Water From Within.

How to decrease inter-basin water-transfer
by enhancing Mexico City's own potable water sources.

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Colophon

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View from the Los Berros dam, one of the seven pumping reservoirs for the Cutzamala system

Mazahua Rally inside Mexico City demanding secure acces to water

Introduction
Water governance as a central driver for political change

The importance of safeguarding a sustainable potable water supply for Mexico City has never been more urgent to address. In order to do so, it is crucial that authorities approach this problem in an environmentally, socially and economically sustainable way, to ensure that it reduces it's negative impact on the planet, it's people, and their prosperity.
During the past century, Mexico City's water management model has evolved into a large scale water extraction infrastructure network that has prompted catastrophic effects on the natural environment within and outside it's hydrological region, such as the drying of the Lerma wet-lands (JACMCWS, 1995) as well as encouraging the eviction of millions of indigenous inhabitants from their homeland in the surrounding regions (Watts, 2015), at the ever growing cost of expanding the freshwater supply system.

Mexico City's current unsustainable water management model is a result of having historically neglected the basin's natural setting, being one of the most inefficient and expensive water supply networks in the world leading the supply cost to approximately $1.00 per cubic meter, compared to $.46 San Diego, California (JACMCWS, 1995). The environmental damage and social inequality that this has provoked has extended beyond the city's limit's, requiring to build multi-million dollar projects across the neighboring states in order to quench the thirst and treat the waste-water of over 25 million people (INEGI, 2012).

The federal and local governments counter measure is to keep investing even more in these projects, expanding them and building new ones under the belief that it is the only feasible solution. Although the demand for potable water for such immense population is virtually impossible without this current model, it is possible to make a gradual transition into enhancing the city's own abundant fresh-water sources through properly planned urbanization.

The increasing demand of potable water required by Mexico City has become so large that since the late 30's the local government has opted for importing water from three different basins away from the city, causing damage to the ecosystems of the region as well as the eviction of thousands of indigenous communities from their homelands.

Since the late 18th century, agrarian land reforms in Mexico have been constantly modified in favor of expanding the development of its main cites, creating a segregation of services and depriving native communities from vital resources as well as indirect consequences such as increasing their cost of living without improving their livelihoods.
The tendency for the city's water management model is to expand the supply regardless of the social and environmental costs, resulting in an ever-growing water infrastructure network that threatens the long term well-being of the population.

Simultaneously, the densely urbanized periphery, where most fresh-water sources still exist, poses the risk of fast land price increase, growing each time developers build housing projects which become unaffordable for the local population. Since the city is currently re-writing it's constitution and with emerging political reforms such as the National Law on Water, the population fears that this process of intense privatization of land and water will increase. Pressure from the city's residents as well as from the 'donating population' at the water's source calls for immediate action on this opportunity to rethink the city's water management model into becoming an integral project that ensures equity and sustainability rather maintaining it's current state of self induced artificial scarcity.

Although the presence of potable water in the city today is almost entirely neglected, the possibility to recover the hydrological potential of the region is key to achieving socially, environmentally and economically sustainable development for the city and the region. The rivers flowing in from the south western maintains have historically been the source of fresh water within Mexico city and, while today they represent only 2%3 of the total supply, they have the potential to gradually supplant the Cutzamala system as the city's fresh-water supply. The Magdalena-Eslava river sub-basin is one the main perennial of the remaining river system and thus can potentially be a strategic starting point for kickstarting a sustainable water management model for the city.

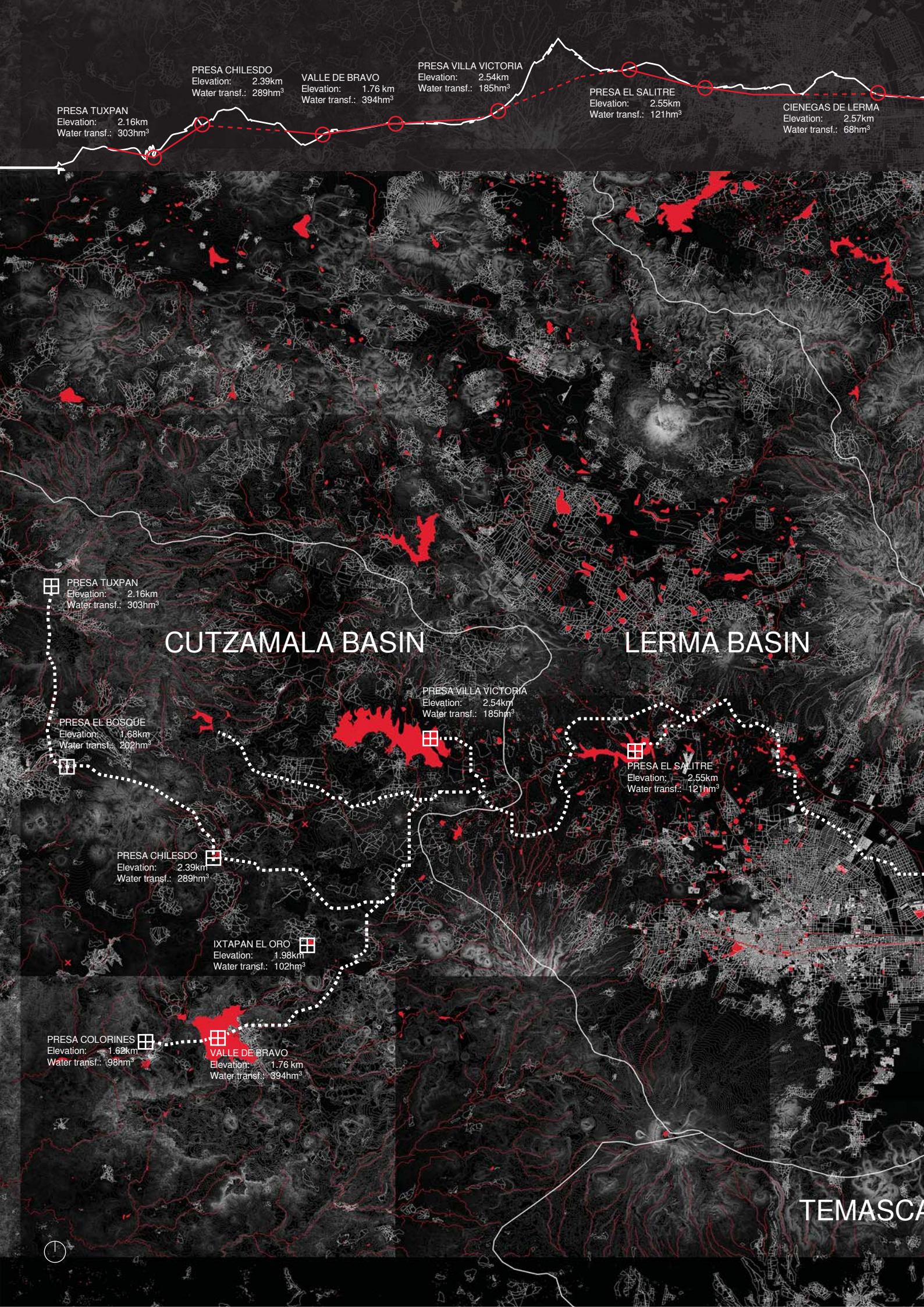
Lerma wetlands drying up in the mid 40's

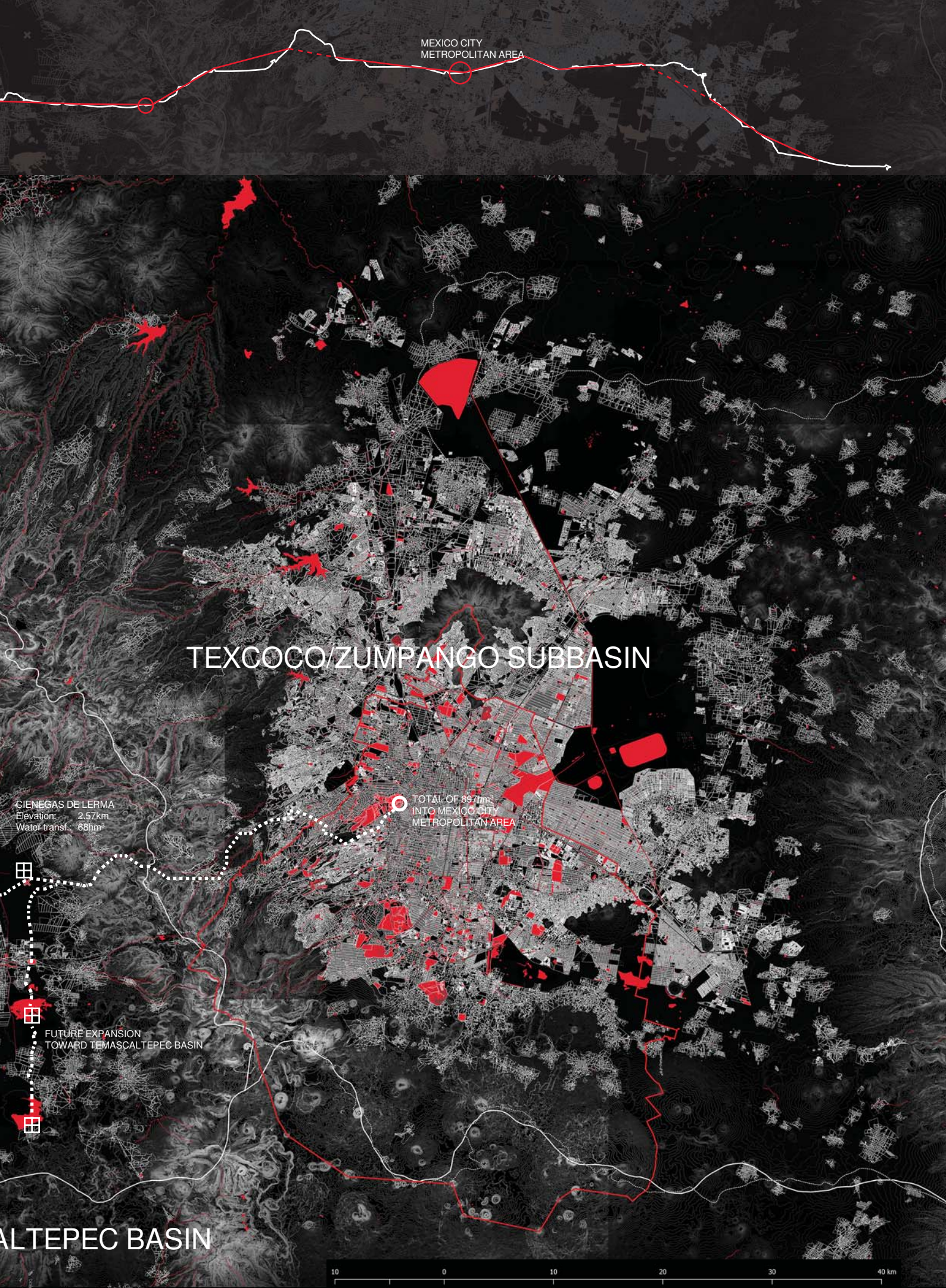
Introduction
Water governance as a central driver for political change

As a result, the government has expanded their main source of fresh-water by means of the Lerma system, and consequently incorporating the Cutzamala system, an inter-basin pumping and treatment system which spans across 200 km in distance and 1200 m in elevation, pumping water from three different states and cutting through valleys through a system of tunnels connecting dams and reservoirs. The population living near these sources of water have become deprived from their own local resources.

This research seeks to understand the process of urban transformation of Mexico city and illustrate how water sensitive urbanization patterns in the city's periphery may create an entry point for other disciplines and interested stakeholders to help ameliorate the ongoing expansion of the city's water extraction infrastructure through an autonomously governed and decentralized collective water management system.

The following research presents alternative urbanization schemes aimed at addressing Mexico city's potable water management system deficiencies. The research has been done through a process of analytical design of the concerned territory at its different scales according to it's urban pattern. The objective of this research is to provide insightful design and planning mechanisms that can help the city's residents by structuring their capacity to be supplied with potable water from sources within the basin and their local hydrological region. By understanding the urban structure of Mexico city and the basin in occupies, this research aims to show the technical, spatial and economic feasibility of reorganizing urban space and social structures in turn of a more adaptive environment.


PRESA TUXPAN
Elevation: 2.16km
Water transf.: 303hm3
PRESA CHILESDO
Elevation: 2.39km
Water transf.: 289hm3
VALLE DE BRAVO
Elevation: 1.76 km
Water transf.: 394hm3
PRESA VILLA VICTORIA
Elevation: 2.54km
Water transf.: 185hm3
PRESA EL SALITRE
Elevation: 2.55km
Water transf.: 121hm3
CIENEGAS DE LERMA
Elevation: 2.57km
Water transf.: 68hm3
PRESA TUXPAN
Elevation: 2.16km
Water transf.: 303hm3
CUTZAMALA BASIN
LERMA BASIN
PRESA VILLA VICTORIA
Elevation: 2.54km
Water transf.: 185hm3
PRESA EL BOSQUE
Elevation: 1.68km
Water transf.: 202hm3
PRESA EL SALITRE
Elevation: 2.55km
Water transf.: 121hm3
PRESA CHILESDO
Elevation: 2.39km
Water transf.: 289hm3
IXTAPAN EL ORO
Elevation: 1.98km
Water transf.: 102hm3
PRESA COLORINES
Elevation: 1.62km
Water transf.: 98hm3
VALLE DE BRAVO
Elevation: 1.76 km
Water transf.: 394hm3
TEMASCA


MEXICO CITY
METROPOLITAN AREA
TEXCOCO/ZUMPANGO SUBBASIN
CIENEGAS DE LERMA
Elevation: 2.57km
Water transf.: 68hm³
TOTAL OF 897hm³
INTO MEXICO CITY
METROPOLITAN AREA
FUTURE EXPANSION
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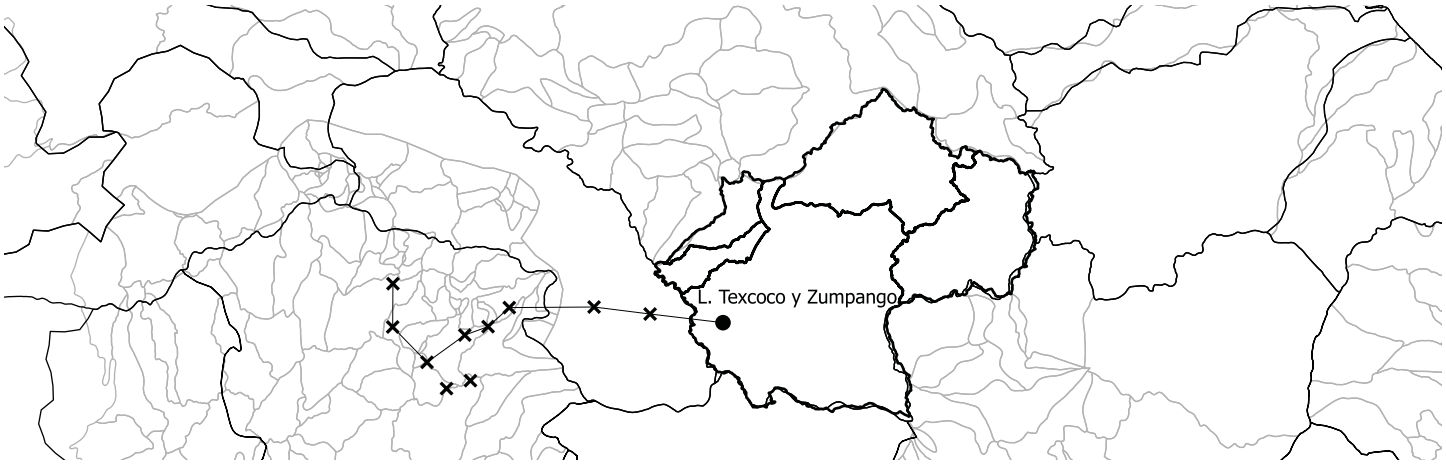
Problem statement
Inter-basin water transfer in the central Mexican valleys



Schematic path of the Cutzamala system

The Cutzamala system

In 2015, the metropolitan region of Mexico City received approximately 493 hm3 of water through the Cutzamala system (EAM, 2016). Mexico City's current potable water supply system is vulnerable to over-exploitation, contamination and ever expanding maintenance costs, posing a risk to the entire city's supply. The dependency on the city's aquifer has caused it's population to extract water from sources outside the valley, causing the ecosystems, societies and economies of the 'donating' regions to suffer environmental degradation which consequently impacts greatly on the farming industry. This contributes to the ongoing migration from rural areas to urban centers, making life in large cities more challenging to manage. In the case of Mexico, property rights have historically been managed to favor powerful investors, opening opportunities for buying farmland and converting it to other industrial uses, as has been the case since the late 40's.

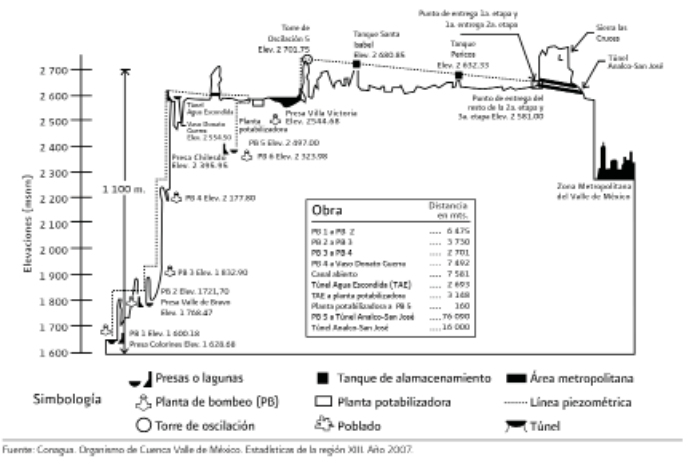
This has led the food production market to be controlled largely by few single companies that own large scales of farmland in the country, with many small scale producers struggling to compete in a market in which they barely figure against the competition. In extreme climate situations, it's this group of lesser powerful and less privileged group that suffers most and takes longer to recover after an extreme climate change such as the expected decrease in rainfall in the LAC (Assad,2013).

Basin of Mexico

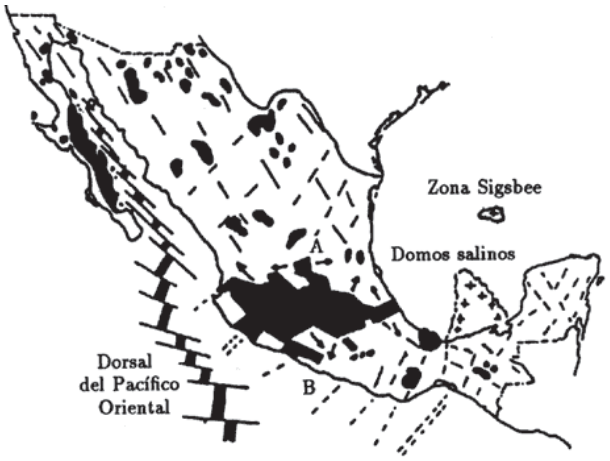
Due to continued subsidence and the increasing awareness of the limited and vulnerable suppy of the basin's groundwater, authorities looked to obtain fresh-water from sources ouside the basin.

Current efforts in urban planning that help mitigate these risks Environmental justice advocates considered the needs of low income residents in order to define a proper regional plan for the city of San Jose called the "Delta Vision'. This regional planning scheme allowed different levels of implementation according to the existing differences in the resident's incomes. To do this, they have succeeding in creating Work-groups in which they differentiate economic possibilities according to risk vulnerability, in a framework similar to the DFID's in the UK (Sustainable livelihoods framework 2010) (Kronik, 2010) in which Financial capital, Human capital and Natural capital are evaluated according it's contribution to long term livelihood.

The Texcoco / Zumpango basin is the main catchment area of the Mexico Basin. It is conssidered to be a endorreic valley, meaning it dows not drain water naturally. The 'Tajo de Nochistongo' drain is known as the city's first man made modification in its hydrological structure, being one of the main changes that prompted the drying of the former lake. The south-wester portion of the basin is known to have highly infiltratable soil due to volcanic formations and eruptons which once consolidated the porosity of the area.



Fuente: Conagua. Organismo de Cuenca Valle de México. Estadísticas de la región XIII. Año 2007.



Trans-Mexican volcaninc belt (source)

Problem statement
Inter-basin water transfer in the central Mexican valleys

The director of SACMEX, Ramon Aguirre has a strong stance on the current model that the city has for supplying water to its citizens in regards of the scale of the demand and the technology required to fulfill its needs. Currently, the Cutzamala system plays that roll of the city's supplier, and the amount of money and energy it requires to function properly is unsustainable. His opinion on small scale efforts to supply the city based solely on rainwater harvest is that it is insufficient.

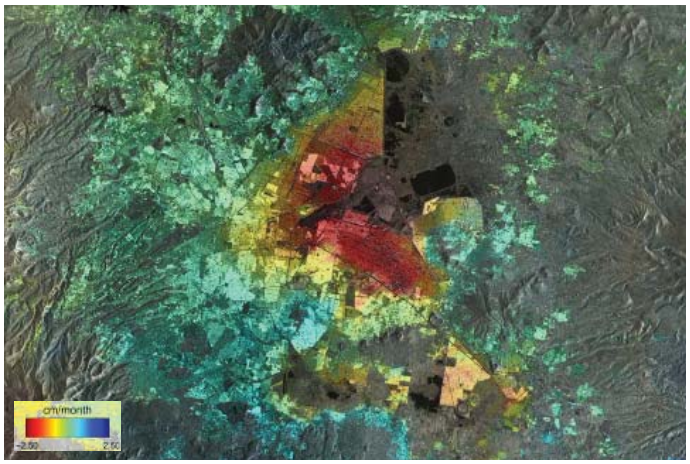
Water treatment in dry areas is crucial for safeguarding not only the domestic use of water in the city, but of the industry as well, and in the case of Mexico city's periphery, the sustainable development of the productive landscape, specifically in the south portion of the basin.

Given the current urban condition of said area, the soil and subsurface presents a high risk of contamination, due to the patterns of urbanization and they way in which they materialized. This has resulted in coletely contaminating the rivers of the southwestern portion of the Mexico Basin.

Mass regional subsidence

Groundwater levels have been declining over the course of the past century, resulting in regional land sunsidence (JACMCWS, 1995). In the lower portions of the valley, where the city center area lies, has subsided an average of 7.5 m, which in some areas may occur at a pace of 2.5 cm per month (ESA, 2014). This has had a severe impact on the built environment, including water supply infrastructure and drainage.

Given the different soil types and composition of the city's aquifers, this subsidence occurs at uneven paces which provockes damage to water provision and drainage infrastrucutre, as well as having an impact on the structural integrity of buildings.



Mass regional subsidence(Source: European Space Agency)

Equity in providing opportunities as the root for environmentally sensitive transformations

It is common in large metropolis that the geographical location of the urban poor is often located away from the central economic developments, ultimately prompting the sprawl of the city towards the periphery. These peripheral settlements are the front-line of humans encounter with nature, and the way authorities and private developers have spatially transformed these areas has left catastrophic damages to the environment, which as stated previously in this paper, is the provider of our well-being.

Rural-urban migration correlation with increased demand of external water sources

This type of impacts on the economy and society are so large that it has even caused migration from poor rural areas into already overpopulated metropolitan centers. Most of the challenges related to this migration involve the determent of natural ecosystems for water provision and the food production industry. In traditional rural areas in Mexico and other countries of Central and South America, indigenous peoples struggle to fight deforestation and variability of it's basin's water cycle highly influenced by local industry supporting urban economies (Kronik, 2010).

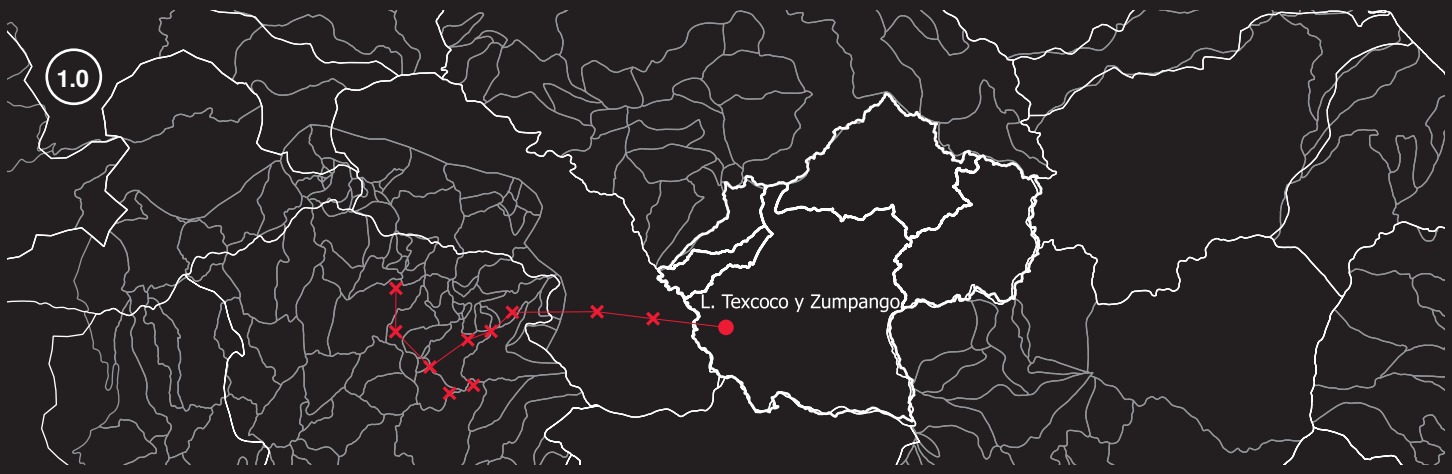
As water distribution systems in Latin American cities continue to to grow without proper planing, so does the climate risks of the such as temperature and precipitation variability. With many small scale farmers dependent on such a tight meteorological regime, it can be inferred that their economic stability is on a tipping point. And this brings with it, within the scope of urban planning, a clear disadvantage within various social stratum of Mexican society which have been the most affected by the general modernization process as well as the ecological crisis in parallel. Potable water supply in particular is one of the city's main concerns, as it poses the risk of contamination, depletion, and subsequently expanding its external water source extraction infrastructure.

The city's present model for supplying it's citizens with it's high demand of fresh water has caused inequality to rise. In order to gradually decrease the city's demand for external sources of potable water, the city must be able to safeguard the quality and extraction-recharge rate of it's aquifer, as well as utilize pluvial and fluvial sources smartly. Various technologies permit the population to treat water and receive subsidies from the government, as well as enable them to re-use their waste water for irrigation and secondary domestic uses, and it's biomass to use as fertilizers and produce domestic amounts of energy.

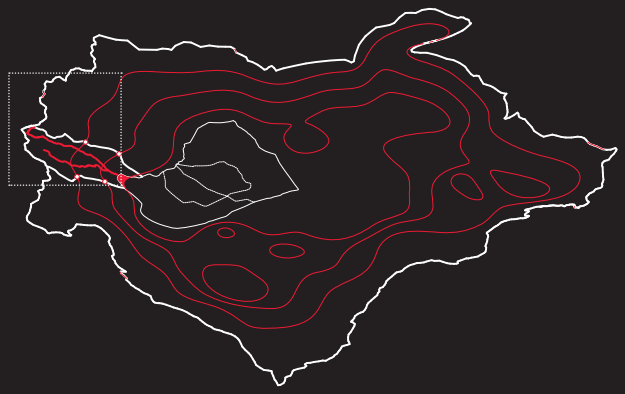
Indigenous woman fetching water (Source: The Guardian)

Diverse indigenous communities span across Latin America being one of the most affected by the decisions made within cities. As demand for potable water increases, supply networks suffer expansion changes in order to extract water elsewhere, which involves the rural population, often living already in extreme poverty, to migrate to nearby cities en search of work and general subsistence. The World Bank's extensive study on the topic concludes by stating the importance of cooperation with these indigenous communities as a feasible strategy for climate adaptation:

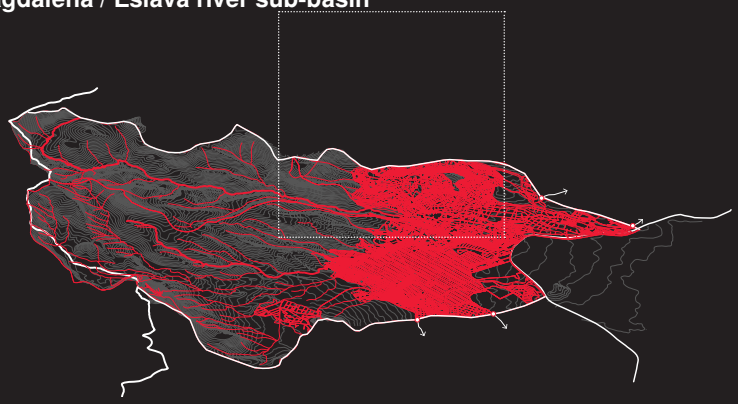
"As existing climate change trends are projected to intensify, with disproportionate effects on the most poor and vulnerable, it becomes increasingly urgent to cooperate with indigenous groups and draw on their knowledge of the local context to identify and implement environmentally and culturally sustainable adaptation measures" (Kronik, 2010)



1.1 Texcoco / Zumpango sub-basin



1.2 Magdalena / Eslava river sub-basin



1.3 Totolapan / Padierna micro-basin

Research questions

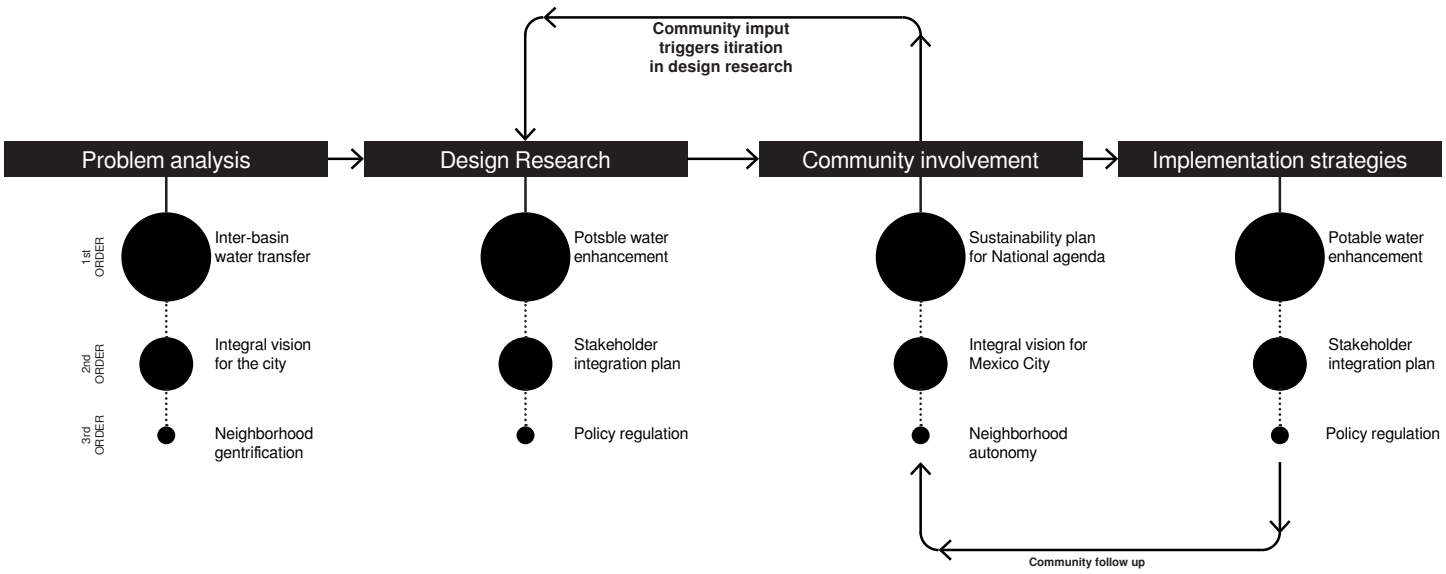
1.0 **Can water sensitive urbanization in Mexico City's periphery help enhance the basin's own potable water sources in order to gradually decrease the need for inter-basin water transfer?**

1.1 **How can the basin become hydrologically autonomous?**

1.2 **How can the mountainous region and transition zones help balance the aquifer recharge rate?**

1.3 **How can water sensitive urbanization enhance existing potable water sources?**

Research methodology



It is important for projects which involve the cooperation of so many sectors of society to be informed and included in early stages of the design process. During this research, critical analysis of the input given from the local community, authorities, and private actors is essential to develop a truly sustainable vision for the city.

For this reason, the methodology for this investigation is centered around the constant cooperation and mediation between all said stakeholders, during research and design phases as well as during and after implementation phases. This process is structured as follows:

1. An initial analysis and mapping is done during the first phase to be able to approach the community with long term visions and objectives. The definition and classification of the problem is done in order to communicate better with the stakeholders.

2. A spatial design is proposed at the different scales of the projects impact: neighborhood, city and region. To do so, a structural vision for the city is proposed to make sure the problem of potable water is included as a fundamental layer of the ongoing process of urbanization.

3. A first review from the local community is done in order to make sure that the objectives of the project are in their best interest. Input is gathered from meetings with the neighbors and local authorities. Then, the project is introduced to the city's main interested departments, such as the water board, the department of public works, housing and environmental impact. Finally, the input collected from these authorities are explained to the community to refine the strategy.

4. A second spatial design is proposed in which the input from the stakeholders refines the implementation strategies. According to the available policies which would enable this project to happen and to what potential benefit's it may bring to the city, the design proposal shall be revisited to best suit the needs of the residents, investors and government authorities.

Scope of the research

This research will provide an alternative urbanization process integrated with water management model for the piedmont neighborhoods of Mexico city in order to safeguard the quality of the city's aqufer. By defining a set of different interventions along a future time-frame, the proposal aims to provide flexible insight on how to spatially reconfigure the neighborhood, in the face of the changing conditions of the natural environment, society and economy.

In order to ensure the healthy recharge of Mexico's aquifer, the project must strategically intervene according to soil type. Due to the specific soil condition the neighborhoods along the Magdalena river basin contribute to the contamination of this finite resource before shedding into the highly infiltratable hidrogeologic zone.

Ultimatley this research could potentially help guide the current process of rewriting the city's constitution, a process which the city has been engaged in for the past four years of the current administration.

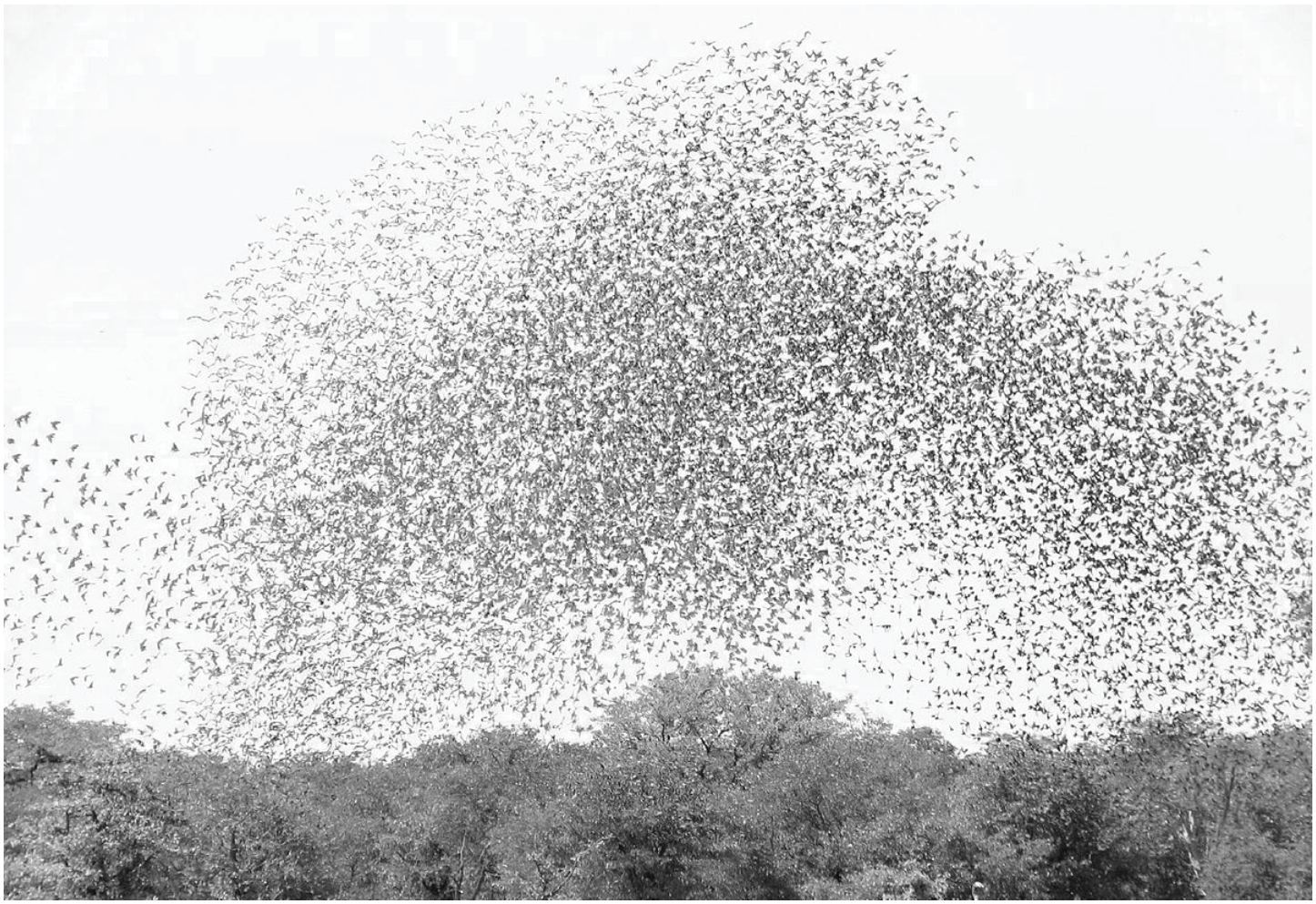
Research objectives

In regards of the socail performance:

- Guide the practices of water governance in Mexico city by defining a desirable and feasible water management model which can create autonomy for Mexico city's fresh water demand.
- Define values in which the involved stakeholders of the Magdalena river basin can cooperate to create a strong partnership to help regulate Mexico City's water management policies.

In regards of the hydrological performance:

- Set a framework which the population living in different fresh water sources in Mexico city can adopt to help secure the recharge of it's aquifer.
- Provide insight on how the districts on the outer side of the transition zone (Hydro-geological zone II) embody a strategy appropriate for its region



Flock (https://www.mnn.com/earth-matters/animals/photos/9-of-the-worlds-largest-animal-swarms/red-billed-quelea)

Theoretical framework
Social ecology: The necessity of recognizing socio-spatial processes as part of nature

Climate change as a trigger for social inequality

Climate variability in Latin America and Caribbean (LAC) is difficult to register, given the small amount of information available(cita). Nevertheless, according to estimates made by the World Bank have confirmed trends which define the type of climate change in this part of the world. Projected temperature changes indicate a tendency to increase heat, mean annual precipitation is projected to decrease in dry areas while intensifying in wetter areas. Within rural farmland, this represents a huge risk: crops such as coffee and maize crops are being grown into optimum temperatures, so when temperature increases and rainfall reduces, yields will reduce significantly (Verner, 2011).

The contemporary approaches to sustainability and it's effect in urban planing have often ignored the preexisting economic conditions in which cities develop. As we define our perception of vulnerability to climate change, we realize that in order to deal with such great challenges it is necessary to rethink the way we create our environment. In cities where income inequality is most present, the strategies to deal with climate change mitigation should be intrinsically founded with specific needs and capabilities of low income residents.

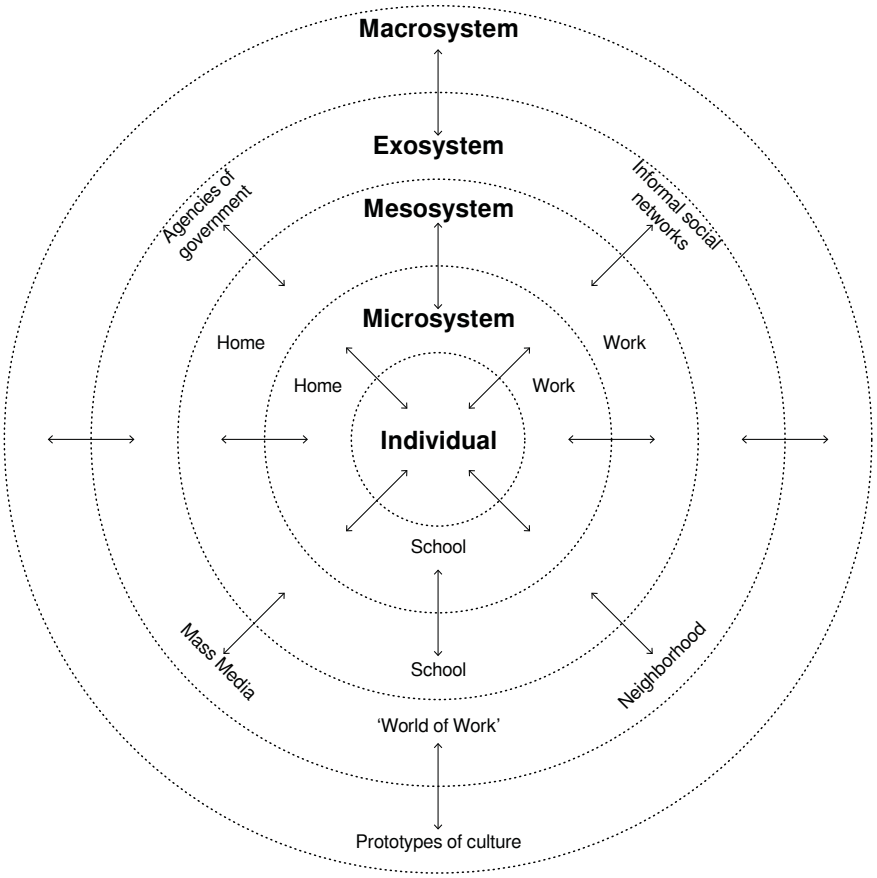
A recent study in Mexico shows the levels of income inequality have dramatically risen, positioning the country within 25% of the worlds most unequal economies and among the 2 most unequal according to the OCDE. Oxfam has estimated that 1% of the population in Mexico receives 21% of the national income (Verner, 2011). This renders an unequal capacity for adaptation when confronting environmental stress.

In hydrological concerns such as drought or flooding, the urban space is affected by the poor handling of the watershed by prioritizing investment for specific infrastructure in order to meet the needs of a small percentage of the populations.

Social inequality as a trigger for climate change

As the city's inhabitants continue to embrace this system and to evolve along with it, the accelerated demand for natural resources remains the same, giving room for less equal access to natural resources. While some efforts of sustainable urban planning have effectively helped reduce emissions and provide safer extraction methods, the overall understanding of the problem has not been fully apprehended by the authorities of these cities, in which short term measures are implemented in order to cope with the immediacy of the problem. Mitigation and adaptation schemes have often failed in delivering long term planning that can safeguard the livelihood and safety of urban centers across Latin America.

The problem with safeguarding a provision system that meets the demands of society as a whole of Latin American metropolis is that the cost to provide water has almost doubled in last ten years (JAWSD, 1995). This has led the population with less income to suffer from constant shortages and over-dependence on a single source. Infrastructure is built around areas which are prone to have intense economic development, whether through housing transformation, commercial and other public services, mobility infrastructure. In Mexico City, 86% of the federal mobility budget is spent on private transportation infrastructure (Medina, 2016), while public transport which is used by the majority of the population suffers from lack of funding and remains in poor conditions.



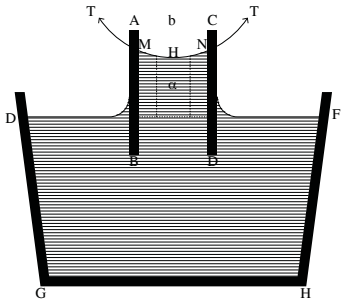
Brofenbrenner's ecological systems diagram (1979)

Theoretical framework
Autonomy & interdependence: Power capillarity and mutual aid

The spatial condition of the basin, understood within the framework of the Ecological systems theory, reveals the center of power for the transformation process as being the individual. As social ecologists suggest, not only is the individual central component of nature, it is within the self that ecology occurs at every scale. Michel Foucault insisted in the natural condition of power in the human bein as being embedded in the self, or as he called it: “capillary power mechanism”.

> “the unison in the hive becomes a power mechanism which is executed in its capillary form, not from above the social body but from within. This mechanism as Foucault remarks is a form of power, which “reaches into the very grain of individuals, touches their bodies and inserts itself into their actions and attitudes, their discourses, learning processes and everyday lives.” (Kroker, 1997)

In this regard, power flows from bottom to the top and is embodied in practices at every level of social relations. To be autonomous means to be in control not only of the self but of one’s surrounds as well, since the the systems the individual is embeded within an extrapolation of the self.



Water capillarity

In regards of water supply infrastructure for Mexico City, the local government assigns more than half of it’s resources for repairing it’s current supply system (known as the Cutzamala system). While this represents a great portion of finances into water provision, the reality is that the city’s inhabitants must pay the taxes for this infrastructure while not having water supply guaranteed. Almost one third of the population of Mexico City depends on independent water supply companies in spite of paying tax for water provision.

Instances similar to the case of Mexico have inspired environmental justice to be central when making climate change adaptation strategies. When defining regions based on their ecological performance, such as Deltas, socioeconomic performance should not be overlooked and be an equally determining actor in the future developments of the city. It is therefore crucially necessary to understand that within a same city, different areas ask for different interventions. In California, planning is made with a ‘multiple visions’ perspective, in which Delta programs subdivide responsibilities and strategies to better fit the specific economic power of specific portions of the population.

The necessary approach for reaching sustainability through the field of urban planing must address the problem taking in account the larger scale and scope of the problem. To do so, it is a matter of changing the spatial structures of cities which mold the economic activities happening inside them, ultimately defining how the neighboring communities. Urban and regional planning are highly concerned disciplines with this situation, and are therefore responsible for taking specific cultural and economic values into account when dealing with climatic and spatial concerns. In essence, the social tissue must be repaired simultaneously to the technical necessities of spatial transformations for achieving actual sustainability.

Chinampa construction process

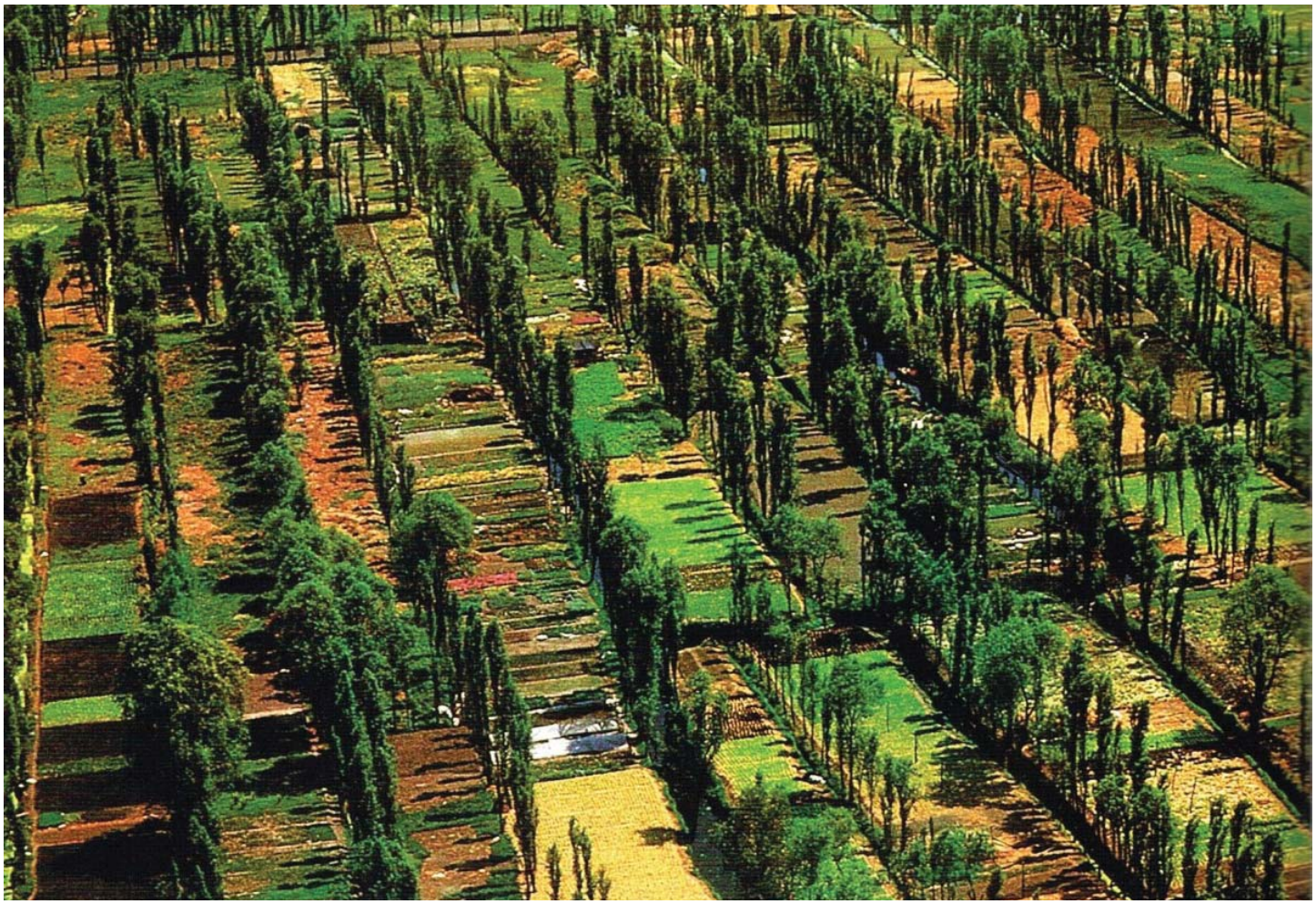
Theoretical framework
Building with nature: Importance of re-naturalizing the city through blue-green infrastructure

Thinking of long term actions requires understanding that infrastructure has a timeframe. In this regard, constant maintenance and supply deficiencies have an impact on society's ways of sustaining life. In the case of Mexico City, using the same technical approach for more than 30 years has left a negative impact on one hand on the city's residents economy, and on the other a large scale deterioration of the local and regional environment. This has posed an enormous risk on drinking water sources for the metropolitan areas of the central Mexican valleys as well as prolonged support for poor governance.

In order to think of technical solutions that not only support natural systems (such as drinking water systems) but also contribute to proper policy making and better living environments, it is necessary to build our infrastructural needs by the means of passive natural technology. For water provision, this would mean that the natural runoff of the basin should be integrated with the urban environment it meets at the city's periphery and consequently it's lowest points.

Building with nature, which requires an effort at many spatial and temporal scales, may be a better approach to dealing with supplying potable water from within the Mexico basin, in order to avoid expanding the damage done to the natural environment as well as the populations economy. It requires constant collaboration between citizens, institutions and professionals understanding the enablers and limitations of the inhabitants and the environment.

As uncertain developments in the populations growth and climatic shifts occur over time, it is necessary to embrace the concept of resilience when deciding upon future urban structures of Mexico City's water supply . Site specific measures are necessary in order for the city to be ready to adapt these constant changes which ultimately leaves way for social inequalities and undeserving living environments, avoiding cookie-cutter solutions to be replicated aimlessly.



Xochimilco chinampa landscape

Theoretical framework

Building with nature: Importance of re-naturalizing the city through blue-green infrastructure

Building with nature provides benefits to the population which extend beyond provision of resources. By transforming urban grids into naturalized networks, it is possible to improve the quality of life of the inhabitants within and outside Mexico City.

> "Green-blue grids can facilitate a variety of functions: water storage and treatment, urban lungs, district cooling, biomass production, nature development, food production, recreation and an attractive and safe route for cyclists and pedestrians." (Pötz, 2016)

In terms of governance, nature has been a framework for cooperation and social organization since the oldest forms of human civilization. It is our understanding of nature as an extension of our selves. It provides a basis for our society's ethical orientation, a means by which human thought found it's normative bearings and coherence (Bookchin, 1993).

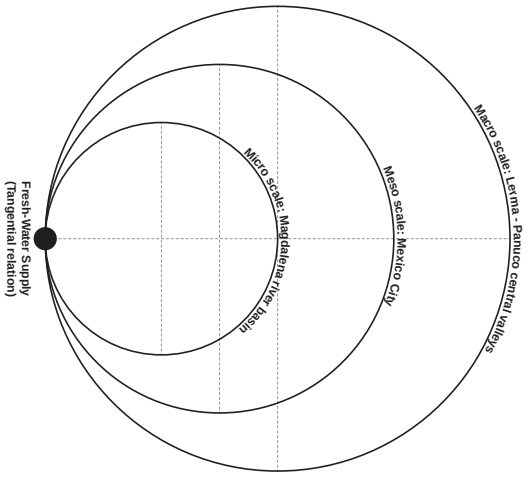
The chinampa strucutre in Mexico, similar to the polder model in the Netherlands, is an example of how society has the capacity to cooperate and benefit mutually through the wholistic understanding of a regions natural system in relation to human occupation. It is through this understanding of our environment with which we can set a ground for cooperation and solidarity in order to transcend as a special being.

2.0 Design research

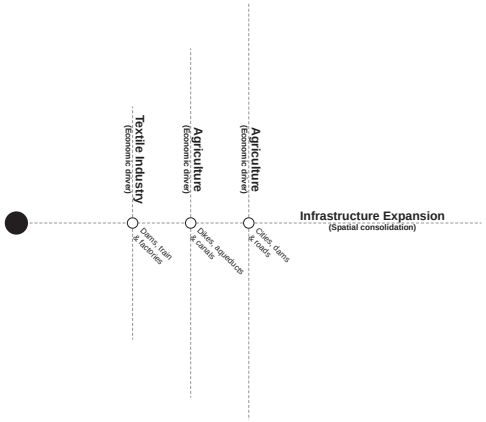
Trans-scalar co-relations

Enhance the capacity for water supply autonomy

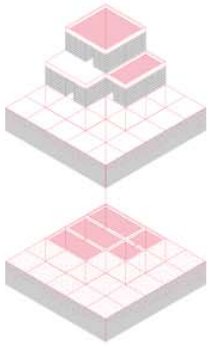
The region of the Mexico central Valleys, Mexico City, and the neighborhoods ant the city's periphery contribute to the same problem of inter basin water transfer. The hydrological structure of the basin as well as the social tissue of the city is inter dependent from eachother due to the need of managing such hig demand for fresh water. At each scale of analysis and intervention, the strategy seeks to link the relation and dependancy between each substructure of the proposed hydrological network. By doing so, the inherent properties of the basin may perform in accordance to the society living in it.



