D5.3 Europe-LAND telecoupling framework

Conceptual framework for understanding land-use change in various socio-spatial structures

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List of Abbreviations and Acronyms

D	Deliverable
WP	Work Package
EU	European Union
CHANS	Coupled Human and Natural Systems
EGD	European Green Deal
LUCAS	Land use/Cover Area Frame Survey
IACS	Integrated Administration and Control System
SNA	Social Network Analysis

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EXECUTIVE SUMMARY

Aligned with the European leading efforts in climate science and multiple initiatives on climate action and sustainability, the project *Towards Sustainable Land-use Strategies in the Context of Climate Change and Biodiversity Challenges in Europe* (Europe-LAND) focuses on the integration of natural and social sciences to identify, develop, test and implement integrated tools to improve the understanding of the factors behind land-use decisions as well as the stakeholders' awareness and engagement in terms of climate change and biodiversity challenges.

Europe-LAND goes beyond the state-of-the-art and fill in specific gaps associated with integrated indicators for monitoring land-use and land cover change, the effects of awareness and behavioural typologies on pathways to more sustainable land-use across Europe, and interactive tools to explore land use under different scenarios and with participatory approaches.

This Deliverable 5.3 - *Europe-LAND telecoupling framework (Conceptual framework for understanding land-use change in various socio-spatial structures)* is written in the framework of Work Package (WP5) "Supporting climate change mitigation and adaptation efforts and biodiversity policy design". Task 5.2 aims at developing a novel telecoupling framework including the evaluation of various socio-spatial structures, complemented with data, findings and information obtained particularly within WP3, but also within WP2 and WP4. The mentioned WPs emphasise factors, motivations, and awareness but not the contextual immaterial structures (e.g., within and cross-scale social relations and interactions, hierarchical structures, power asymmetries, etc.) that shape the decisions of different actors (e.g., "local" decisions could be shaped by "national" and the "EU" actors and vice versa). This category of information is not accessible via quantitative methods; therefore, the proposed qualitative dimension of the framework can improve the depth of understanding of the management strategies of ecosystem services. It is also important to support the development of targeted sustainable strategies and policies at different levels. The Europe-LAND telecoupling framework will then be reflected in Task 5.3 via its application and comparison in eight Europe-LAND case studies, and the guiding framework will be considered also in modelling future land-use and land-cover change related to the WP5 Task 5.4.

This Deliverable 5.3 plays a crucial role in the project, and its aim is to present a comprehensive dataset that effectively reflects how the project will utilise the data available from other work packages and secondary data. While Deliverable 5.1, a systematic review focused on telecoupling frameworks, was submitted and made publicly accessible[1], already submitted Deliverable 5.2 (*Draft of the Europe-LAND telecoupling framework*) was marked as sensitive internal documentation that was used solely within the consortium for discussion and refinement purposes. Afterwards, a guidebook *Internal guide for application of the Europe-LAND telecoupling framework in case-studies* (Milestone 8, Month 25) was prepared, which was presented and discussed by consortium members during the Europe-LAND 3rd General Assembly in Nitra. D5.3 aims to implement summarised key conclusions drawn from previous two deliverables, including the emphasis on the rigorous application of both quantitative and qualitative methods to ensure a comprehensive understanding of telecoupling interactions. This comprehensive dataset is intended to synthesize information and insights pertinent to land-use analysis across various geographic and socio-economic contexts within Europe.

[1] https://doi.org/10.5281/zenodo.13121046

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DISCLAIMER

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Content

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1. Introduction

The overarching goal of this Europe-LAND telecoupling framework is to **construct and validate a framework capable of analysing land-use strategies through detailed empirical analysis**. This involves the synthesis of existing data and filling knowledge gaps by integrating theoretical and empirical insights. The approach also emphasises adaptability, intending to tailor the framework for application across various socio-spatial structures in Europe. This adaptability ensures that the framework remains relevant and effective in addressing specific local conditions and challenges encountered in different regions.

This deliverable has a layered content structure. It is divided into four thematic sections and one annex comprising of distinct datasets for each of our Europe-LAND case studies which serve as the basis for testing and improving the framework's applicability and robustness in the next phase of research action:

1. Introduction: A general outline and objectives of the dataset, setting the context for its importance within the scope of the project.
2. Methodological background: This section briefly delves into the interdisciplinary dimensions of land use science. It aims to articulate the various methodologies employed in telecoupling research, emphasizing the integration of qualitative and quantitative research approaches. The methodological background highlights key challenges facing climate change research and land-use and outlines significant theoretical concepts that will aid in the interpretation of the collected data in T5.3.
3. Description of the Europe-LAND telecoupling framework: This part explains how the methodologies identified in the earlier section are incorporated into the development of the Europe-LAND telecoupling framework. This framework will serve as a conceptual tool for analysing land-use dynamics across different socio-spatial structures.
4. Conclusions and further steps: This section summarises key methodological insights related to framework development and briefly describes next steps which will be reflected in further research undertaken.

Annex 1: Datasets for the Europe-LAND case studies.

2. Methodological background

Since the 1990s, it has been clear that comprehensive climate-change science must incorporate social sciences, with researchers in sociology, anthropology, geography, and archaeology illustrating how land-use changes contribute to anthropogenic climate change (Moss & Schneider, 2000; Jorgenson & Clark, 2012). Investigations in these domains elucidate the societal factors that influence and are influenced by shifting climatic patterns, emphasising the role of economic systems, social institutions, power dynamics, and demographic trends in land-use decision-making (Thomas et al., 2018; Tierney, 2019). Sociology provides insights into the social determinants affecting both mitigation and adaptation, emphasising the policy and cultural conflicts that shape the framing of climate solutions (Dunlap & Brulle, 2015). These viewpoints highlight the relevance of the **telecoupling framework as a significant paradigm**. It examines the interactions across many systems while elucidating the functions of cross-scalar governance and actor networks that facilitate environmental flows and impacts

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(Voulvoulis et al., 2022). This viewpoint necessitates focusing on location-specific factors and the dynamics of human-environment interactions at various scales (Köppel, 2020; Munroe et al., 2019). Several approaches and frameworks of interdisciplinarity are essential, including the judicious use of qualitative and quantitative methodologies (Friis & Nielsen, 2019).

The dedicated Europe-LAND telecoupling framework encapsulates several foundational themes drawn from the first deliverable (**see D5.1 Analysis of telecoupling frameworks**). Among these, the framework underscores the need to integrate both quantitative and qualitative research methodologies, which serve to create a more comprehensive understanding of telecoupling interactions and land-use strategies. According to Arts et al. (2017) this approach needs to adopt a specific interdisciplinary and collaborative model, which builds on the concept of a 'T-shaped' professional model: The key idea is that for successful interdisciplinary or intersectoral collaboration, professionals need to be experts in their own fields in the first place. At the same time, they need to possess the competencies to look beyond the boundaries of these and work together with other experts, while being able to integrate or at least combine different knowledge domains. The authors of the paper opt for dealing with several key dimensions and privilege the following ones: (a) the ecological dimension, (b) the economic and developmental dimension, (c) the socio-cultural dimension; and (d) the political dimension.

2.1 Variety of telecoupling frameworks

Telecoupling frameworks were inspired by theoretical and practical foundation for research on **Coupled Human and Natural Systems (CHANS)** developed by Liu et al. in 2007. The concept of telecoupling substantially expanded the scope of the analysis and allowed links to traditions in the natural sciences and social sciences that emphasized actions at a distance across the world. The integration of socioeconomic and environmental interactions is a major difference between the telecoupling framework and previous frameworks of distant processes. The framework of telecoupled human and natural systems was developed to facilitate primarily quantitative analyses of such linkages (Liu et al., 2021). Telecoupling was also designated as a research priority by the *Global Land Programme*[2] and featured in important reports such as the *Global Assessment of Biodiversity and Ecosystem Assessment*[3] (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) and *Global Environment Outlook*[4]. Most CHANS models currently available are established on the global scale, targeting large-scale human and natural dynamic issues such as climate change impacts. However, frequent environmental human conflicts are occurring locally and regionally, while CHANS models built at these scales, which are more relevant for policy and management, are scarce. Therefore, the development of regional CHANS models should be prioritized to facilitate the decision-making process for promoting regional sustainable development (Li et al., 2023). To capture interactions within and among adjacent and distant CHANS, a new integrated framework of **metacoupling** (human-nature interactions within as well as between adjacent and distant systems) has been developed (Liu, 2017). The metacoupling framework consists of the **intracoupling** (human-nature interactions within boundaries), the **telecoupling** framework, the framework of **pericoupling** (human-nature interactions between adjacent systems), and the interrelationships among intracoupling, telecoupling, and pericoupling (Liu et al., 2021). Telecoupling, among the three, was the first to be designed, and has been quickly adopted by scholars to explore various issues including land-use changes (as described in D5.1). Later, pericoupling and intracoupling were proposed along with

[2] https://glp.earth/

[3] https://files.ipbes.net/ipbes-web-prod-public-files/inline/files/ipbes_global_assessment_report_summary_for_policymakers.pdf

[4] https://www.unep.org/resources/global-environment-outlook-6

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telecoupling to form the comprehensive metacoupling framework. Several examples have used the different couplings to explore interactions between systems via different ranges of distance (Dou et al., 2020).

A **telecoupling framework** (Liu et al., 2013) consists of **five distinctive components**: i) system, ii) flow, iii) agent, iv) cause, and v) effects:

- The **system** can further be divided into a) sending, b) receiving, and c) spillover, which refer to the source and receiver of the flow, and the systems are a byproduct of the connections between sending and receiving systems.
- The **agents** promote or hinder the flow of material/energy or information among the systems, which can be conducted by individuals or organisations.
- **Flows** refer to the exchanges of material/energy or information between the systems.
- **Causes** are factors that generate the dynamics involved in telecoupling, such as economic, political, technological, cultural, and ecological causes.
- **Effects** refer to the ecological environment and socio-economic consequences and impacts caused by telecoupling.

In 2019, one of the key publications on *Telecoupling: Exploring Land-Use Change in a Globalized World* edited by Friis and Nielsen mentioned four types of methodological toolboxes for telecoupling research in recent years, including: flow analysis, network analysis, spatial analysis and modelling, and qualitative ethnographic research. Telecoupling researchers do not use all the above components to develop a study project but will always focus on some dedicated components to explain the actual situation. According to the analysed literature, there are **three archetypes of academic researchers:**

- System-oriented researchers: **Analyzing** the relationship between the political economy's structure and the environment of land use, including international trade, international initiatives and agreements, and national policies. These studies explore how environmental management is affected by the political and economic conditions in different regions.

- Flow-oriented researchers: **Perceiving** flow situations as a network and discuss this relationship through the existing network analysis.

- Agent-oriented researchers: **Mainly exploring** the characteristics of the agents and their roles within a telecoupling system.

Within Europe-LAND, we combine the above-mentioned flow-oriented and agent-oriented perspectives, because they are, for our purposes, the most relevant approaches as they are linked closest with the stakeholder interaction integral to Europe-LAND's overall methodological approach. Flow-oriented methodologies monitor land-use transformation's spatial and material aspects, quantifying the movement of goods, services, or innovations across regional and national borders. Simultaneously, agent-oriented research elucidates how local actors perceive these flows, either adapting to or resisting them, and how they impact choices via governance networks at various levels (Hull & Liu, 2018; Voulvoulis et al., 2022). By synthesising various viewpoints, the framework therefore includes tangible effects (such as land conversion or ecological alterations) and the fundamental motivations (such as social norms or institutional regulations) influencing land-use changes. This thorough approach is essential for understanding how various actors are influenced by global markets, climate change interventions, or biodiversity programs.

A further benefit of making use of a telecoupling framework is that it avoids the binary opposition between local and larger scales, as well as the infinite subjects in the range of research. The system's

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interaction is not only caused by the absolute distance, but also the institutional and interactive social distances that are a measure of the "strength" of the social ties. Telecoupling researchers not only consider the environmental factors involved, but also thoroughly understand the social systems, cultural habits, and human interactions associated with the utilisation of natural resources. This framework is particularly important in socio-ecological systems with special institutions and customs (as it is represented by the Europe-LAND case studies)[5]. Furthermore, the systems, flows, and agents involved in the telecoupling framework correspond precisely to the political–economic structure, network relations, and acting characteristics.

2.2 The Europe-LAND telecoupling framework: key concepts and theoretical perspectives

An analysis of 138 papers (see public Deliverable D5.1) revealed that telecoupling is used to examine socioeconomic and environmental impacts across extensive distances and several disciplines (Hermans et al., 2023). Particular research uses qualitative methodologies that elucidate the governance and institutional intricacies of telecoupled systems. An example utilises qualitative document analysis, semi-structured interviews, and secondary research to evaluate water use, greenhouse gas emissions, and governance strategies (Marola et al., 2020). Another study combines ecological service mapping with Value Chain Analysis to investigate seafood supply and human well-being (Drakou et al., 2018). Comparable methodologies, such as focus groups and social network studies, enhance also comprehension of local stakeholders' viewpoints about the Sustainable Development Goals (Andriamihaja et al., 2021). In different situations, for example mental models illustrate the shift from forest exploitation to more sustainable forest management within a socio-technical framework (Garcia et al., 2020). Simultaneously, participatory mapping and field surveys provide a comprehensive perspective on evolving land-use changes (Zaehringer et al., 2018). High-resolution imaging elucidates the allocation of advantages and disadvantages of plantation growth, guiding governance deliberations (Lathachack et al., 2023). These selected qualitative designs together emphasise the influence of institutions, stakeholders, and policies on remote environmental outcomes.

We summarised some basic conclusions and challenges for further and future research from the first deliverable (D5.1), which was implemented and taken into account in the Deliverable 5.2 that resulted in a first draft telecoupling framework, in this Deliverable 5.3, and in our future scientific work. **Three specific challenges of current frameworks and related research action** are needed to be considered in the further development of telecoupling frameworks in general, and for the Europe-LAND telecoupling framework in particular:

- Firstly, *quantitative methodologies* in studied papers exhibit high certainty due to detailed reporting and broad applicability, while *qualitative approaches* face challenges related to the variability in application and reporting, affecting our confidence in these methodologies uniformly.

- A second key conclusion is that the synthesis highlights the importance of *integrating both quantitative and qualitative research approaches* to capture the full spectrum of telecoupling interactions.

- Finally, building on the synthesised methodologies, future research should *prioritise the empirical application of telecoupling models* to real-world scenarios in Europe, because the majority of studies were outside of Europe.

[5] https://europe-land.eu/about-europe-land/

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Further challenges for research were indicated as not as gaps but as **missing aspects**. Studies and existing research are related to identification of sustainable land use management practices and defining what institutions, strategies and policies are needed at different levels. These levels will be mentioned more times in next chapters, and we have defined them within the project (ref. D1.1/D1.2/D1.3 Project Management Handbook). The regional and local levels are levels of case studies, and the environment in which they operate, and the contextual covering level is understood as the EU level. Then a further challenge is related to including a bottom-up representation also of issues like well-being, social and physical, because it is very strongly related to the fact how mitigation and adaptation efforts can affect the living standards in diverse conditions and circumstances, as well as better integrating of the issue of the institutional effectiveness and governance in the frameworks and models to improve the representation of differentiated capacity and policy feasibility and also better understanding of social perceptions and socio-psychological aspects of climate change in bringing motivation and societal readiness for adopting, for example, sustainable practices.

Our approach respects the **critical importance of social and economic factors influencing changes in land-use patterns**, including demographic changes, social attitudes, traditions and social norms, individual behaviour, ownership and competing economic sectors seeking to maximise profit opportunities. These components are institutionalised through, inter alia, land-use planning policy, property rights, taxation policy, environmental designations (international, European, national and local) and agri-environmental policy, and are also shaped by competing political or sectoral priorities.

Firstly, a sustainable land use strategy should be based on a **complementary view of land** as a relationship between different forms of capital and the values it represents. For understanding (valuing/measuring) land as a symbolic capital we will use Pierre Bourdieu's framework on different forms of capital.[6]

Three key perspectives on land:

1. land as a **commodity** (economic capital) with a focus on sectoral aspects of land-use;
2. land as a **social value** (social and cultural capital), with the aim of understanding the wide range of attitudes and preferences of multiple stakeholders towards land use and land use change, not only in relation to material landscape features, but also to their intangible aspects and in the context of local identity formation;
3. land as a **natural heritage** (natural capital) in a broader socio-economic context, emphasising the concept of ecosystem services and the application of ecosystem services in policy and decision-making processes.

The main objective of our methodological approach is to develop a concept for the analysis of land-use strategies in various conditions by **synthesizing quantitative and qualitative data** assessing the potential of land-use patterns from different perspectives; and to stress that land-use is a complex system with multiple elements and interrelationships, with the methodological starting point being the concept of multidimensional capital, which allows to understand land as a basic resource in terms of economic, social, cultural and natural capital. This interdisciplinary research strategy will allow a more comprehensive understanding of the complexity of land-use change and the identification of land-use

[6] Pierre Bourdieu, one of the most influential sociologists of the 20th century, made substantial contributions to the understanding of social structures and power dynamics through his concept of "capital." Bourdieu (1986) expanded the notion of capital beyond the economic domain, identifying various forms that individuals and groups can possess and mobilize to maintain and enhance their social positions.

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strategies that best contribute to climate change mitigation and adaptation and biodiversity conservation.

Secondly, in our work we will use the concept of "winners and losers" (O'Brien & Leichenko, 2003) in the context of climate change applying the dynamic characterizations in terms of identification of winners and losers following in conjunction with longer-term processes and resulting from larger structural processes. We will also aim to combine two perspectives - the emergence of winners and losers is the natural and inevitable consequence of ecological or economic processes, and the presumption that they are deliberately generated by inequitable social and political conditions.

3. Description of the Europe-LAND telecoupling framework

In a first draft deliverable, we proposed a straightforward version of a telecoupling framework (Figure 1), one that is adaptable on various case studies, comprising the following key elements:

- sending system = local system (case study);
- spillover system = policies, governance (regional/national/global levels);
- receiving system = socio-economic system (regional/national levels);
- flows = exchange of different forms of capital, technology, information, labour, and products and services;
- agents/actors = individuals and organizations connected by flows.

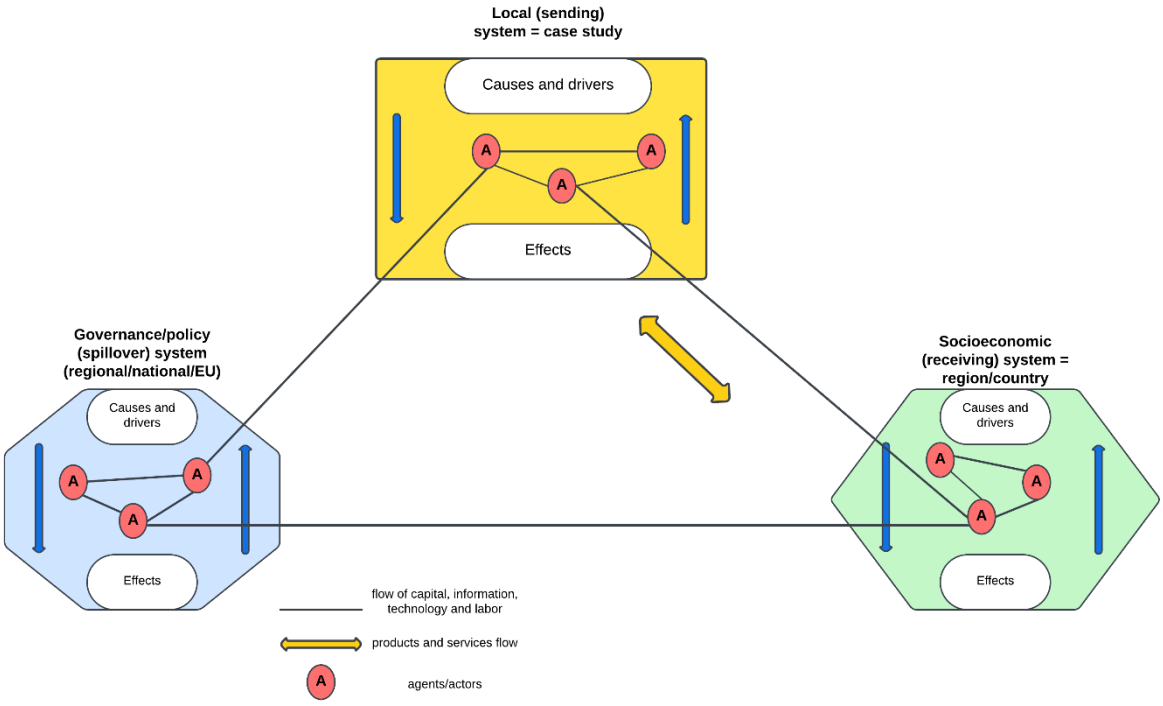

Figure 1: Draft of the Europe-LAND telecoupling framework in D5.2

The local system refers to our heterogenous Europe-LAND case studies. This is the yellow part of the scheme. These case studies thus represent this local sending system. The green part on the right side represents the receiving system, which refers to the socio-economic system in each country or region

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where the case studies are located. The spillover system on the left side refers to the governance or policy system at different levels, which are also defined in our project. The black lines denote the flow of information technology capital and labour; the yellow line is understood as the flow of products and services between the local system and the regional or national socio-economic system in the country. The red dots are agents or actors. We understand both terms as complementary because social science usually uses the term actors. However, in the context of telecoupling, it refers to agents.

Based on discussions within our team, we have revised and clarified the original proposal in line with the umbrella concept of metacoupling (Liu, 2017; Liu et al, 2021; see also section 2.1 of this deliverable). Interactions that occur within CHANS system are *intra*coupling. Interactions that occur between systems are *inter*coupling, while between adjacent systems are *peri*coupling and between distant systems are *tele*coupling. Here we have used intracoupling and pericoupling, while telecoupling that refers to larger global contexts is only outlined.

We defined the Europe-LAND case studies as the local CHANS that constitute local agents, and as the focal system of our analyses, they can be part of a pericoupled or telecoupled system. Our case studies interact with other systems through flows of capital, technology, labour, information, and products and services. Local CHANS are always a part of a larger system (pericoupled and/or telecoupled system).

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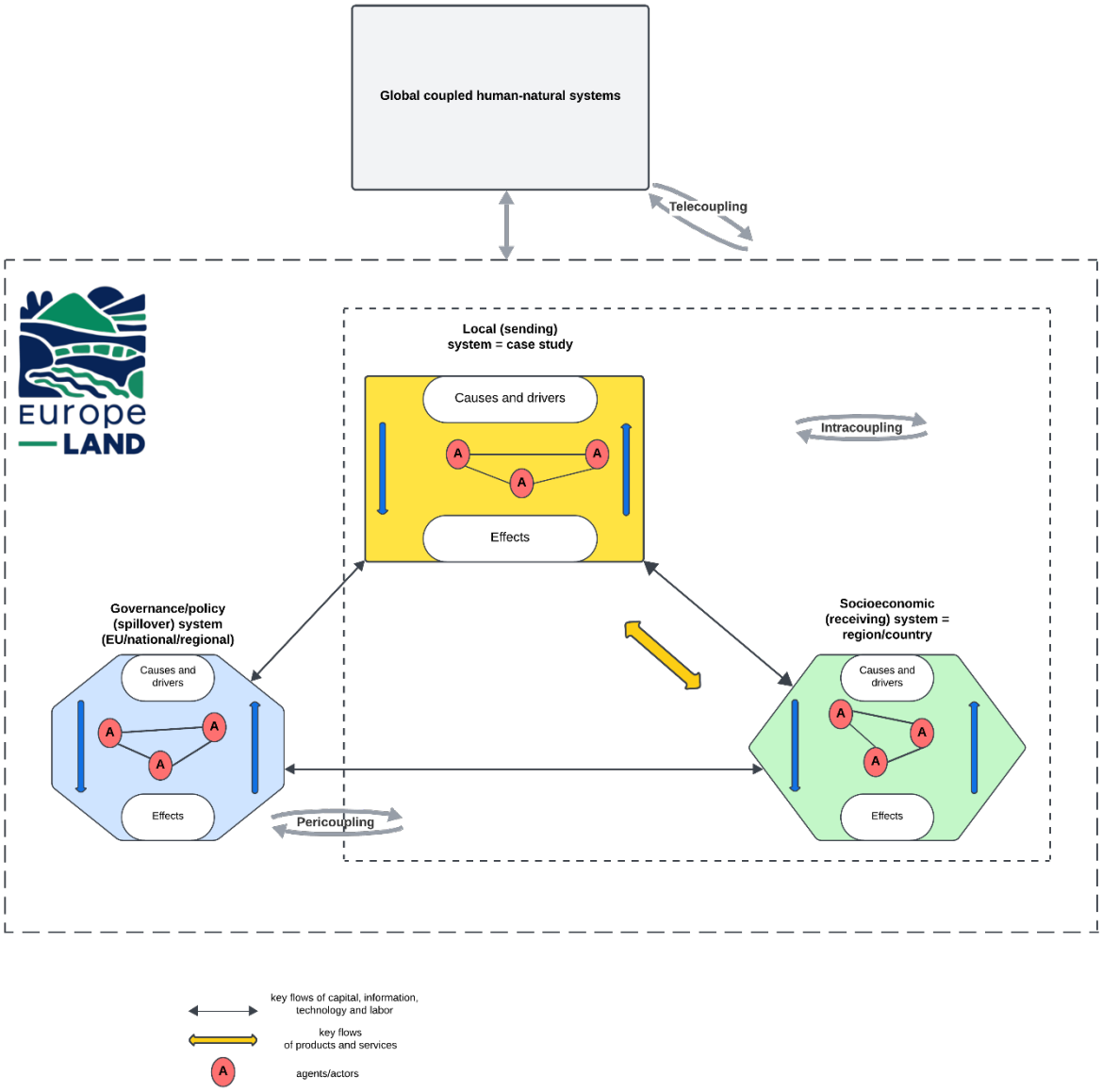

Figure 2: Final version of the Europe-LAND telecoupling framework

The **concept of proximate causes and underlying driving forces** from former studies was used, because it systematically assesses the two different classes of drivers behind land-use change. Proximate causes are generally human activities or immediate actions at the local level that have direct impact on land cover and land use. These factors are the direct reason for land-use change, but to explain the reason for the proximate causes, underlying driving forces have to be assessed. The word 'causes' was used to describe the direct explanatory reason for land-use change, whereas 'underlying forces' was used to describe the more indirect reasons. 'Factors' and 'drivers' were used as umbrella terms for anything creating land-use change.

The next scheme (Figure 3) deals with the analysis of factors and causes. We have used a term that is often used, namely the notion of proximate causes and underlying drivers. It has been used in some studies (Friis & Nielsen, 2014; Geist & Lambin, 2001; Geist & Lambin, 2002; Lambin & Geist, 2006) but usually based on metadata. We have followed the recommendations and suggestions for further research where it was recommended to combine both quantitative and qualitative data when using this concept of proximate causes of underlying drivers. Thus, proximate causes are usually or generally

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human activities or some intermediary activities at the local level that have a direct impact on land cover and land use. And it is these factors that are the direct cause of land use change. But to explain the proximate causes, it is also necessary to consider the underlying driving forces. These therefore describe the more indirect causes.

The design of the following table (Table 1 A., B.) is an example of how we have summarized data and information, which can take different shapes and forms. They are indicators, quantitative data, facts, but also descriptions, qualitative explanations, etc. We categorized the data for each case study to make it easier to conduct further comparative analyses in the frame of Europe-LAND's work package 5.

In terms of periods, we considered thoroughly how or what period to focus on in particular. The study on transitions in land management regimes in Europe between 1800 and 2010 by Jepsen et al. (2015) defined the key historical periods for each country covering 200 years for 28 European countries. Key methodological challenge of the study was to identify the predominant drivers of land-use change at the national level. We have continued the diachronic analysis, focusing on the last two decades. We have followed up with two periods starting in 2004, when all the countries mapped were already EU Member States. The adoption of the European Green Deal (EGD) strategy and pandemic crisis could be a milestone in some cases, too.

Table 1: Example of structured dataset of basic telecoupling elements for every case study

A. Period[7] 2004-2018

System	Main land-use types	Agents	Causes (domains)[8]	Drivers (domains)[9]	Effects (domains)[10]

B. Period 2019-2024

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)

Main land-use types[11]

Land is the basis for most biological and human activities on the Earth. Agriculture, forestry, industry, transport, housing and other services use land as a natural and/or an economic resource. Land is also an integral part of ecosystems and indispensable for biodiversity and the carbon cycle. Land can be divided into two interlinked concepts:

[7] If there were no relevant differences between these periods, only one table was used.
[8] See Figure 2 and 3: infrastructure expansion, agricultural transformation, industrial development, other factors. Reasons behind intracoupling and pericoupling in our framework.
[9] See Figure 2 and 3: demographic, economic, technological, political and institutional, cultural.
[10] See Figure 2 and 3: consequences of intracoupling and pericoupling in our framework.
[11] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=LUCAS_-_Land_use_and_land_cover_survey

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- **land cover** refers to the biophysical coverage of land (for example, crops, grass, broad-leaved woods, or built-up areas);
- **land-use** indicates the socioeconomic use of land (for example, agriculture, forestry, recreation or residential use); areas of land can be used for residential, industrial, agricultural, forestry, recreational, transport etc. purposes.

We have used the **main classes** defined in the LUCAS land use nomenclature[12] as follows:

- Agriculture
- Forestry
- Fishing
- Mining and quarrying
- Hunting
- Energy production
- Industry and manufacturing
- Transport, communication networks, storage and protective works
- Water and waste treatment
- Construction
- Commerce, finance and business
- Community services
- Recreational, leisure and sport
- Residential
- Unused.

All above mentioned categories and indicators were identified by the responsible team and persons for each case study, as the structure of indicators for infrastructure expansion, agricultural transformation, industrial development and other factors may be different. In the next phase of our project work, we will look into the detailed definition of these indicators and also the sources, as we should use statistical data here, but also data from other work packages (e.g., IACS data from WP2 at the level of individual case studies). In this document D5.3 some examples of secondary data and sources are already available. We have used the insights from expert interviews, and we also considered outputs from the analysis of policy incentives and institutional factors, all conducted in the frame of Europe-LAND's Work Package 3. The inputs from the Work Packages 4 (modelling) and 6 (user-friendly interactive toolbox) will be integrated later as they will broaden the scope of understanding of all these factors and causes and visualise them in the one-stop online platform.

[12] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Land_use_-_cover_area_frame_survey_(LUCAS);
https://ec.europa.eu/eurostat/databrowser/view/lan_use_ovw/default/table?lang=en&category=lan

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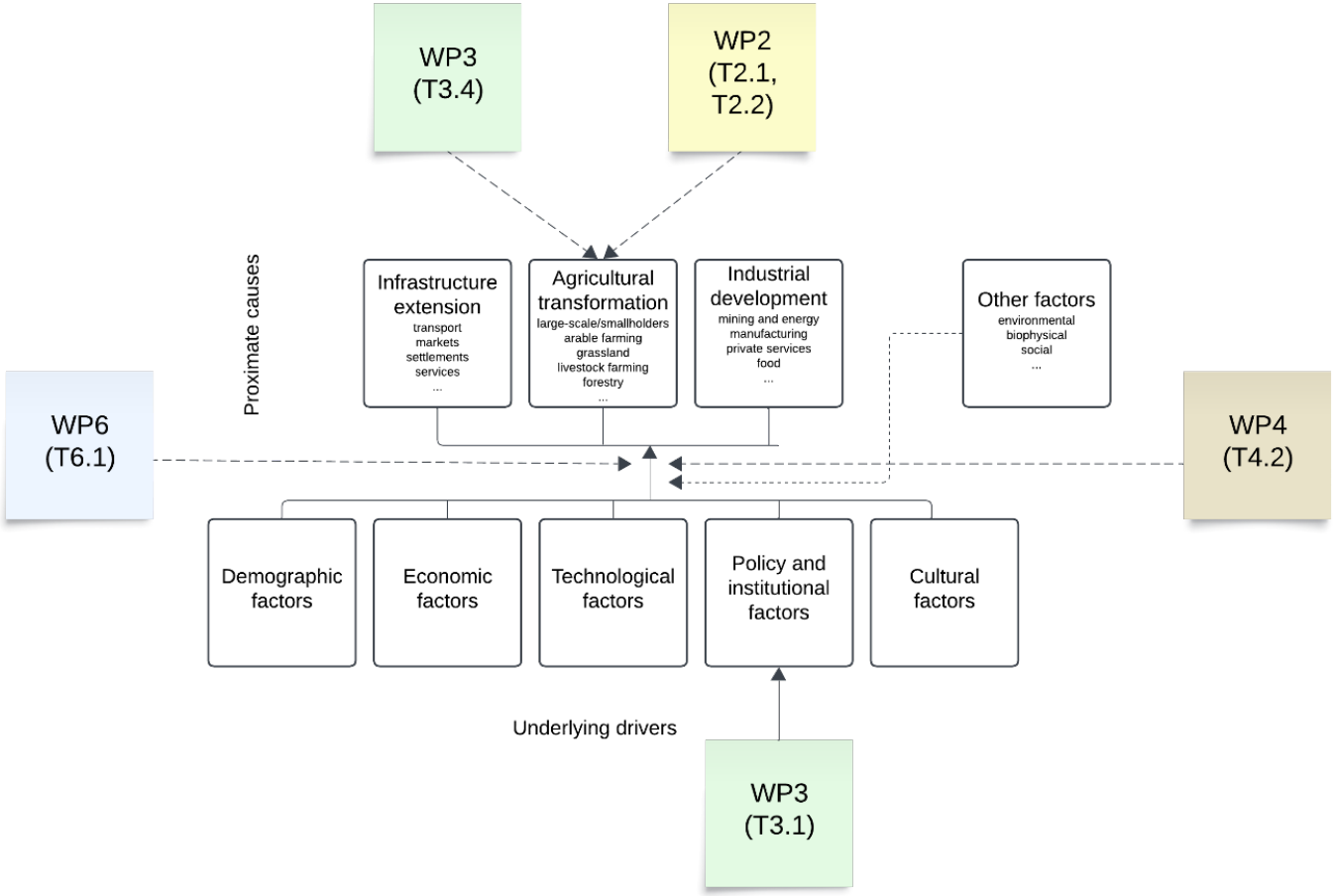

Figure 3: Structure of proximate causes and underlying drivers and their WPs linkages

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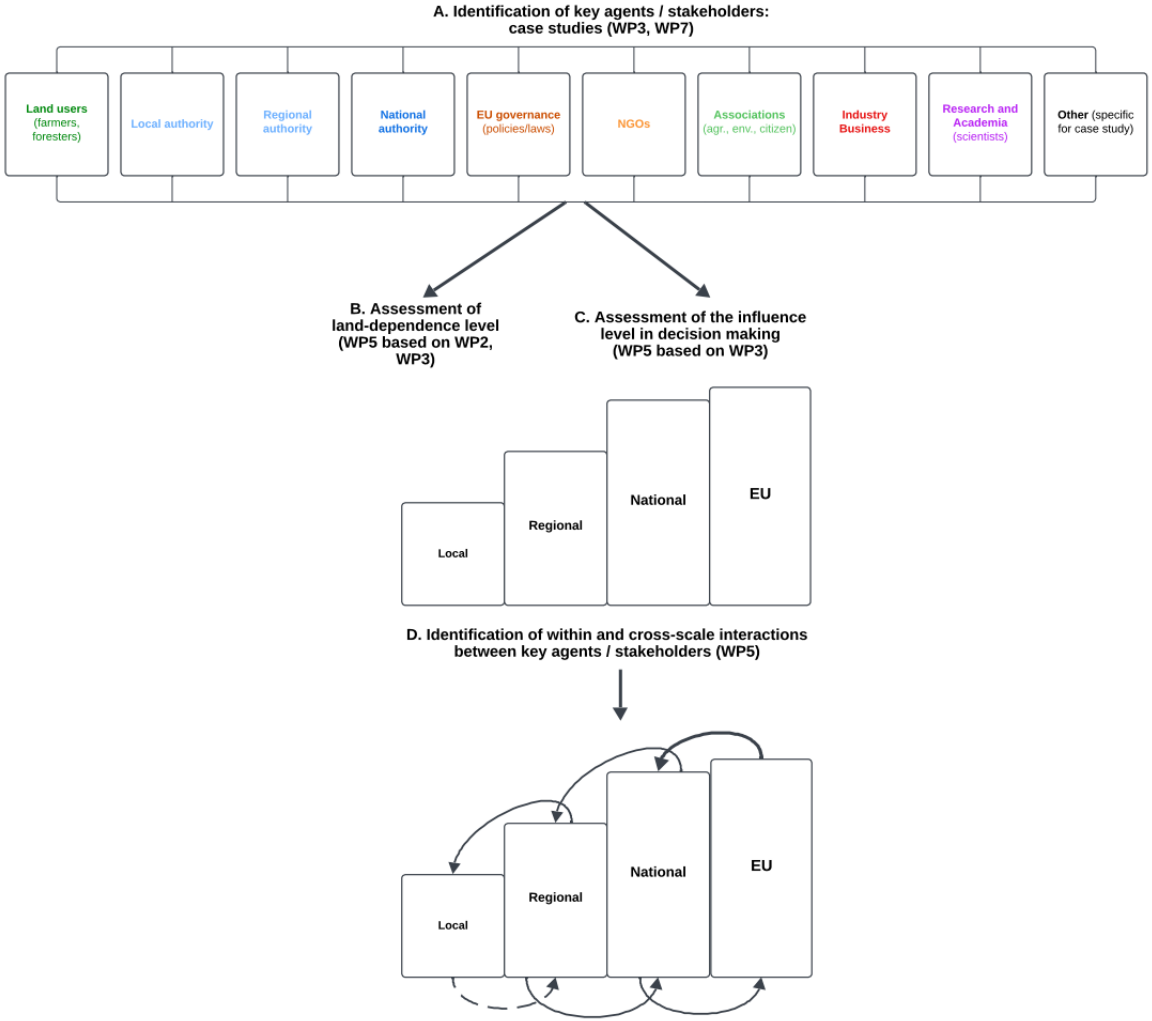

Figure 4: Steps of agents/stakeholders' analysis

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Furthermore, the Europe-LAND telecoupling framework has adopted the **agent-oriented approach**, or agent-oriented approach. We have divided the analytical work into several steps (Figure 4).

The first **step A.** has been taken – a detailed **identification of key agents, social actors, and stakeholders**, was done within the project in relation to WP3 and WP7. We have more categories defined in our research database but merged some – now totaling 10 categories of agents, actors, or stakeholders. Within the individual case studies, every case study has identified the key actors at these levels. Key actors at the local level should be in line with respondents selected for semi-structured expert interviews and target groups of questionnaire survey.

The second **step B.** resembled the **assessment of actors' land dependence level** based particularly on data from WP3. Actors at each level were assigned a relative score according to their dependence on land-use and according to their capacity to influence decision-making (**step C.**). We understand dependence as the level by which actors' well-being relies on the defined land-use type. Influence we understand as the capacity of actors to determine and control land management. The land dependence level and the level of presence of actors in decision making has been interpreted in a simple way - low, medium, high - based on content analysis of experts' opinion.

*Table 2: Example of structured information for the case study related to agents/actors' analysis at **local level**[13]*

Key agents[14]	Stakeholder category[15]	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A					
B					
…					

Methodological tools that also contribute to assessing the actors' land dependence level and influence level in decision-making processes at different scales were rainbow diagrams and influence-dependency matrices (Section 5 of this deliverable).

