Catarina, processed food is prevalent, and visitors and consumers are not engaged in the production of local fresh produce. Furthermore, the infrastructure poses a significant barrier to accessing the river. The river is nearly inaccessible, and during site visits, it became evident that people fear the river due to its association with flooding events.

Figure 91: Current system Foodscape 2 by author.





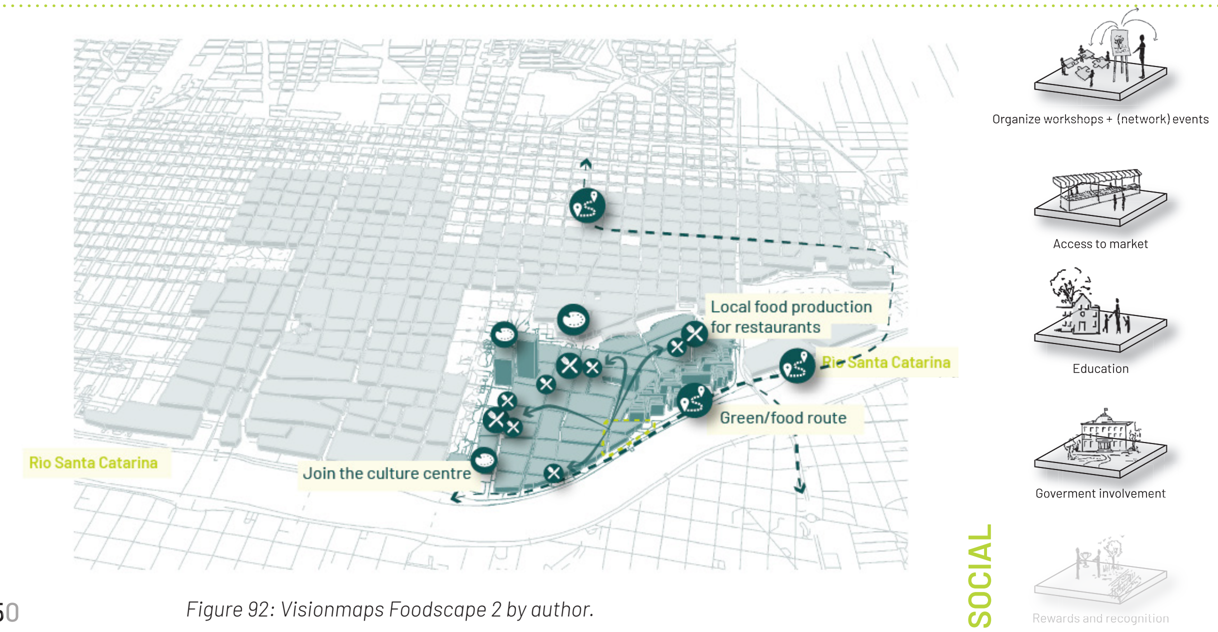


Figure 92: Visionmaps Foodscape 2 by author.

The second design location is situated along the Santa Catarina River. It resides within a highly urbanized environment, positioned centrally amidst various cultural institutions such as museums and restaurants. Additionally, weekly markets are also hosted within this district. Due to high population density, space availability is limited. Cultivating crops in this area can foster collaboration with cultural institutions to supply produce. The concrete riverbanks of the Santa Catarina have the potential to be transformed to enhance ecological value. On-site, compost utilization can be facilitated through vertical vermiculture systems. Surrounding residences may deposit their green waste here to further engage with the locale. Adjacent structures can contribute to the ecological significance of the site by introducing more greenery on rooftops and within street profiles. This initiative will attract diverse organisms to the area, restoring ecological equilibrium. Encouraging tree growth within open spaces between lanes will augment the prominence of greenery in the urban landscape, establishing a green linkage between the urban farm and the river.

Surrounding the Santa Catarina River, numerous challenges arise. During heavy rainfall or hurricanes, the river swells with significant water flow (Aguilar-Barajas et al., 2019), occurring approximately every 10 to 15 years. This phenomenon renders the areas adjacent to the river vulnerable due to the rapid influx of water along its banks. Between these peak moments, the river remains nearly dry. Consequently, alternative methods must be employed to access water for cultivation along this river. The area constitutes a hyper-urban environment where efficiency is paramount due to limited space. Implementing vertical cultivation and/or aquaponics systems proves particularly intriguing in this context, as they require minimal water resources. Rainwater can be collected on the rooftops of surrounding and on-site structures to replenish these aquaponics systems. Consequently, the location achieves self-sufficiency in water usage, thereby reducing dependence on the extremes of the river.

Implementing direct community involvement is challenging given the complexity of crop cultivation. However, it is imperative to organize events, markets, workshops, and other educational programs to foster community engagement with the site and, consequently, with crop cultivation. Growing food locally for surrounding restaurants not only serves sustainability purposes but also raises awareness. The choice of crops is determined by studying the traditional cuisine of Nuevo Leon. By examining contemporary recipes with a traditional foundation, it becomes evident which crops are desired in the area. This approach connects the environment more closely with traditional cuisine and its associated crops, fostering a modern approach to food cultivation. To integrate with the surroundings, the current pedestrian bridge (which currently leads nowhere) will be enhanced and expanded to provide not only social value but also ecological value. The bridge will connect to a designed route along the Santa Catarina River.

A middle-sized restaurant with 50 seats typically requires a weekly food supply of 20 kg of tomatoes and 5 kg of lettuce, prepared according to traditional recipes. To meet these demands sustainably, an aquaponics system can be implemented.

Based on the total system outlined by Bosma et al. (2017), which includes 15 fish tanks and a cultivation area of 96 m2, the production output is estimated at 1250 kg of fish, 83020 kg of lettuce, and 1885 kg of tomatoes.

For every 100 m2 of vegetable supply, enough produce can be generated to support two traditional restaurants. Therefore, on a 5500 m2 plot, approximately **100 middle-sized traditional restaurants** can be accommodated, allowing for pathways and communal spaces.

Additionally, herb cultivation, including oregano, cumin, coriander, and chili, can be integrated into the system through soil cultivation. Approximately 1600 m2 of land can be allocated for herb cultivation, with community involvement enhancing the sustainability and productivity of the endeavor.

Reference Project 1: Karma Verde, Monterrey:

In the Karma Verde project, each unit consists of 1.3 m2 of space with a height of 3 m. Utilizing a 7-shelf system, it yields approximately 47 kg of green leaf crops every 23 days (Fresh, n.d.-b).

Reference Project 2:
According to Portfarms & Portfarms (2018), in the Portfarms project, an area of 18 square meters yields approximately 25 kilograms of tomatoes each week.

The main structure is based on:

1. Following current forms
2. Connecting surrounding infrastructure
3. Improve existing walking routes
4. Sunlight study for the optimal amount of light
5. Utilize the surrounding built-up area and land use
6. Protect residential areas from highway

Figure 93: Integral plan Foodscape 2 by author.

Research through Design.

Foodscape 2 Rio Santa Catarina

This image showcases the transformation of an unused urban space, characterized by abandoned buildings and structures, into a verdant oasis with community involvement. Vertical crops are cultivated within the abandoned buildings to supply local restaurants with fresh, locally sourced produce. The space is publicly accessible, functioning as an open-air museum where individuals can experience and learn about urban food cultivation firsthand.

Before

Figure 94: Current unused open space. (Google Maps, 2024)

Figure 95: Impression Community Garden Foodscape 2 by author.

Research through Design.

Foodscape 2 Rio Santa Catarina

Here, we observe how the current walking bridge can transform into a more integrated object. Greening the bridge through crop growth on its structures, creates an intriguing link between the river and the urban garden. Alongside the river, a recreational path will run above the terraces, featuring informal informational boards to educate visitors about native crops and the diverse flora thriving in the area.

Before

Figure 96: Current walking brigde with disconnection infrastructure. (Google Maps, 2024)

Figure 97: Impression Green Walking Bridge by author.

Foodscape 2 Rio Santa Catarina

RENEWED SYSTEM

ADDED COMPONENTS

- Community gardens
- Implement native species
- Implementation of agroforestry
- Collection points for organic materials
- Diversified Planting Schemes
- Establishment of native floral borders
- Use of local resources
- Establishment of buffer zones
- Create different microclimates
- Implementing polycultures
- Utilize worm hotels
- Drip irrigation

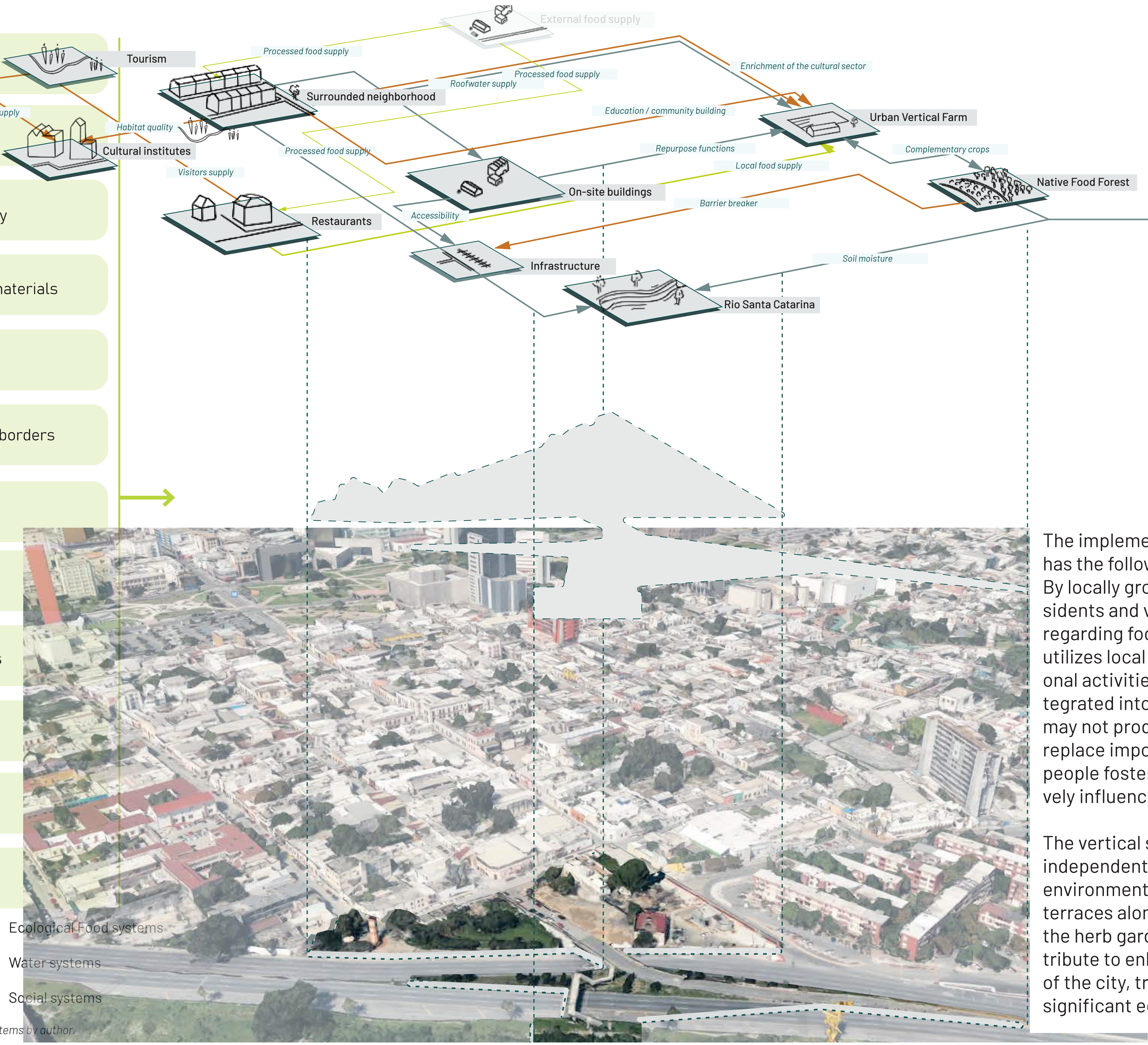


Figure 98: Influence on systems by author.

Source: Google Earth.

Foodscape 2 Rio Santa Catarina

RENEWED SYSTEM

- Better consumption
- Ecosystem services
- Habitat quality
- Independence
- Increasement of (bio)diversity
- Nutrient cycling

The implementation of the components has the following impact on the systems. By locally growing crops and integrating residents and visitors, awareness is created regarding food consumption. The system utilizes local water, and through recreational activities, the river becomes more integrated into the city. While the urban farm may not produce enough food to entirely replace imported goods, the integration of people fosters learning, which can positively influence consumption habits.

The vertical system is primarily local and independent, contributing minimally to the environment ecologically. Therefore, the terraces along the river, the native forest, the herb garden, and the flowers all contribute to enhancing the ecological value of the city, transforming it into a small but significant ecological stepping stone.

The regional research is used for the design the first zoom-in. At this location, the toolbox is applied along the Rio Pesquería. The focus here is on closing the neighborhood loop through the use of local resources. Subsequently, reflection on the toolbox occurs, further development takes place, and it is re applied to the two other foodscape locations.

The Rio Arroyo Seco is a tributary of the Rio Silla. Given that the Rio La Silla holds relative high ecological value (it is colloquially referred to as the only green river in Monterrey) a design has been developed for the centrally located tributary, which currently has very lo ecological value. This is because cultivation this area can significantly contribute to ecological improvement.

Figure 99: Identity Rio Arroyo Seco and Rio La Silla by author.

Available selling points

Arroyo Seco

School institutes

Design location

Figure 100: Pictures by author.

Proximity to Arroyo Secco ensures enhanced access to water, a vital resource for sustainable development (1). Interventions targeting socially disadvantaged areas seek to mitigate social inequalities, prioritizing efforts where they are most needed (2).

At the heart of the educational district, the establishment of educational gardens, alongside initiatives at TEC, cultivates a culture of learning and awareness regarding agricultural practices (3). Strategically positioned open urban spaces, adjacent to the food mall, provide avenues for community engagement and facilitate access to fresh produce (4).

Utilizing Fluvisol along the rivers offers fertile soil for cultivation, bolstering local food production efforts (5). Remediation endeavors aimed at areas with diminished ecological value, such as concrete riverbanks, endeavor to transform them into ecological stepping stones between reserves (6). This approach aims to augment biodiversity and fortify ecological resilience within the urban landscape.

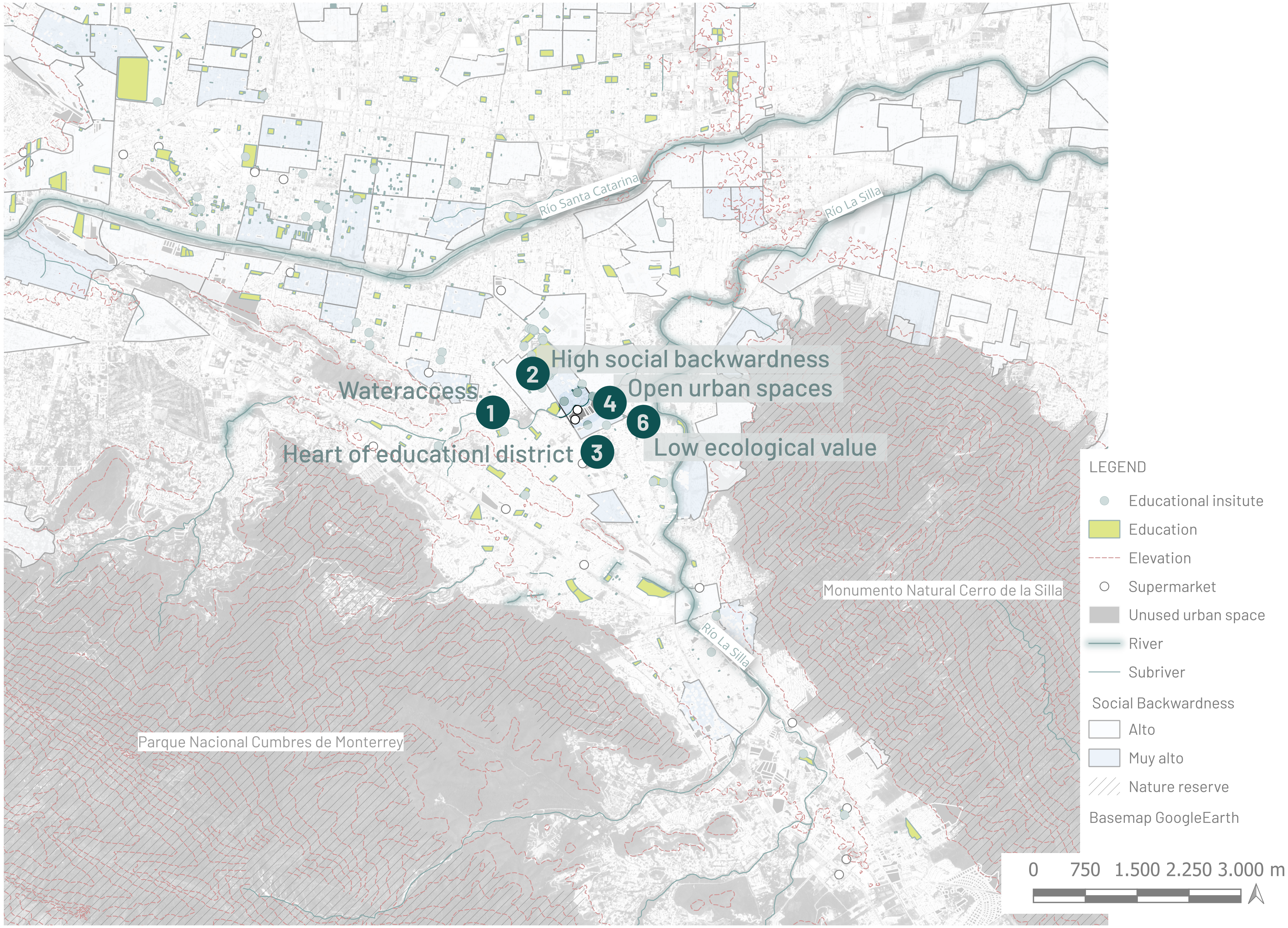
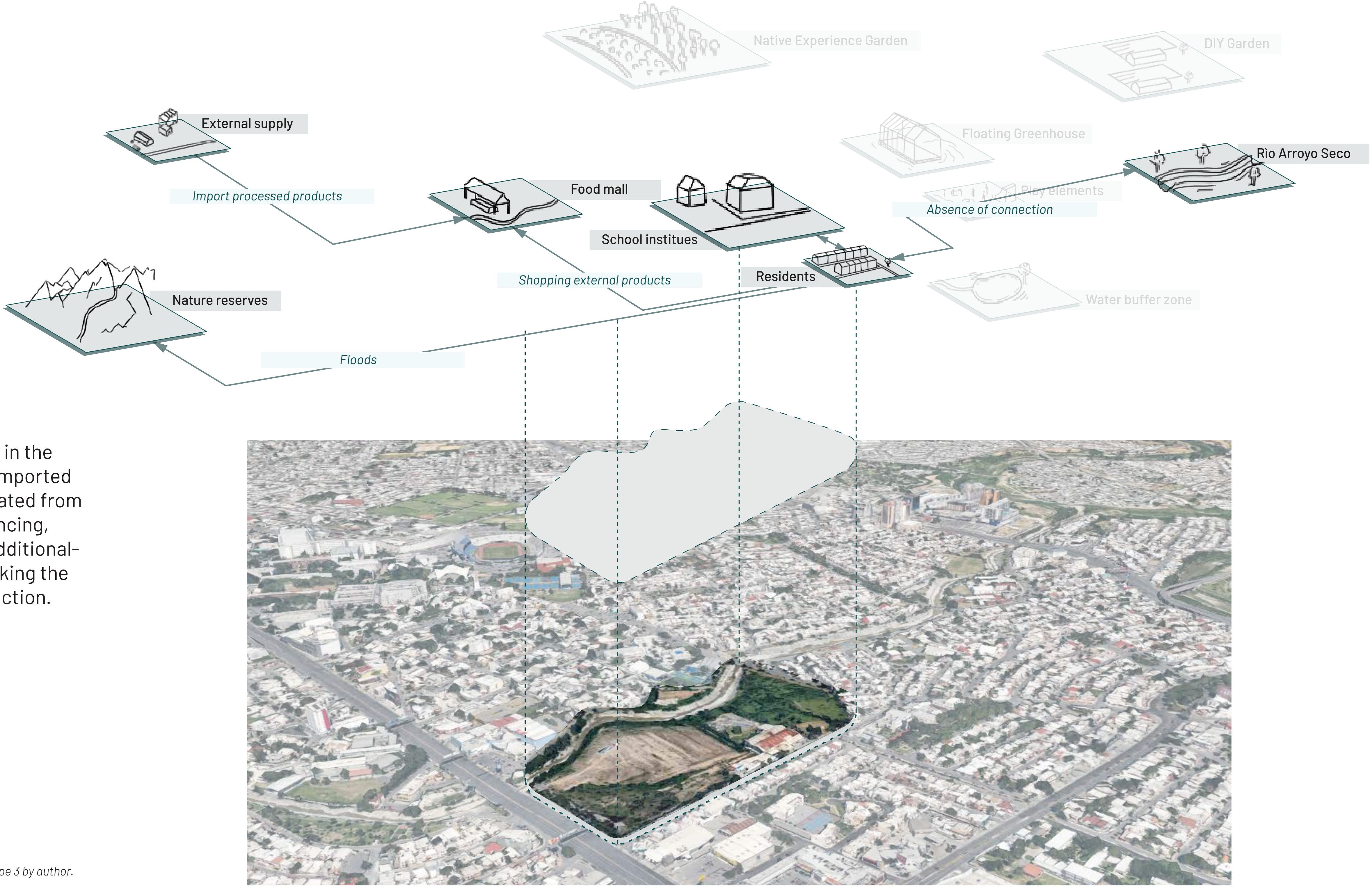


