

Hydrate Monterrey

Implementing green and blue infrastructure to tackle droughts and heat stress in the metropolitan area of Monterrey, Mexico

29th May 2024

P4 of Pieter van der Wel

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Content

- Introduction
- Problematization
- Methods
- Analysis & Design principles
 1. Landscape and Ecology
 2. Heat stress
 3. Hydrological cycle
- Metropolitan vision
- Spatial design
- Conclusion

The Metropolitan area of Monterrey, Mexico



Source by GIS

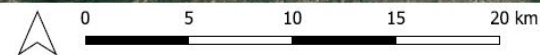


- **Semi-Arid** Environment
- **2nd biggest** Metropolis
- **Population:** 5,341,177 (2020)

[economiagov. 2023]



By Pieter



Problem: Water scarcity

Cerro Prieto reservoir 2015 and 2022

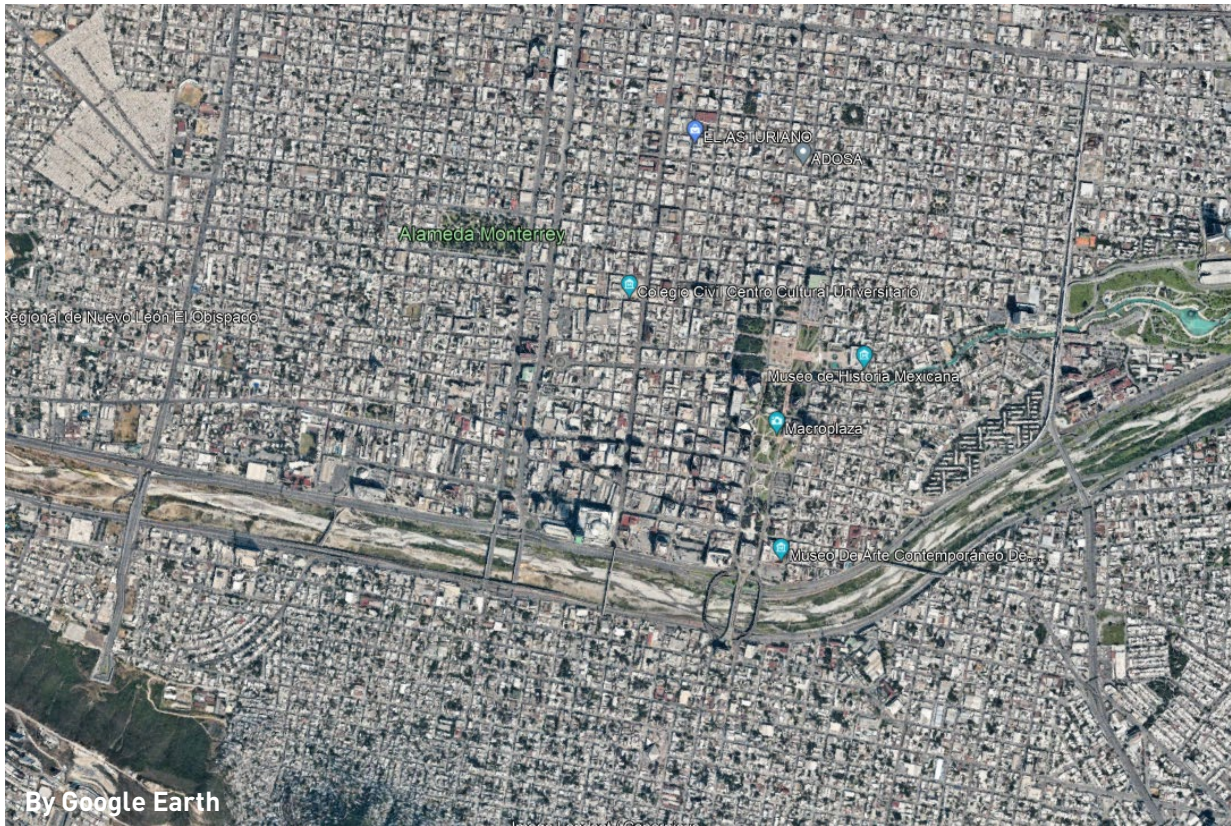


People gathering for water which is brought by trucks



Problem: Heat waves

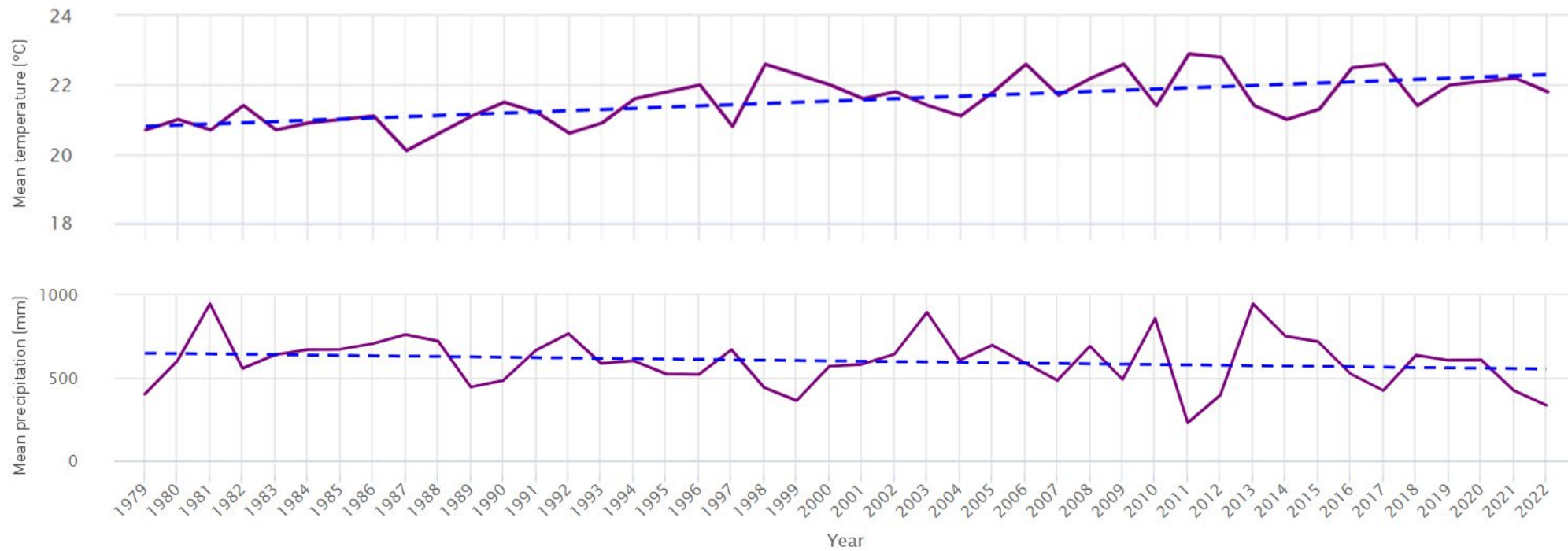
Top view urban environment centric Monterrey



Big asphalt surface area



Climate change



Expectation of more severe and frequent droughts

Trend of rising temperatures and declining precipitation in Monterrey between 1979 -2022. (Retrieved and modified from Meteoblue, 2023)

Monterrey at risk in the future

Climate change increases these problems:



Droughts



Water scarcity



Floods



Heat stress



Biodiversity loss

Problem Statement

Droughts and **heat waves** result into waterscarcity and heat stress in Monterrey whereby **residents** are facing consequences:

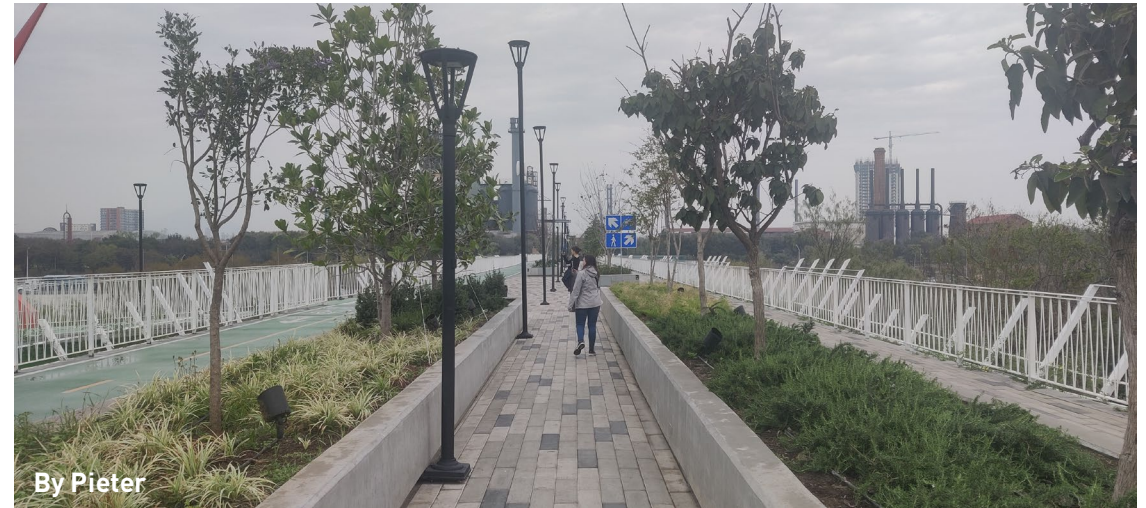
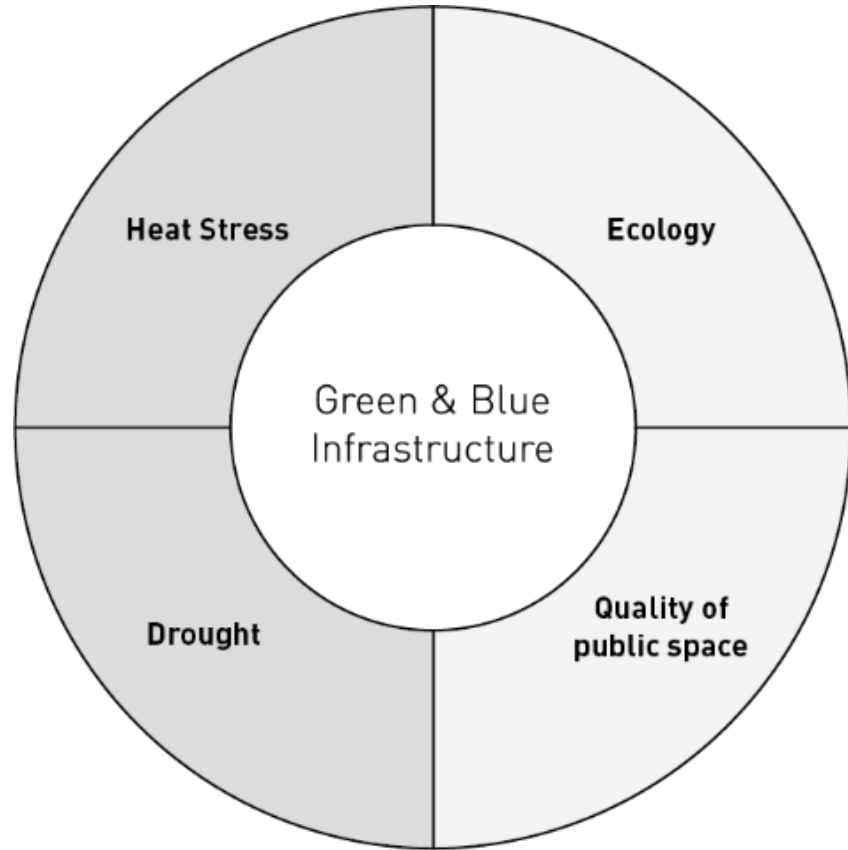
- **Waterscarcity** leads into dehydration, sickness and death.

(Tecnológico de Monterrey, 2023)

- **Heat stress** turns houses and public spaces into uncomfortable and dangerous places to live in.

(CarbonDisclosureProject, 2023)

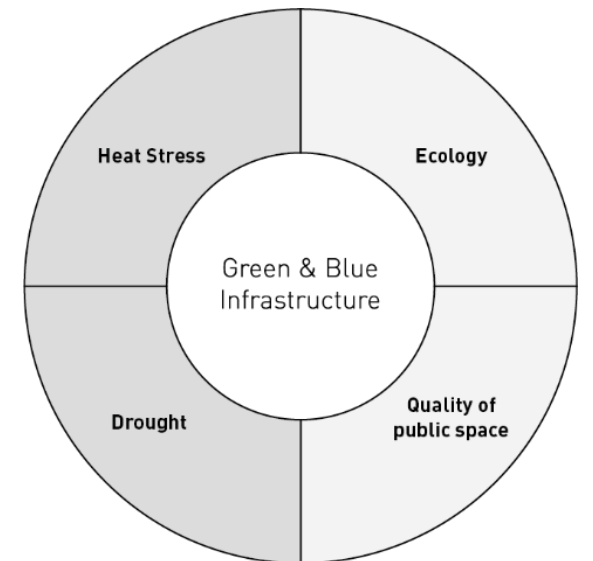
Objections



Main objective: Implementing green and blue infrastructure to tackle droughts and heat stress in the metropolitan area of Monterrey

Research question

"What spatial strategy can be used to implement green and blue infrastructure in order to tackle droughts and heat stress in the metropolitan area of Monterrey?"



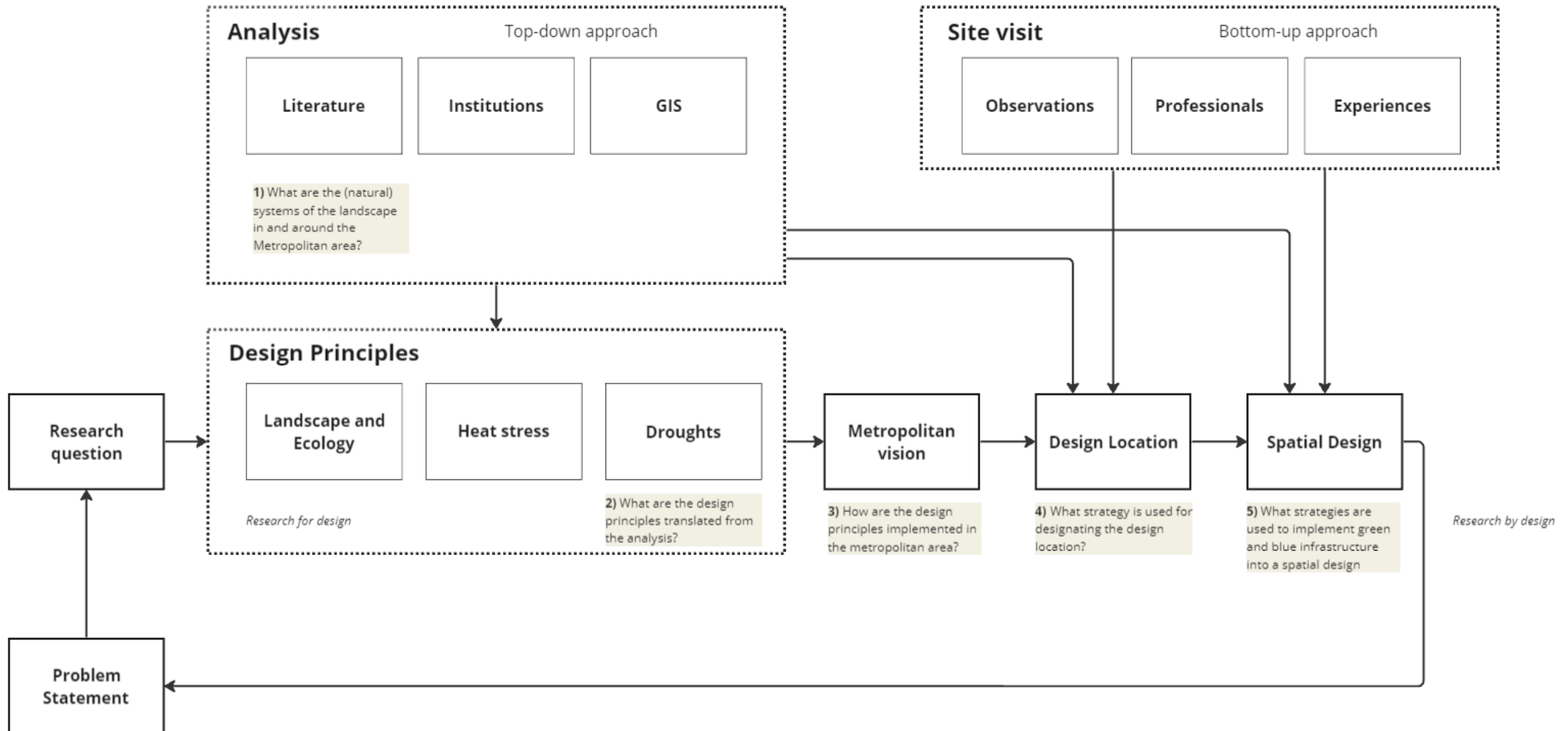
Subquestions

"What **spatial strategy** can be used to implement **green and blue infrastructure** in order to tackle droughts and heat stress in the metropolitan area of Monterrey?"

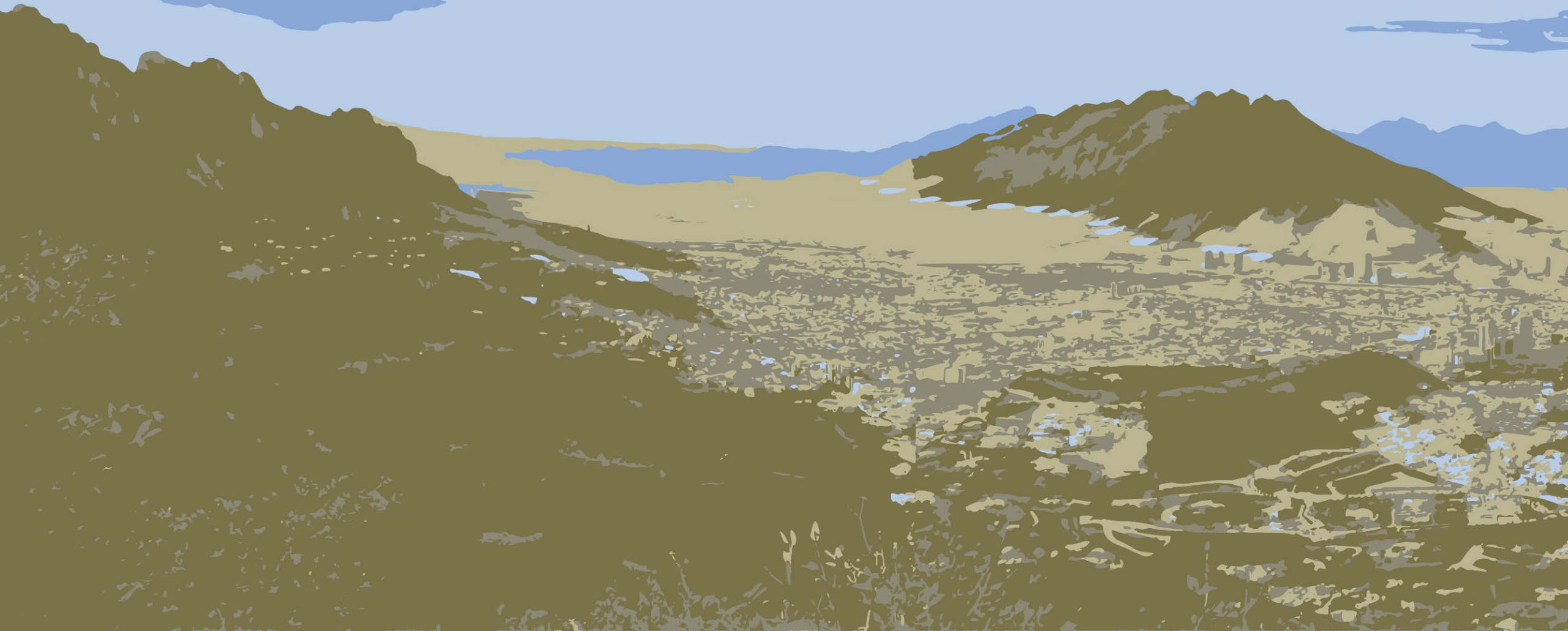
1. What are the **(natural) systems** of the landscape in and around the Metropolitan area?
2. What are the **design principles** translated from the analysis?
3. How are the design principles implemented in the **metropolitan area**?
4. What strategy is used for designating the **design location**?
5. What **strategies** are used to implement **green and blue infrastructure** into a **spatial design**

Methodology

“What **spatial strategy** can be used to implement **green and blue infrastructure** in order to tackle **droughts** and **heat stress** in the **metropolitan area** of Monterrey?”

