Counteracting desertification and abandonment in the rural Spanish landscape



revealing potentialities of regeneration through a local sensitive adaptive strategy

Germaine ter Brugge

Colophon

Germaine ter Brugge
4818539

Delft University of Technology
Faculty of Architecture and the Built Environment
Master of Science Architecture, Urbanism, and Building Sciences
Department of Urbanism

Transitional Territories
Altered Nature: *Poetics of Change*

Thesis Report
June 2024

First Mentor: Dr. Diego Andrés Sepulveda Carmona
Second Mentor: Dr. Fransje Hooimeijer

If not stated otherwise, images used are own work.

TU Delft BK Bouwkunde Department of Urbanism

URBAN DESIGN AT TUDELFT

PHILIP-SPANGENBERG-TRAVEL-GRANT

Previous page: Figure 1. Counteracting desertification through systemic local agency and actions



Het waren geen gesprekken

Laat het vonnis
snel voltrekken

vreemd
en gedwee
galmde de dreun nog na

in dit totaal verteerde landschap

None of them were conversating
Let the verdict be swiftly

unfamiliar
and meek
The thud still echoed

in this utterly consumed landscape

Figure 2. BIrd flying over cliff in Monfragüe

Abstract



Desertification and depopulation are mutually reinforcing processes that cause global socio-ecological ecosystem vulnerability through land degradation. The dehesa landscape in Spain is especially vulnerable, facing severe threats from these combined pressures and urgently needing strategic intervention. This research explores the potential of adaptive strategic planning to mitigate the socio-environmental impacts of depopulation and desertification in the rural regions of northern Extremadura, Spain, particularly focusing on the dehesa landscape. By integrating a combination of qualitative and quantitative research methods, this study analyses historical conditions and forecasts future scenarios, providing a holistic approach to environmental, ecological, social, economic, and political factors. The use of cartography and GIS tools enhances spatial understanding and visualisation of impact distributions. The fieldwork, characterised by landscape photography and semi-structured interviews establishes a baseline understanding of the landscape's health and land management practises. Furthermore, surveys delve deeper into community- and landscape identity, offering insights into local values and potential engagement in future scenarios.

These narratives reveal a strong community willingness to restore landscapes, dependent on clear visions for change, structured help in the form of technical knowledge of nature-based solutions, and incentives for ecosystem services. The findings suggest that an adaptive strategy, focusing on the active regeneration of the trees in the dehesa through a framework that integrates diverse actions over time, can reverse negative trends in landscape restoration. This research contributes to existing knowledge by highlighting the importance of community-engaged fieldwork and sustainable land management on a local scale to minimise effects of global processes.

Keywords: adaptive strategic planning, sustainable land management, landscape restoration, ecosystem services, community engagement

Figure 3. Forest with soil

Table of conrtent

6 **Abstract**

10 **Introduction**
Motivation
The anthropocene
Dimensioning
Desertification
Disproportionate consequences

20 **Problematisation**
Context
Intersectionality
Approach
Site analysis

68 **Methodology**
Theoretical framework
Research question
Methods
Methodological framework
Tools
Conceptual framework
Outcome

Fieldwork 86
Manual
Log of activities
Observations
Interviews
Survey outcomes
Conclusion

Forecast of conditions 156
Climate forecast
Spatial impact

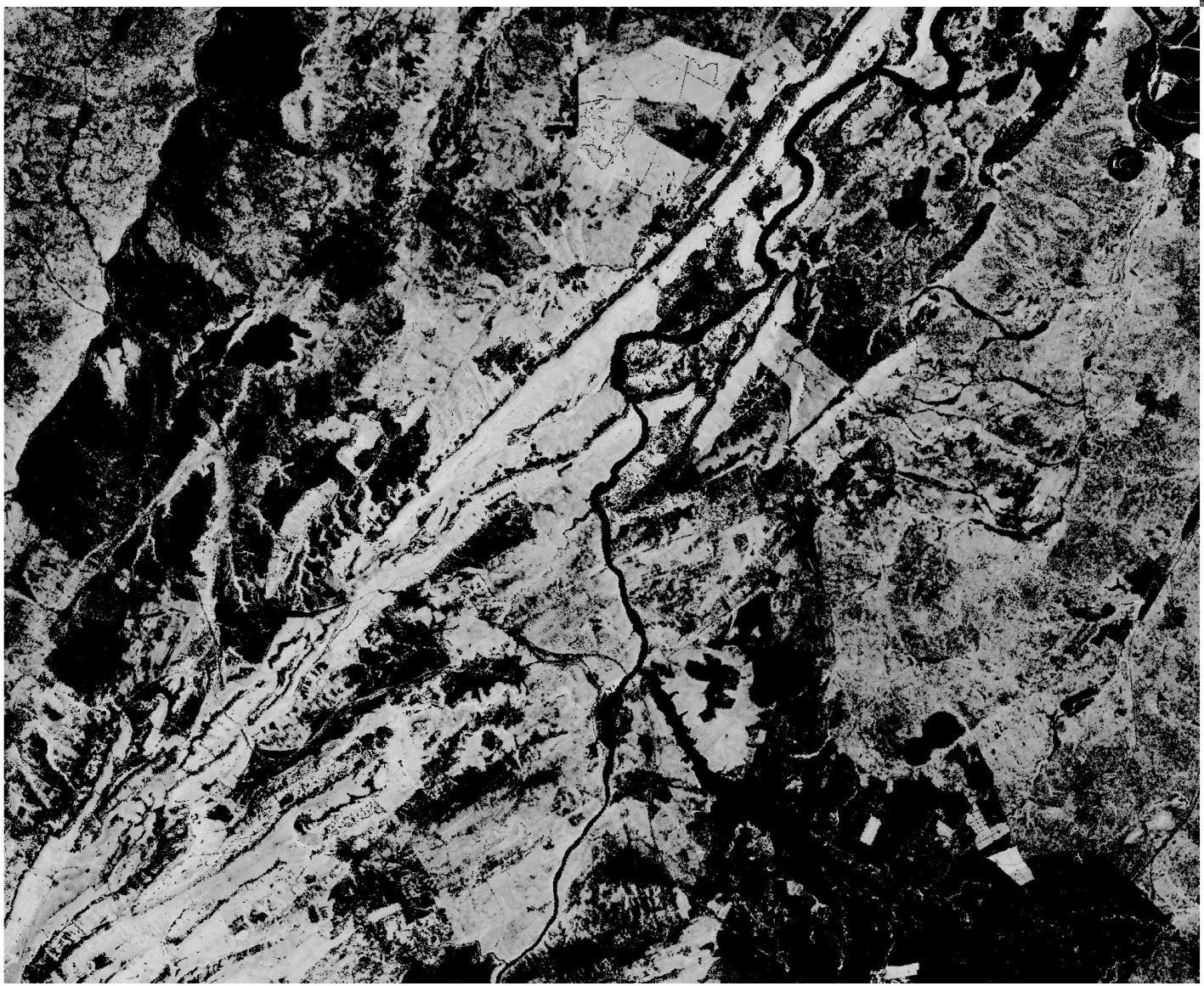
Towards co-evolution 170
System of care
Sharing knowledge
Structuring actions
Transforming the landscape

Evaluation 220
Evaluating preservation

Reflection and conclusion 224

Bibliography 232

Appendix 238
Survey content



1 Introduction

This thesis embarks on a journey through globally occurring processes, ethical realities, and the intricate relationship between human endeavours and the natural world. Herein lies the opportunity to navigate between adaptation, mitigation, and restoration.

The introductory chapter of this thesis explores the complex relationship between human societies and the natural world, starting with a personal motivation to study this interaction and highlighting the urgency of addressing these dynamics. It introduces the Anthropocene, an era characterised by significant human influence on the earth's ecosystems and geology. It sets the stage for detailed discussions of environmental change.

It then translates this into focus areas and the overall vision. Global issues such as desertification, climate change and biodiversity loss are explored further, focusing on desertification and its global consequences. It highlights how these environmental challenges are interrelated and disproportionately affect different regions and communities, highlighting the unfair burden on vulnerable populations.

Figure 4. Tree density in northern Extremadura

1.1

Motivation

Nature as a production landscape. This project started with my growing awareness of the utilitarian valuation of natural resources reveals a deeply human-centred perspective. This approach, which sees the natural world primarily as a resource for human benefit, reveals a fundamentally flawed relationship with our environment - a worrying commodification that perpetuates an imbalance.

This persistent imbalance is reflected in a wider societal indifference and a noticeable lack of concern for the environment. For me, climate change is a telling indicator of our disturbed relationship with nature. The earth is suffering under the weight of our neglect, and despite clear signs of distress, there is a collective failure to acknowledge our role in these environmental crises - either as part of the problem or as potential contributors to the solutions.

During my first master's course in Urbanism at Delft, an interview with a local resident in Vlissingen about sea-level rise and climate change demonstrated the severe consequences of this attitude. The resident's dismissal of the implications of climate change as 'a problem for my grandchildren' underlined the overwhelming nature of the problem and the general unwillingness to confront or address it. In situations where apathy seemed omnipresent, I initially felt incredibly lost.

Fortunately, in the same year I became involved in a sustainable land management project that offered a stark contrast. Volunteering on a self-sustaining farm, where resources were carefully respected and used sustainably, renewed my hope. The community members' commitment to living in harmony with nature and their eagerness to share their sustainable practices inspired me. They were the embodiment of the change they aspired to create.

Through my participation in the climate change movement, I am committed to promoting both awareness and action. This thesis aims to make a significant contribution to the discourse on climate change mitigation.



Figure 5. Alternated from Hilma af Klint, the swan no. 2 (1914), Hilma af Klint, the swan no. 1 (1914)

1.2

Human dominance and global consequences

The Anthropocene: our current geological epoch, defined by the profound impact and dominance of human actions on the planet's geological and ecological systems. The range of activities that started from the Industrial Revolution mark the start of an era of a dominant force triggering alterations in the systems of the earth at a rate exceeding natural processes. This perspective translates into a utilitarian attitude towards the natural world, viewing all other beings primarily as instrumental resources for human benefit: nature and natural resources become objects. Consequently, this worldview underpins practises as resource overexploitation, deforestation, and urban expansion (Pagliarino & Pronti, 2016).



Arranging nature

Toni Hamels paintings question our behaviour regarding our current thinking models. Her clothing reminds us of the 1950's, the period when our current socio-economic model commenced. The painting gives an uneasy feeling and reminds us of the ideology that humankind is the head of the universe. She implies the natural world is slowly disappearing and being replaced.

Justice and disproportionate impacts

This rise in atmospheric CO_2 levels is a primary marker of the Anthropocene. Climate change, a critical aspect of this epoch, exemplifies this acceleration, with the current rate of warming happening faster than at any point in Earth's history. The Intergovernmental Panel on Climate Change (IPCC) report predicts and warns for a future where temperatures skyrocket and intense heatwaves will be more present, affecting ecosystems worldwide (World Health Organization: WHO, 2018). The social, ecological, and economic consequences of this process are huge. Tangible consequences of climate change are felt globally: chronic hazards as drought, extreme heat, rising sea levels, along acute hazards as heat waves and floods, disrupt people's lives (Adger et al., 2013; Bryan et al., 2020; Stone et al., 2010; Umar et al., 2018).



The burden of these disruptions are not distributed equally. Vulnerable and marginalised communities face disproportionate challenges in absorbing these changes leading to even more inequalities (Holling, 1973). The presence of capital and resources may determine the adaptability of these marginalised groups. As these groups tipically have less access to resources, compounded by systematic factors as historical injustices, socio-economic inequalities and limited political representation, the impact of disasters and slow violence may be huge. There is a lack of social evaluation of these accumulated problems induced by climate change. Moreover, there is a lack of visions and plans on how to improve equality regarding climate justice.

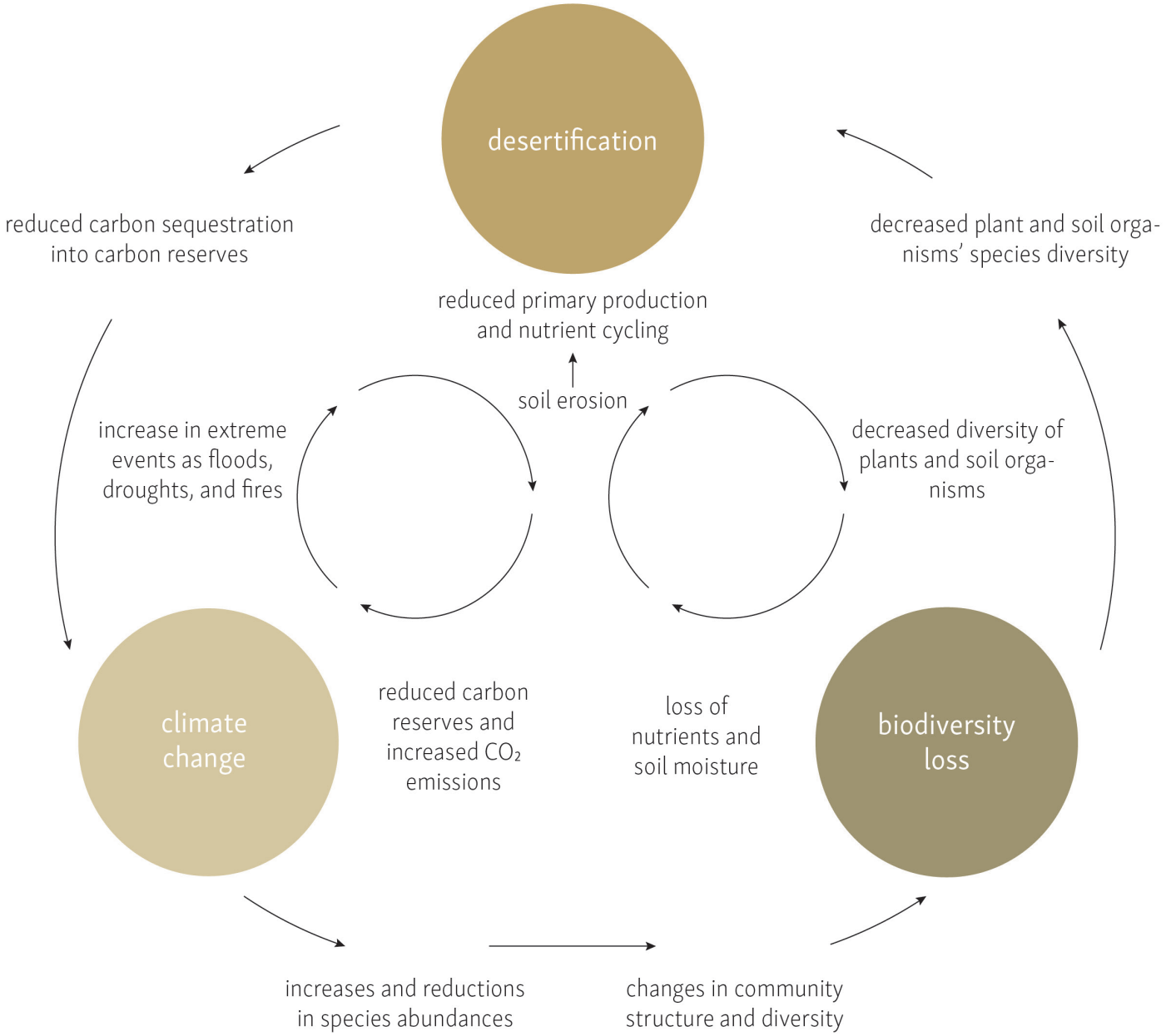
"However the desire to find solutions to climate change necessarily requires a change of scale, combining the global approach required to reduce greenhouse-gas emissions, with a local strictly urban and extremely localized approach for adaptation"

- Mondini et al., 2016, p.355

Figure 6. Ikebana VII (the arrangement) Toni Hamel, 2023

1.3

Dimensioning of phenomena



As human activities reach geological dimensions, it is essential to recognize the interconnectedness of all forms of life. The consequences of prolonged periods of elevated temperatures during day and nighttime extent beyond effects on the physiological performance of humans: many hazards are also posed to non-human species and ecosystems (Shah Habibullah et al., 2021).

Ecological justice and nature's balance

Ecological justice demands equitable treatment of all living organisms: a recognition of the intrinsic value of nature beyond its utility to humans. This perspective requires a multispecies vision that includes the well-being of all life and promotes ecological care. This concept highlights the importance of land as a medium that brings humans and more than human together (Davis et al., 2019). Socio-ecological justice can therefore also be expressed in territorial forms, with soil as a critical focus.

Interrelations

The links between desertification, climate change and biodiversity loss underline the complex system of processes that reinforces negative impacts. Climate change intensifies droughts and heatwaves, worsening desertification and affecting biodiversity. At the same time, climate change itself increases biodiversity loss. Thus, environmental conservation, greenhouse gas mitigation and desertification control are essential for ecological balance. Understanding these interrelations in the history of environmental exploitation is essential for understanding socio-ecological justice and promoting mutispecies well-being.

Figure 7. Feedback loops among desertification, global climate change and biodiversity loss. Included from Millenium Ecosystem Asessment, 2005

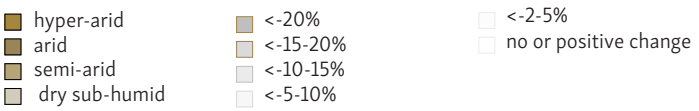
Desertification

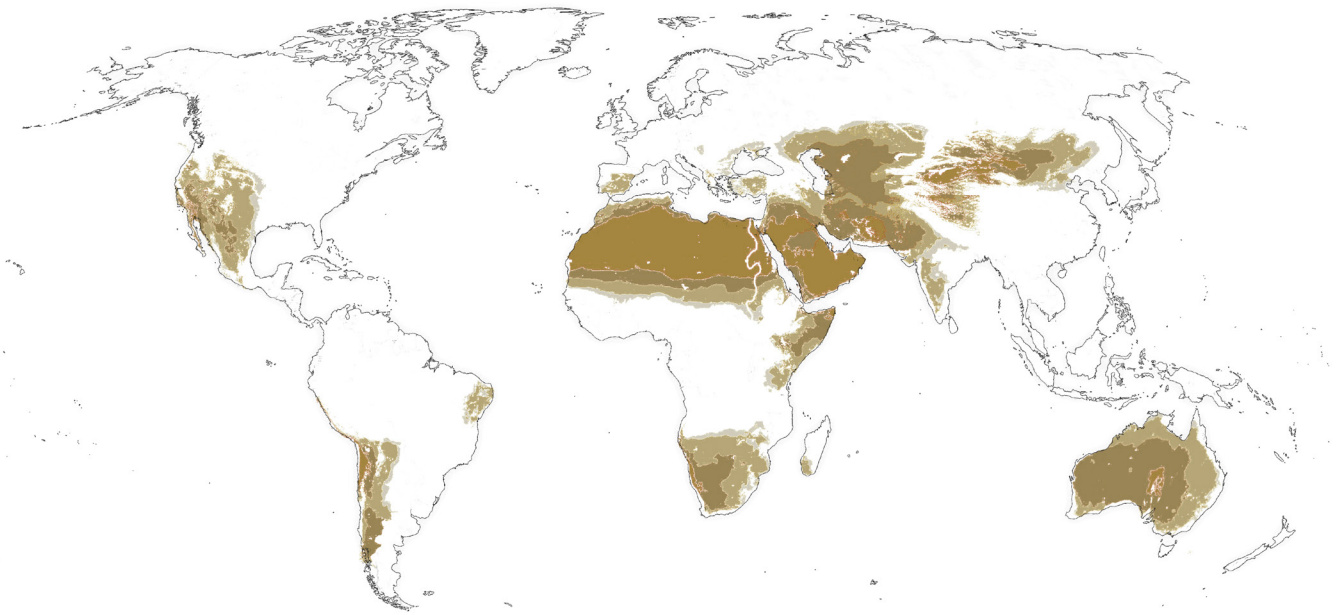
1.4

Desertification is a visible process taking place on a global scale. This umbrella term does not only mean the literal expansion of desert, but is a term for land degradation in water-scarce territories. The most important effect of this degradation is the permanent decline in quality of soil. Vegetation loss, decline in water resources, wildlife, and economic productivity of the land are also associated with this loss. Desertification is triggered by changes in climatic and socio-economic boundary conditions in dryland systems, with land degradation and disruption of local economies as consequences (Puigdefábregas, 1997).

Arid, semi-arid and dry sub-humid areas are known collectively as drylands and are defined by a scarcity of water. Precipitation is here balanced by evapotranspiration. Drylands cover 41.35 of the earth's land surface and are distributed according to figure 4 (Abatzoglou et al. 2018). These lands are particularly prone to land degradation. Wind erosion, soil salinisation and water erosion dominate in drylands. While part of the degradation process is natural, human drivers are increasingly defining the state of degradation of the land. Erosion, one of the main processes of soil degradation, typically takes place through forces of nature, but can be intensified by human activities. Agricultural activities are a driver of the decline of soil fertility, which is another form of degradation.

Preventing desertification plays a significant role in the mitigation of climate change through carbon storage & sequestration, as well as species conservation (Critchley et al., 2023). The decrease of vegetation and loss of fertile soil reduce the capacity of the ecosystem to capture and store carbon. This creates a negative feedback loop, as increased greenhouse gas concentrations contribute the rise of global temperatures and therefore the risks on desertification. Next this impact, desertification can contribute to food insecurity, biodiversity decline, poverty, emigration, and reduced human well-being (Smith et al., 2020).





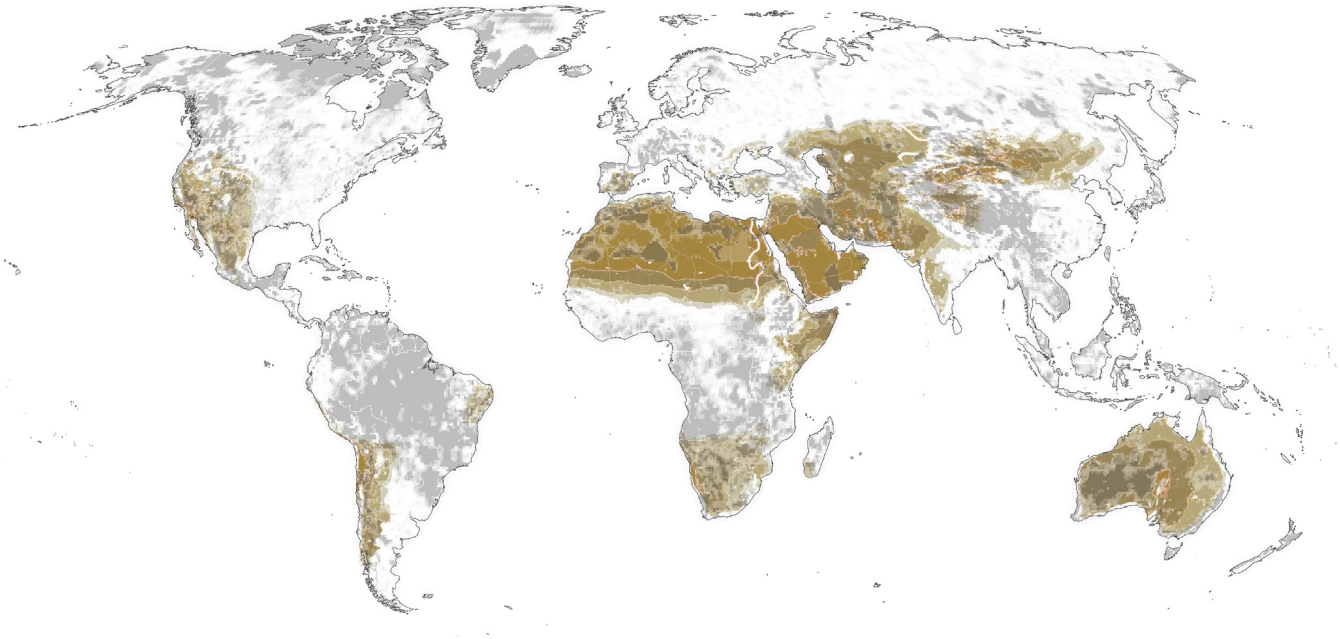


Figure 8. Geographical distribution of drylands, delimited based on the aridity index. Adopted from Abatzoglou et al. 2018.
Figure 9. Imminent future - 2011-2040. Projected future changes in the Aridity index for three 30-year periods. Results from scenario RCP 8.5. Adopted from Reynolds, J. et al.





2 Problematisation

From global desertification, erosion processes in Spain, and agricultural land abandonment in Extremadura: by decomposing and descaling the problem the broader system becomes more comprehensible and the and the outlines of the problem arise.

This chapter begins with an examination of the Spanish landscape and changes it has undergone. It explores complex interrelations and elaborates on the political influences affecting these changes. The chapter delves into the intersectionality of the two major phenomena depopulation and desertification. It uses a specific landscape in Extremadura as a case study to illustrate these issues. The A specific landscape in Extremadura is later explained and used as a case study. The most crucial factors and variables within this system are analysed and concluded.

FIgure 10. May 10, 2022. NASA, 2022
Figure 11. May 11, 2023. NASA, 2023

Context

2.1.1

Emergency status

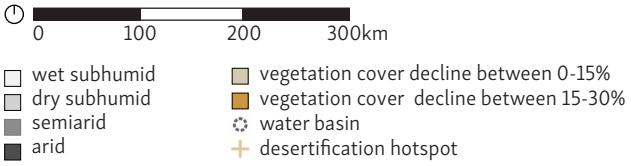
The Spanish landscape is formed by a variety of ecosystems and climatic zones, shaped by its geographical features, its complex topography and its location between the North Atlantic Ocean and the Mediterranean sea. In general, most of the Spanish territory is covered by arid steppes. The north-western regions have a climate dominated by the Atlantic Ocean, with higher levels of rainfall. In contrast, the southern and eastern parts of the country have a Mediterranean climate with hot, dry summers and mild, wet winters. The only desert in Europe can also be found in this region: the Tabernas Desert in Almería.

Current processes and accumulation

According to the Spanish National Strategy to Combat Desertification, 75% of Spain's land suffers from climatic conditions that could lead to desertification (Ministerio para la Transicíon ecológica y el reto demográfico, 2022). Desertification is induced by changes in the climatic and socio-economic conditions of dryland systems, resulting in land degradation and disruption of local economies (Puigdefábregas, & Mendizabal, 1998).

Desertification itself initiates the process of reduced soil fertility, water scarcity and reduced vegetation cover. Both natural and human factors can be identified as initiators of this process. Natural factors include climatic variability and geomorphological processes causing soil erosion (Martinez-Fernandez & Esteve, 2004). Climate change exacerbates this through increased evaporation, water stress, and altered precipitation patterns, resulting in more soil erosion and reduced soil moisture retention.

Human activities have significantly accelerated desertification in Spain, especially during the last century. Anthropogenic factors such as land use practices, agricultural practices, urban expansion, and infrastructure development challenge the bio-physical systems. Especially negative land management practises are threatening for the already very poor overall soil quality in the country. Only 7% of Spanish soils are of high agricultural quality, making them the rarest in Europe (Martinez-Fernandez & Esteve, 2004). Poor land management practices such as overgrazing, deforestation, excessive irrigation, monoculture, agrochemical use and soil sealing, significantly degrade soil quality. Subsequently, the equilibrium of the semi-arid ecoystems can be brought to a critical state (Puigdefábregas & Mendizabal, 1998).

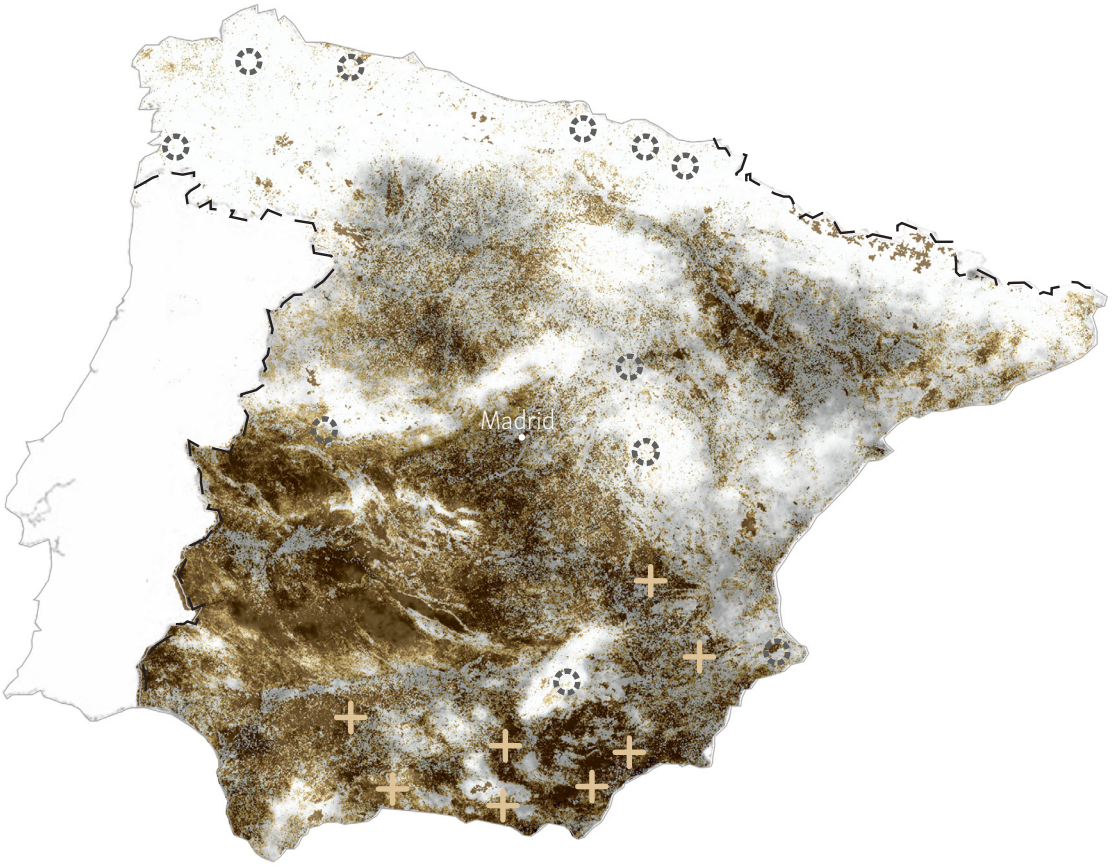


3/4
of Spain faces desertification

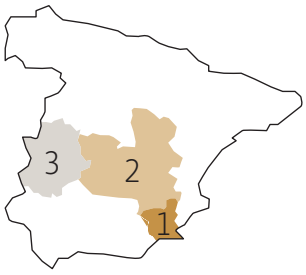
67.14%
total of arid, semi-arid and dry subhumid areas



159.337 km²
of 506.061 km² is highly or very highly affected by desertification



Autonomous Communities at risk of desertification:



1 Murcia
99,97%

2 Castilla-La Mancha
94,4 %

3 Extremadura
90,2%

Figure 12. Status of the Spanish Landscape. After Epdata, 2021; Leopoldo Rojo Serrano, 2004; Rodríguez-Berbel 2022

2.1.2

Governance

Ambiguity in actions

The Spanish government has been aware of the desertification process for a long time, but there is some ambiguity in the perception of this process. Controlling erosion was In the 90's the way to combat desertification (Martinez-Valderrama, 2022). The focus here was restoring vegetation cover to stop erosion.

Investigations and intentions

The first attempt to find the causes of desertification, drivers of the phenomenon and its effects to lay foundations for the formulation of solutions appeared 21 years ago in the Surmodes project. Here desertification was identified as a cause, and degradation as an effect. Finding hotspots before irreversible land degradation was the main goal, by looking at climatic and socio-economic indicators. It showed which combination of factors were driving the process of desertification and provided information about which stressors could be relieved to deactivate the risks.

In 2008, the Spanish National Action Program Against Desertification (PAND) appeared, which diagnosed desertification landscapes accurately, but lacked an action plan. As a consequence of the absence of actions that halted the progress of desertification, landscapes have lost parts of their natural resources already (Martínez-Valderrama et al., 2022). Next to the absence of proposed solutions, the document is no longer accurate as recent as trends of global warming, depopulation, expanded industrial farms, increased irrigation and an increased demand for products are not included. It is necessary to capture the current drivers of desertification and formulate concrete solutions.

Since PAND, water erosion is no longer seen as the main degrader of land, and southeastern Spain is no longer solely

the focus of desertification policies. Before, the term desertification was solely associated with soil erosion, while salinisation, water over-exploitation, forest fires, soil contamination, urban expansion and loss of biodiversity are all playing a role in the process (Martinez-Fernandez & Esteve, 2004).

The newest document that describes the actions that are needed to take against desertification are published in 2022 in the National Strategy to Combat Desertification. This strategy aims at updating the diagnosis of desertification, identifying the most vulnerable landscapes, and integrating actions across sectors. Within a framework different policies and actions are unified. It emphasises the importance of the integration of sustainable land and water management practises, to prevent further degradation and mitigate effects (Ministry for Ecological Transition and the Demographic Challenge (MITECO), 2022).

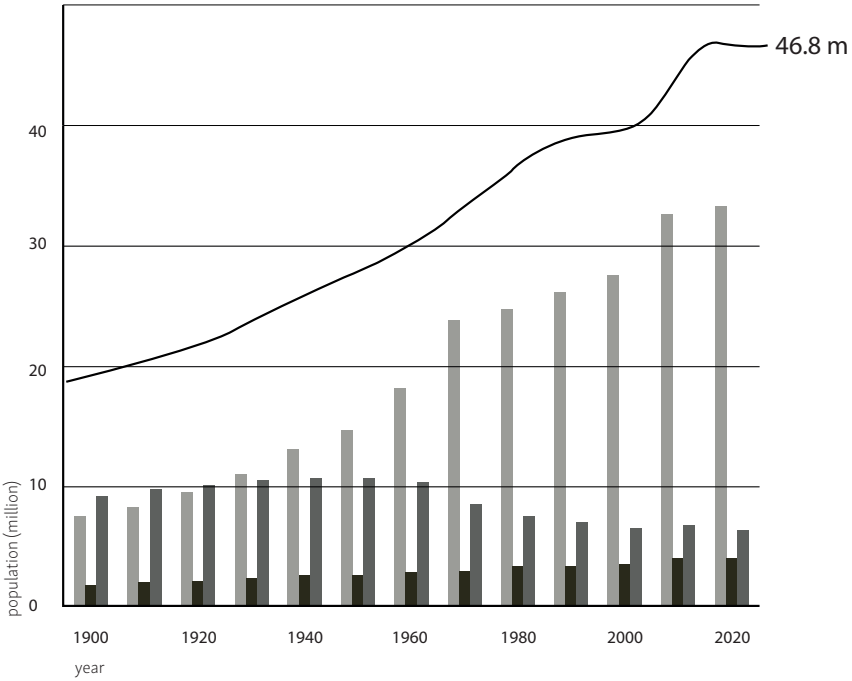




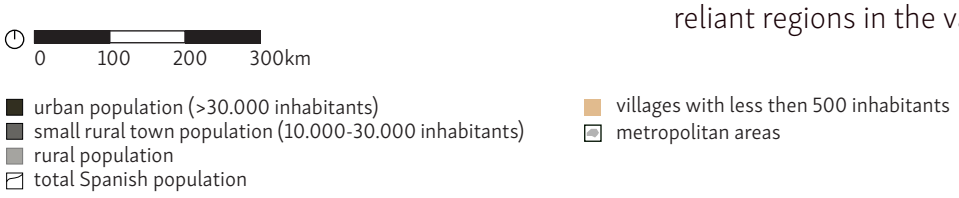
Figure 13. PAND document cover. After Ministry of Environment and Rural and Marine Affairs,2008. Figure 14. National Strategy to Combat Desertification cover. After MITECO, 2022

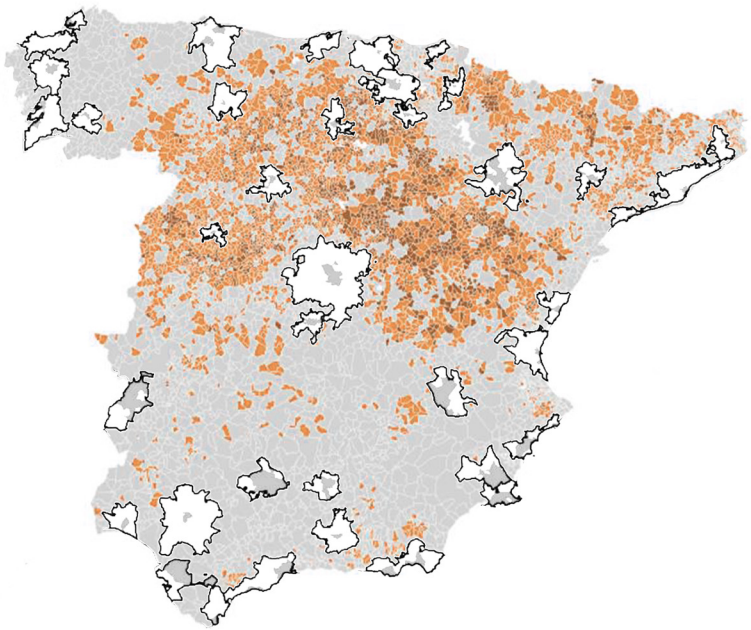
2.1.3

The revolt of empty Spain



Low-density municipalities cover 48% of the Spanish surface. More than eighty percent of small municipalities with less than 5.000 inhabitants have lost inhabitants the past decade, while the loss of municipalities with less than 1.000 inhabitants reached almost ninety percent. The greatest reductions in density from 2011-2022 are seen in Castilla y León and Extremadura (Ministry for Ecological Transition and the Demographic Challenge, 2022). Empty Spain encompasses agriculture-reliant regions in the vast interior of the





country such as Castile and León, Castile-La Mancha, Extremadura and Aragón, see figure sixteen.

Ongoing processes

Depopulation is not a recent phenomenon in Spain. Already since the 60's this movement has been taking place. Massive rural emigration to cities and other European countries in pursuit of better working and living conditions took place in the country in the 1950s and 1960s. Such trends decreased in the following decades, but were never stopped or reversed. (Rodríguez-Rodríguez & Larrubia Vargas 2022). This exodus has social implications. The remaining population is ageing, and the quality and quantity basic public services is decreasing.

Factors related to fluctuations

Demography, geography, economy, and infrastructure all contribute to the challenges facing rural areas. The negative balance between natural population growth and emigration contributes significantly to rural depopulation, highlighting the critical issue of population ageing. Agricultural viability in these regions is closely linked to geographical factors such as landscape relief, where altitude and slope of the terrain limit activities and settlements. In addition, the presence of aquifers, climatic conditions and proximity to the coast play a crucial role in determining the potential for agricultural activities. In terms of the economy, rural areas have limited employment opportunities, especially those specialising in less productive and export-oriented agriculture, often dominated by small enterprises (Gómez Valenzuela & Holl, 2023). The importance of infrastructure cannot be overemphasized, as access to highways stimulates growth, while inadequate internet coverage and scarce basic services risk depopulation. The interconnectedness of these factors underlines the complex nature of rural challenges (Rodríguez-Rodríguez & Larrubia Vargas 2022).

Figure 15. Mainland population of Spain from 1900 to 2020. after Víctor Gómez Valenzuela & Adelheid Holl; UN DESA & Gapminder.
Figure 16. Empty Spain. After Feria et al., 2016; Cano, 2018

Governance

The denial of rural populations

Ongoing political choices cause a lack of investments in rural Spanish regions (Ruiz Pulpón & del Carmen Cañizares Ruiz, 2020). Economic policies aimed at industrialisation were central to the transformation of the labour landscape. The creation of employment opportunities in cities, particularly in the service and industrial sectors, attracted people from rural areas. This economic pull towards urban centres further accelerated the decline of the rural population.

In parallel with these policies, significant investments were made in urban infrastructure. Urban locations became the focus of development initiatives, receiving substantial resources for the construction of highways, transport networks and other key facilities. This urban-centric approach further encouraged migration from rural areas (Castillo et al., 2020; Gómez Valenzuela & Holl, 2023).

The revolt

Among rural communities there have been growing concerns about this described depopulation and economic decline. Protests have been taking place on large scales, assembled in a rural movement called España Vaciada. Hundreds of collectives across the country are united under this movement. The aim of these protests is the raise of awareness for the severe depopulation, and the need for effective policies that can reverse this trend and revitalise

s and ongoing political choices



rural communities. Goals as equitable resource distribution and infrastructure development are aimed at, to increase liveability for these communities.

While the impact of these protests is gradual, it can be said the issues of depopulation are put on the national political agenda. However, the trend is far from reversed. The concrete impact of these measures on reversing population decline and stimulating revitalisation have to be evaluated.

Figure 17. Man holding a sign to protest against the lack of infrastucture in Spain's rural interior. Edited from OSCAR DEL POZO/AFP

Intersectionality

2.2.1 Where depopulation and desertification meet

In many rural areas, depopulation is closely linked to the abandonment of traditional agricultural practices, as highlighted by van Leeuwen et al. (2019). A total of 2.32 million hectares of agricultural land have already been abandoned (Martínez-Fernández & Esteve, 2005).

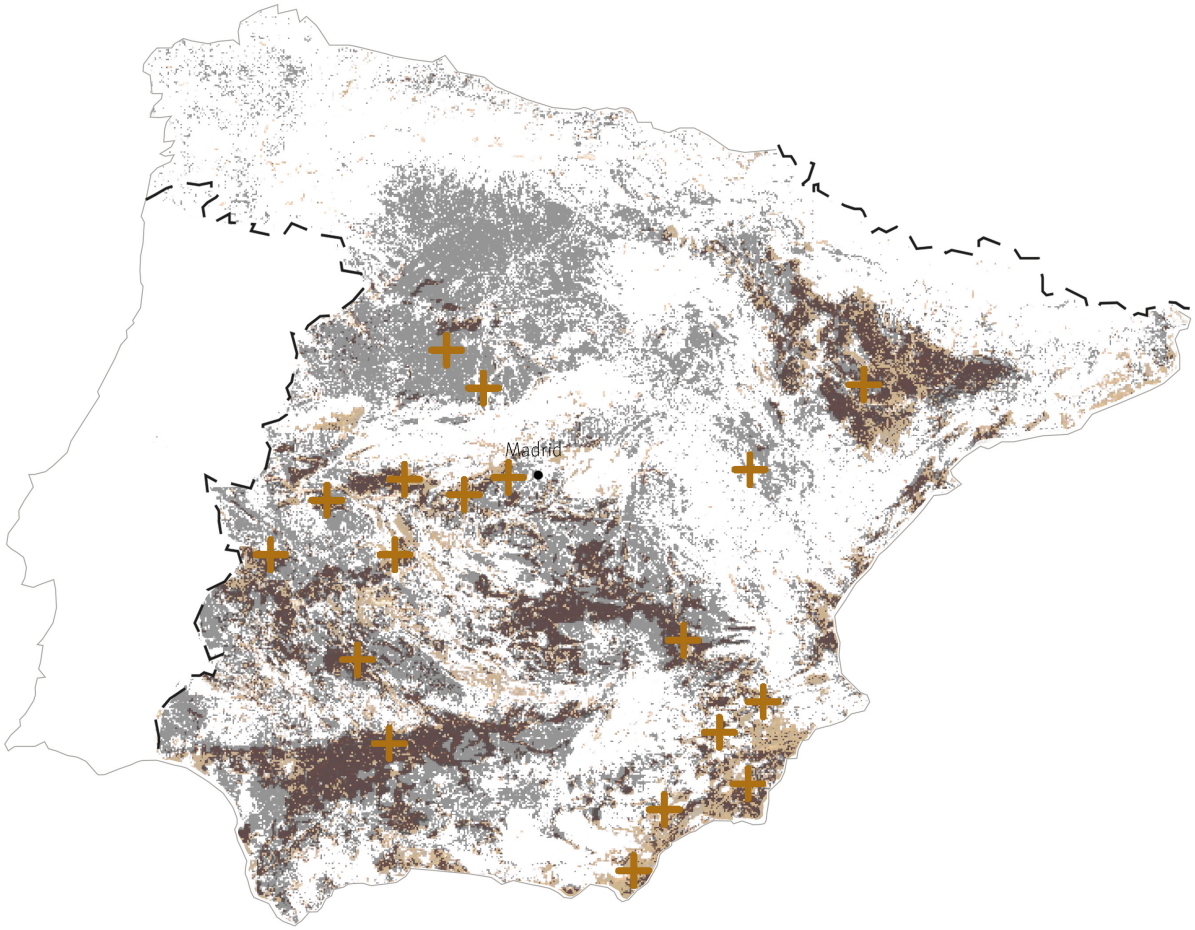
Dynamics of depopulation and land abandonment

According to the European Commission's territorial model, Spain is one of the countries in the European Union most affected by the abandonment of agricultural land. Projections indicate that around 1.1 million hectares, or 5% of Spain's total agricultural area (23 million hectares), will be abandoned by 2030 (Perpiña et al., 2020).

Factors leading to abandonment

The abandonment of agricultural land is concentrated in areas with specific biophysical and socio-economic characteristics. Semi-arid regions with low annual rainfall, poor soils prone to degradation and low population density appear to be particularly vulnerable to land abandonment. This process is accelerated by the lack of infrastructure and services and accelerated urbanisation, creating a self-reinforcing feedback loop between desertification and depopulation.





Social consequences for communities

The loss of rural population triggers significant social, economic and environmental changes that affect territorial sustainability. Traditional economic activities linked to the primary sector cease, leading to active degradation, loss of income, economic challenges and declining living conditions. Subsequent soil degradation further reduces land productivity, leading to abandonment and the disappearance of local economies (Ruiz Pulpón & del Carmen Cañizares Ruiz, 2020). Socially, this leads to population displacement, leaving behind smaller and more vulnerable communities. Ageing, reduced provision of basic services, loss of cultural practices and shifts in the provision of ecosystem services are all potential consequences, with the likelihood of rural depopulation and abandonment increasing.

Figure 18. Status of the agricultural landscape. After Castillo et al., 2020

Governance

Agricultural policies steering

2.2.2

As Van Leeuwen et al. says, recent land abandonment in Spain can be associated with changing policies and international market development (2019). Both national as international policies contribute to the soil and water conservation at national level. As written in the previous chapter, the National Action Plan to Combat Desertification is a leading policy instrument. Together with the National Rural Development Programme they steer the development of agricultural land in Spain.

Moreover, international plans have proven to have an extended impact on the country's current state. From three international policies, the United Nations Convention to Combat Desertification, the European Water Framework Directive and the European Common Agricultural Policy (CAP), the influence of the CAP has been the most proved impact. These effects did not only cover land abandonment, but also soil erosion, degradation, and production.

The Common Agricultural policy

The CAP has been funded in 1962 with the goal of steering European production towards high productivity, following post-war food shortages. When Spain entered the European Union in 1986, subsequently the CAP was adopted. Through incentives for intensification, a growth in productivity was experienced.

As mechanisation became a key focus, leading to increased efficiency but also to reduced demand for labour in rural areas. This shift contributed to a significant migration of people in search of employment opportunities in growing urban centres. At the same time, efforts to consolidate smaller farms into larger units led to the abandonment of many small farms.

rural development and land abandonment

	CAP	*situation Spain*
1960	steering towards high productivity through market stabilisation	no food security
1990	research on conservation of resources, more focus on environment with income stabilisation and rural development	higher production but negative environmental effects perceived
2003	focus on sustainability and environment	high competiveness between farmers, simplification of processes
2013	producer support by green payments, maintaining stable prices	lots of farmers depending on CAP, not self-sufficient

Reform

Since 1962, the CAP underwent several reforms with associated consequences. Figure 19 shows the development and goals of the CAP through time. Where its first focus was an increased production, its focus shifted from product support to producer support as negative environmental effects started to become perceived. Later reforms and subsidies also addressed the protection of natural resources. This was done by compensating farmers who adopted agri-environmental commitments. Assessments of the impact of CAP subsidies are contradictory. Some studies do not recommend policy measures based on subsidies, as they do not encourage the environmental awareness of farmers but perverts it. Other research shows that rewarding management practises that sustain ecosystem services as promising instruments to reverse land abandonment (Van Leeuwen et al., 2019).

Figure 19. CAP development and consequences. Based on van Leeuwen et al., 2019

Approach

2.3.1

The role of local practises

It is crucial to look at local management practices and their impact on ecological forces. Overexploitation of surface and groundwater resources creates a permanent imbalance between demand and available water resources. This structural deficit is caused not only by agricultural irrigation, but also by industrial development and consumption habits, which vary in size and composition from region to region. Effective management should take into account not only resource use but also site-specific geomorphological characteristics. Steep slopes contribute to high erosion rates, and the ability of nature to recover varies according to soil composition. Natural processes continue even after abandonment, with ecological succession leading to landscape changes and increased wildfire risks in the short term (Rodríguez-Rodríguez & Larrubia Vargas, 2022). If left unchecked, this process may lead to the total disappearance of ecosystem capacity and functions.

2.3.2

Restoring landscapes & building resilience

Land degradation, characterised by the deterioration of soil quality, significantly reduces the available habitat and resources for a wide range of species, resulting in a decline in biodiversity. Within an ecosystem, the maintenance of biodiversity is a key factor, particularly in its ability to cope with and recover from multiple environmental pressures. The different responses of different species to perturbations underline the role of diversity in supporting the overall stability and resilience of an ecosystem. The critical importance of biodiversity in enhancing resilience is further illustrated by the following quotation.

"[Diversity] can be equated with maintaining a range of options or set of answers that can be used to respond to questions tha tare posed by the environment. These options, together with the possibility to change between them, provide the adaptive capacity that characterises CASs [complex adaptive systems]. Thus diversity is most valuable during times of change, when the integrity of a complex adaptive system is threatened. During times of stability, diversity can become a burden on the system because maintenance of system components requires energy, and many components in a diverse system may be relatively inefficient or even unnecessary. Consequently, many complex adaptive systems go through cycles in which diversity is gradually reduced, which also reduces the adaptive capacity of the system and makes it more vulnerable to change. Disturbances may cause a loss of function and a systemic reorganisation, possibly leading to a new configuration of the system" (Norberg & Cumming, 2008, p. 12)

Conservation through Natura 2000 sites

Natura 2000 sites play an important role in conserving biodiversity by contributing to a long-term plan for nature conservation and ecosystem regeneration. As an actor in managing long-term outcomes, Natura 2000 exemplifies the influence of subsystems on the whole system. These areas, often biotopes of cultural significance, face challenges, particularly in the context of depopulation. While migration is seen as a positive factor in enabling rewilding, semi-arid areas prone to erosion require human intervention for conservation (Nila & Hossain, 2019).