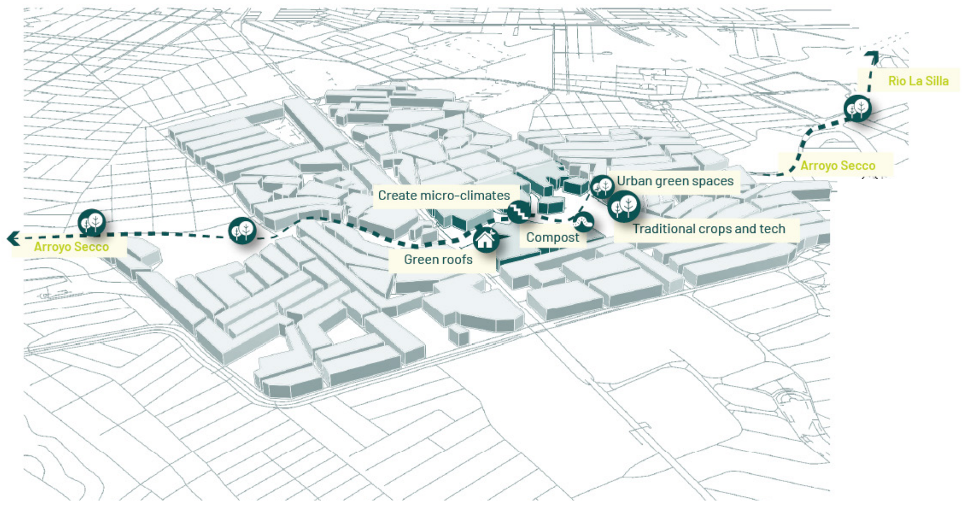
Figure 101: Localization Foodscape 3 by author.



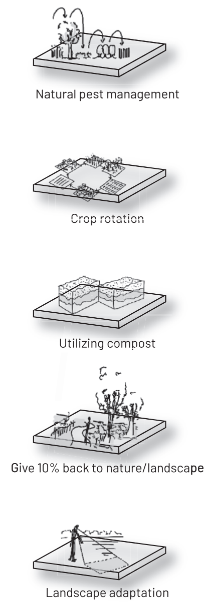
The current river causes flooding in the area. The food mall on-site sells imported products. The Arroyo Seco is isolated from the rest of the environment by fencing, vegetation, and infrastructure. Additionally, there is no cohesive system linking the schools, the river, and food production.

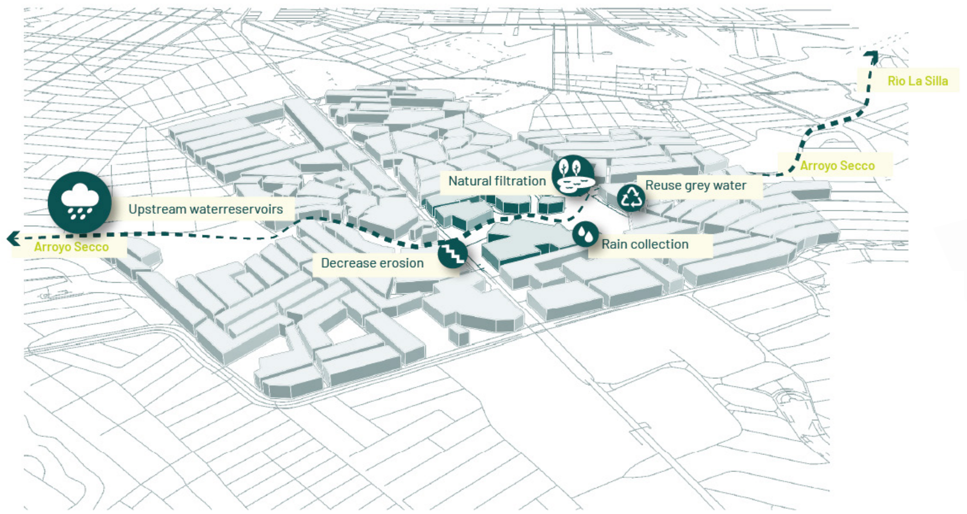
Figure 102: Current system Foodscape 3 by author.

Foodscape 3 Rio Arroyo Seco

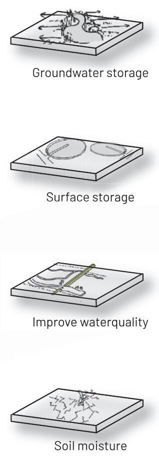


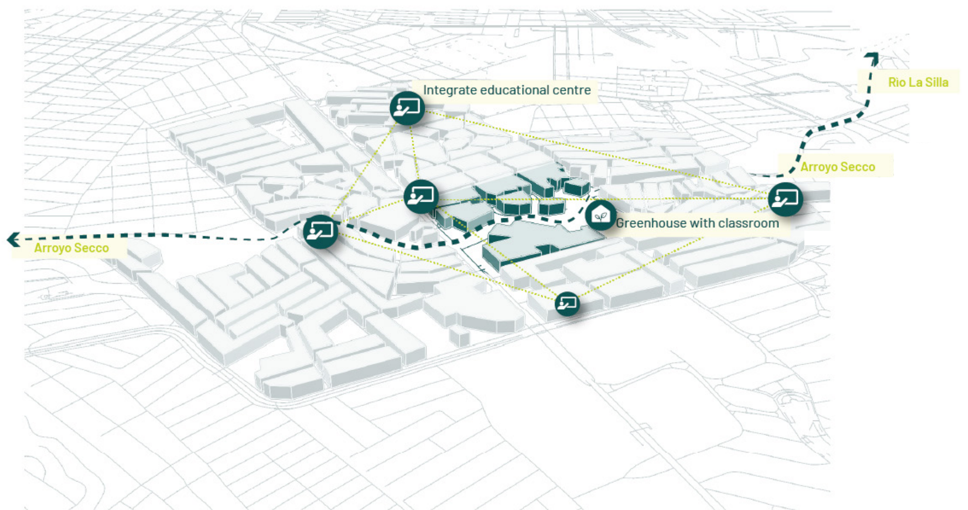
ECOLOGY





WATER





SOCIAL

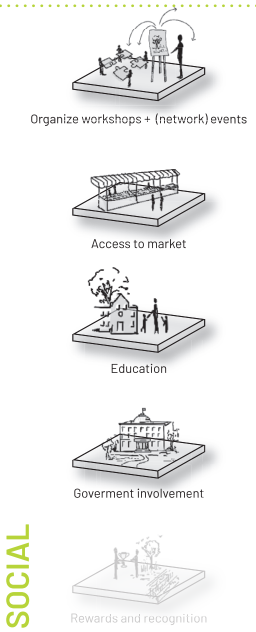


Figure 103: Visionmaps Foodscape 3 by author.

The Rio La Silla holds significant ecological value and is regarded as the only green river within the city. Therefore, applying urban agriculture to enhance its ecological value is not logical. Conversely, the tributary of the river, Arroyo Secco, exhibits very low ecological value, characterized by concrete riverbanks. Flowing past various educational institutions, the river presents an opportunity for this design location to serve as an educational experiential garden. It aims to provide a learning environment for both young and old through experimentation and hands-on experiences. Visitors can learn about traditional techniques and crops and how these can be applied at home (on rooftops, balconies, living rooms, parks, etc.). The traditional technique of the three sisters is employed here, enriching the soil and biodiversity. The current riverbanks are transformed into green embankments with play areas for children, utilizing wood sourced from trees growing on-site. By cultivating native flowers such as asters and goldenrods, this initiative contributes to a more balanced ecosystem, fostering improved soil quality and attracting insects for natural pollination, among other benefits.

The Arroyo Secco consistently flows with water of relatively high quality, making it suitable for use in the experiential garden. To combat erosion, the riverbanks need to undergo transformation to meet higher ecological standards. The greywater from surrounding institutions can be repurposed for cultivation. Native crops serve multiple purposes: firstly, they facilitate natural water filtration, improving water quality. Additionally, they contribute to soil aand act as natural sponges, enhancing water retention in the soil and providing a buffer during drier periods.

The social aspect holds paramount importance in this context. Both young and old can contribute to maintenance efforts, with children having the opportunity to cultivate their plants. Annual harvest festivals can be organized, featuring dishes prepared with crops from the three sisters, which not only ecologically support each other but also complement each other in taste. These crops synergize effectively as they collectively provide nearly all essential nutrients (Kimmerer, 2020), thus fostering awareness and ultimately encouraging healthier eating habits through such experiences. Furthermore, experiential learning is facilitated for individuals of all ages. A greenhouse with a classroom will be available, allowing for the dissemination of necessary knowledge for home cultivation on balconies, rooftops, etc. This integration of knowledge promotes individual-scale urban greening, advancing gradually, step by step.

One of the traditional cultivation techniques will be introduced in this area, providing an educational demonstration for children and other visitors. This demonstration garden will showcase the efficiency and practicality of traditional methods within an urban setting, illustrating how such techniques can be scaled up and implemented in peri-urban areas.

The Milpa system of "The Three Sisters" operates through four-stage process over 20 years:

In stage 1, a designated forest patch is identified and prepared for cultivation. This involves selecting an appropriate section of the forest that will be used for the Milpa cycle.

In stage 2, the chosen forest area is burned to clear the land, a traditional method that enriches the soil with nutrients from the ash. Following this, maize, beans, and squash are planted together. These crops are known as "The Three Sisters" because they complement each other in terms of growth and nutrient provision: maize provides a structure for the beans to climb, beans fix nitrogen in the soil, and squash spreads across the ground, reducing weed growth and retaining soil moisture.

Stage 3 involves the maturation of fruit trees planted alongside the annual crops. As the fruit trees grow and begin to bear fruit, the cultivation focus transitions away from the annual crops like maize, beans, and squash, moving towards a more permanent orchard system.

Finally, in stage 4, the area undergoes reforestation. This stage involves planting native tree species to restore the forest ecosystem, ensuring the sustainability and ecological balance of the area. The reforestation process not only replenishes the forest but also prepares the land for future Milpa cycles, thus completing the 20-year process (Watson et al., 2020).

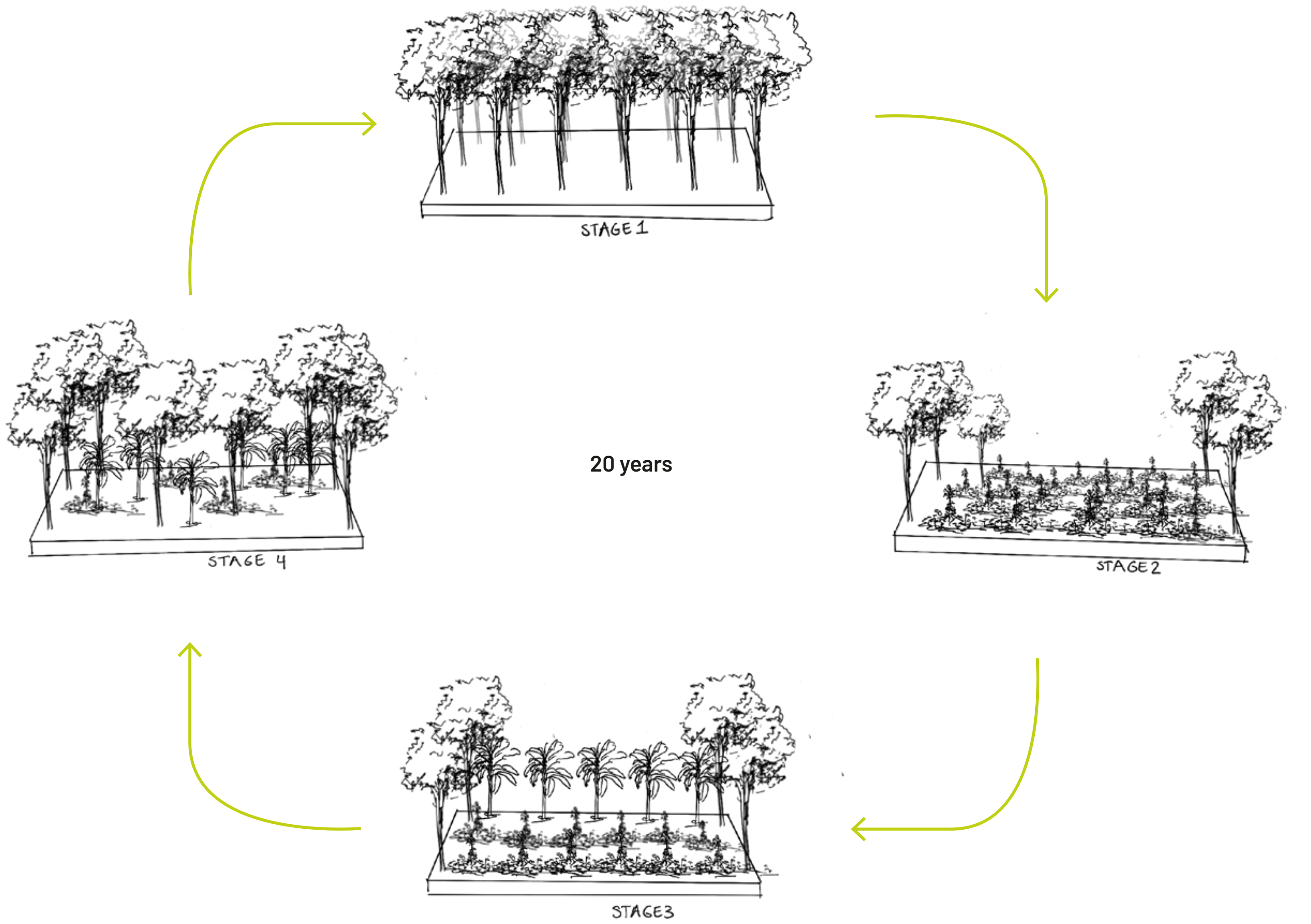
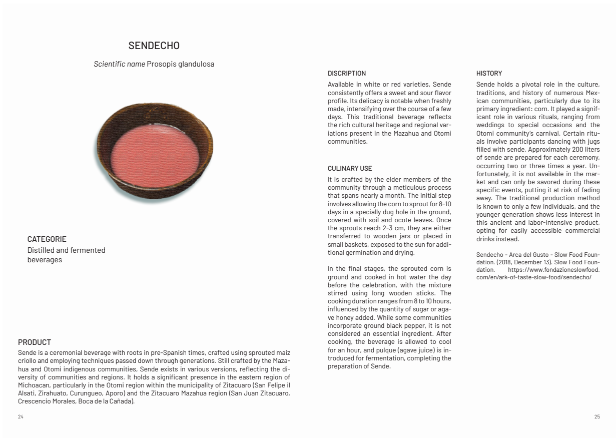


Figure 104: Milpa-system. (Watson et al., 2020)

Foodscape 3 Rìo Arroyo Seco FOOD PROVISION



SENDECHO

Scientific name Prosopis glandulosa

CATEGORIE

Distilled and fermented beverages

PRODUCT

Sende is a ceremonial beverage with roots in pre-Spanish times, crafted using sprouted maiz criollo and employing techniques passed down through generations. Still crafted by the Mazahua and Otomi indigenous communities, Sende exists in various versions, reflecting the diversity of communities and regions. It holds a significant presence in the eastern region of Michoacan, particularly in the Otomi region within the municipality of Zitacuaro (San Felipe il Alsati, Zirahuato, Curungueo, Aporo) and the Zitacuaro Mazahua region (San Juan Zitacuaro, Crescencio Morales, Boca de la Cañada).

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DISCRIPTION

Available in white or red varieties, Sende consistently offers a sweet and sour flavor profile. Its delicacy is notable when freshly made, intensifying over the course of a few days. This traditional beverage reflects the rich cultural heritage and regional variations present in the Mazahua and Otomi communities.

CULINARY USE

It is crafted by the elder members of the community through a meticulous process that spans nearly a month. The initial step involves allowing the corn to sprout for 8-10 days in a specially dug hole in the ground, covered with soil and ocote leaves. Once the sprouts reach 2-3 cm, they are either transferred to wooden jars or placed in small baskets, exposed to the sun for additional germination and drying.