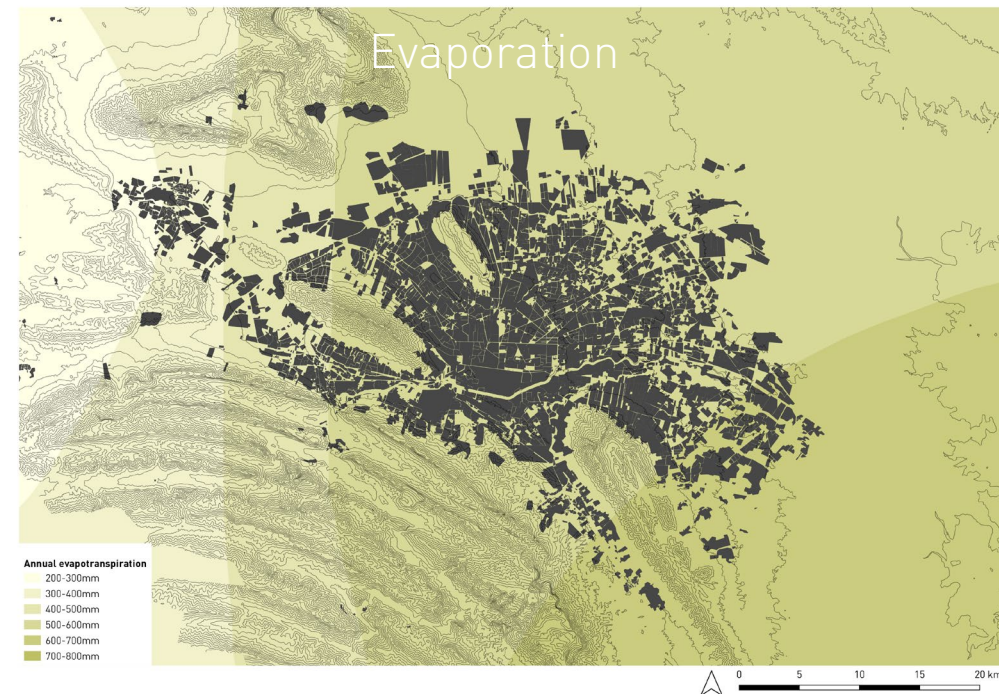
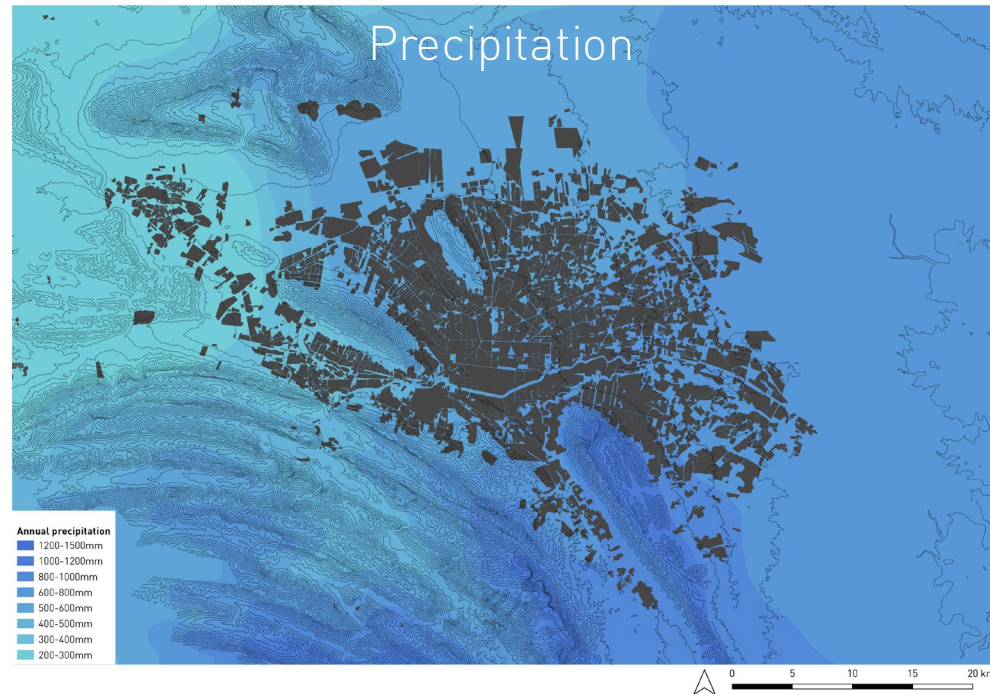
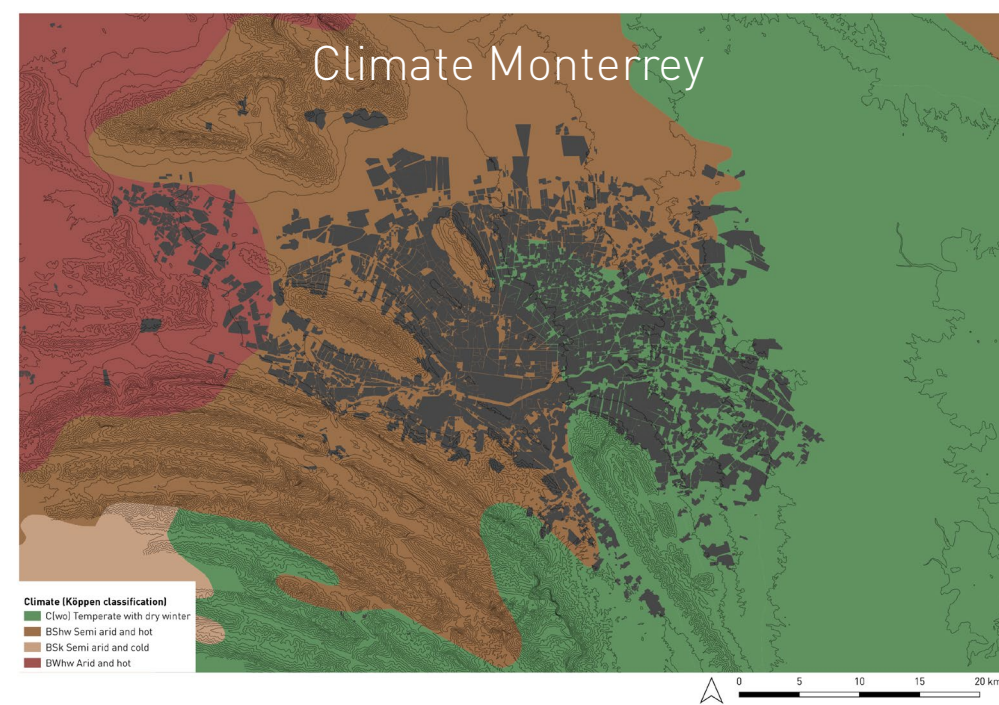
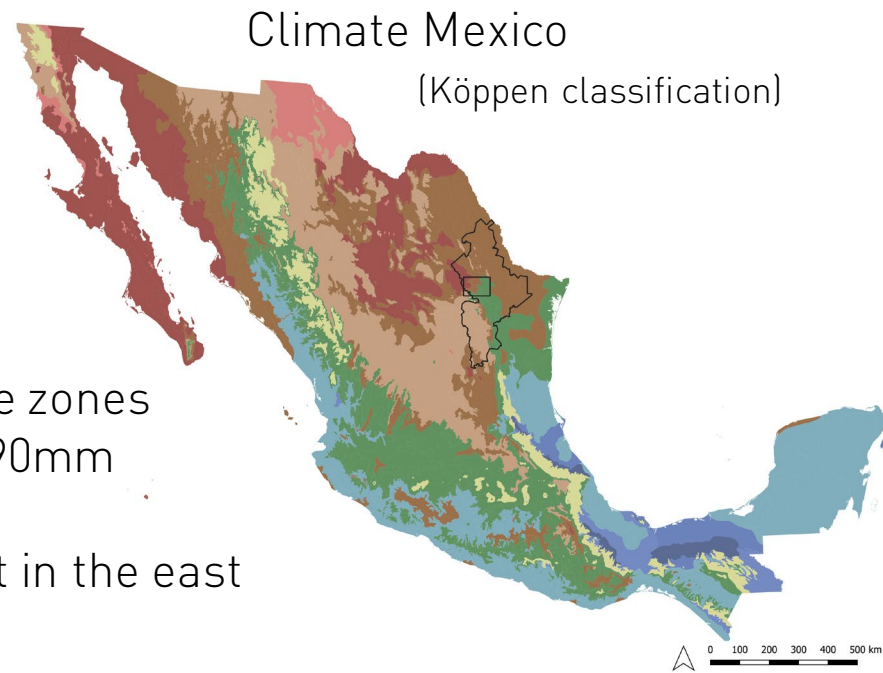


Analysis & Design principles 1: Landscape and Ecology



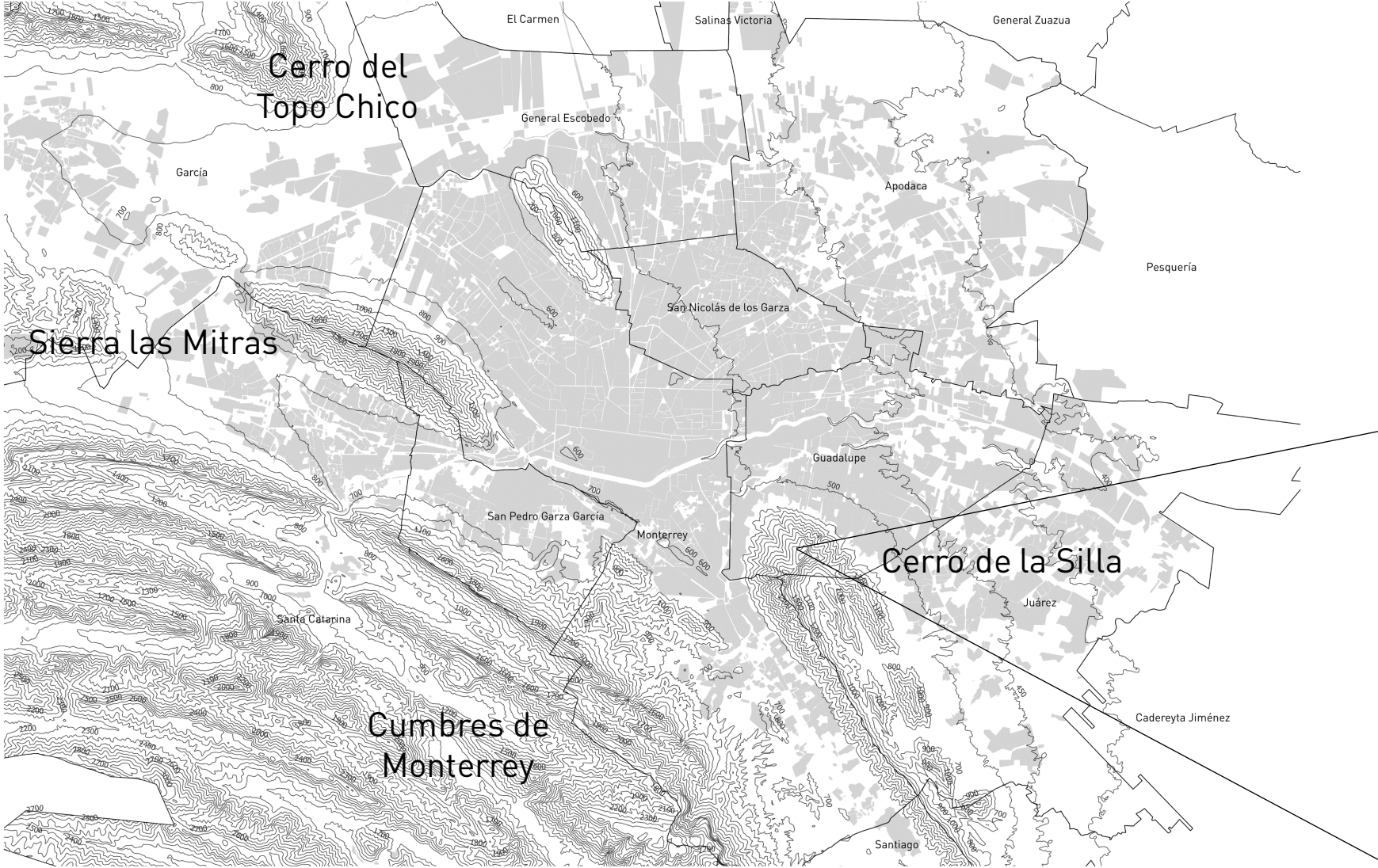
Analysis 1: Climate

- Between different climate zones
- Annual precipitation of 590mm (Hurricane ± 800 mm)
- Dry in the west, more wet in the east



Sources:
INEGI, Conabio, OSM

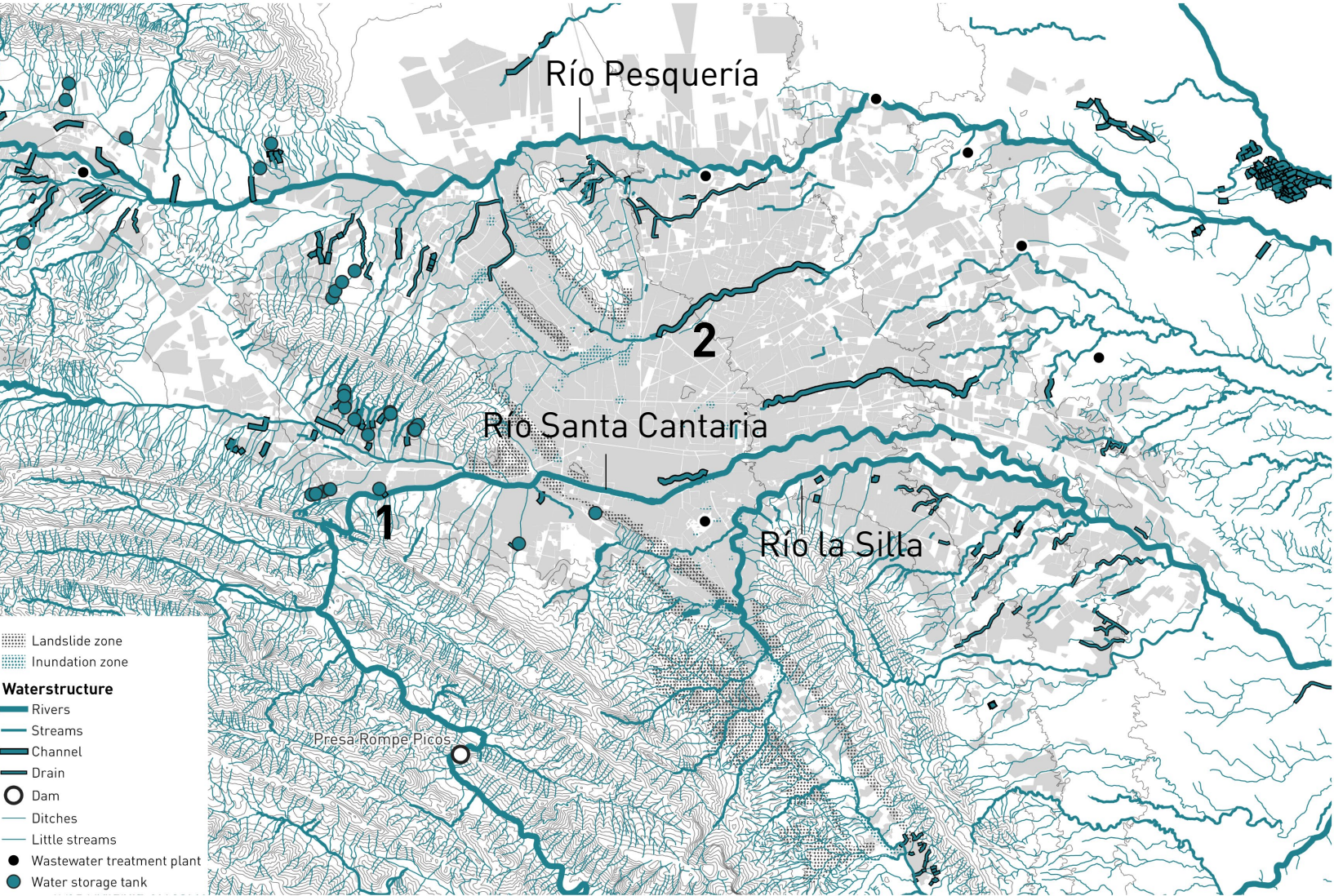
Analysis 1: Terrain and Landuse



- Mountain range Sierra Madre Oriental
- Several mountains in the area with slopes
- Urban area has been expanded until the slopes.



Analysis 1: Waterstructure

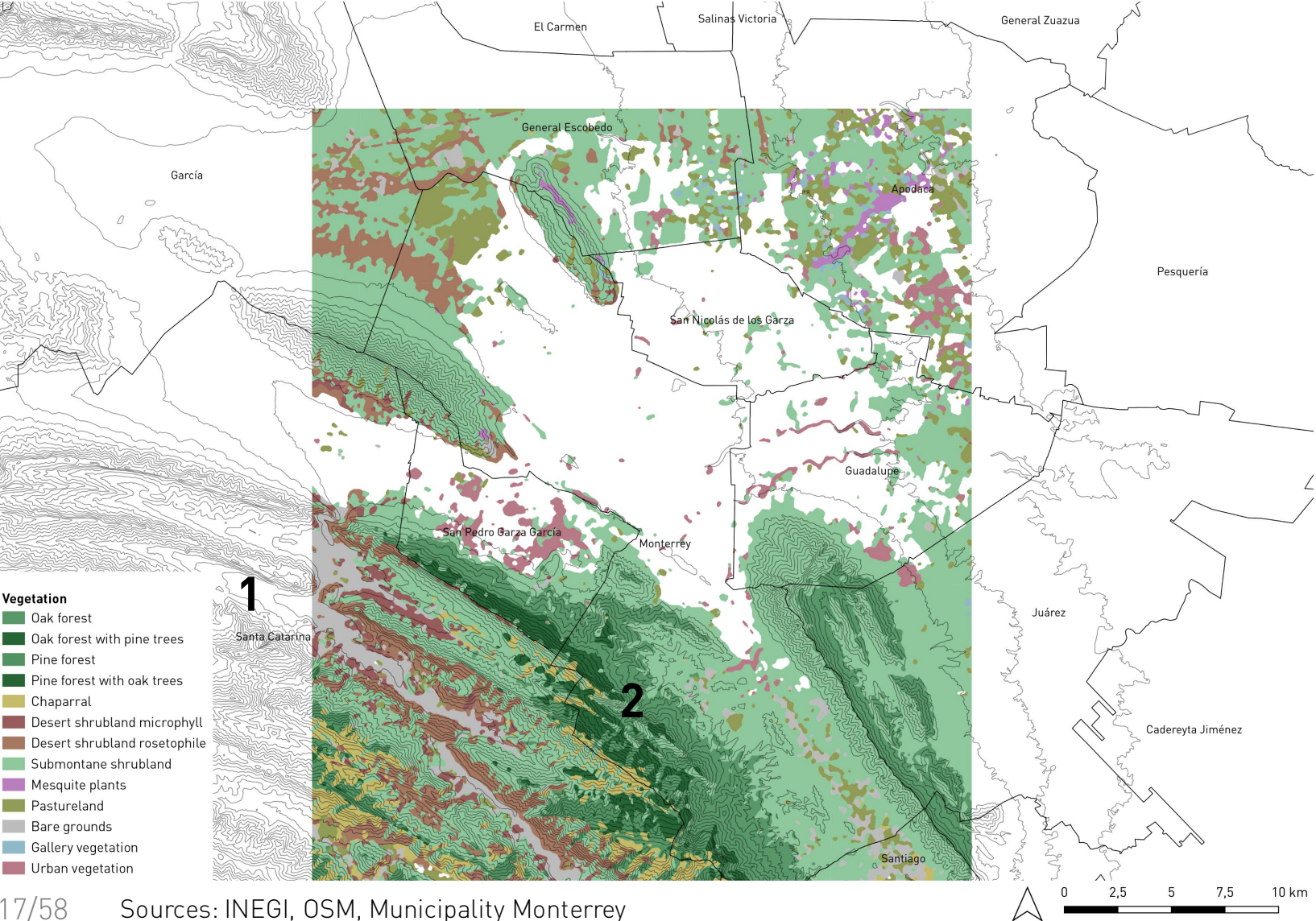


- Most of the streams are dry
- Lot of canalized waterways
- Risks of floods and landslides because of urbanization

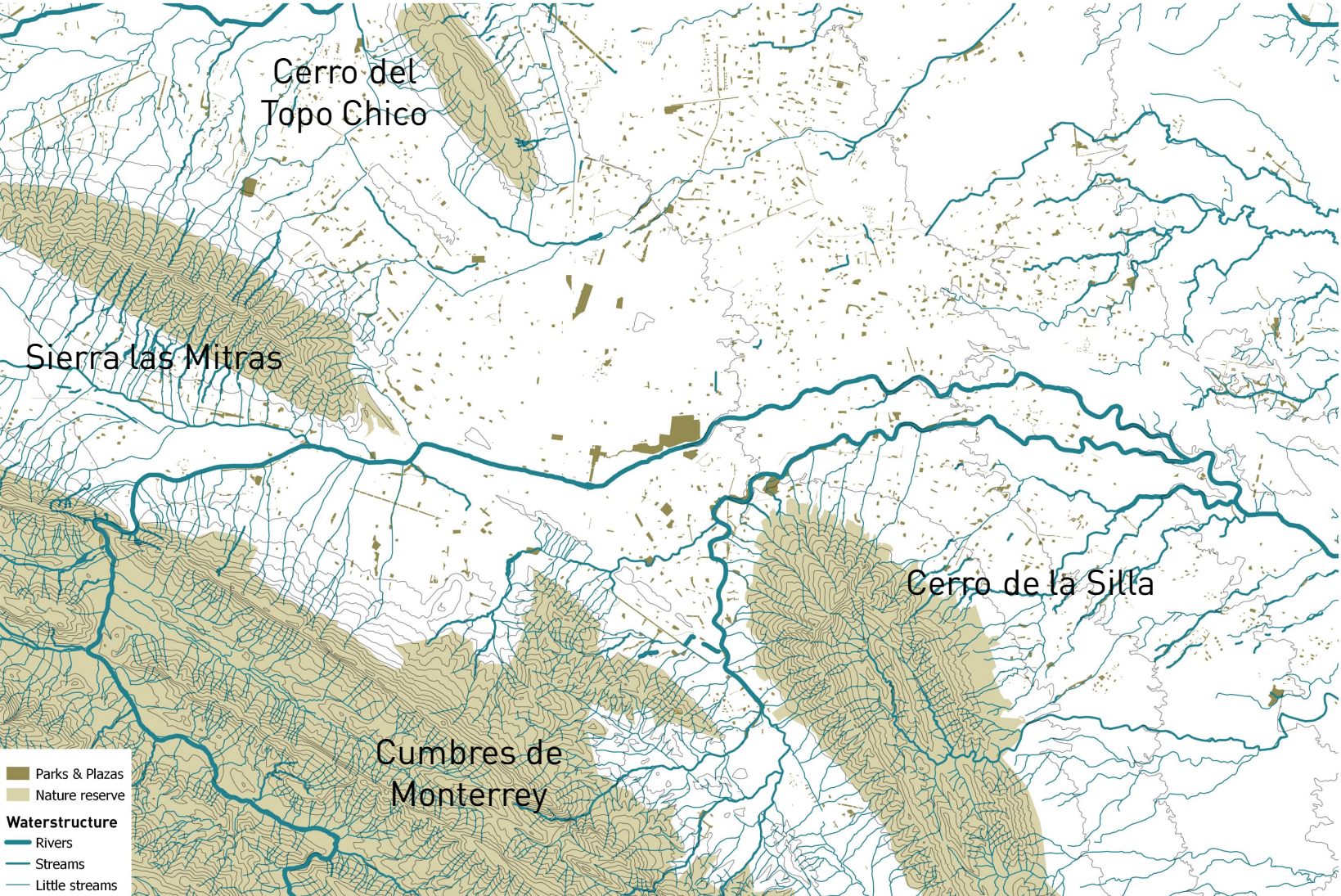


Analysis 1: Vegetation covers

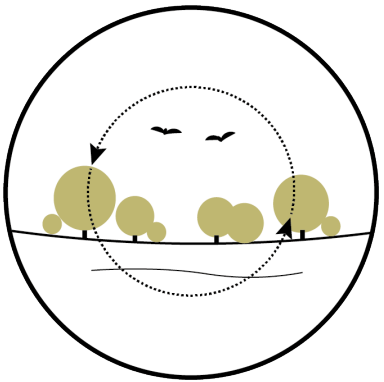
- The soil types and climate sets the conditions for plant species.
- Urbanisation caused loss of vegetation cover.