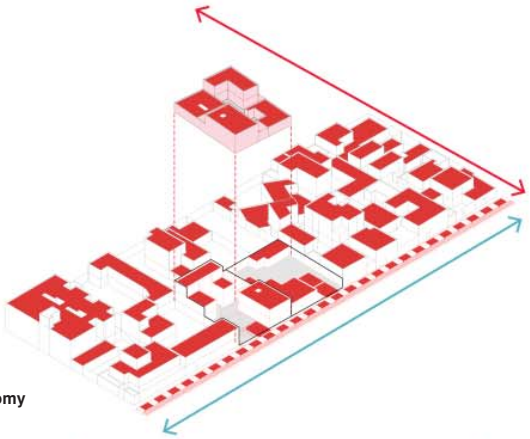
Trans-scalar correlations



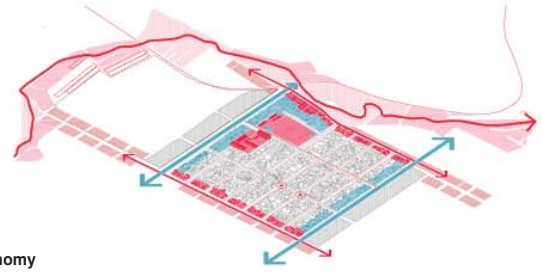
Trans-scalar driving forces



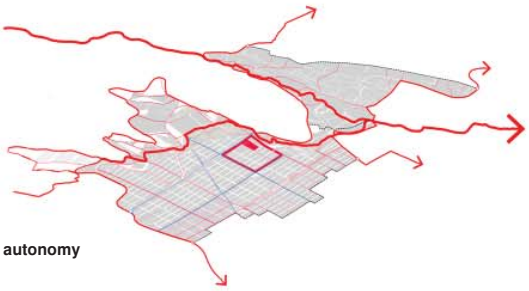
Domestic autonomy



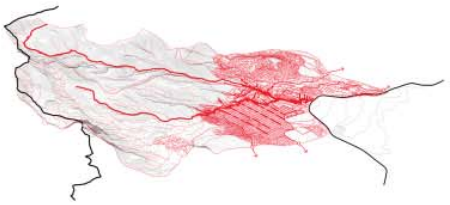
Block autonomy



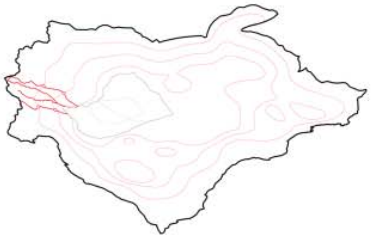
NHU autonomy



Micro-basin autonomy

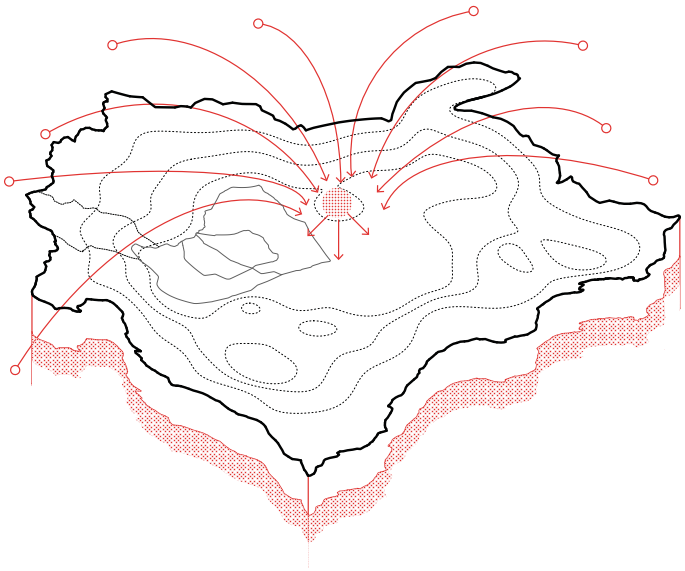


Sub-basin autonomy

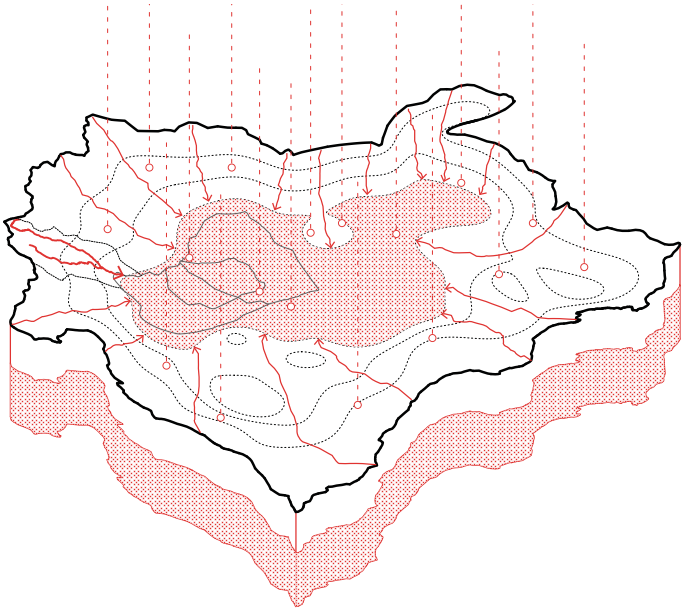


Basin autonomy

Spatial strategy
Water supply autonomy and support for collective values



Current water supply model: Centralized distribution from resources extracted from external sources and groundwater.



Proposed supply scheme: Autonomous water management cells interdependent through the city's aquifer.

Ensuring the economic potential of the productive landscape in the city's periphery could lead to requiring to change the city's urban growth pattern while decreasing it's demand for non-local sources of fresh water. The feasibility of utilizing rainwater as the main source of fresh water is risky, since rainy seasons in Mexico city range from light rain in February and march and heavy storms from June to October. The rest of the year the population is left with only reserves from rainwater and whatever is treated for later use.

In the long term, the city should ideally be able to loose it's dependancy from external water sources by enhancing it's own potential to store, reuse and recharge water effectively. By setting objectives according to each scale of space and time, the city's residents may be able to gain autonomy from the correct organization of their domestic, local and regional hydrologic networks.

Territorial transformation of the Texcoco/Zumpango basin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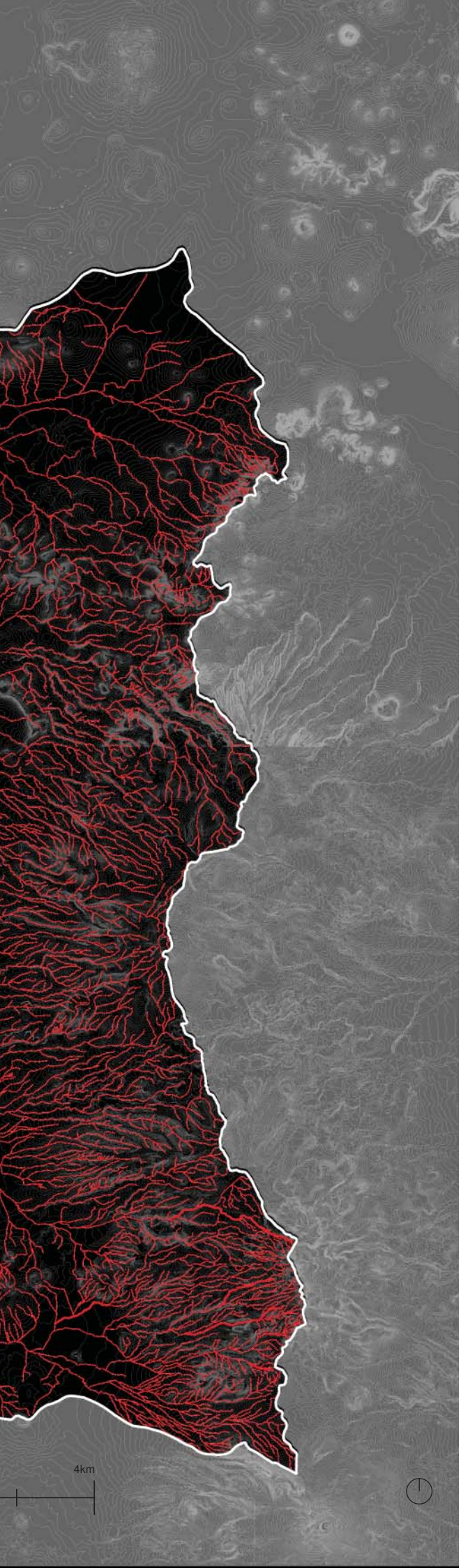
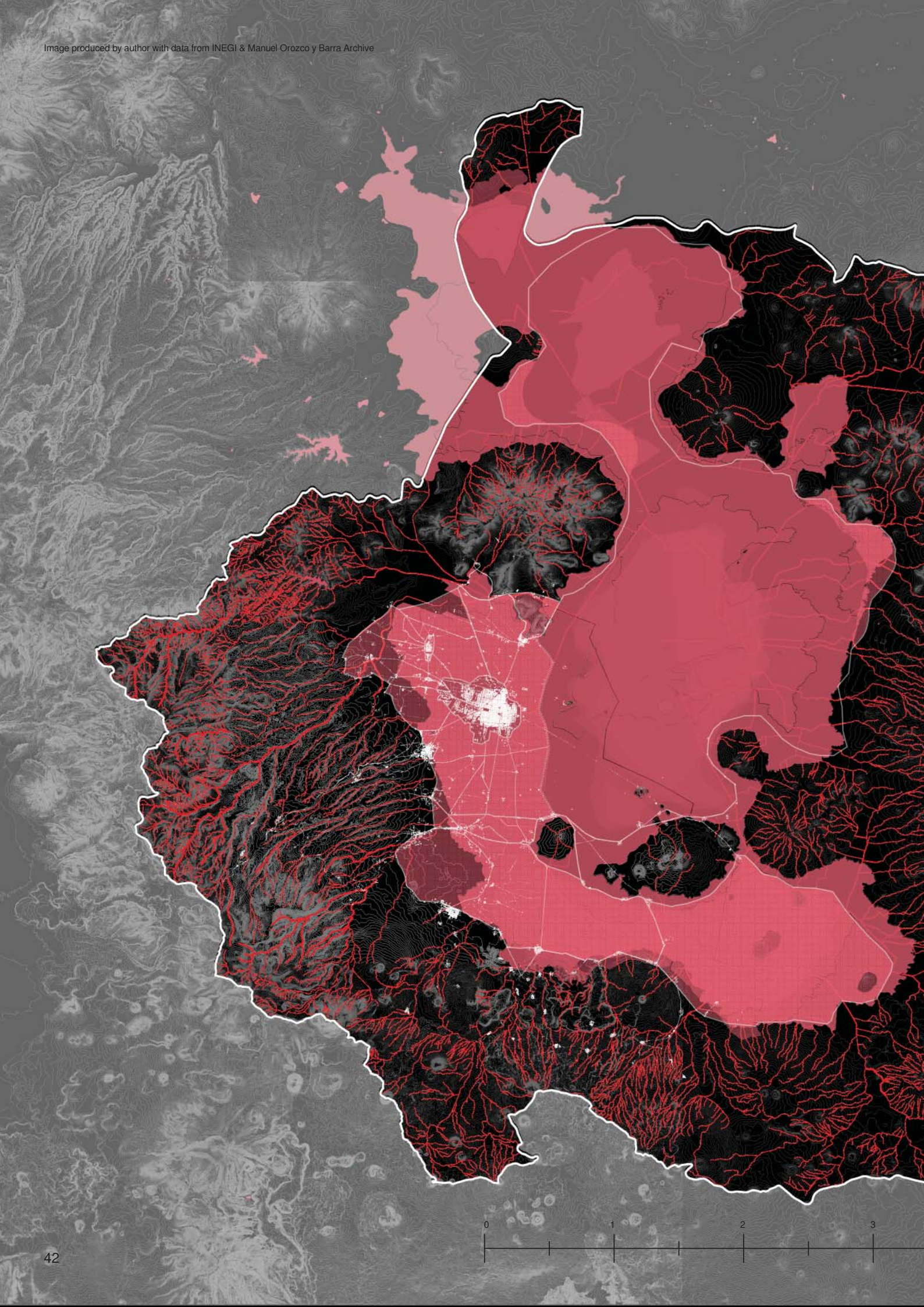


1325 First settlements

Land reclamation on Texcoco Lake through chinampas
Hydroponic agriculture sustains economy and drives settlement

In order to understand the current state of this inequitable and inefficient water management model, it is necessary to look back into the city's history where land reforms consolidated the city into it's different stages, either spatially or politically. Some of these chapters in the city's history represent a technological breakthrough that prompted great economic activity and brought prosperity to the local population while simultaneously locking the inertia of the city's growth into a seemingly irreversible state of environmental negligence.

Infrastructure
Occupation
River
Surface water
Basin delimitation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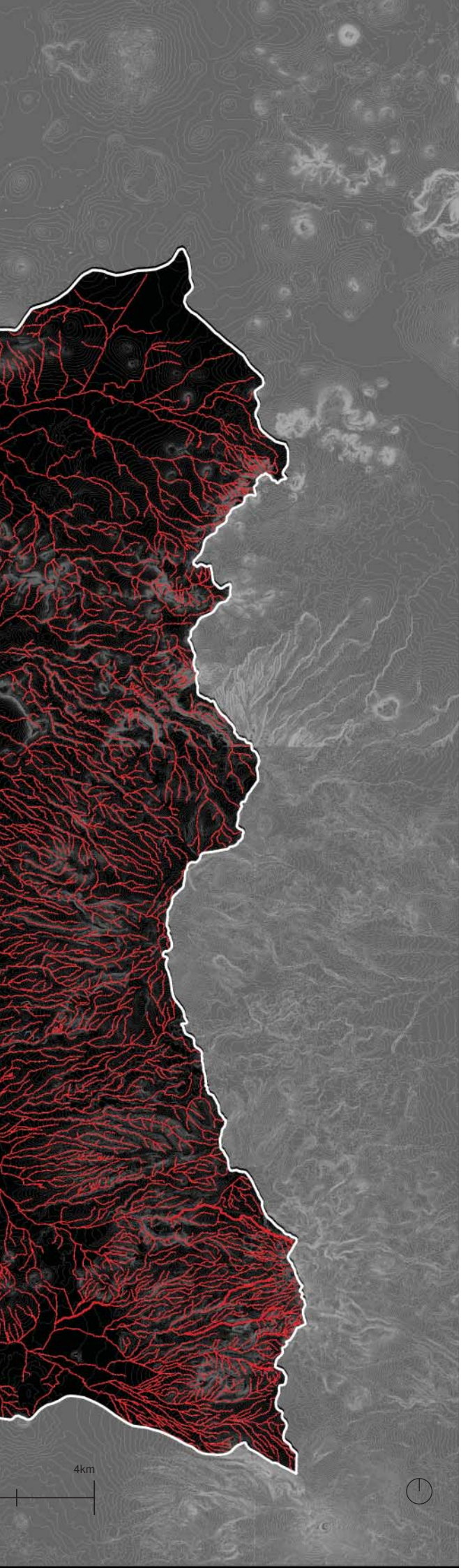
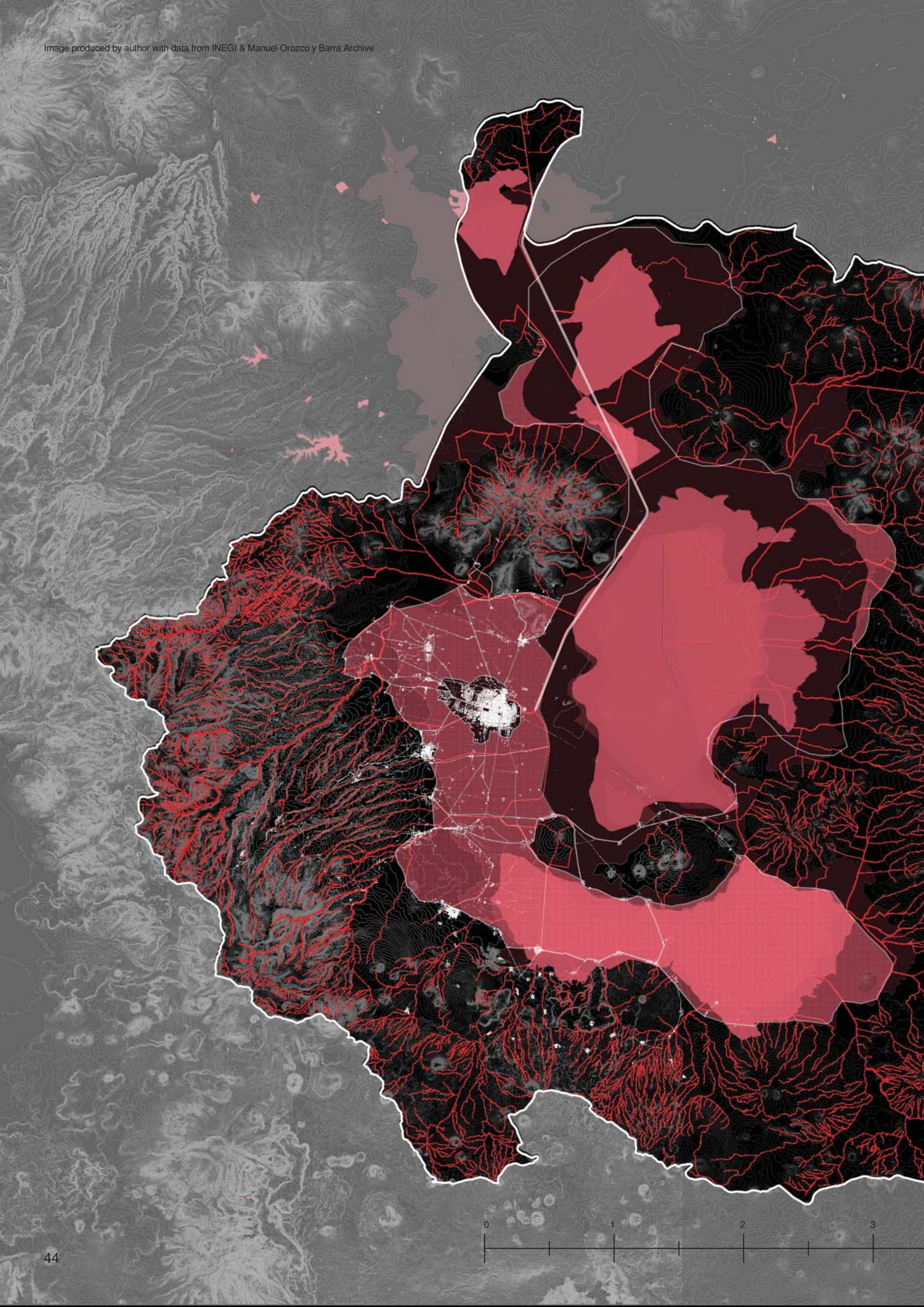


1325 – 1521 Aztec occupation

Aqueduct roads and dike systems divide fresh water from salt water, regulating the lake tides.

The Aztecs settled in the middle of Texcoco lake in the Basin of Mexico almost 700 years ago, and were able to do so by reclaiming land and producing agriculture by the means of chinampas (similar to a polder) in the middle of the lake, where they founded the city of Tenochtitlan. This became an empire which was able to settle in this territory thanks to alliances between the lake's main cities, such as the Triple Alliance. This cooperation prompted a series of interventions on the lake such as the Nezahualcoyotl Dike, which allowed them to separate salt water from the northern portion of the Texcoco lake, giving room for massive agricultural production in the southern portion of the lake, Xochimilco (Diaz, 2015). Potable water was directed from the flowing river-streams in the southwestern portion of the valley into aqueduct-roads used to move fresh-water between the different artificial islands.

Infrastructure
Occupation
River
Surface water
Basin delimitation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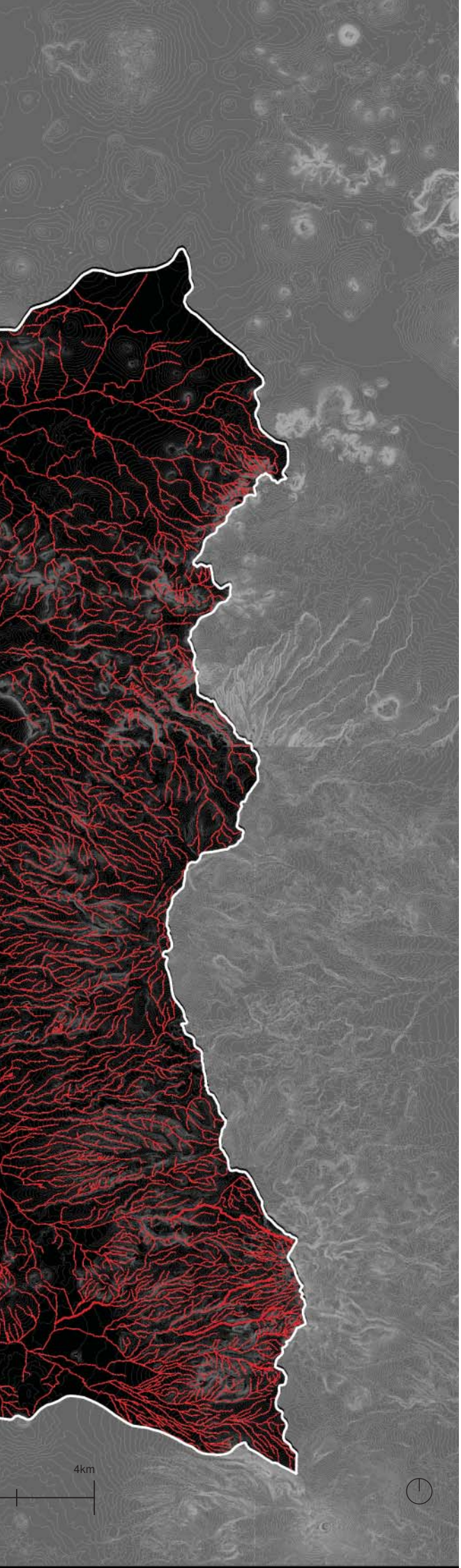


1521- 1810
Spanish re-territorialization

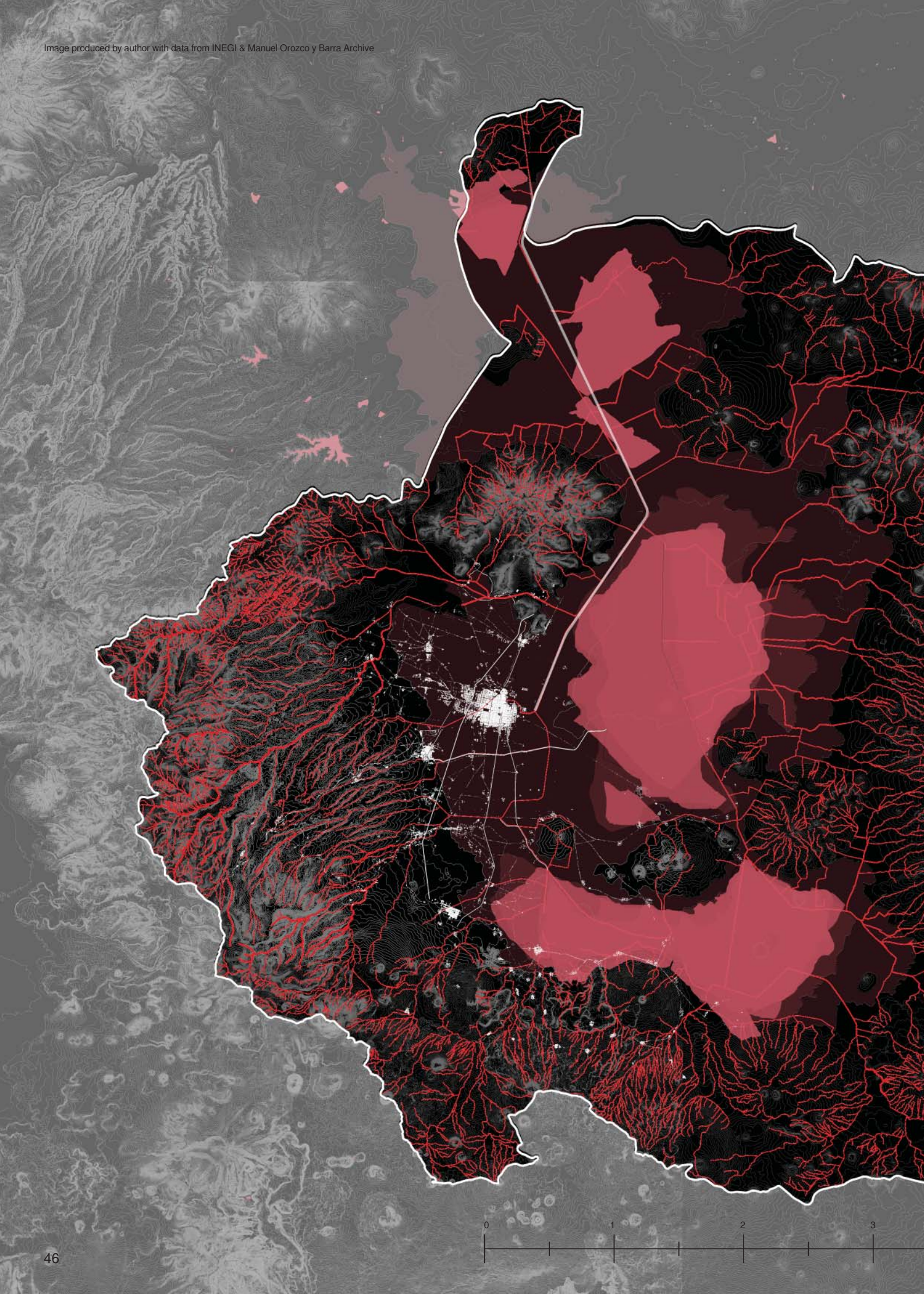
Urbanized portion of the lake is drained, separation of waters through dike contention.

The foreign colonizers inherited such urban infrastructure and retook the political structure of the Aztecs by consolidating various heads of state in the existing former ones: Azcapotzalco, Texcoco, Chalco, Tlatelolco, Iztapalapa & Tlalpan. This is important to note because this reveals that the city always "grew around these concentrations of population and power" (Diaz, 2015). The first transformation that this territory suffered was the drying up of land for the cattle industry:

> "[The Spanish]...drawn by the fertility of the soil and abundance of water in the region, particularly the sea-weed found in the lacustrine region (which constituted an important fodder), installed farming and cattle industries, introducing the ongoing process of dispossessing land from the indigenous communities." (Ibarra, 2008)

The lacustrine environment represented a nuisance for the new Spanish settlers since this way of inhabiting the territory was unlike what they were used to back home, leading them to experience flooding in multiple occasions. The first measure to 'domesticate' the city to best suit their needs was to drain the urbanized portion of the lake towards the eastern side of the lake through the Nochistongo Channel. This was later revealed as a mistake since 20 years later the city suffered once more from severe flooding. This led to the construction of the San Cristobal dike separating the water from north and south, which eventually also failed to protect the city. Later, the water management model changed from being a 'contention' strategy to a 'drainage' one, in which drainage canals enabled the city to rapidly urbanize the dry land.

Infrastructure
Occupation
River
Surface water
Basin delimitation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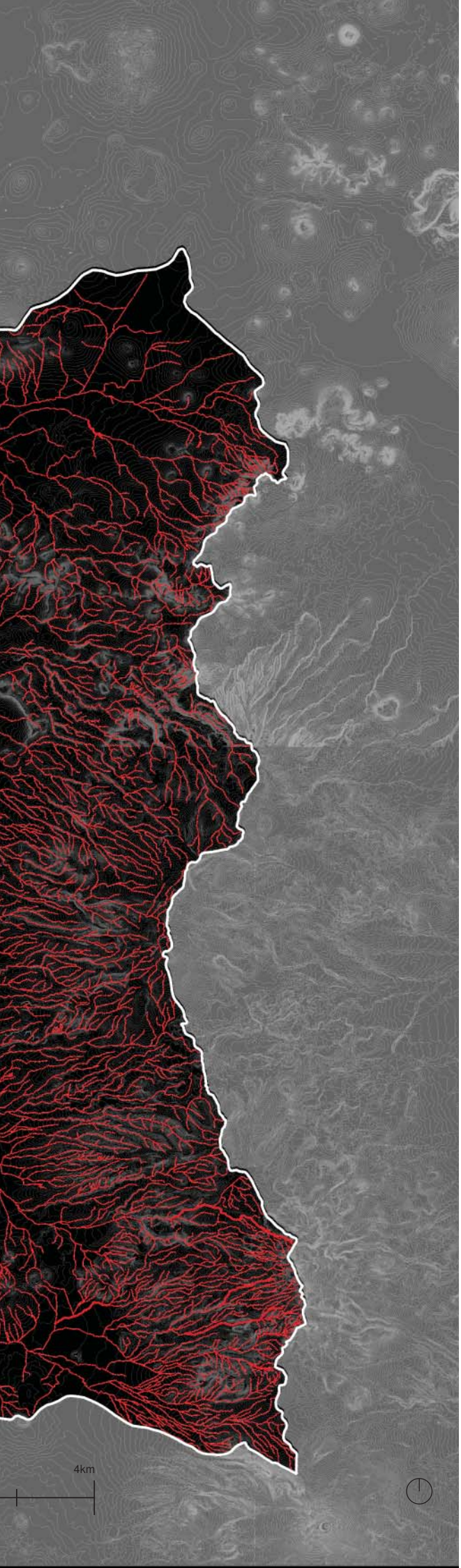
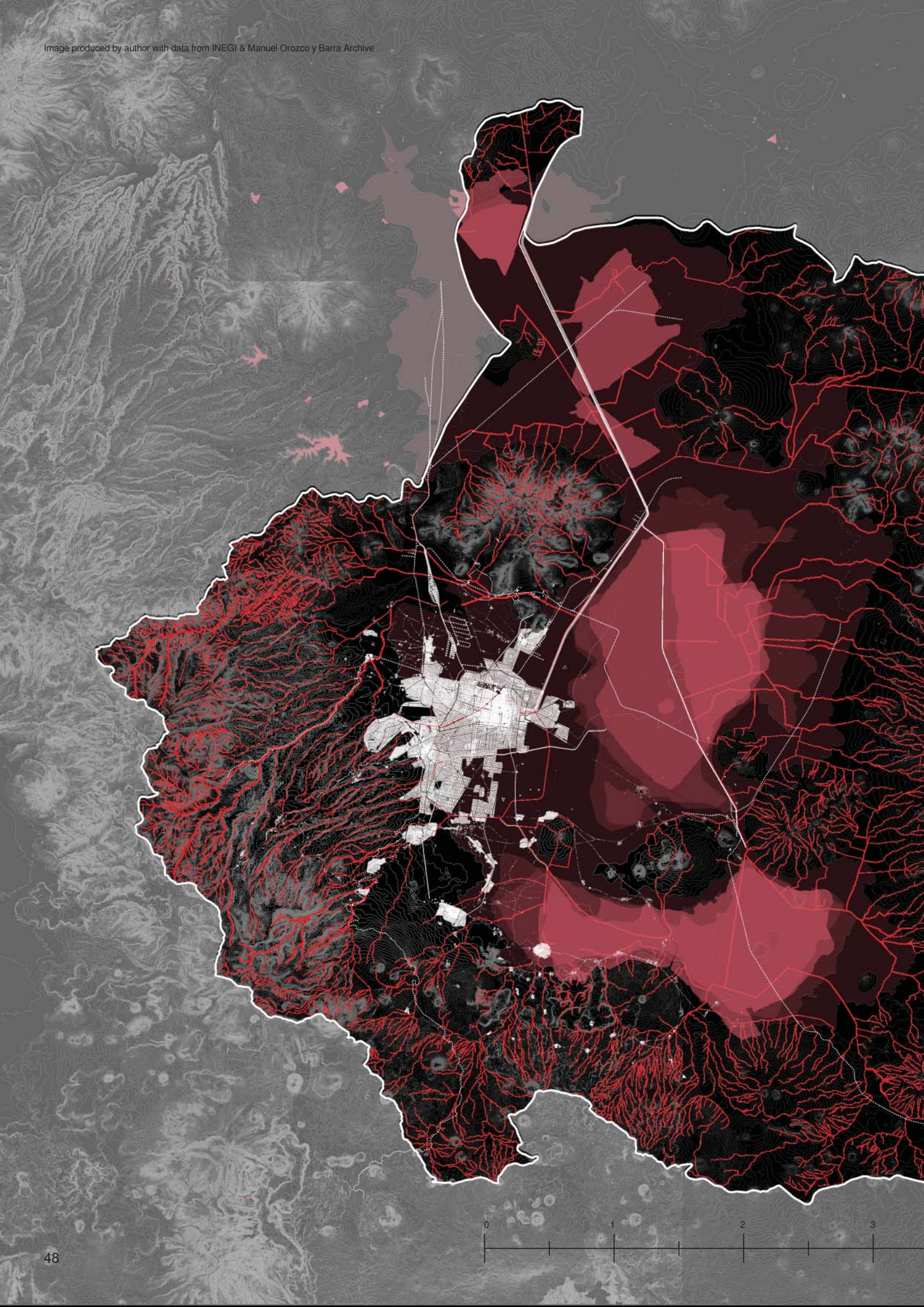


1876 – 1899 The Porfiriato I

Urbanized land is dryed up by draining the surfacewater through cannals.

Porfirio Diaz's regime was known to be responsible for modernizing the country by the means of built infrastructure. This required elaborate plans to build along the landscape across the country, such as train tracks, dams and piped infrastructure in the country's main cities. This had a direct impact on the rural population, since the ownership of communal lands had to modified into Ejidos, which conditioned their collective ownership as long as they met a specific amount of crops to produce as national property and giving them 'freedom' to own their land. The introduction of the Ejido was a turning point in land allocation reforms. Since the Spanish colonization was consolidated, land ownership in the traditional communities of Mexico was dealt as communal since the families lived within their production spaces(Diaz, 2015). The existence of the Ejido system converted this autonomous form of ownership into private ownership with the emergence of the Terrateniente, a type of feudal lord who claimed ownership of the workforce of said territory.

Infrastructure
Occupation
River
Surface water
Basin delimitation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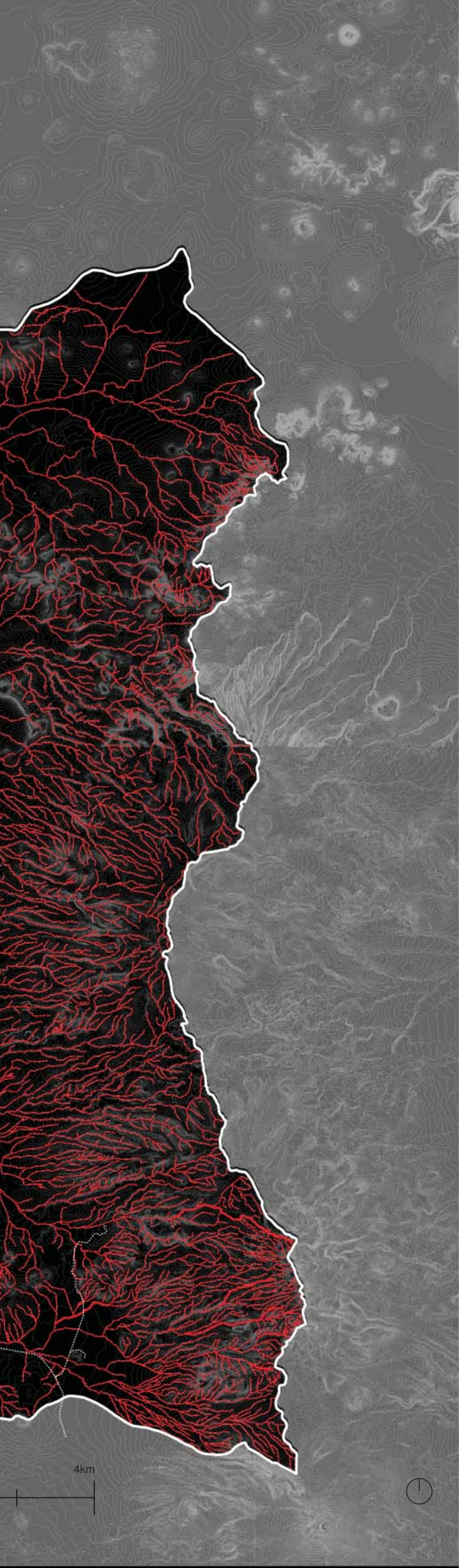

1899 – 1911 The Porfiriato II

Textile industries as wells as the infrastructure connecting them expand the city's limits and start to polute the fresh water streams

During the final stages of the Diaz's regime, many technological advances in energy production started to transform the industrial sector which led to numerous labor strikes from the factory workers (Galindo, 2012). This, along with an increasing discontent exasperated by the displacement of communities from their land are known to be the reasons that triggered the Mexican Revolution in 1910, leading to demands of new land reforms in defense of rural farmlands and indigenous land ownership in general.

Infrastructure
Occupation
River
Surface water
Basin delimitation

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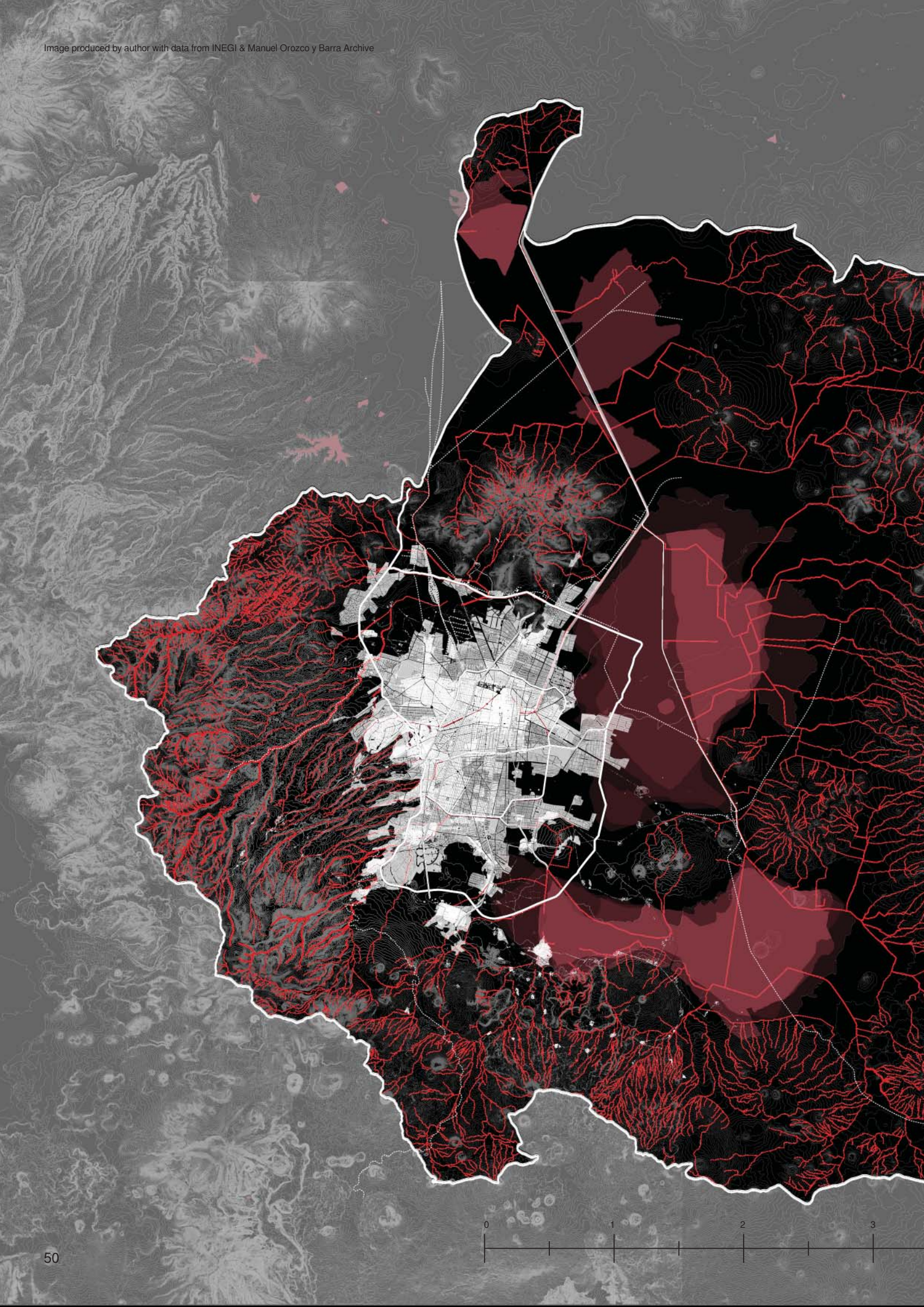

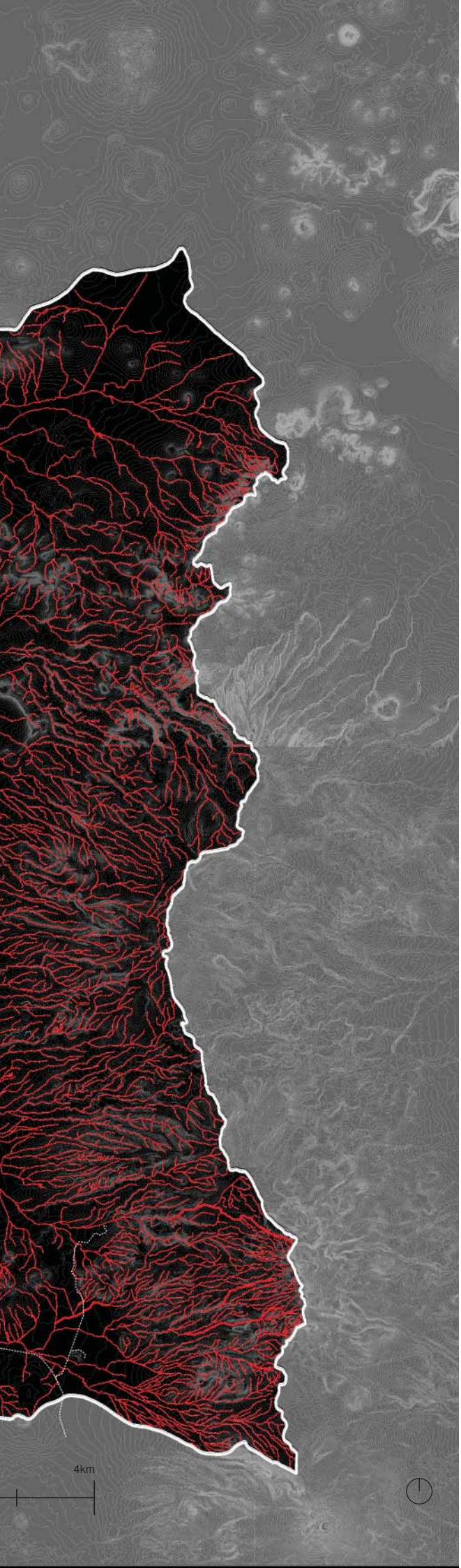

1940 – 1980's Modernization

Automobile industry and infrastructure prompt the city to sprawl and consolidate the city's footprint

By the late 1930's the government of Manuel Avila Camacho introduced the 'Importation substitute model' as a result from the decreasing production capacity of Europe given the devastated conditions the first and second world war brought. Since Mexico was dependent on the European industries to a certain extent, it too had to change their economic performance. This led to the increase in local industries within the country's main cities, amplifying their production capacity and therefore skyrocketing the demand for living in the cities. As a result, the city experienced an extremely fast urbanization process in which water resulted the main fuel for the industries to strive, stating that water would stop being a local factor and would become a nationally owned resource (Campos, 2011). This prompted the construction many water extraction infrastructures, intensifying the damages to the natural environment, society and the economy.

> "The first sign of groundwater level declines were the drying up of natural springs in the 1930's, coinciding with intensive exploitation of the main aquifer with deep wells"(JACMCWS, 1995)

Eventually, the introduction of the automobile industry and the necessary infrastructure for this type of mobility consolidated this rapid urbanization process into an expansion of the city into a 150% increase (JACMCWS, 1995), and along with it the demand for space and the resources to live prosperously in the city.

- Infrastructure
- Occupation
- River
- Surface water
- Basin delimitation


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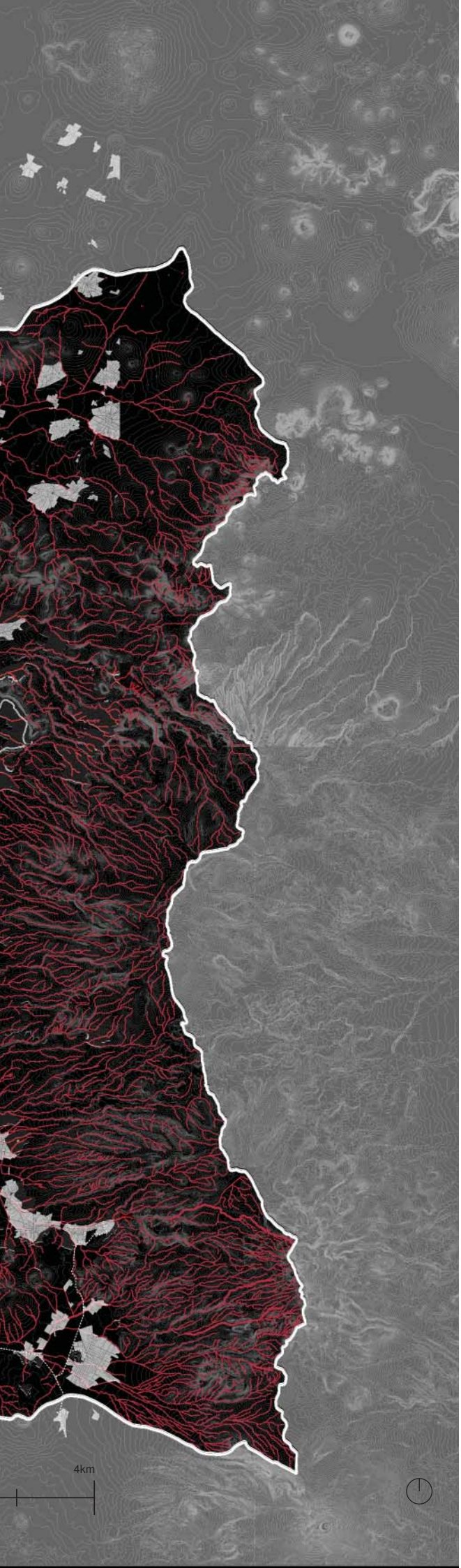
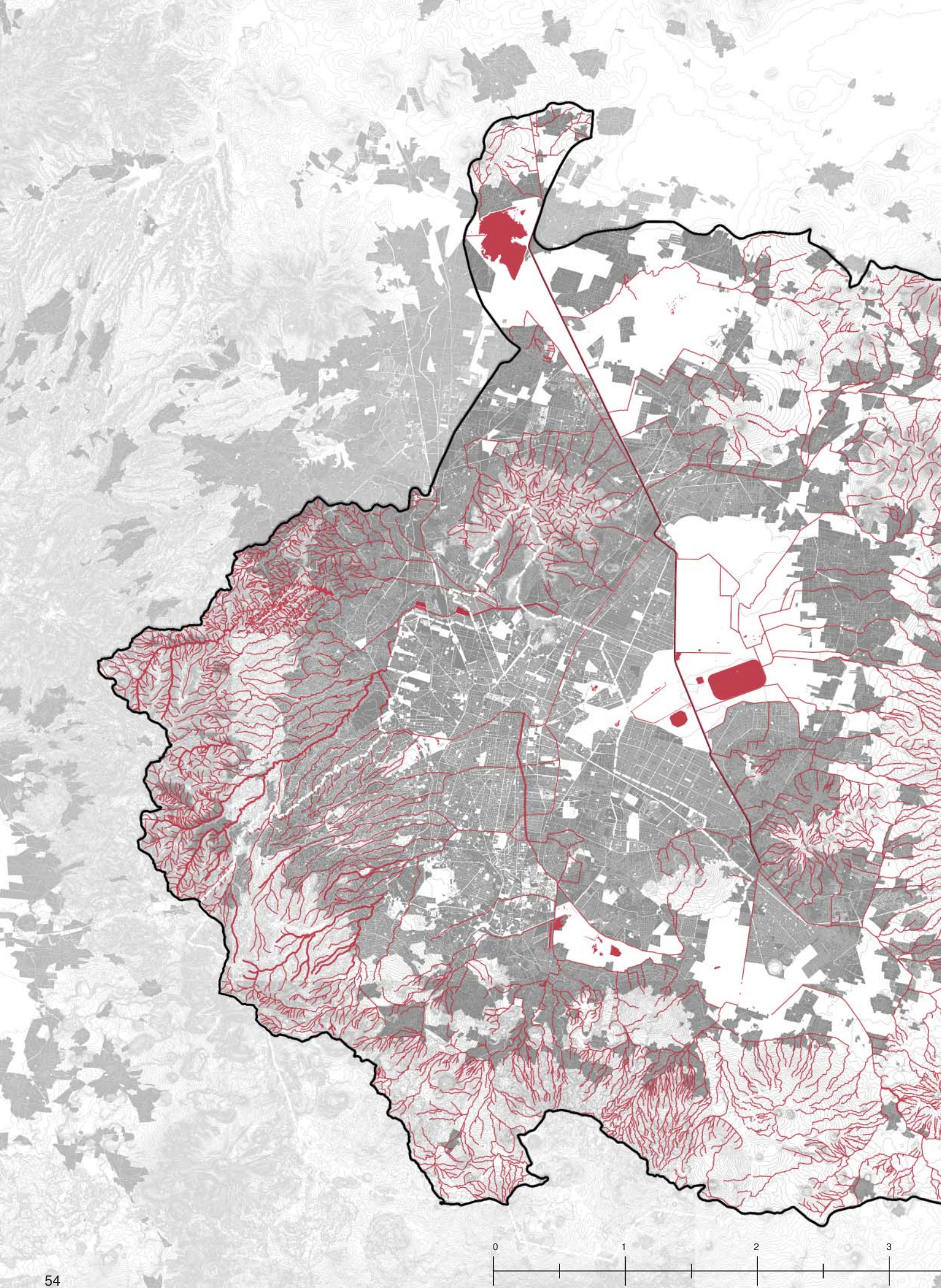


1980’s -1994 NAFTA and the Neoliberal urbanization

Land reforms enable Ejidos (communaly owned) to be bought by private actors. The city periphery expands due to the pattern of landprice increase.

During the late 80s authorities started to find ways of expanding their modernized model for economic growth, encouraging the construction of infrastructure and other developments that would ensure economic prosperity. This led to the introduction of the North American Free Trade Agreement (NAFTA) in 1994, where the condition for Mexico to be included in this trans-national commercial agreement was to agree to change the land rights of Ejidos, making it possible for a private actor to buy land even if it was communally owned (Campos, 2011). This land reform disregarded the rights and values of the rural poor, inciting social unrest once more as the population was being violently displaced from their homelands at the sources of water.

Infrastructure
Occupation
River
Surface water
Basin delimitation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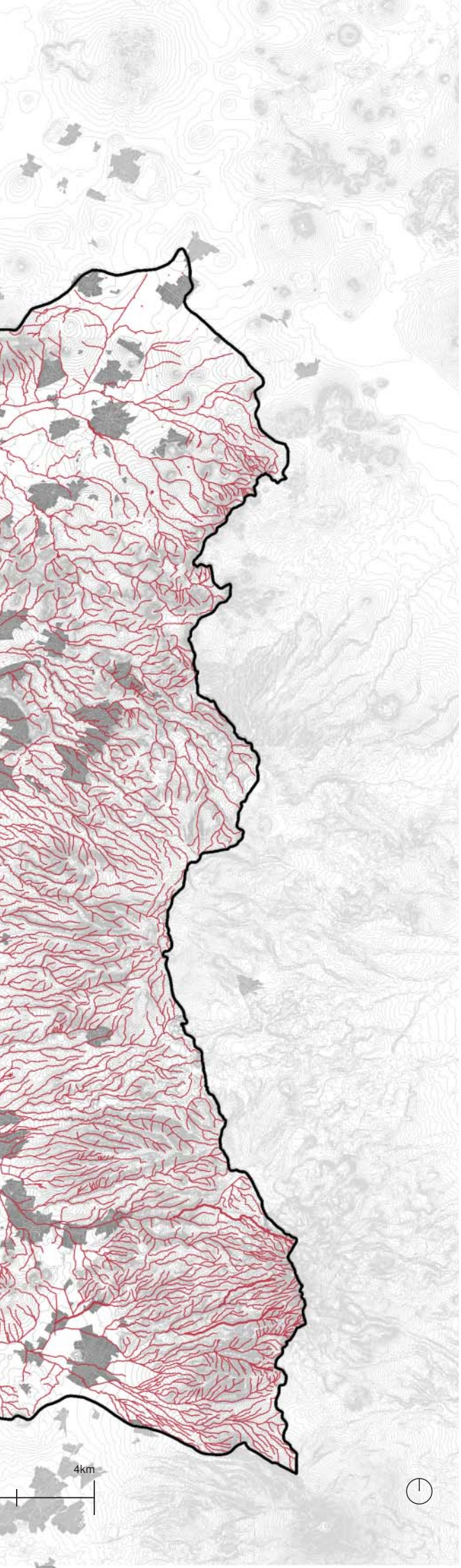
Current situation



River

Occupation

Basin delimitation

Zapatista Mazahua from the Temazcaltepec river basin.

Theoretical framework
Effects of neoliberal urbanization in Mexico

Ignoring indigenous people's rights, ignoring laws of nature

Today, potable water in Mexico city is "readily available at a low cost for some, while water service is undependable and/or inconvenient for others"(JACMCWS, 1995). The segregation suffered in Mexico today is an evolution from colonial and imperialist practices that formerly established in the territory. As it has become almost a tradition in the country, to displace the original settlers from their land and reclaim it for the wealthy and powerful (Davis, 2006). It is undeniable that this has occurred since the XV century with the transformation of the Aztec's urbanization patterns. As stated before, the way in which the Aztec civilization managed their hydrological resources was based on mutual aid within the population, making their water infrastructure the backbone to their urbanization process, therefore growing in balance around the consumption and sewage of water.

These resource extraction practices have escalated even faster during recent years, expanding the area of impact of the city's water infrastructure and consequently harming indigenous and rural poor communities. These indigenous groups are known to have an autonomous form of governance and a different perception of ownership (Villoro, 2015).

For example, land was shared amongst various families which had ties together often because of agricultural production. Every occasion in which land was dispossessed from them, their sense of union has brought them together to resist this ongoing process. Recently, with the initiative from the government to expand the Cutzamala system into the Temascaltepec basin, farmers started once more to direct action questioning and opposing the decisions made regarding the distribution of water in the region of Temascaltepec. (Campos, 2012).

Although these social movements have slowed down the process of water extraction, the government's agenda seems to maintain it's position on expanding it's infrastructure, claiming that it is the only way to supply water for such large population. The CNA (National Water Commission) has defined that "the supply of fresh water for the ZMVM (Mexico City Metropolitan Area) should be it's priority" (Campos, 2012), since it in Mexico City where most economic and political powers are settled.

Social inequality in peripheral settlements

Prioritizing economic growth for short term earnings

With the introduction of the NAFTA treaty, the already existing polarization of the society became stronger and the tendency of the housing market began ensure highest economic gains regardless of it's effects on the local population. These practices have created an urbanization pattern in which the wealthy population has freely invested in housing and infrastructure projects that and ultimately cost the government a large percentage of their budget. As a counter measure, authorities have recurred to subsidizing services with little to no control over the quality (Quintero, 2015). Reports state that "Traditionally, water supply and drainage services have been strongly subsidized by the federal government. The results have been severe financial deficits and waste of the resource through leakage and inefficient use."(JACMCWS, 1995). This shows why the present emergence of private companies supplying water have begun to appear, making the cost of living in the city higher than ever.

The Basin of Mexico is located within three different states and the federal district, where each local government ultimately decides on the basis of it's own benefit. This has become an obstacle to environmental concerns, specially in relation to water governance in the region. The emergence of ZODEs (Economic Development Zone), a form of zoning that allows private investment to buy property and build massive housing, service and infrastructure, creating not only unaffordable housing and services but an unsustainable way of life (Torres, 2014). These 'privately autonomous' zoning areas have different ownership rules in regards to water supply, creating a strong service segregation between them and the local communities.

Mega-structures as a preference

While the current infrastructure for supplying freshwater and treating waste water are highly complex hydraulic engineering projects, the actual provision and service for water for the population in not met. Nevertheless, the federal and local government have a preference for these types of projects instead of small scale decentralized solutions, since these requires a longer term planning and less control over financial resources. It is no surprise that the levels of corruption in Mexico contribute to this preference, since many of these projects are subsidized to private construction companies, creating a gray economy easy to steal money from (Carmona, 1997).

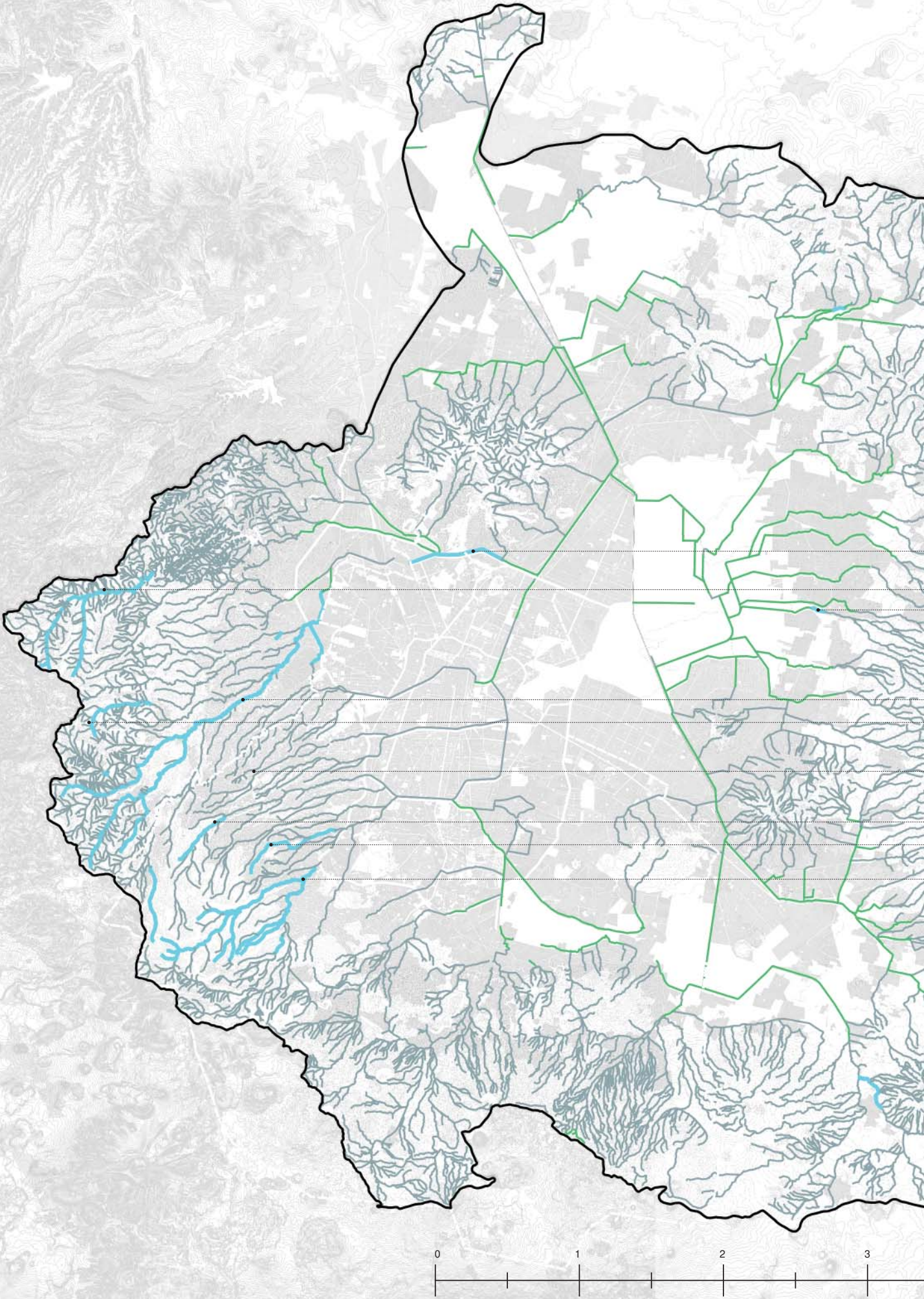
Water rights rally

The director of SACMEX, Mexico city's water board, states that investing in these large scale pumping system is the only efficient way of supplying drinking water to the city's residents (Aguirre, 2014). His disapproval of other type of decentralized, smaller scale water management system is based on the city's tendency to prefer single contractor to deal with a larger project, involving more built area resulting in greater real estate value. There is a lack of integration in planning the urbanization of Mexico City, which makes it difficult to revert the process of over urbanization and environmental exploitation.