In the final stages, the sprouted corn is ground and cooked in hot water the day before the celebration, with the mixture stirred using long wooden sticks. The cooking duration ranges from 8 to 10 hours, influenced by the quantity of sugar or agave honey added. While some communities incorporate ground black pepper, it is not considered an essential ingredient. After cooking, the beverage is allowed to cool for an hour, and pulque (agave juice) is introduced for fermentation, completing the preparation of Sende.

HISTORY

Sende holds a pivotal role in the culture, traditions, and history of numerous Mexican communities, particularly due to its primary ingredient: corn. It played a significant role in various rituals, ranging from weddings to special occasions and the Otomi community's carnival. Certain rituals involve participants dancing with jugs filled with sende. Approximately 200 liters of sende are prepared for each ceremony, occurring two or three times a year. Unfortunately, it is not available in the market and can only be savored during these specific events, putting it at risk of fading away. The traditional production method is known to only a few individuals, and the younger generation shows less interest in this ancient and labor-intensive product, opting for easily accessible commercial drinks instead.

Sendecho - Arca del Gusto - Slow Food Foundation. (2018, December 13). Slow Food Foundation. https://www.fondazioneslowfood.com/en/ark-of-taste-slow-food/sendecho/

25

As evident from the adjacent map, the location is partially flooded during heavy rainfall. To accommodate this water influx, adaptive land use strategies have been explored. The Milpa system is situated on higher ground that remains dry. Conversely, the flood-prone area will host vegetation that requires minimal growth time, such as native herbs and flowers, which will also facilitate water infiltration into the soil. Greenhouses are strategically placed in the flood zones, serving as visible examples of how to adapt to water presence. These greenhouses are designed to float and adjust to water levels. Lastly, wooden play structures are installed along the riverbanks to encourage children's interaction with the water, transforming the river from a perceived adversary into an integral part of the landscape.

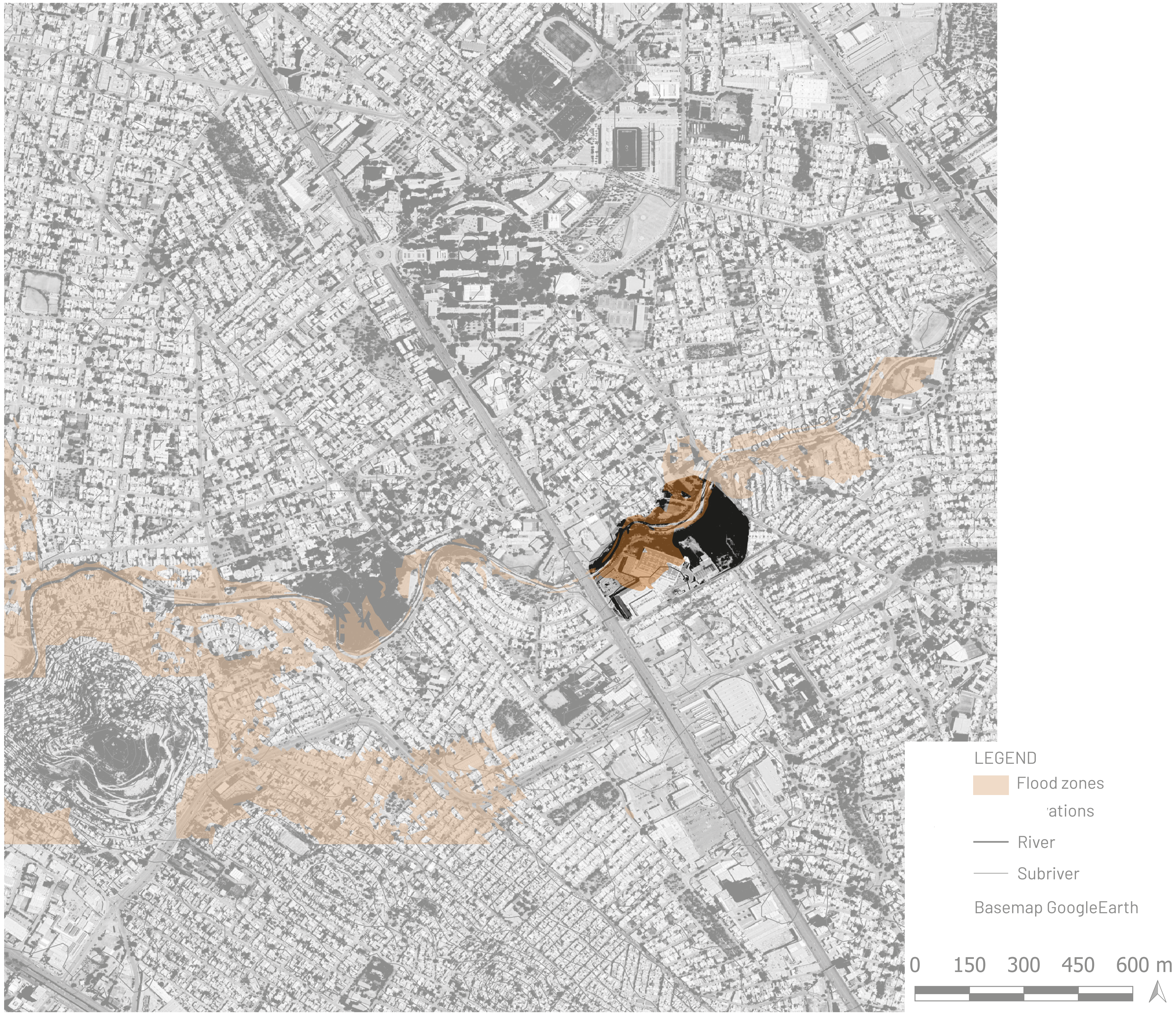


Figure 105: Flood areas. (Atlas Riesgos : NL, n.d.)(QGIS.org,2024)

Foodscape 3 Rio Arroyo Seco
INTEGRAL PLAN

The main structure is based on:

1. Following current forms
2. Connecting surrounding infrastructure
3. Improve existing walking routes
4. Sunlight study for the optimal amount of
5. Flood zones vs. higher drylands
6. Integration of surrounding land use

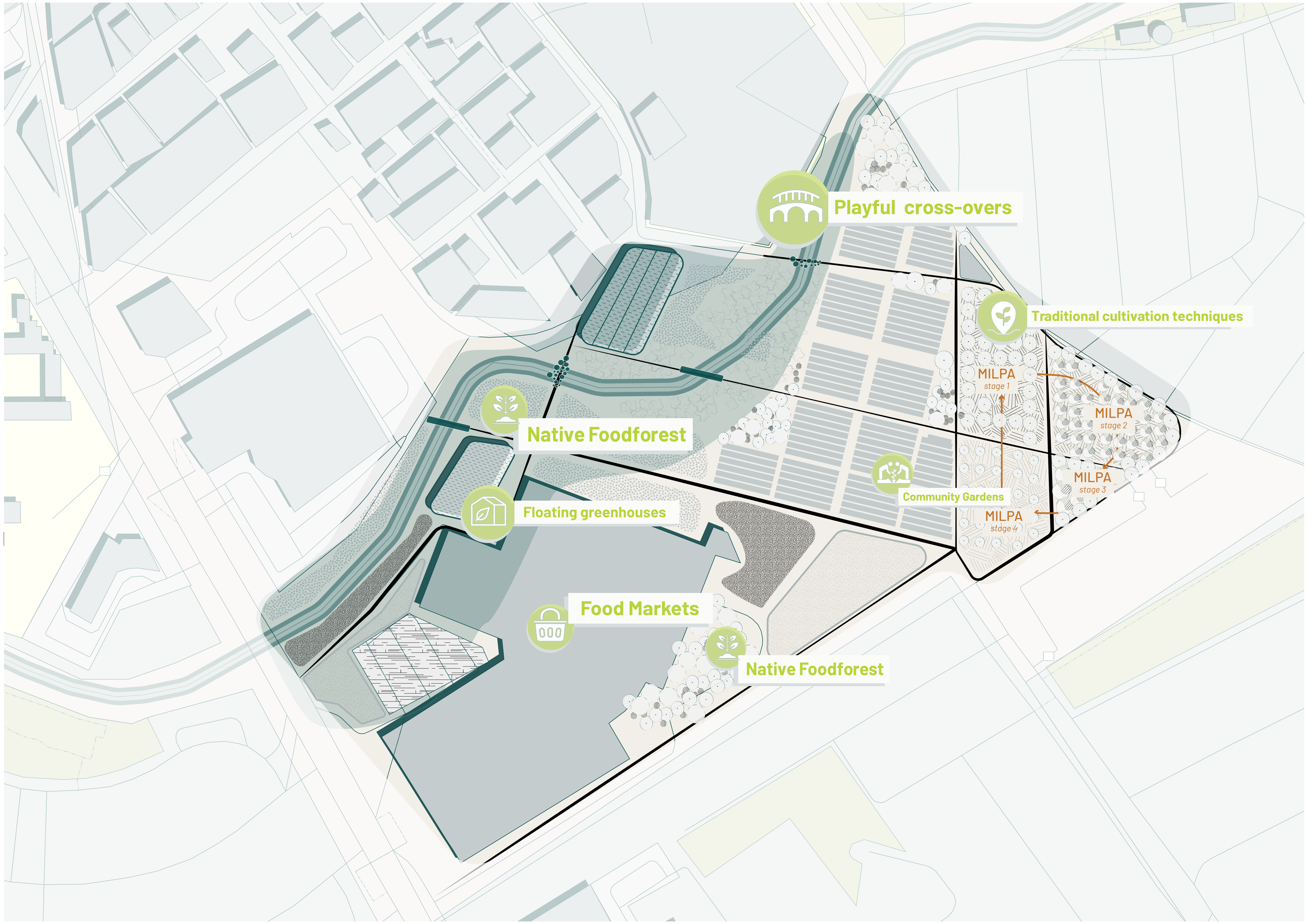


Figure 106: Integral plan Foodscape 3 by author.

Research through Design.

Foodscape 3 Rio Arroyo Seco

This illustration depicts the transformation of concrete riverbanks into green shores with playful elements, aimed at enhancing accessibility. The greenhouse serves as an educational space where plants are cultivated. Various native cultivation techniques are showcased at the site.

Before

Figure 107: Current riverbanks of Rio Arroyo Seco. (Google Maps, 2024)

Figure 108: Impression Riverbanks of Foodscape 3 by author.

Research through Design.

Foodscape 3 Rio Arroyo Seco

This illustration shows the interior of a greenhouse integrated with educational activities. Large, long tables are placed among the cultivated plants. Through hands-on experience, individuals learn techniques that can be applied at home. This approach incrementally makes the city greener, with individual actions contri-buting to regional sustainability.

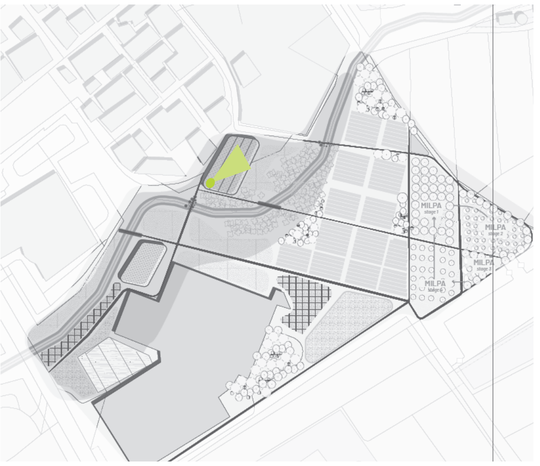
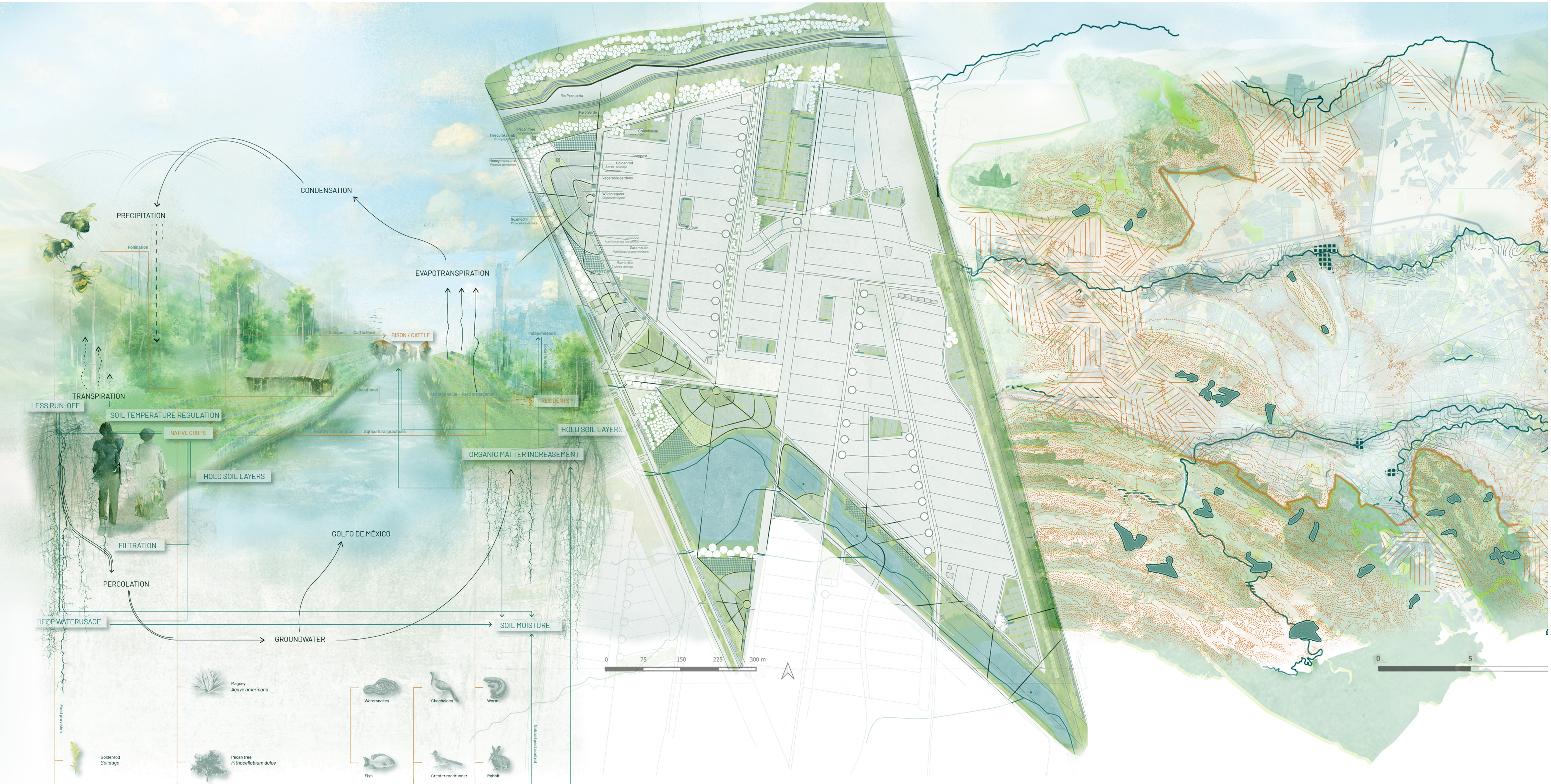
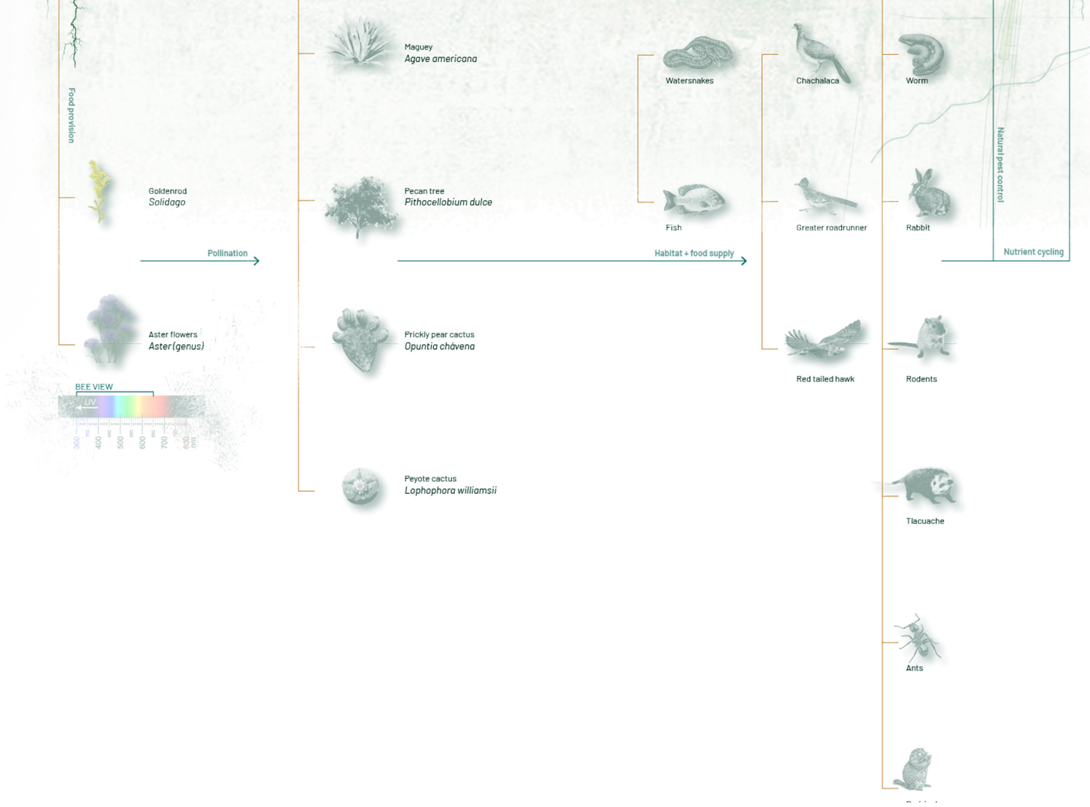


Figure 109: Impression Greenhouse with education by author.

6. OVERVIEW





During the site visit, the value of using native species became evident at the Villa de Patos farm, a large-scale operation. By implementing the Maguey plant, the farm integrated its crops and livestock into the ecosystem. This made the struggle for water in the semi-arid climate less challenging, since irrigation was not needed anymore, as the soil retained more moisture due to the introduction of the plant. The local livestock provided healthy compost and grazed on the grass attracted by the Maguey. In addition to ecosystem services, the plant offered a nutritious food source, reduced erosion, captured CO_2 and increased soil microorganisms. Embracing the ecosystem, this vision and approach formed the foundation for the subsequent design.

Overview.

The strategy for implementing the toolbox is divided into several phases. Essential maps have been included for each step to provide the necessary data and information for localization and development. This approach aims to offer Monterrey a starting point for further developing the city in terms of nature inclusivity and urban food production.