The last **step D.** (Figure 4) was the **identification of within and cross-scale interactions** between different agents or social actors/stakeholders. This is the mix of quantitative and qualitative data and comparison of Eastern and Western European cases that will be done later in task 5.3. The level of presence of actors in decision making is interpreted in a simple way - low, medium, high based on qualitative analysis.

[13] Similar tables were prepared for the regional and (or) national level, and for the EU level (depending on character of the case study).
[14] According to tables in part I./A, I./B of case studies datasets.
[15] According to the Figure 4.

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Table 3: Example of basic SNA matrix

Key agents[16]	A	B	C	…
A				
B				
…				

Methodological tools to identify social relations among actors are listed in Table 4 and they also include social network analysis (SNA).

Table 4: Methodological tools and qualitative data and information sources for WP5 tasks in the Europe-LAND project

Tool	Description	Source	Steps
Brainstorming	The identification of key persons and the creation of a comprehensive list of potential stakeholders, taking into account the different categories of stakeholders.	WP7, WP3	A.
Stakeholder workshop/mirror workshop	Facilitate workshops where stakeholders can share their perspectives, identify their concerns, and define their roles.	WP3	B., C.
Expert interviews	Pre-arranged semi-structured interviews based on a guide or structure (a list of topics or questions to address) but not constrained by it.	WP3	B., C.
Rainbow diagram	Tool to classify social actors according to the degree they can affect or be affected by a problem or action.	WP3	B., C.
Influence-dependence matrix	An analytical tool for sorting social actors in a two-dimensional graph according to their relative level of interest and influence on a specific environmental issue.	WP3	B., C.
Net-Map	An interview-based mapping tool that enables the identification of complex formal and informal relations and power relations among social actors.	WP3	D.
Content analysis	Content analyses are a group of research methods used to explore the goals, messages, and impacts of communication content. By analysing texts, researchers can draw conclusions about the individuals or groups who produced and received the messages.	WP3	D.
Social network analysis	Social network analysis does not focus solely on the characteristics of individual actors but also examines how actors are distributed within the network, which subgroups of actors emerge based on their relationships, and how relationships within the network are structured overall.	WP3	D.
Actor-linkages matrix	Mapping and descriptive tool used as starting point for discussing relationships (usually based on flows of information) between key actors. One of the main aims is to explore power relationships in the control of flow of information	WP3	D.

[16] Categories of agents (stakeholder categories as in step B.) at all levels (local + regional/national) + EU governance (spillover system).

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Finally, the Europe-LAND telecoupling framework is expected to provide a comprehensive toolset for understanding the complexities of land-use interactions in a European context. This framework is expected to be highly flexible and adaptable across a variety of socio-spatial structures represented in the Europe-LAND case studies included in the project. Furthermore, the ongoing tasks within other project work packages will support comparing results from various case studies to understand regional differences, feedback loops, and the interconnectedness of various socio-environmental factors influencing land-use in T5.3.

4. Conclusions and further steps

This Europe-LAND telecoupling framework offers an **innovative tool for comprehending land-use change as one of biodiversity challenges[17] by integrating quantitative and qualitative research approaches** and adopting an agent-oriented approach. It addresses significant deficiencies in existing climate and biodiversity policy formulation while thoroughly comprehending socio-spatial systems and interrelations. The framework integrates system, flow, and agent views to examine the effects of governance, socio-economic systems, and policy interventions at various scales, providing a comprehensive approach to sustainable land management.

This Deliverable 5.3 has proven crucial in **integrating existing data and datasets from other WPs** and **enhancing methodological principles** applicable across many socio-spatial situations. The amalgamation of quantitative and qualitative variables facilitates a comprehensive understanding of coupling interactions, considering environmental, socio-cultural, and economic issues that affect land-use choices. This deliverable's methodological framework emphasizes significant obstacles and possibilities for the progression of land-use research:

- **Integrating qualitative insights with quantitative data substantially enhances the comprehension of various coupling exchanges** (intracoupling, pericoupling, telecoupling).
- The framework's **focus on proximal causes and underlying drivers** offers a thorough perspective for analysing land-use change, including immediate human activities with deeper socio-economic and institutional factors.
- The **scalability of the Europe-LAND telecoupling concept** across the Europe-LAND regional case studies is a significant strength, enabling the assessment of distinct local dynamics while accounting for broader impacts. This flexibility is crucial for addressing the varied socio-spatial structures across Europe, as it guarantees that the framework stays relevant and successful in distinct regional settings.
- The **local, regional, national and European linkages** examined within the framework highlight the significance of comprehending **land-use as a complex problem necessitating coordinated efforts across many government levels**.

In the remaining implementation period of Europe-LAND, this research will **test the offered approaches and improve the framework's applicability and robustness** by applying them to real-world case studies. This iterative approach is essential for guaranteeing that the framework effectively tackles

[17] https://biodiversity.europa.eu/topics

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present difficulties in land-use management while also maintaining the flexibility to adapt to future requirements and changing environmental and socio-economic situations.

In summary, the Europe-LAND telecoupling framework is a structured means to assist stakeholders in comprehending and regulating land-use change under climate change, thereby facilitating the formulation of more precise and practical sustainable solutions across several government tiers. The framework facilitates the possibility of integrating scientific research and policy-making by fostering collaboration and communication between researchers and policymakers within the project using planned tools and methods, promoting the development of evidence-based policies attuned to local settings and consistent with overarching climate and biodiversity objectives. All in all, the insights from this research are anticipated to guide policy and practice, promoting a more resilient and sustainable approach to land-use management across Europe.

Finally, the Europe-LAND telecoupling framework will be reflected in further research undertaken , e.g. in the frame of a **comparative study on land-use causes and transitions** via its application and comparison of eight Europe-LAND case studies, and the guiding framework will be considered also in modelling future land-use and land-cover changes related to the modelling tasks within Europe-LAND.

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Annex: Datasets for the Europe-LAND case studies

The team of authors has generated distinct datasets for each of Europe-LAND case studies which serve as the basis for testing and improving the framework's applicability and robustness.

The structure of datasets is following:

- **Introduction** (Geographical location; Short description of the case study context, land-use pattern and land management; Dataset Description)
- **Basic telecoupling elements**

  A. / B. Period / Periods

  C. Spillover system - Governance / policies (regional / national / EU)
- **Key agents / stakeholders**

  A. Identification

  B. Assessment of stakeholders' land dependence level (at local, regional / national level)

  C. Assessment of their influence level in decision making

  D. Identification of within and cross-scale interactions between agents / stakeholders.

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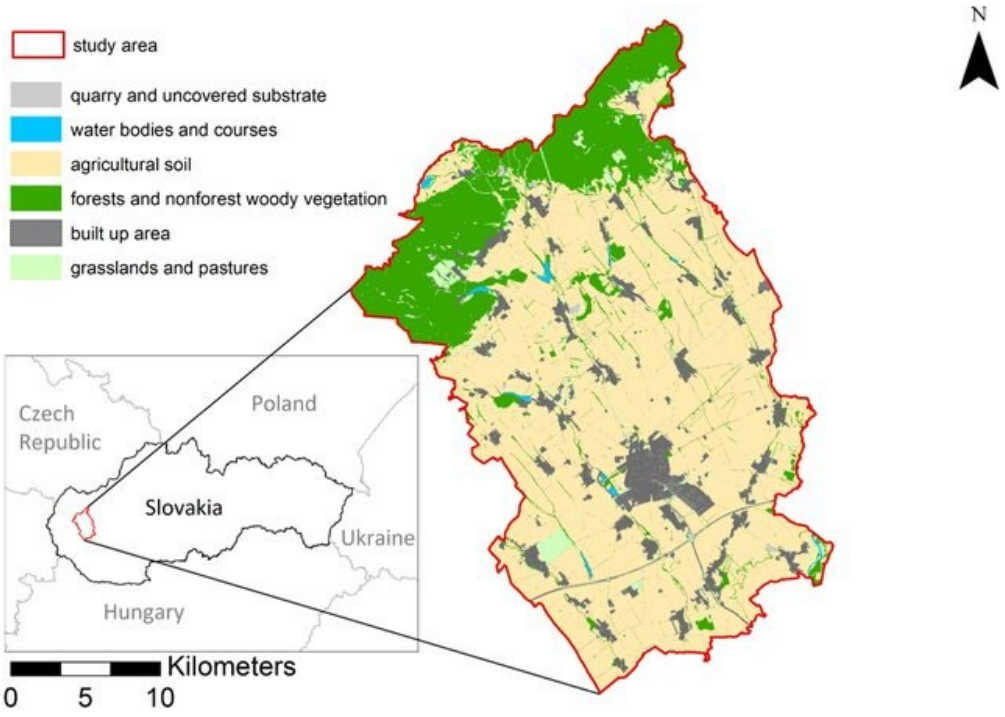
1.1 Slovakia: LTSER Trnava

Introduction

LTSER Trnava[18] is located in the south-west Slovakia, in territory of one city (Trnava) and 22 rural municipalities with total area of 364 km^2. The main part of the LTSER (central and southern parts) is located in the Danubian Lowland. City Trnava represents the administrative centre of the county and region with highest population, trade and industry. The LTSER represents intensively used industrial and agricultural area with specific environmental problems (strong degree of contamination of environment, the degradation processes of agricultural land, etc.) and low degree of ecological stability. Use of the most productive soils for construction of industrial parks represents a significant environmental issue.

Current landcover of the study area of Trnava LTSER platform



Annex Figure 1: Current landcover of the study area of Trnava LTSER platform

Source: Izakovičová, Z., Miklos, L., Spulerova, J. et al. Data collection for assessment of the natural capital at the regional level: case study of LTSER Trnava region. Environ Sci Eur 36, 65 (2024). https://doi.org/10.1186/s12302-024-00894-w

Arable land dominates (75.1 %), followed by forests (13.1%), water bodies (0.5%), vineyards, orchards and gardens. Because of the best, most fertile soils and favourable climatic condition, it is intensively used for agriculture, especially as arable land. Hilly northwest part of the LTSER, located in the Little Carpathians Mts. belongs to the Malé Karpaty Protected Landscape Area. This is the only large

[18] https://deims.org/fabf28c6-8fa1-4a81-aaed-ab985cbc4906

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protected area having vineyard character in Slovakia; vineyards forms transition belt between lowland arable land and forested hills/mountains. Several types of deciduous forests are developed – oak-hornbeam and beech forests are most common, in steeper sites are developed ravine forest dominated by ash and maple. There are several protected areas in the 4th and 5th stages of nature protection: 3 protected areas, 8 nature reserves, 2 national the Nature Reserves. There are also 3 locations of the category natural Monument and 4 Natura 2000 sites. Industry is at the core of the economic base and agriculture. Industrial production is concentrated in the city of Trnava – dominating sectors are Automotive, Engineering and Glass industry. From a national point of view, the county dominates in electricity generation, there is nuclear power in the territory (Jaslovské Bohunice). The economic activity of rural settlements is represented by small production, storage and repair operations. Agricultural production is focused on both crop and livestock production. Crop production is dominated by arable land management. The area in the past was very important in terms of viticulture. In the present period, vine cultivation is significantly receding, which is a nationwide trend. Fruit production is also partially represented and gardening. The area has a smaller share of permanent grassland. Livestock production specialises mainly in the rearing of pigs and cattle, in particular meat and milk. Animal production is also gradually declining due to its complexity.

Many results of landscape-ecological research formed the basis for the processing of development documents not only for the region, but also for the processing of development documentation of individual municipalities – the territorial and planning documentation of the Trnava Self-governing Region, the Plan of Economic and Social Development of Municipalities. The municipalities of the region have drawn up the development documentation into which they have been also incorporated criteria and principles of sustainability (territorial planning documentation, economic and social development plans, in some cases also land-environmental documents such as the territorial system of protection of ecological stability, regional environmental plans, or local Agendas 21). Various grant schemes of an international or national nature have been set up to implement environmental projects. The Village recovery programme was successfully launched, thanks to which it was implemented several measures aimed at improving the environment in individual municipalities.

Geographic Coverage:

- Country: Slovakia
- Region: Western Slovakia
- Coordinates Extent (Min-Max Lon-Lat):
  - Min Lon (western boundary): 16°49’60” E near Záhorská Ves, border with Austria)
  - Min Lat (southern boundary): 47°43’60” N (near Patince, border with Hungary)
  - Max Lon (eastern boundary): 22°34’00” E (near Nová Sedlica, border with Ukraine)
  - Max Lat (northern boundary): 49°37’00” N (near Oravská Polhora, border with Poland)

Time Coverage:

- 1990 – past Corine Land Cover
- 2006 – past Corine Land Cover
- 2018 – present Corine Land Cover
- 2064 – future Corine Land Cover

Data Source: Corine

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Data Format:

- File Format: KML
- Projection system (Mandatory): EPSG:4326 – WGS84
- past_1990.kml; past_2006.kml; present_2018.kml; future_2064.kml

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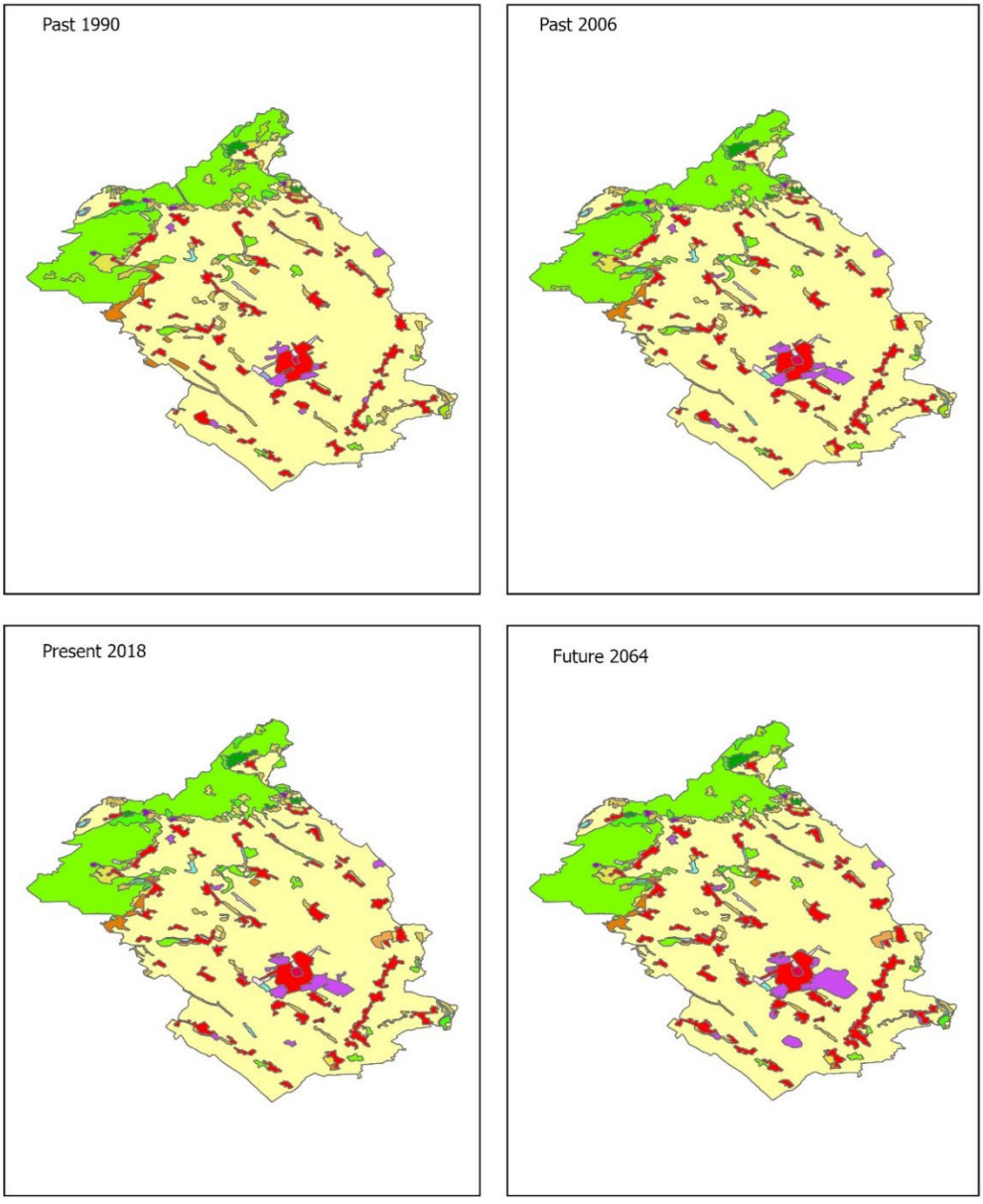

Annex Figure 2: Time coverage

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Basic telecoupling elements

A. Period 2004-2019

Annex Table 1: Period 2004-2019

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending (local) Trnava region NUTS 3	• Agriculture • Forestry • Transport, communication networks, storage and protective works • Residential	• Agricultural enterprises • Local and regional governments • Investors and developers • Businesses in industry • NGOs • Local producers of food, wine and crafts • Slovak Land Fund • Landowners • Environmental protection authorities	• infrastructure expansion • agricultural transformation • industrial development • other factors	• Demographic • Economic • Technological • Political, Institutional • Environmental • Cultural, Historical	• Urbanization and Infrastructure • Agriculture and Industry • Environmental
receiving (regional/national) West Slovakia NUTS 2 Slovakia NUTS 1	• Agriculture • Forestry	• Farmers associations • Industry business • National Authorities • NGOs	• infrastructure expansion • agricultural transformation • industrial development	• Demographic • Economic • Technological • Political, Institutional • Environmental	• Demography and Labor Force • Economic • Institutional

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		• Large agricultural enterprises • Small farmers • National transport operators and infrastructure • Universities, Research Academy	• other factors	• Cultural, Historical	

Causes in detail (sending system):

- Soil quality enabling favorable soil conditions for agricultural production (the Trnava region has some of the best in Slovakia – yet the automotive industry dominates there, and agricultural land is decreasing).
- Housing shortage (migration to urban settlements – increase in the urban population).
- Increased demand for jobs, housing, transportation, and other services in cities as well as rural areas – pressure to develop social infrastructure.
- Arrival of investors (automotive industry, logistics, large warehouses).
- Pressure to develop transport and other technical infrastructure.
- Competition for land between agricultural commodities and energy crops.
- Pressure for more efficient land use in agriculture.
- Land use in the region is determined by spatial plans.
- Lower local taxes and fees may make the region more attractive.
- Greenhouse gas emissions from industry and agricultural intensification.
- Limited land use options due to erosion.
- Wine region (*Malokarpatská*) and production of local products.
- Fragmentation of land ownership and land owned by unknown owners.

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Drivers in detail (sending system):

- Suburbanization and construction of new satellite towns near cities.
- Residential and civic development.
- Migration of workforce from surrounding regions.
- New housing trends – solo living, weekend homes (cottages and chalets).
- Investments in industry and services (automotive industry, logistics, large warehouses, shopping centers).
- Development of intensive agriculture, organic farming, and biomass cultivation.
- Regional competition.
- Direct payment (an economic incentive and political instrument that motivates landowners and land users to adopt a certain type of land use, thereby influencing the dynamics of landscape change).
- Development of transport network – reconstruction of roads and bridges.
- Waterworks projects.
- Spatial planning, municipal and regional land-use plans.
- Local taxes and fees.
- Forest management plans.
- Local climate change – drought, soil erosion, conditions for growing thermophilic crops.
- Overgrowth of areas by invasive woody plants and vegetation.
- Viticulture, designation of origin, and traditional production of food and other crafts.
- The establishment of agricultural cooperatives *(JRD*) and state-owned farms during 1948–1989 shaped the current farm structure.

Effects in detail (sending system):

- Increase in the area of agricultural land converted for residential, civic, and industrial construction.
- Rapid growth of satellite villages and changes in the spatial structure of the landscape.
- Expansion of transport infrastructure – increased pressure on landscape features and soil erosion.
- Outflow of young people from more remote rural areas to work in the automotive industry.
- Impact on crop structure on arable land.
- Support for monocultures, fewer hedgerows and field margins.
- Growing competition between food and energy crops.
- Rising real estate prices.

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- Higher costs of farming due to compliance with environmental conditions and protected areas.
- Increased demand for local products domestically and abroad.
- Farm structure has not significantly changed in terms of land area managed, with cooperatives predominantly farming areas larger than 1,000 hectares.
- Land buying by foreign investors and farmers who use land regardless of local needs.
- Modern technologies in agriculture focused on large-scale farming, which suits conditions in the Trnava region, but monocultures remain dominant and hedgerows and field margins are not restored.
- Decline in agricultural labour force.
- Continued fragmentation of land.
- Worsened access to land for new farmers.
- Increase in forest land – conversion of part of the withdrawn agricultural land into forests.
- Land use possibilities.
- predetermined by territorial planning.
- Deterioration of environmental quality and quality of life.
- Loss or fragmentation of habitats, reduction of biodiversity of native species.
- Adaptation to climate change.

Key flows (sending system): food, labour, goods, services

Causes in detail (receiving system):

- Migration from less developed regions to the Trnava region.
- Outflow of workforce from other regions.
- Worsening age structure of the population in other regions.
- Concentration of industry and services in the Trnava region – prioritization of western Slovakia.
- Low economic diversification in the country.
- Consumer preferences for local and healthy food enable the emergence of smaller farms.
- Development of transport infrastructure facilitates commuting between Trnava, Bratislava, and Nitra regions, as well as international transit.
- Support for innovation and digitalization in various economic sectors.
- The land market and land management are becoming more difficult (inaccessibility of plots, problematic contract closures, high transaction costs).
- Lack of land for new farmers.

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- Inability of owners to farm their own land.
- Concentration of subsidies and land into the hands of a few entities.
- Cultivation of thermophilic and drought-resistant crops.
- Changes in biodiversity and local habitats.
- Preservation of vineyards and traditional local products and crafts.
- Farming in large land blocks under agricultural cooperatives (*PD*) or limited liability companies (*s.r.o.*)
- Although the number of smallholder farms (*SHR*) and small farms is high, their share of land is low compared to agricultural cooperatives (*PD*).

Drivers in detail (receiving system):

- Migration from less developed regions to the Trnava region.
- Outflow of workforce from other regions.
- Worsening age structure of the population in other regions.
- Concentration of industry and services in the Trnava region – prioritization of western Slovakia.
- Low economic diversification in the country.
- Consumer preferences for local and healthy food enable the emergence of smaller farms.
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- Inability of owners to farm their own land.
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- Changes in biodiversity and local habitats.
- Preservation of vineyards and traditional local products and crafts.
- Farming in large land blocks under agricultural cooperatives (*PD*) or limited liability companies (*s.r.o.*).
- Although the number of smallholder farms (*SHR*) and small farms is high, their share of land is low compared to agricultural cooperatives (*PD*)
- Urbanization pressure.
- Migration from other Slovak regions and international migration.

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- Demographic development and population aging.
- Industrialization pressure – investments in industry and industrial development create pressure on the Trnava region due to its attractiveness and infrastructure.
- Agricultural markets together with the Common Agricultural Policy (CAP) determine crop structure.
- Increased demand for labour.
- Prices of inputs and outputs on agricultural markets.
- Consumer preferences.
- Development of the highway network (D1, R1) and railway transport.
- Innovations and modern technologies in agriculture.
- Implementation of EU policies, e.g., Common Agricultural Policy (CAP) - including the CAP (change in the classification of LFA to ANC), Cohesion Policy, Environmental Policies.
- Budgetary and subsidy policies of Slovakia.
- Support and regulation of organic farming, biomass.
- Land law issues (restitutions, undocumented ownership, abandoned land, land grabbing, fragmentation of land ownership, inaccessibility of land, prohibition of land fragmentation, fees for land withdrawal, lease relations).
- Climate change (drought, floods, soil erosion, landslides, conditions for growing new thermophilic crops).
- Invasive species of plants and animals (new pests, diseases, extinction of native species).
- Traditional forms of farming (shepherd huts, vineyards, land communities) and production of traditional and local agricultural and food products (e.g., *Hrušovský lepník*, *Bardejov* honey).
- Farming on large land areas during 1948–1989 by agricultural cooperatives.
- Land inheritance.

Effects in detail (receiving system):

- Outflow of inhabitants from rural areas to satellite towns of regional centres.
- Outflow of inhabitants from other parts of the region.
- Economic imbalance between regions.
- Industrial and infrastructure dominance of the Trnava region.
- Growth of GDP and employment.
- Redistribution of agricultural production and disappearance of traditional farming practices in other parts of the region.

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- Concentration of subsidies in the Trnava region.
- Cultivation of thermophilic (heat-loving) crops.
- Combatting invasive species, new pests, and diseases.
- Pressure for land consolidation and simplification of access to land.
- Digitization of ownership records and resolution of unknown ownership rights.
- Pressure to eliminate fees for land removal (land taken out of agricultural use).

Key flows (receiving system): information, policy, investment, technologies

B. Period 2020-2024

Annex Table 2: Period 2020-2024

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending (local) Trnava region NUTS 3	• Agriculture • Forestry • Transport, communication networks, storage and protective works • Residential	• Agricultural enterprises • Local and regional governments • Investors and developers • Businesses in industry • NGOs • Local producers of food, wine and crafts • Slovak Land Fund • Landowners	• agricultural transformation • industrial development • other factors	• Demographic • Economic • Technological • Political, Institutional • Environmental • Cultural, Historical	• Agriculture and Industry • Environmental • Other

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		• Environmental protection authorities			
receiving (regional/national) West Slovakia NUTS 2 Slovakia NUTS 1	• Agriculture • Forestry	• Farmers associations • Industry business • National Authorities • NGOs • Large agricultural enterprises • Small farmers • National transport operators and infrastructure • Universities, Research Academy			

Causes in detail (sending system):

- Land acquisition by interest groups.
- Development of precision agriculture (smart farming, digitalization).
- Climate change – more pronounced droughts and temperature fluctuations.
- Local production and short supply chains.

Drivers in detail (sending system):

- Suburbanization and construction of new satellite towns near cities
- Residential and civic development
- Migration of workforce from surrounding regions

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- New housing trends – solo living, weekend homes (cottages and chalets)
- Investments in industry and services (automotive industry, logistics, large warehouses, shopping centers)
- Development of intensive agriculture, organic farming, and biomass cultivation
- Regional competition
- Investments in transport network – reconstruction of roads, bridges, and construction of cycle paths
- Waterworks
- Photovoltaic panels on agricultural land
- Spatial planning, municipal and regional land-use plans
- Local taxes and fees
- Forest management plans
- Local climate change – drought, soil erosion, conditions for growing thermophilic crops
- Overgrowth of areas by invasive woody plants and vegetation
- Viticulture, designations of origin, and traditional production of food and other crafts
- The establishment of agricultural cooperatives (JRD) and state-owned farms during 1948–1989 shaped the current farm structure

Effects in detail (sending system):

- Pressure for sustainable farming and soil protection.
- Reduction of pesticides and fertilizers applied to the soil.
- Threat to the existence of small farmers by large interest groups.
- Implementation of photovoltaic systems and other renewable energy sources (RES) in apartments, houses, and other buildings.
- Development of short supply chains and local production offering seasonal products grown with fewer pesticides and sustainable methods, priced without transport costs and with little or no carbon footprint.
- Support for local farmers.

Key flows (sending system): food, labour, goods, services

Causes in detail (receiving system):

- Implementation of Green Deal goals.
- Support from the Next Generation EU recovery funds.
- Diversification of energy sources.

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- Support for short supply chains.

Drivers in detail (receiving system):

- Implementation of Green Deal goals.
- Support from the Next Generation EU recovery funds.
- Diversification of energy sources.
- Support for short supply chains.
- Urbanization pressure.
- Migration from other Slovak regions and international migration.
- Demographic development and population aging.
- Industrialization pressure – investments in industry and infrastructure, increased labour demand.
- New labor market requirements – home office, new professions, and remote work.
- Prices of inputs and outputs in agricultural markets.
- Consumer preferences.
- Development of highway network D1, R1, and railway transport.
- Innovations and modern technologies in agriculture.
- Implementation of EU policies, e.g., Common Agricultural Policy (CAP), Cohesion Policy, Environmental Policies.
- Budgetary and subsidy policy of Slovakia.
- Support and regulation of organic farming and biomass.
- Land law issues (restitutions, undocumented ownership, abandoned land, land grabbing, fragmentation of land ownership, inaccessibility of land, prohibition of land fragmentation, fees for land withdrawal, lease relations – long-term and relatively cheap leases do not motivate changes in land use or ownership changes, land consolidation).
- Climate change (drought, floods, soil erosion, landslides, conditions for growing new thermophilic crops).
- Invasive plant and animal species (new pests, diseases, extinction of native species).
- Traditional farming forms (shepherd huts, vineyards, land communities) and production of traditional and local agricultural and food products (e.g., Hrušovský lepník, Bardejov honey).
- Farming on large land areas during 1948–1989 through agricultural cooperatives.

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- Land inheritance.

Effects in detail (receiving system):

- Outflow of inhabitants from rural areas to satellite towns of regional centers
- Outflow of inhabitants from other parts of the region
- Economic imbalance between regions
- Industrial and infrastructure dominance of the Trnava region
- Growth of GDP and employment
- Redistribution of agricultural production and disappearance of traditional farming practices in other parts of the region
- Concentration of subsidies in the Trnava region
- Cultivation of thermophilic (heat-loving) crops
- Combatting invasive species, new pests, and diseases
- Pressure for land consolidation and simplification of access to land
- Digitization of ownership records and resolution of unknown ownership rights
- Pressure to eliminate fees for land removal (land taken out of agricultural use)

Key flows (receiving system): information, policies investment, capital, technologies

Secondary data sources and framework for quantitative data analysis

Using the following sources as a foundation, a secondary data research database has been constructed:

- The DataCubes of the Nation's Statistics Office
- The World Database on Protected Areas
- Reports on Agriculture and Food Production
- The Register of Financial Statements
- The National Bank of Slovakia
- The Geodesy, Cartography, and Cadastre Authority

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- The European Investment Bank
- The European Environment Agency

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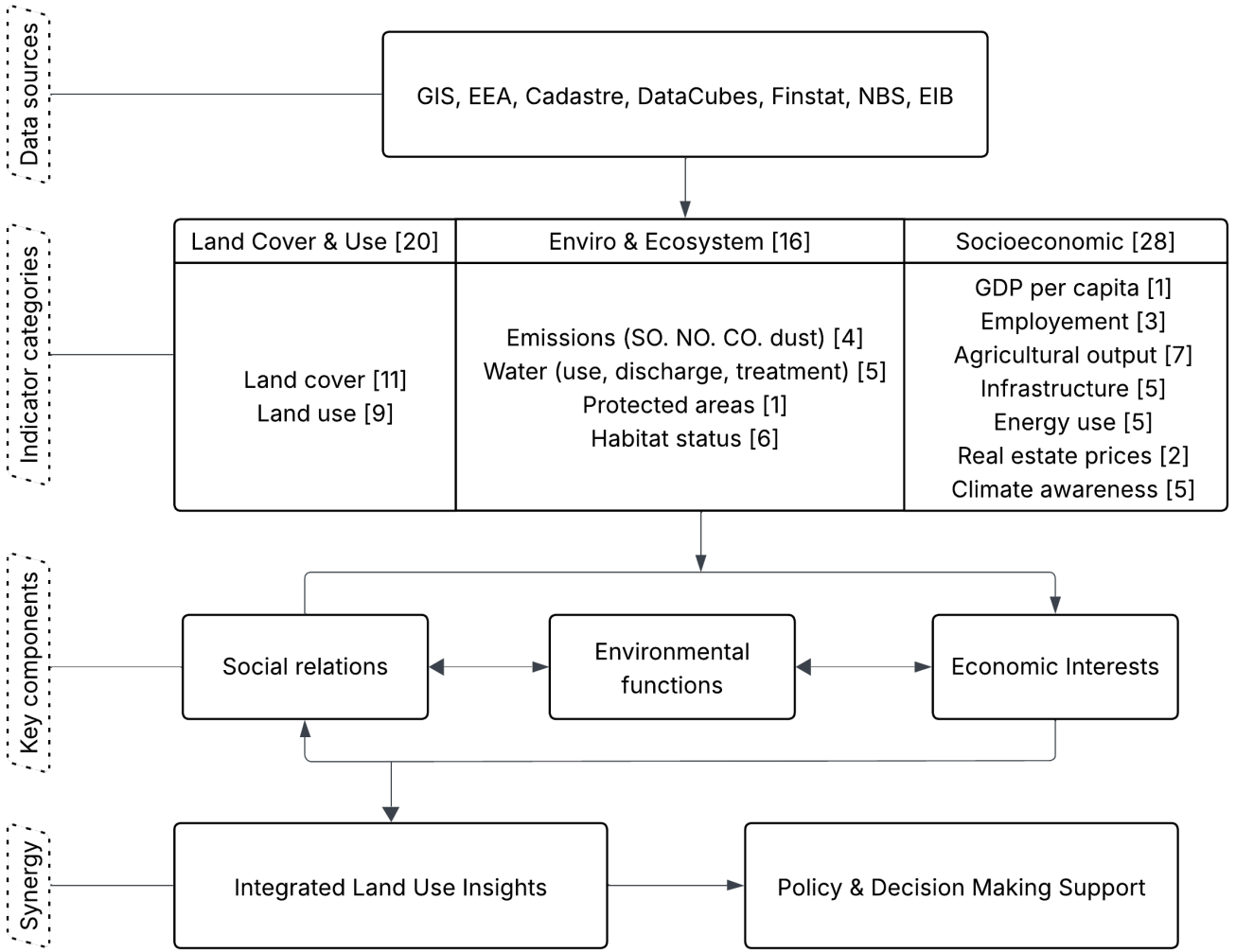

Annex Figure 3: Framework of quantitative analysis

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Spillover system - Governance / policies (regional/national/EU)

Annex Table 3: Spillover system - Governance / policies (regional/national/EU)

Sector (select from the drop-down list)	Title of document in national language	Title of document in English	Type of document (select from the drop-down list)	Link	Institution/Publisher	Year	Language/s	Level of document (select from the drop-down list)	General remarks regarding instruments/incentives
agriculture	Strategický plán SPP 2023 – 2027	Strategic plan CAP 2023-2027	strategic	https://www.mpsr.sk/rozvoj-vidieka-a-priame-platby-rybne-hospodarstvo/strategicky-plan-spp-2023-2027/47-43-1327	Ministry of Agriculture and Rural Development	2021	slovak	national	The main challenge of Slovak agriculture is the provision of healthy and high-quality food at reasonable prices.
agriculture	Vízia spoločných postupov pri budovaní moderného pôdohospodárstva v horizonte roku 2035	Vision of joint procedures in building modern agriculture in the horizon of 2035	strategic	https://www.enviroportal.sk/dokument/vizia-spolocnych-postupov-pri-budovani-moderneho-podohospodarstva-v-horizonte-roku-2035	Ministry of Agriculture and Rural Development	2021	slovak	national	The vision is an analytical-synthetic document, designed with the intention of naming the current state, starting points and expectations of development until 2027 and 2035, development problems and the proposal of pro-development measures in six basic areas (Agriculture, Food, Forestry, Environmental Protection, Rural Development, Agricultural education, science and research).
forestry	Národný lesnícky program Slovenskej republiky 2022 - 2030	National forestry program of the Slovak Republic 2022 - 2030 (Source report)	strategic	https://www.mpsr.sk/aktualne/oznamenie-o-strategickom-dokumente-narodny-lesnicky-program-sr-pre-obdobie-rokov-2022-2030-lesy-pre-spolocnost/18445/	Ministry of Agriculture and Rural Development	2021	slovak	national	a description of the key problems of forestry in the Slovak Republic addressed in the strategy, their causes and consequences, a description of the environment, the current state and also the expected future development of the environment, including visions of solving individual problems.
forestry	Národný lesnícky program Slovenskej republiky pre obdobie rokov 2025 – 2030 „LESY PRE SPOLOČNOSŤ	National forestry program of the Slovak Republic 2022 - 2031	strategic	https://www.mpsr.sk/oznamenie-o-strategickom-dokumente-narodny-lesnicky-program-sr-2025-2030/59--19074/	Ministry of Agriculture and Rural Development	2024	slovak	national	a basic forestry-political document, an important tool for ensuring sustainable forest management, interdepartmental cooperation and the fulfillment of international obligations related to forests and forestry
biodiversity and nature protection	**Vízia a stratégia rozvoja Slovenska do roku 2030 - dlhodobá stratégia udržateľného rozvoja Slovenskej republiky – Slovensko 2030**	**Vision and development strategy of Slovakia 2030 - long-term strategic planning of sustainable development of Slovak Republic - Slovakia 2030**	strategic	https://mirri.gov.sk/wp-content/uploads/2021/01/Slovensko-2030.pdf https://www.minzp.sk/en/documents/strategic-documents/	Ministry of Investments, Regional Development and Informatization	2020	slovak, english	national	The creation of the document was conditioned by Slovakia's accession to the 2030 Agenda for Sustainable Development of the United Nations.
biodiversity and nature protection	Zelenšie Slovensko - STRATÉGIA ENVIRONMENTÁLNEJ POLITIKY SLOVENSKEJ REPUBLIKY DO ROKU 2030	Greener Slovakia - ENVIRONMENTAL POLICY STRATEGY OF THE SLOVAK REPUBLIC UNTIL 2030	strategic	https://www.minzp.sk/files/iep/publikacia_zelensie-slovensko-sj_web.pdf https://www.minzp.sk/en/documents/strategic-documents/	Ministry of Environment	2019	slovak, english	national	procedure for facing the biggest environmental challenges and solving the most serious environmental problems
biodiversity and nature protection	Koncepcia ochrany prírody, biodiverzity a krajiny do roku 2030	Concept of nature, biodiversity and landscape protection until 2030	strategic	https://www.slov-lex.sk/legislativne-procesy?p_p_id=processDetail_WAR_portletsel&p_p_lifecycle=2&p_p_state=normal&p_p_mode=view&p_p_cacheability=cacheLevelPage&p_p_col_id=column-2&p_p_col_count=1&_processDetail_WAR_portletsel_fileCooaddr=COO.2145.1000.3.3761517&_processDetail_WAR_portletsel_file=Koncepcia_ochrany_prirody_a_krajiny_do_roku_2030.pdf&_processDetail_WAR_portletsel_action=getFile	Ministry of Environment	2019	slovak	national	It evaluates the state of nature and landscape protection, determines strategic goals and measures to achieve them, especially in the field of territorial and species protection, tree and landscape protection, education and training, cooperation with other state administration bodies, with local government, with non-governmental organizations and in the field of international cooperation with using institutional, legal and economic tools.
climate change	Stratégie adaptácie SR na zmenu klímy	Slovakia's adaptation strategies to climate change	strategic	https://www.minzp.sk/files/odbor-politiky-zmeny-klimy/strategia-adaptacie-sr-zmenu-klimy-aktualizacia.pdf	Ministry of Environment	2018	slovak	national	The main tool for increasing the adaptation capacity of the Slovak Republic to climate change
climate change	Akčný plán pre implementáciu Stratégie adaptácie SR na zmenu klímy	Action plan for the implementation of the Slovak Climate Change Adaptation Strategy	implementation (operational)	https://www.enviroportal.sk/dokument/akcny-plan-pre-implementaciu-strategie	Ministry of Environment	2021	slovak	national	
climate change	Nízkouhlíková stratégia rozvoja Slovenskej republiky do roku 2030 s výhľadom do roku 2050	Low-carbon development strategy of the Slovak Republic until 2030 with a view to 2050	strategic	https://www.minzp.sk/klima/nizkouhlikova-strategia/ https://www.minzp.sk/en/documents/strategic-documents/	Ministry of Environment	2020	slovak, english	national	The NuS represents Slovakia's response to the obligations in the fight against climate change resulting from membership in the European Union (EU) and the United Nations (UN) and the associated obligation to develop a long-term strategy with a validity period of at least 30 years. The goal of the strategy is to identify existing and propose new additional measures within the Slovak Republic to achieve climate neutrality by 2050.

