Collaborative Systems

Water-Landscape Commons Shaped by Community-driven Resource Governance for Drought Resilience in the Tagus Basin

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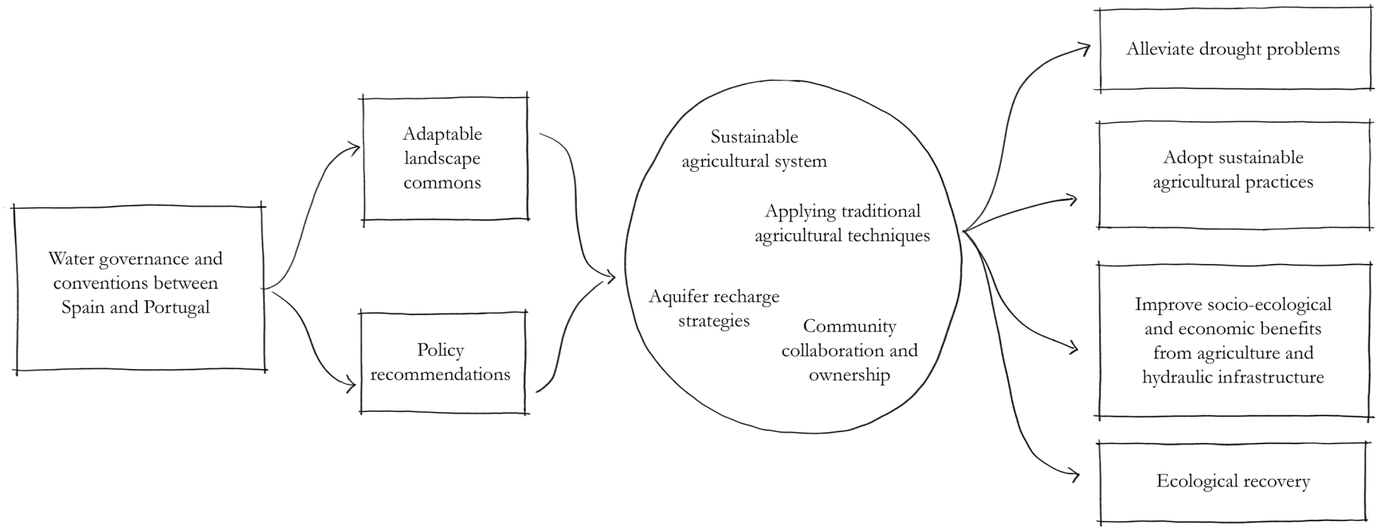
"What should shock everyone is that governments, public administrations and companies continue to turn a blind eye to these risks and base their planning on increased water use."

- Teresa Gil, WWF España

"Irrigation is not to blame..."

- Andrés del Campo, Fenacore





Landscape Urbanism and Personal Interests

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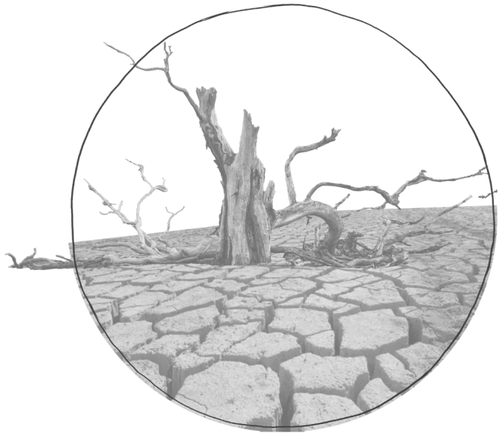
Despite the Tagus being the largest river in the Iberian Peninsula, spanning across Spain and Portugal, the basin struggles to maintain groundwater levels, contributing to the annual drought problems.

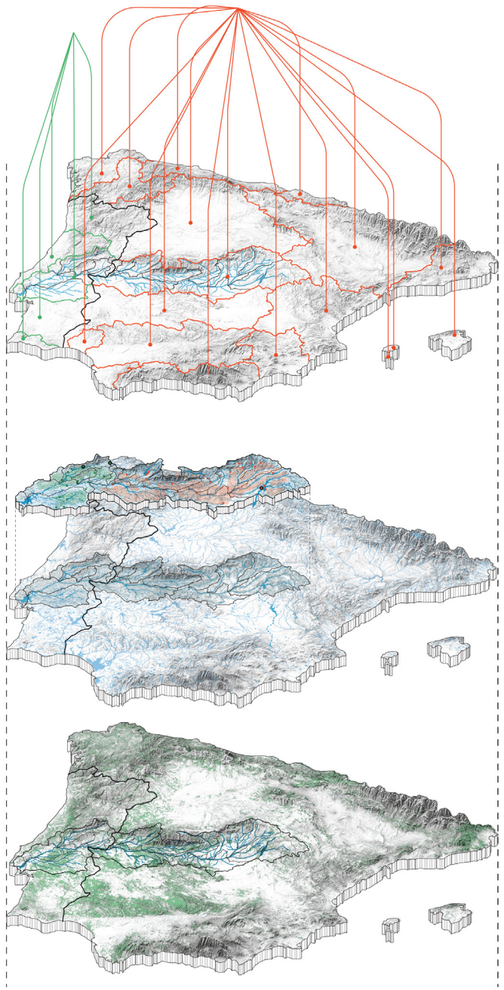
The lack of collaboration between the environment, society and resource governance, on a global scale, has been a detriment to the state of the climate. This persists on smaller community scales, further exacerbating the situation. A common problem amongst the situations in the Mediterranean is the impact of large-scale agriculture across the landscapes on groundwater recharge, making these places extremely vulnerable to more droughts and even desertification.







Problem Statement



Systems of Governance

Systems of Society

Systems of the Environment

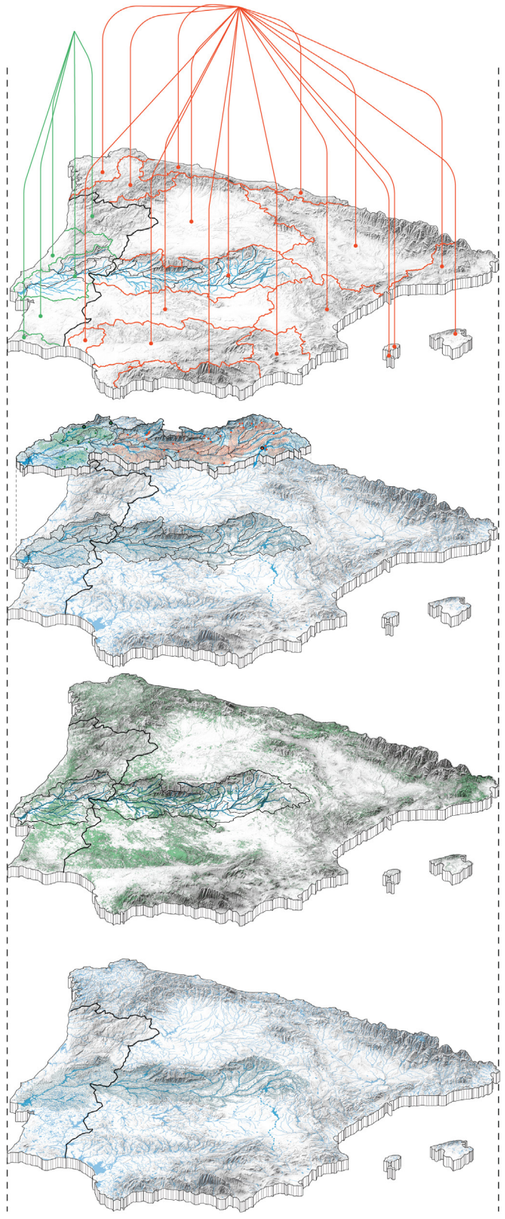
I : landscape as a medium

Systems of Governance:
- How did the authorities react to society's actions?

Systems of Society:
- What were the main human activities that contributed to the changes to these environment?
- How did people react to the drought situation?

Systems of the Environment:
- What are the changes to the environment in the Iberian Peninsula that contributed to these droughts?

Methodology and Research Questions



II: landscape commons as a connecting factor

Systems of Governance

Systems of Society

Systems of the Environment

Landscape Commons

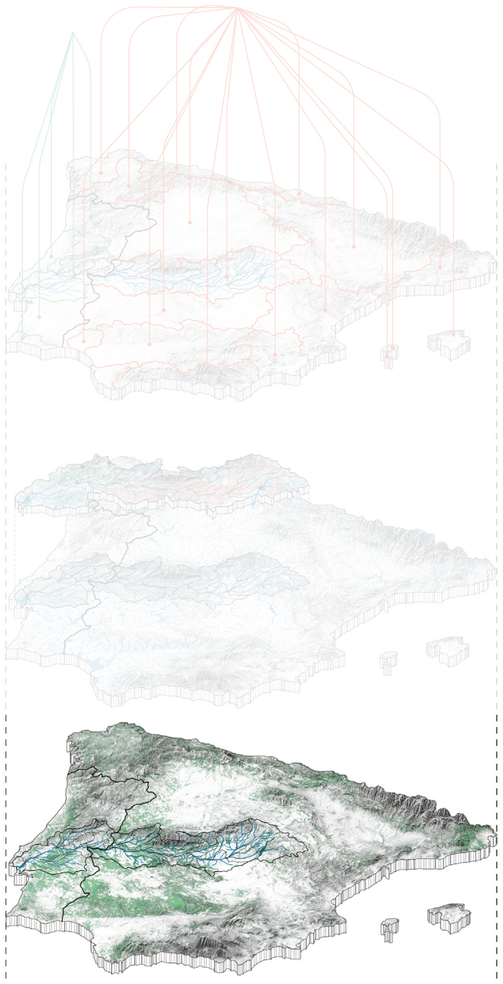
Systems of Governance:
- What are the responsibilities of the different communities and stakeholders in this collaborative system?
- How can progress and conflicts be managed when building the water-landscape commons?
- What long-term and short-term governance strategies can be used to achieve the collaborative potential of the water-landscape commons?

Systems of Society:
- What are the rules and boundaries of the commons?
- What are some principles and strategies that the community can use to build the water-landscape commons?
- How can cultural landscapes become part of the commons?

Systems of the Environment:
- How can the drought situation be alleviated with the management of water-landscape features?
- What are part of the water-landscape commons (and partial commons)?
- What long-term and short-term environmental strategies can be used to achieve the collaborative potential of the water-landscape commons?

Methodology and Research Questions

What are the changes to the environment in the Iberian Peninsula that led to these droughts?



Collaborative Systems of Governance

Collaborative Systems of Society

Collaborative Systems of the Environment

Analysis: Systems of the Environment

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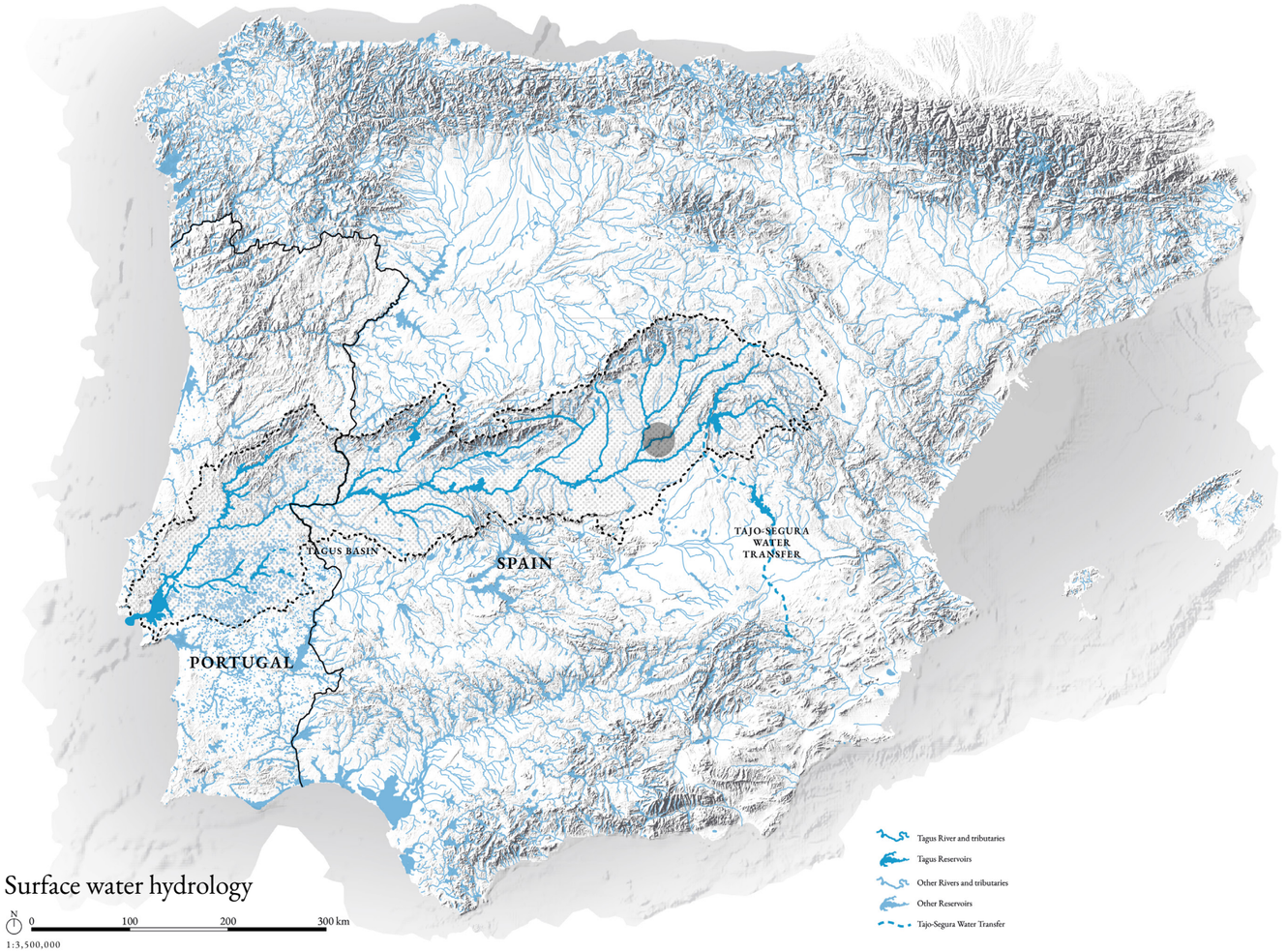


Surface water hydrology

Broadleaved and semi-deciduous forests:
Forests, based on 2022 data, around water sources can help reduce evaporation and maintain moisture of an area.

276.67 — 0.00

Soil permeability:
This estimated subsoil water content level is calculated based on soil permeability data. The higher the estimated water content, the higher the soil permeability.

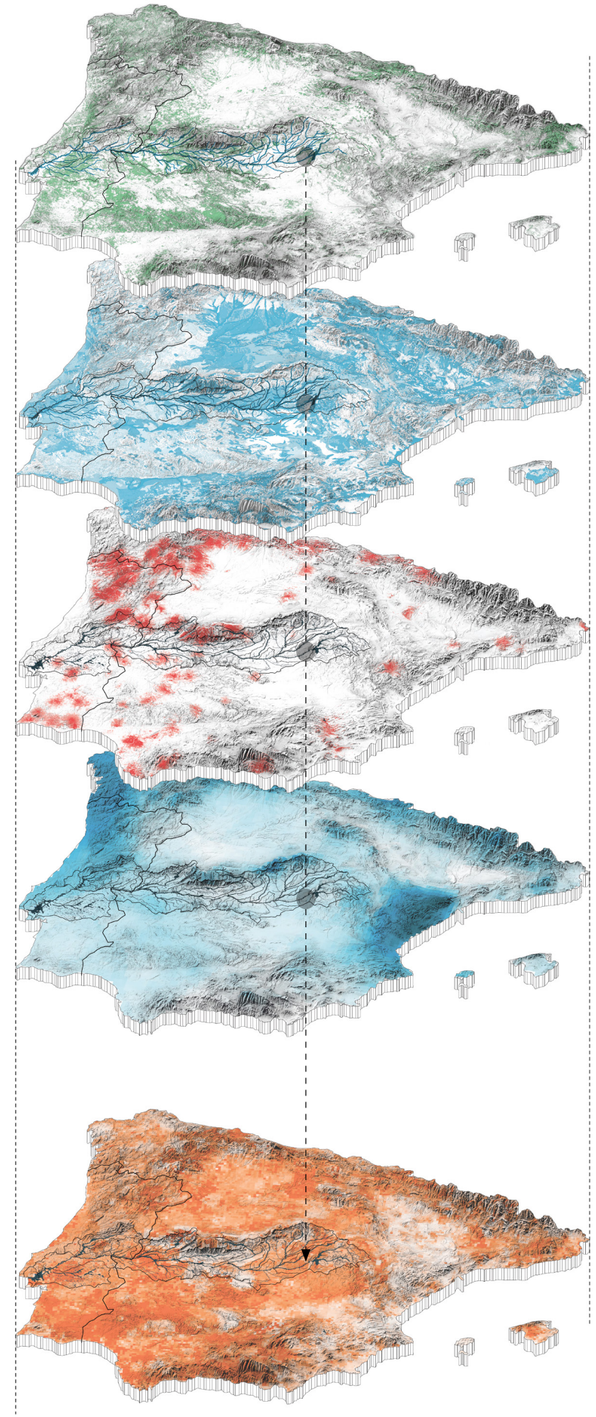
Burned areas:
Satellite estimation of areas where fires occurred in 2022 (typically from slash-and-burn agricultural practices).

1200 - High — 0 - Low

Average annual precipitation:
Calculated average based on precipitation across several 36 days in the year 2022.

7 - Extreme drought — 0 - No drought

Combined Drought Indicators (CDI):
Drought intensity experienced across the peninsula in 2022.
Despite the Tagus River being the largest in the Iberian Peninsula, spanning across Spain and Portugal, the basin struggles to retain water at a subsoil level, which contributes to the annual drought problems.
The lack of aquifer recharge and low groundwater levels are the secondary causes of extended droughts in these areas.



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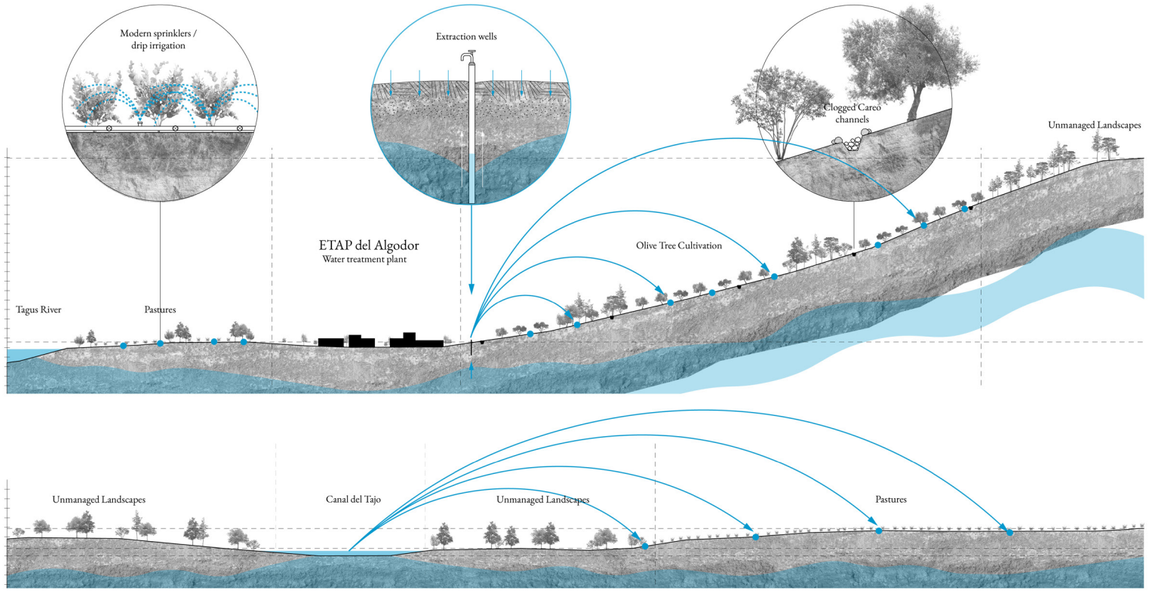
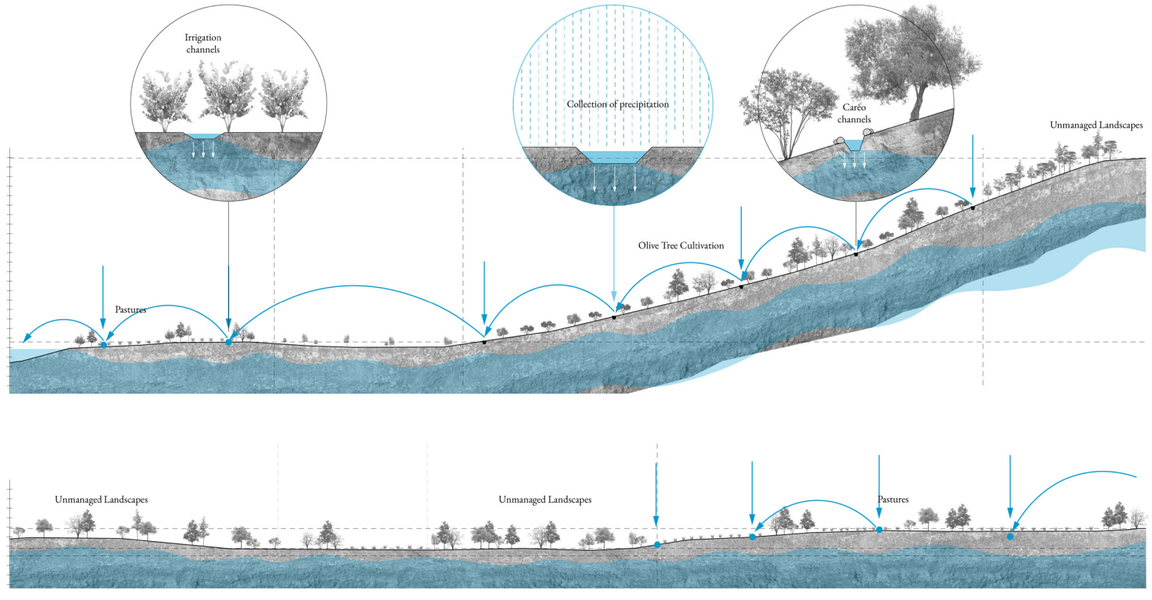


Water regime of today



Water regime before modern Iberia

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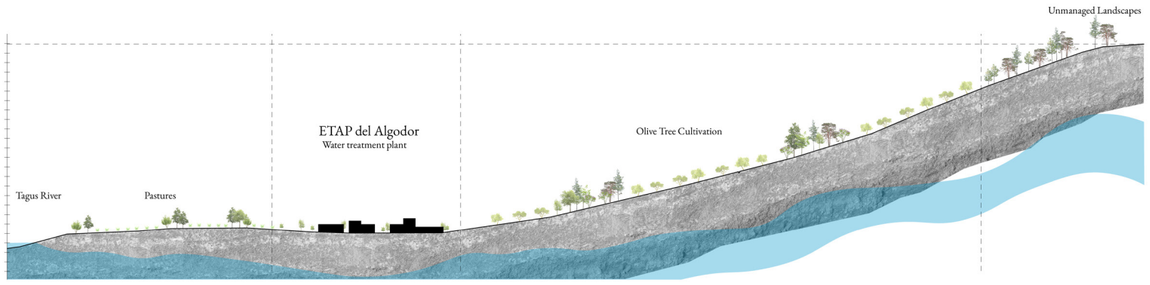
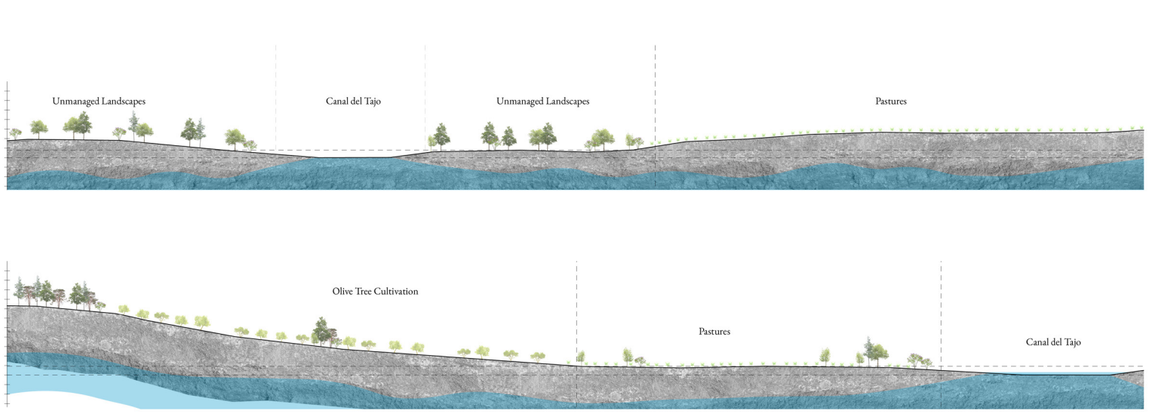
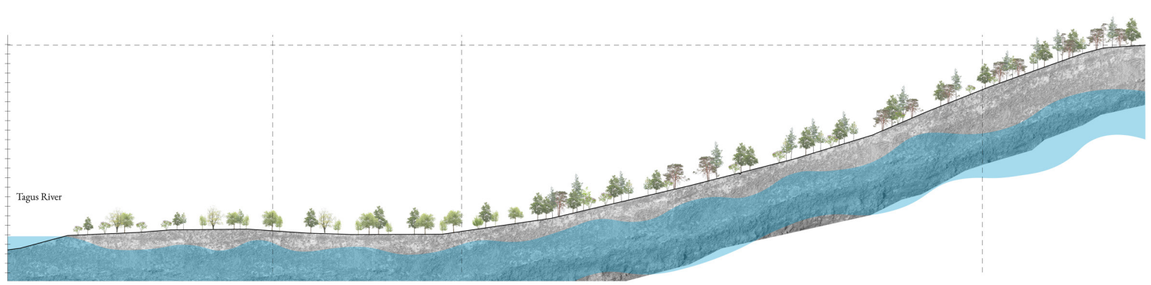
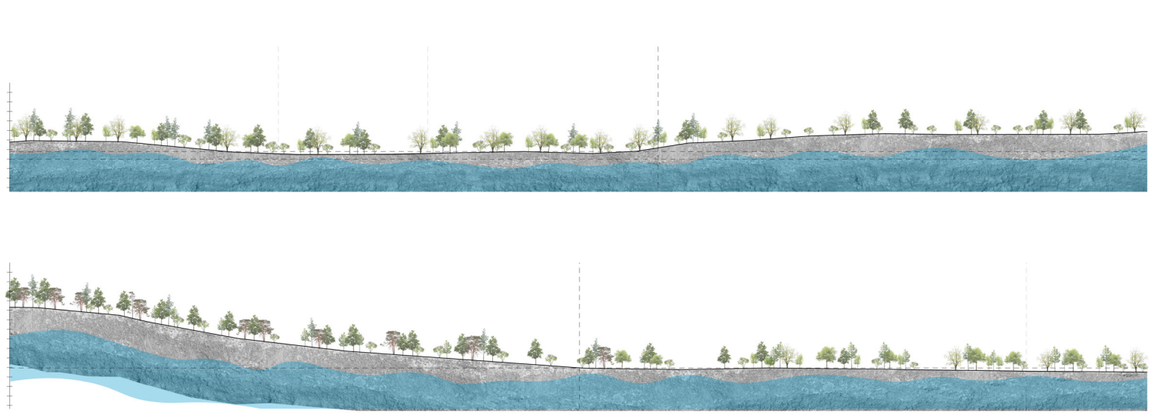




Vegetation of the landscapes now





Potential Natural Vegetation

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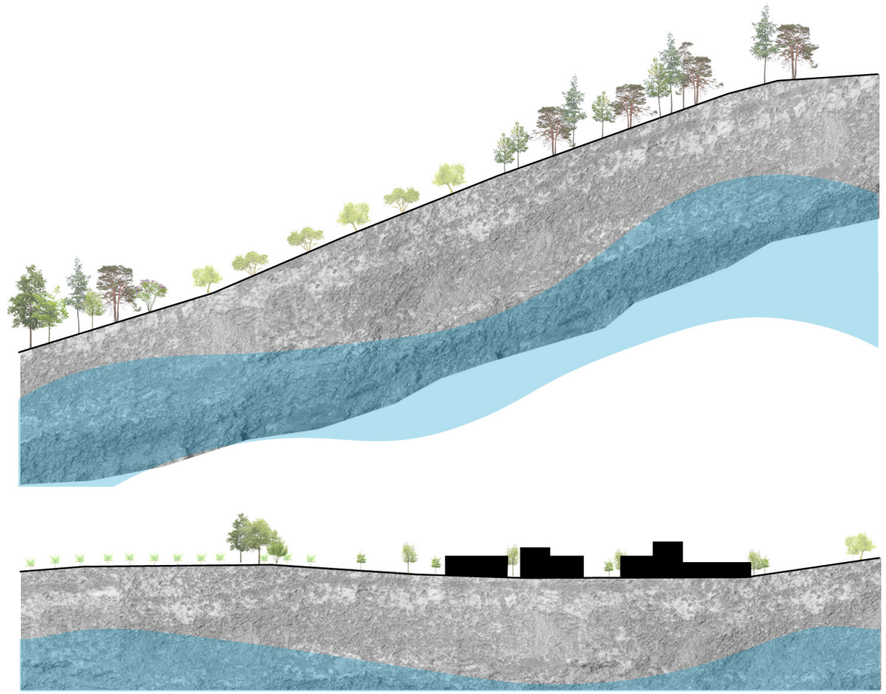