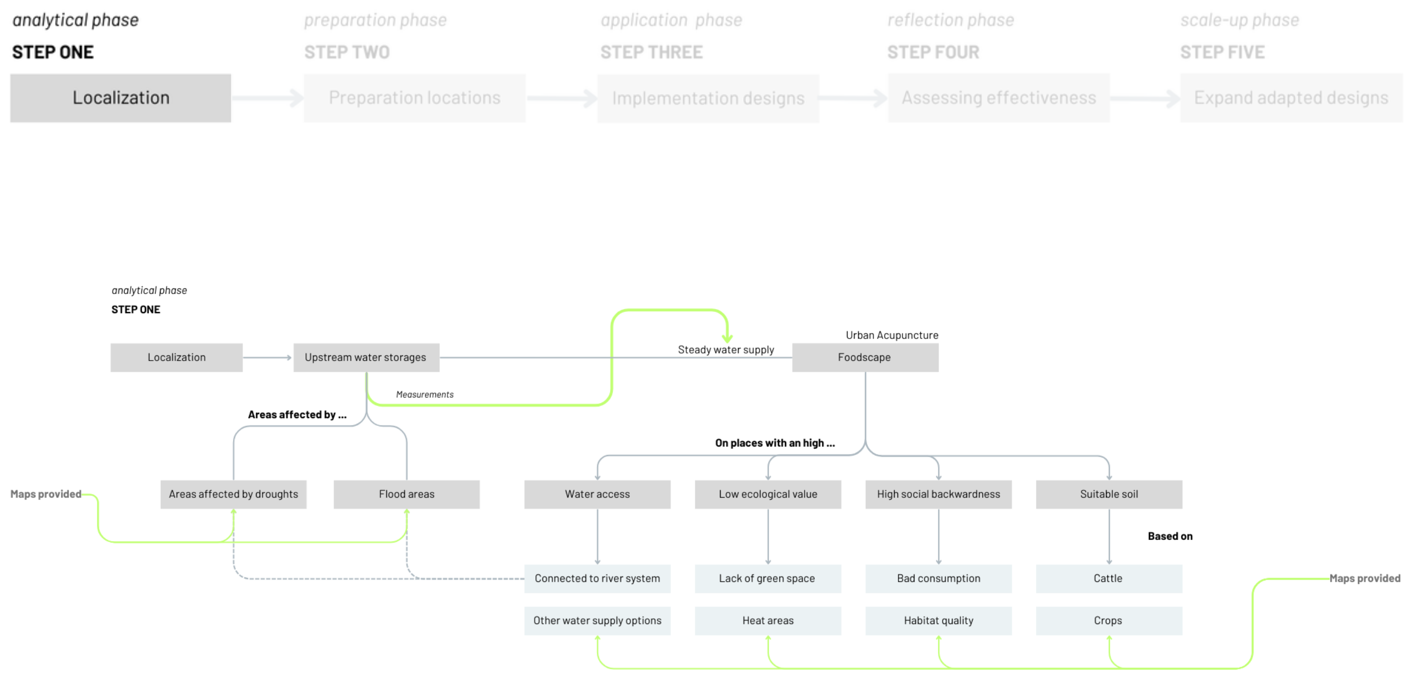
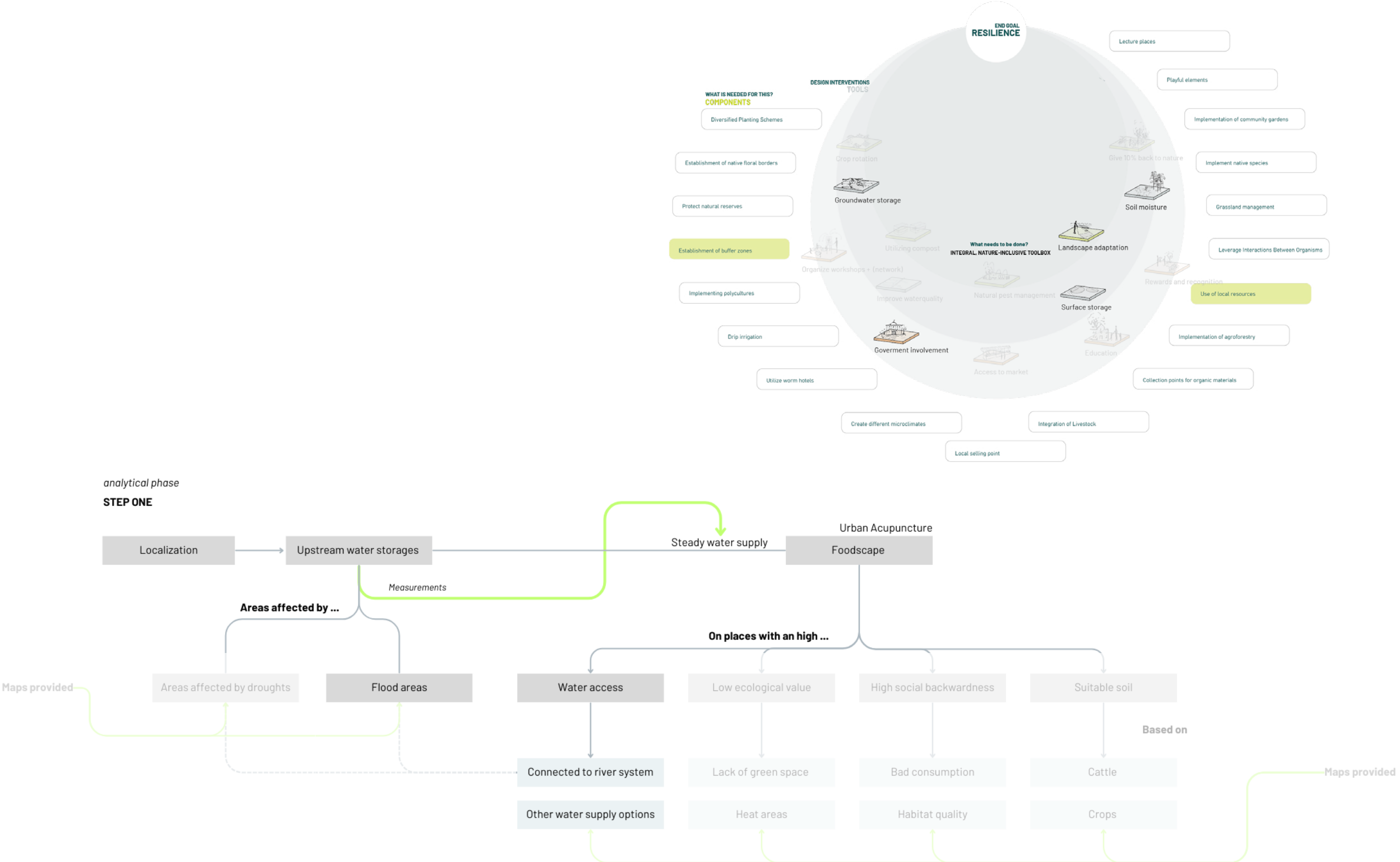


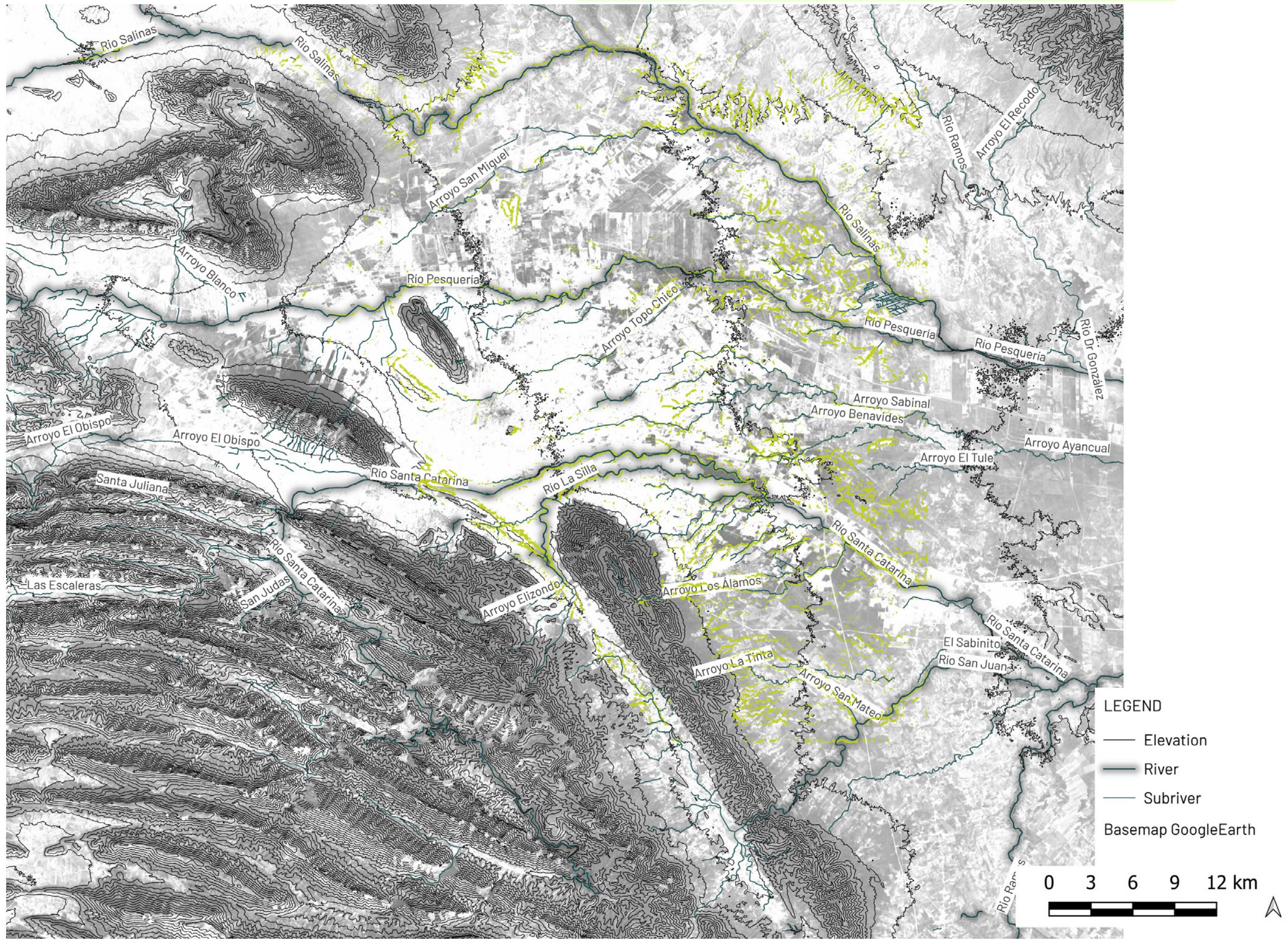
Figure 111: Strategy step one by author.

Overview.

Strategy

MONTERREY





Strategy

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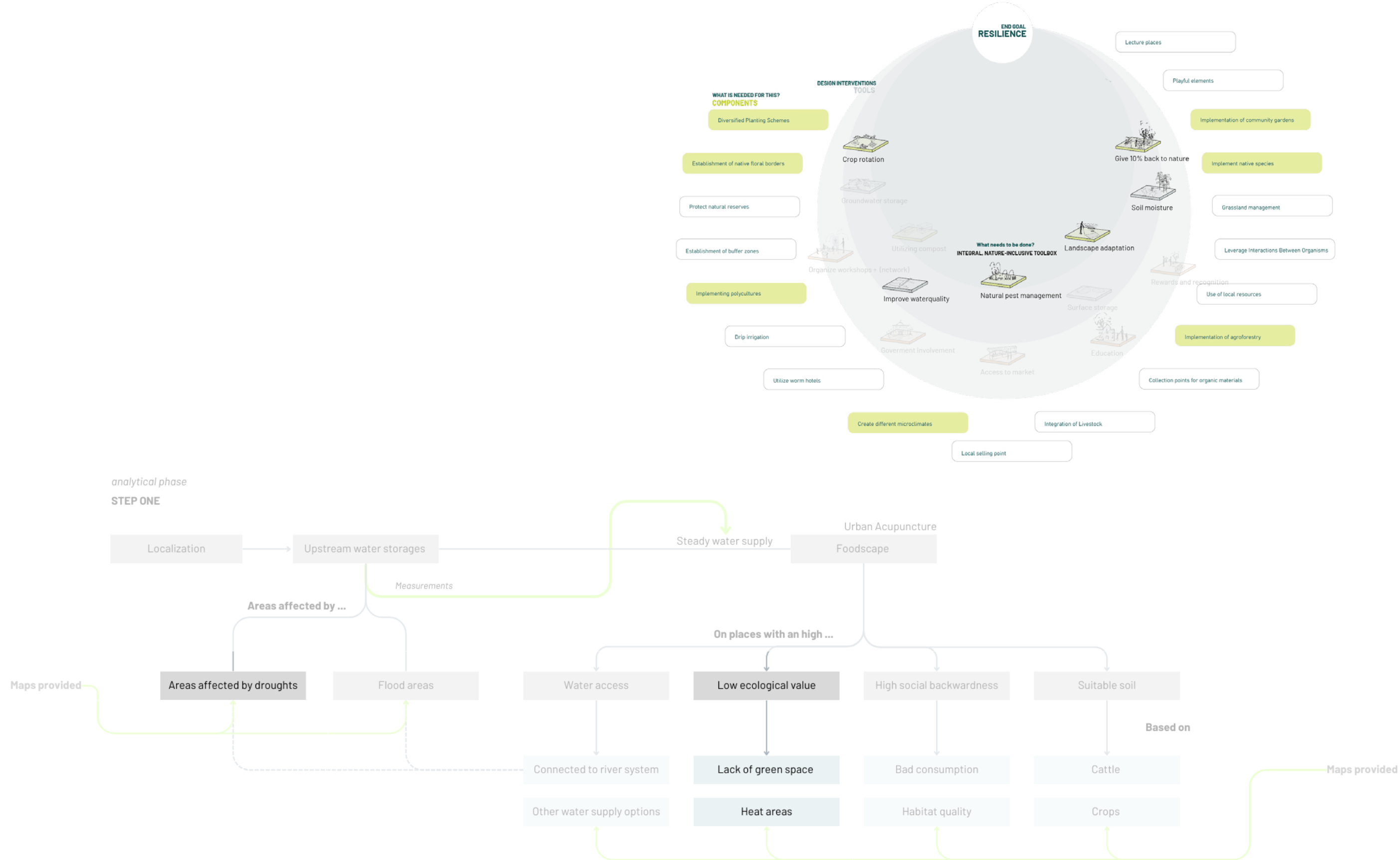
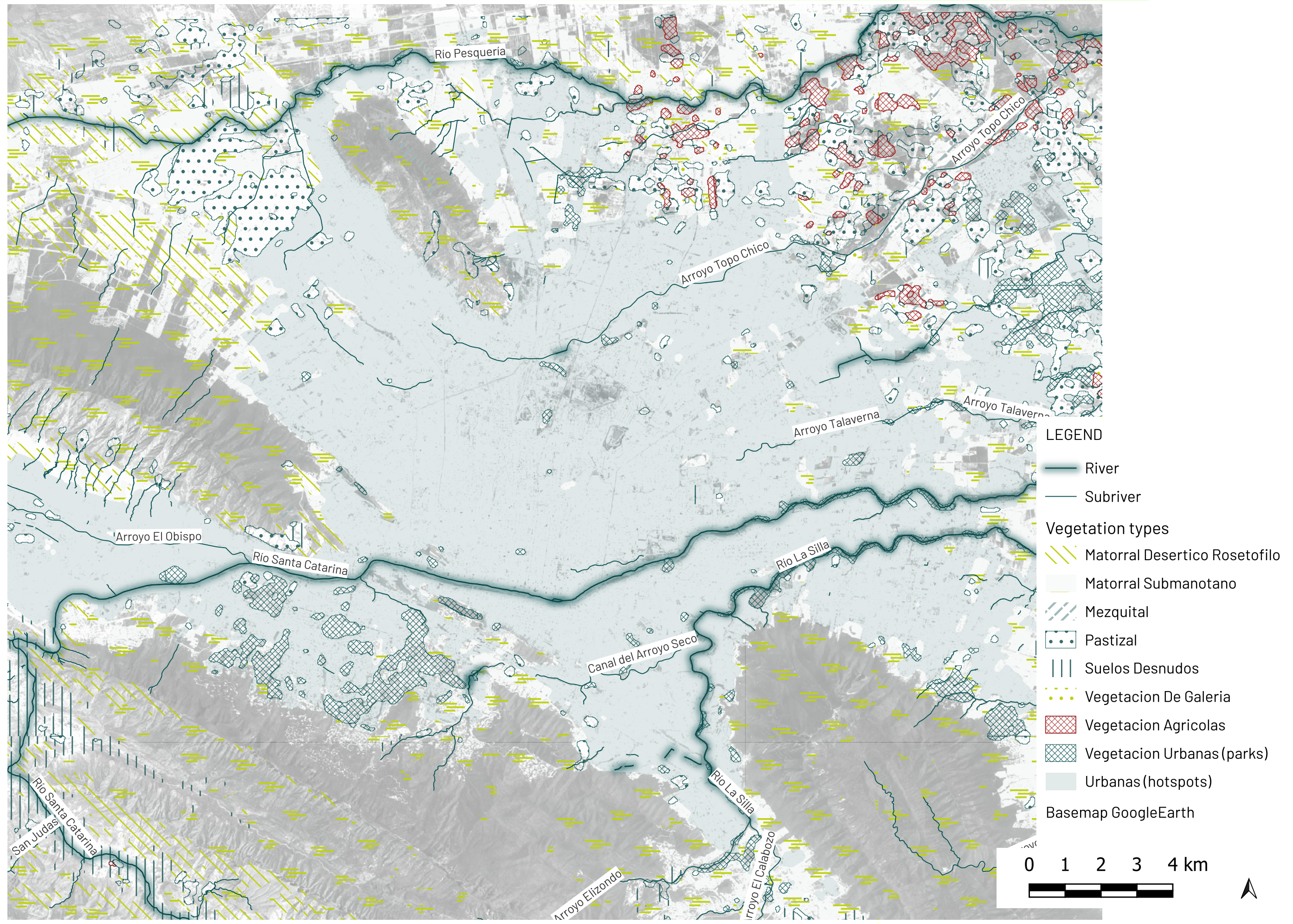
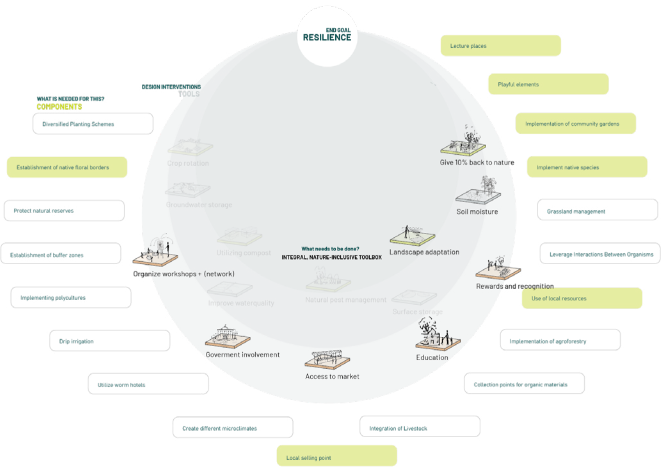
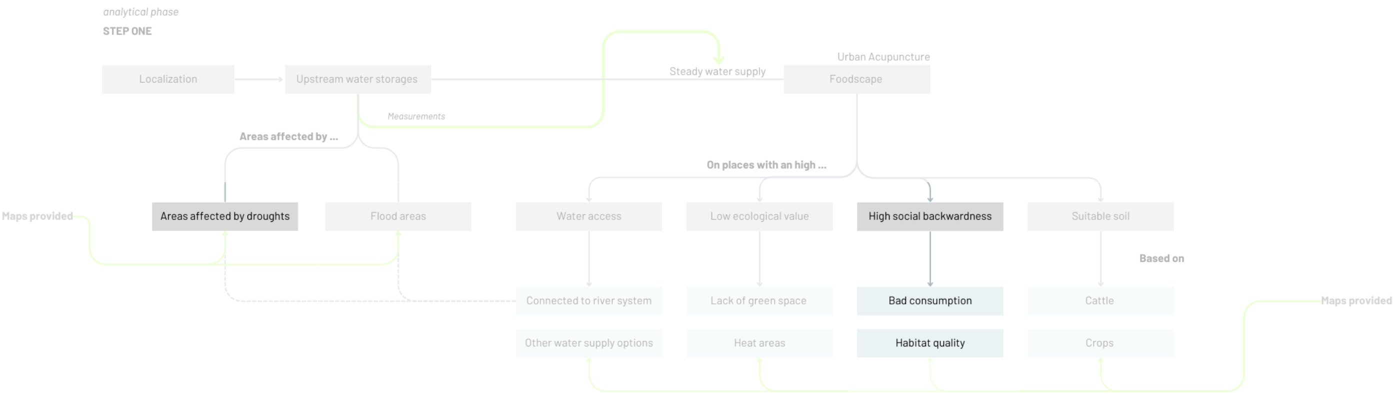
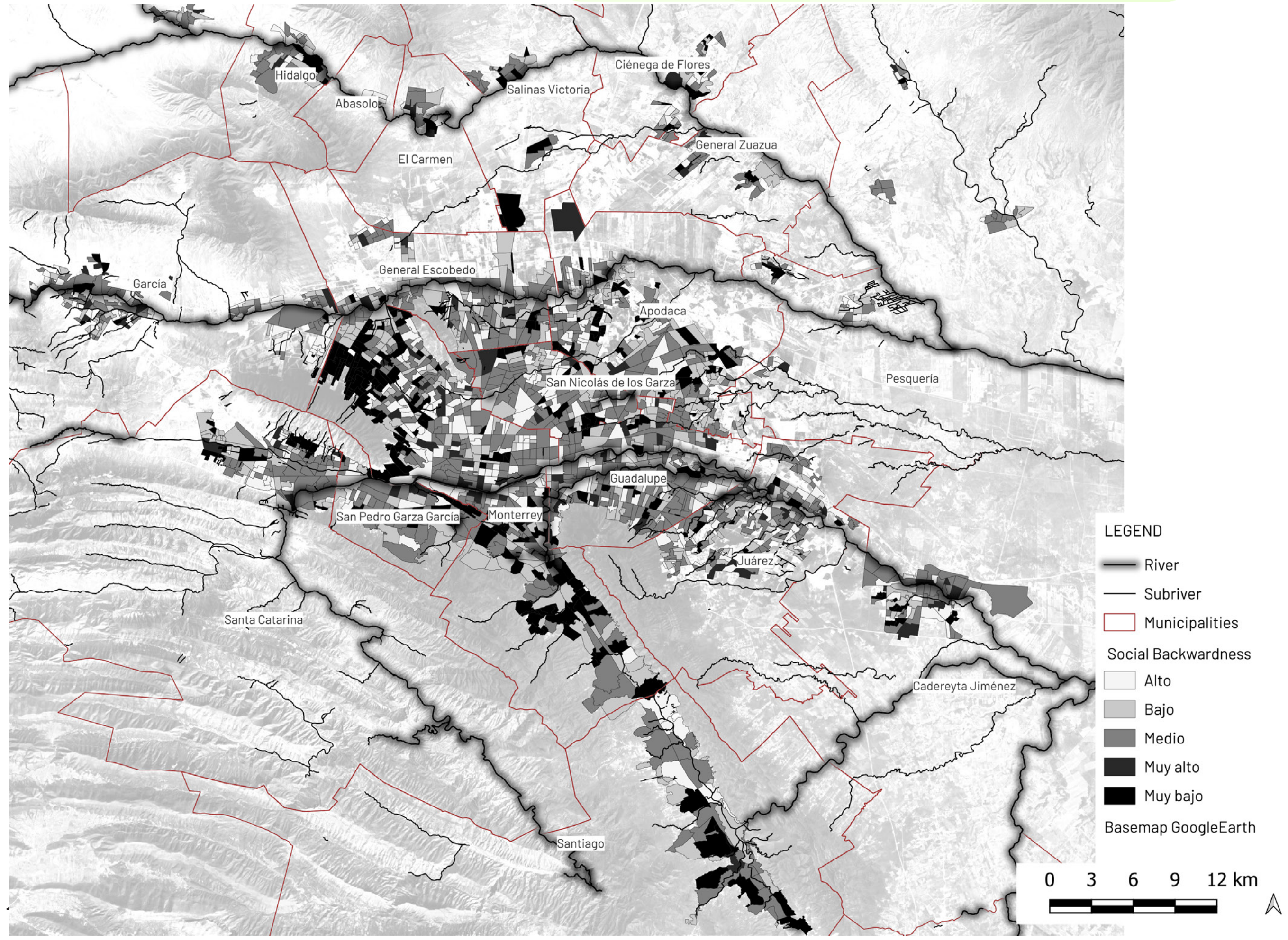
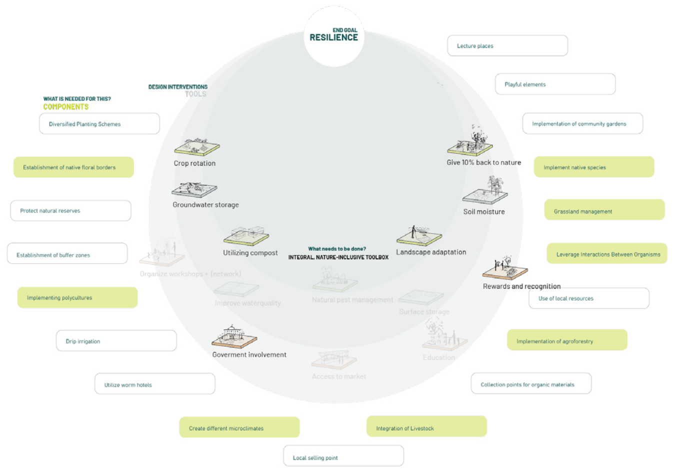