Persistence, disappearance, adaptation, emergence

Ongoing depopulation poses a challenge as age-old customs and traditional methods of land management disappear. To reconnect these communities with nature, it is key to show the region's intrinsic values and revitalise its economic prospects. Protecting against land degradation requires an unwavering commitment to maintaining organic matter and fertility, thereby restoring soil quality and bringing vitality back to the environment. The complex interplay between communities and nature has a profound impact on environmental action. Combating depopulation and desertification means defending the identity of the landscape and promoting the harmonious coexistence of agriculture and nature (Fried, 2000).

Management of protected areas

Protected areas, which cover more than a third of Spain, have different perceptions of their contribution to local well-being. Management regulations can restrict human use, affecting local well-being and contributing to rural depopulation. The challenge is to find a balance between conservation objectives and socio-economic development (Wojewódzka-Wiewiórska et al., 2022).

Intertwining cultural and natural identities

Hourdequin and Havlick's (2016) concept of remaking the world through human agency emphasises the interconnectedness of human and natural processes. Cultural and natural heritage are intertwined, and their conservation requires the recognition of human influence and responsibility. According to Puigdefábregas (1997), the Mediterranean landscape is inseparable from the human presence. Conservation should focus on restoring what has been destroyed. This is particularly relevant in the fight against desertification through adaptations in agricultural practices and soil quality. It is important to further prevent soil erosion immediately, as there is no turning back to a balanced state when the capacities of the soil have been fully destroyed. This recovery of organic matter is depending on the geomorphological aspects of the soil, and thus location specific (Romero-Díaz et al., 2017).

Soil as an ecosystem service

2.3.3

Ecoystem services are by the Millenium Ecosystem Assessment (MEA) defined as "*the benefits people obtain from ecosystems*", in the categories supporting, provisioning, regulating and cultural services (van Leeuwen et al., 2019). Soil has a wide variety of supporting survices, such as soil structure and fertility, nutrient cycling, water provision and genetic biodiversity. These are the basis of all ecosystems. Moreover, it provides living spaces for plants and animals and maintains genetic diversity (van Leeuwen et al., 2019).

Agricultural ecosystems are especially depending on the soil ecosystem services. When these processes are damaged lsoses are substantial, and moreover, difficult to restore. These plants absorb carbon dioxide from the atmosphere during photosynthesis and store it in their roots and soil. This process, known as carbon sequestration, helps mitigate climate change by reducing the amount of greenhouse gases in the atmosphere.

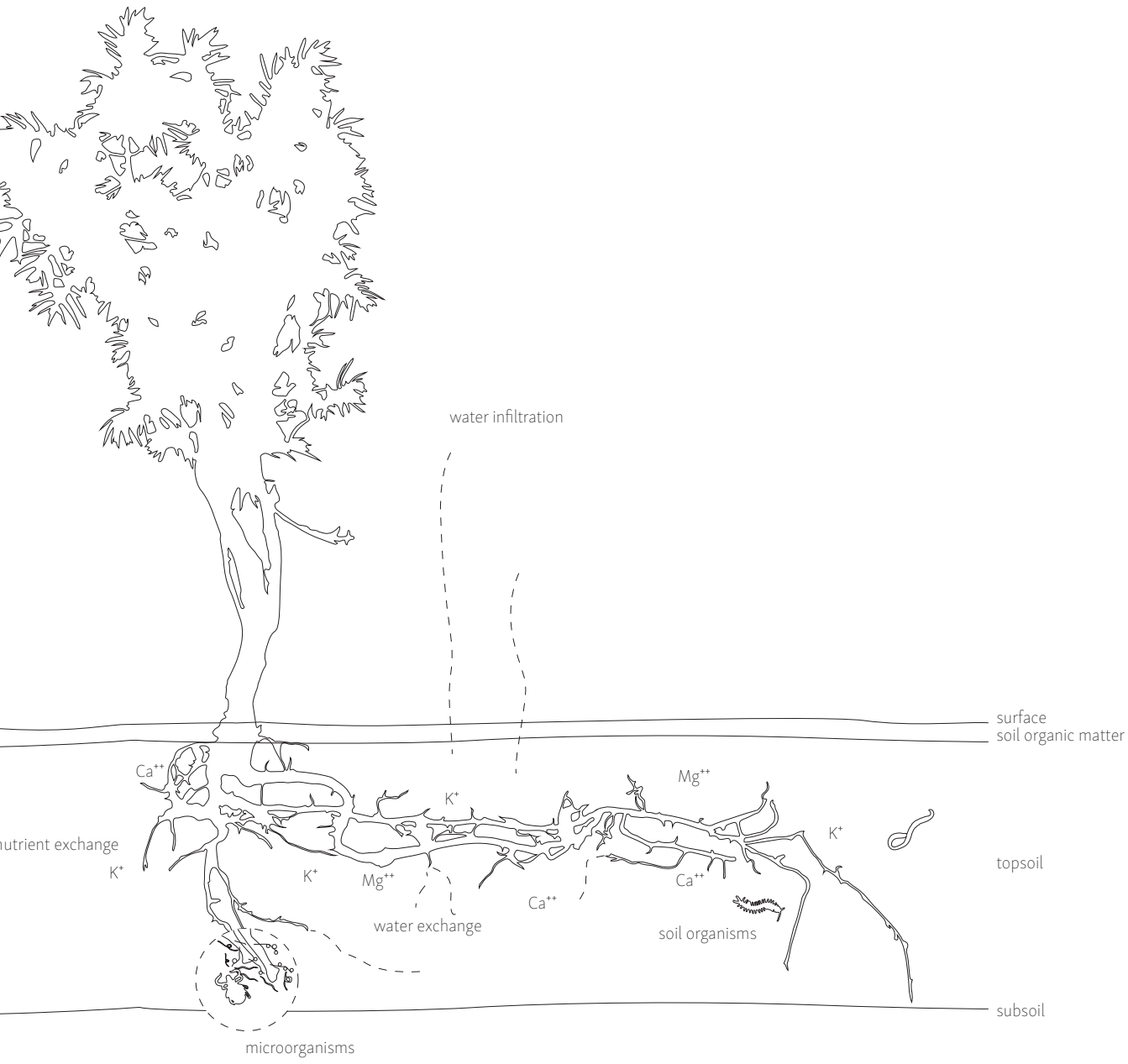
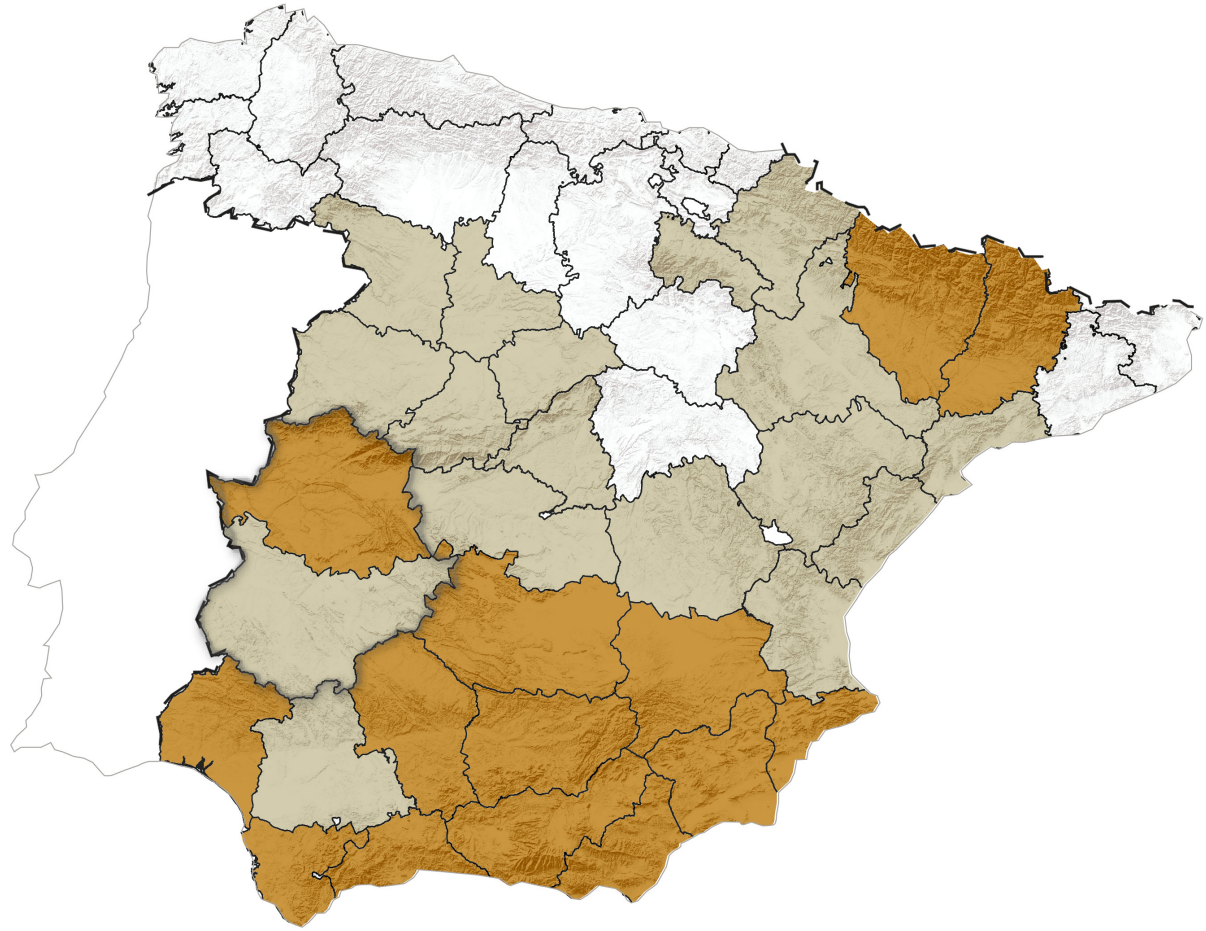


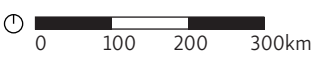
Figure 20. Ecosystem services of soil

Site analysis

Extremadura

2.4.1





- climatic conditions for desertification do not exist
- there are no socio-economic conditions for desertification
- both climatic and socio-economic conditions for desertification are found

As rural conditions differ widely in Spain, there is a need of a focus on a specific region. In Extremadura, an autonomous community located in Midwest Spain, all the criticalities regarding desertification and depopulation are present. Moreover, these processes have been going on for a while: desertification is advancing, and depopulation has been taking place since the 1950's.

Risks

The decision to focus on a specific region is made by layering conditions of landcover and landuse, demography, geology, and resource management. The additional figure elaborates on provinces where both climatic and socio-economic conditions for desertification were identified. This is based on the Surmodes method, that identified hotspots of conditions that can lead to desertification. By distinguishing desertification as a cause and degradation as an effect, its occurrence could be effectively combated. Therefore the current situation was summarized in qualitative terms. This diagnostic tool looked at a combination of technological, market, and agricultural policy factors that were driving the process. By reflecting on the causes, drivers, and effects, a foundation was laid to design solutions.

In the classification of the current hotspots, the following criteria were used: provinces with more than half of their territory belong to dry sub-humid, semi-arid, or arid classes. The normalised annual increase in gross value added in agriculture and the relative annual increase of rural population were used as economic conditions risking desertification (Martínez-Valderrama et al., 2022).

Social conditions

Population in total 1,1 million, thinly spread out in the lower laying areas. The average density is 26 inhabitants per square kilometre. Depopulation is a trend that has been observed over several decades. (García-Alonso & Fonseca, 2022) Moreover, the percentage of aging people is increasing: the percentage of the population of 64 years is 20.7% of the total population. In Cáceres this is even 23.02%.

Figure 21. Presence of climatic and socio-economic conditions for desertification. Adapted from Martínez-Valderrama al., 2022

2.4.2

Territorial conditions

The drawings illustrate the varying territorial conditions in Extremadura, starting with degrees of aridity across the autonomous community. The northern part is relatively wetter, particularly in the mountainous regions. These northern areas receive more precipitation, which contrasts with the drier southern parts of the region. This gradient of aridity significantly influences the ecological characteristics and land use practices (Moral et al., 2023).

Degradation of soils in the dehesa

The dehesas in the northern part of Extremadura are depicted as being of relatively lower quality compared to those in the south. This degradation is primarily due to declining soil quality, which severely reduces the available habitat and resources for a diverse range of species. The compromised soil health undermines the ecological integrity of these dehesas (Pulido Fernández et al., 2020).

Water management challenges

Drought poses a significant threat to the delicate dehesa ecosystems. Effective water management is crucial for sustaining these landscapes. As the figure highlights, the over-exploitation of different rivers has resulted in alarmingly low water levels (Tejeda & Lavado, 2018).

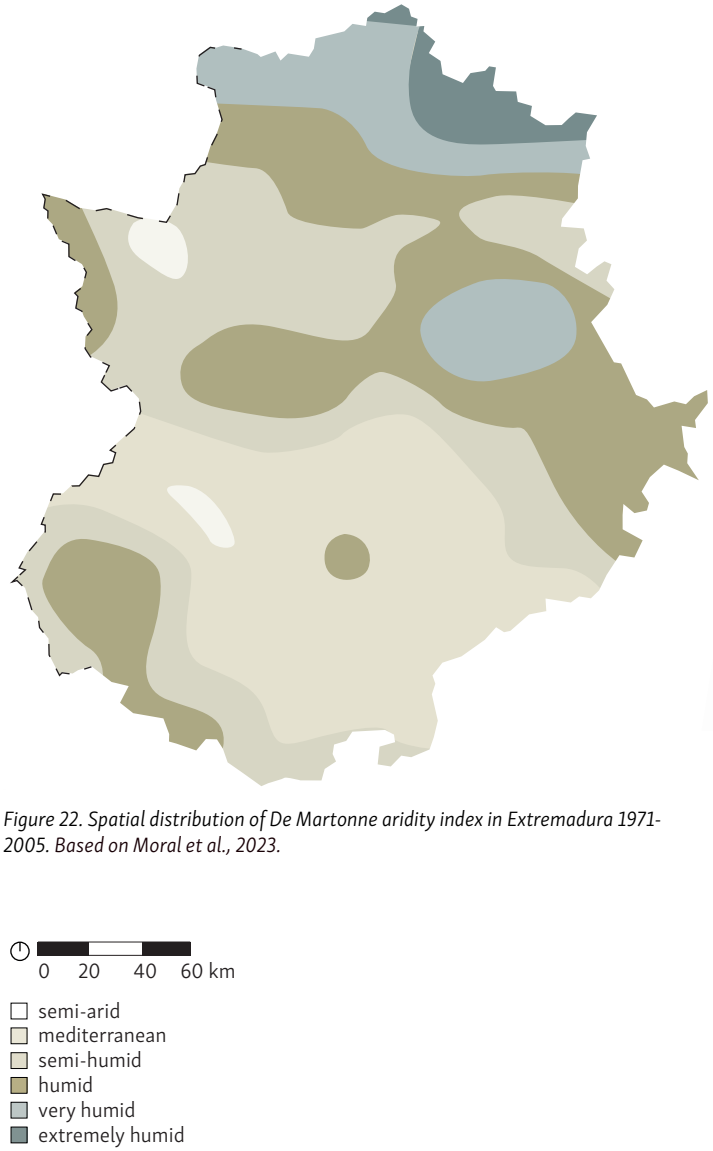


Figure 22. Spatial distribution of De Martonne aridity index in Extremadura 1971-2005. Based on Moral et al., 2023.

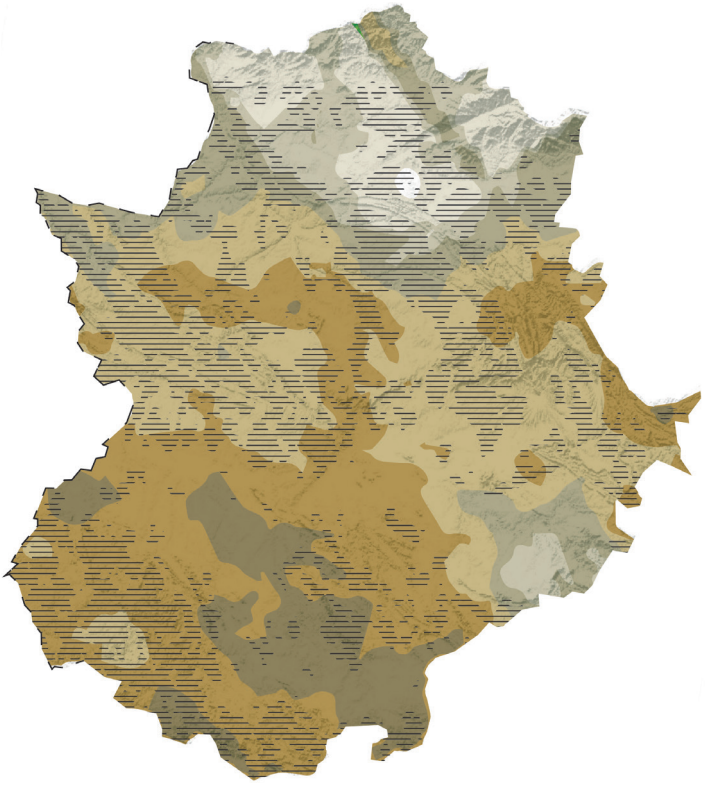


Figure 23. Spatial distribution map of Integrated Quality Index Analytic Hierarchy Process using a kriging interpolation method. Based on Fernández et al., 2020

0 20 40 60 km

- 0.154–0.205
- 0.205–0.242
- 0.242–0.269
- 0.269–0.288
- 0.288–0.315
- 0.315–0.353
- 0.353–0.404
- 0.404–0.474
- 0.474–0.571
- 0.571–0.705
- dehesa

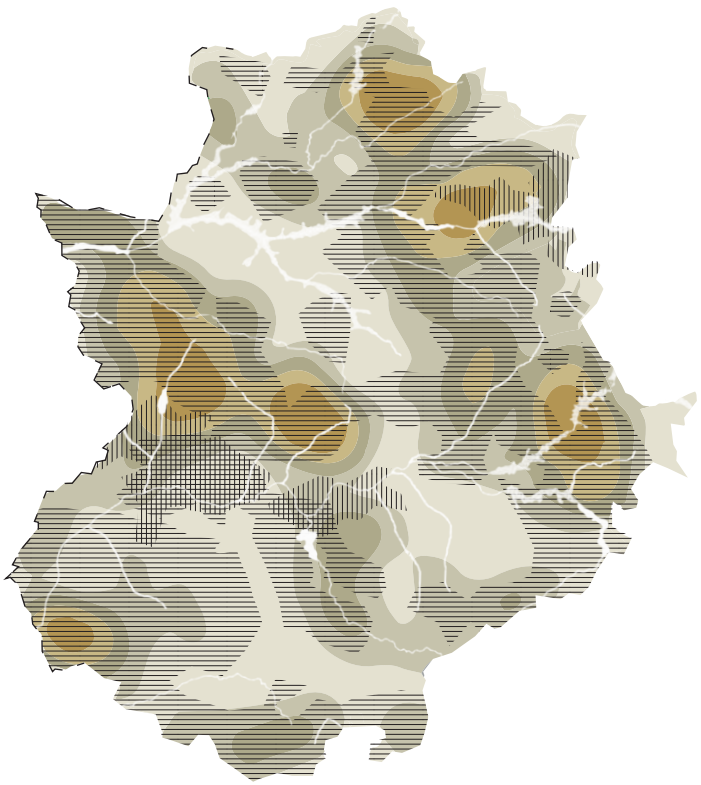


Figure 24. Hydrological risks & soil erosion in Extremadura. Based on Tejeda & Lavado, 2018

0 20 40 60 km

- density of drought outbreaks per ha 0,058-0,092
- drought density 0,038-0,058
- drought density 0,022-0,038
- drought density 0,010-0,022
- drought density 0-0,010
- soil erosion
- water overexploitation
- national border
- water bodies

2.4.3

Water availability

Extremadura has to deal with a decrease and limited supply of water resources. The landscape is in a critical state, exacerbated by the fact that a significant part of the region is arid. The Tagus River runs through the northern part of the community and serves as a vital source of water for both agricultural activities and the metropolitan area of Madrid. Unfortunately, years of over-exploitation of the river have led to alarmingly low water levels. The resulting drying up of the reservoirs poses a significant risk to the community, making it particularly vulnerable to the challenges of drought and desertification.

The image elaborates on the Water Exploitation Index, the total use of water as percentage of renewable fresh water resources calculated for the months July, August, and September 2015. Values above 20 % indicate that water resources are under stress, and above 40 % indicate severe stress and a clearly unsustainable use of freshwater resources. Jul, Aug, Sep 2015 (European Environmental Agency, 2018).



0 50 100 150 km

- Tagus river
- rivers
- elevation of Tagus river basin
- overexploided water resources
- 10-20 WEI
- 20-40 WEI
- 40-100 WEI
- 100-200 WEI
- >200 WEI
- country border
- Extremadura border
- North Atlantic Ocean

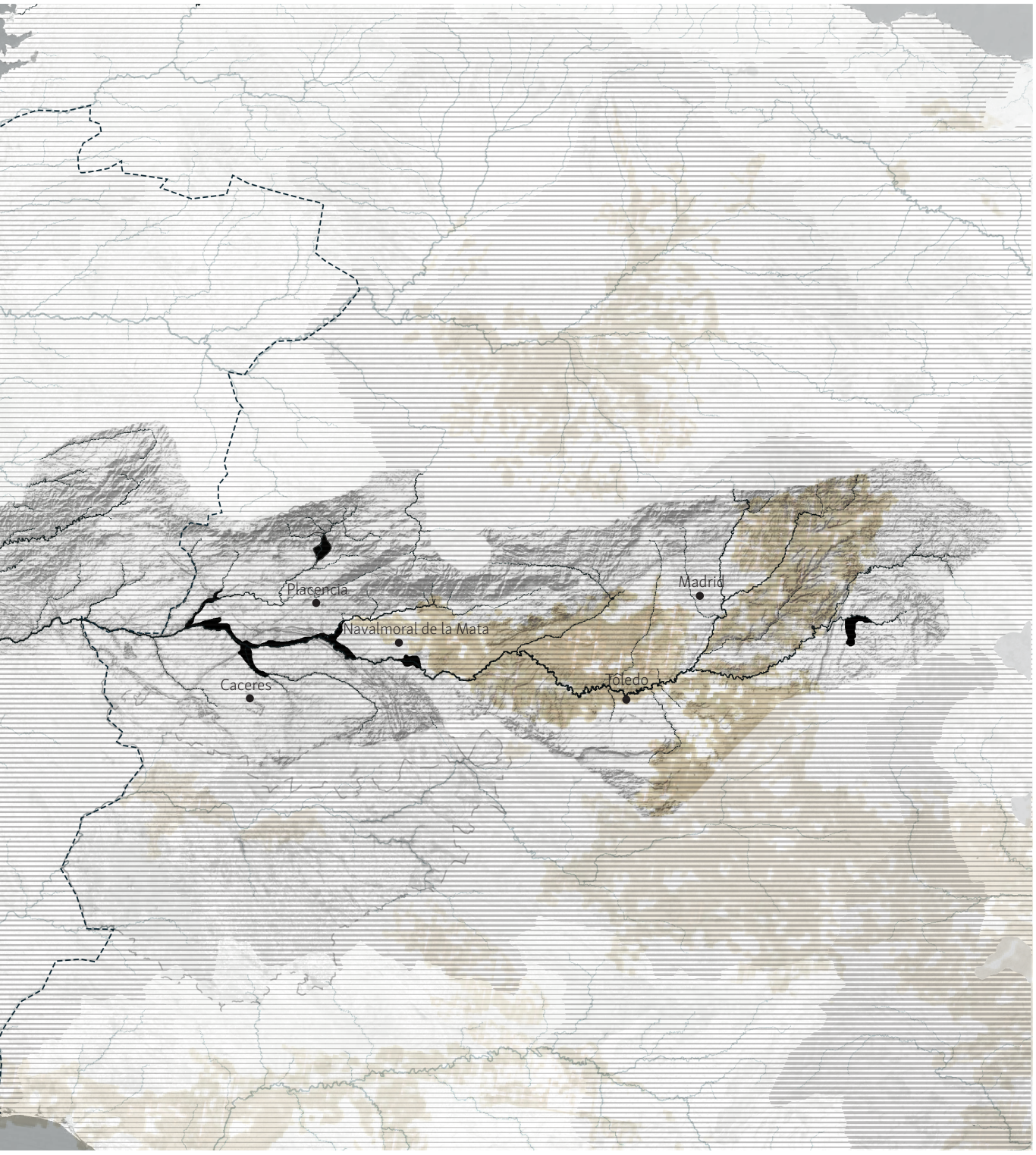
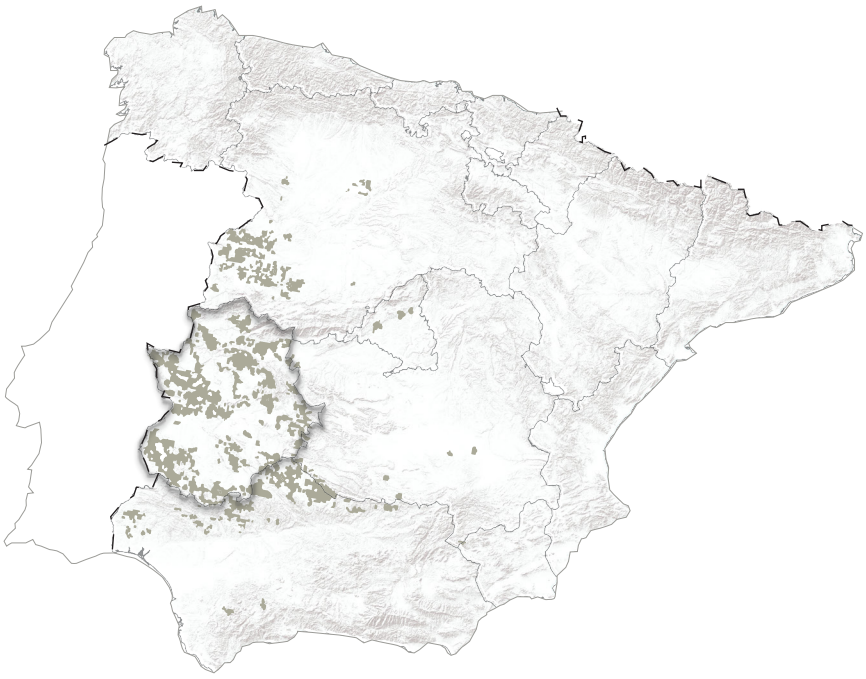


Figure 25. After Simon-Rojo 2023; ESRI 2021.

2.4.4

The Extremaduran landscape



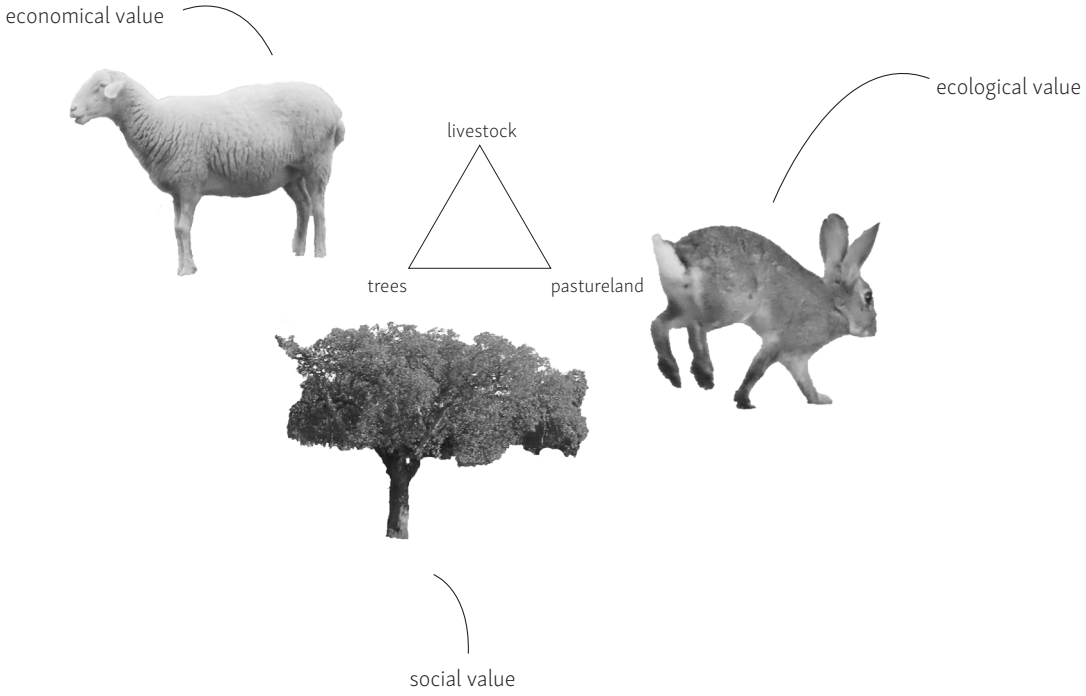
0 100 200 300km

dehesa
elevation
regional border
national border

A large part of the area of Extremadura is covered by dehesa, or Iberian Mediterranean oak woodlands. The dehesa is a high nature value farming system, compromising multiple land types. Decades of land practises, maintenance and cultivation created a semi-natural habitat with high biodiversity (Plieninger et al., 2021). The mosaic of land uses is defined by a differentiation of composition, density and structure.

Cultural landscape

This agroforestry system consists of oak trees, with extensive grazing activities by mixed livestock. It is the oldest agroforestry system



in Europe, and has been developed since two thousand years. It is a consequence of land conversion from forest to agroforestry to make grazing possible, and has been human-dominated for a long time. The ecosystem is altered in order to increase specific parts of ecological production (Norberg & Cumming, 2008). It is characterized by a savannah-like, open tree layer. The Mediterranean evergreen holm oak, Quercus ilex, and cork oak, Q. suber, are mainly found. Below the tree, a grass layer is used for grazing or occasionally cultivating of cereals. Sheep, goat, pigs, and cattle are an integrated part of the system.

Nature and culture have become a complex entanglement through time, shaping a distinctive socio-ecological system, characterised by sustainable land use practises. The oak trees act as nutrient pumps, reduce wind speed, and increase soil organic matter, an increase in soil moisture (Joffre et al., 1999; Plieninger & Wilbrand, 2001). The shade that the trees offers attracts grazing animals, that leave their dung underneath.

Figure 26. 1:100000. Distribution of dehesas in Spain. Based on SIOSE database 2012 . Figure 27. Values of the dehesa

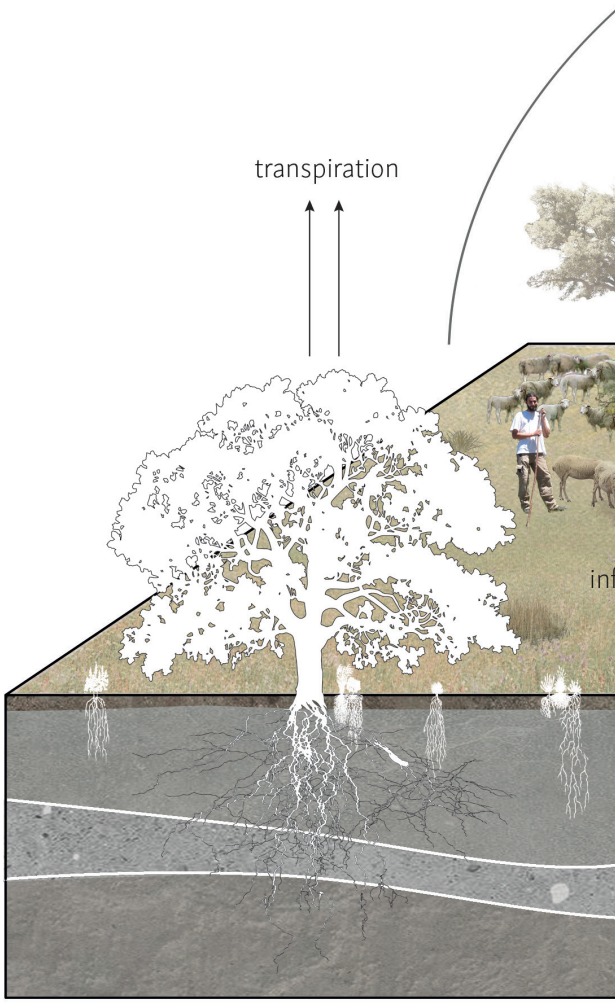
Cycles

2.4.5 The dehesa entails complex and dynamic ecological processes that define this distinctive system. Each component of the dehesa contributes to a series of interconnected cycles that sustain both the land and its inhabitants.

The system is characterized by spatial variety, influenced significantly by the intensity of grazing and tree density. Areas with higher tree density generally provide more shade, affecting ground temperatures and soil moisture, while heavily grazed areas experience higher rates of soil compaction and erosion. This spatial heterogeneity is critical to understanding the dehesa's ecological dynamics.

Central are the interactions between plants and the soil. Rainwater infiltration is essential for maintaining soil moisture and supporting plant growth, while evaporation from soil and plant surfaces regulates the microclimate. Trees play a vital role in the carbon cycle through CO2 and O2 exchange. Additionally, transpiration from trees not only adds moisture to the air, cooling the environment, but also influences local weather patterns.

Moreover, the dehesa ecosystem is embedded within a broader climatic system, showing significant temporal variability due to seasonal changes and climatic fluctuations. These variations impact ecological processes like photosynthesis and transpiration, thereby affecting the land's health and productivity.



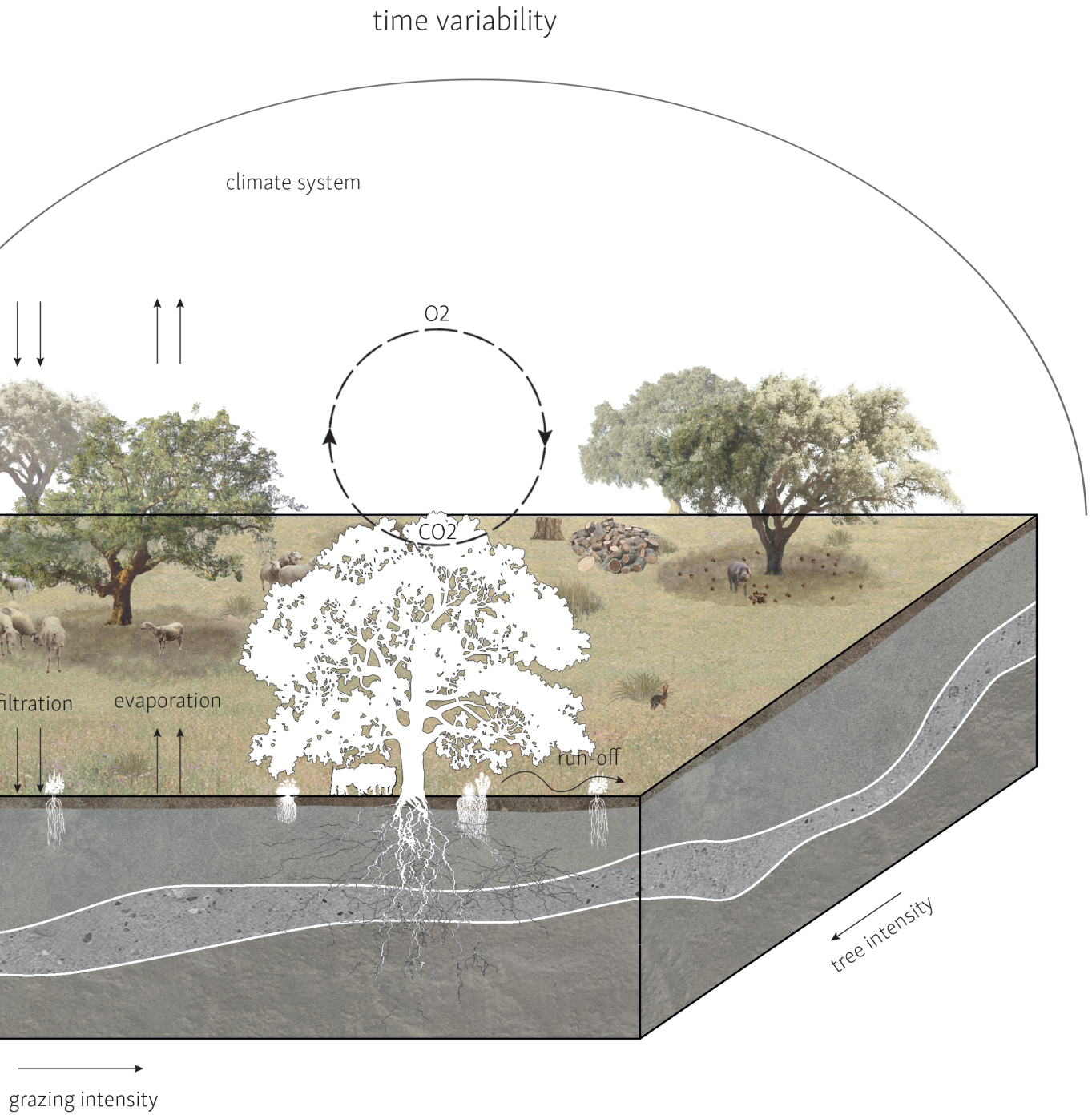
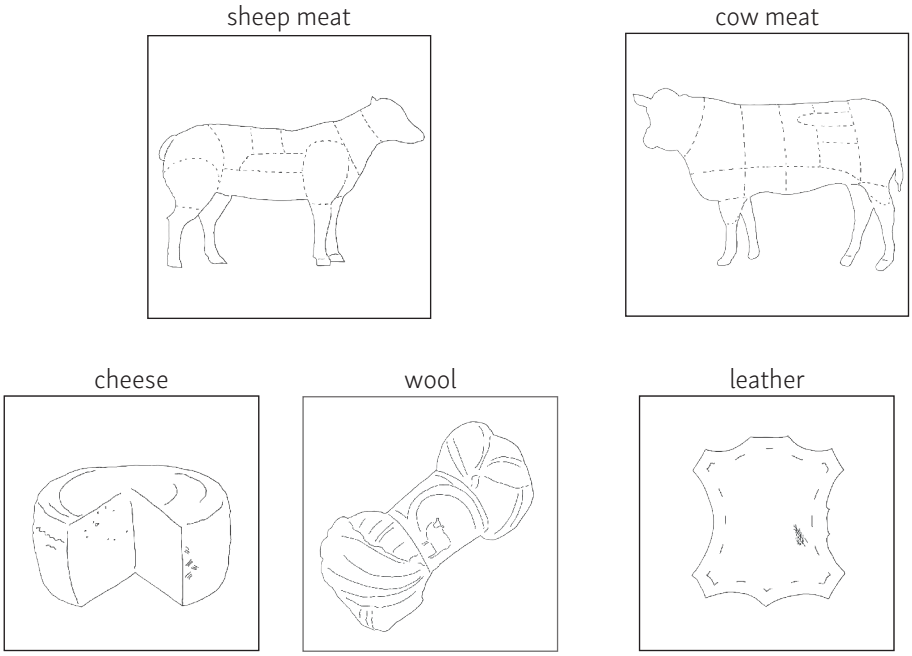


Figure 28. Overview of interrelations in the dehesa

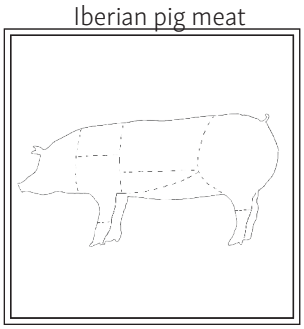
Economic activities

2.4.6



A dehesa farm produces various products, depending on the kind of trees and livestock. The grazing of the Iberian pig is the most profitable component of the dehesa system. Other income bringers are firewood, charcoal and tannin production, cork, acorns, grasses, fodder, as well as hunting activities. They not only offer market goods, but also a multiplicity of non-market ecosystem services as biodiversity, fresh air, and scenery. Until around forty years ago, very little changed within this landscape.





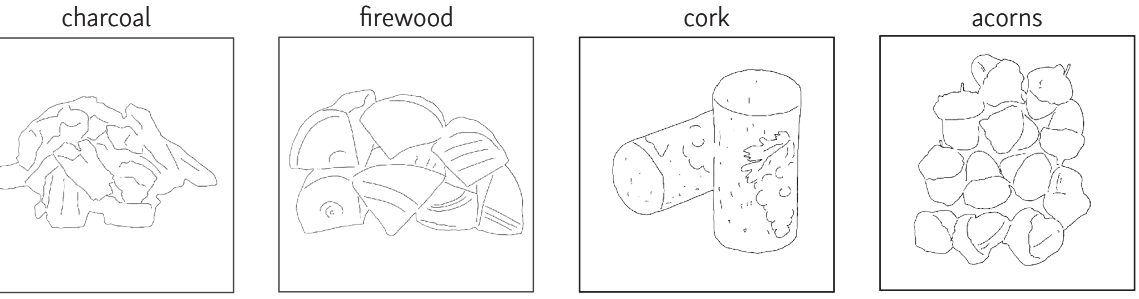




Figure 29. Economic valuable outputs of the dehesa

Management and interventions

2.4.7

Management in this system consist of spatio-temporal interventions that prevent the domination of a single entity.

Trees form a large part of the management of the land. The active planting of trees for optimised light exposure, the regular pruning for acorn production enhancement, cork harvesting, and disease management are all part of continuous interventions. With adequate pruning tree cover can be extended, which reduces the ambient and ground temperature beneath (Campos et al., 2010). Changes in management have consequences on the long-term sustainability of the system (Luisa De Lázaro & González González, 2015).





Figure 30. Management activities in the dehesa and forest. Pictures by Christian Ferrer, 2014; Gertjan de Zoete, 2012.

2.4.8

Transhumance

Deeply rooted in the ecosystem of the dehesa, transhumance is a traditional practice that is an integral part of the identity of local communities. This ancient practice, handed down from generation to generation, plays a crucial role in understanding the sustainability of the landscape and meeting the challenges of climate change. However, with depopulation and the exodus of younger generations the continuity of transhumance knowledge becomes uncertain, putting ecosystem services at risk. Disruptions to these practices contribute to increased vulnerability in rural landscapes, leading t increased threats from forest fires, invasive species and loss of bio-cultural diversity.

History

Historically, transhumance has been a widespread practice in Mediterranean countries, facilitated by climatic conditions and the availability of seasonal pastures. This dictates semi-annual movement. Ancient transhumance routes, facilitating this movement (cañadas), form a dense network of over 12.500 km within the Iberian peninsula (Plieninger e al., 2021).



9-12 years

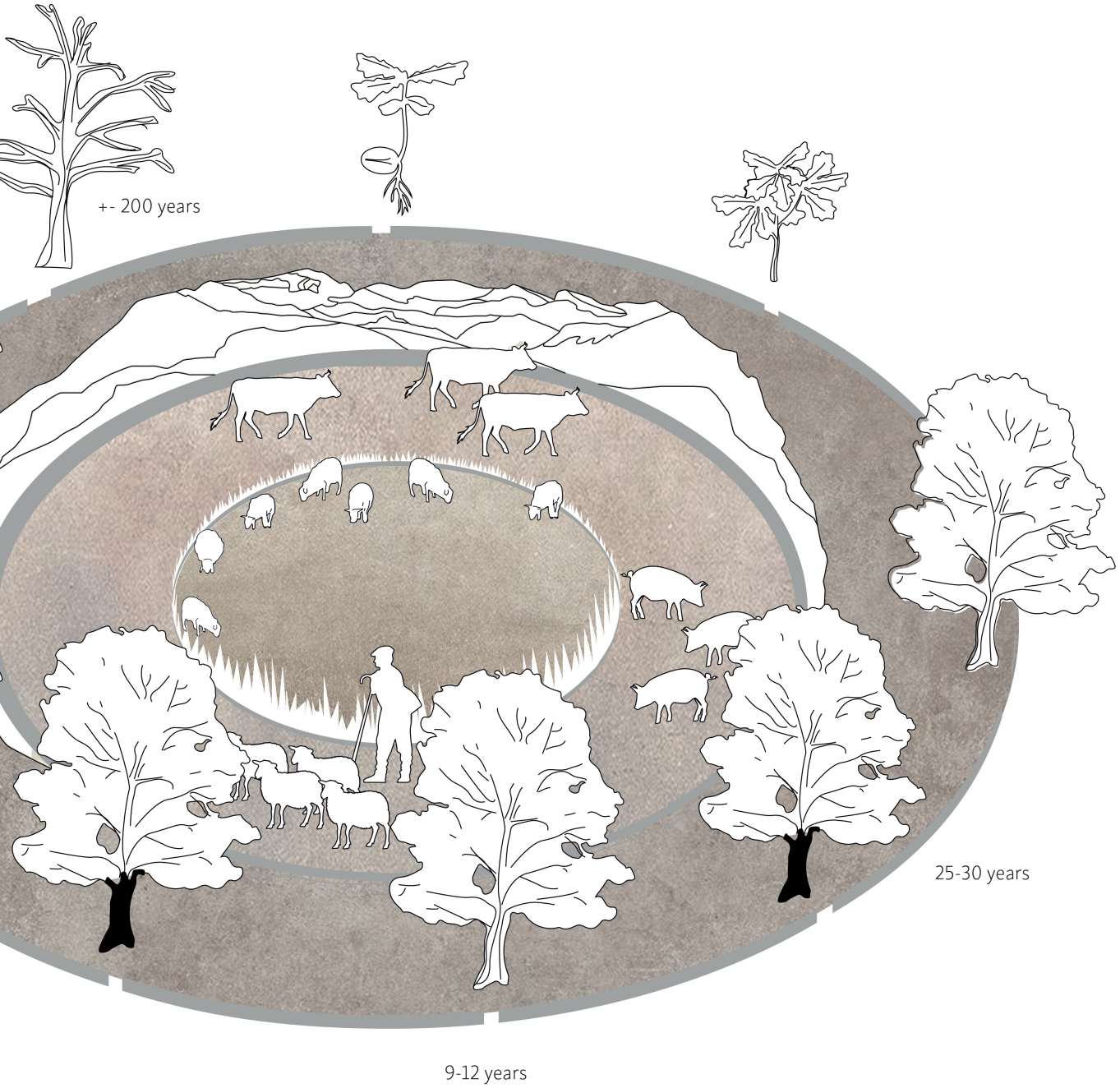
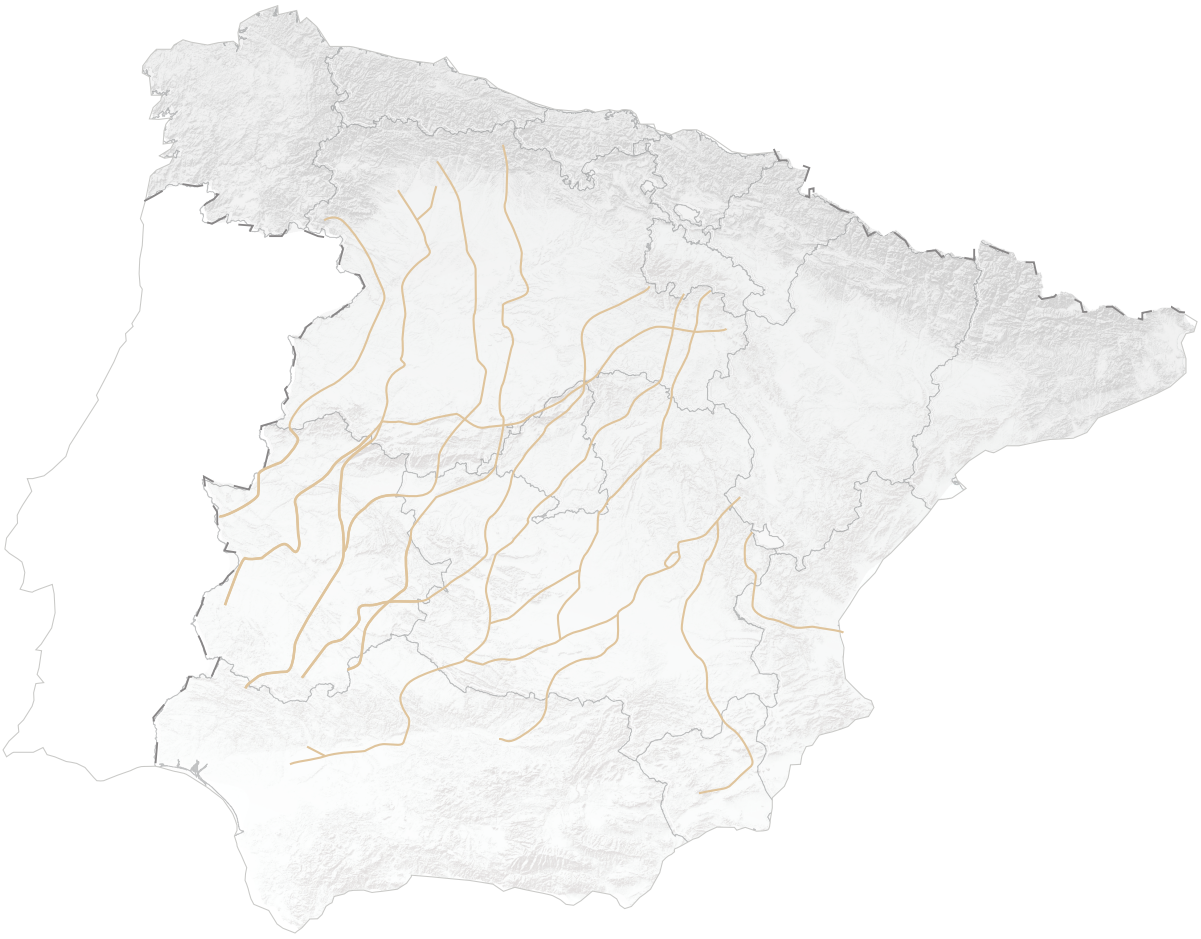
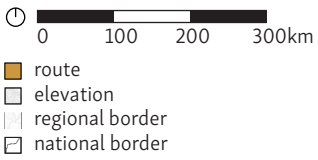


Figure 31. Transhumance as a part of the cylces of the dehesa

2.4.9

Connecting landscapes





Transhumance, a form of extensive livestock farming, is not just about seasonal grazing, but is a driving force behind the conservation of high value ecosystems. For centuries, seasonal grazing has been seamlessly integrated into the natural cycle of the ecosystem, with livestock moving from winter pastures in soutern regions to cooler summer pastures in the mountains. The disappearance of this seasonal movement threatens both livestock quality and forest health (De Lázaro y Torres & González González, 2015).