The over-empowerment of the private sector

This has created a bubble of few enterprises which are able to invest in public infrastructure, having more authority over deciding which projects to be built, and how. With a few companies monopolizing over public services, the city risks over increasing the housing market and not being able to successfully make a good business due to the poor speculation, resulting in unfinished projects and privatization of potential public goods. As a counter measure, it is possible to revert this process by reverting the process of land ownership. "If land privatization is the threat, land collectivization is the answer" (Diaz, 2015). If this active investment is on the other hand regulated in order to ensure that it responds to values of societal and environmental concern as well as the economic potential, then it would require this investment to concentrate on public services and housing for all.

Basin strategy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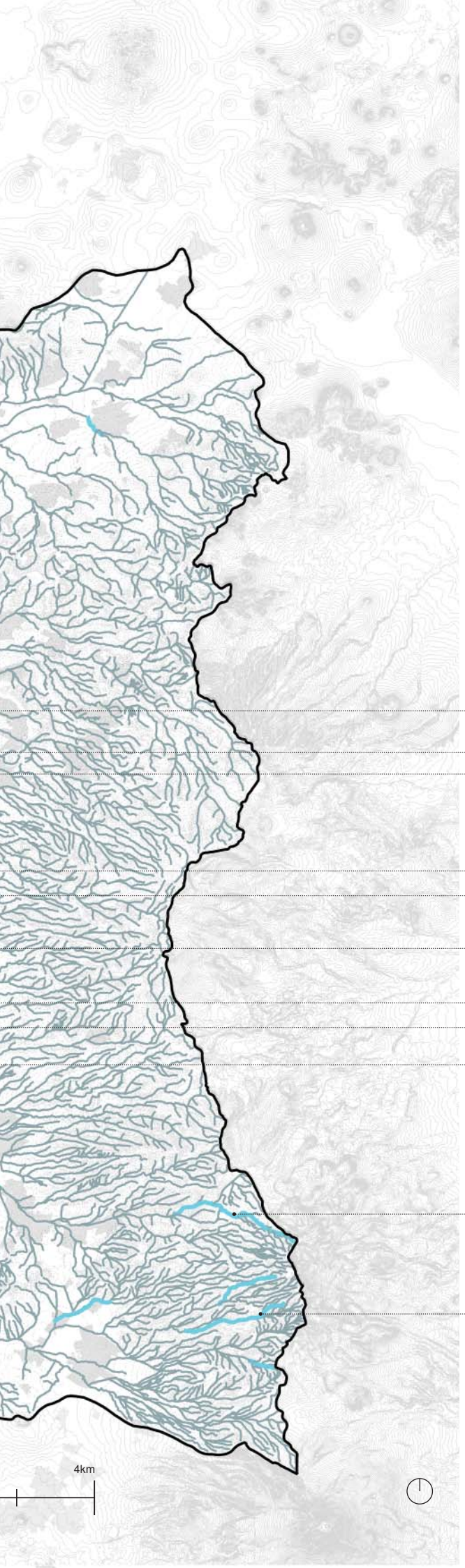
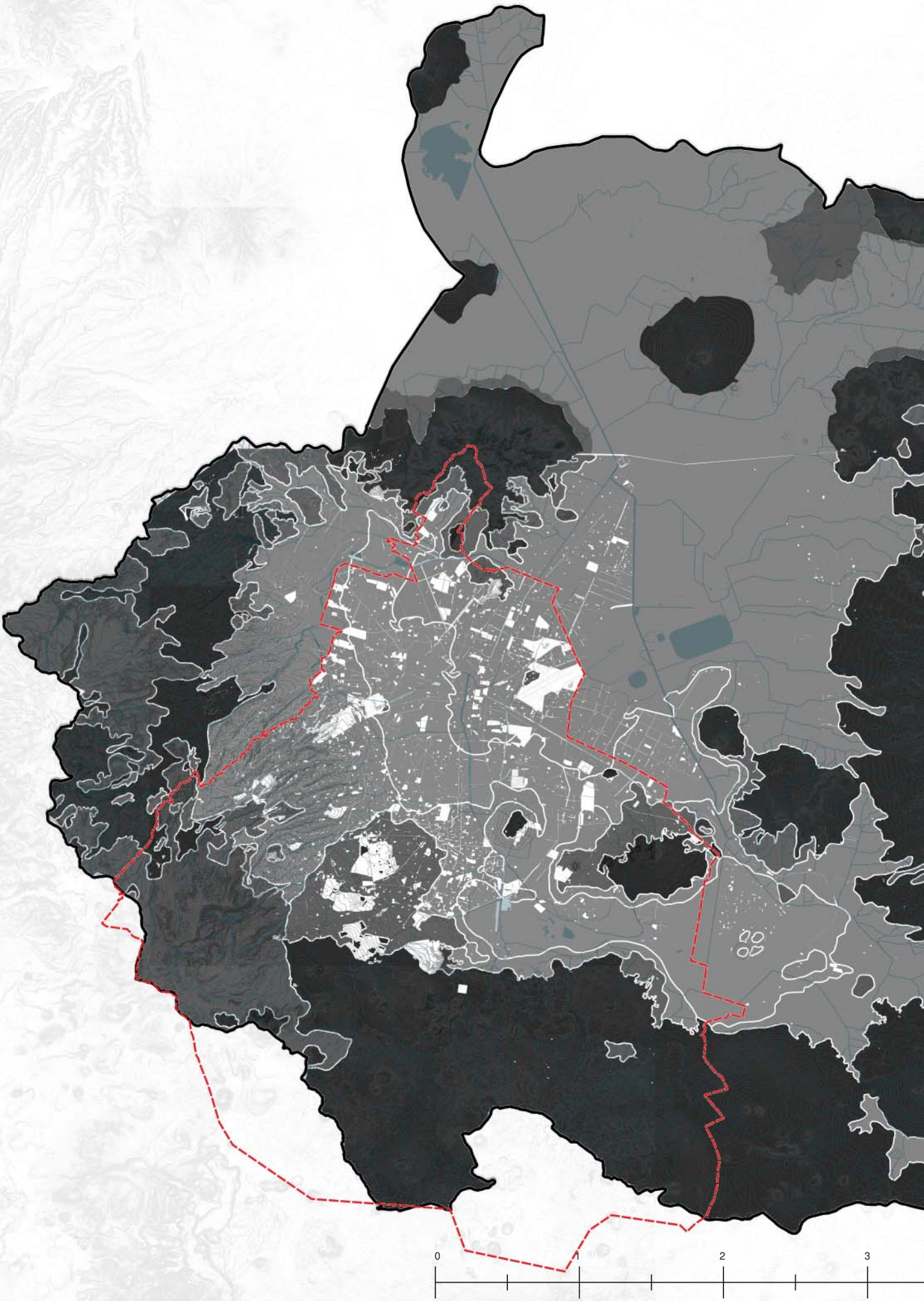
Texcoco & Zumpango basin

Last surviving sources of potable water

Being one of the most important sources for fresh-water for the city, the Magdalena-Eslava River presents an opportunity toi vastly recharge the Mexico City aquifer. To do this, the quality of the water should remain as clean as possibl ebefore reaching the transition zone, where the conditions of the soil make it possible to recharge the aquifer.

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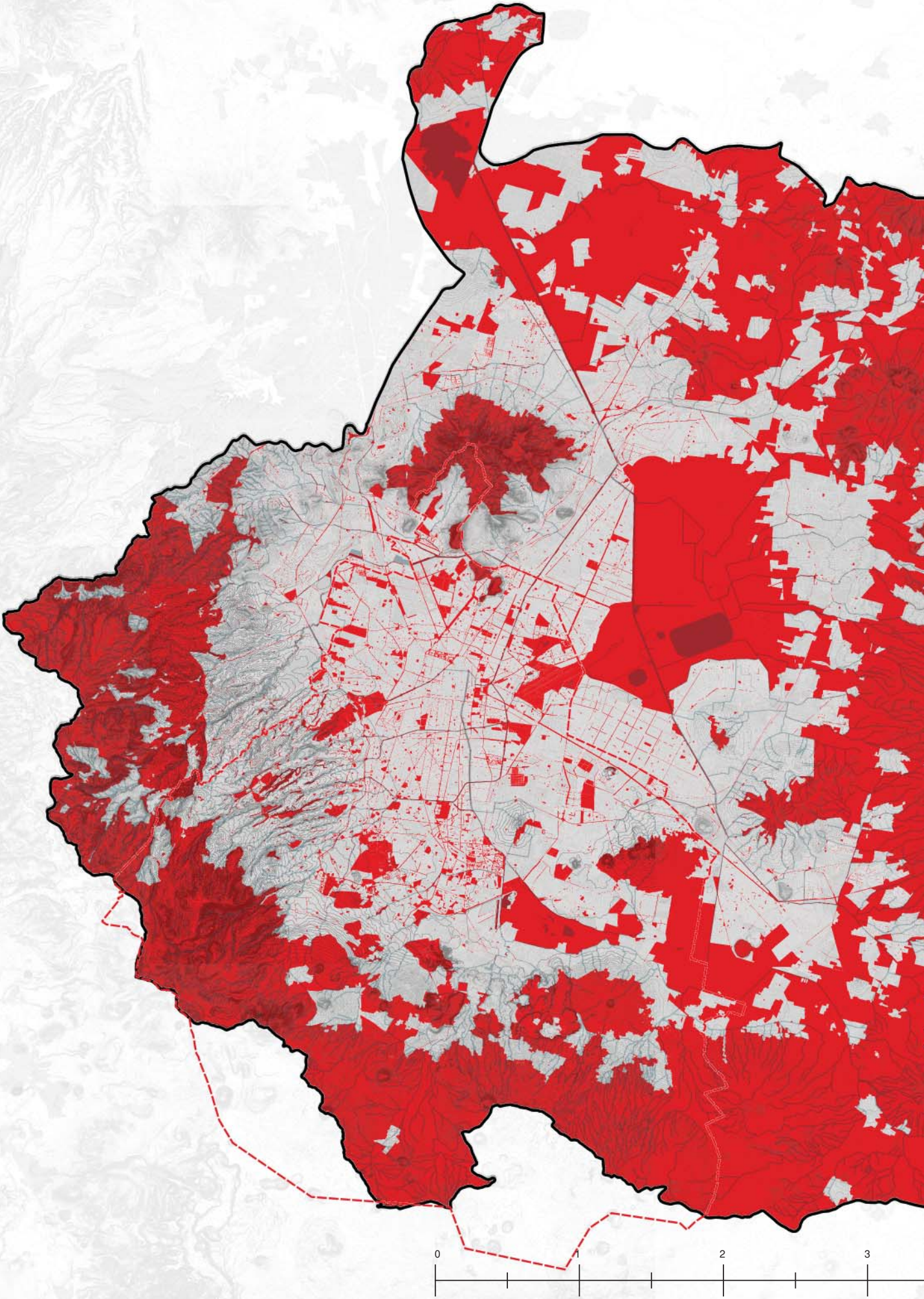
Basin structure
Groundwater structure & infiltration capacity

The original condition of the endorreic valley of Mexico resulted from volcanic activity during various periods of the Miocene, closing off the valley with porous soil formations. The former lake deposited sands and sedimentation in the lower portions of the basin. This as a result created an uneven infiltration capacity in various mountainous regions and formed a series of aquifers along the subsurface.

Today, the basin shows a great risk of contaminanting the ground water due to extensive urban sprawl on these highly infiltratable soil types, creating a priority in groundwater control strategies.

- High transmisivity
- Low infiltration capacity
- Medium infiltration capacity
- High infiltration capacity
- Basin delimitation


0
1
2
3

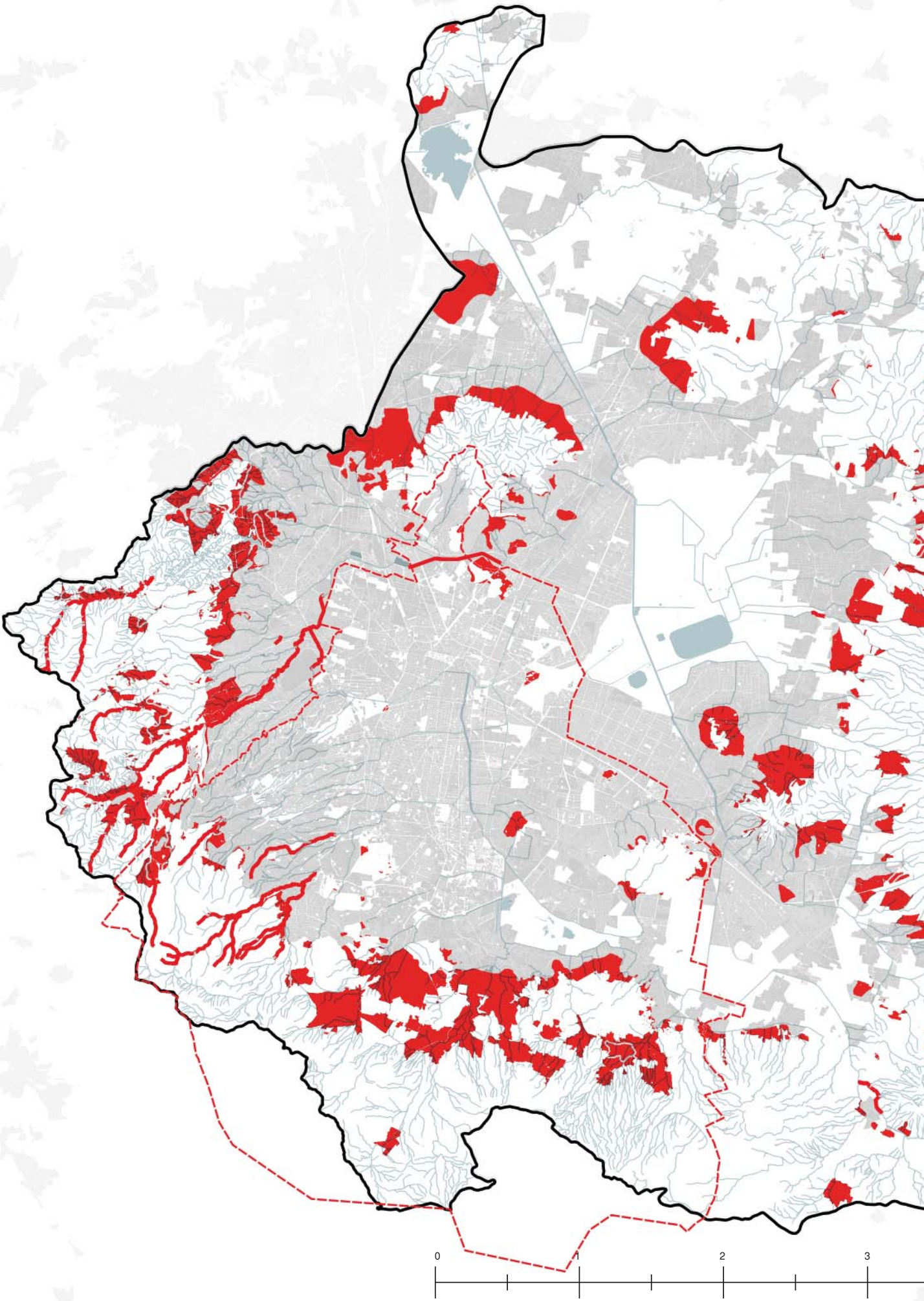
Basin structure
Urban occupation vs conservation areas

The city's expansion has led the mauntanous regions of the valley separated from the large patches within the city's multiple cores mainly due to blockage from large scale road infrastructure. Anillo Periferico, known as the city's second ring road, delimits the peripherial hydrological strcuture from meeting its core. In addition to these barriers, the city has historically entubed it's rivers due to contaminants originated in textile industires from the 30's, locking the city's water infrastructure into a combined sewer system.

Occupation

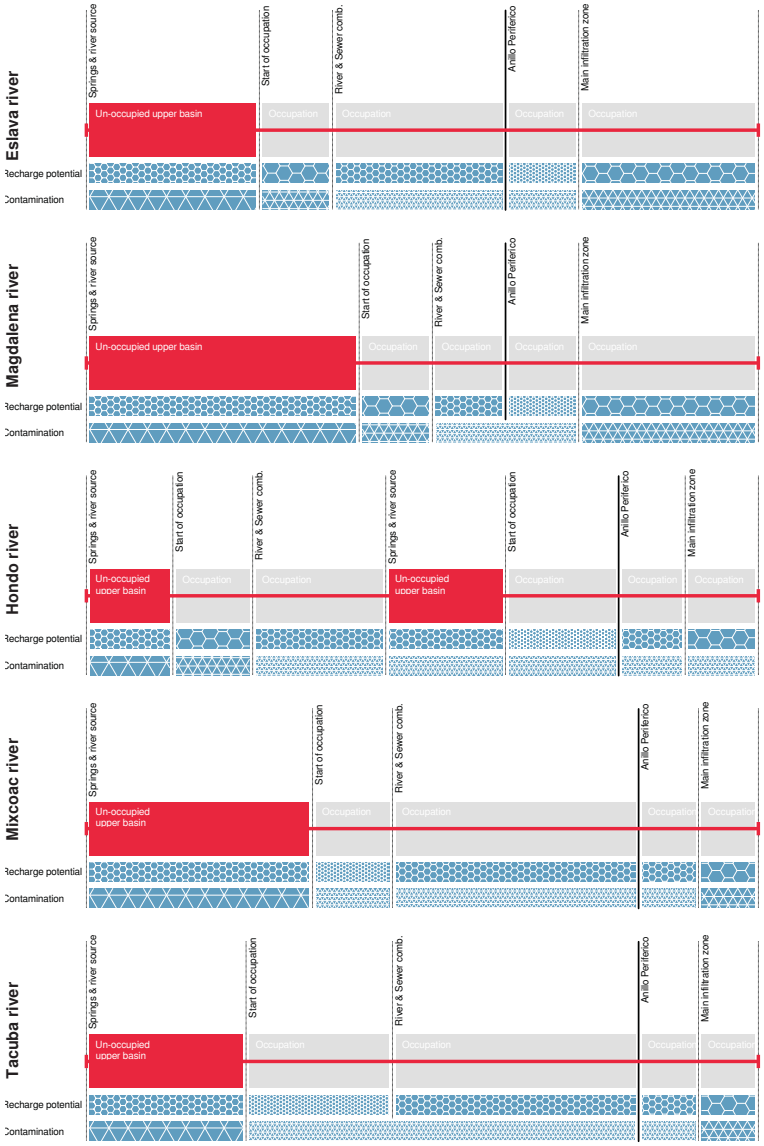
Conservation soil

Basin delimitation


0
1
2
3

Basin structure

Potential potable water sources ranked based on soil conditions and surface pollution

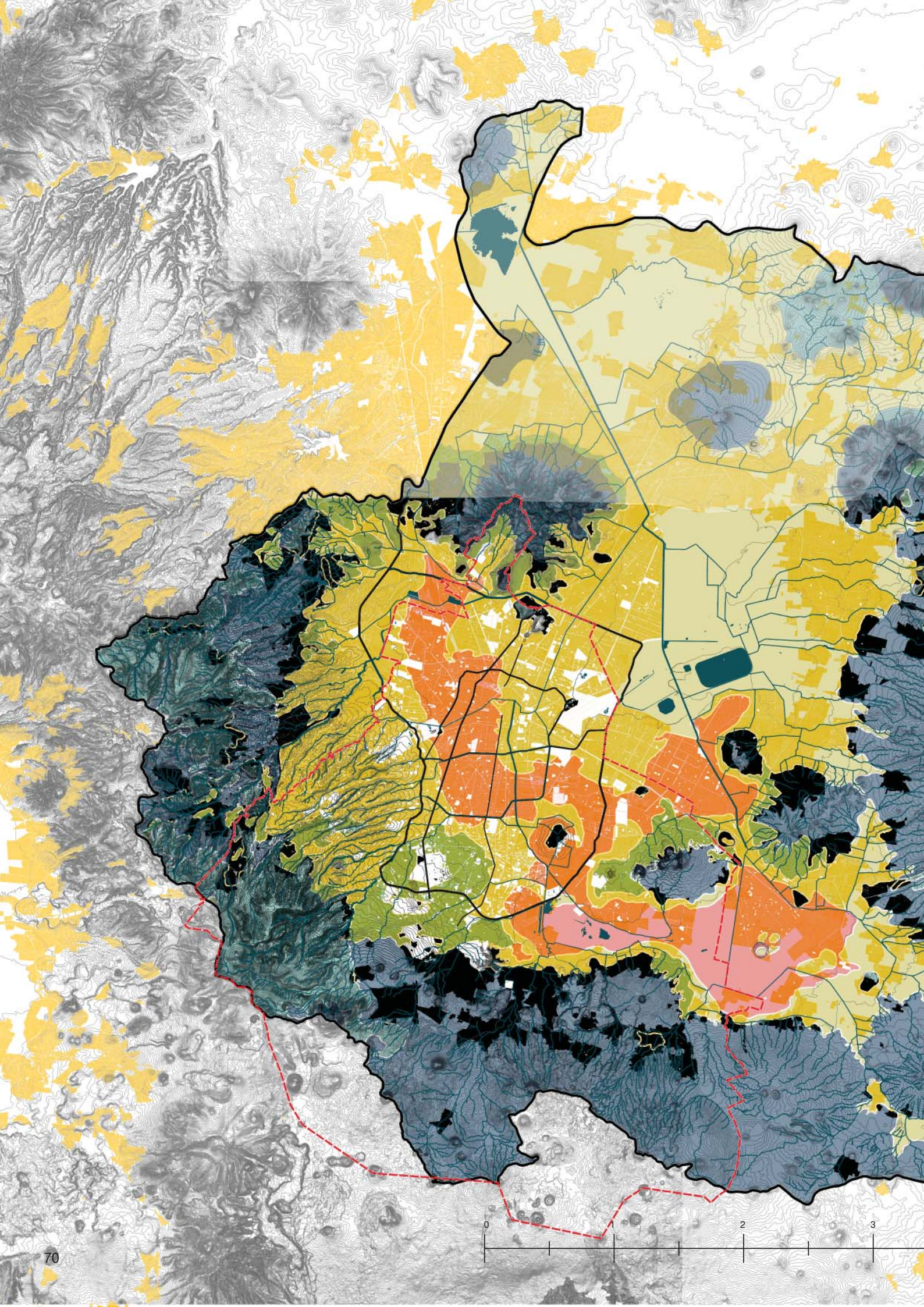


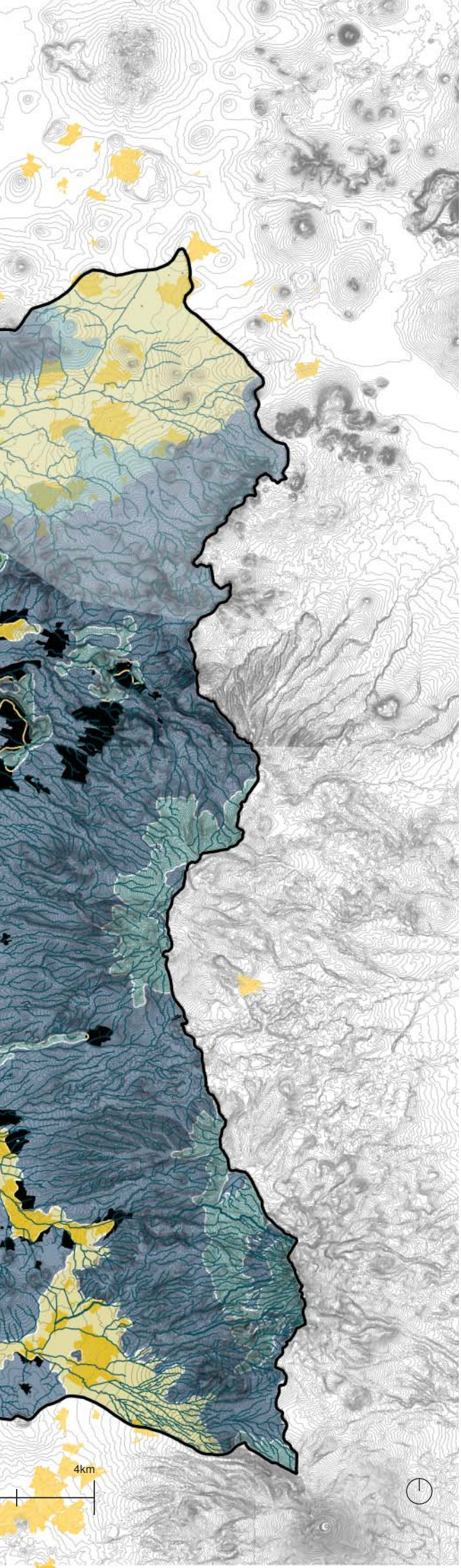
Perennial river

Occupation

Critical zones

Basin delimitation

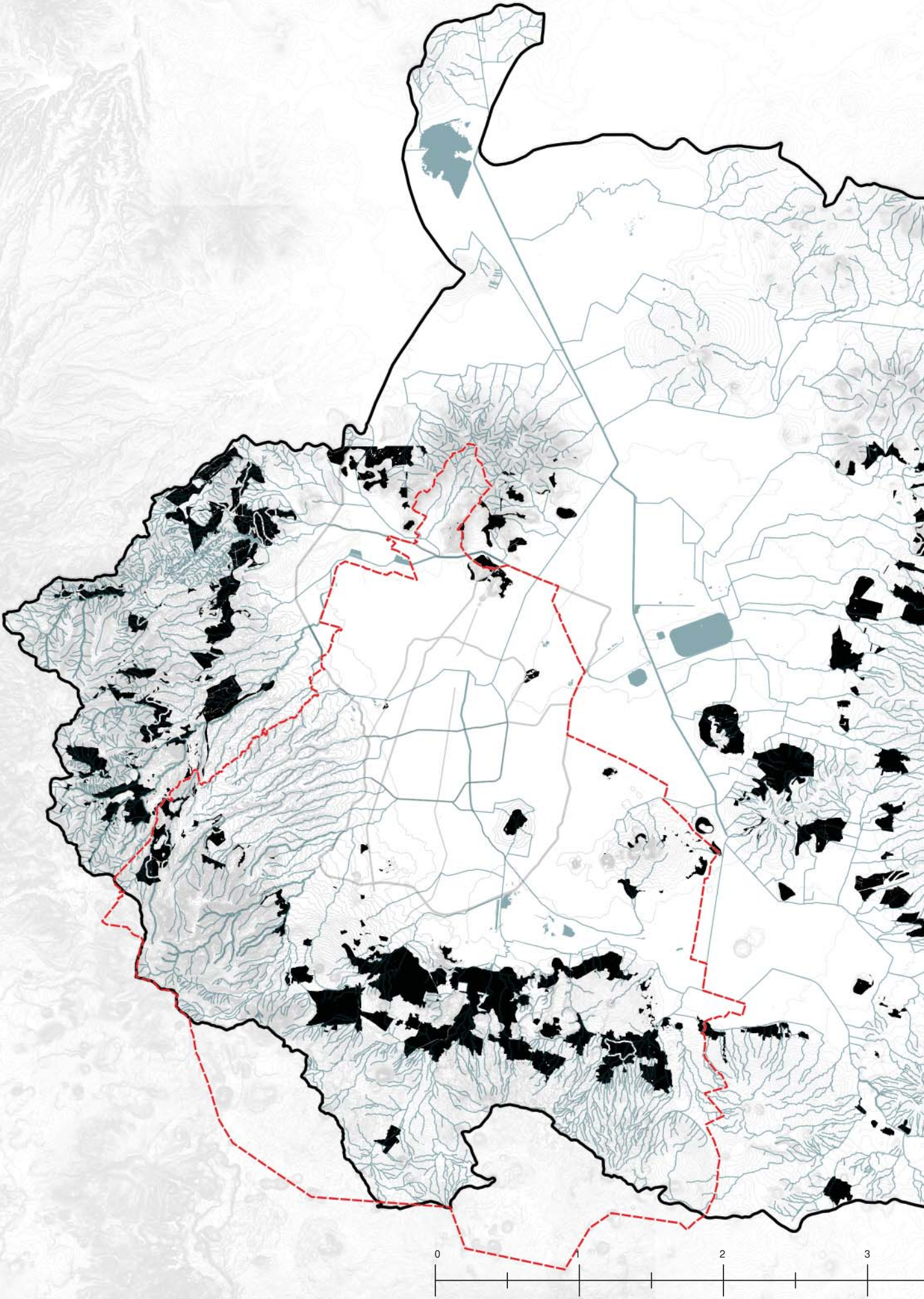

0
1
2
3



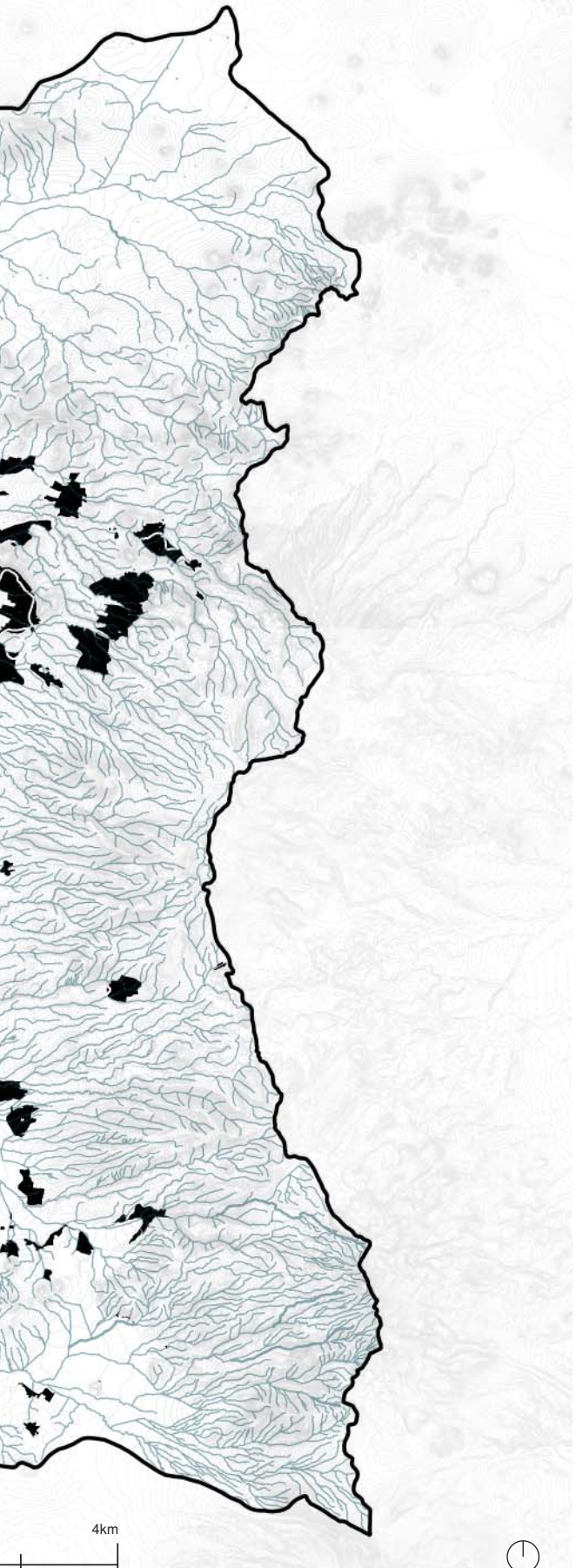
Basin structure
Synthesis

By establishing strict zoning, the city can potentially organize its urban space in accordance to improving the basin's hydrological performance. By creating a distinction betweeen soil types in conjunction with the city;s conflicting borders and land occupation, the basin's spatial structure can meet the demands of a more adaptive environment.

- Critical zones
- Low transmisivity
- Medium transmisivity
- High transmisivity
- Low infiltration capacity
- Medium infiltration capacity
- High infiltration capacity
- Basin delimitation


0
1
2
3

Basin structure
Critical areas

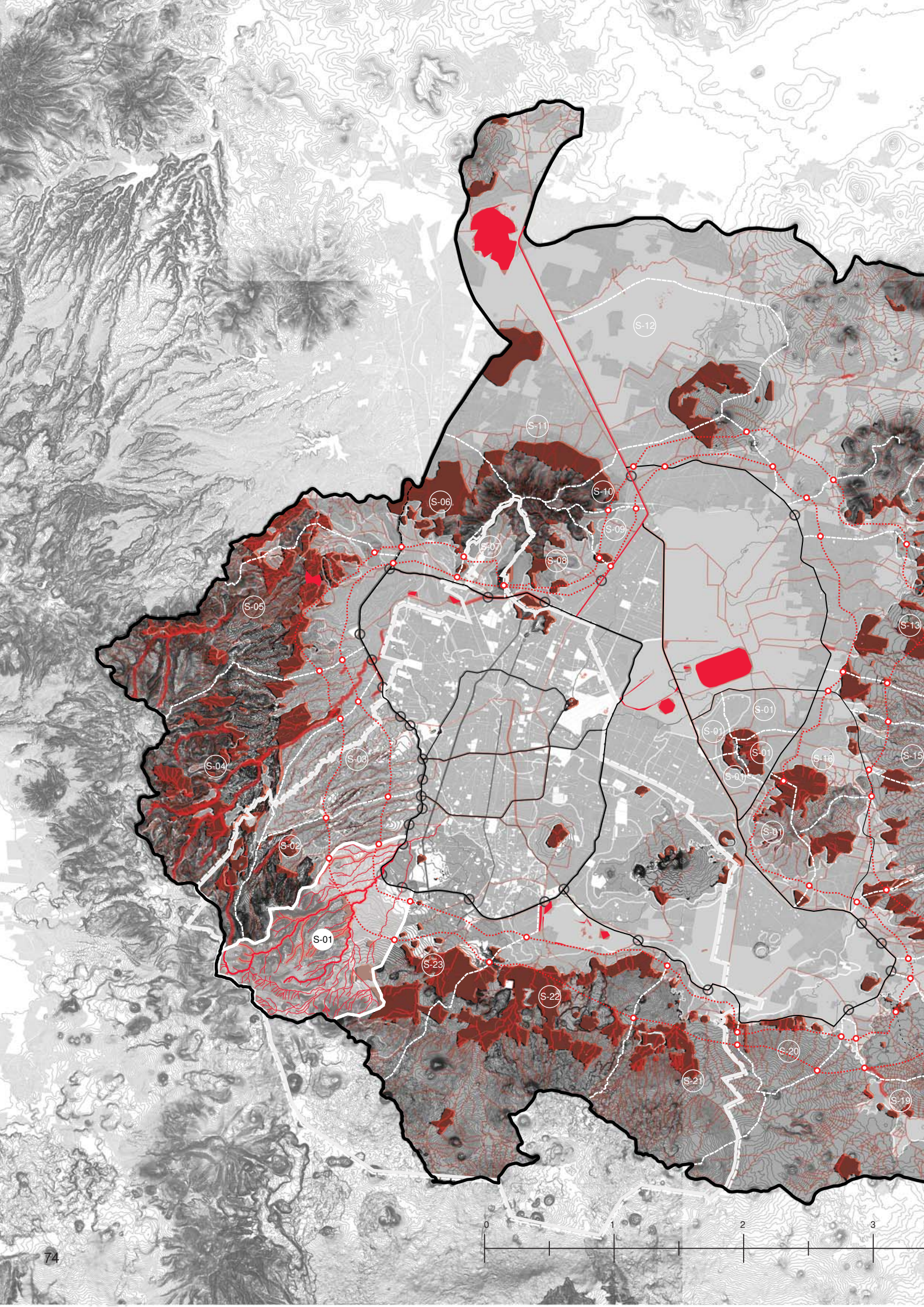


The following areas become revealed as critical areas for intervention: a)Urban occupation on conservation soil, & b)Urban occupation on potential water sources. This establishes priorities in long term planning by setting stepping stones for the rest of the water sensitive network.

Main road infrastructure

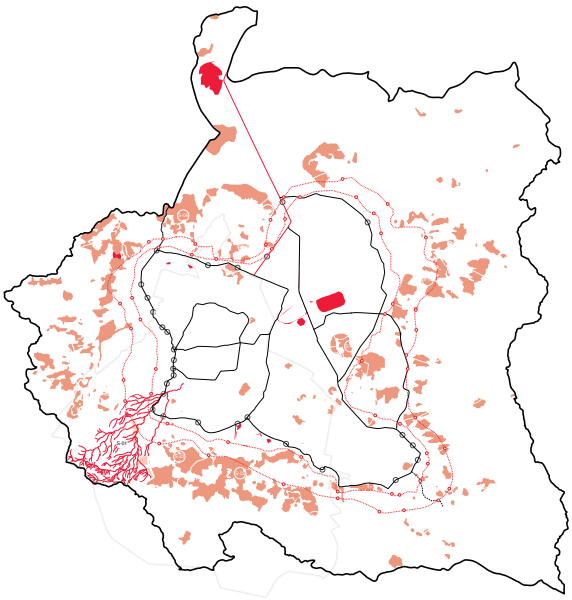
Critical zones

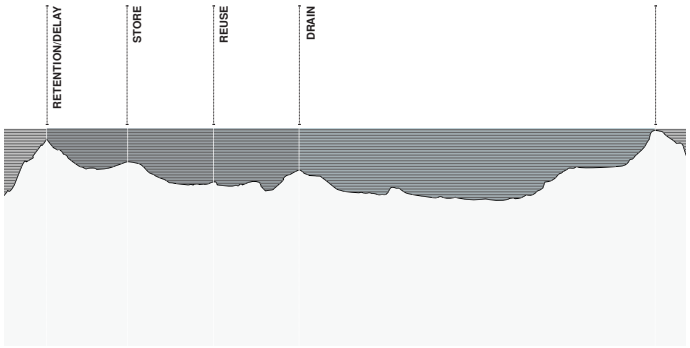
Basin delimitation


S-12
S-11
S-10
S-06
S-09
S-07
S-08
S-05
S-13
S-01
S-01
S-01
S-16
S-15
S-01
S-04
S-03
S-02
S-01
S-23
S-22
S-20
S-21
S-19
0
1
2
3

Basin structure

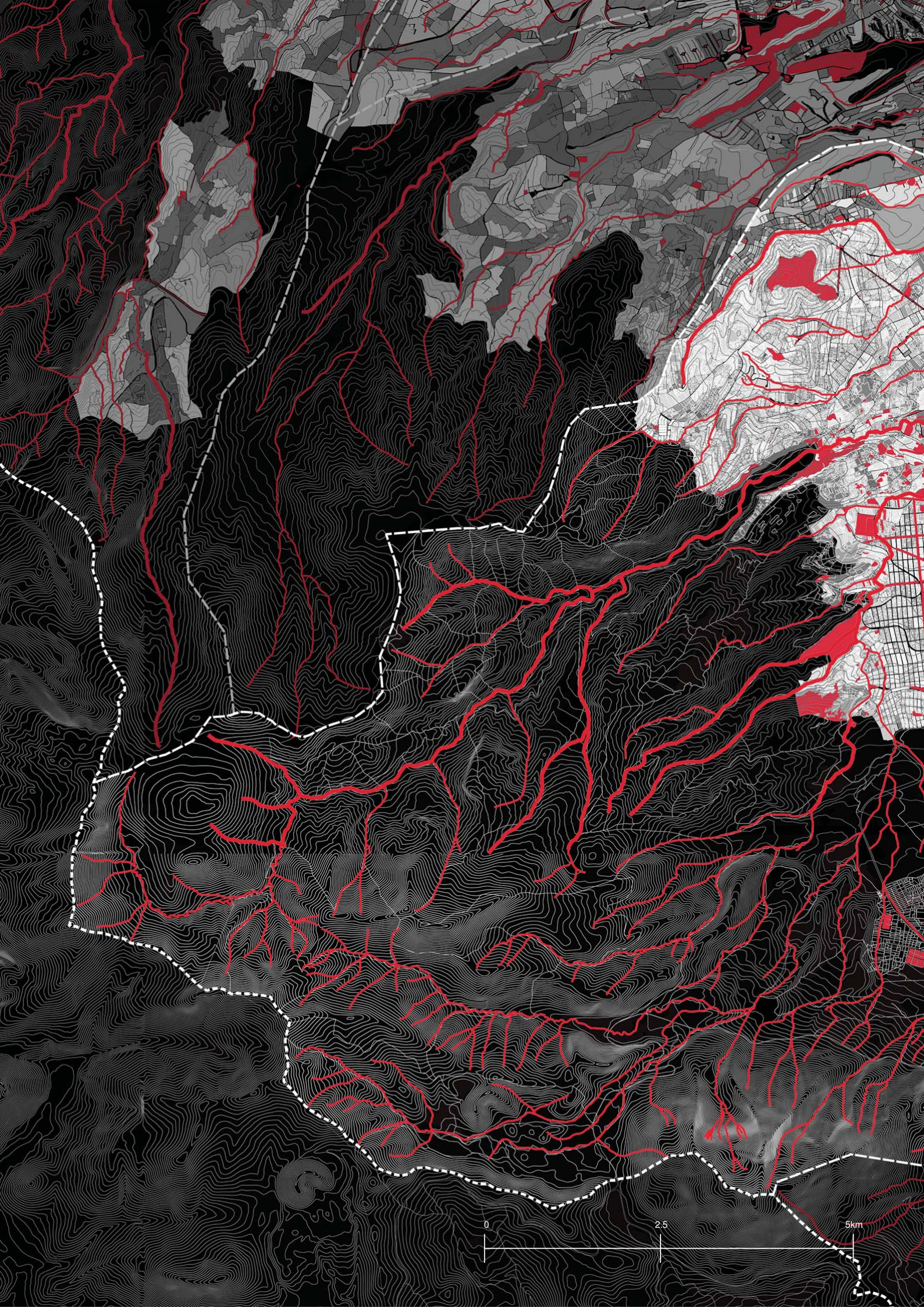
Proposed sub-basin division,
critical intervention areas
& morphological zoning





Occupation
Virtual sink
Critical zones
Stream condition scheme
Sub-basin delimitation
Basin delimitation

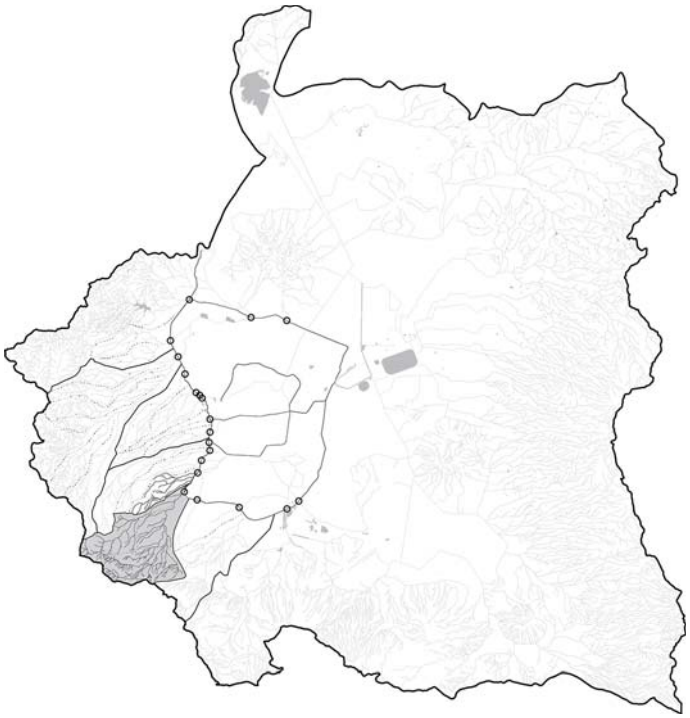
Sub-basin strategy


0
2.5
5km

Sub-basin structure

As a conclusion from the analysis made at the basin level, it is inferred that the Magdalena - Eslava river Sub-basin holds the highest potential to amplify existing water sources due to its small urban footprint compared to the rest of the city. The rivers emerge in the mountanous regions and meet the peropheral settlemets long before its reached the transition zones, meaning that the contamination of the water flowing into these areas is constant and the overall existence of these rivers is ignored.

The upstream condition of the sub-basin leaves high potential for recharge and ground-water infiltration, while the mid and low stream concentrate on storing the largest amount of water possible for use in dry season. Understanding this structure is crucial for defining a water management plan for de region, taking in account soil condition (infiltration capacity), built density, and income level.

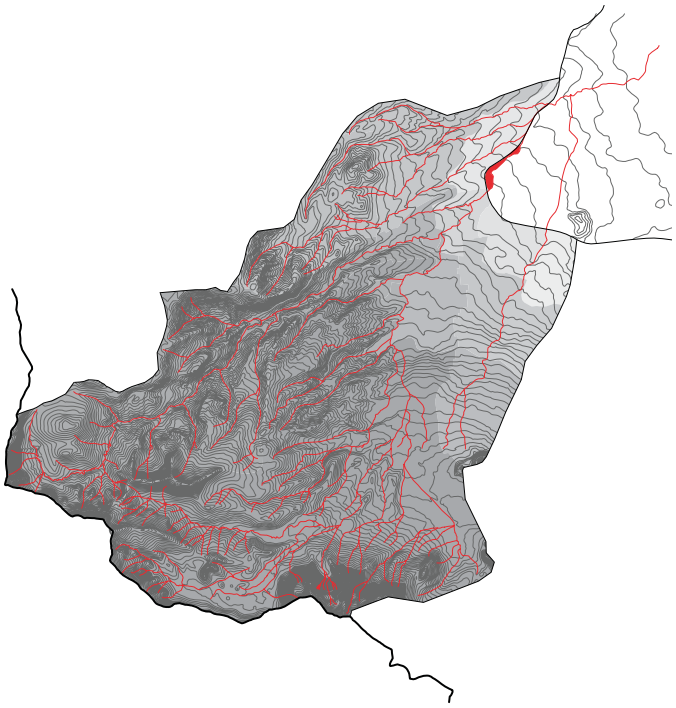


Magdalena / Eslava river sub-basin

Sub-basin structure

The capacity of this portion of the basin to retain water and ultimately supply water to it's residents is high yet under stress due to the great demand of potable water of millions of inhabitants. Given the great amount of conservation areas and great extension of the mountainous areas, the aquifer recharge capacity of the local communities is of crucial concern.

The monthly average precipitation of the city falls within 5 mm, but experiences high rainfall seasons (with monthly average up to 65 mm in August)(CONABIO, 2016) making it able to supply itself with water during only half of the year. The remaining year, the city mus be able to meet its quota by restructuring it's urban water management system. For this, it must be understood that the Magdalena-Eslava river sub-basin is located in an area in which groundwater infiltration is of upmost priority, and as such, it must focus on recovering it's existing own internal potable water sources so as to decrease the extraction practices in the neighboring basins.



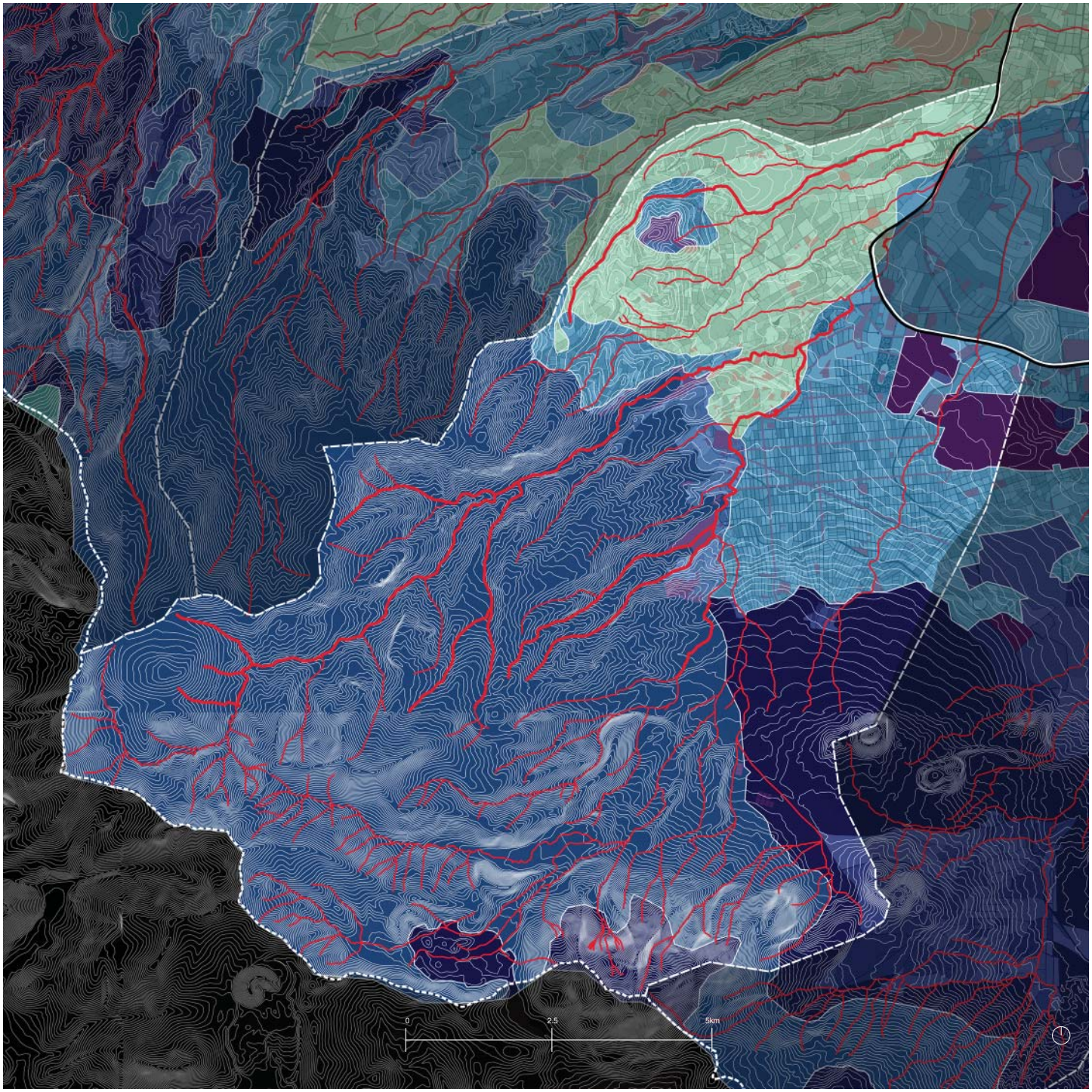
Magdalena / Eslava river sub-basin's micro catchment areas

Magdalena river
Upstream

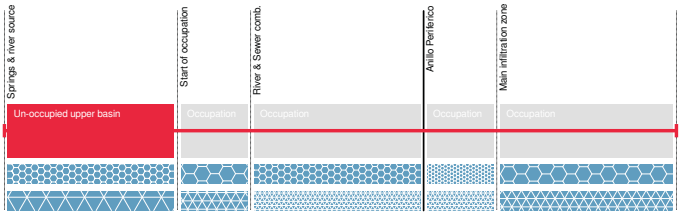
Eslava river
Upstream

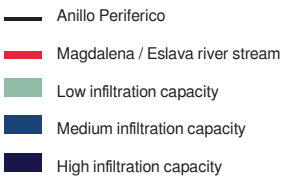
Magdalena/Eslava
Midstream

Magdalena/Eslava
Downstream



Infiltration capacity of the Magdalena / Eslava river sub-basin



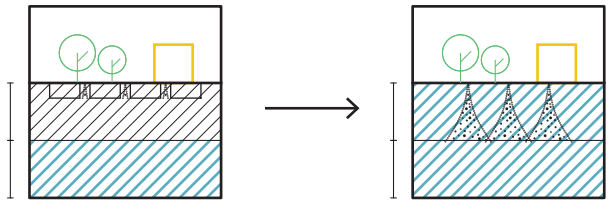


Sub-basin structure
Upstream condition

Soil condition

The mountainous region of the sub-basin's upstream is known to have high infiltration capacity, ideal for rebalancing the regions recharge rate.

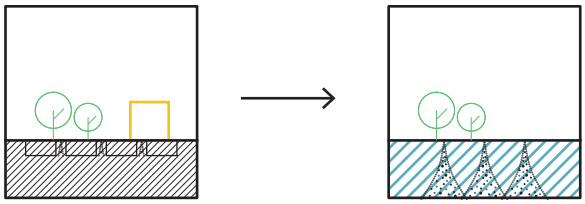
Due to this condition, informal settlements in these areas should be encouraged to be relocated to lower portions of the basin. Water provision infrastructure in this area should strictly be built through natural systems so as to not expand the urban footprint.



Built density

Given the nature of informal urbanization in these areas, housing density is often low and poorly constructed, since these settlements tend to emerge as peripheral growth.

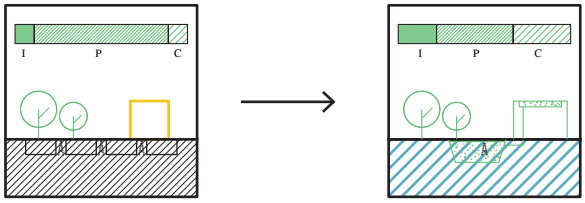
In regards of redensification strategies, this area poses the highest impact on conservation soil, therefore should be incentivized to reduce built foot print and ultimately relocation. The agrarian landuse of these areas pose a great role as a strategy to renaturalize the periphery.

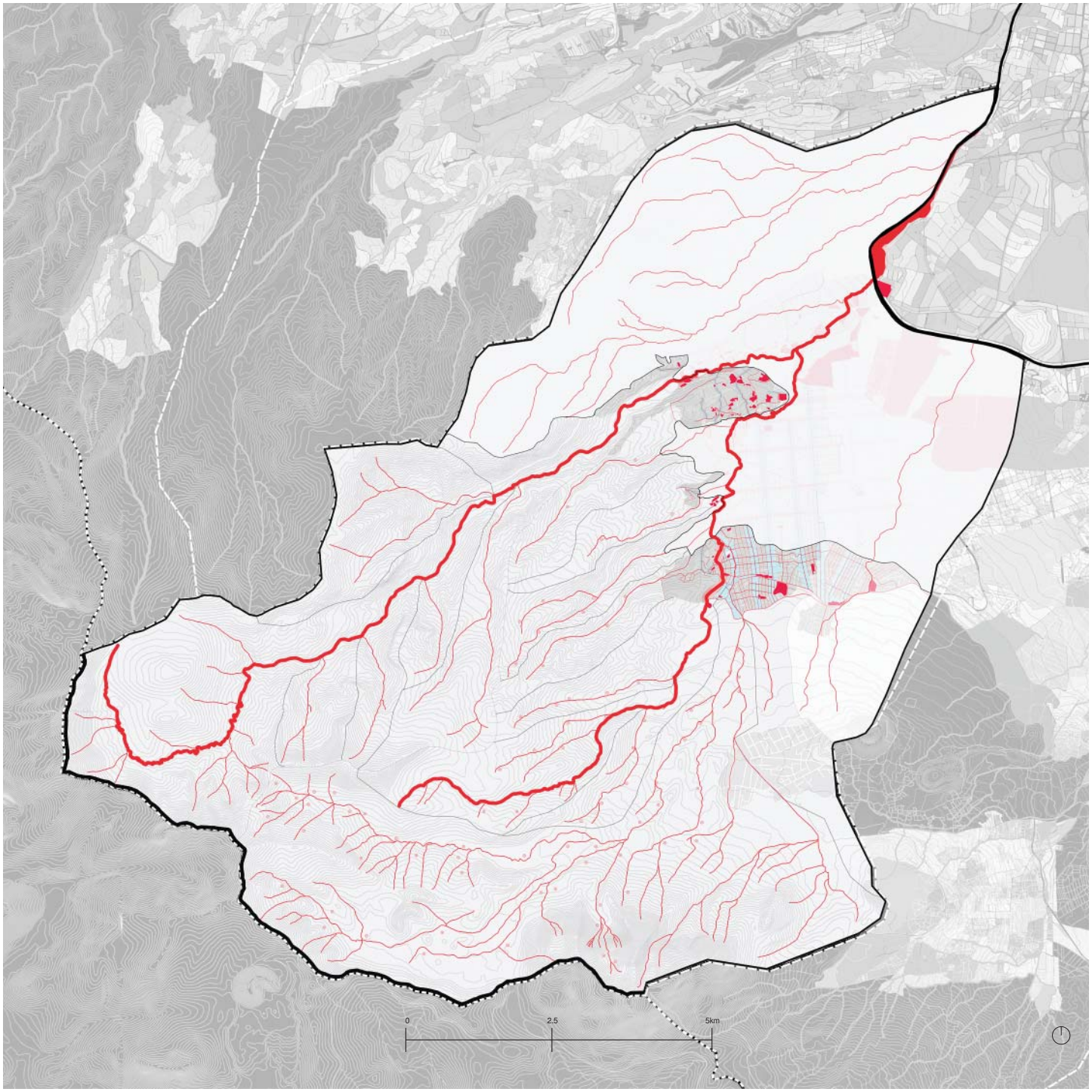


Income level

The periphery of Mexico City experiences a gradual growth towards it's edges, being a result of ongoing land price increase due to real estate development in the lower income districts.