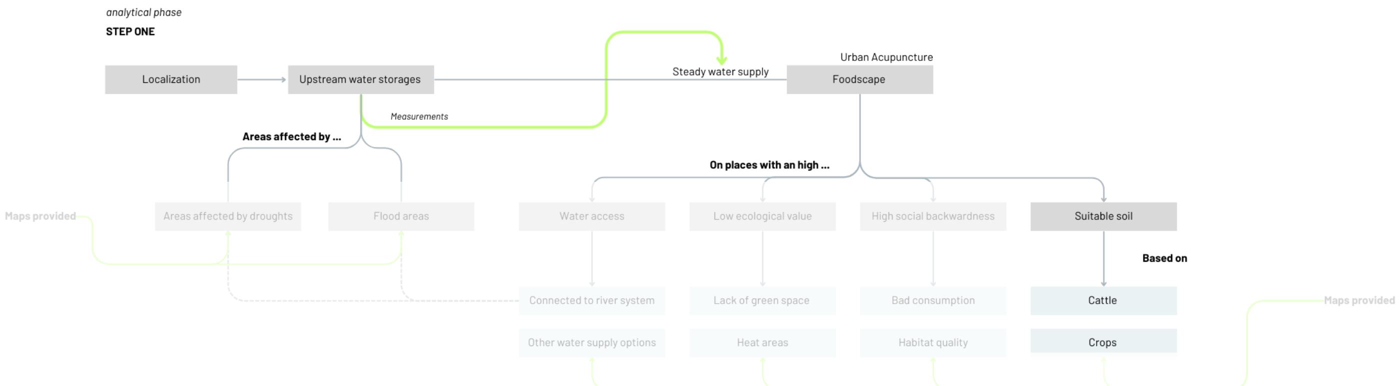


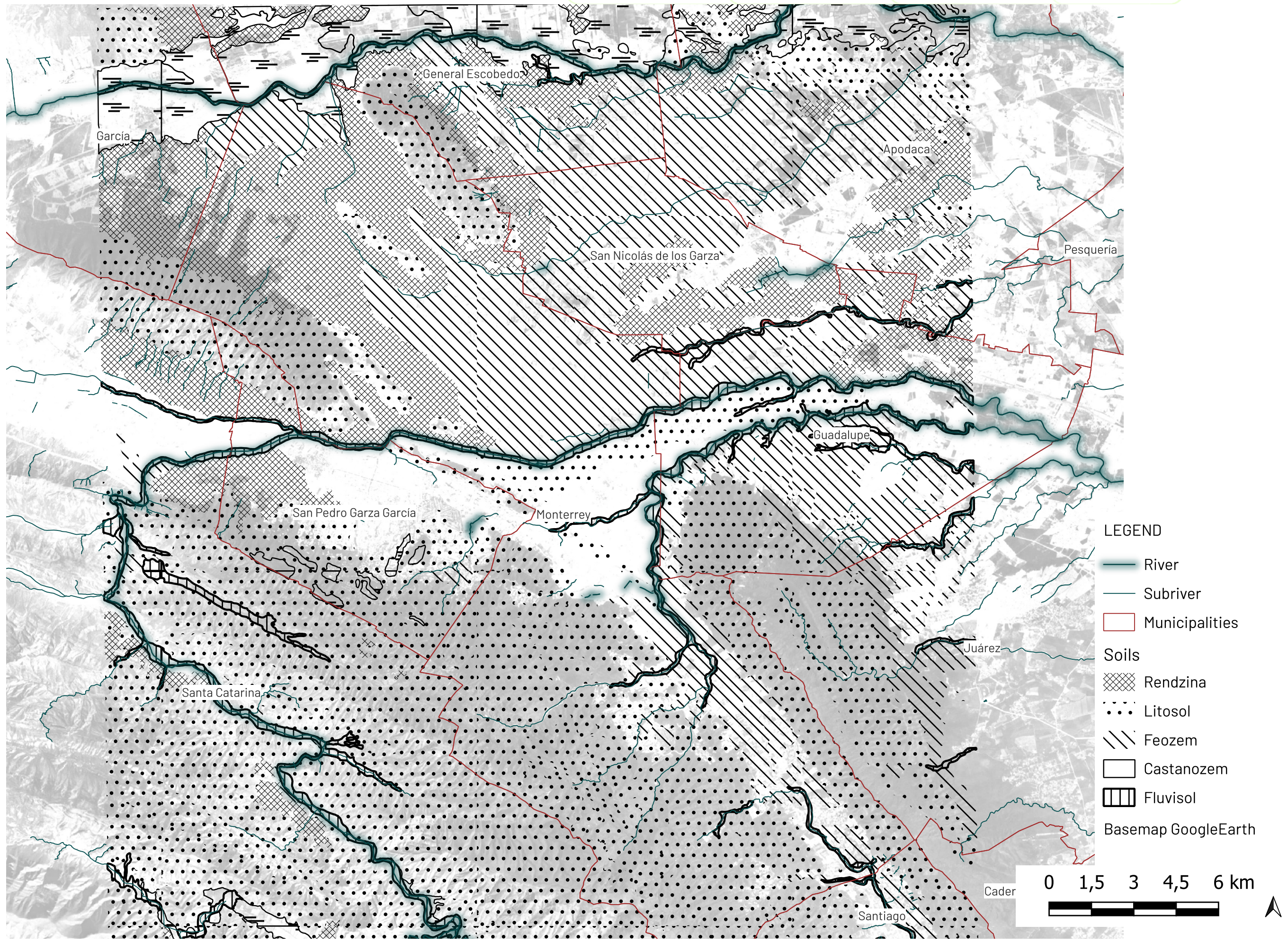

RESILIENCE
Give 10% back to nature
Soil moisture
Landscape adaptation
Organize workshops + (network)
Rewards and recognition
Government involvement
Access to market
Education


analytical phase
STEP ONE
Localization
Upstream water storages
Steady water supply
Urban Acupuncture
Foodscape
Measurements
Areas affected by ...
On places with an high ...
Maps provided
Areas affected by droughts
Flood areas
Water access
Low ecological value
High social backwardness
Suitable soil
Based on
Connected to river system
Lack of green space
Bad consumption
Cattle
Maps provided
Other water supply options
Heat areas
Habitat quality
Crops


Hidalgo
Abasolo
Salinas Victoria
Ciénega de Flores
General Zuazua
El Carmen
Garcia
General Escobedo
Apodaca
Pesquería
San Nicolás de los Garza
Guadalupe
San Pedro Garza García
Monterrey
Juárez
Santa Catarina
Cadereyta Jiménez
Santiago
LEGEND
River
Subriver
Municipalities
Social Backwardness
Alto
Bajo
Medio
Muy alto
Muy bajo
Basemap GoogleEarth
0 3 6 9 12 km







Kastanozem
Kastanozems are soils abundant in humus, initially covered by early-maturing native grassland vegetation, resulting in a distinctive brown surface layer. These soils are typically located in semi-arid areas with rainfall ranging from 200 to 400 mm (8-16 inches) annually, often adjacent to arid regions like southern and central Asia, northern Argentina, the western United States, and Mexico. Kastanozems are primarily utilized for irrigated farming and grazing purposes (The Editors of Encyclopaedia Britannica, 2000).

Phaezom
Phaeozems feature a top layer abundant in humus, naturally covered with lush grass or deciduous forest vegetation. These soils are highly suitable for cultivation and are utilized for growing crops like wheat and soybeans, as well as for grazing cattle. Additionally, they are utilized for wood and fuel production (The Editors of Encyclopaedia Britannica, 2000b).

Rendzina
Rendzina soils typically pose challenges for agricultural purposes. Their shallow depth inhibits effective mechanical tillage, while their limited soil volume restricts water storage and distribution capabilities. Moreover, these
soils frequently occur on sloped terrain, exacerbating the risk of erosion (Loveland, 2013).

Litosol
Because of their shallow depth or high rock content, these soils have good drainage, leading to low water retention. Lithosols or leptosols are limited in their agricultural use primarily due to their shallow depth and stony nature. Nevertheless, with appropriate management practices, they can be made productive for specific crop cultivation and forestry purposes (Castro, 2020).

Fluvisol
Fluvisols are commonly located in flat areas that experience occasional flooding from surface water or groundwater, such as river floodplains, deltas, and coastal plains. These soils are suitable for growing crops without irrigation or for cultivating rice, and they also serve as grazing land during the dry season (The Editors of Encyclopaedia Britannica, 2000a).

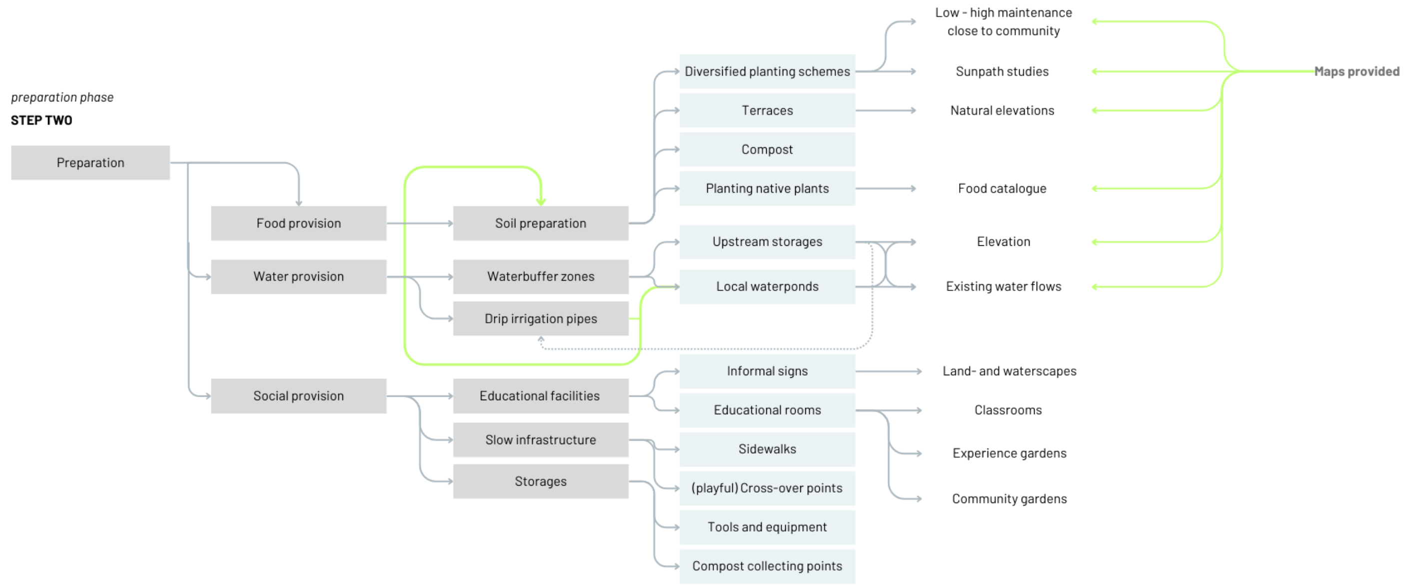


Figure 112: Strategy step two by author.

Overview.