Grazing animals, often referred to as 'fireman sheep', act as natural fire prevention aids by reducing the build-up of dry vegetation. Their controlled grazing helps restore vegetation, which is particularly important in areas prone to wildfires. In addition to the economic benefits, transhumance provides many non-quantifiable values, including the above-mentioned fire protection, reduced greenhouse gas emissions, erosion control, and the preservation of biodiversity and cultural heritage.

Figure 32. Traditional transhumance routes through Spain. Based on https://gestionagroganadera.com/rutas-trashumantes-de-espana/

Governance

Regulating the dehesa

2.4.10

The Common Agricultural Policy (CAP) has had a profound impact on the traditional dehesa system. Although it provides funding for the conservation of indigenous livestock breeds and the maintenance of natural land uses, its main influence has been the drive towards intensification in the 1960s, which is still evident today (Fragoso et al., 2011).

Simplification of the system

The impact of the CAP on dehesa management comes from its subsidy schemes, which are particularly influential as dehesas are mostly privately owned. Various stages of CAP reform have created incentives to intensify and simplify the complex dehesa system (Plieninger et al., 2021). Previously, subsidies were linked to livestock numbers, which led to higher livestock densities and consequent erosion. Certain rules inadvertently disadvantaged well-managed dehesa farms by excluding plots with dense shrubbery or trees, undermining their economic sustainability. In addition, they target certain separate monofunctional sectors and do not consider the landscape as a cross-sectoral system.

In 2003, the CAP underwent a major reform with the decoupling of payments, making subsidies independent of production levels. This was intended to discourage overproduction and encourage environmentally sustainable farming. However, for the dehesa ecosystem, this change meant a greater reliance on market prices and competitive advantages, which had a negative impact on traditional farming activities and resource use. Therefore, policies that support sustainable land management and maintain traditional practices, while recognising the unique needs of the dehesa system,

are essential for its future sustainability (Fragoso et al., 2011).

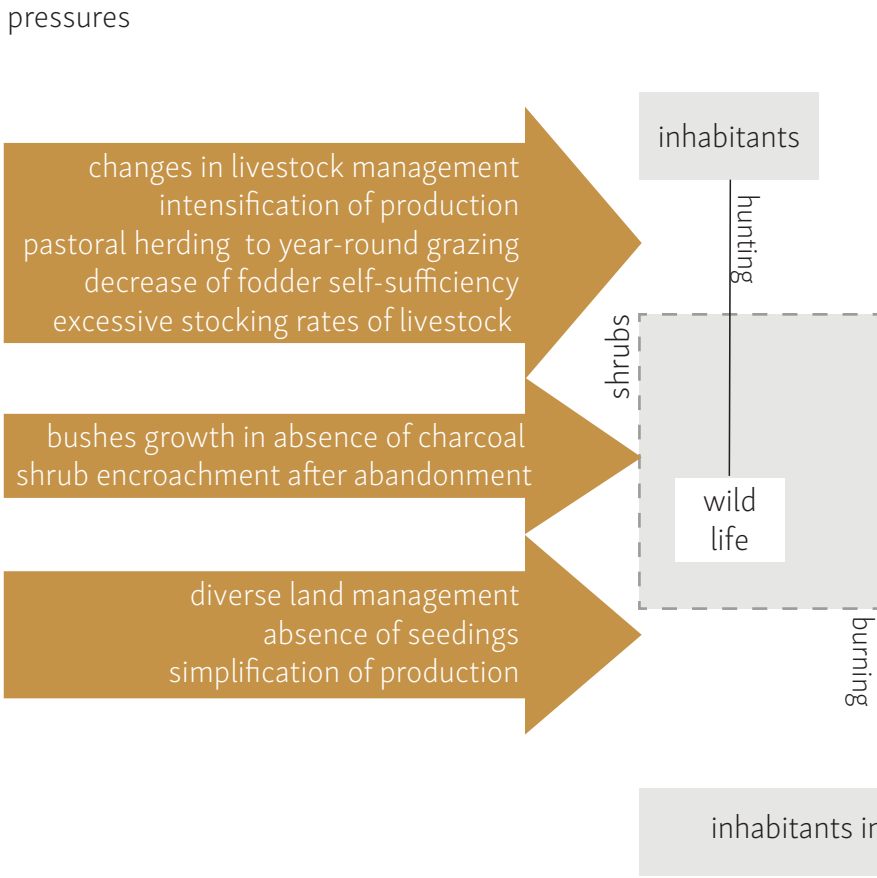
The latest CAP 2023-2027 introduces eco-schemes specifically designed to support sustainable farming practices that enhance soil health and biodiversity. These schemes represent a pivotal shift towards recognizing and incentivizing ecosystem services provided by agriculture. However, the Dehesa's distinctive management requirements mean that these generic schemes may not be entirely suitable. Recognizing this, the CAP now allows for the customization of eco-schemes to better meet the specific agricultural and regional needs of different member states.

Protecting transhumance

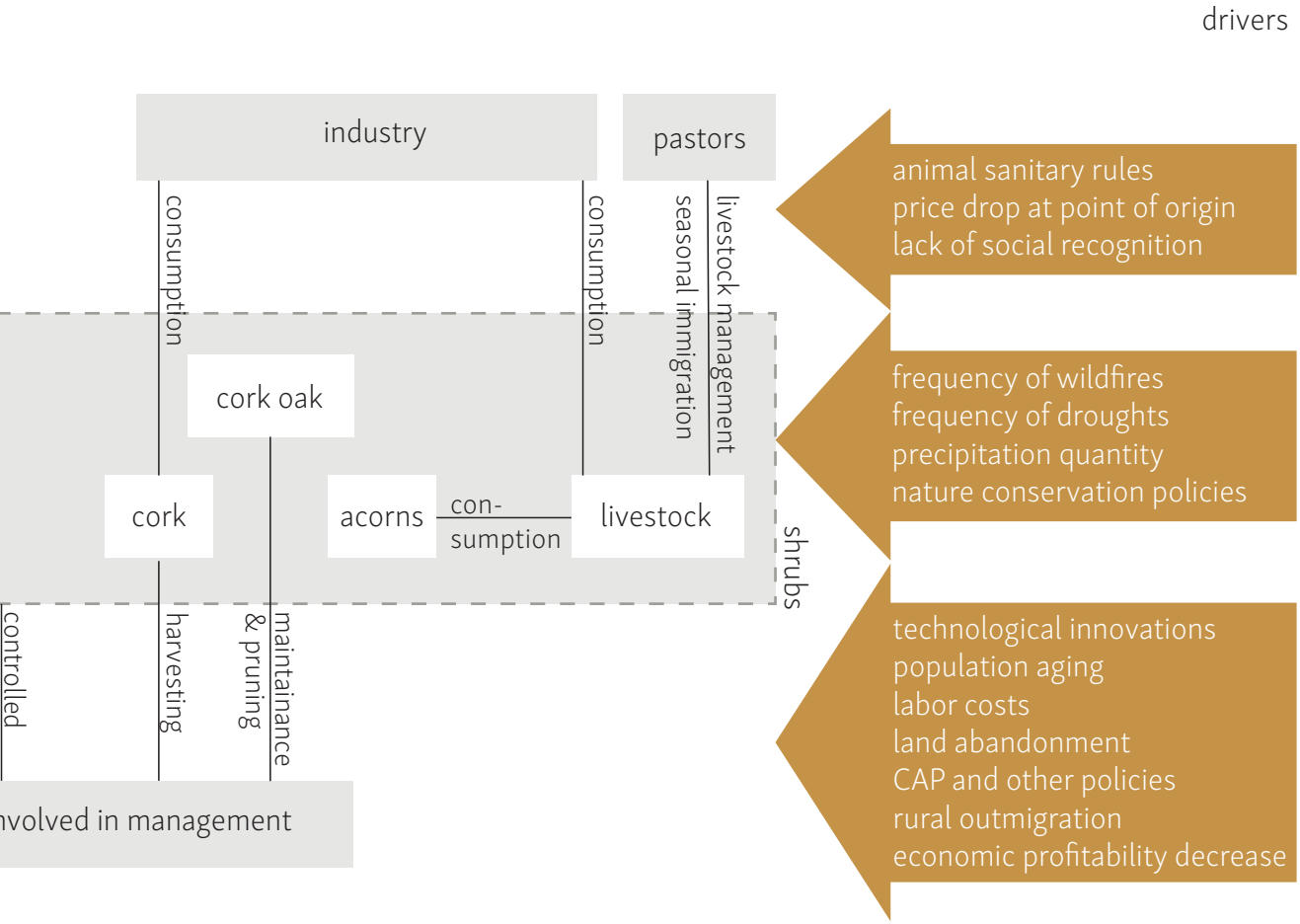
The Spanish government has taken steps to protect transhumance, recognising its significance. In 1995 the government protected the road network and gave priority to livestock use. The responsibility for environmental issues is put on the local regional authorities. They have been ignoring the requests of society to support transhumance, and concentrate instead on tourism and leisure (Manzano Baena & Casas, 2010). However, there is economic support for herders within many provinces. The Spanish National Rural Network promotes the revitalisation of transhumance. There is a need to overcome challenges as blockades of traditional routes, lack of infrastructure and the introduction of new rules that make herding harder, for example a sanitary pass for the livestock. But, several initiatives highlight the need for a greater investment in pastoralism, both on national as European level. The Common Agricultural policy could help here too.

2.4.11

Pressures and drivers



Management in these regions consist of spatio-temporal changes that prevent the domination of a single entity and the management of key components that sustain diversity in the system (Norberg & Cumming, 2008). Changes in management have consequences for flora and fauna, but also on the long-term sustainability of the system. Demographic changes lead to underuse of the landscape. Low economic profitability and intensification of other agricultural practises challenge communities, and lead to overuse of the landscape. Natural factors as climate change, pests, and diseases undermine the overall functioning of the system (Plieninger et al., 2021). Agricultural policies also have a large influence.



Perspectives on dehesa abandonment

On one side, abandonment can increase soil organic carbon: a positive environmental outcome in the context of climate change mitigation. But, abandonment could also lead to changes in the configuration of vegetation through the absence of traditional land use practises. There is a potential loss in biodiversity. Abandonment has effects on different terms.

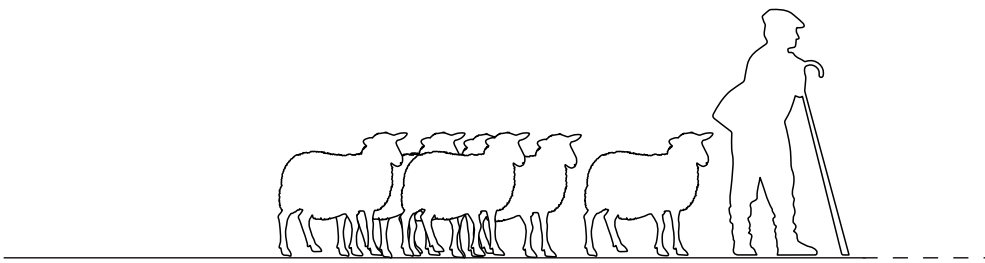
Figure 33. Dehesa systemic overview with pressures and drivers. After Plieninger et al., 2021; de Lázaro y Torre & González González, 2015

2.4.12

Navigating the future

The future of the dehesas is at a critical point, influenced by climate change, economic decisions and management practices. Changes in rural areas, driven by industrialisation and agricultural intensification, have led to the decline of transhumance, resulting in the loss of cultural heritage and memory. In 2011, there were 270,000 sheep on the holding, of which only 10% migrated on foot. If the tradition is not maintained, this knowledge will be lost forever.

The Mediterranean climate, known for its great contrasts, will increasingly be affect by climate change. This alteration has profound implications for the territory, affecting spatio-temporal patterns in the region. The future of the dehesas depends on economic and management decisions, as they face short and medium term risks. In order to preserve the dehesa landscape, key priorities need to be addressed. Economic viability should not be overlooked, requiring diversification through pathways as organic farming or ecotourism.



In addition, the influence of agricultural policies and subsidies looms large over the management of the dehesa. Beyond economic considerations, the viability of the dehesas is of paramount importance for the conservation of biodiversity and protection against the threats of forest fires and erosion. Adaptation to climate change, particularly the challenges posed by increased drought, is essential. Resilient agricultural practices are emerging as a key strategy, although caution is urged against large-scale land-use changes that could threaten biodiversity (Luisa De Lázaro & González González, 2015).

The success of these initiatives depends on the interplay of individual characteristics and environmental factors. This thesis aims to contribute to the decision-making process by examining perspectives through the creation of a management system based on the resources of local communities. The management of these areas, carried out by both farmers and herders, is examined through a comprehensive case study. By synthesising environmental, social, economic and political considerations, this research aims to dimension the path towards the future sustainability of the dehesa, providing foresight and informed decision-making.



Figure 33. Shepherd facing an uncertain future

2.4.13

Problem statement

The intensifying global challenge of rising temperatures continues to worsen existing problems in semi-arid regions, contributing to reduced rainfall and increased evaporation. Particularly vulnerable areas will be further affected, adding to the challenges they already face. Human activity also plays a major role in causing desertification, particularly in Spain, where 75% of the land is at risk of becoming desertified. The additional factor of depopulation, mainly due to economic challenges, increases the vulnerability of rural areas and triggers a damaging cycle of land abandonment and degradation. This socio-environmental challenge has far-reaching consequences for local communities and ecosystems that go beyond demographic shifts.

In the semi-natural landscape of the dehesa, the abandonment of cultivated land is threatening its continuity, posing an immediate threat to the region. Without immediate action, the land will lose value, organic soil matter will disappear and local communities will face further abandonment. These intertwined challenges are disrupting local ecosystems and threatening community well-

being, and require urgent attention. Existing strategies fall short by failing to take a holistic view of this multifaceted problem, highlighting the need for comprehensive and adaptive solutions.

In the midst of these challenges, there is a critical need for knowledge to counteract territorial degradation, focusing on the central role of individuals and communities in this process. Actions need to be directed towards long-term viability, emphasising a sense of ownership and responsibility for place. Place attachment, a key aspect, highlights the need to empower local communities, drawing on their cultural foundations and resources, to respond effectively to immediate and future threats. Facilitating transformative pathways towards ecosystem-based adaptation, validating local conditions, preserving cultural practices and restoring semi-arid lands are crucial steps to counteract depopulation and create sustainable actions across time and space. Building resilience within communities will be central to mitigating adverse impacts and ensuring that these areas adapt and thrive in the face of impending challenges.

2.4.14

Aim

The research seeks to redefine the human-nature relationship in rural communities, fostering responsible ecosystem care and sustainable management of the dehesa. The overarching vision is to establish a framework promoting coexistence with desertification, transforming the negative cycle of degradation and depopulation into a positive one. Key components involve preventing erosion, deforestation, and unsustainable land management practises, while fostering ecosystem regeneration and environmental resilience. The project will engage in restoring balance through restoring soil quality.

Community engagement is central to the study, empowering local responses to climate challenges and building coping capacity based on their current response and capacity. Local vernacular practices inform potential adaptation pathways, aligning with the overall goal of sustainable and resilient landscapes. Strategic alignment of agencies across different scales facilitates the integration of measures against desertification. Emphasizing regenerative practices rooted in local culture prevents immediate decay and enhances overall human and more than human liveability.



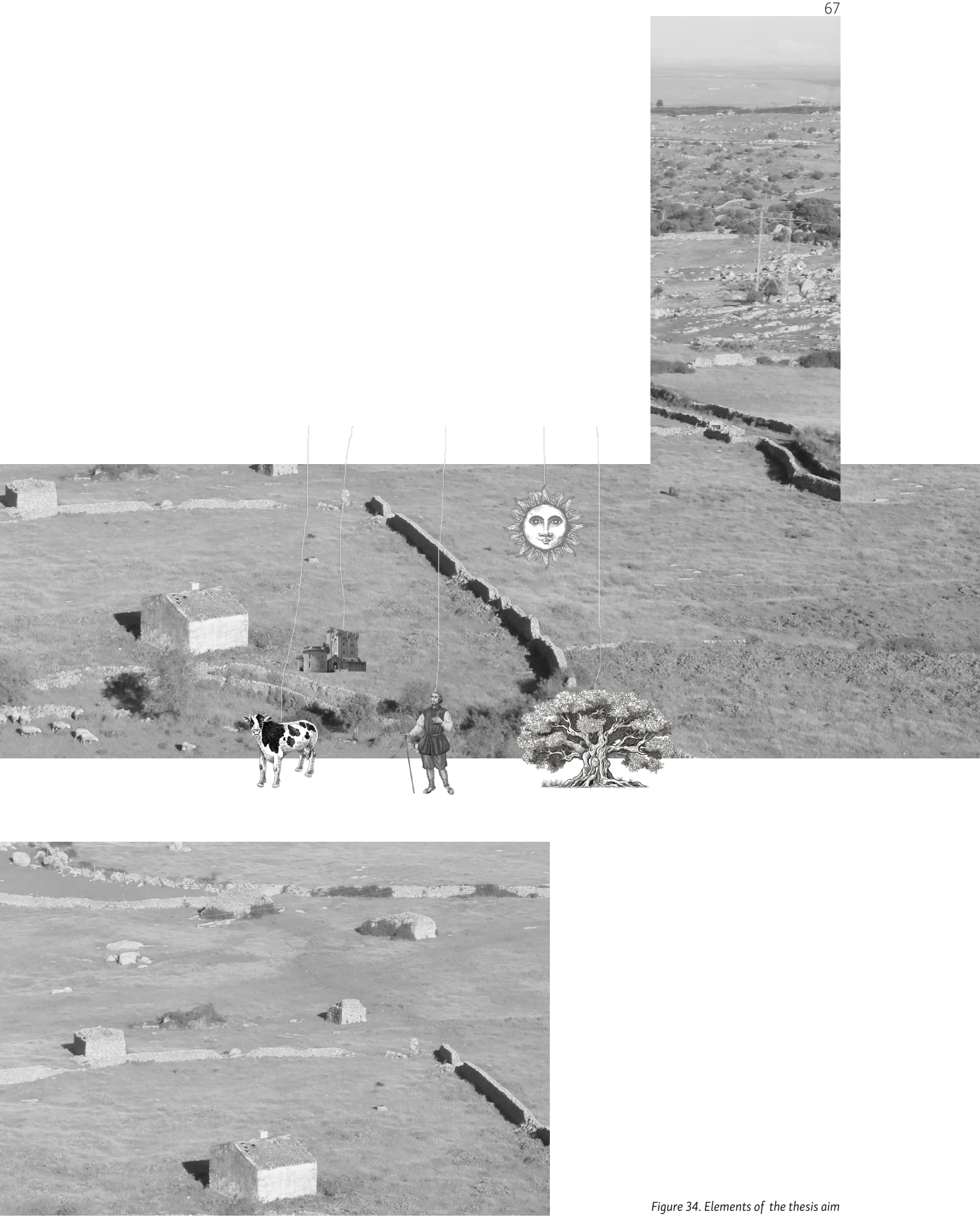


Figure 34. Elements of the thesis aim

3 Methodology

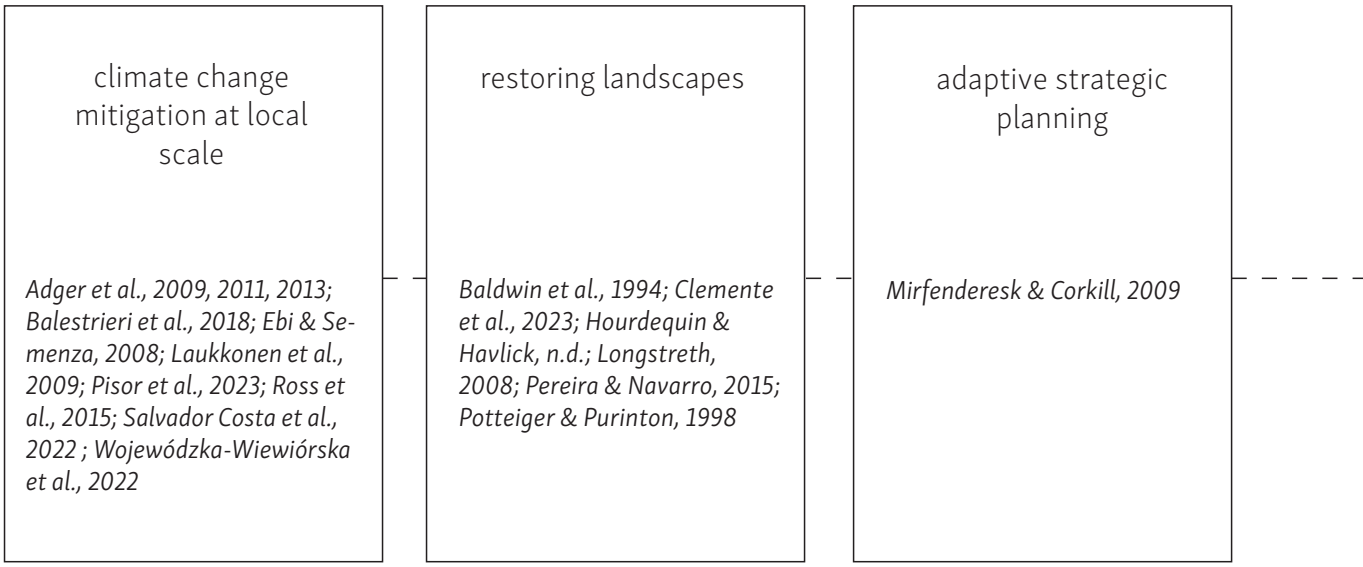
Exploring the intricate socio-ecological system through a combination of methodologies and analytical tools, this chapter describes the detailed approach that steers the investigation.

The methodology chapter outlines the theoretical and methodological foundations of the project. It begins by reviewing current theories and identifying gaps in knowledge, followed by the research questions and associated sub-questions. Describing the methods and tools used in the study, the chapter provides a framework that maps the flow of data through the various phases of the project. It also explains the conceptual approach to solving the research problem, showing how each research output contributes to the overall outcome. Overall, this chapter serves as a critical guide to understanding the research design and analytical strategies used.

Figure 35. Birds flying over Monfragüe national park

3.1

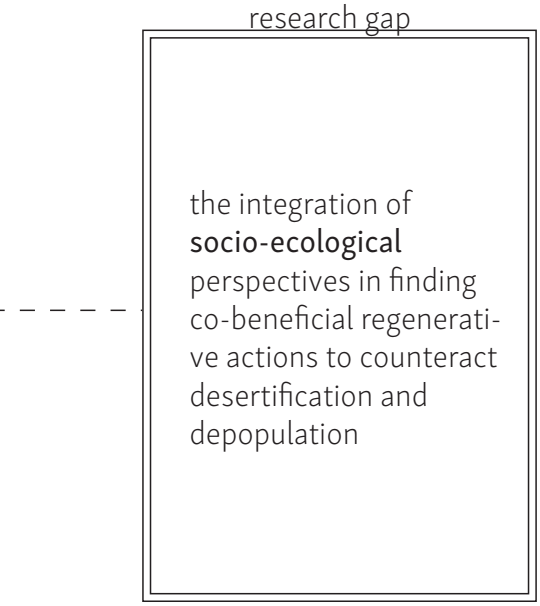
Theoretical framework



The concepts outlined above provide a theoretical framework through which to approach the complex and intertwined challenges of depopulation and desertification. By integrating various theoretical perspectives a multifaceted understanding of these issues is obtained, which is essential.

Existing theories

Theories focusing on the mitigation of climate change at a local scale argue for addressing global processes like desertification at more manageable, local levels. Additionally, theories on restoring landscapes discuss practices of ecological restoration aimed at repairing, regenerating, and enhancing degraded ecosystems. Adaptive strategic planning examines the network of interrelated components within a system and underscores the importance of adaptability—proposing strategies that can evolve in response to changing circumstances. This adaptability is considered crucial for managing the complex and dynamic nature of depopulation and desertification.



These approaches stress the importance of understanding the unique characteristics of each local context. By recognising and valuing the specificities of these regions, these theories lay the groundwork for contextually relevant solutions.

Towards a hypothesis

However, when comparing these theories, a significant research gap becomes apparent: the integration of socio-ecological perspectives in finding co-beneficial, local actions. Recognising that human societies and ecological systems are intricately linked is vital for understanding the dimensions in which synergistic solutions can be found and developed. An integrated approach that emphasises the mutual dependency of these systems is crucial. This is made particularly clear given the multitude of dimensions in which both depopulation and desertification are entwined, and calls for solutions that harmoniously address these social and ecological concerns.

Figure 36. Correlation between relevant literature

3.2

Research question

Starting from the dehesa in northern Extremadura, how can adaptive strategic planning (A) anticipate on capacities of local communities mitigating the the socio-environmental impact of depopulation (B) and desertification (C) in rural regions?

Subquestions

To assess

What are the environmental, ecological, social, and economical impacts of desertification and depopulation in Extremadura?

How are governmental bodies involved in addressing depopulation and desertification?

How are local communities currently responding to the challenges posed by desertification and depopulation?

How willing and capable are local communities in engaging in an adaptive land management strategy for the dehesa?

What are the potential socio-ecological risks associated with the projected climatic changes in the coming decades?

To design

How can a local adaptive strategic land management strategy contribute to a more resilient socio-ecological landscape?

What regenerative landscape actions can restore the landscape through scales and time?

What elements of the current policy framework can be flexibilised to align sustainable land management practises?

To evaluate

To what extent can fieldwork inform an adaptive strategy to mitigate the processes of depopulation and desertification?

3.3

Methods

This project covers a diverse range of qualitive and quantitative research methods to effectively study the complex phenomena of desertification and depopulation. The interdisciplinary approach ensures a deeper understanding of the underlying dynamics and their forms. By analysing past conditions, understanding the current dynamics, and describing future scenarios of a specific case study, a visualisation of the impact of the two phenomena will be formed. By applying these methods in a specific case study outcomes can serve as a model for similar situations elsewhere. The strength of this method is the systemic approach, which addresses environmental, ecological, social, economic, and political impacts. Social considerations of both human and non-human is what makes this method unique. Several of the outlined methods will be elaborated in detail in the following sections.

Reading and restoring layered landscapes

Several authors advocate for the concept of reading landscapes by understanding its patterns, perception, and processes. Bell (1999) proposes to read the landscape by understanding the created physical patterns created by natural and human influences, understanding how these patterns are perceived through time, and analysing the ongoing processes that modify and maintain the landscape. The past uses, and original forms are still implicit, but need to be deciphered according to Corboz (1983). By accepting that landscapes are dynamic and continuously evolving with the interaction between natural elements and human activities, its complexity can be understood. By analysing and interpreting these layers the landscape will be understood, which will serve as a foundation for restoring the landscape.

As many landscapes have recently been damaged or undermined, restoration is necessary. This includes the return of the landscape towards a healthier state by removing ecological damage. According to Hourdequin & Havlick (2016), restoring a landscape involves the understanding of embedded historical

layers of meaning and value. Therefore, decisions need to be made among which meanings and which layers to preserve and restore. Embedded layers will be interpret, and certain histories and meanings will be covered up or revealed in a new layer in the landscape. Artifacts with symbolic value from different historical periods are still visible.

In contrast to traditional views on restoration, the believe is rejected that there is a single stable state to be achieved. There is no return towards a natural state prior to human influence, just the restoration of natural processes, including disturbance. Ecological restoration in a changing landscape involves an understanding of the system. Cultural and natural heritage are both part of the world as we find it, their intermingling is part of what we inherit. Understanding this intertwinement through time and acknowledging ecological systems as well as social, cultural, and political meanings into restoration practises is what this approach strives for.

Fieldwork as action research

In this research fieldwork serves as a crucial method for understanding the relationship between the landscape and communities living in it. Action research is a participatory research methodology that is based on active involvement of community and stakeholders in problem solving. Fieldwork can therefore become a process that engages actively with the study environment, and its participants. By emerging in the setting, new perspectives and experiences can not only be found but also better understood.

Concretely, this means not only visiting the landscape and performing as an observer, but transcending this traditional role and combining data and experience. A variety of methods, exploring the landscape with photography, assessing the ecosystem with bio-indicators, conducting semi-structured interviews with stakeholders, and handing out surveys to residents, are used to gain insight into the role of the landscape as a resource, community identity, management practices, adaptation to climate change and potential for the future.

The interviews will give insights in the values of the local community. This understanding is crucial in formulating a strategy that actively involves the local people in the decision-making process. The interviews will be used as validation of literature research as well. The interviews explore the notion that people are not only an integral part of nature, but are also profoundly affected by changes in the natural environment. Understanding the effects of change until this moment provides valuable insights into the dynamic interplay between human communities and their natural environment and the unravelling of the cultural landscape. The narratives obtained provide valuable perspectives on the values held by the local community. Values, as emphasised by Wojewódzka-Wiewiórska et al. (2022), justify people's actions and priorities. In addition, the interviews serve as a means of validating the literature review, confirming a commitment to the natural environment, recognising nature's contribution to people, establishing a connection with nature and recognising nature as a value. Potential of future scenarios will also be discussed and possibly confirmed.

It is important to emphasise the ethical relevance of involving local people in the interviews. The process goes beyond the mere observation of practices; it actively involves individuals in the exploration, thus ensuring a participatory and ethical research approach.

Storytelling and personal narratives

Storytelling and narrative methods are essential tools for understanding, analysing and interpreting environments (Potteiger et al., 1998). Narratives are a critical lens through which meanings embedded in places can be explored. *"stories link the sense of time, event, experience, memory and other intangibles to the more tangible aspects of place"* (p.ix). As they are implicit in the processes of the landscape, storytelling can also be used to understand the multiplicity of layers. Through stories, routines of practises, rituals, journeys and memories the lived landscape can be unravelled. According to Potteiger et al. (1998) the landscape does not only serve as a background for stories,

but is one itself. They emerge from the interplay of natural and cultural processes. Through stories we can get to know a place.

Concretely, this means formulating the fieldwork as a story. By including personal experience in the evaluation of the landscape, depth will be added to quantitative data. A personal narrative helps to illustrate abstract concepts, and makes the research more engaging. This approach can reveal nuances that might not be captured through more observational methods. The cultural and emotional dimensions of the landscapes are even deeper discovered and connectedness and empathy with the is fostered. This can make the research more impactful.

Scenarios

Scenarios play a central role in the adaptive strategic planning approach. After the assessment and interpretation of the landscape, scenarios can be applied to identify long-term socio-environmental risks. It is particularly valuable when dealing with uncertainty and (dis)continuity.

Scenario development involves a deep understanding of the causal relations regarding change and variation. As Potteiger (1998) states: *"Change may be sudden or cataclysmic or it may be a barely perceptible shift in routine"* (p. 109). The identification of driving forces and critical uncertainties is a requirement for the formulation of plausible scenarios in which the consequences for ecosystems become clear. This is followed by a discussion of implications and possible pathways, exploring what is both feasible and what choices therefore need to be made.

3.4

Methodological framework

subquestion	subject	data collection	
What are the environmental, ecological, social, and economical impacts of desertification and depopulation in Extremadura?	land cover	analysis with GIS data	fieldwork on landscape patches
	management	literature on local vernacular practises	fieldwork and interviews on practises
	ecosystem health	literature on pressures and drivers	soil quality assessment through fieldwork
	community identity	survey non-physical resources	interviews on identity
	demographic change	National Institute of Statistics (INE) data projection	literature review on landscape consequences
	adaptability	analysis of resources	economic situation and additional values data
How can a local adaptive strategic land management strategy contribute to a more resilient socio-ecological landscape?	heat and drought	precipitation and heat projections	literature on ecological consequences
	adaptive strategic planning	critical mapping	flexible points in current land management
	economic activities	potentialities of semi-arid areas	interviews about local potentialities with stakeholders
	regenerative actions	best nature-based solutions practises	interview local nature-based solutions
	policy alignment	bottleneck definition	interview with local actors
To what extent can fieldwork inform an adaptive strategy to mitigate the processes of depopulation and desertification?	evaluation	strategy testing through interviews	

	tool	output
fieldwork on cultural landscape elements	layered landscape reconstruction: integrating historical map data with observations	1 historical geo-spatial synthesis, a carthographic timeline and review on layer restoration
	systemic land management evaluation: assessment of vernacular and current practises including risk identification.	2 atlas of vernacular practises and land management in photo's, system diagrams, maps
interviews on pressures and drivers	multi-criteria ecosystem evaluation	3 holistic understanding of the environmental status shown in infographics and diagrams
	community cultural resources assessment, qualitve data analysis	4 inventory of cultural identity and resources
survey about consequences	synthesis of consequences of demographic changes for the community and landscape	5 Overview of consequences of changing demography
survey & interview on current flexibility to changes	resilience capacity assessment, combining inhabitant's perspectives, physical aspects and economic aspects	6 comprehensive resilience report showing risks and opportunities
	assessing the risks and hazards of drought and heat	7 forecast of conditions and liveability
	integrating adaptive stragic planning tools into the system of care through pathways	8 adaptive strategy: a system of care
	synthesis of consequences and opportunities of economic activities	9 potentialities of economic opportunities
opportunities in maps	integrated location specific nature-based solutions strategy development	10 strategy for future land management for a specific location
	critical review of the collaboration between governmental bodies and actors	11 policy impact on management practises and guidelines for the future
	using interviews for improvement and feedback on designed strategy	12 review on strategy

3.5

Tools

As the overview on the previous page shows, a variety of tools is used to answer the sub questions. Some of the most important concepts for the solution are elaborated below.

Nature-based solutions

After initial attempts to understand the landscape and decompose the subsystems, nature-based solutions offer a wide range of solutions that are based on natural processes and cycles, taking advantage of the benefits of nature. With this tool, perceived challenges are addressed through the promotion of natural regeneration and restoration of landscapes. The overarching objective of this method is to provide effective and sustainable solutions that enhance the well-being of both people and the environment. This is possible as they use natural flows of matter and energy. It is a powerful tool for promoting harmonious relationships between human activities and the environment, because of its comprehensive and integrative nature. Interventions and management efforts following this method are systemic, cost-effective, and have long term effects for land degradation. In contrast to other restoration projects, nature-based solutions are not focused on artificial, man-made high maintenance strategies, depending on a high demand of external inputs.

According to Keesstra et al (2018) nature-based solutions can be divided into two groups: soil solutions and landscape solutions. Where soil solutions aim at enhancing soil health and functioning and therefore restoring ecosystem services, landscape solutions focus on connectivity. Examples of soil solutions are land agro-forestry, organic farming, and rewilding. Green infrastructure is an example of a landscape solution. These solutions can efficiently address multiple issues. However, each site requires a tailored solution, and a deep understanding of natural processes is needed. If this is achieved, and we are able to work together with nature, a cascade of processes occurs.

Best practises

Implementing best practises as a method of combating desertification is a tool with multiple advantages. Good practises have been proven effective in similar situations, allowing a desired outcome to be effectively achieved. Successful cases can serve as a blueprint for other locations facing similar challenges. Underlying principles can be adapted to the specific geographical, cultural and socio-economic characteristics of a given area. By using best practises the probability of a positive research outcome is maximised. The applicability of good practises extents across different domains, which makes it applicable to management approaches, the implementation of nature-based solutions, and community action.

Conceptual framework

3.6 The research question adopts a holistic approach integrating a variety of concepts to address the challenges of depopulation and desertification. This conceptual framework shows the relations between the concepts and methods on two scales, and how they add up to a socio-ecological co-evolution. The relationships are shown in a chronological way, top-down.

The decomposition of the concepts depopulation and desertification led to the exploration of agricultural land abandonment. Two dimensions were taken into consideration: the socio-cultural and bio-physical dimension.

Former vernacular practises need to be evaluated and integrated, as they are build upon a deep-rooted understanding of the local environment. This conscious way of resource use still reflect sustainable principles. As these practises have been refined through generations, it is closely related to landscape and cultural identity. By revitalising these practises again, communities can maintain a sense of identity and continuity, fostering a sense of responsibility, which is crucial for resilience. These practises form the base for nature-based solutions.

With agency of local residents over the landscape, those nature-based solutions can be applied to achieve soil regeneration. With regeneration the recovery of the ecosystem will be facilitated. To achieve soil regeneration on a large scale, adaptive strategic planning and policy alignment will operate as steering devices. The adaptable strategy is designed to be flexible, and able to adjust to changing environmental conditions over time. Moreover, it is based on the understanding that resilience is an evolving quality and can be progressively strengthened over time. By defining critical areas as well as areas with opportunities, nature-based solutions can be coupled to a location. This will lead to environmental restoration. On the other hand, policies at various levels need to be aligned to ensure the effective implementation and facilitation of sustainable management practises. Governance should also balance the needs of economic opportunities and conservation efforts.

On long term and large scale this will lead to ecosystem service enhancement and a socio-ecological co-evolution through strengthened interconnections.

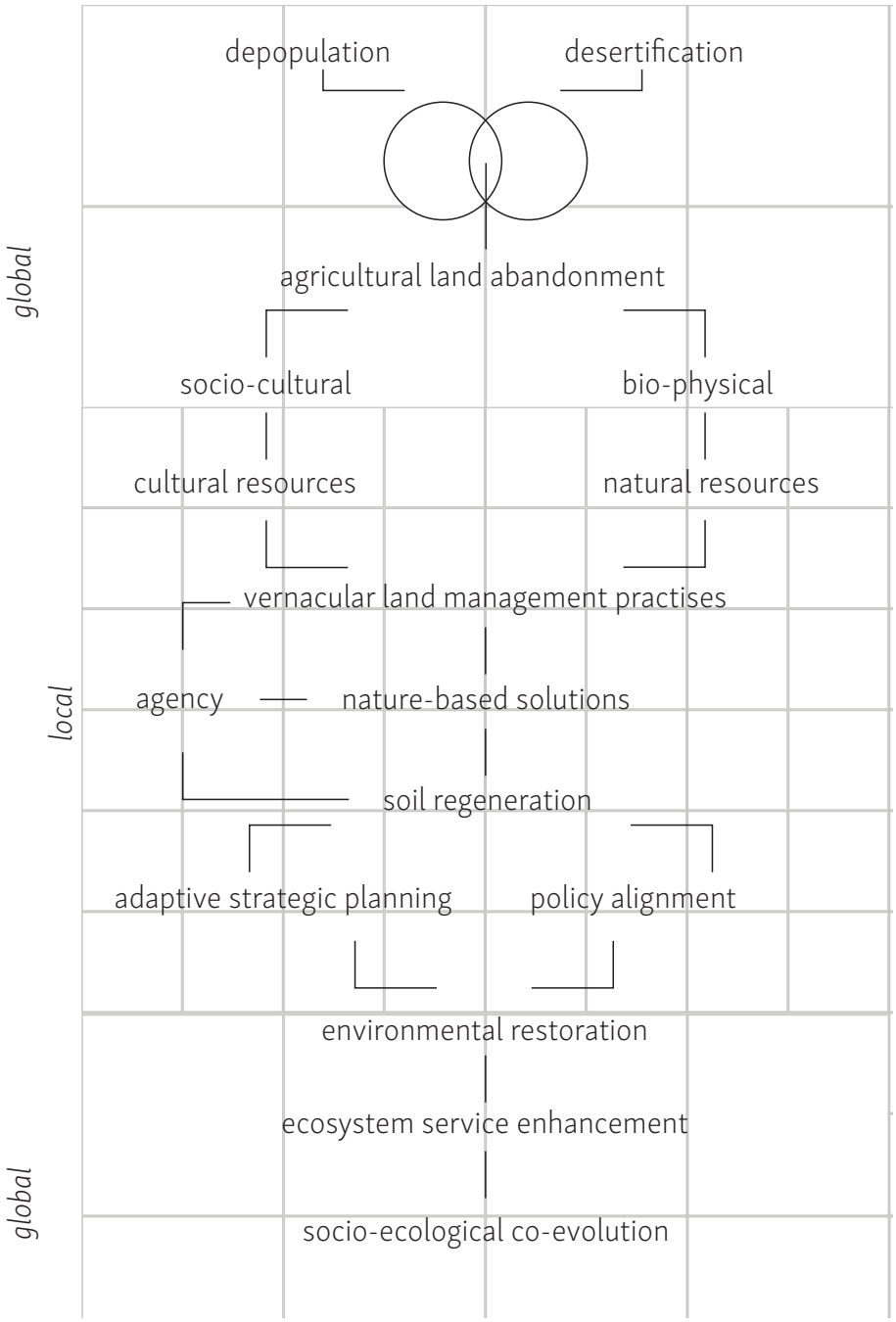


Figure 37. Conceptual framework

3.7

Outcome

The systematic progression of outputs aimed at formulating a strategy for depopulation and desertification is shown in the following image. As arrows represent new data, an overview is created that focusses mainly on the subsequence of stages. It gives insights in how literature research serves as an input for fieldwork, which in term serves as an input for the adaptive strategy.

literature or fieldwork input
inform

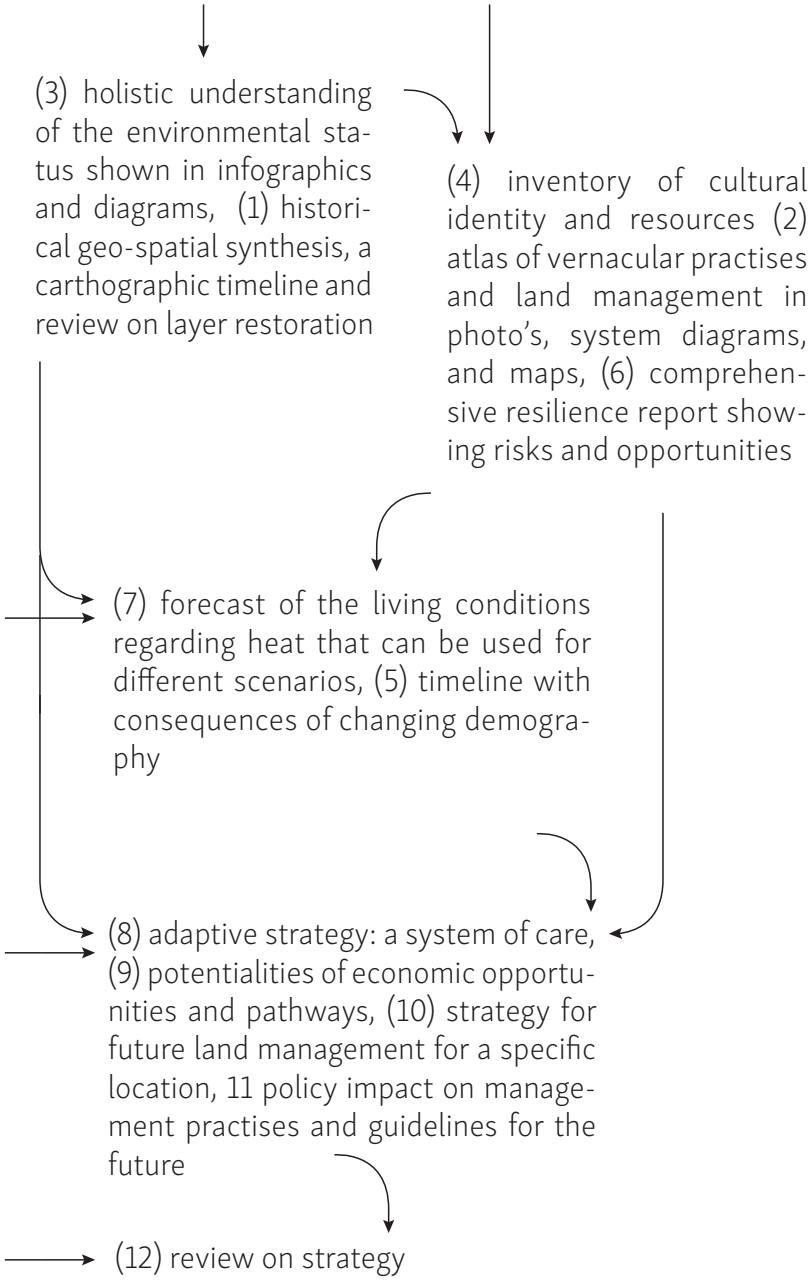


Figure 38. Use of output for outcome

4 Fieldwork

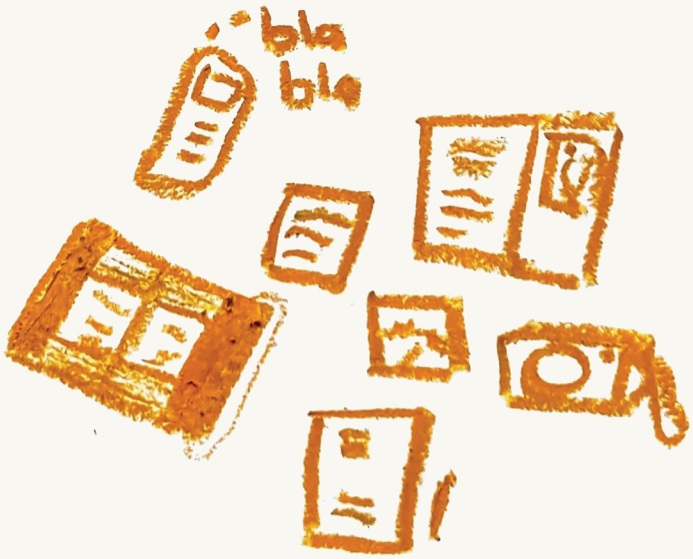
Manual



Fieldwork is a vital chapter in this research, providing a means to validate literature and explore practical possibilities. This section highlights my active role as the researcher, emphasizing the value added by including personal experiences during fieldwork.

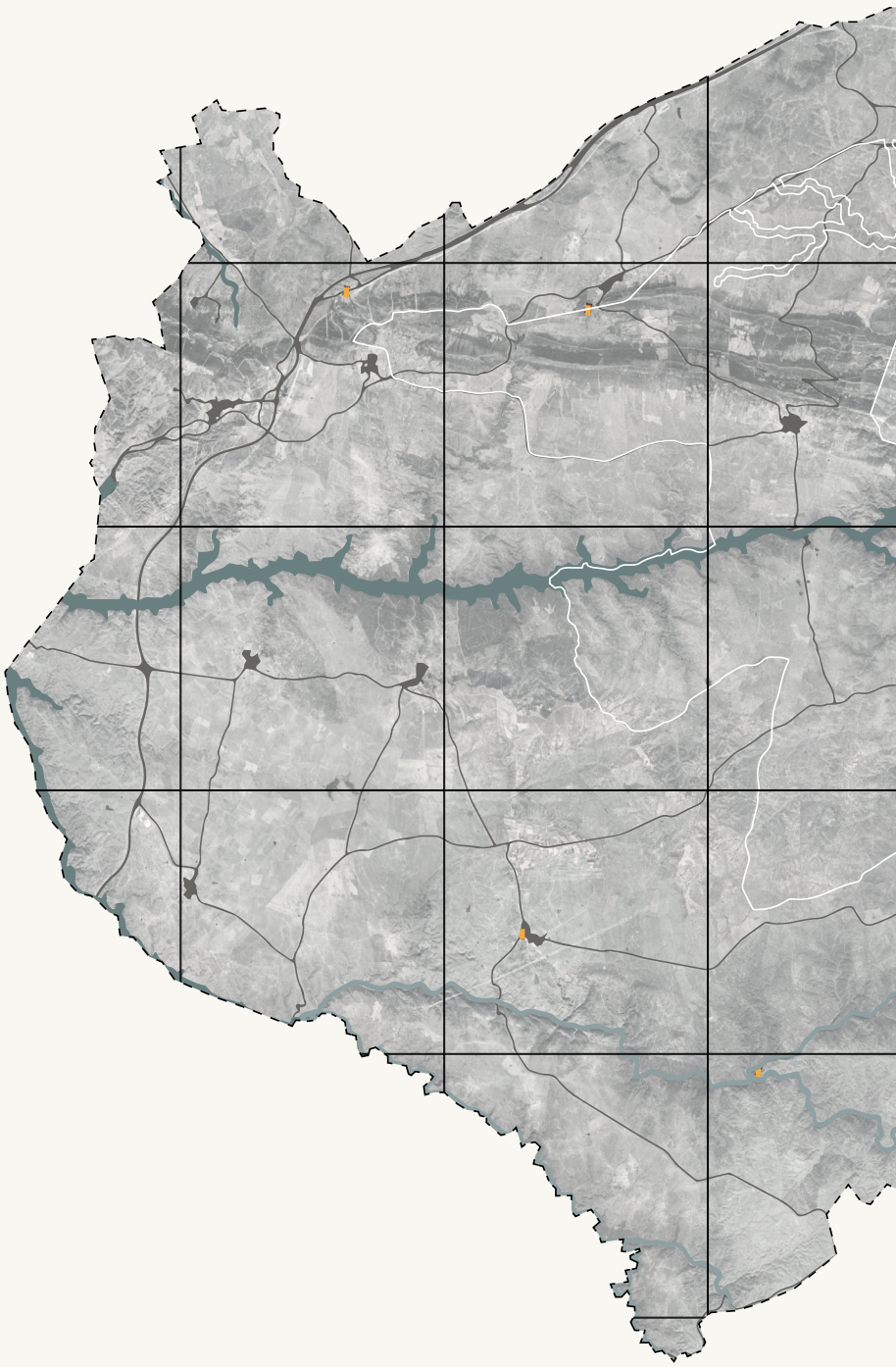


The chapter follows the week of fieldwork, detailing the people I met, interviewed, and the information gathered. Each person is introduced as a character, offering insights into our conversations.