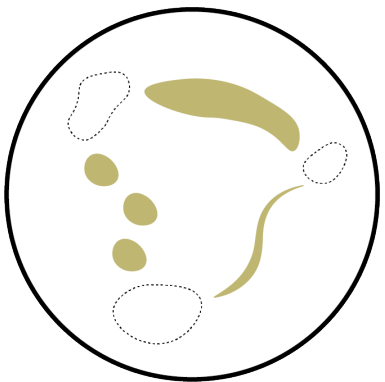
Design principles 1: Landscape & Ecology



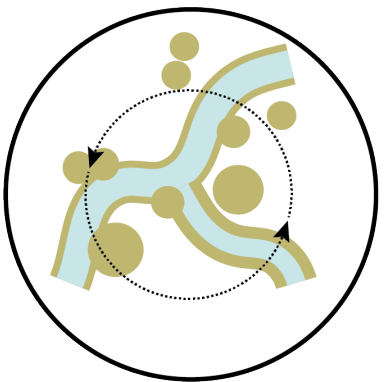
Creating patches of natural areas



Restore the ecology

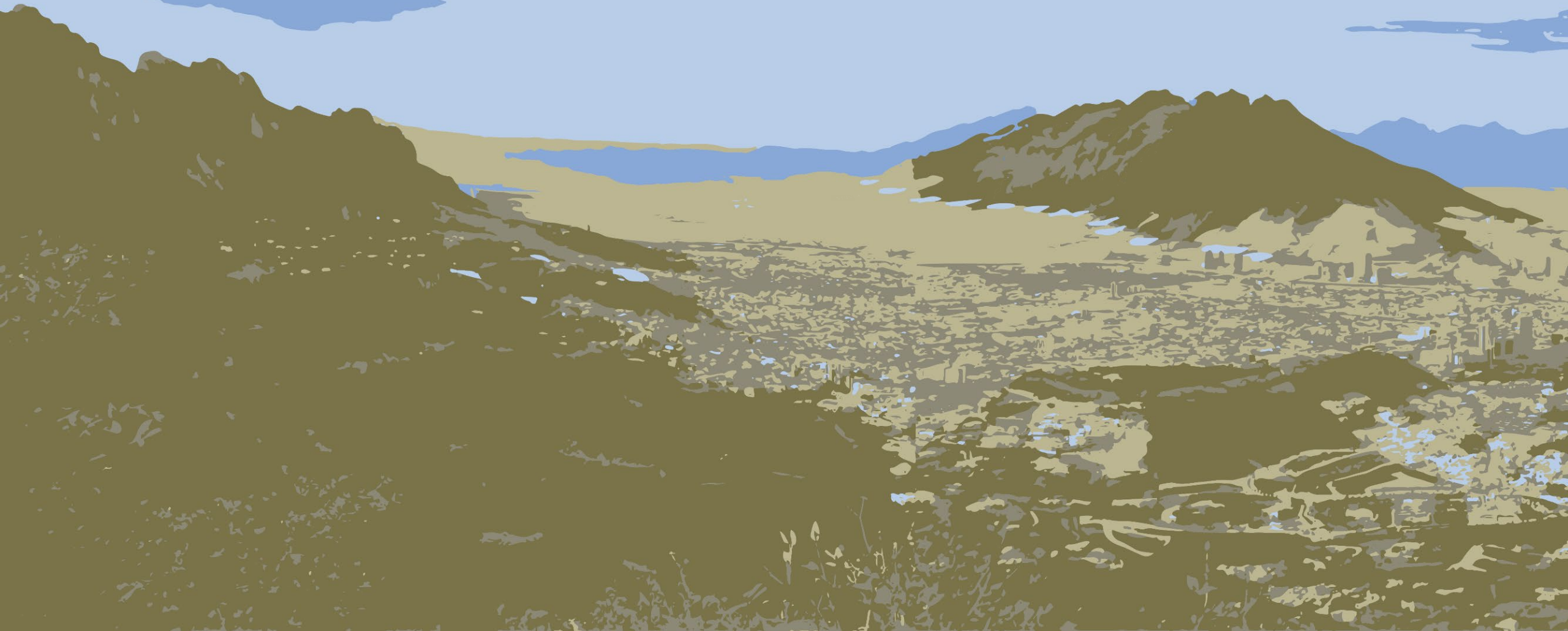


Creating connection
(Forman, 2006)



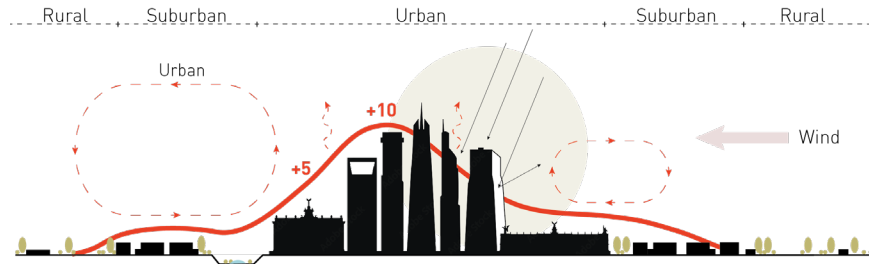
Restore the waterstructure

Analysis & Design principles 2: Heat stress

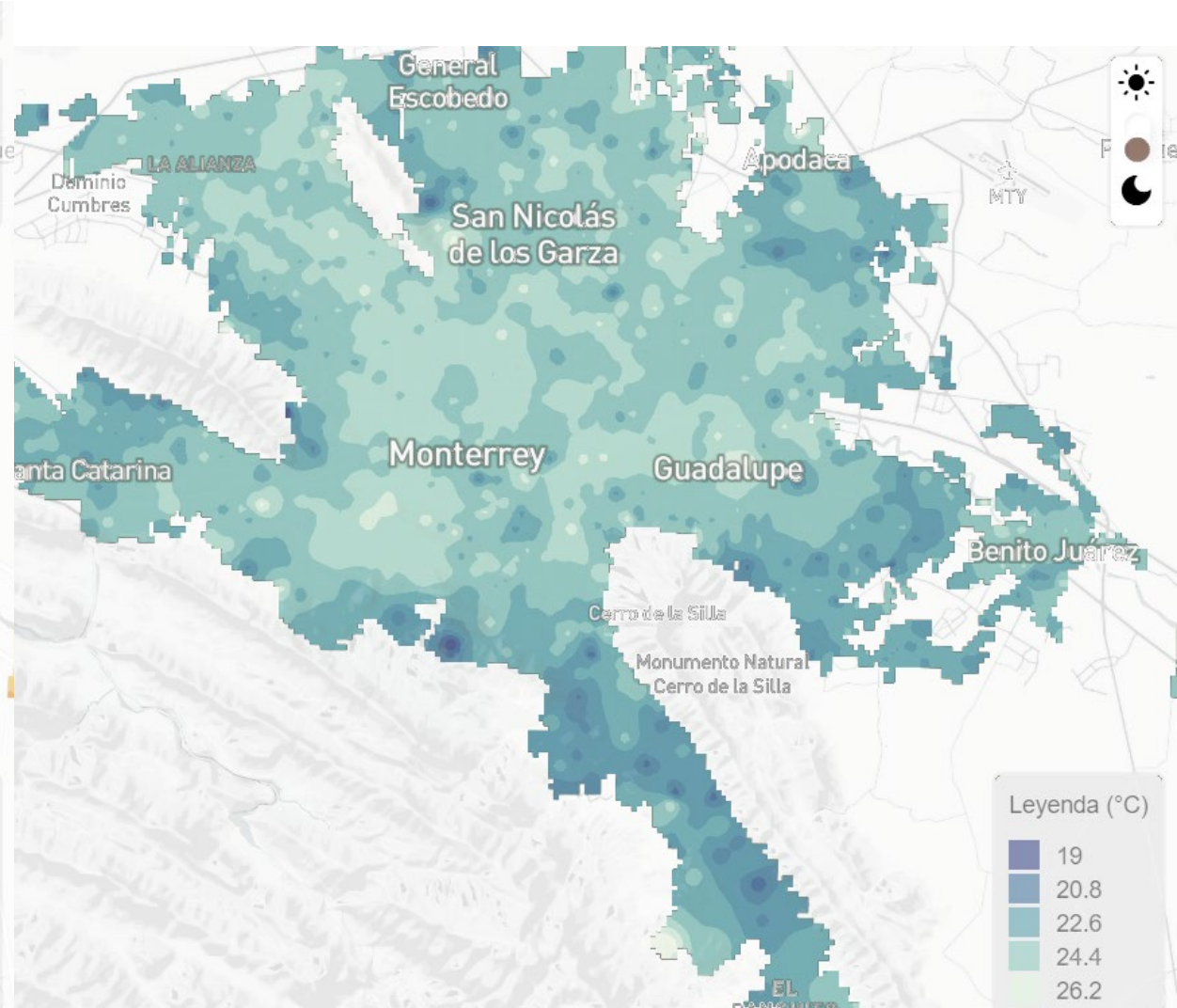
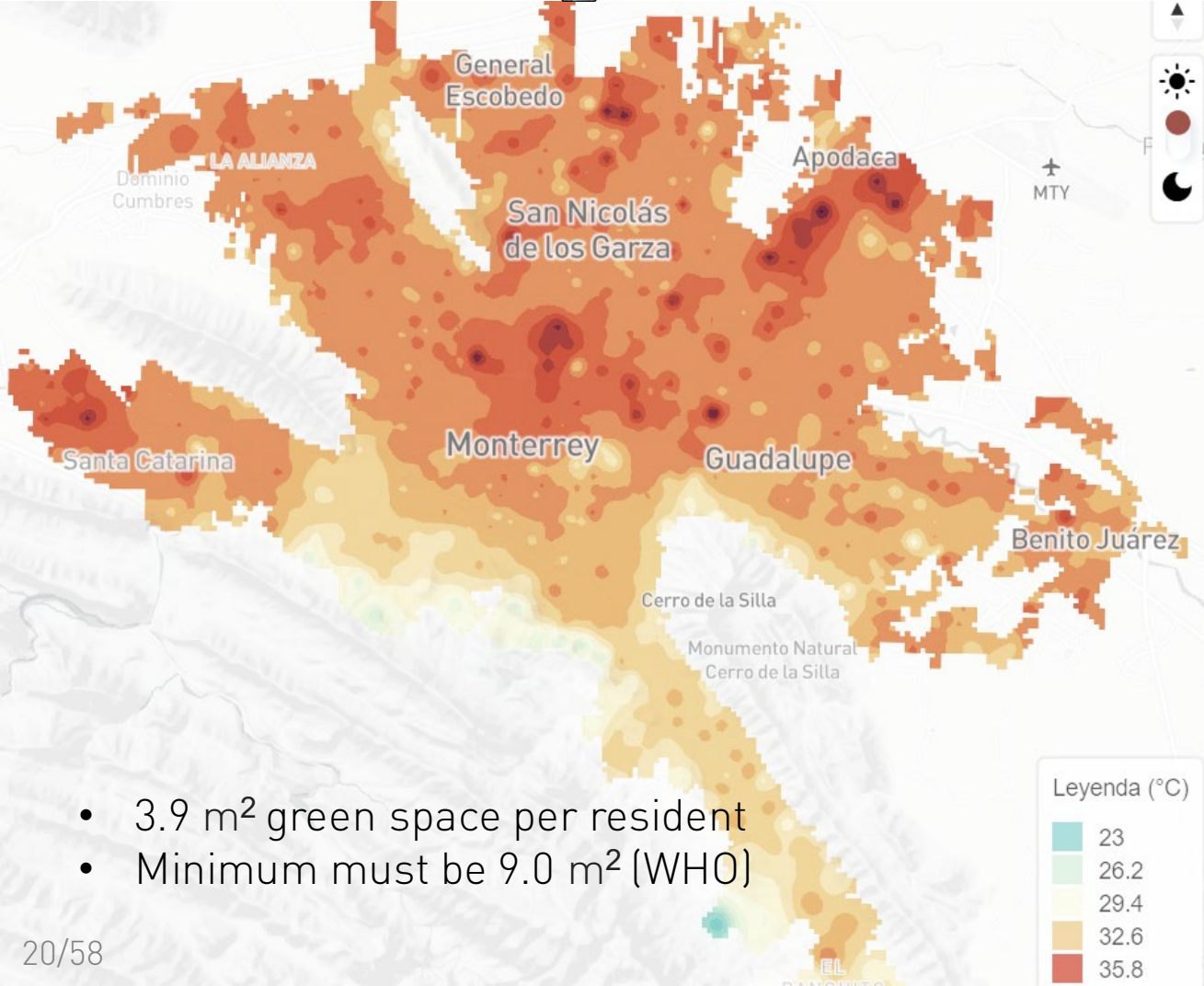
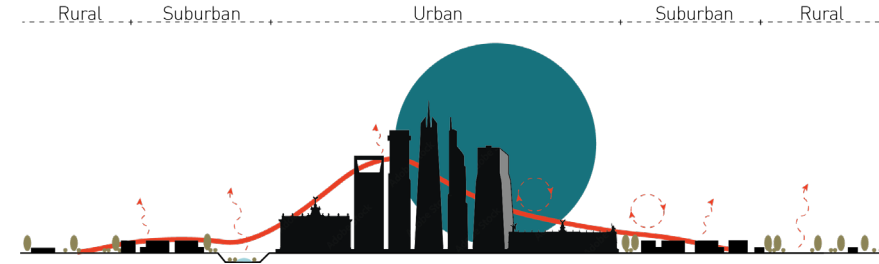


Analysis 2: Heat stress

Day



Night



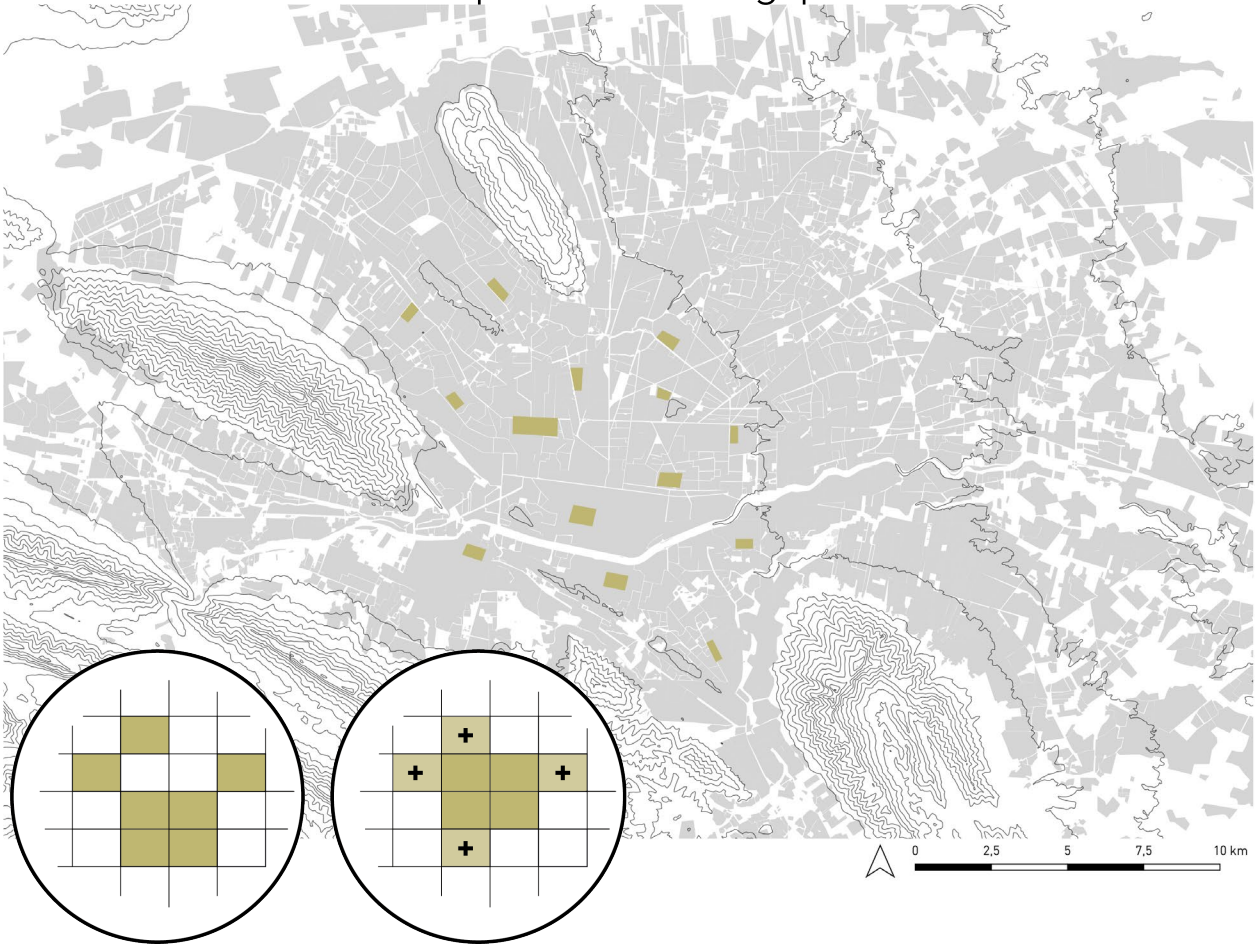
- 3.9 m² green space per resident
- Minimum must be 9.0 m² (WHO)

Design principles 2: Mitigating heat stress

Transform channels and rivers into new accessible and connective parks



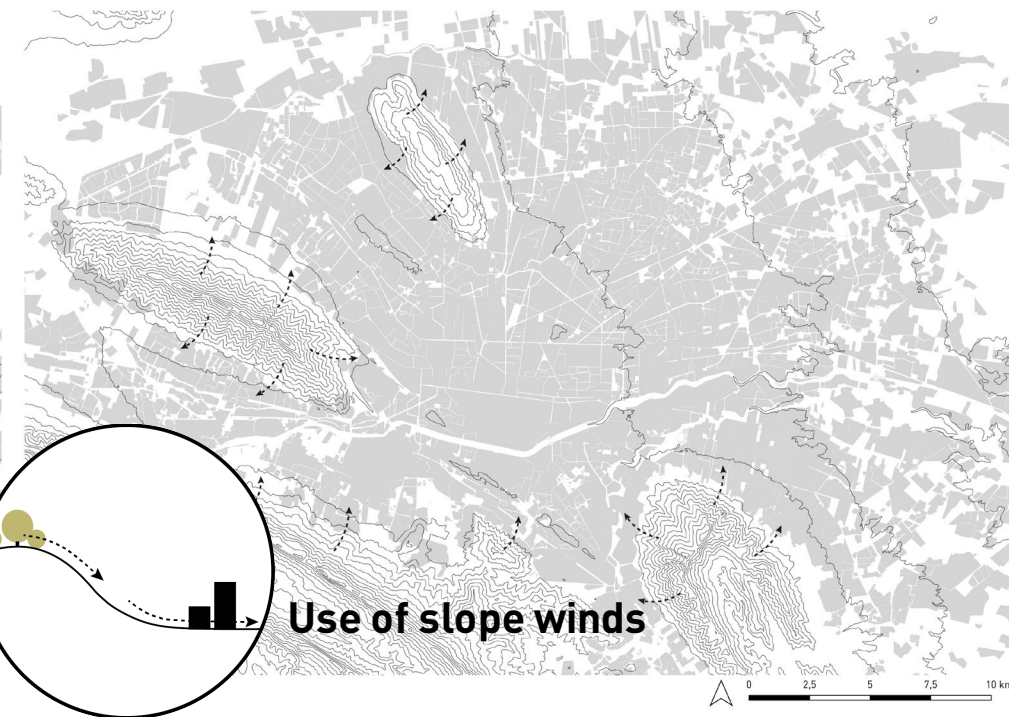
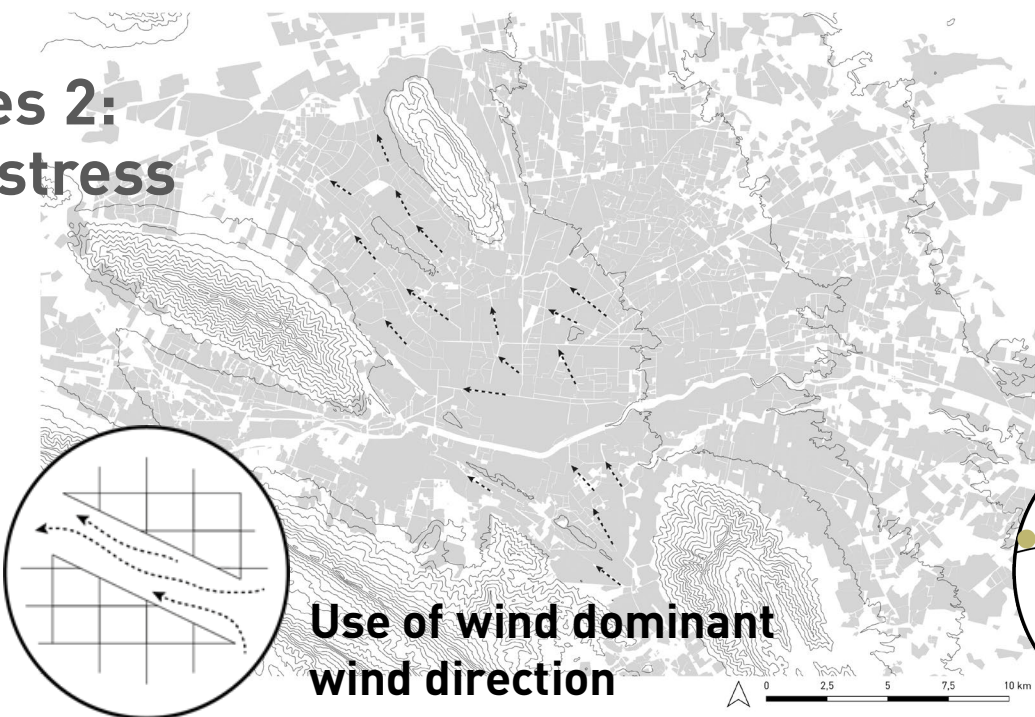
Transform concrete areas into new parks and expand existing parks