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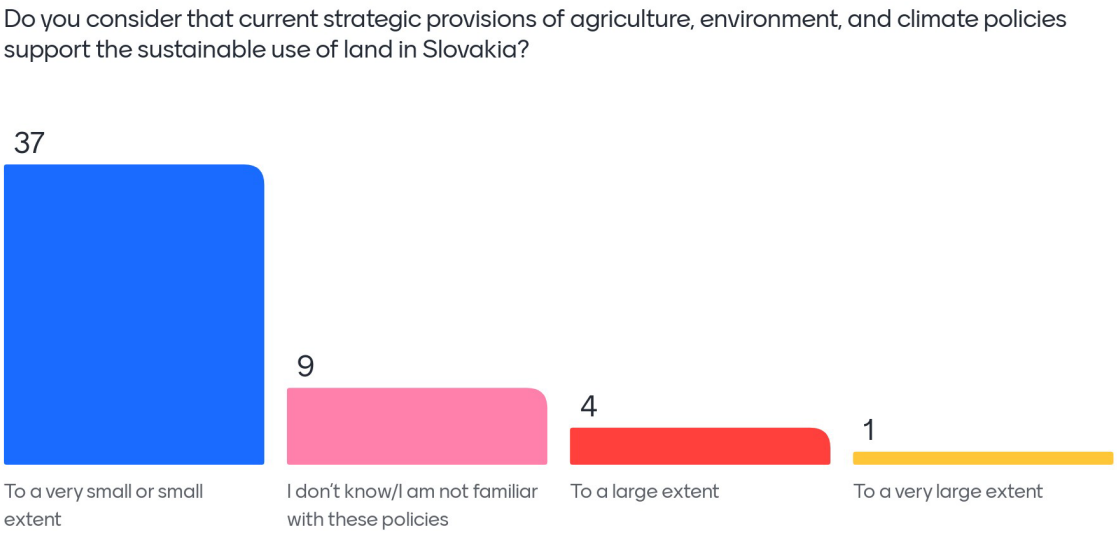
Stakeholders' opinion on support of the current policies to sustainable land management



Annex Figure 4: Stakeholders' opinion on support of the current policies to sustainable land management

Summary of the discussion of stakeholders on policies:

- *Slovak farmers versus the EU - we need to start a strategic dialogue; the problem is our farm structure. Subsidies should be given to those who are in need + payments for social and green objectives, or linked to need and consumption, considering sustainable agriculture.*
- *The number of applicants for subsidies is declining, and so-called couch farmers are emerging. The number of subsidised agricultural land is decreasing. There is a need to increase participation in ecoschemes. Ecoschemes - protectionists versus farmers, need to set realistic conditions.*
- *Negotiations with the EU are ineffective because there is a lack of scientific and technical basis. There are big green targets that are not being met. Sustainability and competitiveness need to be reconciled in legislation.*
- *Policies need to be simplified, their impacts evaluated and decisions made inclusively.*
- *Large land losses due to poor management - up to 2500 hectares of land excluded from the land register!*
- *There needs to be analysis, not just feelings and emotions. Rich countries are racing to see who will give more to the farmer, and in Slovakia we cannot agree on how we want to go in the future... by supporting farmers or the automotive industry?*
- *Area-based payments versus production-based payments. For large farms, area-based payment is important.*
- *We need a national policy and a long-term strategy for soil conservation. There are many approaches, but none has been followed through.*
- *What is the future philosophy of subsidies - a repressive approach, or valuing the above standard? I prefer the latter.*
- *Biobelts - theory versus practice. The target was 12,000 ha of land and only 0.9% compliance. It is better to create a whole-farm ecoscheme.*

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- *Restoring the ecosystem functions of the soil should be the basis of agricultural policy reform. We need to start with ecosystems and bring landscape structures back into play.*

The discussion primarily focused on EU and Slovak Republic subsidies for farmers. The key questions were whether the subsidy scheme is sufficiently motivating for farmers to take better care of the land and other environmental components in the country. There was also a debate on whether we can politically secure additional tools to increase interest in better care for the soil, water, and other living elements in the environment. The participants evaluated the main issues with the state's motivational policy settings and also discussed training for farmers on how to manage the land to prevent its degradation. The topic of creating methodological guidelines for land management that would lead to stability and sustainability was also highlighted.

Key insights from expert interviews

Annex Table 4: Key insights from expert interviews

	Which aspects are the most dynamic?	**What conflicts exist or are likely to arise?**
Regional socio-economic development	industrial development, demographic change, increasing number of inhabitants	investors vs landowners, conservationists vs tourism and recreation
Agriculture	conversion of agricultural land to other uses, sale of land to foreign owners through domestic entities	small vs large land users; eco-friendly vs traditional farmers
Policies	unwillingness to participate in their creation, weak awareness of their priorities and content, weak implementation capability	opposite attitudes to eco-schemes and measures, preparation of strategies/policies vs their implementation
Climate Change and biodiversity	drastic weather fluctuations, invasive plant species, animals and pests	biodiversity protection vs climate change impacts and consequences
Future	linking the needs of different stakeholders, raising environmental awareness among all actors	residential capacity of the region vs growing domestic immigration, future of automotive industry

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Key agents / stakeholders

A. Identification

Annex Table 5: A. Identification

Stakeholder	Geographic coverage/Level	Main category	Sub-category
representative of the Self-Governing Trnava Region	regional	policy/government	regional authority (regional administration)
representative of the Self-Governing[19] Trnava Region (Department of spatial planning and living environment)	regional	policy/government	regional authority (regional administration)
representative of the City of Trnava[20]	local	policy/government	local authority (local administration)
representative of the District Office (Department of Living Environment)	regional	policy/government	regional authority (regional administration)
representative of the District Office (Department of Land and Forests)	regional	policy/government	regional authority (regional administration)
representative of the District Office (Department of Construction and Housing Policy)	regional	policy/government	regional authority (regional administration)
representative of VUJE, a. s.	national/regional	industry	business
representative of YMS, a.s.	national/regional	industry	business
representatives of Regional Agricultural and Food Chamber in Trnava Region	regional	industry	business/land users (farmers)
representative of Apimed meadary	national	industry	business/land user (farmer)
representative of Magula Family Wine Estate	regional	industry	business/land user (farmer)

[19] Expert interview.
[20] Two expert's interviews.

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representatives of local municipality Zvoncin (local schools, NGOs, local government, local entrepreneurs, local associations)	local	industry; policy/government; societal actors/community	land user (farmer); Local authority (local administration); Non-governmental organization (NGO); Business; citizen association
representatives of local municipality Sucha nad Parnou (local schools, NGOs, local government, local entrepreneurs, local associations)	local	industry; policy/government; societal actors/community	land user (farmer); Local authority (local administration); Non-governmental organization (NGO); Business; citizen association
mayor of Dolna Krupa	local	policy/government	local authority (local administration)
farmer in village Spacince	local	industry	land user (farmer)
students and researchers at the University of St. Cyril and Methodius in Trnava and Trnava university	national/regional	academia	research and academia
representative of CHKO Male Karpaty[21]	national/regional	policy/government	regional authority (regional administration)
representative of Golden Ruzindol	local	industry	land user (farmer)
church/churches	regional	societal actors/community	other
Ministry of Agriculture and Rural Development of the SR	national	policy/government	national authority (central government, related ministries and agencies)
Ministry of the Environment of the SR	national	policy/government	national authority (central government, related ministries and agencies)
Slovak Environment Agency	national	policy/government	national authority (central government, related ministries and agencies)
Slovak Fishermen's Association (Municipal Organisation Trnava)	local	societal actors/community	non-governmental organization (NGO)
Universities in TT region	national/regional	academia	research and academia

[21] Expert interview.

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Institute of ecology SAS[22]	national/regional	academia	research and academia

B. Assessment of stakeholders' land dependence level (at local, regional / national level)

C. Assessment of their influence level in decision making

Local level

Annex Table 6: Local level

Key agents[23]	Stakeholder category[24]	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A Environmental protection authorities	national authority	low	2	medium-moderate	3
B Agricultural enterprises	land users (farmers, foresters)	high	5	low	1
C Investors and developers	industry/business	medium-moderate	3	high	5
D Businesses in industry	industry/business	low	2	medium-moderate	3
E Local producers of food, wine and crafts	industry/business	medium-moderate	3	low	1
F Landowners	land users (farmers, foresters)	high	5	low	2
G Local governments	local authority	medium-moderate	3	medium-moderate	3
H Regional government	regional authority	low	2	medium-moderate	3
I Non-governmental organizations	NGOs	low	1	low	1
J Slovak Land Fund	national authority	high	5	high	4
K Residents	other	high	4	low	1

[22] Two expert's interviews.

[23] According to tables in part I./A, I./B of this dataset.

[24] According to the Figure 3 in *Internal guide for application of the Europe-Land telecoupling framework in case-studies*.

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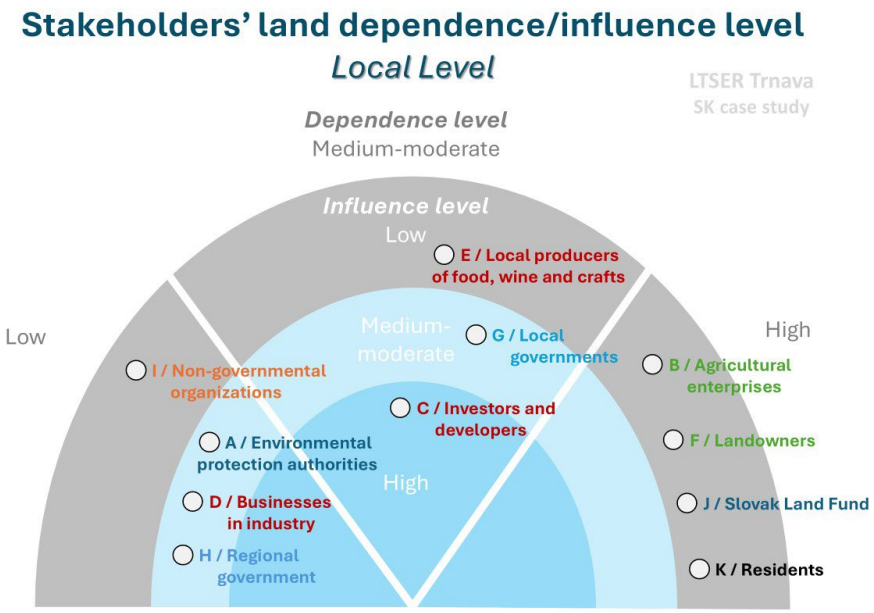
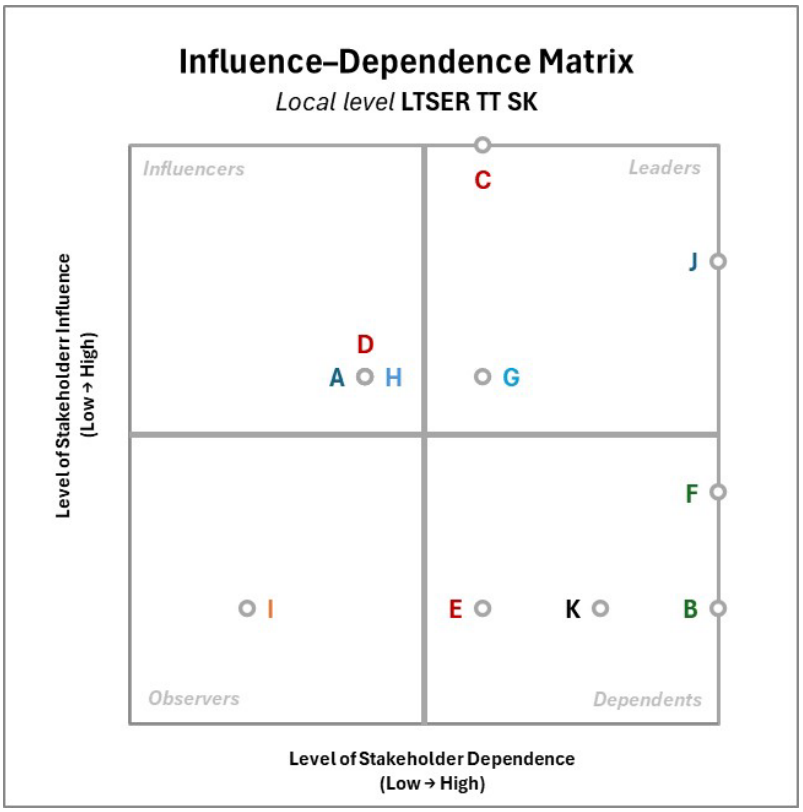


Annex Figure 5: Stakeholders' land dependence/influence level Local Level



Annex Figure 6: Influence-Dependence Matrix Local level

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Regional / national level

Annex Table 7: Regional / national level

Key agents	Stakeholder category	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A Farmers associations	land users (farmers, foresters)	high	5	medium-moderate	3
B Industry business	industry/business	low	2	medium-moderate	3
C National Authorities	national authority	low	2	high	5
D Non-governmental organizations	NGOs	low	1	low	1
E Large agricultural enterprises	land users (farmers, foresters)	high	5	medium-moderate	3
F Small farmers	land users (farmers, foresters)	high	5	low	1
G National transport operators and infrastructure	national authority	high	5	high	5
H Universities, Research Academy	research and academia	low	1	low	1
I Residents	other	high	4	low	1

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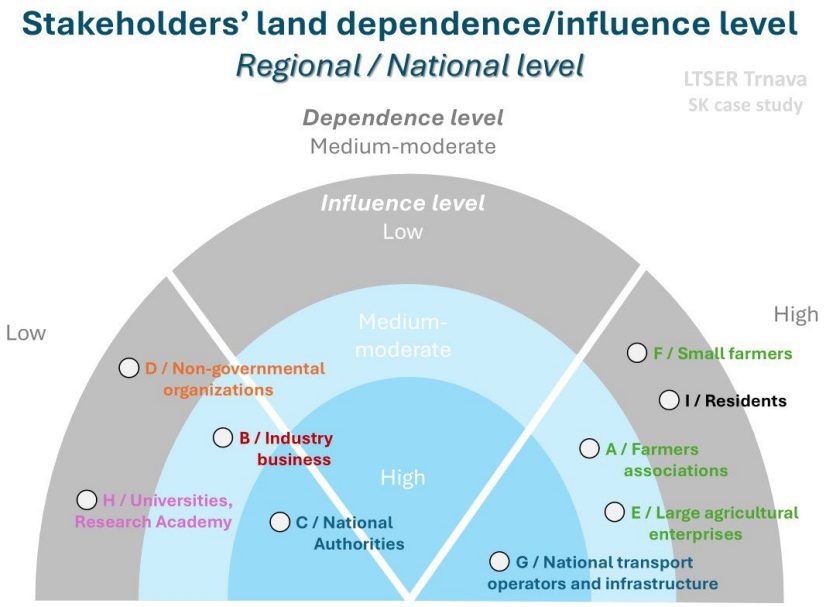
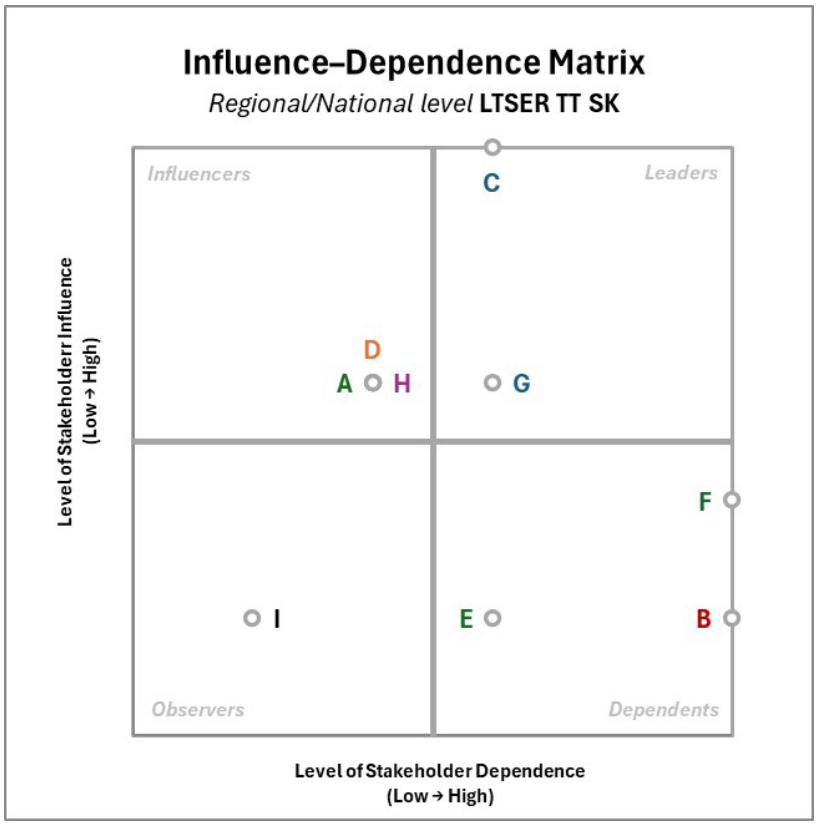


Annex Figure 7: Stakeholders' land dependence/influence level Regional/National level



Annex Figure 8: Influence-Dependence Matrix Regional/National level

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Basic matrix for SNA[25]

Annex Table 8: Basic matrix for SNA

Key agents[26]	land users (farmers, foresters)	Industry business	local authorities	regional authorities	national authorities	NGOs	research and academia	other	EU governance
land users (farmers, foresters)		1	1	1	1	0	0	1	1
Industry business	1		1	1	1	0	1	1	1
local authorities	1	1		1	1	1	0	1	1
regional authorities	1	1	1		1	1	1	1	1
national authorities	1	1	1	1		1	1	1	1
NGOs	0	0	1	1	1		0	1	1
research and academia	0	1	0	1	1	0		0	1
Other	1	1	1	1	1	1	0		1
EU governance	1	1	1	1	1	1	1	1	

1=weak relationship; 1=medium relationship; 1=strong relationship

[25] A cell with a 1 indicates a relationship (direct mutual influence/dependence) between agents is present, while a 0 indicates no relationship.

[26] Categories of agents (stakeholder categories) at all levels (local + regional/national) + EU governance (spillover system).

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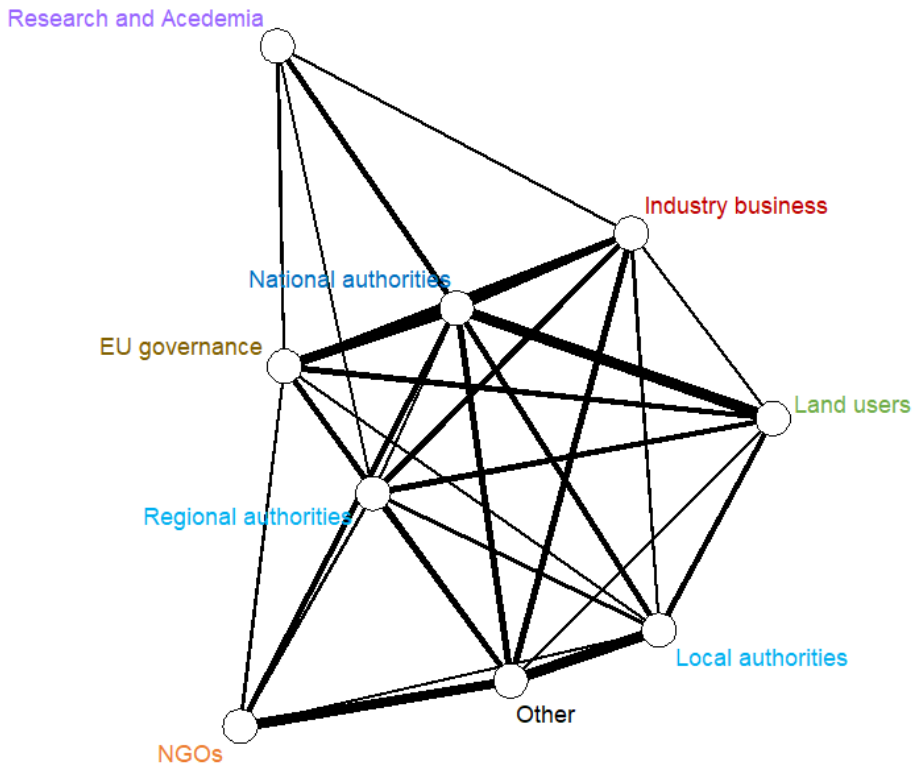

Annex Figure 9:Visualization of relationships among key agents / stakeholders

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1.2 Czechia: Krkonoše Mts. National Park

Introduction

The Krkonoše case study area consists of mountainous terrain within a national park and biosphere reserve in northeastern Bohemia. The territory stretching along the Czech-Polish border represents a unique collection of mountain ecosystems, which are both subject to nature conservation and contribute significantly to the development of recreational function of the area. However, in past centuries, the Krkonoše Mountains were also a traditional area of mountain agriculture. Compared to other mountainous areas in Czechia, there has always been the least proportion of arable land here. The local landscape was shaped primarily by mountain pasture farming, rational forest management, industrial development in the settlements situated in the valleys, and the early development of tourism, which reached a high intensity here as early as the 19th century. Higher mountain locations, including the border ridge above the upper forest line, have been used since the 16th century for seasonal mountain pasture, character of which was similar to Alpine pastures, but adapted to local conditions. Experience with mountain grazing was brought here by colonists from Alpine countries, who were called here as lumberjacks. They developed mainly cattle grazing on cleared areas. Part of the mountain meadows was used not only as pastureland, but also as an important source of hay. Since the 17th century, but mostly in the 18th century, summer mountain huts were built (e.g., Dvoračky, Martinova hut, huts in Rokytno, and many others). The reasons for their construction were initially purely economic, but gradually their owners began to offer accommodation to visitors. By the 19th century at the latest, many of these buildings had taken on an important recreational function.

The 19th century is connected with a gradual decline of mountain pastoralism as one of the main forms of land use in the area, partly in association with the gradual banning of grazing in forests (1866) and the ban on grazing above the upper forest boundary (1897). At the end of the 19th century, it was decided to plant dwarf pine trees to prevent avalanches. Occasional mowing and hay harvesting were still common at the beginning of the 20th century. Mountain huts were converted into recreational cottages for summer and winter recreation and tourism, and many of them also disappeared. The complete end of agricultural use of the Krkonoše Mountains was brought about by the expulsion of the original German speaking population immediately after World War II (1945-1946) and the declaration of the Krkonoše National Park (1963).

The transformation of the Krkonoše landscape can be characterized as follows:

I. The original natural forest landscape with subalpine dwarf pine stands at the highest elevations above the upper tree line was transformed between the 16th and 18th centuries into a landscape of mountain agriculture (arable and pastoral, exclusively pastoral at higher elevations), with a preserved high proportion of forest.
II. Mountain farming and deforestation reached their peak at the turn of the 18th and 19th centuries; since the mid-19th century, mountain farming has been in decline, along with the associated loss of arable land and pastures, the proportion of forest has increased, and the function of the landscape has changed from productive forest and agriculture to recreation.
III. Today, the landscape is dominated by recreational and sporting activities and its primary importance for nature conservation (Krkonoše National Park).

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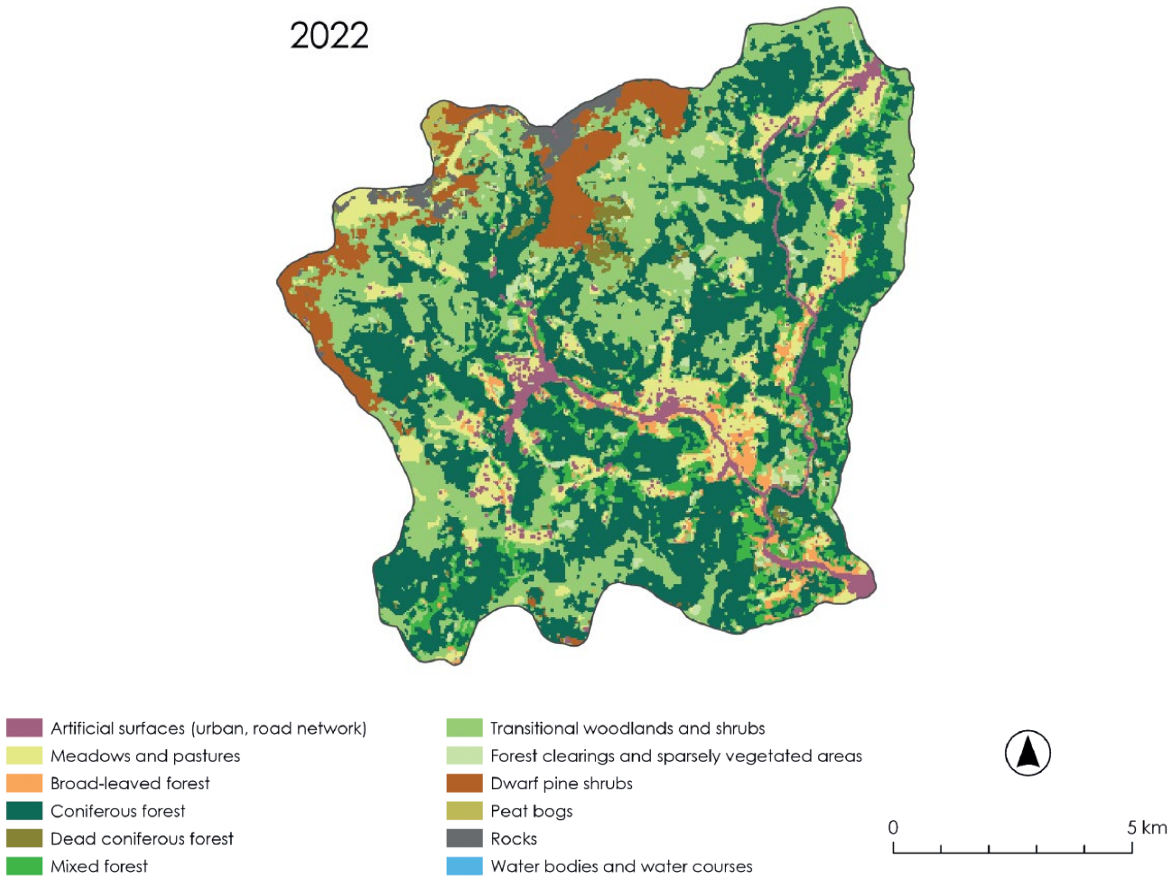
To fulfil the objectives of nature and landscape conservation, the Krkonoše National Park is divided into four management zones: the nature zone (7 328,5 ha, 20,2 % of the area), the new nature zone (8 097,3 ha, 22,3 % of the area), the zone of concentrated nature conservation (20 730,3 ha, 57,0 % of the area), the cultural landscape zone (196,1 ha, 0,5 % of the area). The nature zone is defined as an area where natural ecosystems predominate, and these ecosystems are left to their natural development without interference. The new nature zone then includes ecosystems that have been partially altered by human activities but are transforming towards completely natural character. Parts of the zone may be converted into a natural zone in the future. The zone of concentrated nature conservation includes highly man-made ecosystems – especially unstable spruce stands planted by man in place of the original beech forests, which will need to be converted to mixed and broadleaved forests and thus restored to their natural state. It also includes the wildflower meadows, which were historically created as pastures and meadows in place of deforested enclaves and existence of which depends on permanent management. The cultural landscape zone is delimited the vicinity of local settlements and should be managed according to principles of sustainable development. This zone is relatively small, as most of the villages have not been directly integrated into the national park since 1991 but are located in its protection zone.

Land cover in case study area the Krkonoše Mts. (eastern part) in 2022



Annex Figure 10: Land cover in case study area the Krkonoše Mts. (eastern part) in 2022

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Annex Table 9: Land cover in case study area the Krkonoše Mts. (eastern part) in 2022

Category	***Area in km²***
Artificial surfaces (urban, road network)	4.23
Meadows and pastures	8.25
Broad-leaved forest	2.22
Coniferous forest	36.53
Dead coniferous forest	1.1
Mixed forest	5.96
Transitional woodlands and shrubs	26.72
Forest clearings and sparsely vegetated areas	1.68
Dwarf pine shrubs	5.42
Peat bogs	0.24
Rocks	1.32
Water bodies and water courses	0.01

Source: Zelíková, N., Potůčková, M., Purm, M., Šípek, V., Falátková, K., Hofbauer, M., Šrollerů, A., Červená, L., Lhotáková, Z., Albrechtová, J., Kupková, L. (2025): Land cover change and its effects on catchment hydrology: A quantitative analysis using SWAT in Horní Úpa. AUC Geographica, e23361980.2025.18 https://doi.org/10.14712/23361980.2025.18

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Basic telecoupling elements

A. Period 2004-2019

Annex Table 10: A. Period 2004-2019

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending (local) NUTS 3 (Liberecký kraj Region, Královéhradecký kraj Region) Krkonoše National Park	• agriculture • forestry • residential • tourism and recreation	• environmental protection authorities • agricultural enterprises • private farmers • investors and developers • landowners • local and regional governments • interest associations	• infrastructure expansion • nature conservation • development of tourism and recreation • other factors	• demographic • economic • technological • political and institutional • environmental • cultural	• environmental • development of infrastructure • economic • institutional
receiving (regional/national) NUTS 2 (Northeastern Czechia) NUTS 1	• agriculture • forestry	• national authorities • environmental protection authorities • agricultural enterprises • private farmers • investors and developers • regional governments • interest associations • universities, research academy	• infrastructure expansion • spatial and regional planning • other factors	• demographic • economic • technological • political and institutional • environmental • cultural	• environmental • demography • economic • institutional

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Causes in detail:

- Growing popularity of the area among tourists.
- Increased demand for tourism infrastructure.
- Arrival of investors (apartment housing, tourism infrastructure).
- Competition between nature conservation, recreational use and well-being of residents.
- An area with less favourable conditions for agriculture.

Drivers in detail:

- Construction of new housing and infrastructure.
- Restrictions resulting from spatial planning and the national park management plan.
- Strict environmental regulation promoted by the national park administration.
- Further development of tourism and recreation (large investment projects into tourism infrastructure and services).
- Direct payments to landowners and land users to adopt certain type of land use.
- Decrease in local employment opportunities outside of tourism industry.

Effects in detail:

- Touristification of the area, its negative impacts on local communities and environment.
- Conflicts with nature conservation and the national park administration over further development of the area.
- Traditional mountain landscape substituted by the sports and recreational environment.
- Migration of residents outside of the area.
- Rising real estate prices.
- Decreasing power of local population and institutions to make decisions about the future of their area.
- Higher costs of farming due to compliance with environmental conditions and regulations.
- Land buying by investors coming outside of the area regardless of local needs.
- Struggle to maintain current land use structure to preserve biodiversity.

Ignoring the possible negative impacts of climate change (environmental as well as economic) by reducing its impacts by technological means.

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B. Period 2020-2024

Annex Table 11: B. Period 2020-2024

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending (local) NUTS 3 (Liberecký kraj Region, Královéhradecký kraj Region) Krkonoše National Park	• agriculture • forestry • residential tourism and recreation	• environmental protection authorities • agricultural enterprises • private farmers • investors and developers • landowners • local and regional governments interest associations	• infrastructure expansion • nature conservation • development of tourism and recreation other factors	• demographic • economic • technological • political and institutional • environmental cultural	• environmental • development of infrastructure • economic institutional
receiving (regional/national) NUTS 2 (Northeastern Czechia) NUTS 1	• agriculture forestry	• national authorities • environmental protection authorities • agricultural enterprises • private farmers • investors and developers • regional governments • interest associations universities, research academy	• infrastructure expansion • spatial and regional planning other factors	• demographic • economic • technological • political and institutional • environmental cultural	• environmental • demography • economic institutional

Causes in detail:

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- Growing popularity of the area among tourists.
- Increased demand for tourism infrastructure.
- Arrival of investors (apartment housing, tourism infrastructure).
- Competition between nature conservation, recreational use and well-being of residents.
- An area with less favourable conditions for agriculture.

Drivers in detail:

- Construction of new housing and infrastructure.
- Restrictions resulting from spatial planning and the national park management plan.
- Strict environmental regulation promoted by the national park administration.
- Further development of tourism and recreation (large investment projects into tourism infrastructure and services).
- Direct payments to landowners and land users to adopt certain type of land use.
- Decrease in local employment opportunities outside of tourism industry.

Effects in detail:

- Touristification of the area, its negative impacts on local communities and environment.
- Conflicts with nature conservation and the national park administration over further development of the area.
- Traditional mountain landscape substituted by the sports and recreational environment.
- Migration of residents outside of the area.
- Rising real estate prices.
- Decreasing power of local population and institutions to make decisions about the future of their area.
- Higher costs of farming due to compliance with environmental conditions and regulations.
- Land buying by investors coming outside of the area regardless of local needs.
- Struggle to maintain current land use structure to preserve biodiversity.
- Ignoring the possible negative impacts of climate change (environmental as well as economic) by reducing the negative impacts through using technological means (especially by tourism entrepreneurs).

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C. Spillover system - Governance / policies (regional/national/EU)

Annex Table 12: C. Spillover system - Governance / policies (regional/national/EU)

Title of the document in national language	Title of the document in English	Link	Year	Language	Level of document	Detailed description
Zákon o ochraně přírody a krajiny 114/1992 Sb.	Act on Nature and Landscape Protection 114/1992 Coll.	https://www.zakonyprolidi.cz/cs/1992-114	1992	Czech	National	The law determines both general principles of nature protection – protection of plants, animals, geological elements (caves), paleontological findings and protection of the landscape character of the area. It also defines individual types of special protected areas, e.g. national parks, protected landscape areas, natural reserves and monuments. It establishes the obligations of natural and legal persons in the protection of nature, defines nature protection authorities and their powers. A special part of the Act is also devoted to the Natura 2000 system of protected areas.
Územní plán obce	Municipal zoning/master plan; Principles of spatial development; Construction Act 283/2021 Coll. (formerly Act on Spatial Planning and Building Code)	https://www.ochrance.cz/letaky/uzemni-plan/uzemni-plan.pdf	2021	Czech	Local	A master plan is a spatial planning documentation designed to further develop and make better use of the local area of an entire region. A master plan aims to reconcile the interests of the environment, the economy and the community of people inhabiting the area. At the same time, it is intended to help maintain or improve the standard of living of present and future generations.
Strategický plán Společné zemědělské politiky 2023–2027: Přímé platby v zemědělství	Common Agricultural Policy Strategic Plan 2023–2027: Direct Payments in Agriculture	https://mze.gov.cz/public/portal/mze/dotace/szp-pro-obdobi-2021-2027	2023	Czech	National	Direct payments in agriculture in Czechia are financial support provided to Czech farmers by the European Union (EU) under the Common Agricultural Policy (CAP). These payments aim to support the stability of the agricultural sector, ensure rural development, protect the environment and promote sustainable agricultural practices and motivate farmers to implement environmentally friendly farming techniques. Payments are paid for each hectare of land farmed by the farmer.
Podpora specifických forem zemědělského hospodaření (diverzifikace)	Support for specific forms of farming (diversification)	https://www.databaze-strategie.cz/cz/mze/strategie/strategie-resortu-ministerstva-zemedelstvi-s-vyhledem-do-roku-2030?typ=detail	2016	Czech	National	Support for specific forms of farming (diversification of agricultural activities) is an important tool for the sustainability of agriculture and the development of rural areas. Diversification takes various forms:
Asociace regionálních značek	Association of Regional Brands	https://www.regionalni-znacky.cz/	2025	Czech	Regional	Promoting local production is a key aspect of ensuring sustainability, economic growth and stability in the region. It focuses on supporting businesses and farmers who offer products and services locally, which is believed to have many benefits for local economy, community and environment.
Asociace soukromého zemědělství ČR	Association of Private Farmers of the Czech Republic	https://www.asz.cz/o-asz/about-us/	2025	Czech	Local	The Association of Private Farmers of the Czech Republic (ASZ ČR) is a professional organization that represents and supports private farmers in Czechia. It was founded in 1990 and its aim is to defend the interests of small and medium-sized farmers, to promote the development of rural areas and sustainable agriculture, and to engage in environmental protection and sustainable farming.
Asociace soukromého	Association of Private Farmers of the Czech	https://www.asz.cz/poradenstvi/	2025	Czech	Local	The consulting activities of the Association of Private Farmers of the

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zemědělství ČR – poradenství	Republic – consultancy					Czech Republic (ASZ ČR) focus on support and assistance to private farmers, ranchers and entrepreneurs in agriculture. The aim is to improve their farming, orientation in legislation and access to new technologies or financing. The Association provides advice in several key areas:
Program LIFE: finanční nástroj EU pro životní prostředí a klima	LIFE: the EU's financial instrument for the environment and climate	https://www.program-life.cz/	2025	Czech	Local	The LIFE programme is a financial instrument of the European Union established to support projects in the field of environment, nature conservation and climate change. The main objective is to support sustainable and innovative projects that contribute to nature conservation, biodiversity, environmental improvement and the fight against climate change
Pozemkové spolky	Land Associations	https://pozemkovespolky.cz/	2025	Czech	Local	Land associations are non-profit organizations caring for valuable natural and historical sites. They take care of the land they own or have a long-term legal relationship to it – lease, easement, etc. They are based on the experience of similar organisations abroad and follow the tradition of pre-WWII ornamental associations in Czechia. In the Czech legal system, a land association is not exactly defined as an independent legal entity. Thus it is rather understood as a function performed by a legally established non-profit sector entity (registered civic association, public benefit corporation, institute, foundation or endowment fund). The activities of land associations are very diverse, ranging from taking care for single site or historic building, to managing multiple sites or objects. Land associations thus take care for natural as well as cultural heritage. The work of land associations is built on trust between them, the owners and other partners. It is a primary goal that this trust is not broken. Since the term "land association" and the possibility of declaring land inalienable are not known in the Czech legal system, this shortcoming is compensated for by making the activities as transparent as possible and by thoroughly treating all mutual relations contractually. The guarantor and organizer of the movement of land associations in Czechia is the Czech Union of Nature Conservationists, an organization with almost thirty years of tradition, many thousands of members and rich experience in caring for valuable sites. The Union performs the role of the National Land Association and represents the activities of regional land associations. The Board of the National Land Association grants accreditation to other land associations, which is a confirmation to partners that the land association complies with and meets all the requirements.

Stakeholders' opinion on support of the current policies to sustainable land management (Mirror workshops)

Factors influencing land use change are mainly factory political and legislative factors (political regime, strategies, laws, regulations), economic factors (prices, market demand and supply, development, profitability), social factors (demography, migration and education), environmental factors (climate change), technological factors (land development, technological innovation), cultural factors (culture and tradition, attitudes, values, local identity).