Vegetation composition of today



Quercus ilex

Quercus pyrenaica





Fraxinus ornus



Pinus sylvestris





Flueggea tinctoria



Pinus pinaster





Hordeum vulgare sp. (Barley)



Triticum sp. (Wheat)





Olea europaea (Olives)

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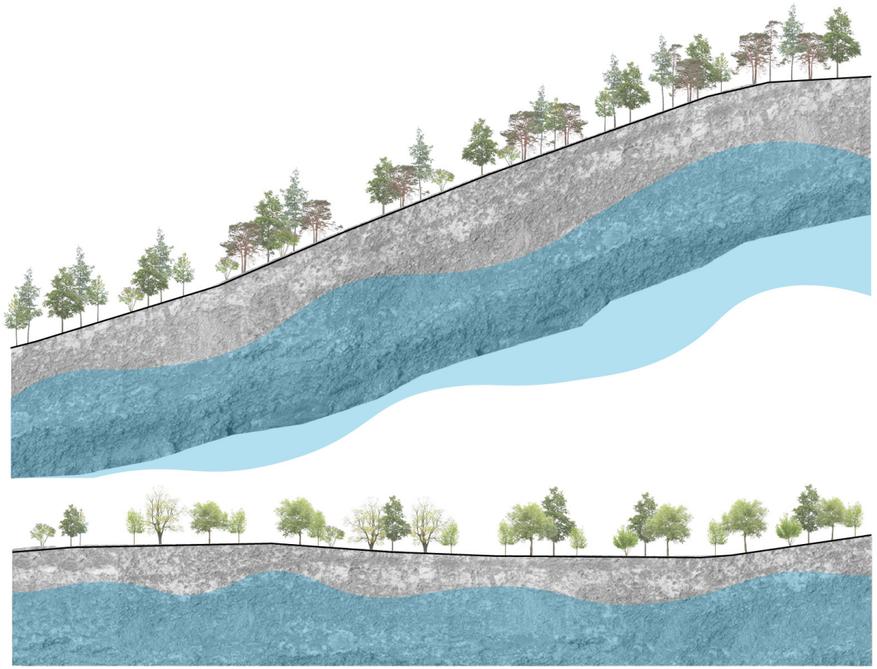


Vegetation composition according to Potential Natural Vegetation study





Quercus ilex



Quercus pyrenaica



Quercus faginea subsp. broteroi





Abies pinsapo



Flueggea tinctoria



Pinus pinaster





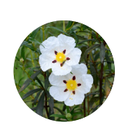
Fraxinus ornus



Quercus suber



Salix pedicellata



Cistus ladanifer



Nerium oleander



Image source: Pedro Miguel F.A Patrício, 2012. Acessed via https://commons.wikimedia.org/wiki/File:Ribeira_da_Safareja_em_Agosto.JPG

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Image source: Jorge Cancela - Cazorla, 2014. Acessed via https://commons.wikimedia.org/wiki/File:Cazorla_(14091642828).jpg

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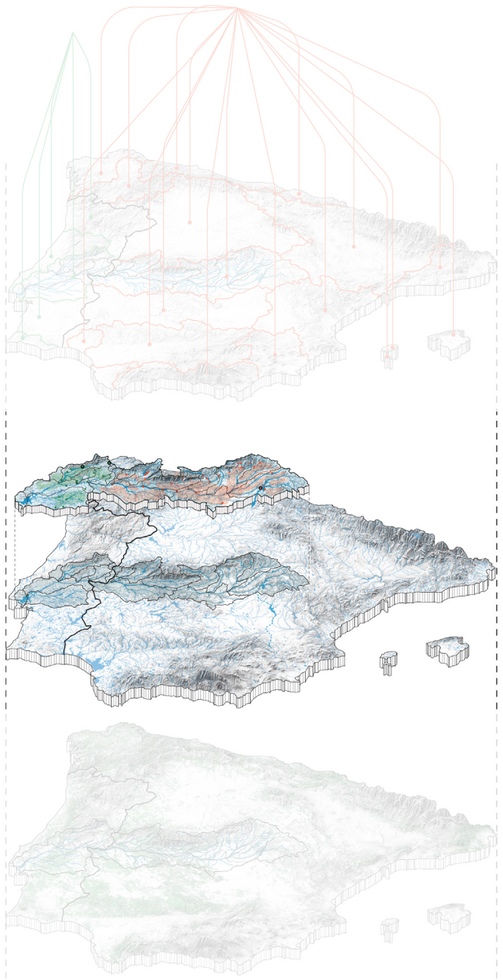
What were the main human activities / cultural changes that caused the aforementioned changes?



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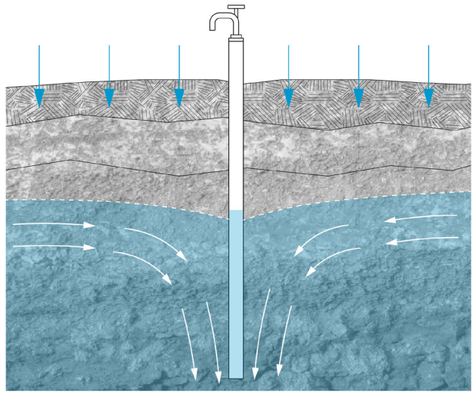
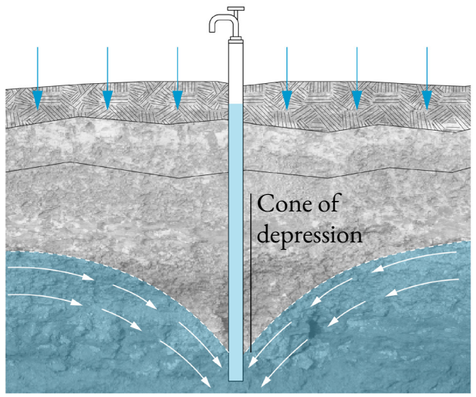
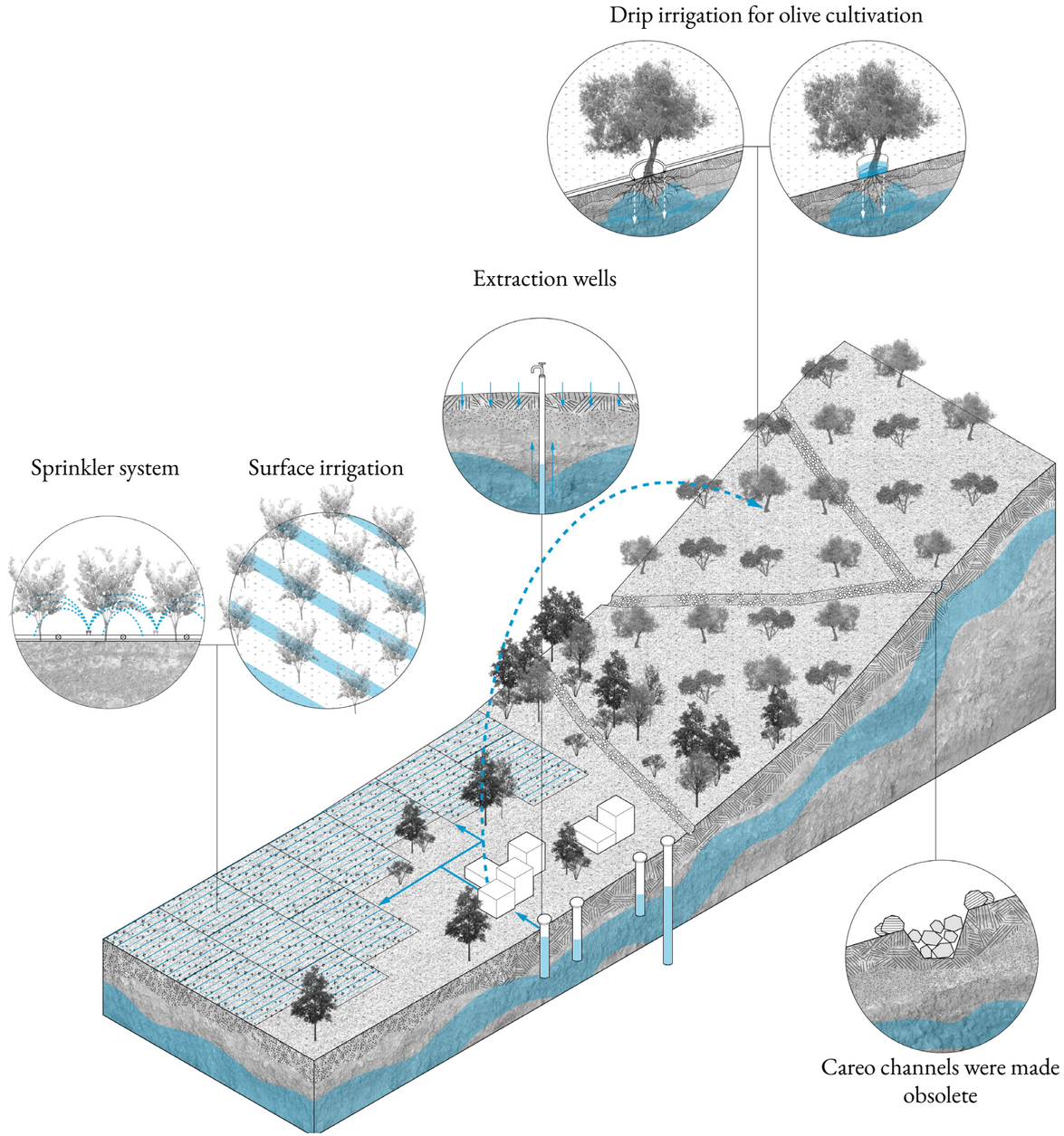


Regular water extraction from extraction wells



Illegal / over-extraction from aquifers



Careo channels were made obsolete

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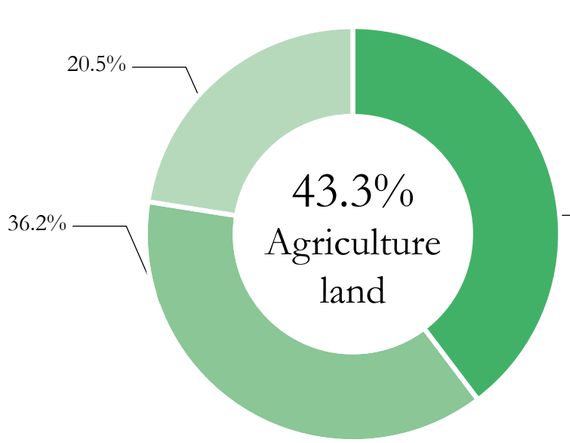
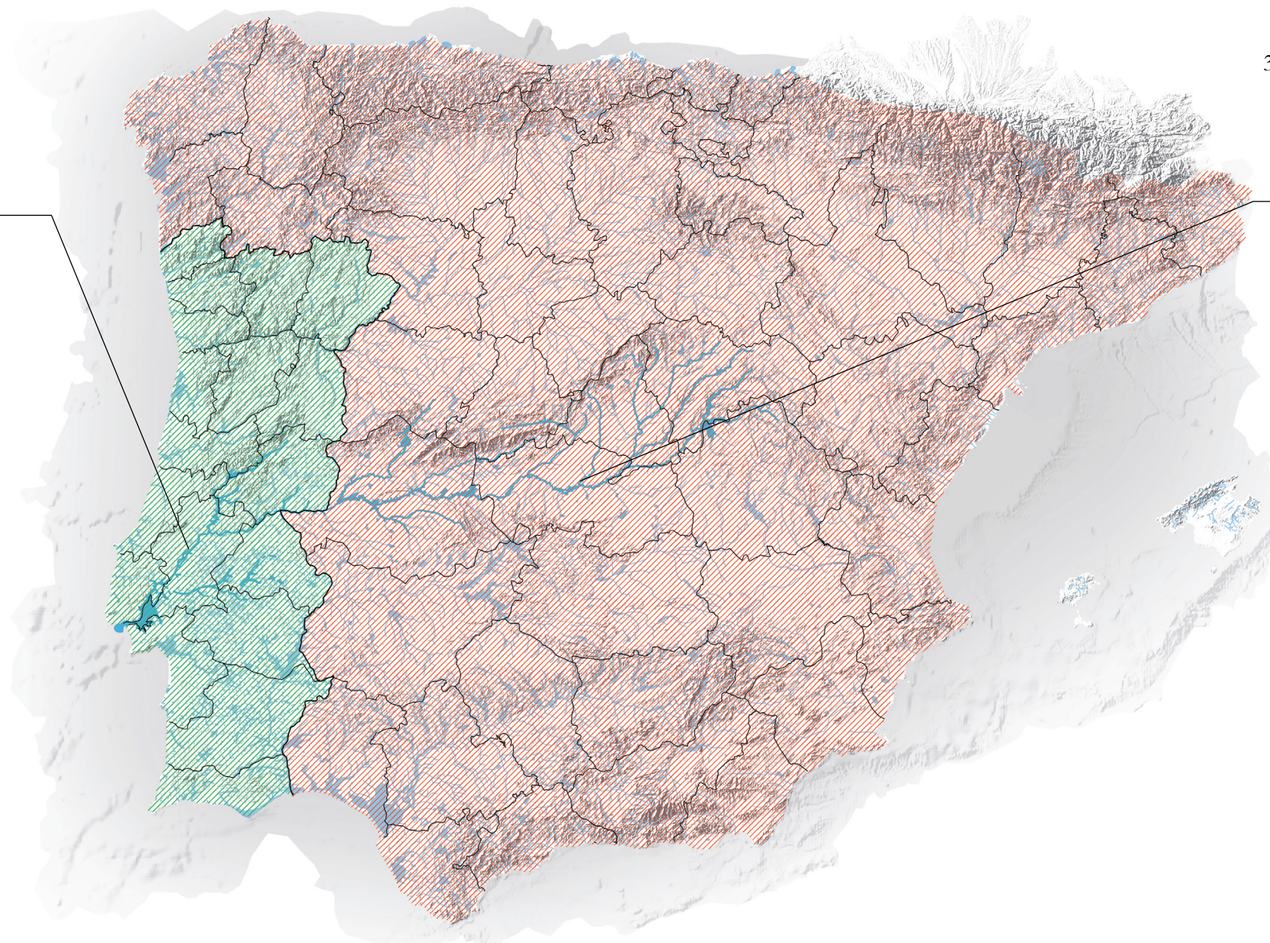
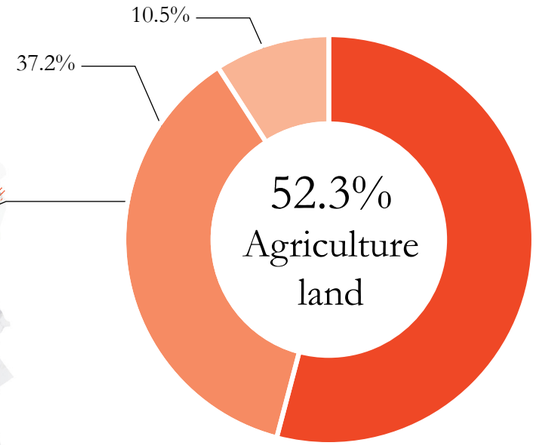


Land use of Portugal
(2021)

- Agriculture
- Forests
- Others





Land use of Spain
(2021)

- Agriculture
- Forests
- Others

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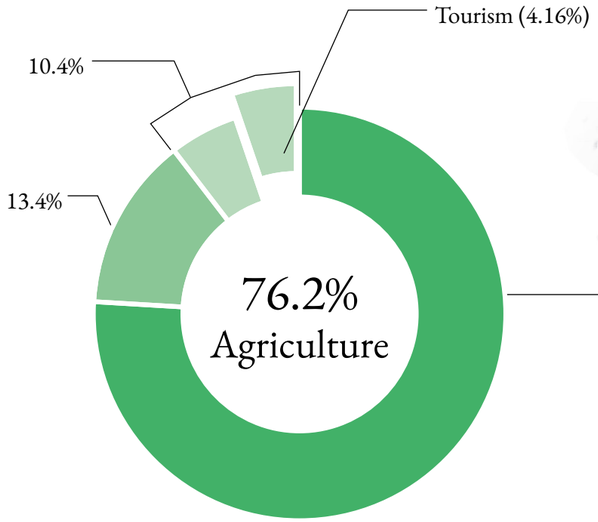
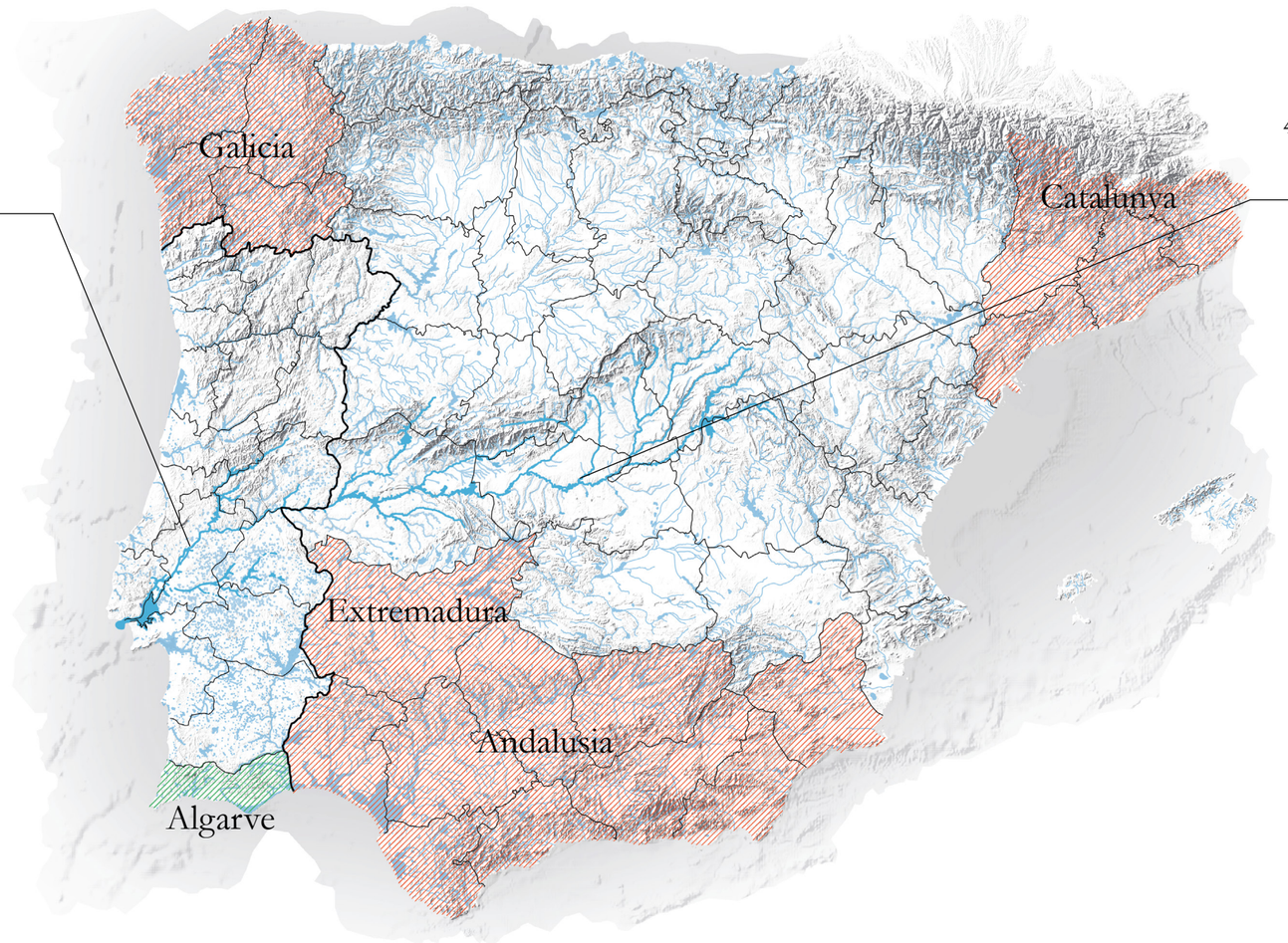


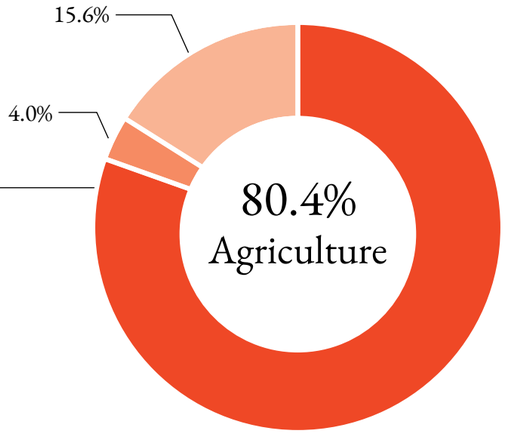
Internal water footprint of Portugal (2021)

- Agriculture
- Industry
- Urban, others



Water restrictions to Spanish provinces

Water restrictions to Portugues districts



Internal water footprint of Spain (2021)

- Agriculture
- Industry
- Urban, others

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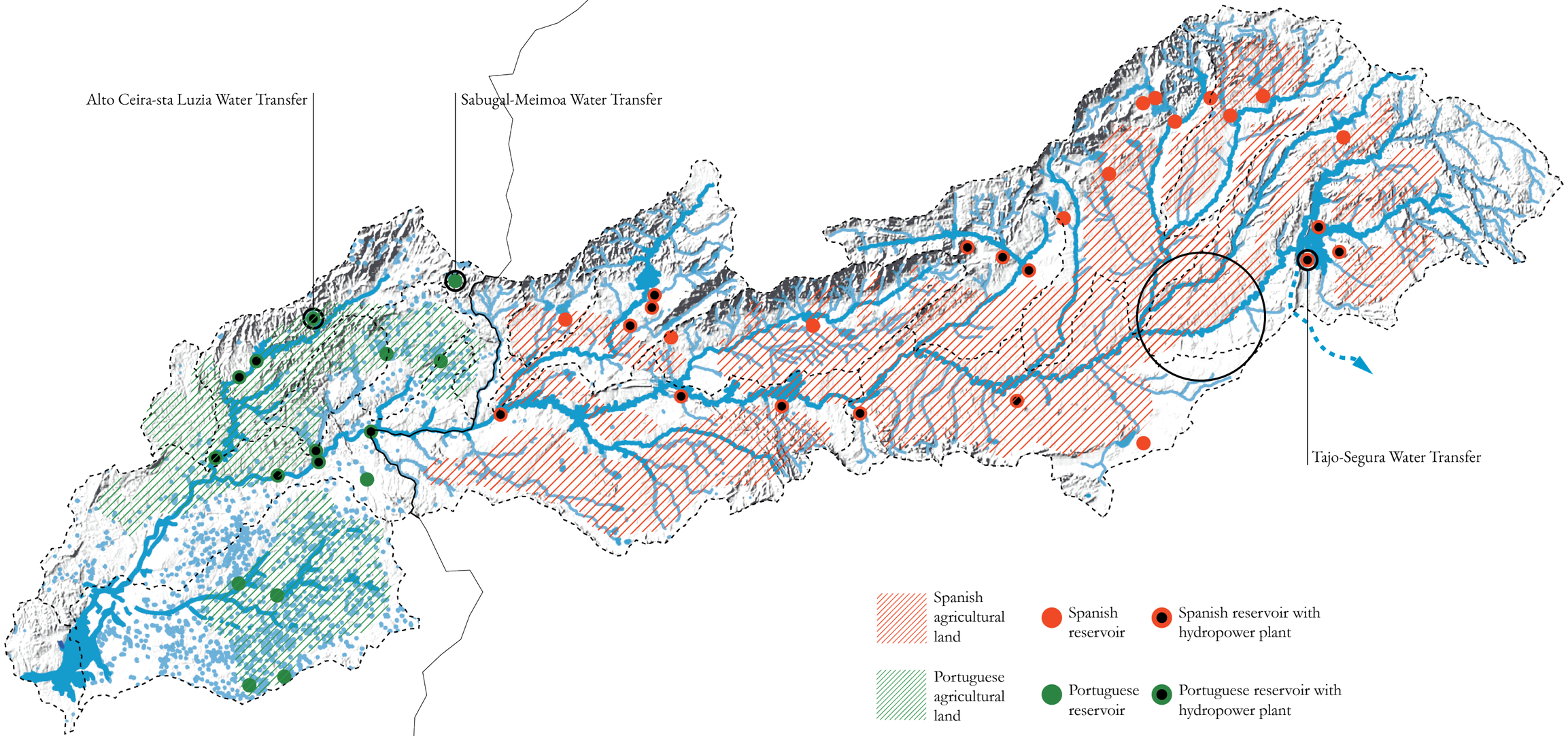

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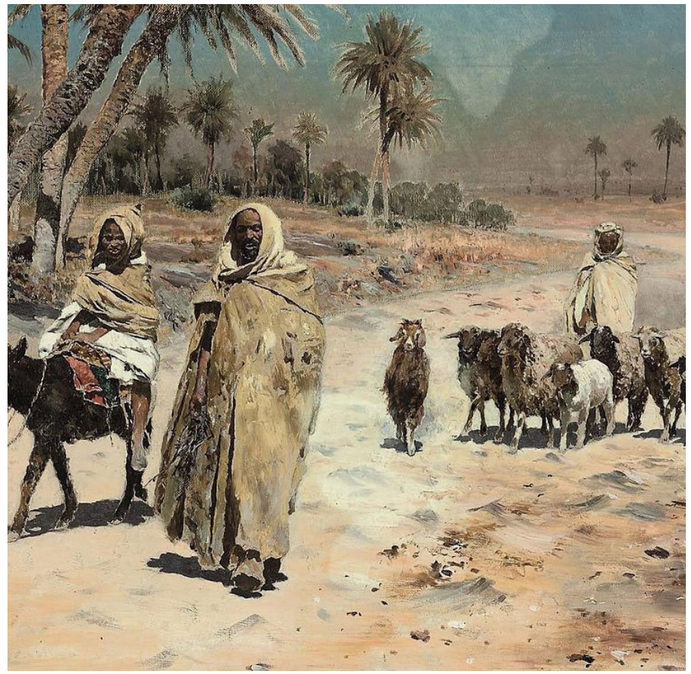
Cultivation of olives and other tree crops

In medival Islamic horticulture, Ibn Bassal and Abū l-Khayr al-Ishbīlī provided comprehensive explanations on propagating and nuturing cultivated trees and palms. Some of these crops, such as olives and dates, are also farmed today.



Origins of regional irrigation methods

“Sowing water“ is the modern-day dub for the Moorish innovative irrigation strategy that was widely used across the peninsula. Precipitation was diverted from headwaters to mountainsides by Careo channels to crops in lower lands. These porous channels help water to infiltrate the ground, subsequently recharging aquifers.



Beginings of regional animal husbandry

The rearing of certain animals, such as sheep were believed to have increased during the Islamic period in Southern Portugal. Archeologists inferred that this increase was owed to the improvement of animal husbandry techniques as well as Islamic preferences for mutton.

Around 711-720AD, Muslims (the Moors) overcame the Visigoths that preceded the Iberian Peninsula. They brought with them an enduring tradition of agriculture and culinary practices that collaborated with the landscapes to provide food with relative sustainability.