Strategy

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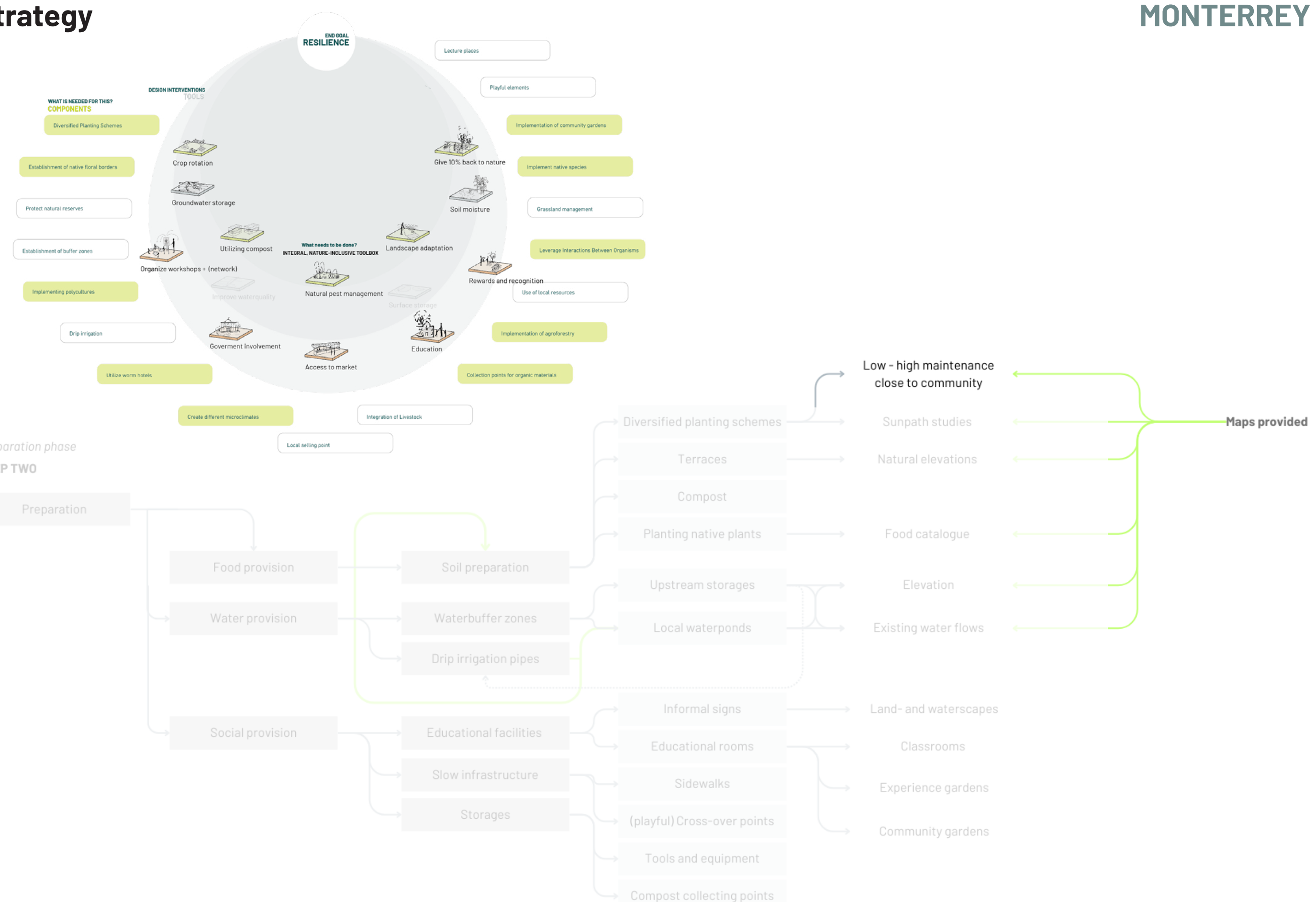

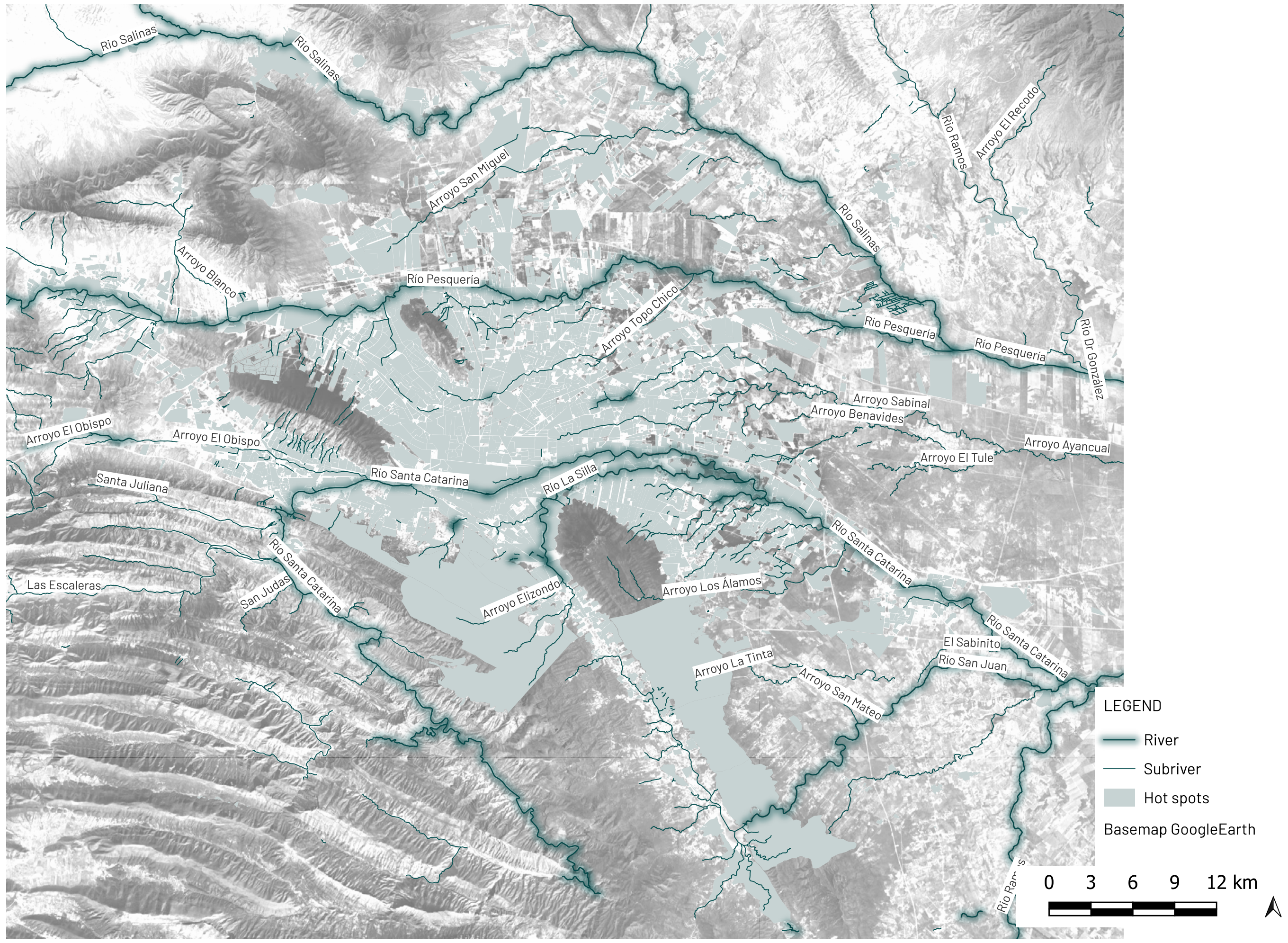

Strategy

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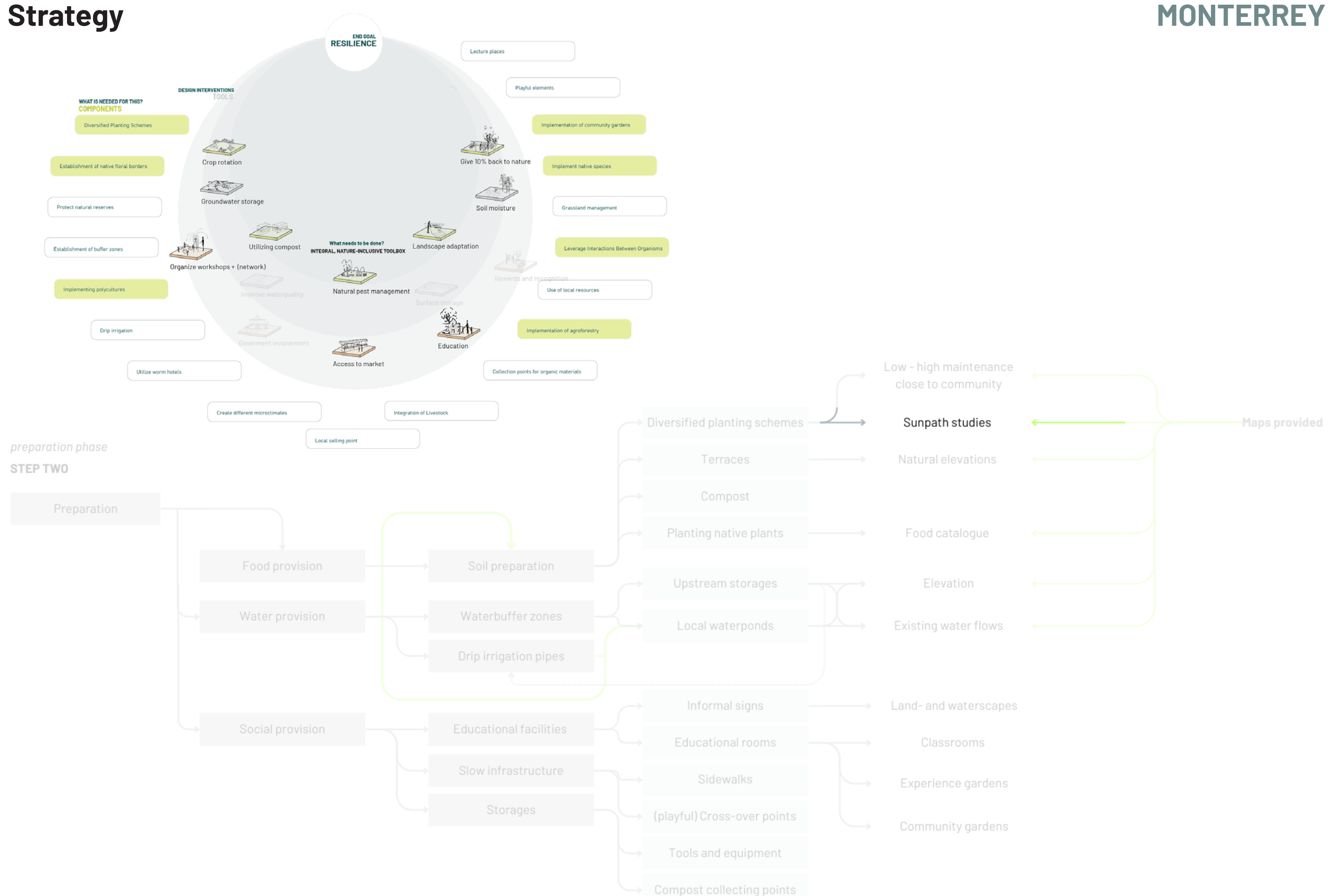

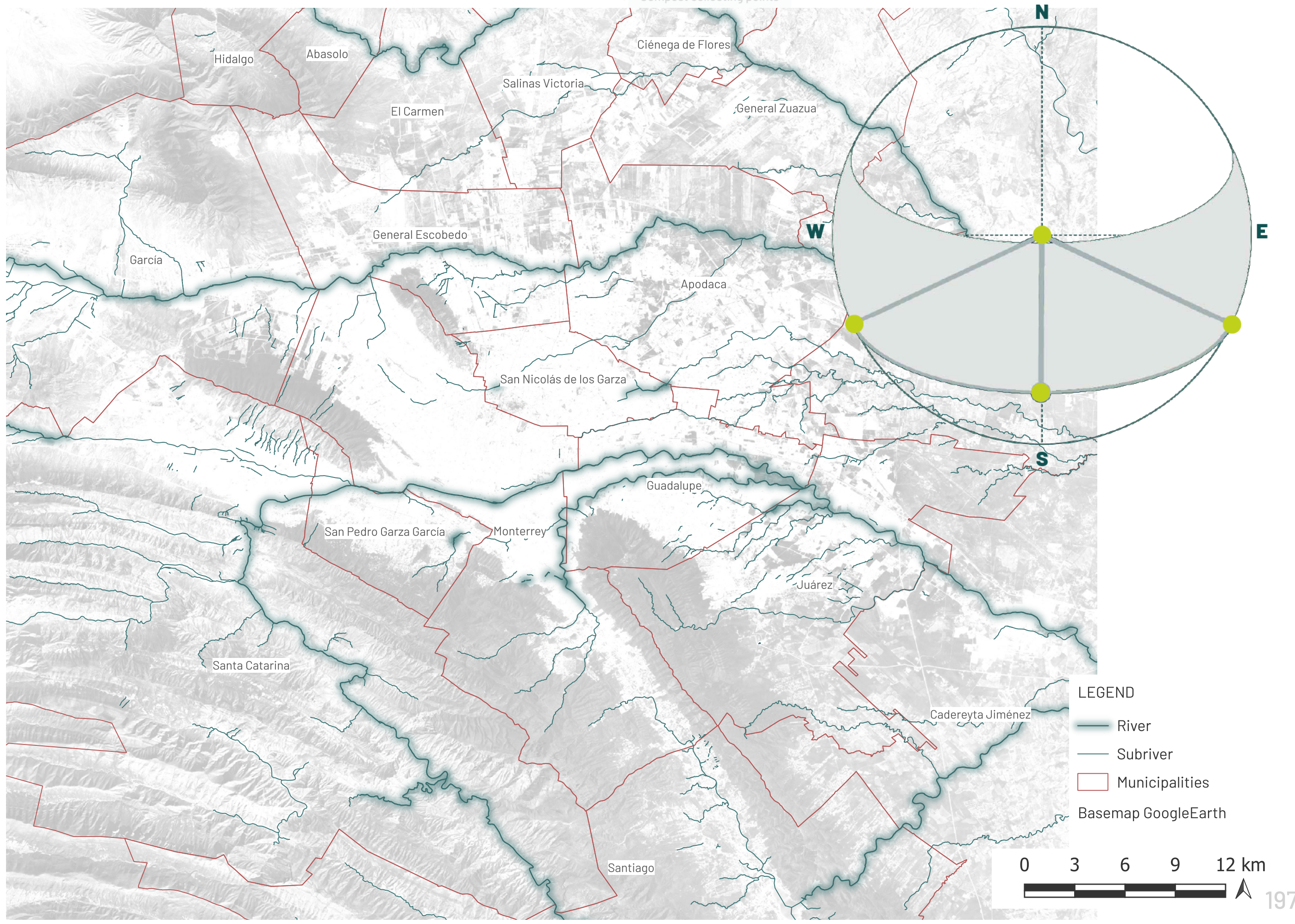

Overview.

Strategy

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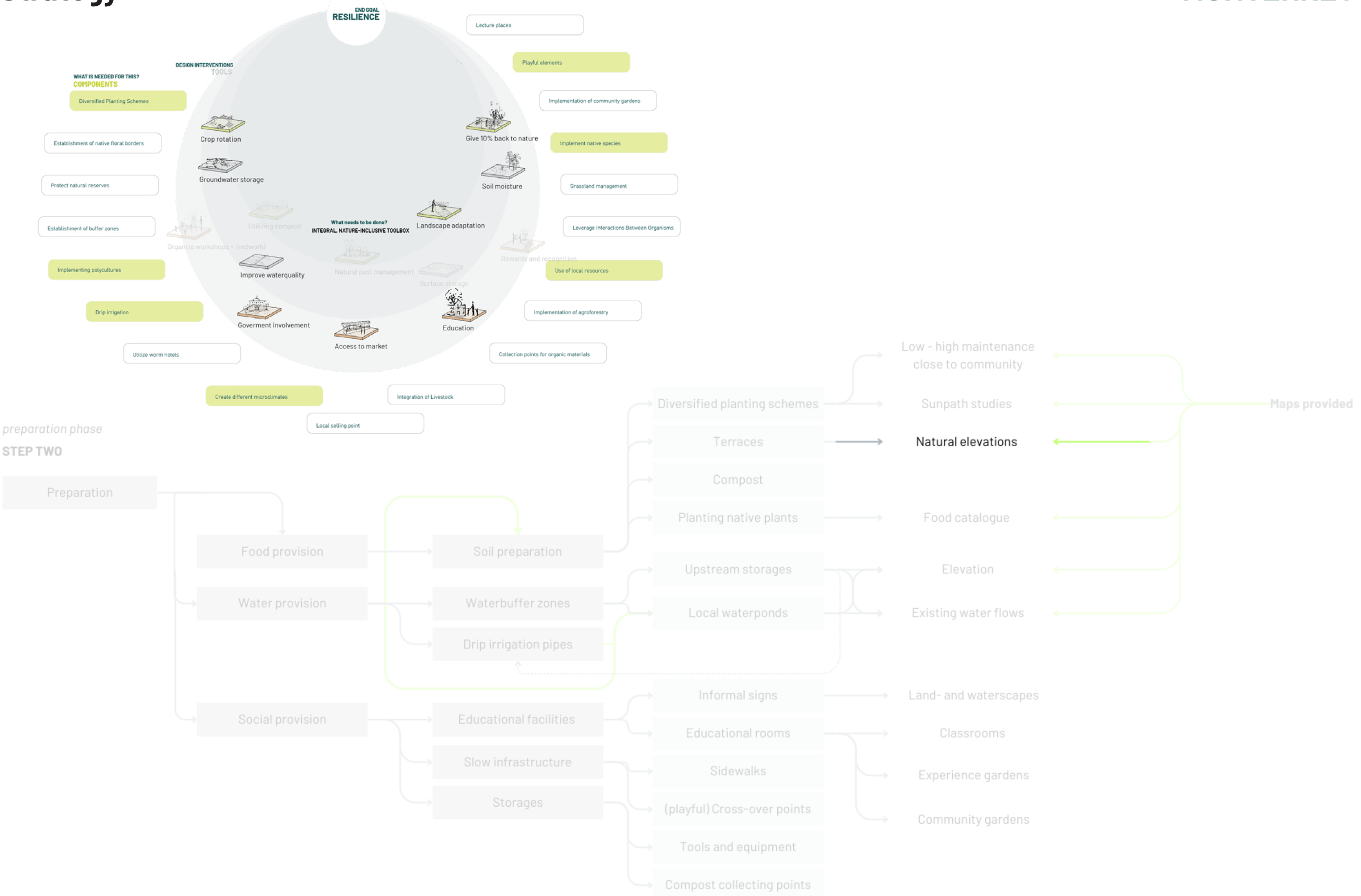