Summary of the discussion on POLICIES

- *EU CAP: setting the parameters of subsidies crucial to determining the shape of farming in the EU.*

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- *Greater biodiversity and climate change adaptation through increased support for non-productive functions of agriculture, greater restrictions on non-compliance with environmental standards and reduced administrative burden.*
- *A marketing campaign to promote local production can also help.*
- *Forest policies and strategies on wood use (e.g. whether wood is considered as a renewable energy source) are also important.*
- *Tightening rules in legislation.*
- *Role of political drivers, risk of war, greater instability of global system - ensure sufficient arable land, ensure sufficient agricultural production.*
- *Greater institutional (legislative) protection of land: slowing the loss of agricultural land.*
- *Farmers will need to be more educated and adapt to current trends.*
- *Fewer farmland owners, probably easier to implement landscape measures.*
- *In the event of an adverse international situation (e.g. Russia-NATO conflict), permanent grassland can be converted to arable land and help with food security.*

Key insights from expert interviews

Annex Table 13: Key insights from expert interviews

	Which aspects are the most dynamic?	**What conflicts exist or are likely to arise?**
Regional socio-economic development	tourism development (overtourism); increasing number of visitors; new housing construction in recreational centres; influence of developers; regulation of development by the national park administration; challenges of cross-border cooperation (cross-border mountain landscape between Czechia and Poland)	tensions between municipalities, national park and tourism entrepreneurs over land management and vision of local development; conflicts between locals (municipalities, community representatives, inhabitants) and outsiders (investors and developers, visitors, tourists)
Agriculture	conversion of agricultural land to other uses; discussions about proper agricultural land management systems	conflicts over land use (tourism housing and infrastructure development vs. preservation of nature and landscape)
Policies	growing differences in the visions of various stakeholders (e.g. national park, local municipalities, tourism entrepreneurs); changing relationship local representatives towards tourism development; strict regulation of local activities by the national park administration	divisive visions of the future management of development between the national park, local communities and investors in tourism services; conflicts over functions and management of unique ecosystems in the national park (national park as a attractive setting for sports and recreational activities); restrictions put by the national

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		park administration on the rights of local land users
Climate Change and biodiversity	impact of climate change on local ecosystems; impact of climate change on winter tourism	biodiversity protection vs. climate change impacts and consequences; continuation of present forms of land use (especially recreational) by technical means vs. adaptation
Future	relationships between stakeholders; development of tourism and recreation (intensive all year round); commercialization; decreasing attractivity for permanent residents	further growth of tourism and recreational use (including building new infrastructure, housing and facilities, increasing number of visitors) vs. focus on well-being and quality of life of local communities and nature conservation

Key agents / stakeholders

A. Identification

Annex Table 14: A. Identification

Stakeholder	Geographic coverage/Level	Main category	Sub-category
Ministry of Environment	national	policy/government	national authority
Ministry of Agriculture	national	policy/government	national authority
Královéhradecký kraj Region	regional	policy/government	regional authority
Liberecký kraj Region	regional	policy/government	regional authority
Krkonoše National Park	regional	policy/government	regional authority; land manager (nature protection)
farmers	local	societal actors	business, land user (farmer)
land and property owners	local	societal actors	land and property owners
land and property users	local	societal actors	land and property users
forest managers and owners	regional/local	societal actors	business, land user (forester)
Forests of the Czech Republic, state enterprise	national	societal actors	business, land user (forester)

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local governments and municipalities	local	societal actors	local authority (local administration)
local interest associations	local	community	citizen association
local residents	local	societal actors/community	public
visitors, tourists	local	societal actors/community	public

B. Assessment of stakeholders' land dependence level (at local, regional / national level)

C. Assessment of their influence level in decision making

Local level

Annex Table 15: Local level

Key agents[27]	Stakeholder category[28]	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A Environmental protection authorities	regional authority	medium-moderate	4	high	5
B Agricultural enterprises	land users (farmers, foresters)	high	5	high	4
C Private farmers	land users (farmers, foresters)	high	5	medium-moderate	3
D Investors and developers	business	low	2	medium-moderate	4
E Landowners	land users (farmers, foresters)	high	5	medium-moderate	3
F Local governments	local authority	medium-moderate	3	medium-moderate	3
G Regional governments	Regional authority	low	2	medium-moderate	2
H Interest associations and NGOs	NGOs	low	1	medium-moderate	2
I General public	other	high	4	medium-moderate	2

[27] According to tables in part I./A, I./B of this dataset.

[28] According to the Figure 3 in *Internal guide for application of the Europe-Land telecoupling framework in case-studies*.

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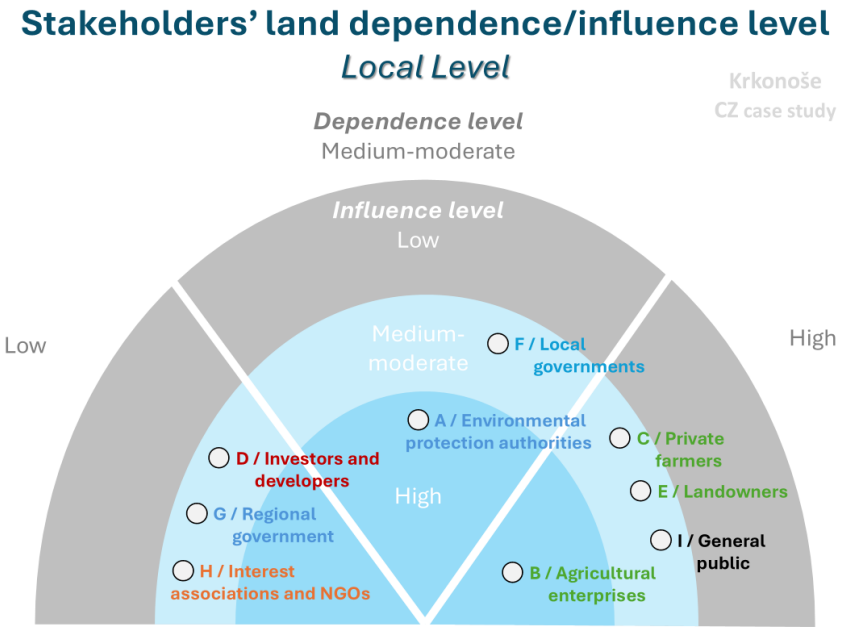
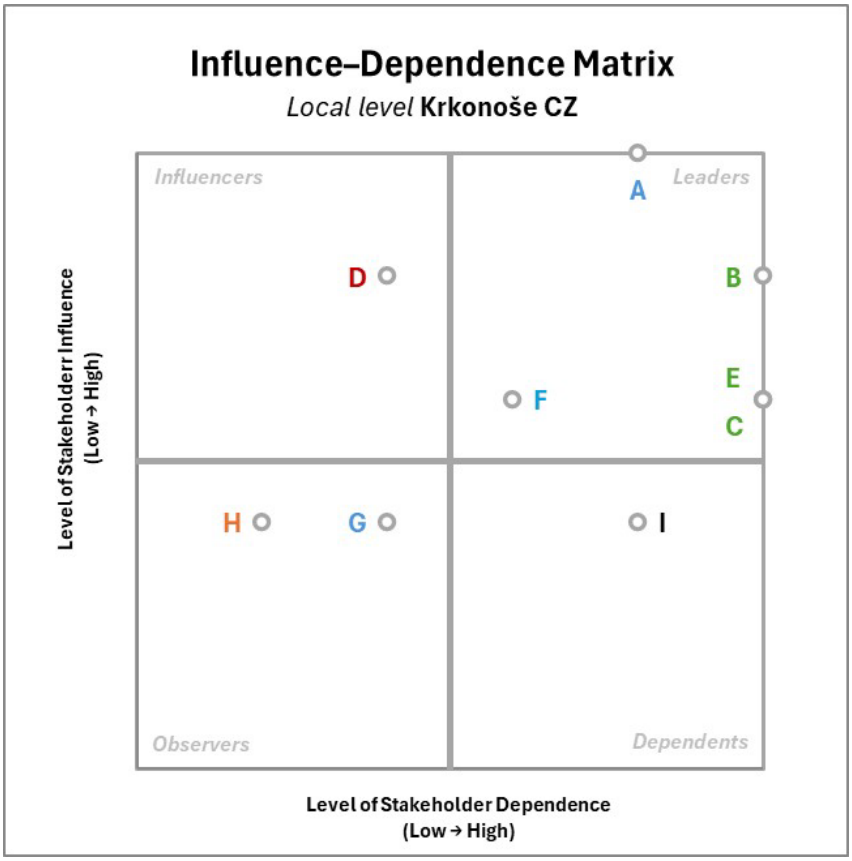


Annex Figure 11: Stakeholders' land dependence/influence level Local level



Annex Figure 12: Influence-Dependence Matrix Local level

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Regional / national level

Annex Table 16: Regional / national level

Key agents	Stakeholder category	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A Environmental protection authorities	national authority	medium-moderate	4	high	5
B National authorities	national authority	low	2	high	5
C Agricultural enterprises	land users (farmers, foresters)	high	5	medium-moderate	3
D Private farmers	land users (farmers, foresters)	high	5	low	1
E Investors and developers	business	low	2	medium-moderate	2
F Regional governments	regional authority	low	1	medium-moderate	3
G Interest associations and NGOs	NGOs	medium-moderate	2	low	1
H Universities, Research Academy	research and academia	low	1	low	1
I General public	other	medium-moderate	3	low	1

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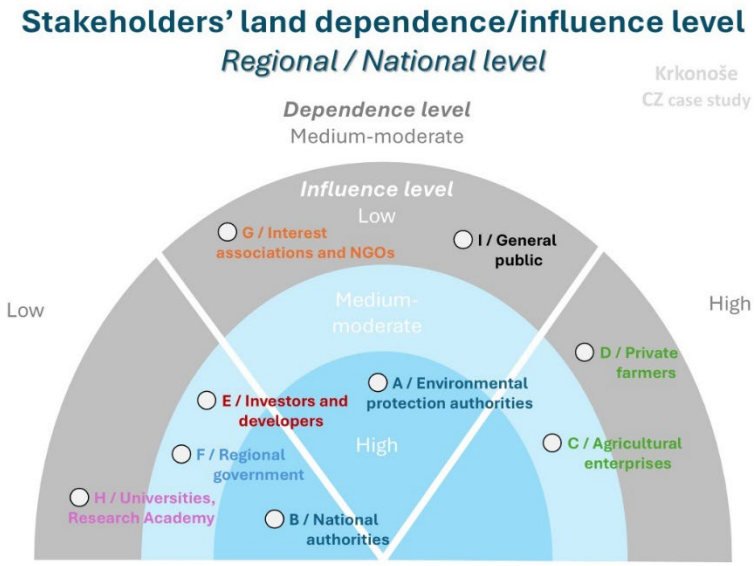
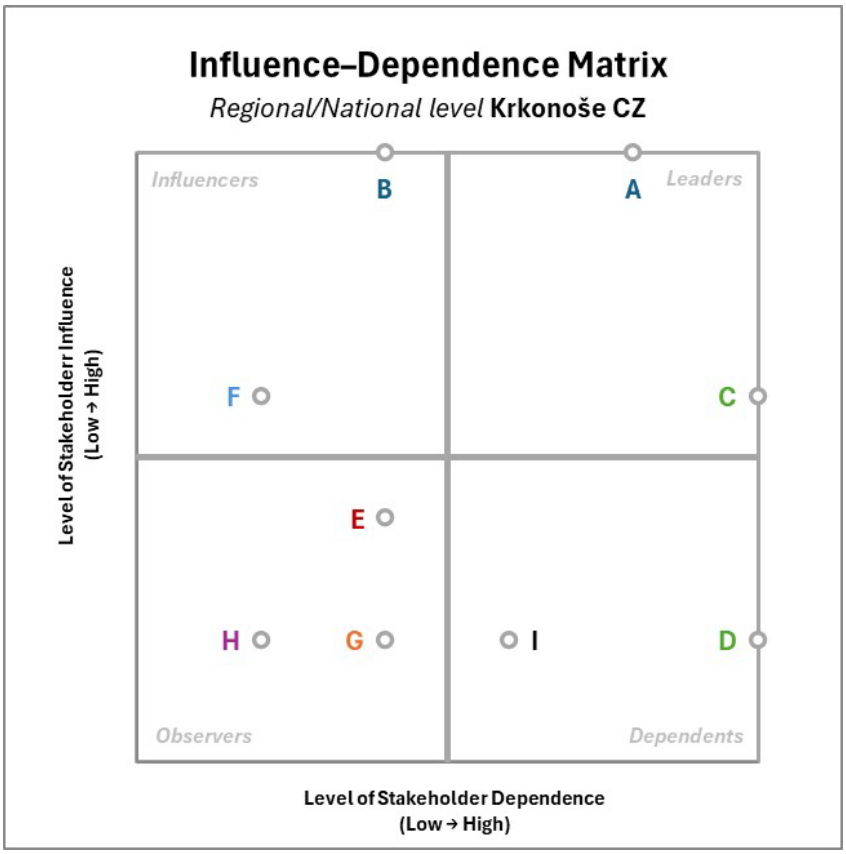


Annex Figure 13: Stakeholders' land dependence/influence level Regional/National level



Annex Figure 14: Influence-Dependence Matrix Regional/National level

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Basic matrix for SNA[29]

Annex Table 17: Basic matrix for SNA

Key agents[30]	land users (farmers, foresters)	Industry business	local authorities	regional authorities	national authorities	NGOs	research and academia	other	EU governance
land users (farmers, foresters)		1	1	1	1	1	1	1	1
Industry business	1		1	1	1	0	1	1	1
local authorities	1	1		1	1	1	1	1	1
regional authorities	1	1	1		1	1	1	1	1
national authorities	1	1	1	1		1	1	1	1
NGOs	1	0	1	1	1		1	1	1
research and academia	1	1	1	1	1	1		1	1
Other	1	1	1	1	1	1	1		1
EU governance	1	1	1	1	1	1	1	1	

[29] A cell with a 1 indicates a relationship (influence/dependence) between agents is present, while a 0 indicates no relationship. 1=weak relationship; 1=medium relationship; 1=strong relationship.

[30] Categories of agents (stakeholder categories) at all levels (local + regional/national) + EU governance (spillover system).

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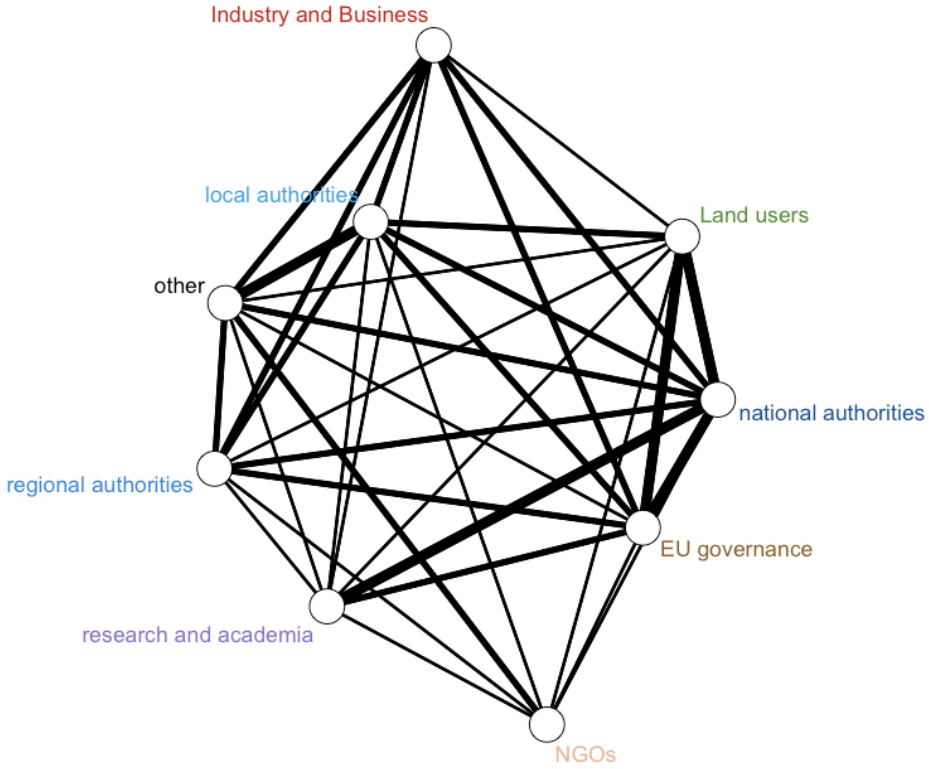

Annex Figure 15: Visualization of relationships among key agents / stakeholders

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1.3 Poland: Bialowieza Forest

Introduction

The Białowieża Forest is located on the border between Poland and Belarus, in the Podlaskie Voivodeship in Poland and the Grodno Region in Belarus. Administratively, in Poland, the Białowieża Forest region lies within the municipalities of Białowieża, Hajnówka, Narew, Narewka, and Dubicze Cerkiewne, which are part of the Hajnówka County (NUTS3: PL842). The Białowieża Forest spans an area of 150,000 hectares. The western part, located in Poland, covers 62,500 hectares, while the eastern part in Belarus covers 87,500 hectares (forming the "Belovezhskaya Pus hcha" National Park).

Hajnówka County covers an area of 162,353 hectares. It consists of 9 communes, including one urban commune, one urban-rural commune, and seven rural communes.

The most valuable part of the Polish section of the Białowieża Forest (about 1/6 of the area) is covered by the Białowieża National Park (BPN).

The main factors determining the current and future land (forest and agro land) use (in the Białowieża Forest region include: protected area with restrict rules, demographic problem connected with depopulations problems, tourism development, quality of soil.

Agriculture is one of the most critical sectors of the economy of the Hajnówka County (Raport, 2019), which covers the Bialowieza Forest region. Agricultural land covers approximately 39.1% of the district's area, with arable land making up 20.9% of it (Statistical Office in Białystok, 2023).

The specificity of the region is the extensive forestation. The forest area in the Hajnówka County covers 88 852 ha. In the ownership structure of forest land, public ownership dominates (86.3%). Private forest land accounts for only 13.7% of all forest land in the county. The State Forests manage 74.4% of the forest land in Hajnówka County, while the national park manages 11.2% of the county's forest land.

A.B. Basic telecoupling elements

Annex Table 18: Basic telecoupling elements

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
Sending: The Hajnówka County Office NUT3	Agriculture – 39,6% Forest land as well as wooded and bushy areas – 54,6% Urbanized area – 0,7% Other – 5,1%	• Environmental protection national institutions • Hajnówka Forest District • Bialowieza National Park • Landowners (farmers) • Landowners (foresters) • Local governments • County government • Non-governmental organizations (LGD, LOT) • Diary production • Agriculture machinery production • Agriculture association • Residents • Universities, research academy	• Agriculture transformation • Other: Environmental protection related issues • Other: Social conflicts	• Demographic • Economic • Political and Institutional • Cultural	• Demography and Labor Force • Environmental • Agriculture and Industry • Economic • Institutional

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Receiving: Podlaskie voivodship NUT2/Poland NUT1	Agriculture – 60,3% Forest land as well as wooded and bushy areas – 31,7% (of which forests –31,4%) Urbanized area – 3,9 % Other – 4,1 %	• National Authorities • Regional-self government • Agricultural Advisory Centres (ODR) • National Agricultural Support Centre (KOWR) • Regional State Administration • Agriculture Modernization Agency • Non-governmental organizations (PROT)) • Large agriculture enterprises • Food production association • Agriculture association Universities, research academy	• Infrastructure expansion • Agriculture transformation • Industrial development • Other: Environmental protection related issues	• Demographic • Economic • Technological • Political and Institutional • Cultural	• Demography and Labor Force • Urbanization and Infrastructure • Environmental • Agriculture and Industry • Market and production • Economic • Institutional
Spillover EU		• EU governance • National and regional authorities • Research and academia • Agricultural key players • Forestry key players • Environmental protection key payers	• Infrastructure expansion • Agriculture transformation • Industrial development • Other: Environmental protection related issues	• Demographic • Economic • Technological • Political and Institutional • Cultural	• Environmental • Economic

Causes in detail:

- Relatively difficult conditions for agricultural production: low average annual temperatures, short growing season, and lack of fertile soils
- Poor soil quality limiting the development of organic farming and agro-cultivation
- Fragmented land ownership structure (predominance of small-scale farms)
- Decreasing number of households that earn income from agricultural activity
- Low number of people employed in agricultural holdings
- Limited number of organized producer groups capable of marketing agricultural products and entering wider markets with local goods
- Poorly developed distribution channels for organic food
- Increasing pressure to improve the efficiency of agricultural land use
- Development of local food products. The main local products of Hajnówka County include honey, dairy products, cider, herbs, oil, and processed forest fruits – all of high food quality
- Favourable natural and environmental conditions for the development of agritourism
- High forest coverage in the region
- Conflicts caused by bison herds destroying crops and wolves threatening livestock
- Unique natural resources. Nearly 66% of Hajnówka County is covered by legally protected areas, which limits land-use options (the Białowieża Forest is a UNESCO World Heritage Site)
- Declining groundwater levels in the Białowieża Forest and water shortages in catchments during drought periods (the area is at risk of groundwater deficit)
- Clear conflict between agricultural needs and nature conservation, particularly regarding water management (irrigation vs. land drainage)
- Depopulation resulting from the migration of young people to larger urban centres (e.g., Białystok)
- Social pressure to expand transport and social infrastructure (schools, healthcare facilities, cultural centres, etc.)
- Restrictions associated with the border zone
- Low investment attractiveness of the county
- Declining number of tourist facilities, many of which are not adapted for people with disabilities

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- Land use in the region is determined by spatial plans, but the planning coverage rate is low – only 13.5% of the area is covered by local land-use plans
- Environmental pressure from intensive agriculture, which may threaten water, soil and air quality and contribute to noise pollution; greenhouse gas emissions resulting from agricultural intensification
- Spatial expansion of intensive farming leading to ecological degradation of agricultural landscapes
- Low environmental awareness among farmers, resulting in excessive use of chemical plant protection products

Drivers in detail:

- Development of intensive agriculture, organic farming, and biomass cultivation
- Growing demand for organic agricultural products and healthy food
- Adverse climate change trends affecting habitats and species. Climate change enables the expansion of various species into new areas (including alien and invasive species), which threatens native wildlife and biodiversity, and also causes economic losses (e.g., damage to asphalt and concrete surfaces). Climate change also leads to an increase in the frequency and intensity of extreme weather events (droughts, flash floods, hurricanes).
- Increasing drought resulting in lower agricultural crop yields
- Progressive urbanization and loss of agricultural land to residential and industrial development (especially near larger towns in the district)
- Threats to protected areas, including loss of biodiversity, caused by habitat fragmentation due to infrastructure development and disruption of ecological corridors
- Geopolitical instability (e.g., uncertain situation on the Polish–Belarusian border) reducing opportunities to benefit from the region's cross-border location and access to eastern markets
- Depopulation, declining population numbers, and negative migration balance
- Aging population and outmigration of young people to larger urban centers
- Spatial planning policies, including local and regional land-use plans
- Forest management plans
- Direct payments (economic and policy instruments that encourage landowners and land users to adopt specific land-use practices, influencing landscape change)
- Financial support for projects aimed at active protection of species and natural habitats
- National investments related to the development of the Via Carpatia road corridor
- Low level of external investment
- Growing demand for firewood, driven by high prices of other traditional energy sources and long-standing habits of heating homes with wood

Effects in detail:

- Increase in the area of agricultural land converted into residential, public, and industrial development
- Expansion of transport infrastructure
- Decline in the number of agricultural holdings
- Rising farming costs due to environmental regulations and protected areas
- Changes in the crop structure on arable land
- Outflow of young people from the district
- Land consolidation – intended, but currently hindered by high fragmentation
- Loss or fragmentation of habitats and a decline in the biodiversity of native species
- Adaptation to climate change

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C. Spillover system - Governance / policies (regional/national/EU)

Annex Table 19: C. Spillover system - Governance / policies (regional/national/EU)

Sector (select from the drop-down list)	Title of document in national language	Title of document in English	Type of document (select from the drop-down list)	Link	Institution/Publisher	Year	Language/s	Level of document (select from the drop-down list)	General remarks regarding instruments/incentives
agriculture	Strategia Zrównoważonego Rozwoju Wsi, Rolnictwa i Rybactwa 2030	Strategy for Sustainable Development of Rural Areas, Agriculture and Fisheries for 2030	strategic	https://www.gov.pl/web/rolnictwo/dokumenty-analizy-szrwrir-2030	Ministry of Agriculture and Rural Development	2019	Polish (full version) English (abstract)	national	Different type of instruments mantioned in II4.Sustainable management and protection of environmental resources and in II5. Adaptation nad mitigation of climate change.
forestry	Polityka leśna państwa	National forest policy	strategic	https://www.katowice.lasy.gov.pl/c/document_library/get_file?uuid=506deebb-988d-4665-bcd9-148fcf66ee02&groupI	Environment Protection Ministry	1997	Polish	national	financial instruments for afforestation of former agricultural land
forestry	Strategia Państwowego Gospodarstwa Leśnego Lasy Państwowe na lata 2014-2030	Strategy of the National Forest Holding 'State Forest' for the period 2014-2030	strategic	http://zlpwrp.pl/wp-content/uploads/2014/08/strategia-LP.pdf	State Forest	2013	Polish	national	-
climate change	Strategiczny plan adaptacji dla sektorów obszarów wrażliwych na zmiany klimatu do roku 2020	Strategic Adaptation Plan for the Sectors and Areas Sensitive to Climate Change up to the Year 2020 with a Perspective until 2030	implementation (operational)	https://bip.mos.gov.pl/g2/big/2013_10/0f31c35e8e490e9d496780f98d95defc.pdf	Ministry of the Environment	2013	Polish	**national**	
spatial planning	Ustawa z dnia 27 marca 2003 r. o planowaniu i zagospodarowaniu przestrzennym	Act on Spatial Planning and Development of March 27, 2003 (with further amendments)	implementation (operational)	https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20030807017/U/D20030717Lj.pd	Sejm of the Republic of Poland	2003	Polish	national	spatial planning instruments (mainly types of planning documents at different levels of decision-making in Poland)
spatial planning	Ustawa z dnia 9 października 2015 r. o rewitalizacji	Act on revitalization of October 9, 2015 (with further amendments)	implementation (operational)	https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20150001777/U/D20151777Lj.pdf	Sejm of the Republic of Poland	2015	Polish	national	communal revitalization program
biodiversity and nature protection	Ustawa z dnia 16 kwietnia 2004 r. o ochronie przyrody	Act of April 16,2004 on nature protection	implementation (operational)	https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=wdu20040920880	Sejm of the Republic of Poland	2004	Polish	**national**	all types of instruments regarding nature protection
agriculture	Ustawa z dnia 8 lutego 2023 r. o Planie Strategicznym dla Wspólnej Polityki Rolnej na lata 2023-2027	Act of February 8, 2023 on the Strategic Plan for the Common Agricultural Policy for 2023-2027	implementation (operational)	https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20230000412	Sejm of the Republic of Poland	2023	Polish	**national**	economic instruments regarding agriculture
agriculture	Ustawa z 3 lutego 1995 o ochronie gruntów rolnych i leśnych	Act of the protection of agricultural and forest land, February 8, 1995	implementation (operational)	https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=wdu19950160078	Sejm of the Republic of Poland	1995	Polish	national	economic instruments regarding agriculture
agriculture	Rozporządzenie Rady Ministrów w sprawie "Programu działań mających na celu zmniejszenie zanieczyszczenia wód azotanami pochodzącymi ze źródeł rolniczych oraz zapobieganie dalszemu zanieczyszczeniu"	Decree of the Council of Ministers on the "Program of measures to reduce water pollution by nitrates from agricultural sources and to prevent further pollution	implementation (operational)	https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20230000244	The Council of Ministers	2023	Polish	national	economic and administrative instruments regarding agriculture
agriculture	Zbiór zaleceń dobrej praktyki rolnej	Collection of good agricultural practice recommendations for voluntary use	implementation (operational)	https://www.gov.pl/web/rolnictwo/zbior-zalecen-dobrej-praktyki-rolniczej-do-dobrowolnego-stosowania	The Ministry of Agriculture and Rural Development	2019	Polish	national	administrative instruments
other	Ustawa z dnia 3 października 2008 r. o udostępnianiu informacji o środowisku i jego ochronie, udziale społeczeństwa w ochronie środowiska oraz o ocenach oddziaływania na środowisko	Act of October 3, 2008 on providing information on the environment and its protection, public participation in environmental protection and environmental impact assessments	implementation (operational)	https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=wdu20081991227	Sejm of the Republic of Poland	2008	Polish	**national**	informational and educational instruments

Key insights from expert interviews

Annex Table 20: Key insights from expert interviews

	Which aspects are the most dynamic?	What conflicts exist or are likely to arise?
Regional socio-economic development	The population is declining (both as a result of falling birth rates and rising migration balances). An ageing population	The biggest problem is the labor market. The population is aging, there is a shortage of specialists, and young people lack entrepreneurial attitudes. There are major social conflicts related to the functioning of the Bialowieza Forest as a UNESCO site.
Agriculture	The decline in cattle and pig and poultry farming means that the use of natural fertilisers is decreasing. Decline of small-scale agriculture (small hectare farms are unprofitable and no longer viable), large-scale farms are beginning to emerge.	Poorly dispersed organic food sales channels (especially in small towns and villages) can be one of the barriers to the development of organic production in the region. Conflicts are also caused by herds of bison, which destroy

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		farmers' crops, and wolves, which are a threat to livestock.
Policies	Growing interest among agricultural producers in benefiting from agri-environment-climate payments.	Currently, the Białowieża National Park has two administrators. Conflicts may arise due to different legal regulations. Conflicts between the managers of the Białowieża Forest national park and farmers. The conflict concerns the herds of bison leaving the reserve and the destruction of agricultural crops in the area. Previous restrictions in the border area, "Shield East", the increased number of soldiers and a decreased sense of security have significantly inhibited the development of the tourism function. The increased mobility of military vehicles has also negatively affected nature.
Climate Change and biodiversity	In Białowieża, the spread of new species has been observed. According to experts, the best solution is to monitor how nature copes with them. Declining groundwater levels in the Bialowieza Forest; changing precipitation pattern as a result of climate change (there is more precipitation in winter and less in summer when agricultural demand is much greater); worsening drought	The progressive drought is causing a decline in crop yields in agricultural production. The conflict concerns the herds of bison leaving the reserve and the destruction of agricultural crops in the area. At the moment, there is a lack of systemic solutions in this area. Climate change causes various species to expand into new areas; new species (including alien, invasive species) often cause threats to native wildlife; this causes threats to biodiversity, but also industrial losses (destruction of asphalt and concrete pavements); diseases and other pathogens also appear; tree species that have functioned for decades in the area begin to be in poor condition (spruce is an example)
Future	Geopolitical situation (uncertain situation on the Polish-Belarusian border)	The expert believes in the sustainable future of the region as the awareness to protect the nature is on the rise. Low awareness of the UNESCO World Heritage Site among visitors to the region.

Key agents / stakeholders

A. Identification

Annex Table 21: A. Identification

Stakeholder	Geographic coverage/Level	Main category	Sub-category
The Hajnówka County Office	local	policy/government	local authority
Hajnówka Municipality Office	local	policy/government	local authority
Białowieża Municipality Office	local	policy/government	local authority
Czeremcha Municipality Office	local	policy/government	local authority
Narewka Municipality Office	local	policy/government	local authority
Narew Municipality Office	local	policy/government	local authority
Dubicze Cerkiewne Municipality Office	local	policy/government	local authority
Kleszczele Municipality Office	local	policy/government	local authority
Hajnówka City Council	local	policy/government	local authority

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Department of Promotion and Development, The Hajnówka County Office; Center for Tourism and Promotion	local	policy/government	local authority
Head of the Department of Geodesy, Cadastre and Real Estate, The Hajnówka County Office	local	policy/government	local authority
Students and researchers at Bialystok University of Technology, Forestry Department	local	academia	research and academia
Farmers in Hajnowka County	local	industry	land user (farmer)
Representatives of local municipality Sucha nad Parnou (local schools, NGOs, local government, local entrepreneurs, local associations)	local	industry; policy/government; societal actors/community	land user (farmer); local authority (local administration); non-governmental organization (NGOs); business; citizen association
Hajnówka Forest District	local		land user (foresters); local authority (local administration);
Białowieża National Park	regional	policy/government	regional authority
Polish Association of Environmental and Resource Economists	national	academia/societal actors	NGOs
The Marshal's Office of the Podlaskie Voivodeship, Department of Agriculture and Rural Development	regional	policy/government	regional authority
Marshal's Office of the Podlaskie Voivodeship, Department of Environmental Protection	regional	policy/government	regional authority
Białowieża Forest District	regional	policy/government	regional authority
Hajnówka Forest District	regional	policy/government	regional authority
Browsk Forest District	regional	policy/government	regional authority
The Regional Directorate of State Forests (RDLP) in Białystok	regional	policy/government	regional authority
Podlasie Agricultural Advisory Center	regional	policy/government	national authority (central government, related ministries and agencies)
Foundation of Environmental and Resource Economists in Białystok	national	academia/societal actors	NGO
The Institute of Environmental Protection – National Research Institute	national	academia	research and academia
Institute of Soil Science and Plant Cultivation - State Reseach Institute	national, regional, local	academia	research and academia
Institute of Technology and Life Sciences -State Research Institute	national, regional, local	academia	research and academia
Chief Inspectorate for Environmental Protection	national	policy and governement	national authority (central government, related ministries and agencies)
The National Centre for Emissions Management (KOBiZE)	national	policy and governement	national authority (central government, related ministries and agencies)
The Agency for Restructuring and Modernization of Agriculture	national, regional, local	policy/government	national authority (central government, related ministries and agencies)
Ministry of Climate and Environment, Department of Nature Conservation,	national	policy/government	national authority (central government, related ministries and agencies)
Ministry of Funds and Regional Policy, Department of Strategy	national	policy/government	national authority (central government, related ministries and agencies)
National Agricultural Support Center	national	policy/government	national authority (central government, related ministries and agencies)

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B. Assessment of stakeholders' land dependence level (at local, regional / national level)

C. Assessment of their influence level in decision making

Local level

Annex Table 22: Local level

Key agents [31]	Key agents	Stakeholder category[32]	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A.	Environmental protection national institutions	National authority	2	low	5	high
B.	Hajnówka Forest District	Land users	5	high	4	high
C.	Bialowieża National Park	National authority, land users,	5	high	4	high
D.	Landowners (farmers)	Land users	5	high	4	high
E.	Landowners (foresters)	Land users	5	high	3	medium-moderate
F.	Local governments	Local authority	3	medium-moderate	3	medium-moderate
G.	County government	Local authority	2	low	2	low
H.	Non-governmental organizations (LGD, LOT)	NGOs	1	low	2	low
I.	Diary production	Industry business	3	medium-moderate	3	medium-moderate
J.	Agriculture machinary production	Industry business	1	low	2	low
K.	Agriculture association	Associations	2	low	2	low
L.	Residents	Other	2	low	1	low
M.	Universities, research academy	Research and academia	3	medium-moderate	1	low

[31] According to tables in part I./A, I./B of this dataset.

[32] According to the Figure 3 in *Internal guide for application of the Europe-Land telecoupling framework in case-studies*.

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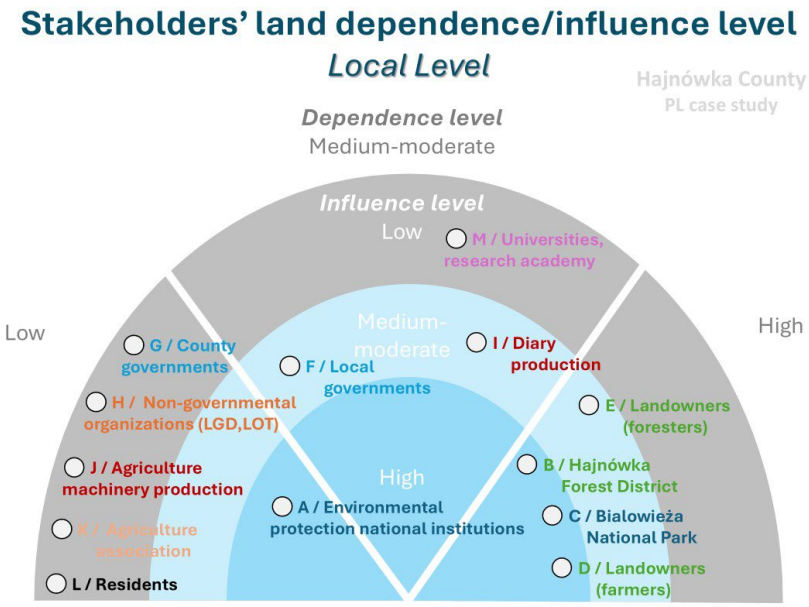
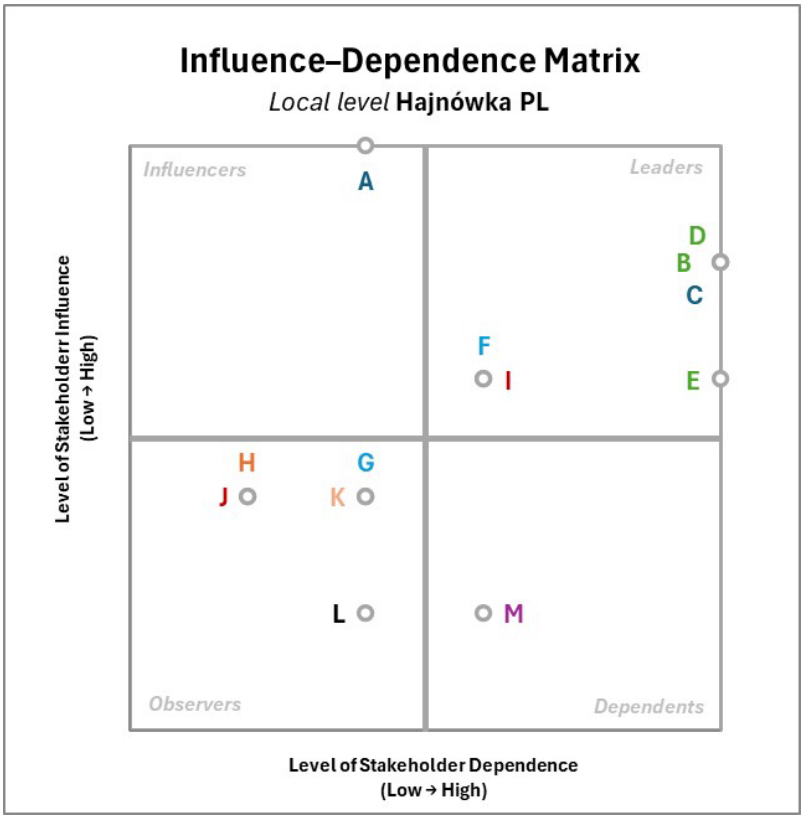


Annex Figure 16: Stakeholders' land dependence/influence level Local Level



Annex Figure 17: Influence-Dependence Matrix Local level

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Regional / national level

Annex Table 23: Regional / national level

Key agents[33]	Key agents	Stakeholder category[34]	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A.	National Authorities	National authority	2	low	5	high
B.	Regional-self government	Regional authority	3	medium-moderate	3	medium-moderate
C.	Agricultural Advisory Centres (ODR)	Associations	3	medium-moderate	3	medium-moderate
D.	National Agricultural Support Center (KOWR)	National authority	3	medium-moderate	3	medium-moderate
E.	Regional State Administration	Regional authority	3	medium-moderate	3	medium-moderate
F.	Agriculture Modernization Agency	Regional authority	3	medium-moderate	4	high
G.	Non-governmental organizations (PROT)	NGOs	1	low	1	low
H.	Large agriculture enterprises	Industry business	5	high	4	high
I.	Food production association	Associations	3	medium-moderate	3	medium-moderate
J.	Agriculture association	Associations	4	high	3	medium-moderate
K.	Universities, research academy	Research and academia	2	low	1	low

[33] According to tables in part I./A, I./B of this dataset.

[34] According to the Figure 3 in *Internal guide for application of the Europe-Land telecoupling framework in case-studies*.