Design principles 2: Mitigating heat stress

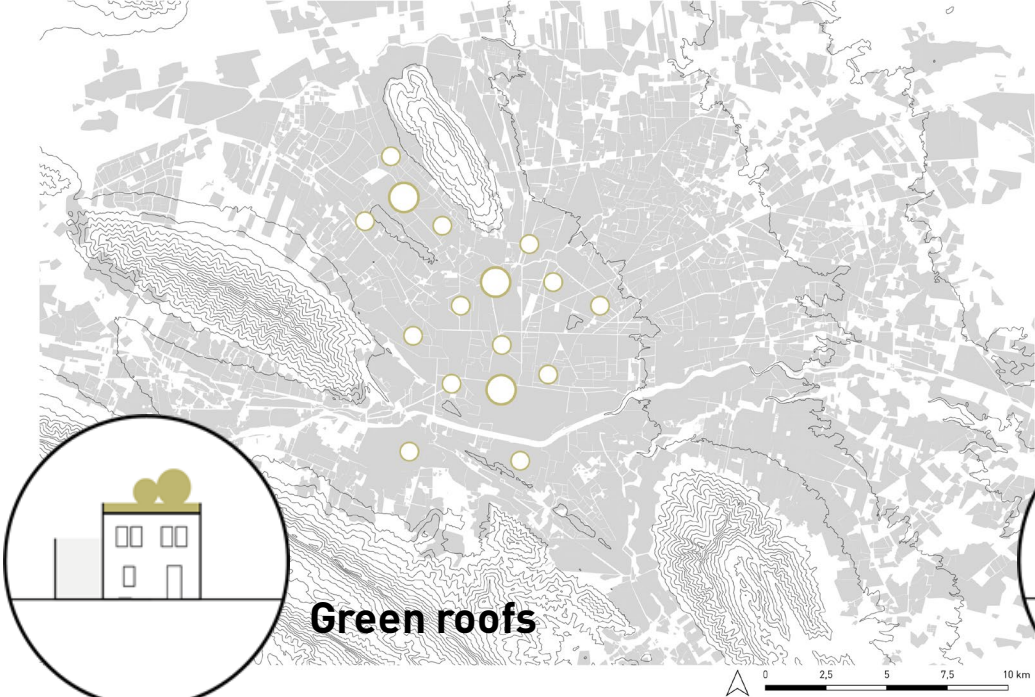
Make use of wind corridors and slope winds

(Ganbat et al., 2014)
(Hsieh & Huang, 2016)



Nature based solutions

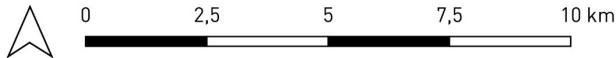
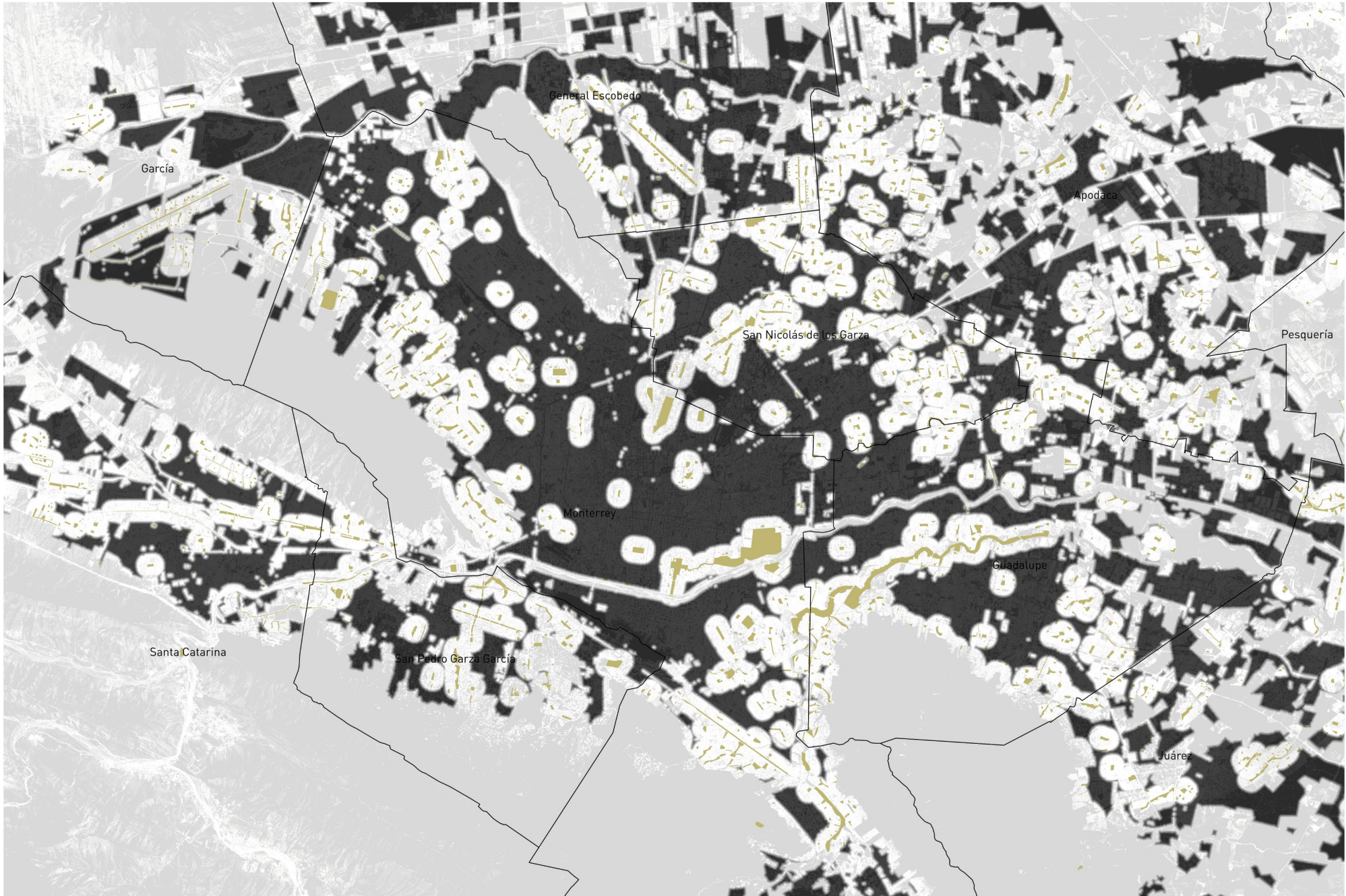
(Wageningen 2023)



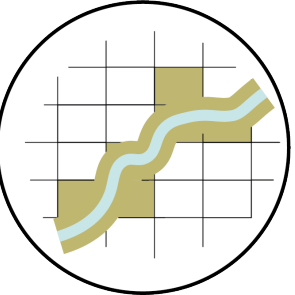
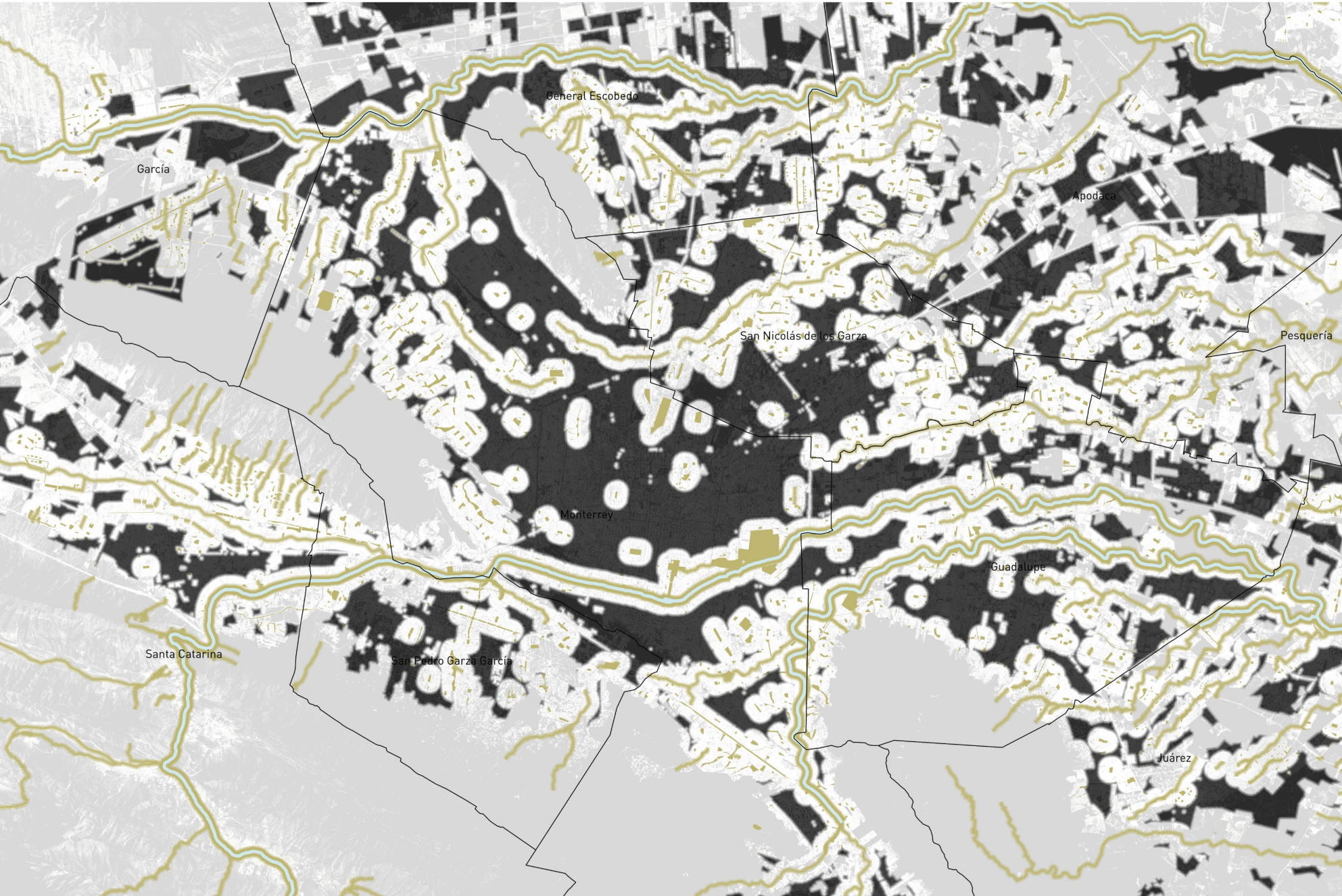
300 meter rule

300m from current green spaces > **1 ha**

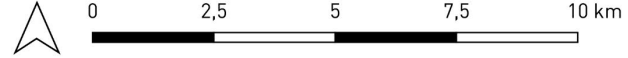
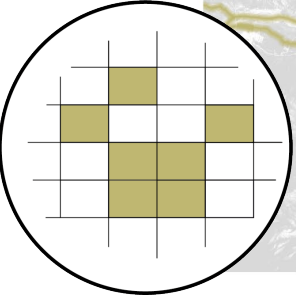
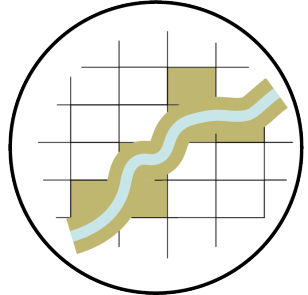
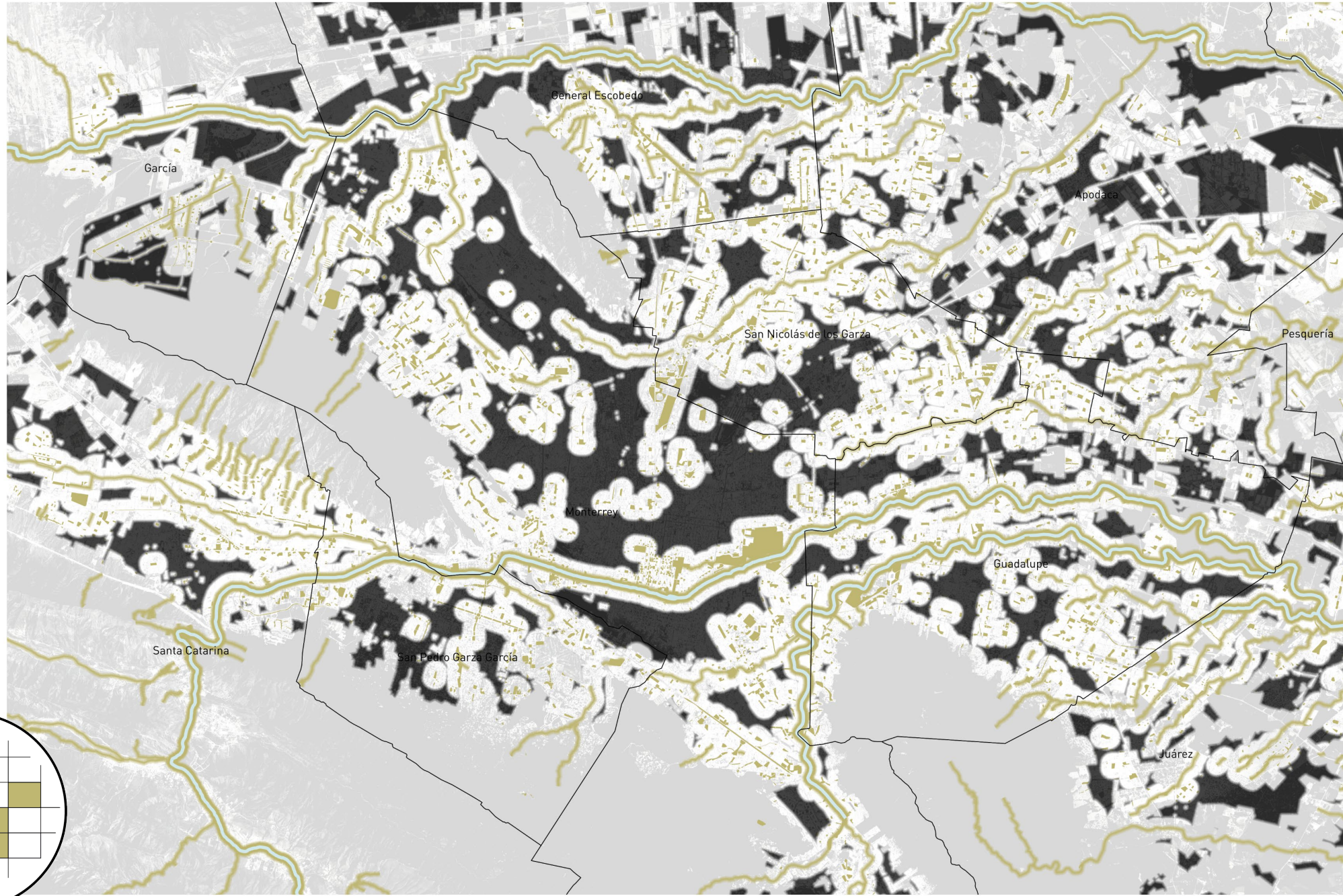
(Konijnendijk, 2021)



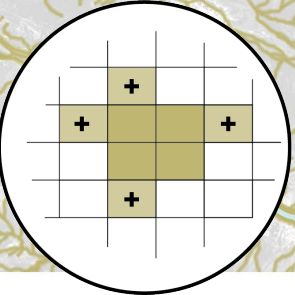
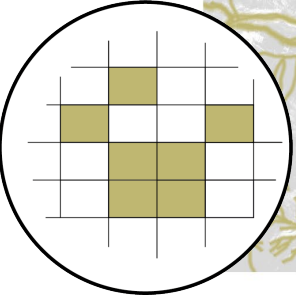
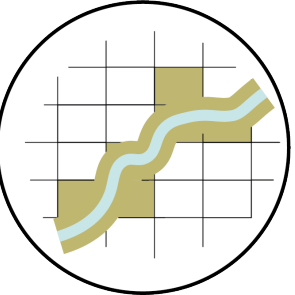
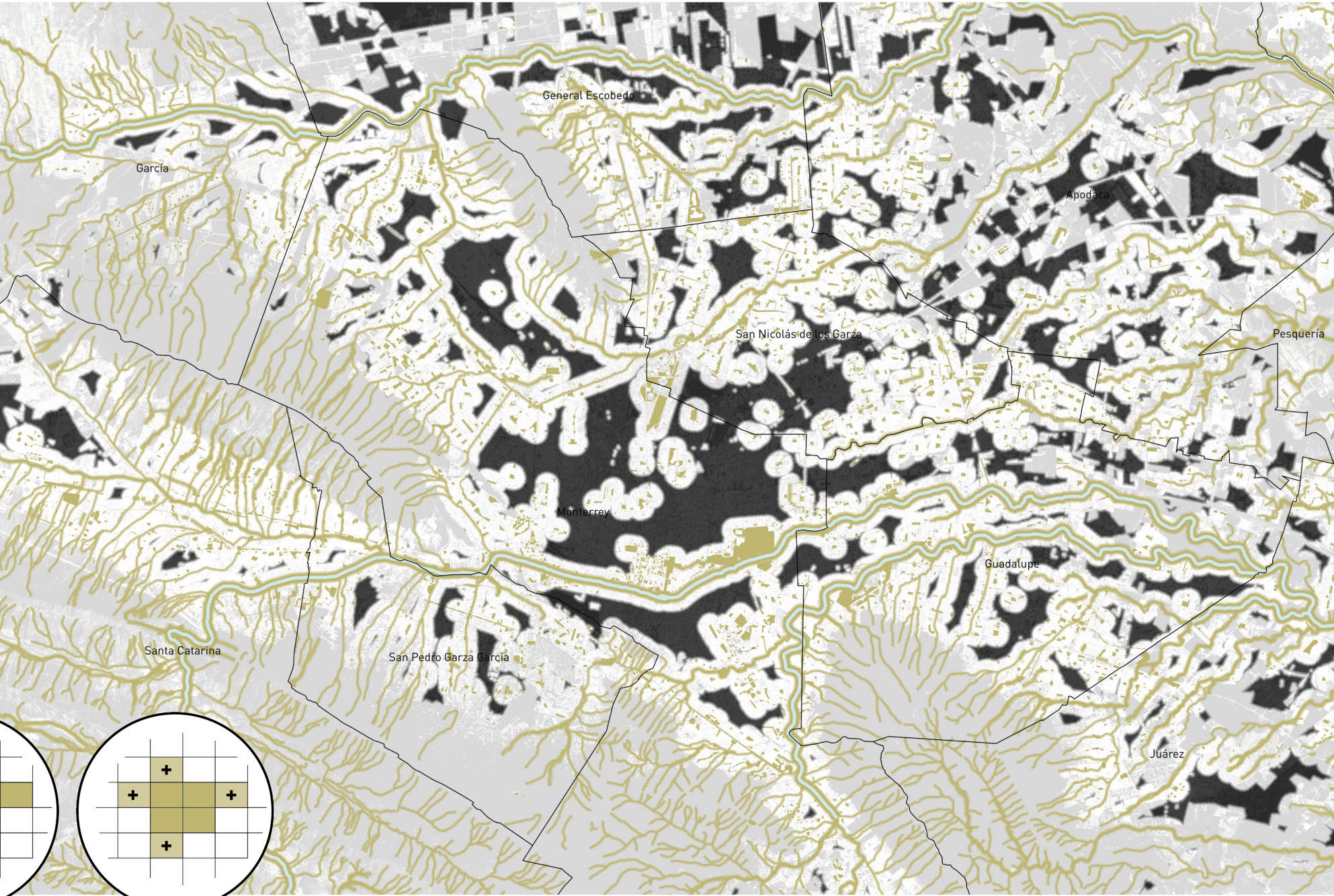
300 meter rule