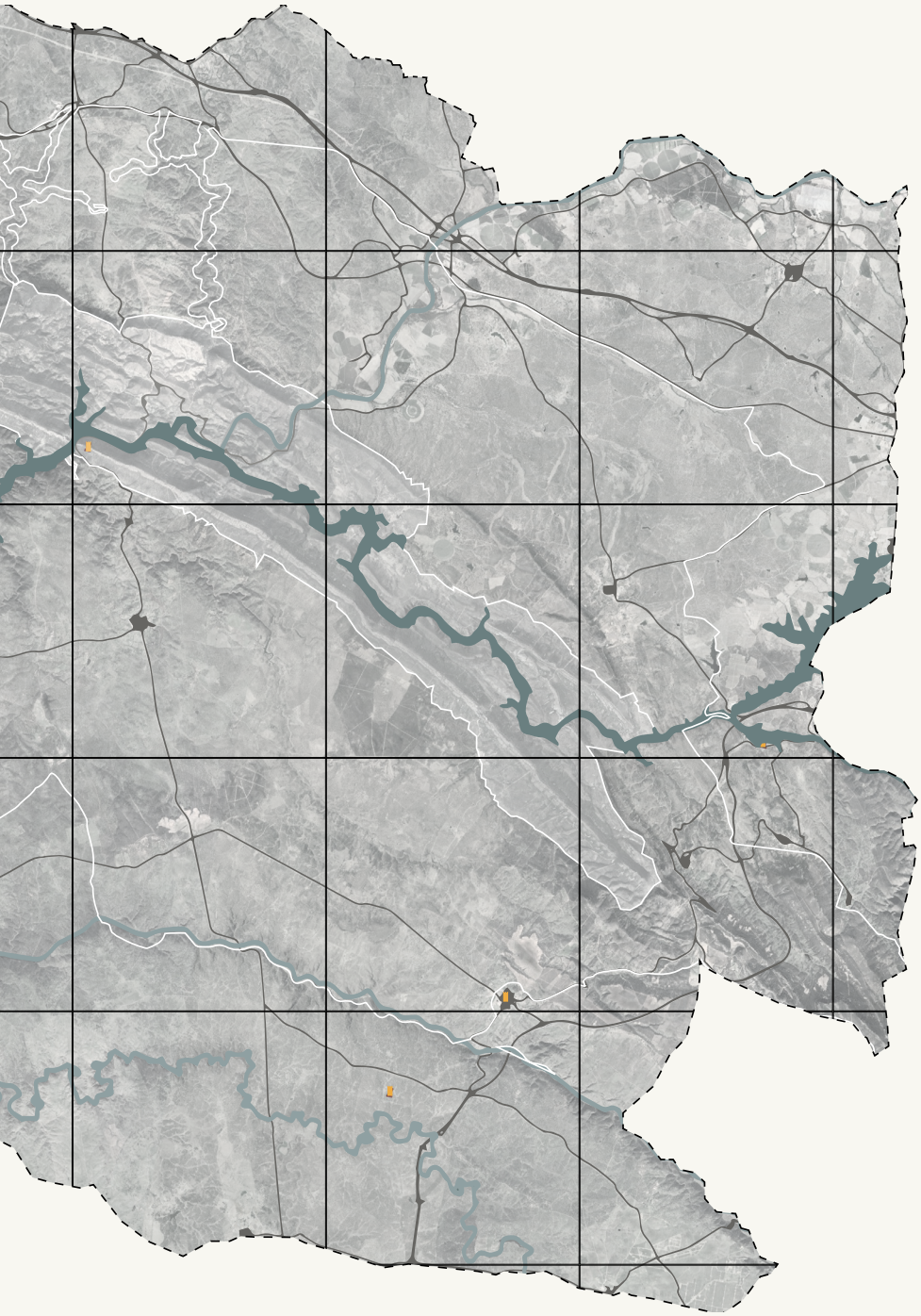
This chapter blends personal experiences with real-life data, including photos, interviews, conclusions, drawings, ideas, and observations. It presents a comprehensive view of the fieldwork experience, integrating real-life data and personal insights, conversations with various stakeholders, and data collected through surveys. Key findings and insights drawn from the fieldwork are highlighted.

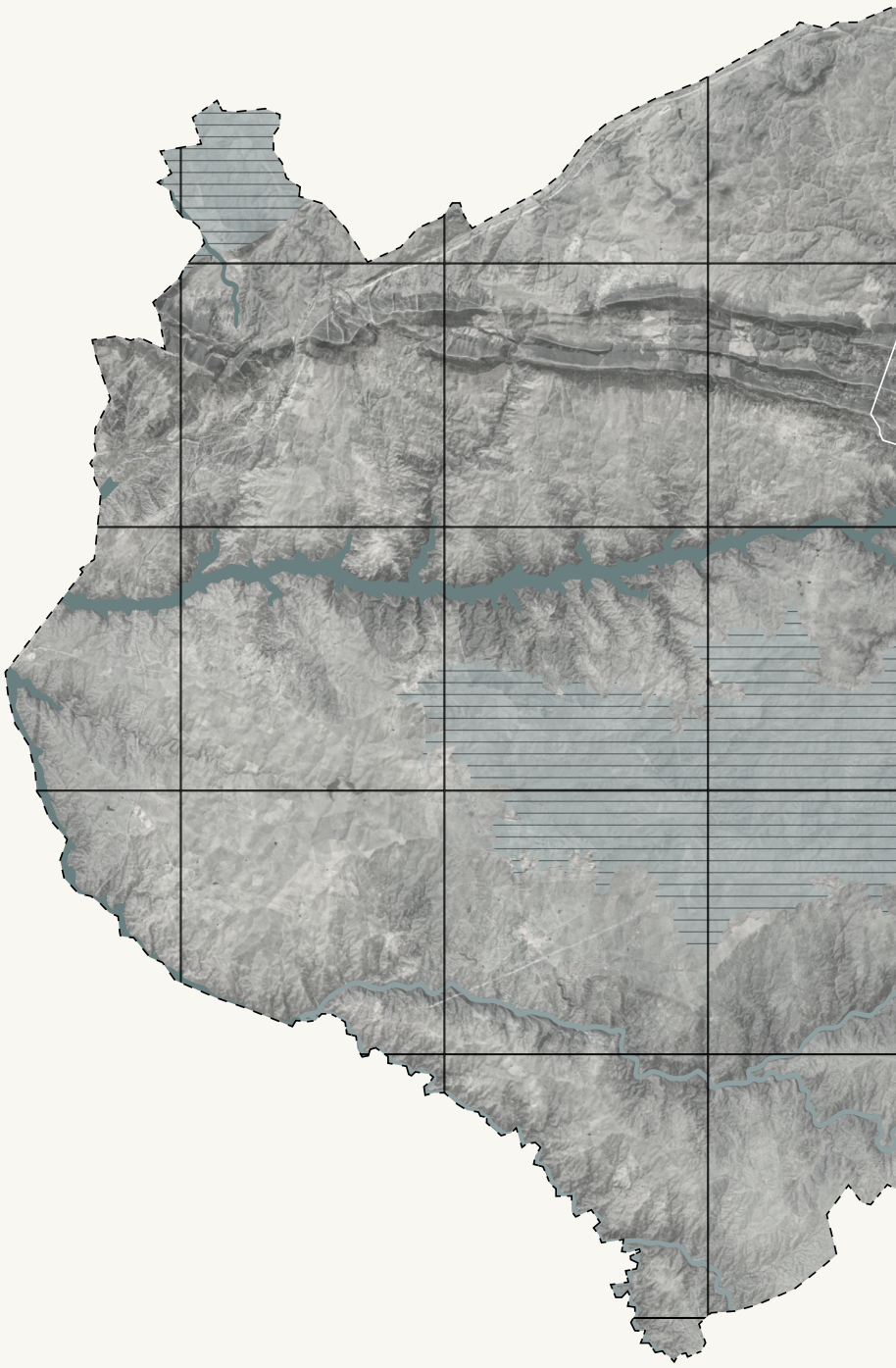


Location of case study. Based on LUISA.
1:40000

0 5 10km

terrain
river
roads
castles
national park
natura 2000

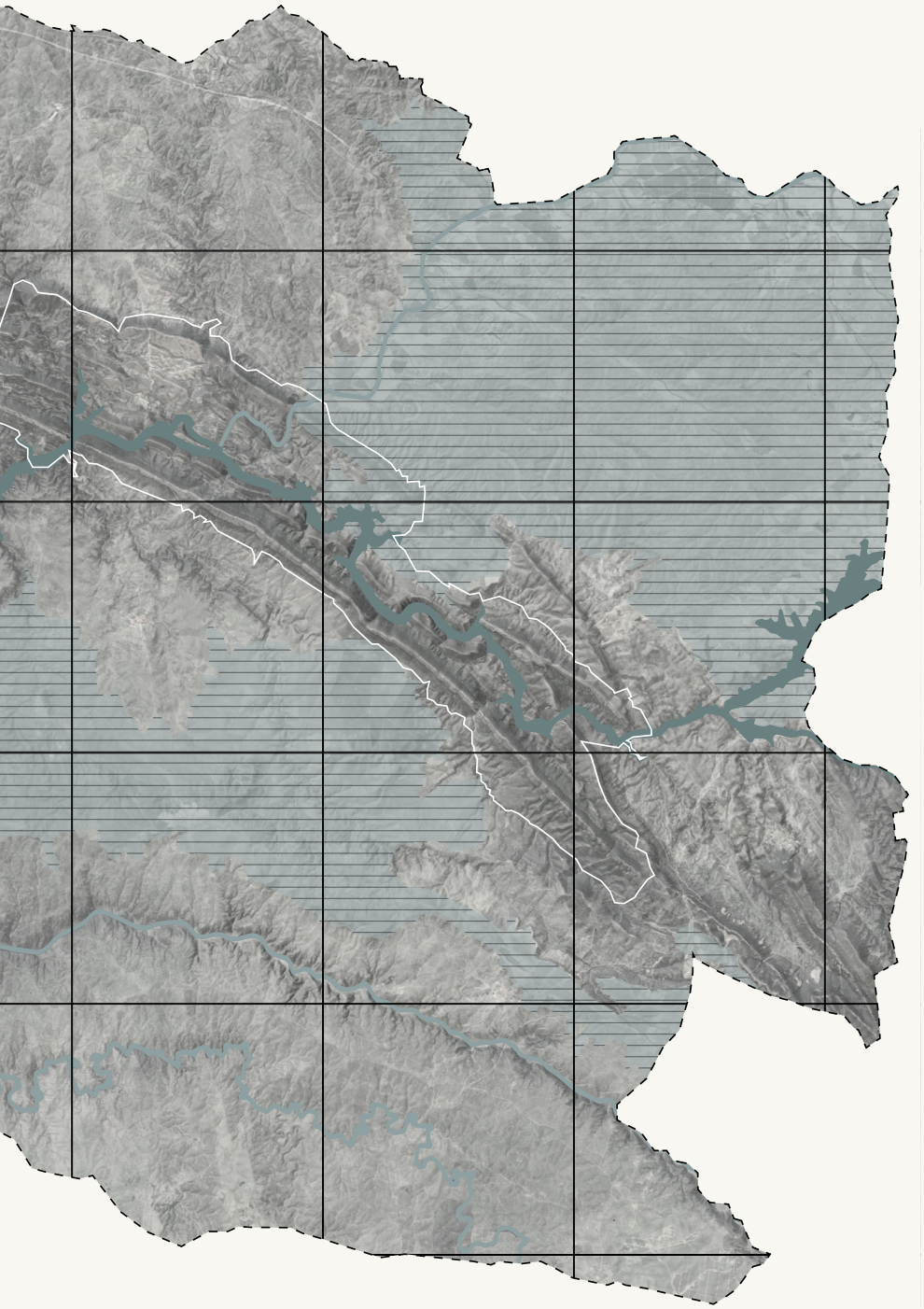




Location of case study. Based on LUISA.
1:40000

0 5 10km

terrain
water reservoir
river
groundwater bodies
national park



DAY 1 AFTERNOON

I hired a car for the 2.5 hour drive to Trujillo, admiring the stunning landscape I had been studying for weeks. On arrival, I brushed up on my Spanish by chatting to the host and arranged to visit his property the following morning. I spent the evening preparing questions and exploring the picturesque town.

DAY 2 MORNING

We met as planned and drove 10 minutes to his property. He kindly answered all my questions and gave me an insight into the history of the land and his recent return to the area. He showed me the distinctive characteristics of the land. Unfortunately, I made the beginner's mistake of not properly recording the interview, so I took notes from memory. The information gathered was mainly about lives-



DAY 2 AFTERNOON

I drove to the National Park to see the magnificent views, birds and wide dehesa landscapes. I walked the path to the old castle and enjoyed the views of the park and surrounding villages. Without a set plan, I drove around the area, visited Villarreal de San Carlos, the smallest village, and handed out my first survey. It was an exciting day.

DAY 3 MORNING

I left early to collect surveys from towns around the National Park. Heading east, I tried to visit a farm I had not been able to contact before. In the small towns, where I found no one on the streets, I visited local cafes and supermarkets to talk to people, which proved to be an effective strategy.

DAY 3 AFTERNOON

After visiting several villages, I found someone who knew a worker on the dehesa farm. I translated my needs and made an appointment. However, I wrote down the wrong number and had to call back, which was not well received. Nevertheless, I managed to collect survey responses and observe the landscape.





DAY 3 EVENING

As the first farm I wanted to visit had not yet responded, I spent the evening researching other possible places to visit. The first farmer I spoke to managed his cows in a traditional way, but I was keen to visit someone with holistic management and an expert in regenerative practices. I called two people, one relatively young who had recently started regenerative practices with cows, and another who owned a dehesa with Iberian pigs. I also contacted people through a volunteer platform to see as many dehesas and farms as possible.

DAY 4 MORNING

Strolling through the beautiful centre of Trujillo. It was fascinating to see and hear all the birds. It was not even spring yet. I also saw the most amazing little dehesas when I climbed the city walls.

DAY 4 AFTERNOON

Since I had not yet succeeded in planning a visit to a farm, I decided to visit Cáceres. On the way, I passed through some other villages on the western side of the National Park, where I did some more surveys.



DAY 5 MORNING

I had to continue my journey towards the National Park to attend an international birdwatching fair that was taking place all weekend. I checked the programme and found some interesting talks. A very famous protector of the dehesa, Jesús Garzón, who has done a lot for the National Park over the years, was being honoured. After this talk, I wanted to talk to one of the shepherds present. I had prepared my questions and went to the stage after the meeting. I managed to ask her a few questions, but I could hardly understand her answers. Luckily I recorded it and planned to look at the answers later.

DAY 5 EVENING

In the evening I visited a social project. After helping them on their volunteer day and seeing their landscape, I had a much clearer idea of the different types of people who live in this area. This young family were looking for a quiet, slow life and had an incredibly strong network of friends. Together they were making sure there were opportunities for their young children, despite the fact that the area was predominantly elderly and lacked facilities.



DAY 6 MORNING

Another busy day. I met with a farmer for an interview. She was very passionate about restoring the land and had managed to attract the attention of the local people with her transformations. She invited me to visit the dehesas I had seen before on the outskirts of town, which I learnt were apparently very rich in biodiversity. Later, at the birdwatching fair, there was a conference about the future where someone from an NGO was going to speak. I wanted to talk to her about opportunities for bottom-up initiatives and the role of government.



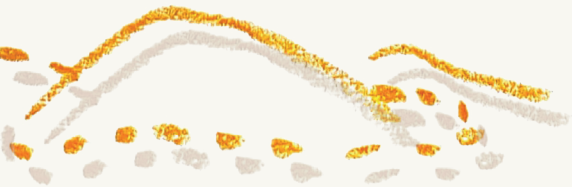
DAY 6 EVENING

I planned to visit the farm of a family who seemed to know a lot about regenerative practices. After almost three hours of conversation I was so much more aware of the landscape, its history, farming, practices, gardening, changes, and a lot of technical knowledge about soil and plants. It felt like I understood the landscape.



DAY 7 MORNING

With everything I wanted to see and more ticked off, I decided to visit another mountain range and geopark, Villuercas Ibores Jara, on the east side of Monfrague. I was surprised to see fresh snow. I visited a small town, had a coffee and talked to some locals. I was confident in my Spanish again and got some interesting views on depopulation.



DAY 7 AFTERNOON

After several hours of driving through the mountains, I came across an old bridge and mills. This made the rich history of the area more apparent.

DAY 8 MORNING

Time to go home! With a bag full of survey responses, hours of interview tapes, more than 1500 photos of the environment and tons of notes, I headed home.




Plasen
Cáceres


Trujillo



I could not keep count of the variety of bi

a fascinating amount of species, cros



irds I saw when I drove back and forward..

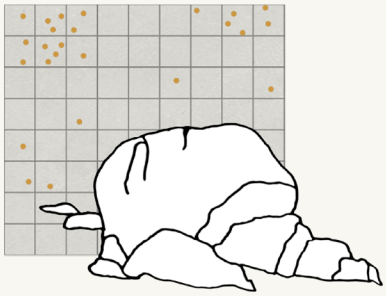
ssing the dehesa, crossing roads

natural

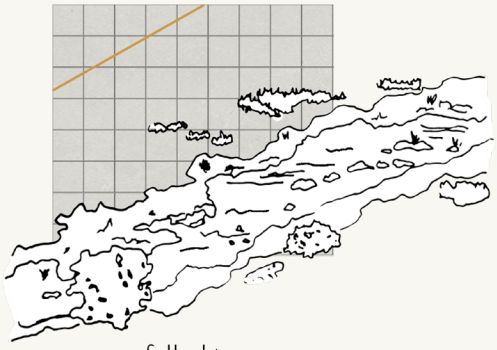
man-made

constructed

rock formation



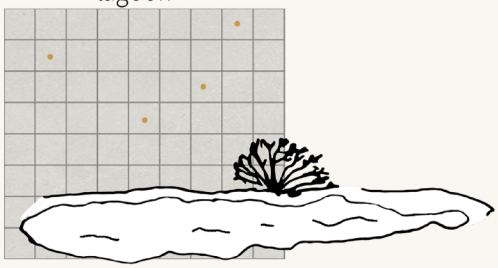
river valley



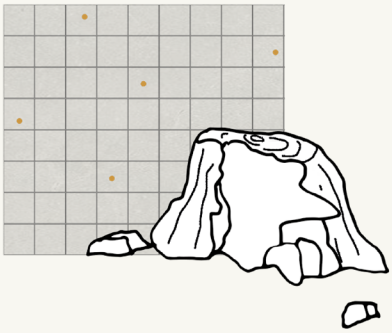
moss-co



lagoon



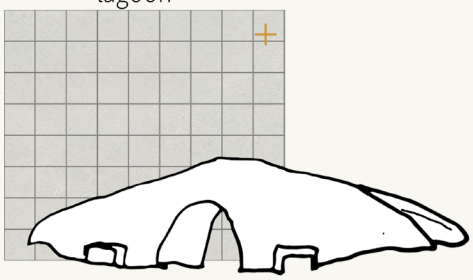
felled tree



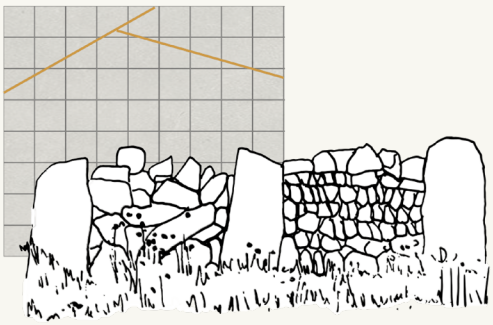
protec



lagoon



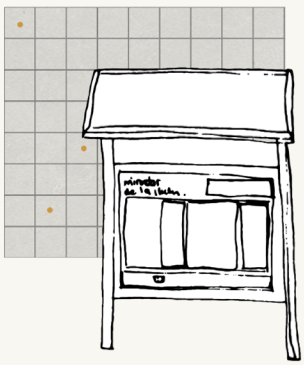
stone fence



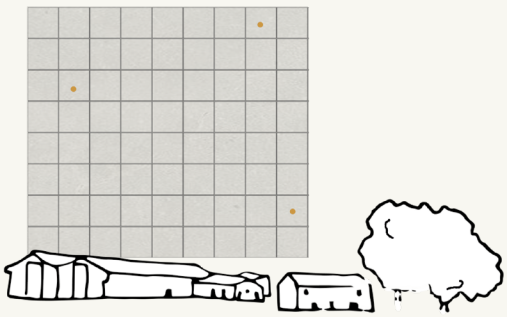
decayin



tourist information



industrial farm



Rom



Sequence of observed natural and cultural elements

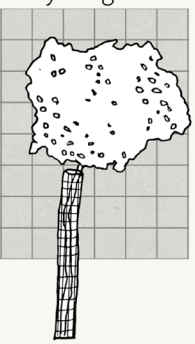
By listing and categorising the elements I encountered along the way, I became aware of their history, occurrence and persistence and relations.

- object
- frequency of object in space
- punctual object
- distinctive object
- linear object

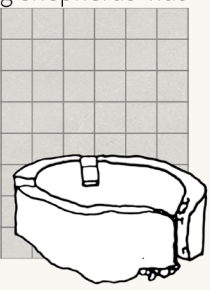
vered dead tree



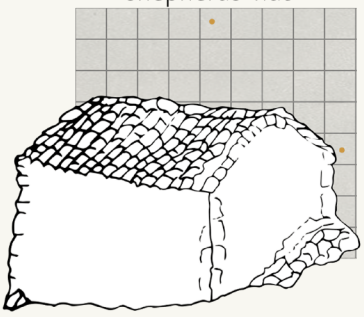
cted young tree



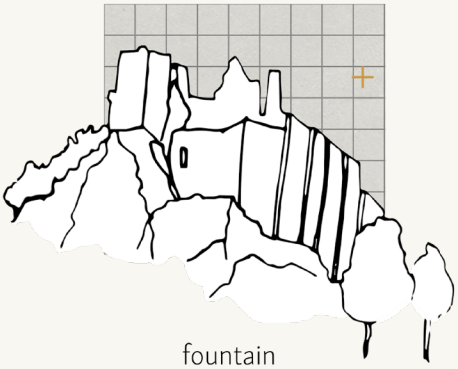
g shepherds' hut



shepherds' hut



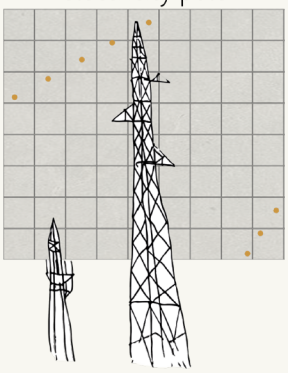
castle



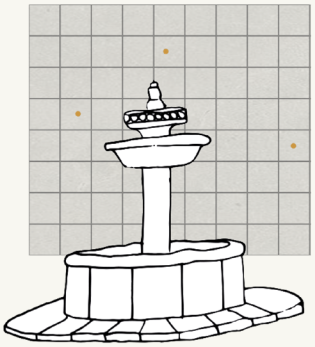
han temple



electricity pole



fountain



Persistance of dehesa structures

Rich in plant diversity, animals, and appereance, the surrounding dehesas of some old towns, like this one in Serrejon, has important not only natural but also cultural value.



Visible old structure of the dehesas in Serrejón, accompanied by images. Based on LUISA.













RESOURCE depletion, overexploitation, land degradation

grazing without proper management and rotation, leaving the soil bare

radation, reduced



exposed soil highly susceptible to erosion, caused by large scale olive tree groves









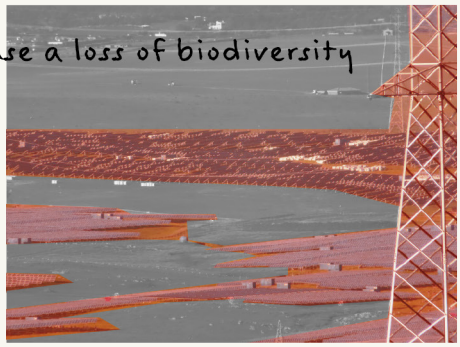
irrigation for grasslands, depleting valuable water resources



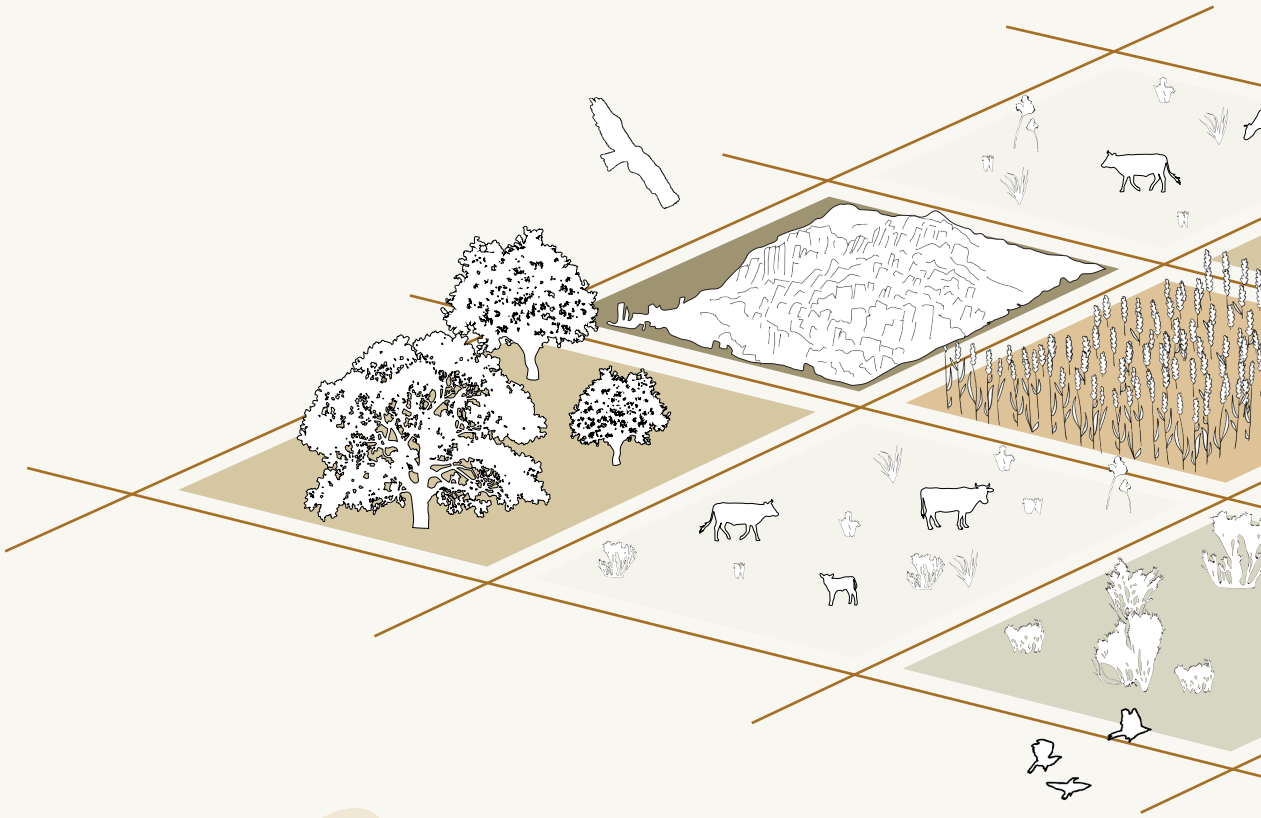


immense solar panel fields cause a loss of biodiversity and destroy habitats



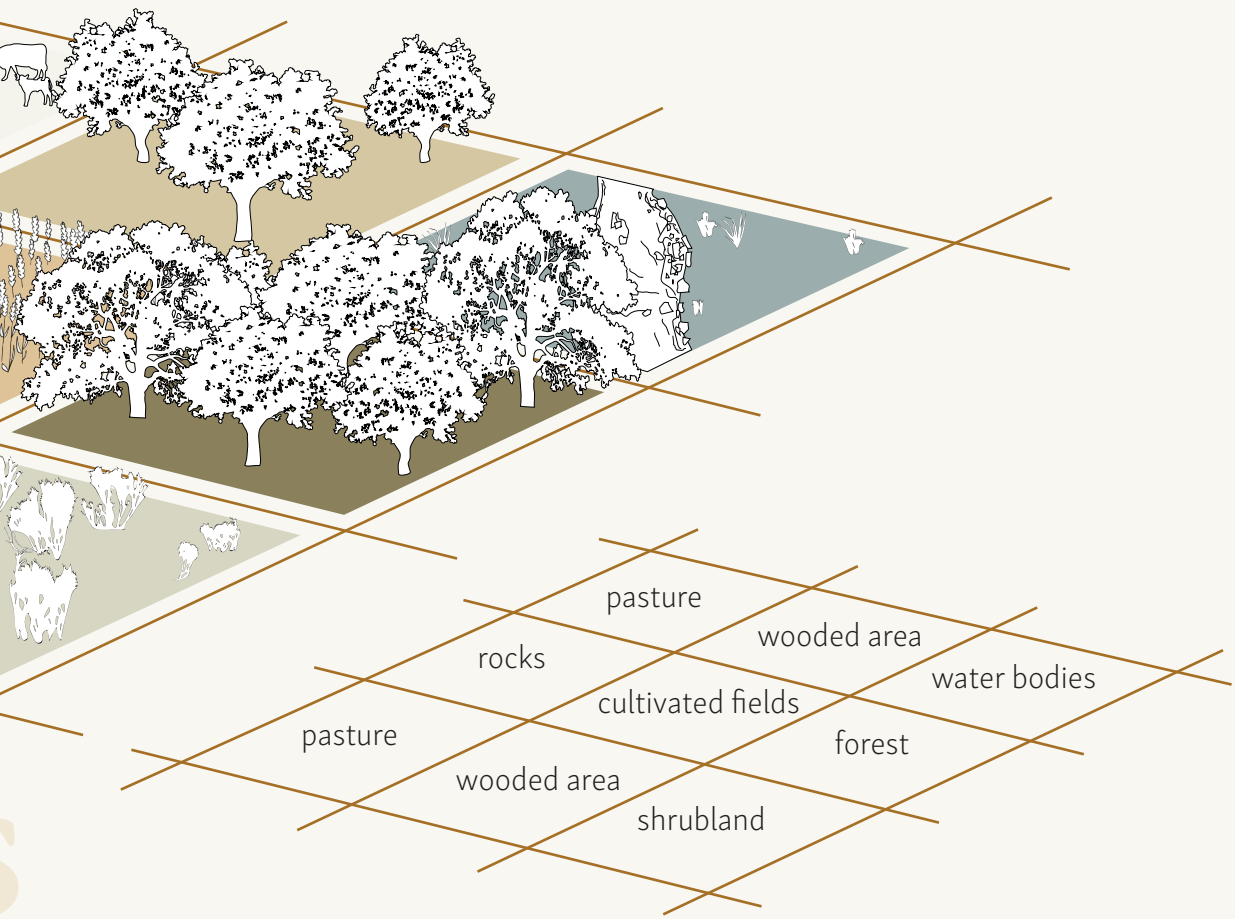


patches



configurations

/ varia


pasture
wooded area
rocks
water bodies
cultivated fields
pasture
forest
wooded area
shrubland

Welcome in the dehesa,

What do you want to k



These character are based on interviews with a diverse group of farmers: one returned to the region after inheriting land from his grandparents, another came back with a focus on regenerating the land and optimizing the balance between livestock and soil, and a third has always lived in the area, dedicating himself to restoring the land and maintaining a closed-loop agricultural system.

now?



“if it is getting dryer in the futu



animals: about 130 cows
size: 350 hectares
returned to his roots
traditional livestock farming

re I don’t know what to do”



Returned from the big city, this farmer inherited a part of a family dehesa. He longed for more freedom, an outside job, and going back to his roots. He holds about 130 cows on a plot of 350 hectares. It seems that he cares a lot about his animals. Even though he does not life on the land, he drives there everyday to check on the animals. Are any of the cows sick? Are they eating enough? Is there still enough grass? How are the calves?

His land consisted of never ending pastures with a tree every here and there. Walls seperated the pastures from each other. I asked from where to where his land was, but you could not even see the end. Threehundred fifty hectares is quite a lot. I started asking general questions about the management of the dehesa, as I was far from an expert at this point. The management of the land was mainly about the animals. Land management for this man meant cow management. Human activities influence the health of the land with the cows: they keep the soil healthy. He says the management has not changed in the recent decades, only the intensity varied. More land can be managed and is already being managed by less and less people.



"In a pasture of 350 hectares like the one you visited today, several families worked (8-12 people), some planted crops, others had sheep, others cows, others worked making the stone walls... Now I manage that farm alone and I also have other jobs."

Technology did make the management esasier, especially machines increased efficiency. I make a note that this can be helpfull for the future, since there will maybe be less people around to take care of the cows.

I learn more about why the dehesa is so special. Cows eat acorns, you need three hectares of land for each cow, and it is normal that July, August, and September are the dry seasons with almost no rain. There is normally not enough food for the cows, and you can feed pellets to the cows, as well as grass that you harvest before summer. The cows are adapted to these tough summers. These native types of cows, which are different from the Dutch cows, called the retinta cattle breed, are used to the heat and the less availability of food in summer.


large contrasts between
summer and the other
seasons are common. I
can't image what this
now so green land would
look like in summer...

Observation



Erodium cicutarium

Spotted in many pastures, part of the diet of livestock



Narcissus bulbocodium L.



Romul



Muscari commutatum Guss.



Silene secundiflora Otth

herbs con
the healt
livestock



Diplotaxis catholica (L.





ea ramiflora Ten.



Calendula

many medicinal uses

tribute to
h of the

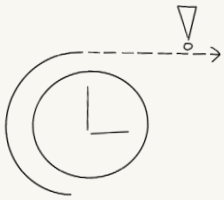


Saxifraga granulata L.

) DC



Anchusa undulata L.



The future

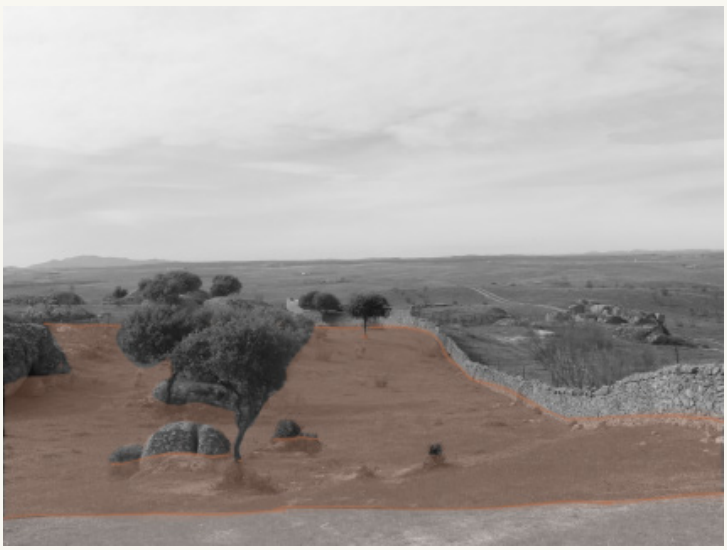
Talking about threats and risks, the conversations starts to feel heavy. As he says that there will not be a future if it is not going to rain, I start to realise the extent of this problem. He looks worried when he says that does not know any solutions for the drought. Climate change makes the summers even longer, but there are also more extremes in precipitation. He mentions that last time there was extreme rain within a short period, but the water could not infiltrate in the earth because of its dryness.

He also perceives the recent social risks because of depopulation. Attracting new people is hard, as it is almost impossible to start a new farm from scratch. They need to have roots here, as the purchasing costs and the rental price is very high.

But, in case you do have roots, and family with land and cows, you can make enough money to support yourself.







Observation

The cows looked incredibly happy. The young calves were still with their mothers, which I had never seen in the Dutch farming system. They had so much space, but also shelter. Moreover, the owner seemed to care so much about them. Even though the land was huge, he still drove around with his binoculars everyday to check on every single one of them.





“the dehesa has traditionall



animals: 200 cows
returned recently to her roots
regenerative livestock farming

ly been very well managed”



Only until very recent did this woman return to where her family came from when she inherited the family farm. She now takes care of the land and is now fighting to change farmers' working methods to avoid carbon emissions.

Therefore, she uses regenerative agriculture with livestock. This holistic approach to farming uses livestock such as cattle to regenete degraded lansdcapes and improve the health of the ecosystem. She explains why it is possible to regenerate the land with cows:



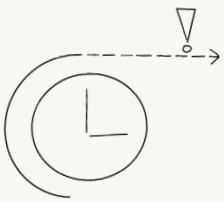
"These marvellous creatures return 95% of the minerals they consume to the soil through their urine and poo, as well as inoculating the soil with micro-organisms from their intestinal biomass and saliva."

Adapting and regenerating
To regenerate the land, the search for an optimalisation between pasture, livestock, and trees can start. The key concept for this is the imitation of nature with the herds. Predators normally stay shortly in an area, eat everything there is to be found, and then leave it for a long time. With rotational grazing this is also possible with the cows.

To improve the ability of the soil to function as a sponge and to improve the water cycle, no machinery is used, and no chemicals are applied. Moreover, a vegetation cover is always left under the trees in the small olive grove. She notices, that as they started to manage the cattles among these ideas, the earth gives back in quality and quantity. This also saves money.

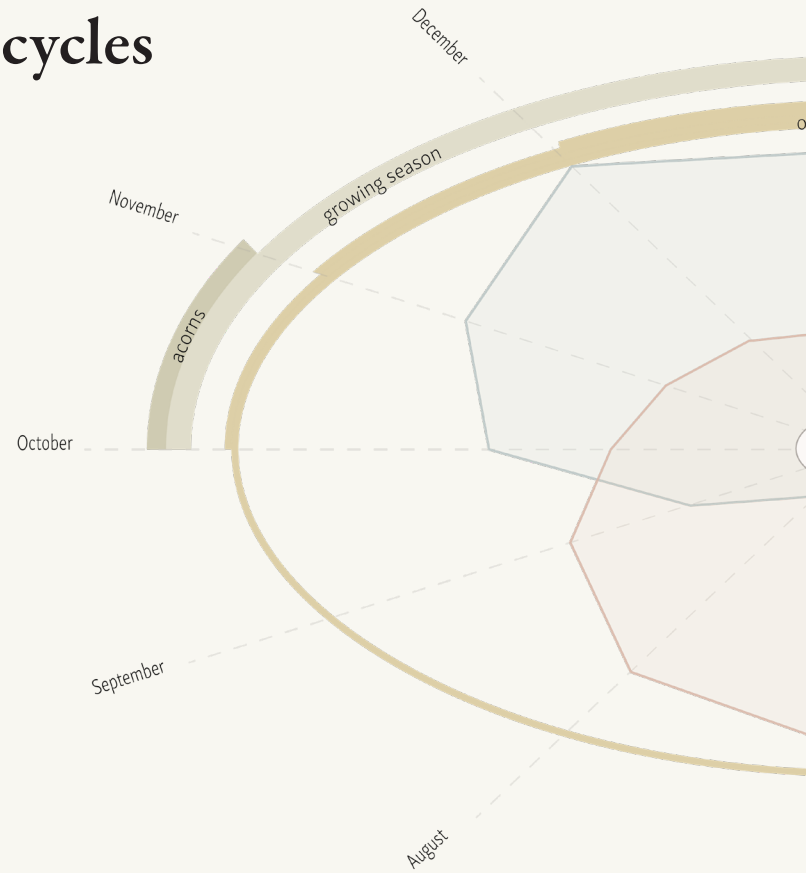
She also applies transterminance, a a minor variety of transhumance, characterised by seasonal movements over short distances, generally less than 100 km. Bij moving the animals for about 20 km through a cattle track, we stress on the animals is reduced compared to movement by lorry, which is much more common. This process is also to optimise the grazing: by making better use of the pastures trhough more intensively grazing and increasing the rest times on the ground.



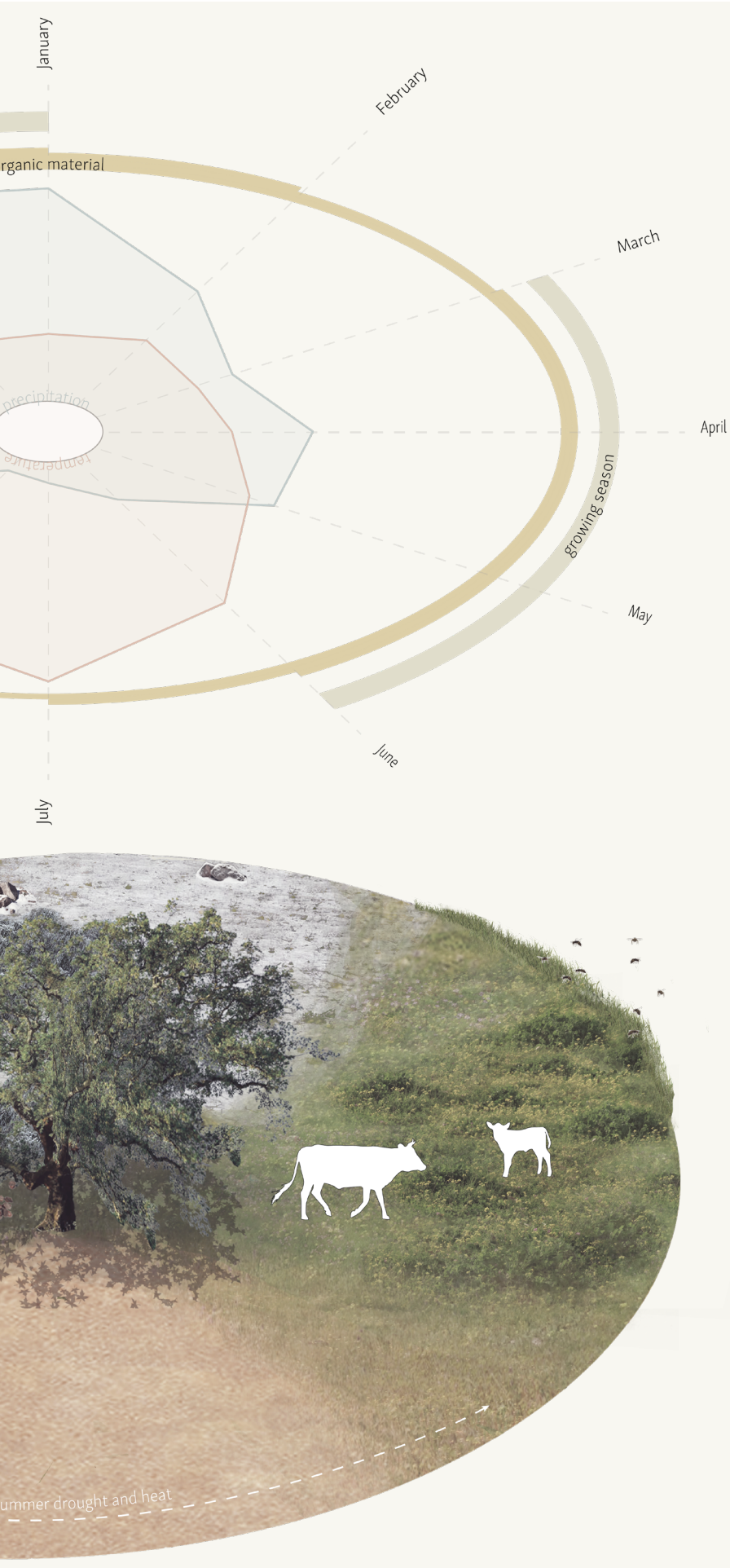


When she started to apply these management techniques, many people interfered. They told her that she was demolishing the land if she continued. However, after improvement of the soil started to become noticablem they slowly started being interested. As this management takes more time and effort, and they are not used to it, spreading the change is hard.

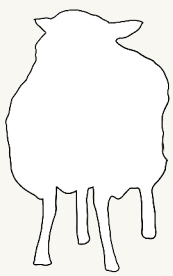
In- and output in cycles






January
February
rganic material
March
precipitation
temperature
April
growing season
May
June
July
ummer drought and heat

“Extensive livestock farming and transhumance





has worked as a shepherd for
15 years

e are the only ways to deal with climate change”

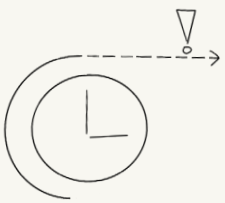


Independent but part of the community, this woman has worked as a shepherd for more than fifteen years. Talking about the power of transhumance, we fastly get to the point where I am convinced transhumance is such an old practise, but still very relevant to todays issues and concerns. With transhumance and extensive livestock farming, you move with nature. Moving from the south to the north, you are perfectly adapted to the resource availability in the different seasons. When it is cold, you can go south, when there is no food or it is too hot, you go north. There are no key dates for this, it is based on the availability.

Moreover, transhumance is risk prevention. LIvestock is the best in fertlising the land, and filtering water into the ground. Forest fires are prevented with the movement of the livestock. Forest fires occur on areas where there is no grazing.

There is only one condition for this process: the availability of cattle tracks. She explains that there are 125.000 kilometres of tracks in Spain. The Guardia Civils helps them to keep them open and prevents them from being invaded or closed. As they are nationally protected, protection is guaranteed.

Although the goal of transhumance and it's effects are clear, the future of this system is not secured. When I asked what support or resources would be most beneficial to help to manage the risks, I got a very clear answer: the support is and must always come from the administration. They do not always believe in it, and do not always support. What they really should do is *"come to the field and see how it works".*



Although the goal of transhumance and it's effects are clear, the future of this system is not secured. When I asked what support or resources would be most beneficial to help to manage the risks, I got a very clear answer: the support is and must always come from the administration. They do not always believe in it, and do not always support. What they really should do is *"come to the field and see how it works".*





“We have long understood tha



animals: about 40 Iberian black pigs
size: 60 ha

at the soil is the source of life”



This man seems very affectionate with the environment. He is using his site as a living experiment, trying things out with small patches of land, ignoring people that tell him he is doing it all wrong. What he does with its land is focused on the ecology, it is sustainable and it fulfils many things and values. He is very conscious about his actions. He notices change. In my opinion, this quote summarizes his approach:

> *"in all dehesas, in the whole livestock farming world, we are seeing these big solutions to big problems, but on a tiny scale, nobody pays attention".*

On his farm he is focussing on regeneration with animals by focussing on microbiology. Taking care of the soil is very important, as the soil in this area is very poor in all aspects. It is not deep, you can not grow crops, neither can you put a fruit tree in it. Fruit trees need a deeper soil. So, there are a lot of meadows and shrubs. Where there are deep soils, there are large holm oaks, with a lot of contribution and a lot of life. In other places, as here, the holm oaks will never be very big. There are lots of minerals in it, there is a lot of microbiology, but there is little organic matter. The one thing that is needed is more organic matter. To improve this, shredded olive trees are used. Residents from all over the village could count on a service where they were trimming the olive trees down short, and they could keep the branches and use them. We are trying to improve the organic matter, with a wide diversity. THis can also happen in small plots. He showed their vegetable garden, where a permaculture student helped with developing a garden with a lot of diversity. They are doing tests to see if the organic matter is increasing in the soil. The includance of legumes is the next step. Also tree barks and straw help the development. Another thing they do to gain resources is the providance of another surface, to put straw on the ground in summer for people with lots of cows. They also clean it, and they get the resource in exchange for the service.

"We had to learn what we were doing wrong here. Get it right here. And replicate it."

Moreover, with help of the animals, the soil is improved. He started doing this, as he saw species dissapear on his land. In the beginning, he had many animals including goats and pigs, but only few pastures. Trees were dying, so he knew he had to change something. He reduced the number of sheep, and changed the breed of sheep. Then he changed the breed of the pigs, and reduced the animals a couple of times more. Then he started to use animals as a regeneration tool. Pigs were used as a tractor. His goal: to generate a space with animals in a number that covers the needs of a family economically. With a couple of cows there is a little bit of milk, a couple of calves to sell, some chickens for eggs. For this, he bought a cow to have poo to fertilise the vegetable garden. This regeneration is a process. But with holistic mangement and a holistic vision on animal management, you produce more food. With poo, plants, worms, soil quality is improving slowly but noticably.

Concretely, to take most advantage of the pigs, he used a method to have the soil equally fertilised. He used cereal and put it on the ground in lines, so the pigs went there to eat it, and poop there. Afterwards, he sowed oats and lupin and different kinds of seeds there to create a symbiosis to improve the soil. This was done not with the intention to obtain harvest, but to plant holm oak again, and fruit trees that will be rainfed. Chickens and birds will be used to create a large ecosystem within half a hectare. He clarifies that this is how the system worked for 2000 years, and that we have to copy it.

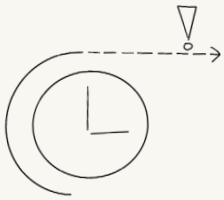




“that there is more life in a dead tree than in a living tree. [...]. Because of the amount of life, there are worms, larvae, butterflies, beetles, termites, ants, fungus, bacteria. Something that you might not find in a living tree. [...] . It’s important to have it. [...] Although it doesn’t look like it, there is a lot of soil regeneration”



When I asked about the option to cut down dead trees or to keep them, I got an extensive explaination about the value of dead trees: they are full of biodiversity. When mosses, lichens and algae grow, many insects, such as ants and bees, as well as butterflies, descend on them. Birds then descend on these. The death of a tree is a complex process: if the holm oak is weak, the lichen lodges and mineralises it and kills it. If the soil is strong, the lichen doesn't resist and they reach a balance and so on. This are normal events.



The future

Talking about the future of the dehesa, I got an answer that I did not hear before. He elaborates on the wisdom of nature, and its capacity to self-regulate. When there would be no people in the pasture, it will turn into a forest again. He says you don't have to wait fourty or fifty years for life to regain its space. Species will return, and it will happen very quickly. Man's existence is insignificant, and everything will regain its space.