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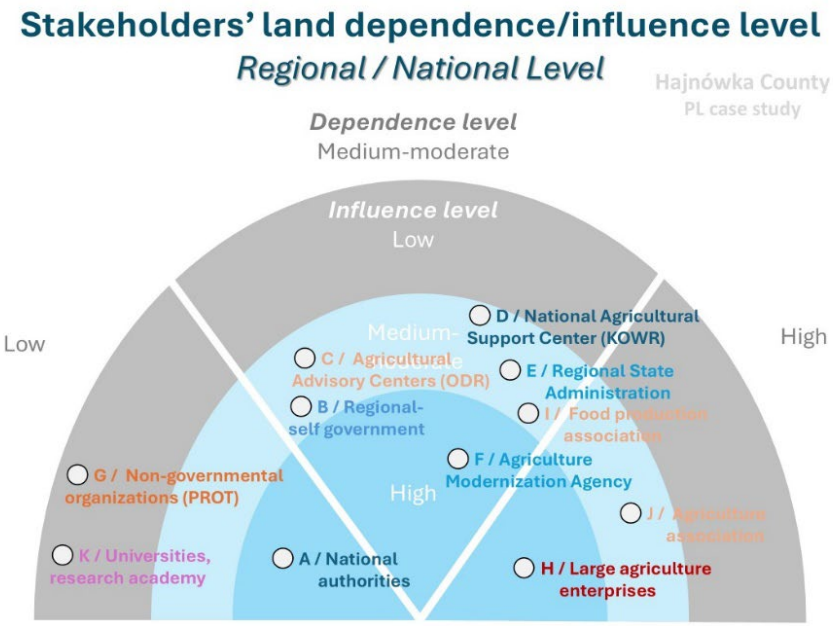
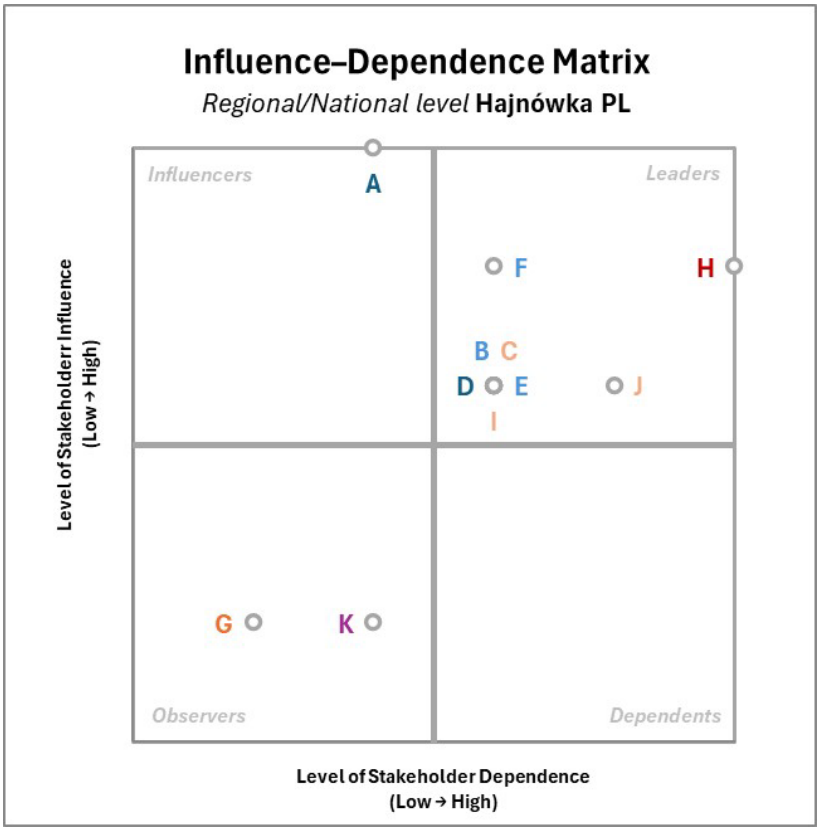


Annex Figure 18: Stakeholders' land dependence/influence level Regional/National Level



Annex Figure 19: Influence-Dependence Matrix Regional/National level

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Basic matrix for SNA[35]

Annex Table 24: Basic matrix for SNA

Key agents[36]	Land users	Local authority	Regional authority	National authority	NGOs	Associations	Industry business	Research and academia	EU Governance
Land users		1	1	1	1	1	1	0	0
Local authority	1		1	1	1	1	1	0	0
Regional authority	1	1		1	1	1	1	1	1
National authority	1	1	1		1	1	1	1	1
NGOs	1	1	1	1		1	0	0	0
Associations	1	1	1	1	1		1	0	1
Industry business	1	1	1	1	0	0		0	1
Research and academia	1	0	1	1	0	1	1		0
EU Governance	1	1	1	1	1	1	1	1	

0 – lack of influence; 1=weak relationship; 1=medium relationship; 1=strong relationship

[35] A cell with a 1 indicates a relationship (influence/dependence) between agents is present, while a 0 indicates no relationship. 1=weak relationship; 1=medium relationship; 1=strong relationship.

[36] Categories of agents (stakeholder categories as in step B.) at all levels (local + regional/national) + EU governance (spillover system).

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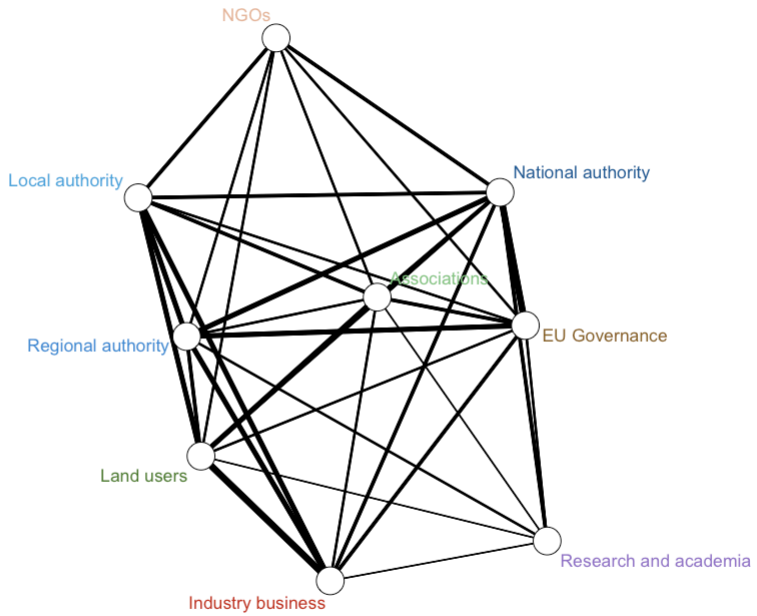

Annex Figure 20: Visualization of relationships among key agents / stakeholders

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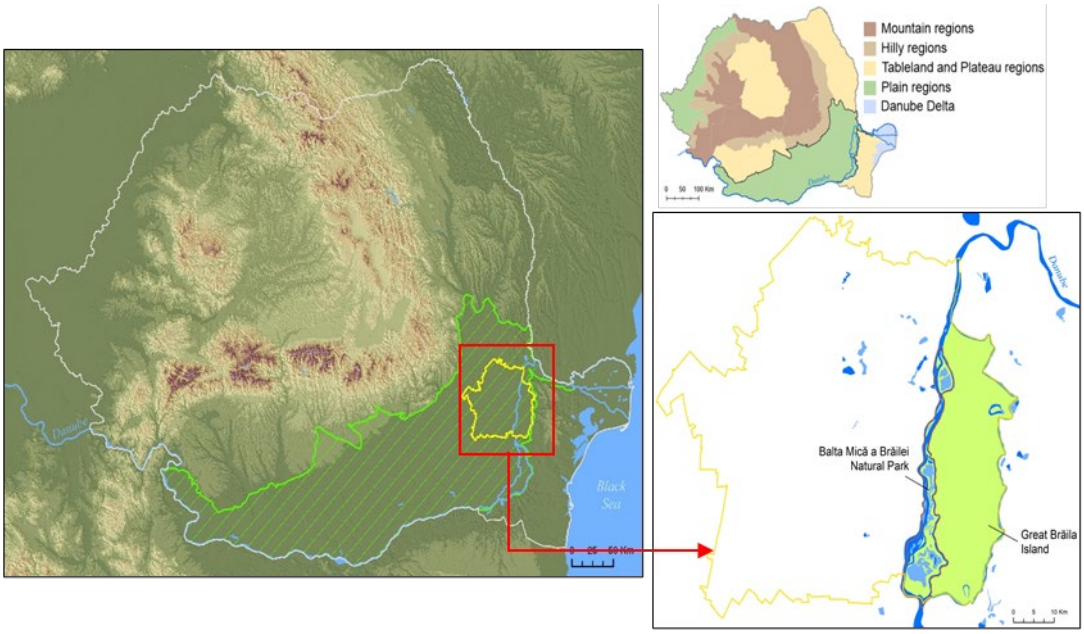
1.4 Romania: Brăila Islands

Introduction

Brăila Island is located in the south-eastern part of Romania, in the Danube Floodplain, between the main branches of Danube River (Cremenea and Măcin). The study area covers about 97,000 hectares and includes two distinct areas: a predominantly agricultural area, the Big Brăila Island (over 71000 hectares) and a wetland protected area, Balta Mică a Brăilei (Small Brăila Island) natural park (24 100 hectares). The case study in Romania targets a local level approach (Braila Island area located between the Danube arms). However, since the casestudy does not cover entirely the farms' typology in this area of Romania, we will also go for a regional-level approach, meaning the Braila County (as an administrative unit).

Geographical position of Braila Islands and Brăila County



Annex Figure 21: Geographical position of Braila Islands and Brăila County

Land use pattern. In Brăila Islands, in 2018 (according to CLC 2018), arable land represented the main land use category with 70,379 ha (72% of total surface area); followed by forests 13,704 ha (14%); inland marches 6,145 ha (6.3%); water bodies 5,609 ha (5.7%); built-up areas 1,001 ha (1%) and natural grasslands and pastures 866 ha (0.9%) (Annex Figure 22). In Big Brăila Island there is located the largest agricultural farm in Europe (56,000 ha) where an intensive agriculture is practiced and high yield/ha is obtained (up to 10,000 kg/ha for maize, 6,500 kg/ha for wheat), far above the national average production.

Brăila County. According to CORINE land Cover 2018, the total arable area of Brăila County was 357,981 ha (75% of the total area); pastures and natural grasslands 32,522 ha (6.8%); forests 23,370 ha (4.9%); built-up areas 21,227 ha (4.5%) and water bodies 12,457 ha (2.6%).

Among the 41 counties of Romania, Brăila County has the largest irrigated agricultural areas. In 2023, 235,832 ha of agricultural lands were irrigated, which represents over 66% of the agricultural area equipped with irrigation facilities in Braila County and almost 50% of the irrigated agricultural area at

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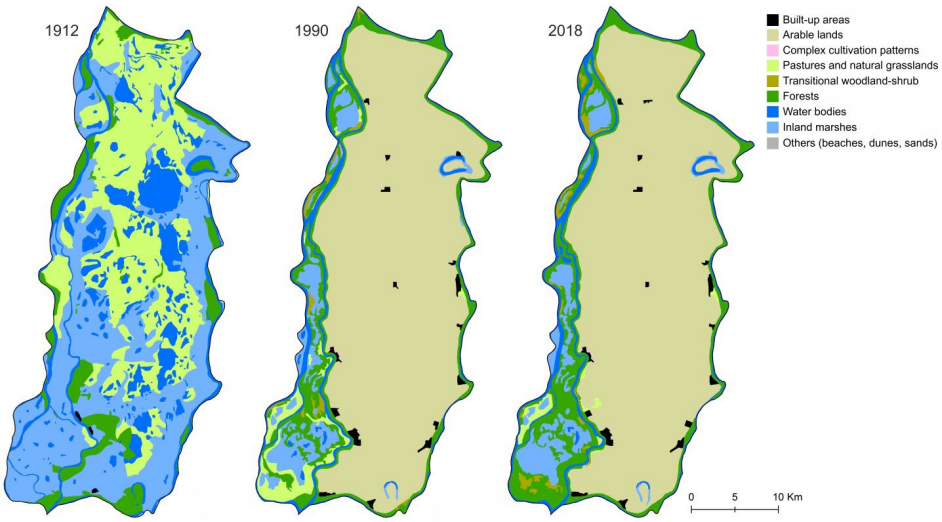
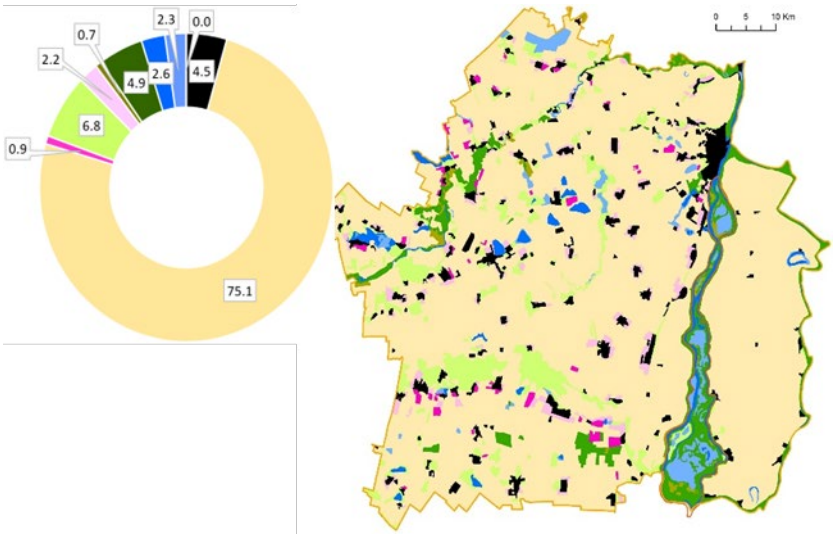
the country level. The rest of the unirrigated agricultural land is usually owned by small farms that, in the absence of state support, don`t have sufficient financial resources to support the irrigation costs.

Dynamics of land use/cover pattern 1912, 1990 and 2018



Annex Figure 22: Dynamics of land use/cover pattern 1912, 1990 and 2018

Current land use/cover of the Braila County



Annex Figure 23: Current land use/cover of the Braila County

In 2020, in Brăila County, there were 29,576 agricultural holdings (2020) using over 382,995 hectares of agricultural land (National Institute of Statistics). The average agricultural area/farm was 12.9 ha,

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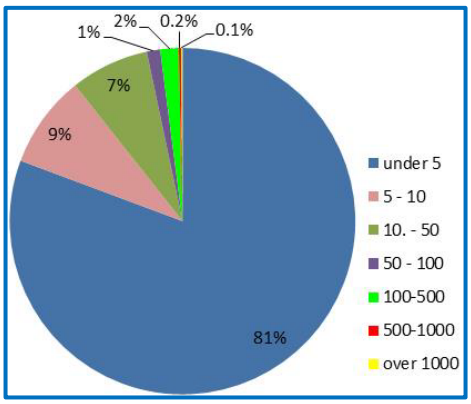
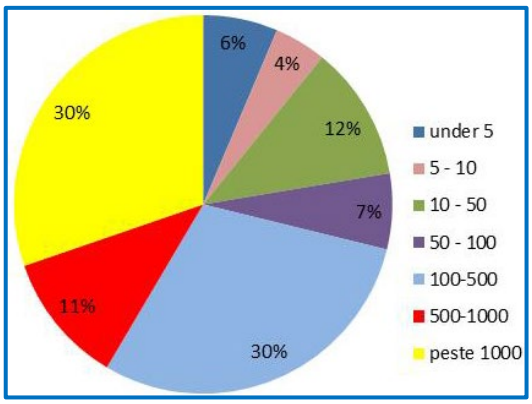
above the national average of only 2.73 ha. Regarding the spatial size of farms, in Brăila County two categories can be clearly distinguished within the farm size class. The first category includes very small and small farms of less than 5 hectares, which represent 81% of the total number of farms (2020), possessing about 6.4% of the total agricultural area used. It should be mentioned that 52% of farms in this category have below one hectare, therefore they are not eligible for receiving direct payment/hectare.

The second category consists of large and very large farms of over 100 ha, or even 1,000 ha (the largest agricultural farm in Europe has over 56,000 hectares and is located on the Big Brăila Island). These large farms possess 71.2% of the total agricultural area, but represent only 2% of all farms (2020).

In between these two categories stand the medium-sized farms (5-10 ha, 10-50 ha and 50-100 ha), basically family associations, producing for the market or some of them for self-consumption. Although these farms should be dominant, they represent only 17.2% of the total number of farms and possess 22.4% of the total agricultural area used.



Number of agricultural farms by size classes (%) in Brăila county



Agricultural farms by size classes of utilised agricultural area (%) in Brăila county

Annex Figure 24: Agricultural farms sizes

Geographic Coverage:

- Country: Romania
- Region: Brăila County, Brăila Island
- Coordinates Extent (27°49’20’’ - 28°11’50’’ Lon; 44°45’20’’ - 45°17’10’’ Lat)

Time Coverage: (~1912)

- 1912 – historical land use/cover pattern
- 1990 – past Corine Land Cover
- 2018 – present Corine Land Cover
- 2050 – future land use/cover pattern

Data Source: (own processing by using Austrian-Hungarian maps, scale 1:200 000, available at: geo-spatial.org, http://geo-spatial.org/vechi/download/harile-austriece-1910-reproiectate-in-stereo70)

Data Format:

- File Format: Shapefile

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- Projection system: EPSG:4326 – WGS84

A.B. Basic telecoupling elements

Annex Table 25: Basic telecoupling elements

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending Regional/Local Brăila Island/Braila County NUTS2, NUTS 3, NUTS 5	Agriculture	• Regional government • Local government • Landowners • Farmers associations • Universities, Research Centres • Environmental protection authorities	Agricultural transformation Socio-economic changes Other factors	Political and institutional Economic Demographic Technological Environmental	Type of property and land exploitation Agricultural intensification / extensification Urbanization Intensification of extreme climate events
receiving National	Agriculture	• National Authorities (policymakers) • Universities, Research Academy • Industry business • Non-governmental organizations	Agricultural transformation Socio-economic changes Other factors	Political and institutional Economic Demographic Technological Environmental	Demography and Labor Force Economic Institutional

Causes in detail:

- the fall of the communist regime
- Romania's accession to the EU and the adoption and implementation of the Common Agricultural Policies and other EU regulations and directives
- the existence of very fertile arable land and a functional irrigation system
- industrial restructuring in the region and shortage of employment opportunities, leading to out-migration
- arrival of investors in agriculture (large agricultural holdings, including external investors)
- pressure for more efficient land use in agriculture
- land availability due to multiple ownership and land fragmentation
- high impact of climate extremes (e.g. drought, water scarcity, erosion)
- proximity of the Danube and water availability for irrigation as well as an extensive former irrigation system
- market aspects (e.g. cereal price)

Drivers in detail:

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- the restitution of land to former owners (replacing collective and state ownership with private ownership)
- the existence of inadequate agricultural policies, especially during the transition and post-transition periods
- the evolution of demographic factors (population decline, internal and external migration, etc.)
- the restructuring of all branches of the economy
- poor mechanization of agricultural works, difficulty in applying new production technologies, insufficient/arbitrary fertilization of agricultural crops, and the destruction or abandonment of irrigation systems and other land improvement systems during the transition and post-transition periods
- the intensification of extreme climatic phenomena (drought, desertification, hail, torrential rains, floods, etc.)
- development of intensive agriculture
- proximity of the Danube and facilities for grain transportation
- Direct payment (an economic incentive and political instrument that motivates landowners and land users to adopt a certain type of land use, thereby influencing the dynamics of landscape change).

Effects in detail:

- the expansion of private ownership was the direct result of the processes of decollectivization and privatization of agriculture
- the formation of a very large number of individual subsistence farms
- excessive fragmentation of agricultural land during the transition period
- a significant consolidation of agricultural land into commercial farms after Romania's accession to the EU
- a reduction of productive agricultural services (irrigation, fertilization, mechanization)
- a significant decline in the productive quality of the land, affecting both the quality and quantity of crop production, which, on non-irrigated lands, has fluctuated from year to year and has been largely dependent on climatic conditions
- After Romania's accession to the EU and the emergence of Romanian and foreign investors, agriculture experienced a positive trend, with all productive agricultural services developing
- land concentration, land grabbing and competition on land
- the livestock sector has experienced a sharp decline
- expansion of agricultural lands affected by drought and aridification
- population aging, youth emigration and job shortages, but it also shows recent signs of revitalization. The benefits of European funds and the reorientation of young people towards agriculture offer significant development potential.
- Support for monocultures, fewer hedgerows and field margins, and difficulty in planting forest belts originally existing in the region to combat wind erosion
- Agriculture as the main economic activity in the region, with little diversification and relatively low employment opportunities
- Modern technologies in agriculture focused on large-scale farming (especially the large farm in the Braila Island)
- Decline in agricultural labor force and low professionalization in agricultural labour.
- Adaptation to climate change

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C. Spillover system - Governance / policies (regional/national/EU)

Annex Table 26: C. Spillover system - Governance / policies (regional/national/EU)

Sector (select from the drop-down list)	Title of document in national language	Title of document in English	Type of document (select from the drop-down list)	Link	Institution/Publisher	Year	Language/s	Level of document (select from the drop-down list)	General remarks regarding instruments/incentives
agriculture	Planul Național Strategic PAC 2023-2027	National Strategic Plan PAC 2023-2027	strategic	https://www.madr.ro/docs/dezvoltare-rurala/2023/Plan-Strategic-PAC-2023-2027-versiunea-3.1.pdf	Ministry of Agriculture and Rural Development	2023	Romanian	national	The National Strategic Plan for Romania foresees 89 types of interventions, including 51 interventions through the European Agricultural Guarantee Fund EAG (Pillar I) and 38 interventions through the European Agricultural Fund for Rural Development EAFRD (Pillar II). The PNS has clear objectives for the development of agriculture, the food industry and the Romanian countryside and includes support instruments financed from both the EAG and the EAFRD: Pillar I: EAG - Direct payments and sectoral interventions (market support measures). Pillar II: EAFRD - Rural Development Policy The total PNS budget for the period 2023-2027 is 15.8 billion euros, of which PILLAR 1 (EAG) composed of Direct Payments = 9.78 billion euros + Sectoral Interventions 151 million euros, and PILLAR 2 (EAFRD) = 5.87 billion euros.
agriculture	Strategia Națională de Reabilitare și Extindere a Infrastructurii de Irigații din România	The National Strategy for the Rehabilitation and Expansion of the Irrigation Infrastructure in Romania	strategic	https://www.madr.ro/proiecte-de-acte-normative/download/3833_0a8f3b4bc637bf180491ef7d9507a71d.html	Ministry of Agriculture and Rural Development	2019	Romanian	national	The main objectives of the strategy are: a) Supporting investments in irrigation facilities where farmers have a high potential for using and maintaining the systems, as well as contributing to investments in the facilities b) Modernization of the irrigation infrastructure by reducing water losses and energy consumption.
agriculture	Strategia Națională privind Prevenirea și Combaterea Deșertificării și Degradării Terenurilor 2019-2030	The National Strategy on Preventing and Combating Desertification and Land Degradation 2019-2030	strategic	https://www.mmediu.ro/categorie/strategia-nationala-privind-prevenirea-si-	Ministry of Environment, Waters and Forests	2023	Romanian	national	The overall objective of the strategy is to respond to the anticipated new environmental challenges and to update the old strategy in line with current national and European policies and strategies in the field of combating desertification and land degradation.
agriculture	Strategia Națională pentru Reducerea Efectelor Secetei pe Termen Scurt, Mediu și Lung	The National Strategy for Reducing the Effects of Drought in the Short, Medium and Long Term	strategic	https://old.madr.ro/pages/strategie/strategie_antiseceta_update_09.05.2008.pdf	Ministry of Agriculture and Rural Development	2008	Romanian	national	The main aim of the National Strategy for reducing the effects of drought and combating land degradation and desertification is to indicate the actions to be taken in the short, medium and long term, to reduce the vulnerability of local communities, natural ecosystems and socio-economic activities and to reduce their social, economic and environmental effects.
agri-food	Strategia pentru dezvoltarea sectorului agroalimentar pe termen mediu și lung orizont 2020-2030	Strategy for the development of the agri-food sector in the medium and long term 2020-2030	strategic	https://www.madr.ro/docs/agricultura/strategia-agroalimentara-2020-2030.pdf	Ministry of Agriculture and Rural Development	2015	Romanian	national	The strategy aims at the intelligent and sustainable capitalization of the agro-food potential and the development of the rural space, being a visionary support document that supports the progress of agriculture and rural development in Romania.
fishing	Strategia de dezvoltare locală integrată a zonei pescărești a județului Brăila	The integrated local development strategy of the fishing area of Brăila county	strategic	https://www.pescuitbraila.ro/popam-2014-2020/	The Local Group Association for the Promotion of the Integrated Development of the Fishing Area of Brăila County (FLAG)	2023	Romanian	regional	The strategy aims to strengthen and develop the infrastructure and services for fisheries, aquaculture and tourism, support related and alternative fishing and aquaculture activities, preserve local identity and protect the environment.
spatial planning	Strategia de dezvoltare a județului Brăila 2021-2027	Development strategy of Brăila County 2021-2027	strategic	https://cjbraila.ro/dm/portal.nsf/AB8DBE2BD0441665C225877300416A8B/$FILE/Strategia%20de%20dezvoltare%20a%	Brăila County Council	2021	Romanian	regional	The objective of strategy was to impove the knowledge and skills of the staff from the local public administration of Braila county through specific training in the field of strategic planning, in order to obtain sustainable benefits. The development of a modern and efficient local and county public administration
energy	Strategia energetică a României 2020-2030, cu perspectiva anului 2050	Romania's energy strategy 2020-2030, with the perspective of 2050	strategic	https://www.mmediu.ro/app/webroot/uploads/files/Strategia%20Energetica%20a%20Roma	Ministry of Environment, Water and Forests	2020	Romanian	national	The document provides strategic objectives for energy development of Romania; indicates the national, European and global benchmarks that influence and determine policies and decisions in the energy field
climate change	Planul Național Integrat în domeniul Energiei și Schimbărilor Climatice 2021-2030	The 2021-2030 Integrated National Energy and Climate Plan	strategic	https://energy.ec.europa.eu/system/files/2020-06/ro_final_necp_main_en_0.pdf	Ministry of Energy	2020	Romanian/ english	national	The document includes the establishment of (i) national emission reduction targets greenhouse gas emissions, increasing the share of energy from renewable sources in final energy consumption, improving energy efficiency in all economic sectors and increasing the degree of interconnection of the internal electricity market to the European energy market, as well as some (ii) policies and measures to achieve those targets.
climate change	Strategia pe termen lung a României pentru reducerea emisiilor de gaze cu efect de seră – România Neutră în 2050	Long term strategy of Romania	strategic	https://www.mmediu.ro/app/webroot/uploads/files/Long%20Term%20Strategy%20pf%20Ro	Ministry of Environment, Water and Forests	2023	Romanian/ english	national	According to the Romania Neutral scenario, which is the chosen one, Romania aims at becoming climate neutral in 2050, reaching 99% net emission reduction in 2050, compared to the 1990 level
climate change	Strategia Națională privind Adaptarea la Schimbările Climatice pentru perioada 2022-2030	The National Strategy on Adaptation to Climate Change for the period 2022-2030	strategic	https://www.mmediu.ro/categorie/strategia-nationala-privind-adaptarea-la-schimbarile-climatice-pentru-perioada-2022-2030/419	Ministry of Environment, Water and Forests	2022	Romanian	national	***the draft decision of the framing stage was made available to the public for consultation** The general objective of the National Strategy on Adaptation to Climate Change for the period 2022-2030 with the perspective of 2050 is to improve the capacity to adapt and increase the resilience of socio-economic and natural systems to the effects of climate change, in different areas and time intervals. At the same time, the strategy aims at sectoral development in accordance with the principles of the New EU Strategy on adaptation to climate change, i.e. smart, rapid, systemic and connected adaptation at the global scale of action.
climate change	Planul Național de Acțiune pentru implementarea Strategiei Naționale privind Adaptarea la Schimbările Climatice	The National Action Plan for the implementation of the National Strategy on Adaptation to Climate Change	implementation (operational)	https://www.mmediu.ro/categorie/strategia-nationala-privind-adaptarea-la-schimbarile-climatice-pentru-perioada-2022-2030/419	Ministry of Environment, Water and Forests	2022	Romanian	national	***the draft decision of the framing stage was made available to the public for consultation** The National Action Plan for the implementation of the National Strategy on Adaptation to Climate Change covers the fields of (1) Water resources, (2) Forests, (3) Biodiversity and ecosystem services, (4) Population, public health and air quality, (5) Education and awareness, (6) Cultural heritage, (7) Urban systems, (8) Agriculture and rural development, (9) Energy, (10) Transport, (11) Tourism and recreation, (12) Industry and (13) Insurance .
other	Strategia națională privind economia circulară	National Strategy for the Circular Economy in Romania	strategic	https://circulareconomy.europa.eu/platform/sites/default/files/national_strategy_for_the_circular_economy_in_romania.pdf	Romanian Government, Department of Sustainable Development	2022	romanian	romanian	The Romanian Strategy for the Circular Economy (NSCE) is a roadmap for accelerating Romania's transition from a linear to a circular economic model. The implementation of the Action Plan (to be adopted in September 2023) will provide a framework for this transition. The strategy gives an overview of the fourteen economic sectors, and identifies the following as having the greatest circular potential: agriculture and forestry, automotive sector, construction, consumer goods (food and beverages), packaging (glass, paper, plastic materials etc.), textiles, electrical and electronic equipment.
other	Planul de acțiune privind economia circulară pentru România	The circular economy action plan for Romania	implementation (operational)	https://www.mmediu.ro/app/webroot/uploads/files/Planul%20de%20Actiune%20pentru%20SNEC.pdf	Romanian Government, Department of Sustainable Development	2022	romanian	romanian	The circular economy action plan for Romania is part of the government's recent efforts to accelerate the transition to a circular economy in Romania. While the Strategy established the vision, mission and high-level objectives for the transition process to the circular economy in Romania, the action plan proposes and describes concrete actions to orient the Romanian economy towards circularity.
forestry	Strategia națională pentru păduri 2030	National Forest Strategy 2030	strategic	https://www.mmediu.ro/categorie/strategia-nationala-pentru-	Ministerul Mediului, Apelor și Pădurilor/Ministry of Environment, Waters and	2022	Romanian	national	Aims to ensure the balanced integration of social, ecological and economic functions in forest management
forestry	Strategia forestieră națională 2018-2027	National forestry strategy	strategic	https://www.mmediu.ro/app/webroot/uploads/files/2017-10-	The Government of Romania	2017	Romanian	national	has the role of providing benchmarks and predictability to the forestry sector for the next 10 years.
biodiversity and nature protection	Strategia națională și Planul de acțiune pentru conservarea biodiversității 2014 – 2020		strategic	https://www.mmediu.ro/img/attachment/32/biodiversitate-54784fdbc3ea5.pdf	Ministerul Mediului, Apelor și Pădurilor/Ministry of Environment, Waters and Forests	2013	Romanian	national	the main objectives of the conservation of biological diversity are: conservation of biological diversity; sustainable use of biological diversity components; correct and fair distribution of the benefits resulting from the use of resources genetics.
biodiversity and nature protection	Strategia Nationala pentru Dezvoltarea Durabila Romaniei 2030	National Strategy for the Sustainable Development of Romania 2030	strategic	https://dezvoltaredurabila.gov.ro/files/public/10000001/Strategia-nationala-pentru-dezvoltarea-durabila-a-Romaniei-2030_002.pdf	Secretariatul General al Guvernului - Departamentul pentru Dezvoltare Durabila/General Secretariat of the Government - Department for Sustainable Development	2018	Romanian	national	Through this strategy, Romania establishes its national framework for supporting the 2030 Agenda and implementing the set of 17 SDGs. The strategy supports Romania's development on three main pillars, namely economic, social and environmental.
other	Planul Național de Acțiune pentru implementarea Strategiei Naționale pentru Dezvoltarea Durabilă a României 2030 (SNDDR 2030)	The National Action Plan for the implementation of the National Strategy for the Sustainable Development of Romania 2030 (SNDDR 2030)	implementation (operational)	https://dezvoltaredurabila.gov.ro/files/public/10000001/planul_national_de_actiune_pentru_implementarea_snddr_2030_hg.pdf	The Government of Romania Department for Sustainable Development	2022	Romanian	national	Represents the key document that guides the implementation of the National Strategy for Sustainable Development of Romania 2030, in accordance with the objectives of the 2030 Agenda for Sustainable Development and the strategic documents of the EU, in all sectoral policies, for sustainable development at the national level in the period 2022-2030.
biodiversity and nature protection	Strategia de dezvoltare a județului Brăila 2021-2027	Brăila county development strategy 2021-2027	strategic	portal.nsf/AB8DBE2BD0441665C225877300416A8B/$FILE/Strategia%20de%20dezvoltare%20a%20Judetului%20Braila%202021-2027.pdf	POCA - Programul Operațional Capacitate Administrativă/Administrative Capacity Operational Program; Consiliul Judetean Brăila/Brăila County Council	2021	Romanian	local	
biodiversity and nature protection	Planul de Management al Parcului Natural Balta Mică a Brăilei	The Management Plan of the Balta Mică a Brăila Natural Park	strategic	https://bmb.ro/wp-content/uploads/2019/11/plan-management-bmb.pdf	Parcul Natural Balta Mică a Brăilei/ Natural Park Balta Mică a Brăilei	2011	Romanian	local	The management of this protected area combines the protection and conservation of a sustainable vision particularly fragile natural capital
biodiversity and nature protection	Plan de management integrat pentru ariile naturale protejate Parcul Natural Balta Mică a Brăilei și siturile Natura 2000 ROSCI0006 Balta Mică a Brăilei și ROSPA0005 Balta Mică a Brăilei	Integrated management plan for protected natural areas Park Natural Balta Mică a Brăila and Natura 2000 sites ROSCI0006 Balta Mică a Brăila and ROSPA0005 Balta Mică a Brăila	strategic	https://bmb.ro/wp-content/uploads/2023/12/PM-draft-final.pdf	Programul Operațional Infrastructură Mare (POIM)/Large Infrastructure Operational Program (POIM)	2023	Romanian	local	The management plan represents the official planning, regulation and presentation document of a protected natural area through which establish the objectives, measures and human and material resources necessary for the conservation of the biodiversity of the respective protected natural area.
spatial planning	Strategia de Dezvoltare Teritorială a României (SDTR). România policentrică 2035	Territorial Development Strategy of Romania. Polycentric Romania 2035.	strategic	https://www.mdlpa.ro/pages/sdtr	Ministry of Development, Public Works and Administration	2016	Romanian	national	The strategy aims to to ensure the functional integration of the national territory by enhancing energy, transport, and broadband networks; developing infrastructure for quality urban and rural spaces; fostering the development of a network of competitive and cohesive localities by supporting territorial specialization and the formation of functional urban areas; preserving heritage, and strengthening institutional capacity for territorial development.
other	Planul Național de Redresare și Reziliență (PNRR)	Romania's National Recovery and Resilience Plan	strategic	https://mfe.gov.ro/pnrr/	Ministry of European Investments and Projects	2021	Romanian	national	The primary goal of Romania's PNRR is to advance the country's development through vital programs and projects aimed at mitigating the socio economic effects of the COVID-19 crisis. These initiatives aim to enhance resilience, crisis preparedness, adaptive capacity, and growth potential through substantial reforms and key investments funded by the Recovery Mechanism and Resilience. The specific objective of the PNRR aligns with the overarching goal of the European Union's NextGenerationEU, aiming to attract funds to achieve specified milestones and targets for reforms and investments as detailed in the Regulation.
spatial planning	Planul de Amenajare a Teritoriului Zonal Regional (PATZR)	The Regional Zonal Territory Development Plan	strategic	https://lege5.ro/Gratuit/geydcojtg43q/ordinul-nr-233-2016-pentru-aprobarea-normelor-metodologice-de-aplicare-a-legii-nr-350-2001-privind-amenajarea-teritoriului-si-urbanismul-si-de-elaborare-si-actualizare-a-documentatiilor-de-urbanism	Ministry of Development, Public Works and Administration	2016	Romanian	national	The Regional Zonal Territorial Development Plan (PATZR) serves as the strategic planning document for territorial development. It establishes a comprehensive framework for long-term spatial development, aligning sectoral public investments within a regional context. The development plans for regional zonal territories are implemented at the level of development regions, as outlined in Law no. 315/2004 concerning regional development in Romania, along with subsequent amendments and additions.
spatial planning	Strategia Națională de Dezvoltare Urbană Integrată oentru Orașe Reziliente, Verzi, Incluzive și Competitive 2022-2035 (Politica Urbană a României)	The National Integrated Urban Development Strategy for Resilient, Green, Inclusive and Competitive Cities	strategic	https://www.mdlpa.ro/pages/politicaurbanaro2035	Ministry of Development, Public Works and Administration	2022	Romanian	national	It serves as a first national-level strategic document dedicated to urban development, outlining a vision for sustainable, inclusive, and resilient urban growth in Romania from 2022 to 2035 by translating the objectives and principles of relevant European and global frameworks to the national context. This document establishes a foundation for shaping urban policies and local strategies, adhering to the principles of local autonomy and subsidiarity. It aims to foster a shared agenda among central and local public authorities, enhancing the urban development framework through a cohesive set of measures and coordinated efforts across various sectors and stakeholders.
other	Planul Național de Management al Riscurilor de Dezastre	The National Disaster Risk Management Plan	implementation (operational)	https://www.igsu.ro/Resources/COJ/ProgrameStrategii//pdf24_merged.pdf	National Committee for Special Emergency Situations (Ministry of Internal Affairs)	2020	Romanian	national	The primary goal is to enhance the capabilities of specialized institutions, local, and national public administration authorities to prevent and manage emergency situations. The overarching objectives include preventing emergencies, saving lives, establishing an integrated emergency response system, empowering local public administration, and ensuring the optimal functioning of critical infrastructure. This involves identifying, documenting, and assessing various risks, notifying relevant stakeholders, issuing population warnings, and mitigating, removing, or countering risk factors.
spatial planning	Strategia Națională de Descentralizare	National Decentralization Strategy	implementation (operational)	https://www.mdlpa.ro/pages/strategiageneraladedescentralizare	Ministry of Development, Public Works and Administration	2017	Romanian	national	The Strategy aims to transfer competences from the central administration in various sectors, including agriculture, education, health, culture, environment, youth and sports, and tourism. Initiatives include ministries conducting impact assessments of the transfer of powers from central to local levels, drafting sectoral decentralization laws, and finalizing proposals on cost and quality standards for the provision of decentralized public services.
spatial planning	Programul Național de Dezvoltare Locală	National Local Development Program	strategic	https://www.mdlpa.ro/pages/programulnationaldezvoltarelocala	Ministry of Development, Public Works and Administration	2013	Romanian	national	It establishes the legal framework for implementing projects within the largest local and regional development program. Its sub-programs focus on investments in the urban regeneration of municipalities and cities, county-level infrastructure, and the modernization of Romanian villages.
spatial planning	Planul de Amenajare a Teritoriului Județean (PATJ) Brăila	County Territory Development Plan Brăila	implementation (operational)	not available online	Brăila County Council	2023	Romanian	regional	The County Territory Development Plan has a directive character and serves as the spatial expression of the county's socio-economic development program. This plan is aligned with the national land development plan, the zonal development plan, sectoral government programs, and other development initiatives

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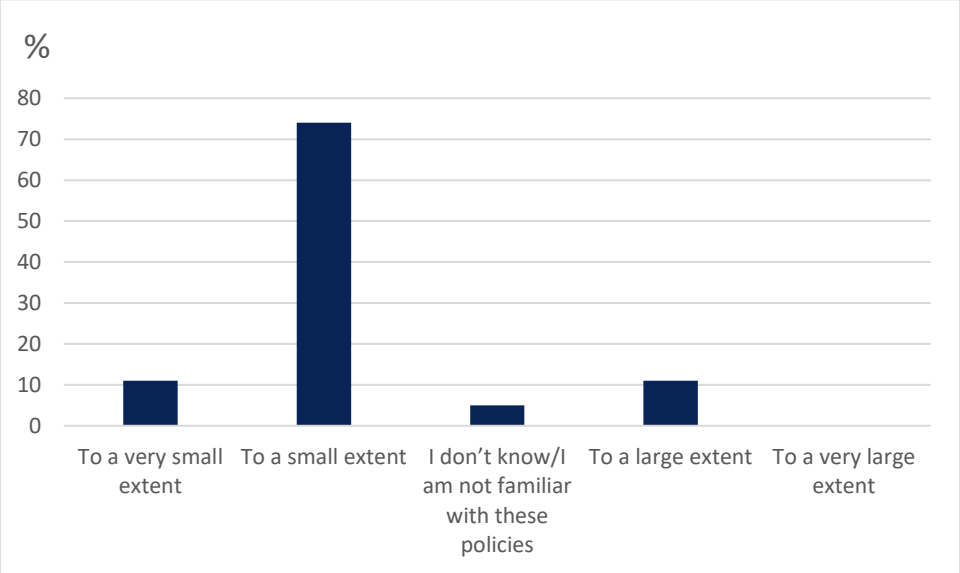
Stakeholders' opinion on support of the current policies to sustainable land management (Mirror workshops)

Do the existing policies on agriculture, the environment, and climate effectively contribute to sustainable land use in Romania?