The resident's capacity to develop spatial strategies on their own is fairly limited, hence more public funding for water sensitive urbanisation should be introduced in these areas.





Magdalena / Eslava river sub-basin's upstream

Magdalena / Eslava river stream

Potential patches

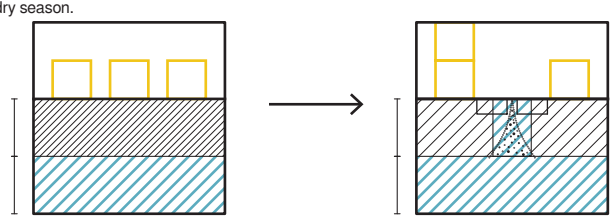
Occupation

Sub-basin structure
Midstream condition

Soil condition

In the middle portion of the sub-basin, the urban expansion of the late 80's delimited the geo-morpholigical structure of the sloped mountainous region, creating a large scale sprawl which deteriorated the superficial soil layer. In this area, the urban surface material has made the soil impervious and in adition to this, the lower inclination of the slope lead to slower runoff speed.

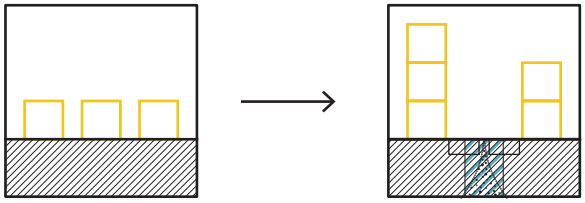
In this area, an urban transformation must consider less infiltration and should concentrate more on slowing down the runoff speed as well as finding more storage space for water during dry season.



Built density

In the districts of Tlalpan and Magdalena contreras, low density housing blocks have sprawled without providing enough centralities and open space. Given the large population of the area, one of the main challenges to adress along water sensitivity is to provide adequate urban centralities through public space and services.

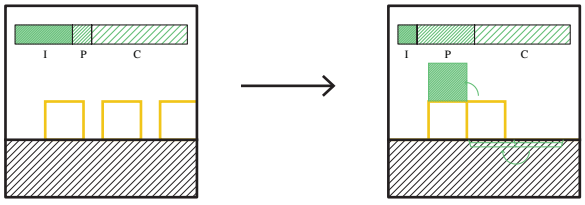
Given the formal nature of these housing typologies, densification program funds and public space programs can systematically change the urban grids and provide a proper blue-green network through private, public and collective initiatives.

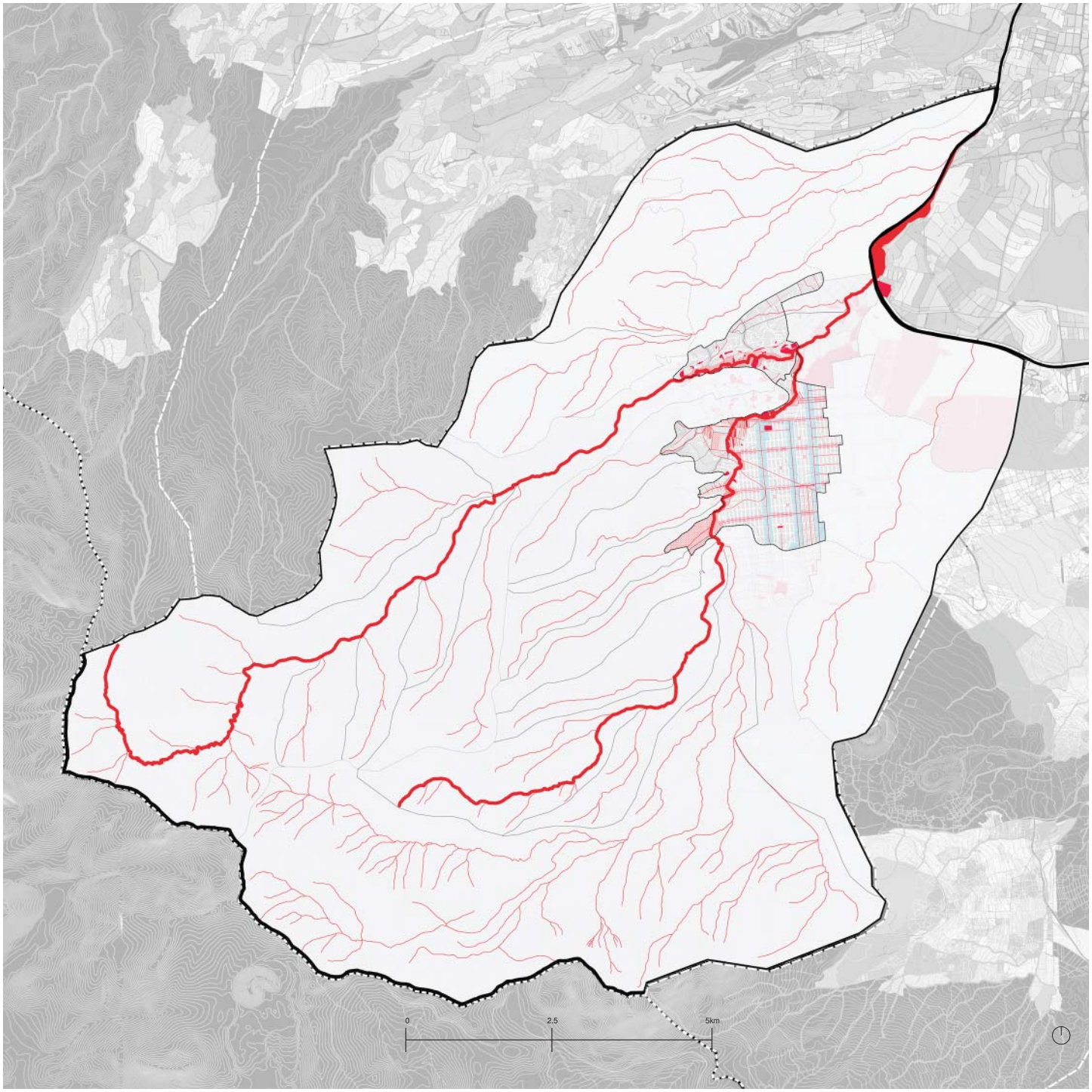


Income level

As these areas are much more formalized than the settlements in the upstream, there is a larger capacity of the population to tranform their own environment with the help of public funding.

Since these are still considered low income areas in comparison to the rest of the city, new housing developments should be aware of the risk of increasing land price, since this would promp an expansion of the periphery if housing does not meet the budget needs of the local residents.





Magdalena / Eslava river sub-basin's midstream

Magdalena / Eslava river stream

Potential patches

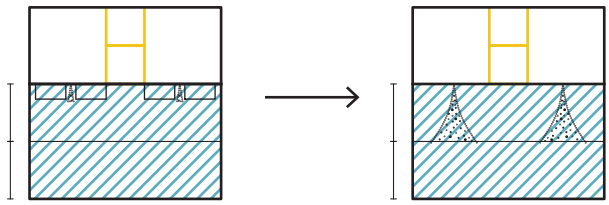
Occupation

Sub-basin structure
Downstream condition

Soil condition

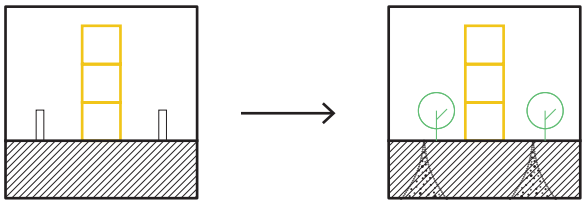
The lower portion of the city's river sub-basins suffers from a similar soil deterioration. However, in the Tlalpan district in particular, the basalt rock formations from volcanic eruptions created high infiltration capacity points, which often overlap with natural reserves and high income housing open spaces.

A crucial strategy for urban water management in these areas should ensure a full treatment of waste water in order to take advantage of this potential infiltration soil type.



Built density

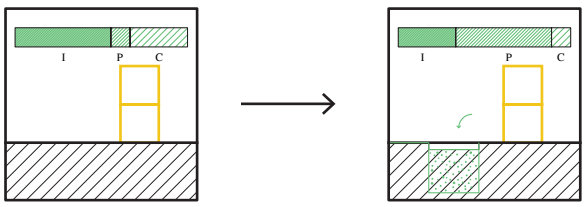
These lower lying areas concentrate most of the newer housing developments given their proximity to the city's main road infrastructure. These typologies are of course of much higher density and land price, meaning that there is enough open space in relation to their built density as well as a larger responsibility to ensure propper groundwater recharge.

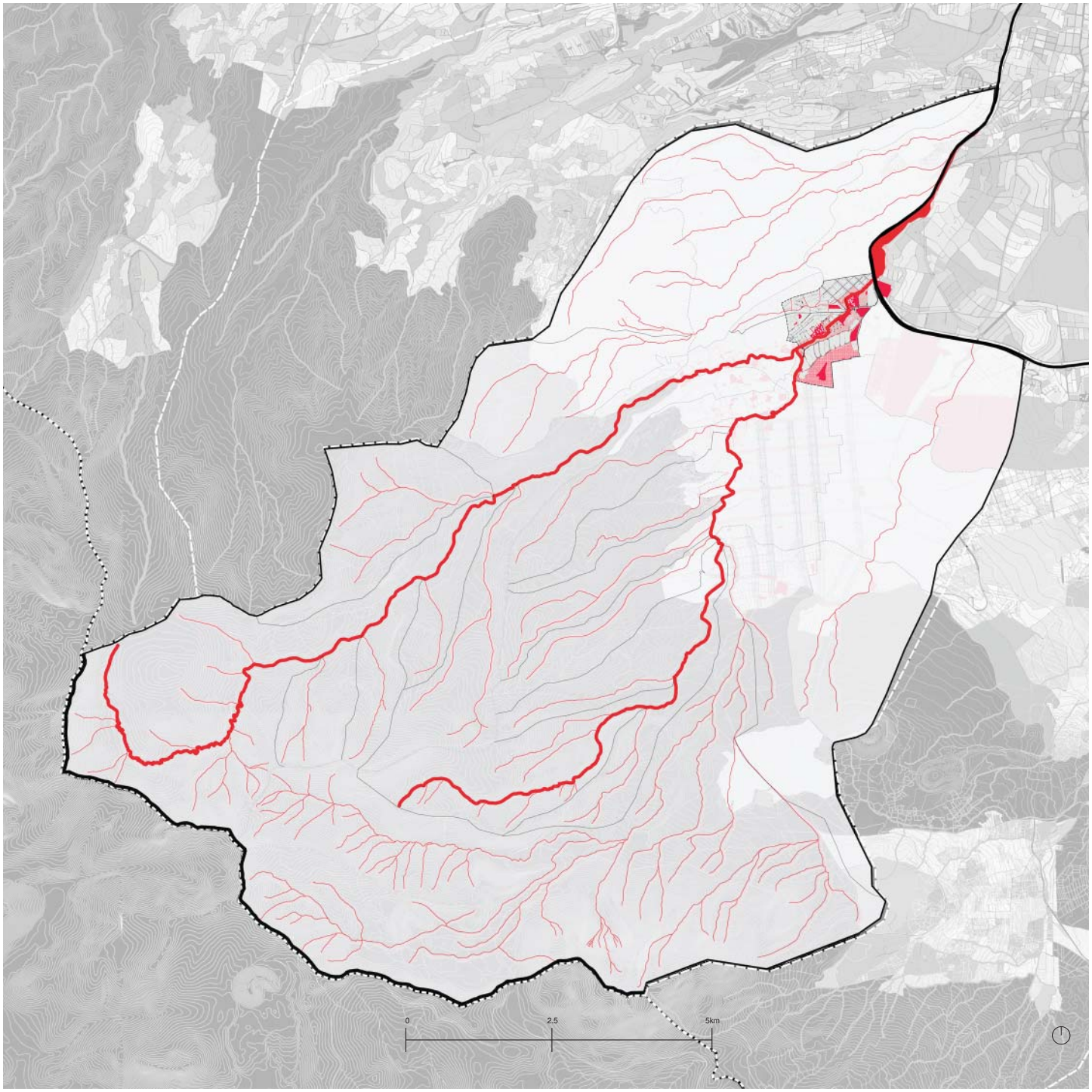


Income level

As these areas concentrate high income level residents in high density housing blocks, there is great opportunity to fund water sensitive urbanization from the private sphere.

As a consequence, this portion of the sub-basin represents many opportunities linked to many private funding mechanisms which can accelerate the water balance of the region.





Magdalena / Eslava river sub-basin's downstream

Magdalena / Eslava river stream

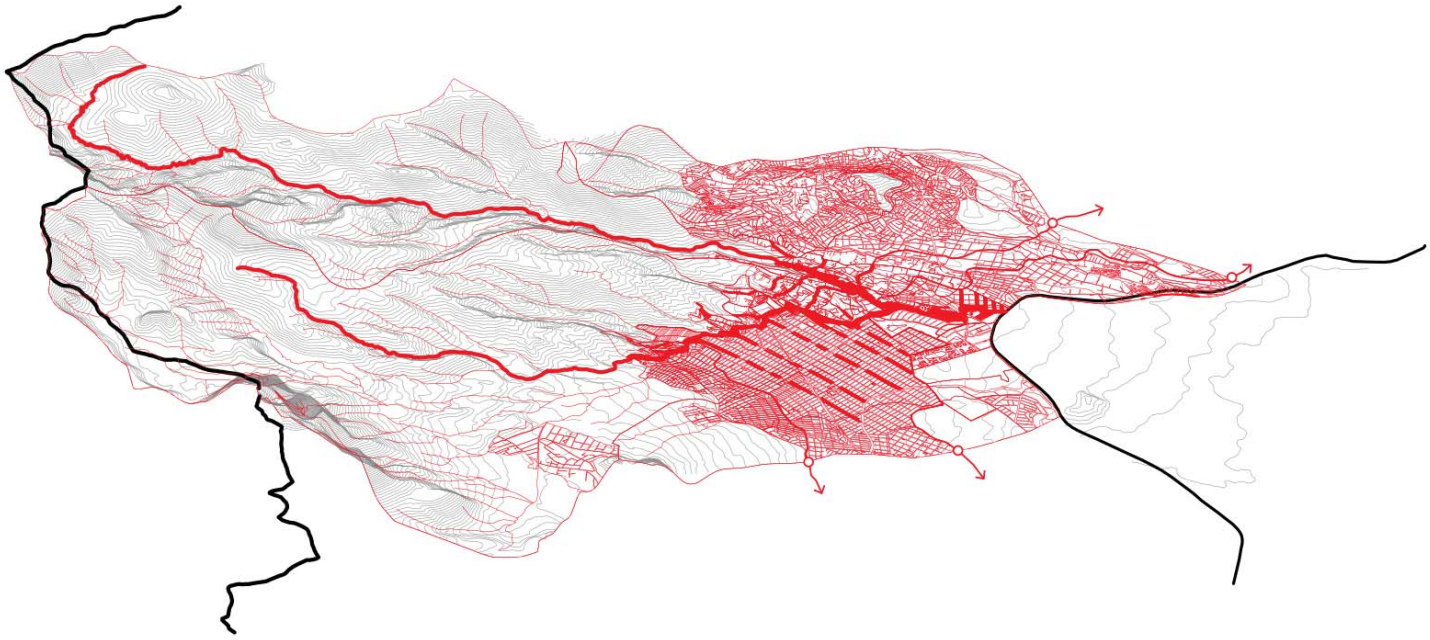
Potential patches

Occupation

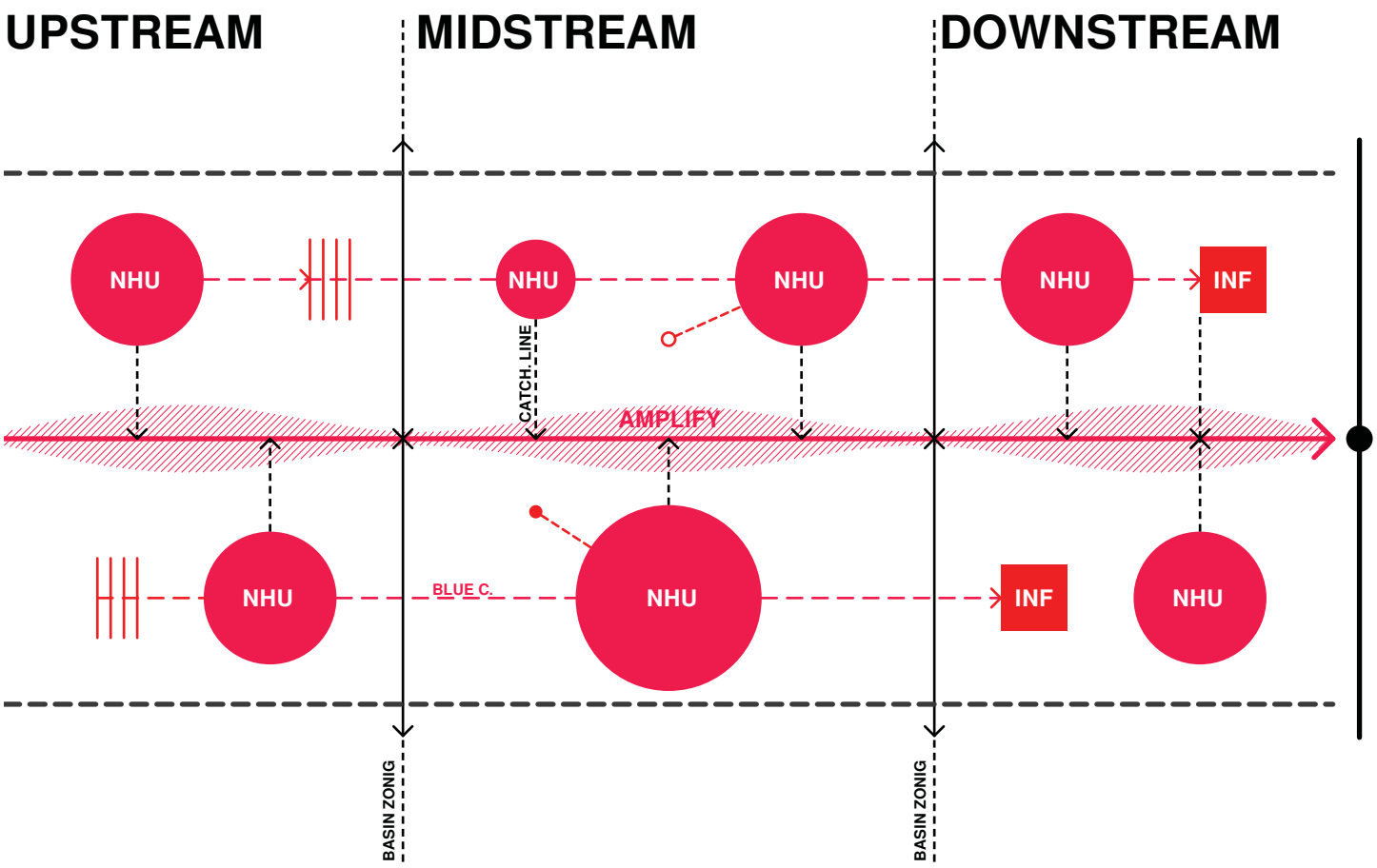
Magdalena-Eslava Sub Basin
Spatial strategy based on it's geomorphological structure

As each portion of the sub-basin hold it's own role and responsibility in regards of the overall hydrological performance, it is crucial that coordinated efforts aim towards working as a single system. The existing urban tissue allows this through specific lines of road infrastructure in combination with public open spaces and the overall geomorphological structure.

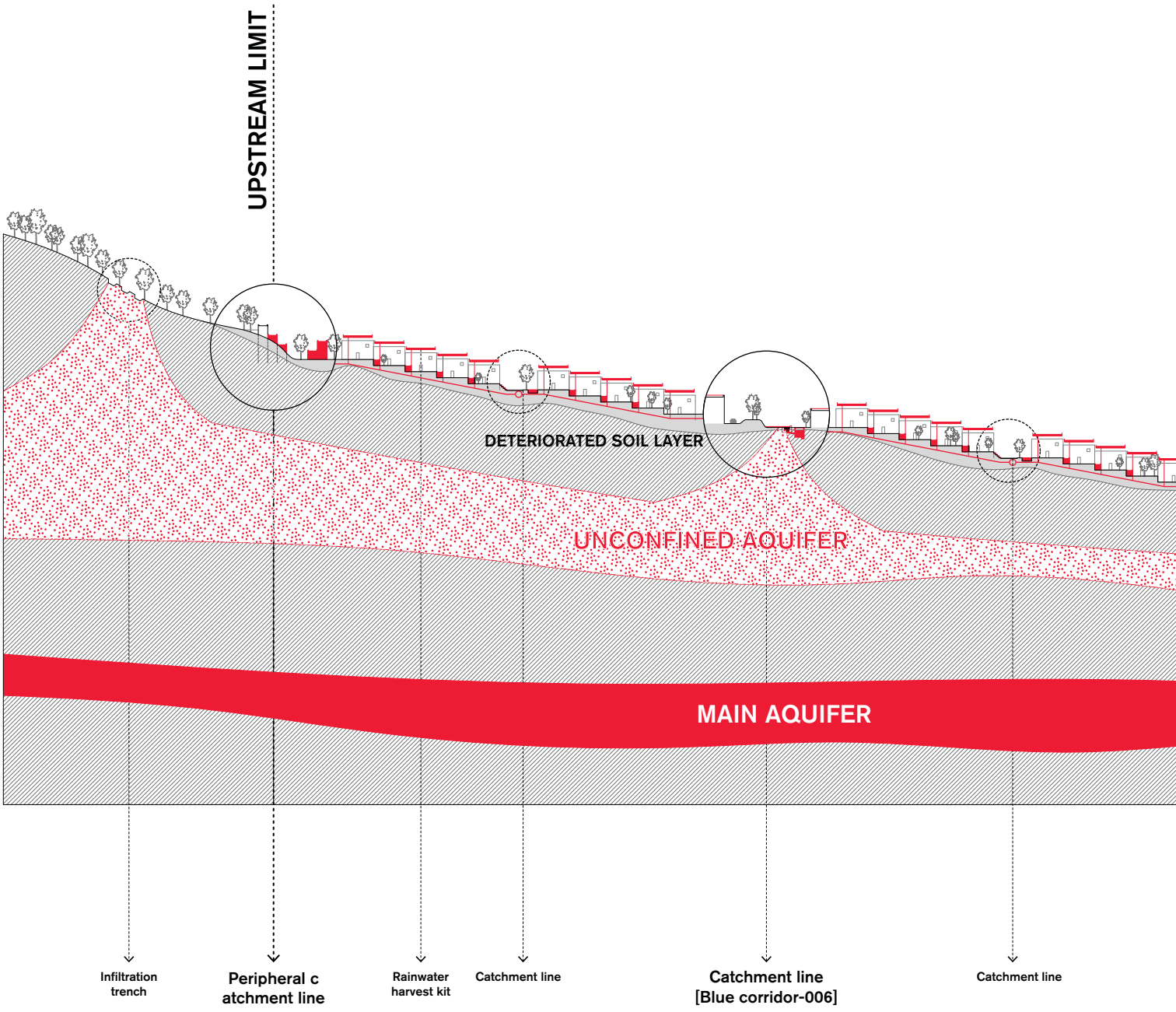
Main infrastrucutre lines subdividing the Magdalena / Eslava river sub-basin

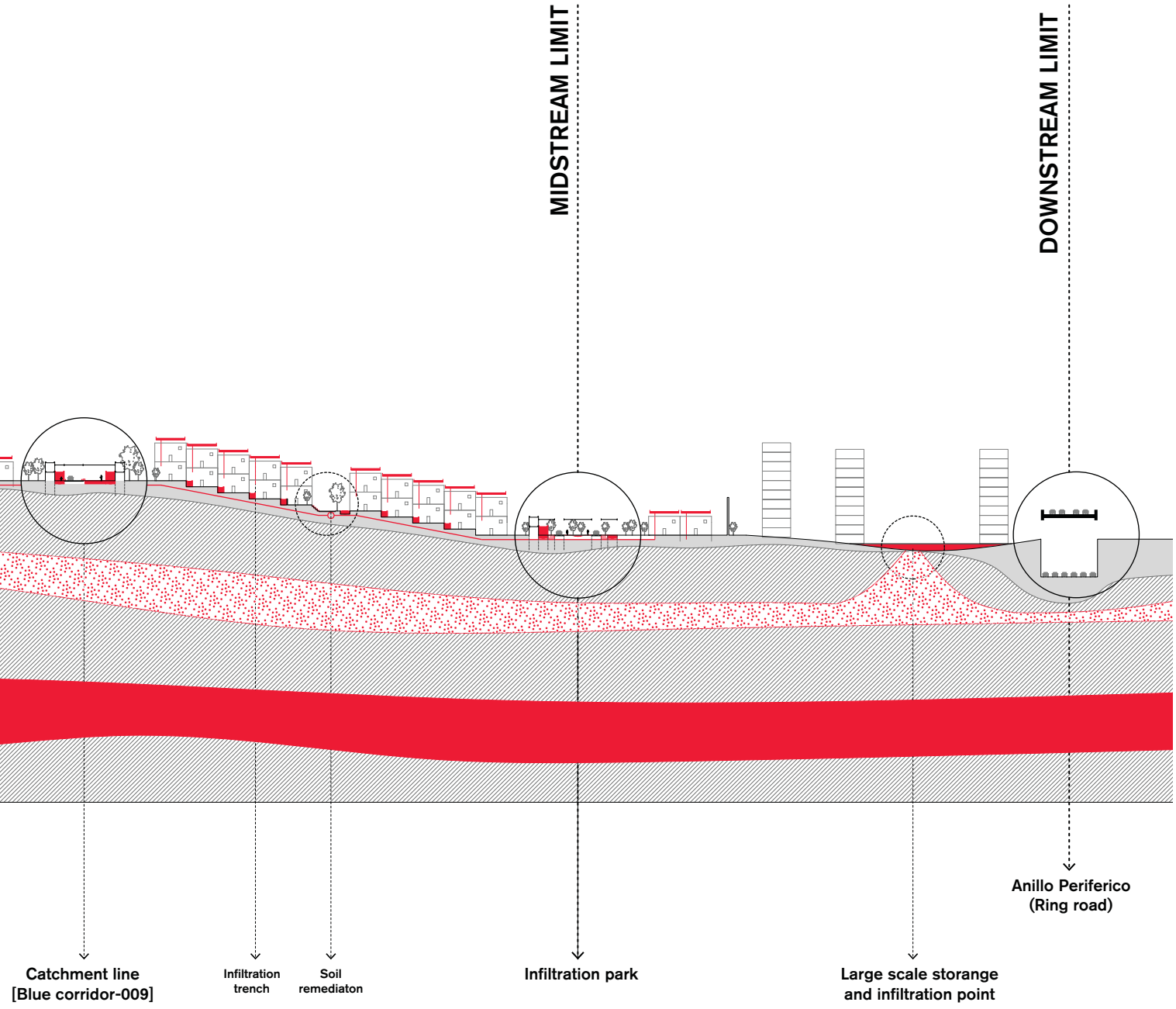


Isometric view of the sub-basin

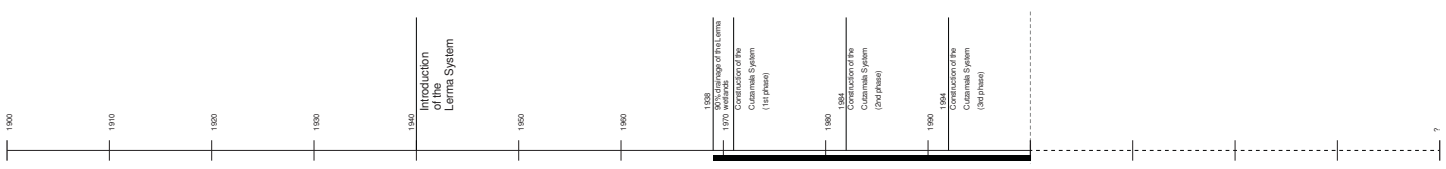


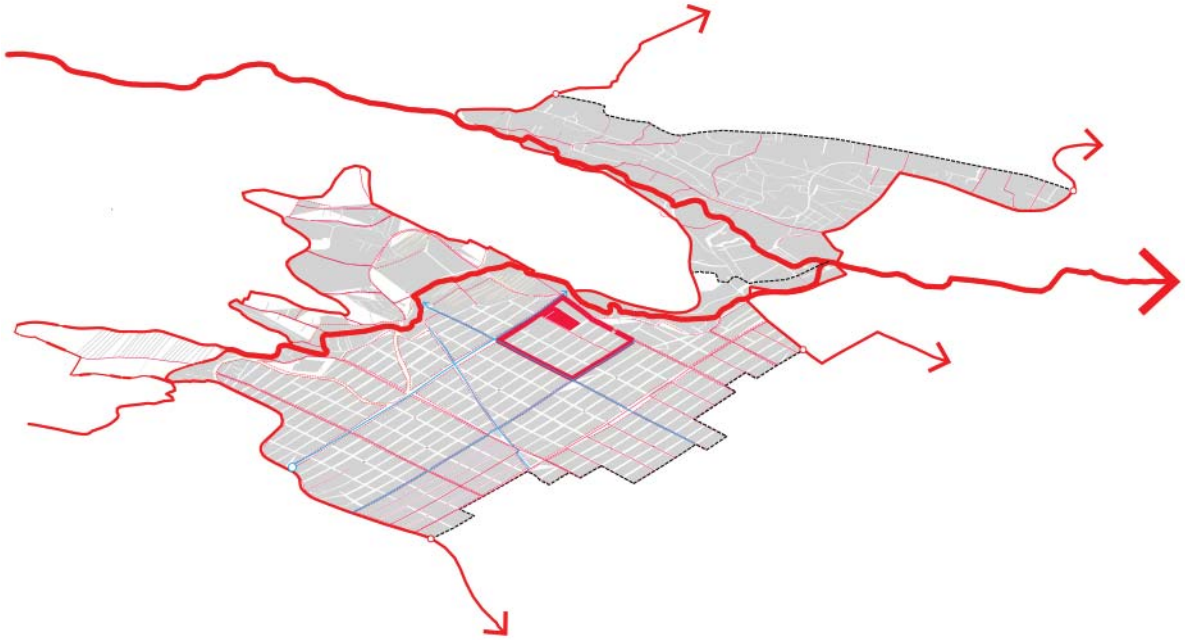
Sub-basin structure
Spatial strategy




MIDSTREAM LIMIT
DOWNSTREAM LIMIT
Anillo Periferico
(Ring road)
Catchment line
[Blue corridor-009]
Infiltration
trench
Soil
remediaton
Infiltration park
Large scale storange
and infiltration point

Micro-basin strategy



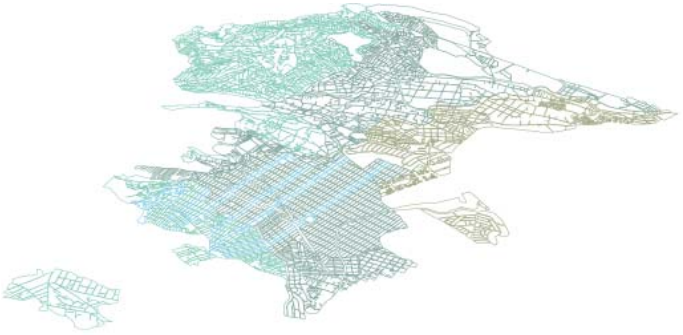


Totolapan / Padierna micro-basin strategy

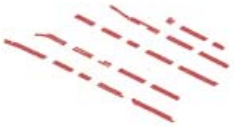
Micro-basin structure

The Totolapan / Padierna Micro-basin initially developed upon soil conformed of relatively recent volcanic eruption. The flow of the Eslava river became diverted by the rapid urbanization process of the 80's and is highly neglected byt the local residents. the streams flowing from the upper portion of the micro-basin reach this area with high speed and encounter an urban tissue which challenges the direction of the stream.

Micro-basin structure
Proposed hydrological network



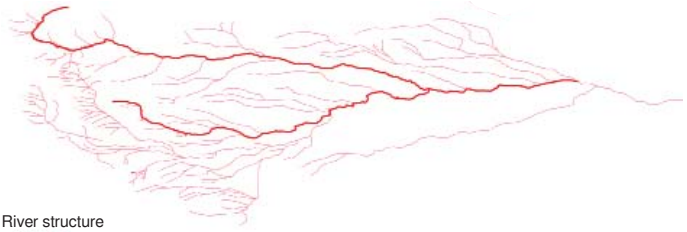
Proposed zoning



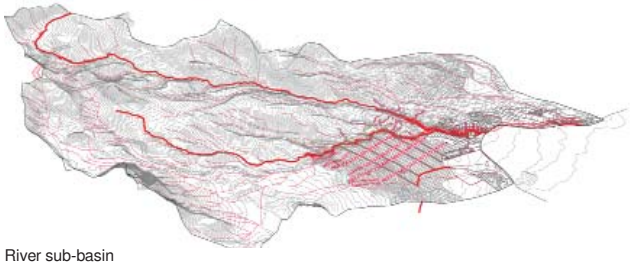
Public space corridors

Blue-Green network

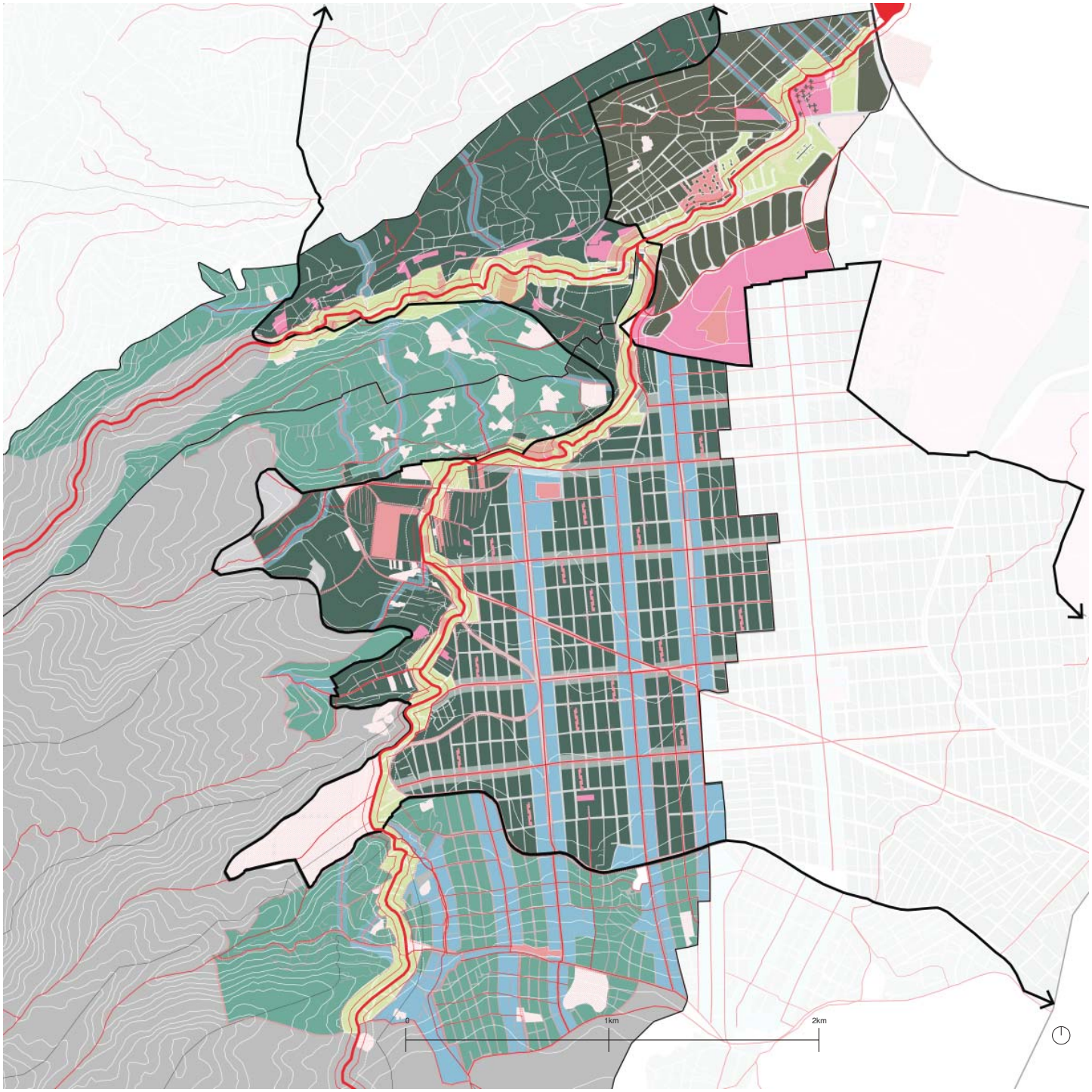
Amplification strategy



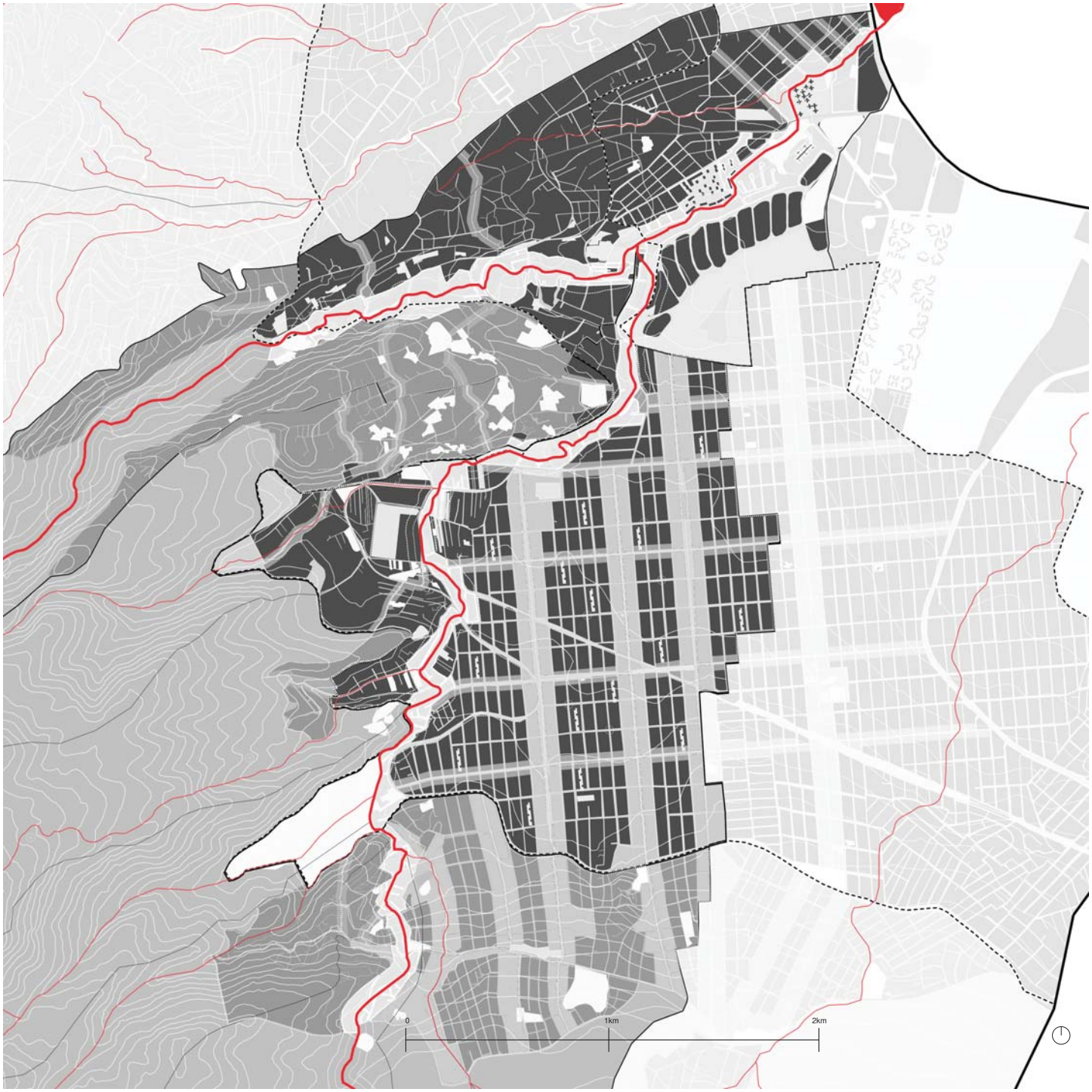
River structure



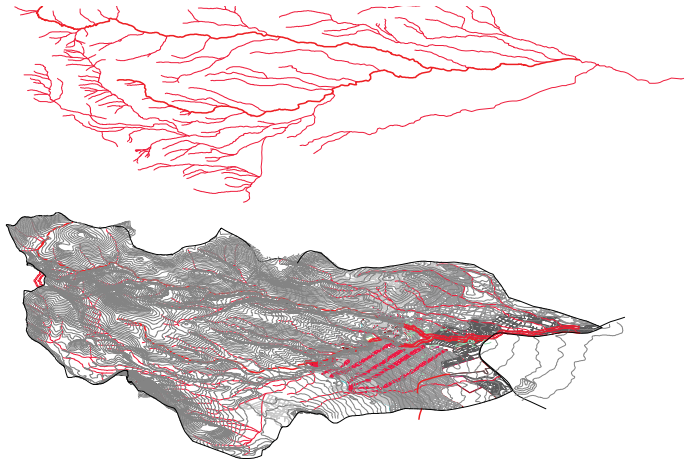
River sub-basin



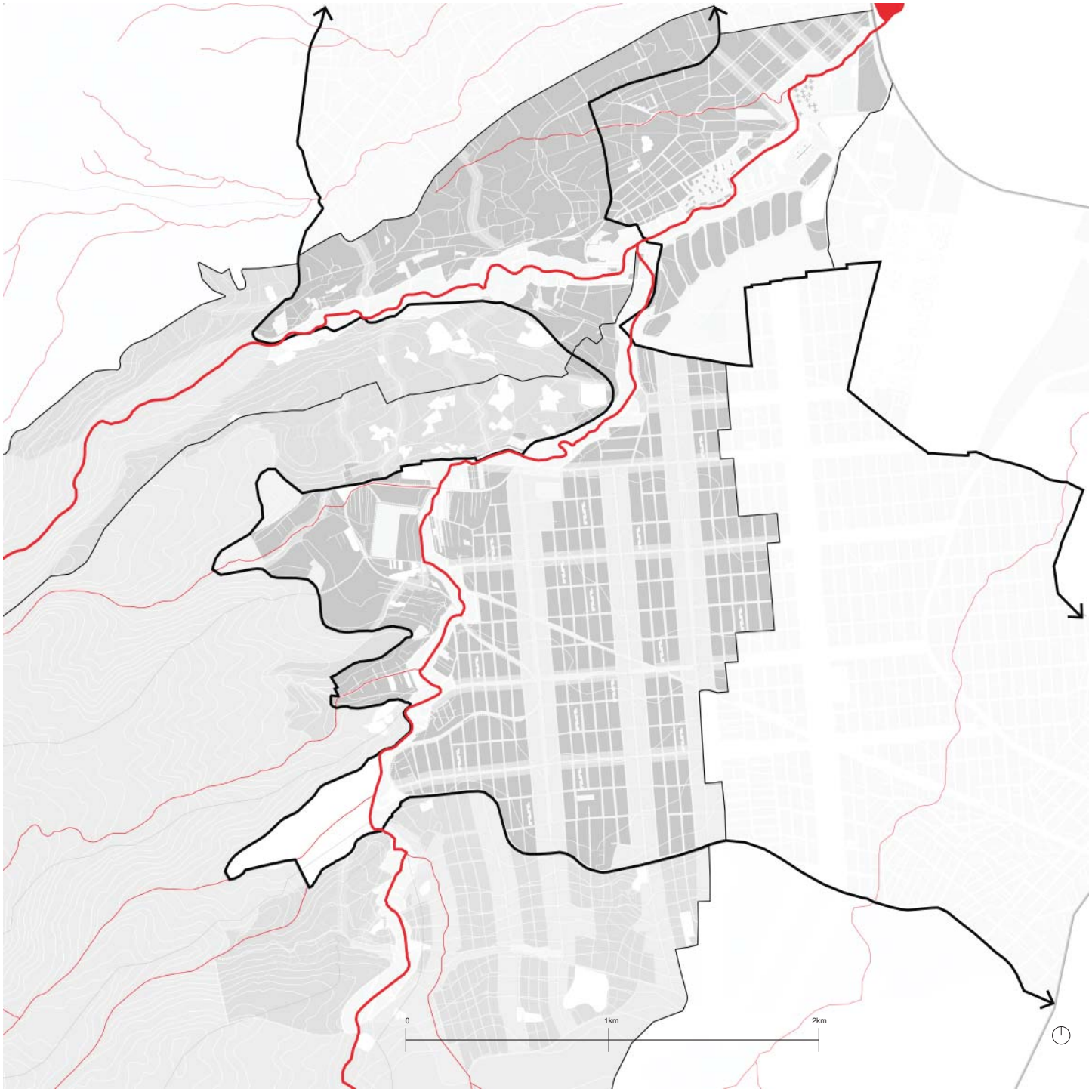
- Stream condition delimitation
- Magdalena / Eslava river stream
- NHU delimitation
- Infiltration
- Soil remediation
- Water storage
- Conservation soil
- Public space corridor
- River amplification
- Blue corridor zoning
- Downstream zoning
- Midstream zoning
- Upstream zoning



River structure

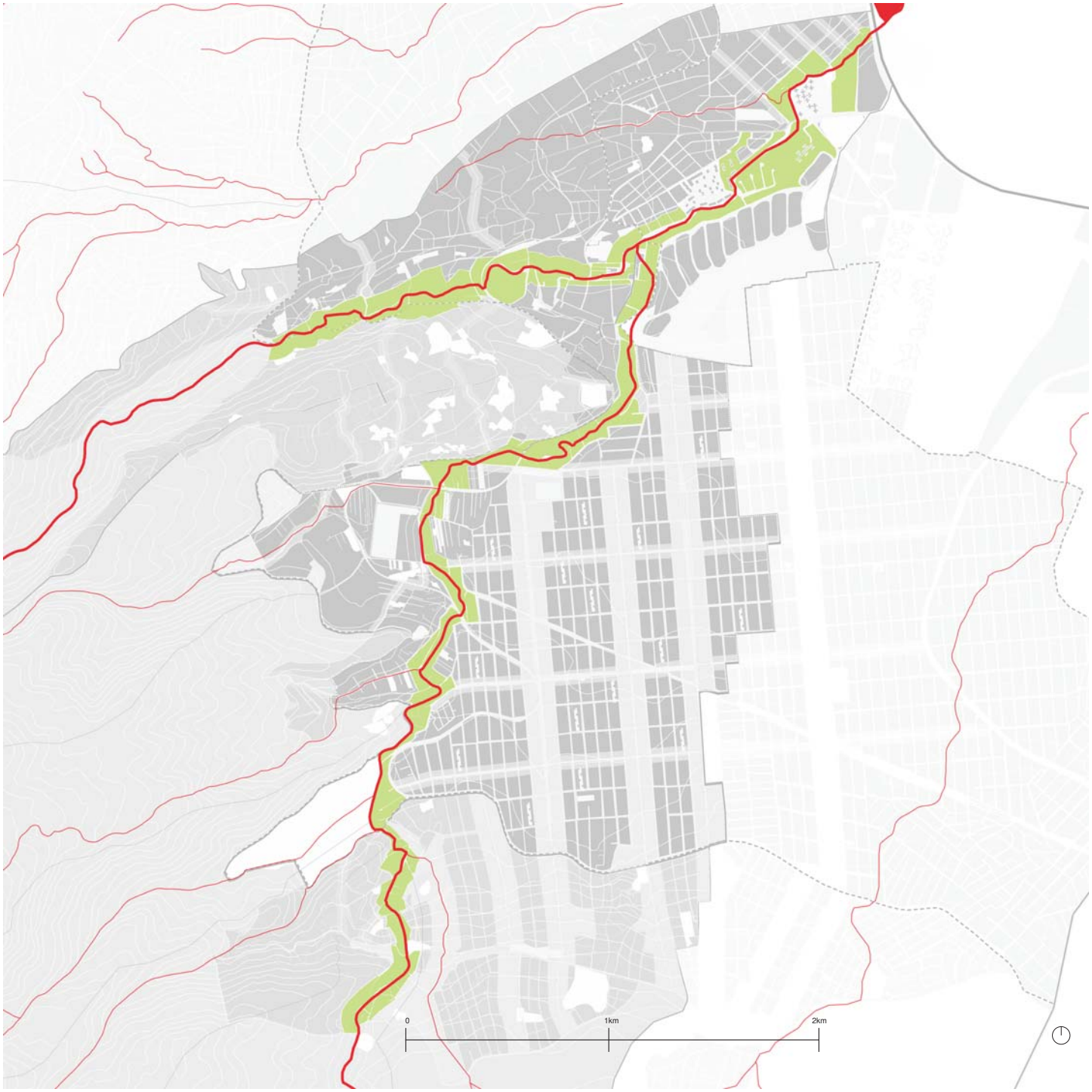


Magdalena / Eslava river stream

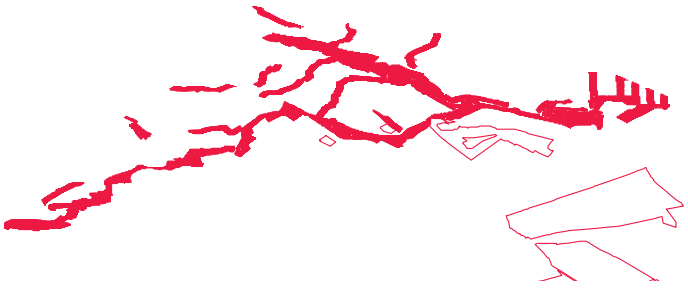


Geomorphological delimitation

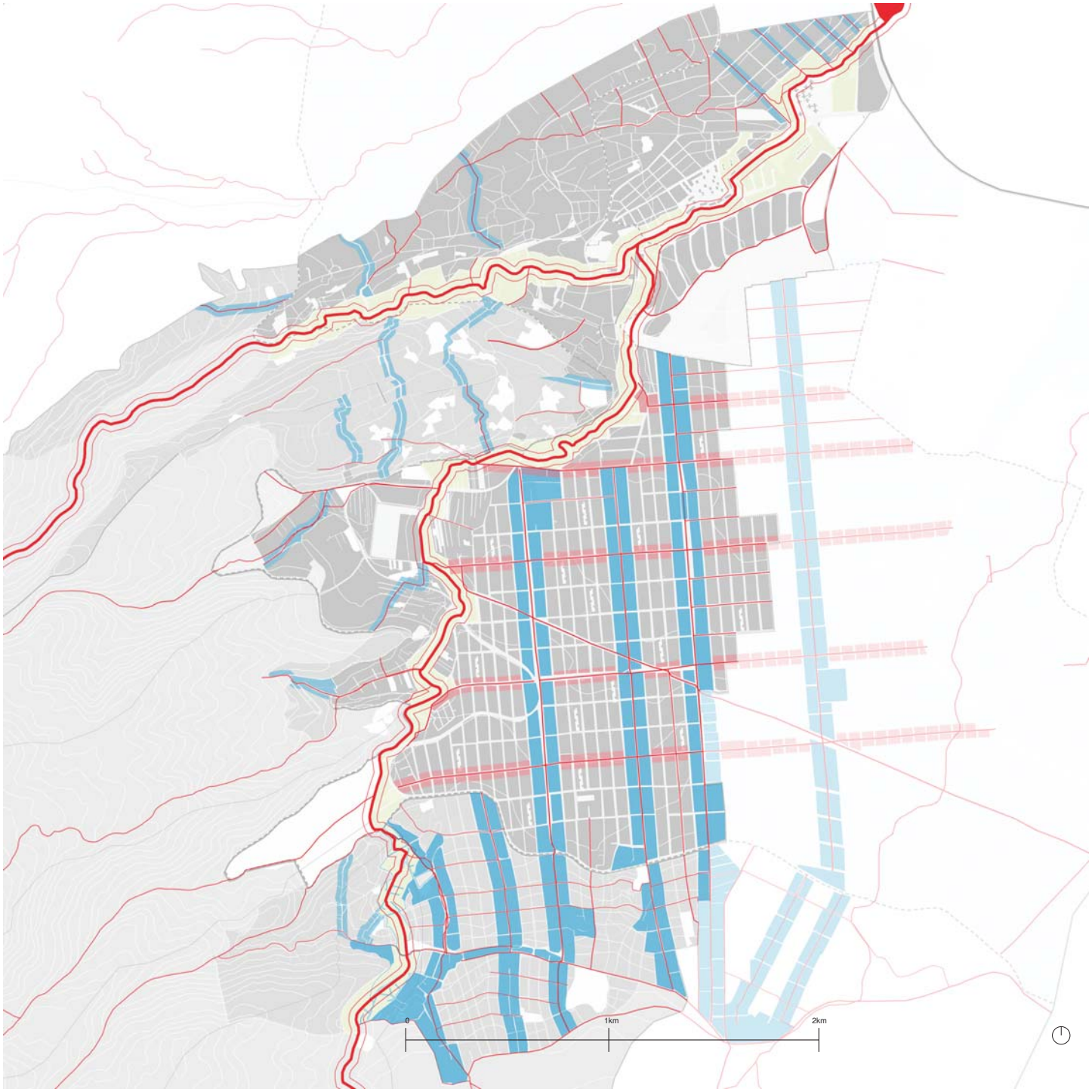
Stream condition delimitation



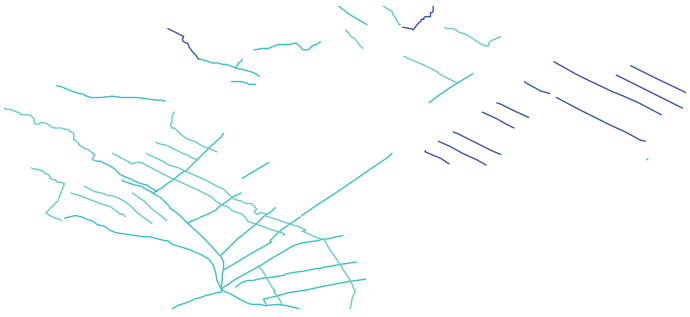
Amplification strategy



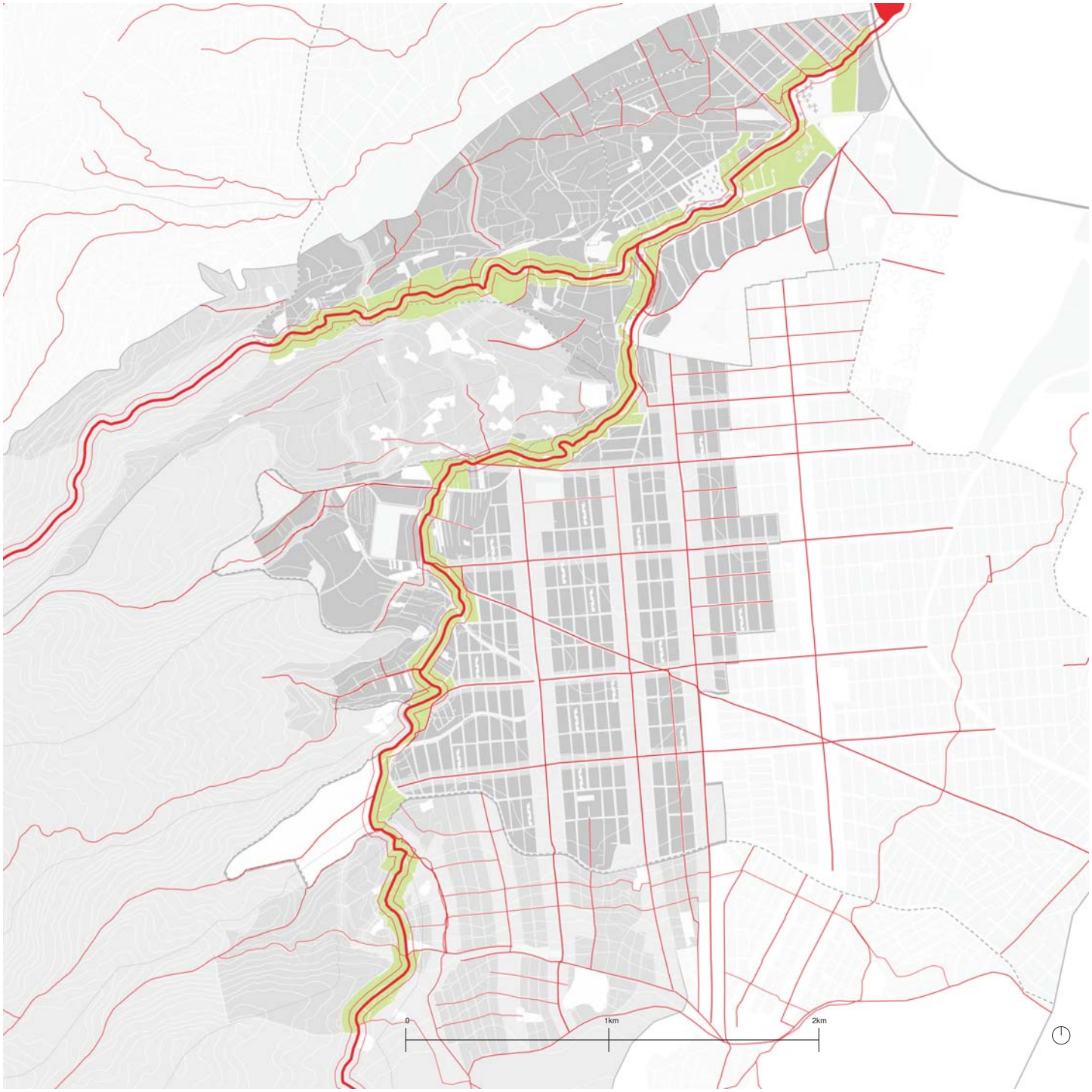
River amplification



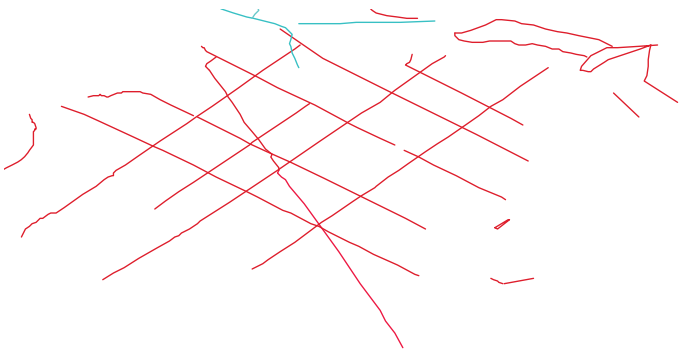
Blue corridors



Blue corridor zoning

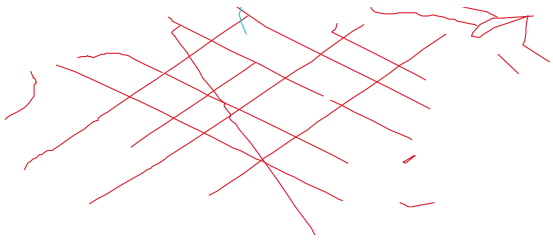


Main green corridors

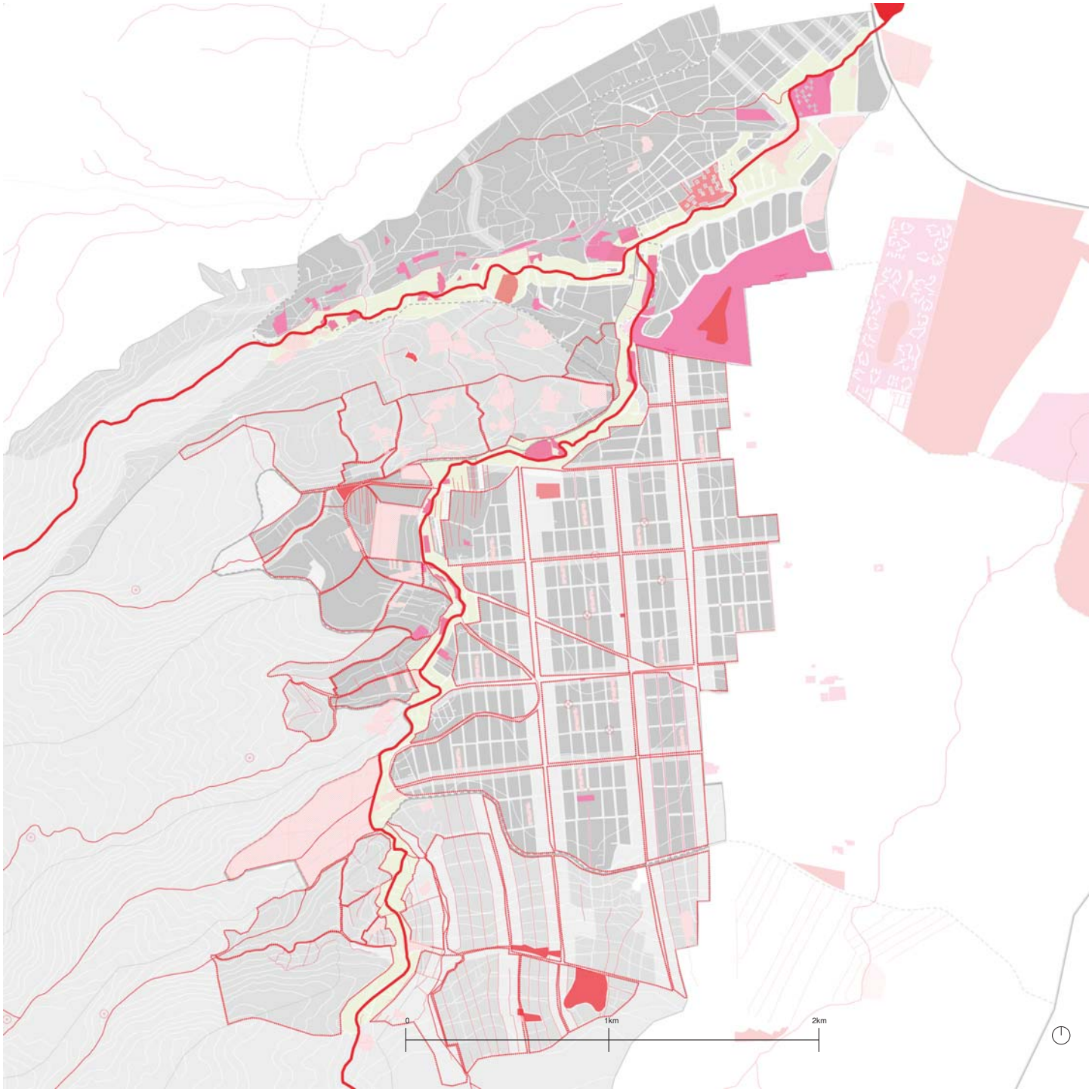


Stream condition delimitation
Magdalena / Eslava river stream
Main green corridors
River amplification