This does not mean there will not be fires again. He says with confidence that in some places the dehesa will collapse, and in others the climate will return to a forest very quickly. There will be events that we will not understand. He emphasises that if we want to a part of the future of the dehesa, we can not be outside the ecosystem, but have to be inside. NOt at the top of the pyramid, thinking that he is the dominator or the creator, but inside and shee himself as a form or part of the dehesa. Mankinds have seen themselves as part of it for thousands of years, and this has worked.

However, he seems worried and angry when he talks about his neighbour that overexploited the land for years. He is not moving his cows and became rich by increasing the number of cows and receiving more incentives, and so the cycle repeats. But now he sees that his soil no longer produces food. There are no flowers, there are no bees, no beehives. Biodiversity decreased: his land could not take it anymore.

Another neighbour noticed there was no regrowth of holm oaks on his land. His land was very much like a savannah, very homogeneous. He did not have any cows any more, it was all empty. His solution was to buy and spread monogastic pig poo around the farm. *"the bottom line is that these people are not managing".*

“nature has shown that we can’t dominate”



livestock system - trees in livestock system - livestock system in woodland - woodland

“Change is necessary”

How do you see the future when less people are missing?
“The problem is not the future, the problem is today. If the future consists of the consequences of not doing good things today, then what can we do today so that the future doesn’t happen?”

He looked very worried when he was telling the last two years it was already 32 degrees in February, and they started watering the orchard. This year it is another world: about 20 degrees, and lots of rain: *“for us it’s great”*. They are very lucky. I, as a traveler, am not. But that’s not important.

What is needed to be done is clear for him. No one is using incentives *“to make a change and to increase water efficiency, to make more ponds, to make new farm designs, water catchment, or forest. Nobody is going to do that. […]. Nobody is going to change anything to improve anything. If there is no help behind that [incentives] to tell you you have to do things better for the next time there is a drought, which there will be.”*
As I understood, people are given money, but there is no proper information about what farmers have to do for the future. It is not accompanied by a package of training and information. People receive money to maintain the dehesa, but they are not doing it correct. He talks about renewal in the forest, and how it is key. *“you will go through hecatres and hectares of dehesa forest, but there are no small holm oaks growing, because there are many animals there all the time, they dont’take their animals out.”*

Moreover, in his opinion the 2030 agenda and the Sustainable Development Goals do not give much real vision. He is in favour of them, but not of how it is being implemented.

“[…] it is implemented through obligation, and not through training or information or knowlegde. […] People have to understand that it is harmful to have dairy cows, or to have stalls ,or that the models we have for agriculture or livestock farming are not [sustainable].”

He also mentions trade protection, and that people are fighting for the protection of national trade, against trade from the European Union and Morocco. This was there before. Spain is losing right now. He is afraid new measures are not going to be focused on the environment. *"Above all, all the measures are going to be economic".*

Generational replacement and the economy

The economy here is precarious for my father, it was precarious for my grandfather, it was precarious for me, and it is precarious for my children. They are staying here. It's going to be precarious, but because we only see price, we don't see value. The value of my life is priceless.

A couple of months ago, they said on the radio, in 2030 in Spain about 200.000 ranchers, farmers, and small farmers are going to dissapear as there is no generational replacement. That does not mean anything will happen, as instead of one person with five hectares one person will own 500 hectares. These will probably be owned by multinationals. There will also be big management companies with 25.000 hectares, and everyone will work for them. It will become a pyramidal business model, with less people in the middle. There are no longer going to be owners, there are going to be workers. Someone will tell you, now you produce this. It will be less free. When there is no generational changeover, in a few years, there will be an imbalance and we are going to suffer later on. He does not see a solution for the fact people are leaving their farms behind. But, he also says the future does not depend on one person, or one generation.

Traditions in the future

"maintaining these stone walls. But for me it's a hobby. For me it's an ancient craft. For me it's a source of pride."





Determining the capacity and willingness

with a survey and nineteen responses - all questions and answers can be found in the appendix.

"traditional markets"



of people to restore the land

What traditional practices or customs do you practice?

"respect for the environment"



"routes through the countryside"

"visits of natural and historical sites"

Heritage and local traditions are important!

yes, "very important" - 11
"important" - 6

Do you feel connected to the landscape?



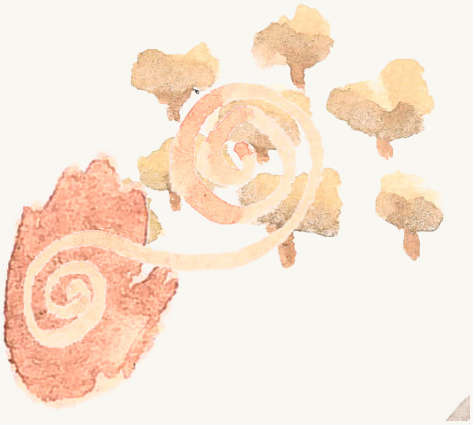
Do you think the landscape reflects the values and history of the community?

/ It does reflect them. The landscape we have is the result of the treatment received by our ance / Yes, it is shaped by the community / Yes, the landscape says a lot. Everything if it is well cared for / Yes, in every way / Yes, in everything / Yes, in how we take care of it / Yes, with respect for the environment and resilience to climate change / Yes, in the sense of preserving the work of o forefathers / Yes, we are a community with a lot of history / Yes. We have tried to take care of ou countryside / Yes, because Extremadura is unique/ Yes, because without this landscape we wou like a city and that makes us different /

More in the past than in the present /

Which aspects of the landscape do you value most?

trees / care / services and values







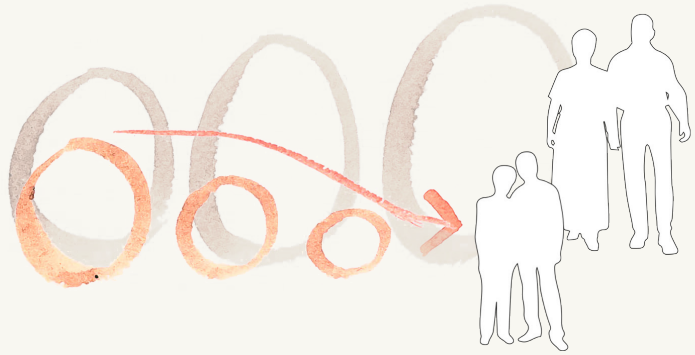
estors

ur
ur
ld be

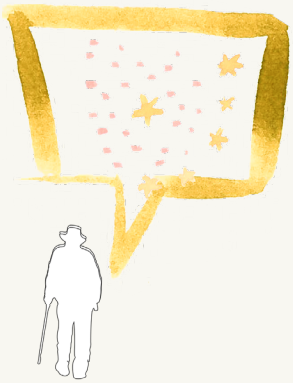
I don't know half-heartedly / Not in its totality. It could be improved /

changes in the community

All answers are related to the loss of inhabitants, the lack of generational renewal, ageing of population, lack of future for the youth, abandonment of livestock and agricultural activites, and the poor preservation of all this.



"Ageing of the population. Lack of generational renewal due to such environmental restrictions and the sucking in of policies and administration"



"People now prefer not to live in rural areas"

What do you think is the main cause of change in the community over the last decade?

Social factors	10
Political factors	10
Economic factors	9
Environmental factors	7
Other	

"Failure to combine respect for the environment with the progress of our community"

"They should help the surrounding villages more and encourage more tourism"

population decrease and what it means



disappearance of...

a lifestyle

young people

embezzlement

job opportunities

population

traditions



Are you concerned about the future?

Yes

Yes

Yes

Ofcourse

Yes

I am concerned mainly for future generations

Yes

Yes, especially for my children

Yes

Yes, a lot

yes

Yes

Yes, the field is ageing and becoming less and less profitable. Costs are rising and sales are stagnating

A little. If we take into account the political objective and agenda that the “wiping out” of the rural population.

In your opinion, what are the main challenges for this community?

Economic instability: 11

Population decline: 10

Environmental degradation: 5

What changes would you like to see in this area?

Conservation and protection
“remove unnecessary and unnatural protection measures that impede the development of the community”
“that respect for the environment should not be incompatible with the future of the populations of protected natural areas”
“balancing the conservation of the natural environment with the economic development of rural communities”
“more plants, more tourism”
“more preservation of the flora and the possibility of pruning cork oaks”
“more investment to maintain customs, traditional livestock farming, encourage young people to stay”

Policy
“environmental sensitivity in policy”
“change of politician and everything will be better”
Employment
“I would like to see more employment initiatives for young people and not to have to leave the municipality”
“Economic activity that respects the natural environment and provides jobs”
“more work for the future”

Commitment
“More commitment from the people to the countryside and more protection from the state”
“clearing the bush”

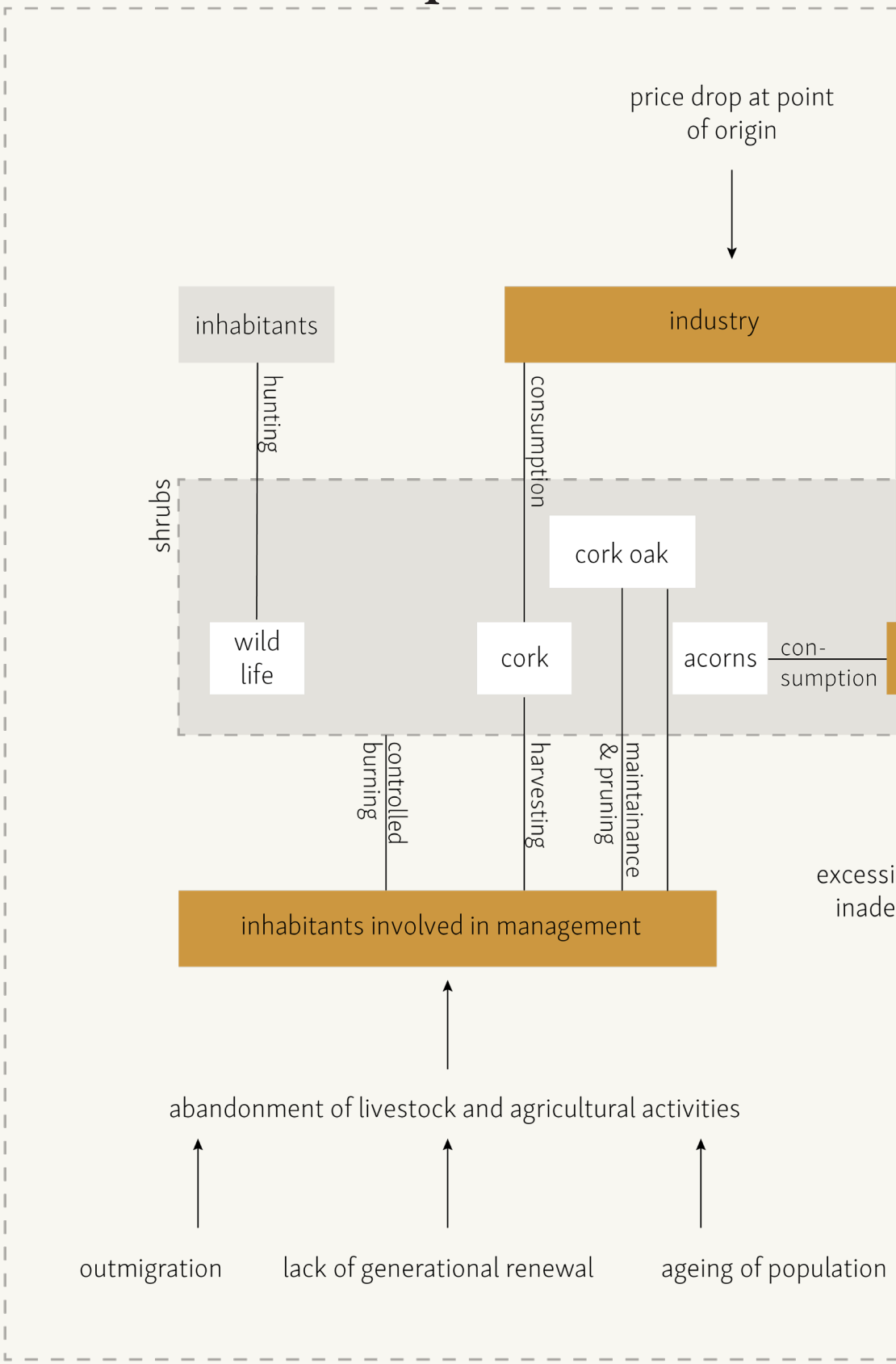


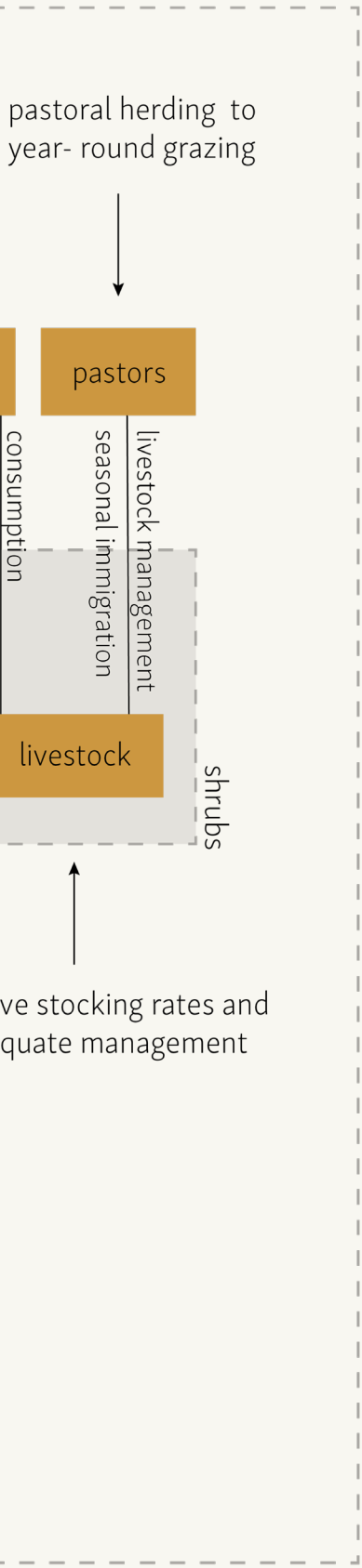
Visual conclusion

Stakeholders are highly motivated to contribute to a transition. people want to revert land degradation processes and care about reverting depopulation.



Validation of the pressures and drivers





lack of social recognition

lack of future for the youth

CAP and other policies

economic profitability decrease

5 Forecast of conditions

Forecasting the future becomes a tool for today's decisions as we explore climate scenarios shaped by current trends.

By analysing aridity, temperature, and precipitation forecasts in two climate scenarios, an image can be formed about the future of the area. Discussing the development and implications of various forecast models, details will be revealed about consequences for the different parts of the ecosystem. Additionally, the chapter will assess the perspectives of various governmental bodies on shaping the future.

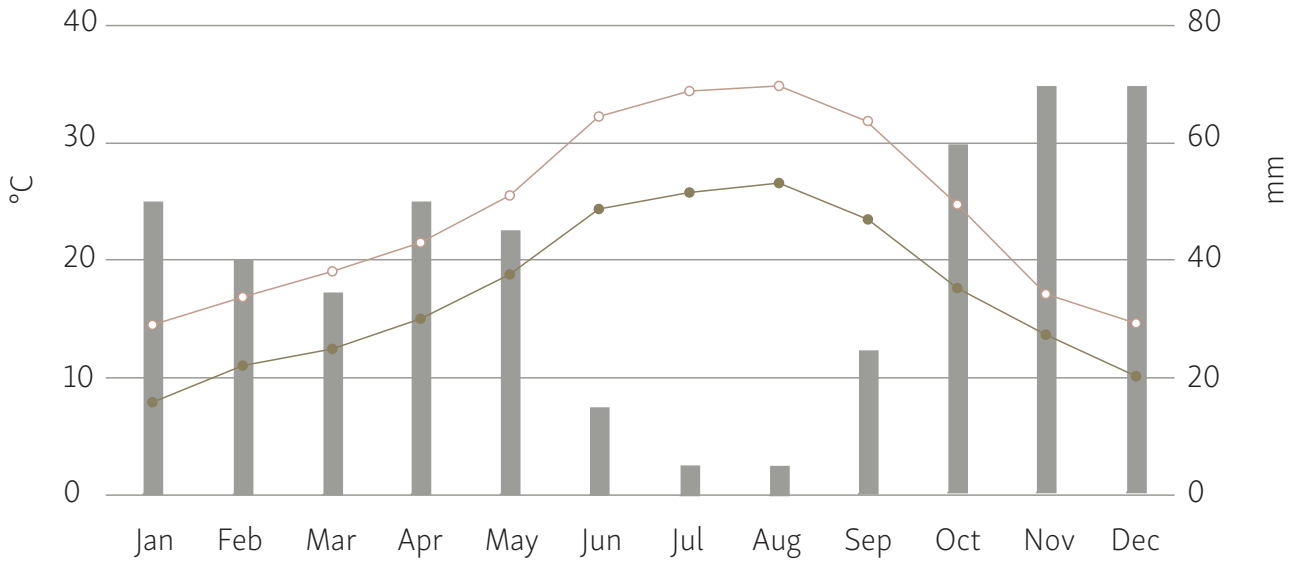
Figure 38. View on the forests and mountains near Monfragüe.

5.1

Climate forecast

		SSP2 4.5	SSP5 8.5
mid term	aridity (2036-2065)	semi-humid	mediterranean
	average temperature (2040-2059)	+1.59 °C	+2.20 °C
	average maximum temperature change (2040-2059)	+1.73 °C	+2.44 °C
	precipitation change (2040-2059)	-16%	-21%
long term	aridity (2066-2095)	mediterranean	mediterranean
	average temperature (2060-2079)	+2.14 °C	+3.65 °C
	average maximum temperature change (2060-2079)	+2.38 °C	+3.99 °C
	precipitation change (2060-2079)	-19%	-30%

A forecast of the conditions starts with the comparison of timespans and climate scenarios. A medium and long term are chosen. As different data is compared, 2036-2059 and 2060-2095 are the compared terms. Moreover, four indicators are compared in two climate scenarios: drivers for climatic conditions. These are used to form an image about the liveability for both humans, animals and ecosystems in the future: not only is the mean surface temperature important, also the maximum temperatures and precipitation plays a crucial role. The aridity is a significant indicator as it is a combination of precipitation, evaporation and water availability. To predict these, two Shared Socioeconomic Pathways (SSP) are used. SSP2 is the middle of



the road scenario, while SSP5 is the fossil-fuelled development or the highway (O'Neill et al., 2014). Subsequently, SSP2-4.5 is a medium scenario, where 4.5 indicates Watts per square meter of Radiative Forcing, resulting from the greenhouse gas emissions in this scenario. SSP5-8.5 is a high scenario.

These are significant alterations of the current climate of Extremadura. This is characterised by a hot summer Mediterranean climate. Seasonal variations are large, especially noticeable in temperature and precipitation levels. In summer, average maximum temperatures can reach up to 34°C, but with little precipitation. In contrast, winter is characterized by remarkably more precipitation. Temperature is hovering around 13°C. Despite this seasonal rainfall, the region receives over 2.800 hours of sunshine annually, which influences its overall aridity.

Figure 39. Current temperature and precipitation in Extremadura. Adapted from World Bank Climate Change Knowledge Portal, 2021; World Data, 2024. Figure 40. Climate forecast for Extremadura in two scenarios. Based on Moral et al., 2023; Climate Change Knowlegde Portal, 2021

5.2

Temperature and precipitation

The two images depicting changes in temperature and precipitation in Extremadura under the SSP5-8.5 and SSP2-4.5 climate scenarios provide crucial insights into the future climatic conditions of the region. These visualizations serve as tools for understanding the potential impacts on both human and ecological systems.

Temperature changes

The first image details both maximum and average air temperatures under both scenarios. Observing both maximum and average temperatures is essential, as the average temperature gives insights in the general warming trends, which can alter habitat suitability and growing seasons. Moreover, the maximum temperatures are often more impactful because they can push both systems to their limits. Peak events like heatwaves have significant health, ecological, and infrastructural impacts. These extremes can stress ecosystems, lead to heat-related illnesses in humans, and affect crop viability.

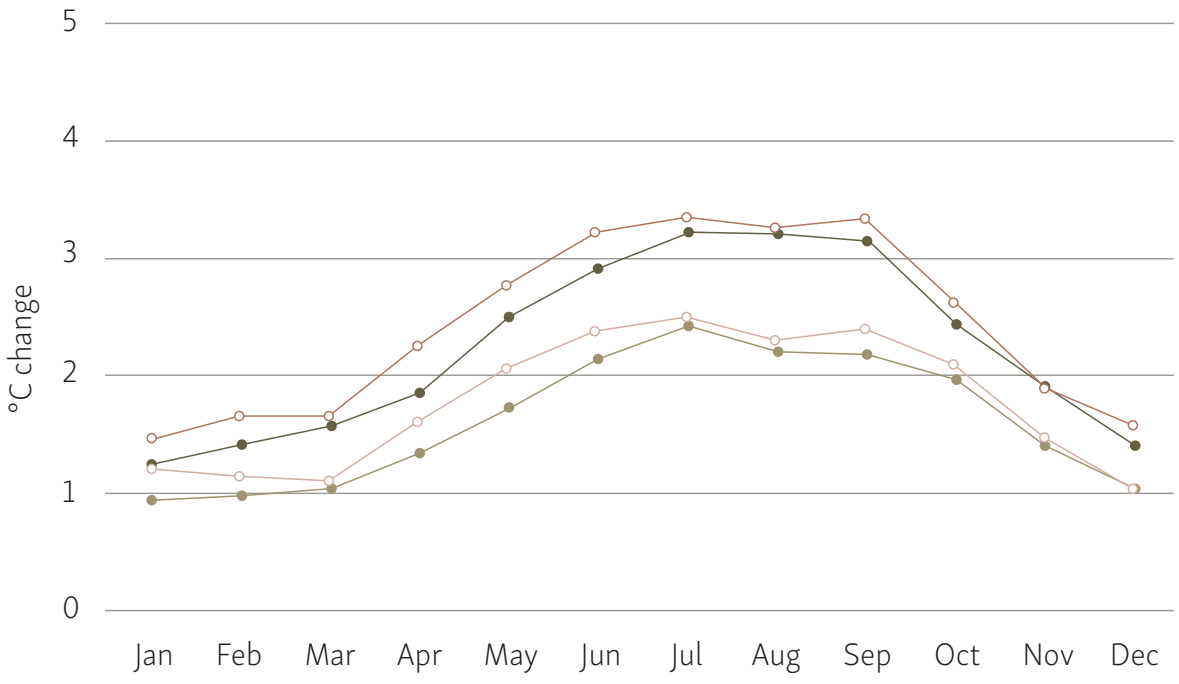


Figure 41. Temperature forecast in two IPCC scenarios. Adapted from World Bank Climate Change Knowledge Portal, 2021

Precipitation changes

The second image illustrates changes in average precipitation and specific shifts in precipitation volumes under both scenarios. A decline in precipitation across all seasons suggests a future where water scarcity becomes a more pressing issue. The decline is particularly problematic for summer months when water deficiencies are already a challenge. This persistent decrease implies that the water shortages experienced in the summer may not be sufficiently mitigated by rainfall in other seasons, potentially leading to prolonged drought conditions. Such changes can disrupt water supply for agriculture, human consumption, and natural ecosystems, further exacerbating the challenges posed by increased temperatures.

For humans, the increase in maximum temperatures and decrease in precipitation will necessitate enhanced heat management and water conservation practices to maintain liveability and productivity. For non-human species and plants, these changes could mean shifts in species distributions, changes in breeding events, and increased vulnerability to diseases and pests.

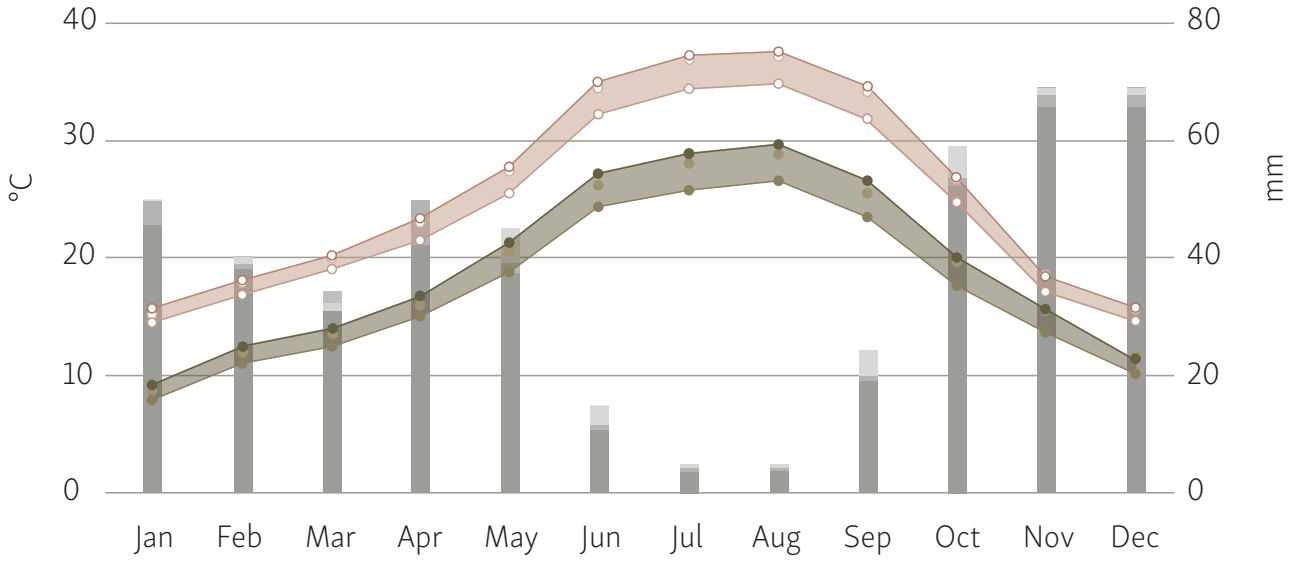


Figure 42. Temperature and precipitation forecast in two scenarios compared to current situation. Adapted from World Bank Climate Change Knowledge Portal, 2021

5.3

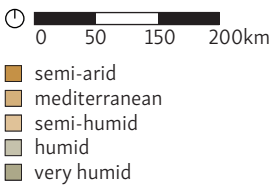
Aridity

The series of five maps depicting the study area provides a narrative of the expected shifts in aridity under two climate scenarios, SSP2-4.5 and SSP5-8.5, over different time periods: 2017, 2036-2065 and 2066-2095. These maps illustrate the transformation of the Park's climate from predominantly humid conditions in 2017 to increasingly Mediterranean and semi-arid conditions in future decades.

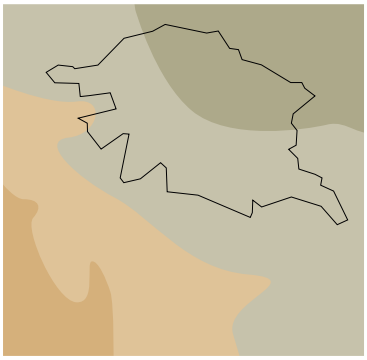
Under the moderate SSP2-4.5 scenario, the transition to a Mediterranean climate is gradual but noticeable, with an increase in aridity expected by mid-century (2036-2065). This shift intensifies by the end of the century (2066-2095), suggesting a significant drying trend that could alter the Park's ecological balance, affecting water availability, vegetation types and biodiversity.

The more extreme SSP5-8.5 scenario presents a stark contrast, with a rapid and severe increase in aridity. Especially the area within the national park will experience more drought. By 2036-2065, the area begins to experience conditions approaching semi-aridity, which escalate further by 2066-2095. This change poses a serious threat to the ecological health of the area, potentially leading to species loss, changes in habitat structure, and increased vulnerability to wildfire and drought.

These projected changes have profound implications for conservation strategies and management practices within the area and Monfragüe National Park.



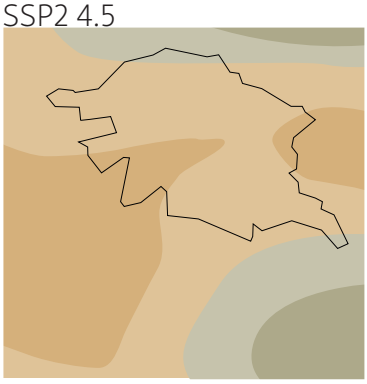
2017

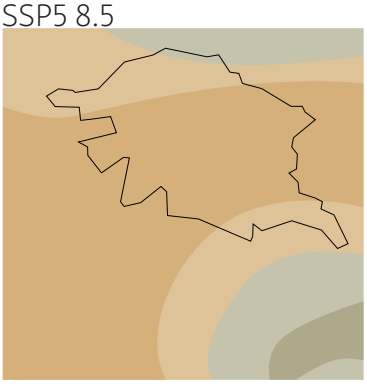


SSP2 4.5

SSP5 8.5

2036-2065

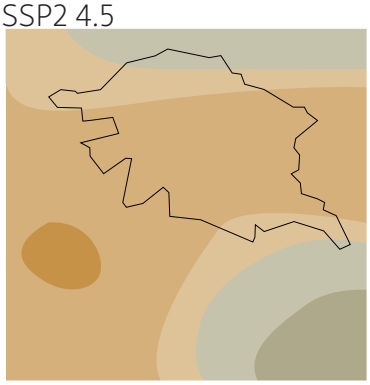




SSP2 4.5

SSP5 8.5

2066–2095



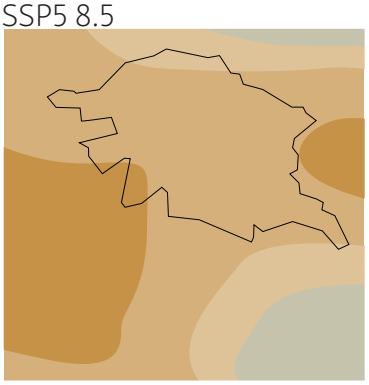


Figure 43. Aridity changes for researched area in Extremadura under different scenarios and time periods. Adapted from Moral et al., 2017; Moral et al., 2023

5.4

Degradation of the landscape

The abandonment of the dehesa leads to the emergence of unmanaged scrubland dominated by native species. While the abandonment of land use may initially support rewilding efforts and enhance biodiversity conservation and species recovery, it also poses significant challenges. Shrub encroachment in the Mediterranean ecosystem is closely associated with increased wildfire risk and intensification of drought conditions, posing a direct threat to biodiversity. Conversely, the intensification of pasture use hinders the natural regeneration of oak and cork trees, pushing the ecosystem towards grassland landscapes. This shift leads to a deterioration in soil quality and composition, as documented by Laporta et al. (2021).

The accompanying image illustrates the potential degradation of the land under two different climate scenarios, covering three different landscape types: traditional dehesa, grazed dehesa and forest. Under these scenarios, the traditional dehesa could face severe aridification, leading to a reduction in tree cover and an increase in shrub dominance, increasing the risk of wildfires. The grazed dehesa, subject to intensive grazing, could experience a more rapid decline in biodiversity due to soil depletion and the inability of oak and cork trees to regenerate, transforming these areas into less diverse grasslands. The forested areas, while initially more resilient, could eventually suffer a similar fate if not managed properly, with increased susceptibility to pest outbreaks and fire spread due to drier conditions. If current socio-ecological trends continue unchecked, these landscapes will not only be transformed, but are likely to dry out, burn out and, crucially, face significant challenges in recovery. This potential trajectory underscores the urgent need for adaptive management strategies to mitigate the effects of climate change and conserve these valuable ecosystems.





Figure 44. Development of the landscape under two climate scenarios

Governance

Documents leading the future

	soil conservation
international	Sustainable Development Goals (2016) United Nations Convention to Combat Desertification Strategic Framework 2018-2030 (2018)
European	European Common Agricultural Policy (2023)
national	National Strategy to Combat Desertification Spain (2022) Spanish Forest Strategy EFE 2050 (2022)
regional	Extremadura Spatial Planning Guidelines DOTEX (2015) Extremadura's Integrated Energy and Climate Plan 2021-2030 (2021) Recovery, transition and resilience plan (2023)
local	

The typical framework for these policy documents is a top-down approach: regional strategies are aligned with national visions, which in turn are informed by European ambitions. However, there is an exception in the case of Sites of Community Importance. These sites were initially identified by local communities as areas of ecological

socio-cultural development of rural areas	protection of natural areas
Sustainable Development Goals (2016) UNESCO Medium-Term Strategy for 20220-2029 (2022)	Sustainable Development Goals (2016) United Nations Convention to Combat Desertification Strategic Framework 2018-2030 (2018) Post-2020 Global Biodiversity Framework 2030 (2022)
	Natura 2000 network European Green Deal European Biodiversity Strategy for 2030
Spanish National Rural development plan (2022) National Strategy against Depopulation (2021)	Spanish National Parks Law (2014) Strategic Plan on Natural Heritage and Biodiversity to 2030 (2022) Spanish Forest Strategy EFE 2050 (2022)
Rural Development Programme (RDP) of Extremadura 2014-2022 (2010) Recovery, transition and resilience plan (2023)	Priority action frameworks MAP for Natura 2000 in Extremadura 2021-2027 (2021) Extremadura Forestry Plan (2010) Recovery, transition and resilience plan (2023)
	Sites of Community Importance (LIC)

value. They were then recognized as protected areas at national level and finally incorporated into the wider Natura 2000 network. This process represents a unique case of local initiatives influencing higher level environmental policy, demonstrating the potential of bottom-up approaches to environmental protection.

Figure 45. Overview of governmental documents steering on three topics

5.6

Spatial impact

The spatial impact of climate change can be illustrated through various elements and layers. This map highlights the zones with the highest risks due to their geological, geographical, and natural characteristics.

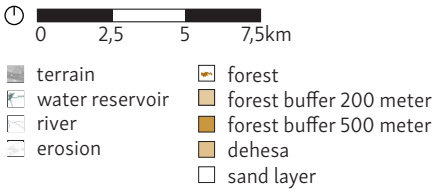
Desertification and erosion

The height and steepness of areas are significant geographical indicators of erosion risk, independent of land management techniques. Therefore, a layer has been added to show erosion correlated with the highest points. Steepness greatly influences the probability of forest fires spreading. As an area becomes steeper, fires spread more easily. This steepness has been overlaid with forest areas. A 500-meter buffer zone has been created around forest areas located on steep terrain, while a 200-meter buffer zone surrounds forests on less steep terrain. These buffer zones represent the areas with the highest immediate risk in all scenarios.

Minimal risks

Soil characteristics positively influence risk through water infiltration. This is determined by the soil's water storage capacity. Sandy soil can retain more water, thereby lowering the risk.





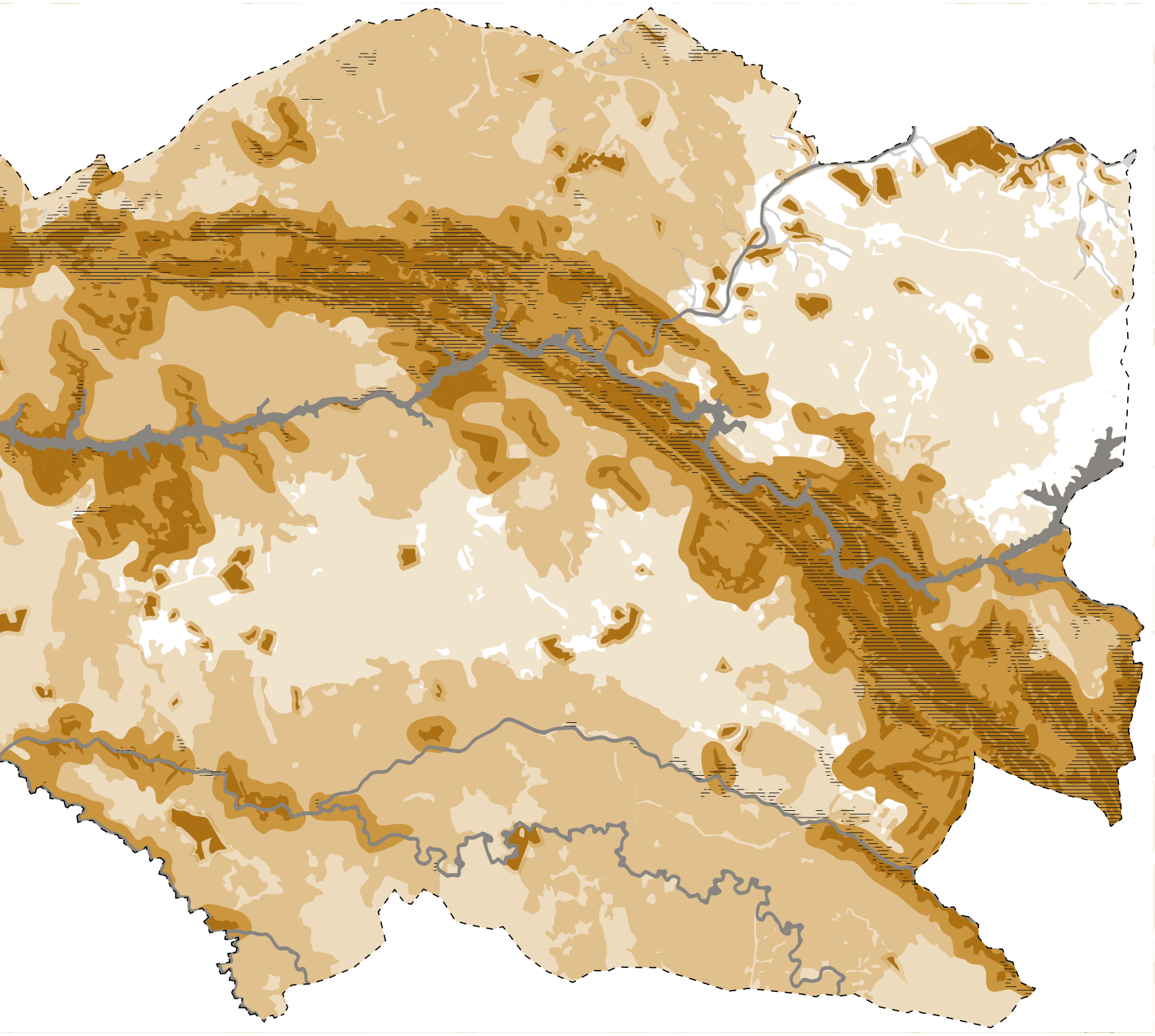


Figure 46. Spatial impact map highlighting areas with high risks. Based on National Inventory of Soil Erosion, 2022; Copernicus, 2018

6 Towards co-evolution

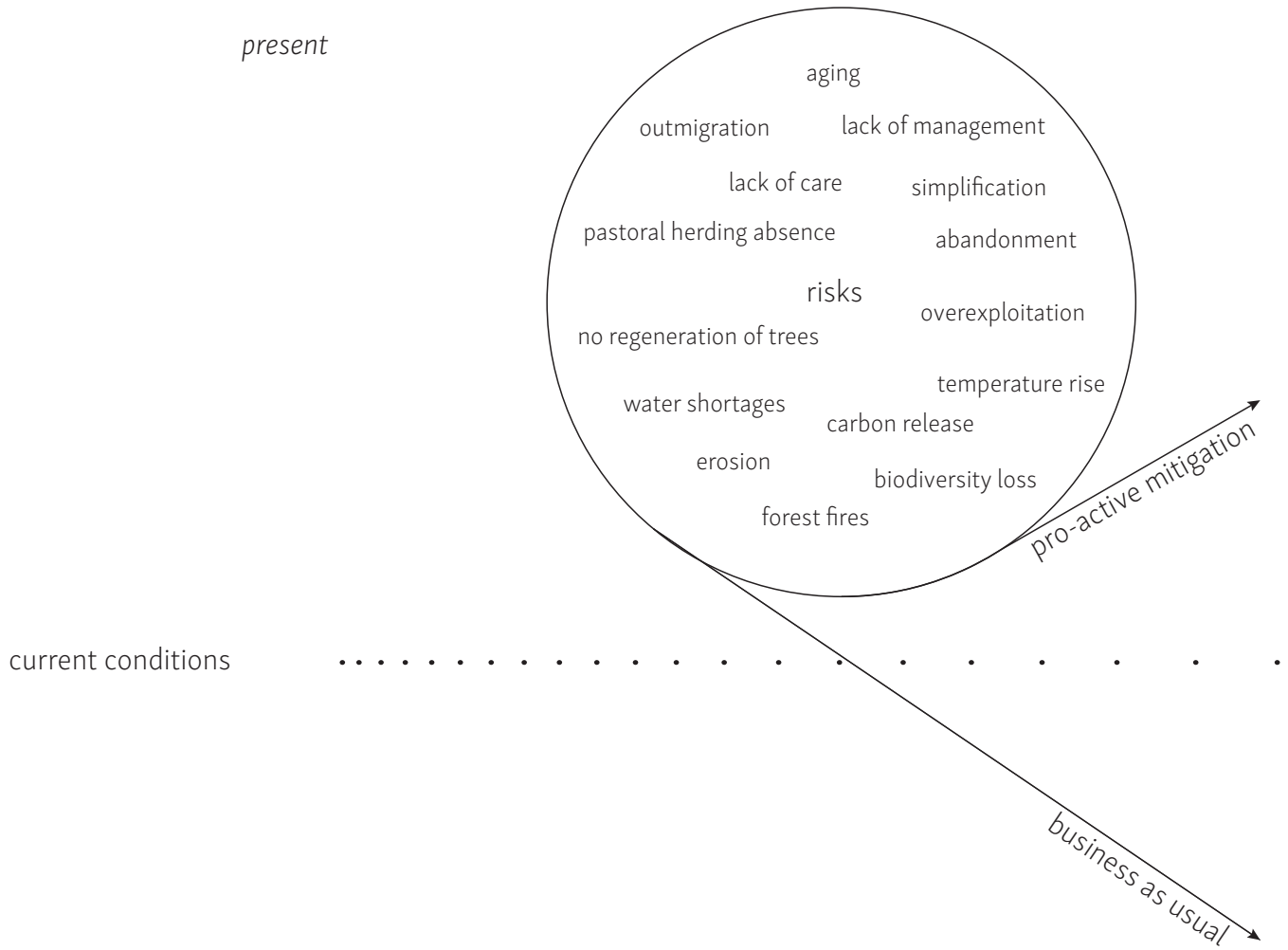
Finding opportunities, discovering synergies and developing an adaptive strategy are central goals in this chapter.

This chapter, focused on design, explores potential transformations of the landscape under projected conditions. It will provide a vision of what might occur when regenerative actions are implemented, guided by relevant governmental policies. Within location-specific opportunities and risks synergies will be identified. This method aims to harmonize various elements to optimise landscape strategies and management.

Figure 47. Historical dehesa around Trujillo.

6.1.1

Management towards a desired future



To achieve a preferable future, we must acknowledge that solving every individual risk is not feasible. Instead, we need to find synergies and mitigate risks by enhancing our coping and adaptive capacities. The complex structures have been mapped, and both short- and long-term risks have been unraveled. The next step is to define proactive mitigation strategies and to set out a path towards a desirable future.

future

holistic management

$$\text{risk} = \frac{\text{hazard x exposure x vulnerability} \quad - \quad (\text{pro-active mitigation} + \text{hazard} * \text{synergies})}{\text{coping capacity} + \text{adaptive capacity}}$$

desired future

undesirable future

short term disaster risk management

$$\text{risk} = \frac{\text{hazard x exposure x vulnerability}}{\text{coping capacity}}$$

Figure 48. Pathway from short term disaster risk management towards holistic management.

Finding synergies in a system of care

6.1.2

The dehesa, an inheritance for present and future generations, needs to be protected and managed for present and future generations. The current dehesa dilemma requires innovative approaches to increase agricultural profitability without damaging the environment, promoting good agricultural practices (Luisa De Lázaro & González González, 2015).

As figure 49 explains, different actors and actions are part of the strategy that promote different levels of agency over time to counteract desertification and depopulation. This system of care includes considerations tailor made to the needs of the examined region. It is a proposal for place-based and nature-based adaptation and both vertical and horizontal policy recommendations.

Who is involved

Active community participation and involvement of the different stakeholders is needed. Based on the research, the categories are the community, young professionals, grassroot initiatives, and governmental organisations. These groups are all capable of facilitation transformative change in the region.

Decomposition of actions

This system includes both cultural and natural resources and aims to break down actions into different management objectives as biodiversity conservation, ecosystem restoration, sustainable land use and socio-economic benefits, promoting cohabitation.Different components such as vegetation management, water use, livestock grazing, fire prevention, forest management, crop cultivation, and landscape patterns are integral parts of the strategy.



☐ actor
⊟ action

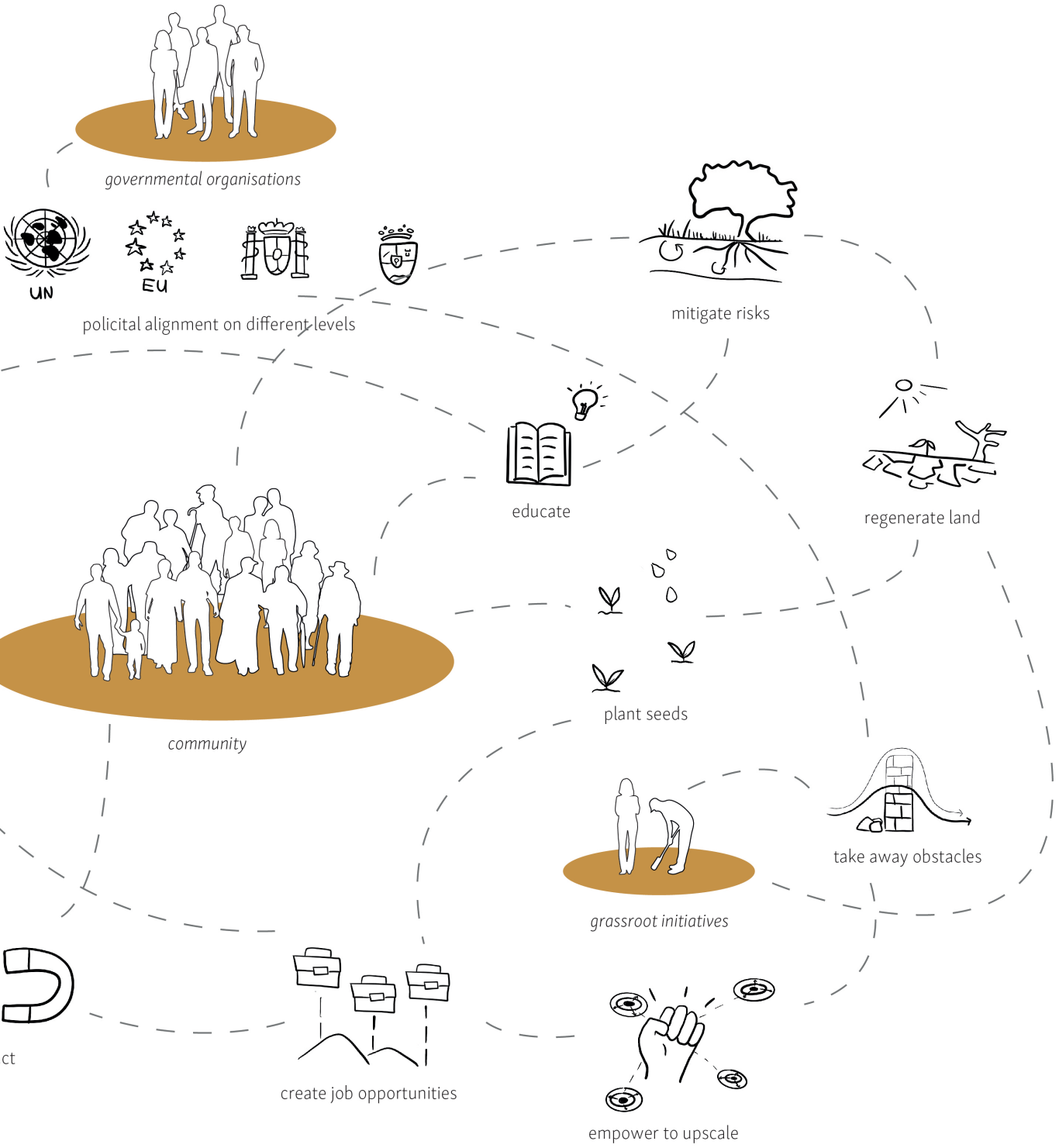


Figure 49. Operalisation of the system of care

6.1.3

Governance

Including nature as a stakehol

Focusing on stakeholders from local to supra-national scales, various sectors can be divided into four categories, as illustrated in figure 50. By including nature, a non-traditional stakeholder, it's importance is being recognized. Conflicts between nature and other sectors often revolve around the clash between economic development and environmental conservation. Economic activities typically pursue short-term gains, putting the long-term sustainability and health of ecosystems at risk. This dynamic is visible from the numerous conflict lines from the private sector to nature. Ecosystem services and biodiversity are especially vulnerable when the pursuit of economic gains from natural resources disrupts the ecosystem's balance.

These issues primarily arise from differences in time perspectives across stakeholder categories. Nature inherently operates on extended time scales due to its gradual processes, while private and public stakeholders tend to prioritize immediate results. This misalignment of time horizons acts as a catalyst for conflicts but also presents opportunities for resolution: if stakeholders can acknowledge the long-term effects of their visions and actions, sustainable development can be realized.