Annex Figure 25: Stakeholders' opinion on support of the current policies to sustainable land management (Mirror workshops)

Summary of the discussion of stakeholders on policies (21 participants)

- centralized decision-making with limited political influence
- political engagement with technology and environmental issues
- need for policy coherence to meet sustainable land management
- unused potential for organic farming
- weakness in soil conservation laws and directives
- farmer discontent with changing agri-environment policies

Romania's centralized decisi-------on-making limits its ability to effectively address local agricultural and environmental challenges. While political engagement with technology is essential for addressing environmental issues, this approach often lacks the flexibility needed for local adaptation. Achieving sustainable land management requires aligning economic and environmental policies, but such coherence is currently missing. Romania's potential for organic farming remains underdeveloped due to insufficient political commitment. Additionally, weak soil conservation laws and the failure to implement the EU Soil Directive weaken environmental protection efforts. As a result, many farmers are dissatisfied with the current agri-environmental policies, and upcoming stricter regulations may increase this dissatisfaction unless policies are better adapted to local realities. This suggests that Romania needs stronger political commitment and more adaptable, enforced, and region-specific policies to meet both agricultural and environmental sustainability goals.

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Key insights from expert interviews

Annex Table 27: Key insights from expert interviews

	Which aspects are the most dynamic?	What conflicts exist or are likely to arise?
Regional socio-economic development	The important role of agriculture in the region, the economic revitalization driven by the attraction of European funds and the shift of young people towards agriculture. The touristic development opportunity related to Balta Mică a Brăilei Natural Park.	Tensions between agricultural expansion and environmental protection, possibly within protected areas. Population aging and youth migration could cause a labor shortage and social imbalances. The poor development of transportation and water supply infrastructure in certain localities could create tensions between citizens and local authorities.
Agriculture	The most dynamic aspects are farm consolidation, irrigation system expansion, and the growing interest in organic farming among young farmers. These trends reflect broader processes of agricultural modernization and adaptation to climate change.	The most likely conflicts that could arise are: Tensions between large investors and small farmers (land prices and lease rates have increased, making it difficult for small farmers to survive) Conflicts related to water use (due to extensive irrigation and frequent droughts, competition for water resources is expected to intensify) Land ownership and tenure disputes (for example, issues related to leasing and concessioning of large areas of land, especially when linked to state-owned land and large operators).
Policies	The important role of CAP in influencing the development of agriculture.	
Climate Change and biodiversity	Clear signs of climate change in the region: warming, droughts, less winters, drier	Climate change doesn't seem to be targeted directly by the interviewed institutions, to be

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	summers, less strong winds Good awareness on the impact, damages from extreme past events (droughts, especially year 2024).	specific measures in their internal documents. There are not strategies at the regional or local levels specifically targeting climate change.
Future	Agriculture will be a key sector in the region also in the future It is recognized by all interviewees the clear necessity to adapt to climate change.	

Key agents / stakeholders

A. Identification

Annex Table 28: A. Identification

Stakeholder	Geographic coverage/Level	Main category	Sub-category
Ministry of Environment, Waters and Forests	National	Policy/Government	National authority (central government, related ministries and agencies)
General Directorate for Impact Assessment, Pollution Control and Climate Change	National	Policy/Government	National authority (central government, related ministries and agencies)
General Directorate of Forests and Strategies in Forestry	National	Policy/Government	National authority (central government, related ministries and agencies)
General Directorate of Biodiversity	National	Policy/Government	National authority (central government, related ministries and agencies)
National Agency for Environmental Protection	National	Policy/Government	National authority (central government, related ministries and agencies)
National Agency for Natural Protected Areas	National	Policy/Government	National authority (central government, related ministries and agencies)
Ministry of Agriculture and Rural Development	National	Policy/Government	National authority (central government, related ministries and agencies)
General Directorate of Agricultural Policies	National	Policy/Government	National authority (central government, related ministries and agencies)
Directorate of Land Improvements and Land Fund	National	Policy/Government	National authority (central government, related ministries and agencies)

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General Directorate of Rural Development	National	Policy/Government	National authority (central government, related ministries and agencies)
Payments and Intervention Agency for Agriculture	National	Policy/Government	National authority (central government, related ministries and agencies)
National Land Improvement Agency	National	Policy/Government	National authority (central government, related ministries and agencies)
The Agency for Financing Rural Investments (AFIR)	National	Policy/Government	National authority (central government, related ministries and agencies)
National Directorate of Forests – Romsilva	National	Policy/Government	National authority (central government, related ministries and agencies)
”Apele Romane” National Administration	National	Policy/Government	National authority (central government, related ministries and agencies)
National Meteorological Administration	National	Academia	Research and Academia
National Institute of Hydrology and Water Management	National	Academia	Research and Academia
Academy of Agricultural and Forestry Sciences “Gheorghe Ionescu-Şişeşti”	National	Academia	Research and Academia
University of Agronomic Sciences and Veterinary Medicine of Bucharest	National	Academia	Research and Academia
Danube Delta National Institute for Research and Development	National	Academia	Research and Academia
National Research-Development Institute for Pedology, Agrochemistry and Environmental Protection (INCDPAPM-ICPA)	National	Academia	Research and Academia
Institute of Agricultural Economics	National	Academia	Research and Academia
„Marin Drăcea” National Institute for Research and Development in Forestry (INCDS)	National	Academia	Research and Academia
National Institute for Research and Development in Construction, Urban Planning and Sustainable Territorial Development “URBAN-INCERC”	National	Academia	Research and Academia

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Research Center in Systems Ecology and Sustainability (RCSES)	National	Academia	Research and Academia
MULTIDIMENSION SRL	National	Academia/Industry	Bussines/Research and Academia
South-East Regional Development Agency	Regional	Policy/Government	Regional authority (regional administration)
Brăila County Agriculture Directorate	Regional/Local	Policy/Government	Regional authority (regional administration)
The Agency for Payments and Intervention for Agriculture, Brăila County Center	Regional/Local	Policy/Government	Regional authority (regional administration)
Brăila County Office of Pedology and Agrochemical Studies	Regional/Local	Academia	Research and Academia
Brăila County Office for Rural Investment Financing	Regional/Local	Policy/Government	Local authority (local administration) Regional authority (regional administration)
Territorial Inspectorates for the quality of seeds and propagating material Brăila	Regional/Local	Policy/Government	Local authority (local administration) Regional authority (regional administration)
Association of Agricultural Producers of Brăila	Regional/Local	Societal actors/Community	Non-governmental organization (NGO)
Balta Mică Natural Park of Braila	Regional	Policy/Government	Environmental/Nature conservation authorities
AGRICOST S.A.	Local	Industry/Societal actors/Community	Agricultural farm/Business
Braincoop Agricultural Cooperative	Local	Industry/Societal actors/Community	Agricultural farm/Business
Unirea Sutești Agricultural Cooperative	Local	Industry/Societal actors/Community	Agricultural farm/Business
Agridudcoop Farm Agricultural Cooperative	Local	Industry/Societal actors/Community	Agricultural farm/Business
Western Plain of Brăila Agricultural Cooperative	Local	Industry/Societal actors/Community	Agricultural farm/Business
Sheep Breeders Association Chiscani Brăila	Local	Industry/Societal actors/Community	Agricultural farm/Business
Agrisol Farm Agricultural Cooperative	Local	Industry/Societal actors/Community	Agricultural farm/Business
IFBV AGRO Agricultural Cooperative	Local	Industry/Societal actors/Community	Agricultural farm/Business
The City Hall of Frecaței Commune	Local	Policy/Government	Local authority (local administration)
The City Hall of Mărașu Commune	Local	Policy/Government	Local authority (local administration)

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B. Assessment of stakeholders' land dependence level (at local, regional / national level)

C. Assessment of their influence level in decision making

Regional / local level[37]

Annex Table 29: Regional / local level

Key agents[38]	Stakeholder category[39]	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A Regional government	Regional agricultural administration (regional administration)	high	5	high	5
B Local government	Local authority (local administration)	medium-moderate	3	medium-moderate	3
C Landowners	Land users (farmers)	high	5	low	2
D Farmers associations	Industry/Societal actors/Community	high	5	medium-moderate	3
E Large agricultural enterprises	land users (farmers)	high	5	medium-moderate	3
F Universities, Research Centres	Research and academia	low	1	low	1
G Environmental protection authorities	Nature conservation authorities	low	2	medium-moderate	3
H Administration of the Braila Islands Natural Park	Nature conservation authorities	Medium-moderate	2	medium-moderate	3
I Non-governmental organizations	NGOs	low	1	low	1

[37] We prefer a mix of these levels, since our case study covers a regional-level perspective, rather than local.
[38] According to tables in part I./A, I./B of this dataset.
[39] According to the Figure 3 in *Internal guide for application of the Europe-Land telecoupling framework in case-studies*.

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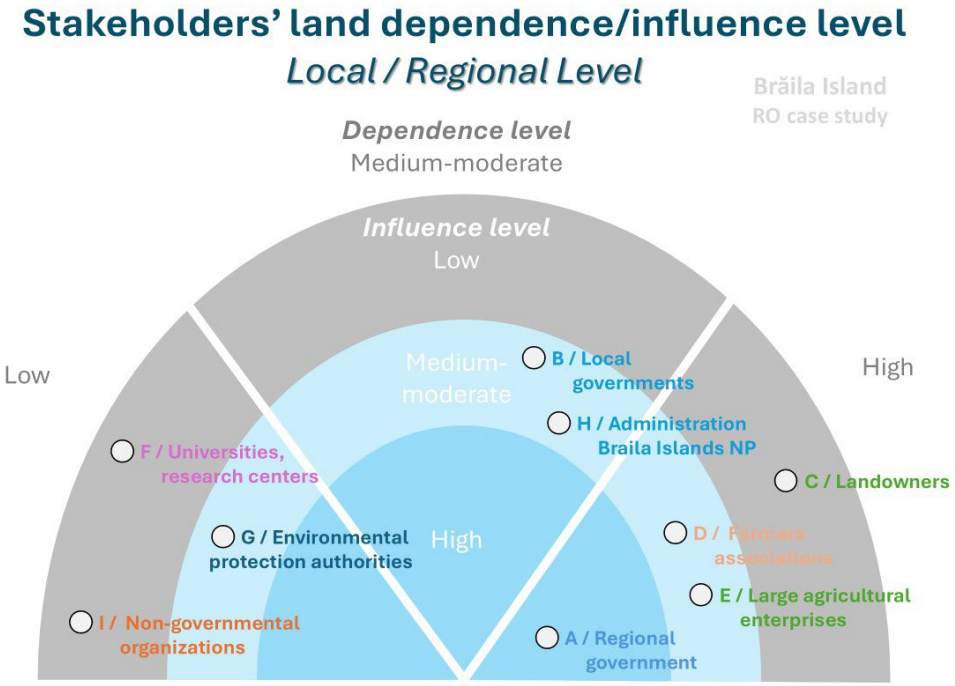
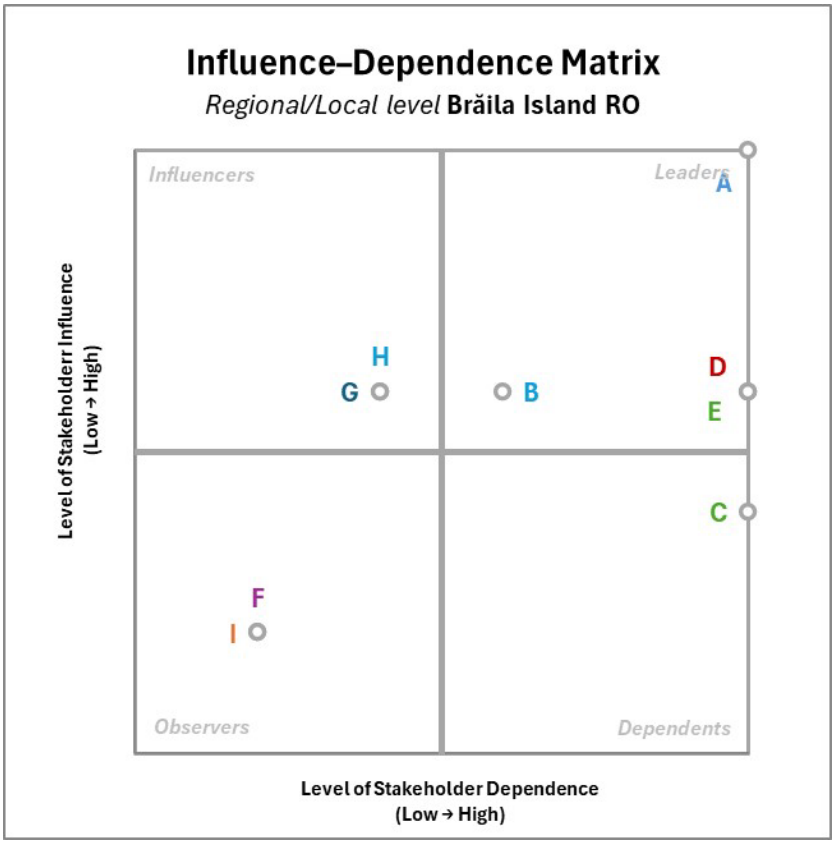


Annex Figure 26: Stakeholders' land dependence/influence level Local/Regional level



Annex Figure 27: Influence-Dependence Matrix Regional/Local level

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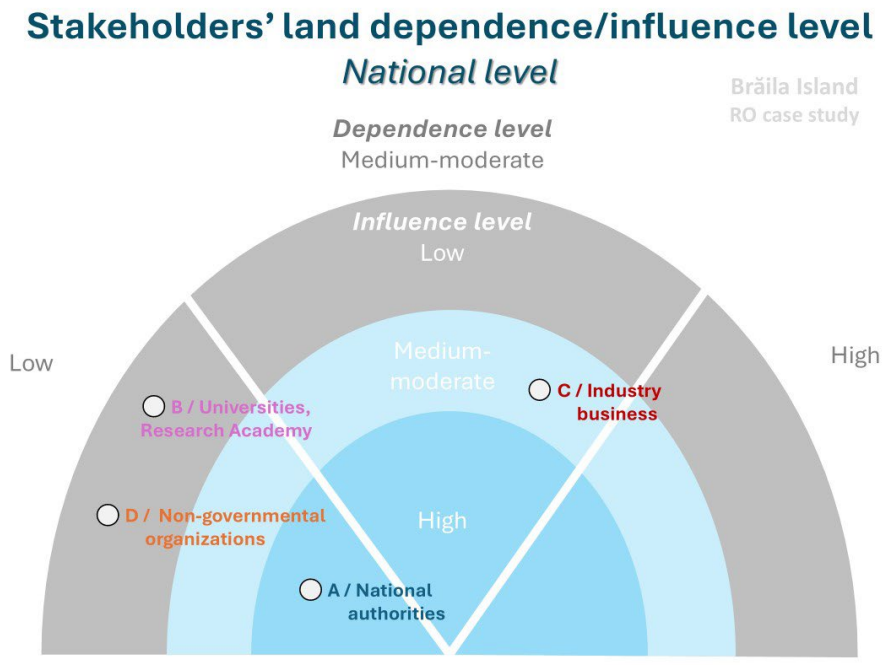
National level

Annex Table 30: National level

Key agents	Stakeholder category	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A National Authorities	National authority (central government, related ministries and agencies)	low	1	high	5
B Universities, Research Academy	Research and academia	low	1	low	1
C Industry business	Academia/Industry	medium-high	3	medium-moderate	3
D Non-governmental organizations	NGOs	low	1	low	1



Annex Figure 28: Stakeholders' land dependence/influence level National level

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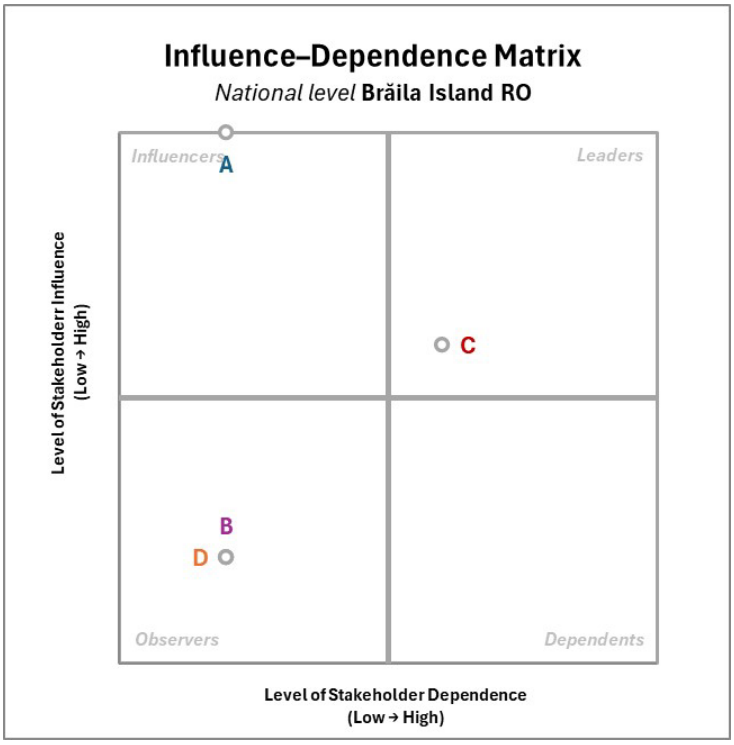

Annex Figure 29: Influence-Dependence Matrix National level

Basic matrix for SNA[40]

Annex Table 31: Basic matrix for SNA

Key agents[41]	Land users (farmers)	National authorities	Regional/local authorities	Research and academia	Industry business	Farmers associations	NGOs	Other	EU governance
Land users (farmers)		1	1	1	1	1	0	1	1
National authorities	1		1	1	1	0	1	1	1
Regional/local authorities	1	1		1	1	1	0	1	1
Research and academia	1	1	1		1	1	1	1	1
Industry business	1	1	1	0		1	1	1	1
Farmers associations	1	1	1	1	1		0	1	1
NGOs	0	1	0	1	1	0		0	1
Other	1	1	1	1	1	1	0		1
EU governance	1	1	1	1	1	1	1	1	

1=weak relationship; 1=medium relationship; 1=strong relationship

[40] A cell with a 1 indicates a relationship (influence/dependence) between agents is present, while a 0 indicates no relationship. 1=weak relationship; 1=medium relationship; 1=strong relationship.

[41] Categories of agents (stakeholder categories) at all levels (local + regional/national) + EU governance (spillover system).

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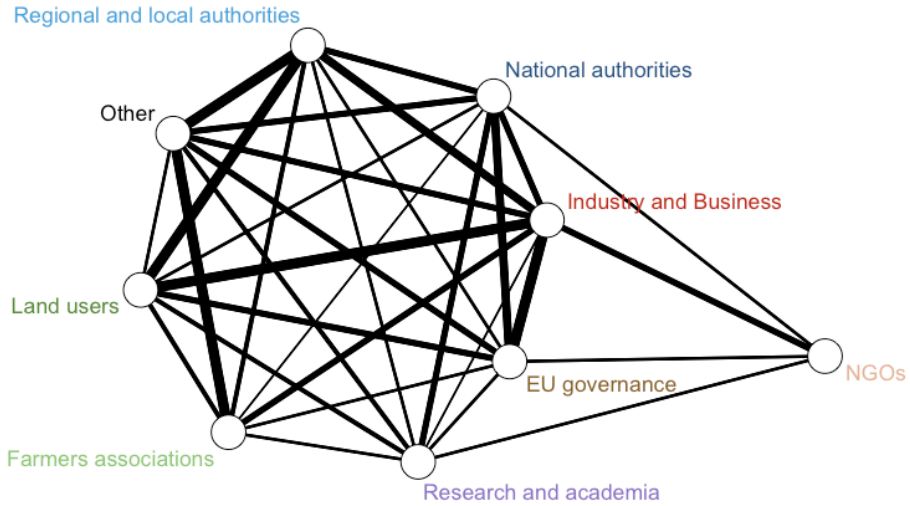

Annex Figure 30: Visualization of relationships among key agents / stakeholders

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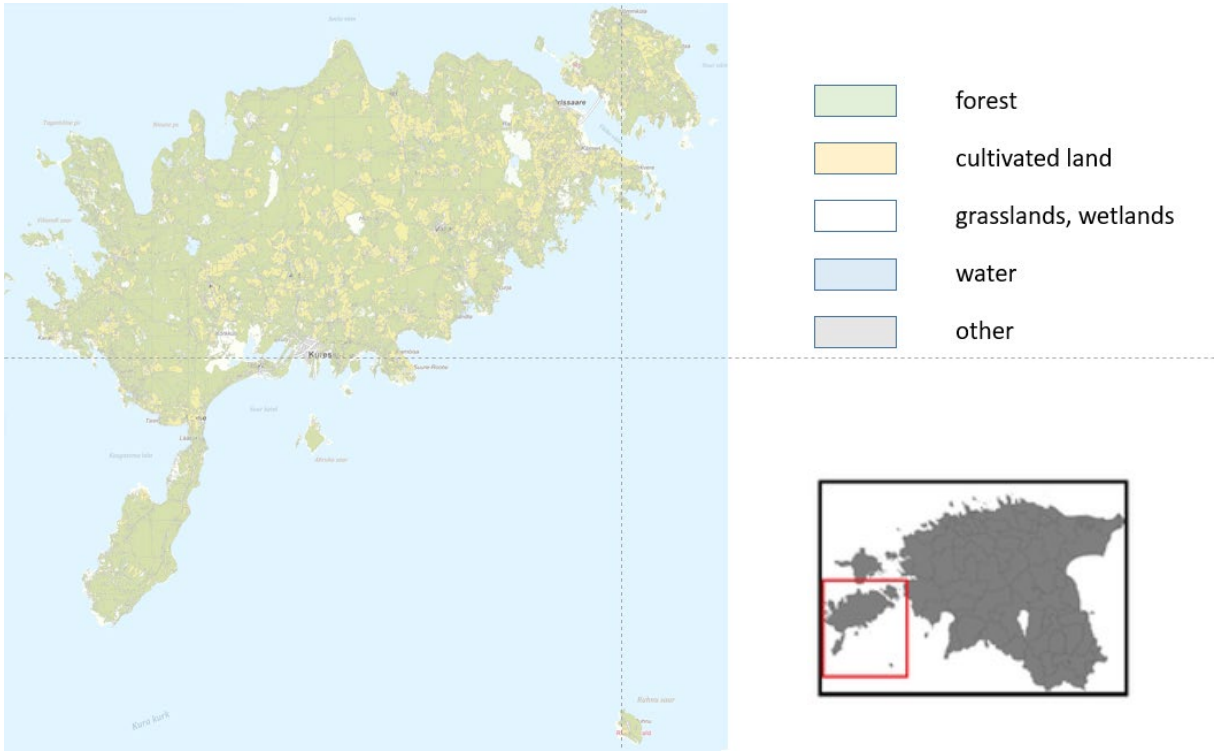
1.5 Estonia: Saaremaa County

Introduction

The Saaremaa county is most western from the 15 counties of Estonia with the area of 293 832 ha (2,938 km^2). It consists of Saaremaa (2,673 km^2), the largest island of Estonia, and several smaller islands near it, most notably Muhu (198 km^2), Ruhnu (11,9 km^2), Abruka (8,8 km^2) and Vilsandi (9,0 km^2). In 2022 Saare County had a population of 31,292, which was 2.4% of the population of Estonia. The county is subdivided into 3 municipalities (in Estonian: *vallad* – parishes): Saaremaa, Muhu and Ruhnu parishes.

The landcover of Saare County



Annex Figure 31: The landcover of Saare County

The West Estonian islands are low-lying plains underlain by limestone bedrock and covered by a thin layer of glacial moraine. The landscape is predominantly flat, with an average elevation of approximately 15 meters above sea level. The highest point, Viidumägi, reaches 54 meters above sea level. In most areas, the limestone bedrock is overlain by only a few meters of moraine sediments. In some places, however, the surface layer is only a few centimeters thick, creating a distinctive habitat type known as alvar, which occurs primarily in Sweden and Estonia.

Alvars are characterized by extremely thin soil layers—typically less than 30 cm—which result in dry, calcareous conditions that support highly specialized and valuable plant and wildlife communities. Historically, these areas were used mainly for grazing, particularly by sheep. Another distinctive traditional land-use type in the region is the wooded meadow, which was extensively managed

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through hand mowing and livestock grazing. These meadows, characterized by scattered trees, support one of the highest plant species diversities in Europe.

The islands are also renowned for their coastal meadows, which were historically managed through extensive grazing and mowing. These habitats have developed unique plant and animal communities due to their proximity to the sea. Over the past century, however, the abandonment of traditional management practices has led to the overgrowth of many of these valuable semi-natural habitats. In recent decades, significant efforts have been undertaken to restore them.

Owing to their high ecological value, the islands host numerous protected areas and sites of high conservation importance. Many semi-natural habitats fall under the protection of the EU Habitats Directive, and the region as a whole is designated as a UNESCO Biosphere Reserve.Because of its unique natural environment, the region requires sustainable and well-balanced economic activities, particularly in agriculture, to preserve its natural value while supporting local livelihoods. The main focus is on ecological farming and nature-based tourism, which attract visitors from around the world.

Historically, agriculture has been a significant land use in Saare County. However, due to the poor soils, agricultural activity has remained relatively low in intensity. About a century ago, grazing and haymaking on grasslands and wooded meadows were the predominant forms of land use. These practices were sustainable and helped maintain the region's high biodiversity. During the Soviet period (after 1945), agriculture became more intensive, although low soil fertility continued to limit yields. Many traditional grasslands were converted into croplands, and smaller patches were abandoned. Following Estonia's independence in 1991, farming practices shifted once again. Given the poor soils and extensive grassland cover, livestock farming—especially beef cattle and sheep—has increased. These conditions are favorable for organic (ecological) farming, and Saare County now has the highest proportion of ecological farms in Estonia.At present, land use in Saare County is distributed as follows: forest (56.92%), cultivated land (19.04%), natural grassland (7.67%), and other land-use types (14.66%) (Annex Table 32).

Landuse classes of cadastral units in Saare county registry data by Estonian Land Board (Maa- ja Ruumiamet, 31.08.2023)

Annex Table 32: Landuse classes of cadastral units in Saare county registry data by Estonian Land Board

Land use type	ha	%
Cultivated land:	55943,60	19,04
Natural grassland:	22548,90	7,67
Forests land:	167250,80	56,92
Yard areas:	4426,50	1,51
Other:	43090,30	14,66

The farms are smaller in Saare county than in as average in Estonia (59,7 ha and 74,4 ha, respectively).

The characteristics of agricultural farms in Saare county by Agricutural Registers and Information Board of Estonia (PRIA), 2023

	Estonia	Saare County	% of Estonia
Agricultural land	978973	62495	6,4
Number of farmers	13152	1047	8,0
Average area in ha per farmer	74,4	59,7	80,2

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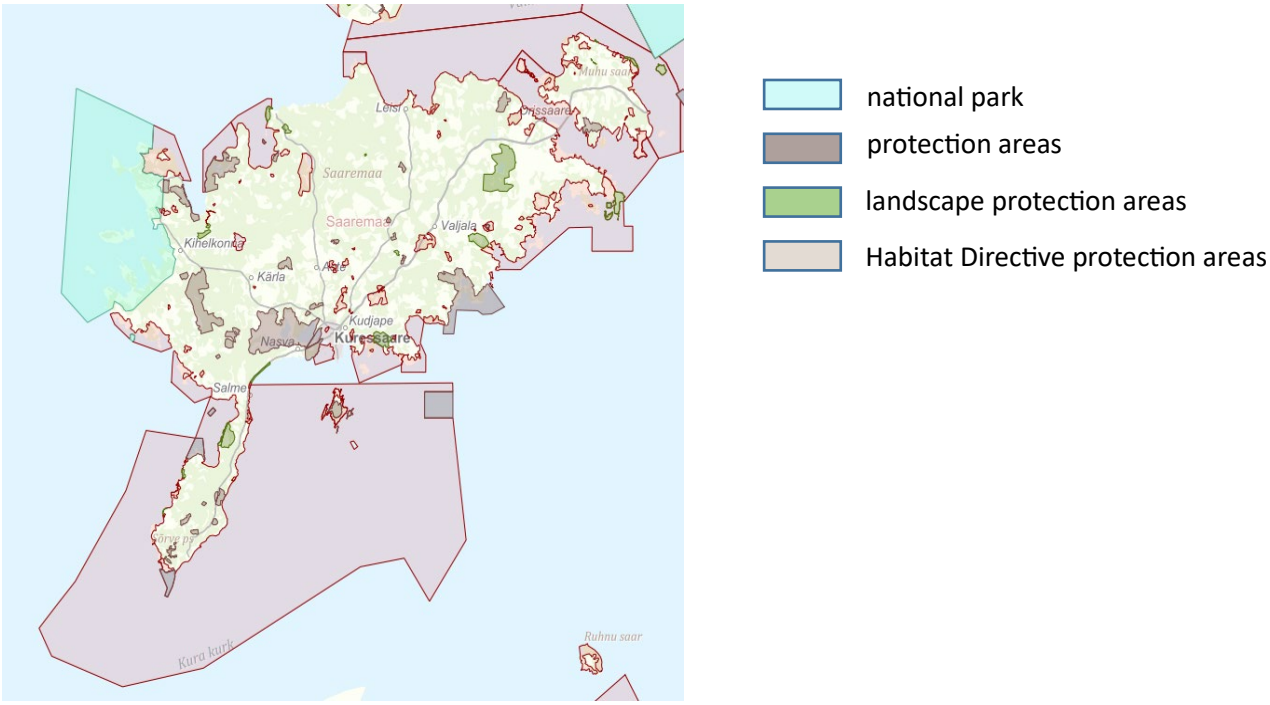
The percentage of organic farms in the area is (29,8 %) considerably higher than the average for Estonia (20,9%).

The characteristics of organic farming in Saare county by Agricutural Registers and Information Board of Estonia (PRIA), 2023

organic farming 2022	organic		conventional	
	ha	%	ha	%
Estonia	202522	20,9	766375	79,1
Saare county	16832	29,8	39674	70,2

Approximately 19.4% of the county's mainland area is designated under various protection regimes, a figure very similar to the national average of 19.8%. Areas protected under the EU Habitats Directive account for about 7.6% of the county's territory. In addition, nearly the entire surrounding marine area of the island falls within the marine EU Habitats Directive category (Annex Figure 32).

Protected areas of Saare County



Annex Figure 32: Protected areas of Saare County

After the restoration of the Estonian Republic, ownership rights from before the Soviet occupation were reinstated, and land was returned to the former owners. These farms had generally been small, and in many cases, the land was divided among several heirs. As a result, numerous landowners possessed relatively small parcels of land. Importantly, most of these owners did not reside in the area. Consequently, a large proportion of the land is rented out to farmers who are directly engaged in agricultural production. Most tenants are professional farmers, although there are also several hobby farmers—particularly on the islands—who typically manage semi-natural areas through mowing or grazing.

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Much of Saare County has historically been used for various forms of agriculture. However, due to the predominance of thin soil cover, agricultural production has never been highly intensive. About a century ago, the main agricultural activities consisted of grazing and haymaking on grasslands and wooded meadows. During the Soviet period (after 1945), more intensive agricultural practices were introduced, but the thin soils limited productivity. Nevertheless, many grasslands were converted into cropland. Since Estonia regained independence in 1991, farming practices have shifted once again: the proportion of grasslands has increased, and the numbers of beef cattle and sheep have risen accordingly.

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Basic telecoupling elements

A. Period 2004-2019

Annex Table 33: A. Period 2004-2019

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending (local) NUTS 3 Western Estonia	• Agriculture • Forestry • Protection areas • Residential • Transport, communication networks,	• Agricultural enterprises • Forestry enterprises • Tourism enterprises • Local governments • Environmental protection authorities • Investors and developers • NGOs • Local producers of food • Land owners	• infrastructure expansion • Agricultural transformation • other factors	• Demographic • Economic • Technological • Political, Institutional • Environmental • Cultural, Historical	• Urbanization and Infra-structure • Agriculture and Industry • Environmental
receiving (regional/national) Estonia NUTS 1 and NUTS 2	• Agriculture • Forestry • Protection areas	• Farmers associations • National Authorities • Environmental protection authorities • NGOs • Small scale farmers • National transport operators and infrastructure • Universities, Research Academy	• Infrastructure expansion • Agricultural trans-formation • other factors	• Demographic • Economic • Technological • Political, Institutional • Environmental • Cultural, Historical	• Demography and Labor Force • Economic • Institutional

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		• **Agricultural Registers and Information Board (ARIB)** • Land and Spatial Development Board			

Causes in detail:

- Introduced direct payments and rural development schemes, causing widespread restructuring
- Subsidies reward scale and efficiency → disadvantages small farms
- Decline of smallholders; consolidation into large agribusiness units
- **Technological modernization** enabled by EU funds increased efficiency
- **Forestry intensification**: high harvesting rates as timber prices rose and state policies allowed extensive clear-cutting
- Traditional livestock systems collapse; fewer grazing livestock → grassland abandonment
- Administrative burden and compliance checking push smallholders out
- Organic farming area is increasing
- **Rural depopulation**: young people left for mainland jobs; ageing farming population reduced labour availability.
- **Starting r**estoration of semi-natural meadows and increase a number of beef cattle and sheep
- Lifestyle newcomers prefer “weekend countryside” instead of farming

Drivers in detail:

- CAP incentives. CAP payments rewarded land area, not ecosystem services, accelerating consolidation; regulatory enforcement still moderate
- Profitability strongly dependent on subsidies; large farms able to scale, small farms unable to compete. Be big or be gone”
- Biodiversity restrictions, unclear protected-area rules
- Rapid mechanization and precision farming favoured large, contiguous land parcels High machinery cost, low farm profitability
- Weak local markets

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- Rural depopulation, aging farmers, declining agricultural labour
- Digital bureaucracy barriers
- High timber demand → incentivized clear-cuts; organic farming still rising due to supportive subsidies.

Effects in detail:

- Loss of small farms, concentration of land in corporate hands
- Strong increase in organic farming share, but often certification-driven rather than deeply ecological.
- Loss of semi-natural grasslands & coastal meadows
- Loss of cultural landscapes & pollinator habitats
- Rural depopulation, decline in services, identity, resilience
- Starting restoration of abandoned grasslands
- Intensive forestry, forest structure simplification, loss of old stands, decrease in habitat diversity.
- Cultural erosion, disappearance of traditional landscape stewardship
- Reduction in local food-production diversity as large farms specialised.

Key flows:

- Capital flows: Strong EU funding for modernization → machinery upgrades, farm enlargement.
- Ownership flows: gradual concentration; emergence of absentee owners.
- Biomass flows: shift from multi-functional landscapes to cereal–grass rotations; high timber extraction flow.
- Labour flows: outmigration reduced management capacity for small parcels.
- Knowledge flows: erosion of traditional grazing and coastal meadow management practices.

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Saaremaa's land-use change between 2004 and 2019 has been shaped by a set of reinforcing flows that gradually transform the island from a traditional, mosaic-style landscape stewardship system toward a more consolidated and efficiency-oriented land-use model. This transition also includes the first major wave of semi-natural habitat restoration.

Capital and subsidy flows introduced through Estonia's accession to the European Union have strongly favored larger and technologically modernized farms, facilitating field enlargement and specialization. In contrast, smaller farms—unable to meet increasing investment demands—have progressively exited the landscape.

Simultaneously, targeted agri-environmental measures have promoted the restoration of alvars, coastal meadows, and wooded meadows. These policies have led to a rapid increase in beef cattle numbers, re-establishing grazing pressure on many semi-natural sites. Although these restoration-driven flows temporarily counteract land abandonment in high-value habitats, they often remain dependent on continued subsidies and stable livestock markets.

Outflows of labor and knowledge persist, as younger generations migrate and traditional practices such as haymaking and small-scale grazing decline. Nevertheless, new forms of extensive grazing are emerging. As a result, biomass flows have become increasingly heterogeneous: while overall livestock numbers decline and marginal fields revert to scrub, restored meadows experience renewed, grazing-based biomass turnover.

Forestry intensification continues to sustain high timber extraction rates, contributing to habitat simplification. Governance and ownership flows have shifted toward greater land concentration and rising absentee ownership, gradually weakening local stewardship structures.

Taken together, these interacting flows have produced a landscape characterized by advancing consolidation and intensification, a partial revival of biodiversity-rich meadows through beef cattle grazing, and a growing dependence on external incentives. At the same time, the landscape has become progressively detached from its traditional, multifunctional management practices.