Analysis: Systems of Society

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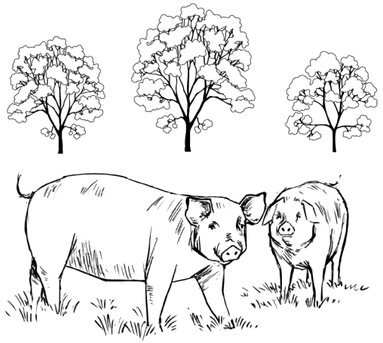
From left to right:

Image source 1: Dioscorides - Kitab al-hasha’ish, Topkapi Sarayi Museum, Istanbul, A 2147. Acessed via https://commons.wikimedia.org/wiki/File:Arboriculture_Mediaeval_Islam.jpg

Image source 2: Muslim Heritage, c. 1200. Acessed via https://muslimheritage.com/article/agriculture-muslim-civilisation-green-revolution-pre-modern-times

Image source 3: Antonino Leto , 1844-1913. Accessed via https://www.christies.com/lot/lot-5391538/?intObjectID=5391538

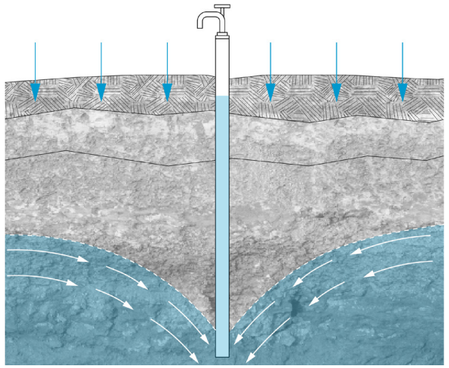


Monospecific Agriculture

- Maximising yield by intensively farming one type of crop, such as Olives, Iberian pigs, wheat, barley, etc.
- Use of greenhouses in Murcia is prevalent and has overtaken the Southern Mediterranean landscapes of Spain



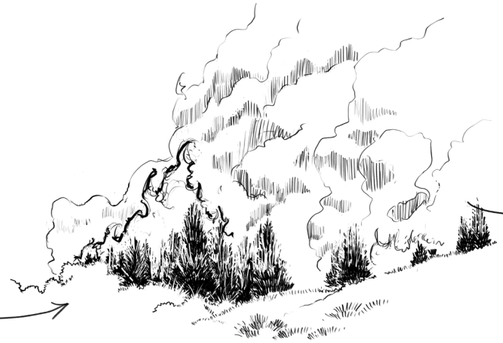
Barren land / low vegetation regeneration



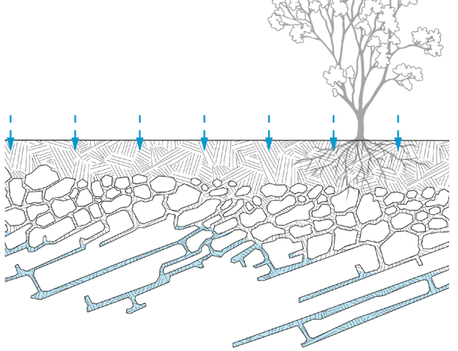


Slash-and-Burn

- Burning grasses and bushes to renew pastureland
- Clears space for agricultural fields (swidden)
- Ashes can provide a nutrient-rich layer to make the soil more fertile
- Temporarily eliminate pests and weeds
- Abandonment of land once land productivity decreases
- Move on to a new area to repeat the process



Uncontrollable wildfires



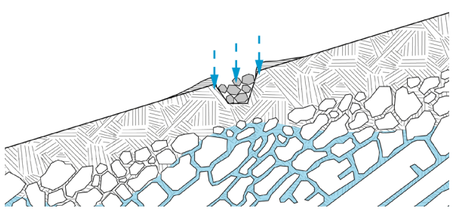


Irrigation

- The Acequia Careo channels collect water from headwaters and edges of the river basins. They help break up the soil so that groundwater can be recharged during precipitation.
- Transfer of water from Careo channels to irrigation channels to bring water to crops.
- Many Careo channels were abandoned and left to clog after this method became outdated in the advent of more advanced technology. However, recent understanding of aquifer recharge has slowly brought this practice back.



Clogged careo channels



Low groundwater levels and aquifer recharge rate

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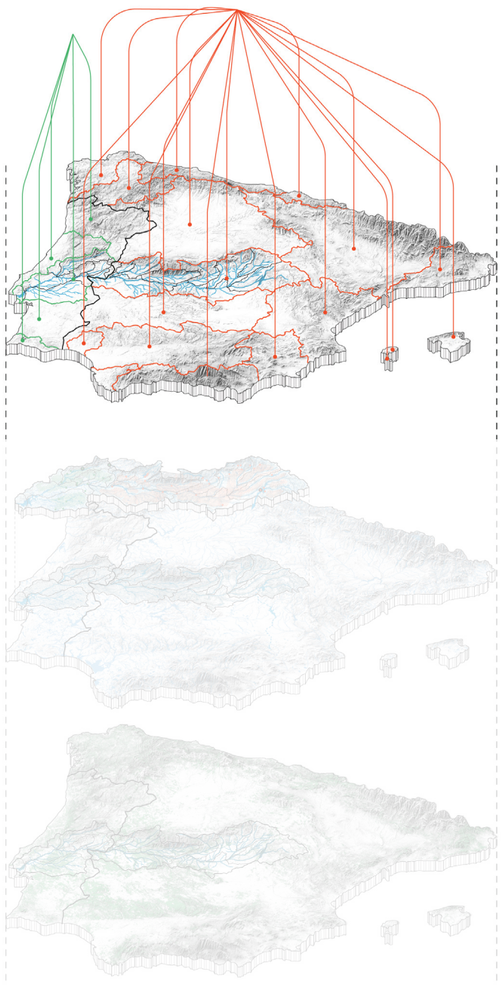
What did the authorities do to act on the environmental disaster and how did they react to their society's actions?



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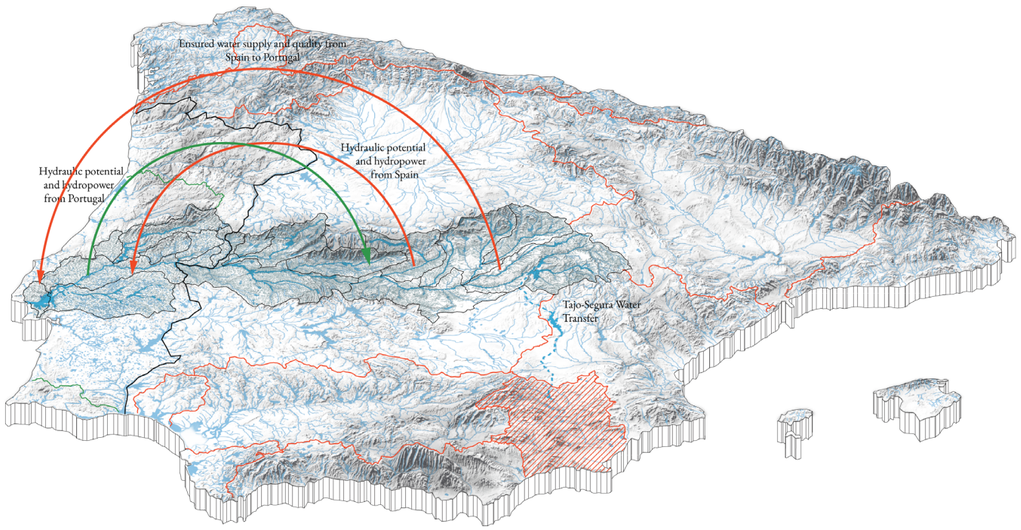
Water conventions between Spain and Portugal:
A transboundary agreement between the two territories encompassing the management and use of the Tagus River's resources.



National Levels of Governance

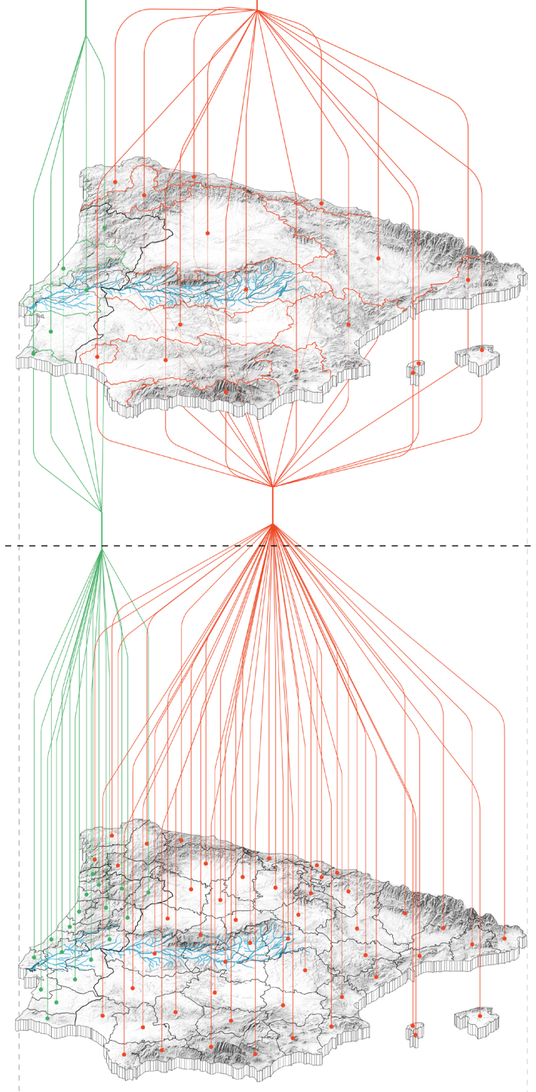
National Level Water Governance of Spain:
- Ministry for Ecological Transition and Demographic Challenge
- Ministry of Health
- National Council of Water
- Ministry of Territory and Policy
- Ministry of Agriculture, Fisheries and Food (Formerly)
- Ministry of Development (Formerly)

National Level Water Governance of Portugal:
- Águas de Portugal (co-owner of water services)
- Regulatory Entity for Water and Waste Services (Entidade Reguladora de Serviços de Águas e Resíduos)
- River Basin District Administrations (Administração da Região Hidrográfica, ARHs)
- Portuguese Environment Agency (Agência Portuguesa do Ambiente, APA)

Regional Levels of Governance

Regional Level Water Governance of Portugal: River Basin District Councils

Regional Level Water Governance of Spain: River Basin Authorities



Regional Levels of Admin

Regional Level Water Governance of Portugal: District Administration

Regional Level Water Governance of Spain: Province Administration

Municipalitiy Levels of Admin

Municipalities and local Authorities: 308

Municipalities and local Authorities: 8000

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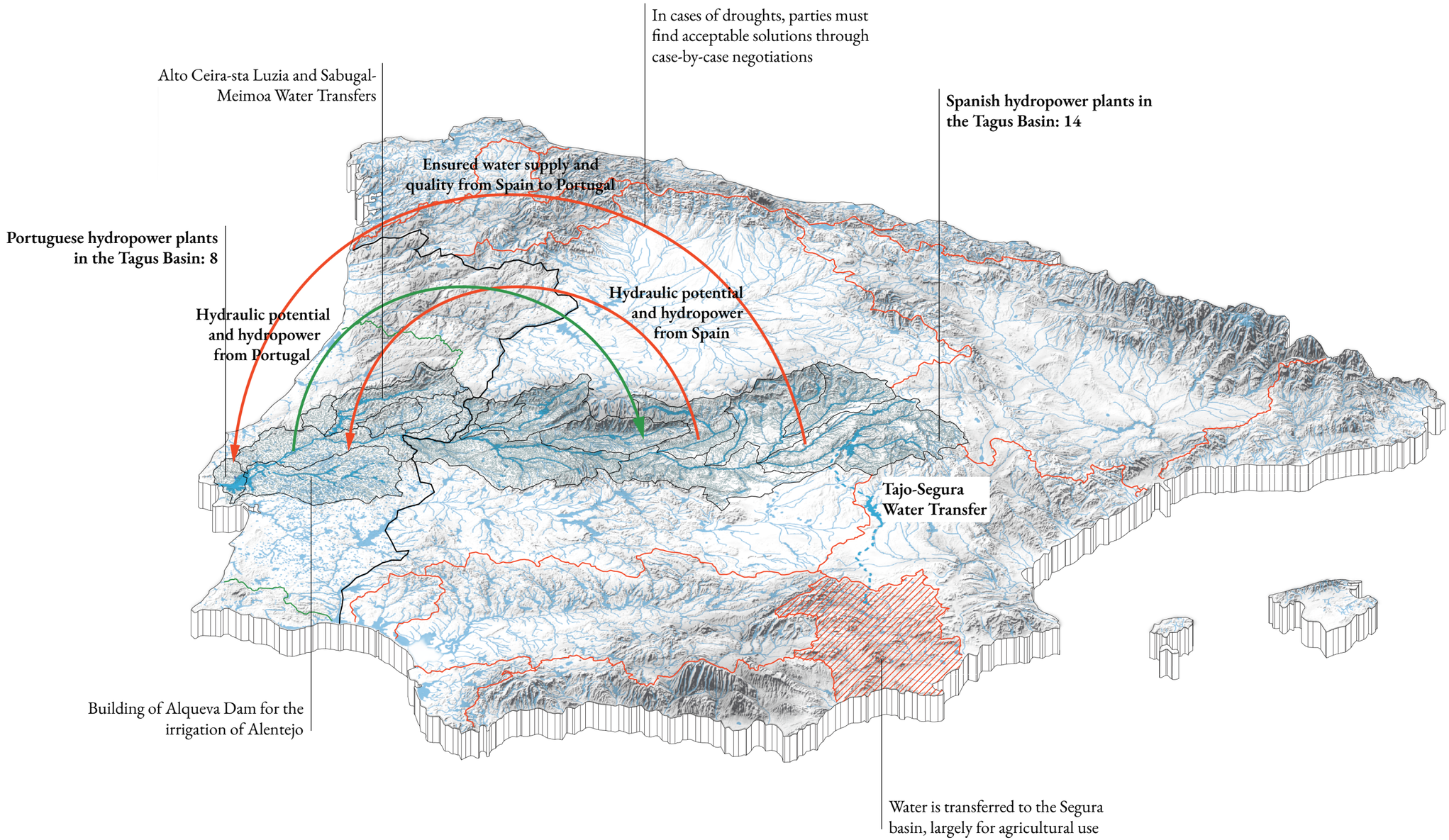

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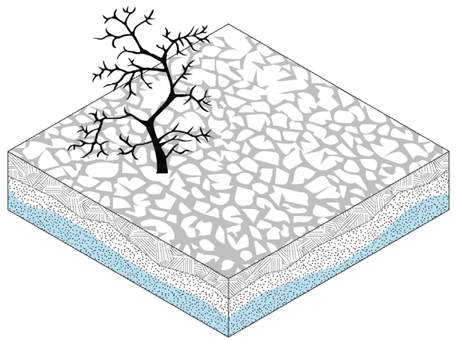
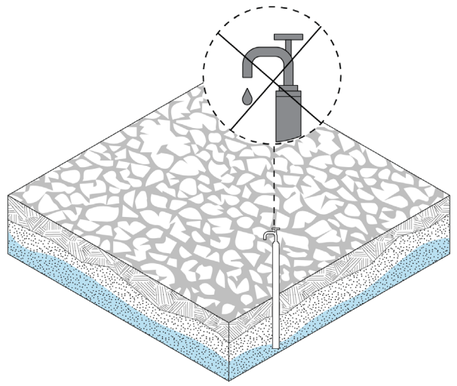
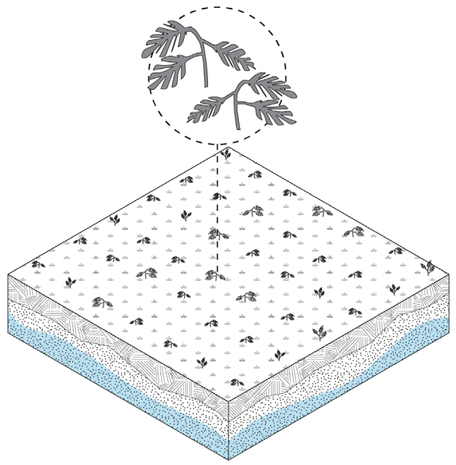


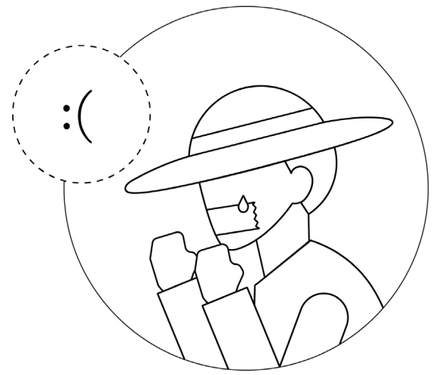
Consequences of environmental degredation



Water restrictions



Low agriculture yield and economic returns



Farmers feeling disenfranchised



CNN World Live TV

Dozens of fruit growers arrested in Spain over illegal wells as drought grips the country

By Al Goodman, CNN
Published 2:41 PM EDT, Tue May 9, 2023

Carlos Gil/Getty Images

The Viñuela reservoir, located in La Axarquia, on September 01, 2022 in Málaga, Spain.

(CNN) — Spanish police have arrested 26 people in recent months for an alleged scheme to use water from illegal wells to grow subtropical fruit, as the country grapples with damaging heat and drought.

A Spanish Civil Guard statement said a four-year investigation had uncovered 250 illegal wells and ponds in the in a drought-stricken area Axarquia district east of Malaga, along the Mediterranean coast.

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Green | Climate Politics

Spain Police Crack Down on Illegal Water Wells as Drought Bites

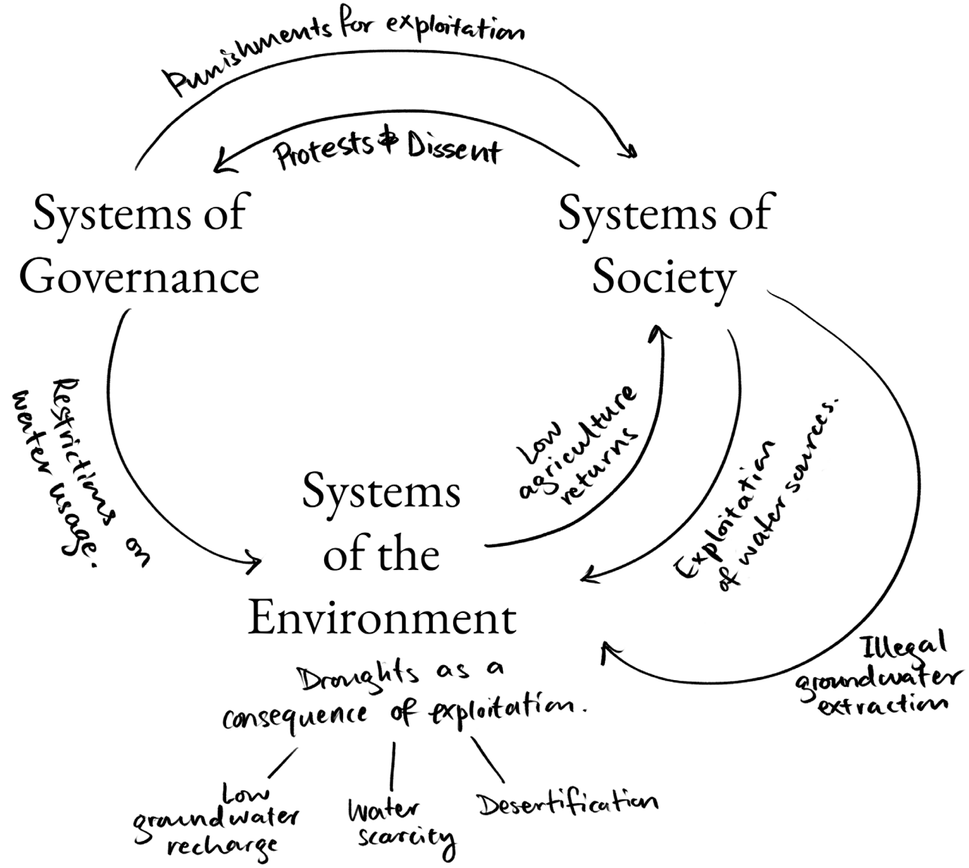
Mango and avocado farmers in Málaga are accused of digging 250 wells without permits to irrigate their fields.

Extremely low water levels on the exposed bed of the Rialb reservoir during a drought in La Baronia De Rialb, Spain in 2022. *Photographer: Angel Garcia/Bloomberg*



Image source: Violeta Santos Moura, 2023. Acessed via https://www.reuters.com/world/europe/spanish-farmers-protest-against-plans-curb-water-supply-irrigation-2023-01-11/

Analysis: Systems of Governance



Lack of Collaboration Between the Systems



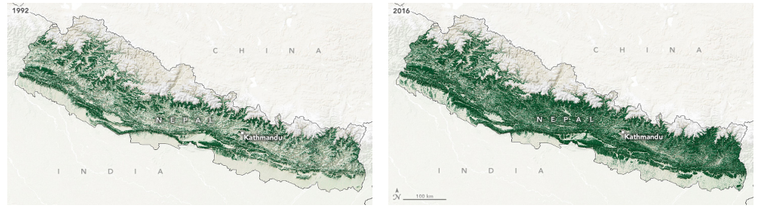
New Forest Northern Commons of The United Kingdom

Systems of the Environment (impact): the conservation of historical heathlands and ‘commonable’ livestock for agriculture.

Systems of Society (community efforts): the community turn out livestock that graze in the commons while participating in efforts, such as controlled burning, cutting and mulching, to maintain the landscape.

Systems of Governance (policies and management): areas of the heathlands were designated for grazing, community members are to protect the landscape’s wildlife and biodiversity by use of the aforementioned methods, in exchange for the rights to use part of its returns – the livestock.

(National Trust UK, n.d.)



Community Forests of Nepal

Systems of the Environment (impact):
the growth of the biodiversity and wildlife conservation in Nepali forests have been maintained since the 70s.

Systems of Society (community efforts): the forest is an agricultural resource and profit earned from this is invested back into efforts for forest cover growth and wildlife conservation. The community also invests efforts into keeping open data of the biodiversity.

Systems of Governance (policies and management): the community forestry program designates a limit to wood collection from the forests and approves divisional plans.

(NASA Earth Observatory, 2021)



Lobster Fisheries of Maine, USA

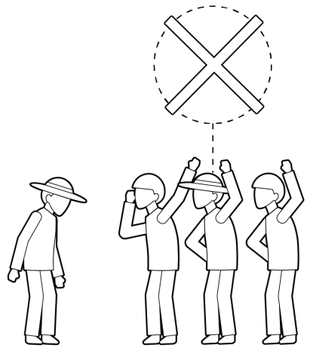
Systems of the Environment (impact): maintenance of lobster populations and, by extension, the marine ecosystems around the coasts of Maine

Systems of Society (community efforts): community adherence to the rules of the conservation program

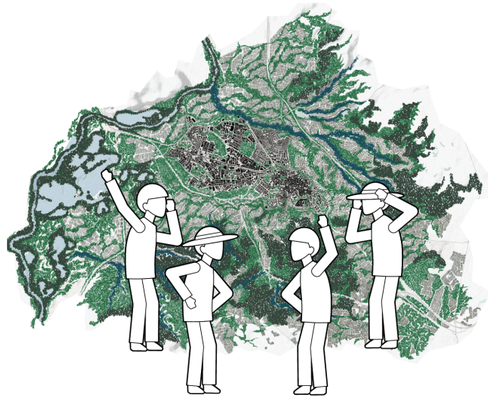
Systems of Governance (policies and management): rules of the conservation program that include (but are not limited to) trap limits to allocated fishing areas, mandatory tagging and release of egg-bearing female lobsters, releasing undersized and oversized lobsters, management of invasive species and use of low-impact gear.

(Department of Marine Resources, 2024)

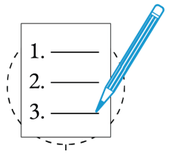
Case Studies: Landscape as the Commons



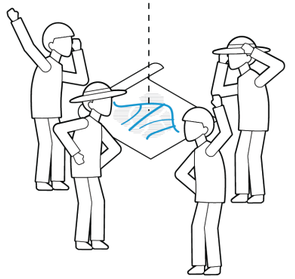
Graduated sanctions:
violators of the rules will be assessed by other users of the commons or officials that are accountable to the users.



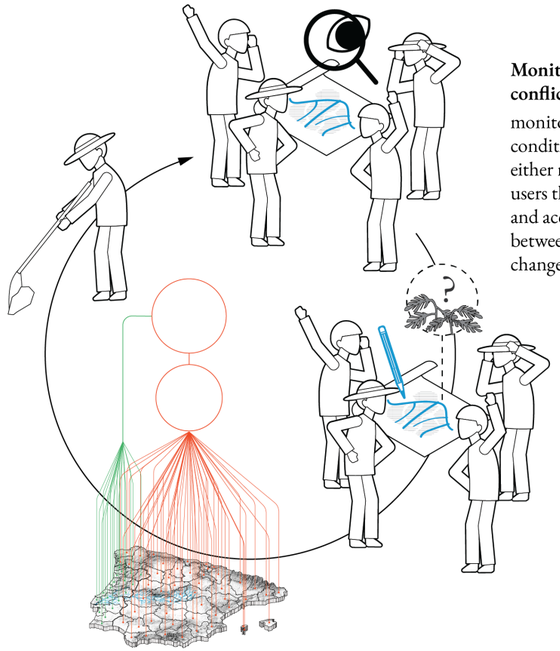
Clearly defined boundaries:
what the resources are and who have the rights to partake - stipulated in systems of society



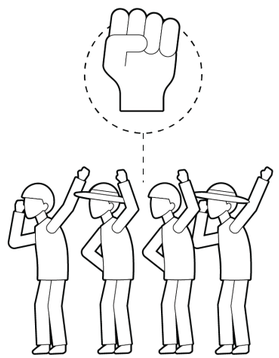
Congruence between appropriation and provision rules and local conditions:
according to that stipulated in the systems of society



Collective -choice arrangements:
individuals participating in the commons can collaborate to form or change the rules that are mutually agreed upon



Monitoring and conflict-resolution system:
monitors will actively track the conditions of the commons who either report to the users or are users themselves. Also an efficient and accessible way to raise conflicts between users, stakeholders or changes to the environment.



Minimal recognition of rights to organise:
users have rights to plan their institutions without rights being challenged by external forces.

Case Studies: Landscape as the Commons



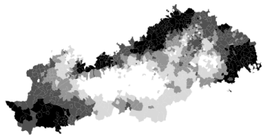
CDI



Land productivity potential



Fire burned areas



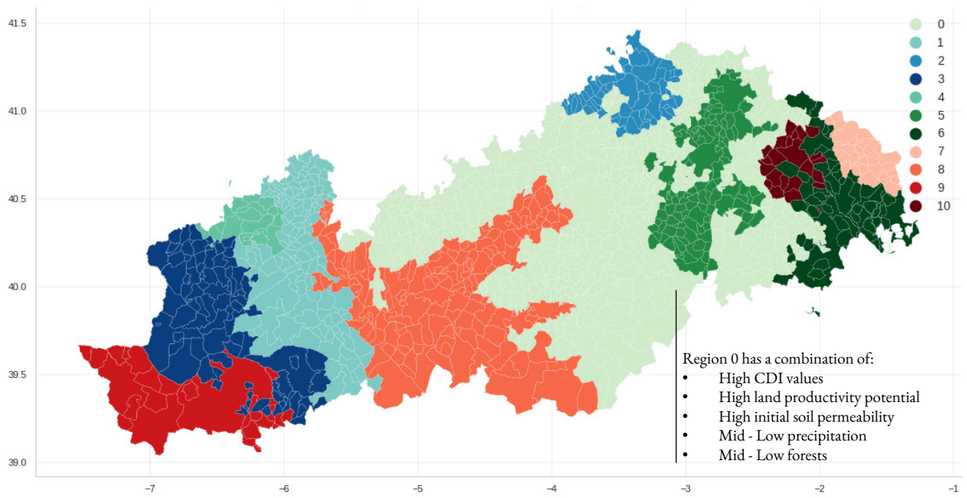
Annual precipitation



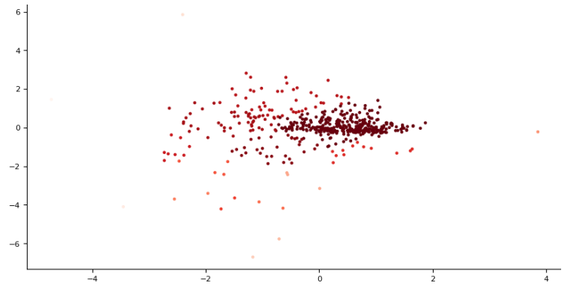
Forest covers

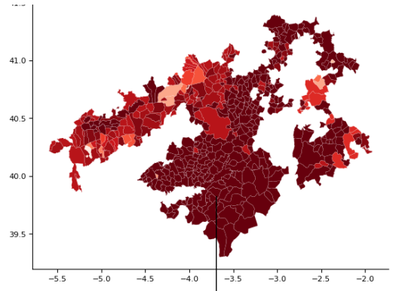


Soil permeability



This regionalised clustering was used to group similar values that might affect each other. This is to understand which areas have similar combination of values, implying similar situations that are contributing to the drought problems and that each situation may affect its neighbours. The next part will analyse Region 0 more as it has the highest drought intensity levels.