Civic
C1 Biodiversity NGOs
C2 Rural development NGOs
C3 Agricultural associations
C4 Academic institutions
C5 Community action

Nature
N1 Biodiversity
N2 Ecosystem services
N3 Water bodies
N4 National parks
N5 Nature 2000 areas

Private
P1 Small scale farmers
P2 Large scale farmers
P3 Agricultural cooperatives
P4 Civilians
P5 Business and industry
P6 Multinationals
P7 Tourism sector
P8 Renewable energy companies
P9 Future generations

Public
PU1 United Nations
PU2 European Union
PU3 Spanish Central Government
PU4 Ministry of Ecological Transition and Demographic Challenge
PU5 Ministry of Agriculture, Fisheries and Food
PU6 Hydrographic Confederation
PU7 Autonomous Community Extremadura
PU8 Local municipalities

- - Predominantly conflicting
— Conflict
— Collaboration
- - Predominant coorporation

der in future development

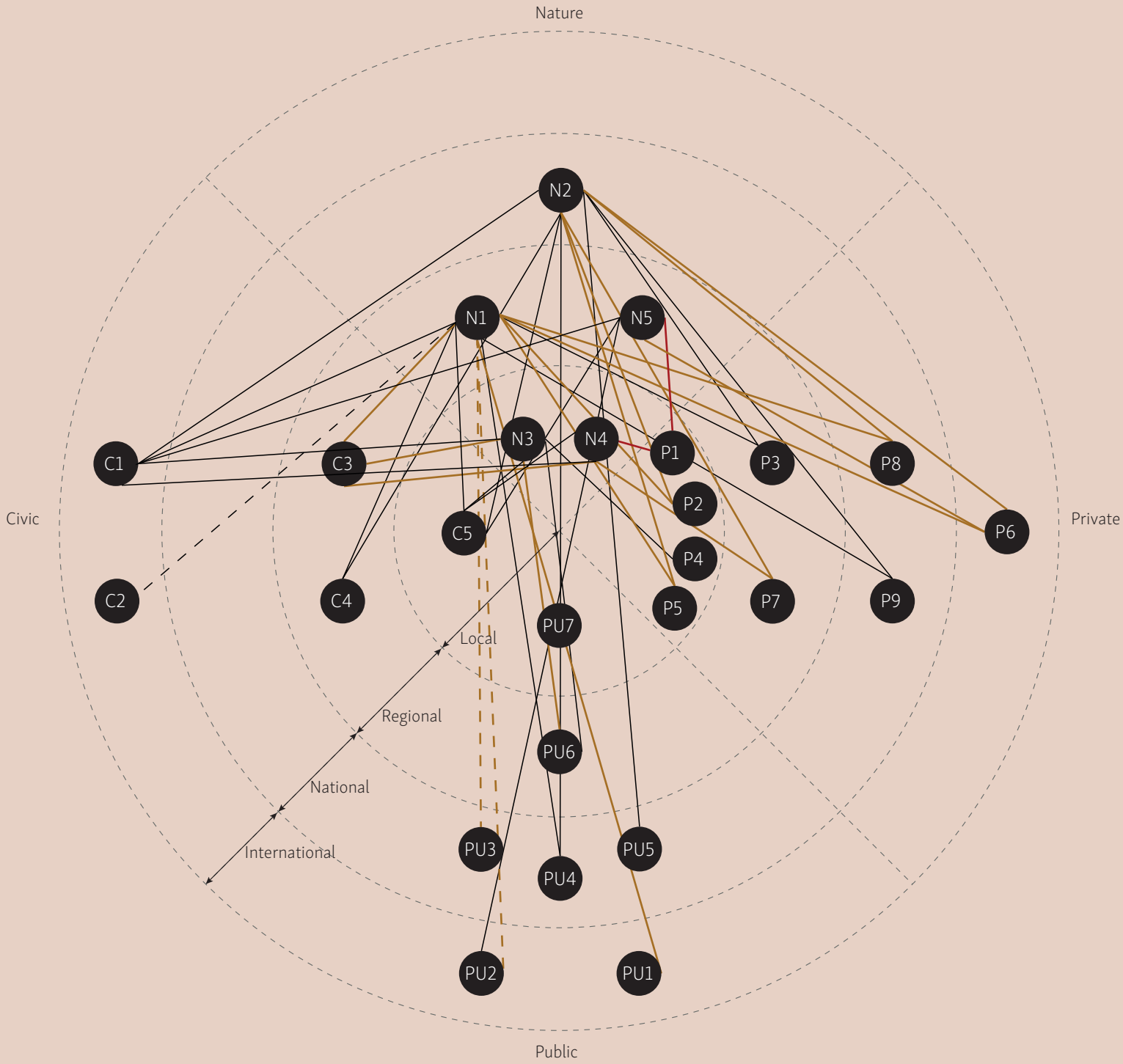
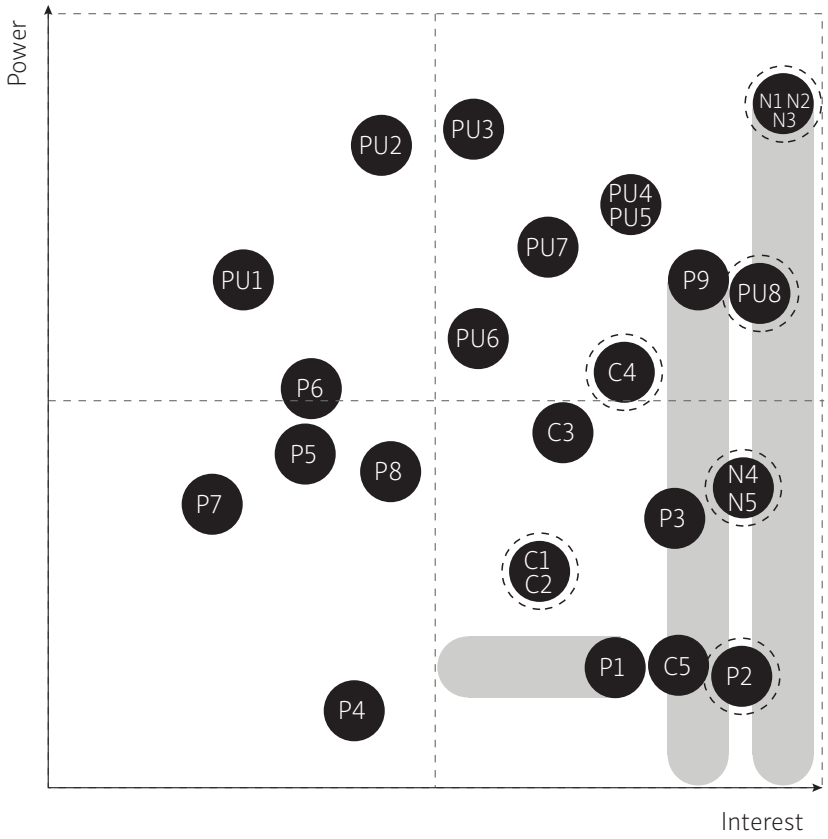


Figure 50. Conflicts and collaboration between nature and other stakeholders

6.1.4

Balancing power and interest



Civic
C1 Biodiversity NGOs
C2 Rural development NGOs
C3 Agricultural associations
C4 Academic and research institutions
C5 Community action

Nature
N1 Biodiversity
N2 Ecosystem services
N3 Water bodies
N4 National parks
N5 Nature 2000 areas

Private
P1 Traditional farmers
P2 Organic farmers
P3 Agricultural cooperatives
P4 Civilians
P5 Business and industry
P6 Multinationals
P7 Tourism sector
P8 Renewable energy companies
P9 Future generations

Public
PU1 United Nations
PU2 European Union
PU3 Spanish Central Government
PU4 Ministry of Ecological Transition and Demographic Challenge
PU5 Ministry of Agriculture, Fisheries and Food
PU6 Hydrographic Confederation
PU7 Autonomous Community Extremadura
PU8 Local municipalities

stakeholder
empowered stakeholder to represent nature
empowered stakeholder

Creating a power-interest matrix offers insights into which stakeholders need to be satisfied, managed, informed, or monitored. This diagram addresses the question, "*How do the power dynamics and level of interest among stakeholders influence their ability to contribute to the implementation of a system of care?*"

Generally, businesses and industries are likely to be opponents, as their activities often conflict significantly with environmental interests and aim at short term profits. Therefore, they should be monitored and potentially managed. Renewable energy companies, while influential, also pose risks to natural systems and thus require careful management. Especially growth should be foreseen and coped with.

The European Union possesses considerable power but tends to operate on a larger scale. Coordination is necessary to ensure that European policies align with regional initiatives. Agricultural associations hold significant power; given that radical changes in land management are required, they have the potential to obstruct implementation.

Redirecting power and interest

It is important to assess whether the power and interest levels of various actors are aligned with the goals of the system of care. As previously mentioned, nature itself requires more support and a stronger voice. This can be achieved by having nature represented by other actors. One approach is through farmers who embrace organic practices, where nature is a central element and thus better protected compared to conventional farming or management by multinationals. Furthermore, non-profit organizations already play this role to a certain extent. Academic and research institutions in Spain have considerable influence in shaping policies and regulations, but they could exert a greater impact on practices than is currently the case.

Convincing traditional farmers to adopt new practices is a key element in the development of the system of care. Their interest in new farming methods might not be high at the moment, as longevity of land is not a major concern.

Figure 51. Power-interest matrix and proposal.

Governance

Integrating ecosystem service

The dehesa landscape, if correctly managed, is a sustainable agricultural system that not only supports biodiversity and carbon sequestration but also aligns with broader environmental and socioeconomic benefits (Laporta et al., 2021). People and farmers that perform sustainable management of the dehesa, and therefore improve ecosystem services, deserve greater financial support.

Promoting ecosystem services through incentives

While traditional assessments of farming systems focus on productivity and are often measured by yields, the new Common Agricultural Policy (CAP) seeks to recognize the multiple values provided by systems such as the Dehesa. The introduction of new eco-systems seeks to incorporate these broader values, by recognising the integrative role of ecosystem services, even though these are not always explicitly named within policies (van Leeuwen et al., 2019).

To further promote the conservation and enhancement of ecosystem services, the concept of assigning a monetary value to these services is growing in importance. This approach can be used to catalyse recognition and encourage investment in conservation and restoration. By quantifying these benefits, nature shifts from being a luxury or an afterthought to being recognized as essential to the well-being of both humans and non-humans (Daily et al., 2009).

Towards flexible schemes

To effectively implement these principles, eco-schemes have to offer flexibility, allowing farmers to choose methods that best suit their specific land typology and local environmental conditions (Jack et al., 2008). This flexibility not only allows for diverse farming practices but also encourages a

wider participation by offering different pathways to meet environmental targets.

Promising instrument

The effectiveness of direct payments for ecosystem services (PES) as policy tools has been demonstrated in various countries, including Costa Rica, China, and Mexico. These programs provide financial incentives to landowners to adopt management practices that directly enhance the quality of ecosystem services (Jack et al., 2008). In southern Spain, particularly in Doñana National Park, stakeholders view PES as a viable economic instrument for the long-term conservation of ecosystem services, highlighting its potential impact on local conservation efforts (Gaitán-Cremaschi et al., 2017).

However, the valuation and implementation of ecosystem services are not without challenges. Daily et al. (2009) emphasize that the adoption of these services often faces significant social and political hurdles, necessitating the development of effective institutions to manage, monitor, and sustain incentive mechanisms. Consistent with these views, Jack et al. (2008) advocate for rigorous evaluation of these incentives to ensure their efficacy and adaptability.

6.1.6

Governance

Aligning to location specific p

To effectively manage the dehesa and enhance its ecosystem services, it is essential to align policies at multiple governmental levels with local actions. This is crucial for supporting sustainable management practices that maintain the ecological and economic values of the dehesa. By tailoring policies to the unique environmental and social context, we can ensure that incentives are both supportive and effective.

European Union

Spanish national government

Autonomous Community Extremadura

research and academic institutions

local municipality

NGOs

Local policy customisation

The new CAP for 2023-2027 introduces eco-schemes that support sustainable farming practices, tailored to meet the diverse agricultural and regional needs of member states. This adaptability is vital for the management of the dehesa. It is recommended to enhance flexibility for regions and local municipalities to more effectively encourage and support farmers through as much as possible tailor-made incentives and benefits. By giving the local governmental bodies more power in allocating measures the practises and goals should be more aligned.

Co-monitoring and feedback loops

Effective incentives for ecosystem management on all scales, require monitoring and feedback loops. The environmental impacts of policies such as the CAP are often not well understood due to a lack of assessments (van Leeuwen et al., 2019). To identify effects of current and new policies, more weight has to be put on the monitoring process, especially at a local scale. Impacts and outcomes are collected through a set of indicators at the regional and national levels. Local farmers contribute solely indirectly, by providing data through agricultural cooperatives or associations.

Therefore, co-monitoring practises can be stimulated to effectively help with collecting feedback on effects on management, and adjust in an early stage. This can provide accurate data, bridging the gap between policy intentions and actual impacts. For this, collaborative partnerships between farmers and research and academic institutions and farmers have to be supported. Farmers can be directly involved in data collection in monitoring when farmers are partnered with field studies and research projects. In return, researchers can provide farmers to new tools for increasing soil health and biodiversity.

ractises and needs

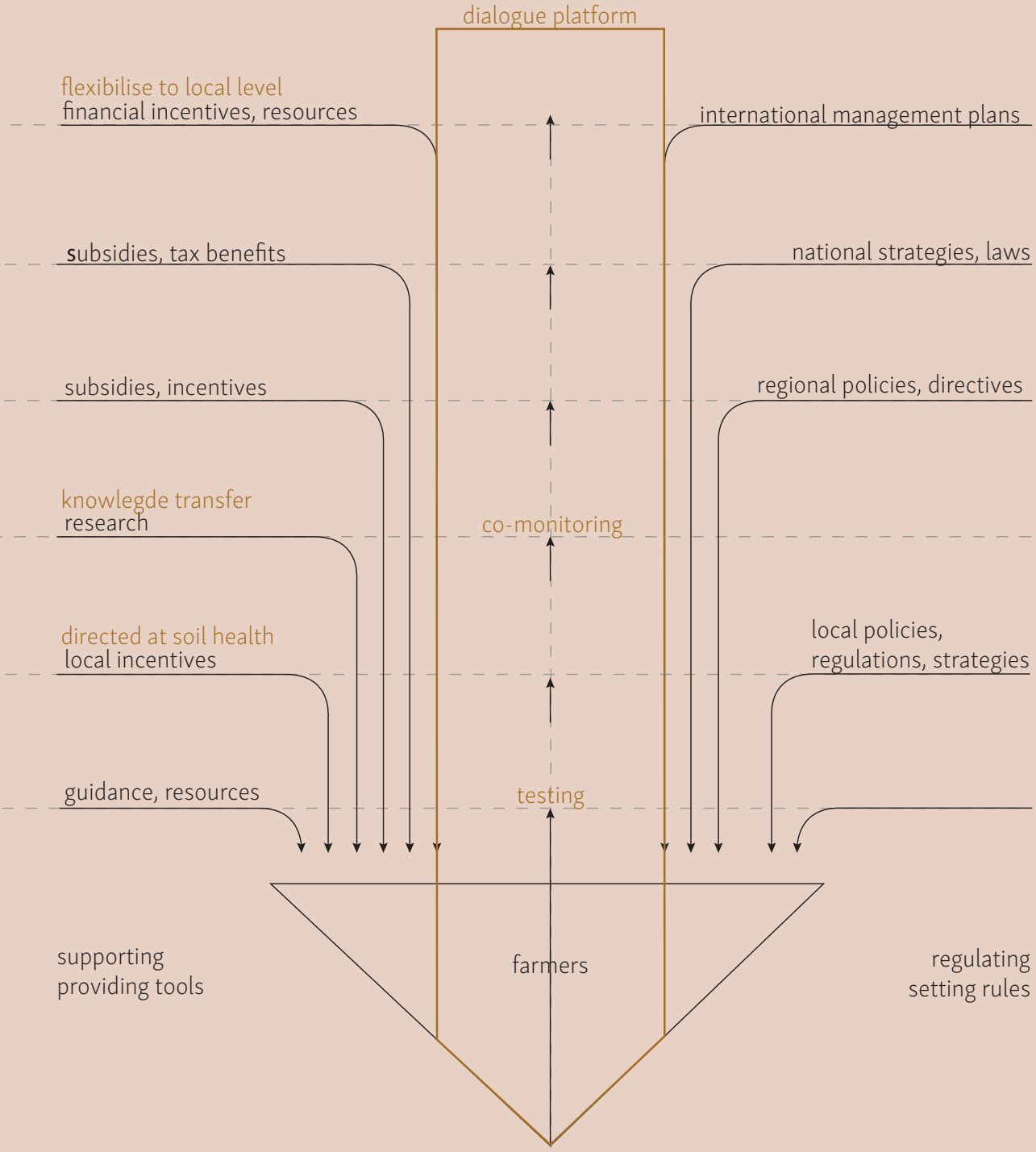


Figure 52 . Levels of governance and their supporting and regulating function regarding farmers

Actors and relations through time

6.1.7

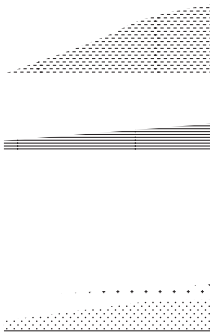
The primary aims of this system are to mitigate impacts, regenerate land and provide care through education and co-monitoring. Targets can be set for the development of these processes to ensure a structured approach to achieving these objectives.

mitigate

educate

regenerate

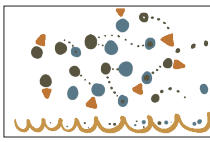
co-monitor



Dimensioning relations

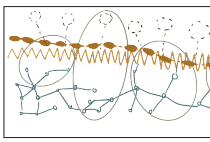
Relationships between key stakeholders are dynamic and evolve over time. This diagram defines the stages of communication and the overall relationships between the actors in four dimensions: knowledge, communication, regulation and economics. Each actor is represented by a colour, with fluid shapes indicating its position and function in relation to other actors.

knowledge



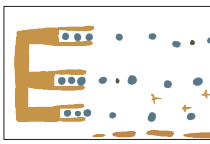
First, knowledge is transferred from grassroots farmers to traditional farmers with the support of knowledge institutions. The government plays a recipient role, aiming to monitor and understand the transfer of knowledge. Over time, the government's role becomes more integrated, facilitating broader knowledge sharing between traditional farmers and other actors.

communication



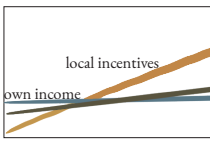
Communication starts with a strong network among traditional rural farmers. Initially, communication with grassroots farmers is mainly through the government, with NGOs helping to connect and build links between these groups. Knowledge institutions communicate with grassroots farmers primarily to gather information. Over time, direct communication among all farmers increases, and research institutes become more central to the communication network.

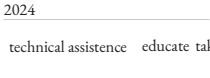
regulation



Regulation begins with preparations for the new CAP, where farmers will be rewarded for maintaining ecosystem services. Meanwhile, local governments reward farmers for implementing mitigation and restoration measures. Regulations are becoming more tailored to local conditions and the measures needed. It is crucial that farmers are rewarded directly, as regeneration efforts are slow to improve their incomes.

economics





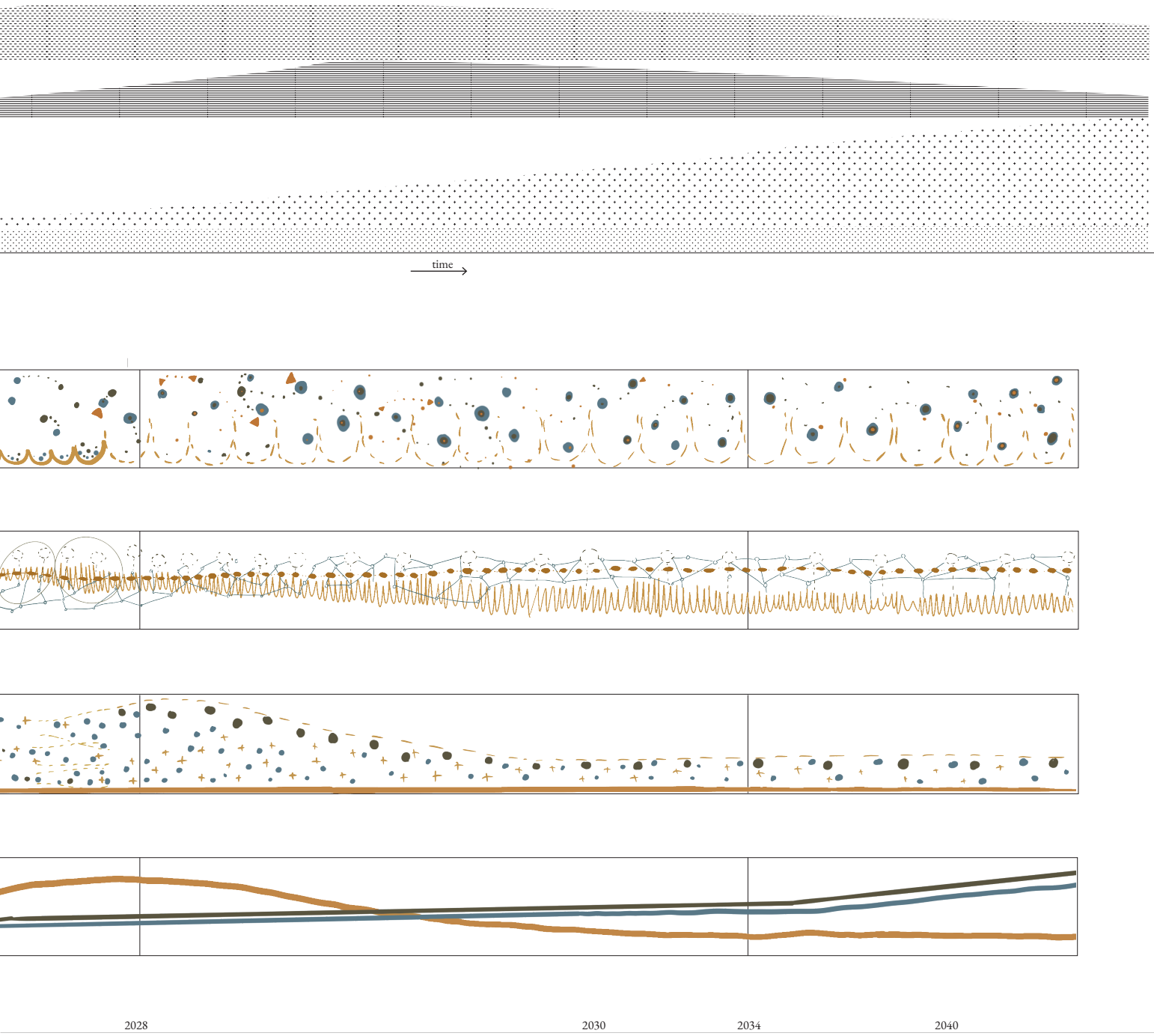


Figure 53. Actors relations in different domains

Sharing knowledge

6.2.1 A platform

As the following image illustrates, it is not a lack of knowledge about taking action that hinders progress. Some farmers are already changing their farming methods. However, most farmers are uncertain about what exactly to do and why it would benefit them. The image depicts a farmer on the verge of giving up and another with extensive knowledge but no audience.

Actors can and need to collaborate

What if they could effectively share this knowledge? Imagine a platform where farmers and stakeholders could exchange information and resources seamlessly. Such a platform would offer concrete, applicable, and tested nature-based solutions, easy-to-understand technical knowledge about microbiology and sustainable land management, and videos highlighting how the land changes over time. It would include translations of complex government documents about incentives, maps of local experiments with nature-based solutions, and expert information presented in an accessible way for traditional farmers.

Flexibilization

This platform would allow knowledgeable farmers to share their expertise, enabling the government to observe practical implementations and assess the effectiveness of their incentives and policies. It can facilitate co-monitoring and help to increase flexibility of incentives towards local specific needs. What would such a platform look like, and how could it transform agricultural collaboration and knowledge sharing?

Figure 54. Problem of different stakeholder and subsequent proposal

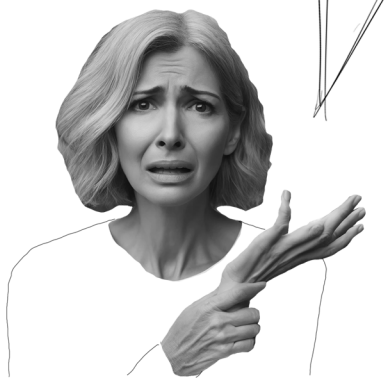
We need to revert desertification now!

Why are you not doing anything?

I could give you support

I DON'T KNOW

what to do if the land gets even drier...



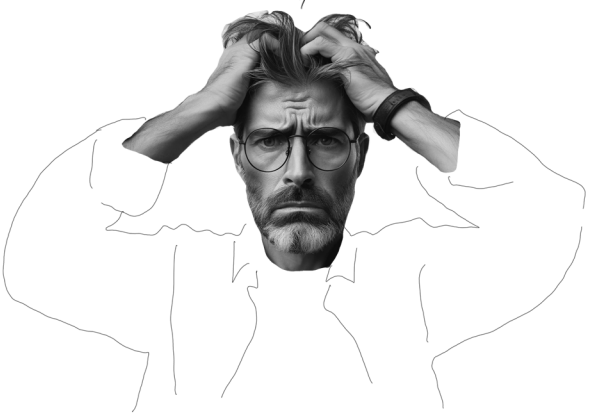


government

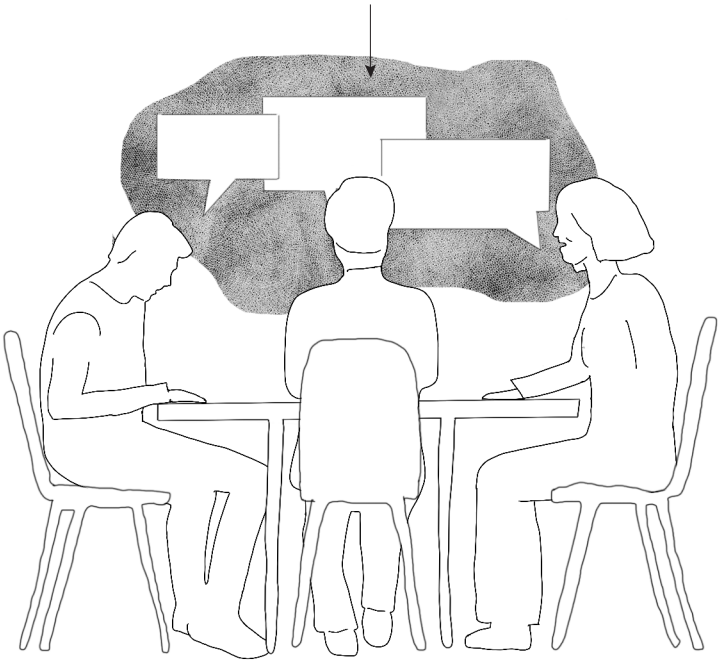
traditional farmers

I want to regenerate the land but everyone thinks I am crazy

Why is no one listening!



grass-root farmers

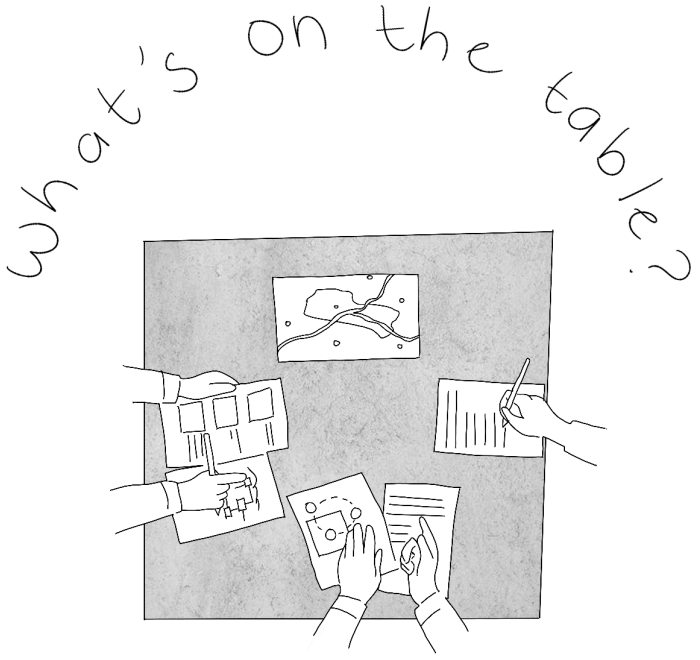


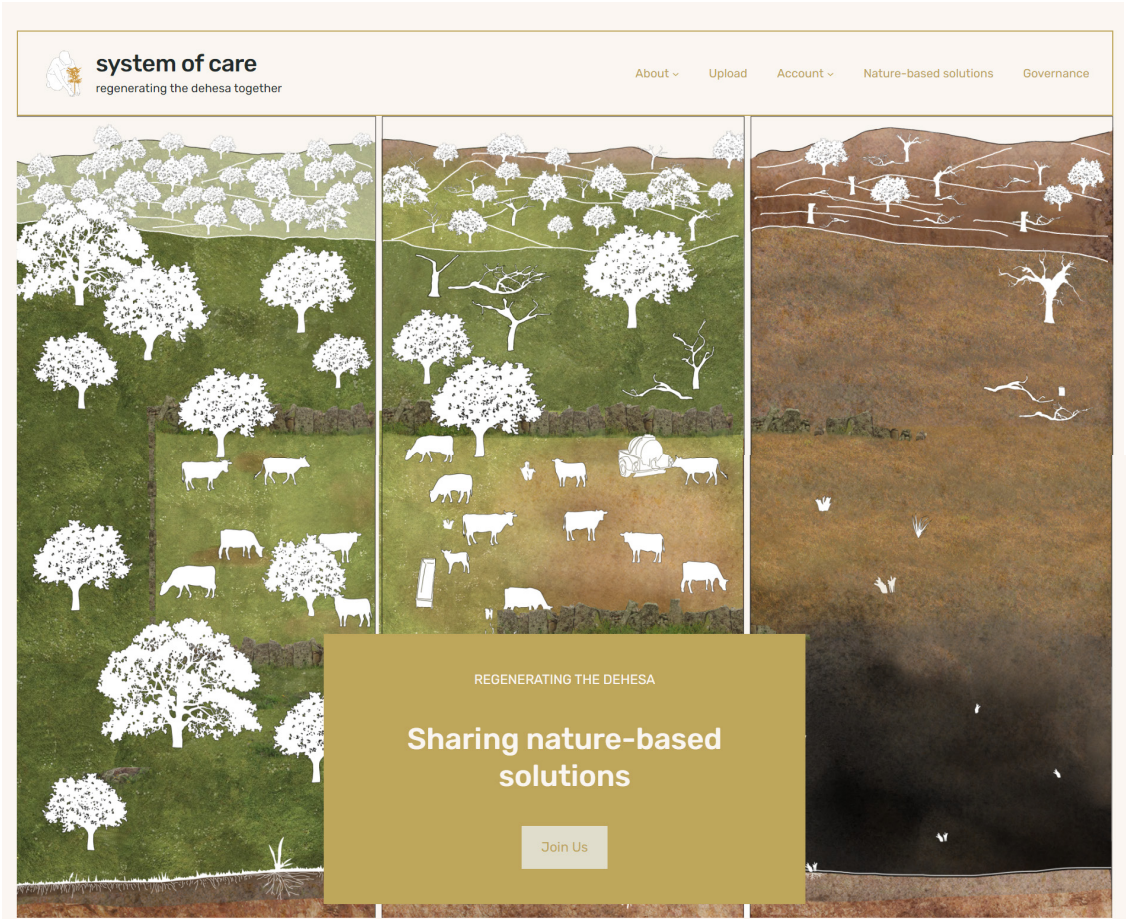
6.2.2

Structuring an online platform

To bring this platform as close as possible to traditional farmers, new farmers moving to the countryside, grassroots farmers eager to try new methods, farmers who have implemented nature-based solutions, research institutions, and policy developers, an online platform presents many opportunities. This platform should facilitate sharing and discovering solutions among farmers. It should allow users to filter solutions based on specific needs, such as water infiltration or soil type.

To achieve this, the platform must have an intuitive and user-friendly interface that encourages exploration, sharing, and engagement. As shown in Image X, the opening page of the platform includes features such as logging into a personal account, where users can view their saved and uploaded solutions. Moreover, there will be a dedicated section for communication between farmers and research institutes. Another page will focus on governance, presenting graphs and information in a straightforward manner.





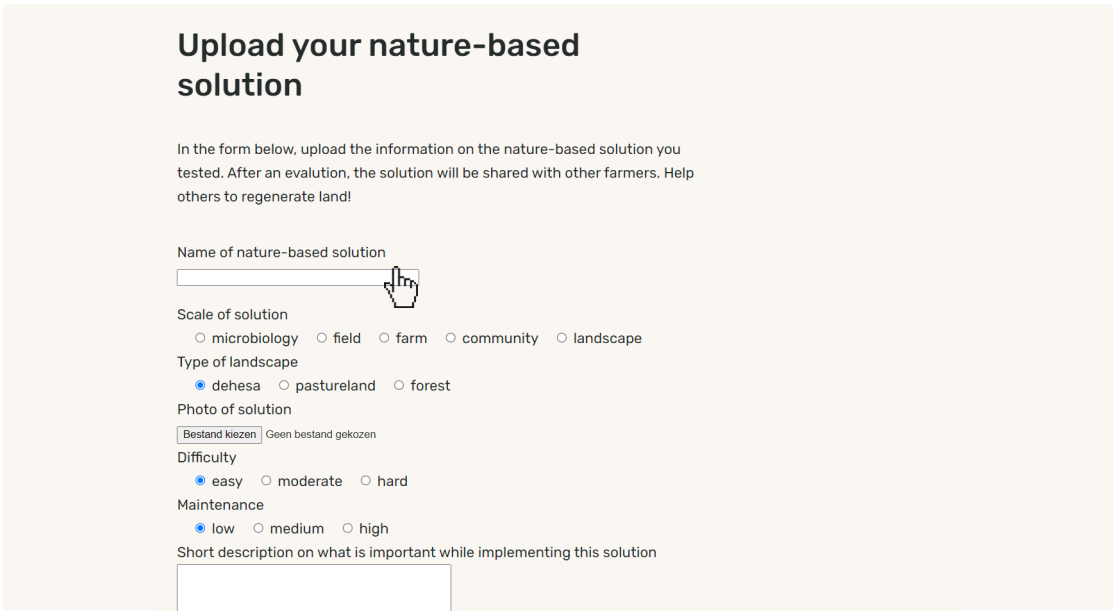


Figure 55. What's on the table?
Figre 56. Previews of the website

Adaptive planning through time

Continuation of the landscape and the social-cultural aspects is achieved through co-evolution, facilitaed by agency and co-monitoring. By using the platform as a guide, the evolution can look as explained in figure 54.

Monitoring (and) action

It is important for all actors to realise when different management is starting to pay off. If the implementation of payment for ecosystem services is succesfull and landscapes are protected and managed differently, when will farmers and land owners start to notice effects of their efforts? This starts with soil health improvement. This improvement can be seen within a few years. Soil health is an indicator and can be measured with simple soil tests. Moreover, GIS and remote sensing can monitor land use with real-time data on land cover and ecosystem conditions, mainly for tracking the environmental impact of landowners activities over large areas. With this information new regulations can be adapted to these new practises. Bonds will be formed and the landscape will be slowly transformed and regenerated.





Figure 57. Alignment of actions and co-monitoring through time

Structuring actions

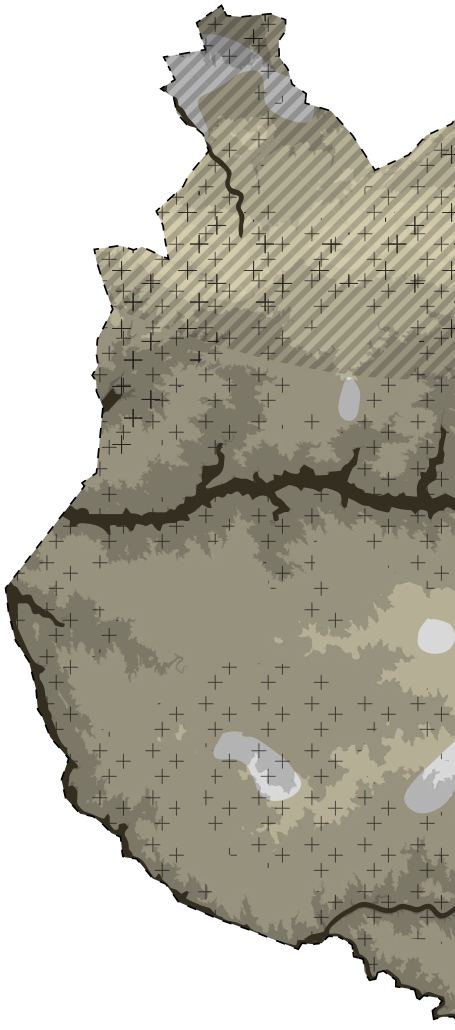
6.3.1

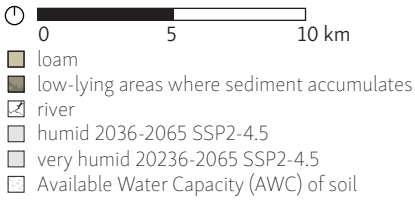
Linking actions and sites

Identifying sites of opportunity allows site-specific interventions to be effectively implemented in the dehesa landscape. Through research through design, detailed maps are created that evaluate the landscape based on opportunities water infiltration, soil structure improvement and erosion control. These maps help to identify zones where nature-based solutions can improve the soil structure and fertility. These individual maps are combined to create a zoning map that categorises landscape areas and types, each requiring specific interventions. Then, detailed explanations of the actions needed to address the needs of each area are created.

Water infiltration and retention

Looking at the framed area and its complexity, not only risks but also opportunities can be found. Regarding the risks that are coming along with the decline of precipitation and higher temperatures, soil humitidy is very important. This especially seen the increasing duration of the dry period in summer. An inventarisation is therefore made to locate places where water could infiltrate and be held. The following map is based on geo-morphological characteristics of the soil, as well as the prospects for the climate on medium term. These factors combined give insights in the key-locations for infiltration. These areas can be further used as a backbone for development.





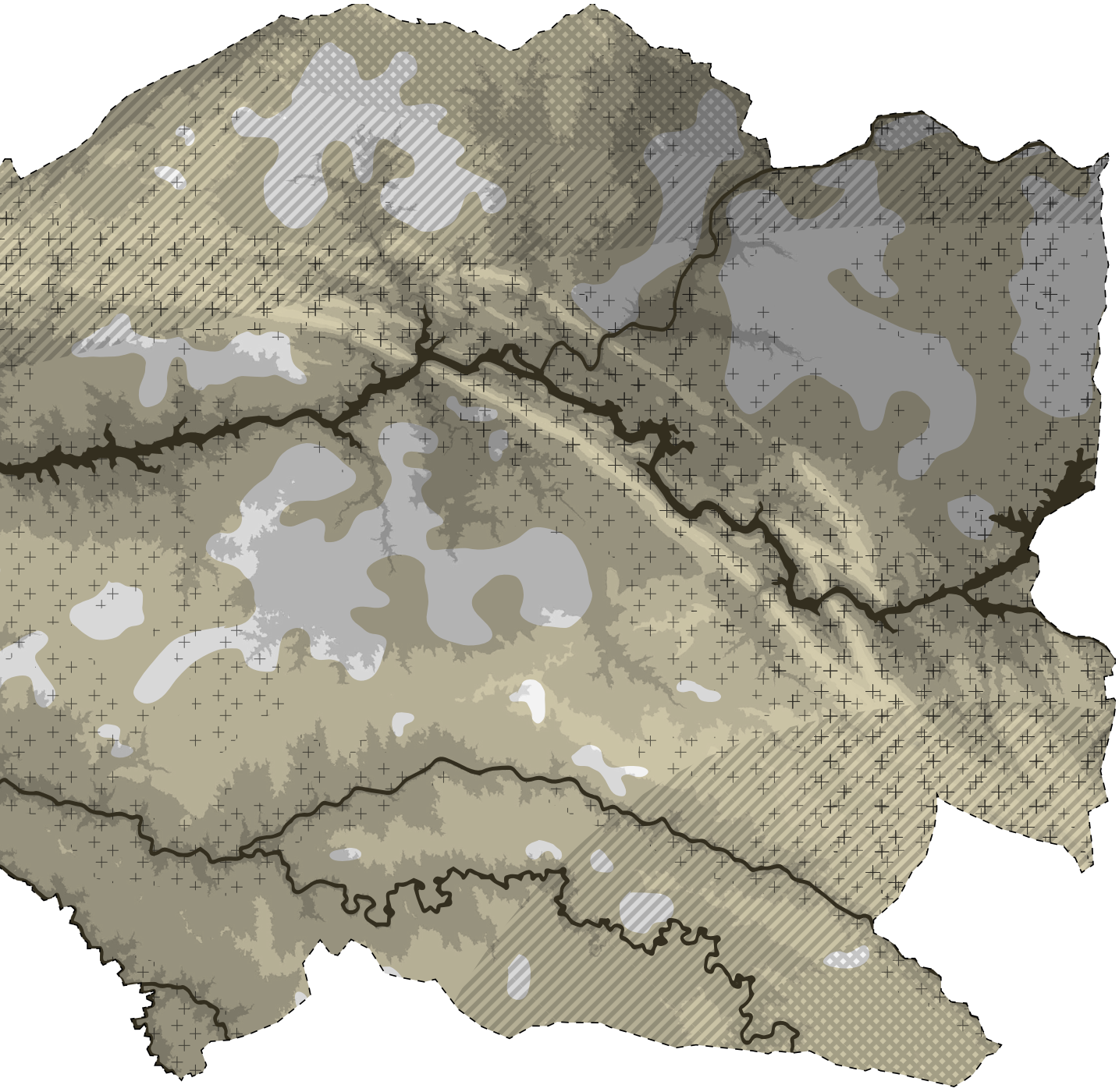


Figure 58. 1:4000000. Opportunities for water infiltration and retention. Based on Ballabio, 2016; Ballabio, 2019; Moral et al., 2016; Moral et al., 2023; Panagos Panos, 2006

Tree regeneration

6.3.2 Low tree densities in the dehesa present both challenges and opportunities. Tree regeneration has long been an issue, but it is crucial for the future of the dehesa (Campos et al., 2010). Trees aged one to five years are particularly scarce. The highest chances for these young trees to survive and mature come from protection against livestock, which can harm them through browsing and trampling. Effective shelter, such as shrubs, can prevent livestock from eating the young plants, provide shade, and help bring water to the surface with their roots.

Ensuring successful tree regeneration is essential for the persistence of the dehesa system. It is urgent to address the most appropriate regeneration techniques from both economic and ecological perspectives. This effort should start with areas that do not meet the minimum thresholds of tree presence and cover. By implementing this strategy, tree survival rates can be enhanced.

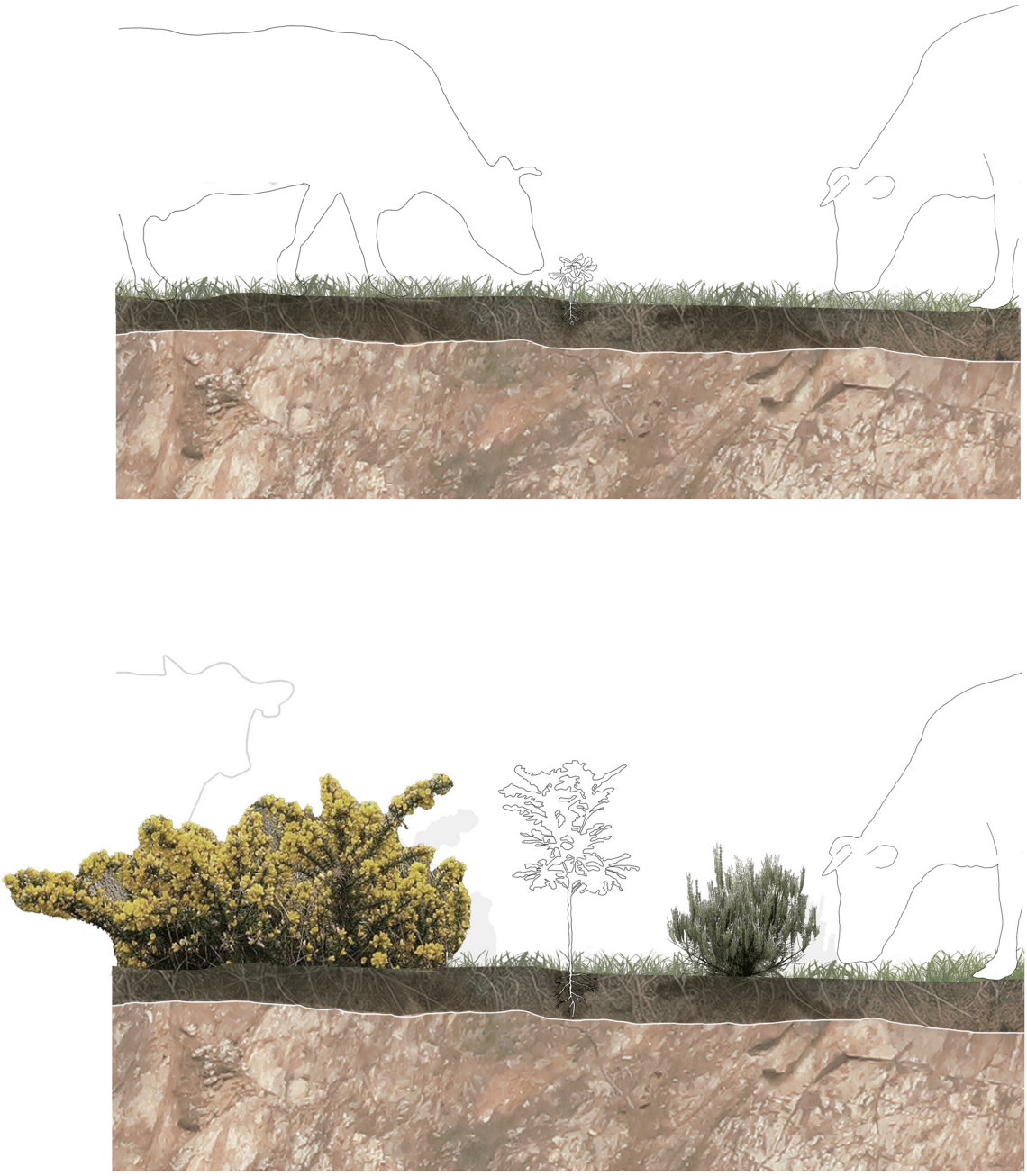


Figure 59. Tree growth in different circumstances

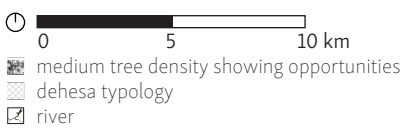
Tree densification opportunities

6.3.3

This map highlights areas of incomplete tree cover and low tree density, providing opportunities for tree densification. The map shows regions within the dehesa that currently have sparse tree cover and are marked as potential areas for tree densification efforts. These areas should be targeted for conservation and restoration initiatives.

Importantly, areas adjacent to forests have been deliberately excluded from this map. These areas are at high risk of wildfire, which poses a significant threat to both existing tree cover and any new planting. By excluding these high-risk areas, the map focuses on safer areas where tree densification can be implemented more effectively and sustainably.





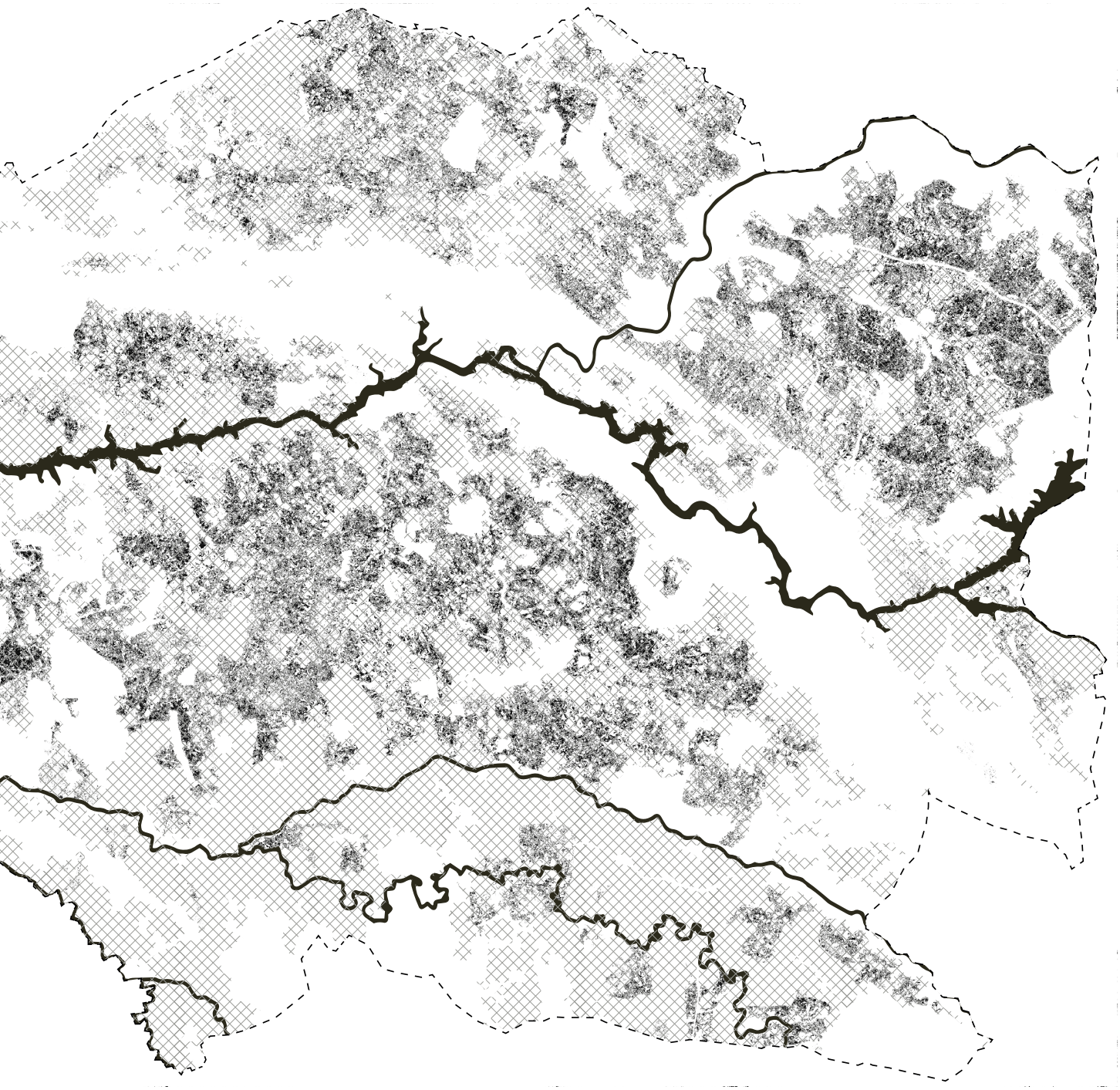


Figure 60. Comparing tree cover density and dehesa patches for regeneration opportunities. 1:4000000. Copernicus, 2018

Transforming the landscape

6.4.1 Regenerative landscape restoration

This map integrates previous layers to define zones requiring tailored approaches for regenerating different dehesa types. In addition to tree densification and water opportunity zones, an extra layer identifies dehesa land near forests, which has a high forest fire risk. For steep areas, a 500-meter offset has been created due to higher fire risks, while a 200-meter offset is used for other forests. By combining these layers, risks and opportunities can be synthesized.