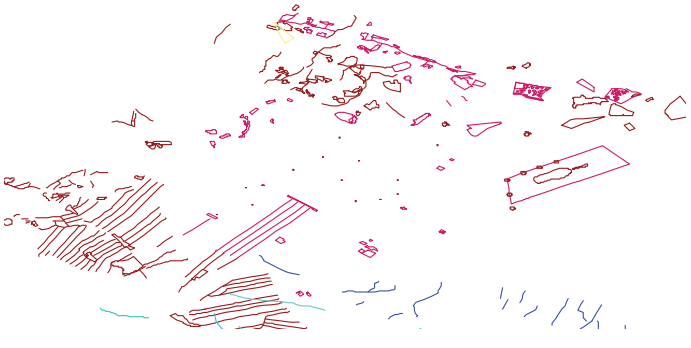
Proposed ‘Neighborhood Hydrological Units’



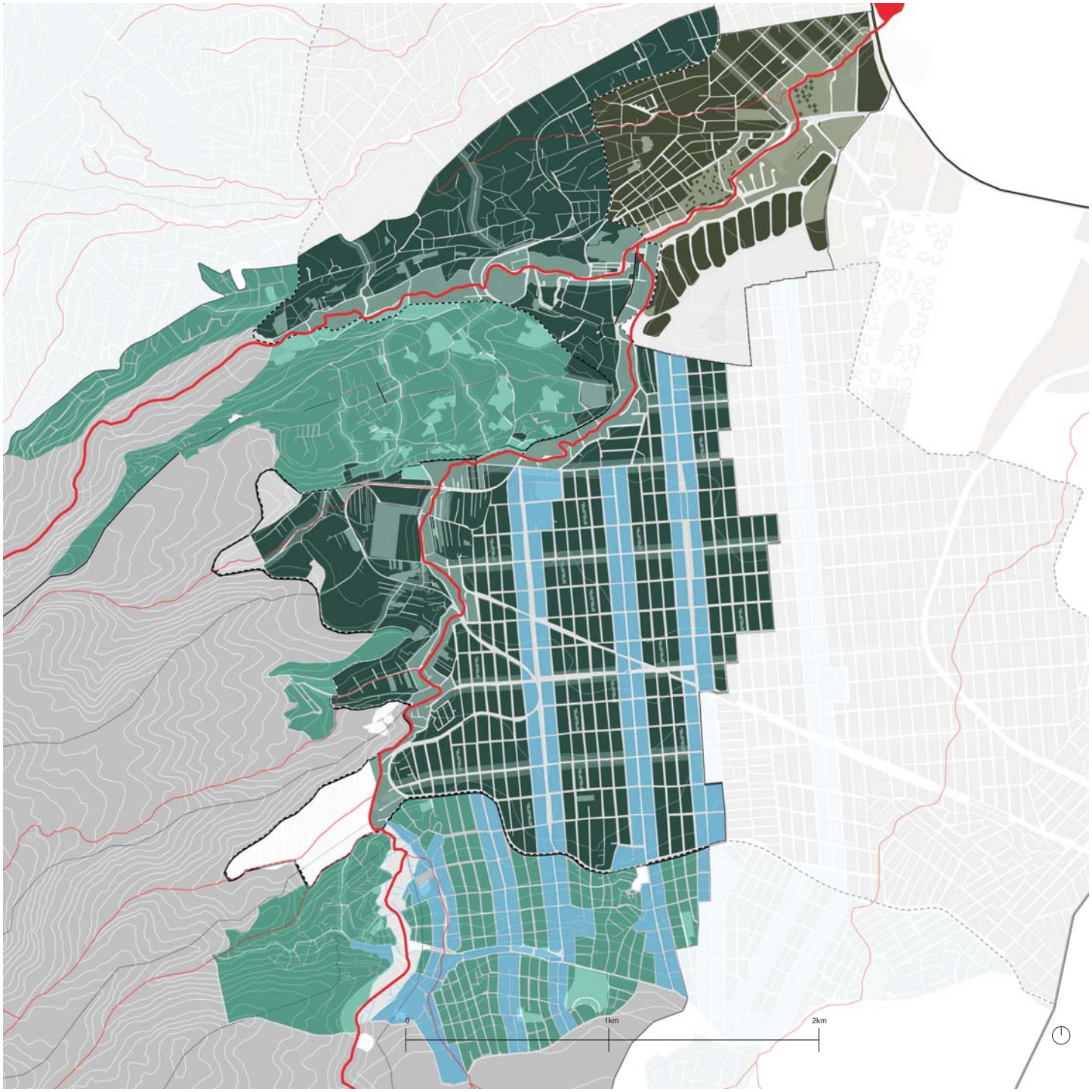
NHU delimitation



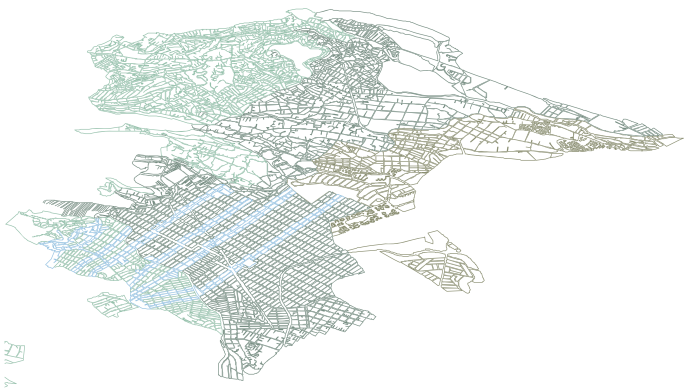
Infiltration, storage & soil remediation



Magdalena / Eslava river stream
Infiltration
Soil remediation
Water storage
Conservation soil

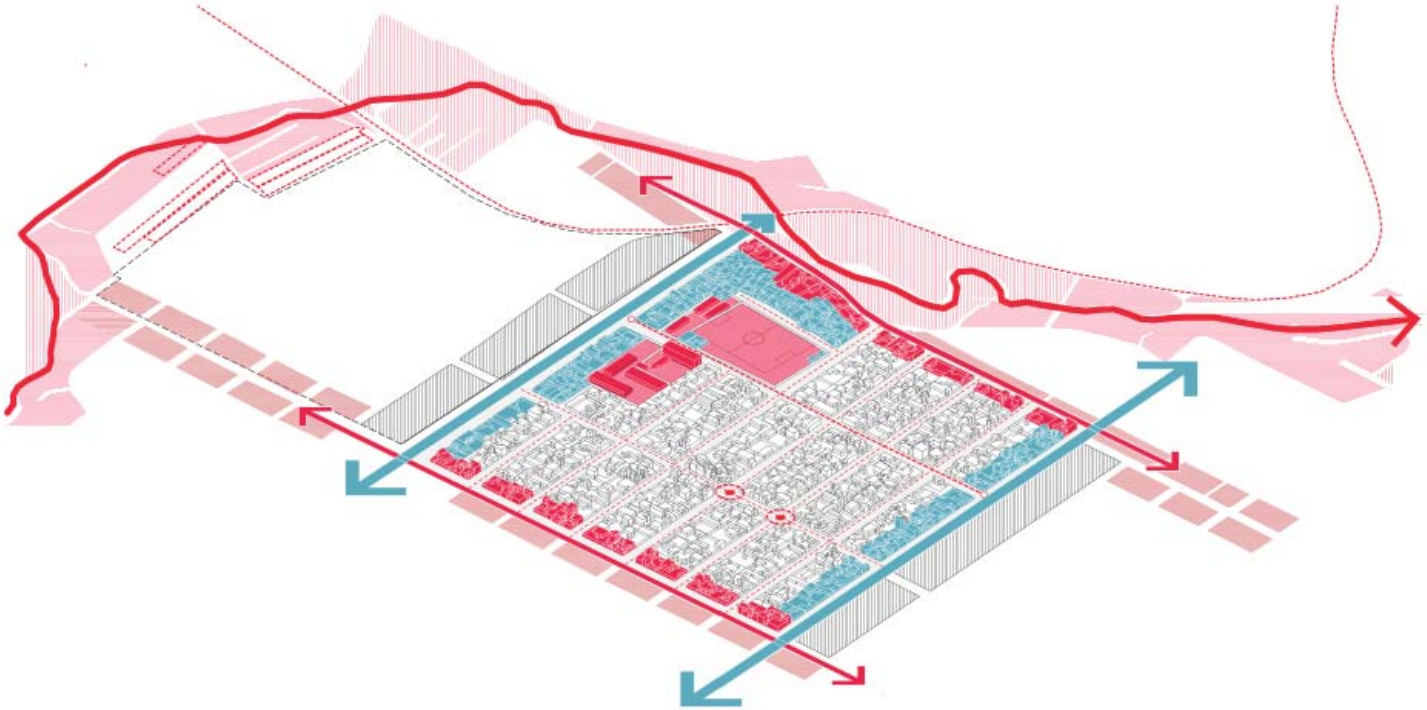


Proposed zoning



Magdalena / Eslava river stream
Public space corridor zoning
Blue corridor zoning
Downstream zoning
Midstream zoning
Upstream zoning

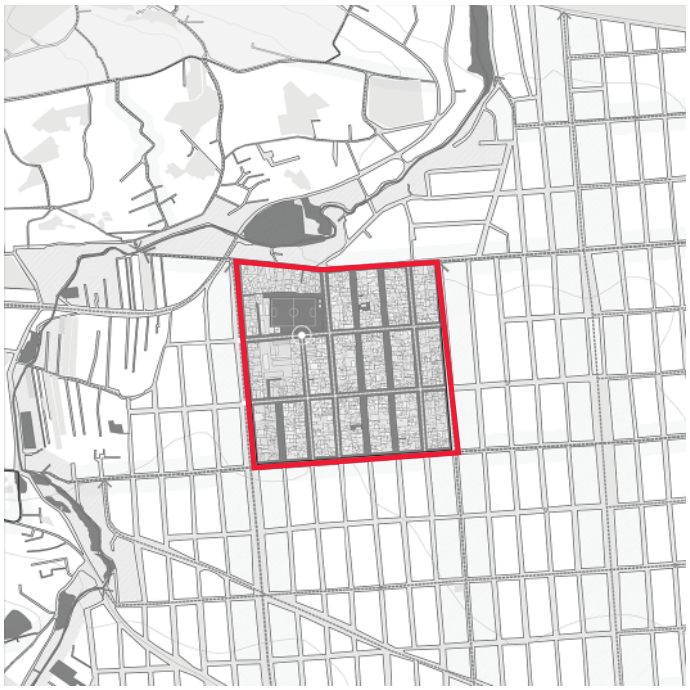
NHU strategy



NHU 001 strategy

Neighborhood Hydrologcial Unit Structure

NHU 001 in its system & spatial context

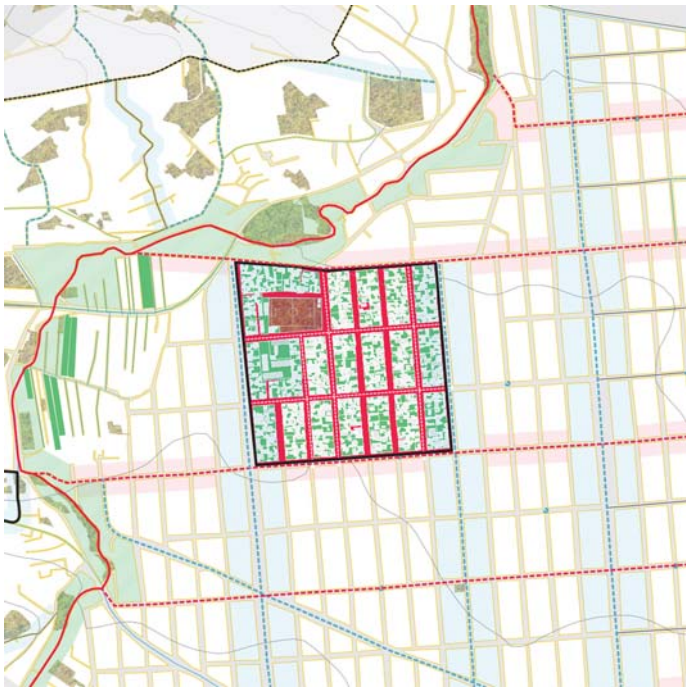


The resulting grid formed from the main potential blue-green corridors reveals a feasible scale to organize water treatment. Given the strong sense of community of these neighborhoods, it is highly important that any potential changes to the urban structure follow the existing community's patterns.

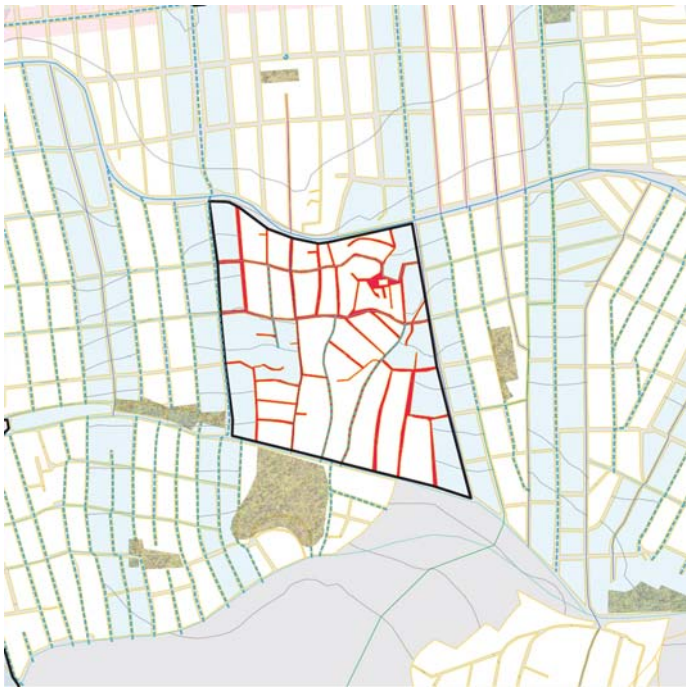
The proposed subdivision of the micro-basin corresponds to the potential corridors and network components of the water sensitive system. The 'boundaries' are defined by collecitve action of it's adyacent residents and with thier initative the delimitation of the NHU can be consolidated.

Neighborhood Hydrologcial Unit Structure

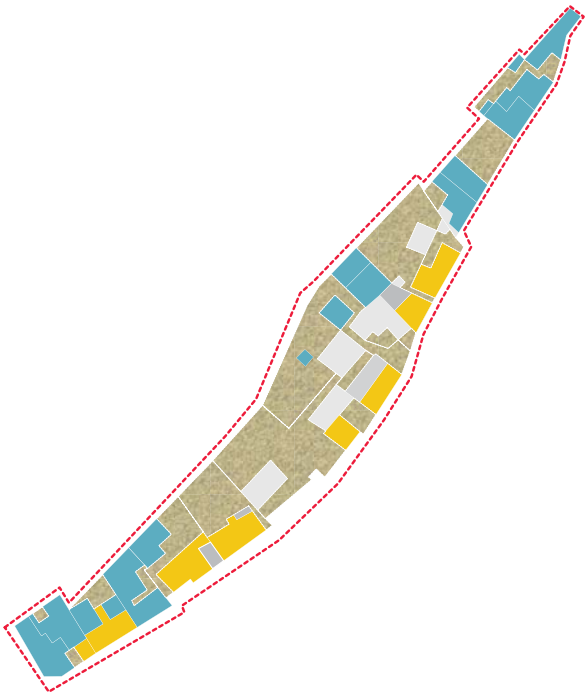
NHU typologies



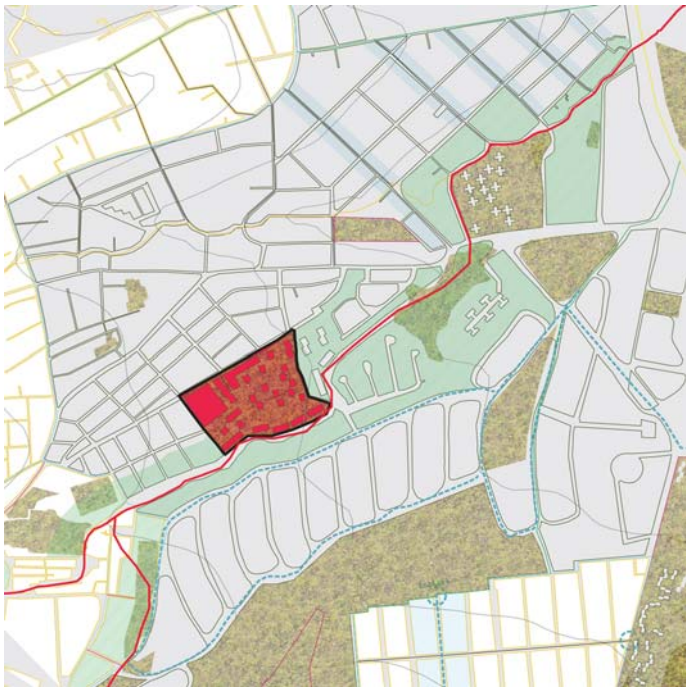
Midstream - Heroes de Padierna neighborhood type



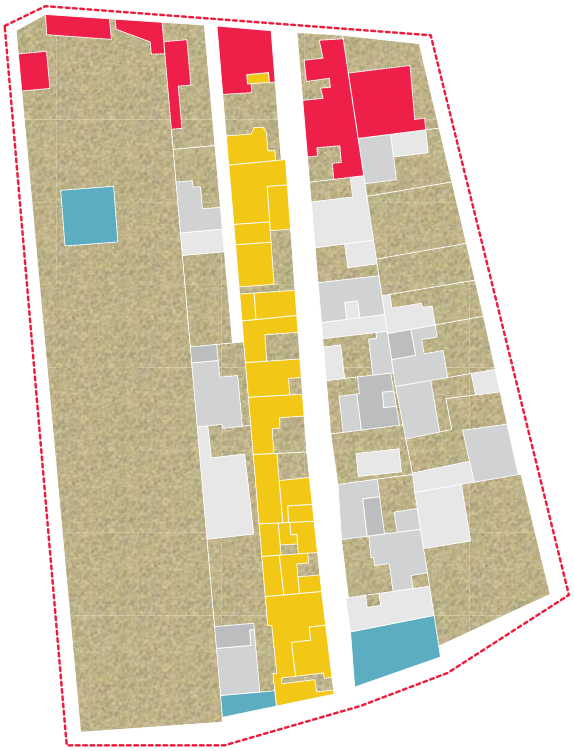
Upstream - Lomas de Cuilotepec neighborhood type

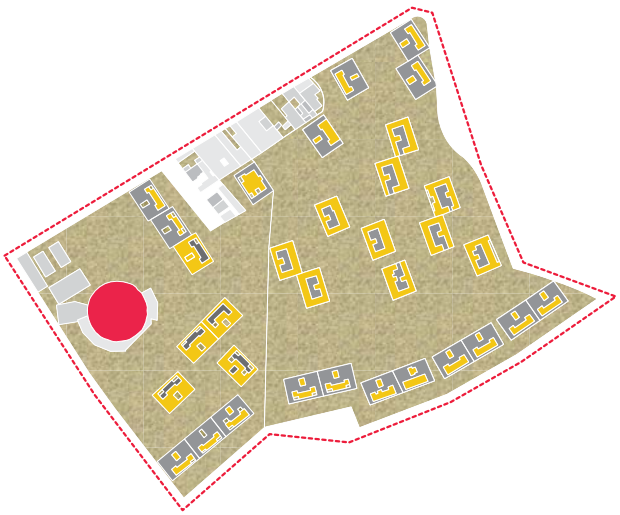


Midstream - San Nicolas Totolapan neighborhood type



Downstream - Magdalena neighborhood type





Potential public space regeneration plot

Potential housing redensifiaction plot

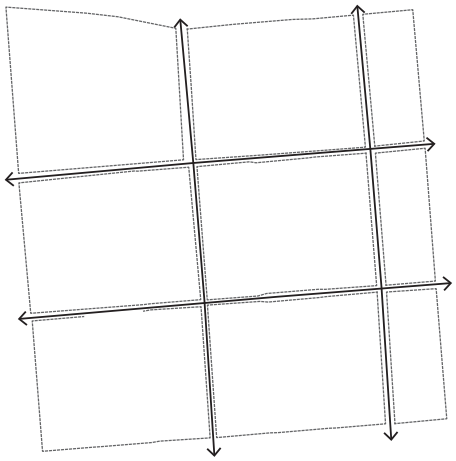
Potential water treatment plot

Neighborhood Hydrologcial Unit Structure

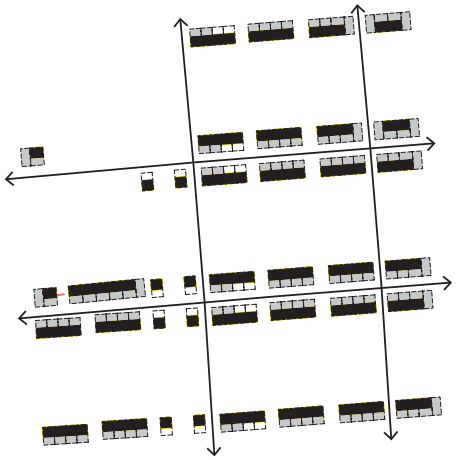
At the neighborhood scale, the main blue-green grid delimits the core of the operational scope of the project. Within this cell, neighbours can potentially take part in collective actions that may construct the water sensitive infrastrucutre as a whole.

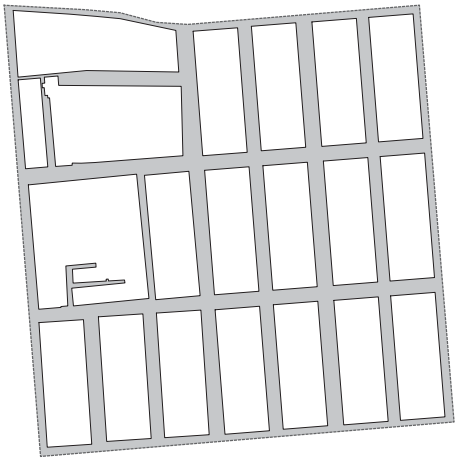
The backbone of the Neighborhood Hydrological unit consists of reducing the internal road infrastructure to its minimal car-based conectivity to the outer blue-green network, leaving secondary streets as private block corridors and shared public spaces.

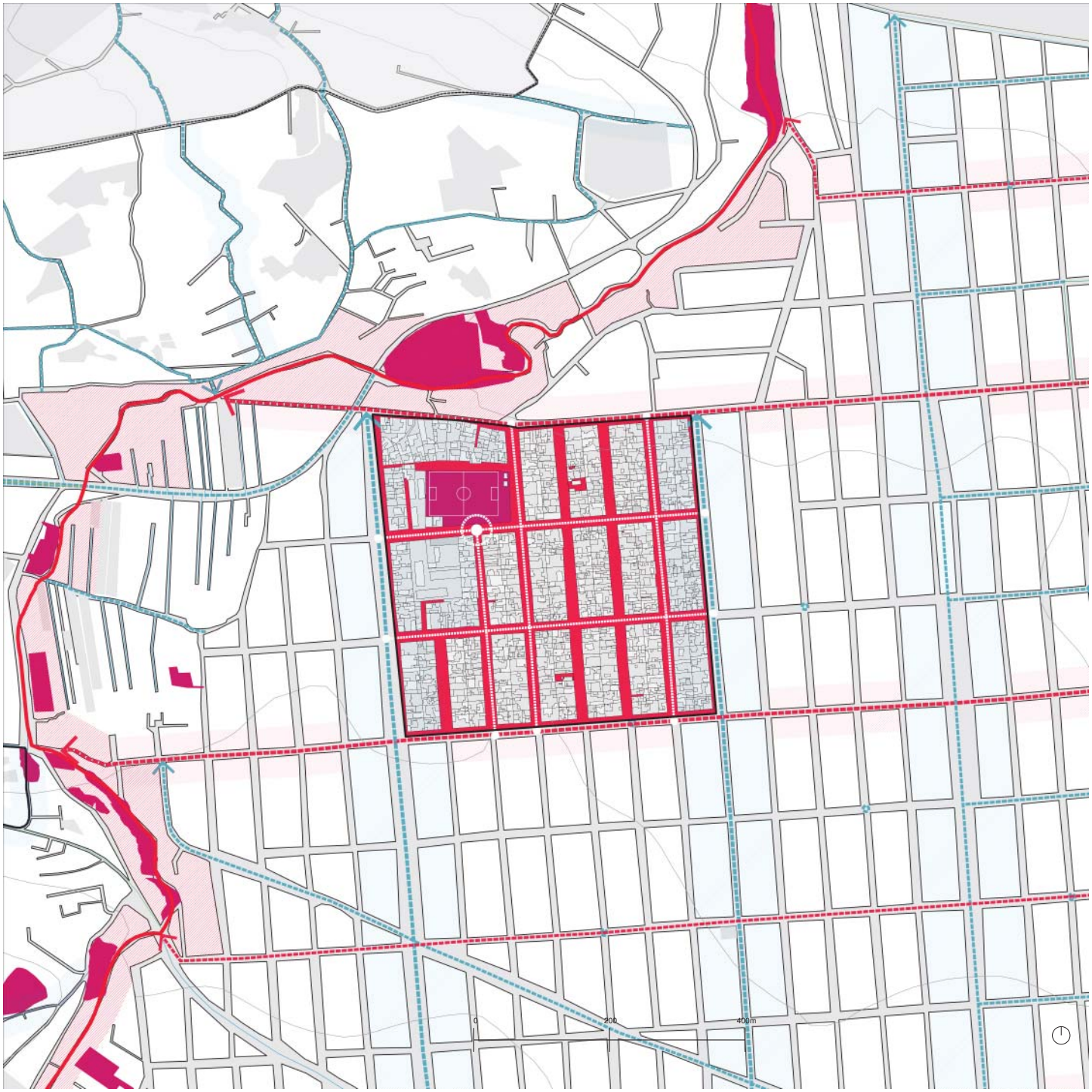
In order to ensure equitable developent within the unit, it is important that the neighborhood helps define this backbone by regarding spaces which already hold collective meaning to the relocal residents. This can be reinforced via empy plots and other existing public spaces and facilities.



Neighborhood hydrological unit phasing components







Neighborhood hydrological unit structure

Basin delimitation
Basin delimitation
Basin delimitation
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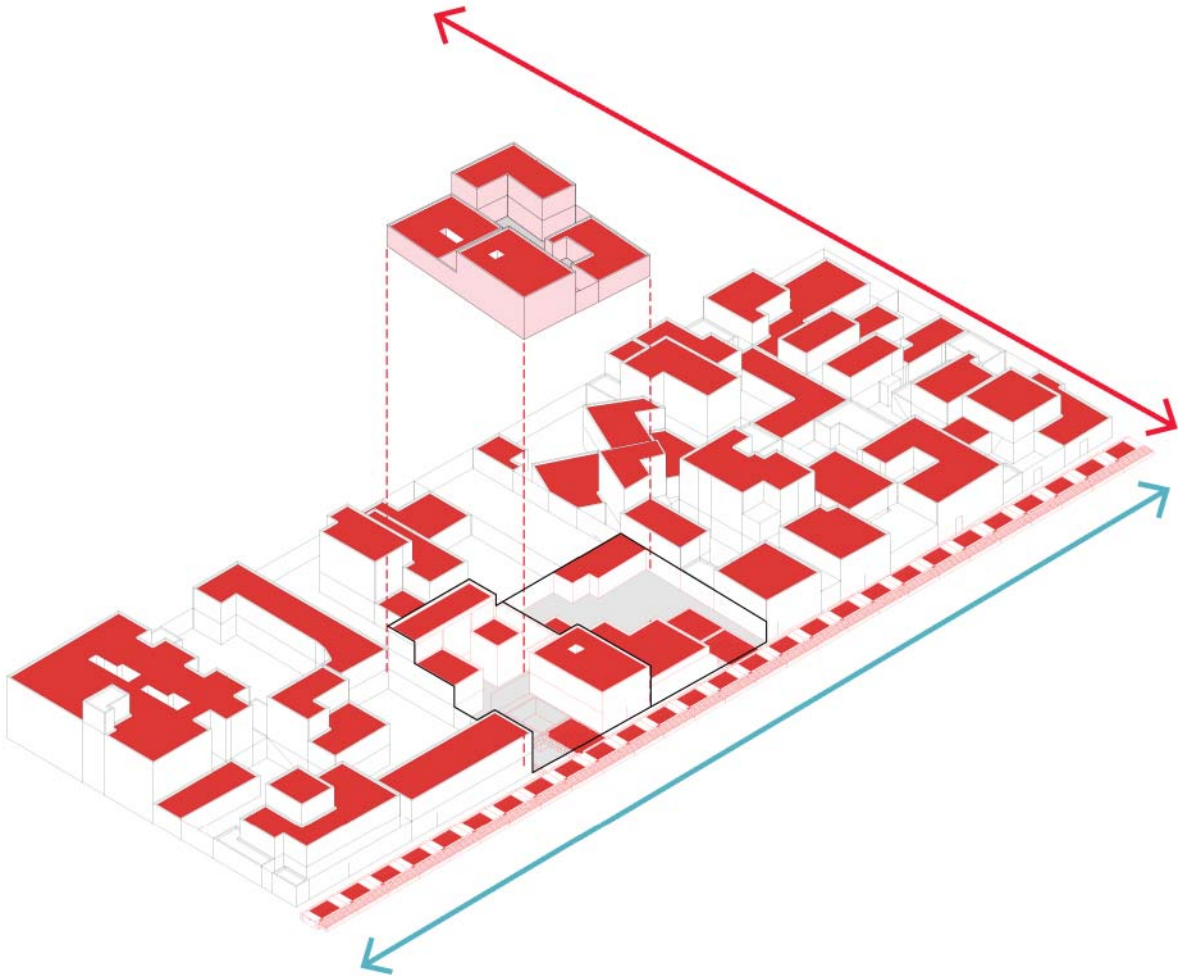
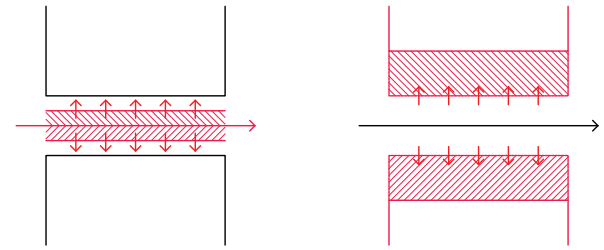
Basin delimitation

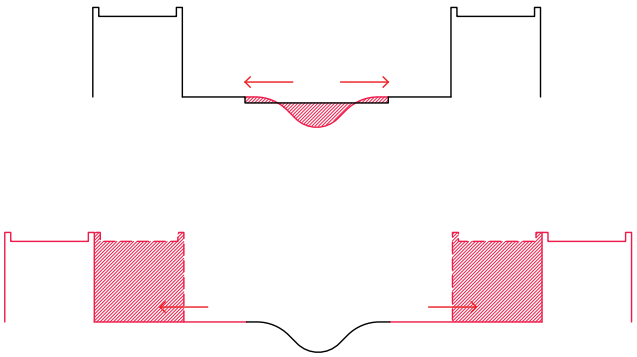


Block redensification strategy

Block Structure
Main design operation



Operational scheme



Operational scheme reflected on street profile

The operational scope of this project falls within re-configuring the relation between built and non built urban space along potential hydrologically sensitive networks to free up open space.

By allowing the residents to be the main driver for changing the local context, the management of water can hypothetically replace the need for water supply originating from outer regions. The smart water management of the local catchment areas as well as the structures it lies within depends on the governance structure of the city's population. In theory, residents have the capacity to supply themselves through their community, by cooperating and extending the potential catchment of local urban spaces. This in turn allows the residents to gain autonomy through mutual cooperation.

By proposing a diversified densification scheme, the city's residents are encouraged to redesign their housing while introducing domestic and local improvements. In order to follow a systematic organization of the hydrological network, set-backs, height regulations & water management infrastructure must be modified towards introducing a nature built infrastructure.

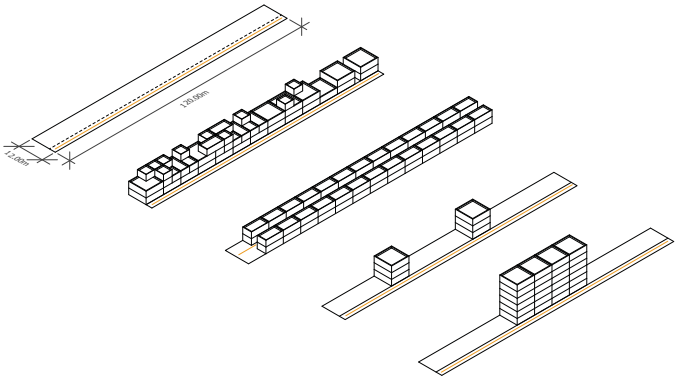
Depending on the densities and income level of the housing projects in the river basin, a typological distinction can be made for each Neighborhood Hydrological Units. Freeing up open space will then require distinct and specific approaches to redensification according to income level, density type and role within the micro-basin's hydrological structure.

Block density
Mex-Block type 01

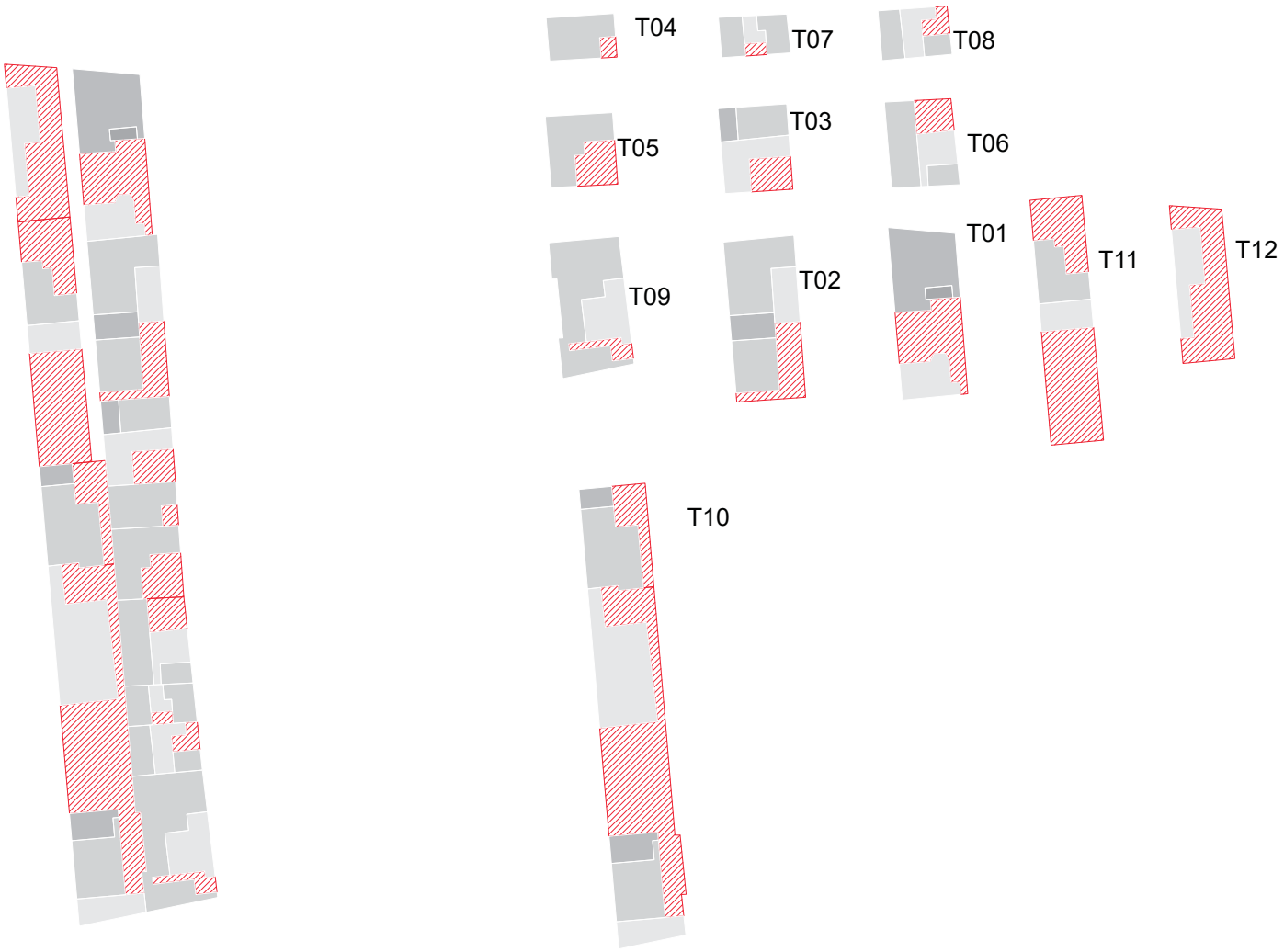
In the Magdalena Contreras district, an area which was formerly a highly active productive landscape, housing blocks inherited their elongated shape from formar irrigation subdivisions of the land. Today, these housing blocks hold a strong sense of community since they also inherited communal ownersip of the former *ejido* plot.

The proportion of this type of block forces the neighbors to cooperate fully in order to have any type of water treatment infrastructure within their plots, making ideal collaborative housing units.

San Nicolas Totolapan predominant housing block typology



Densification variations found in the neighbourhood



Block 02

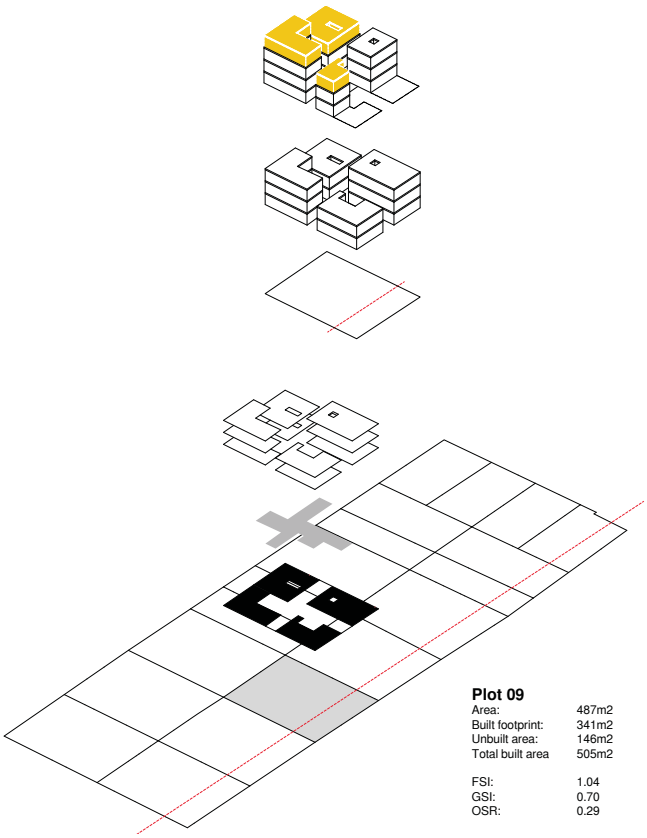
	Area de terreno	Area libre	Area de desplante	Area construida total	% Area Libre	% Area Construida	FSI	GSI	OSR	FAR	N
Plot 01	248	90	158	385	36.3	63.7	1.55	0.64	0.23	155.24%	
Plot 02	253	52	201	396	20.6	79.4	1.57	0.79	0.13	156.52%	
Plot 03	131	30	101	161	22.9	77.1	1.23	0.77	0.19	122.90%	
Plot 04	66		59	120	10.6	89.4	1.82	0.89	0.06	181.82%	
Plot 05	107	37	70	140	34.6	65.4	1.31	0.65	0.26	130.84%	
Plot 06	130	27	103	173	20.8	79.2	1.33	0.79	0.16	133.08%	
Plot 07	61	6	55	98	9.8	90.2	1.61	0.90	0.06	160.66%	
Plot 08		13	64	100	16.9	83.1	1.30	0.83	0.13	129.87%	
Plot 09	206	15	191	329	7.3	92.7	1.60	0.93	0.05	159.71%	
Plot 10	686	266	420	615	38.8	61.2	0.90	0.61	0.43	89.65%	
Plot 11	288	200	88	140	69.4	30.6	0.49	0.31	1.43	48.61%	
Plot 12	179	127	52	51	70.9	29.1	0.28	0.29	2.49	28.49%	
Total	2432	870	1562	2708	35.8	64.2	1.11	0.64	0.32	111.35%	

Block density
Mex-Block type 02

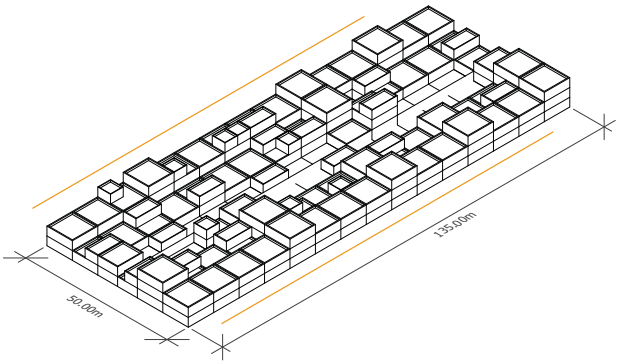
On the side of the Tlalpan district, the predominant 2:1 block type is sprawled across the micro-basin. This typology was introduced throughout many cities of mexico as a solution to providing housing for fast growing areas. The proportion of this block and consequently the plots make it difficult for neighbor cooperation since it needs a longer building front.

The advantage of this typology is it's repetitive grid, which allows large scale transformations to ocurr in a more systematic manner. This could potentially povide authorities with planning rules and design guidelines that may be applicable in other parts of the city which share a similar urban tissue.

Heroes de Padierna predominant housing block typology



Open space ratio and floor area ratio in this block requires carefull redensification patterns



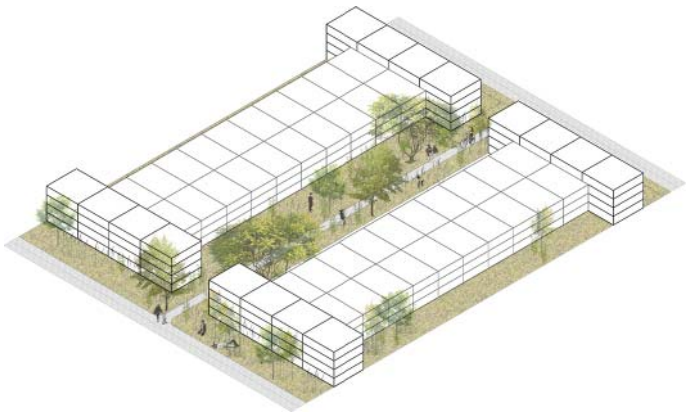
Typical block isometry

Block 01

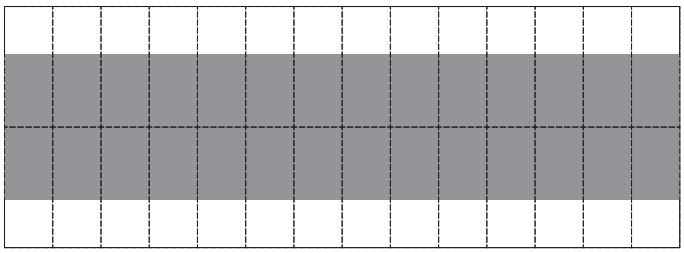
	Area de terreno)	Area libre	Area de desplante (B)	Area construida total (F)	% Area Libre	% Area Construida	FSI	GSI	OSR	FAR	N
Plot 01	240	58	182	264	24.2	75.8	1.10	0.76	0.22	110.00%	
Plot 02	258	66	192	261	25.6	74.4	1.01	0.74	0.25	101.16%	
Plot 03	251	80	171	234	31.9	68.1	0.93	0.68	0.34	93.23%	
Plot 04	242	128	114	170	52.9	47.1	0.70	0.47	0.75	70.25%	
Plot 05	298	108	190	331	36.2	63.8	1.11	0.64	0.33	111.07%	
Plot 06	211	71	140	223	33.6	66.4	1.06	0.66	0.32	105.69%	
Plot 07	508	138	370	811	27.2	72.8	1.60	0.73	0.17	159.65%	
Plot 08	495	315	180	180	63.6	36.4	0.36	0.36	1.75	36.36%	
Plot 09	487	146	341	505	30.0	70.0	1.04	0.70	0.29	103.70%	
Plot 10	503	394	109	272	78.3	21.7	0.54	0.22	1.45	54.08%	
Plot 11	477	217	260	456	45.5	54.5	0.96	0.55	0.48	95.60%	
Plot 12	485	21	464	1348	4.3	95.7	2.78	0.96	0.02	277.94%	
Plot 13	521	299	222	372	57.4	42.6	0.71	0.43	0.80	71.40%	
Plot 14	498	327	171	379	65.7	34.3	0.76	0.34	0.86	76.10%	
Plot 15	250	250	0	0	100.0	0.0	0.00	0.00	-	0.00%	
Plot 16	477	172	305	472	36.1	63.9	0.99	0.64	0.36	98.95%	
Plot 17	195	25	170	334	12.8	87.2	1.71	0.87	0.07	171.28%	
Total	6396	2815	3581	6612	44.0	56.0	1.03	0.56	0.43	103.38%	

Collective block operation
Blue corridor side swale & treatment kit

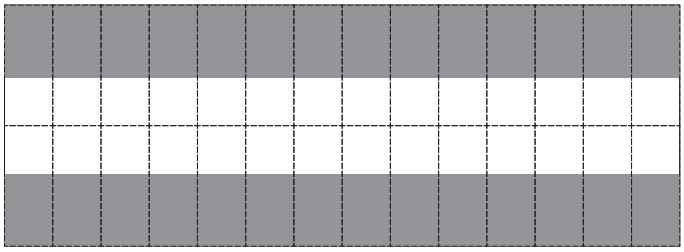
In order for residents to gain collective agency over their living environment, water management infrastructure should be the main incentive to find common ground between neighbors. The typical block typology of the Heroes de Padierna neigborhoods allows a systematic approach to transforming urban corridors in to blue/green grids that improve local public spaces and create centralities as well as private community spaces.

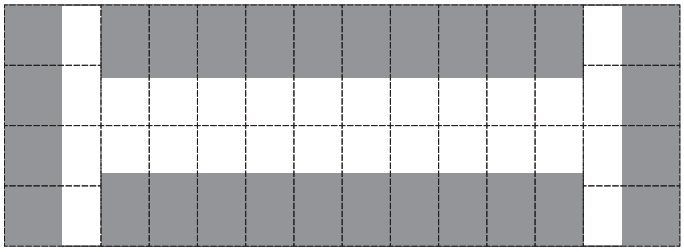


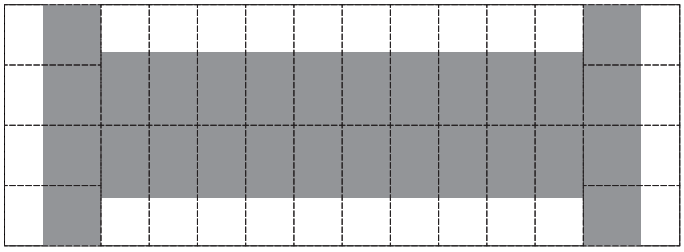
Potential block scheme

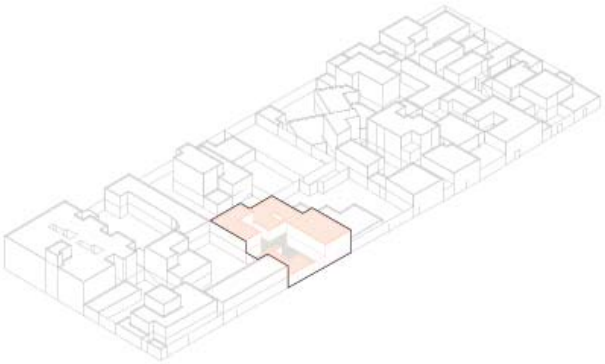


Compact variation on typical parcelation scheme (Mex-Block type 2)

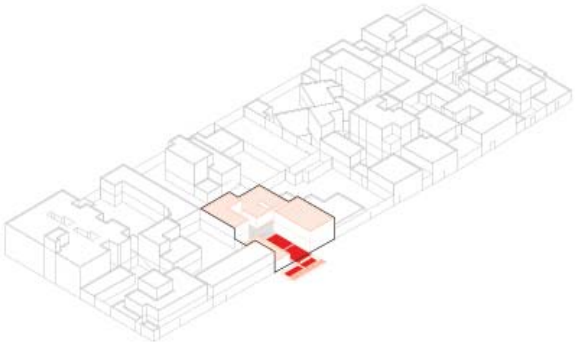




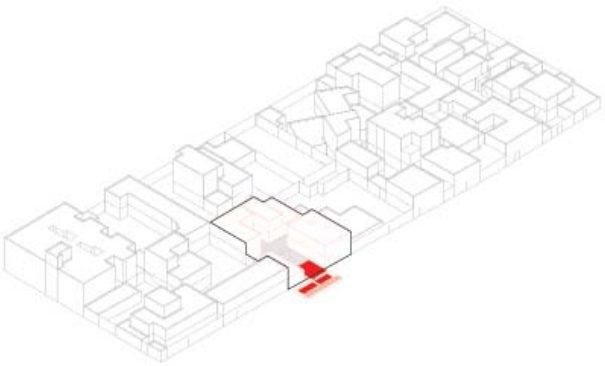




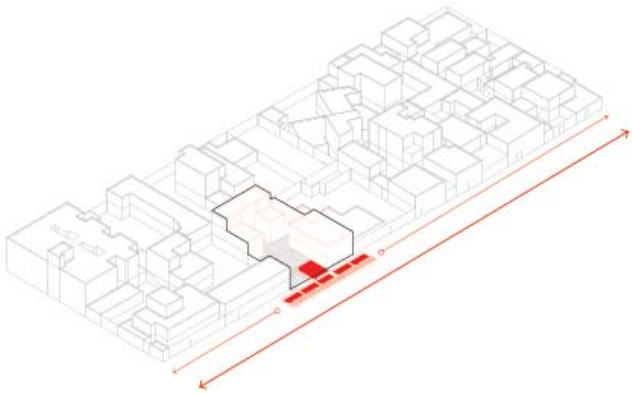
Initial plot occupation



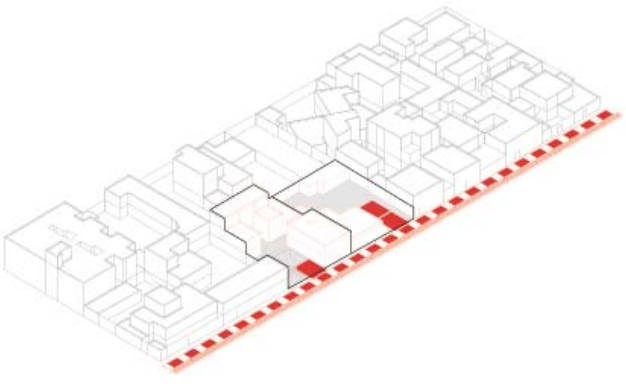
Integration of harvest, treatment & storage kit with NHU infrastructure



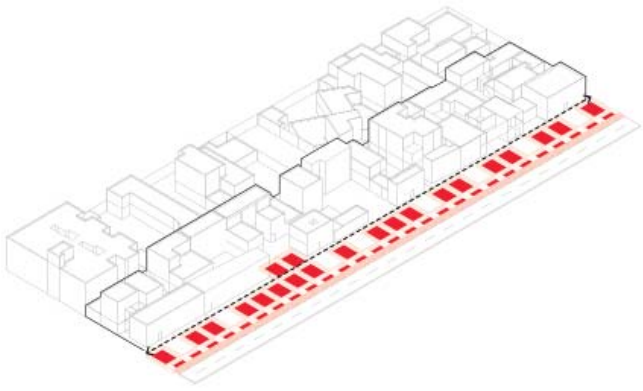
Increased density in rear side of the plot



Redensification & increased storage area



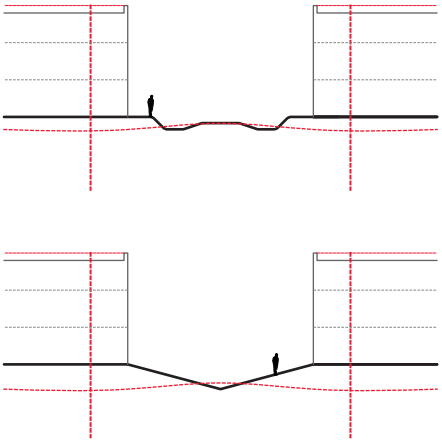
Neighbor cooperation enables block scale treatment system

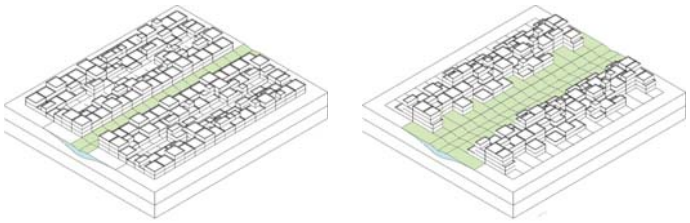


Block redensification program liberates facade space* of block to gain more open space

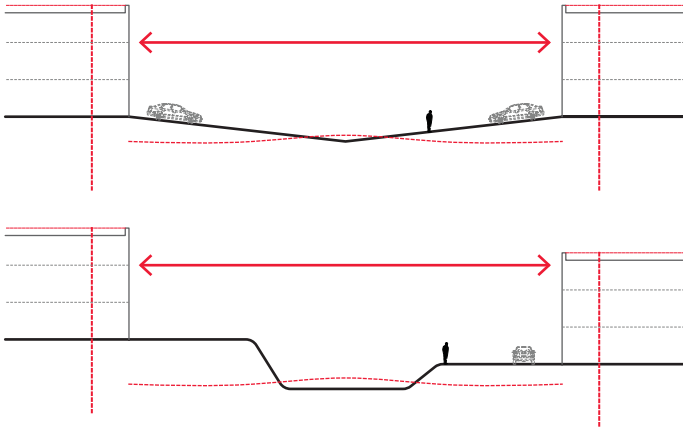
Collective block operation
Blue corridor side swale & communal courtyard

According to each specific portion of the blue-green network, housing blocks can be transformed into water sensitive urban spaces by either freeing up side space to make room for larger scale networks, or through creation of communal courtyards for more private water management open spaces.