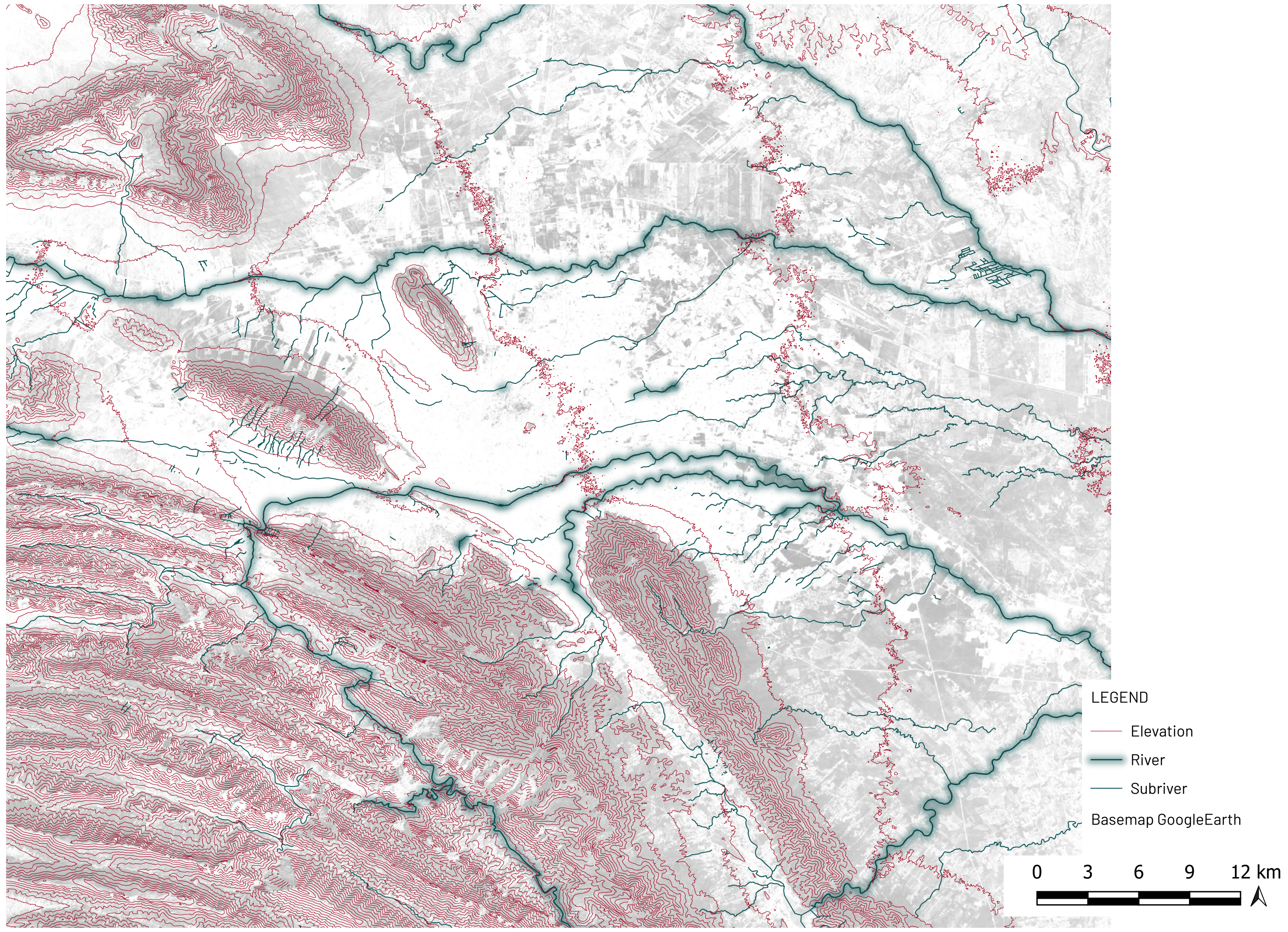

Strategy

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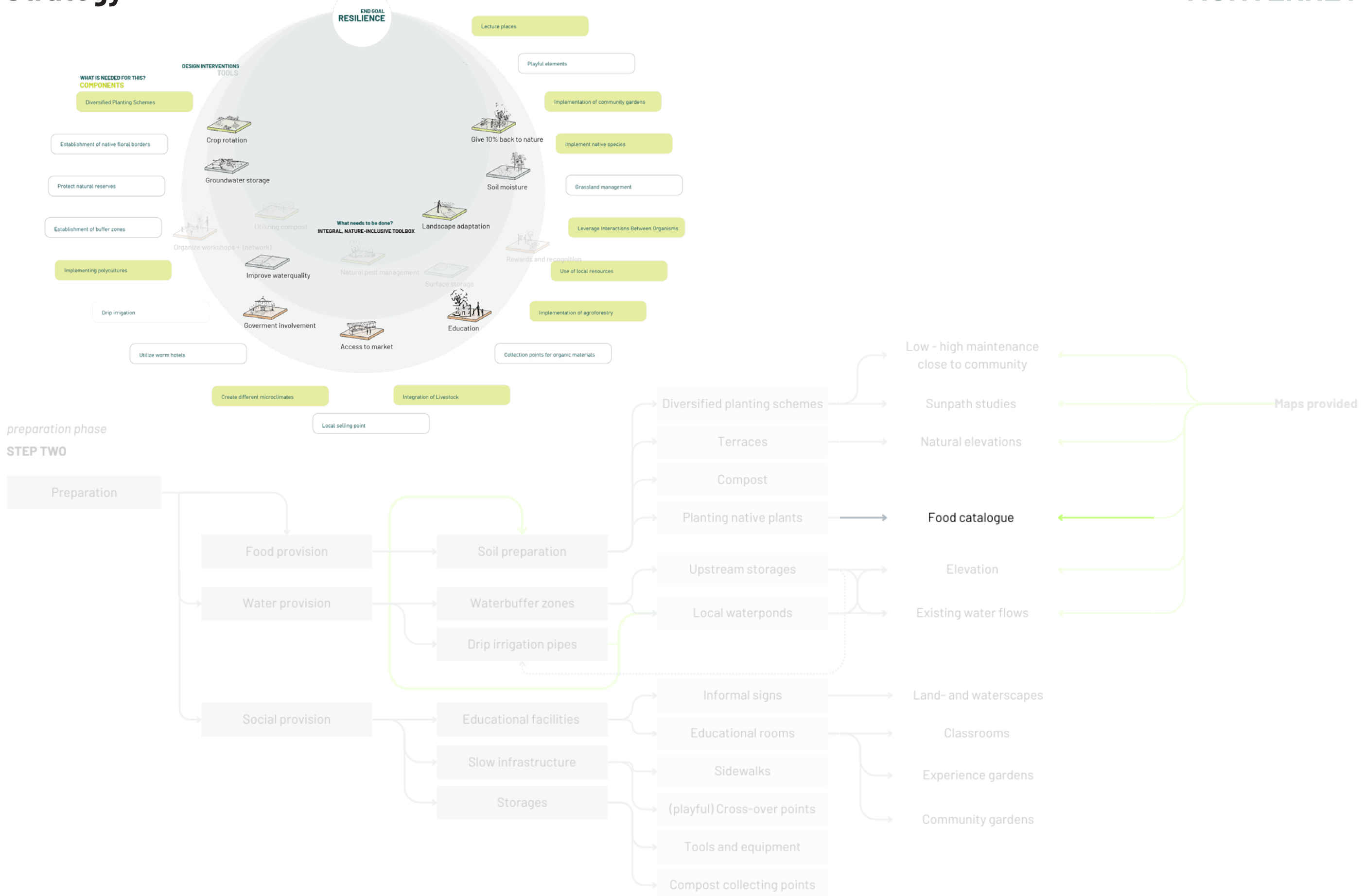
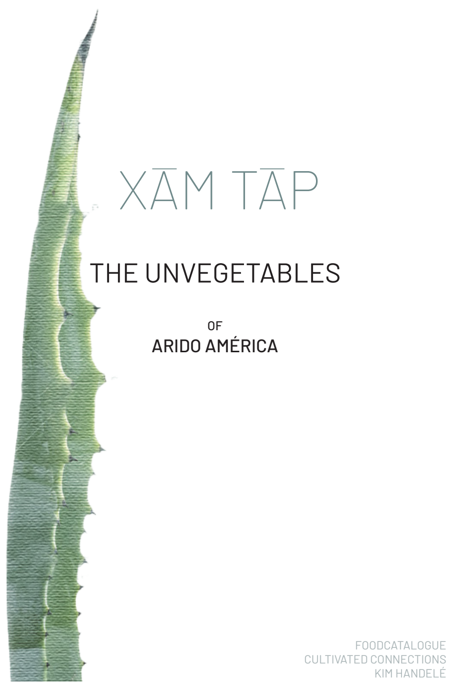
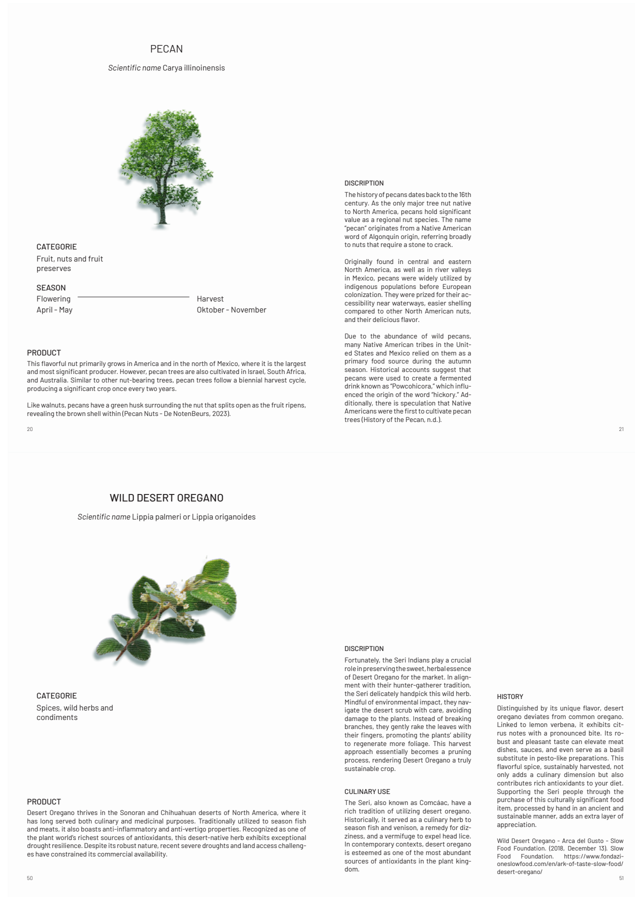
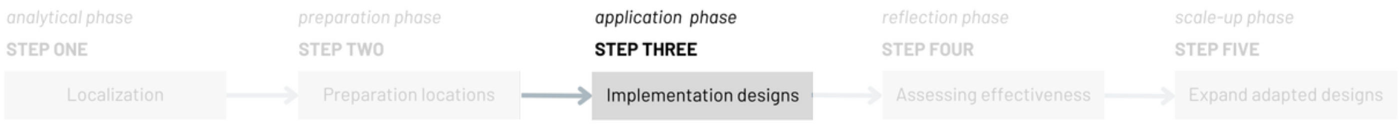




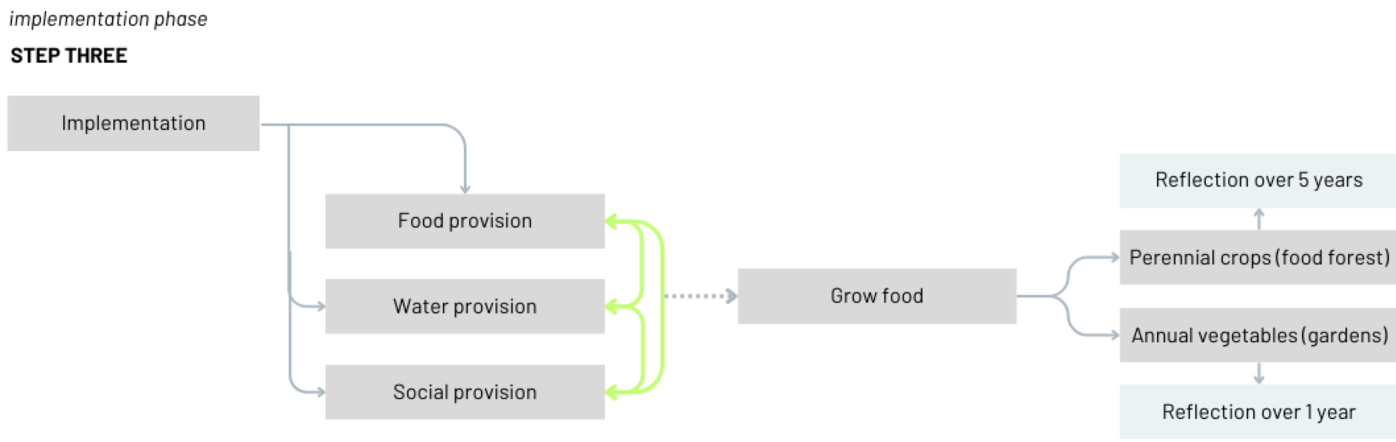


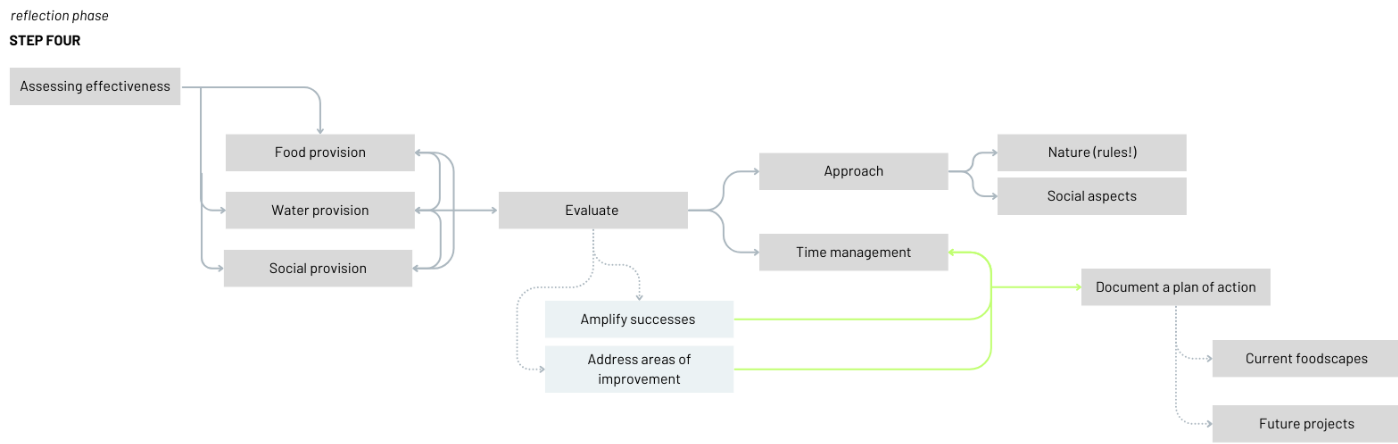
Overview.

Strategy



Strategy





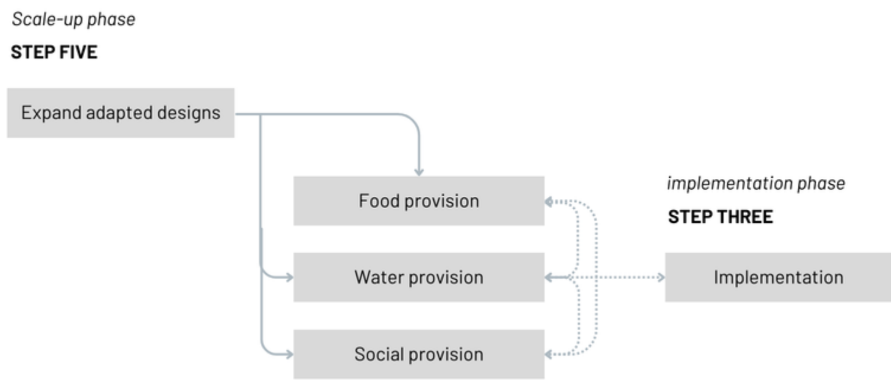


Figure 113: Strategy step three, four and five by author.

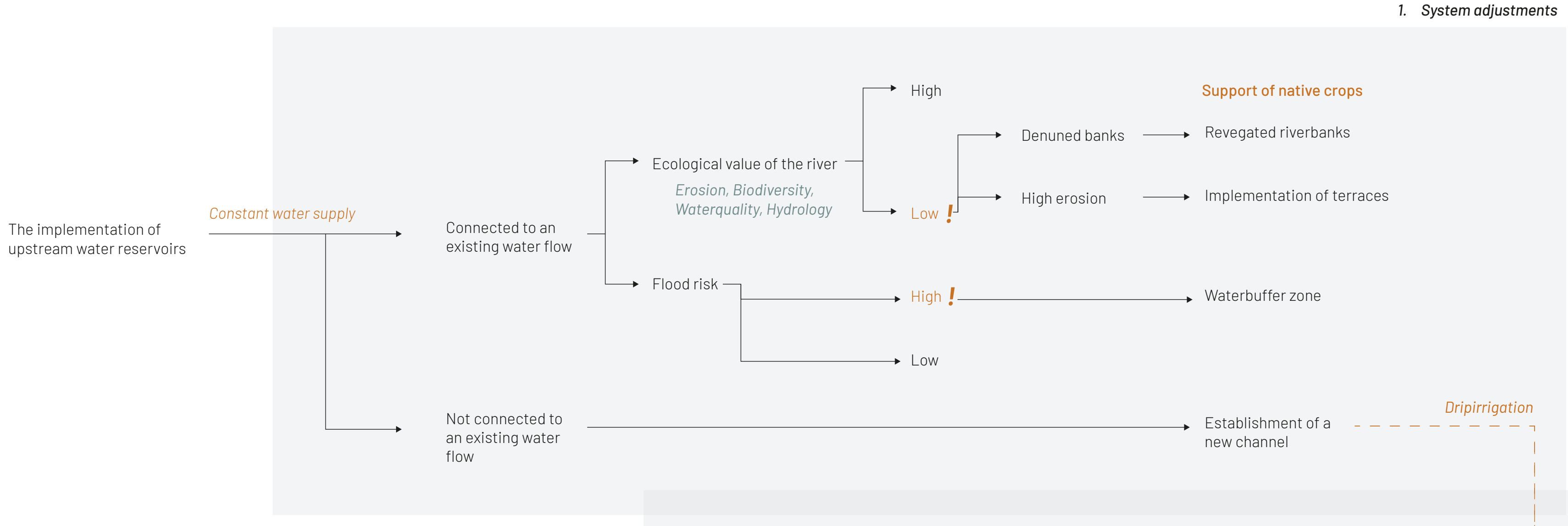
Overview.

The application of the toolbox is integrated into this strategy as a recommendation for the city of Monterrey. It serves as a guideline and step-by-step plan for further implementation. Without a proper water system, the plan cannot succeed. With flooding and water scarcity, vegetation cannot thrive. Therefore, it is crucial to address the water system on a large scale and ensure the city has a constant supply of fresh water. If the location is situated near an existing water flow, the flood risk should be analyzed and anticipated with a water buffer zone.