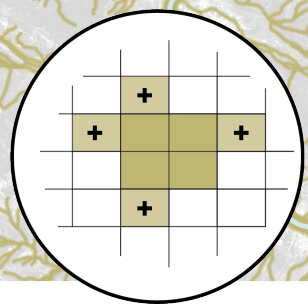
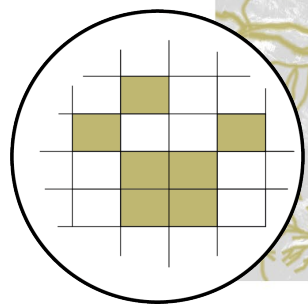
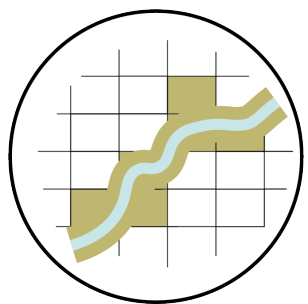
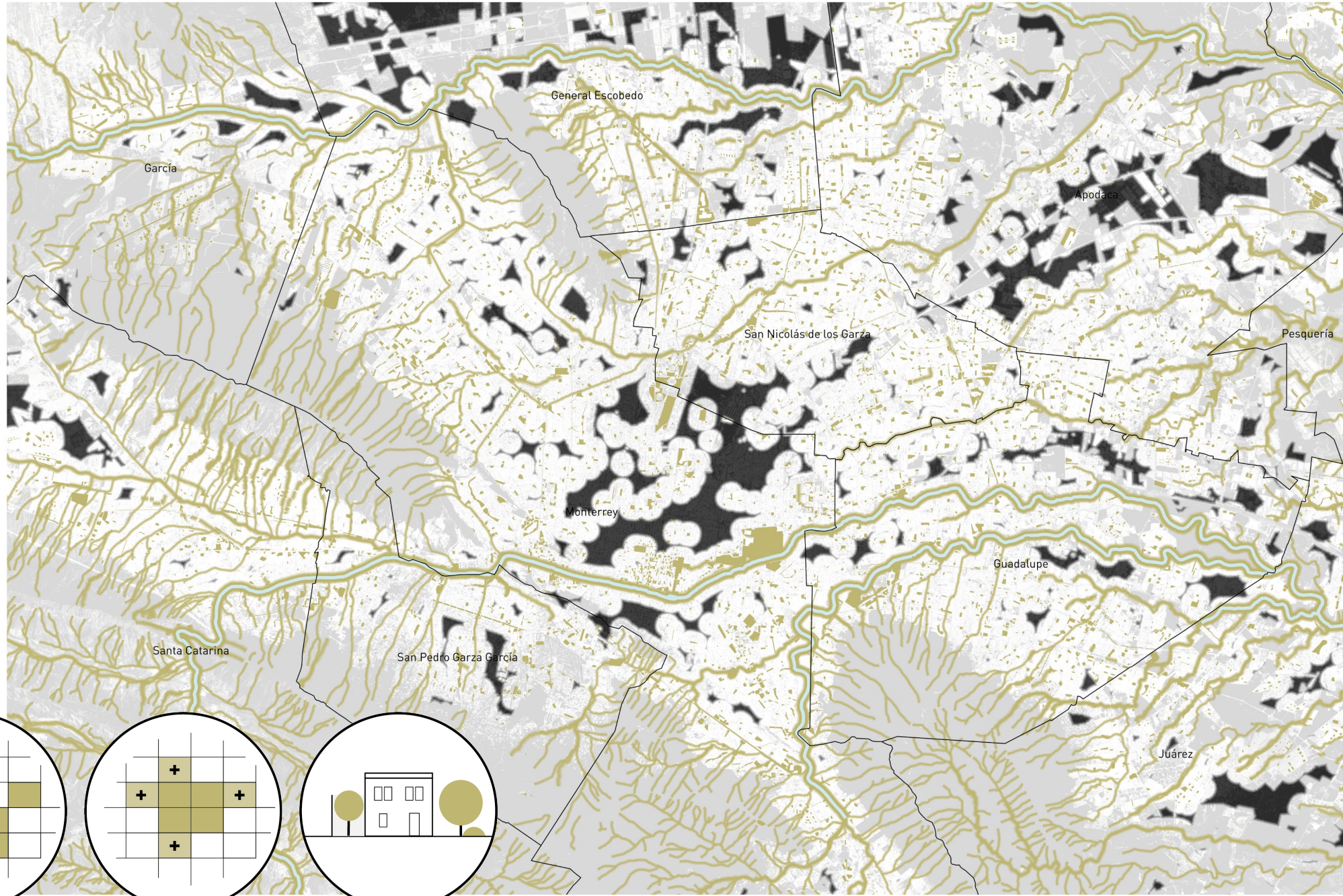
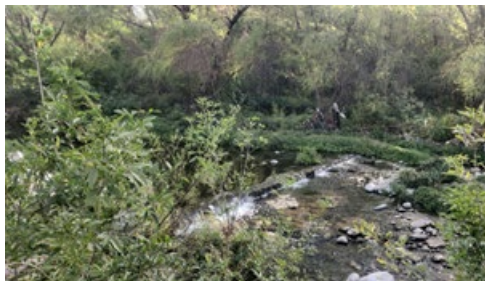
300 meter rule



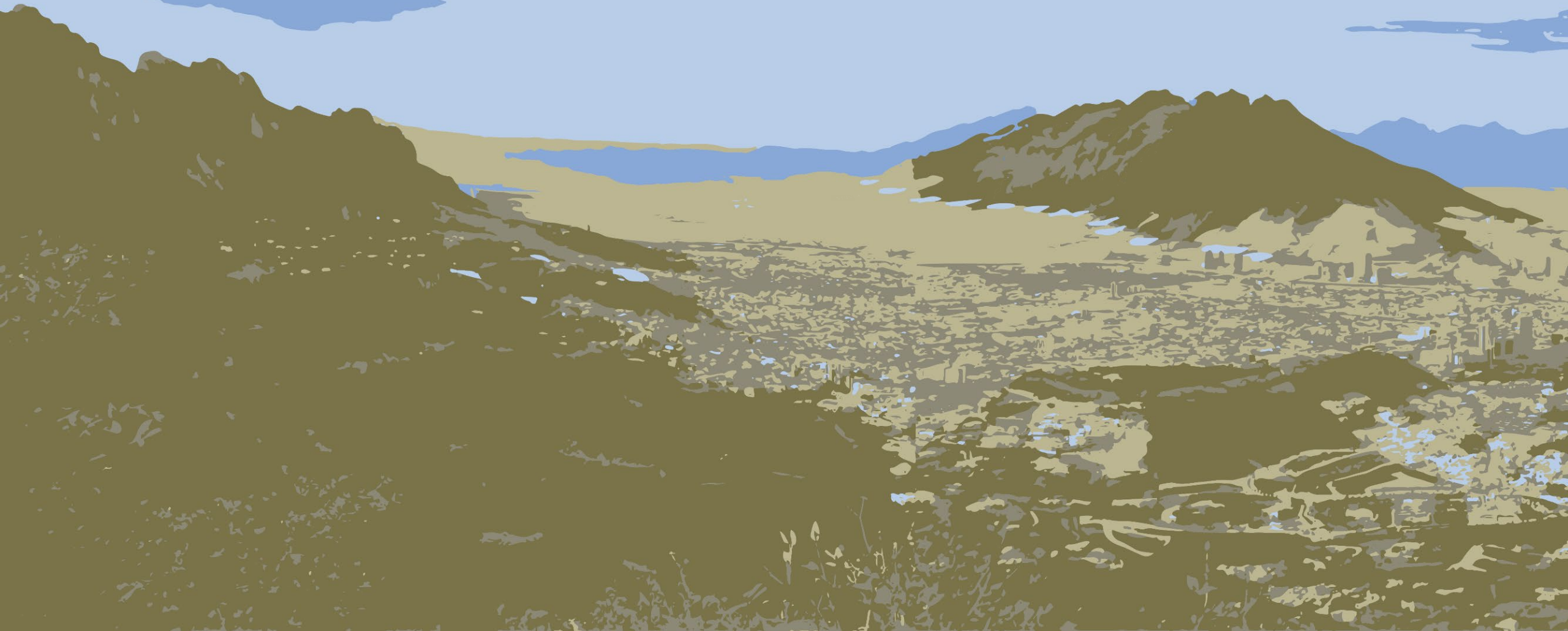
300 meter rule



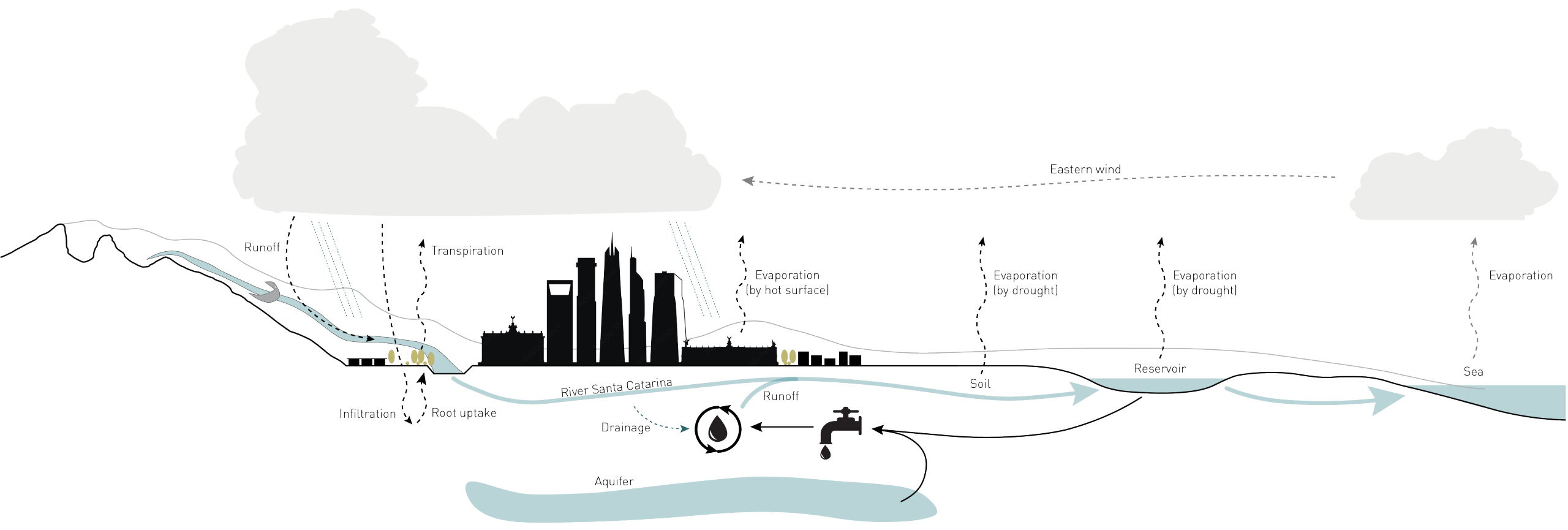
300 meter rule



Analysis & Design principles 3: Hydrological cycle



Analysis 3: Hydrological Cycle



Sources: SADM, Tecnológico de Monterrey

Creating a sustainable watermanagement with equal distribution and restoring the ecological environment

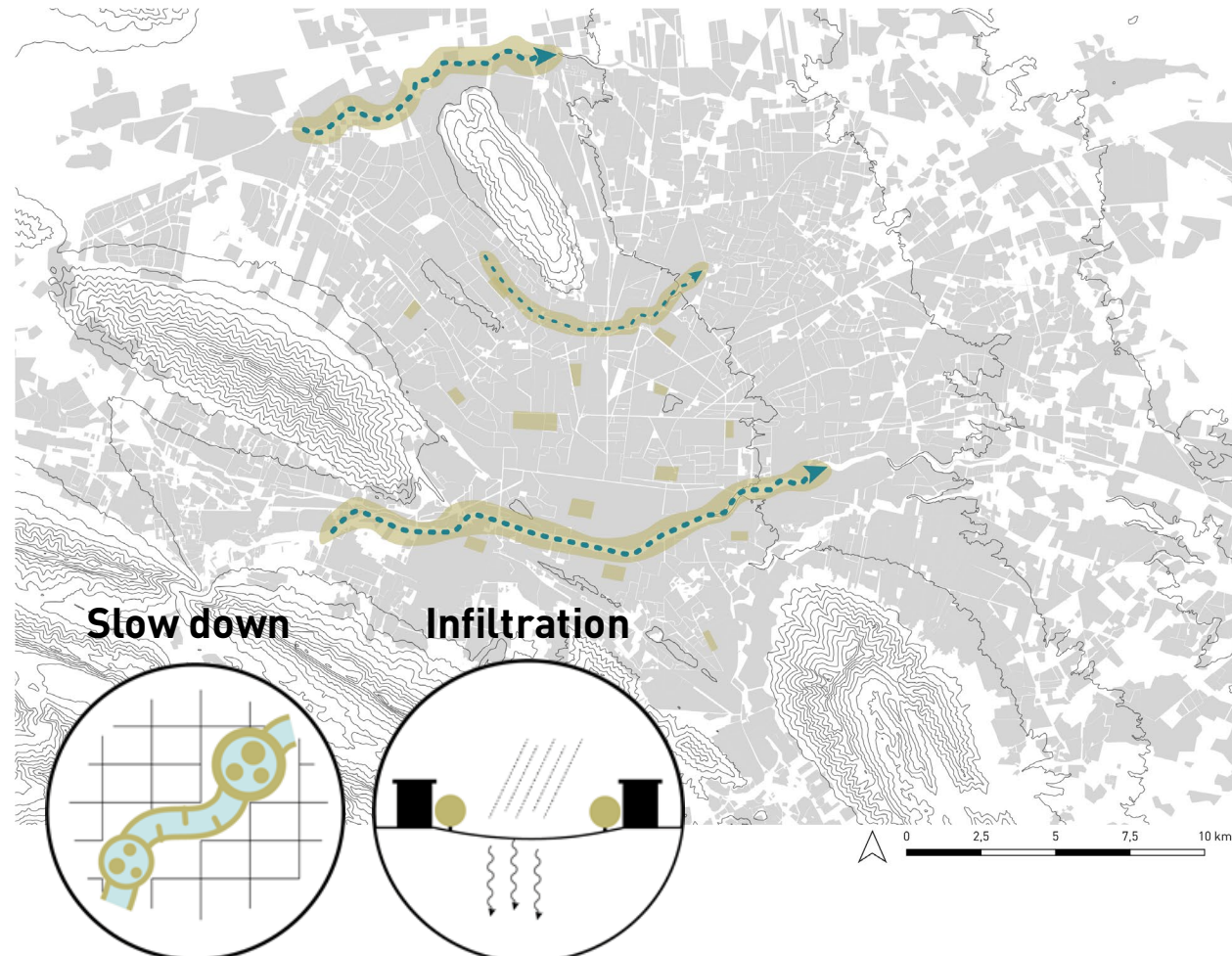
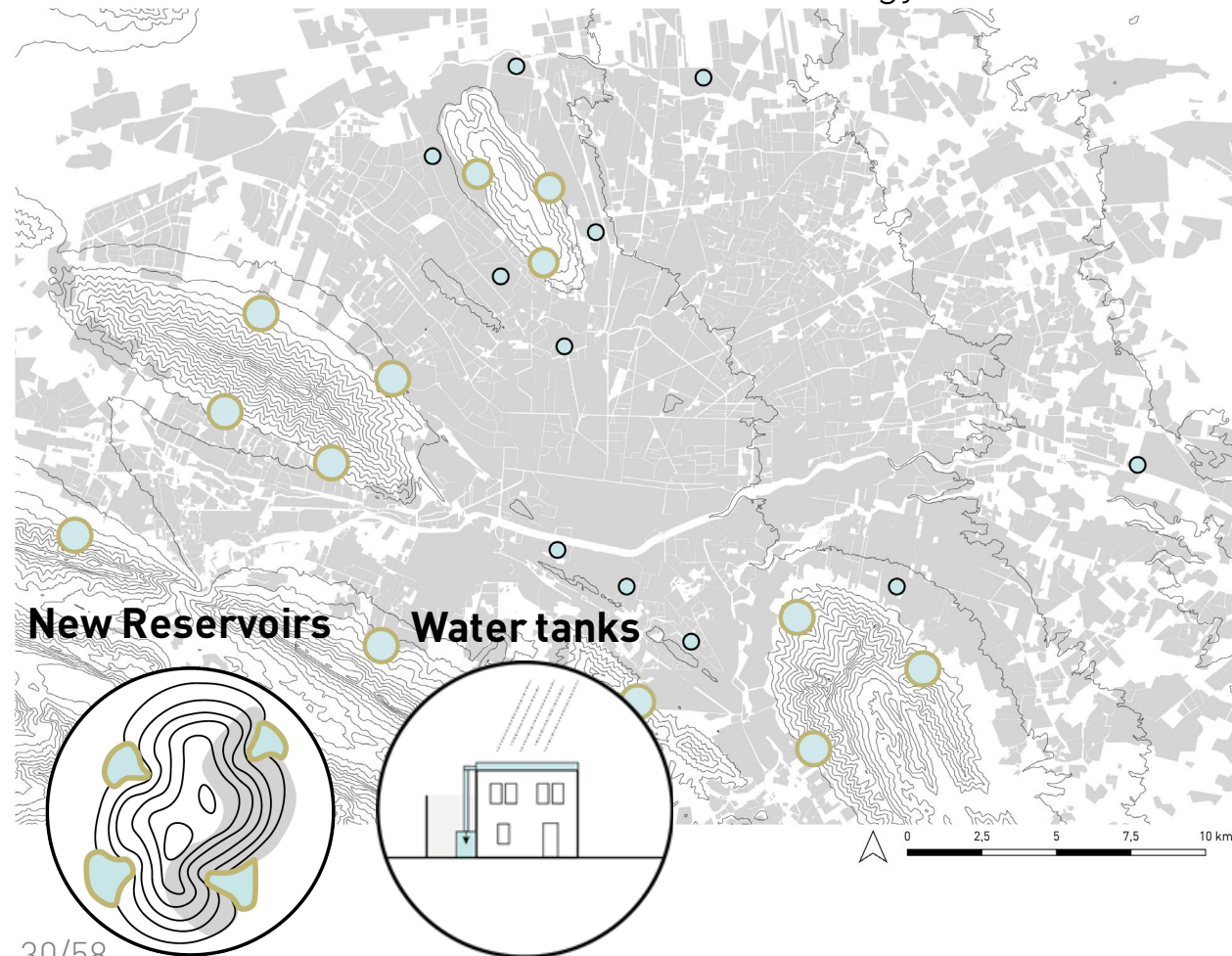
Design Principles 3:

Store water upstream

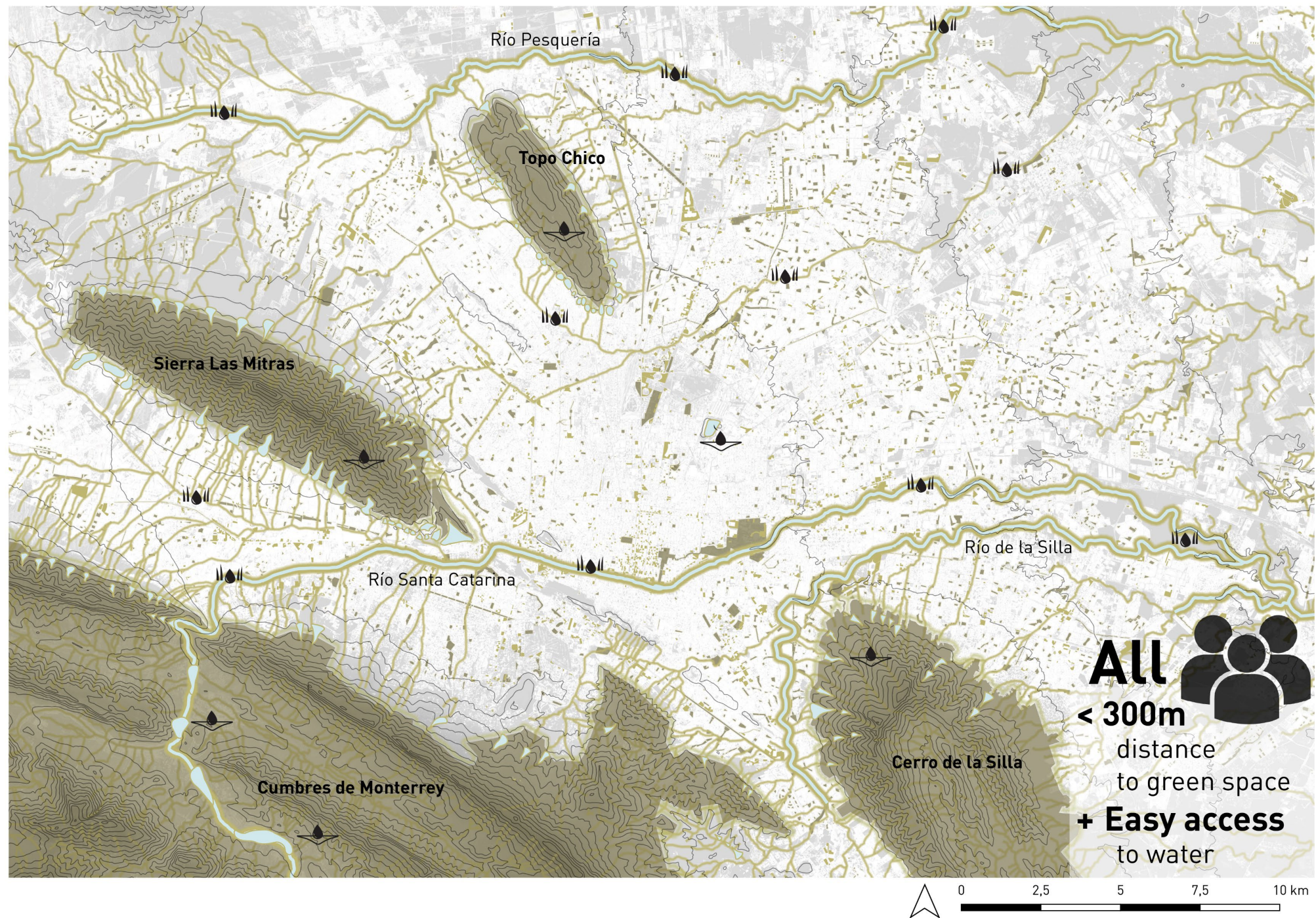
- Quality water
- less evaporation
- Water available for the urban ecology