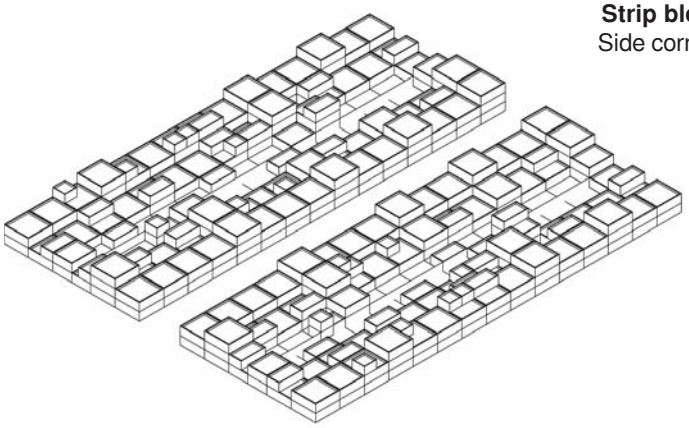




Corridor amplification



Strip block operation
Side corridor generation



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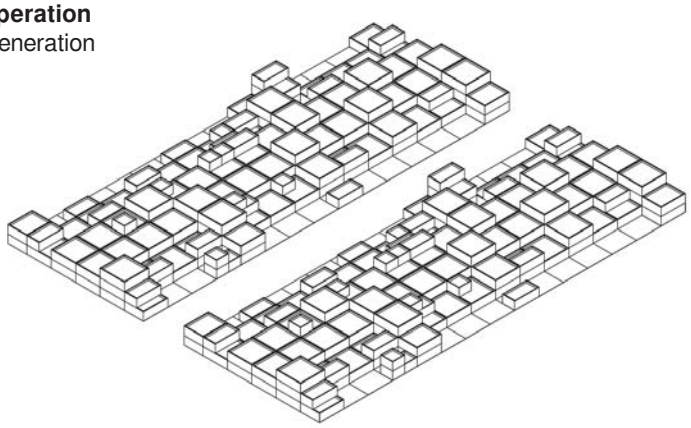

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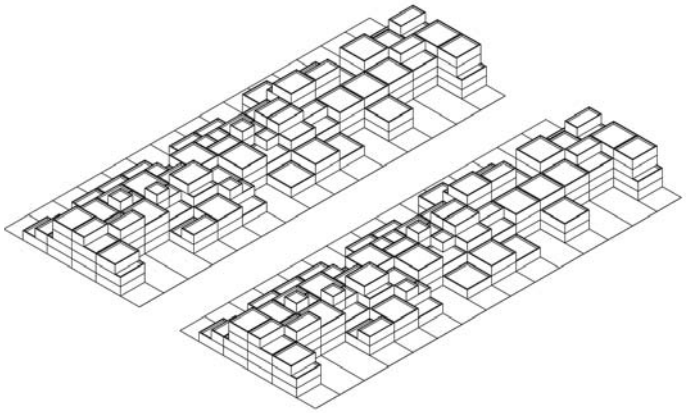

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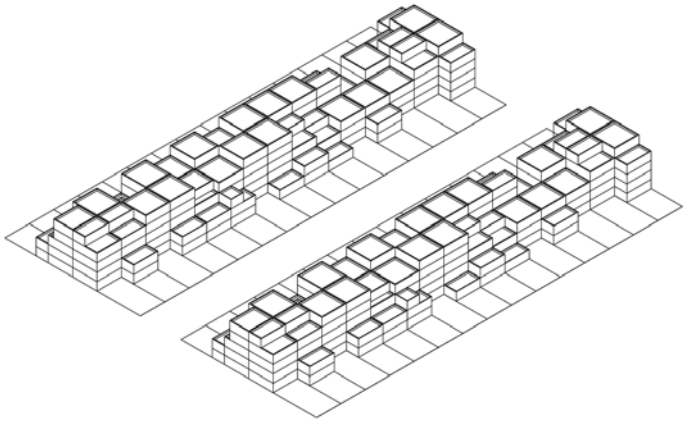
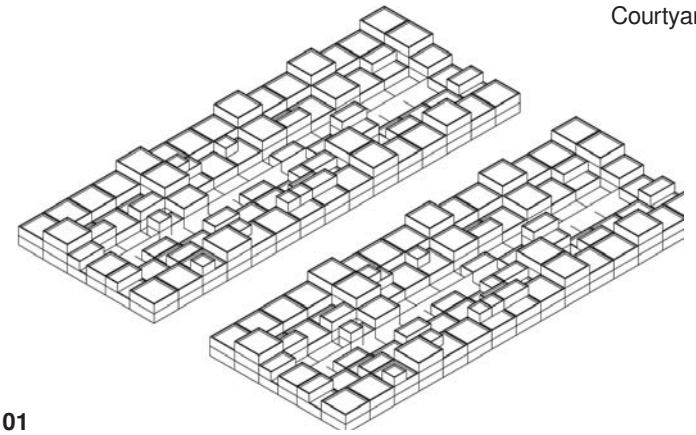


04

Court block operation
Courtyard generation



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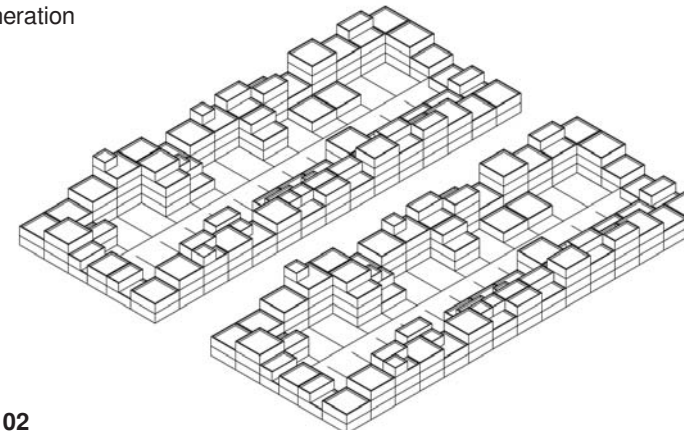

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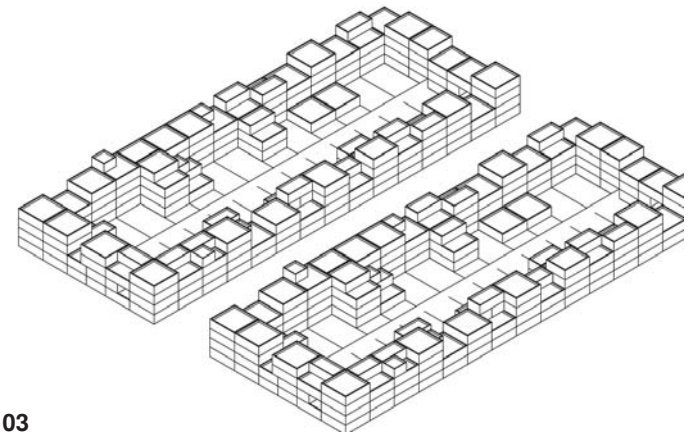

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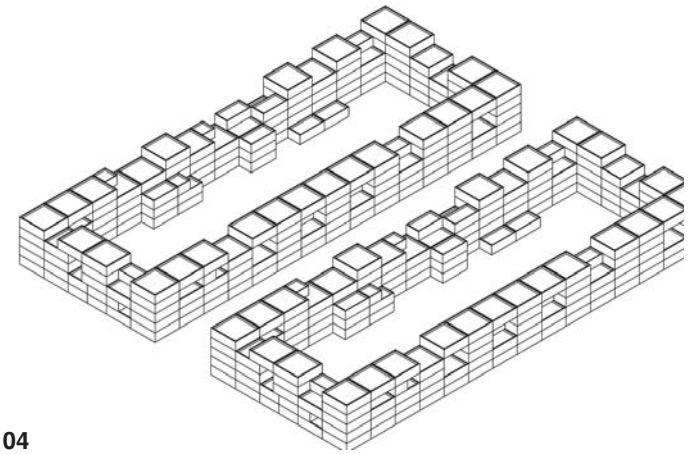
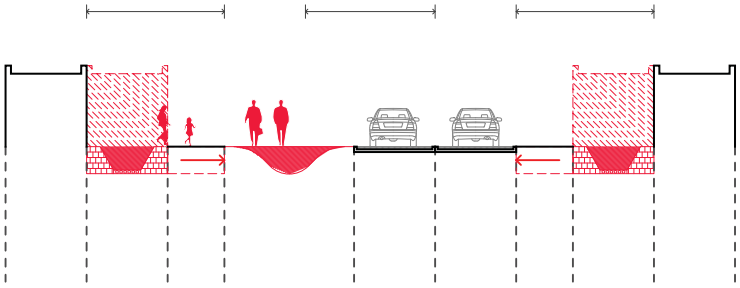
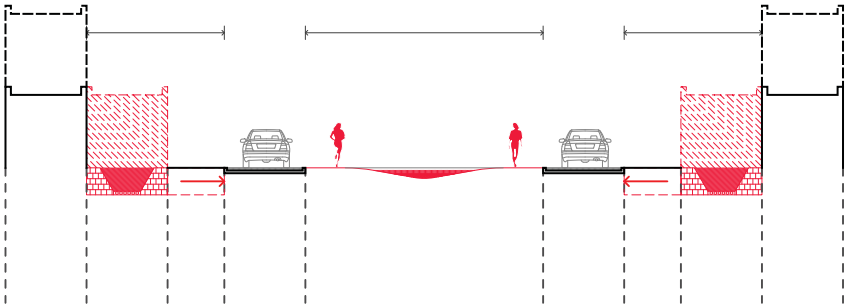


04

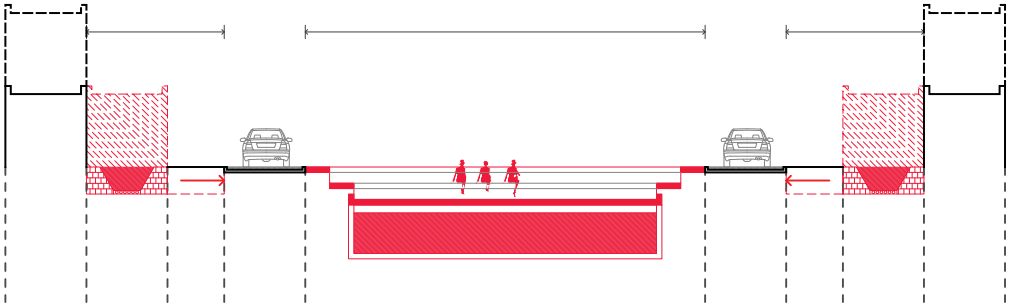
First order blue corridor
Inner & inter-NHU operations



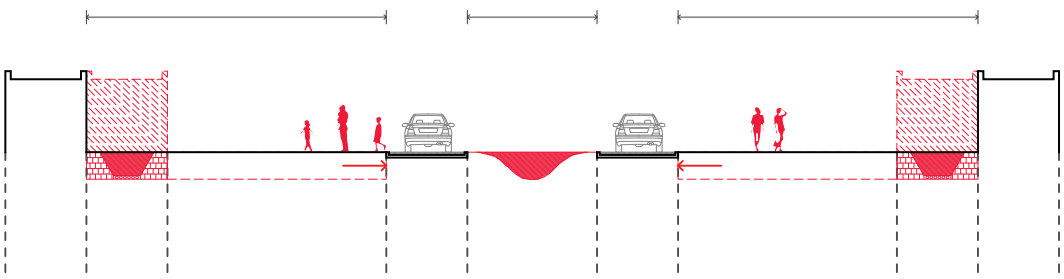
Acanceh street profile



Popolna street profile

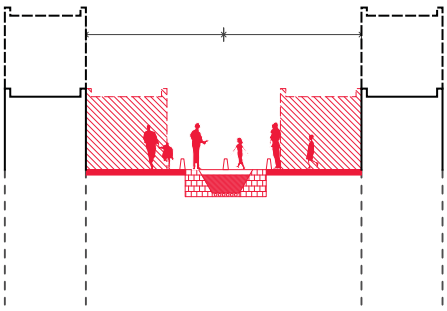


Tetiz street profile

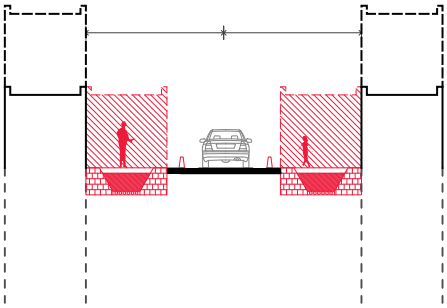


Chicoasen street profile

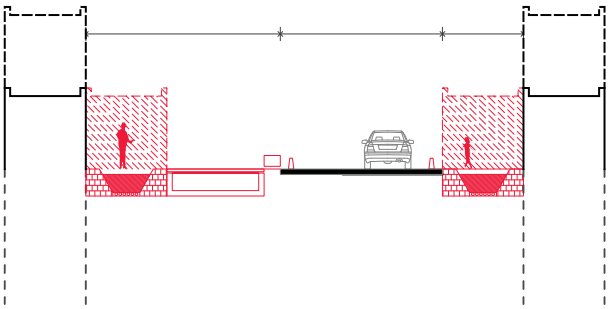
Second order blue corridor
Inner-NHU operations



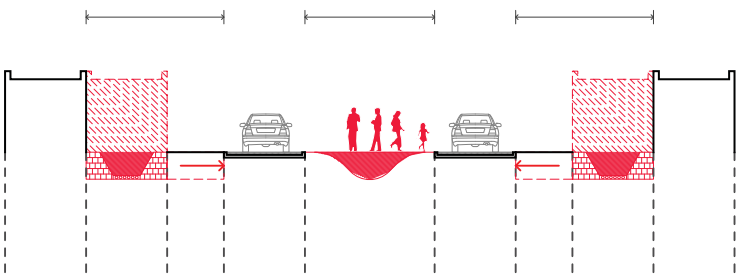
Buenavista street profile



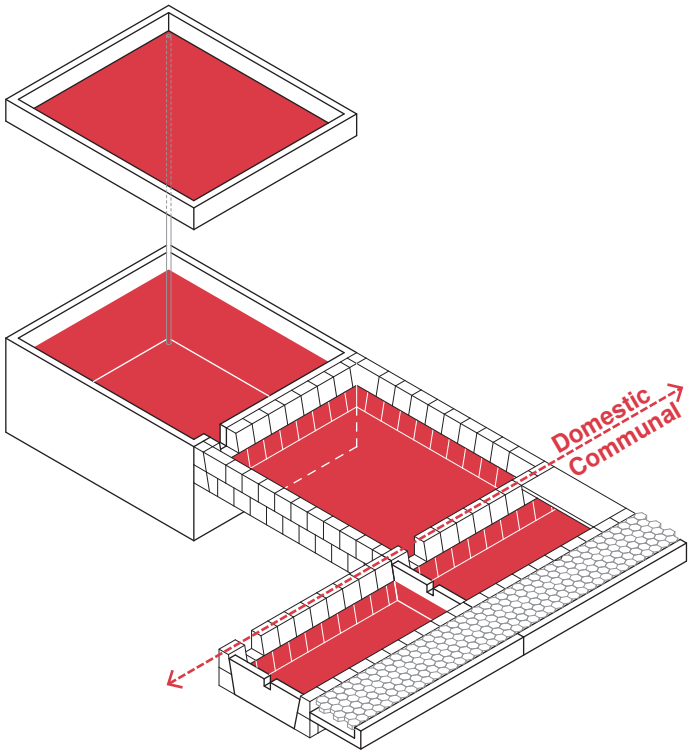
Roble street profile



Gavillero street profile



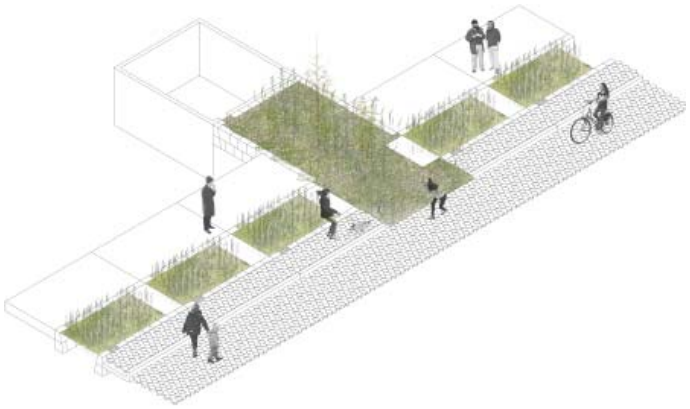
Conkal street profile



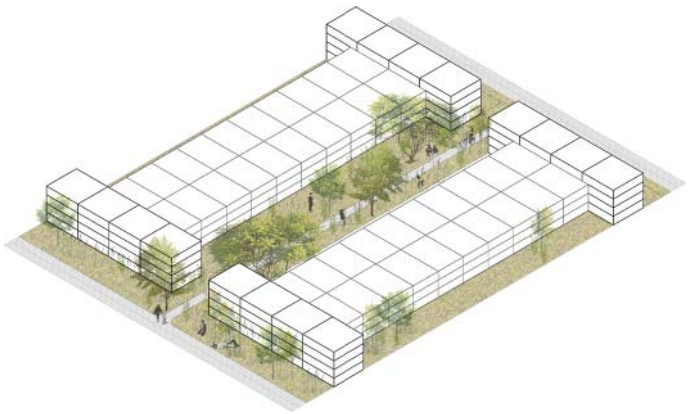
Domestic scale strategy

Domestic struture
Rainwater storage & treatment kit

In terms of the infrastructure required for fulfilling the performance of the design units, the objective is to meet the technological requirements by providing a ‘landscape as infrastructure’ design approach in which the overall built area is gradually reduced to make room for natural water storage and treatment space through urban green.



Domestic scale strategy isometry

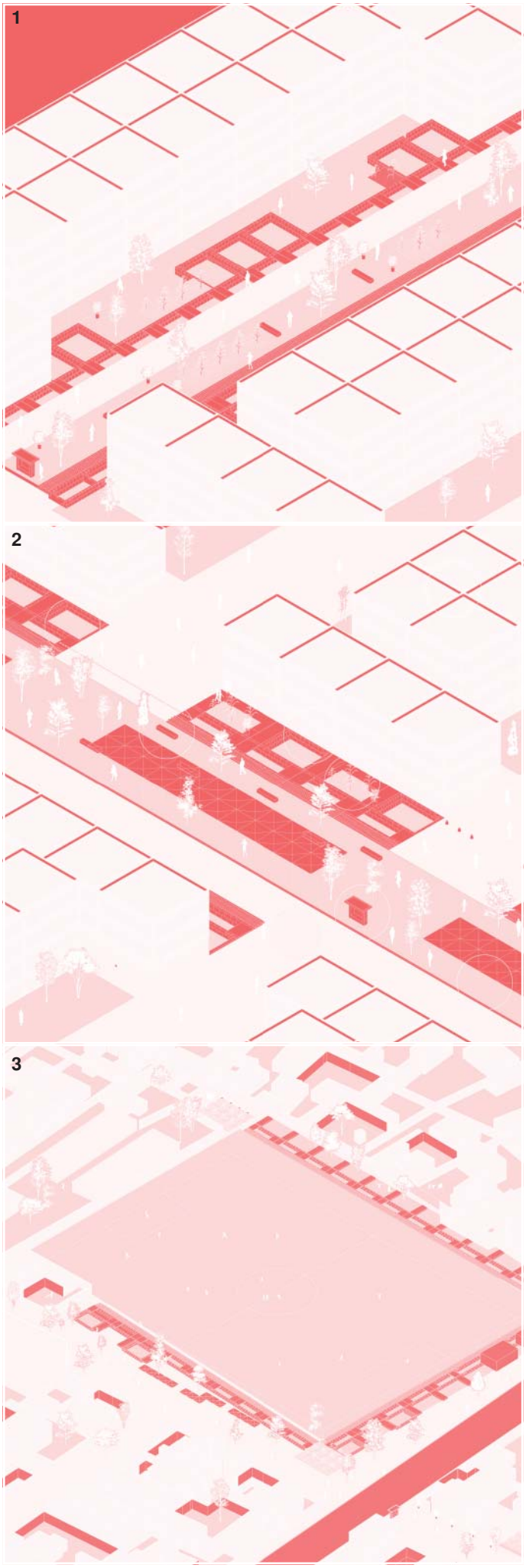


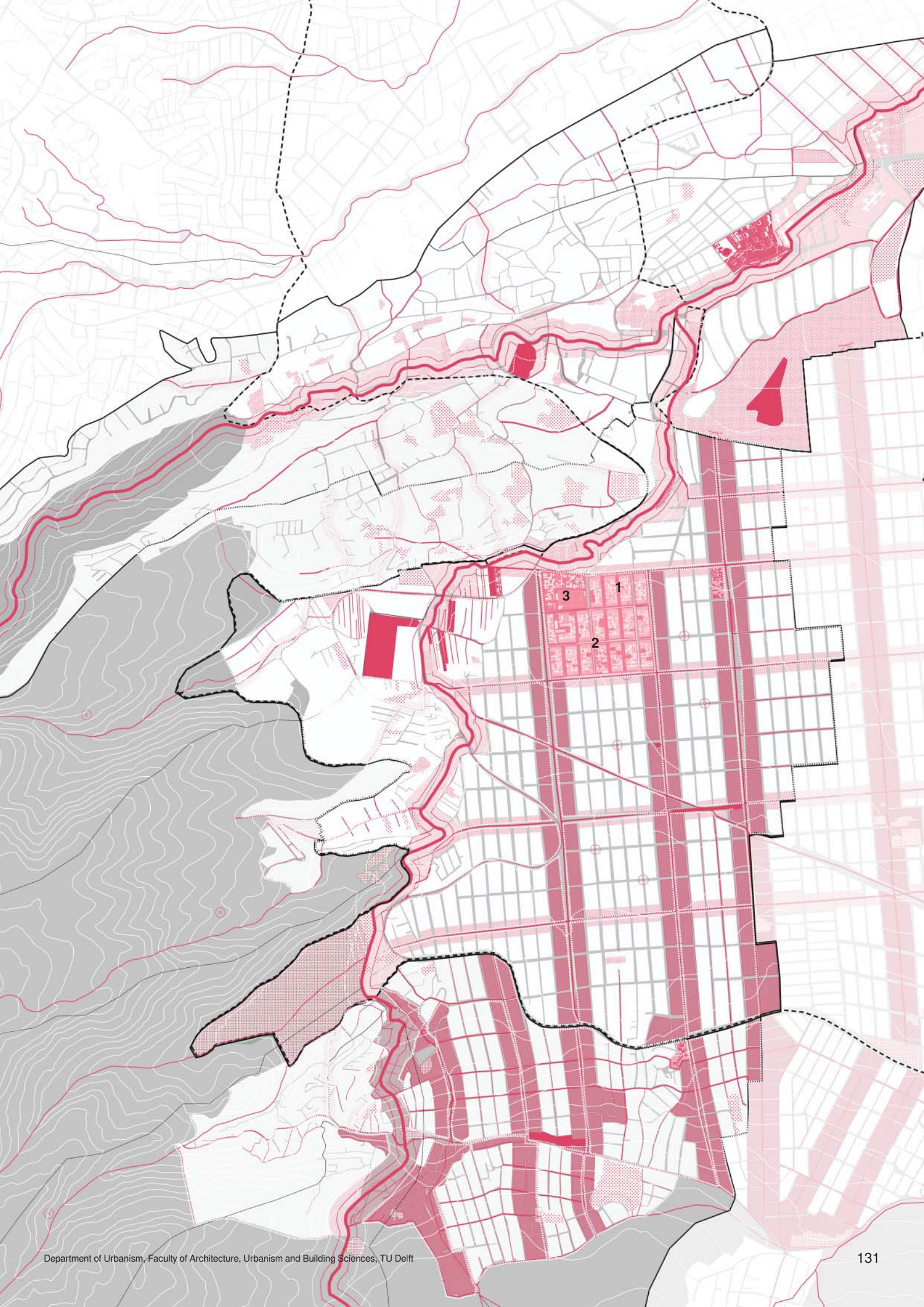
Block scale strategy isometry

Spatial vision

Spatial vision

Collective actions which consolidate a neighborhood's hydrological performance

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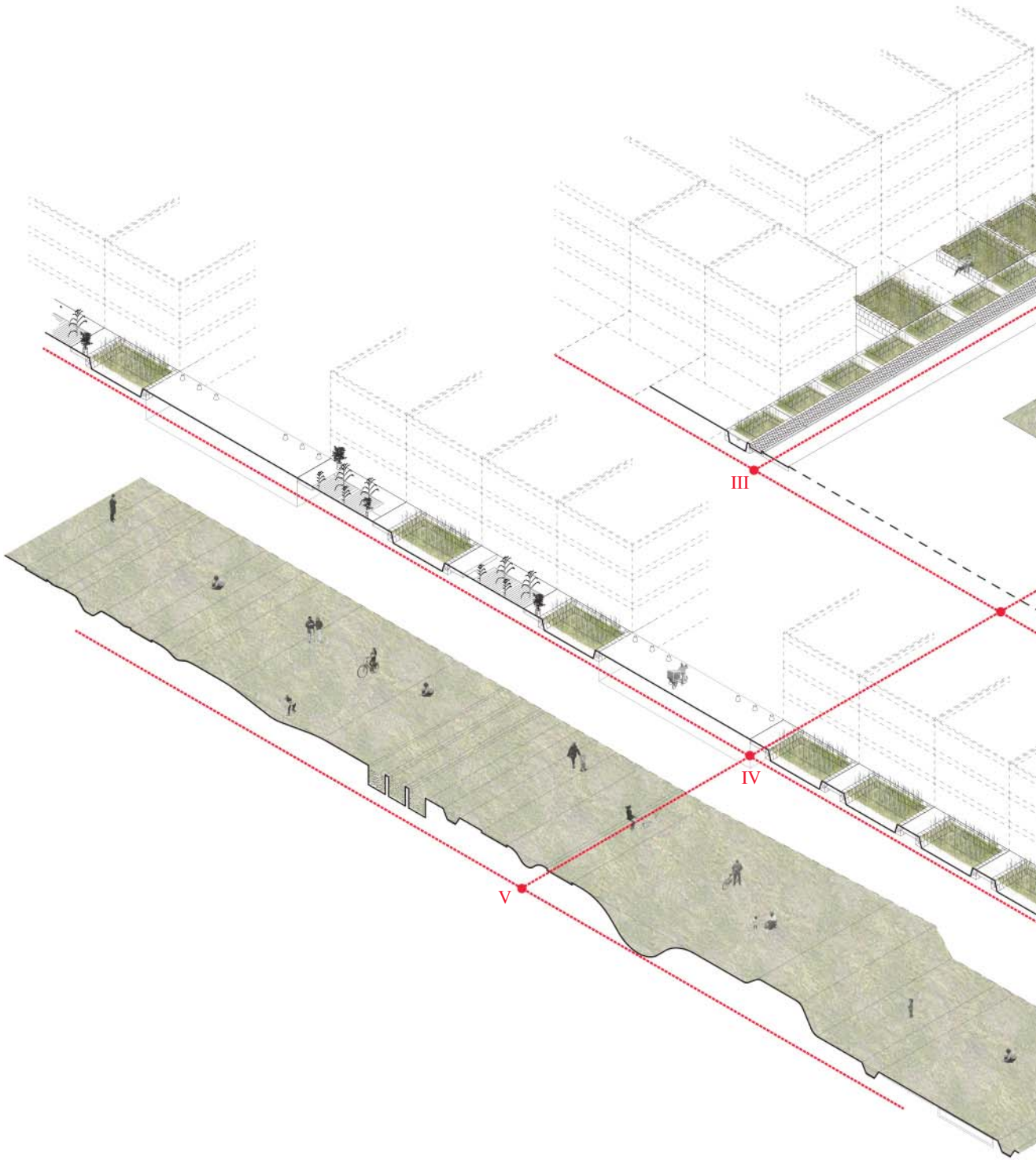
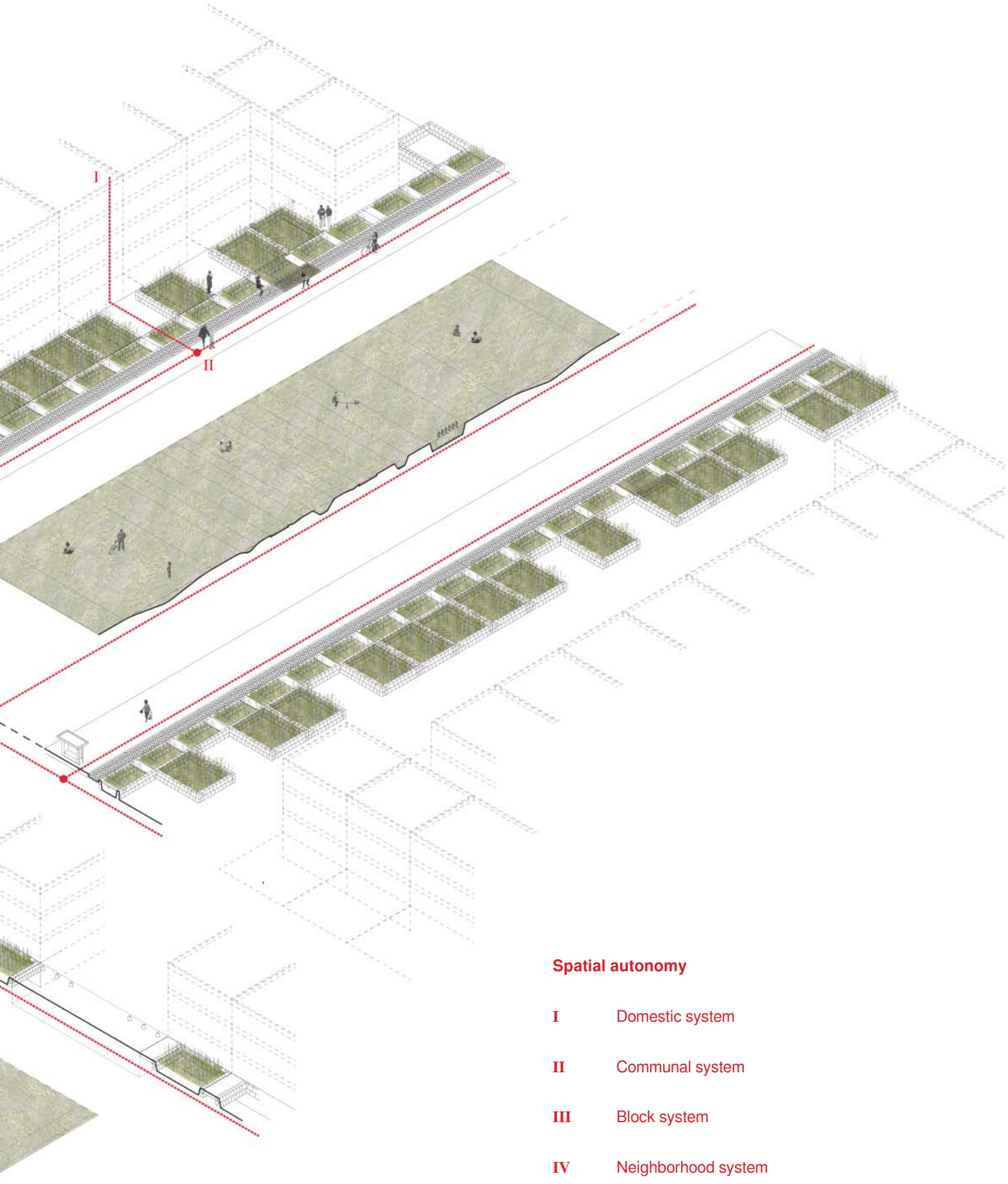
3
2


III
IV
V



Spatial autonomy

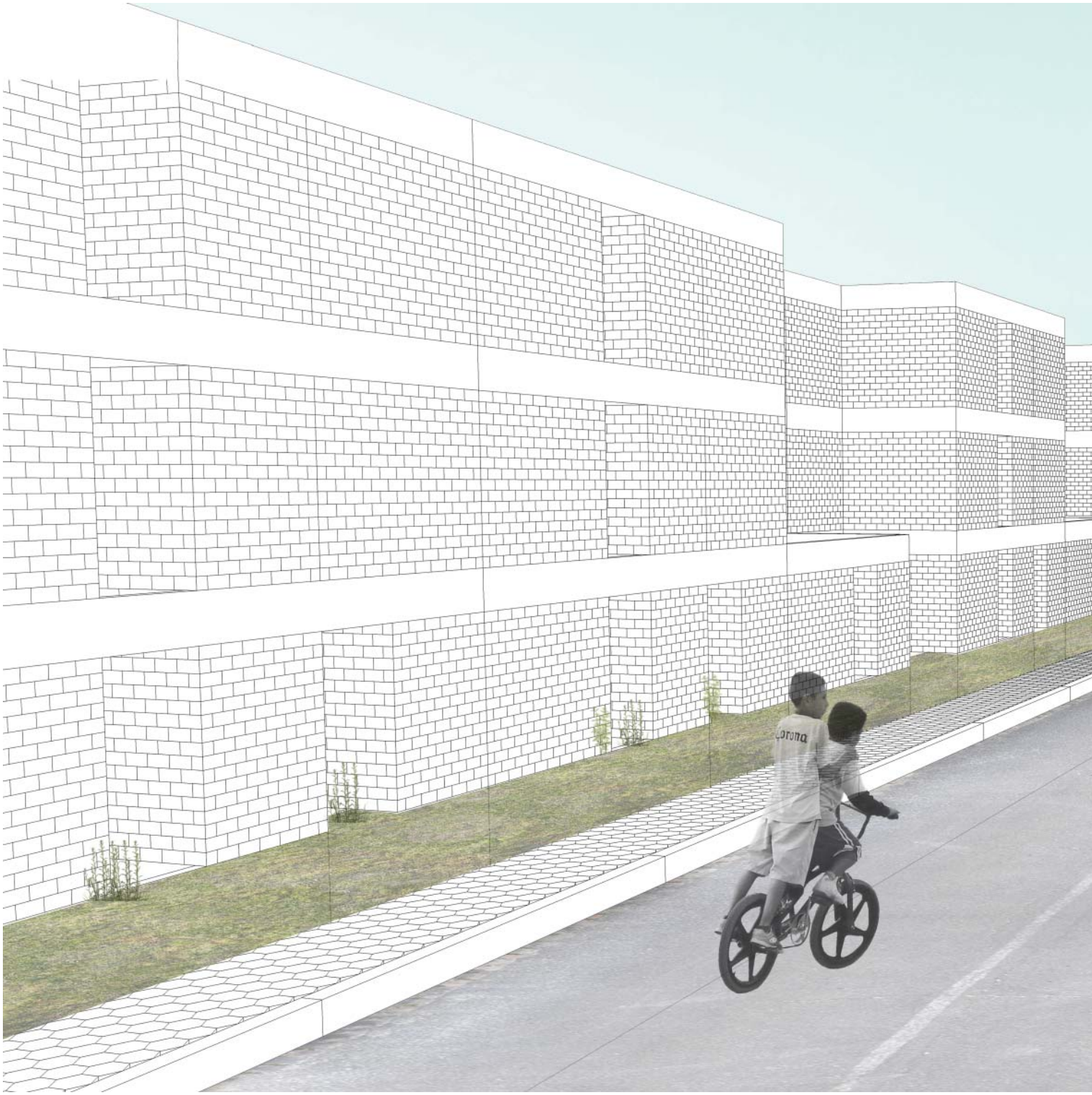
I Domestic system

II Communal system

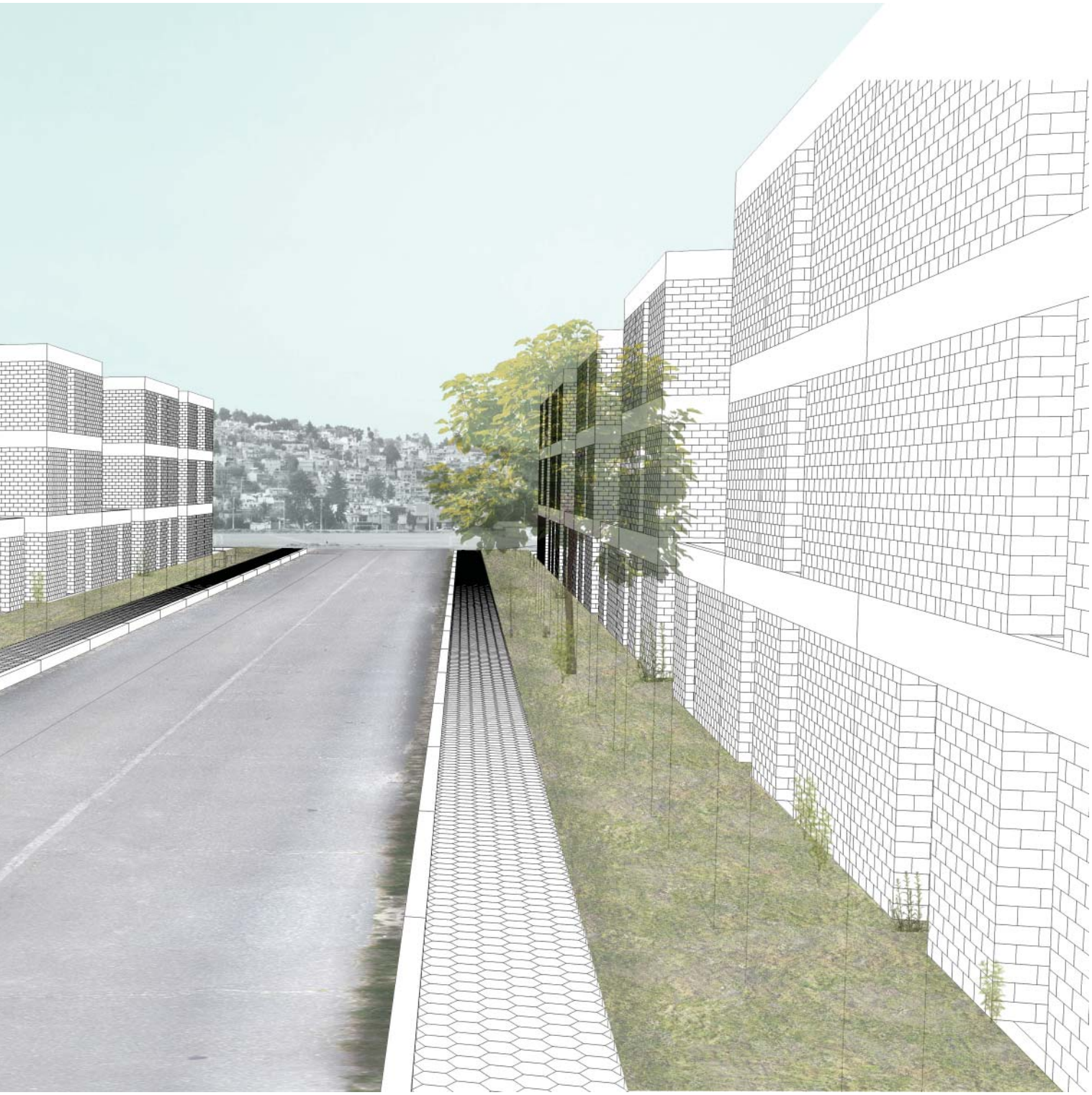
III Block system

IV Neighborhood system

V Micro-basin system

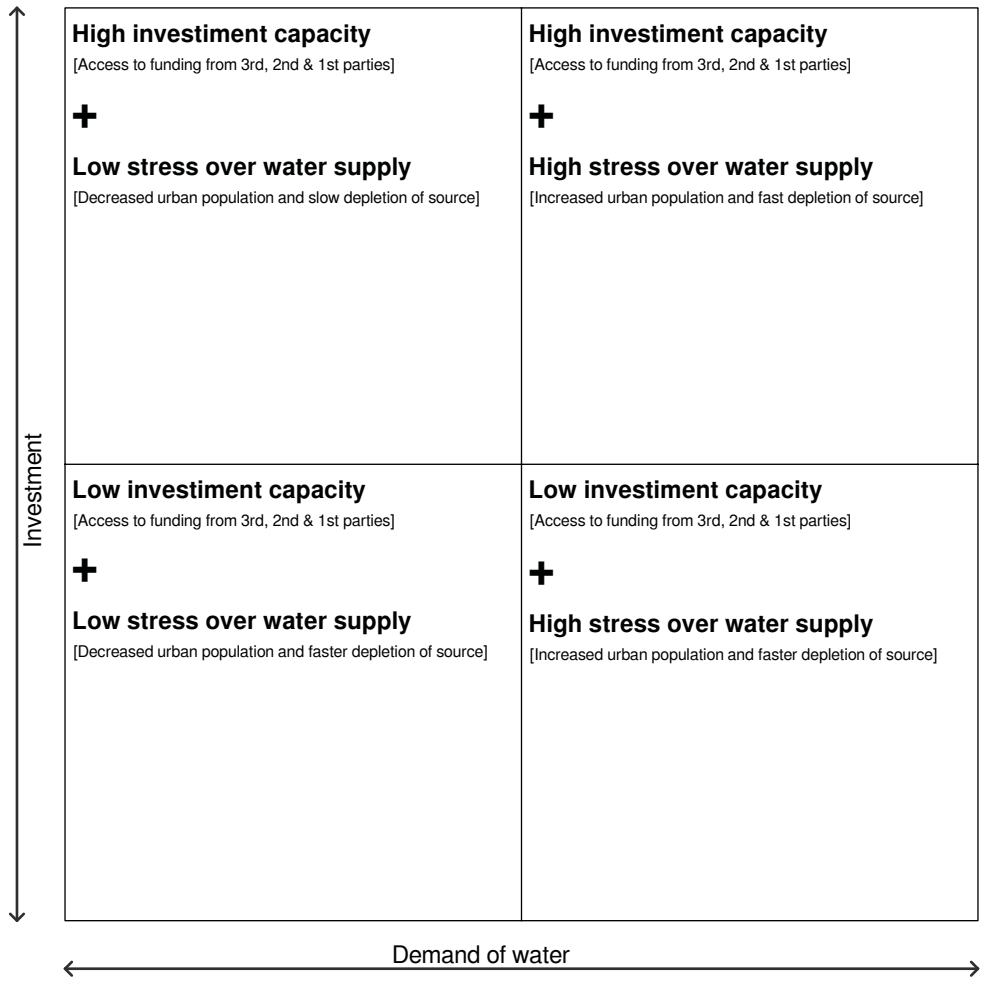


Street profile of typycal block



Potential scenario

Implementation strategies



Main scenario planning definition

Adaptation pathways
Scenario planning for neighborhood collaboration

Long term planning is necessary in order to provide a city wide solution to autonomous water supply. Given the uncertainty of future developments of the city, it is necessary to think of these long term planning objectives as adaptable as possible in order to ensure resilience to any possible social or environmental constraint. In order to develop a large scale green-blue network, it is necessary that authorities and the concerned population cooperate to develop site specific short and mid-term planning actions.

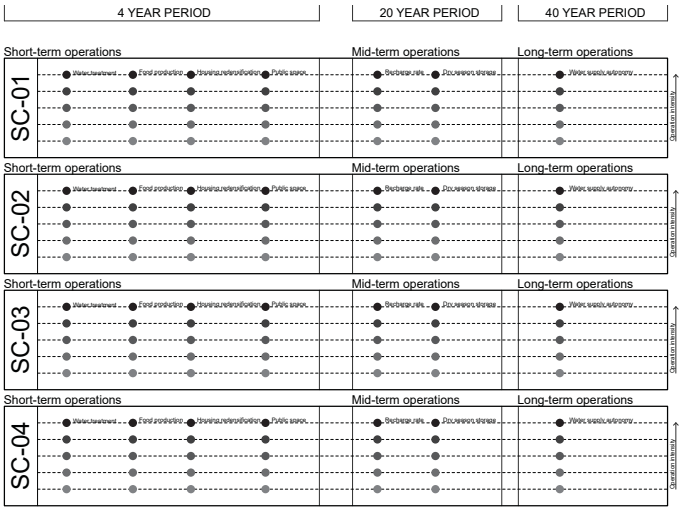
Population growth on one hand defines the potential stress over the resource, while funding mechanisms define potential investments which can enable urban transformations in a short or long time frame. Setting these objectives can allow the overall plan to be developed at different paces, adapting to each neighborhood's specific needs.

Establishing objectives per scale, such as a 4 year action plan for Neighborhood Hydrological Units, 20 year action plans for river sub-basins and 40 year action plans for the city, limits the operational scope of the spatial intervention. In order to define which action comes first, the populations capacity to empower their community sets the basis for equitable path dependency.

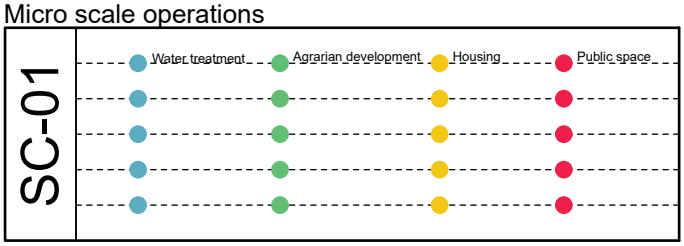
Adaptation pathways
Scenario planning for neighborhood collaboration

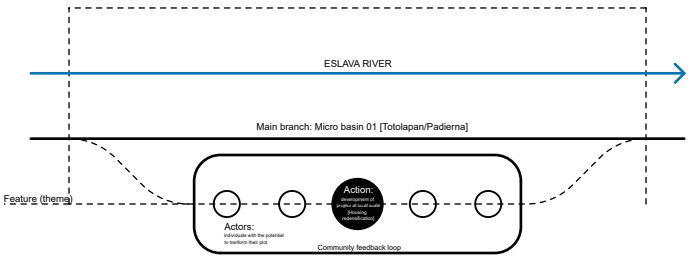
Scenario planning

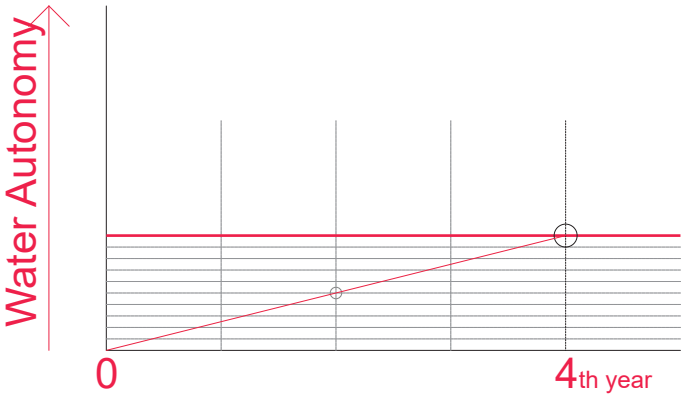
1.
In an optimistic view, the first scenario takes in consideration the existence of high investment provided by a third party as well as a high income level of the residents. In its social dimension, this scenario considered a low stress over the resource, meaning a consistent level in the population.
2.
Second to this is the scenario in which high investment capacity is present, yet the stress over the resource is high as well, creating a more accelerated approach from top to down process.
3.
In contrast to the previous two, this scenario takes in consideration a lower investment capacity from third parties, and is concentrated mostly on what is feasible through government subsidies. The stress over the water is considered low in this scenario, meaning that it is mostly applicable to areas which have better coverage of water supply.
4.
On the extreme opposite, this scenario is aimed for localities or situations in which the private investment capacity is practically null, and the stress over water supply is high due to poor connection to the city's supply network. Given that this scenario is mostly applicable to informal settlements, the end goal from this perspective is to ultimately encourage inhabitants of these areas to relocate through federal housing programs and to intensify the re-naturalization process of the city's periphery.

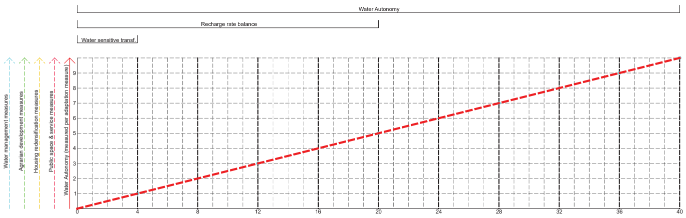


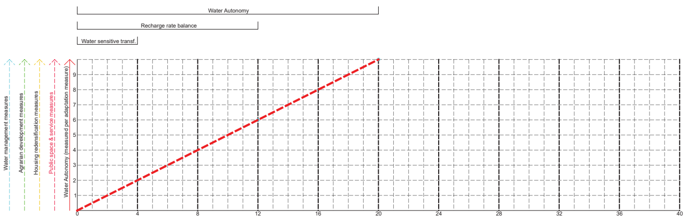
Micro scale operations

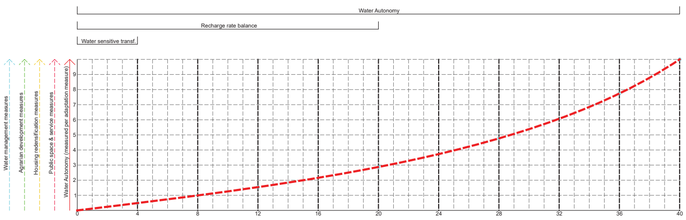


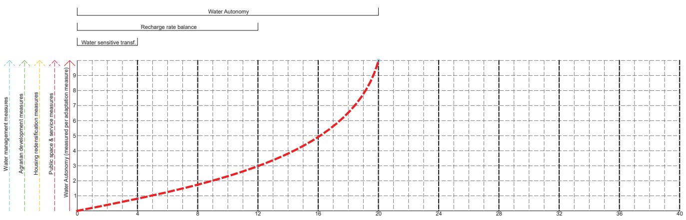






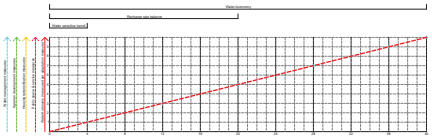


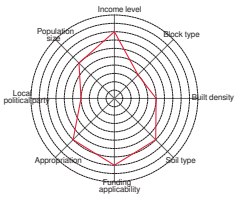




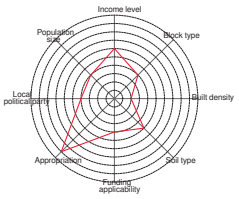
Possible time frames according to each scenario

Adaptation pathways
Fourth year design goal





Current condition

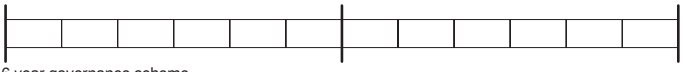


Potential condition

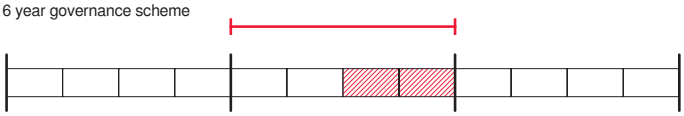
Scenario 01

Given the uncertain development of future population increase, water demand and economic prosperity of the city, authorities must be able to understand that a succesfull water sensitive transformation may be implemented through different circumstances.

In Mexico, governance cycles have a duration of six years. Each time an administration cycle ends,projects and initiatives from one office tend to become unresolved and it is common to find a lack of continuity, especially when the incoming party differs from the initial one. For this, I considerd 4 year cycles to force an overlap between administrations in order to ensure long term planning actions.