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B. Period 2020-2024

Annex Table 34: B. Period 2020-2024

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending (local) NUTS 3 Western Estonia	• Agriculture • Forestry • Protection areas • Residential • Transport, communication networks	• Agricultural enterprises • Forestry enterprises • Tourism enterprises • Local governments • Environmental protection authorities • Investors and developers • NGOs • Local producers of food • Land owners • Estonian	• infrastructure expansion • Agricultural transformation • other factors	• Demographic • Economic • Technological • Political, Institutional • Environmental • Cultural, Historical	• Urbanization and Infra-structure • Agriculture and Industry • Environmental
receiving (regional/national) Estonia NUTS 1 and NUTS 2	• Agriculture • Forestry • Protection areas	• Farmers associations • National Authorities • Environmental protection authorities • NGOs • Small scale farmers • National transport operators and infrastructure • Universities, Research Academy	• Infrastructure expansion • agricultural trans-formation • other factors	• Demographic • Economic • Technological • Political, Institutional • Environmental • Cultural, Historical	• Demography and Labor Force • Economic • Institutional

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Causes in detail:

- Increasing drought frequency and water scarcity. Multiple dry summers affected crop yields and groundwater availability.
- Collapse of organic farming motivation: persistent drought, poor profitability, and limited livestock markets.
- Escalation of bureaucracy and regulatory burden, especially inspections and reporting obligations.
- Rapid renewable-energy Agricultural land converted into solar farms
- Expansion, especially solar installations on farmland and offshore wind planning
- Conflicts between local communities and energy developers
- Sharp rise in land concentration as small farms exited under economic pressure. Forestry overharvesting impacts became visible: soil damage, biodiversity loss, deer overpopulation

Drivers in detail:

- Stricter environmental rules, complex subsidy applications, increased remote monitoring (satellite inspections). Droughts, water scarcity, and reduced groundwater recharge
- Powerful incentives for solar and wind development, often overriding local planning concerns.
- Solar park expansion on fertile land, offshore wind conflicts
- Increasing costs, outdated machinery, lack of labour, and volatile markets.
- Erosion of trust in governance, conflicts between state and local communities, declining nature education.
- Pest outbreaks and wildlife imbalances driving land-use change (e.g., farmers abandoning pesticide-free crops)
- Loss of nature education & traditional knowledge, urban–rural disconnect

Effects in detail:

- Economic vulnerability, heavy dependency on subsidies; drought risk
- **Reduction in organic farming area**, as farmers exit due to climate stress and weak markets.
- **Increasing conflicts** between landowners, conservation authorities, and renewable-energy developers. Conflict, farmers vs. state, locals vs. renewable energy developers
- **Abandonment of small and marginal fields** accelerated by water shortages.
- Reduced food sovereignty, shrinking local production capacity
- **Loss of restored semi-natural coastal meadows** due to declining grazing livestock.
- **Large-scale solar farms replacing farmland**, sometimes fragmenting traditional landscapes.
- **Biodiversity decline** coupled with increased pests and fewer natural enemies.
- **Decreasing rural resilience**, shrinking population, weakening local identity, fewer young farmers

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- High deer numbers damaging regeneration, predator tensions rising.

Key flows:

- Capital flows: external investment into solar and wind projects; local profits often limited.
- Water flows: reduced availability, drying wells, poor retention—water scarcity becoming a strategic factor.
- Agricultural biomass flows: shift toward drought-tolerant crops (hemp, maize, beans); decreased livestock biomass.
- Socio-economic flows: intensified outmigration; large corporate actors dominate land-use decisions.
- Governance flows: increasing centralization of decision-making; local disengagement; mistrust grows.
- Energy flows: strong influx of energy infrastructure on farmland, altering land-use logic.

Saaremaa's land-use dynamics between 2020 and 2025 are shaped by accelerating and increasingly disruptive flows that drive the islands toward heightened ecological vulnerability, socio-economic tension, and externally influenced land-use decisions. Climate-related processes intensify markedly: recurrent summer droughts, declining groundwater availability, and rising evapotranspiration reduce agricultural reliability, compelling farmers to abandon marginal fields or transition to drought-tolerant crops such as hemp, beans, and maize.

Capital flows are directed predominantly toward renewable energy infrastructure. The rapid expansion of solar parks and planned offshore wind developments competes directly with agricultural land, reshaping the spatial logic of land use. However, profits and decision-making authority largely leave the islands, deepening local distrust and perceptions of external control. In contrast, subsidy and policy flows grow increasingly complex and administratively burdensome, disadvantaging small producers who lack the capacity to navigate these systems. As a result, large enterprises consolidate land ownership and capture the majority of available financial incentives.

Labour and knowledge flows continue to weaken as rural outmigration persists and local management expertise declines. This erosion of human capital places restored semi-natural habitats at risk, particularly when livestock numbers fluctuate and maintenance funding proves insufficient. Biomass flows simplify across the broader landscape: livestock populations decline following drought years, pest pressures intensify, and the continuity of management in wooded and coastal meadows deteriorates. Concurrently, imbalances in forestry and wildlife populations exacerbate habitat degradation.

Governance flows become increasingly centralized, generating conflict among state agencies, developers, and residents as regulatory decisions appear detached from local priorities. Collectively, these interacting dynamics transform Saaremaa into a system

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characterized by water scarcity, reduced ecosystem services, contested land-use decisions, and declining rural resilience. Energy-sector expansion and climate stress now threaten to override earlier achievements in landscape restoration and sustainable land management.

Comparing two periods:

Across the two periods, land-use change on Saaremaa shifted from a phase of restructuring to one characterized by stress, conflict, and accelerated transformation. Between 2004 and 2019, changes were primarily driven by EU accession, Common Agricultural Policy (CAP) support, and technological modernization, which facilitated farm consolidation, production intensification, and large-scale forestry, while gradually eroding traditional grazing systems and smallholder landscapes (insert citation). Although biodiversity declined and land ownership became more concentrated, the overall trajectory remained economically motivated and relatively stable.

In contrast, the years 2020–2025 were marked by climate-driven disruptions, including recurring droughts, water scarcity, and pest outbreaks, which amplified the vulnerabilities established in the previous period (insert citation). Simultaneously, the rapid expansion of renewable-energy projects, stricter regulatory frameworks, and increasingly complex subsidy administration intensified tensions among local communities, large landowners, and state institutions (insert citation). During this period, small farms declined further, coastal meadows lost management continuity, and conflicts over land, water, and ecosystem services became more frequent.

Thus, whereas the earlier period was characterized by structural adjustment and gradual landscape simplification, the recent period is defined by accelerating environmental stress, socio-political conflicts, and a decisive shift toward externally driven land-use decisions.

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Secondary data

Using the following sources as a foundation, a secondary data research database has been constructed:

- Database of **Agricultural Registers and Information Board (ARIB),** https://www.pria.ee/infokeskus/statistika
- **Environmental Portal of Environmental Agency (KAUR),** https://keskkonnaportaal.ee/
- **Environmental Portal of Environmental Agency (KAUR EI), Environmental Indicators,** https://keskkonnaportaal.ee/et/keskkonnanaitajad
- Land and Spatial Development Board (ETAK) , Estonian Topographic maps), https://geoportaal.maaamet.ee/est/
- **Estonian Nature Information System** (EELIS), https://keskkonnaportaal.ee/et/eelis, www.eelis.ee
- The National Bank of Estonia, www.eestipank.ee
- Statistics Estonia, https://andmed.stat.ee/et/stat
- The European Environment Agency (EAA), www.eea.eu
- Spatial Plans, https://riigiplaneering.ee/maakonnaplaneeringud/kehtivad-maakonnaplaneeringud
- Ministry of Climate, Energy (MoC), https://kliimaministeerium.ee/energeetika-maavarad/valisohk/valisohu-kvaliteet-ja-seire
- Forest Register, https://register.metsad.ee/

Annex Table 35: Overview of secondary data

Source	Data category	Indicator	Framework affiliation	Unit	From year	To year	NUTS level	System (sending/ receiving/spillover)	Causes (domains)	Drivers (domains)	Effects (domains)
ARIB	Land cover	Crop fields	Land cover and Land use	m^2	2004	2024	NUTS5(LAU2)	Sending (NUTS3)	Agricultural transformation	Environmental /Economic/Institutional	Land cover
ARIB	Land cover	Grasslands	Land cover and Land use	m^2	2004	2024	NUTS5(LAU2)	Sending (NUTS3)	Agricultural transformation	Environmental /Institutional	Land cover
EELIS	Land cover	Semi-natural grasslands	Land cover and Land use	m^2	1999	2024	NUTS5(LAU2)	Sending (NUTS3)	Agricultural transformation	Environmental /Institutional	Land cover
Forest Register, ETAK	Land cover	Forest	Land cover and Land use	m^2	1996	2024	NUTS5(LAU2)	Sending (NUTS3)	Agricultural transformation	Environmental /Institutional	Land cover
ETAK	Land use	Water area	Land cover and Land use	m^2	2008	2024	NUTS5(LAU2)	Sending (NUTS3)	Agricultural transformation	Environmental	Agriculture and Industry

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ETAK	Land use	Built-up area and courtyard	Land cover and Land use	m^2	2008	2024	NUTS5(LAU2)	Sending (NUTS3)	Industrial development	Economic	Urbanization and Infrastructure
EELIS	Land use	Protected areas	Restrictions	m^2	1999	2024	NUTS5(LAU2)	Sending (NUTS3)	Policy	Environment	Environmental
ETAK	Infrastructure	Length of motorways	Socioeconomic	km	2008	2024	NUTS1	Receiving (national) NUTS1	Infrastructure expansion	Technological	Urbanization and Infrastructure
MoC, ETAK	Infrastructure	Are of solar and wind farms	Socioeconomic	m^2	2020	2024	NUTS5(LAU2)	Receiving (NUTS3)	Infrastructure expansion	Technological	Economic, Environmental
Statistics Estonia	Energy use	Heat consumption	Socioeconomic	GJ	2000	2023	NUTS3	Sending (NUTS3)	Industrial development	Technological	Economic, Environmental
Statistics Estonia	Agricultural output	Gross agricultural production from gross turnover	Socioeconomic	EUR	1997	2023	NUTS3	Sending (NUTS3)	Industrial development	Economic	Economic
KAUR EI	Emissions	Solid, compounds missions	Enviro and Ecosystem	t	1996	2019	NUTS3	Sending (NUTS3)	Environmental	Environmental, Institutional	Environmental
Statistics Estonia	Population	Number of people	Socioeconomic	Number	1991	2004	NUTS3	Sending (NUTS3)	Regional policy	Social	Environmental/ Social

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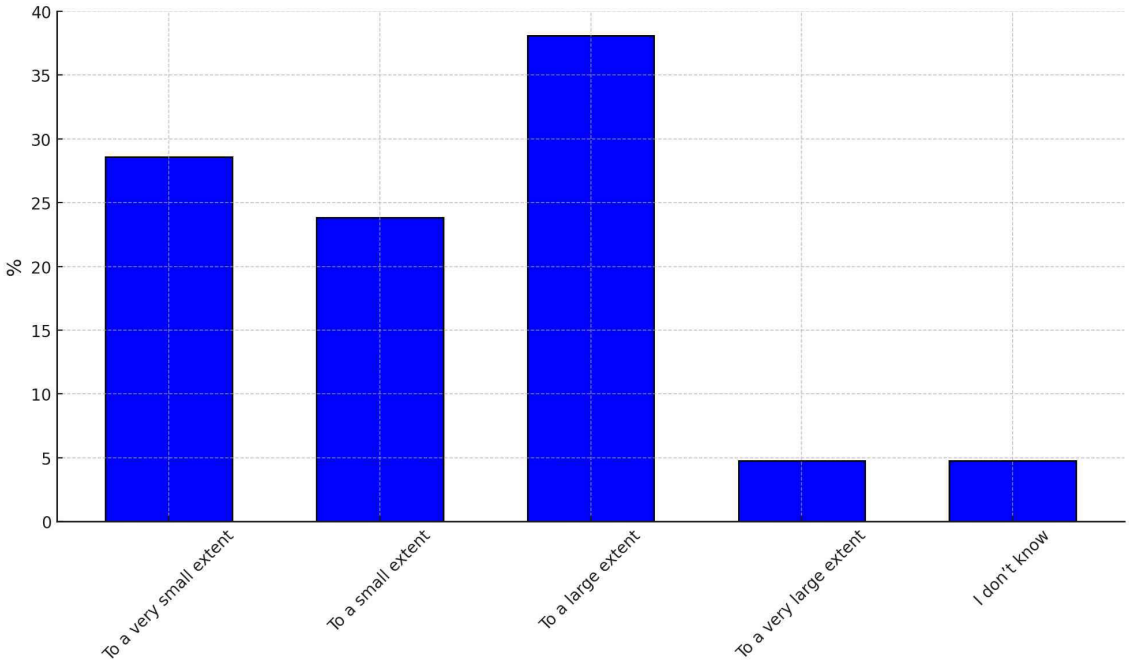
C. Spillover system - Governance / policies (regional/national/EU)

Annex Table 36: C. Spillover system - Governance / policies (regional/national/EU)

Partner	Sector (select from the drop-down list)	Title of document in national language	Title of document in English	Type of document (select from the drop-down list)	Link	Institution/Publisher	Year	Language/s	Level of document (select from the drop-down list)	General remarks regarding instruments/incentives
	other	Põllumajanduse ja kalanduse arengukava 2030 (PÕK 2030)	*"Development Plan for the Agriculture and Fisheries Sectors until 2030"* (PõKa 2030)	strategic	chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.valitsus.ee/sites/default/files/documents/2021-04/poka-2030-taistekst.pdf?utm_source=chatgpt.com	Ministry of Regional Affairs and Agriculture	2021	Estonian	national	Estonia's core strategy for agriculture, food systems, and rural development. Sets targets for productivity, sustainability, nutrient management, climate resilience, and sector innovation.
	agriculture	Eesti ÜPP strateegiakava	Eesti CAP Strategic Plan 2023–2027	strategic	https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans/estonia_en?utm_source=chatgpt.com	Ministry of Regional Affairs and Agriculture	2022	Estonian/English	national	Binding EU-level and national framework for direct payments, rural development measures, eco-schemes, and agri-environmental commitments.
	forestry	Eesti Metsanduse arengukava	*National Forestry Development Plan until 2030"* (MAK 2030) *(draft)*	strategic	https://peatlandpolicyportal.eu/policy/307?utm_source=chatgpt.com	Ministry of Climate	Draft	Estonian?English	national	The plan focuses on protecting forest ecosystems and biodiversity while addressing climate change. It promotes a competitive forest sector. It ensures forestry respects social and cultural values. It supports the strategic goals of Estonia 2035.
	other	Eesti keskkonnastrateegia 2030	"Estonian Environmental Strategy 2030"	strategic	chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://kliimaministeerium.ee/sites/default/files/documents/2021-07/The%20Environmental%20Strategy%202030.pdf?utm_source=chatgpt.com	Ministry of Climate	2007	Estonian/English	national	The strategy sets long-term goals for protecting Estonia's environment, improving resource efficiency, strengthening biodiversity, ensuring clean air and water, and supporting a climate-resilient economy. It guides environmental policy across sectors to 2030, aiming to balance ecological well-being with sustainable development.
	climate change	Kliimapoliitika põhialused aastani 2050:	General Principles of Climate Policy until 2050"	strategic	https://kliimaministeerium.ee/kliimapoliitika-pohialused-aastani-2050	Ministry of Climate	2017	Estonian/English	national	The document outlines Estonia's long-term path to a low-carbon economy by 2050. It sets targets for reducing greenhouse gas emissions, increasing energy efficiency, expanding renewable energy, and improving climate resilience. It guides all sectors—energy, transport, industry, agriculture, and forestry—in aligning development with climate neutrality goals.
	spatial planning	Riiklik planeering Eesti 2030+	National Spatial Plan Estonia 2030+	strategic	https://www.riigiplaneering.ee/uleriigline-planeering/uleriigline-planeering-2030-kehtiv	Ministry of Finance	2012	Estonian/English	national	The plan outlines Estonia's long-term spatial development principles to 2030. It promotes balanced regional development, stronger urban–rural connections, efficient land use, improved transport networks, and protection of natural and cultural landscapes. It supports sustainable settlement patterns and guides major infrastructure and spatial decisions at the national level.

Stakeholders' opinion on support of the current policies to sustainable land management (Mirror workshops)



Annex Figure 33: Stakeholders' opinion on support of the current policies to sustainable land management (Mirror workshops)

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Main Challenges:

- Overly permissive forestry laws, such as clear-cutting allowances, degrade biodiversity and forest health.
- Ambiguity in protected area regulations undermines enforcement.
- The lack of regional policy support fosters neglect of rural areas, diminishing biodiversity-friendly practices.
- Alienation of local populations due to centralized decision-making reduces stakeholder engagement.
- Coastal meadows are restored but lack ongoing maintenance resources.
- Disruptions in predator-prey dynamics (e.g., wolf and deer populations) arise from poor forest and wildlife management.
- The decline of nature education weakens public understanding and appreciation of biodiversity's importance. Foreign Ownership: Sale of land to non-residents disconnects local communities from their lands, leaving large areas unmanaged.
- Policies impose stricter controls, especially on private and coastal lands, impacting local economic activities.
- The shift toward renewable energy leads to the repurposing of farmland, creating conflicts with local communities.
- Intense construction in quality coastal areas undermines their ecological integrity.

Key insights from expert interviews

The discussion in Saaremaa focused strongly on how national and EU-level subsidies influence farmers' ability and motivation to manage land sustainably under growing climate and biodiversity pressures. Participants questioned whether the existing subsidy system, characterized by high bureaucratic complexity, unequal access for small producers, and a strong bias toward large agricultural enterprises, can genuinely encourage better care for soil, water, semi-natural coastal meadows and other vital ecosystem components.

A central theme was whether additional political and financial tools are needed to strengthen interest in sustainable practices, especially given recurring droughts, declining organic farming, land abandonment, and the rapid expansion of renewable-energy infrastructure on agricultural land.

The group critically assessed the shortcomings of the current motivational framework, including limited support for small-scale farmers, inadequate long-term funding for habitat maintenance, and weak integration of local knowledge in decision-making. Participants also emphasized the need for practical training and advisory support that would help farmers adapt

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to climate change, reduce degradation risks and diversify crops. The creation of clear, region-specific methodological guidelines, covering land management, forestry practices, coastal habitat maintenance, and climate-resilient agriculture, was highlighted as essential for ensuring ecological stability and long-term landscape sustainability on the islands.

Annex Table 37: Key insights from expert interviews

	Which aspects are the most dynamic?	**What conflicts exist or are likely to arise?**
Regional socio-economic development	• Outmigration of young people; shrinking rural population • Increasing share of externally-owned land • Declining rural services vs. expectations for local development	• Rapid land concentration in hands of large enterprises • Local communities vs. external investors (renewables, land purchase
Agriculture	• Reduce of small-scale and organic farming • Agricultural land conversion to solar fields vs. food security • Risk of abandonment of marginal land due to drought and labour shortages	• Intensification and upscaling; “be big or be gone” dynamic • Large-scale producers vs. small farmers over access to subsidies and markets
Policies	• Highly centralised decision-making • Frequent policy changes and short-term, project-based funding • *Growth of protected-area regulations without maintenance funding	• Renewable-energy targets vs. landscape and biodiversity protection • Conservation priorities vs. local autonomy (alienation from land governance) • Farmers vs. state institutions over bureaucracy and inspection practices • Increasing regulatory pressure on landowners (environmental rules, inspections)
Climate Change and biodiversity	• Increasing drought frequency; water scarcity becoming critical • Forest overharvesting → biodiversity decline and trophic imbalance • Spread of pests due to warmer climate and loss of natural enemies	• Biodiversity protection vs. intensive forestry • Predators vs. livestock farmers (wolf–deer–forest dynamics) • Climate-adaptation needs vs. economic limitations of small farms

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Future	• Potential for new crops and climate-driven shifts in production • Rising societal debate over landscape identity and rural viability • Demographic decline vs. need for long-term land stewardship	• Growing tension between sustainability goals and economic pressure • Industrial agriculture vs. cultural heritage landscapes • Solar and wind expansion vs. farmland preservation • Accelerated transition toward energy-dominated land use

Key agents / stakeholders

A. Identification

Annex Table 38: A. Identification

Stakeholder	Geographic coverage/Level	Main category	Sub-category
Member of the Council and regional head of the Estonian Society of Nature Conservation	regional	Societal actor/Community	non-governmental organization
Advisor of Estonian Environmental Board	national	Policy/Government	national authority (central government…)
Head of the Estonian National Commission of UNESCO	regional	Societal actor/Community	Estonian National Commission of UNESCO
Advisor of Ministry of Climate	national	Policy/Government	national authority (central government)
Chef specialist of Land Use Policy Department of Ministry of Regional Affairs and Agriculture	national	Policy/Government	national authority (central government)
Member of Saaremaa Community council	local	Societal actor/Community	local authority

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Head of department in the Centre of Estonian Rural Research and Knowledge	national	academia	research and academia
Head of the Fishermen's Society of Islands	local	Societal actor/Community	non-governmental organization
Forest owner	local	Societal actor/Community	land user (forester)
Ministry of Climate	national	Policy/Government	national authority (central government)
Ministry of Regional Affairs and Agriculture	national	Policy/Government	national authority (central government)
University, College of University of Technology	national/regional	Academia	research and academia
Representatives of local municipality, Saare local authority	local	Policy/government	local authority (local administration)
Representative of organic farm	local	Business	land user, farmer
Agricultural Registers and Information Board (ARIB)	national	Policy/government	national authority
Land and Spatial Development Board	national	Policy/government	national authority

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B. Assessment of stakeholders' land dependence level (at local, regional / national level)

C. Assessment of their influence level in decision making

Local level

Annex Table 39: Local level

Key agents[42]	Stakeholder category[43]	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A Environmental protection authorities	national authority	medium-moderate	2	medium	4
B Agricultural enterprises	land users (farmers, foresters)	high	5	medium	3
C Local producers of food	land users/business	medium-moderate	2	low	2
D Businesses in industry	industry/business	low	3	medium-moderate	3
E Landowners	land users (farmers, foresters, energy)	high	5	medium	3
F Local governments	local authority	medium-moderate	3	medium-moderate	3
G Non-governmental organizations	NGOs	low	1	low	1
H Land and Spatial Development Board	national authority	high	5	high	3
I Residents	other	high	4	low	2

[42] According to tables in part I./A, I./B of this dataset.

[43] According to the Figure 3 in *Internal guide for application of the Europe-Land telecoupling framework in case-studies*.

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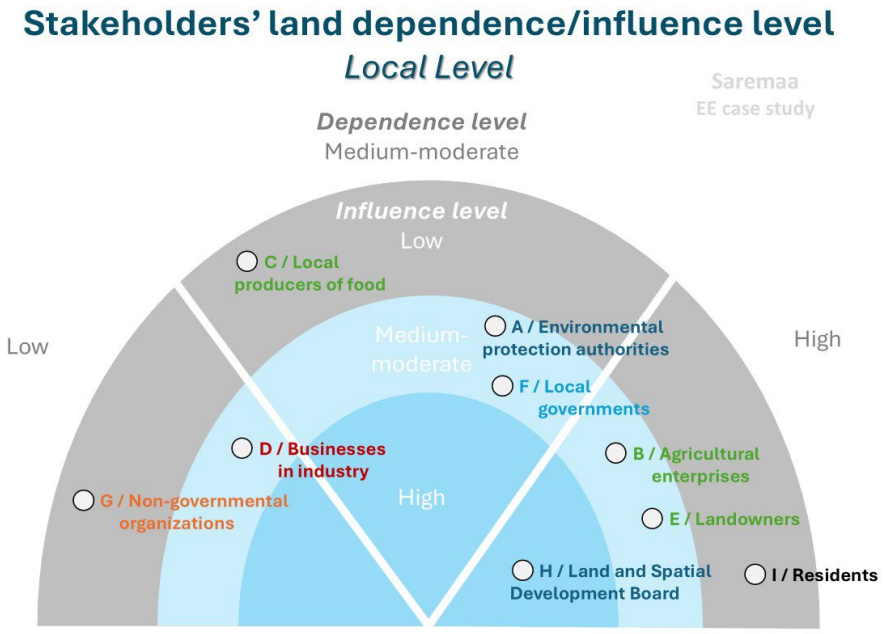
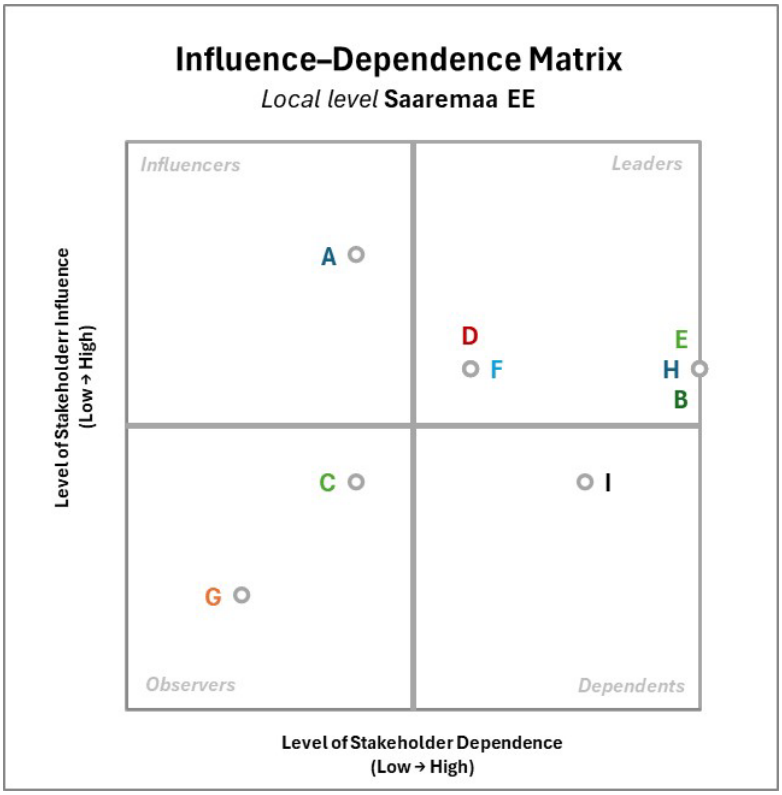


Annex Figure 34: Stakeholders' land dependence/influence level Local level



Annex Figure 35: Influence-Dependence Matrix Local level

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Regional / national level

Annex Table 40: Regional / national level

Key agents	Stakeholder category	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A Farmers associations	land users (farmers, foresters)	high	5	medium-moderate	4
B Industry business	industry/business	low	2	medium-moderate	3
C National Authorities	national authority	low	3	high	5
D Non-governmental organizations	NGOs	low	2	low	2
E Large agricultural enterprises	land users (farmers, foresters)	high	5	medium-moderate	3
F Small farmers	land users (farmers, foresters)	high	5	low	2
G National transport operators and infrastructure	national authority	high	5	high	5
H Energy companies	industry/business	high	4	moderate-high	4
I Universities, Research Institutions	research and academia	low	1	low-moderate	2
J Residents	other	high	4	low	1

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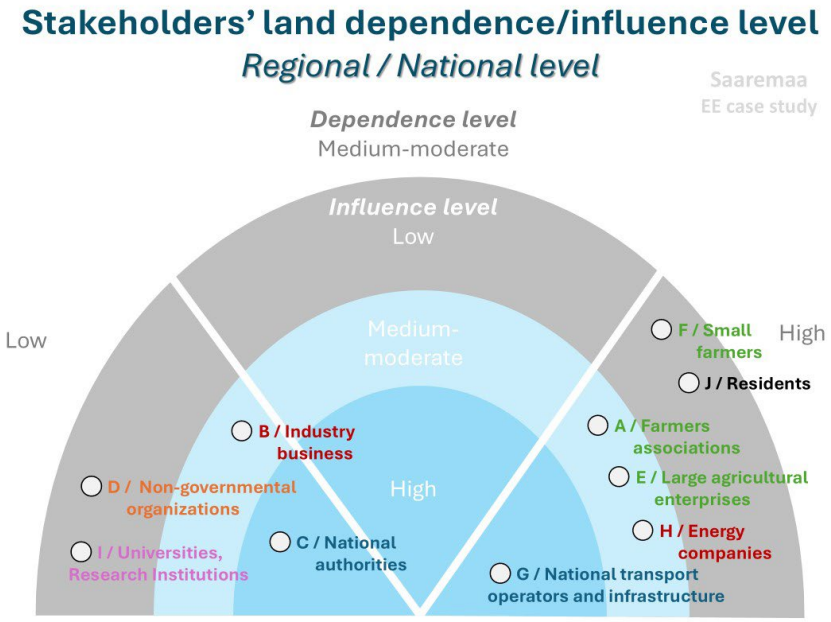
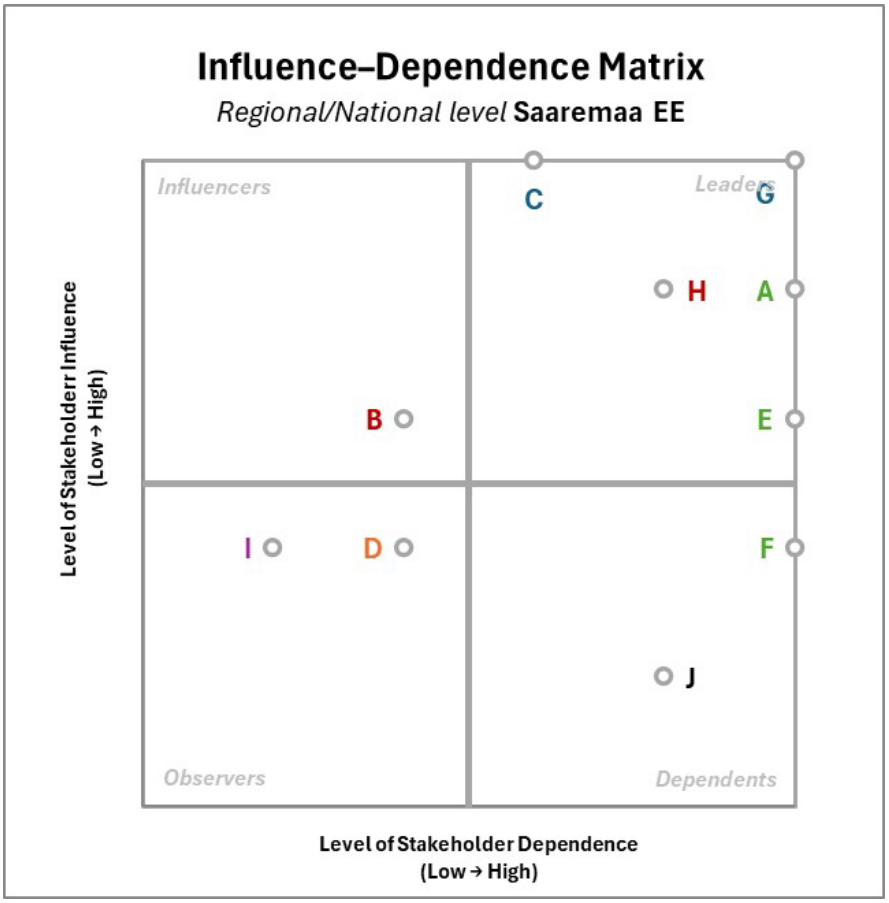


Annex Figure 36: Stakeholders' land dependence/influence level Regional/National level



Annex Figure 37: Influence-Dependence Matrix Regional/National level

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Basic matrix for SNA[44]

Annex Table 41: Basic matrix for SNA

Key agents[45]	land users (farmers, foresters)	Industry business	local authorities	national authorities	NGOs	research and academia	other	EU governance
land users (farmers, foresters)		1	1	1	0	1	1	1
Industry business	1		1	1	0	0	1	1
local authorities	1	1		1	1	1	1	1
national authorities	1	1	1		1	1	1	1
NGOs	0	0	1	1		0	1	0
research and academia	1	0	0	1	0		0	1
Other	1	1	1	1	1	0		1
EU governance	1	1	1	1	0	1	1	

[44] A cell with a 1 indicates a relationship (influence/dependence) between agents is present, while a 0 indicates no relationship. 1=weak relationship; 1=medium relationship; 1=strong relationship.

[45] Categories of agents (stakeholder categories) at all levels (local + regional/national) + EU governance (spillover system).

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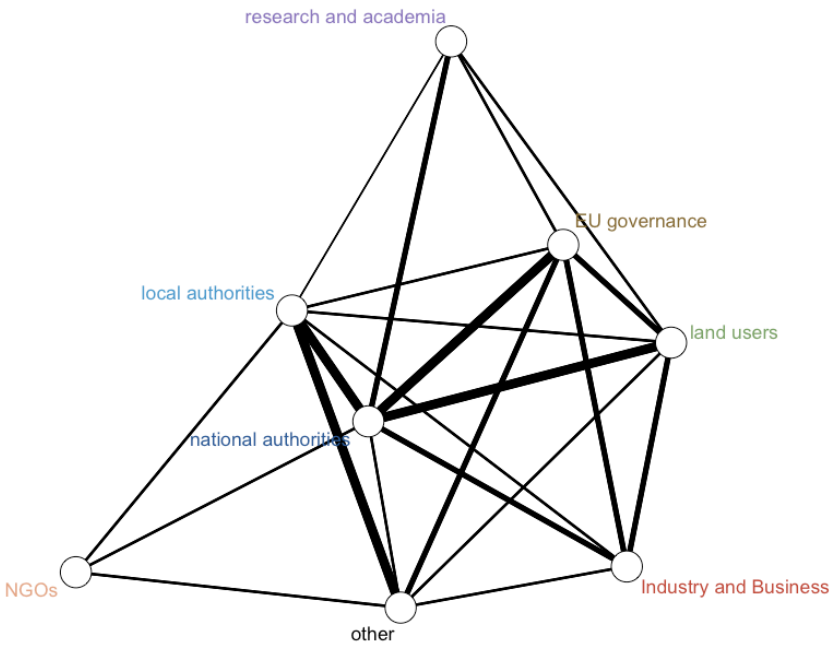

Annex Figure 38: Visualization of relationships among key agents / stakeholders

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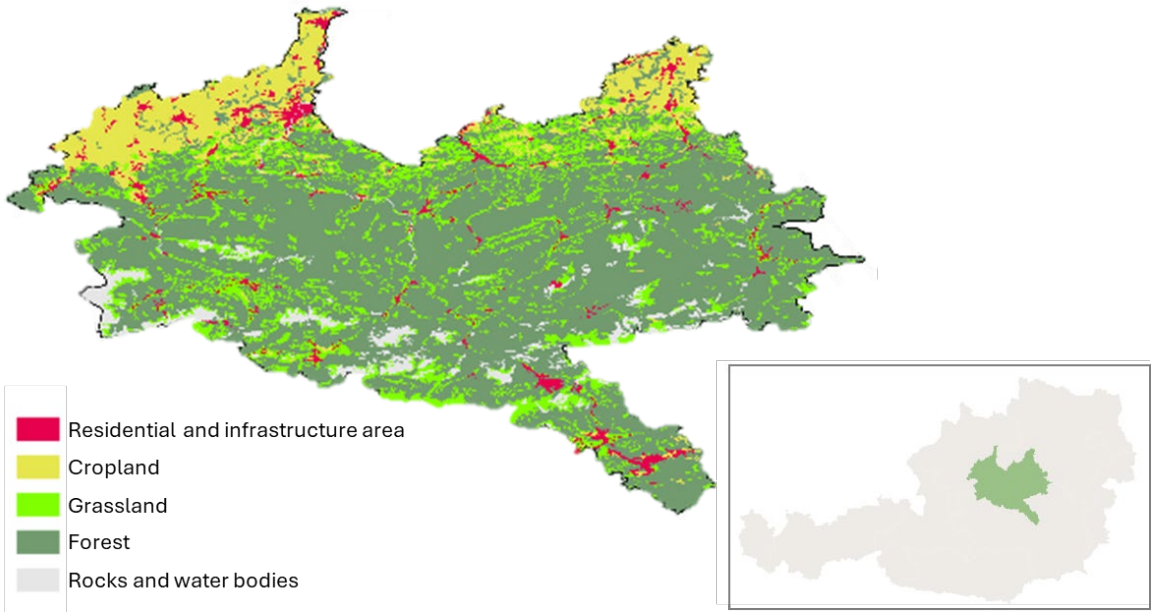
1.6 Austria: LTSER Region Eisenwurzen

The Eisenwurzen region spans 5,904 km², featuring diverse landscapes and topographical variations and includes lowlands in the north that transition to alpine mountains in the center. Correspondingly, land-use systems vary significantly across Eisenwurzen. Intensive crop production dominates the northern borders, while forests and extensive grasslands are prevalent in the hilly and mountainous areas. The region includes 91 municipalities and about 300 thousand inhabitants. Settlements are concentrated in the northern and southern areas, with sparse populations in between. The Socio-economic centers concentrate around Steyr in the northwest and Wieselburg in the northeast. The Eisenwurzen includes two national parks (Kalkalpen and Gesäuse) and the nature and geopark 'Steirische Eisenwurzen'. Tourism focuses on nature experiences and often revolves around the historic "Iron Road", an allusion to the history of iron mining in the region, which also gave it its name "Eisenwurzen" (root of iron). Future challenges include emigration from mountain areas and abandonment of remote agricultural areas, alongside a trend towards organic farming. About half of Eisenwurzen is covered by forest. Agricultural areas are divided in about one third cropland and two thirds permanent grassland, including mountain pastures. Intensive crop farming is concentrated in the northern lowlands, with grain maize and winter wheat as dominant crops. Grassland is split between intensive and extensive types. Austria's strict fertilization regulations mean conventional farming often follows.

Main Land Cover types of the Austrian case study site LTSER platform Eisenwurzen



Annex Figure 39: Main Land Cover types of the Austrian case study site LTSER platform Eisenwurzen

About 50% of the Eisenwurzen region is covered by by forests (Copernicus, 2012). In 2021, there was a total of 125,757 ha of agricultural land, spread over four agricultural main production areas (Alpenvorland, Voralpen, Hochalpen und Alpenostrand). The region consists of 34% cropland and 66% permanent grassland, of which 10% are mountain pastures (GeDaBa, 2022c). In 2010 there were a total of 8105 farms in the region. In 2021, about 5560 farms participated in IACS agri-environmental schemes, of which 29% were organic farms. About 60% of the farms were cattle livestock farms, 16% were forestry farms and about 10% were processing and cashcrop farms, with the remainder being other other forms of farms such as permaculture (GeDaBa, 2022c). As typical for Austria, farms are run

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as family businesses. The livestock numbers for the region come at about 160 tsd livestock units (LU), of which about 60% are cattle and about one third pigs and small shares of sheep, goats and poultry (GeDaBa, 2022d). Areas with intensive crop farming are concentrated in the lowlands in the upper north of the study region. The main crops in the region are grain maize and winter wheat, which together accounted for about 40% of the total cropland in 2021 (GeDaBa, 2022b).
Grassland consists of about 55% intensive grassland (3 and more cuts or 1.5 LSU/ha stocking density) and 45% of extensive grassland (mountain pastures and meadows with 1-2 cuts or <1.5 LSU/ha stocking density) (GeDaBa, 2022b).
Austria follows strict regulations regulating on the application of fertilizers. Due to the high share of farms participating in the ÖPUL program (Austrian IACS), 'conventional farming' refers mainly to farms that follow these guidelines, espacially with regard to fertilization (BML, 2022). Additionally, about 85% of grassland in Austria is exclusivly fertilized with manure (Buchgraber, 2018).