Retain water downstream

- Cooler areas
- More root intake
- Less contaminated water



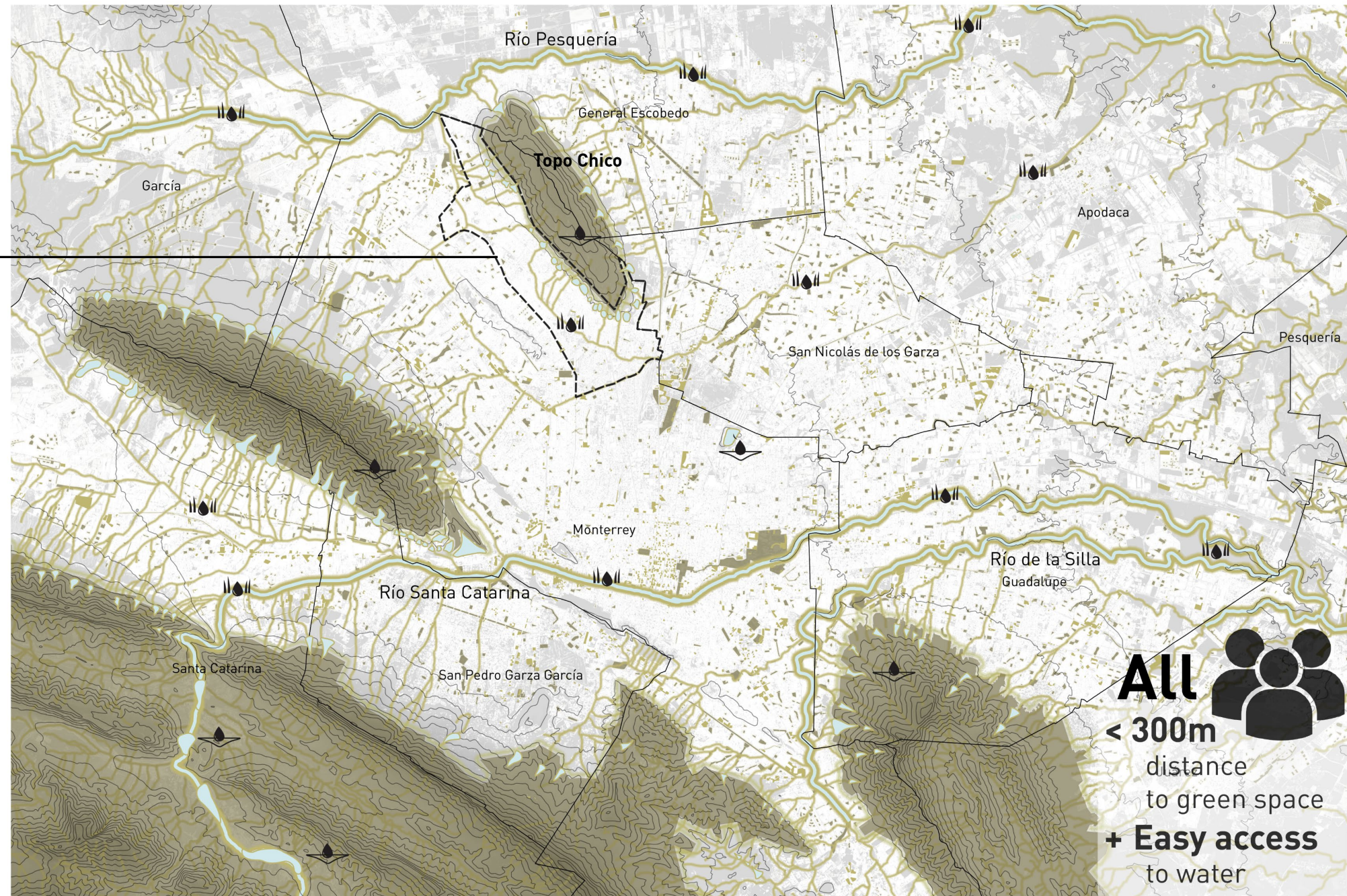
Metropolitan vision



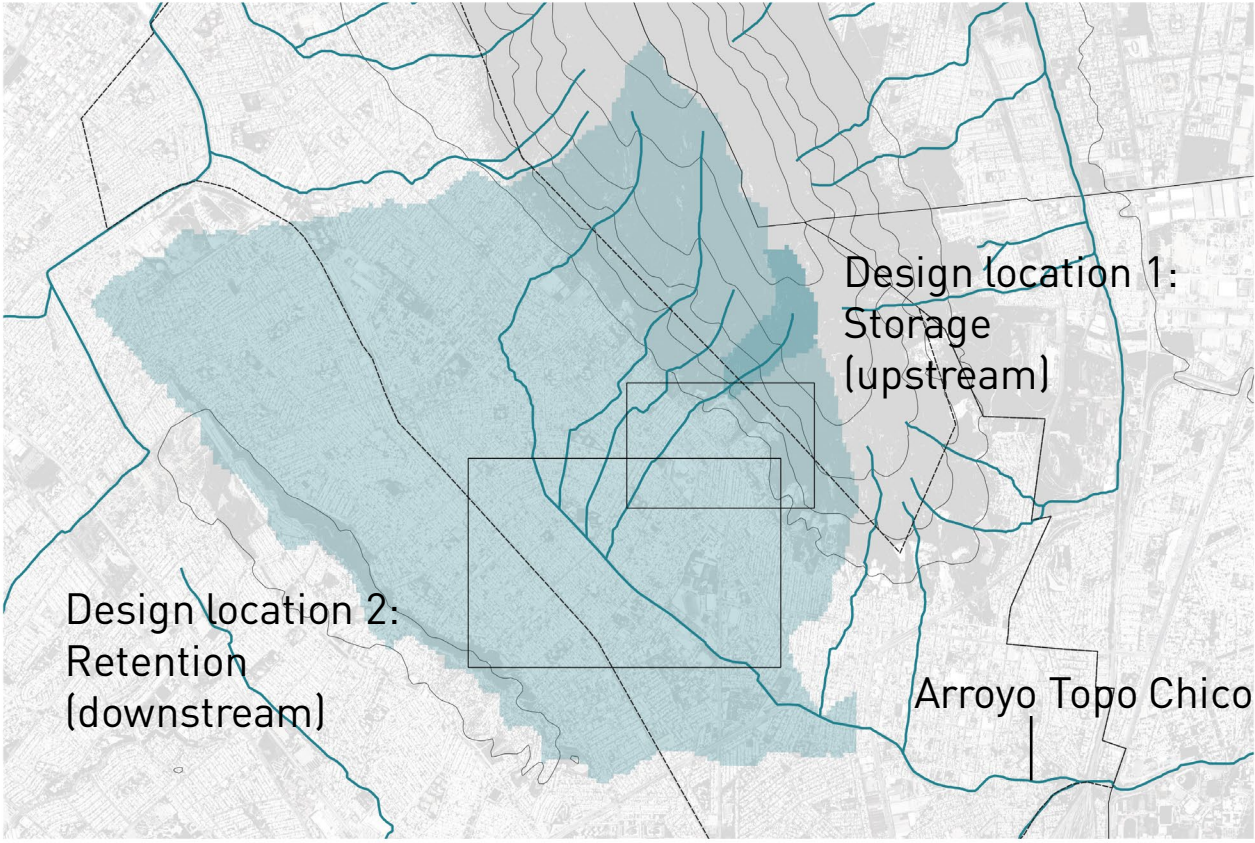
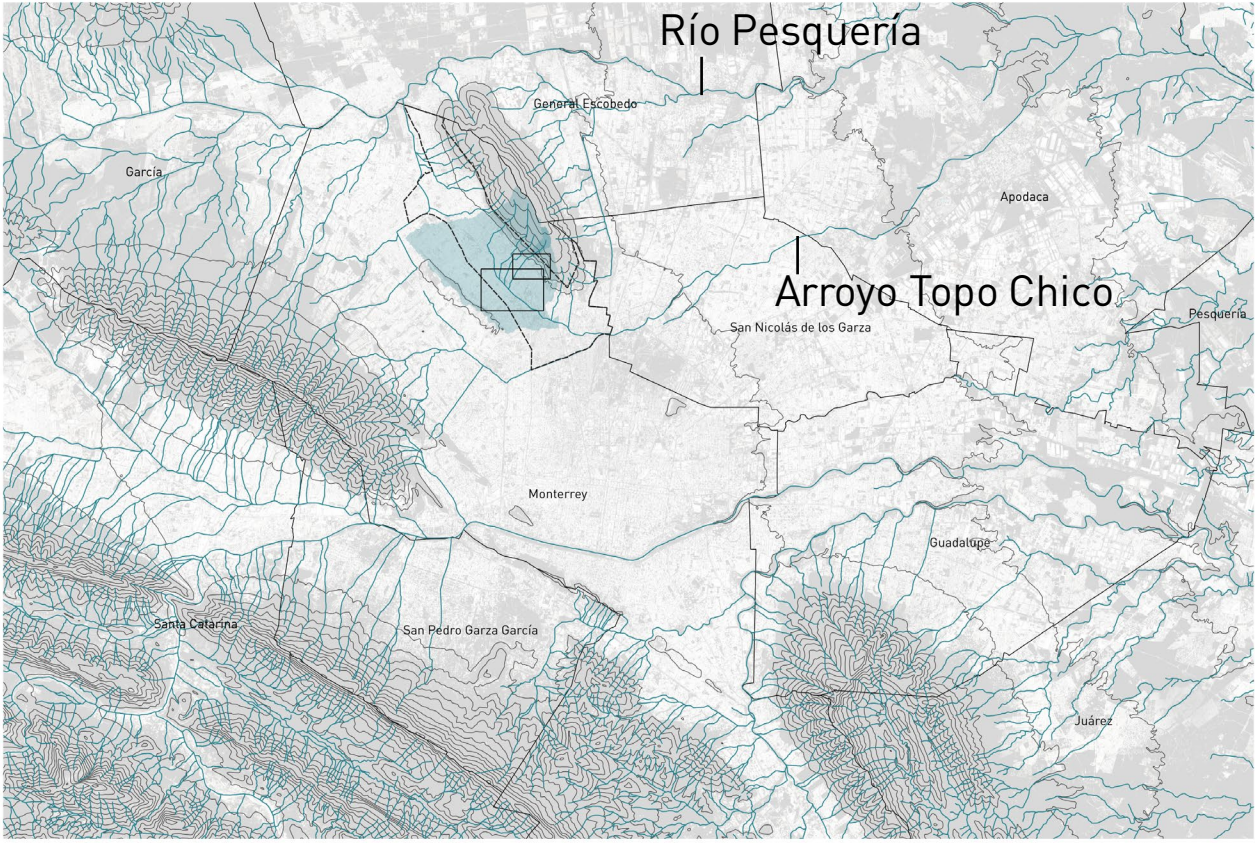
Metropolitan Strategy

Starting with San Bernabé District

- Poverty
- Heat stress
- Lack of green
- Landslides
- Inundation



Upstream Arroyo Topo Chico Watershed



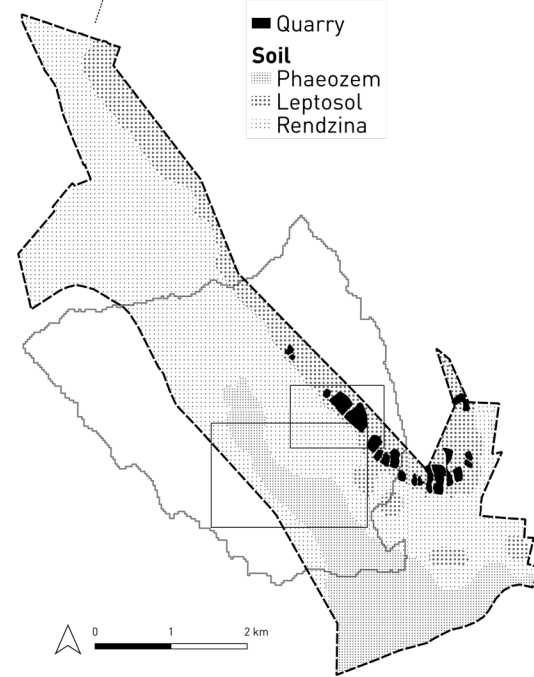
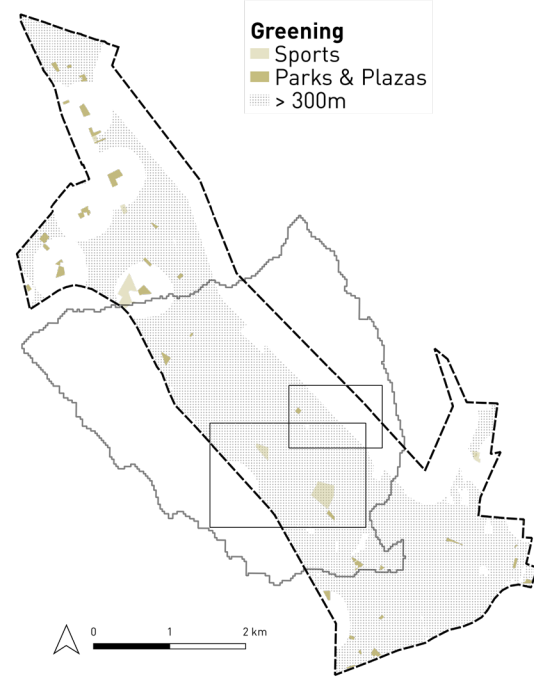
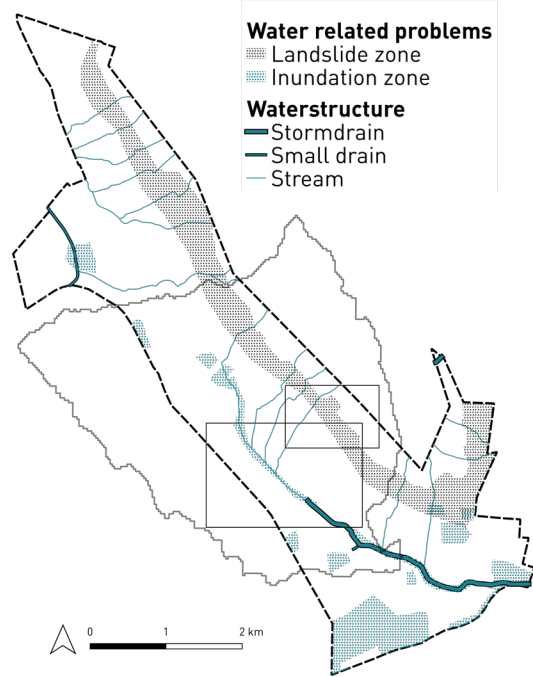
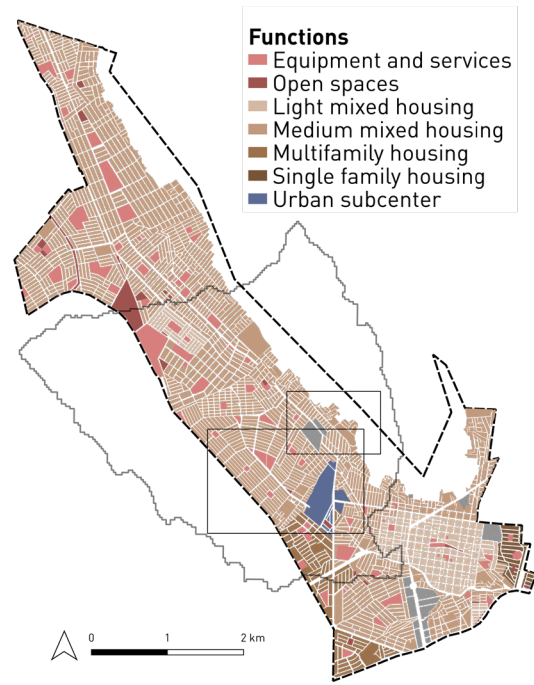
The District of San Bernabé, Monterrey



- Population density: 3523 residents/km
- Two storey buildings



San Bernabé District

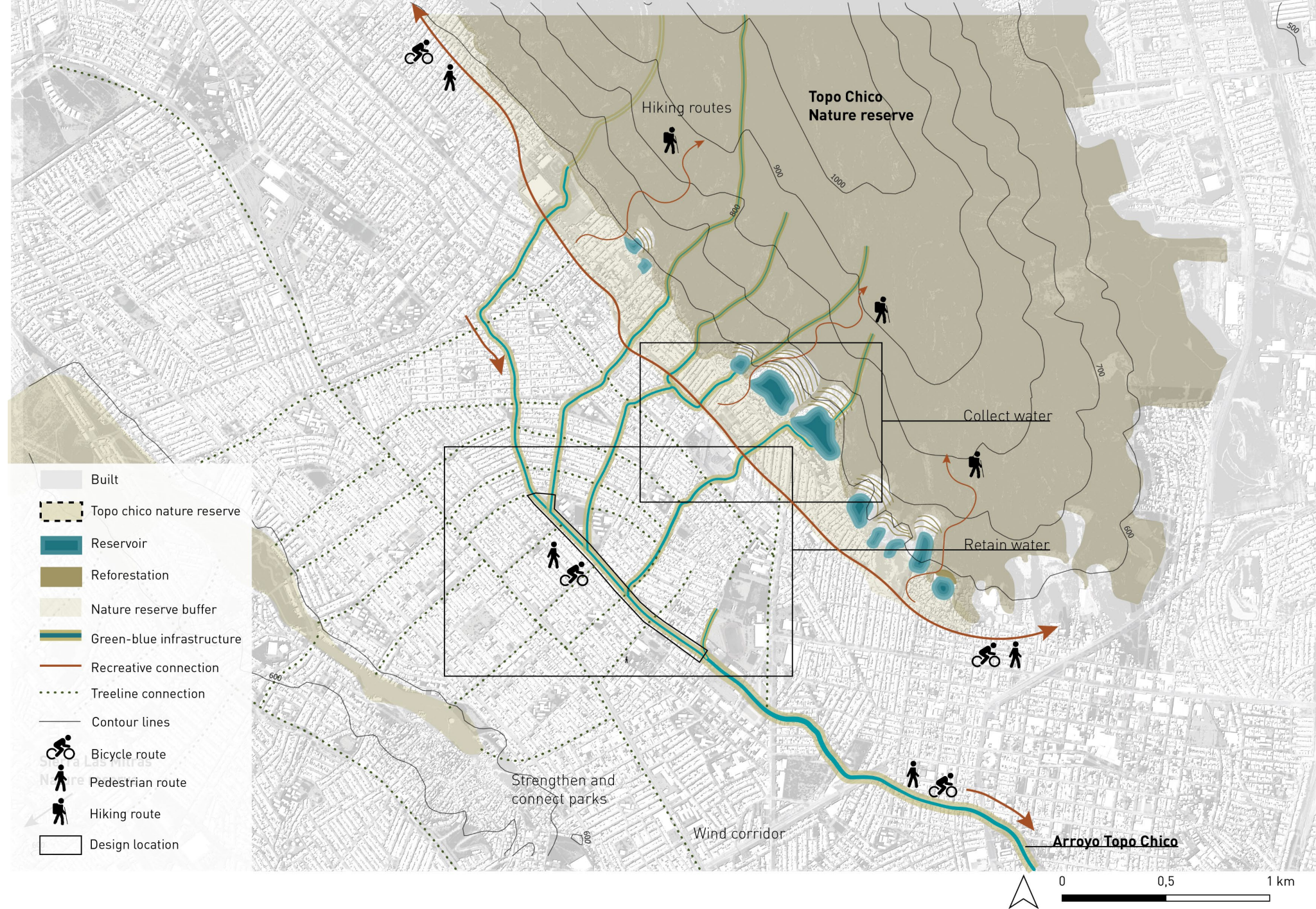


Spatial Design:

Upstream Arroyo Topo Chico Vision

Design location 1:
Quarry restoration
(upstream)

Design location 2:
Linear park
(downstream)



Plant Catalogue

Only Rainfall

Always green

Ehretia anacua
Anachua



Quercus fusiformis
escarpment oak



Sufficient (per 7-10 days)