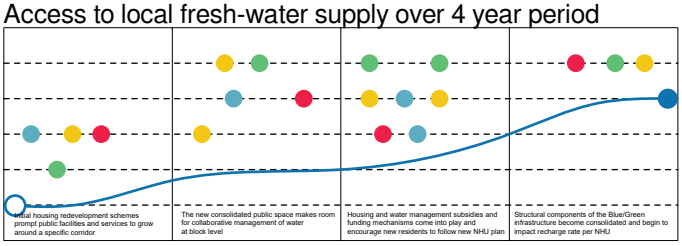


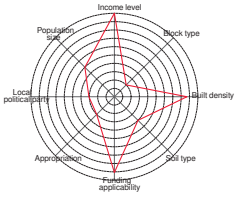
6 year governance scheme



4 year tranformation scheme

Access to local fresh-water supply over 4 year period





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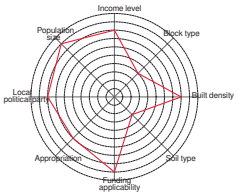
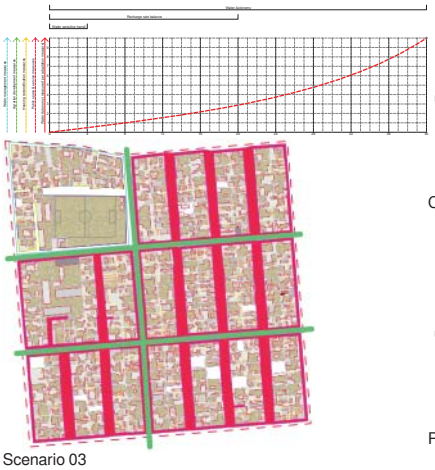
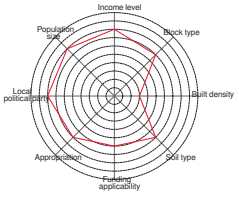


Potential condition

Scenario 02





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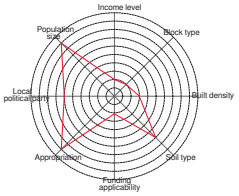
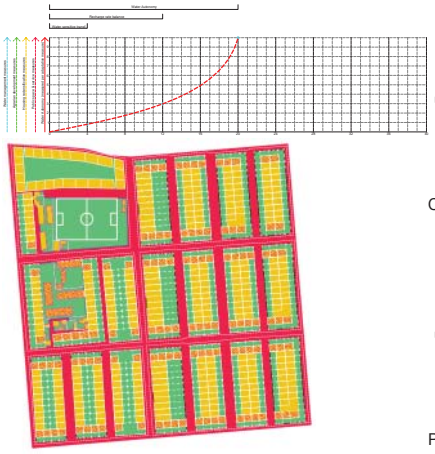
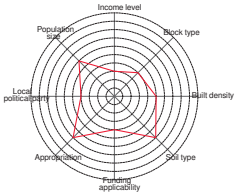


Potential condition

Scenario 03





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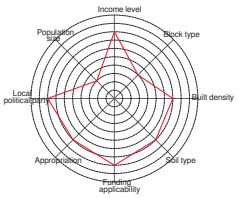


Potential condition

Scenario 04

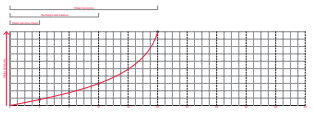
ADAPTATION PATHWAY PER SCENARIO

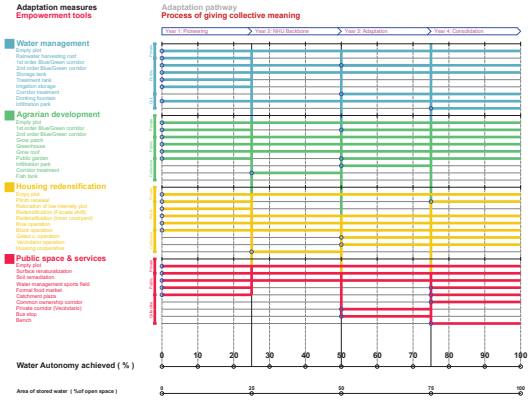
Investment capacity

Demand for water

Scenario 1: +$-W

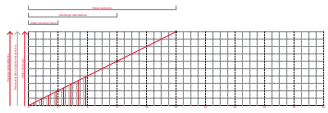
High investment capacity
[Access to funding from 3rd, 2nd & 1st parties]
+
Low stress over water supply
[Decreased urban population and slow depletion of source]

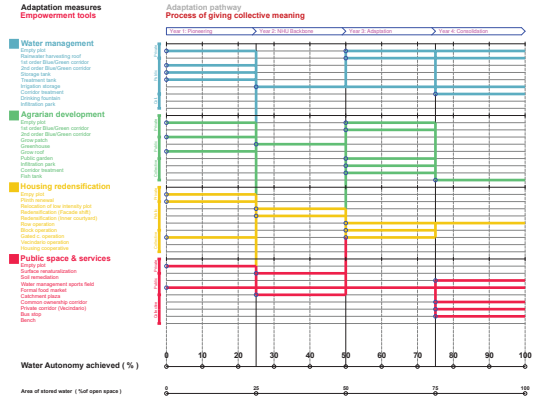




Scenario 2: +$+W

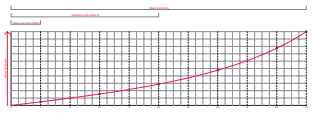
High investment capacity
[Access to funding from 3rd, 2nd & 1st parties]
+
High stress over water supply
[Increased urban population and fast depletion of source]

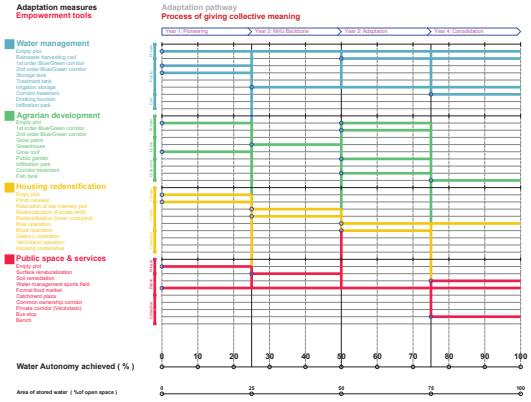




Scenario 3: -$-W

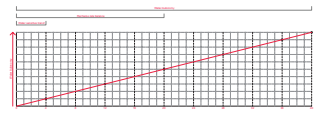
Low investment capacity
[Access to funding from 3rd, 2nd & 1st parties]
+
Low stress over water supply
[Decreased urban population and faster depletion of source]

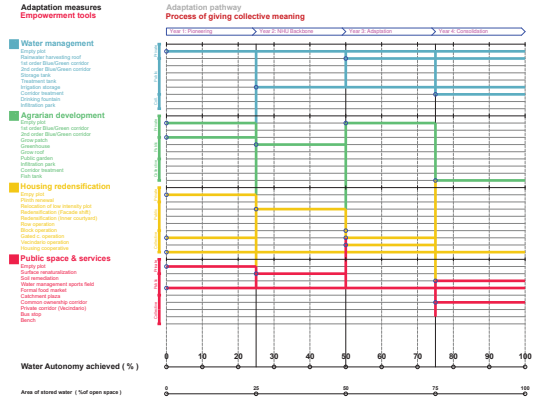




Scenario 4: -$+W

Low investment capacity
[Access to funding from 3rd, 2nd & 1st parties]
+
High stress over water supply
[Increased urban population and faster depletion of source]



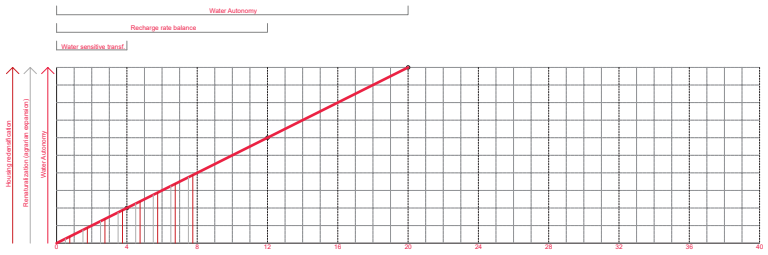


Scenario 02
High investment capacity + High stress over water

High investiment capacity
[Access to funding from 3rd, 2nd & 1st parties]

+

High stress over water supply
[Increased urban population and fast depletion of source]



Adaptation measures
Empowerment tools

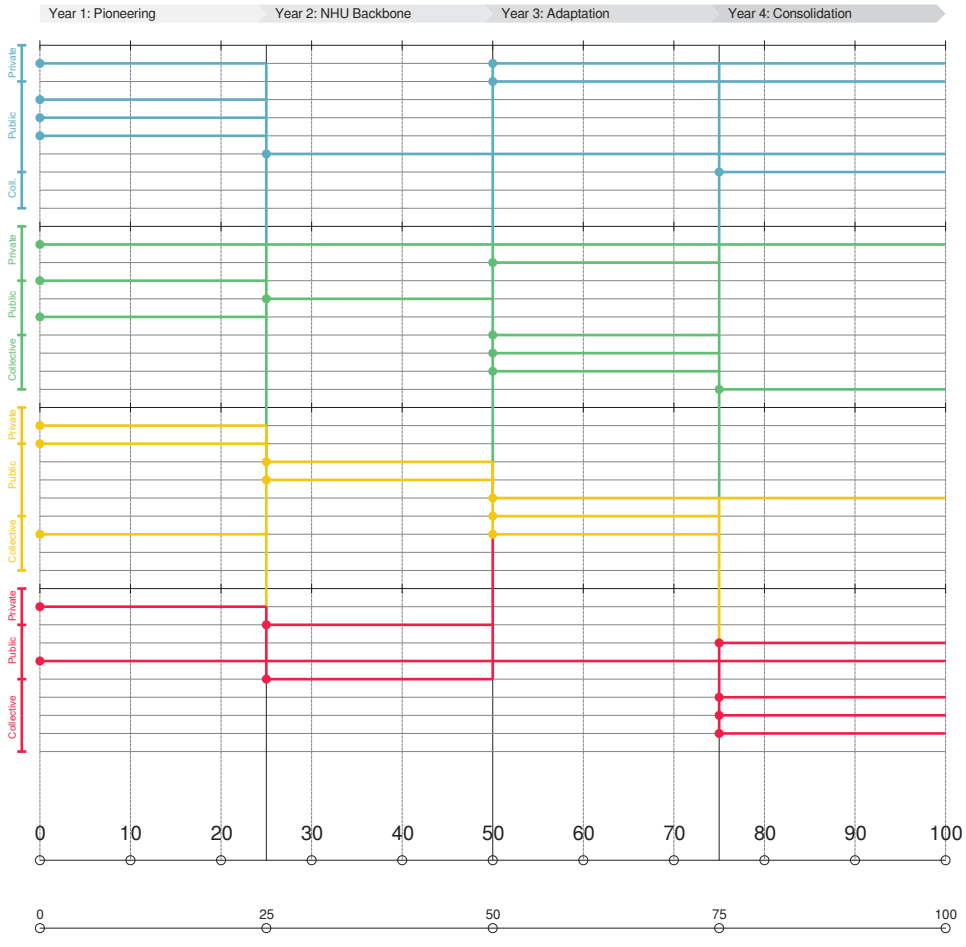
Water management
- Empty plot
- Rainwater harvesting roof
- 1st order Blue/Green corridor
- 2nd order Blue/Green corridor
- Storage tank
- Treatment tank
- Irrigation storage
- Corridor treatment
- Drinking fountain
- Infiltration park

Agrarian development
- Empty plot
- 1st order Blue/Green corridor
- 2nd order Blue/Green corridor
- Grow patch
- Greenhouse
- Grow roof
- Public garden
- Infiltration park
- Corridor treatment
- Fish tank

Housing redensification
- Empy plot
- Plinth renewal
- Relocation of low intensity plot
- Redensification (Facade shift)
- Redensification (Inner courtyard)
- Row operation
- Block operation
- Gated c. operation
- Vecindario operation
- Housing cooperative

Public space & services
- Empty plot
- Surface renaturalization
- Soil remediation
- Water management sports field
- Formal food market
- Catchment plaza
- Common ownership corridor
- Private corridor (Vecindario)
- Bus stop
- Bench

Adaptation pathway
Process of giving collective meaning



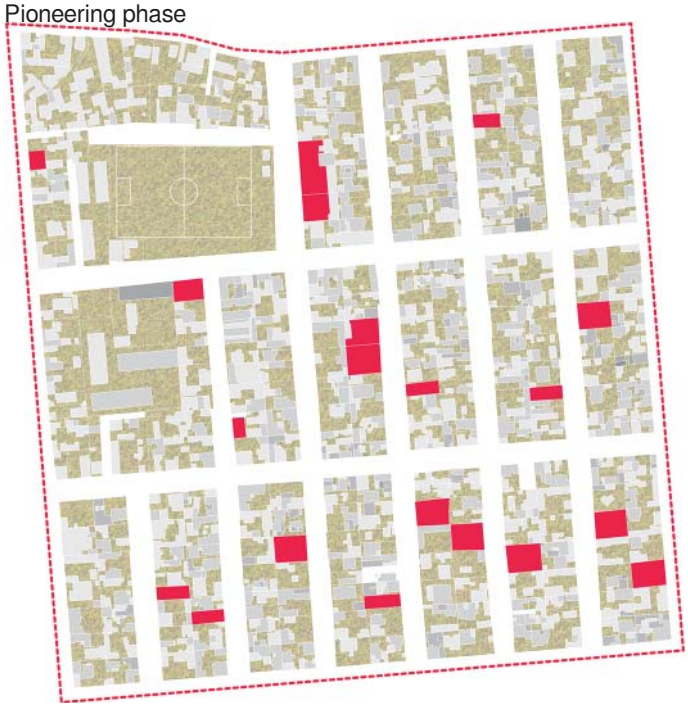
Water Autonomy achieved (%)

Area of stored water (% of open space)

Scenario 2: +$+W

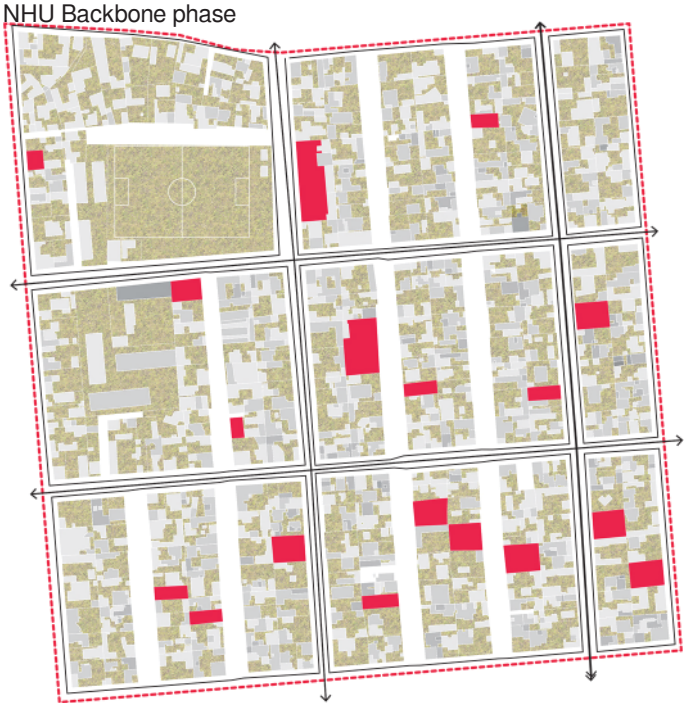
Year 1

Pioneering phase



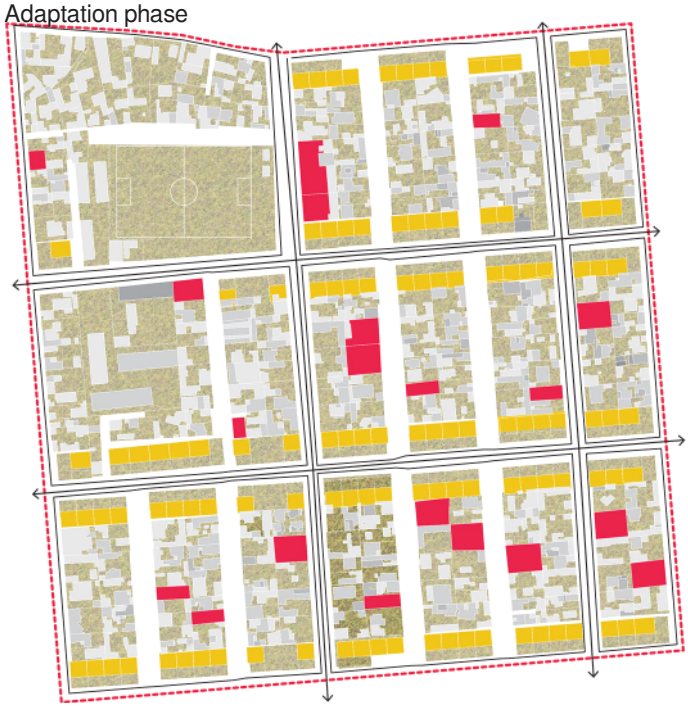
Year 2

NHU Backbone phase



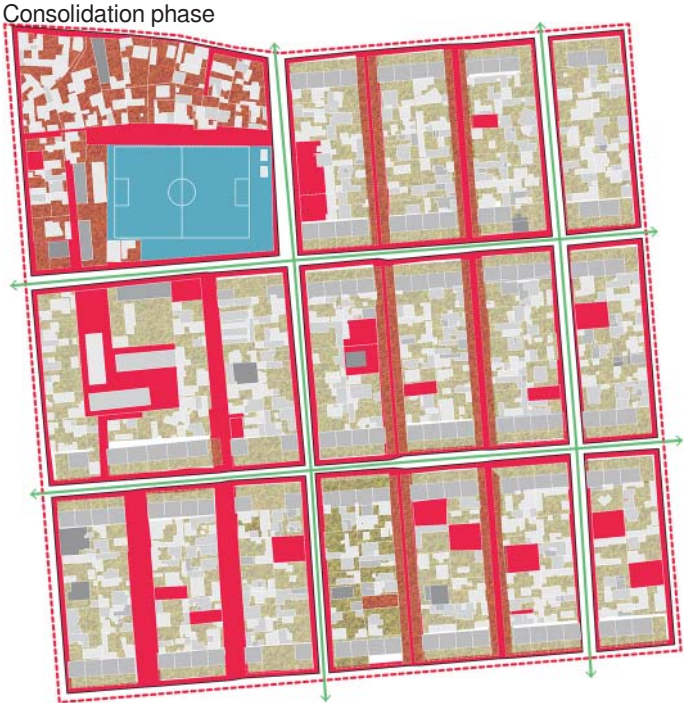
Year 3

Adaptation phase



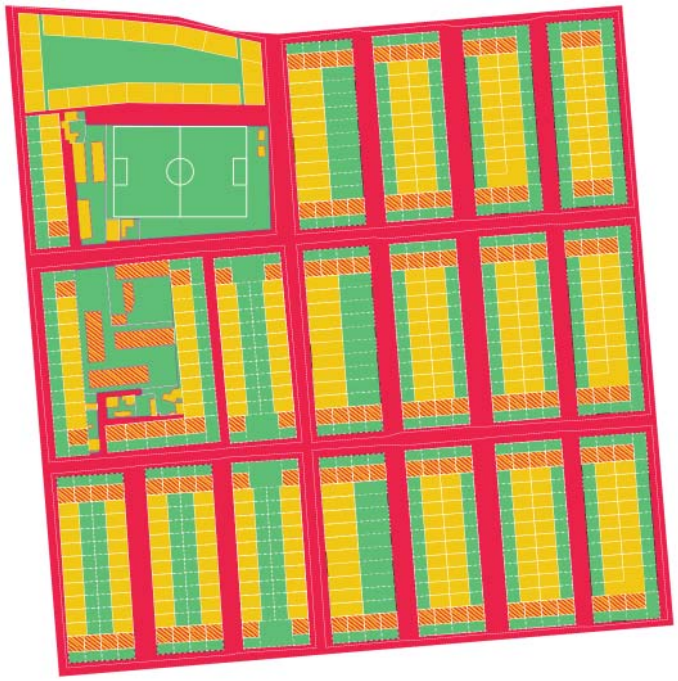
Year 4

Consolidation phase

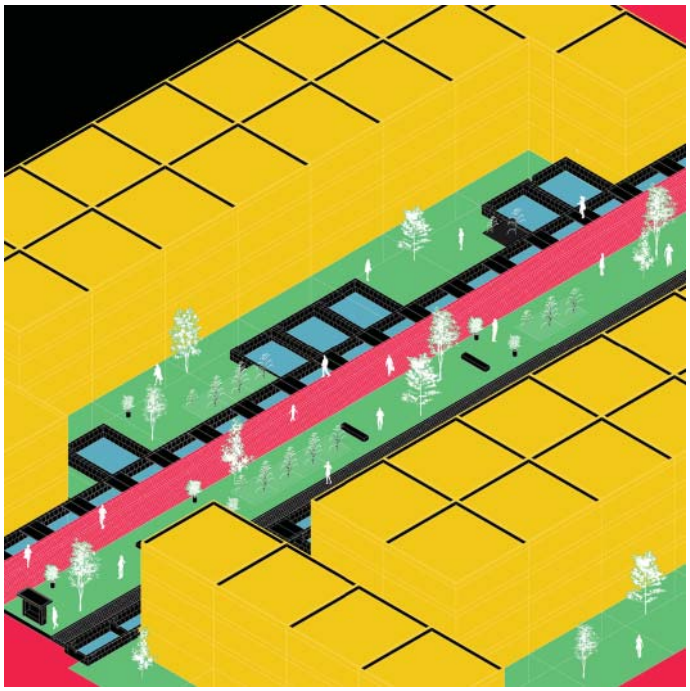


Adaptation pathways

Best case scenario:
High funding capacity
+
Low resource stress

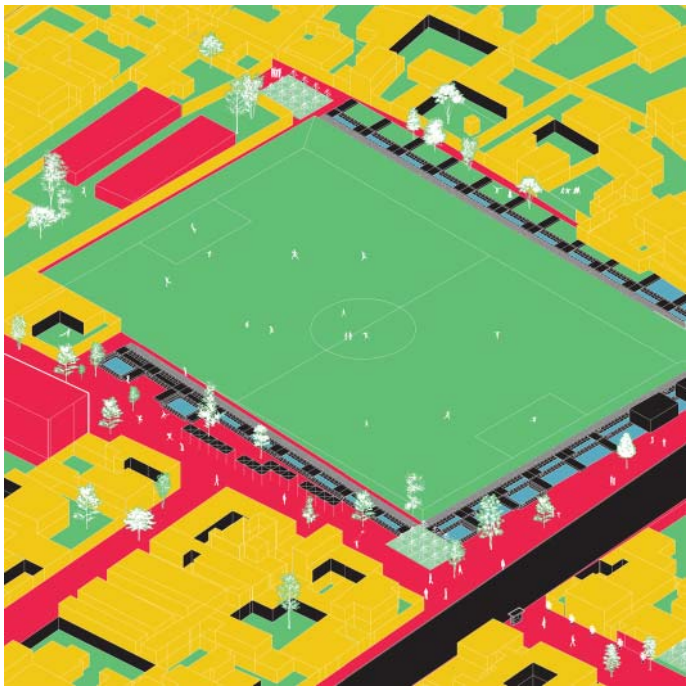


Best case scenario



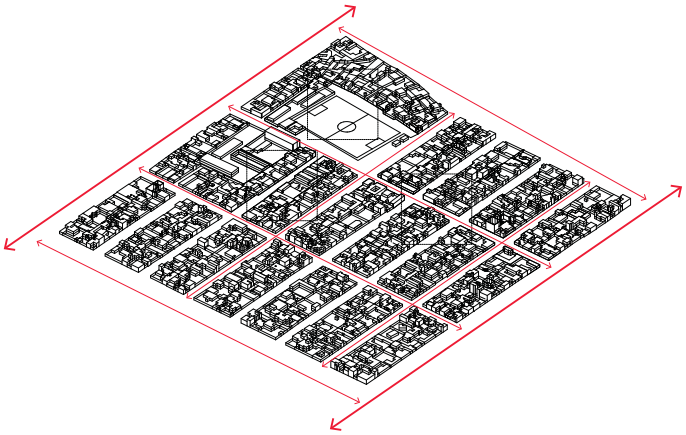
Block scale operation

Public space corridor operation



Sports field operation

Co-benefit strategy
Environmental, Social & Economic gains



Establish micro-hydrological region
Local council for spatial synergy

Decrease demand of external water sources
Decentralized water management system

Reduce the built footprint of the city's periphery
Agricultural production belt

Ensure neighborhood livelyhood
Cooperative housing market

Enhance the local economy
Balance landuse distribution

Integration
Neighbourhood empowerment
Local resource management
Decentralized resource management
Autonomous governance

Hydrological balance
Potable water within the basin
Increase aquifer recharge rate
Rainwater harvest
Decentralized water supply & treatment

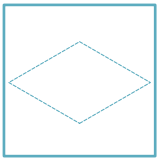
Livability & Housing price
Housing density
Communal block
Open space ratio
Home owner financing

Health & Public space
Recreational public spaces
Biodiverse green structure
Soil remediation
Waste managent

Services & Mobility
Public transport
Soft mobility
Parking space reduction
Infrastructure integration

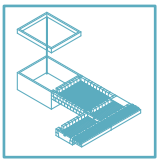
Empowerment tools

Spatial measures to give collective meaning to public space

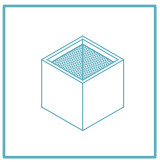


I P C

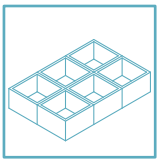
People: Neighbours
Politics: Self management
Place: Plot scale



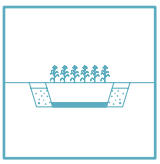
People: Owner
Politics: Self management
Place: Plot scale



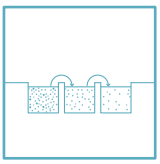
People: Owner
Politics: Self management
Place: Plot scale



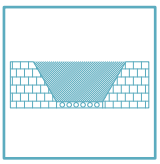
People: Neighbours
Politics: Public responsibility
Place: Public space



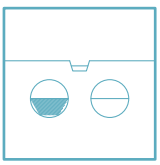
People: Farm owners
Politics: Collective management
Place: Plot scale



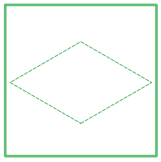
People: Neighbours
Politics: Self management
Place: Public space



People: Neighbourhood
Politics: Planning agency
Place: Block scale



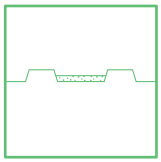
People: Municipality
Politics: Public responsibility
Place: Street scale



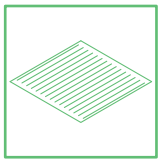
I P C

People: Neighbours
Politics: Self management
Place: Plot scale

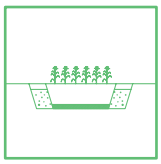
People: Owner
Politics: Self management
Place: Plot scale



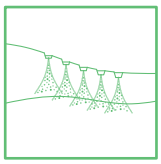
People: Owner
Politics: Self management
Place: Plot scale



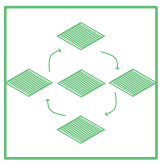
People: Neighbours
Politics: Public responsibility
Place: Public space



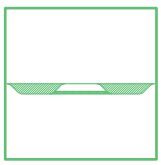
People: Farm owners
Politics: Collective management
Place: Plot scale



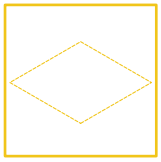
People: Neighbours
Politics: Self management
Place: Public space



People: Farmer unions
Politics: Planning agency
Place: Block scale



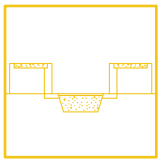
People: Farm owners
Politics: Public responsibility
Place: Street scale



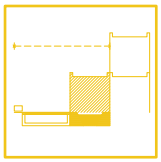
I P C

People: Neighbours
Politics: Self management
Place: Plot scale

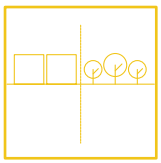
People: Owner
Politics: Self management
Place: Plot scale



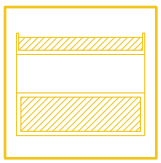
People: Owner
Politics: Self management
Place: Plot scale



People: Neighbours
Politics: Public responsibility
Place: Public space

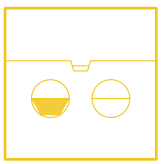


People: Home owner
Politics: Collective management
Place: Plot scale

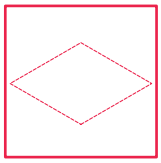


People: Neighbours
Politics: Self management
Place: Public space

People: Neighbourhood
Politics: Planning agency
Place: Block scale

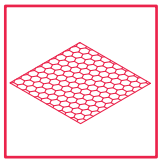


People: Municipality
Politics: Public responsibility
Place: Street scale

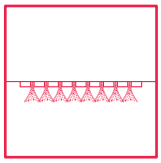


I P C

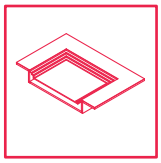
People: Neighbours
Politics: Self management
Place: Plot scale



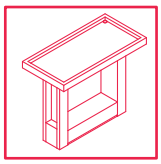
People: Owner
Politics: Self management
Place: Plot scale



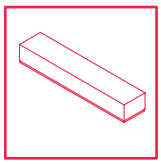
People: Owner
Politics: Self management
Place: Plot scale



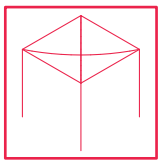
People: Neighbours
Politics: Public responsibility
Place: Public space



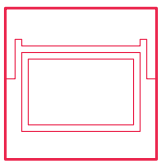
People: Municipality
Politics: Collective management
Place: Plot scale



People: Neighbours
Politics: Self management
Place: Public space

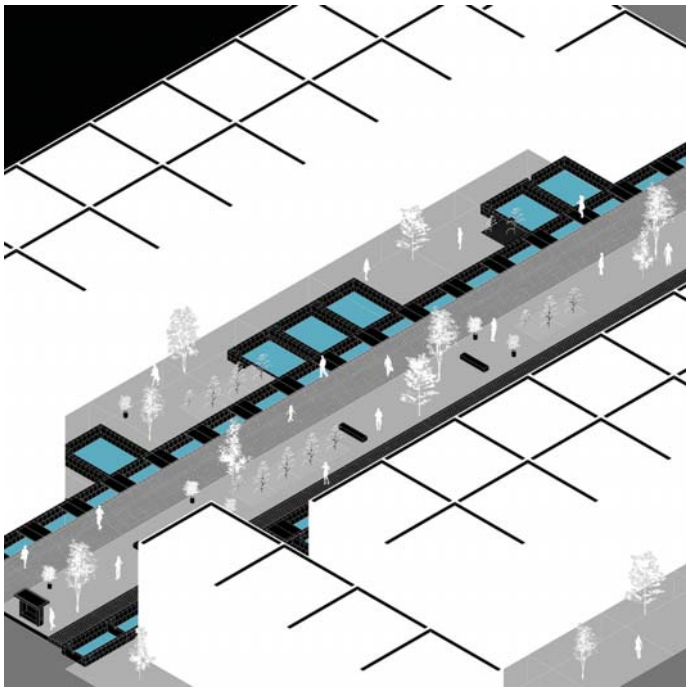


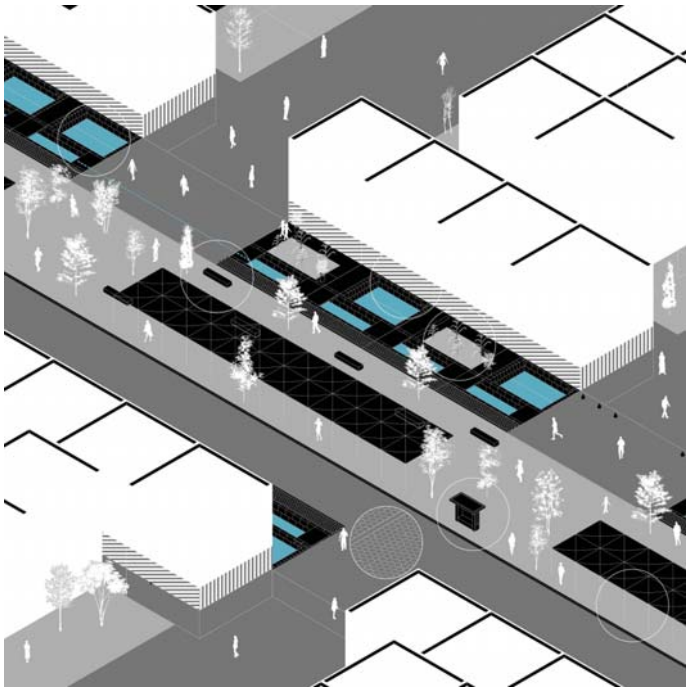
People: Individual
Politics: Planning agency
Place: Block scale



People: Collective management
Politics: Public responsibility
Place: Street scale

Water treatment strategy





MICRO

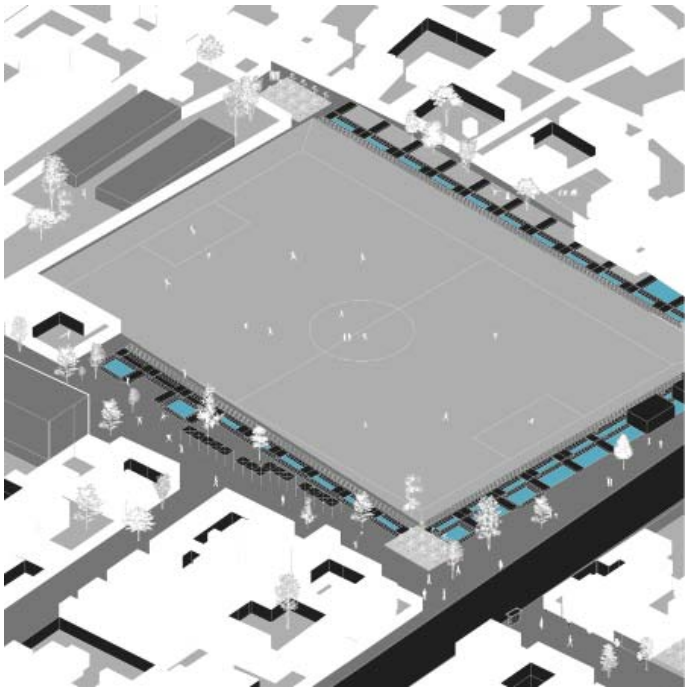
WATER TREATMENT INFRASTRUCTURE

Constraints	Enablers
-Poor solid waste management	-High rainfall

MESO

WATER RETENTION

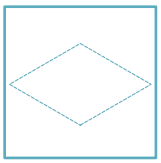
Constraints	Enablers
-Highly densified	-Good soil mechanics



MACRO

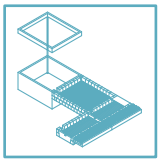
GROUNDWATER RECHARGE

Constraints	Enablers
-Degraded soil quality	-Highly infiltratable soil



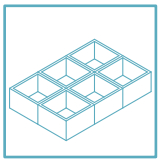
I P C

People: Neighbours
Politics: Self management
Place: Plot scale



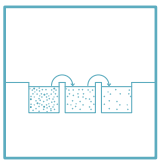
People: Owner
Politics: Self management
Place: Plot scale

People: Owner
Politics: Self management
Place: Plot scale

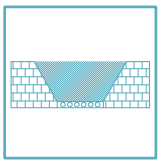


People: Neighbours
Politics: Public responsibility
Place: Public space

People: Farm owners
Politics: Collective management
Place: Plot scale



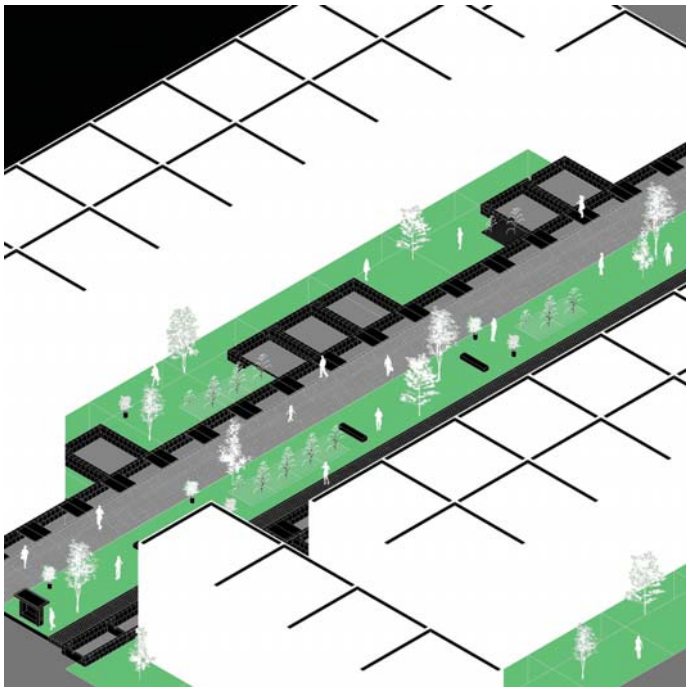
People: Neighbours
Politics: Self management
Place: Public space

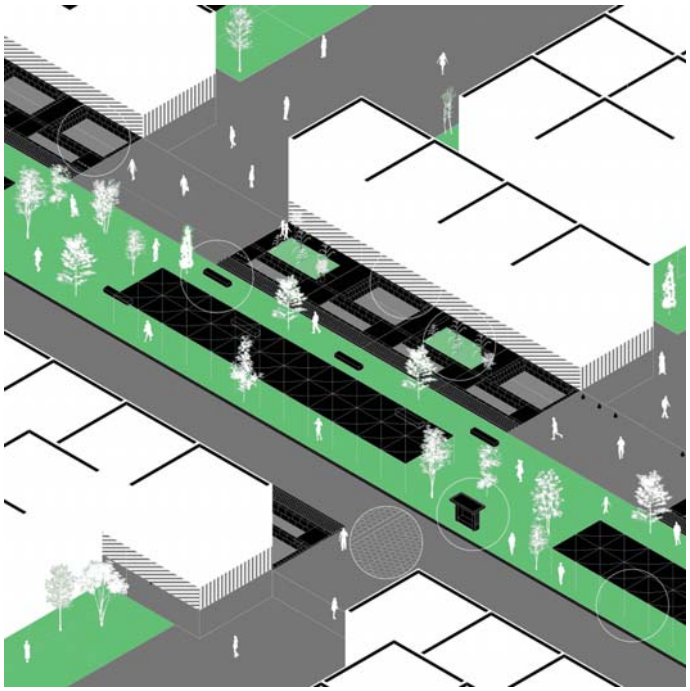


People: Neighbourhood
Politics: Planning agency
Place: Block scale

People: Municipality
Politics: Public responsibility
Place: Street scale

Health and Food production strategy





LOCAL FOOD PRODUCTION

Constraints

-Short rainy seasons

Enablers

-Highly productive landscape

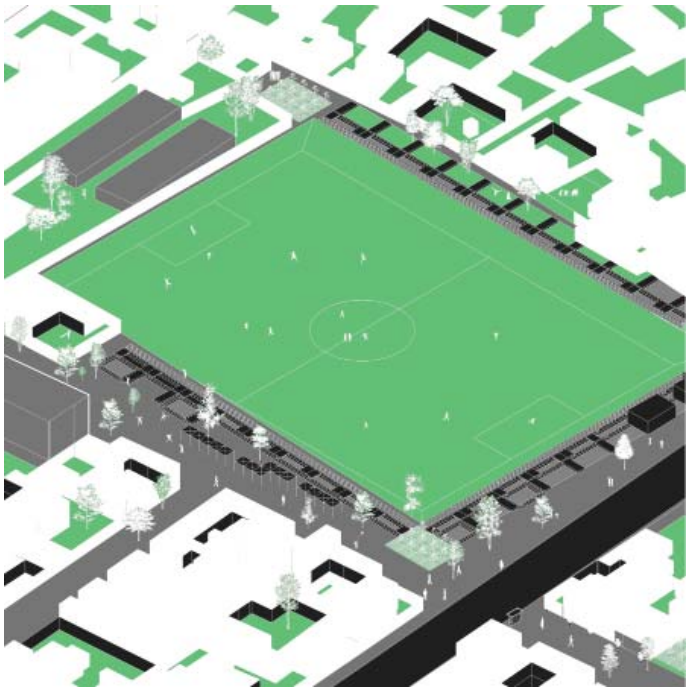
RENATURALIZE URBAN PERIPHERY

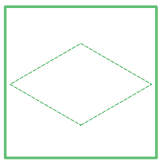
Constraints

-Increasing housing market

Enablers

-Strong existing green network

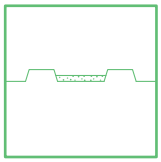




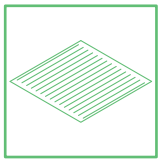
I P C

People: Neighbours
Politics: Self management
Place: Plot scale

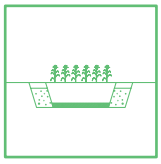
People: Owner
Politics: Self management
Place: Plot scale



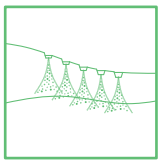
People: Owner
Politics: Self management
Place: Plot scale



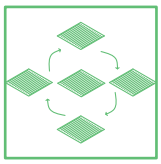
People: Neighbours
Politics: Public responsibility
Place: Public space



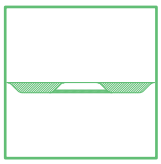
People: Farm owners
Politics: Collective management
Place: Plot scale



People: Neighbours
Politics: Self management
Place: Public space



People: Neighbourhood
Politics: Planning agency
Place: Block scale



People: Municipality
Politics: Public responsibility
Place: Street scale

DECREASE URBAN SPRAWL

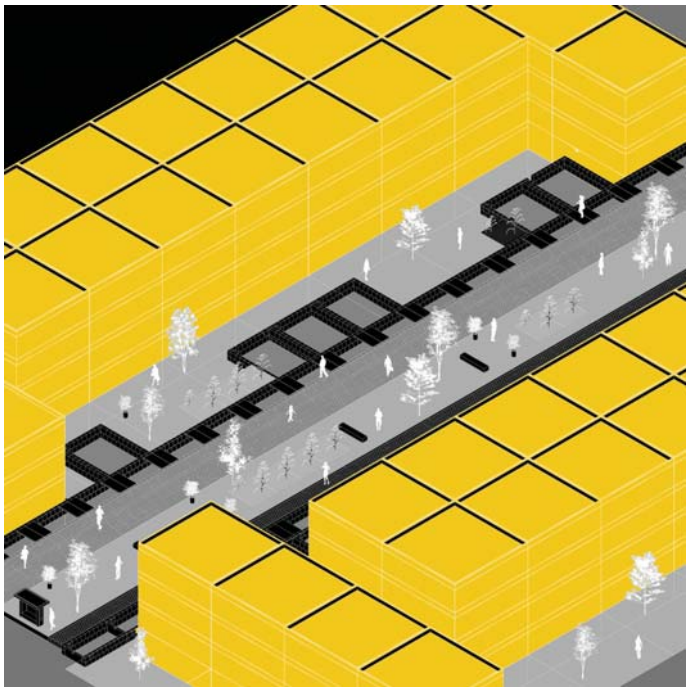
Constraints

-Increasing population de to immigration from rural areas

Enablers

-Good preservation of forests and natural areas

Housing regeneration strategy



HOUSING REDENSIFICATION

Constraints

-Competition for housing market is highly monopolized

Enablers

-Financial incentives from SEDUVI

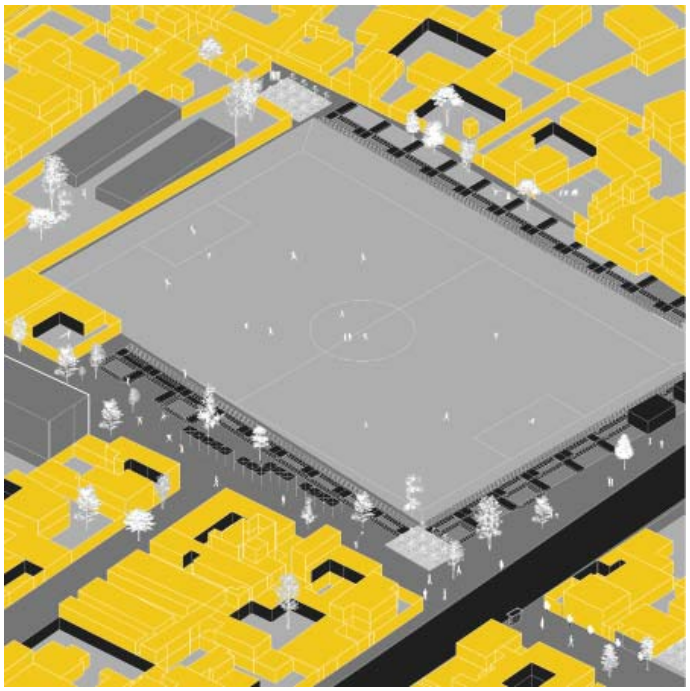
COOPERATIVE HOUSING SCHEME

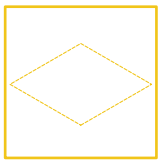
Constraints

-Lack of community organization

Enablers

-Well knit community

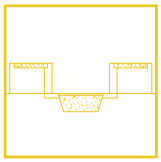




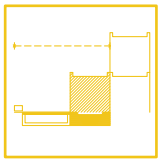
I P C

People: Neighbours
Politics: Self management
Place: Plot scale

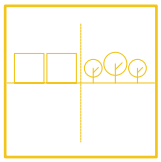
People: Owner
Politics: Self management
Place: Plot scale



People: Owner
Politics: Self management
Place: Plot scale

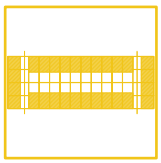


People: Neighbours
Politics: Public responsibility
Place: Public space

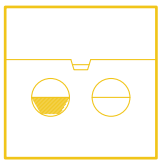


People: Farm owners
Politics: Collective management
Place: Plot scale

People: Neighbours
Politics: Self management
Place: Public space



People: Neighbourhood
Politics: Planning agency
Place: Block scale



People: Municipality
Politics: Public responsibility
Place: Street scale

REDISTRIBUTION OF URBAN DENSITY

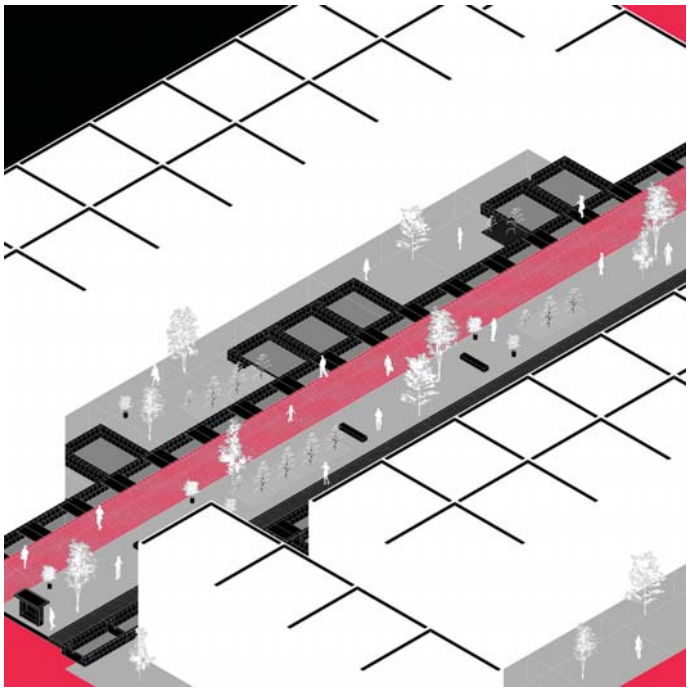
Constraints

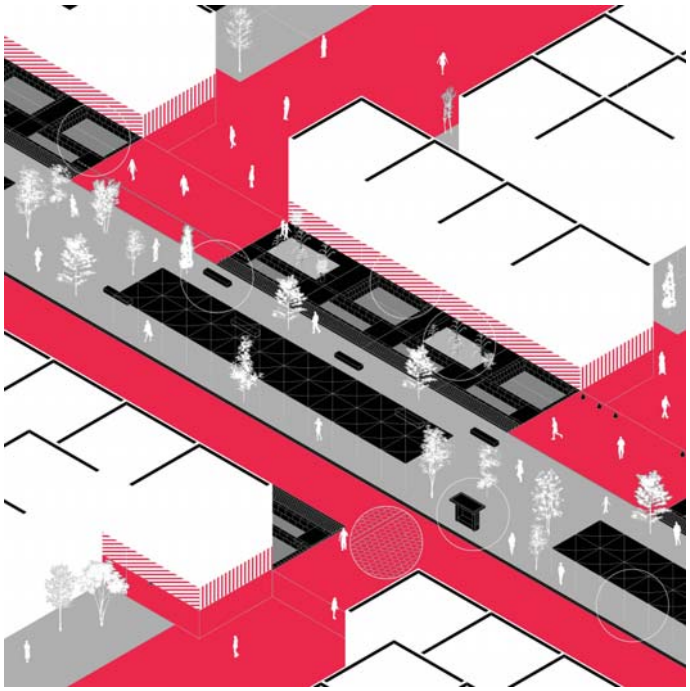
-Strict zoning laws

Enablers

-Pressure from federal funding programs

Public space and services strategy



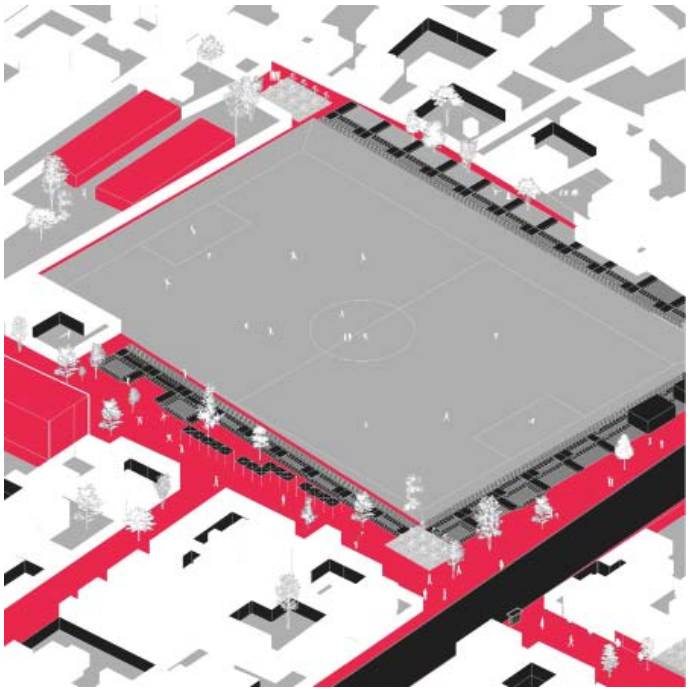


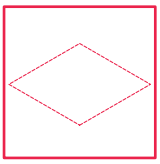
PUBLIC SPACE REGENERATION

Constraints	Enablers
-Low maintainance budget	-High demand

DECENTRALIZATION OF PUBLIC SERVICES

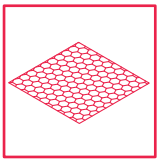
Constraints	Enablers
-High demand of services	-Abundant informal services



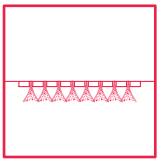


I P C

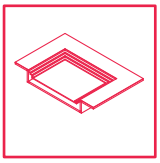
People: Neighbours
Politics: Self management
Place: Plot scale



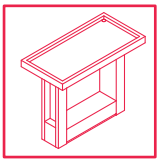
People: Owner
Politics: Self management
Place: Plot scale



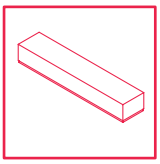
People: Owner
Politics: Self management
Place: Plot scale



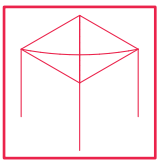
People: Neighbours
Politics: Public responsibility
Place: Public space



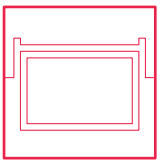
People: Farm owners
Politics: Collective management
Place: Plot scale



People: Neighbours
Politics: Self management
Place: Public space



People: Neighbourhood
Politics: Planning agency
Place: Block scale



People: Municipality
Politics: Public responsibility
Place: Street scale

CREATION OF STRONG LOCAL ECONOMY

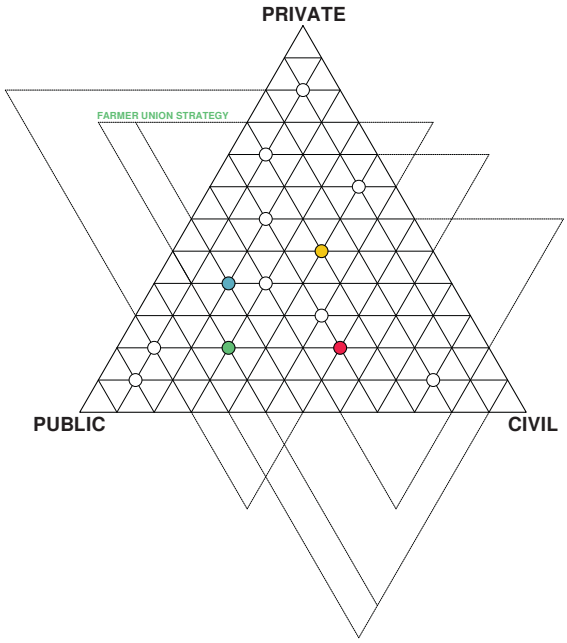
Constraints	Enablers
-Large scale monopolies	-Distance is favorable

Case studies

Stakeholder correlations

Since water management at the basin level is confronted with a lack of coordination between governance structures, it is crucial for implementing urban transformation strateies to take in account these correlations.

Actors from the private, public & civil spheres are the foundation for these interactions, and in order to coordinate decision making processes, there must be constant negotiation during all stages of design and implementation.



	Water treatment strategy	Health and Food production strategy	Housing regen. strategy	Public space and services strategy
MICRO	**WATER TREATMENT INFRASTRUCTURE** Constraints: -Poor solid waste management Enablers: -High rainfall	**LOCAL FOOD PRODUCTION** Constraints: -Short rainy seasons Enablers: -Highly productive landscape	**HOUSING REDENSIFICATION** Constraints: -Competition for housing market is highly monopolized Enablers: -Financial incentives from SEDUVI	**PUBLIC SPACE REGENERATION** Constraints: -Low maintainance budget Enablers: -High demand
MESO	**WATER RETENTION** Constraints: -Highly densified Enablers: -Good soil mechanics	**RENATURALIZE URBAN PERIPHERY** Constraints: -Increasing housing market Enablers: -Strong existing green network	**COOPERATIVE HOUSING SCHEME** Constraints: -Lack of community organization Enablers: -Well knit community	**DECENTRALIZATION OF PUBLIC SERVICES** Constraints: -High demand of services Enablers: -Abundant informal services
MACRO	**GROUNDWATER RECHARGE** Constraints: -Degraded soil quality Enablers: -Highly infiltratable soil	**DECREASE URBAN SPRAWL** Constraints: -Increasing population de to immigration from rural areas Enablers: -Good preservation of forests and natural areas	**REDISTRIBUTION OF URBAN DENSITY** Constraints: -Strict zoning laws Enablers: -Pressure from federal funding programs	**CREATION OF STRONG LOCAL ECONOMY** Constraints: -Large scale monopolies Enablers: -Distance is favorable

Francisco del Moral
Sustainable Development department
Magdalena Contreras District

Luis Gerardo Quijano
Magdalena Contreras Deputee

Ing. Amador Gonzalez
SAGARPA representative

Celia Oliver
Sustainable Development department
Tlalpan District

Victor Rico
Former Project coordinator
Public Space Authority

Ing. Mariana Chew
Independent Consultant / **Activist**

Jose Romero Teran
San Nicolas Farmer

Santiago Martinez Castro
San Nicolas Farmer

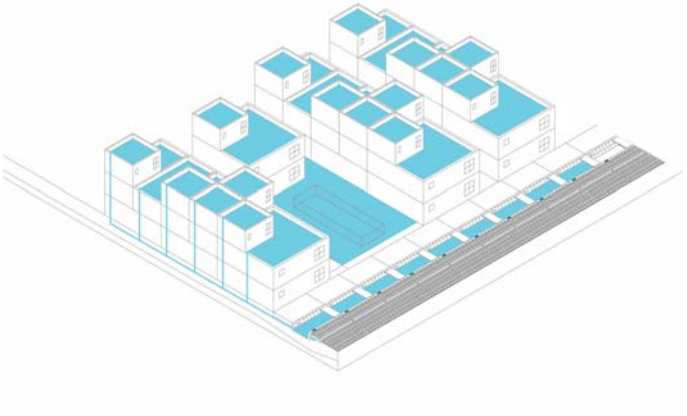
Genaro Lopez
San Nicolas resident

Mario Diaz
Heroes de Pad. resident

Rogelio Sanchez
Local water purification business owner

Jorge Cañez
Lab CDMX

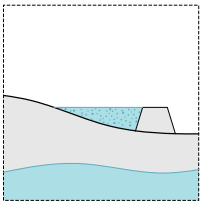
Water treatment strategy
Neighbor cooperation to ensure correct urban water treatment



Nombre: Rogelio Sanchez

Potentially supported by the following councils:
(Memoir from local Farmer's council meeting)
Consejo de cuenca
Consejero tecnico de CONAGUA (Representante)
Representante de SAGARPA (AMADOR GONZALEZ)
Consejos de conservacion de la cuenca
SAGARPA
-reduccion de presupuesto desde el ano pasado de entre 10 y 20 %
-infraesttructura maquinaria y equipo (para agricultura y pecuarias)
-se tienen que tmar cmo referencia los subsidios federales
-apoyo de 80% como particular, hasta 50% como persona moral
-programas a traves de padrones como proagro (tienen que estar inscritos en ese padron)
-para productores de menos de 1 hectarea hasta 1500 pesos
-mas apoyos para productoes chicos
-programa de fomento agricola
-programa de fomento ganadero
-programa de conservacion de suelos y agua
-programas apra comercializacion
-deben registrarse en el padron de SAGARPA
-se requieren expertos tecnicos (para hidrologia) y economicos (para comerucakiizacion)
-proyecto de cria y engorda de conejos
-apoyo con maquinaria, capital fjo, capital ?? , insumos, capacitacion, etc (apoyos integrales)
-apoyo para obra civil!!!(
-25000 pesos por proyecto
-apoyos de programa 'integra' para que dentro de 10 anos sigan recibiendo apoyos. (capacitacion, exposicion,)

Water treatment infrastructure



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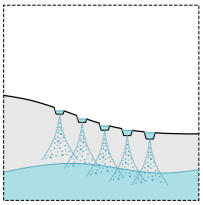
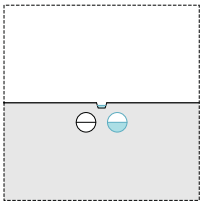
Water treatment infrastructure





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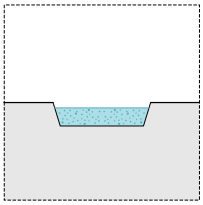
Water retention



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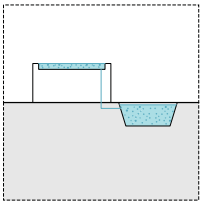
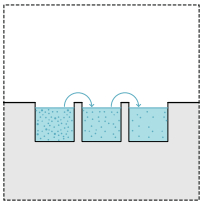
Water retention





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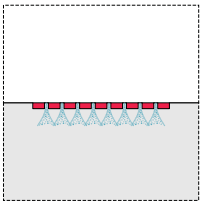
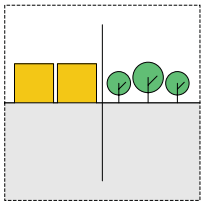
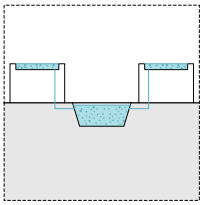
Groundwater recharge



-$

Groundwater recharge





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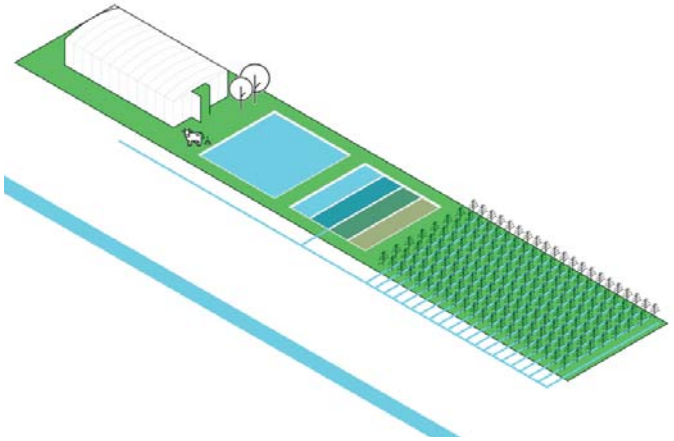
Agrarian development strategy
How to generate an autonomous source of irrigation water for food production



Jueves 9. recorrido. A la 11-00, 11:30
Soledad 86
56456528, cel. 5528104538

1. A que localidad pertenece?

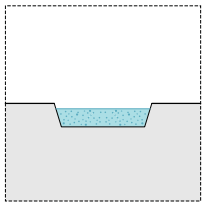
Nombre: Jose Romero Teran

Tamaño de terreno:
Cantidad de agua utilizada para riego: 2500 – 5000 l al dia

Tiene invernadero
Produce jitomate
Cria cerdos (80)
Semental coontagio a puercos
Metio 10 nuevos
Depende del agua para su negocio
Depende de agua pluvial
Pide pipa en temporada de sequia
Es organico pero no esta certificado
Los asentamientos infolrmales contaminan su fuente de agua
Sus vecinos ya lotificaron

San nicolas (pequeno productor) Jose
-Quiere hacer un proyecto que atienda temas de desechos solidos para preservar vegetacion y especies
-Le gustaria producir mas
necesita ayuda para la produccion y comercializacion
-Demanda apoyo del gobierno (acostumbrado de poducir a medias)
se le apoyo con un invernadero.