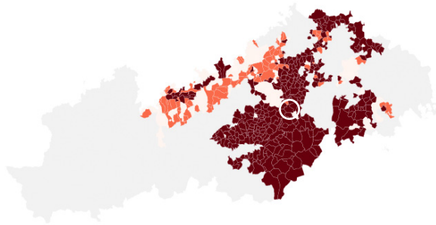




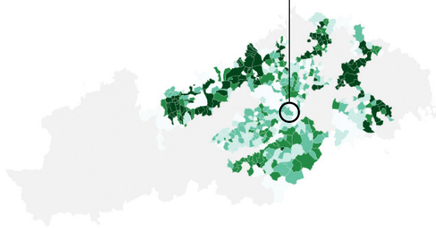
Meanshift clustering of forest land and productive land

Regions that have low forest cover and high production land

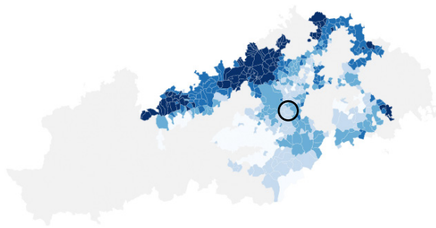
Arganda del Rey



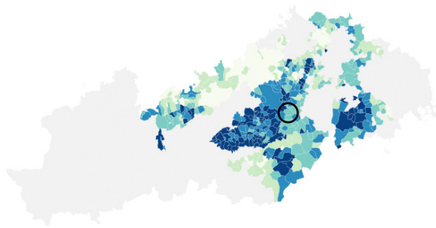
Regional priority scale for land-sharing / crop-rotations



Regional priority scale for forest growing

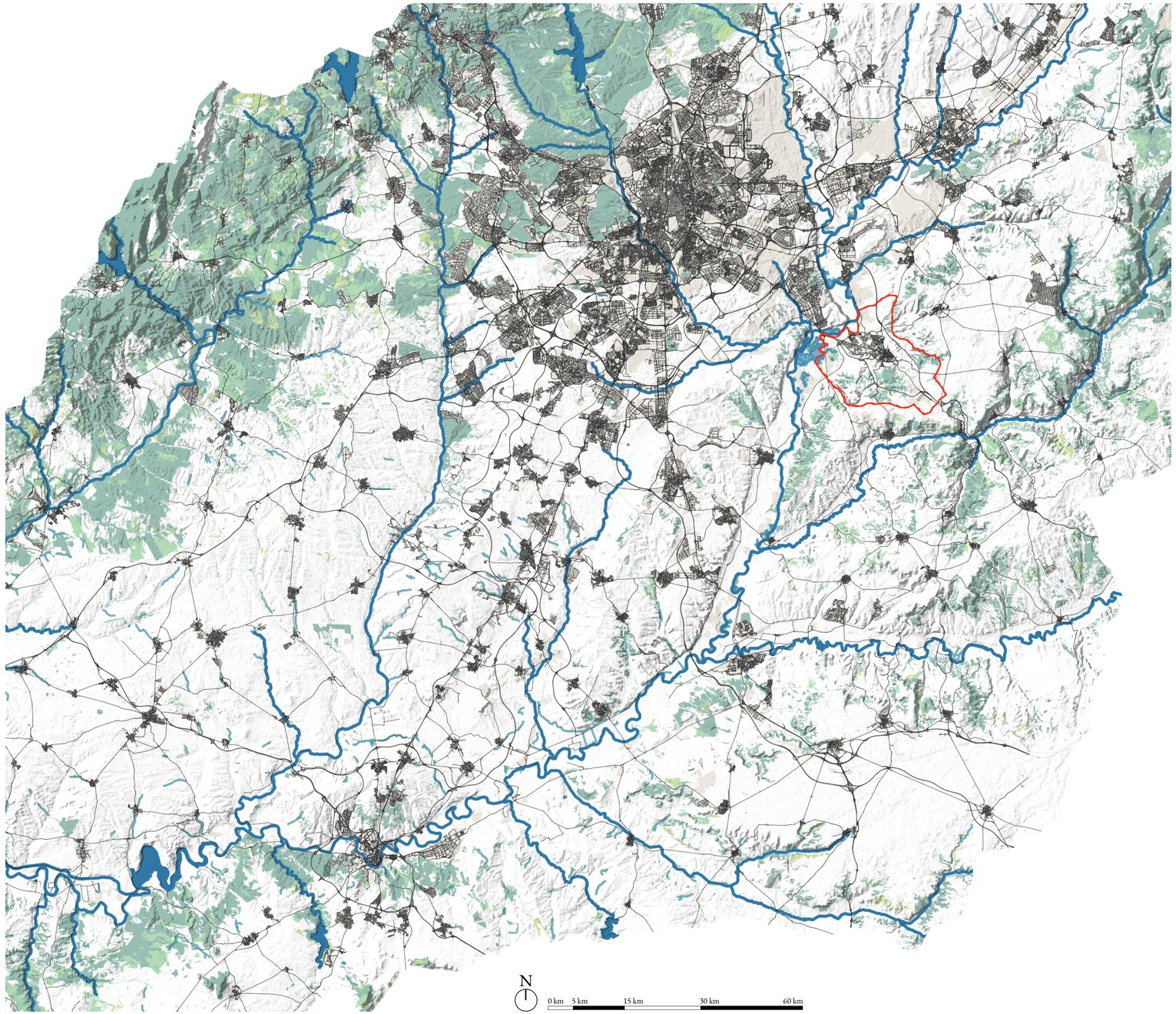


Municipalities to focus on water storage



Municipalities to focus on groundwater recharge

Site: Arganda del Rey



Site: Arganda del Rey

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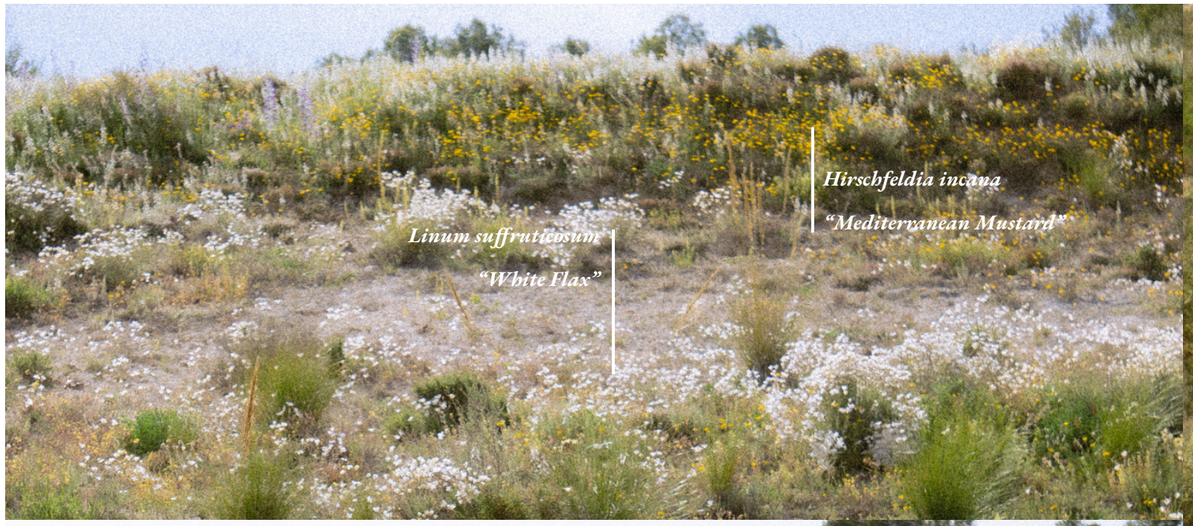

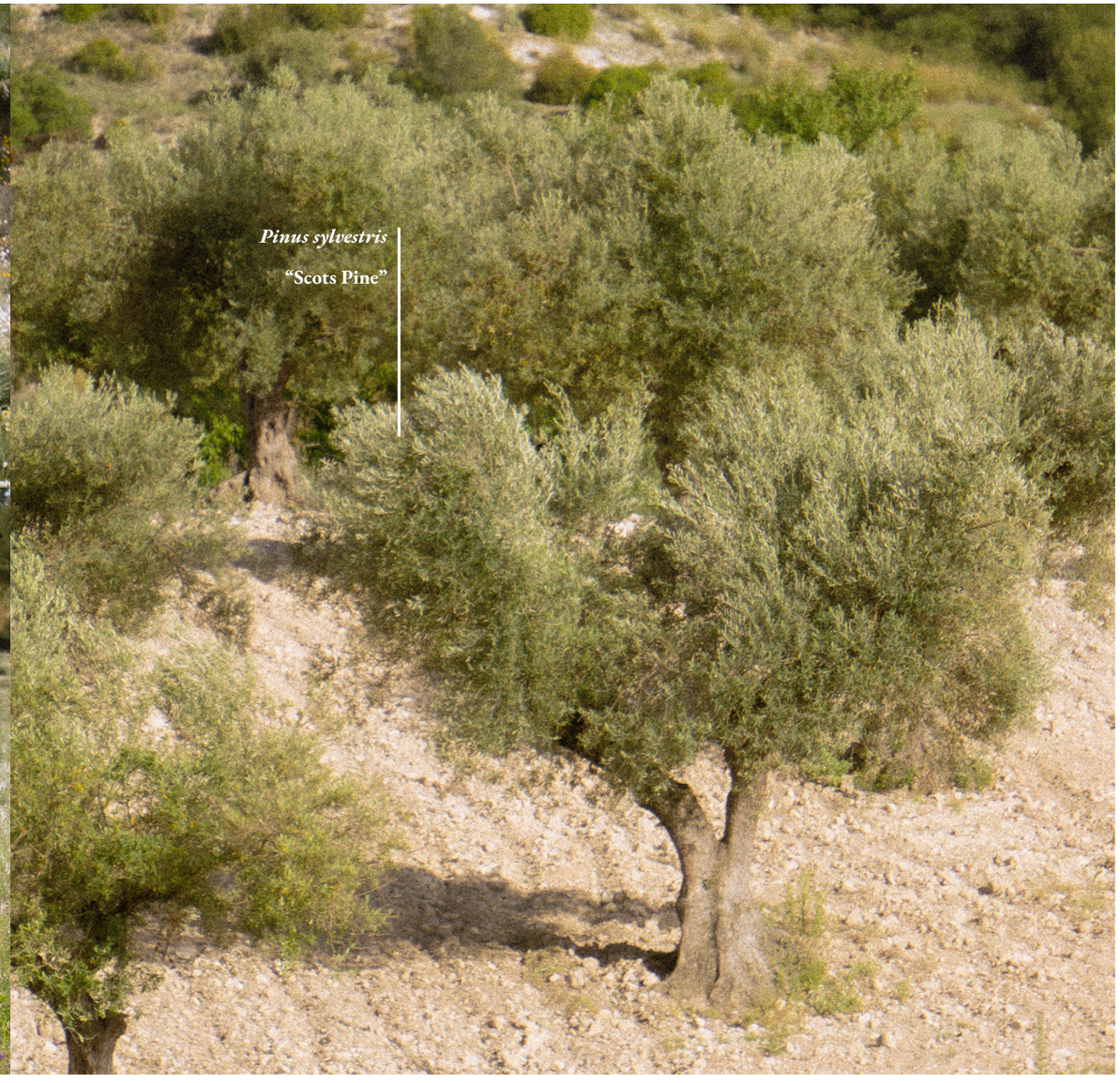



Site: Arganda del Rey

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Arroyo del Vilches

Site: Arganda del Rey

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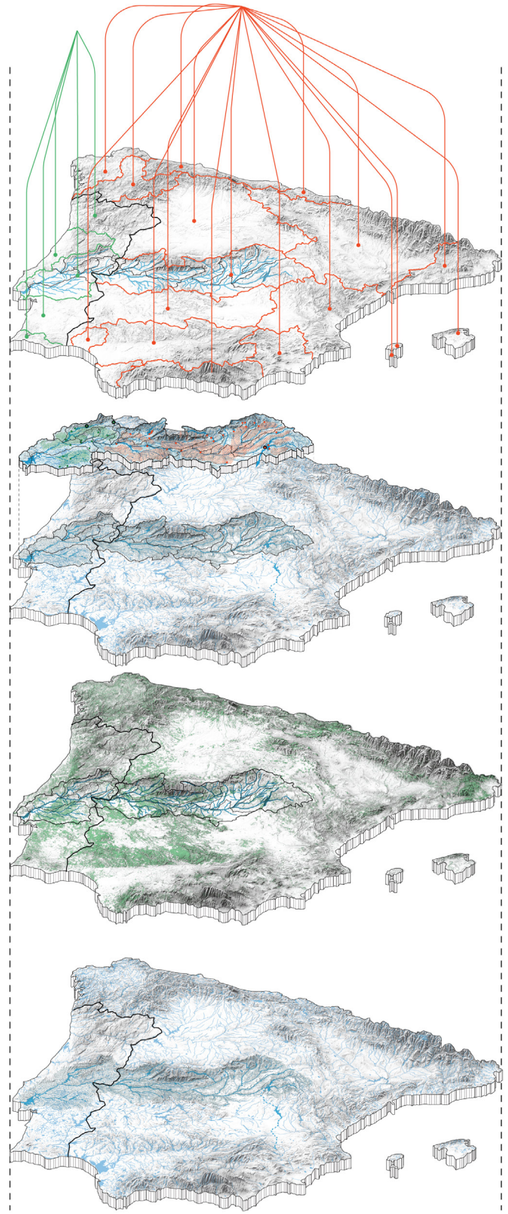
Systems of Governance:
- What are the responsibilities of the different communities and stakeholders in this collaborative system?
- How can progress and conflicts be managed when building the water-landscape commons?
- What long-term and short-term governance strategies can be used to achieve the collaborative potential of the water-landscape commons?

Systems of Society:
- What are the rules and boundaries of the commons?
- What are some principles and strategies that the community can use to build the water-landscape commons?
- How can cultural landscapes become part of the commons?

Systems of the Environment:
- How can the drought situation be alleviated with the management of water-landscape features?
- What are part of the water-landscape commons (and partial commons)?
- What long-term and short-term environmental strategies can be used to achieve the collaborative potential of the water-landscape commons?



Collaborative Systems of Governance

Collaborative Systems of Society

Collaborative Systems of the Environment

Water-landscape commons as the medium

Layers of Collaborative Potential

Jean Ong Wueng Kee
5767628

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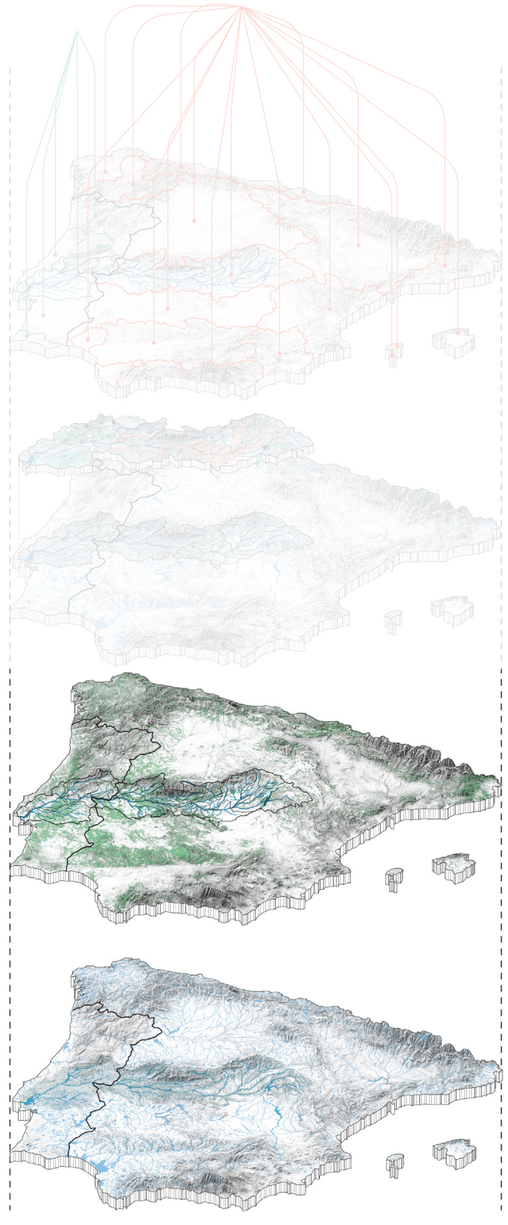

Systems of Governance

Systems of Society

Systems of the Environment

Water-landscape commons as the medium

Designing the Commons: Systems of the Environment

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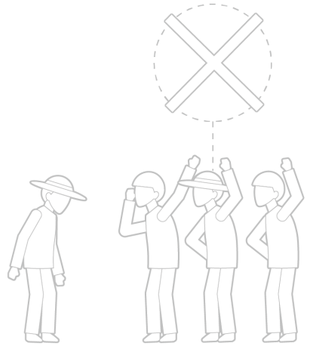

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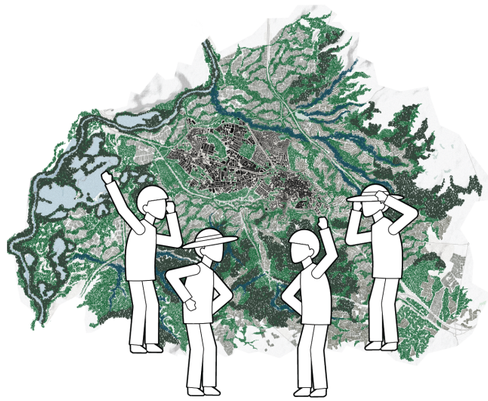

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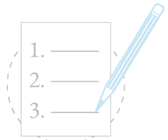

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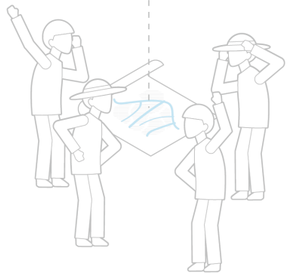

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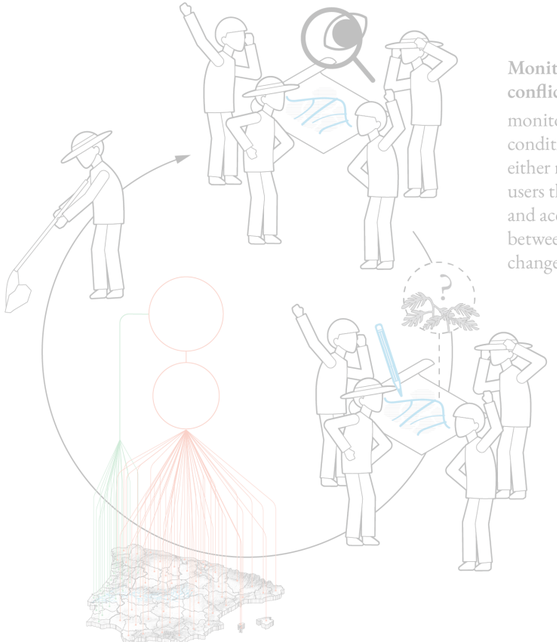

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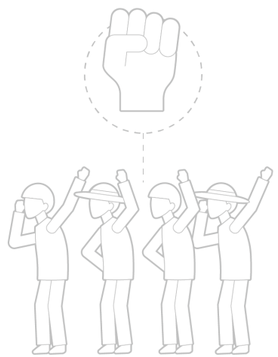

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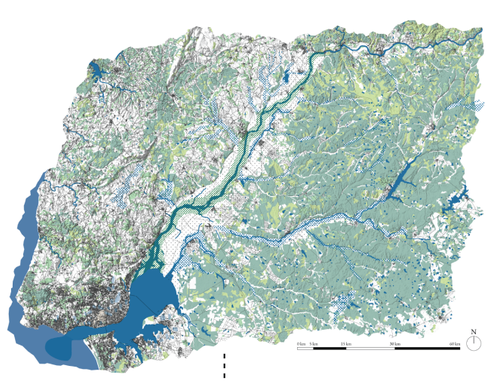

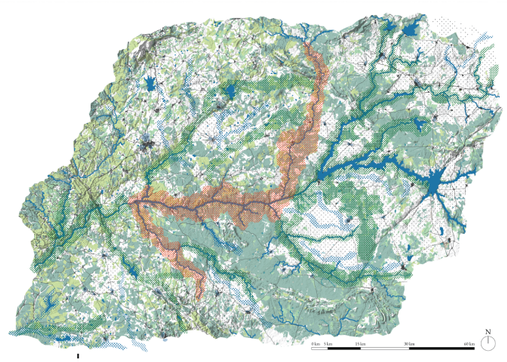

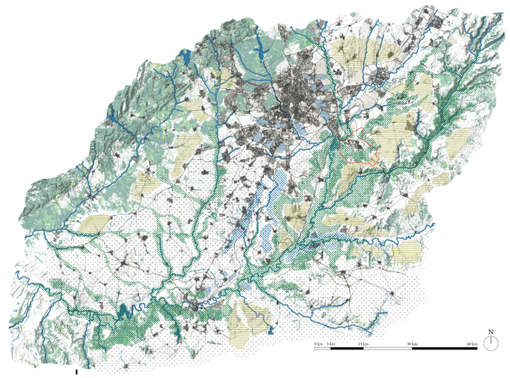

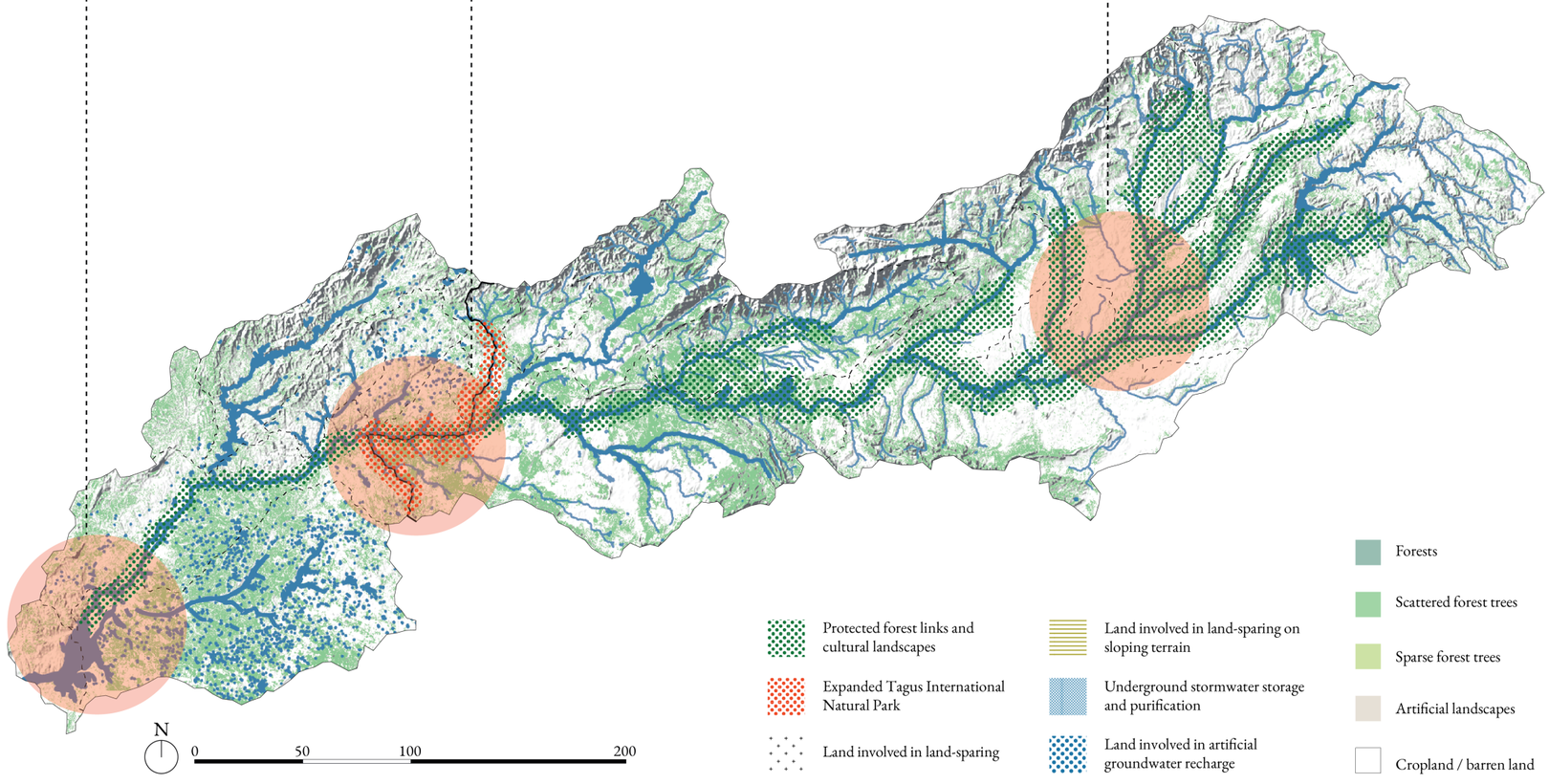

How can the drought situation be alleviated with the management of water-landscape features?

Systems of the Environment

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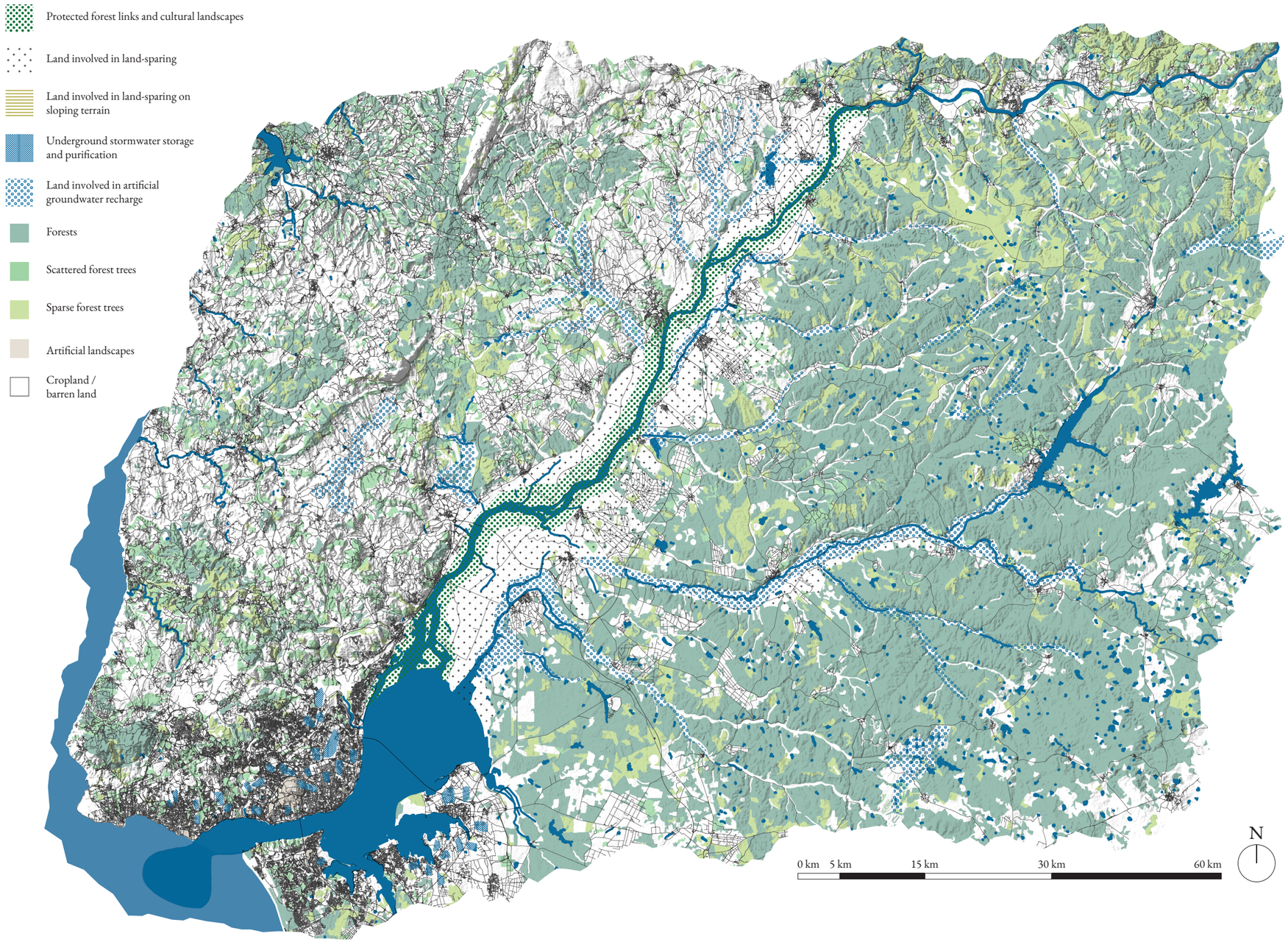