Quercus polymorpha
Mexican white oak



Sideroxylon celastrinum
saffron plum



Sufficient watercare

Quercus virginiana MILL
southern live oak



Maximum watercare

Intermediate

Parkinsonia aculeata
Jerusalem Thorn



Quercus laevis
Lacey oak



Celtis laevigata
Sugarberry



Prosopis glandulosa
honey mesquite



Platanus occidentalis
American planetree



Deciduous

Chilopsis linearis
Desert Willow



Ungnadia speciosa
Mexican Buckeye



Cercis canadensis
eastern redbud



Sapindus saponaria
wingleaf soapberry

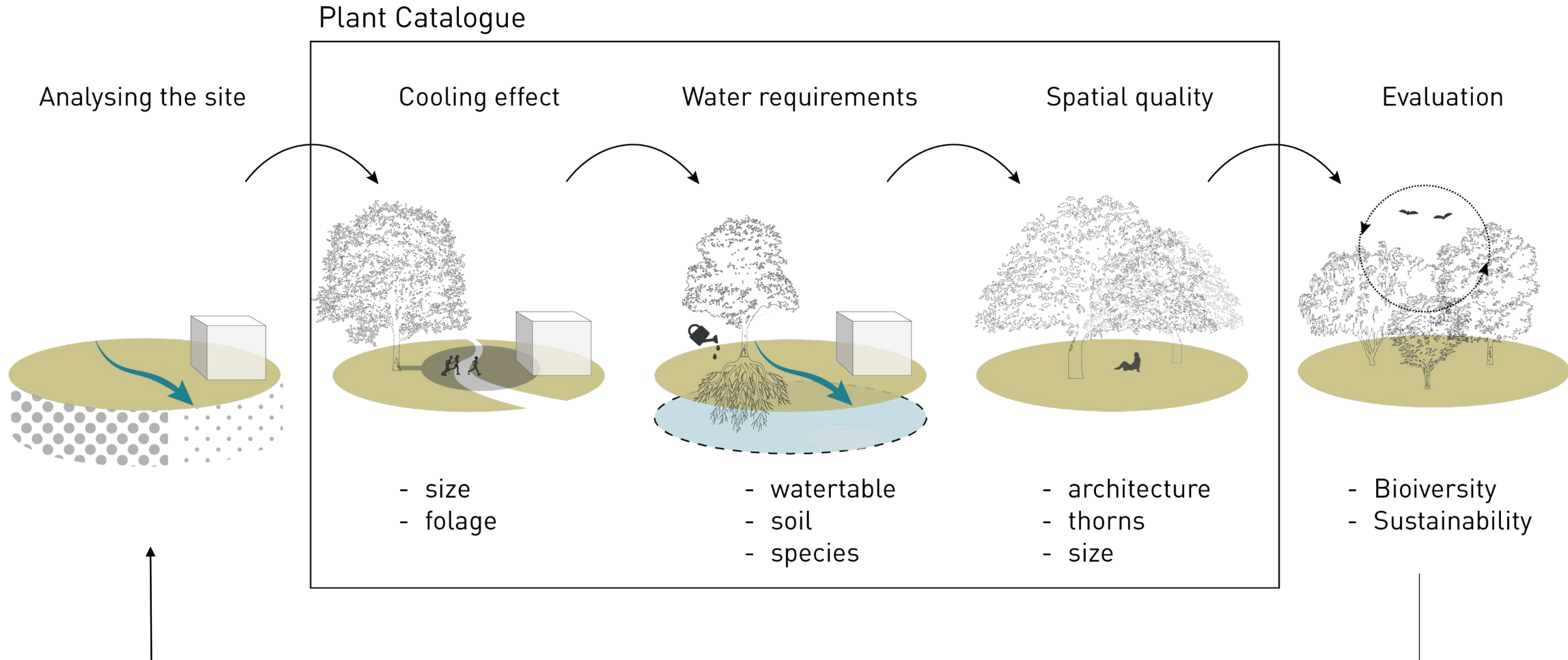


Juglans mollis
Mexican walnut

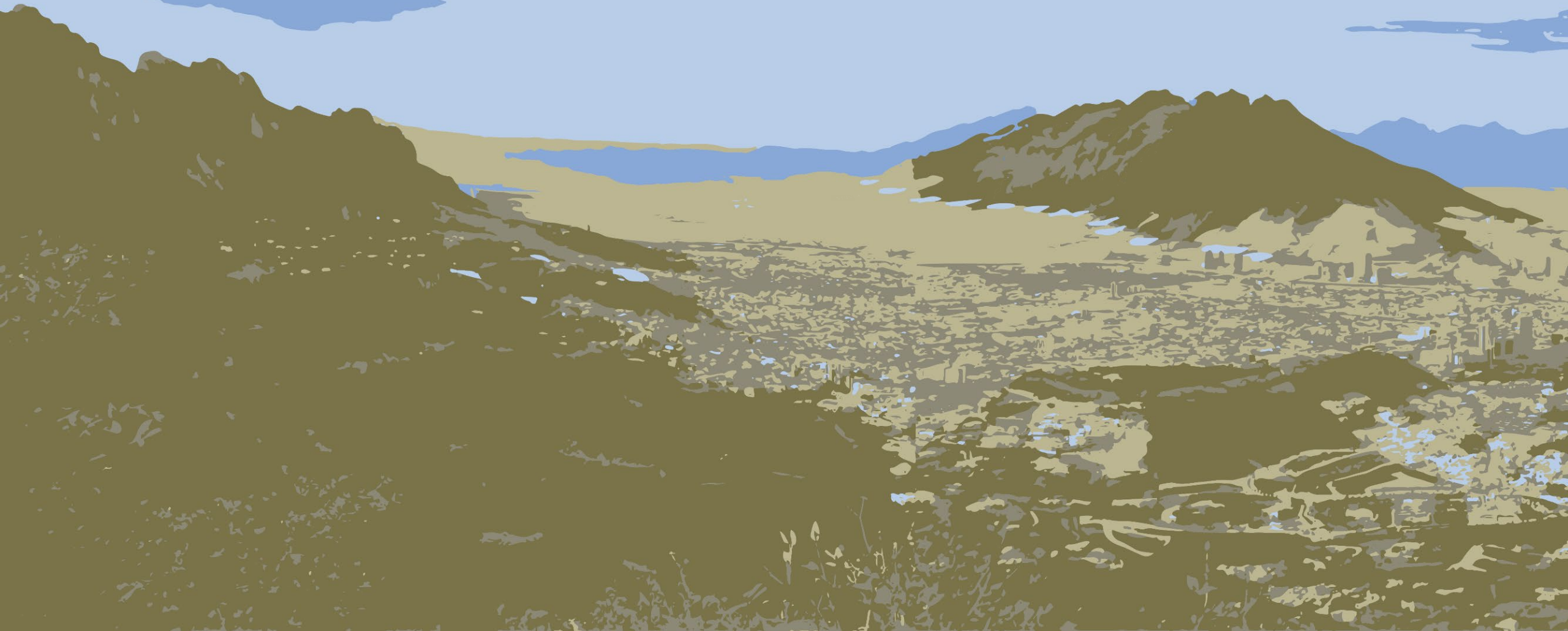


leaves degrade easily.

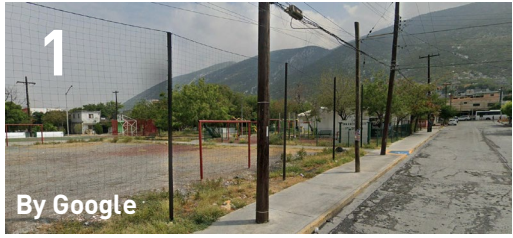
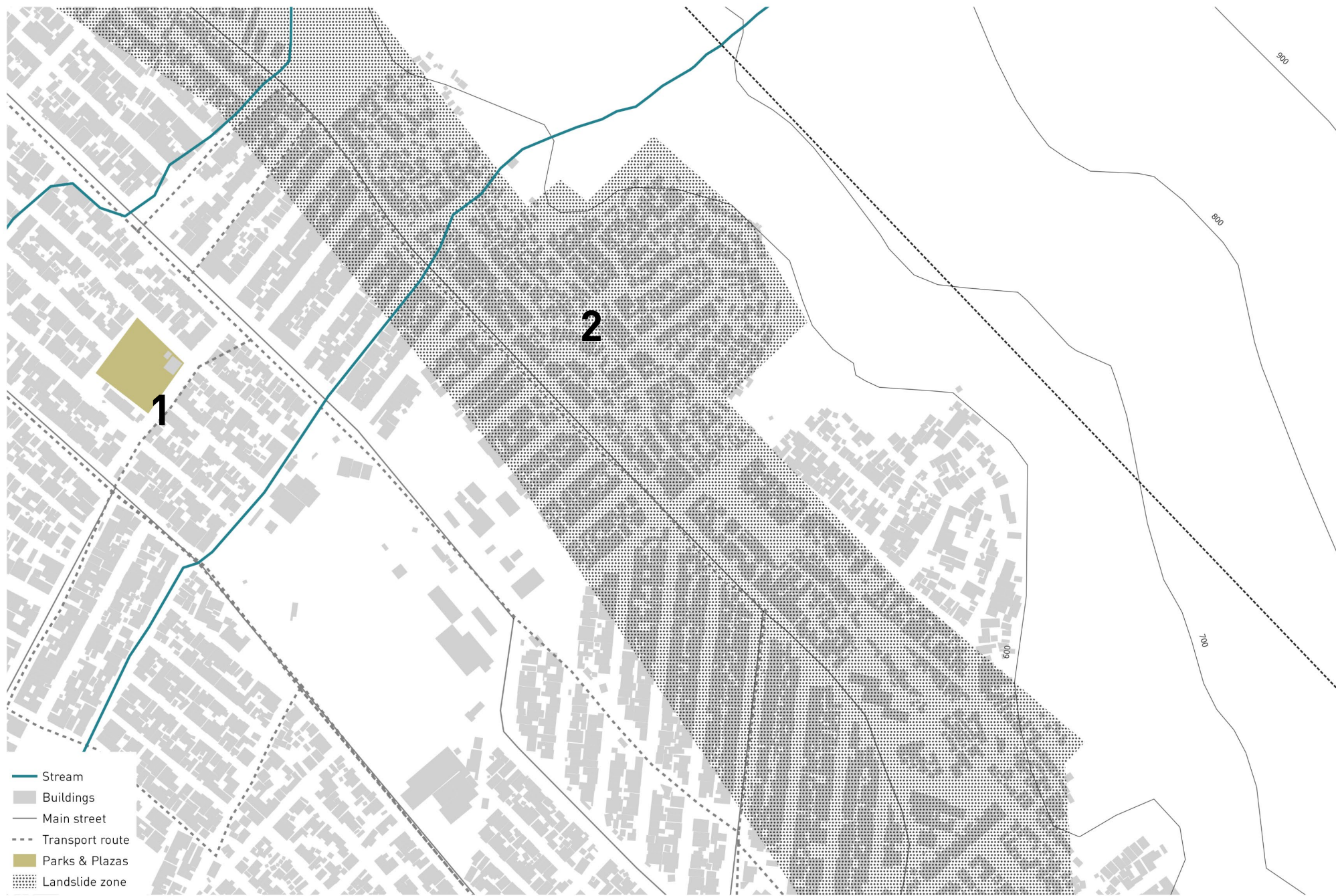
Plant Catalogue operation



**Spatial design
location 1:
Upstream, Quarry Restoration**



Quarry restoration Context



Quarry restoration Design

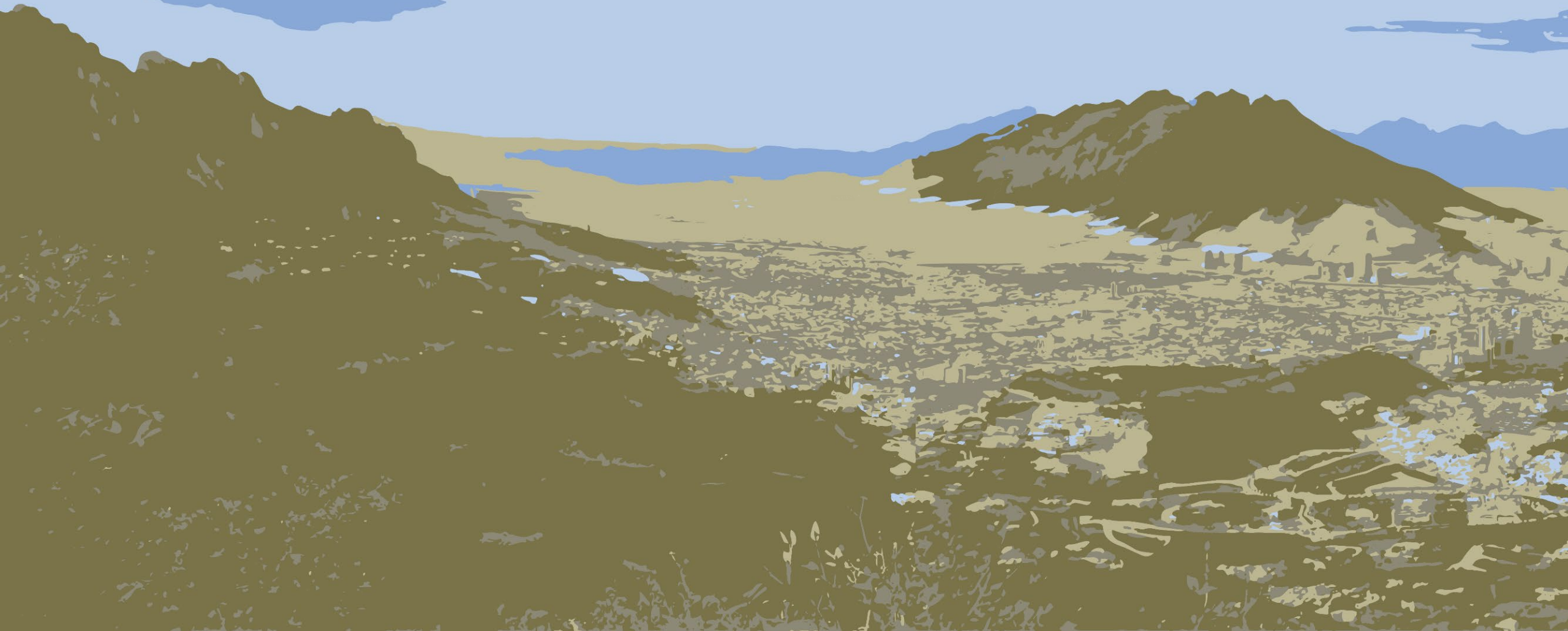


~4 ha
~5m depth
7000+
residents/year

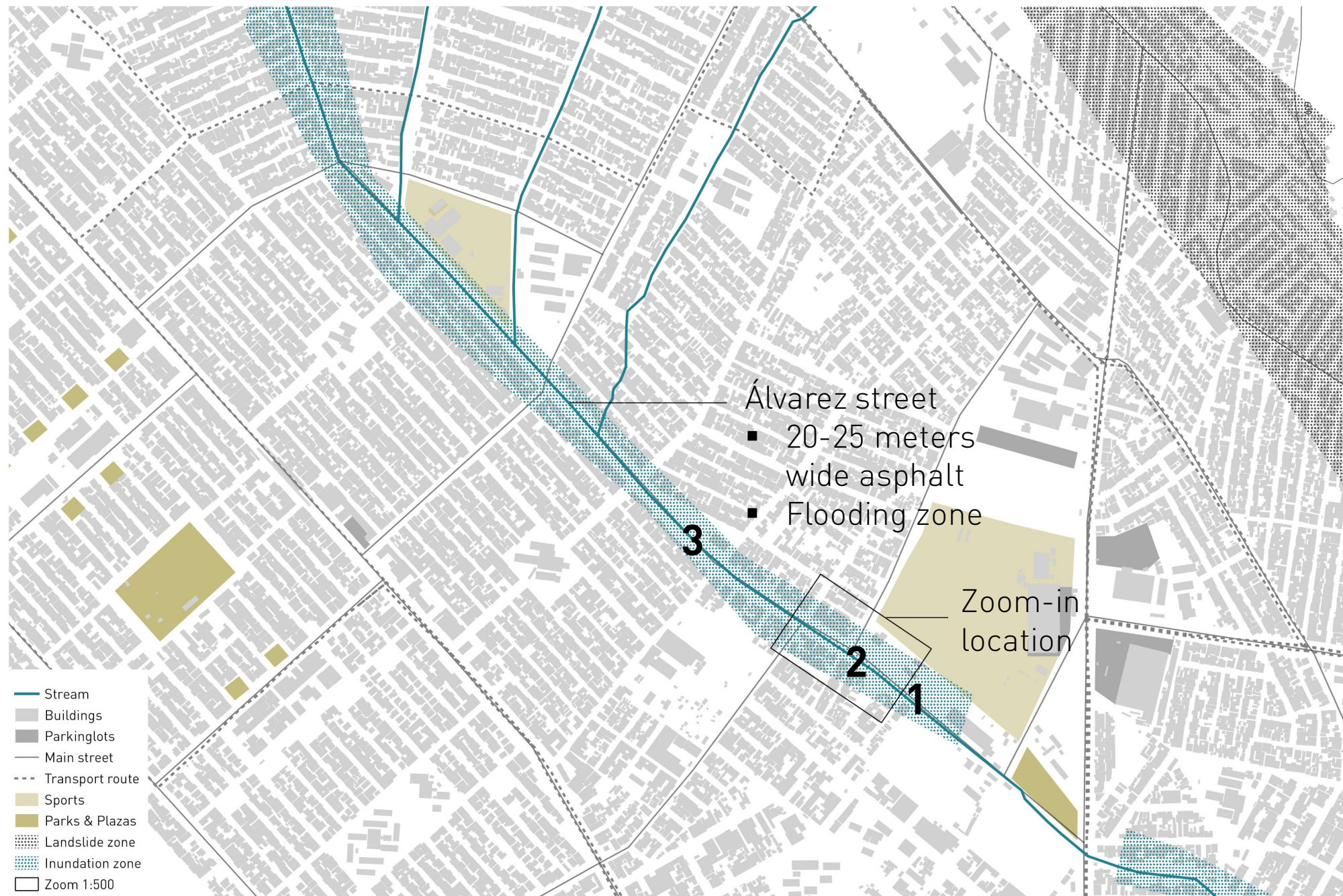
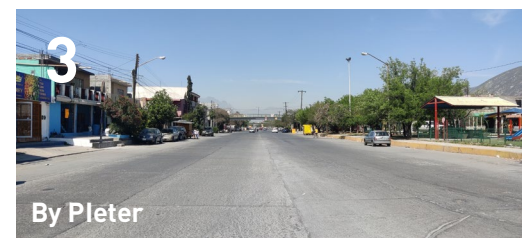
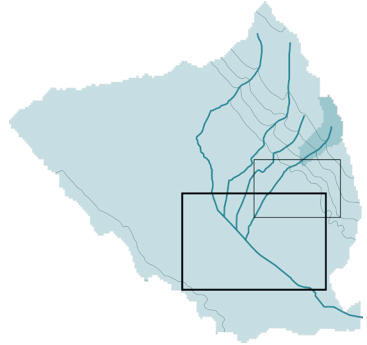
(Inhabitat, 2024)
(Archiru, 2024)



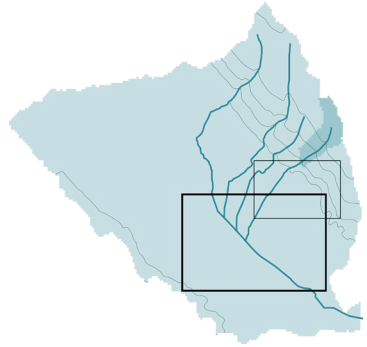
**Spatial design
location 2:
Downstream, Linear Park**



Linear park Context



Linear park Design



- Ecological grid
- Existing of:
 - Daylighting the streams
 - Green streets
 - Pedestrian zones



Linear park Zoom in



Cooling

Trees with the best cooling effect next to southern facades and above sidewalks.



Water

Trees with bigger requirement closer to the stream



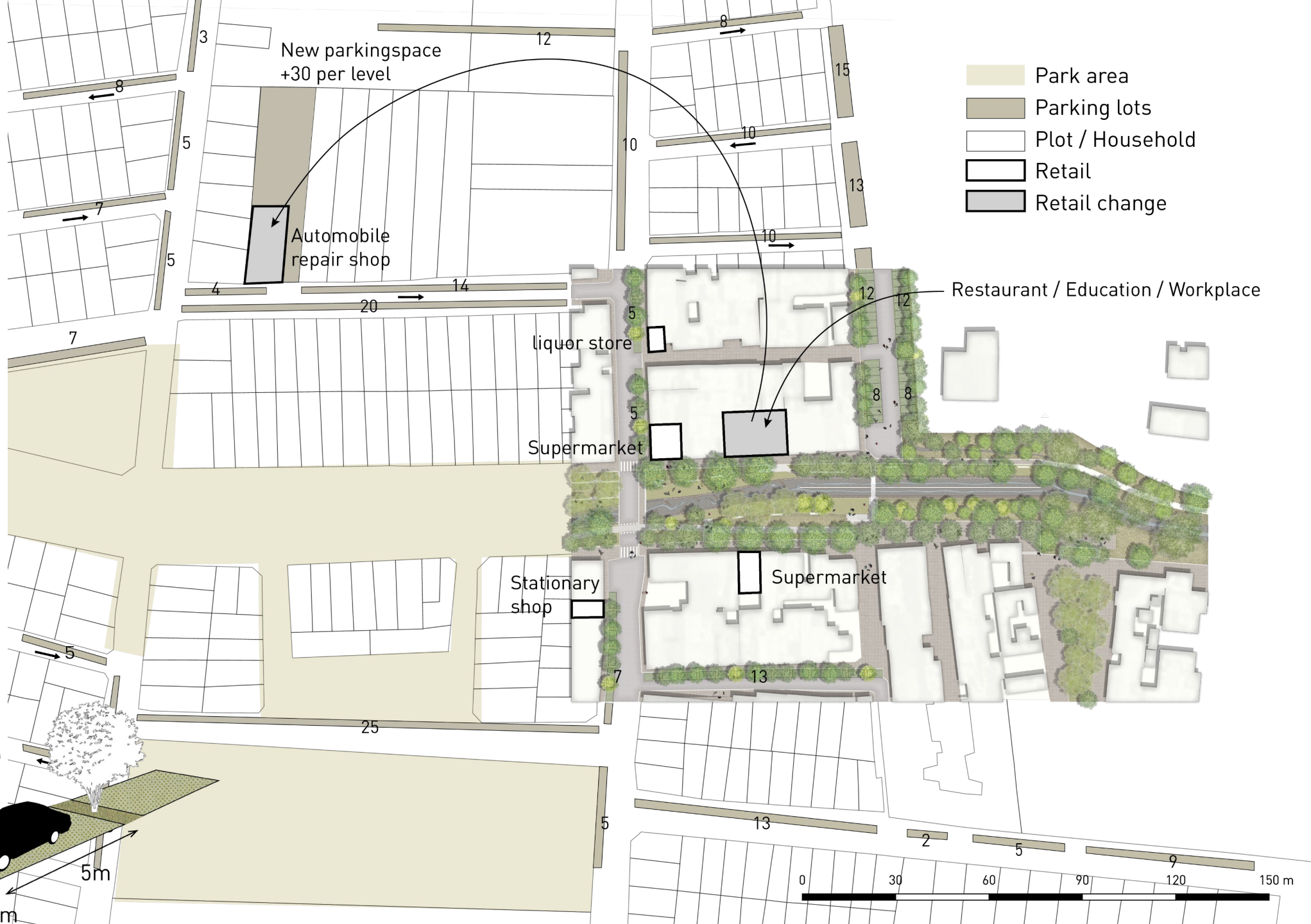
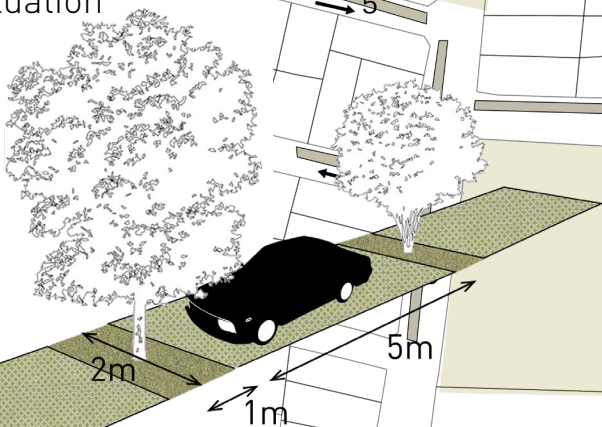
Functioning

- Replacement of retail
- More ordered parking:

Old situation



New situation

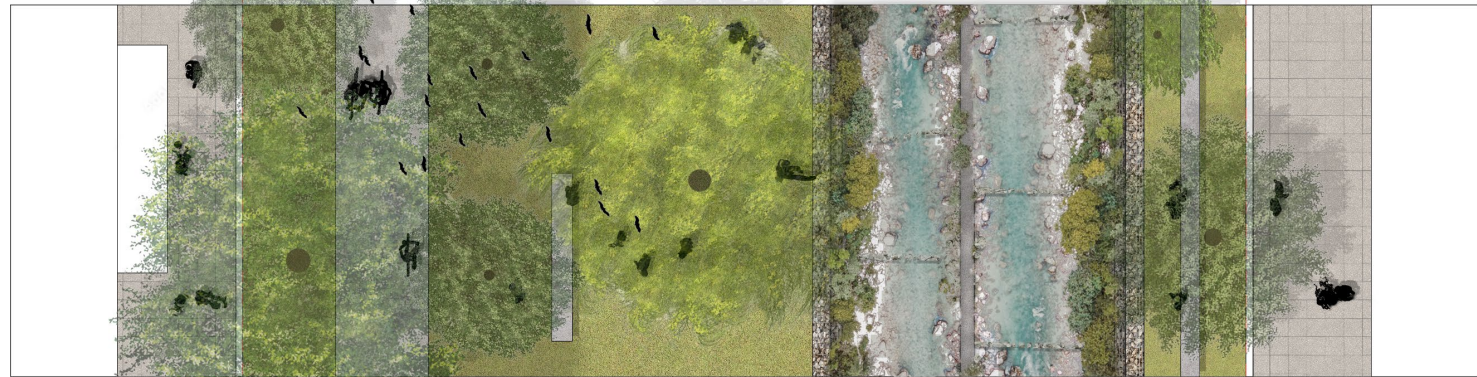
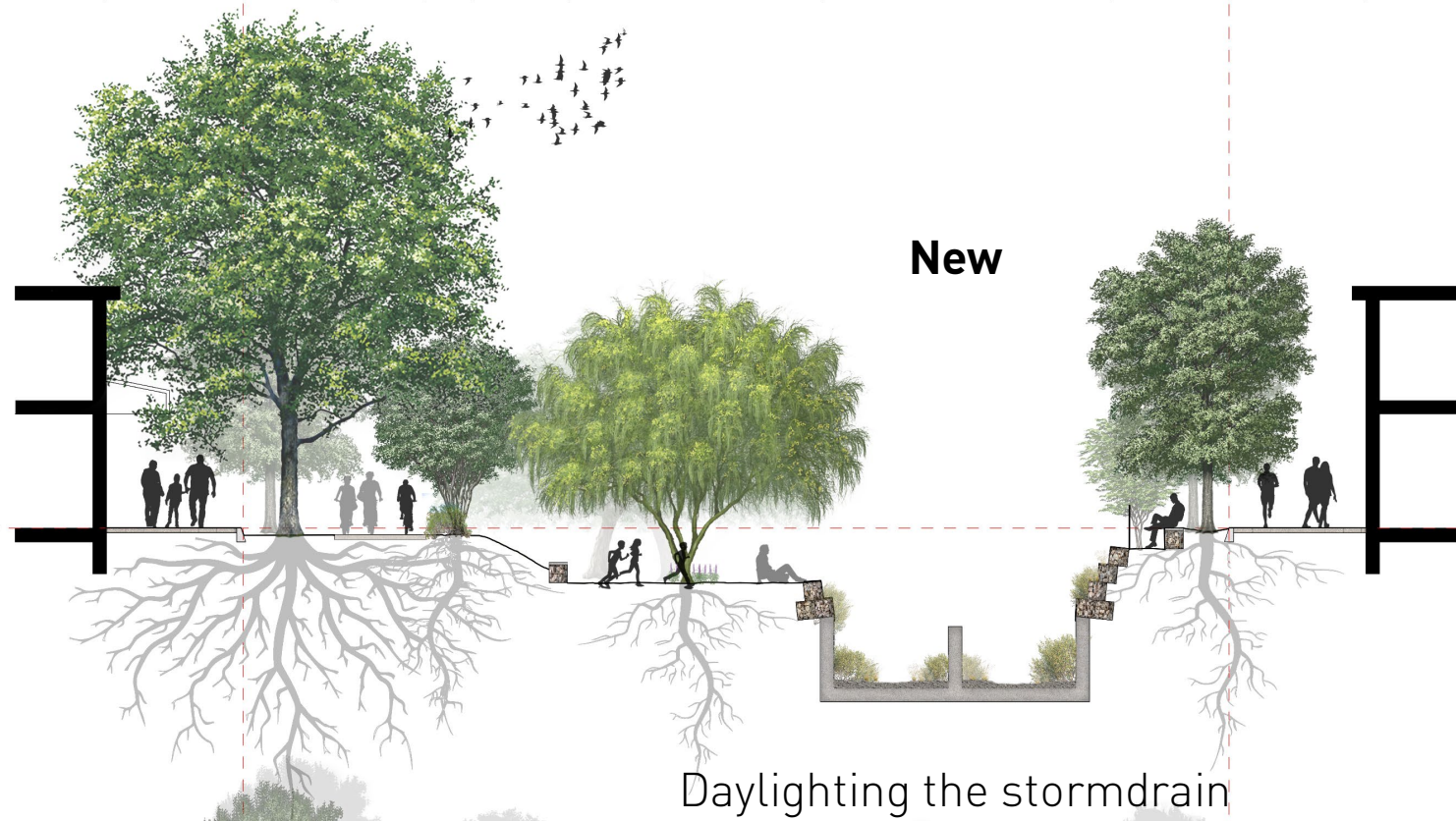


Linear park Section Design

Current

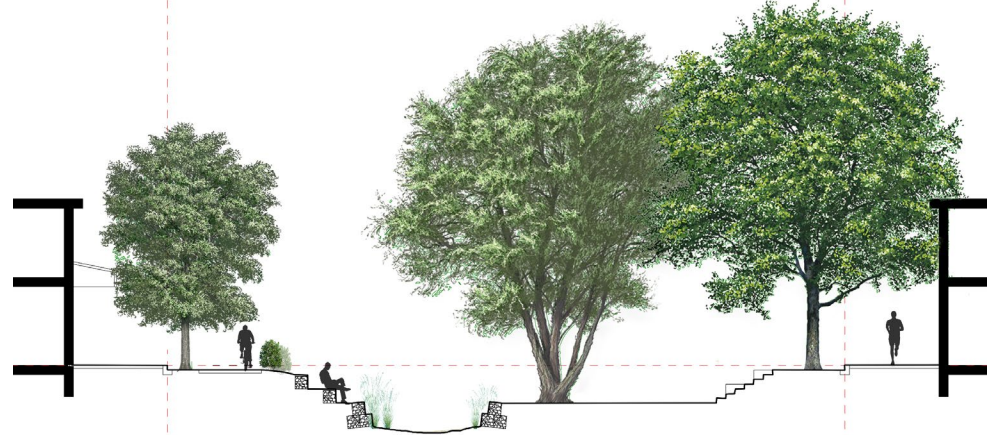
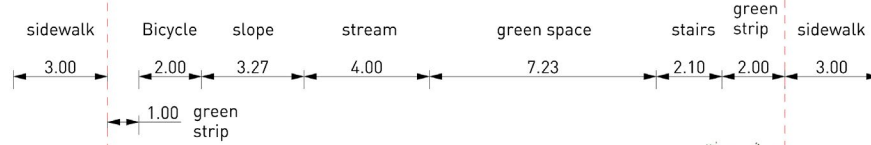


New



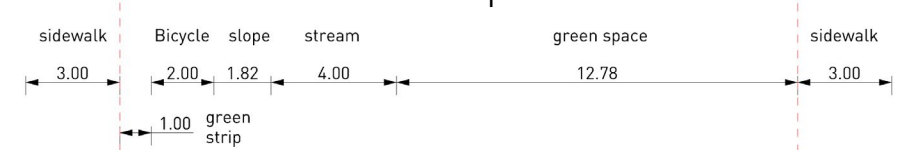
Linear park variants

Tribune



Stream left

Wide park



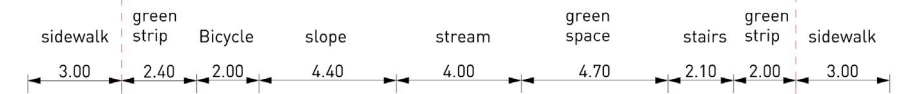
Show what kind of material.
Grass or Plants? Grass or sidewalk?.

Natural



Stream middle

Garden



**Which trees?
Which material?**



Phase 1 in 10 years

Location 1 (upstream)

Upstream:

- First new reservoir
- Testing & Evaluating

Downstream:

- Start of Linear Park

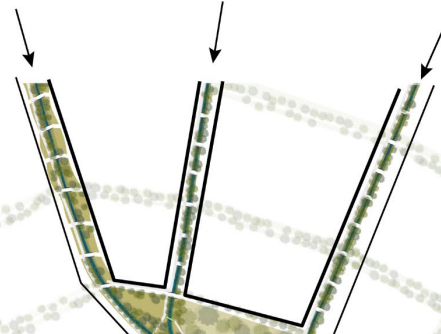
Location 2 (downstream)



Phase 2 in 25 years

Location 1 (upstream)

Waterflows from
new reservoirs



Upstream:

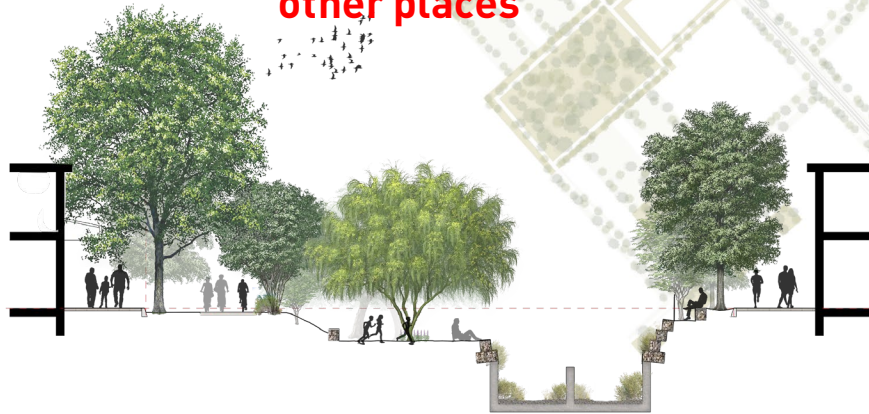
- Finish all reservoirs

Downstream:

- Finish of Linear Park

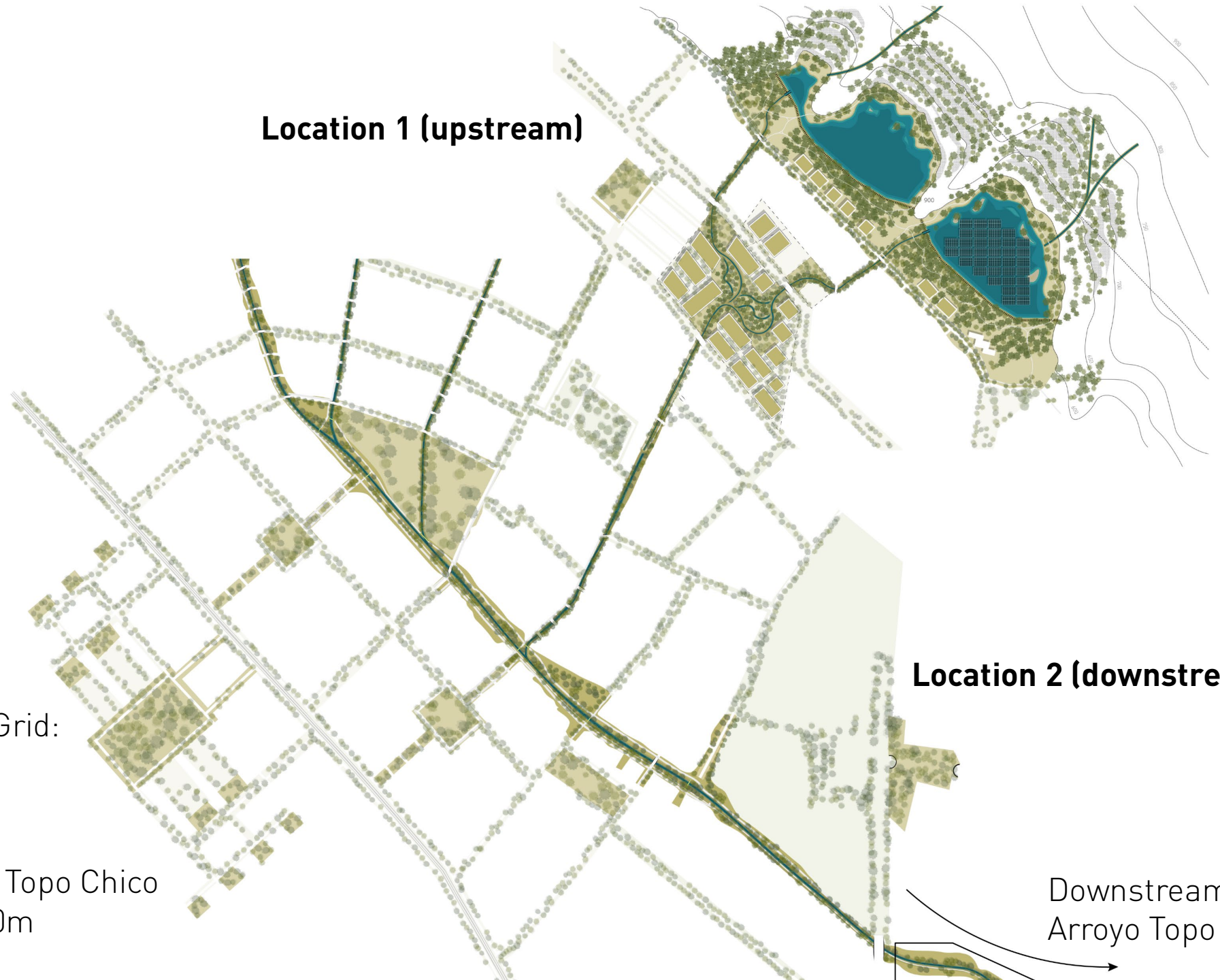
**+ extra section variant for the
other places**

Location 2 (downstream)



Phase 3 in 50 years

Location 1 (upstream)



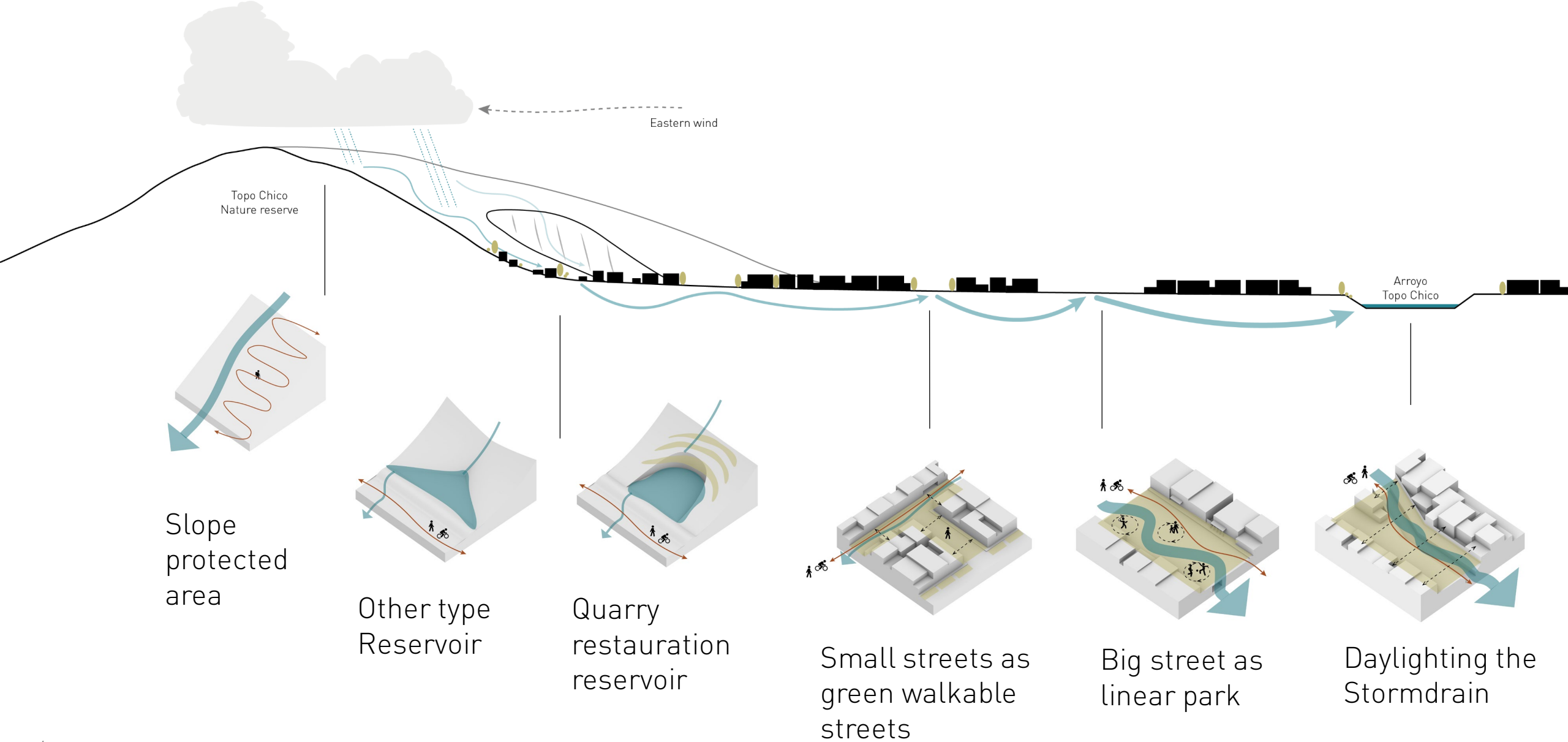
Location 2 (downstream)

Finish the Ecological Grid:

- Green streets
- Treelines
- Expand parks
- Rest of Arroyo Topo Chico
- Everyone < 300m

Downstream
Arroyo Topo Chico

Design Principles (Research by Design)

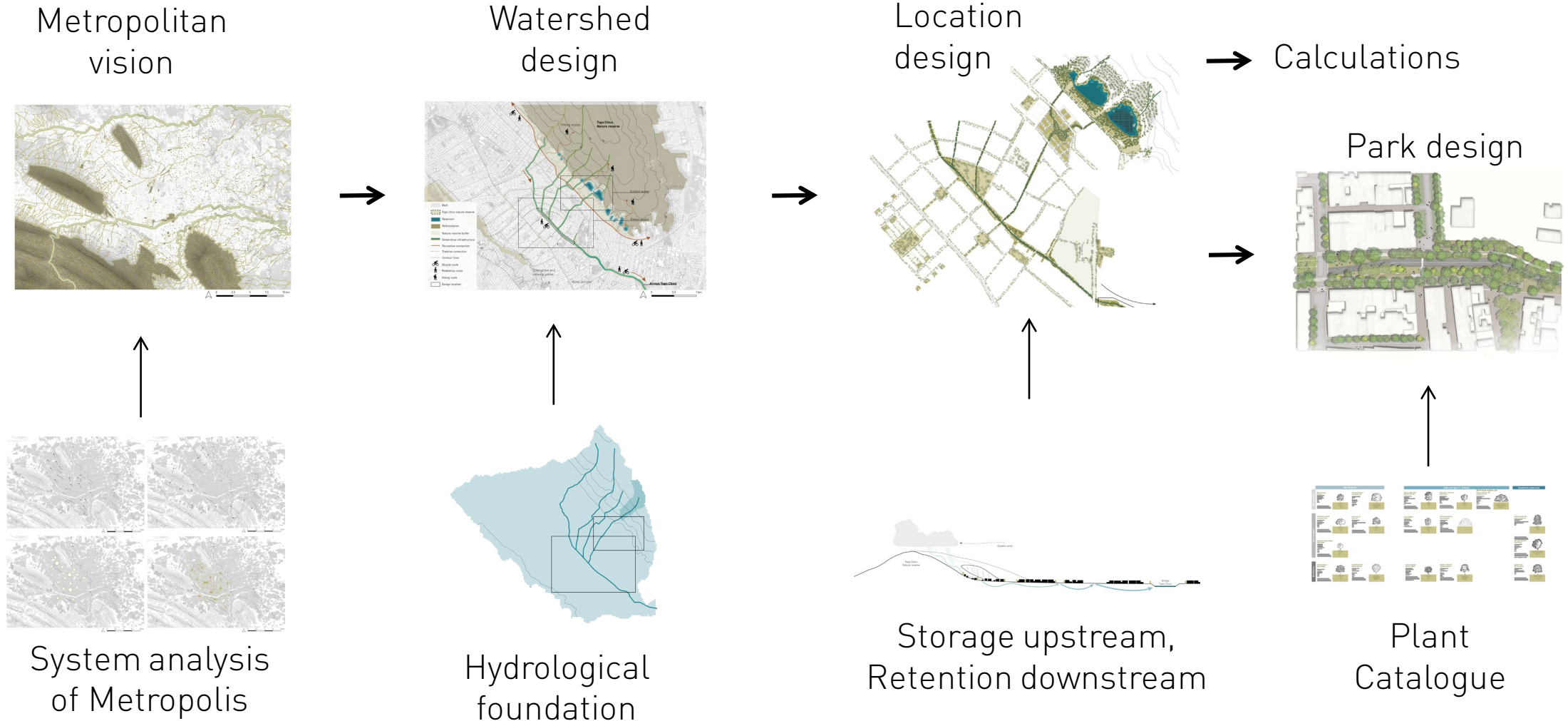


Birdeye



Conclusion

“What **spatial strategy** can be used to implement **green and blue infrastructure** in order to tackle **droughts** and **heat stress** in the **metropolitan area** of Monterrey?”



New Future Scenario

Making a spatial design with green and blue infrastructure

- Make a climate resilient city
- Restore the ecology
- Create quality public spaces
- Finding new strategies by the new design
- Building the first steppingstones for other semi arid and mountainous urban environments:
Mexico City, Los Angeles (USA), Santiago (Chile)



Hydrate Monterrey

Thank you!