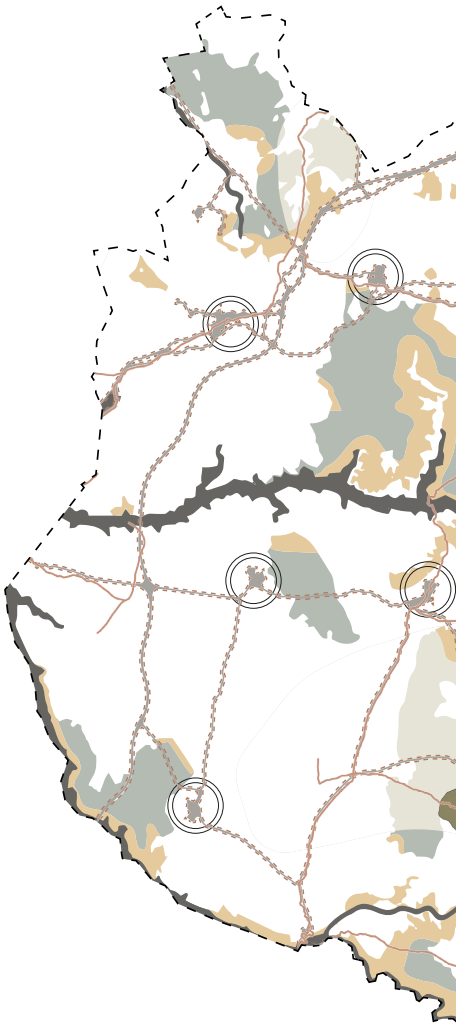


Figure 61. Exploded view

6.4.2

Restoration and risk mediation

By defining different zones, actions can be structured effectively. While land regeneration can occur with specific measures within these zones, additional measures are necessary to prevent the immediate risk of wildfires. Therefore, this map also includes structural elements to prevent forest fires. Roads are used as firebreaks, and buffer zones of low vegetation are created along cattle tracks and roads, which can be burned in a controlled manner during the summer. Villages are highlighted as key areas for action and communication. The dehesas surrounding old towns act as biodiversity conservation hubs.





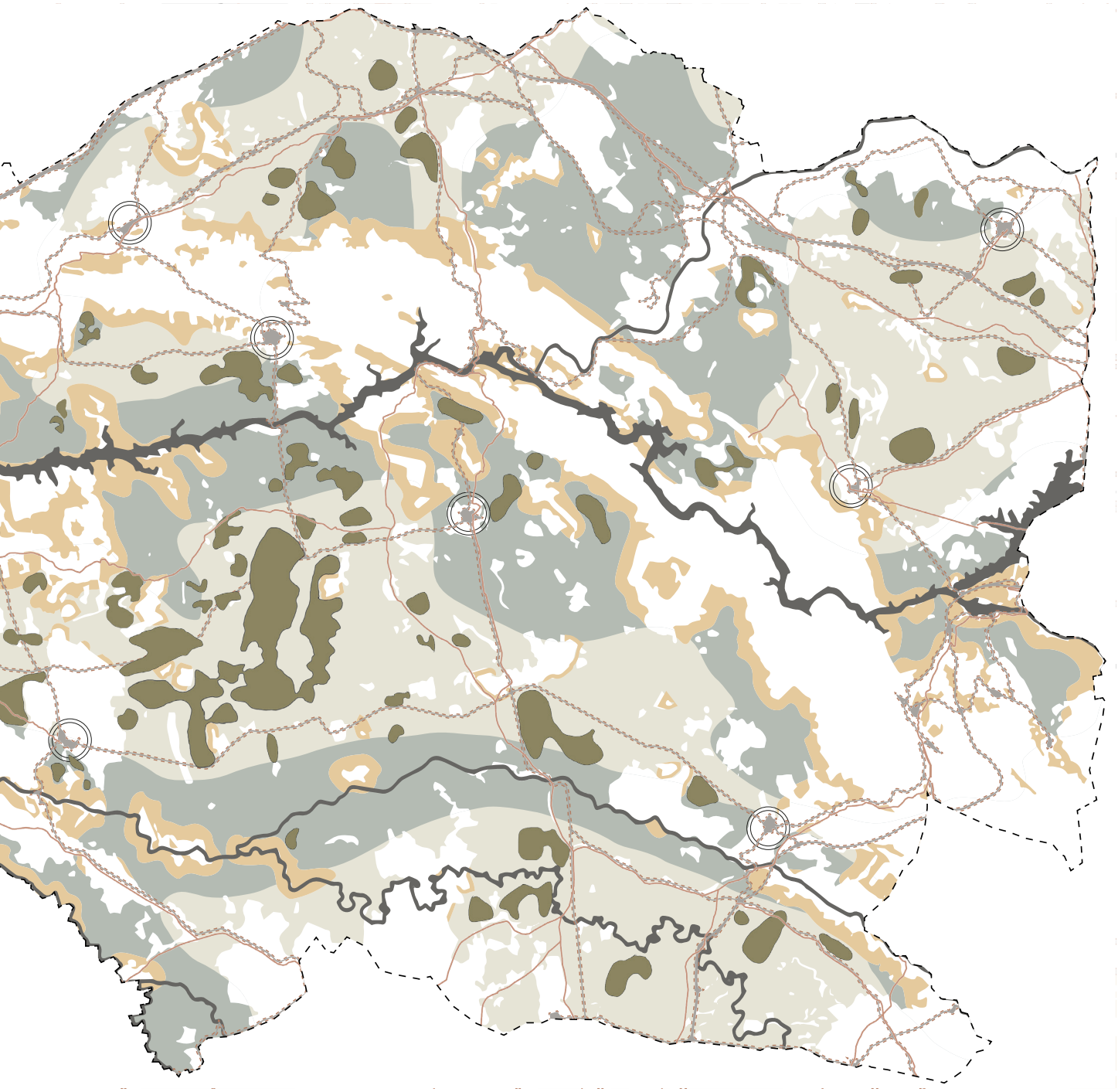


Figure 62. Overview of zones and additional fire prevention, based on CICTEX, n.d.

Governance

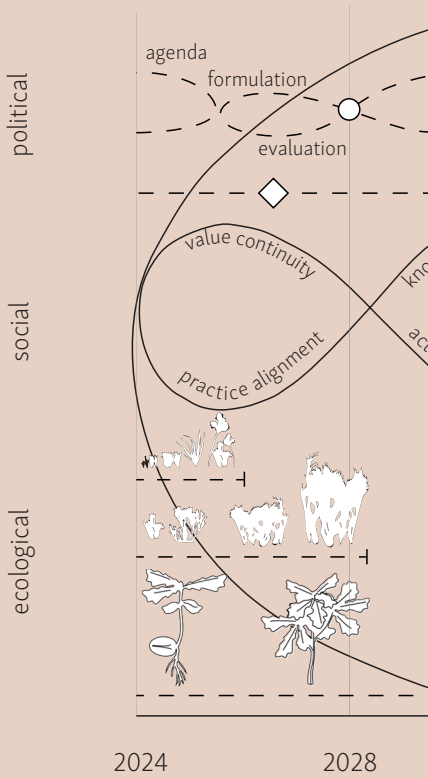
alignment of political decision

6.4.3

Farmers need this financial support to take action as soon as possible to facilitate regeneration. If the new payment for ecosystem services is to be introduced in the CAP in 2028, the agenda and formulation for this needs to start immediately. Such a payment would be based on a financial contribution per square metre of land maintained by the landowner. This is essential given the rapid nature of erosion and the slow nature of soil recovery and replanting. Nature grows at its own pace, especially in arid conditions with limited water, resulting in slow plant growth and recovery of soil health.

Alignment

The following figure shows a timeline using the six-year CAP cycles as key moments. The importance of adaptation can be understood by comparing the environmental, social and political dimensions. Ecological restoration takes time, whereas political cycles are relatively fast, with government elections and a renewed CAP every three and six years. The social dimension, which includes both farmers and politicians, operates on a cycle without a specific timeframe. This adaptation cycle adjusts practices and policies and influences the larger cycle of systemic change. Coping capacity, natural cycles and policy structure and support are all part of this larger continuum.



○ implementation of new CAP
◇ national and local elections

ns, adaptation, and financial pathways

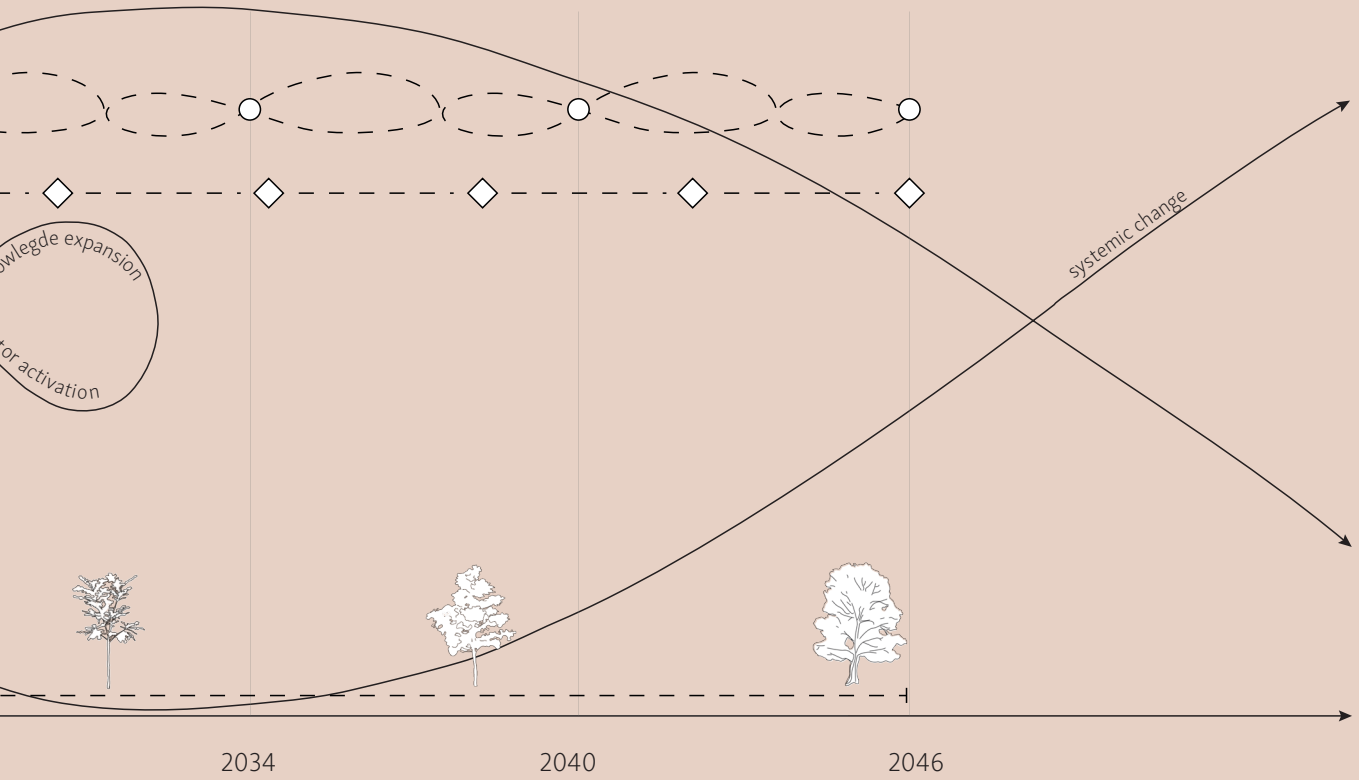
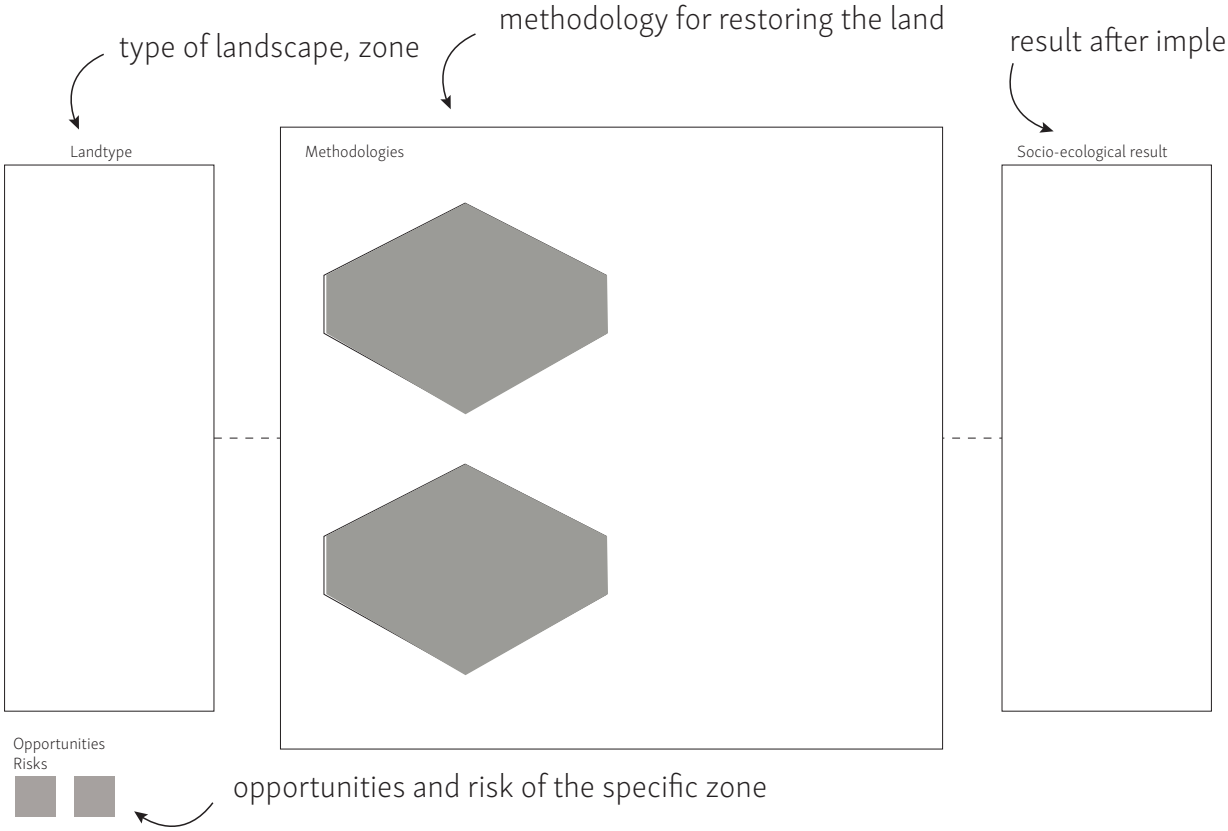


Figure 63. Political, social, and ecological alignment

Landscapes and actions

6.4.4

The results of the zoning map is structured through two templates. The first template provides an overview of the landscape type, applicable methodologies for land restoration, and the socio-ecological outcomes. The second template offers a detailed explanation of the nature-based solutions. By elaborating on the necessary manpower and maintenance, the role of the community in implementing these solutions becomes clear. With a variety of solutions presented, stakeholders can choose the most suitable one for their specific needs.



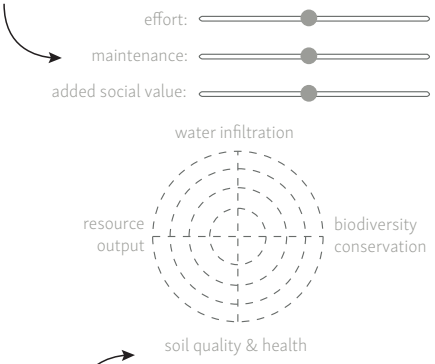
index of landscape typology: dehesa, forest, or pastureland

scale of intervention

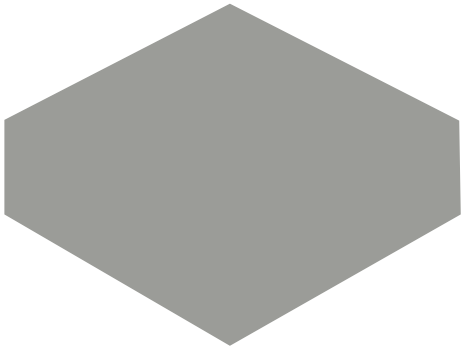
Title

microbiology field farm community landscape

indicator scale of three factors, from low to high



Explanation of the nature-based solution and important aspects.



index of side-effects of intervention

illustration of the nature-based solution

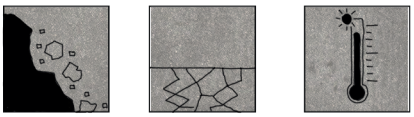
Figure 64. Template for zoning, method, result
FIgure 65. Template for nature-based solution

6.4.5

the empty dehesa



Risks



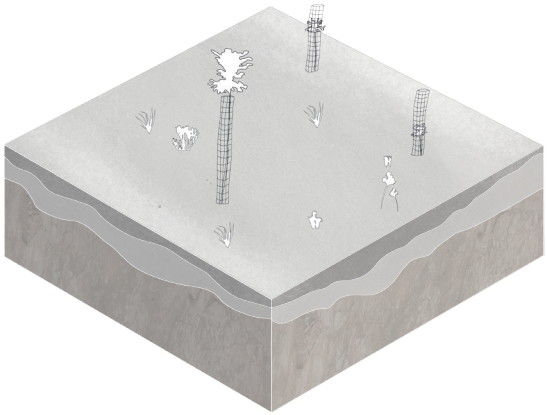
Opportunities



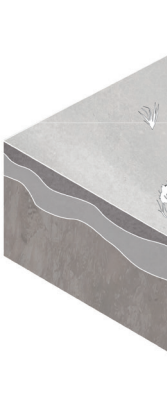
Methodologies

Facilitating a come-back and continuation of the system by
lating growth.

1



2



active reforestation and protection with
livestock

reforestation
without lives

Socio-ecological result

planting new trees and stimu-



with shrub enhancement
stock



A dehesa with a high diversity of aged trees. A relativetly closed foliage prevents soil from eroding by the wind. As the trees act as nutrient pumps and provide shadow to plants, grasses wil grow below them and infiltration will be maximised. A wide range of birds and other animals take shelter in the landscape.

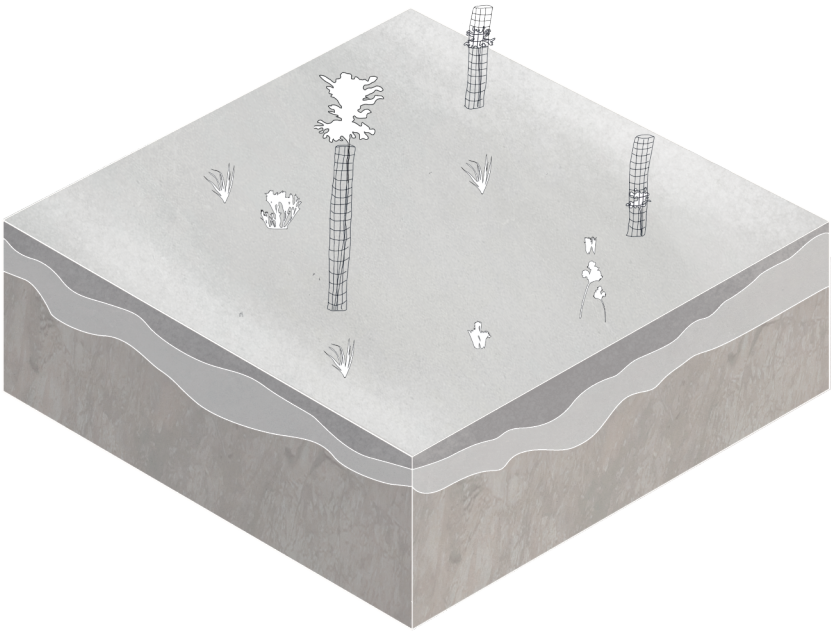
Figure 66. Opportunities for the empty dehesa typology

active reforestation and protection

microbiology field farm community landscape



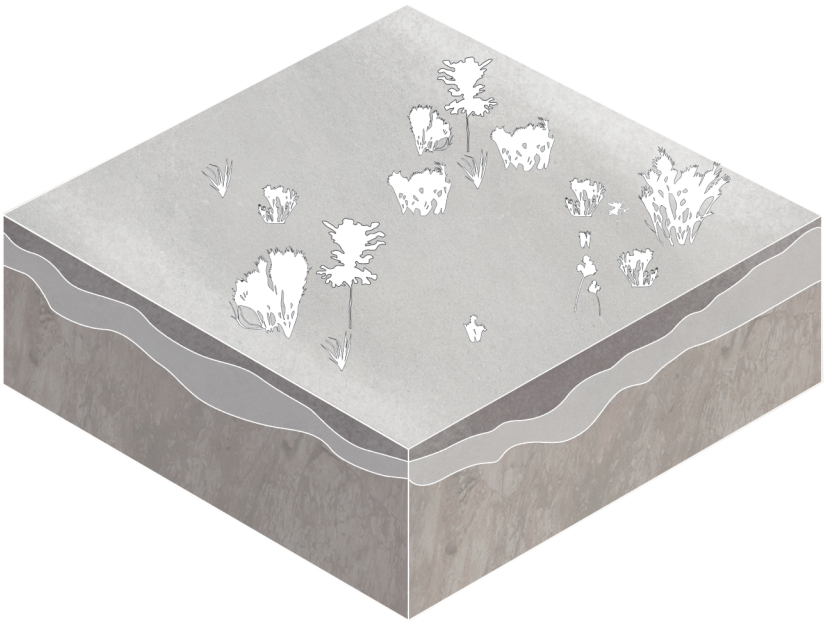
6.4.6

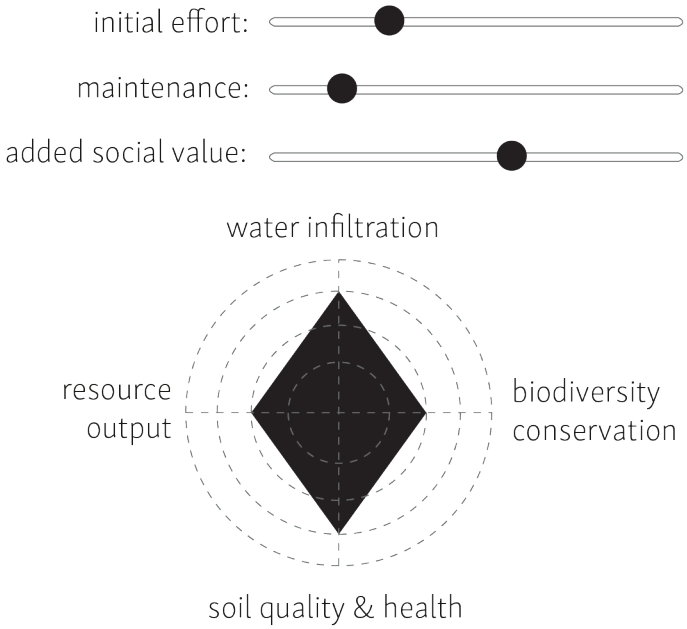


passive reforestation with shrub enhancement

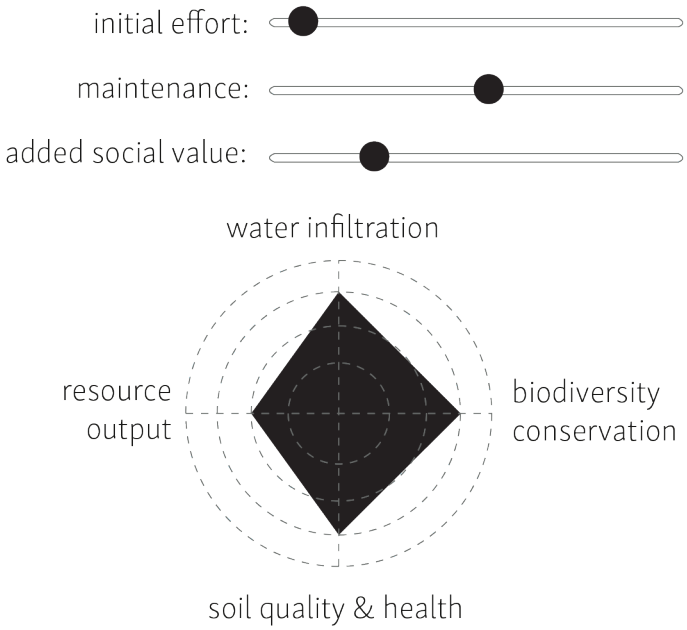
microbiology field farm community landscape







By planting new trees and protecting them with a mesh fence, more young trees will be able to grow into new oaks, enabling te continuity of the dehesa in the future. The fence unables birds as well as livestock to eat the saplings. The initial effort to undertake this is minimal, and there is almost no need for maintenance. The creation of new forests together with the community can have a large social value.



With the initial absence of livestock, the regeneration of trees can start. As shrubs grow and saplings grow, the land starts to transform. When the shrubs start to take up the space and light that the saplings need, maintenance is needed in shortening the bushes. This is also needed to make sure the shrubland does not have an enlarged risk on fires.

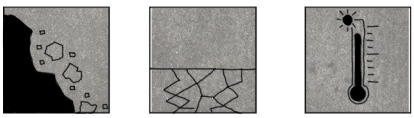
Figure 67. Nature-based solutions for enhanced tree growth

6.4.7

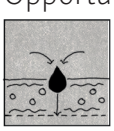
the dry dehesa



Risks



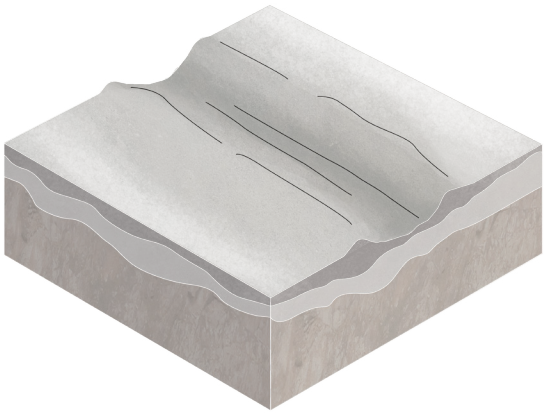
Opportunities



Methodologies

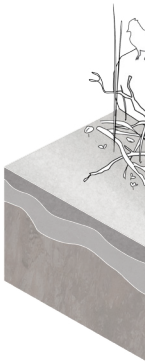
Facilitating a come-back and continuation of the system b
to the local geomorphology.

1



active reforestation and protection with
livestock

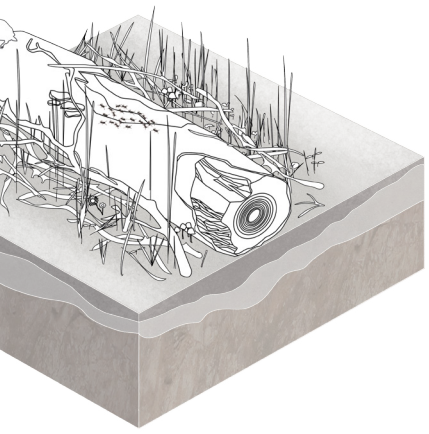
2



reforestati
without liv

Socio-ecological result

oy enhancing infiltration adapted



on with shrub enhancement
estock



A dehesa with a regenerated vegetation cover. By restoring the soil erosion is also prevented. An improved infiltration makes the dehesa capable of water storage again.

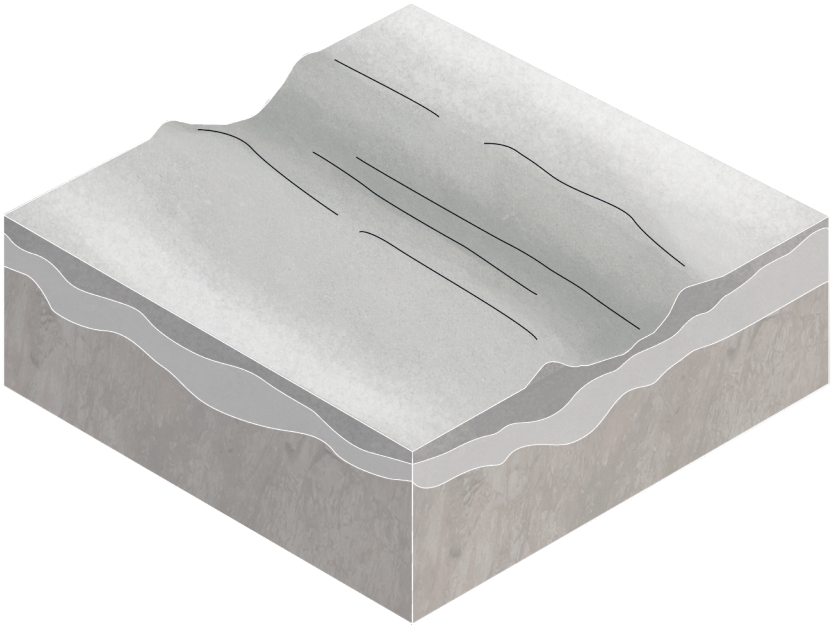
Figure 68. Opportunities for the dry dehesa

water ditches

microbiology field farm community landscape



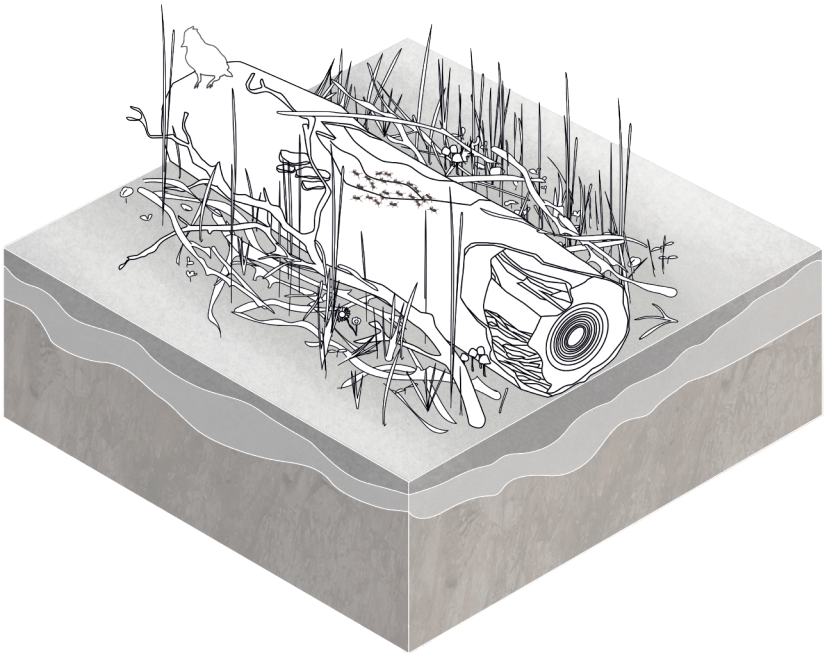
6.4.8

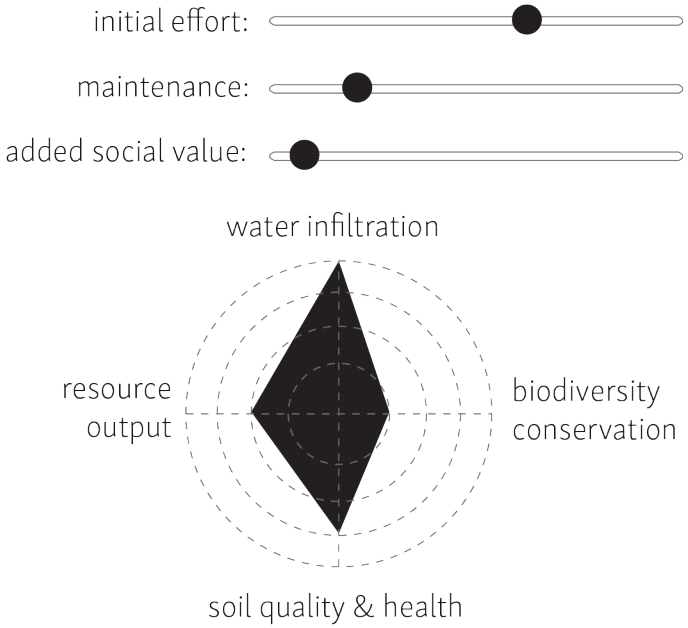


wooded banks

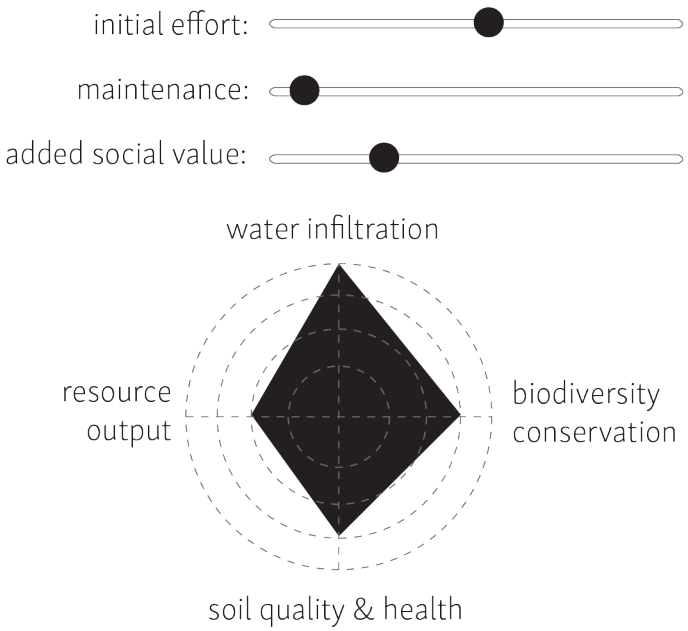
microbiology field farm community landscape







Water ditches, designed to enhance water infiltration, capture and direct rainfall into the soil. By strategically placing them in the landscape surface runoff can be reduced, allowing more water to seep into the ground, replenishing groundwater reserves and maintaining soil moisture. The ditches help prevent soil erosion, improve soil structure, and promote the growth of vegetation.

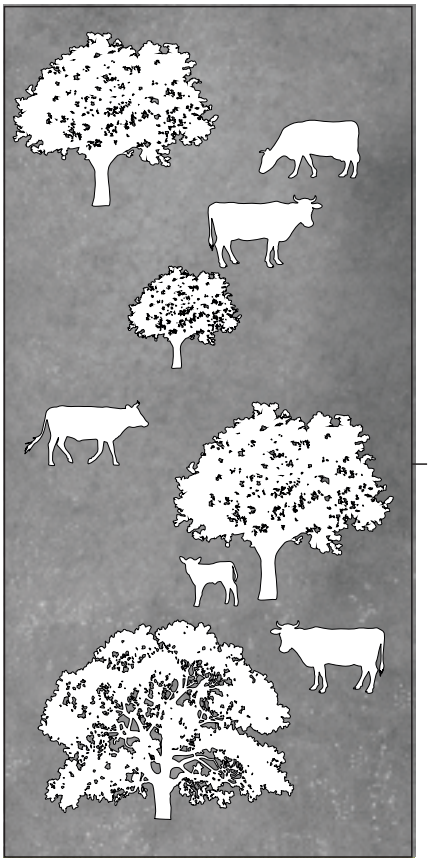


Wooded banks are designed to enhance water infiltration, recharge groundwater, stabilize the soil, and foster a diverse habitat. Lined with trees, branches, and left-overs from pruning, act as natural barriers that slow down water flow, allowing more water to seep into the ground. This method reduces surface runoff, prevents soil erosion, and improves soil structure. The roots of the vegetation help anchor the soil, while shade is provided and biodiversity is supported and enhanced.

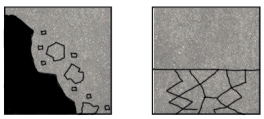
Figure 69. Nature-based solutions for enhanced water infiltration and storage

6.4.9

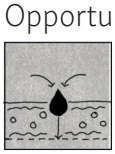
the average dehesa



Risks



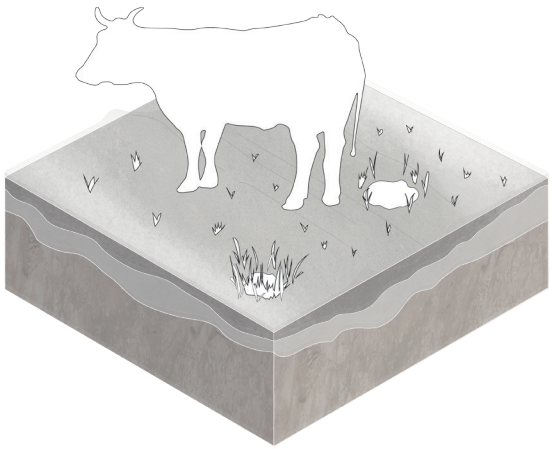
Opportunities



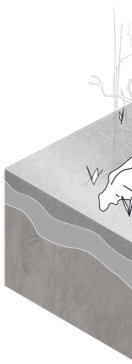
Methodologies

Enhancing the health of soil and trees through well-man
livestock across different patches and imitating natural p
benefits from animal presence. Grazing pastures when th
reached maximizes nutrient recycling, leading to healthi

1



2

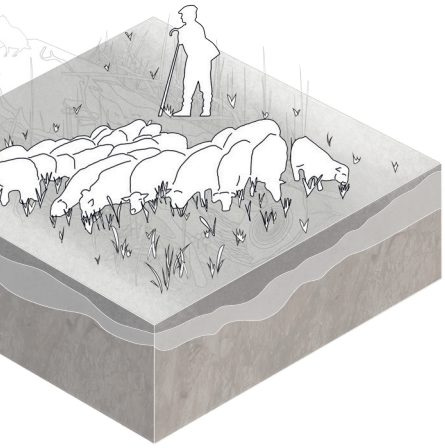


rotational livestock management

long and s

Socio-ecological result

aged livestock. By rotating
predator processes, the soil
he optimal amount of protein is
er soil and more plant growth.



short-distance transhumance



A dehesa with healthy soils, trees, and vegetation cover. By restoring the soil and increasing its organic matter it is more resilient for temperature changes and periods of drought.

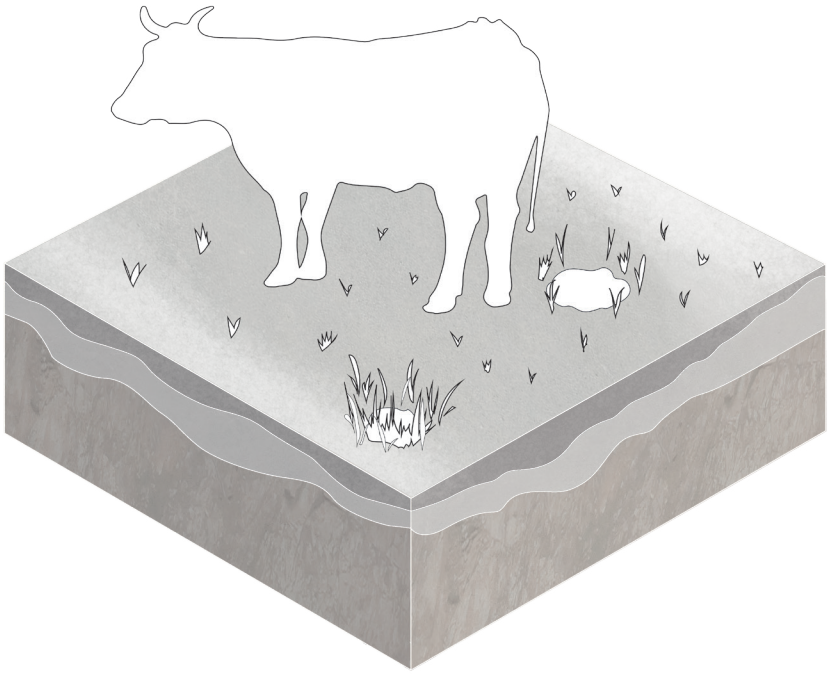
Figure 70. Nature-based solutions for enhanced soil structure and fertility

Rotational livestock management

microbiology field farm community landscape

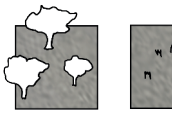


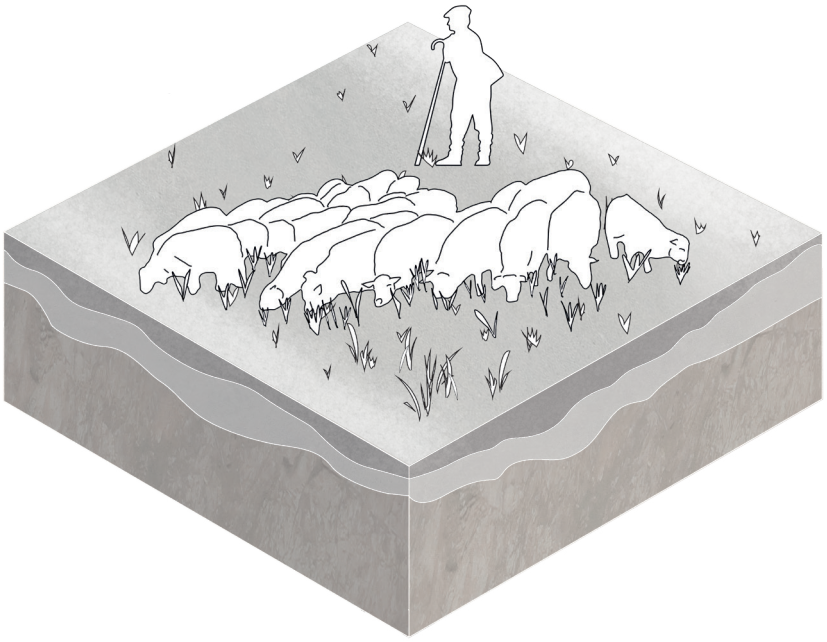
6.4.10

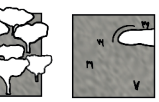


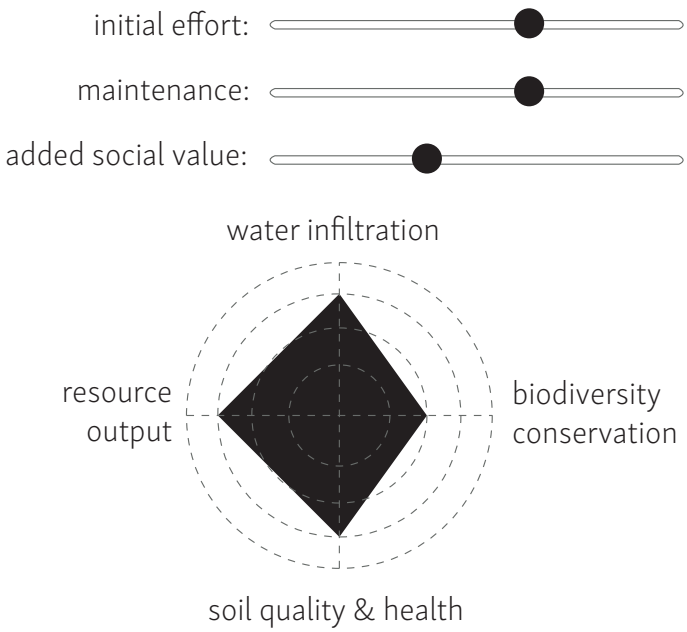
Long and short-distance transhumance

microbiology field farm community landscape



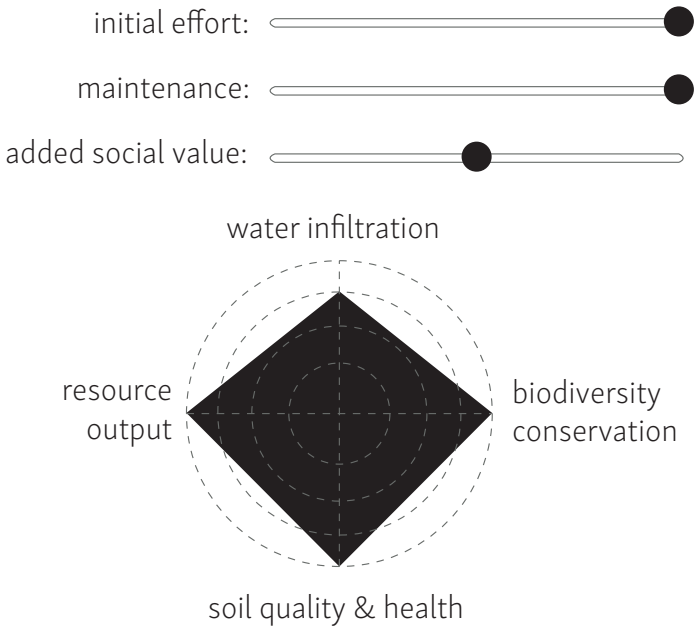






By using animals on the land soil fertility and structure can be enhanced. Essential nutrients as nitrogen, phosphorus, and potassium are added to the soil and improve fertility for plants. The organic matter in manure improves its soil structure and water-holding capacity, which contribute to a healthier soil. This way nutrients are recycled that would otherwise be wasted.





Utilizing livestock through both short- and long-distance transhumance can significantly enhance soil fertility and structure. This practice involves the seasonal movement of animals, which helps in the natural distribution of essential nutrients. These nutrients improve soil fertility and are beneficial for plant growth, leaving the land more productive. Moreover, it maintains ecological resilience.

Figure 71. Nature-based solutions for enhanced soil structure and fertility

Envisioning on a larger scale

6.4.11

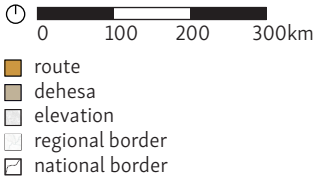
The conservation and restoration actions aim to maintain and enhance the diverse ecological, economic and social values of the dehesa landscape. Key objectives include maintaining biodiversity, improving soil health and ensuring the sustainability of land use and forestry practices. By focusing on nature-based solutions and sustainable land management, these actions aim to restore a healthy ecosystem that can withstand environmental pressures and continue to provide essential services and benefits.

Landscape diversity

Maintaining a mosaic of diverse patches within the dehesa is another important objective. This diversity of land use and vegetation types supports a wide range of species and contributes to the overall health of the ecosystem. By promoting heterogeneity within the landscape, the Dehesa can better adapt to change and maintain its ecological integrity.

Conservation of values

These actions are designed to maintain all values and services of the Dehesa. The preservation of the traditional practices and cultural significance of the Dehesa, developed over centuries, contributes to the identity of the region. By addressing these objectives from the capacity of the residents, the conservation and restoration efforts are working towards a holistic approach that will secure the future of the Dehesa.





Towards a resilient network

By increasing the resilience of the dehesa and collectively protecting this landscape, we can extend the Natura 2000 sites, the backbone of biodiversity and ecological care. Strengthening the protection of transhumance routes and reactivating transhumance practices can link natural and semi-natural areas across Spain into a cohesive collective landscape. This increased connectivity will benefit flora, fauna and whole ecosystems, promoting biodiversity and ecological health.

Figure 72. Expansion of care on national scale

7 Evaluation

Evaluation limits and the effectiveness of interventions, this chapter delves into the various strategies employed in conservation and restoration, critically assessing their outcomes.

By identifying the impact of actions on the soil health, a nuanced understanding of the application of nature-based solutions can be formulated. Furtermore, the chapter reflects on the design process. Discussing the methodology, key decisions, and overall process that guided the project.

Figure 73. Sheep in the dehesa

7.1

Evaluating preservation and restoration actions

The potential losses to the Dehesa landscape are both profound and alarming. If current trends continue without intervention, the system could face massive degradation, and even become lost. Economic challenges such as reduced profitability, lack of financial incentives and declining farm incomes are preventing the necessary investment in conservation and regeneration. Social factors, including the abandonment of the land and the lack of sustainable practices, amplify the threat to the ecosystem of the dehesa. As a result, the risk of landscape degradation and potential losses increases significantly (Luisa De Lázaro & González González, 2015). It is easy for the system to become unbalanced with the continuation of these risks.

Recovery

Once the soil is severely degraded, recovery becomes extremely difficult. However, some soil properties can be improved through interventions. Soil structure, soil organic matter, soil fertility, and waterholding capacity can be improved with nature-based solutions and sustainable land management.However, severe erosion can lead to permanent loss of topsoil, making full recovery almost impossible. Dehesa soils, which already have low levels of organic matter, face slow and difficult recovery if further degradation occurs (Shahane & Shivay, 2021; Gomiero, 2016).

Severe degradation and irreversible changes

The timeframe for recovery varies greatly depending on the extent of degradation. Recovery is possible over decades if conservation and restoration measures are applied promptly, and consistent efforts can accelerate this process. In cases of severe degradation, however, natural regeneration is extremely slow and may take centuries, if at all. Irreversible changes can occur and highly adapted species may be lost forever. Soil erosion is particularly critical, often resulting in permanent loss of soil (Yu et al., 2021). Sustainable soil management practices are essential to prevent further degradation and support soil health and productivity.