Systems of the Environment

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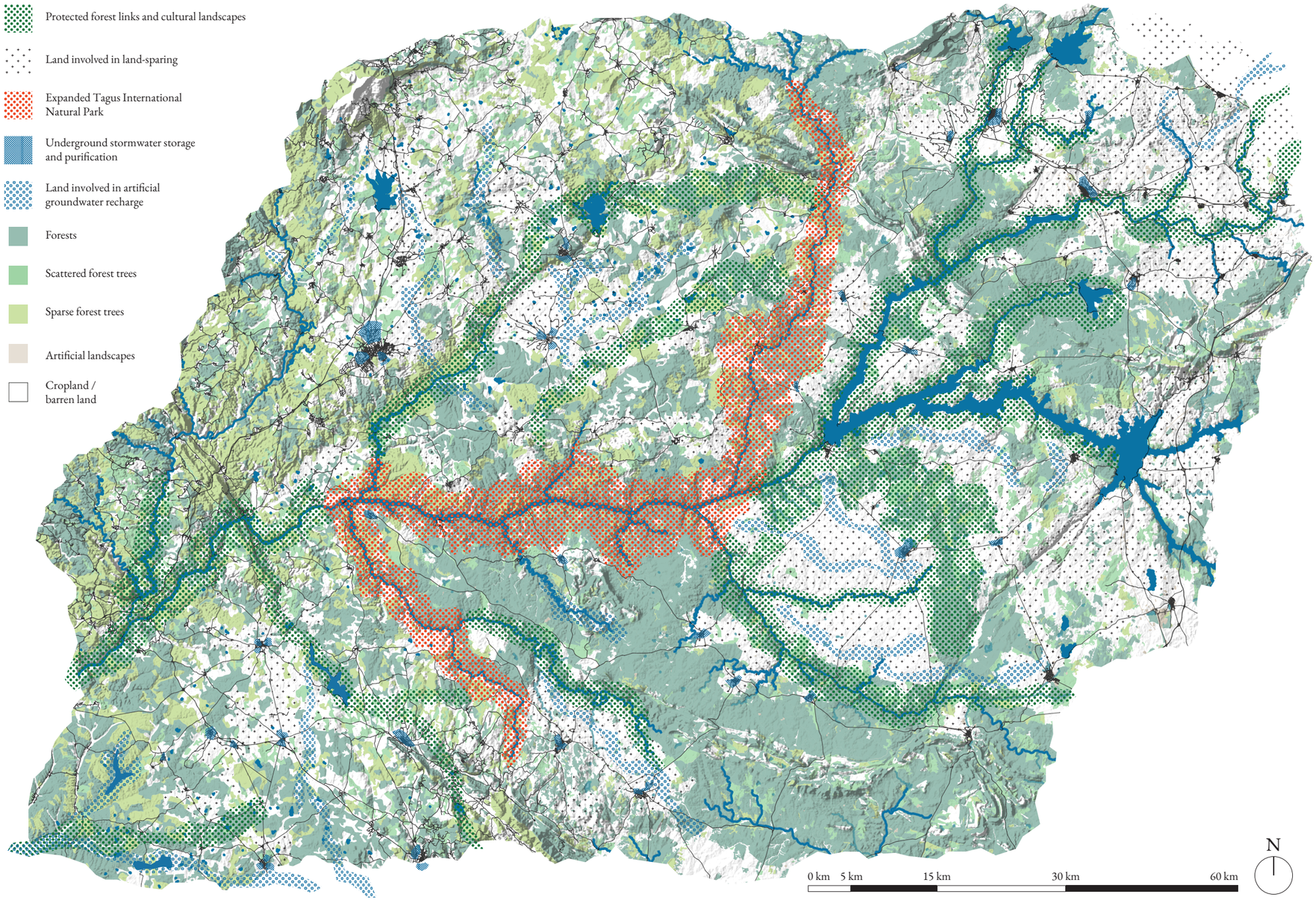

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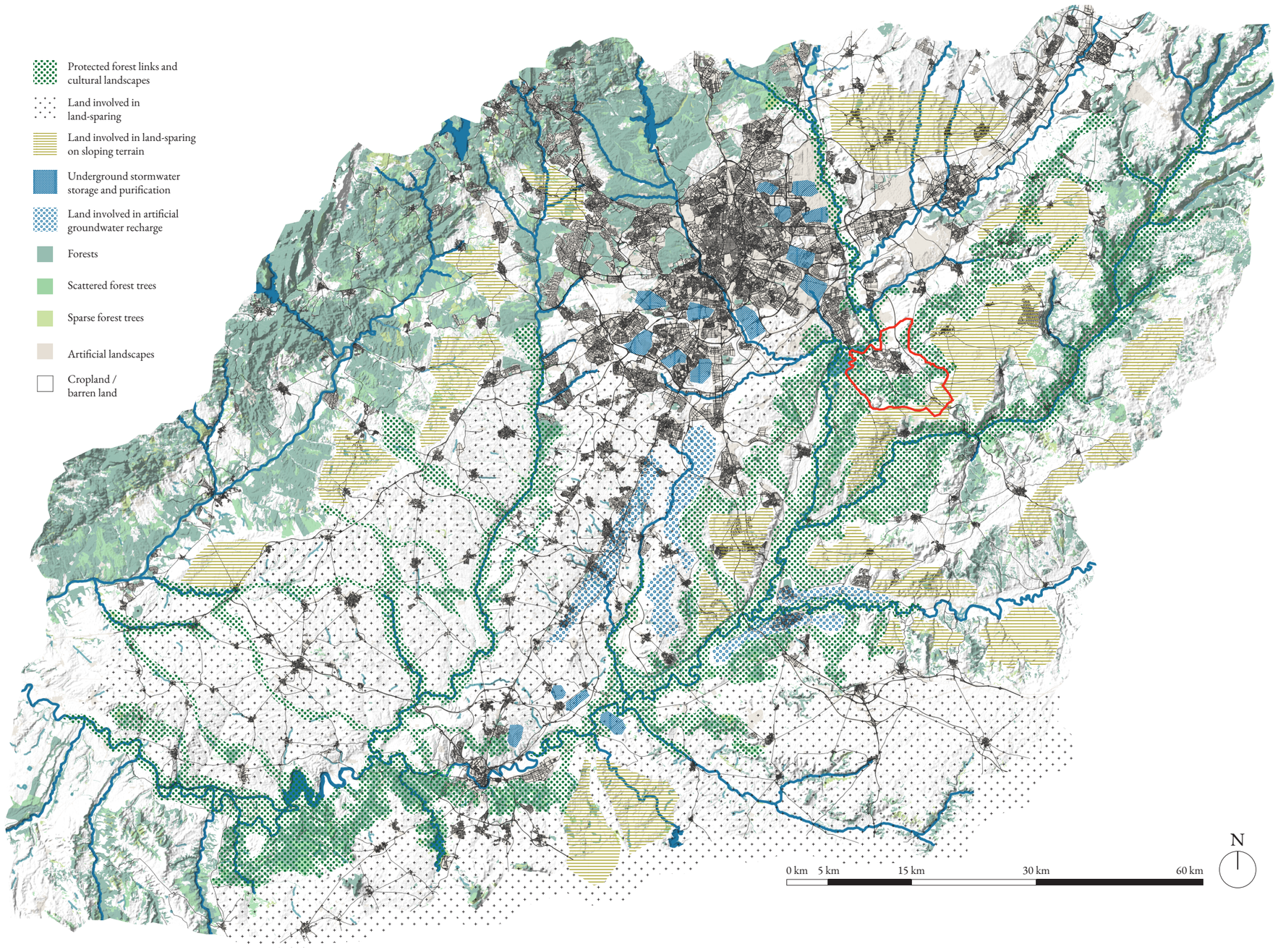

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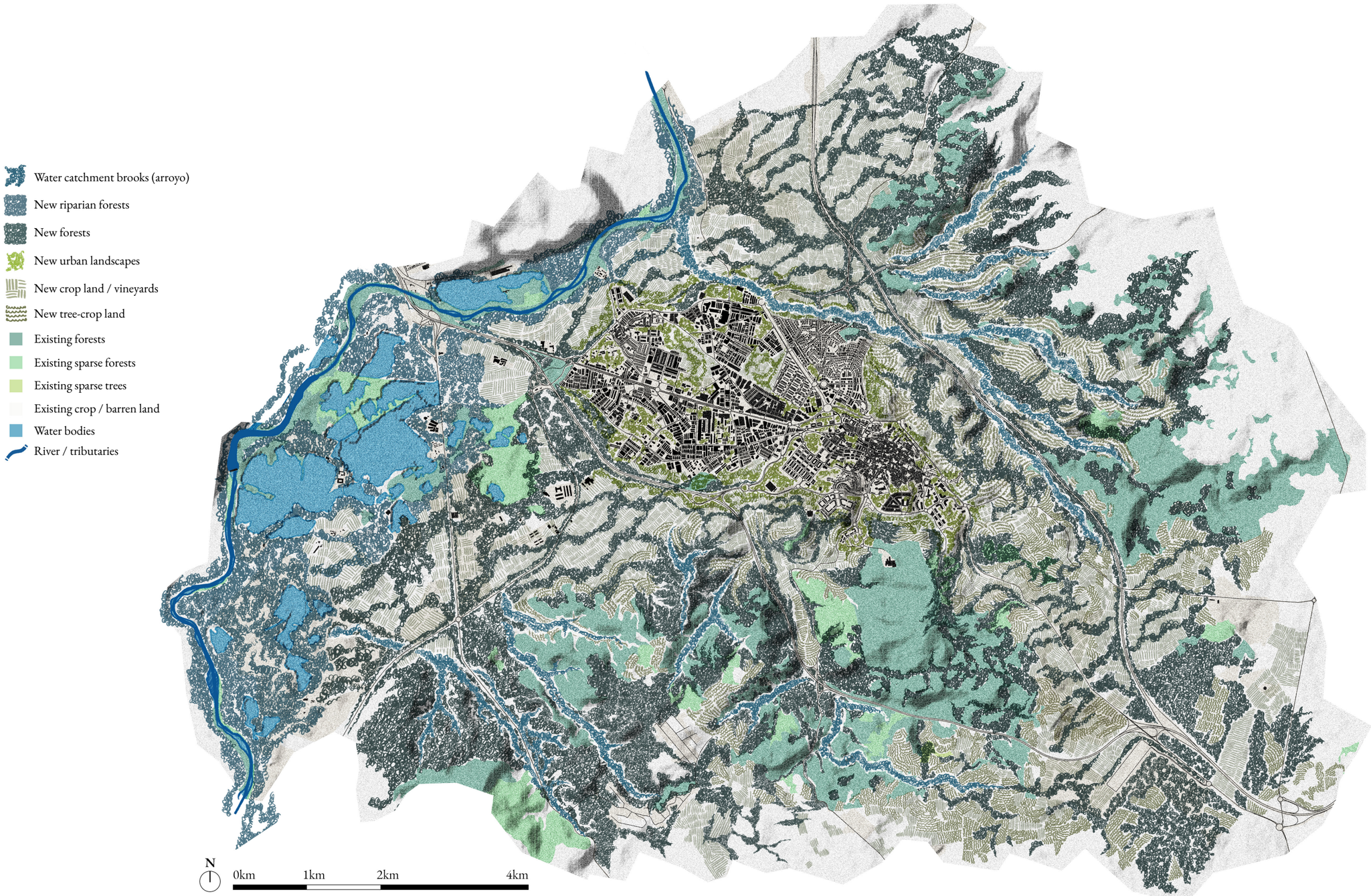

Systems of the Environment

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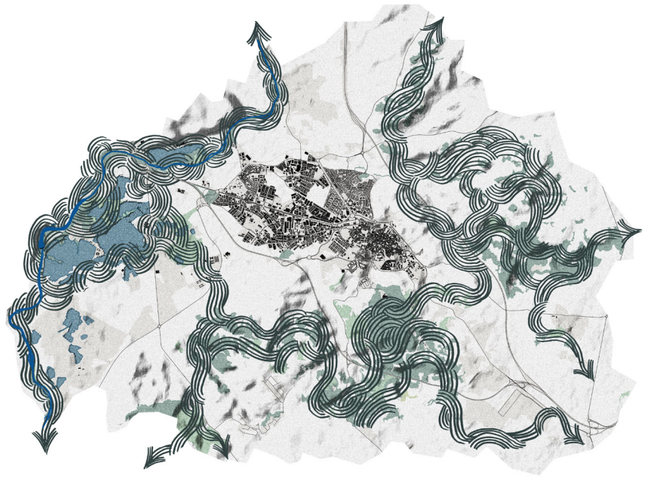
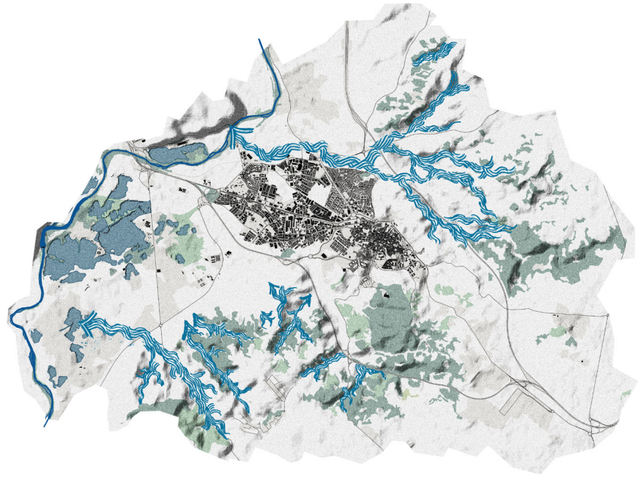
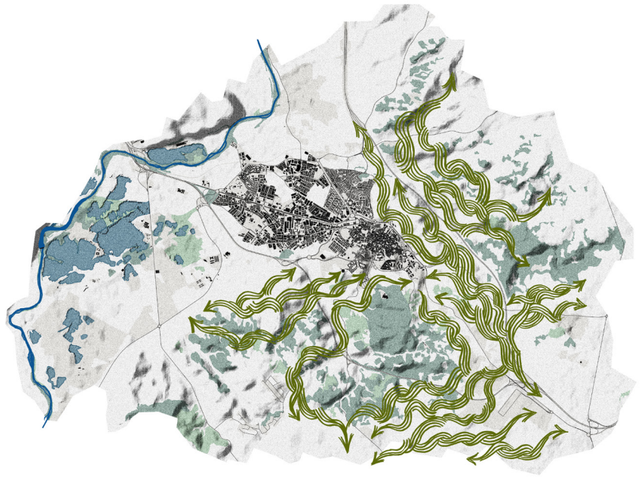


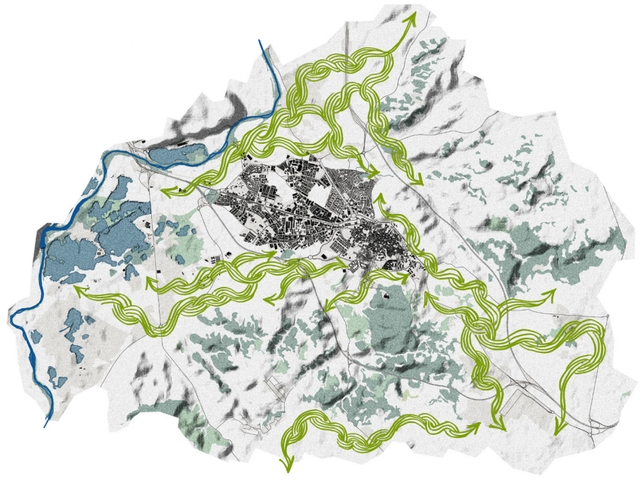
Connecting forests from brook and ravine systems to the Jarama



Strengthening brook and ravine systems and connecting them to other water bodies



Tree crops and vineyards on higher terrain surrounding Arganda del Rey



Low-terrain cropfields to be spread across gentler terrain / flat land

Systems of the Environment

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What is part of the commons?

The Commons

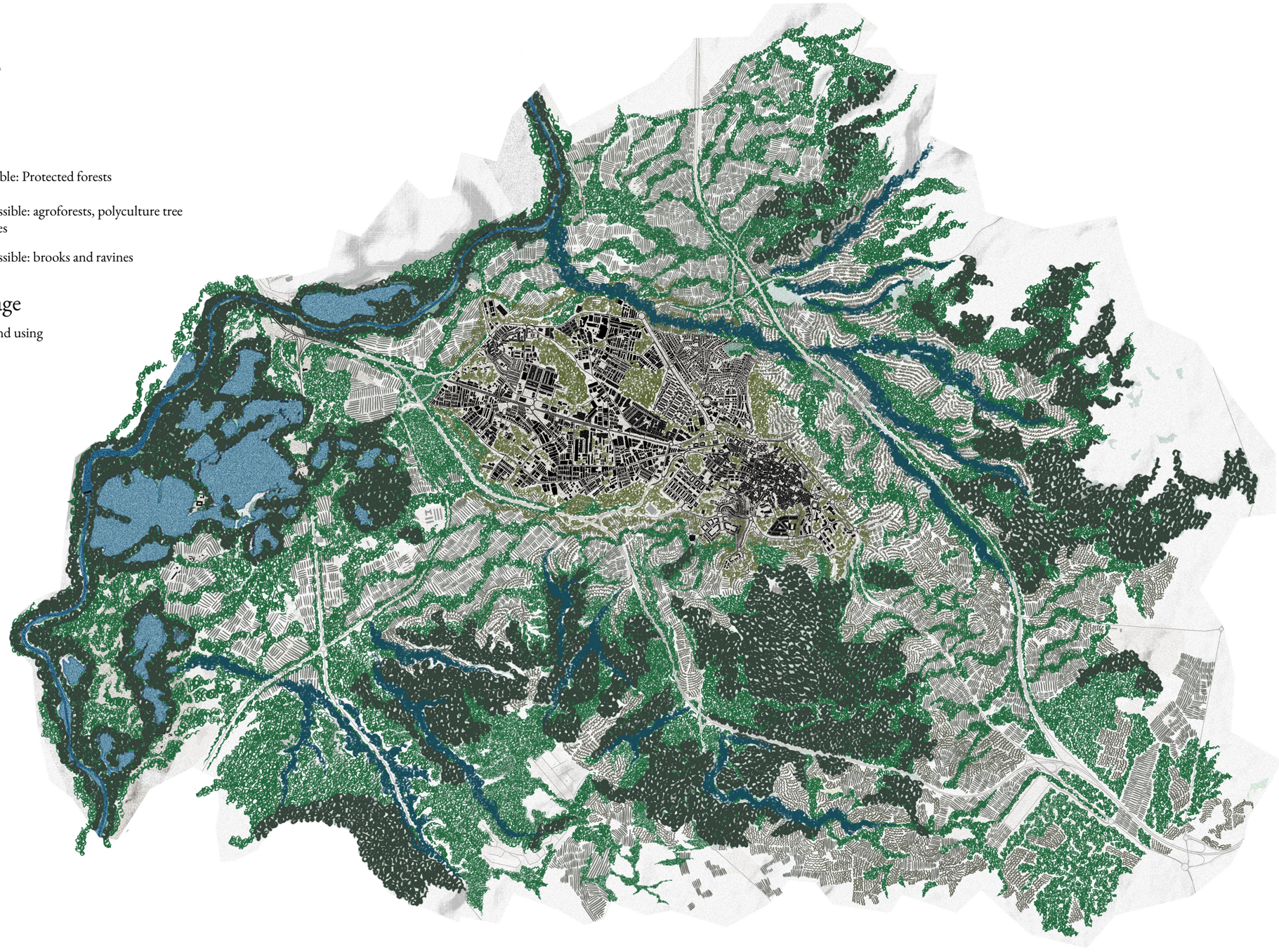
Public good but not accessible: Protected forests

Public goods but semi-accessible: agroforests, polyculture tree cropland, urban green spaces

Public goods but semi-accessible: brooks and ravines

Partial Commons Usage

Inaccessible: Private cropland using water from the commons



Systems of the Environment

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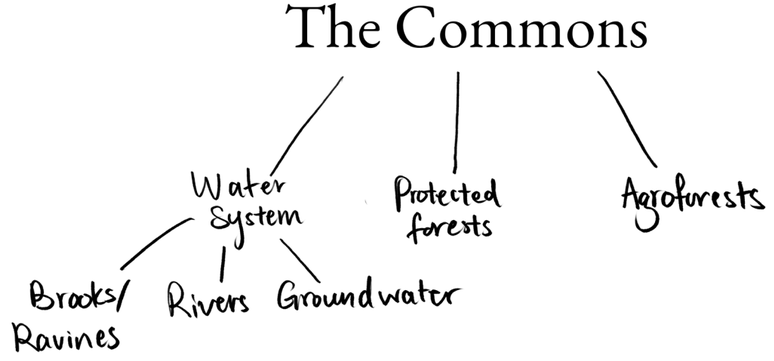
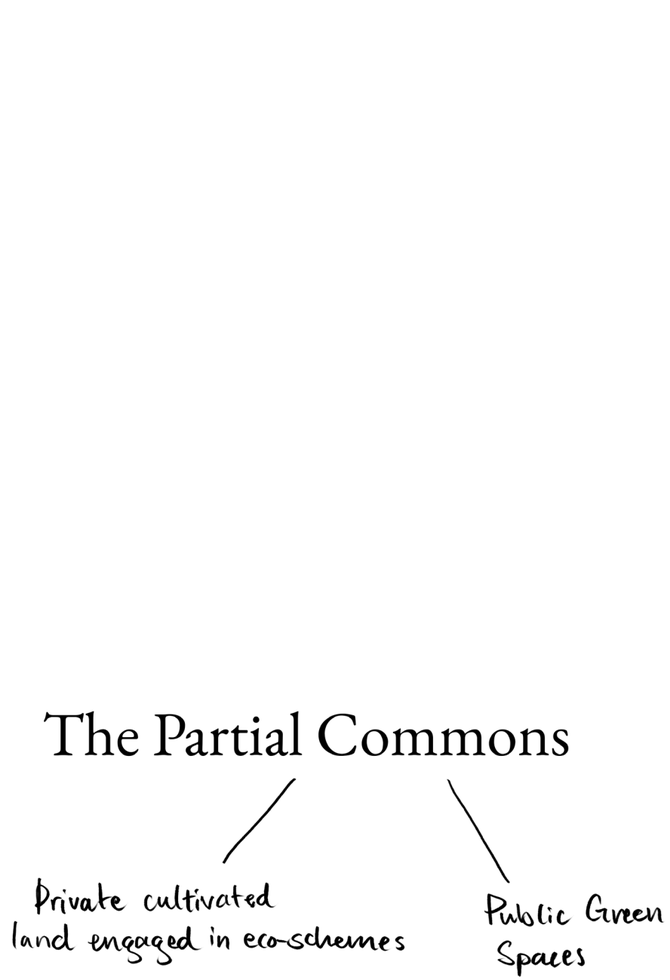
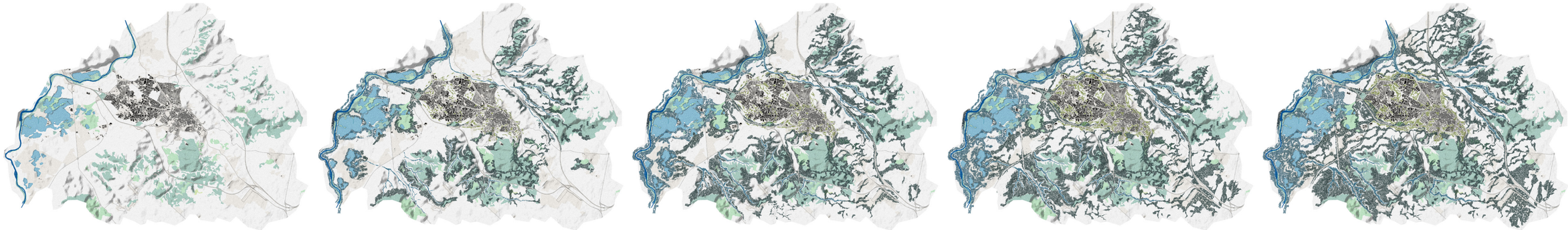


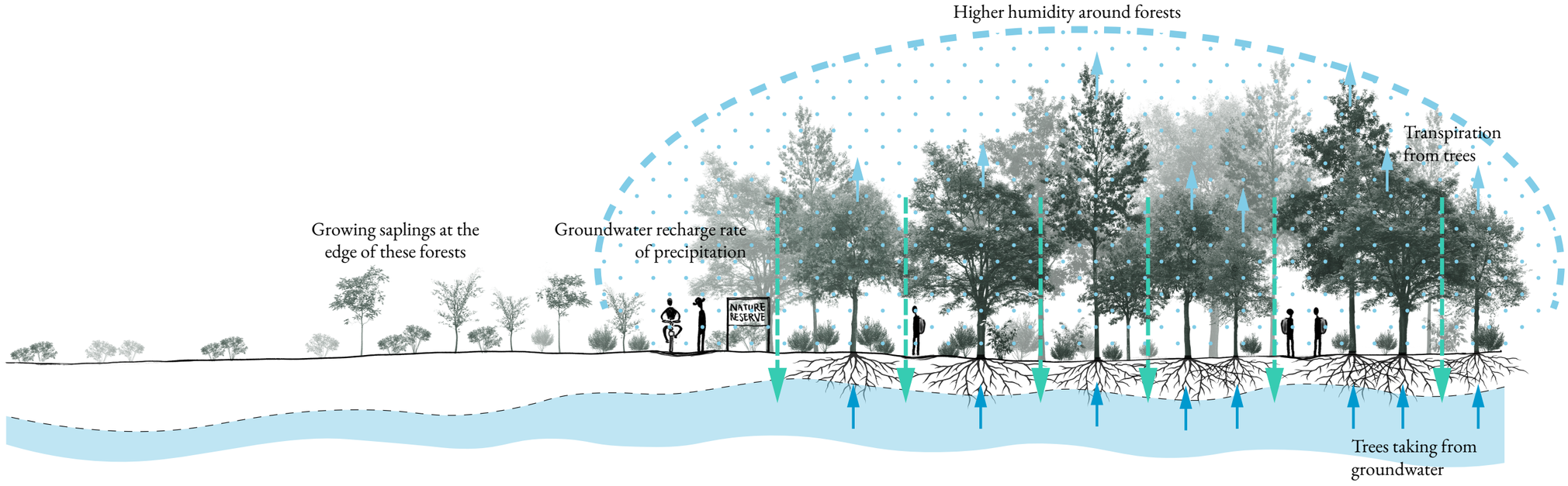
Systems of the Environment

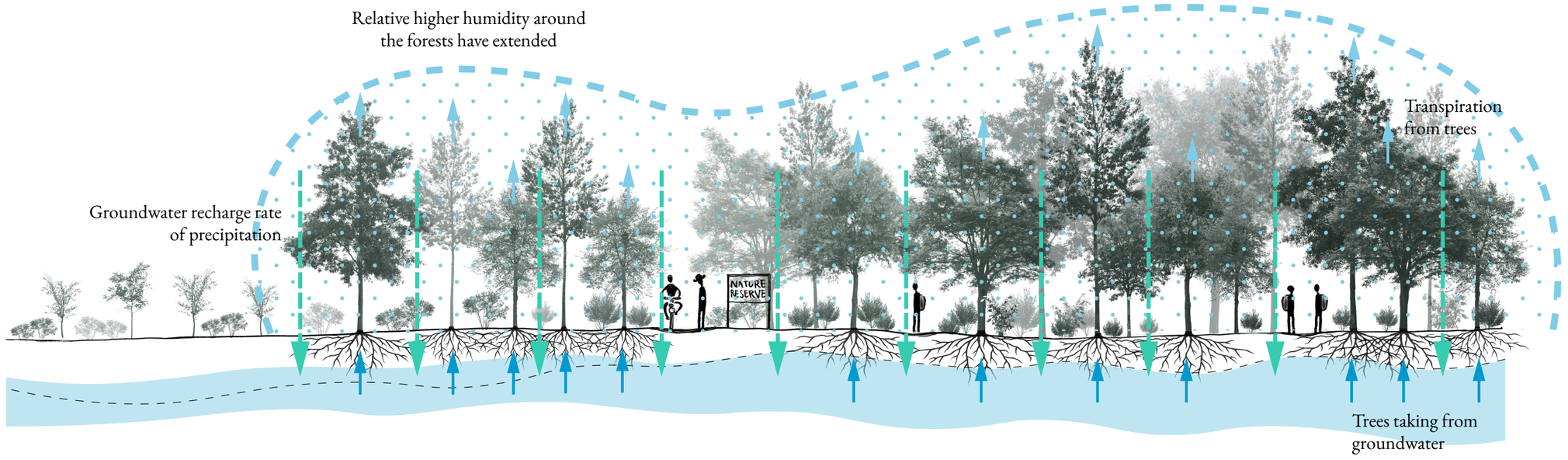

The Partial Commons
Private cultivated land engaged in eco-schemes
Public Green Spaces

What long-term environmental strategies can be used to achieve the collaborative potential of the landscape commons?



Now *In 6 - 8 years* *In 9 - 15 years* *In 16 - 23 years* *In 24 - 30 years*





Systems of the Environment

Sections showing how forests can be extended from the edge of existing forests.