Local food production



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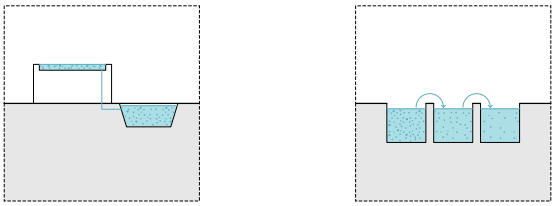
Local food production



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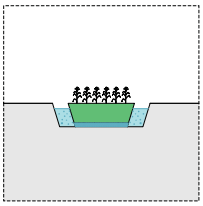
Renaturalize urban periphery



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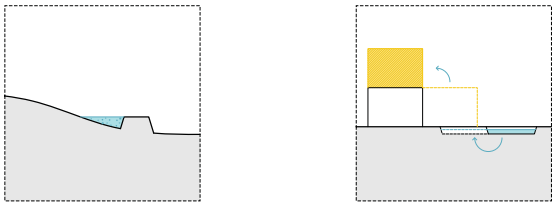
Renaturalize urban periphery



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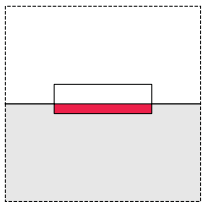
Decrease urban sprawl



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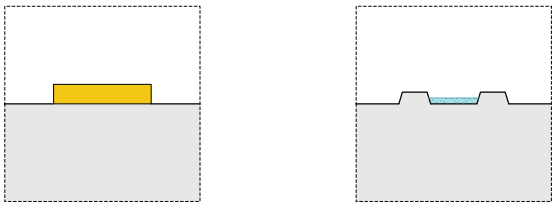
Decrease urban sprawl



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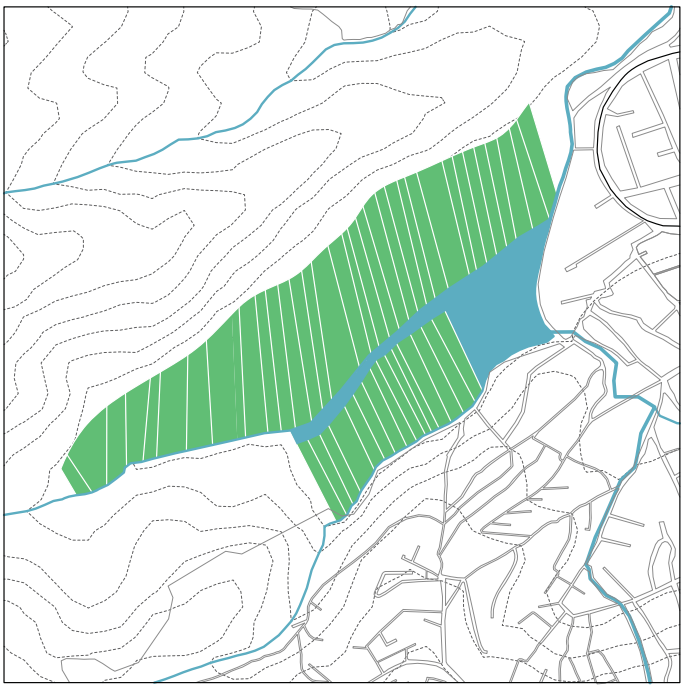
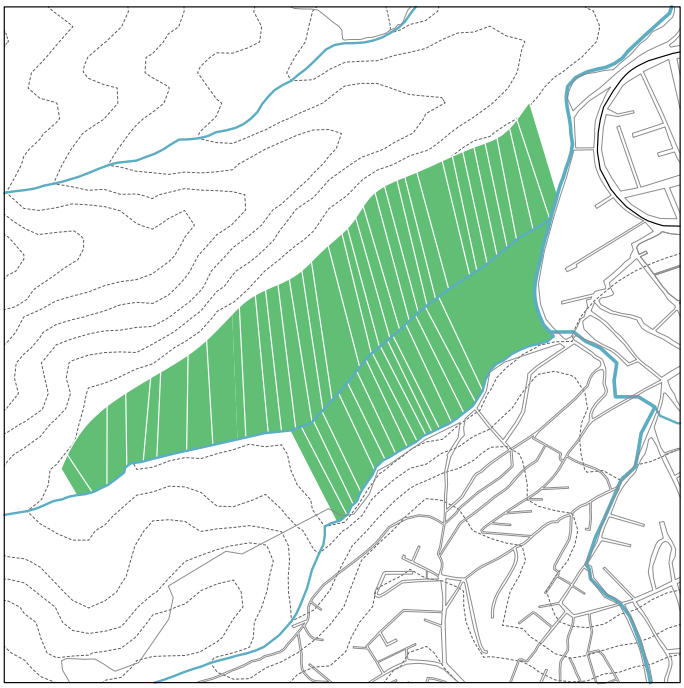
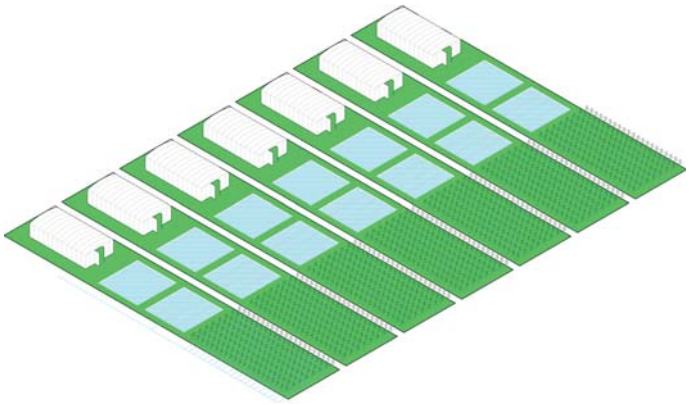
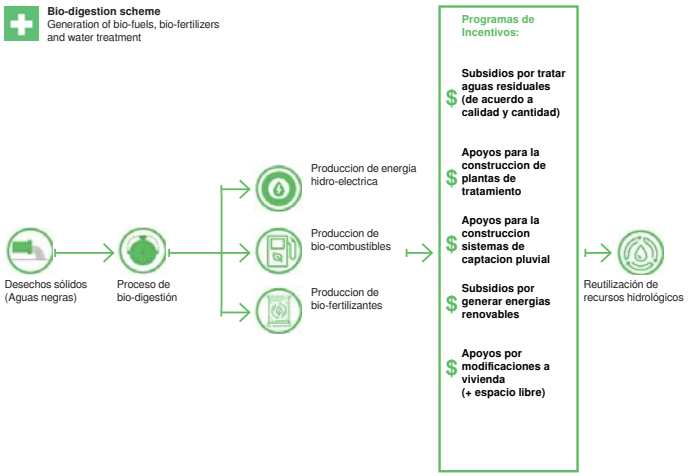
Farmer’s union strategy

How to finance transformations within agrarian landuse.









FEDERAL FUNDS:
Food security and public health program

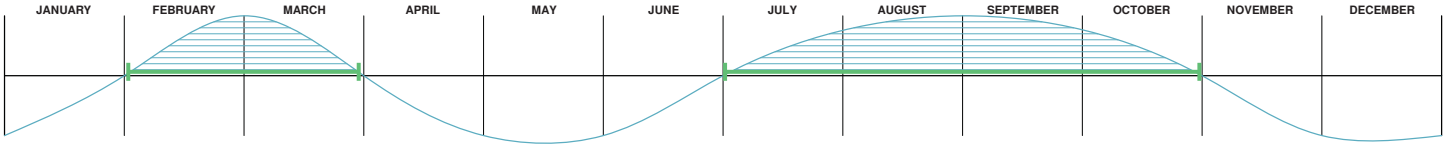
Funds for becoming a certified organic food producer (SEMARNAT)

FEDERAL FUNDS:
Water treatment program

Funds for returning clean water to the municipality (CONAGUA)

FEDERAL FUNDS:
Sustainable rural development programs

Funds for infrastructure construction and training (APARURAL)

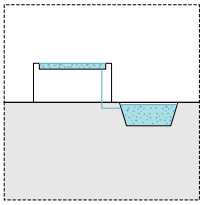


Housing redensification strategy

Neighbour cooperation to ensure correct urban water treatment

Nombre: Genaro Diaz

Housing redensification



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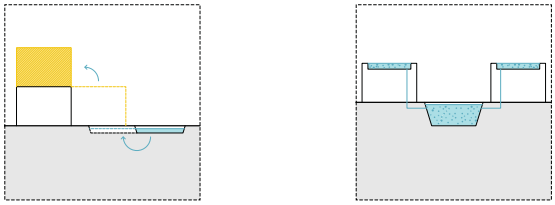
Housing redensification



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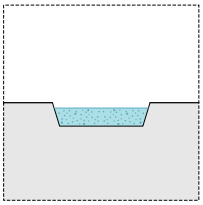
Cooperative housing scheme



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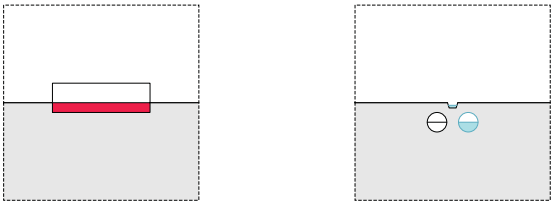
Cooperative housing scheme



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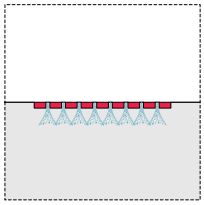
Redistribution of urban density



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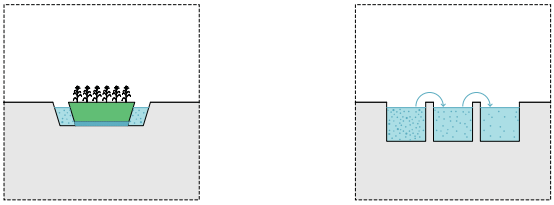
Redistribution of urban density



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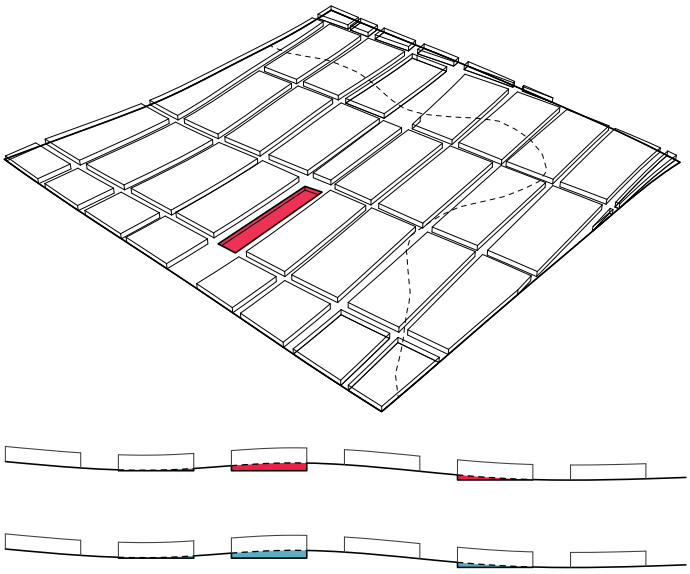
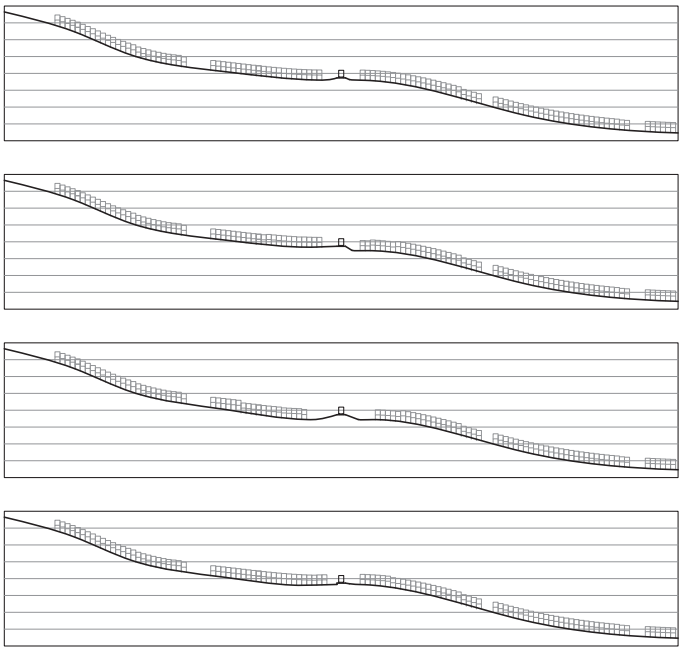
Public space and services strategy

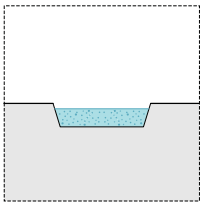
Neighbor cooperation to ensure correct urban water treatment



Nombre: Mario Lopez



Public space regeneration



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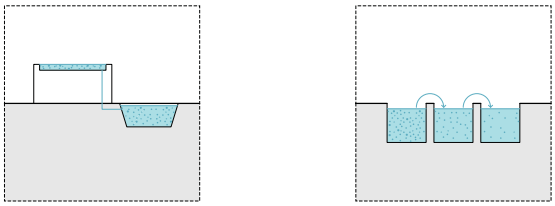
Public space regeneration



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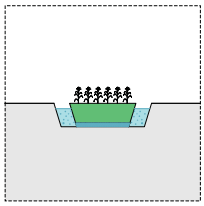
Decentralization of public services



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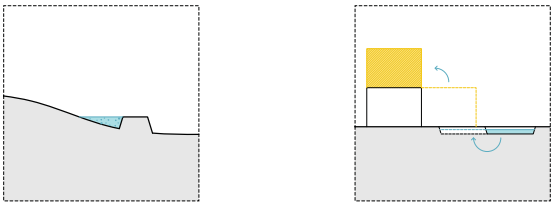

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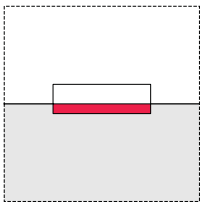
Creation of strong local economy



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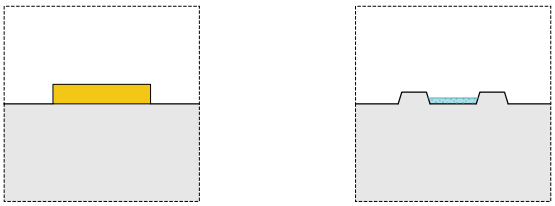
Creation of strong local economy



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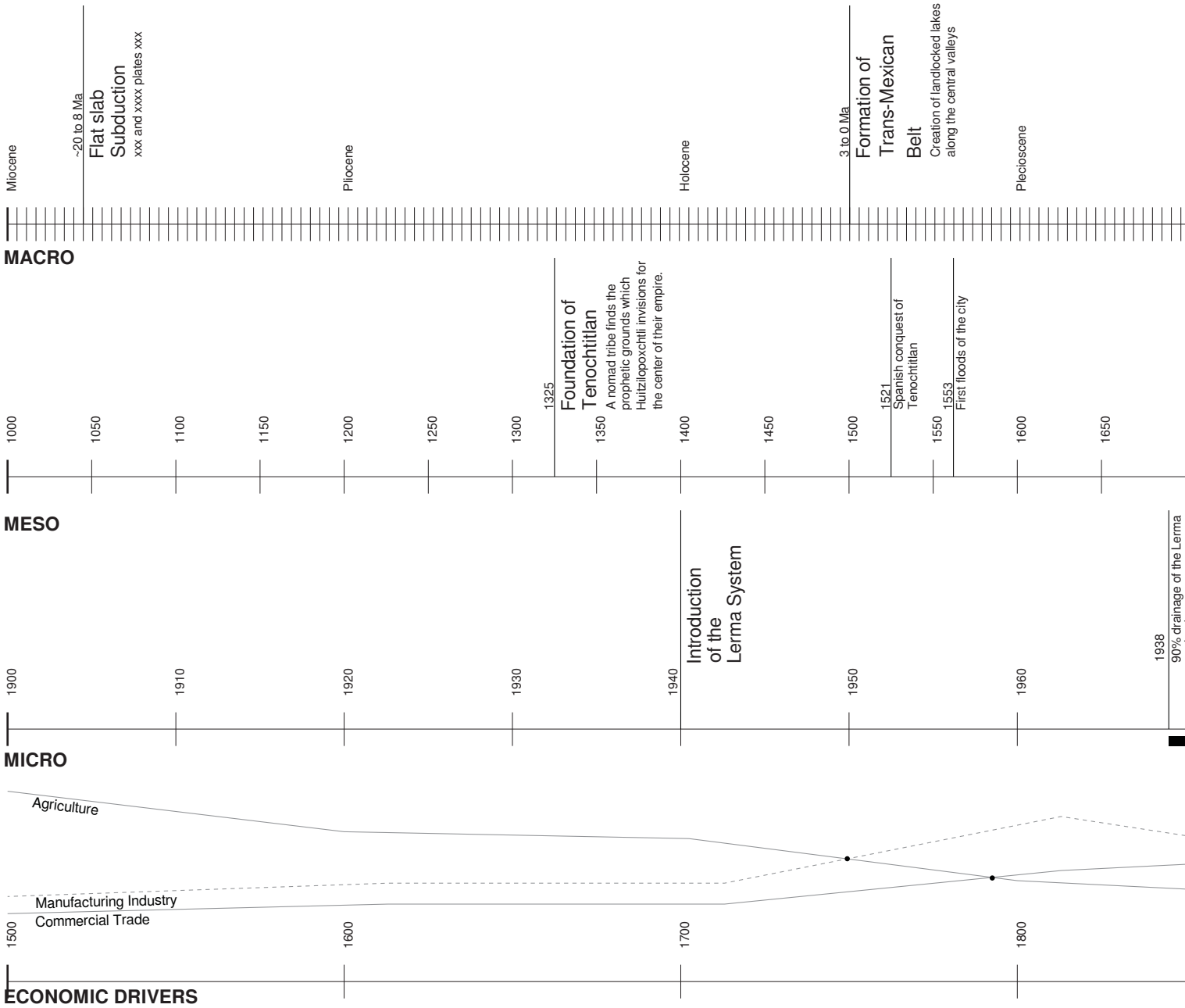
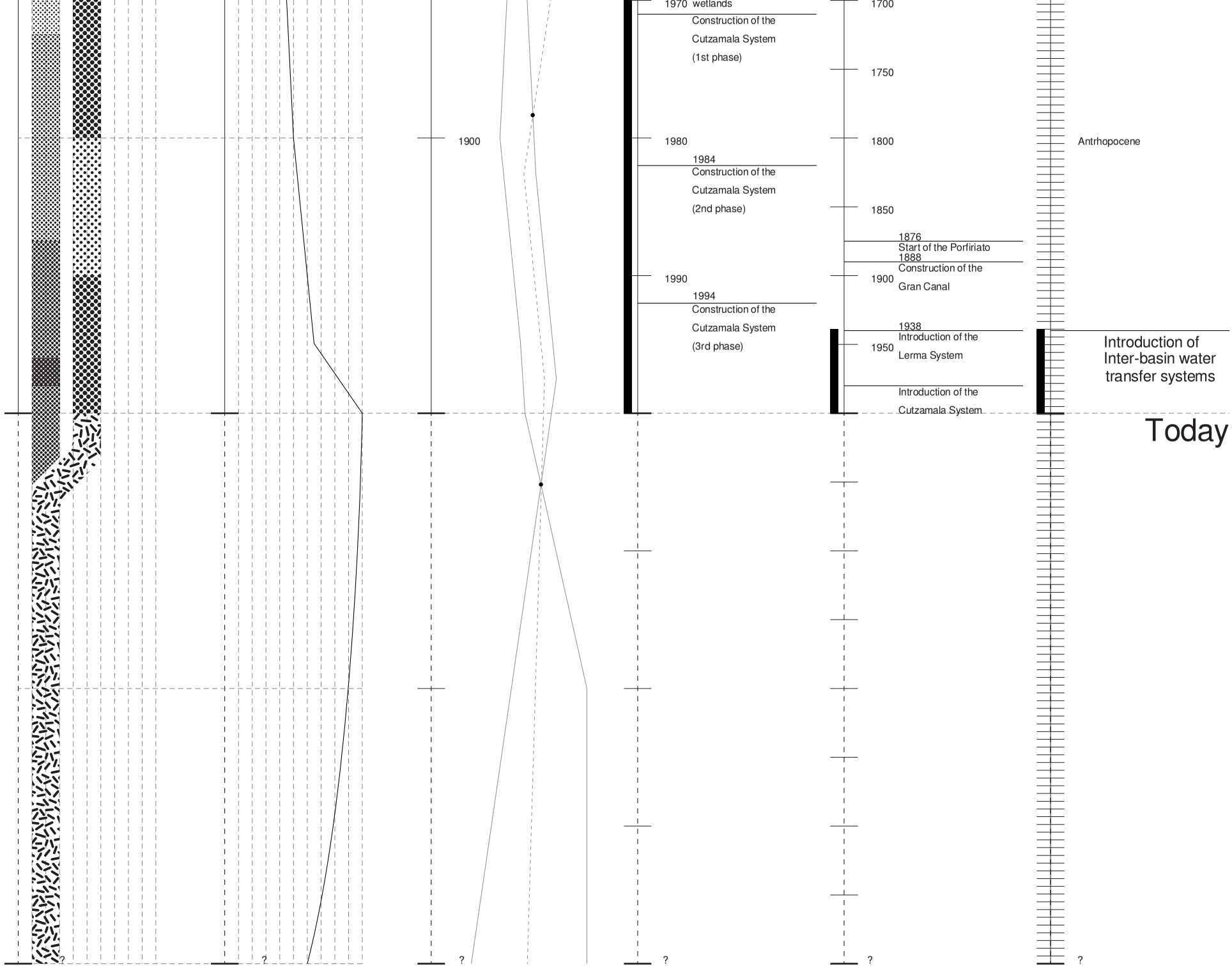
Temporal index

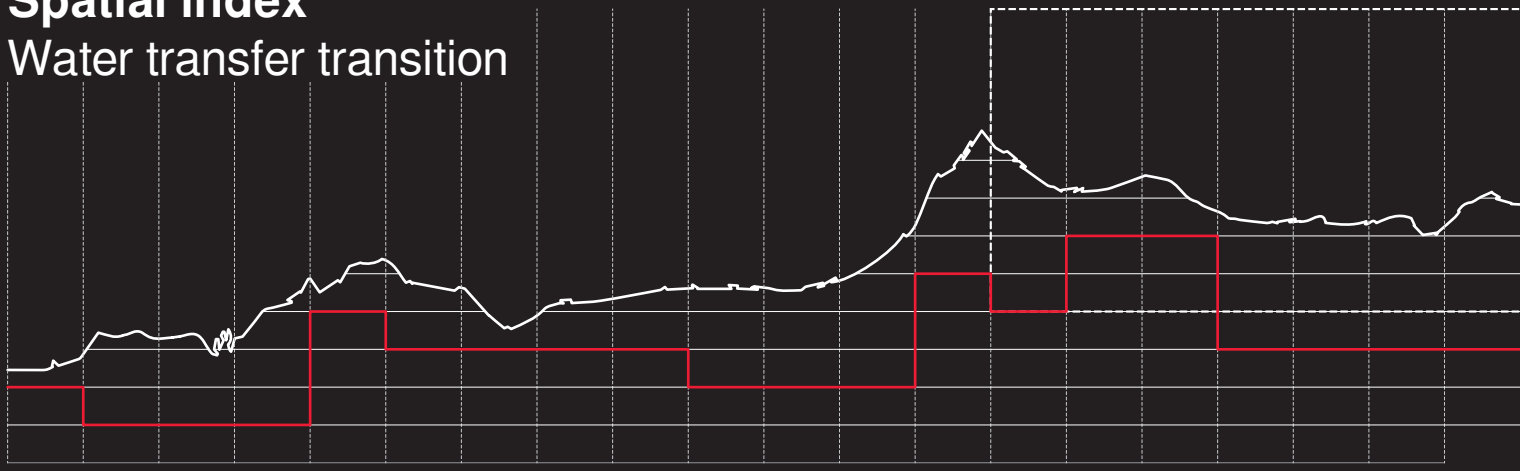
Transformation timelines

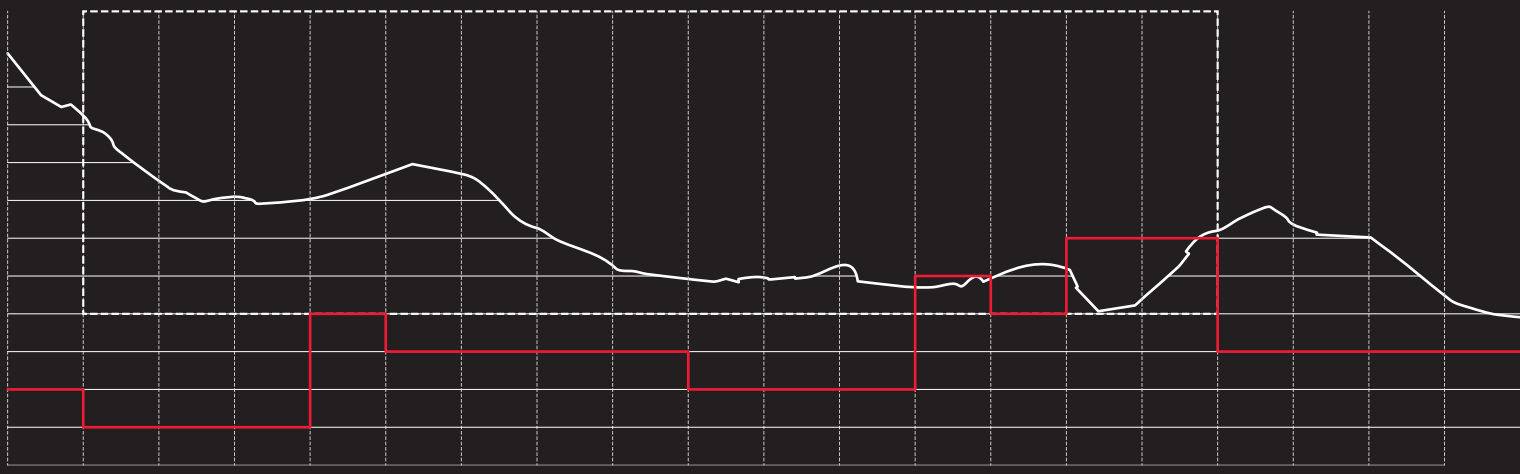


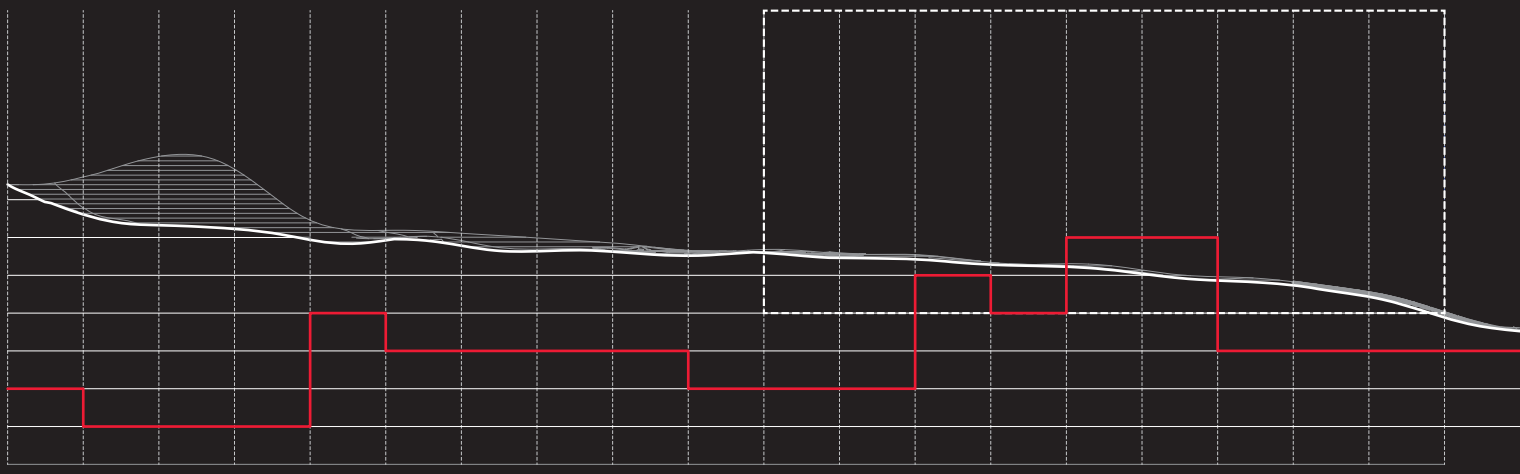

1970 wetlands
Construction of the
Cutzamala System
(1st phase)
1750
1900
1980
1984
Construction of the
Cutzamala System
(2nd phase)
1800
Antrhopocene
1850
1876
Start of the Porfiriato
1888
Construction of the
Gran Canal
1990
1994
Construction of the
Cutzamala System
(3rd phase)
1900
1938
Introduction of the
Lerma System
1950
Introduction of the
Cutzamala System
Introduction of
Inter-basin water
transfer systems
Today
?
?
?
?
?

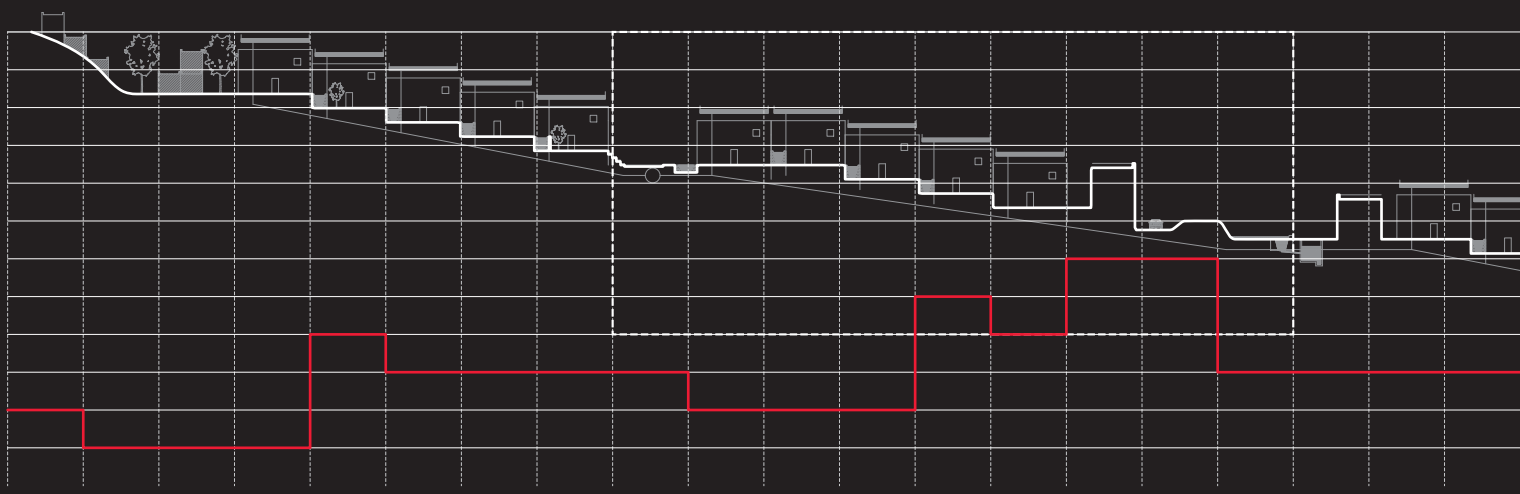
Spatial index

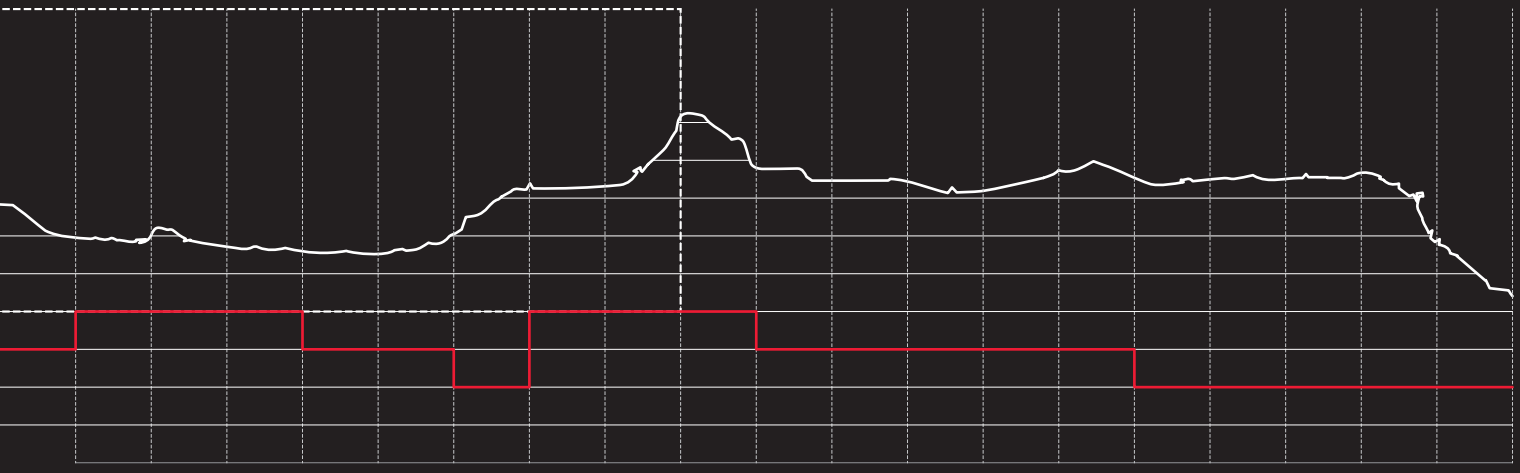
Water transfer transition

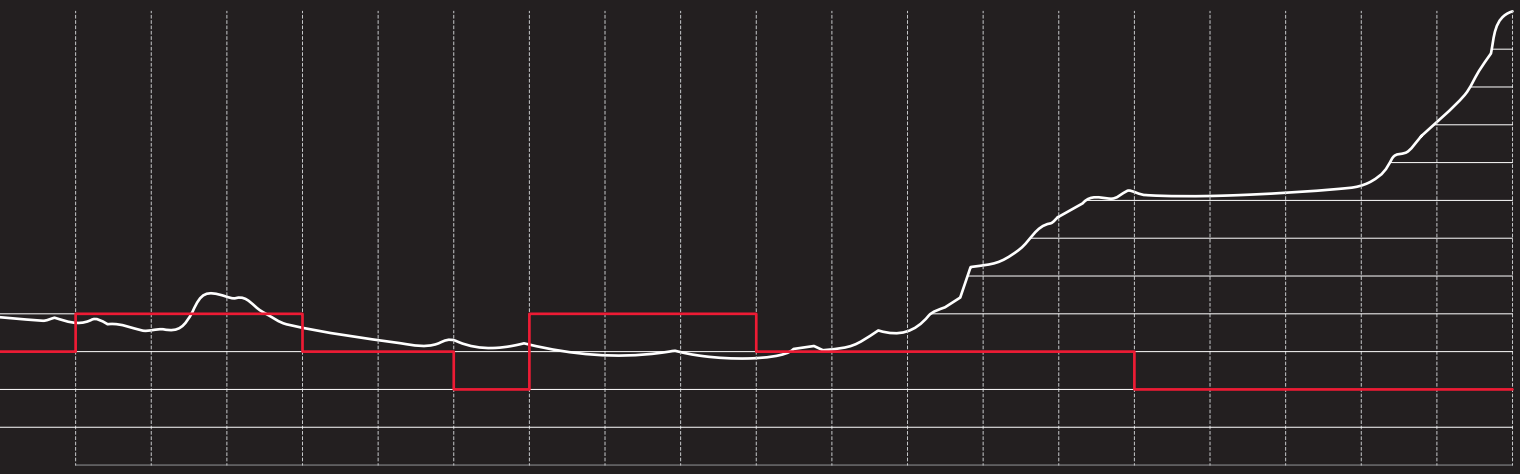


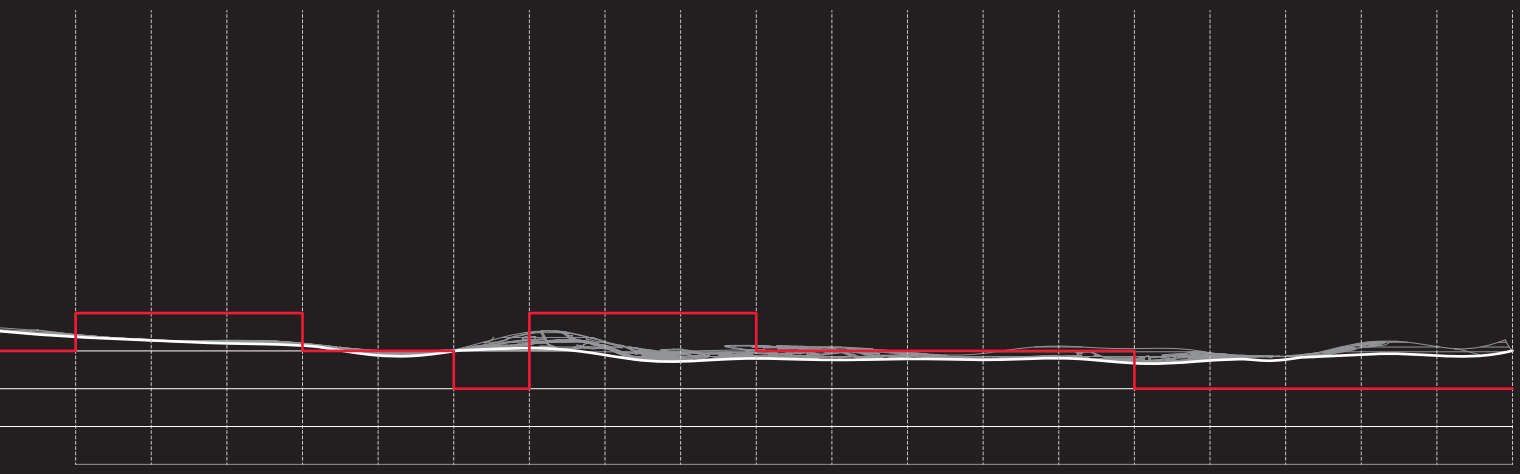


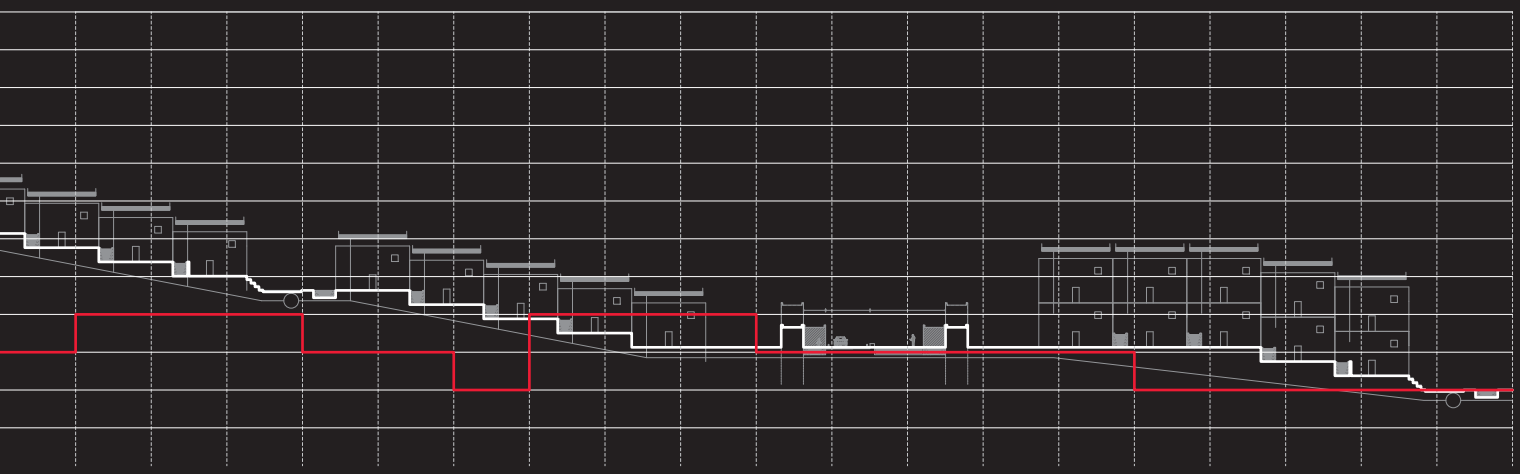












3.0 Conclusions & recommendations

Conclusions

What is urgently needed in Mexico City is a sense of union in which common goals can be reached via cooperation and mutual aid. As the city's demand for potable water increases, so does the continuous over-exploitation of it's neighboring hydrological regions. It is possible to transform the city's vicious cycle of governance, environmental action and collective action through short, medium and long term planing to achieve a more sustainable living environment for all the city's residents.

Water is a main concern for the future of the city, since it poses risks from many stakeholders. It's quality is under threat of contamination produced by car CO2 emissions amongst many other factors. Depending on ever-growing external sources for potable water to quench the thirst of a rapidly growing population is only a sign of destructive mindset, and therefore urgent measures to revert this process are necessary. The current dependency on external sources is indeed in a risky position: it cant afford to simply decrease the incoming amount of imported water since the demand for the resource keeps stable, or even worse, increasing. Ultimately, the infrastructure built for supplying water across such large region can be reversed into becoming irrigation infrastructure instead.

New housing developments in these risk prone areas also become an added layer to the complexity of the problem. This has ultimately created the need for housing redevelopment, restructuring mobility systems, public space improvement, and provision of public services. In the existing polarized society of Latin American cities, this is a common problem that enables urban sprawl to occur as the only way of finding affordable housing. Paradoxically, these areas show the highest requirement for safe potable water provision, and therefore must be taken into account when dealing with housing. This process has contributed to rural-urban migration process in many of Mexico's largest metropolitan areas, as part of the newer waves of industrialization and modernization programs that originally aimed to benefit the urban population.

Although many cities around this region present many risks towards climate variability and change, the path to adaptation is filled with opportunities which can restructure communities, households and local economies in direction towards a safer future. As previously explained, the social inequalities that accumulate in large cities may create a greater challenge,

As a consequence, further improvement projects should be dealt in a socioeconomically sustainable focus in parallel to technically oriented research on the matter. The governance levels that share a single territory, such as the Texcoco-Zumpango basin in Mexico require the cooperation and mutual aid of each of it's independent administrative units. Their political borders are often defined by their geographical condition and it's relation to the transformation of the city sets a crucial task: cooperation to safeguard mutual survival.

Further research is needed to properly design schemes which take advantage of existing efforts in other sectors concerned with climate change adaptation. In many cases this involves the cooperation between two extremely contrasting income level groups, which should ideally share benefits in order to function properly. Investment in plots with high land value often is looked for in order to bring more investment in the area, but under the ideals of climate change adaptation the investment should generate mutual benefits regardless of investment opportunities.

According to a study made by the world bank in 2010, a great portion of the southern half of Mexico and many Caribbean countries have been designated as 'Hotspots for Climate Change Risks' (Verner,2011) and as such, require to be set on a high priority level of action. This same organization has implemented measures for climate variability by assessing the vulnerability of socioeconomic groups and their capacity to cope in the presence of shocks and adapt to changing trends (Kronik, 2010). In regions where these measures are not yet mature enough to implement such assessment tools, a clear definition of the regions hydrological boundaries and sub-boundaries should be encouraged in order to give room for future assessment strategies.

Conclusions

As for Mexico, there are existing mechanisms for implementing assessment tools for climate variability which involve subsidizing fresh water supply and drainage infrastructure coverage in exchange of infiltration space in space occupied by housing. This way the residents receive a financial incentive to help transform their local environment. An economically feasible way of doing so, for example, could be through federal public health and food security program via integration with urban planning efforts to provide better public health through public space and services. But in order to succeed in these efforts, it must be made clear to authorities that vulnerability to climate change is not equally distributed and income-specific assessment must be adapted accordingly.

Whether it regards new urban transformations pushing towards degrowth or new forms of reclamation of rural land by collective landscape ownership, it is clear that the new ways of thinking are necessary to make our profession relevant in such an unstable and critical chapter of society.

Conclusion 01
Water autonomy may not be reached,but population can still be benefited from public health and increased urban centralities.

Conclusion 02
Community appropriation enables continuity

Conclusion 03
Planning culture must permeate public institutions

Conclusion 04
Short term actions can create a path dependency for long term objectives

Implementation mechanism findings

Finding 1: Agrarian clusters show great potential for:

-Limiting the city's growth,
-Provide a source of sustainable food secirity for the local population
-Create collective water treatment clusters
-Energy production for own use and gov sub (GANADEROS)
-Create a dependency on the local fresh water sources for food production

Possible federal funding programs:

-SAGARPA
-SEMARNAT
-PROAGUA
-APAUR
-APARURAL
-PRODI
-Cruzada Nacional por el Hambre (Federal Food Security Program)
-Publi - Salud (Public health funding program)

Finding 2: Local (private) water purification businesses show great potential for:

-Providing the local population with a potable water source
-Provide a local solution for im[proving the quality of natural water sources (Eslava river)
-Creating an attractive business opportunity for local entrepe neurs

Possible federal funding programs:
-SEMARNAT
-PROAGUA

Finding 3: The Public Space Authority's recent effort in water sensitivity has prompted the following:

-Creation of an urban planning office within the AGUA
-Creation of a Resilient development office
-Raised awareness on the situation hydrological performance

Finding 4: The adyacent neighborhood's urban structure calls for the following transformations:

-In relation to its centralities, the distribution of public space and public buildings,

Finding 5: The geomorphology of the area in conjunction with the urban tissue and historical infrastructure have prompted the following opportunities:

-Formation of micro catchment areas within:
-Concave street crossings
-Former train path embankment

Finding 6: Informal settlemts within the river-basin have increasingly deteriorated the quality …

Finding 7: Hosuing blocks that have inherited an ejido structure show great potential for:

-Cooperative housing systems that may enable local infra structure

Finding 8: Public space intersecting with the river streams may serve as water treatment infrastructure

-Private actors already invest in the FFCC as part of the "Circuito de la Salud", an initiative for providing public space that promotes healthy living (Fundacion Harp-Helu, Marti, Sports World, Interceramic)
-With the current implementation of the "Surplus Value Law", Private developers can potentially contribute to the areas gentrification process.

Further recommendations

Recommendation: A long-term research program aimed to monitor the city's aquifer levels and water quality to ensure inter-generational sustainability.

Recommendation: Establish a local hydrological region council in which neighbors and other local stakeholders can monitor their performance as a micro region within the context of the Basin of Mexico.

4.0 Reflection

Reflection

Until now, the research I have been conducting has led me to understand the potentials and limitations of water sensitive transformations as a strategy to overcome the effects that climate change poses to society. This relation between man and nature, however, became clearer to me as a mutually supporting relationship; not as a disease consuming its own environment in order to survive, but as a natural consequence of the decisions made by society as a whole that itself is occurs as a natural process. Based on the methods I used to dwell into this research topic, I arrived to conclusions that have made me reflect on the social implications as well as the technical and economic feasibility of implementing these water sensitive transformations.

The Delta Interventions studio focuses on adaptation strategies to counter act climate change, such as sea level rise, heat stress & drought. I chose to investigate the case of Mexico City, not only because of my personal attachment but because of the relevance of it's hydrological situation. When referring to the case of water scarcity in this context, climate change is seen as the absence of a vital resource rather than the presence of a physical threat. As I developed my research I became aware that the risks that a city like Mexico City poses are indeed related to climate change, but from this specific social context, the causes and consequences can be understood as a socially-induced water scarcity. This, in my opinion, is fundamental to take in account when dealing with climate change in a context such as Mexico. Until now, it has underlined the development of its current water management model.

I explored this topic throughout my research based on designing as a form of research, in which empirical studies can be tested and understood in spatial terms by geographical analysis and representation, or otherwise 'design thinking'. The methodology I followed for of this research can be structured into four main steps:

1 Theoretical research: philosophical inquiry of the defined problem
2 Design research: understanding of the problem through spatial reading
3 Community input & field research: re-evaluating the research objectives according to real case studies
4 Feedback loop to nourish design research

Based on this methodology, the starting point from which I confronted the problem in question was based on the motivation behind understanding the social implications of climate change. In retrospect, I believe that this is extremely important decision to make when conducting a research that seeks to guide the future transformations of a city: To question the ethical and social repercussions of designing urban water management systems. Within the formulation of my research objectives and hypothesis, the motivation was fundamental to drive my interest in the topic and maintain an open understanding of how fresh water is being supplied to the population of Mexico City.

'Design as Research' methodology

During the process of this research, I constantly re-evaluated my perception of Mexico City. I approached the design task not by making presumptions of an end-product, but by designing as an act of observation, analysis, and recognition. In the process of answering my hypothesis, I found that observation and mapping of the spatial conditions of the city where fundamental in order to fully understand how water is managed in the city. Doing this required a process of recognition in which the problem is not assumed and placed set as a stepping stone for scientific research, but as an end goal through which the process of recognition helps define the structural outline of the problem. The way in which I attempted to translate the initial stages of my research into a design oriented proposal is thanks to this research process.

Through this methodology, I became increasingly aware of the potentials that 'designing with nature' can bring to the city, specially its periphery. This required me to map and analyze the edge of the city and understand what constitutes the border between urban and rural. Doing this led me to discover the fact that while the process of transformation requires the introduction of natural infrastructure and simultaneously requires the reconfiguration of built space. While analyzing and designing the water system, a process of deconstruction of built space requires rules based on hydrological objectives for its reordering.

Reflection

Initially, my hypothesis was challenged when I began to look into the soil mechanic zoning scheme that the city currently uses as a reference for regulating built structures. This led me to assume that this zoning would ultimately define the initial parameters of my design: infiltration according to the stream conditions of water sources. Yet after constant exploration through design thinking methods, I came across more layers of information that define the basin's structural properties: soil type and infiltration capacity. From this point forward, I learned that the availability of water is relative its location in the water stream, and that all future design decisions should respond to this condition. 'Design' in this sense is understood as the process of analyzing space through the direct interaction of between a physical parameter and a reference for an objective. By recognizing the territory through reading its spatial characteristics, designing and outlining information on the map, I came to the conclusion that the distance of urbanization from the periphery to the virtual drain of the city (road infrastructure such as Anillo Periferico ring road) is a determining factor for understanding the challenge of urban water supply.

While mapping these conditions and arriving to conclusions of the basin's spatial structure, I found that the existing patches of green and natural elements can be organized according the role they play in the hydrology of the basin, and as such reveal themselves as components of a system. This led me to understand that the subject of design is a system of natural elements that serve as a backbone for urban water management. In this sense, the design proposal is not limited to a single object or location, but a system in which rules and parameters are designated according to geomorphological structures and socioeconomic values. Doing this allowed me to find the relations between the different scales of the urban system and the relation to the context of the city and the region.

Reflection on field research

After arriving to the first set of my research conclusions, I extended the research methodology into an in-field process of interacting with local authorities, residents and interested parties to further specify the variables that take part in the problematic. In order to link my research with real case studies, I had to understand in what ways the population and authorities can mutually benefit each other through the process of urban transformation. I approached the local environmental development departments of the concerned districts of the Magdalena-Eslava sub-basin to learn about the ongoing projects and efforts that are already being done in the area, and found out that there is a lot of interest in supporting the rural communities growing in the area.

From this point forward, I guided my research by contacting various concerned stakeholders of my project area. This became a crucial part of my research since it placed limitations to my research based on real feasibility mechanisms and the reality of this society. Given that the risk of depleting or polluting the city's drinking water supply ultimately it affects the social well-being and economic prosperity of the city's residents, the local community, government officials and independent interested parties provided me with new insight of how they could become affected and ultimately benefited from the re-evaluation of the city's water management system.

The methodology used to research the situation of urban water management in Mexico City also determines the political process of urbanization. In theories relating to 'open government', a model of participation in which education plays an important role in bringing the community together for political organization. While researching this aspect, I realized that power mechanisms and governance are central to this research, given the trans scalar relation between water provision and urbanization regulations.

Based on the information directly gathered from stakeholders, I restructured my objectives since these seemed to fit a generic urban transformation plan. By learning first hand what the needs of society are at an immediate scale, I was able to understand the direction which the project could take in order to meet the large scale objectives of achieving water autonomy in the basin. In segregated social context such as the one corresponding Mexico City's periphery, the strategies to implement urban water management require the constant input and feedback from the local population and responsible authorities.

Reflection on future directions of the research

Given the current state of ecological and political instability in which Mexico is submerged in, it is reasonable to affirm that in the coming years Mexico City will have to act 'without warning' and propose a change to it's current water management system. From what I've researched, the trend from authorities is to intensify the ongoing process of inter-basin water transfer in the Mexico valleys through strengthening it's centralized infrastructure. Since the reasons behind this are mostly economic, it is possible that a project which promotes decentralized and natural methods of water supply and management would be of lesser interest to invest in, given the time it would take to reflect significant changes. It is practically certain that authorities would prefer a more immediate solution to safeguarding potable water sources for Mexico City which would accelerate the construction of water extraction infrastructure in the region.

Until this point in my research, the results I have obtained have led me to conclude the following points:

1 Given the large population of the city, the strategy to utilize own sources of fresh water will require much more time to fulfill than I first presumed. The current rate at which the city's water supply system succeeds to provide the water from external sources, along with the increasing levels of air and water pollution and other external factors, put the city in a high risk. Nevertheless, implementing such transformations would still bring the added benefits of harvesting water from local sources. While the objective of gradually replacing the supply system may not be met under the current structural policies, the change in supply systems can help empower of the community.
2 The requirement for re-densification in the city's periphery is currently challenged by an increasing demand for housing as well as an unequal capability to pay rent. The required density that a hydrologically sensitive urbanization process would need to be a significant support for the city's water supply would have to be so high that the community risks an acceleration of the gentrification process and deterioration of the community.

3 The possibility to have a reliable source of food to supply the rest of the district is also challenging due to other environmental risks of the Mexico Basin. Air quality, being of great concern in recent years, puts a high risk on the quality of water and consequently food production industry. In order to motivate the development of local agro-industrial economies in the city's periphery, the quality of air and water is fundamental to become reliable. Safeguarding water for irrigation as well as properly remediating contaminated soil are central challenges required to accelerate the process of re-naturalizing the edge of the city. This would need additional research and efforts working parallel with these type of projects.

4 Lastly, although several legal and financial mechanisms exist that could help enable such transformations, the priority of this problem is not yet on a national level, which might be the reason for the ongoing budget cuts that the federal government does to education, science and cultural development. The need for the national authorities to realize the importance of education in these matters is of upmost importance and should be central to any attempt to change the direction of the city's agenda.

The possibility of changing the relationship between the urban and rural environments can be first met through reconsidering the philosophical approach to dealing with climate change in Mexico. Our understanding of the way life is in cities is becoming unsustainable must be challenged by observing the social dimension of climate change, questioning ourselves what responsibility society has to reorder itself in order to find balance with it's environment. It is important to say that the motivation and end goal of this research is to understand the benefits that urban systems can have on society and the power that the population holds to change their environment through the introduction of natural systems as a support for their everyday lives.

The findings of my research changed my opinion regarding the feasibility of implementing such large scale urban transformations to Mexico City. Although this would require great effort from the authorities and the general population, the fact that the risk of loosing autonomy to a vital resource concerns society as a whole has made me believe that adaptation is possible through collective organization and mutual support between the communities inhabiting the Mexico Basin.

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