Acting now

In the face of these challenges, it is essential to act now. Low nutrient availability, increasingly harsh conditions and the risk of erosion make it urgent to intervene before the situation worsens. Restoring the balance is hard, but not entirely irreversible. With a consistent effort and appropriate conservation and restoration, recovery is still possible in the initial stages of degradation. Researchers including Campos et al. (2010) emphasise the urgency of immediate action. Without immediate action, more drastic and potentially less effective measures will be needed in the future. Economic viability and supportive policy frameworks for ecosystem valuation are crucial to ensure that ecosystem valuation and sustainable land use are prioritised (Campos et al., 2008). Without them, efforts to regenerate ageing oak woodlands and other critical components of the dehesa will fail. This is especially important given the long-term nature of agroforestry systems, as reflected in the saying that you plant cork oak for your grandchildren. Just as a farmer highlighted in an interview (personal communication, 24 February):

"The problem is not the future, the problem is today. If the future consists of the consequences of not doing good things today, what can we do today so that the future doesn't happen?"

Alternatives futures

To illustrate this point, the adapted photographs below show the possible alternative futures of the Dehesa if stakeholders prioritise economic profit over restoration. The expansion of shrubs, the prevalence of solar panels, the dominance of monocultures, the expansion of olive groves, and landscapes cleared of trees are part of the fragmented dehesa, with intervening pasture lands and scattered oak trees.



Figure 74. Fast development of patches for economic profit

8 Conclusion & reflection

By synthesizing the findings and reflecting on the design process, future steps can be outlined.

This chapter summarises the key findings and insights and highlights the most important findings. In addition, a reflection will provide a deeper insight into the research process, exploring the challenges, relevance, methods and lessons learned. It aims at providing an understanding of the development of the research and highlighting areas for future improvement.

Figure 75. Typical dehesa landscape

8.1

Conclusion

How to plan for systemic change? Tackling huge, global phenomena such as depopulation and desertification appears implausible. These incredibly large processes with a long-standing history do not seem to have a global solution. Tackling these complex phenomena requires an approach that starts at the local level.

Tackling complex phenomena

To address these challenges, it is essential to zoom in, decompose, explore, elaborate and unpack the local context. By unravelling the phenomena in different dimensions in the territory, the extent of the problem unravels itself. As the processes are deeply intertwined in the local fabric - physically, socially, ecologically and economically - it is important not only to identify pressures and drivers, but also to involve key actors. This locally sensitive approach leads to a more accurate problem definition.

Understanding the local ecosystem

This can be done through fieldwork and active engagement with the environment. Literature research provides clues about the problem and where to focus attention in the area. In particular, cycles and the interconnectedness of cycles should be explored.
Mapping local strengths, skills and resources by communicating with local actors through interviews and surveys deepens this understanding.

Towards co-evolution

Although there's no single solution, actions can be defined to steer the future towards stability, regeneration and mitigation. The key is to identify the coping and adaptive capacity of actors. Integrating knowledge of the land, traditional management methods, the restorative power of nature and future climate prospects allows suitable nature-based solutions to be formulated. Structured action and care of the landscape can mitigate the immediate risks of climate change, delay the degradation of the landscape and, over time, allow the landscape to regenerate. Regeneration is a slow process that starts with active participation and strives to create a desirable future for all stakeholders.

Managing adaptive change

Effective implementation requires clear communication and mutual understanding between stakeholders, who have a right to be heard and whose intentions and goals need to be aligned. Involving people in this long-term process is crucial, with clear rewards and government involvement as essential tools.Monitoring change enables adaptive planning strategies and the ultimate goal of ecological restoration.

8.2

Reflection

By reflecting on different aspects of the thesis, the design steps become clear and the underlying processes are made transparent.

Reflecting on the methodology

The methodology employed in this thesis integrates both qualitative and quantitative research across various scales, with a focus on fieldwork to understand and address global processes at a local level. This approach is based on the assumption that incorporating stakeholder perspectives and focusing on specific locations are crucial for effective urban design.

The methodology proved effective in several ways. Fieldwork, in particular, emerged as a critical component, revealing complexities and controversies that would not have been apparent through online research alone. Conducting fieldwork after P2, midway through the thesis process, highlighted the real-life intricacies of the problem, emphasising the importance of direct engagement with the study area.

Several limitations affected the depth and scope of the research. Firstly, the language barrier: my limited proficiency in Spanish restricted the depth of conversations I could have with local residents, impacting the quality and, more importantly, the limits of qualitative data. Secondly, time constraints: the sheer volume of information gathered during fieldwork required more time for thorough analysis and integration than was available.

Value and transferability

The methodology employed in this thesis is extensive and well-structured, with clear inputs and outputs. During the fieldwork, I well documented the steps I undertook to ensure clarity and replicability. Its primary focus on understanding the specific context and providing detailed descriptions of methods and tools makes it adaptable to different settings. However, there are some constraints on transferability. The design is highly tailored to this specific project. While the methodology and tools can be adapted for other regions, their effectiveness may vary due to different regional conditions and challenges. For instance, the positive outcome in Monfragüe, where residents showed a willingness to change upon recognizing the problems, may not be replicated elsewhere if the local population is less receptive. Additionally, the absence of a detailed script for handling fieldwork outputs introduces a level of subjectivity. My decisions regarding which points, answers, and observations were most important could differ from those of another researcher, potentially affecting the methodology's transferability.

In conclusion, while the methodology offers significant value and potential for application in similar contexts, its success depends on local conditions and the willingness of residents to engage in change. Future projects may benefit from an earlier selection of a specific location and clearer guidelines for managing fieldwork data to enhance replicability and effectiveness.

Between research and design

The relationship between research and design in this project was dynamic and reciprocal, with each informing and shaping the other. The

concept of research by design was a central focus, as new knowledge was generated through the design process itself.

A key example of this interplay was the creation of maps, which served as both research tools and final products. The mapping process provided crucial insights and data that directly influenced the design. Similarly, the creation of systematic overviews helped to understand the complex systems involved, identifying key challenges and opportunities that guided the design.

The development of scenarios demonstrated the mutually reinforcing relationship between research and design. Scenarios were employed to examine and address a range of potential scenarios, at the same time defining the design challenges and providing solutions.

Initially, the research phase defined the scope and approach of the project, setting the parameters for the design. As the design process progressed, it brought new questions and directions for the research, particularly in understanding the specific needs and opportunities within the dehesa landscape. This iterative process ensured that both the research and design were deeply interconnected, enhancing the overall quality and relevance of the project.

On mentor feedback and personal growth

Firstly, the feedback from my mentors provided invaluable tools that guided me through this thesis. Their theoretical insights significantly shaped the development of my conceptual framework, offering new perspectives on relationships between concepts that I had not previously considered. At the beginning of the research, they introduced me to a new vocabulary, expanding my understanding of the subject. Their suggestions on literature enabled me to construct a comprehensive foundation, incorporating theoretical perspectives I had not yet encountered.

Throughout the research process, my mentors provided valuable guidance in developing and refining my research framework and methodology at all phases. Their practical experience and knowledge of specific tools significantly strengthened both my process and the final outcomes of my thesis. In addition to mentor feedback, I was constantly mirrored by interviews and interactions with residents, literature discoveries, and discussions with fellow students. These interactions prompted me to question my actions, values, beliefs, and goals, fostering a deeper understanding of myself and my work.

During fieldwork, I gained valuable insights into my approach to research. Engaging with residents required developing effective communication strategies to gather information and encourage participation. This experience highlighted the importance of empathy and adaptability as a researcher. Moreover, my role as an uban designer became even clearer for me: it is about listening, communicating, decomposing, emphasizing, synthesizing, and finding synergies. Working with actors, allowing them to see the longue duréé, and working towards this is what I aim at.

8.2

Social, scientific, and professional relevance

This research addresses the impacts of climate change on communities, focusing on the well-being and quality of life of people in vulnerable areas. By assessing current liveability, vulnerabilities are identified for both human and non-human species. It emphasises both socio-ecological justice as socio-environmental justice, recognising the interdependence of nature and humans, advocating against the disproportionate exposure of marginalised communities to environmental hazards. The research adds to existing studies on the impacts of climate change at the local level, demonstrating the capacity of communities to contribute to the mitigation of the effects of climate change. It also empowers communities and contributes to the preservation of local cultures, traditions and identities by detangling the cultural landscape.

In addition, the research contributes to the paradigm shift of a non-anthropocentric design, an integrative approach to our existance and to the interdependence of different systems. it also elaborates on the new adaptive planning paradigm, which is responding to emerging challenges and capable of adapting over time. Bridging the gaps between urbanism, ecology, environmental science, geography, economics, politics and sociology, the research contributes to the field that advocates integrative multidisciplinary approaches to adress today's complex challenges. By exploring best practises and assessing risks in a specific context, this design will contribute to ecological design and resilient planning wit place-based solutions in semi-arid regions.

The findings of this research contribute significantly to the formulation of strategic approaches in the field of human-nature integration. The proposed multifaceted methodology can be applied in different contexts facing similar challenges, incorporating local perspectives and values into effective strategies. The study reflects on the responsibilities and skills of designers and advocates the inclusion of different scientific fields within the discipline of urbanism. It highlights the value of acquiring knowledge in management and landscape design as an urban designer. The research proposes tools that could be used in the professional sphere, broadening the scope of urbanism and emphasising its wider social and environmental impact.

Relations with the programme

Within the AUBS programme, my work reflects on the overarching theme of designing for pluralism. I am committed to raising the voices of those who are marginalised. Additionally, the programme's focus on sustainability is embodied in this thesis through adaptive strategies at increasing resilience. The Transitional Territories studio provided a systemic approach that allowed for the exploration of complex relationships and active engagement with future scenarios. I applied this methodology to discover opportunities in the current management system.
The studio and urban design share a transdisciplinary approach, bringing together a variety of expertise to push the boundaries of what urban design can achieve. In the project I embraced a multiplicity of perspectives, considering viewpoints of different stakeholders and the relationship between human and nature. This provided new insights on synergies.

Ethical considerations

Given the limited time frame, it was challenging to ensure that no particular group within the community or ecosystem was disproportionately benefited or disadvantaged. The aim of soil restoration was to benefit both human and natural systems, but the focus was often on human benefits, which is not fully consistent with the principles of social-ecological justice.

Limits

Throughout my research I came across a wide range of information and many leads to explore. Particularly during the fieldwork I came across various other land use practices, such as the development of game hunting. Although this is not necessarily a bad way of using the land, I did not explore the possibility of converting the land to this use. I defined them as non-preferred and chose to focus on the conservation and restoration of the traditional dehesa. Although research suggests that it could be beneficial for farmers to diversify their activities, my study was limited to exploring strategies that support the traditional dehesa system.

8.3

Bibliography

European Commission. A Soil Deal for Europe. (2022).

Adger, W. N., Barnett, J., Chapin, F. S., Ellemor, H., & Adger, • W Neil. (2011). This Must Be the Place: Underrepresentation of Identity and Meaning in Climate Change Decision-Making. http://direct.mit.edu/glep/article-pdf/11/2/1/1816956/glep_a_00051.pdf?casa_token=FyK2WL3au50AAAAA:7UuuOT5bfnvJ1Rvn4rtst1KexU7KIjl66L0jaZphpF--NSK_6FsR32oFeA7nrJT4mY7QnhtiAg

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., Naess, L. O., Wolf, J., & Wreford, A. (2009). Are there social limits to adaptation to climate change? In Climatic Change (Vol. 93, Issues 3–4, pp. 335–354). https://doi.org/10.1007/s10584-008-9520-z

Albrechts, L. (2004). Strategic (spatial) planning reexamined. Environment and Planning B: Planning and Design, 31(5), 743–758. https://doi.org/10.1068/b3065

Baldwin, A. D., De Luce, J., & Pletsch, C. (1994). Beyond preservation: restoring and inventing landscapes. University of Minnesota .

Balestrieri, M., Maciocco, G., & Pusceddu, C. (2018). Climate-change adaptation: New paradigms for environmental urban planning. In Green Energy and Technology (pp. 349–360). Springer Verlag. https://doi.org/10.1007/978-3-319-78271-3_28

Baste, I. A., Watson, R. T., & United Nations Environment Programme. (2021). Making peace with nature : a scientific blueprint to tackle the climate, biodiversity and pollution emergencies.

Bell, S. (1999). landscape: pattern, perception and process.

Bertels, J., Lear, E., & Gutierrez, V. (2023). Towards financing large-scale holistic landscape restoration in Europe: reccomendations for EU policy actors to attain inspirational, social, natural and financial returns.

Bock, A.-Katrin., Krzysztofowicz, Maciej., & European Commission. Joint Research Centre. (2021). Scenarios for EU rural areas 2040 : contribution to European Commission's long-term vision for rural areas.

Campos, P., Carranza, J., Coleto, M., Diaz, M., Diéguez, Escudero, A., Javier Ezquerra, F., López, L., Fernández, Montero, Moreno, Picardo, Á., Pulido, F., Roig, S., Sánchez, E., Solla, A., Vargas, D., & Vidiella, Á. (2010). Libro Verde de la Dehesa.

Campos, P., Ovando, P., & Montero, G. (2008). Does private income support sustainable agroforestry in Spanish dehesa? Land Use Policy, 25(4), 510–522. https://doi.org/10.1016/j.landusepol.2007.11.005

Castells, M. (2009). The Power of Identity. Wiley. https://doi.org/10.1002/9781444318234

Castillo, C. P., Aliaga, E. C., Lavalle, C., & Llario, J. C. M. (2020). An assessment and spatial modelling of agricultural land abandonment in spain (2015-2030). Sustainability (Switzerland), 12(2). https://doi.org/10.3390/su12020560

Corboz, A. (1983). The Land as Palimpsest. Diogenes, 31(121), 12–34. https://doi.org/10.1177/039219218303112102

Critchley, W., Harari, N., Mollee, E., Mekdaschi-Studer, R., & Eichenberger, J. (2023). Sustainable Land Management and Climate Change Adaptation for Small-Scale Land Users in Sub-Saharan Africa. Land, 12(6). https://doi.org/10.3390/land12061206

De Lázaro Torres, M. L., & De Miguel González, R. (Eds.). (2023). Sustainable Development Goals in Europe. Springer International Publishing. https://doi.org/10.1007/978-3-031-21614-5

Ebi, K. L., & Semenza, J. C. (2008). Community-Based Adaptation to the Health Impacts of Climate Change. In American Journal of Preventive Medicine (Vol. 35, Issue 5, pp. 501–507). Elsevier Inc. https://doi.org/10.1016/j.amepre.2008.08.018

Fernández, M. P., Keshavarzi, A., Rodrigo-Comino, J., Schnabel, S., Contador, J. F. L., Gutiérrez, Á. G., Parra, F. J. L., González, J. B., Torreño, A. A., & Cerdà, A. (2020). Developing scoring functions to assess soil quality at a regional scale in rangelands of sw spain. Revista Brasileira de Ciencia Do Solo, 44. https://doi.org/10.36783/18069657RBCS20200090

Fragoso, R., Marques, C., Lucas, M. R., Martins, M. B., & Jorge, R. (2011). The economic effects of common agricultural policy on Mediterranean montado/dehesa ecosystem. Journal of Policy Modeling, 33(2), 311–327. https://doi.org/10.1016/j.jpolmod.2010.12.007

Fried, M. (2000). Continuities and discontinuities of place. Journal of Environmental Psychology, 20(3), 193–205. https://doi.org/10.1006/

jevp.1999.0154

García-Alonso, J., & Fonseca, C. (2022). Gerontechnology IV (J. García-Alonso & C. Fonseca, Eds.). Springer International Publishing. https://doi.org/10.1007/978-3-030-97524-1

Gómez Valenzuela, V., & Holl, A. (2023). Growth and decline in rural Spain: an exploratory analysis. European Planning Studies. https://doi.org/10.1080/09654313.2023.2179390

Gomiero, T. (2016). Soil degradation, land scarcity and food security: Reviewing a complex challenge. In Sustainability (Switzerland) (Vol. 8, Issue 3). MDPI. https://doi.org/10.3390/su8030281

Haraway, D. (n.d.). SITUATED KNOWLEDGES: THE SCIENCE QUESTION IN FEMINISM AND THE PRIVILEGE OF PARTIAL PERSPECTIVE.

Haraway, D. (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. https://about.jstor.org/terms

Hooke, J., & Sandercock, P. (2012). Use of vegetation to combat desertification and land degradation: Recommendations and guidelines for spatial strategies in Mediterranean lands. Landscape and Urban Planning, 107(4), 389–400. https://doi.org/10.1016/j.landurbplan.2012.07.007

Hough, M. (1990). Out of place restoring identity to the regional landscape (M. Hough, Ed.). Yale University Press .

Hourdequin, M., & Havlick, D. G. (n.d.). Restoring Layered Landscapes: History, Ecology, and Culture.

Hourdequin, M., & Havlick, D. G. (2016). Restoring Layered Landscapes: History, Ecology, and Culture.

Hugooreinert, H.-S., & Editors, J.-W. (2015). Landscape Series Ruptured Landscapes Landscape, Identity and Social Change. http://www.springer.com/series/6211

Hummon, D. M. (1986). City Mouse, Country Mouse: The Persistence of Community Identity. In Qualitative Sociology (Vol. 9, Issue 1).
Ingold, Ti. (1993). Temporality of the Landscape.

Javier, F., & García, D. (2021). An overview of Municipalities in Spain: Government, Structure and Financing. https://www.researchgate.net/publication/354623275

Joffre, R., Rambal, S., & Ratte, J. P. (1999). The dehesa system of southern Spain and Portugal as a natural ecosystem mimic. Agroforestry Systems, 45(1–3), 57–79. https://doi.org/10.1023/a:1006259402496

Keesstra, S., Nunes, J., Novara, A., Finger, D., Avelar, D., Kalantari, Z., & Cerdà, A. (2018). The superior effect of nature based solutions in land management for enhancing ecosystem services. In Science of the Total Environment (Vols. 610–611, pp. 997–1009). Elsevier B.V. https://doi.org/10.1016/j.scitotenv.2017.08.077

Laporta, L., Domingos, T., & Marta-Pedroso, C. (2021). It's a keeper: Valuing the carbon storage service of Agroforestry ecosystems in the context of CAP Eco-Schemes. Land Use Policy, 109. https://doi.org/10.1016/j.landusepol.2021.105712

Laukkonen, J., Blanco, P. K., Lenhart, J., Keiner, M., Cavric, B., & Kinuthia-Njenga, C. (2009). Combining climate change adaptation and mitigation measures at the local level. Habitat International, 33(3), 287–292. https://doi.org/10.1016/j.habitatint.2008.10.003

Llano, F. H. (2019). Transhumanism, Vulnerability and Human Dignity. Deusto Journal of Human Rights, 4, 39–58. https://doi.org/10.18543/djhr-4-2019pp39-58

Longstreth, R. (2008). Cultural landscapes: balancing nature and heritage in preservation practise (R. Longstreth, Ed.). University of Minnesota Press.

Lopez-Gunn, E. (2009). Agua Para Todos: A New Regionalist Hydraulic Paradigm in Spain. www.water-alternatives.org
Luisa De Lázaro, M., & González González, J. (2015). An uncertain future for the dehesa landscape and its sustainable management. https://www.researchgate.net/publication/287816870

Manzano Baena, P., & Casas, R. (2010). Past, present and future of Trashumancia in Spain: nomadism in a developed country. https://doi.org/10.6084/m9.figshare.12253130

Martínez-Fernández, J., & Esteve, M. A. (2005). A critical view of the desertification debate in southeastern Spain. Land Degradation and Development, 16(6), 529–539. https://doi.org/10.1002/ldr.707

Martínez-Valderrama, J., Del Barrio, G., Sanjuán, M. E., Guirado, E., & Maestre, F. T. (2022). Desertification in Spain: a sound diagnosis unfollowed by so-lutions. https://doi.org/10.20944/preprints202201.0309.v1

Martínez-valderrama, J., Del Barrio, G., Sanjuán, M. E., Guirado, E., & Maestre, F. T. (2022). Desertification in Spain: A Sound Diagnosis without Solutions and New Scenarios. Land, 11(2). https://doi.org/10.3390/land11020272

Ministerio para la Transicíon ecológica y el reto demográfico. (2022). Estrategia Nacional de Lucha contra la Desertificación. www.miteco.es

Ministry for Ecological Transition and the Demographic Challenge (MITECO). (2022). National Strategy to Combat Desertification. www.miteco.es

Mirfenderesk, H., & Corkill, D. (2009). The need for adaptive strategic planning: Sustainable management of risks associated with climate change. International Journal of Climate Change Strategies and Management, 1(2), 146–159. https://doi.org/10.1108/17568690910955612

Mondini, G., Fattinnanzi, E., Oppio, A., Bottero, M., & Stanghellini, S. (2016). Green Energy and Technology Integrated Evaluation for the Management of Contemporary Cities Results of SIEV 2016. http://www.springer.com/series/8059

Moral, F. J., Aguirado, C., Alberdi, V., Paniagua, L. L., García-Martín, A., & Rebollo, F. J. (2023). Future Scenarios for Aridity under Conditions of Global Climate Change in Extremadura, Southwestern Spain. Land, 12(3). https://doi.org/10.3390/land12030536

Nila, M. U. S., & Hossain, M. L. (2019). Predicting the effectiveness of protected areas of Natura 2000 under climate change. Ecological Processes, 8(1). https://doi.org/10.1186/s13717-019-0168-6

Norberg, J., & Cumming, G. (2008). Complex theory for a sustainable future (T. Allen & D. Roberts, Eds.). Columbia University Press .

Pagliarino, E., & Pronti, A. (2016). Antropocene e agricoltura: il paradigma possibile dell'agroecologia . Culture Della Sostenibilitá.

Parra-López, C., Sayadi, S., Garcia-Garcia, G., Ben Abdallah, S., & Carmona-Torres, C. (2023). Prioritising conservation actions towards the sustainability of the dehesa by integrating the demands of society. Agricultural Systems, 206. https://doi.org/10.1016/j.agsy.2023.103613

Patterson, J. J. (2022). Culture and identity in climate policy. In Wiley Interdisciplinary Reviews: Climate Change (Vol. 13, Issue 3). John Wiley and Sons Inc. https://doi.org/10.1002/wcc.765

PBL Netherlands Environmental Assessment Agency. (2017). European nature in the plural - Finding common ground for a next policy agenda.
Pisor, A., Lansing, J. S., & Magargal, K. (2023). Climate change adaptation needs a science of culture. Philosophical Transactions of the Royal Society B: Biological Sciences, 378(1889). https://doi.org/10.1098/rstb.2022.0390

Plieninger, T. (2006). Habitat loss, fragmentation, and alteration - Quantifying the impact of land-use changes on a Spanish dehesa landscape by use of aerial photography and GIS. Landscape Ecology, 21(1), 91–105. https://doi.org/10.1007/s10980-005-8294-1
Plieninger, T., Flinzberger, L., Hetman, M., Horstmannshoff, I., Reinhard-Kolempas, M., Topp, E., Moreno, G., & Huntsinger, L. (2021). Dehesas as high nature value farming systems: A social-ecological synthesis of drivers, pressures, state, impacts, and responses. Ecology and Society, 26(3). https://doi.org/10.5751/ES-12647-260323

Plieninger, T., & Wilbrand, C. (2001). Land use, biodiversity conservation, and rural development in the dehesas of Cuatro Lugares, Spain. In Agroforestry Systems (Vol. 51).

Potteiger, M., & Purinton, J. (1998). Landscape narratives: design practises for telling stories. John Wiley & Sons.

Prigent, O., Wynn Owen, P., Homrich Hickmann, M., Bryan, K., Caruda Ruiz, A., Huth, J., Bortnowschi, R., Friel, C., Gilson, V., Roberts, G., Roessing, E., & Moore, R. (2018). Combating desertification in the EU: a growing threat in need of more action.

Prins, A. G., Pouwels, R., Clement, J., Hendriks, M., de Knegt, B., Petz, K., Beusen, A., Farjon, H., van Hinsberg, A., Janse, J., Knol, O., van Puijenbroek, P., Schelhaas, M.-J., & van Tol, S. (2017). Perspectives on the future of nature in Europe: impacts and combinations. www.pbl.nl/en.

Puigdefábregas, J., & Mendizabal, T. (1998). Perspectives on desertification: western Mediterranean.

Rodgers, D., & Wolf, R. (2020). PRAISE FOR SACRED COW.

Rodríguez Martín, J. A., Álvaro-Fuentes, J., Gonzalo, J., Gil, C., Ramos-Miras, J. J., Grau Corbí, J. M., & Boluda, R. (2016). Assessment of the soil organic carbon stock in Spain. Geoderma, 264, 117–125. https://doi.org/10.1016/j.geoderma.2015.10.010

Rodríguez-Rodríguez, D., & Vargas, R. L. (2022). Protected Areas and Rural Depopulation in Spain: A Multi-Stakeholder Perceptual Study. Land, 11(3). https://doi.org/10.3390/land11030384

Romero-Díaz, A., Ruiz-Sinoga, J. D., Robledano-Aymerich, F., Brevik, E. C., & Cerdà, A. (2017). Ecosystem responses to land abandonment in Western Mediterranean Mountains. Catena, 149, 824–835. https://doi.org/10.1016/j.catena.2016.08.013

Ross, H., Shaw, S., Rissik, D., Cliffe, N., Chapman, S., Hounsell, V., Udy, J., Trinh, N. T., & Schoeman, J. (2015). A participatory systems approach to understanding climate adaptation needs. Climatic Change, 129(1–2), 27–42. https://doi.org/10.1007/s10584-014-1318-6

Ruiz Pulpón, Á. R., & del Carmen Cañizares Ruiz, M. (2020). Enhancing the territorial heritage of declining rural areas in Spain: Towards integrating top-down and bottom-up approaches. Land, 9(7). https://doi.org/10.3390/land9070216

Ruiz Sinoga, J. D., Garcia Marin, R., Martinez Murillo, J. F., & Gabarron Galeote, M. A. (2011). Precipitation dynamics in southern Spain: Trends and cycles. International Journal of Climatology, 31(15), 2281–2289. https://doi.org/10.1002/joc.2235

Salvador Costa, M. J., Leitão, A., Silva, R., Monteiro, V., & Melo, P. (2022). Climate Change Prevention through Community Actions and Empowerment: A Scoping Review. In International Journal of Environmental Research and Public Health (Vol. 19, Issue 22). MDPI. https://doi.org/10.3390/ijerph192214645

Schwilch, G. (2012). A process for effective desertification mitigation.

Shahane, A. A., & Shivay, Y. S. (2021). Soil Health and Its Improvement Through Novel Agronomic and Innovative Approaches. In Frontiers in Agronomy (Vol. 3). Frontiers Media S.A. https://doi.org/10.3389/fagro.2021.680456

Simon-Rojo, M. (2023). The role of ecosystem services in the design of agroecological transitions in Spain. Ecosystem Services, 61. https://doi.org/10.1016/j.ecoser.2023.101531

Sustainable agriculture and soil conservation Soil degradation processes Organic matter decline. (n.d.). http://soco.jrc.ec.europa.eu

Tejeda, Á., & Lavado, J. F. (2018). MODELOS ESPACIALES PREDICTIVOS DEL RIESGO DE SECA EN EXTREMADURA. APLICACIONES A ESCALA REGIONAL Y LOCAL EN ESPACIOS NATURALES PROTEGIDOS.

Vaara, E., & Reff Pedersen, A. R. (2013). Strategy and chronotopes: A Bakhtinian perspective on the construction of strategy narratives. Management (France), 16(5), 593–604. https://doi.org/10.3917/mana.165.0593

van Leeuwen, C. C. E., Cammeraat, E. L. H., de Vente, J., & Boix-Fayos, C. (2019). The evolution of soil conservation policies targeting land abandonment and soil erosion in Spain: A review. Land Use Policy, 83, 174–186. https://doi.org/10.1016/j.landusepol.2019.01.018

Van Oostenbrugge, R., Van Egmond, P., Dammers, E., & Van Hinsberg, A. (2012). Nature Outlook 2010-2040. Nature and landscape in 2040: Development visions English Summary and Findings. www.pbl.nl/en.

Vang Rasmussen, L., Grass, I., Mehrabi, Z., Smith, O. M., Bezner-Kerr, R., Blesh, J., Alejandro Garibaldi, L., Isaac, M. E., Kennedy, C. M., Wittman, H., Batáry, P., Buchori, D., Cerda, R., Chará, J., Crowder, D. W., Darras, K., DeMaster, K., Garcia, K., Gómez, M., … Kremen, C. (2024). Joint environmental and social benefits from diversified agriculture. https://www.science.org

Walker, S., Evans, M., Cassidy, T., Twigger Holroyd, A., & Jung, J. (2018). design roots: culturally significant designs, products, and practises.

Wojewódzka-Wiewiórska, A., Vaznonienė, G., & Vaznonis, B. (2022). Who Cares for Nature in Rural Areas? Exploration of Relationships between People's Socio-Economic Characteristics and the Perception of Nature as a Value in Poland and Lithuania. Sustainability (Switzerland), 14(16). https://doi.org/10.3390/su141610048

Yu, Y., Zheng, L., Zhou, Y., Sang, W., Zhao, J., Liu, L., Li, C., & Xiao, C. (2021). Changes in soil microbial community structure and function following degradation in a temperate grassland. Journal of Plant Ecology, 14(3), 384–397. https://doi.org/10.1093/jpe/rtaa102

Figures

Figure 7 Finlayson, M., Cruz, R., Davidson, N., Alder, J., Cork, S., De Groot, R., Lévêque, C., Milton, G., Peterson, G., Pritchard, D., Ratner, B., Reid, W., Revenga, C., Rivera, M., Schutyser, F., Siebentritt, M., Stuip, M., Tharme, R., Butchard, S., . . . Taylor, D. (2005). Millennium Ecosystem Assessment: Ecosystems and Human Well-being: Wetlands and water synthesis. https://agris.fao.org/agris-search/search.do?recordID=NL2012017713

Figure 8 Abatzoglou, J. T., Dobrowski, S. Z., Parks, S. A., & Hegewisch, K. C. (2018). TerraClimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958–2015. Scientific Data, 5(1). https://doi.org/10.1038/sdata.2017.191
Cherlet, M., Hutchinson, C., Reynolds, J., Hill, J., Sommer, S., von Maltitz, G. (Eds.), World Atlas of Desertification, Publication Office of the European Union, Luxembourg, 2018.

Figure 13 Ministry of environment and rural and marine affairs. (2008). PROGRAMA DE ACCIÓN NACIONAL CONTRA LA DESERTIFICACIÓN.

Figure 14 Ministry for Ecological Transition and the Demographic Challenge (MITECO). (2022). National Strategy to Combat Desertification. www.miteco.es

Figure 15 Gómez Valenzuela, V., & Holl, A. (2023). Growth and decline in rural Spain: an exploratory analysis. European Planning Studies. https://doi.org/10.1080/09654313.2023.2179390
Feria, JM, & Martínez, L. (2016). De definitie en afbakening van het Spaanse grootstedelijke systeem. Permanenties en veranderingen tussen 2001 en 2011. Stad en territorium. Territoriale Studies , 48 (187), 9-24.

Figure 18 Castillo, C. P., Aliaga, E. C., Lavalle, C., & Llario, J. C. M. (2020). An assessment and spatial modelling of agricultural land abandonment in spain (2015-2030). Sustainability (Switzerland), 12(2). https://doi.org/10.3390/su12020560
` FIgure 19 van Leeuwen, C. C. E., Cammeraat, E. L. H., de Vente, J., & Boix-Fayos, C. (2019). The evolution of soil conservation policies targeting land abandonment and soil erosion in Spain: A review. Land Use Policy, 83, 174–186. https://doi.org/10.1016/j.landusepol.2019.01.018

Figure 21 Martínez-Valderrama, J., Del Barrio, G., Sanjuán, M. E., Guirado, E., & Maestre, F. T. (2022). Desertification in Spain: a sound diagnosis unfollowed by so-lutions. https://doi.org/10.20944/preprints202201.0309.v1

Figure 22 Moral, F. J., Aguirado, C., Alberdi, V., Paniagua, L. L., García-Martín, A., & Rebollo, F. J. (2023). Future Scenarios for Aridity under Conditions of Global Climate Change in Extremadura, Southwestern Spain. Land, 12(3). https://doi.org/10.3390/land12030536

Figure 23 Fernández, M. P., Keshavarzi, A., Rodrigo-Comino, J., Schnabel, S., Contador, J. F. L., Gutiérrez, Á. G., Parra, F. J. L., González, J. B., Torreño, A. A., & Cerdà, A. (2020). Developing scoring functions to assess soil quality at a regional scale in rangelands of sw spain. Revista Brasileira de Ciencia Do Solo, 44. https://doi.org/10.36783/18069657RBCS20200090

Figure 24 Tejeda, Á., & Lavado, J. F. (2018). MODELOS ESPACIALES PREDICTIVOS DEL RIESGO DE SECA EN EXTREMADURA. APLICACIONES A ESCALA REGIONAL Y LOCAL EN ESPACIOS NATURALES PROTEGIDOS.

Figure 25 Simon-Rojo, M. (2023). The role of ecosystem services in the design of agroecological transitions in Spain. Ecosystem Services, 61. https://doi.org/10.1016/j.ecoser.2023.101531

Figure 33 Plieninger, T., Flinzberger, L., Hetman, M., Horstmannshoff, I., Reinhard-Kolempas, M., Topp, E., Moreno, G., & Huntsinger, L. (2021). Dehesas as high nature value farming systems: A social-ecological synthesis of drivers, pressures, state, impacts, and responses. Ecology and Society, 26(3). https://doi.org/10.5751/ES-12647-260323
Luisa De Lázaro, M., & González González, J. (2015). An uncertain future for the dehesa landscape and its sustainable management. https://www.researchgate.net/publication/287816870

Figure 40 Moral, F. J., Aguirado, C., Alberdi, V., Paniagua, L. L., García-Martín, A., & Rebollo, F. J. (2023). Future Scenarios for Aridity under Conditions of Global Climate Change in Extremadura, Southwestern Spain. Land, 12(3). https://doi.org/10.3390/land12030536

Figure 43 Moral, F. J., Aguirado, C., Alberdi, V., Paniagua, L. L., García-Martín, A., & Rebollo, F. J. (2023). Future Scenarios for Aridity under Conditions of Global Climate Change in Extremadura, Southwestern Spain. Land, 12(3). https://doi.org/10.3390/land12030536
Moral, F. J., Paniagua, L. L., Rebollo, F. J., & García-Martín, A. (2017). Spatial analysis of the annual and seasonal aridity trends in Extremadura, southwestern Spain. Theoretical and Applied Climatology, 130(3–4), 917–932. https://doi.org/10.1007/s00704-016-1939-y

Figure 46 CORINE Land Cover 2018 (vector), Europe, 6-yearly - version 2020_20u1, May 2020. (z.d.). EEA Geospatial Data Catalogue. https://sdi.eea.europa.eu/catalogue/copernicus/api/records/71c95a07-e296-44fc-b22b-415f42acfdf0?language=all

Figure 58 Ballabio, C., Panagos, P., & Monatanarella, L. (2016). Mapping topsoil physical properties at European scale using the LUCAS database. Geoderma, 261, 110–123. https://doi.org/10.1016/j.geoderma.2015.07.006
Moral, F. J., Rebollo, F. J., Paniagua, L. L., García-Martín, A., & Honorio, F. (2016). Spatial distribution and comparison of aridity indices in Extremadura, southwestern Spain. Theoretical and Applied Climatology, 126(3–4), 801–814. https://doi.org/10.1007/s00704-015-1615-7
Moral, F. J., Aguirado, C., Alberdi, V., Paniagua, L. L., García-Martín, A., & Rebollo, F. J. (2023). Future Scenarios for Aridity under Conditions of Global Climate Change in Extremadura, Southwestern Spain. Land, 12(3).
Panagos Panos. The European soil database (2006) GEO: connexion, 5 (7), pp. 32-33.

Figure 60 CORINE Land Cover 2018 (vector), Europe, 6-yearly - version 2020_20u1, May 2020. (z.d.). EEA Geospatial Data Catalogue. https://sdi.eea.europa.eu/catalogue/copernicus/api/records/71c95a07-e296-44fc-b22b-415f42acfdf0?language=all

Figure 62 Junta de Extremadura. Servicios map (z.d). http://sitex.gobex.es/SITEX/centrodescargas/view/10

9 Appendix

The inventarisation, categorisation and evaluation of the outcomes of the survey are elaborated in this chapter.

This chapter allows for a deeper insight in the way the fieldwork was conducted, by means of the survey.

Figure 76. Woman walking in a quiet mountain village.

Encuesta

TU Delft Delft University of Technology

Datos personales

Ciudad: _____

Edad: _____ años

Tiempo de residencia: _____ años

Preguntas sobre cultura y comunidad

Cuáles considera que son los aspectos culturales más significativos para esta comunidad?

Qué prácticas o costumbres tradicionales practica?

Hay alguna tradición relacionada con el entorno natural?

Se ha perdido alguna tradición que solías realizar?

En una escala de 1 a 5, ¿qué importancia considera que tiene la conservación de las tradiciones y el patrimonio locales?

1: Nada importante	2 Ligeramente importante	3 Moderadamente importante	4 Importante	5 Muy importante
○	○	○	○	○

Preguntas sobre el paisaje natural

Cómo describiría el paisaje de esta región?

Cuáles son las características más destacadas del paisaje natural?

En una escala de 1 a 5, qué importancia tiene para usted el entorno natural?

1: Nada importante	2 Ligeramente importante	3 Moderadamente importante	4 Importante	5 Muy importante
○	○	○	○	○

Qué aspectos del paisaje valora más?

Se siente unido al paisaje?

¿Cree que el paisaje refleja los valores y la historia de la comunidad? ¿En qué sentido?

Peguntas sobre el cambio

Ha observado algún cambio en la comunidad en la última década?

Sí ◯ No ◯

en caso afirmativo: explique qué cambio ha observado:

¿Cuál cree que es la causa principal de los cambios en la comunidad durante la última década?

- ◯ Factores económicos
- ◯ Factores medioambientales
- ◯ Factores sociales
- ◯ Factores políticos
- ◯ Otros (especifique)

Ha cambiado el paisaje con el tiempo?

Sí ◯ No ◯

Cómo afectó esto a las tradiciones y a la comunidad?

Nota que la población está disminuyendo?

- ◯ Sí
- ◯ No

En caso afirmativo, ¿qué significa esto para usted?

Preguntas sobre conservación de la naturaleza

En una escala de 1 a 5, ¿qué importancia concede a la conservación del medio natural?

1: Nada importante	2 Ligeramente importante	3 Moderadamente importante	4 Importante	5 Muy importante
○	○	○	○	○

Contribuye usted a la conservación y preservación del paisaje natural? ¿Cómo?

Contribuyen los miembros de la comunidad a la conservación y preservación del paisaje natural? ¿Cómo?

Preguntas sobre el futuro

Qué cambios le gustaría ver en este ámbito?

Le preocupa el futuro?

¿Cómo ve las tradiciones en el futuro? ¿Continuarán?

En su opinión, ¿cuáles son los principales retos para esta comunidad?

- ○ Disminución de la población
- ○ Inestabilidad económica
- ○ Degradación medioambiental
- ○ Otros (especifique)

¿Hay algo más que le gustaría compartir?

Survey answers

Questions about culture and community
What do you consider to be the most significant cultural aspects for this community?
“respect for traditions and for our past, which is what has enabled us to inherit the environment we have”
“those related to nature”
“cultural and musical traditions related to traditional festivities“
“nature, traditions, primary production, gastronomy, etc.”
“its traditions”
“being part of the Monfrague National Park, its slate architecture, religious, southern traditions..”
“traditions of the area”
“livestock farming “
“traditions that are passed on from old to young people”
“the marbles “
“the patron saint festival virgen de la jarrera saint isidro labrador”
“traditional festivities such as: holy week, Easter, Easter Sunday, patron saint festivities (virgen de la victoria, virgen del rosario)”
“the face, the parties”
“the altarpiece”
“san agustines”
“the landscapes”
“patronal feasts”

What traditional practices or customs do you practice?
“none” - 4
“the slaughter of the pig”- 3
“respect for the environment”
“socialising with neighbours, pig slaughter, carnival, routes through the countryside”
“sincerely, to give some: the gathering, traditional market, and water nature trail”
“countryside leisure and nature”
“the countryside”
“visit of historical and natural sites and water sports”
“devotion to the patron saint virgin of la jarrera”
“patronable festivals, peñas (groups of friends), vaquillas (young bulls)...”
“easter”

Are there any traditions related to the natural environment?
“traditions related to the natural environment have been lost. The environment has been over-protected and the future has been castrated.“
“none“
“holy week ornament, floral virgin of the olive romenia“
“picking asparagus, routes through the countryside“
“yes, interesting, guided nature walks“
“hiking and nature hunting and fishing“
“here everything revolved around the world of livestock farming.“
“hiking trails“ - 2
“hunting“
“the pilgrimage of San Isidro Labrador“
“pilgrimages“ - 2
“yes“
“the pilgrimage“
“santa catalina romeria“
“saint christopher (pilgrimage)“

Have you lost any traditions that you used to do?
The declaration of the environment as a protected area prevents the enjoyment of our natural environment."
especially the old songs"
singing Christmas carols around the house at Christmas time"
bullfighting tradition in nearby villages and festivals of the "quintos"
that of the drummers"
the slaughter"
No" - 9
I don't know" - 2

On a scale of 1 to 5, how important do you consider the preservation of local traditions and heritage to be?
Very important - 11
Important - 6
Moderately important - 2

Questions about the natural landscape
How would you describe the landscape of this region?
"typical landscape of mediterranean climate. The dehesa as a type of ecosystem."
"preserved, traditional, highly biodiverse dehesa with a high biodiversity, plant and wildlife diversity, and above all birdlife."
"manmade and man-moulded"
"landscape of sierra and dehesa"
"dehesa and mediterranean woodland, biosphere reserve"
"the north is different from the south - it seems that they are not from the same region."
"one of the most beautiful in Spain."
"rural, spacious, quiet and well-kept"
"beautiful"
"unbeatable, but could be better conserved "
"one of the best in spain with its pastano and socarrales"
"green, cosy"
"very nice" - 2

What are the most outstanding features of the natural landscape?
"the characteristic biodiversity of the dehesa."
"the combination of nature and traditional farming and livestock activities"
"the good conservation of the area by the inhabitants of the 'rural' environment, in spite of the administration's disastrous so-called 'conservation' policies."
"Mediterranean forest and dehesa"
"the sierra mediterranean landscape. In dehesa large holm oak groves"
"holm oak woodland, el aruoques and mediterranean woodland"
"the dehesa"
"the views of the mountains, peace, tranquillity"
"clean and quiet"
"its animals, trees, rivers"
"its fauna and flora and its cork oaks"
"large expanses of pastures, holm oaks, animals in semi-freedom"
"the animals"
"the rontano and the sierra of coredos"
"all in extremadura we have the best landscapes"

On a scale of 1 to 5, how important is the natural environment to you?
very important - 17
important - 2

Which aspects of the landscape do you value most?
“the rockrose, the holm oaks and cork oaks”
“rich and varied pastures, holm oak pastures”
“mediterranean forest and dehesa”
“the holm oaks”
“the trees”
“the woodland”
“that they are well cared for”
“the care of the landscape”
“to be preserved in its natural state but with the corresponding maintenance”
“the natural cleanliness”
“the clean air”
“the whole landscape”
“the tranquillity”
“its richness”
“when the countryside is at its most splendorous”

Do you feel connected to the landscape?
Do you feel connected to the landscape?
Yes - 17
No answer - 1
Other: “the politicians have ruined the ‘old’ commitment of the rural population to their environment.“

Do you think the landscape reflects the values and history of the community? In what way?
”does reflect them. The landscape we have is the result of the treatment received by our ancestors.”
”yes, with respect for the environment and resilience to climate change”
”reflected now the population is left out.”
”yes. It is, in the main, shaped by the community.”
”yes, in the sense of preserving the work of our forefathers”
”more in the past than in the present”
”half-heartedly”
”I don’t know”
”if the landscape says a lot sbue all if it is well cared for”
”yes, we are a community with a lot of history”
”not in its totality. It could be improved”
”yes. We have tried to take care of our countryside”
”yes, in how we take care of them”
”yes, because without this landscape we would be like a city and that makes us different.”
”yes, in every way”
”yes, in everything”
”yes, because Extremadura is unique”

Questions about change
Have you noticed any changes in the community in the last decade?
Yes - 13
No - 5
I don’t know - 1

If yes: please explain what change you have observed:
“depopulation, abandonment of livestock and agricultural activities”
“depopulation. Youth has no future.”
“ageing of the population. Lack of generational renewal due to such environmental restrictions and the

sucking in of policies and administration."
"the loss of inhabitants and not being able to take care of the natural environment as it was done before much has changed for the worse"
"people now prefer not to live in rural areas"
"the poor preservation of everything explained above"
"monfrague is not only the natural park but also the surrounding villages should be promoted more."
"The people who work in the countryside are older and there is little generational change. The climate is changing."
"we are not turning into sheep"
"people are less respectful of the environment"
"we are becoming over-prolific"

What do you think is the main cause of change in the community over the last decade?
Social factors - 10
Political factors - 10
Economic factors - 9
Environmental factors - 7
Other (please specify)
"Failure to combine respect for the environment with the progress of our community"
"They should help the surrounding villages more and encourage more tourism"

Has the landscape changed over time?
Yes - 13
No - 5

How has this affected traditions and the community?
"on environmental protection to the detriment of population fixation. There is no future."
"population loss. Excessive conservation of the birdlife has slowed down the population's chances of economic survival."
"it has been charged and the community is on the way to it."
"i dont know" -2
"no more pruning for charcoal and wood, therefore less employment.
"a lot"
"depopulation of villages"
"I see that with each passing year. Because of the neglect of the villages and the lack of promotion of tourism
"we are getting worse."
"in our environment the landscape has not changed much
"by no means"
"yes, because there are fewer and fewer people due to the lack of work."
"they don't allow us to slaughter the best of the land, chorizos, black sausages, pancetta c.t.s."

Do you notice that the population is decreasing?
Yes - 14
Yes a lot - 1
No - 4

If yes, what does this mean for you?
"the disappearance of the surrounding rural population and with it a way of life"
"that we are leaving behind an ageing municipality with no opportunities for young people"
"the disappearance of a people's embezzlement"
"because the villages should have more people coming to them"

“less population”
“the disappearance of traditions and the degradation of environment”
“depopulation, lack of future, ageing population, no activity that generates work”
“the population has decreased a lot due to lack of opportunities promotion of jobs”
“there are more opportunities in the city, the rural world working in the countryside is sacrificed and less and less profitable”
“the loss of jobs and traditions”
“because people are leaving for the big communities to look for work”

Questions on nature conservation
On a scale of 1 to 5, how important do you consider nature conservation to be?
Very important - 15
Important - 3

Do you contribute to the conservation and preservation of the natural landscape? How?
No answer - 5
“Yes, I dedicate myself to conservation”
“Yes, by taking care of it and, as far as I am allowed, by practising traditional uses”
‘Yes. I take care that my animals do not over-exploit the soil. It is very important to calculate the livestock load in order to reach a balance”
“not polluting and respecting the landscape”
“I think so. Respecting it”
“yes by keeping clean and respecting enclosed spaces”
“respecting and taking care of things”
“yes, I recycle, pick up rubbish in the countryside and everywhere else, responsible use of water.”
“yes, cleaning the environment”
“within my means, not littering in the countryside and picking up the rubbish I find on my routes”
“yes, first of all by not littering the countryside”
“Not throwing rubbish in the countryside”
“recycling”
“yes, by not littering the countryside”

Do the members of the community contribute to the conservation and preservation of the natural landscape? How?
“they do“
“some yes others don’t“
“they don’t pollute it“
“yes, respecting the environment.“
“using the resource in a responsible and environmentally friendly way“
“not a lot“
“the vast majority of society does not“
“not always, people are very irresponsible and do not value the rural environment.“
“no“
“yes people are very conscientious and mainly the hunters.“
“yes, they take care of it“
“yes, cleared the mountains and left the old yavodoo customs untouched“

Questions about the future
What changes would you like to see in this area?
“remove unnecessary and unnatural protection measures that impede the development of the community”
“that respect for the environment should not be incompatible with the future of the populations of protected natural areas”
“balancing the conservation of the natural environment with the economic development of rural

communities”
“more plants, more tourism”
“more preservation of the flora and the possibility of pruning cork oaks”
“more investment to maintain customs, traditional livestock farming, encourage young people to stay”
“environmental sensitivity in policy”
“change of politician and everything will be better”
“I would like to see more employment initiatives for young people and not to have to leave the municipality”
“Economic activity that respects the natural environment and provides jobs”
“more work for the future”
“More commitment from the people to the countryside and more protection from the state”
“clearing the bush”

Are you concerned about the future?
Are you concerned about the future?
Yes - 7
“Ofcourse”
“I am concerned mainly for future generations”
“Yes, a lot”
“Yes, especially for my children”
“Yes, the field is ageing and becoming less and less profitable. Costs are rising and sales are stagnating”
“A little. If we take into account the political objective and agenda that the “wiping out” of the rural population.”
No - 1

How do you see the traditions in the future, and will they continue?
”Traditions will be lost with the loss of population.”
”will not continue. The current regulation imprints traditional activities and the evolution towards a better future.”
”no”
”I don’t know”
”will not continue. The current regulation imprints traditional activities and the evolution towards a better future.”
”I hope they will continue the traditions with their counties.”
”in other places I don’t know here we will”
”I don’t think it will continue because they are getting lost”
”yes”
”totally forgotten”
in the short to medium term yes, in the long term I don’t know.”
”I hope so”
”some”
”some, others will dissapear with the years”

In your opinion, what are the main challenges for this community?
Population decline - 8
Economic instability - 11
Environmental degradation - 6

Other (please specify)Is there anything else you would like to share?
”excessive respect for the environment is a brake on the evolution of the population of our country. The only solution is emigration.”
”an environmental management plan cannot exist without taking into account the surrounding population, the ZEPAS have been an example of this.”

”I would like people to be aware of the impact of their actions on the environment we live in because it is the future we leave to our children.”
”for easy opportunities. For youth and jobs.”
”we have to bet more on the countryside and extensive livestock farming. It is healthier, richer and takes care of the countryside.
”no””