When the ecological value of the river (erosion, biodiversity, water quality, and hydrology) is low, implementing terraces on the riverbanks can resolve this issue. Greening the riverbanks also contributes to improved ecological value. If the area is not near an existing water flow or is affected by heavy pollution, a new channel (drip irrigation) should be constructed to support irrigated farming in the next step of the strategy. This approach is applicable to various soil types in peri-urban zones. Other practices such as grazing, creating water bodies, and forest growth are more suitable for different soil types. It is essential to establish regional policies to achieve this, such as dedicating 10% of land back to nature and reducing or eliminating pesticide use.

By investing in these elements, the administration can create a more resilient landscape, which will repay the investments by mitigating current issues. In the central areas of the city, space must be managed differently, as land is scarce and densely populated. This makes it an ideal location for community involvement. If available open spaces are larger than 2 hectares, a true food forest can be developed. Because people live further away from these areas, it is important to focus on perennial crops that require little maintenance. Community gardens are more suitable for areas between 0.5 and 2 hectares, where local residents can directly participate, making annual local crops more appropriate. For spaces under 0.5 hectares, vertical farming is more efficient and can meet specific crop demands, such as those from restaurants.

In the third step, the role and purpose of the location should be determined in relation to the residents of Monterrey. Different typologies should be matched to each area to create a suitable design that contributes both ecologically and socially, all centered around a well-functioning water system.



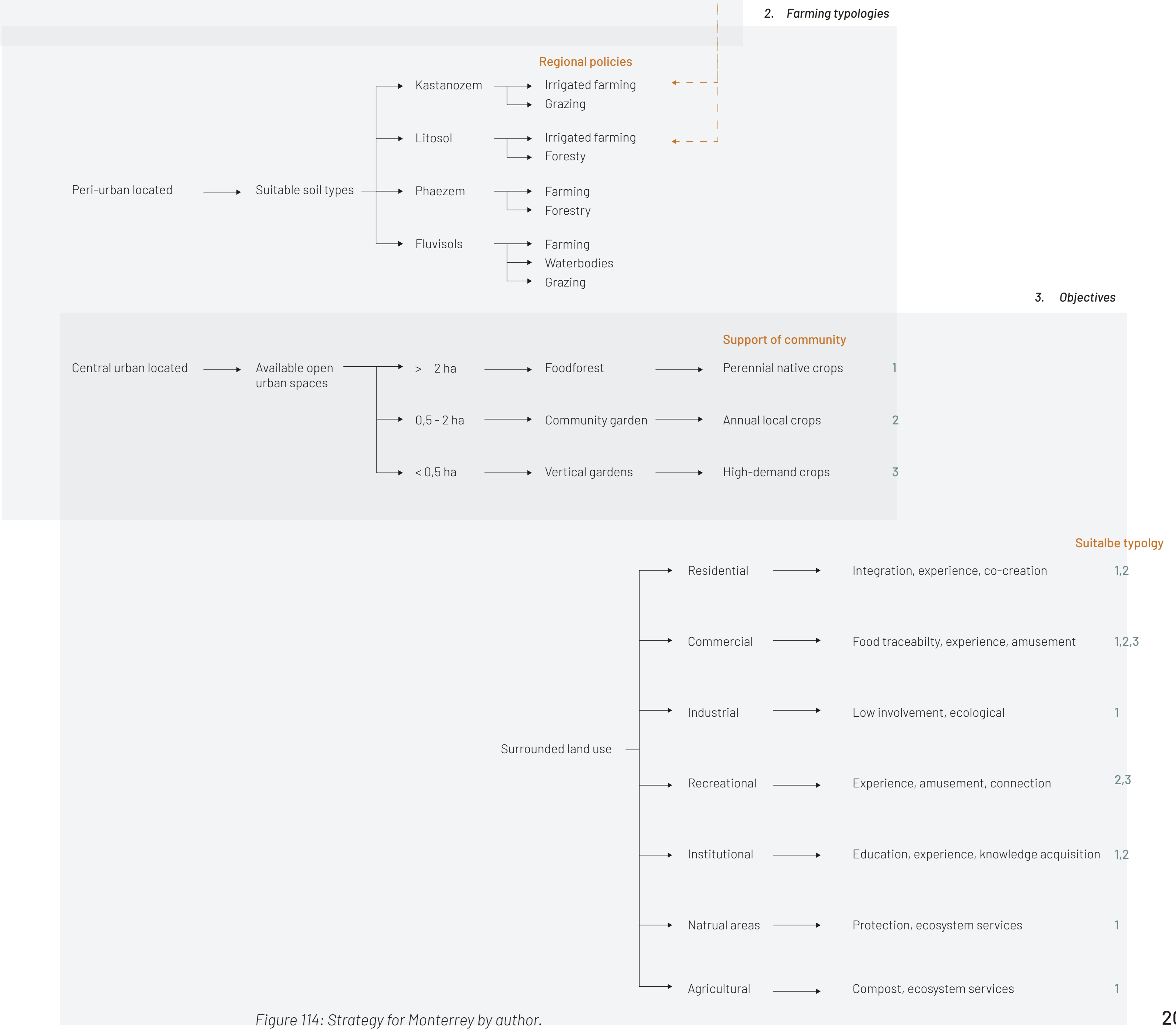


Figure 114: Strategy for Monterrey by author.

Overview.

The toolbox presented in this study demonstrates its applicability on a larger scale, particularly in regions facing similar challenges to Monterrey, Mexico. Situated in a semi-arid climate, Monterrey grapples with a multitude of issues stemming from rapid urbanization, including droughts, floods, health concerns, and heightened vulnerability to climatic and political events. In response to these complex challenges, the study proposes an integrative model of nature-inclusive urban agriculture, which effectively addresses the intricate interplay of ecological, water, and social dynamics within the urban landscape. By incorporating heritage crops and techniques, this model strengthens the connection between humans, nature, and food production.

Employing a multi-level approach that integrates bottom-up and top-down strategies, the study refines this model into a comprehensive toolbox and applies it across various locations in Monterrey. Three distinct foodscapes are strategically designed across the cityscape to enhance resilience against environmental stressors. Importantly, the toolbox transcends geographical boundaries, offering valuable insights and methodologies applicable to other regions grappling with similar challenges in (semi-)arid climates.

By synthesizing perspectives from diverse regions and engaging stakeholders at various levels, this approach facilitates community adaptation and resilience amidst changing environmental conditions. Furthermore, this research not only contributes to academic discourse but also offers tangible solutions with significant potential to enhance the resilience and sustainability of cities in semi-arid areas worldwide.

In conclusion, with approximately 30% of the Earth's surface covered by arid and semi-arid regions, it is imperative to acknowledge that climate patterns and their variability will exert a substantial influence on these areas. By leveraging adaptable strategies like the nature-inclusive urban agriculture model and its accompanying toolbox, cities can proactively mitigate the impacts of climate change and foster sustainable development in semi-arid regions.

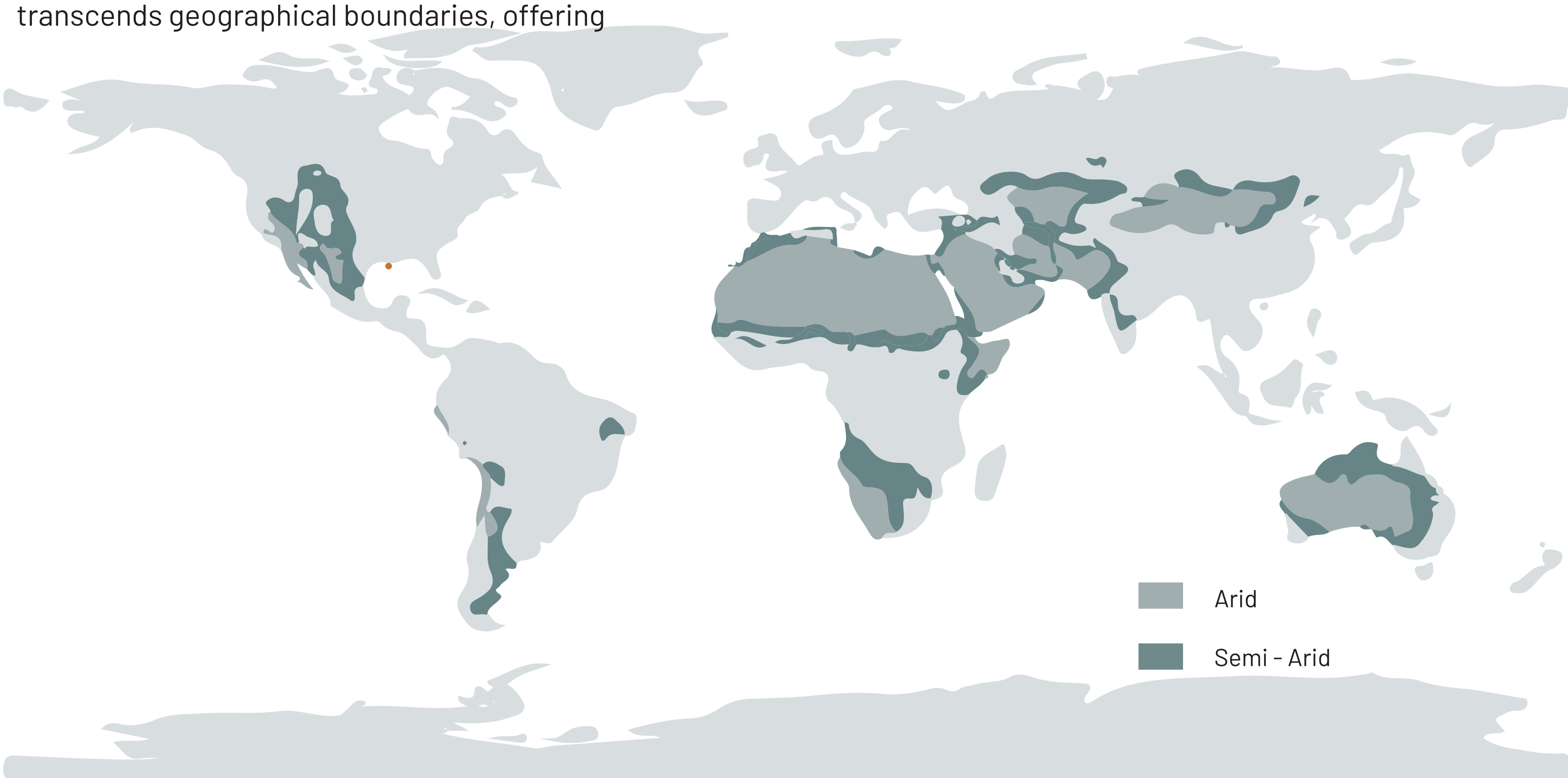


Figure 106: Global arid and semi-arid climates. (Herrmann et al., 2013)

Figure 115: Development and goal drawings by author.

Flowscapes is the name of the landscape architecture graduation studio. The term describes the interaction between people and their environment and the relationship between 'flows' and 'scapes'. Flows refer to processes, specifically, how the interaction occurs between human and natural systems. Within this graduation project, these systems are merged into an integral model to consider the human system as part of the natural system. Ultimately, nature always takes the lead. 'Scapes' refer to spatial entities. This research focuses on the elaboration of various foodscapes throughout Monterrey to provide an essential service of food provisioning. Other aspects are also considered, such as sociocultural aspects like education and health, as well as larger-scale regulation, addressing climate phenomena such as floods and droughts through the implementation of foodscapes.

This reflection is divided into different 'flows'. First, I examine the project itself for context within the graduation project flow, then I zoom out to consider the working process from the perspective of landscape architecture in the bigger flow, and finally, I reflect on the personal process in the personal flow.

The Graduation Project Flow
The first chapter depicts the challenges faced by the metropolis of Monterrey. The illustration is based on various analyses conducted through desk research and on-site visits to the area. The second drawing focuses on the outcome of the design process. Here, the theoretical framework was utilized to translate the identified problems into solutions. On-site visits were essential for this stage to implement detailed and thorough design interventions tailored to the specific location.

Existing knowledge and practices have translated into a toolbox for an integrated plan encompassing various scales and factors such as ecology, water, and social aspects. Direct solutions have been devised for the identified problems. However, these specific solutions also have an impact on other factors. Therefore, an integrated plan is crucial, where different interventions are juxtaposed to design with a fully comprehensive strategy in mind.

The Bigger Flow
For the landscape architecture graduation studio, four perspectives have been formulated. These four perspectives serve as the framework for reflecting on the graduation research. Each perspective offers a unique lens through which the research findings can be examined and understood. This reflective process allows for a comprehensive analysis of the research outcomes, considering various aspects and dimensions. By employing these perspectives, a deeper understanding of the research's implications and significance can be gained, contributing to the advancement of knowledge in the field of landscape architecture.

The four perfectives:
Perspective 1
Landscape as spatial-visual perception
For the design of Cultivated Connections, the design is not solely based on human experience. The visual form of the landscape has therefore emerged based on sensory experiences of various factors. Consider for example plants, soil, water, trees, animals, and so on. All of these factors are interconnected. A design of visual form based on human sensory experience is not appropriate for this thesis project. The goal is for humans to become more integrated into the natural system, rather than assuming the human system separately from the natural system.
To maintain the 'sensory experience' of the natural world as a starting point (and to see humans as part of it), ecology, water, and social aspects are the components on which this research is based. It translates into systems, from regional scale to individual, where plants collaborate and water is no longer seen as a conflict. Humans become part of the water- and food system, enriching the soil and making the landscape (and thus also the residents) more resilient.

Perspective 2
Landscape as palimpsest
A palimpsest refers to a manuscript page where the original text has been erased or obscured, typically because the page has been reused multiple times. Despite the erasure, faint traces of the previous layers of writing remain visible on the current surface. This concept extends beyond manuscripts and is often employed in landscape architecture to describe the historical layers of a landscape, each layer bearing evidence of the events and processes that have shaped the current terrain.
In the case study of Monterrey, efforts are being made to uncover deeper historical layers within the landscape. Due in part to industrialization, the connection between humanity and nature has become attenuated. Recognizing that nature ultimately prevails, it becomes imperative to reestablish this connection, drawing inspiration from indigenous culture. Indigenous communities historically relied on local resources and regarded nature as their guide. Therefore, an analysis of indigenous culture is undertaken, with the aim of translating its principles into contemporary design solutions.

Perspective 3
Landscape as scale-continuum
The toolbox created for this design is developed from this perspective 'Landscape as scale-continuum'. It is about connecting various scales and ecological, water, and social entities. The toolbox is widely applicable across different scales and is not site-specific. The case study in Monterrey served as a means to enrich this toolbox through the method of research by design. It provided a more detailed elaboration on previously acquired theoretical knowledge. Throughout the design process of the location, there was continuous switching between scales and various disciplines of ecology, water, and social aspects because everything is interconnected. A design intervention in one discipline automatically impacts the others. This awareness has led to the design goal of an integrated plan, where various design solutions are juxtaposed because they all influence each other.

Perspective 4
Landscape as an ecologic, economic and social process
The graduation lab of Cultivated Connections was named Urban Ecology. Here, themes such as natural systems, ecosystem services, and eco-components take center stage. The focus is on improving the quality of life and environment in urban landscapes. Because it involves natural processes, it automatically becomes a dynamic design, an interaction between the biotic and abiotic. This graduation lab and its tutoring are primarily viewed through this lens. For Cultivated Connections, design principles have been established to enhance the ecological value in the metropolis. This translates existing design interventions, such as terrace agriculture and food forests, into an integrated plan with spatial elaboration. The design is therefore specific to the location.

Overview.

The Personal Flow

Reflecting on the feedback provided by my mentors, it is evident that each mentor contributed uniquely to the development and refinement of my project. Ulf's feedback was more theoretical and specific, providing a stable foundation upon which I could continually refer back throughout the design process. On the other hand, Nico's guidance focused more on the content and structure, particularly in terms of creating suitable drawings to effectively convey my narrative. In response to this feedback, I have translated Ulf's detailed and specific feedback directly into my frameworks, utilizing it as a guiding framework for my design decisions. For Nico's feedback, which allowed for more freedom in interpretation, I have focused on filling in gaps and ensuring coherence in the visual representations of my ideas.

Reflecting on my work process, I have found pleasure and interest in my project, particularly in its interdisciplinary nature. Despite facing setbacks, such as being cautioned that my approach might not lead to success, I remained resilient and retained confidence in my vision. I recognized the need to consolidate my ideas into a cohesive narrative, avoiding scattering my focus due to the multitude of intriguing possibilities. In terms of methodology, I have embraced a process of making choices, iterating, and zooming in and out to refine my storytelling. I have learned to ask myself what I truly want to convey through my design and to prioritize accordingly. Looking ahead, the final part of the graduation period will be filled with further refinement and implementation of my project.

To further enhance comprehensiveness, I will create a recipe book featuring indigenous crops and a scale model of the area. I will incorporate the feedback from P4 to ensure an optimal outcome during P5.

As it relates to my master track in Landscape Architecture, my project is inherently multidisciplinary, considering the interconnectedness of various scales and natural and cultural aspects of landscapes. Both bottom-up and top-down approaches are integral, as they complement each other in addressing complex landscape challenges. My research has significantly influenced my design recommendations, providing a solid foundation upon which to build and refine my ideas. Conversely, my design process has enriched my research by providing practical insights and opportunities for real-world application.

Assessing the value of my approach and methodology, I believe it has allowed for creative exploration while maintaining a structured and iterative process. This balance has facilitated meaningful progress and refinement throughout the project. In terms of academic and societal value, my project holds relevance in addressing contemporary challenges, particularly in fostering connections between people and nature. Ethical considerations, such as cultural sensitivity, have been carefully addressed through extensive research and immersion in the local context. The transferability of my project results lies in the broad applicability of the toolbox developed, despite the site-specific nature of the case study. While the project's scope may vary, its underlying principles and methodologies remain applicable in diverse contexts.

Individual reflective questions:

Where can further refinement be applied?

The scope of this research is extensive, with each facet capable of standing as an independent graduation project, encompassing aspects ranging from construction to education, policies, and ecology. Consequently, there is potential for endless elaboration. Initially, I struggled to strike a suitable balance among these factors to craft a cohesive narrative.

How was the balance between theory and case study in terms of time allocation? Is it appropriate?

There was significant emphasis on the case study, particularly guided by external mentors and amplified by on-site visits. Initially, I was concerned that there was an imbalance, with too much focus on Monterrey and insufficient attention given to developing a robust theoretical framework and toolbox. However, as the project progressed, I realized the relevance and value of the case study in reinforcing theoretical concepts. This experience marked my first conscious engagement with the principles of research by design, as I effectively linked practical insights from the case study to the theoretical groundwork laid beforehand.

All in all, I am content with the outcome thus far. While it may be challenging to accept that such a project is never truly finished, I have genuinely enjoyed the process. I have had the opportunity to meet fascinating individuals and acquire a wealth of knowledge, both in terms of content and methodology. I had hoped to conclude my academic journey with an engaging graduation project, and I am pleased to say that I have succeeded in doing so. This is also, of course, partly due to the valuable and pleasant guidance provided by my mentors. On to the next chapter!

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