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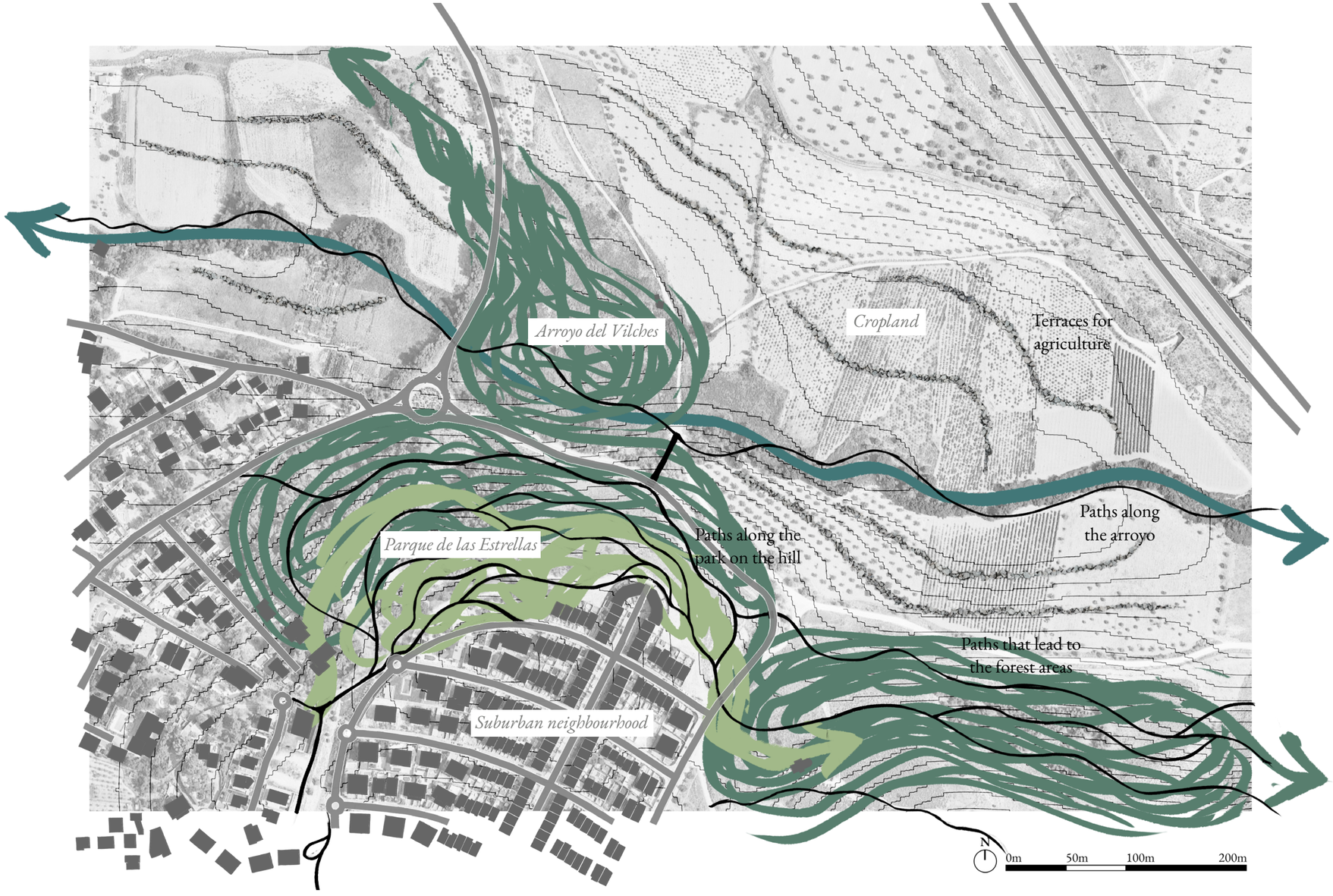

Park connections

Forest connection

Riparian connection of the arroyo

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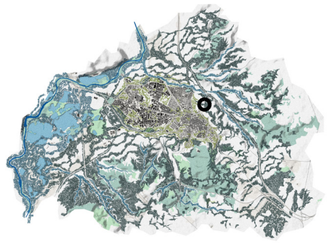

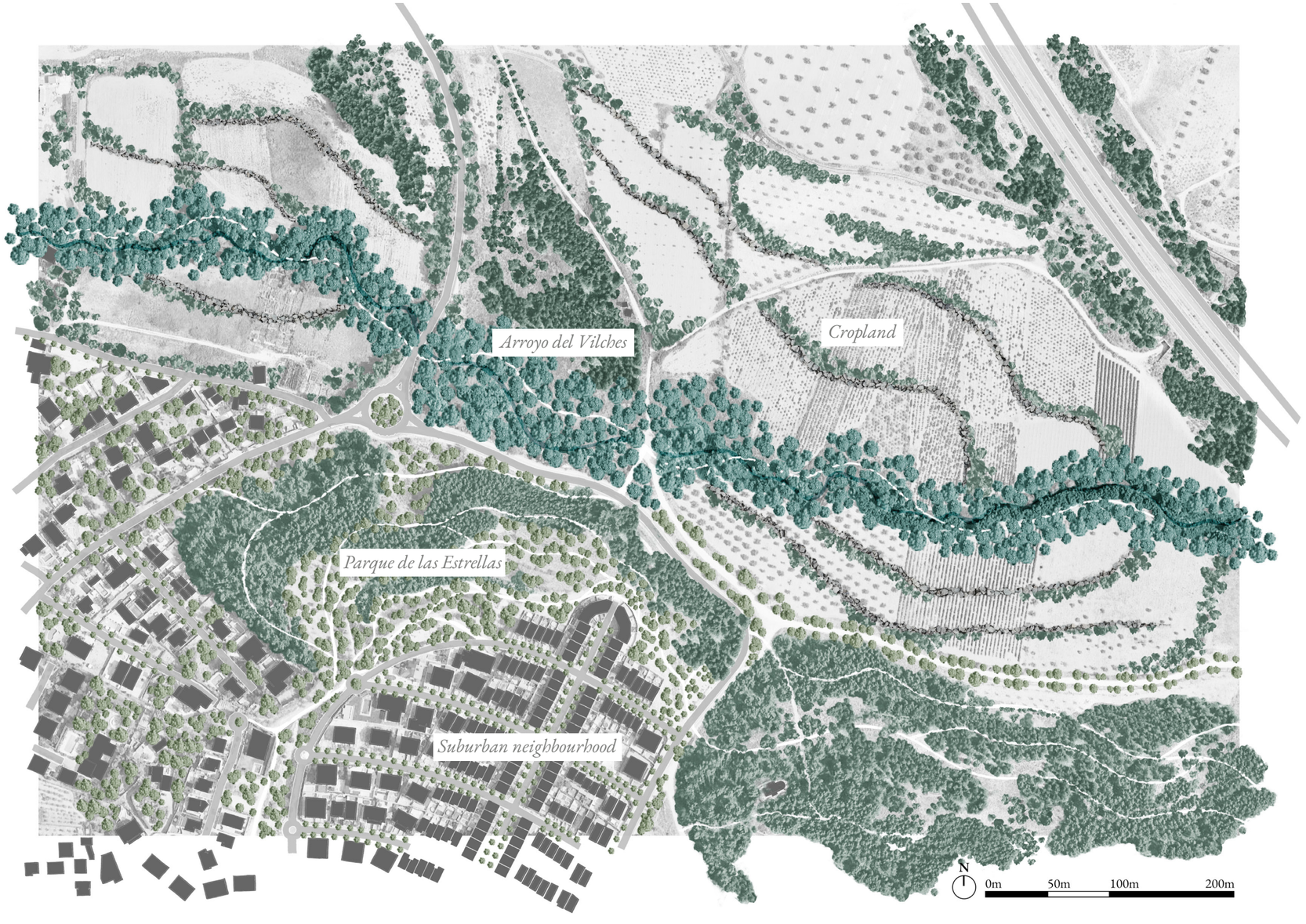

Protected forests / nature reserves

Agroforests

Riparian forests of Arroyo del Vilches

Parks and Urban Green Spaces

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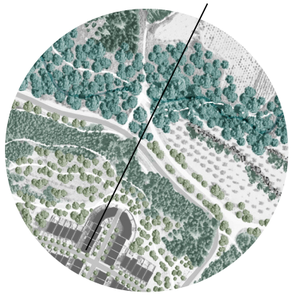
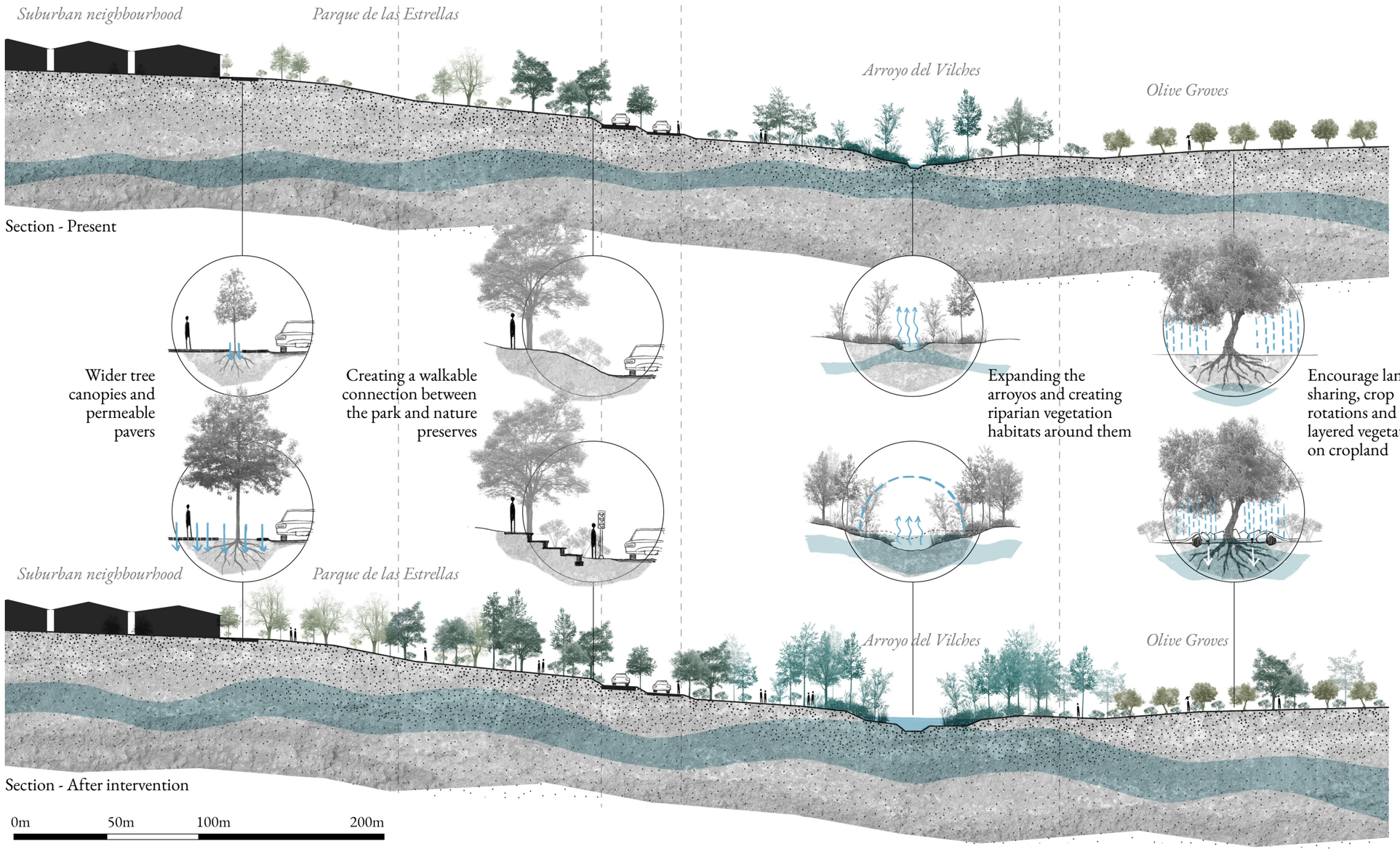
What short-term environmental strategies can be used to achieve the collaborative potential of the landscape commons?





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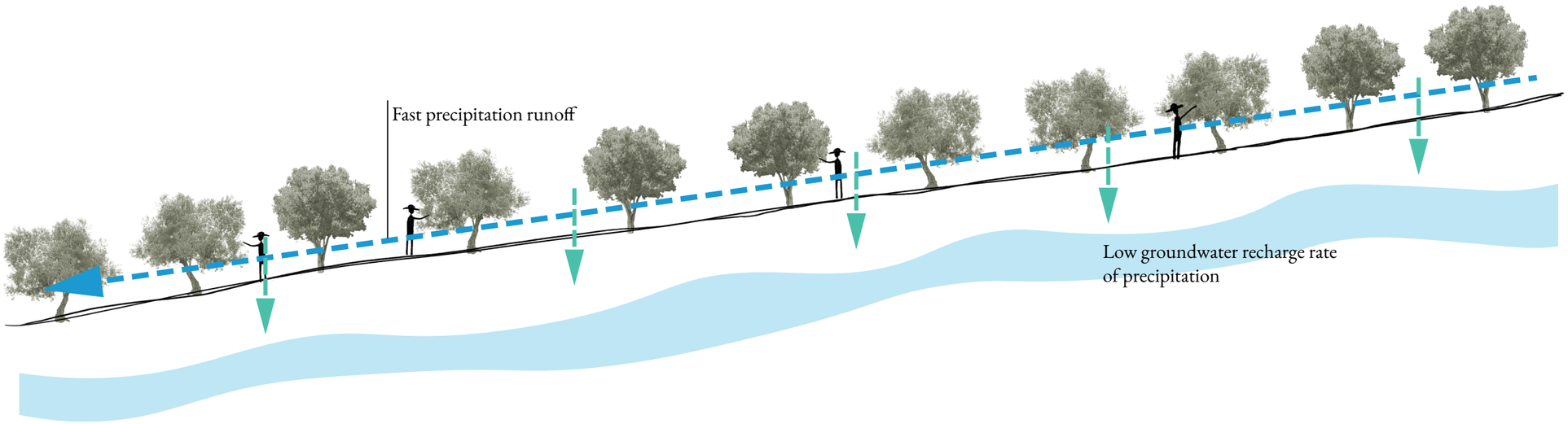

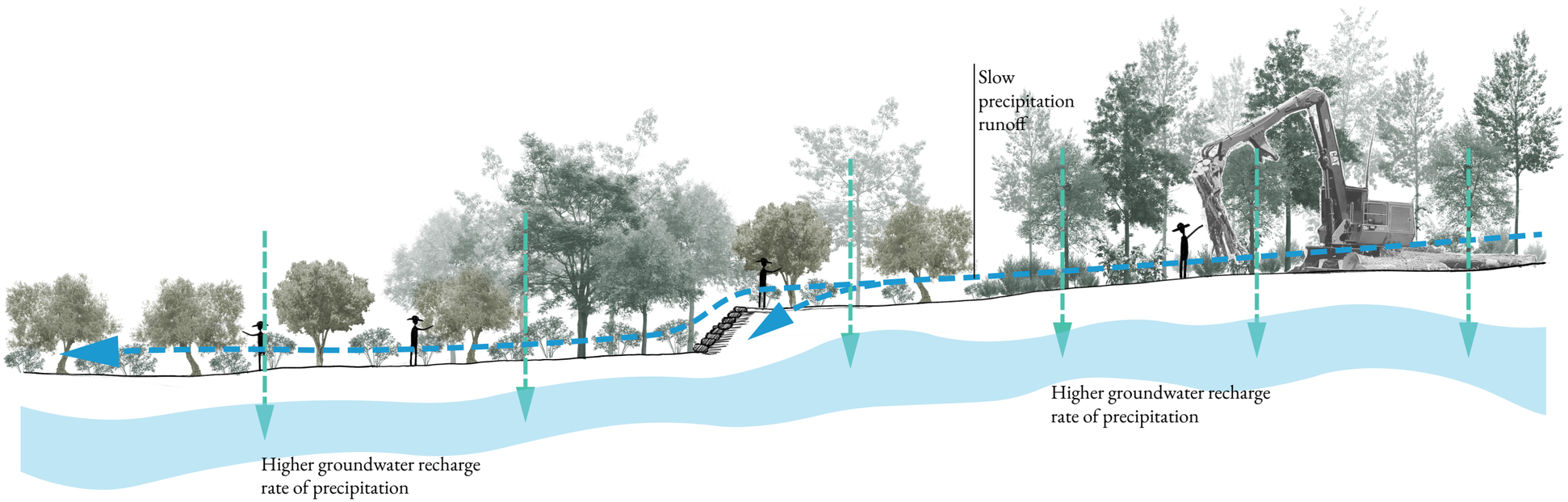

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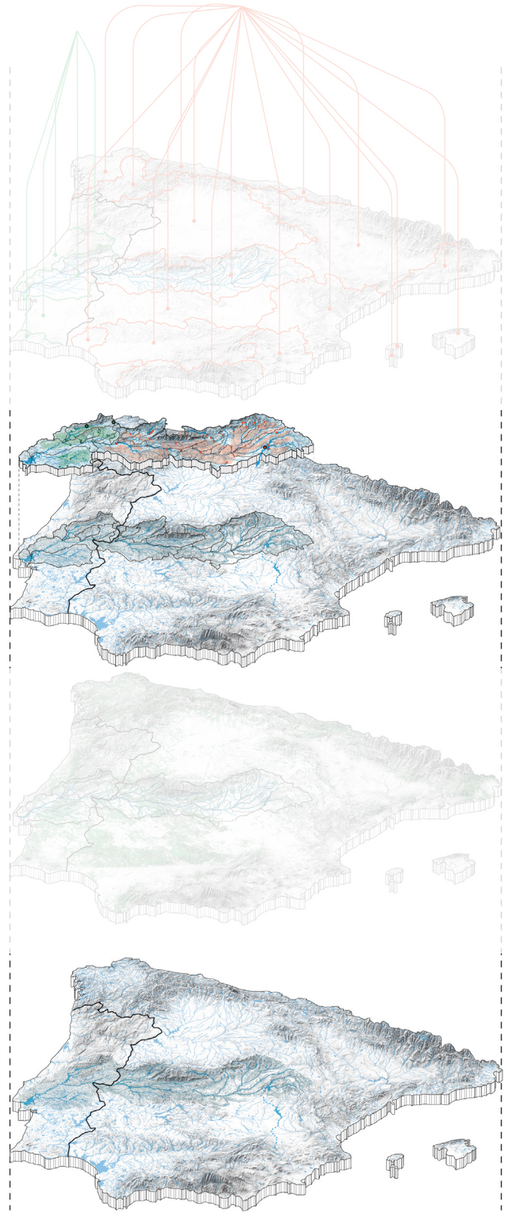
What are the rules and boundaries of the commons?

What are some principles and strategies that the community can use to build the water-landscape commons?

How can cultural landscapes become part of the commons?



Systems of Governance

Systems of Society

Systems of the Environment

Water-landscape commons as the medium

Systems of Society

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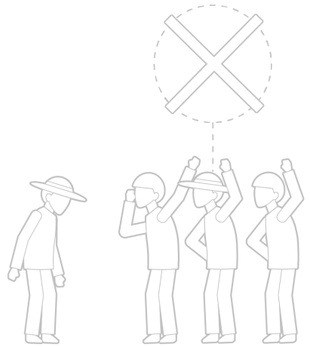
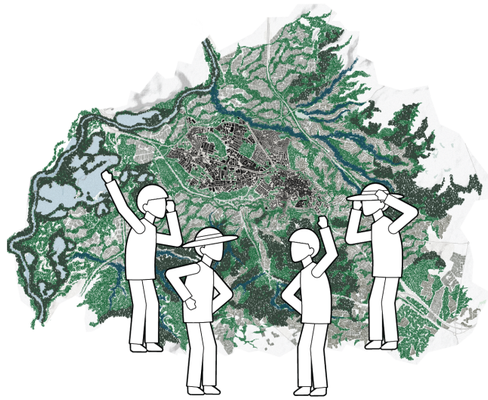
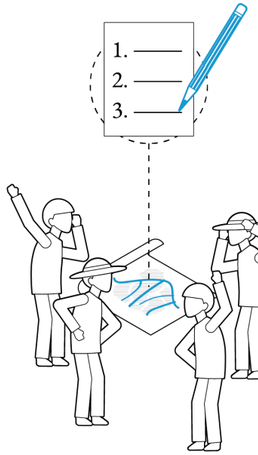


Graduated sanctions:
violators of the rules will be assessed by other users of the commons or officials that are accountable to the users.

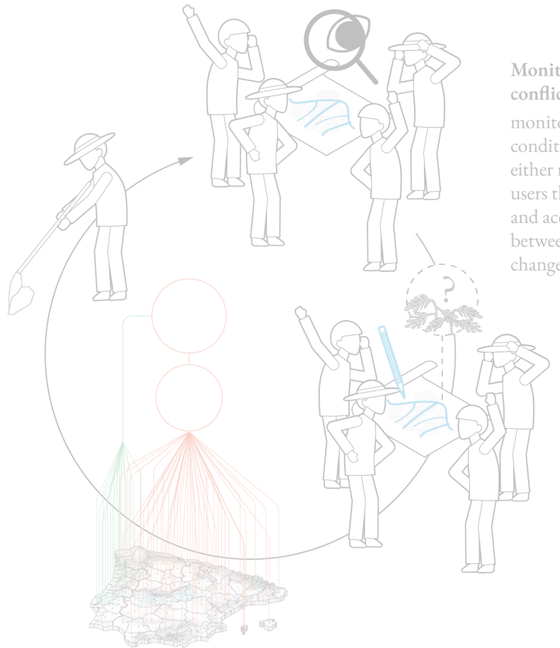


Clearly defined boundaries:
what the resources are and who have the rights to partake - stipulated in systems of society

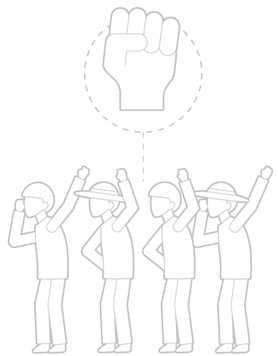


Congruence between appropriation and provision rules and local conditions:
according to that stipulated in the systems of society

Collective -choice arrangements:
individuals participating in the commons can collaborate to form or change the rules that are mutually agreed upon



Monitoring and conflict-resolution system:
monitors will actively track the conditions of the commons who either report to the users or are users themselves. Also an efficient and accessible way to raise conflicts between users, stakeholders or changes to the environment.



Minimal recognition of rights to organise:
users have rights to plan their institutions without rights being challenged by external forces.

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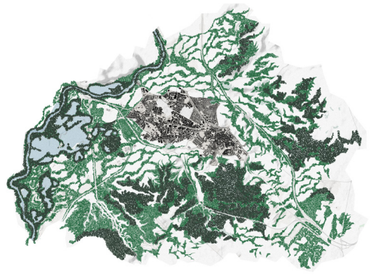
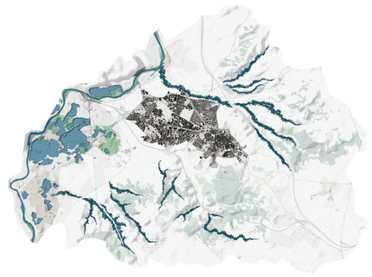


The Commons

Protected forests, agroforests and polyculture tree crops

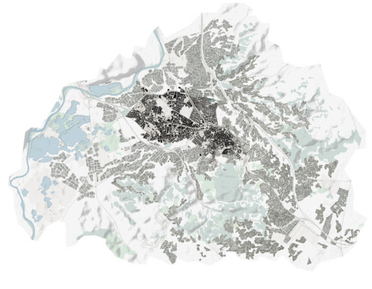
Existing forests are strictly protected. Farmland or abandoned land will be recommended to adopt agroforestry or vegetation layers to become more polycultural. These will form the commons where farmers can freely harvest and use water from the commons in exchange for sustainable maintenance.



River, Brooks and Ravines

Channels in brooks and ravines will be widened and have their banks reinforced with small riparian forests. Cropland along these brooks and ravines will incorporate these features on their land as part of their eco-schemes. These will also be part of the commons.

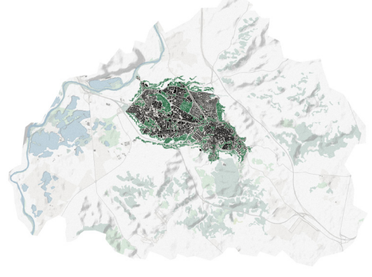
What are the rules of the commons?



Partial Commons

Private cultivated land

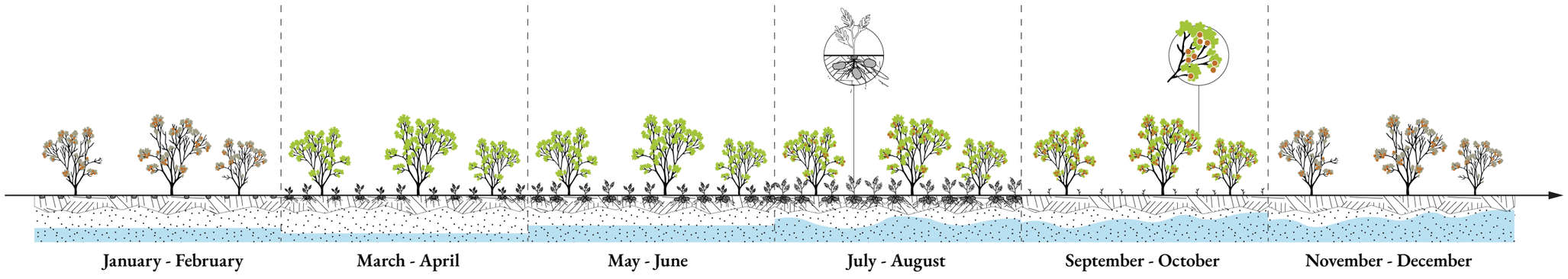
These landscapes will adopt seasonal irrigation rotations. Wet seasons will allow them to use traditional acequias while dry seasons will let them use localised / drip irrigation. Some aspects of the eco-schemes are encouraged, such as growing of non- productive features and crop rotations.

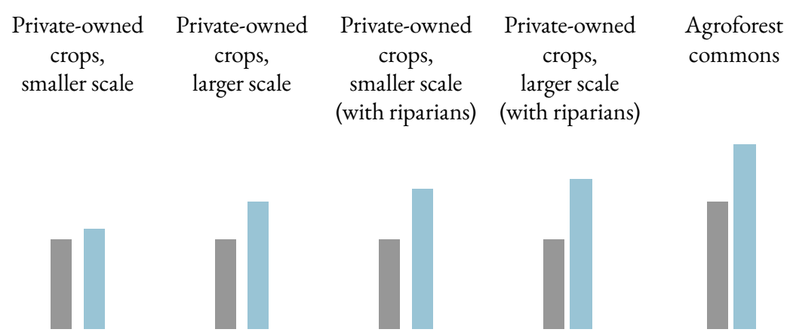


Urban landscapes

Parks will be extended to connect to the commons. Greenery planted along road sides will strive towards layered planting and trees with wider canopies to reduce urban heat island effects. Other features like permeable pavers will be recommended to allow urban runoff and precipitation to seep into the soil more easily.

Systems of Society





Compensation & access to water from natural sources according to scale of business and level of participation in the commons



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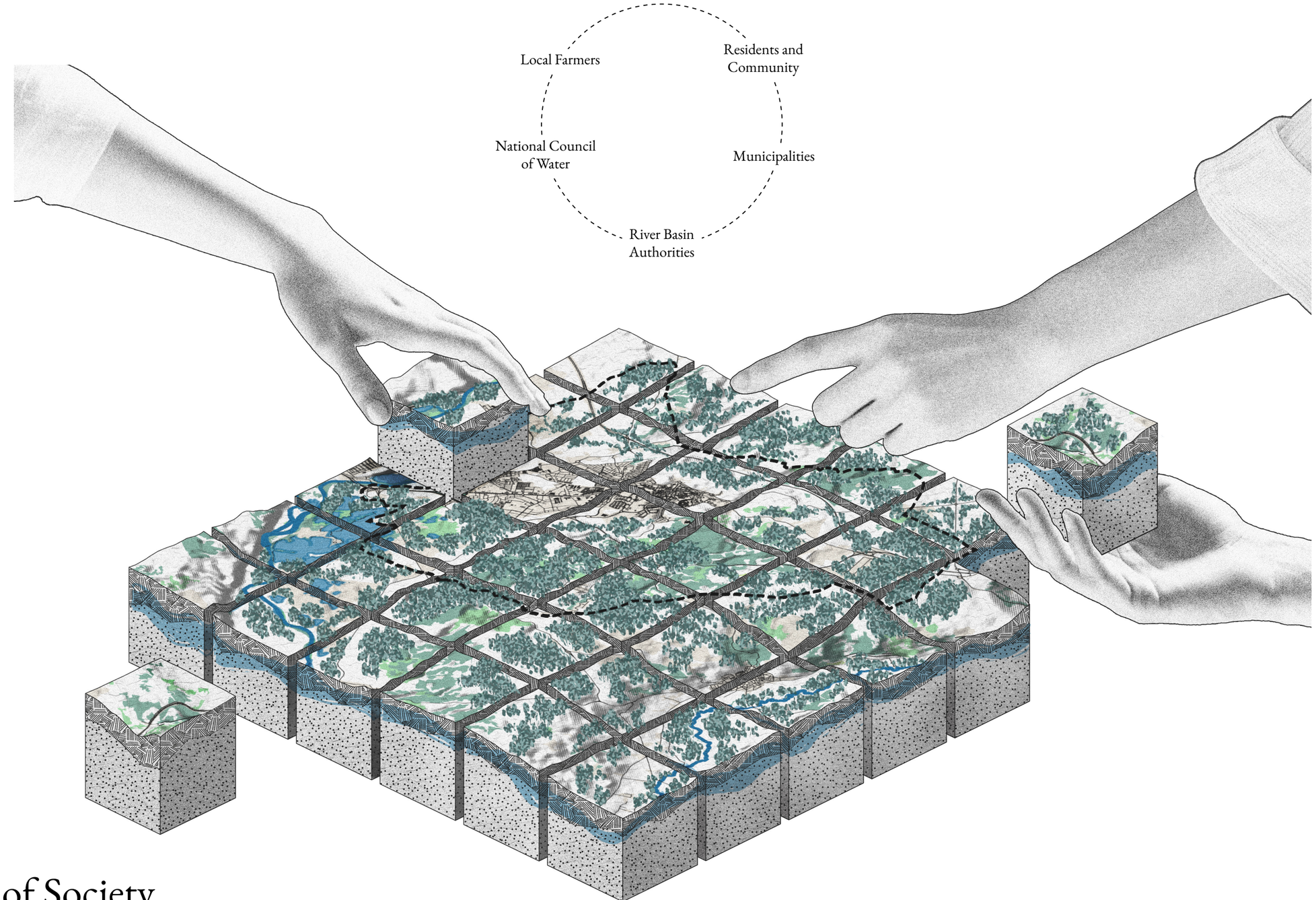
Collaboration Between Stakeholders



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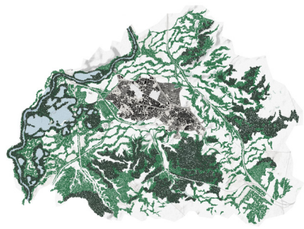
What are the boundaries of the commons?



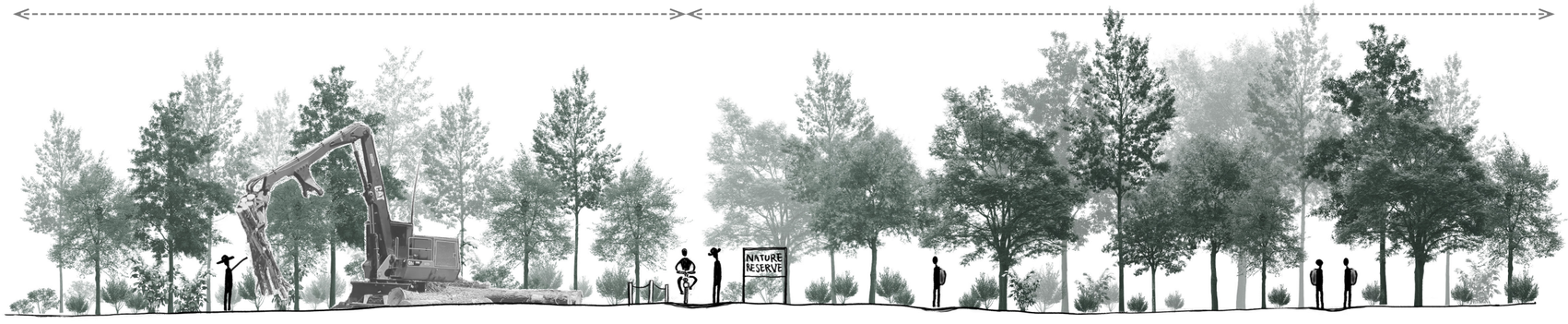
Levels of Accessibility for protected forests, agroforests and polyculture tree crops

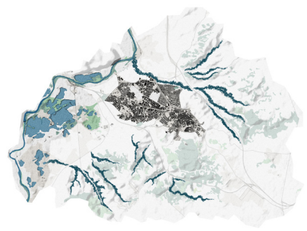
Agroforests

Farmers participating in the commons only

Protected Forests & Nature Reserves

Members of the public and community can enjoy the outdoors but not stray from paths. Rangers of the commons also patrol the area.



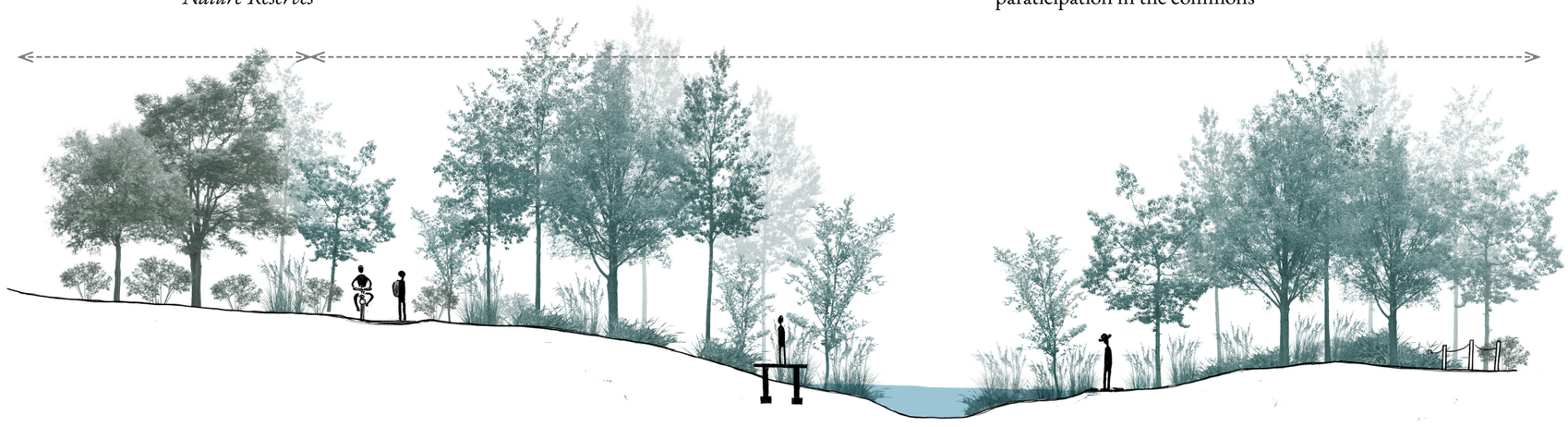


Levels of Accessibility for brooks and ravines

Protected Forests & Nature Reserves

Brooks & Ravines

Members of the public and community can enjoy the outdoors but not stray from paths. Farmers can use amounts of water depending on their paraticipation in the commons



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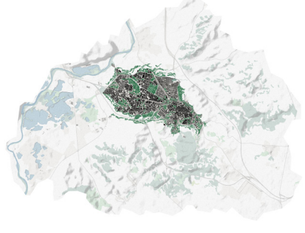
What are the boundaries of the partial commons?



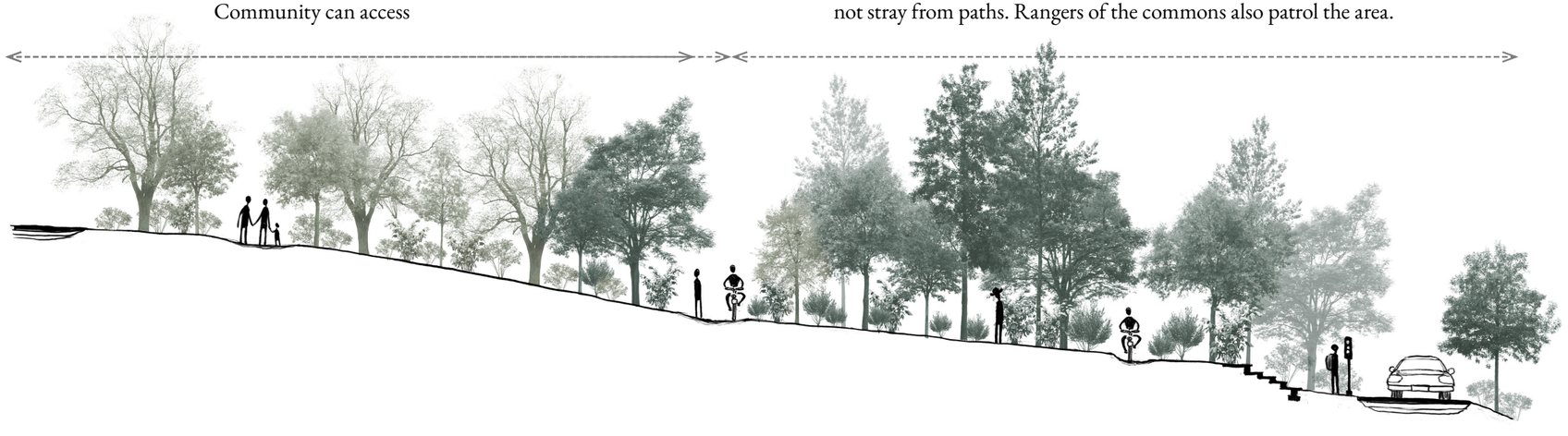
Levels of Accessibility for urban landscapes

Parks (Public Green Spaces)

All members of the Community can access

Protected Forests & Nature Reserves

Members of the public and community can enjoy the outdoors but not stray from paths. Rangers of the commons also patrol the area.





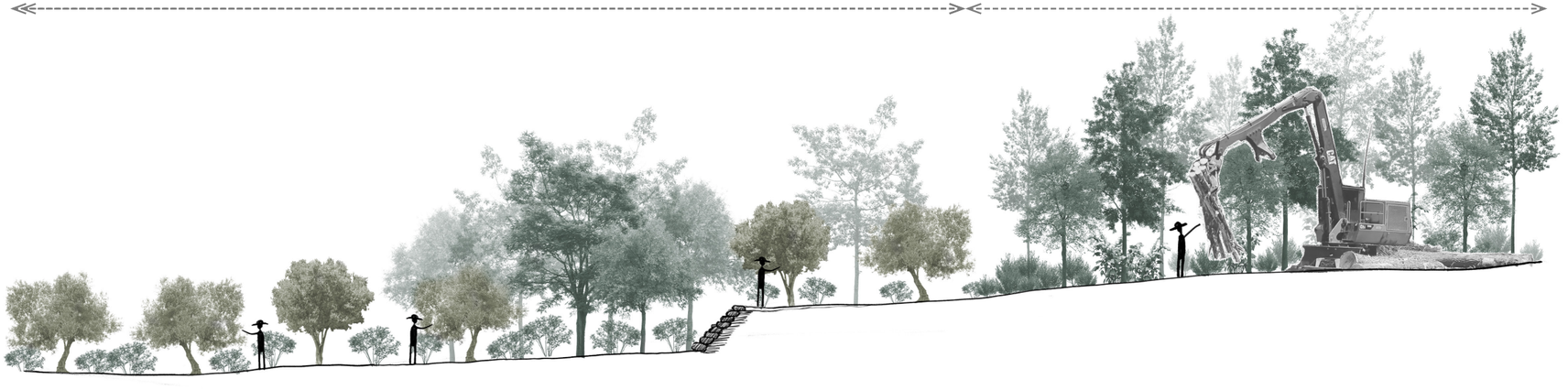
Levels of Accessibility for private cropland

Private-owned Cropland

Farmers or owners of the land only.

Agroforests

Farmers participating in the commons only.



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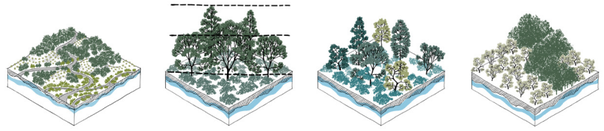
What are some principles and strategies that the community can use to build the water-landscape commons?



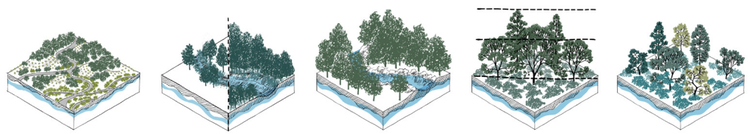
Spatial principles for urban landscapes

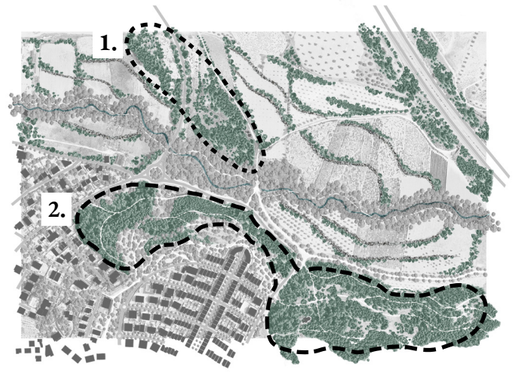


How can a cultural landscape be part of the commons?

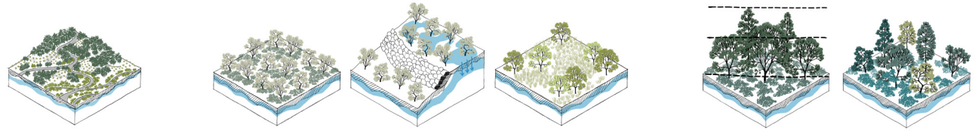


Spatial principles for the Arroyo del Vilches





Spatial principles for protected forests and agroforests



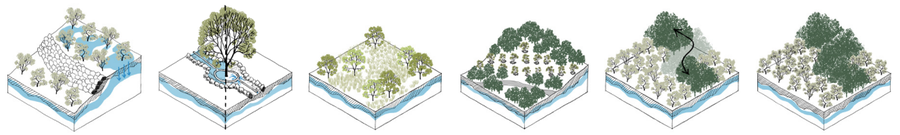
Both

1. Agroforests

2. Protected forests



Spatial principles for cropland



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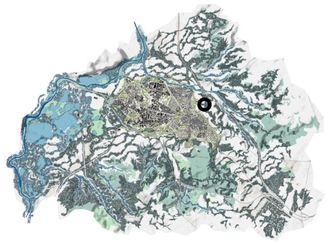

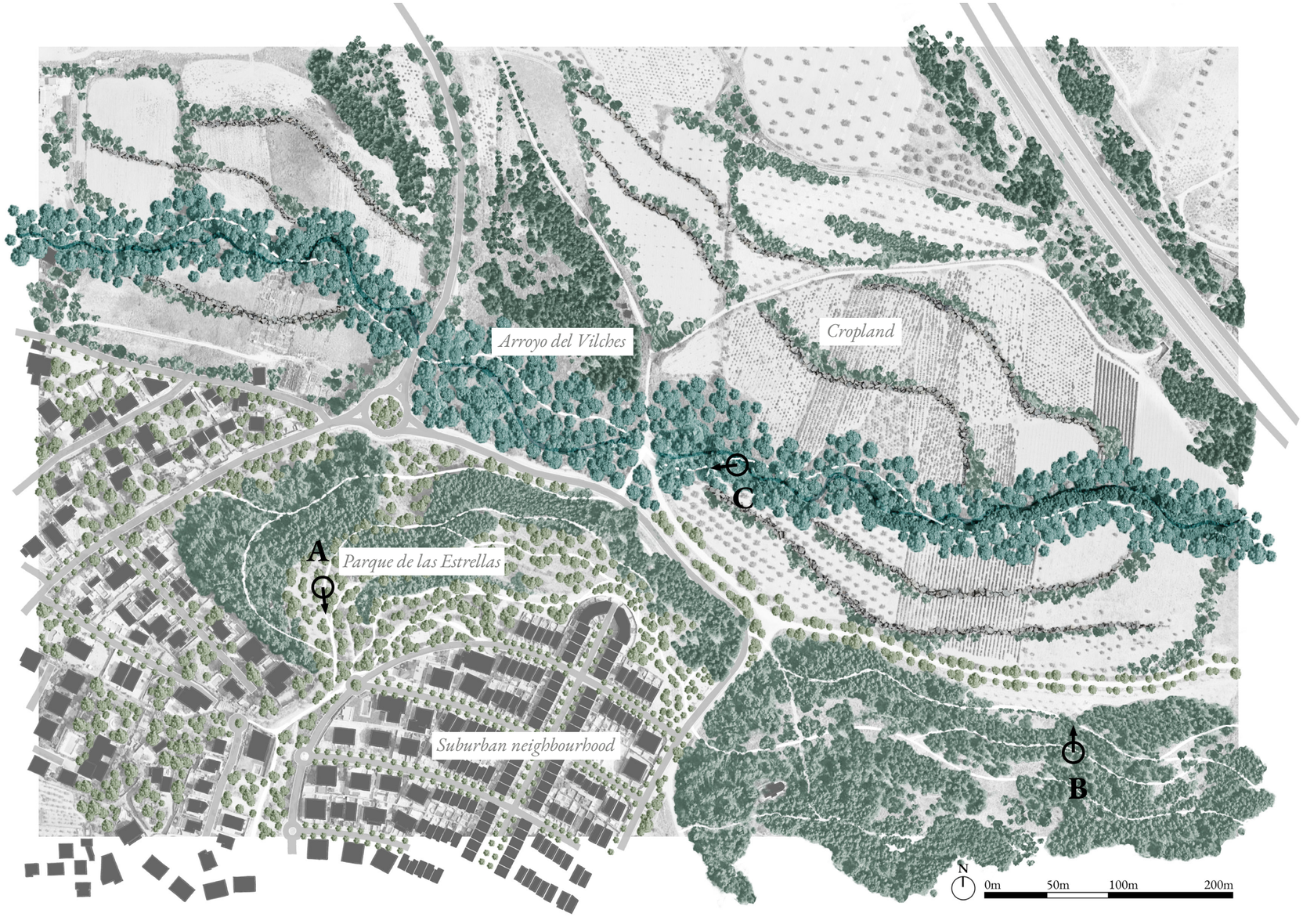

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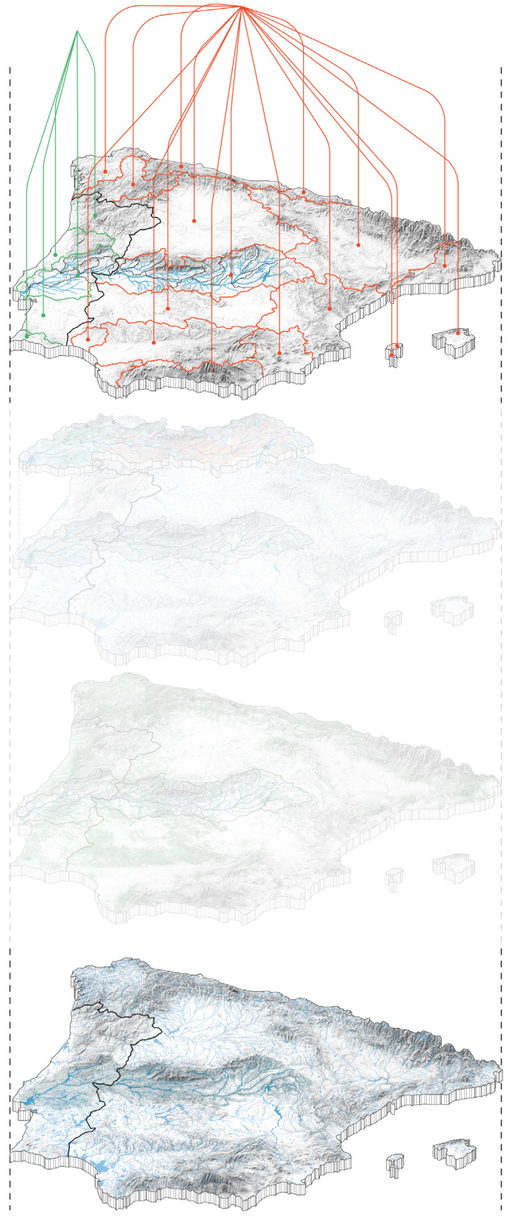
What are the responsibilities of the different communities and stakeholders in this collaborative system?

How can progress and conflicts be managed when building the water-landscape commons?

What long-term and short-term governance strategies can be used to achieve the collaborative potential of the water-landscape commons?



Systems of Governance

Systems of Society

Systems of the Environment

Water-landscape commons as the medium

Systems of Governance

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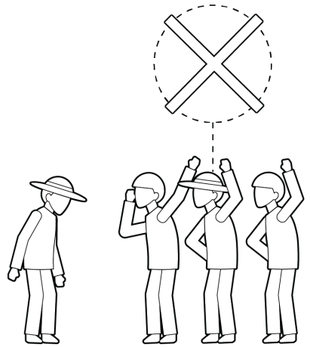

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Clearly defined boundaries:
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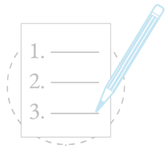

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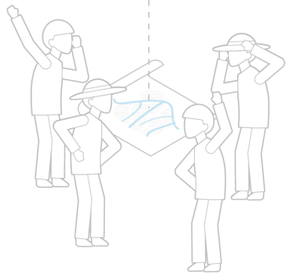

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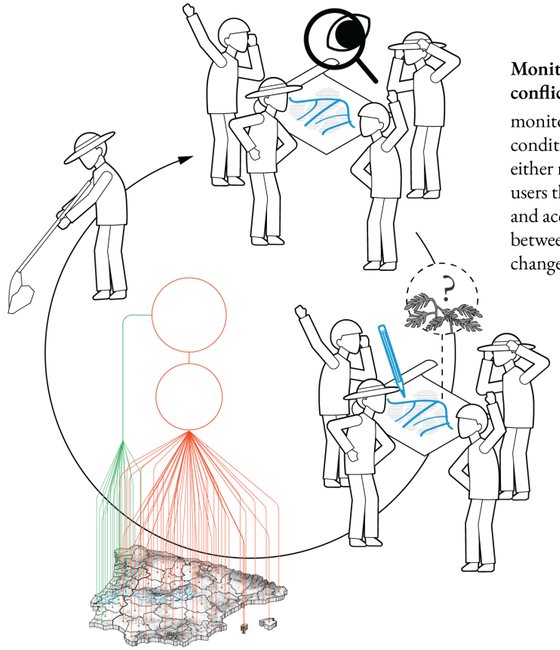

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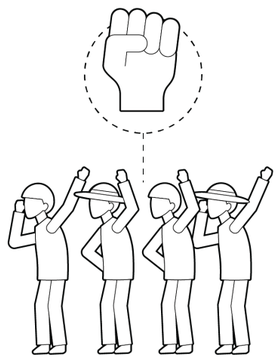

Minimal recognition of rights to organise:
users have rights to plan their institutions without rights being challenged by external forces.

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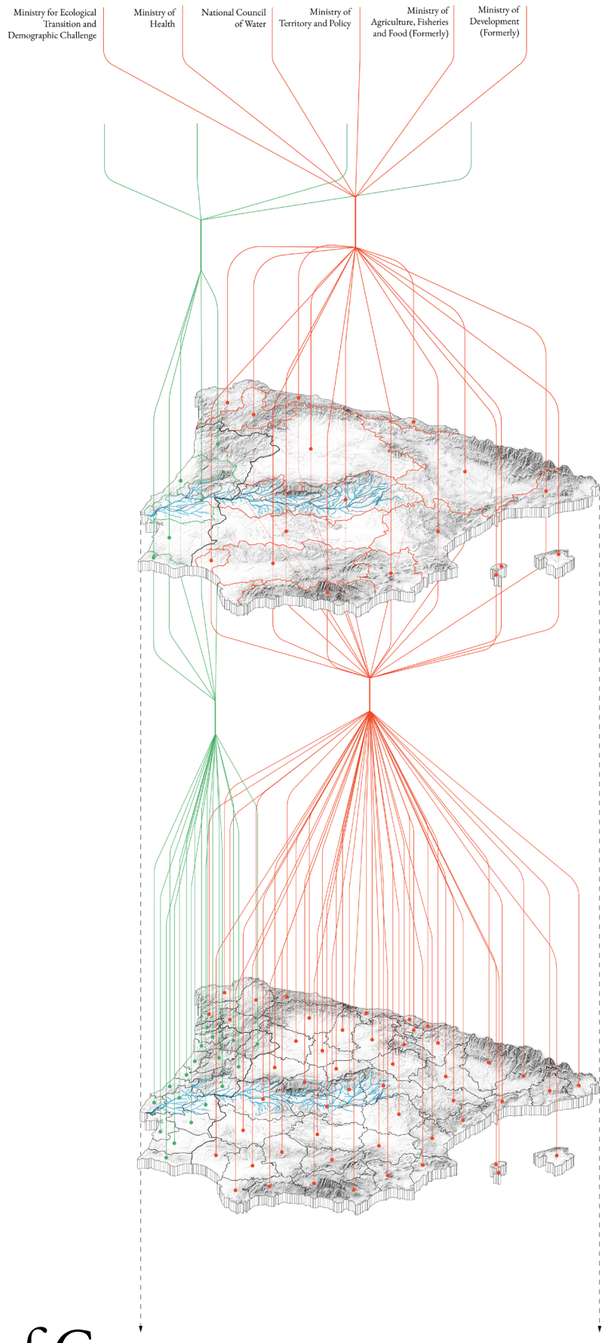

National Level Water Governance of Spain:

What are the responsibilities of the different communities and stakeholders in this collaborative system?

National Council of Water and Other Ministries (Spain)

- Coordinating between different municpalities and RBAs to resolve any conflicts.
- Coordinating proposals with Water Conventions with Portugal
- Monitor environmental conditions to assess if progression of resource usage is sustainable in the coming years

Regional Level Water Governance of Spain: River Basin Authorities

River Basin Authorities and Agriculture Ministry (Spain)

- Monitors water quality, water transfers, agriculture and forests.
- Assists maintenance team designated to these features and the commons.
- Forests, land and cultivation that became national parks / international parks / cultural landscapes will be closely monitored together with the impacts of droughts across river basins

Regional Level Water Governance of Spain: Province Administration

Municipalities & Water Agencies

- Investing in rainwater harvesting systems and underground detention reservoirs within urban areas.
- Investing more in water purification systems such that run-off and waste water can be re-used.
- Maintain some limits urban water consumption & quality while the water scarcity persists.

Municipalities and local Authorities: 8000

Farmers, Communities & Other Labourers

- Regulated use of water for agriculture: amount of water to use is proportionate to scale of business and level of participation in the commons.
- A percentage of profit will be invested into maintenance of the commons
- Would receive compensation for adhering to ecoschemes and participating in the commons.
- Would receive subsidies for materials needed to participate in the commons.
- Adherence to sustainable means of agriculture.
- A community to monitor water channels, reservoirs, forest planting and manual land clearing, and other natural resources.

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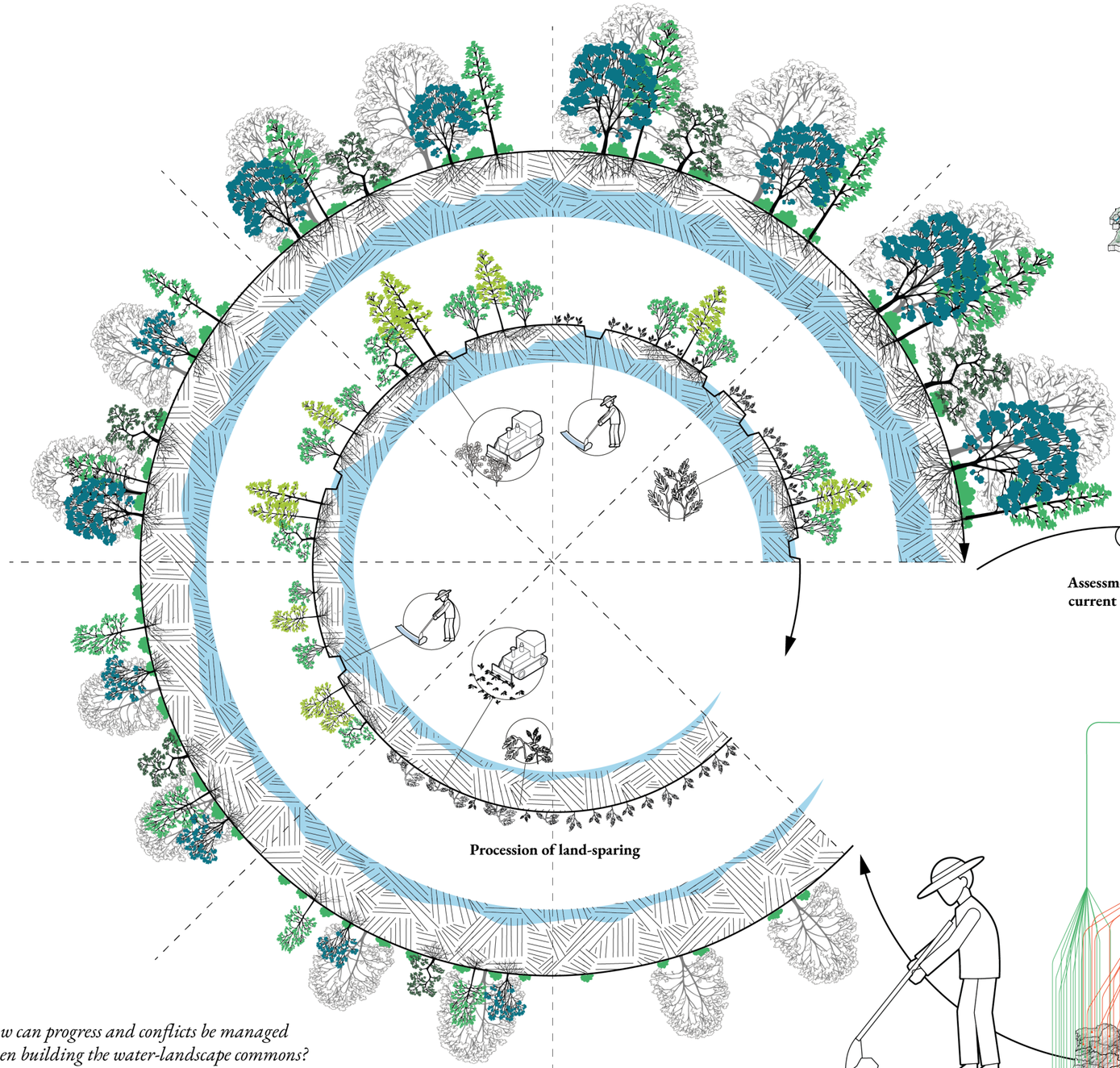
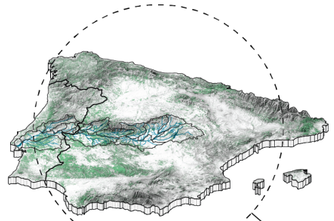


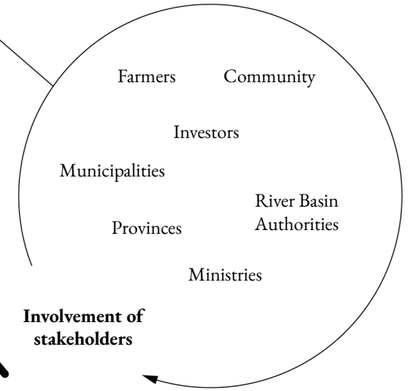
Procession of land-sparing

Procession of monitored regrowth of protected forests

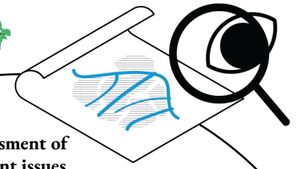
How can progress and conflicts be managed when building the water-landscape commons?



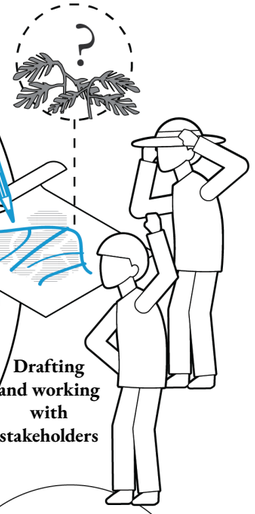
Access to an information hub: to procure materials, apply for subsidies and to monitor progress of forest growing



Involvement of stakeholders

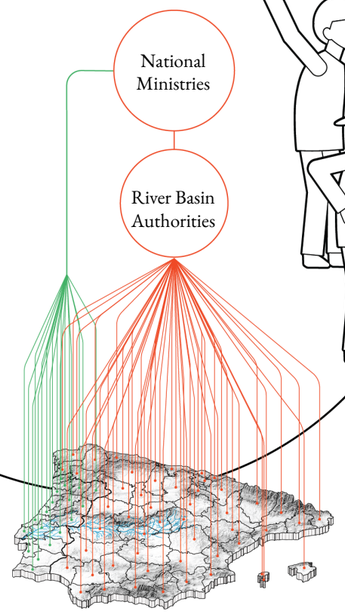


Assessment of current issues



Drafting and working with stakeholders

Acquiring labour for implementation of new scheme



Governing systems to provide grants and approve intervention

Updates on this process on the information hub

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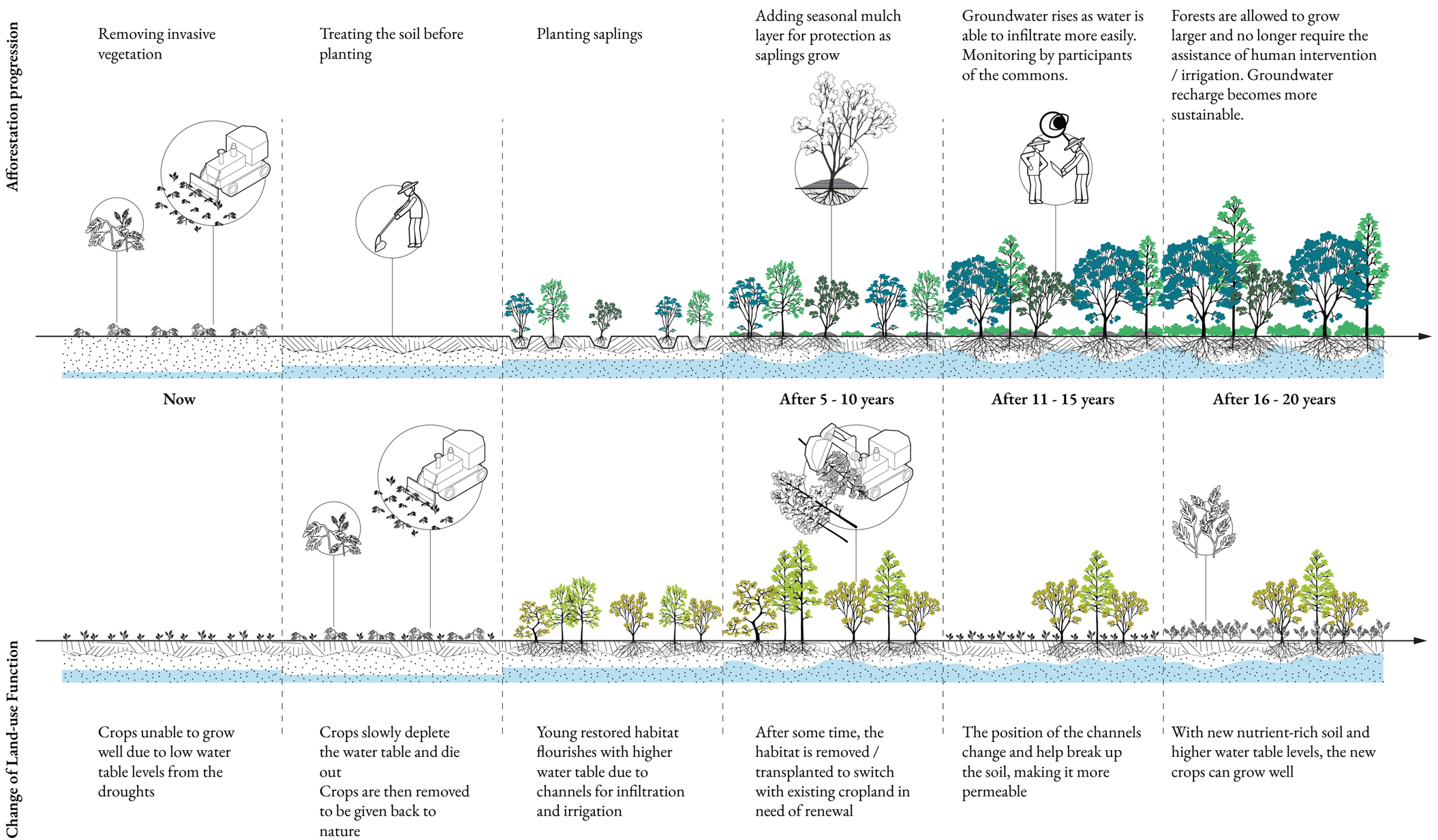

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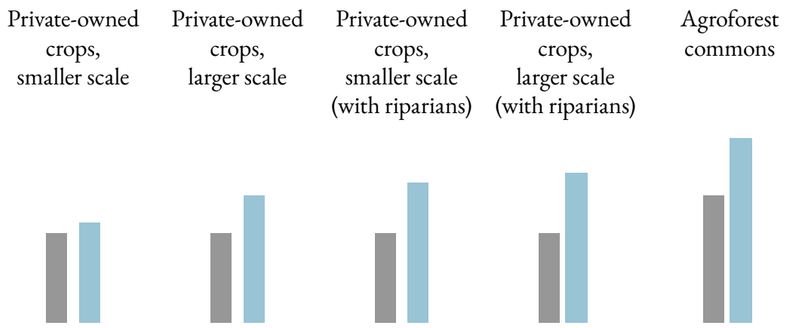
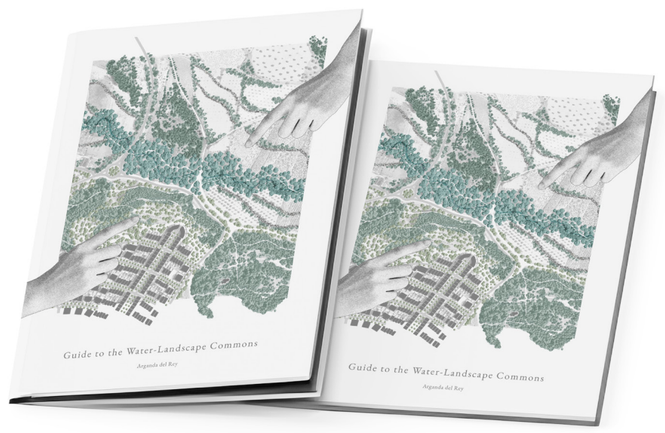
What are the long-term /short-term governance strategies can be used to achieve the collaborative potential of the water-landscape commons?



Compensation & access to water from natural sources according to scale of business and level of participation in the commons





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Case Studies: Landscape Restoration of the Loess Plateau

Jean Ong Wueng Kee
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1

Consideration Climate, Soil and Native Plant Species

2

Soil Preparation For Low-Nutrient Soils

3

Growing The Selected Vegetation

4

Establishing Water Management

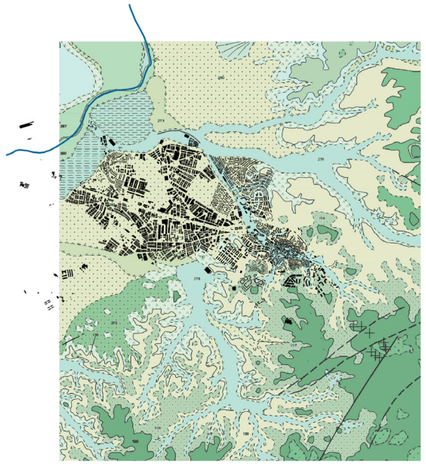
5

Re-Establishing Vegetation Cover

Case Studies: Landscape Restoration of the Loess Plateau

1

Consideration Climate, Soil and Native Plant Species





Quercus ilex
"Holm Oak"
Native



Pinus sylvestris
"Scots Pine"
Non-native



Stipa tenacissima
"Esparto Grass"
Native



Malva multiflora
"Cretan mallow"
Native



Quercus canariensis
"Zean Oak"
Native



Olea europaea
"Olive"
Native



Echium vulgare
"Viper's Bugloss"
Native



Hirschfeldia incana
"Mediterranean Mustard"
Native



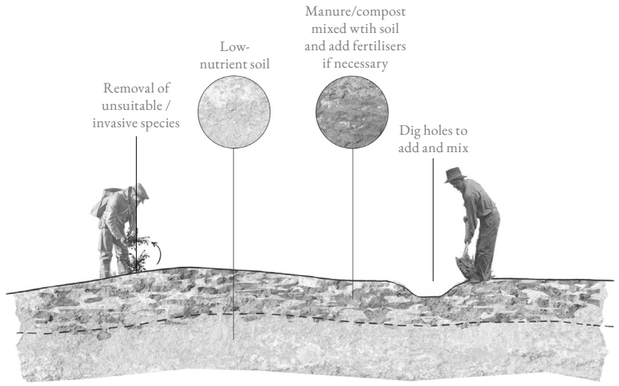
Linum suffruticosum
"White Flax"
Native



Antirrhinum graniticum
"Spanish Snapdragon"
Native

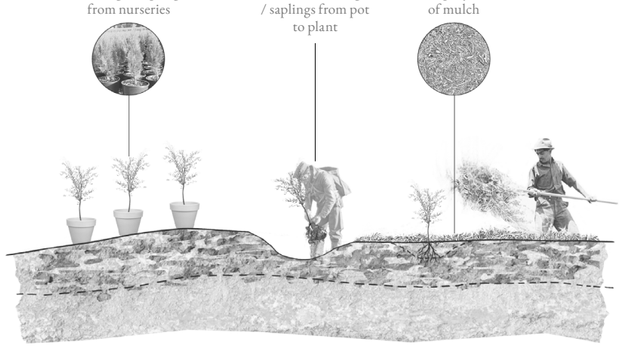
2

Soil Preparation For Low-Nutrient Soils



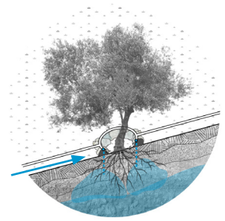
3

Growing The Selected Vegetation

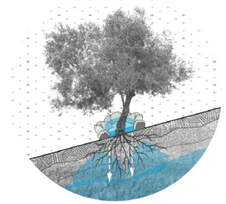


4

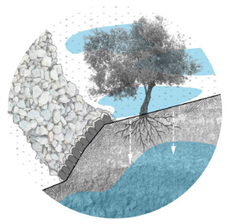
Establishing Water Management



Drip irrgation with water from brooks and ravines



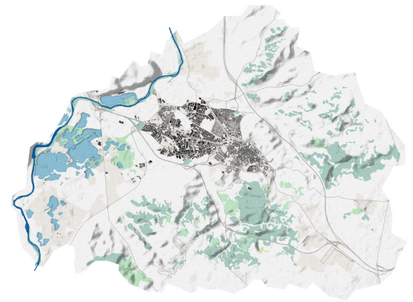
Water from precipitation collected to seep into the soil

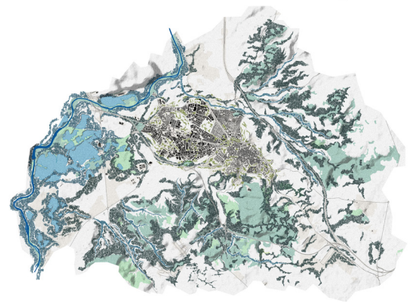


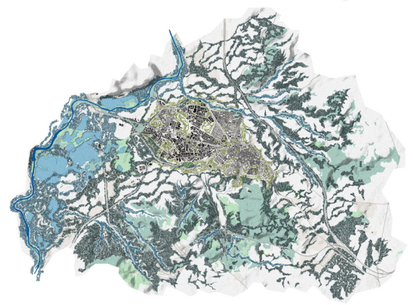
Water runoff slowed down by terraces

5

Re-Establishing Vegetation Cover







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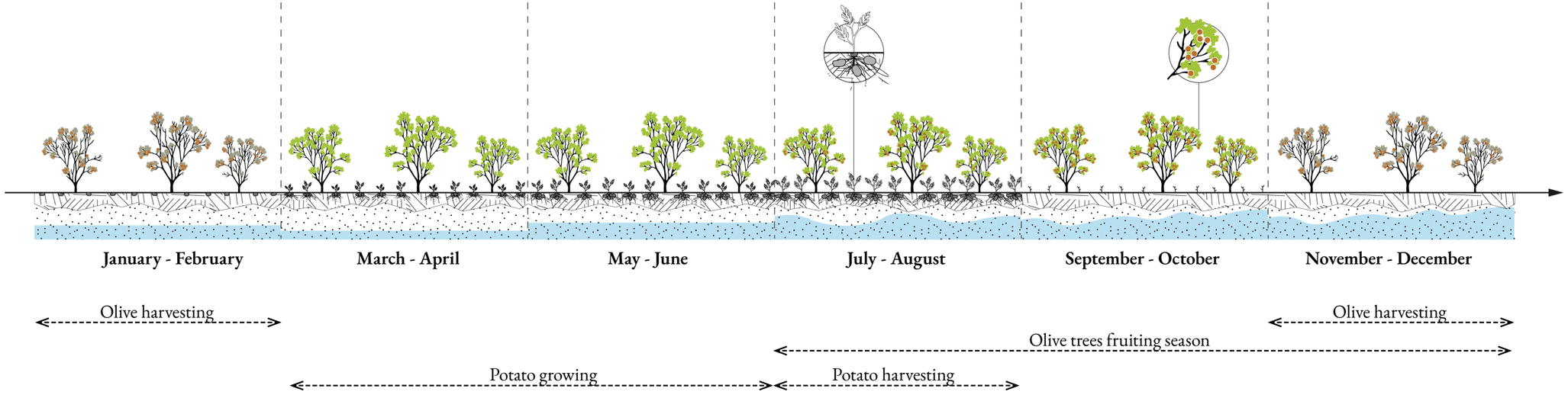
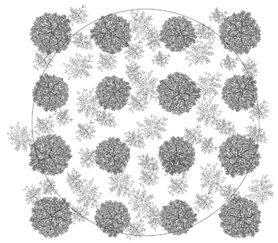
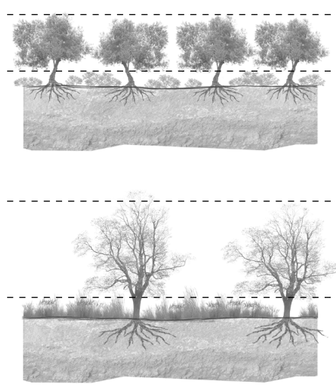
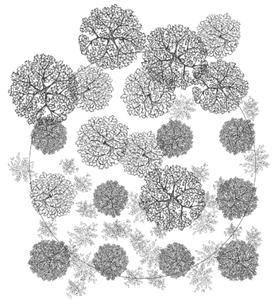


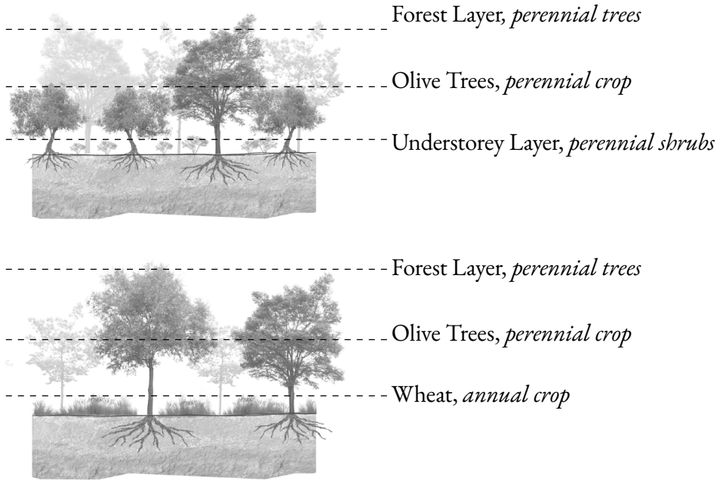


Crop layering option 1
Tree crops mixed with low understorey crops, preferably with shallow root systems.





Crop layering option 2
Crops mixed with ecological forests, preferably with shallow root sytems.



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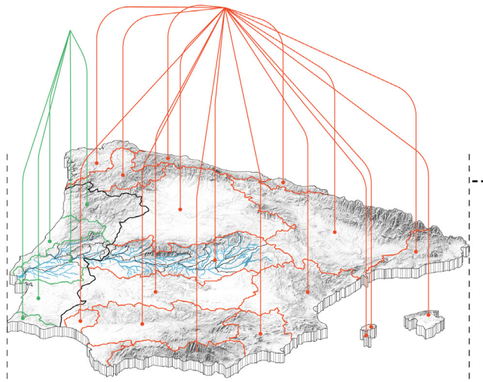
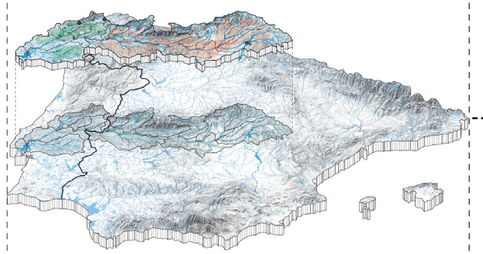
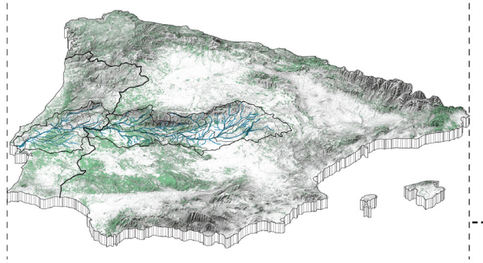
Conflicting Systems
of Governance

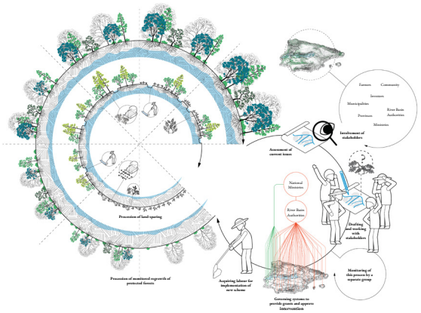


Conflicting Systems
of Society

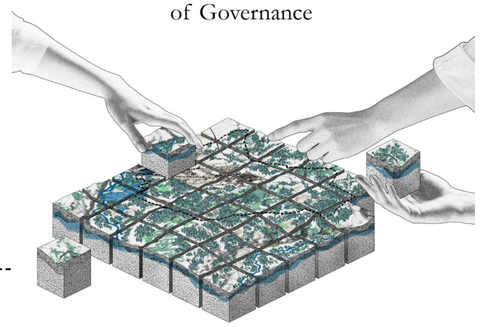


Conflicting Systems
of the Environment





Collaborative Systems
of Governance



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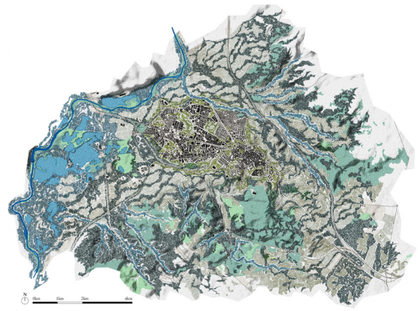
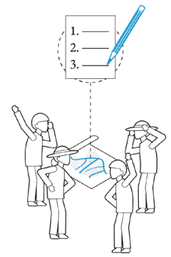


Collaborative Systems
of the Environment

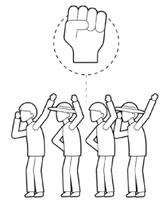


Clearly defined boundaries:
what the resources are and who have the rights to partake - stipulated in systems of society



Congruence between appropriation and provision rules and local conditions:
according to that stipulated in the systems of society

Collective -choice arrangements:
individuals participating in the commons can collaborate to form or change the rules that are mutually agreed upon



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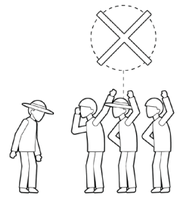


Graduated sanctions:
violators of the rules will be assessed by other users of the commons or officials that are accountable to the users.

The culmination of this collaboration between the systems is the commons, and these are the principles that are the basis of the proposed water-landscape commons.

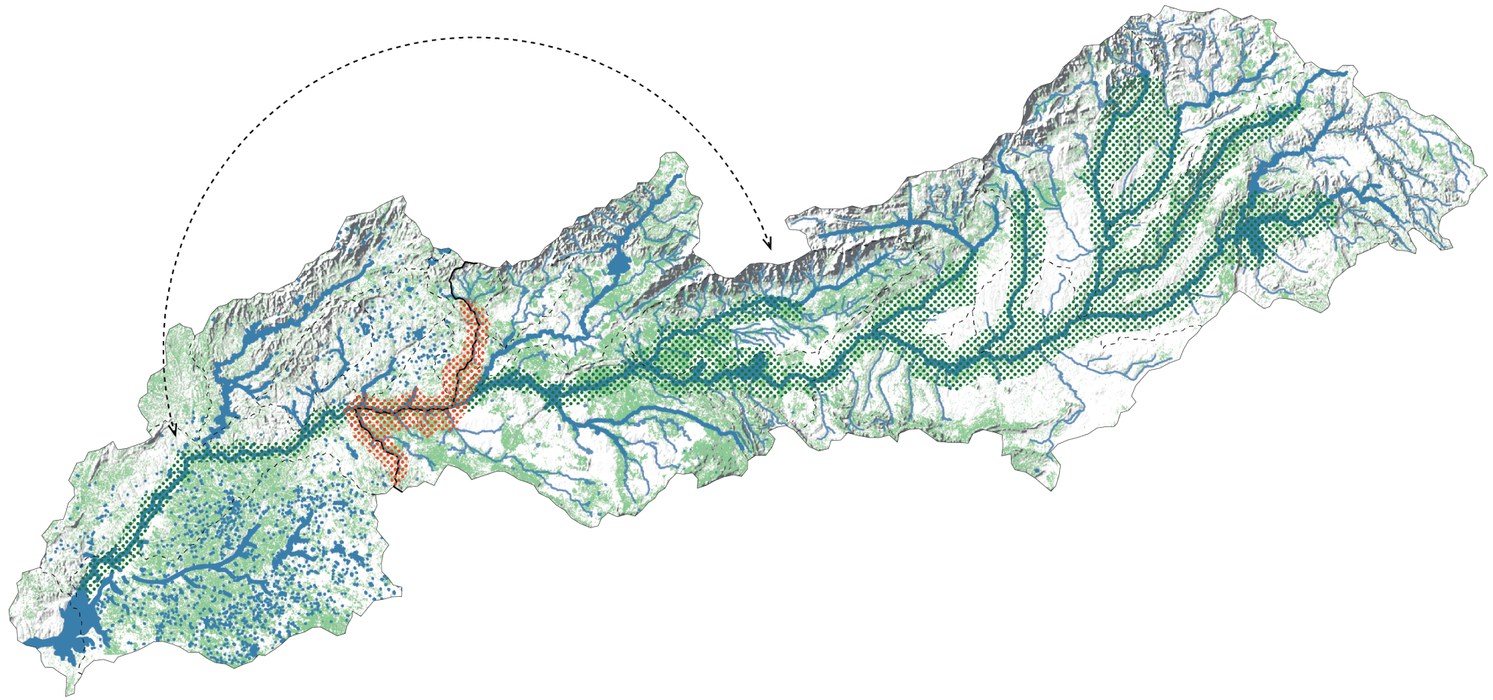
Conclusions & Discussions

What is the relation between your graduation (project) topic, the studio, your master track, and your master program?

What is the relevance of your graduation work in the larger social, professional and scientific framework?

What were some things that could have been improved the thesis or some things that could not be considered due to circumstances and how did that affect the research?

What is the role of the Landscape Architect?



Reflections

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Special Thanks to

Javier Sánchez Jiménez

&

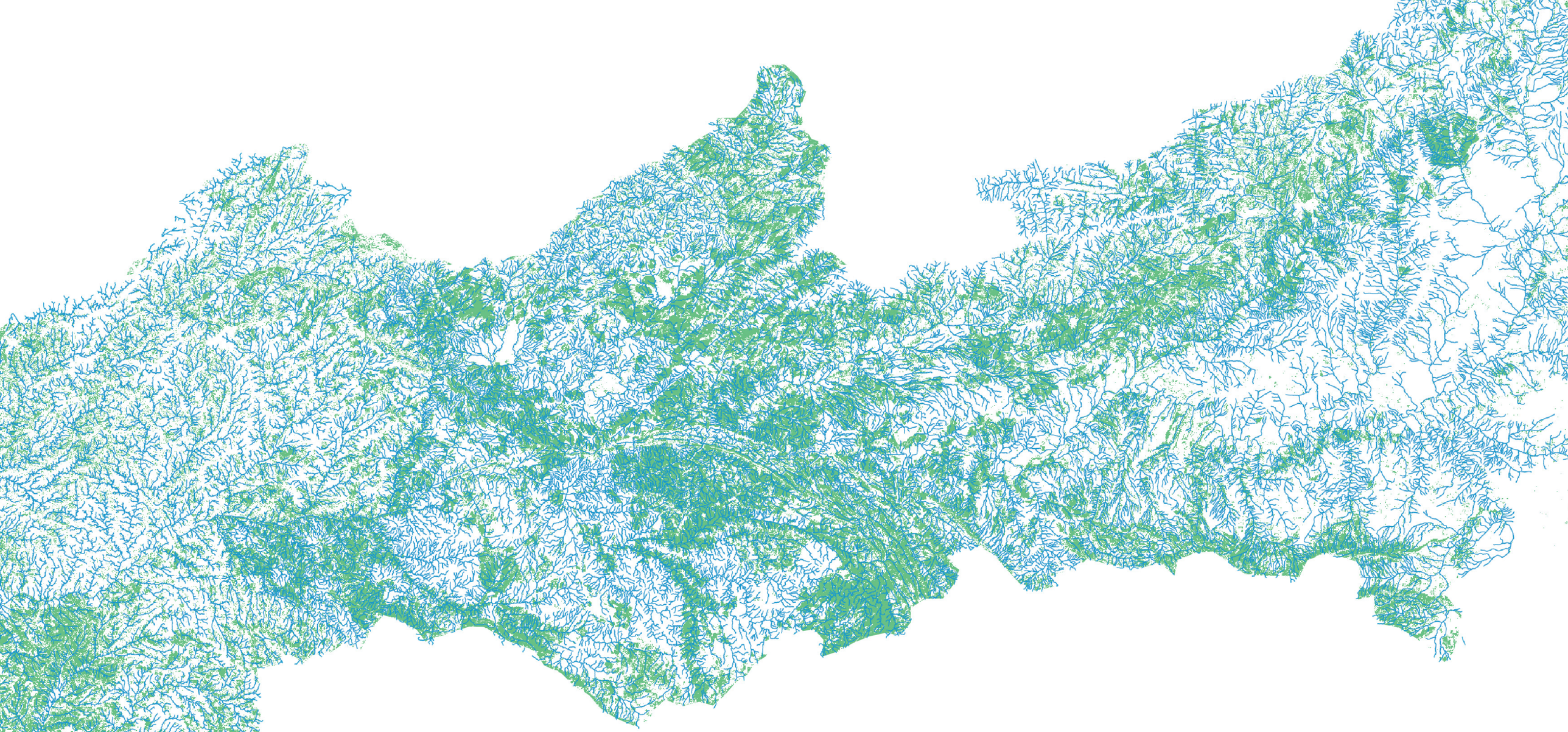
Sergio Zubelzu Minguez

Hidráulica, Hidrología y Riegos

(Departamento de Ingeniería Agroforestal)

Universidad Politécnica de Madrid

End



Thank you.