Geographic Coverage

  - Country: Austria
  - Region: Central at the boarder region covering Lower Austria, Upper Austria and Styria
  - Coordinates Extent (Min-Max Lon-Lat): 14.5, 47.6667
- **Time Coverage:**
  - (Start Date – End Date): IACS 2015-2022, Simulation data 2015-2050
  - 1990, 2000, 2006, 2012, 2018 CORINE land cover
- **Data Source:**
  - (e.g. Corine, EEA, own research – if this is the case please provide respective publication datasets, github repository, etc.): BML (Federal Ministry of Agriculture), SECLAND simulations
  - Relevant Links: (Data Portals): Zenodo Europeland repository

  Data Format:
  These fields are mandatory for successful data import into the Toolbox platform.
- File Format: All datasets should be provided in one or more of the following formats GeoJSON, Shapefile, WMS Service, KML, Tiff (future): Shapefile
- Projection system (Mandatory): EPSG:4326 – WGS84

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Basic telecoupling elements

A. Period 2004-2019

Annex Table 42: A. Period 2004-2019

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending (local) Eisenwurzen platform	• Forestry • Agriculture • Rocks, shrubs and waterbodies • Residential and infrastructure area	• Farmers • Local/municipal governments • Tourism associations • Sawmills/wood manufactures • Environmental protection authorities (national/geo parks)	• agricultural transformation • CAP • industrial development • other factors	• Demographic • Economic • Technological • Political, Institutional • Environmental • Cultural, Historical	• Urbanization and Infrastructure • agriculture, industry and tourism • environmental
Receiving (regional/national) South/East Austria (NUTS3) Upper/Lower Austria, Styria (NUTS2)	• Agriculture • Forestry	• Farmers associations • Forest industry business • National Authorities • NGOs • (inter) national Research institutions	• agricultural transformation • industrial development • tourism	• Demographic • Economic • Technological • Political, Institutional • Environmental • Cultural/Historical	• Demography and Labor Force • Economic • Institutional

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Causes in detail (sending system):

- The decline of the mining industry at the end of the 19th century made agricultural and forestry production the main economic sector for the region. Since the turn of the millennium, tourism and agritourism have also become important
- migration to urban settlements – increase in the urban population, decrease of mountainous village populations.
- Agri-environmental programs to uphold (mountain) agriculture
- different production systems: industrial cropland production vs. extensive mountain farming
- Pressure for more efficient land use in agriculture.
- Land use in the region is determined by spatial plans.
- Fragmentation of land ownership and land owned by unknown owners.
- Settlement expansion around the socio-economic centre of the region (Steyr)

Drivers in detail (sending system):

- Expansion of residential areas in favour of agricultural areas in the top northern parts.
- Outmigration of young people/workforce
- Tourism – outdoor and agri-tourism
- Development of intensive agriculture, organic farming, and biomass cultivation.
- Direct payment (an economic incentive and political instrument that motivates landowners and land users to adopt a certain type of land use, thereby influencing the dynamics of landscape change).
- Abandonment of marginal (grassland) areas
- Spatial planning, municipal (and regional) land-use plans.
- Forest management plans.

Effects in detail (sending system):

- Increase in the area of agricultural land converted for residential construction.
- Development of (agri-)tourism/outdoor tourism
- Outflow of young people from more remote rural areas to urban centres

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- Initiatives to cultivate high value/organic soy (such as Donau soja) increase incentives to crop soy
- Rising real estate prices near urban centres
- High costs of farming due to labour intensive mountain farming conditions
- Increased demand for local products domestically and abroad.
- Small-scale family farming
- Forestland buying by foreign investors
- Decline in agricultural labour force.
- Decreasing use of mountain pastures
- Increase in forest land – abandonment of agricultural (grass-)land.
- predetermined by territorial planning.
- Loss or fragmentation of habitats, reduction of biodiversity of native species.
- Adaptation to climate change.

Key flows

- Agricultural products
- Wood products
- Pillar 1 & 2 subsidies

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B. Period 2020-2024

Annex Table 43: B. Period 2020-2024

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending (local) Eisenwurzen platform			• bioeconomy	• climate change	
Receiving (regional/national) South/East Austria (NUTS3) Upper/Lower Austria, Styria (NUTS2)			• tourism		

Causes in detail (sending system):

- Ageing farmers population, difficult successor situation

Drivers in detail (sending system):

- Abandonment of marginal (grassland) areas
- Forest management plans.
- Increasing demand for (fire)wood
- Local climate change – extension of the growing season
- Extreme events: drought, heavy rain, wind and storms

Effects in detail (sending system):

- Increase in forest land – abandonment of agricultural (grass-)land.
- Loss or fragmentation of habitats, reduction of biodiversity of native species.
- Adaptation to climate change.

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Most pressing issues:

- Land abandonment and forest transition and its implications for biodiversity
- Factors that affect the participation in agri-environmental measures
- Land-use decisions and their effects on the well-being of local farmers
- Future of nature-based solutions as response to climate change.
- Effects of climate change and extreme events on agricultural decision (especially long-term e.g. forest planting)

Secondary data

Annex Table 44: secondary data

Source	Data category	Indicator	Framework affiliation	Unit	From year	To year	NUTS level	System (sending/ receiving/spillover)	Causes (domains)	Drivers (domains)	Effects (domains)
Ministry of Agriculture	IACS Land use	Farms and parcels	Land cover and Land use	numbers, m2	2015	2023	Spatially explicit	Sending below NUTS3	CAP	Environmental, policy	Environmental, agriculture, policy
Ministry of Agriculture	IACS Livestock	Farms	Land cover and Land use	Livestock units [LU]	2015	2023	Spatially explicit	Sending below NUTS3	CAP	Business/production,policy	Environmental, agriculture, policy
Agent-based modelling results	Future land use change	Farms, parcels, livestock	Land cover and Land use	ha, number, LU	2015	2050	Spatially explicit	Sending below NUTS3	CAP	Environmental, policy, buiness	Environmental, agriculture, policy

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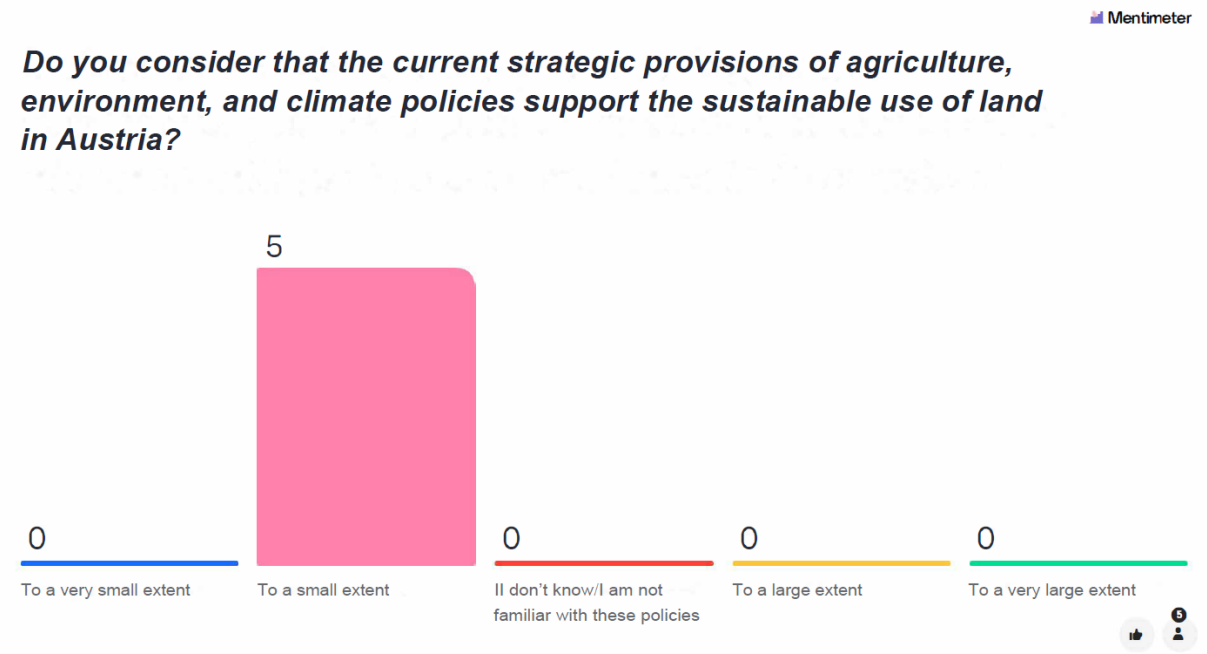
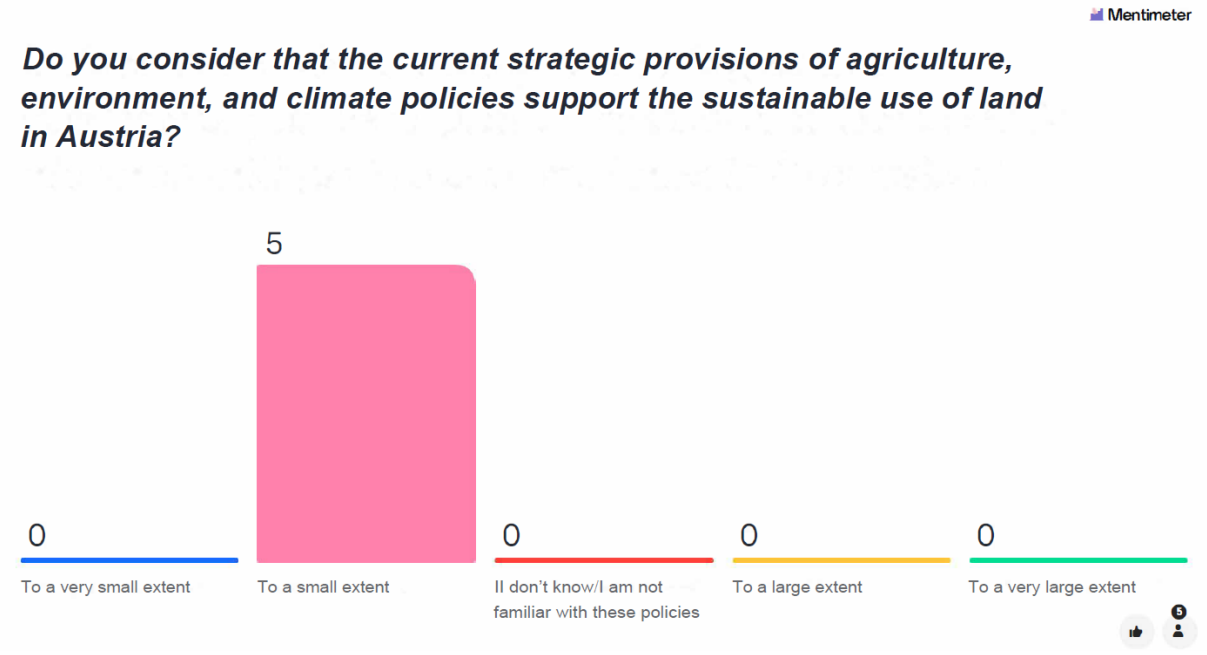
C. Spillover system - Governance / policies (regional/national/EU)

Stakeholders' opinion on support of the current policies to sustainable land management (Mirror workshops)



Annex Figure 40: Stakeholders' opinion on support of the current policies to sustainable land management (Mirror workshops) 1



Annex Figure 41: Stakeholders' opinion on support of the current policies to sustainable land management (Mirror workshops) 2

Summary of the discussion with stakeholders on policies in Austria

Land Use Challenges:

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- Competing priorities: food security, energy security, and urbanization/sprawl.
- Rural depopulation and public transport expansion in Eastern Austria increase pressure on agricultural land.
- Historical land use patterns are changing, impacting infrastructure and sustainability.

Political and Economic Factors:

- EU membership and funding have significantly influenced agricultural trends and land use.
- Subsidies are essential but need better alignment with public welfare goals.
- Decentralized decision-making leads to lengthy negotiations and fragmented policies.

Discussions and Proposals:

- Positive narratives (e.g., protein strategies) are needed to engage people in sustainable practices.
- Sustainable land use requires coordinated prioritization across all levels (local, regional, national).
- Climate change and long-term planning (e.g., forestry) present significant uncertainties.

Key insights from expert interviews

Annex Table 45: Key insights from expert interviews

	Which aspects are the most dynamic?	**What conflicts exist or are likely to arise?**
Regional socio-economic development	ageing of the farmer population and the lack of young successors, lack of skilled workers abandonment of steep (grass-)land and forest transition	young people leaving the region/agriculture urban sprawl vs. agricultural production
Agriculture	Industrial production vs. mountain tradition (in the northern lowlands vs. mountainous south) Organic production Irrigation / drainage	Small land users not feeling represented / listened to enough
Policies	Nature restauration law and its impact on Austrian agriculture	High administration burden Land users not integrated in implementation of policies -> Decisions made in Brussels not in the regions
Climate Change and biodiversity	Negative impacts from climate change related extreme events such as floods/heavy winds	Policies and local best solutions (e.g. afforestation in regard to climate change) Protection vs. agricultural production
Future	Need for change	Tradition vs. innovation

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Key agents / stakeholders

A. Identification

Annex Table 46: A. Identification

Stakeholder	Geographic coverage/Level	Main category	Sub-category
Agricultural farmers	local	business/industry/land user	business/land users (farmers)
Forest farmers	local	business/industry/land user	business/land users (farmers)
Bottom-up land use(r) initiatives	local/regional	non-governmental organization	Land user, policy, non-governmental organization
Representatives of local/regional government authorities (municipality)	local/regional	policy/government	regional authority
Provincial chambers of agriculture	local/regional	policy/government	regional authority
Representatives of the LEADER/KEM/KLAR regional management associations	regional	policy/government/societal actors	regional authority, climate change adaptation
Tourism organizations	regional	Industry/community	business
Representatives of the Austrian federal Forests	national	policy/government	national authority
Representative of nature conservation authority (national/geo-park)	regional	policy/government	regional authority
Manager/owner of the forest district	regional	policy/government	regional authority
Research and education centres (agricultural universities/colleges/research institutes)	local/regional/national	academia/ societal actor	regional authority
LTER AUSTRIA (Environment Agency Austria)	regional/national	policy/government	land use/academia

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Environmental Agency Austria	national	policy/government	national authority
Austrian Agency for Health and Food Safety (AGES)	national	policy/government	land use/industry
A representative of the Federal Ministry of Agriculture	national	policy/government	land use

B. Assessment of stakeholders' land dependence level (at local, regional / national level)

C. Assessment of their influence level in decision making

Local level

	Key agents	Stakeholder category	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A	small farms	land users (farmers, foresters)	high	5	low	2
B	large farms	land users (farmers, foresters)	high	5	medium	5
C	forest industry	industry/business	high	5	high	5
D	local governments	local authority	medium-moderate	2	high	5
E	regional government	regional authority	low	2	medium-moderate	3
F	agricultural chambers	regional authority	medium-moderate	2	high	5
G	agricultural consultants	industry/business	low	1	medium-moderate	3

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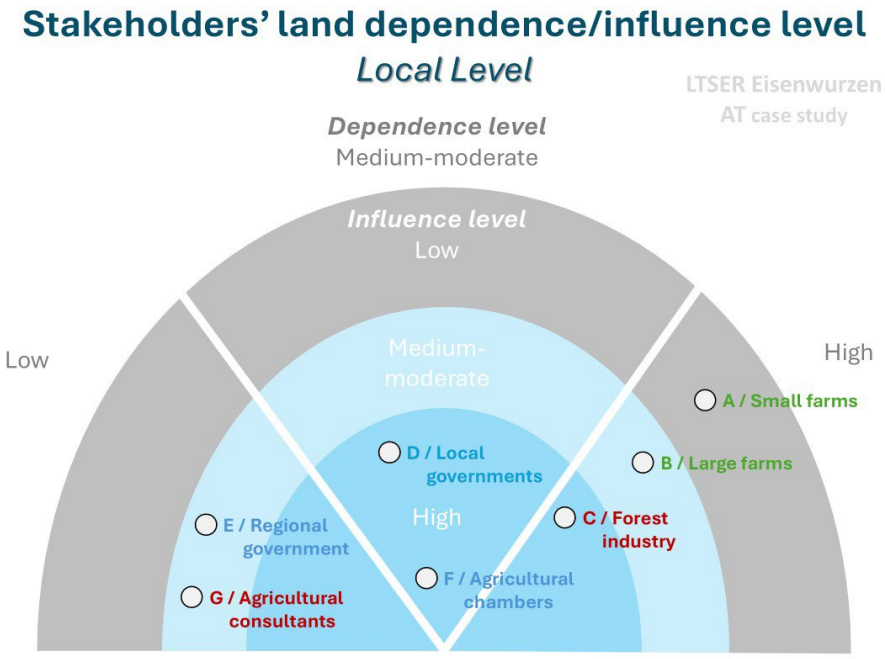
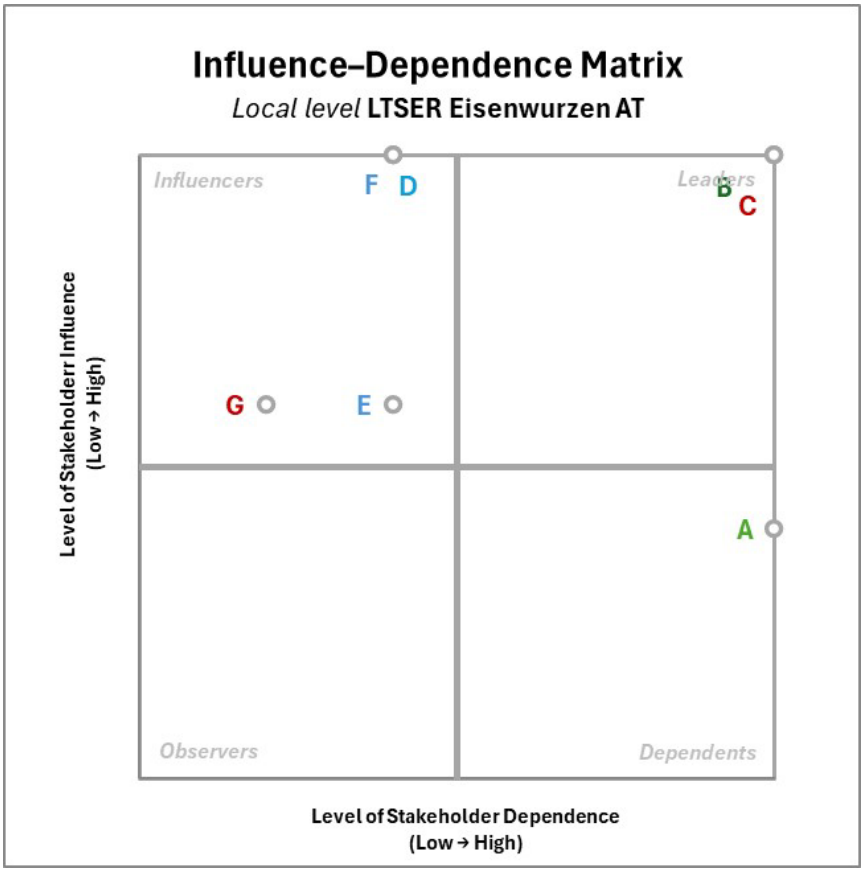


Annex Figure 42: Stakeholders' land dependence/influence level Local Level



Annex Figure 43: Influence-Dependence Matrix Local level

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Regional / national level

Annex Table 47: Regional / national level

	Key agents[1]	Stakeholder category[2]	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A	Large farms	land users (farmers, foresters)	high	5	medium	3
B	Forest industry	industry/business	high	5	high	5
C	Agricultural chambers	regional/national authority	medium-moderate	2	high	5
D	Regional government	regional/national authority	low	2	medium-moderate	3
E	EU/national government	national authority	low	2	medium-moderate	3
F	Environmental protection authorities	regional/national authority	low	2	high	5
G	BOKU University/agricultural colleges	research and academia	low	2	high	5
H	LTER Austria	research and academia	low	1	medium-moderate	3
I	Non-government organizations	NGOs	low	1	low	1
J	Agricultural consultants	Industry/business	low	1	medium-moderate	3

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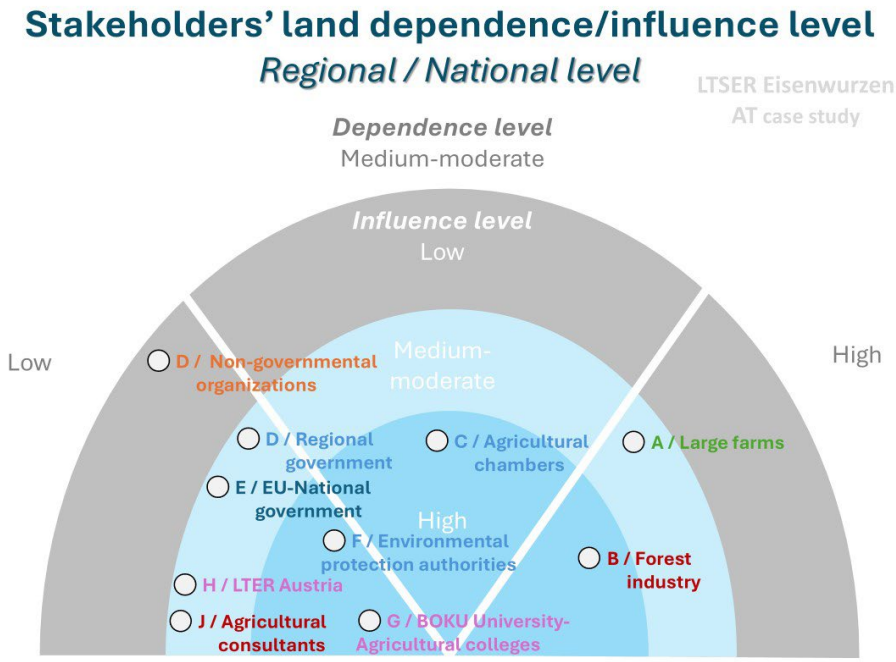
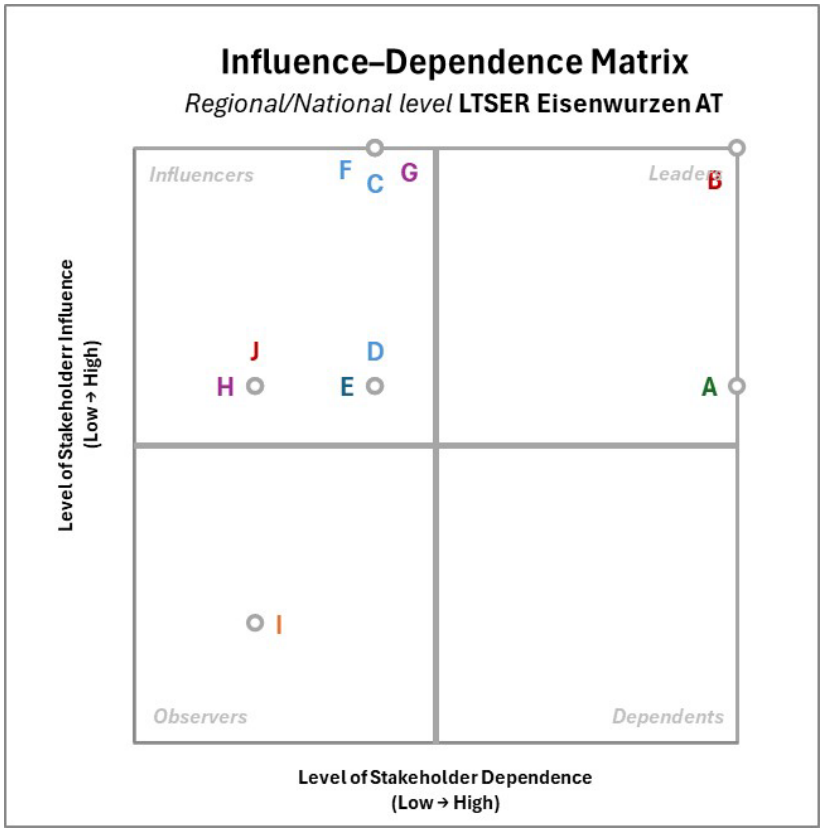


Annex Figure 44: Stakeholders' land dependence/influence level Regional/National level



Annex Figure 45: Influence-Dependence Matrix Regional/National level

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Basic matrix for SNA[46]

Annex Table 48: Basic matrix for SNA

Key agents[47]	**A** Small farms	**B** Large farms	**C** Forest industry	**D** Agricultural chambers	**E** Local/regional governments	**G** EU/national government	**H** LTER Austria (Environment Agency Austria)	**I** University/agricultural college	**J** NGO
A Small farms		1	1	1	1	1	1	1	1
B Large farms	1		1	1	1	1	1	1	1
C Forest industry	1	1		1	1	1	1	1	1
D Agricultural chambers	1	1	1		1	1	1	1	1
F Local/regional governments	1	1	1	1	1	1	1	1	1
G EU/national government	1	1	1	1	1		1	1	1
H LTER Austria (Environment Agency Austria)	1	1	1	1	1	1		1	1
I University/agricultural college	1	1	1	1	1	1	1		1
J NGO	1	1	1	1	1	1	1	1	

[46] A cell with a 1 indicates a relationship (influence/dependence) between agents is present, while a 0 indicates no relationship. 1=weak relationship; 1=medium relationship; 1=strong relationship.

[47] Categories of agents (stakeholder categories as in step B.) at all levels (local + regional/national) + EU governance (spillover system).

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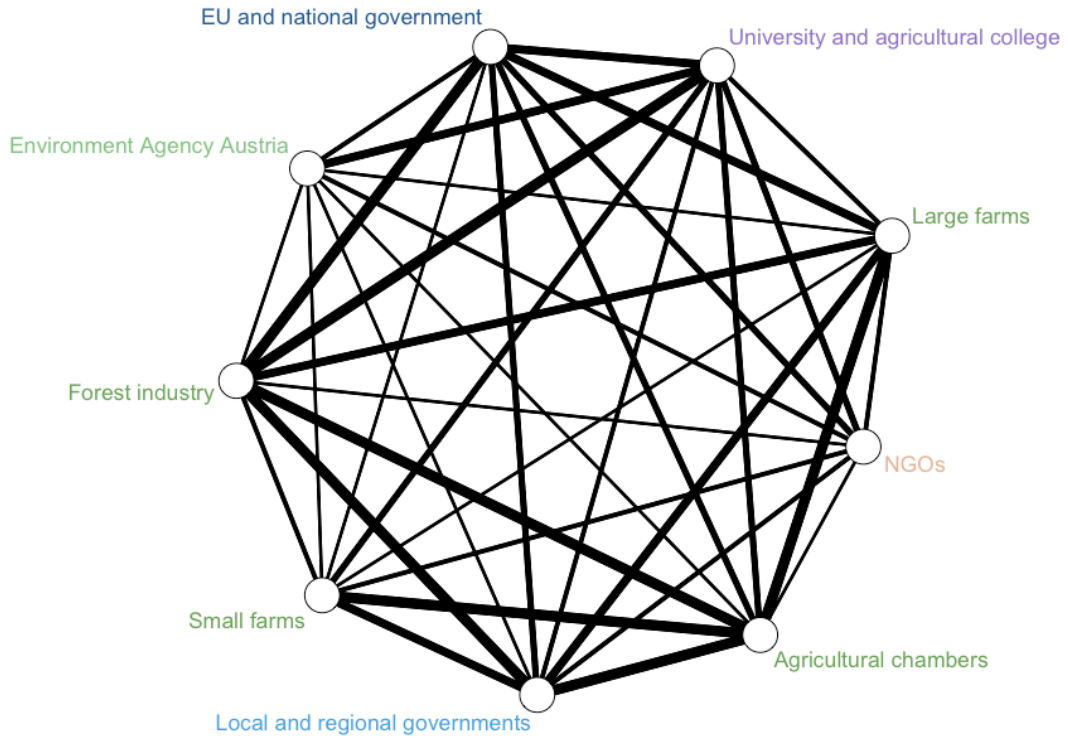

Annex Figure 46: Visualization of relationships among key agents / stakeholders

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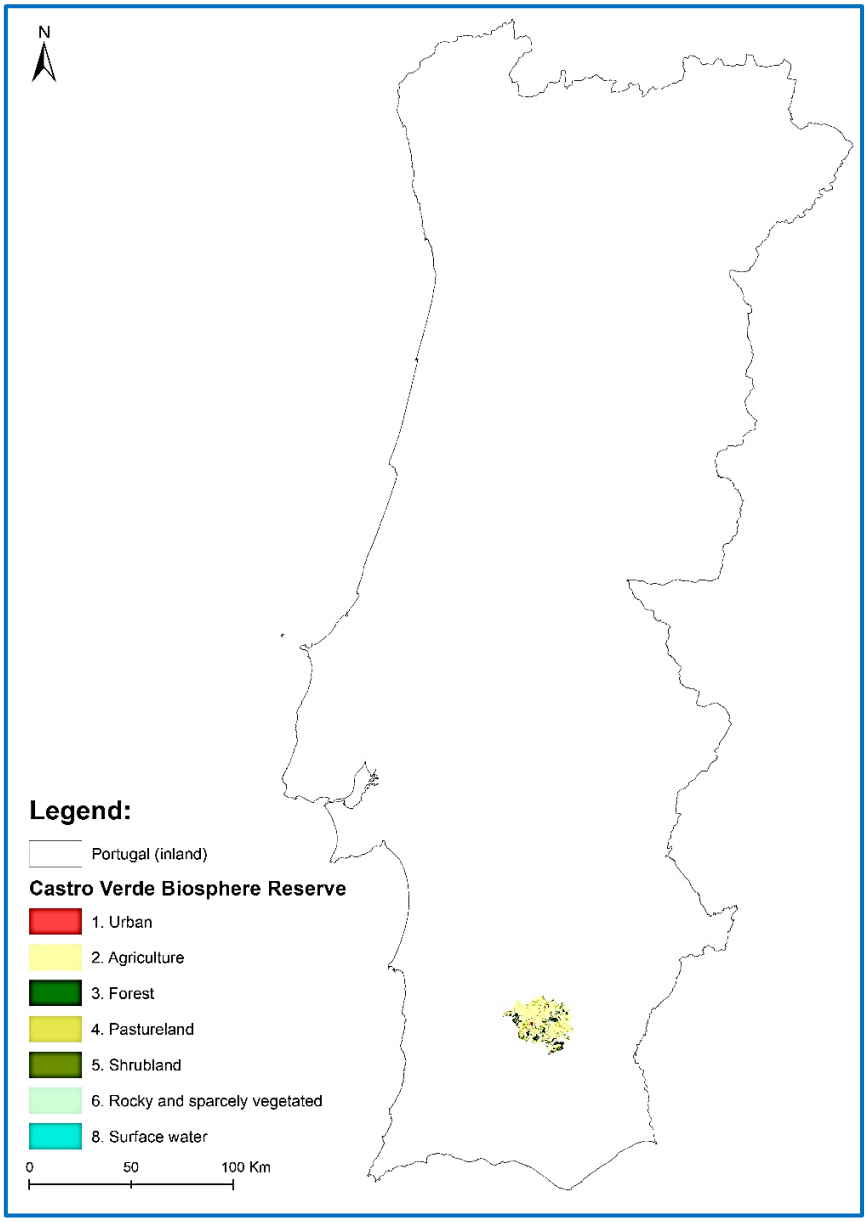
1.7 Portugal: Castro Verde Biosphere Reserve

Introduction

Castro Verde Biosphere Reserve (BR) is in southern Portugal (37°43'N, 7°57'W), in Alentejo region, and have its place in the long and extensive plains of the Beja district. Castro Verde Biosphere Reserve integrates the entire geographical area of the municipality of Castro Verde (567,2 km2) and is bounded by the municipalities of Beja, Aljustrel, Almodôvar, Mértola and Ourique.

Map indicating the geographical location and land cover classification (2018) of Castro Verde Biosphere Reserve in Portugal



Annex Figure 47: Map indicating the geographical location and land cover classification (2018) of Castro Verde Biosphere Reserve in Portugal

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The lansdcape strongly features arable dry-cereal crops in rotation with fallow land and vast grasslands with livestock, permanently populated with steppic birds, being part of the traditional and historical image of the Southern Alentejo region in Portugal.

The landscape of Castro Verde Biosphere Reserve - dry-cereal crops in rotation (at top right), open grasslands (at top left and center) and fallow lands typically populated by steppe birds such as the lesser kestrel (Falco naumanni) (down at left) or the great bustard (Otis tarda) (down at right). Pictures retrieved from www.reservasdabiosfera.pt.

Annex Figure 48: Landscape of Castro Verde Biosphere Reserve (Pictures: CFE/University of Coimbra)

The Castro Verde Biosphere Reserve covers an area of 567,2 km2 in inland south Portugal. An important sector in this territory is the mining industry, which provides job opportunities and stimulates the local economy, namely the Neves-Corvo mine. Additionally, the agricultural and livestock sectors play an essential role in the livelihoods of the local population and in the cultural and environmental characteristics of the region. The vast plains with cereal crops and grasslands are the main landscape feature and are often referred to as cereal steppes. This is an agro-ecosystem constituted by arable dry-

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cereal crops in rotation with fallow land. This spatial-temporal landscape mosaic, perfectly adapted to the ecological features of the territory and the human activities that take place in it, is the result of a millennial relationship between Humans and Nature. However, the Cereal Steppes of Castro Verde represent one of the most endangered rural landscapes in the Mediterranean region. This vulnerability is attributed both to ecological issues (such as the soil's limited productivity) and economic factors, including the shift towards higher-yielding crops. Additionally, this landscape supports high levels of biodiversity, including refuges for many steppic birds with unfavourable conservation status, such as the great bustard (Otis tarda), the little bustard (Tetrax tetrax), and the lesser kestrel (Falco naumanni). It is crucial to understand and manage the conflict between the preservation of biodiversity habitat requirements and the safeguarding of soil productivity. Therefore, this case study will be focused on understanding the influence of agri-environmental measures on agricultural production and biodiversity in the Castro Verde Biosphere Reserve. For that, we intend to analyse historical data, including the 30 years of implementation of the first Zonal Plan in Portugal and the years before its implementation in 1995. This will be done by constructing a geodatabase of the land uses over the last 30 years based on remote sensing images (Landsat and Sentinel), land cover maps, and field parcel information, which will be analysed together with the available information on yield, management actions, and biodiversity assessments. Afterwards, we will estimate the past, current, and future provision of ecosystem services and biodiversity under different scenarios of land use and management and climate change.

The Castro Verde Biosphere Reserve is home to an estimated population of 6900 residents (National Census of 2021). The Castro Verde lansdcape corresponds largely to Cereal crops and Pasturelands as the main occupation (86%) (Annex Figure 49). Structurally, the Cereal Steppe is characterised as an open mosaic landscape, primarily consisting of cereal fields, stubble, ploughed land, grasslands and fallow areas, following a rotational scheme. In this prevalent rotation system, each farm is divided into individual plots, with each plot dedicated to cereal cultivation for one or two years, after which land is left fallow for a period of 2–3 years. Fallow land is predominantly used for sheep grazing, with goats and beef cattle also using it to a lesser extent. After this period, the plot is plowed, initiating a new rotation cycle.

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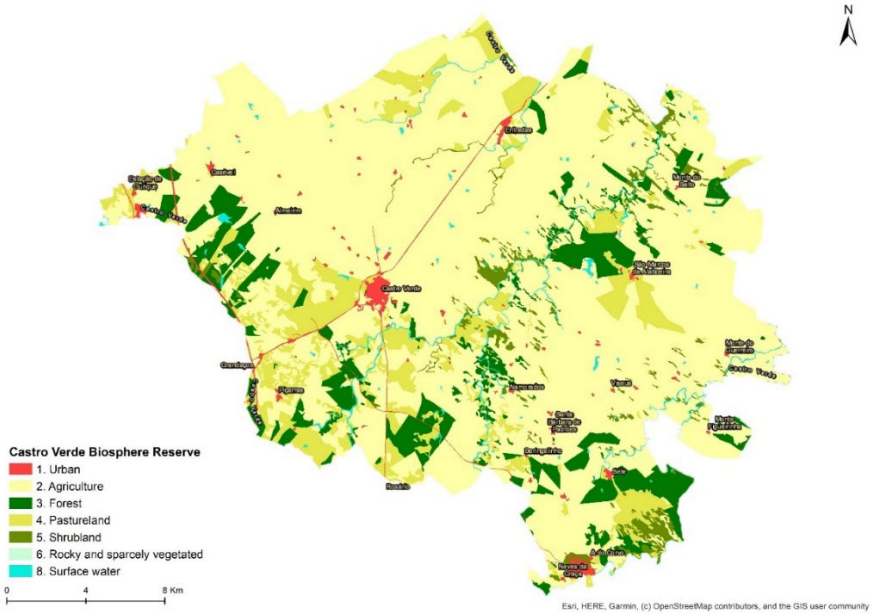
Castro Verde Biosphere Reserve main land cover occupation in 2018 (DGT, 2019)



Annex Figure 49: Castro Verde Biosphere Reserve main land cover occupation in 2018

Within the mosaic of agricultural fields, there are small areas of dryland permanent crops (typical of Mediterranean areas), including olive groves and vineyards, as well as subsistence agricultural crops. Olive groves are associated with extensive farming and grazing practices, where sub-cover is used as natural pasture (mainly for sheep) and for olive oil production (one of the basic products of the Mediterranean diet). There are also some areas of forest systems with recent pure or mixed plantations of stone pine (Pinus pinea) and holm oak (Quercus rotundifolia).

Another distinctive ecosystem is the Mediterranean scrubland, typically found in rocky outcrop areas that are unsuitable for ploughing or in slightly rugged terrain along streams. Here, the rockrose (Cistus ladanifer) dominates, forming rockrose thickets known as 'Estevais,' which are occasionally accompanied by other rockrose species like Cistus crispus and Sage-leaved Rockrose (Cistus salvifolius), as well as aromatic plants from the Lavandula genus.

The Castro Verde Biosphere Reserve hosts 4 listed Habitats from Habitats Directive with high relevance in the region. For isntance, along watercourses there are well-preserved riparian galleries can be observed, characterised by native shrubs such as Oleander, Tamarisk, and Flueggea tinctoria (which corresponds to habitat 92D0 - Southern riparian galleries and thickets [Nerio-Tamaricetea and Securinegion tinctoriae] - of the EU Habitats Directive). These galleries also have trees like Ash (Fraxinus angustifolia), Poplar (Populus spp.), and Willow (Salix spp.). Furthermore, two out of the four habitats are priority habitats listed under the Directive's Annex I, namely the 6220 - Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea, and the 3170 - Mediterranean temporary ponds.

Throughout the territory, there are small dams, reservoirs, and artificial bodies of water, which play a vital role in supporting agricultural activities, supplying water to livestock during the summer, and providing habitat for local wildlife.

Castro Verde territory is essential for preserving biodiversity and promoting sustainable management practices. Several technical, scientific, and educational projects have contributed to the valuation, conservation, and management of the natural heritage of the region. The involvement of farmers,

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environmentalists, and public and private entities in these collective interest projects has allowed the recognition and adoption of sustainable practises that maximise the conservation of steppe birds compatible with human activities in the long-term.

The key protected areas at Castro Verde include Special Protection Areas (SPA), Important Bird Areas (IBA), Special Areas for Conservation (SAC) and the UNESCO Biosphere Reserve classification. Castro Verde Special Protection Areas (Piçarras - PTZPE0058 and Castro Verde - PTZPE0046), designated under the European Union's Birds Directive (under the Natura 2000 Network) correspond to 85% of the entire study area, being of critical importance for the conservation of steppe birds with unfavourable conservation status, providing crucial habitat for breeding and foraging. The significance of this area was also recognised by Birdlife International (PT029), which classified the SPA Castro Verde territories as crucial for the conservation of bird populations and the habitats that sustain them on a global scale. The southern part of Castro Verde is also included in the Rio Guadiana SAC. In 2017, this territory has been designated as a UNESCO Biosphere Reserve, a classification that underscores the region's commitment to balancing conservation with sustainable land use and development. Therefore, Castro Verde has been a pilot area to test tools, methods, and techniques to combat desertification and to promote climate change adaptation and mitigation of negative impacts on steppe biodiversity. As a result, the Biosphere Reserve works like a “living laboratory”, promoting the implementation of environmental policies at the local and regional levels, such as the National Strategy for Nature Conservation and Biodiversity (“Estratégia Nacional da Conservação da Natureza e da Biodiversidade”, ENCNB) and the National Strategy for Adaptation to Climate Change (“Estratégia Nacional de Adaptação às Alterações Climáticas”, ENAAC 2020). In addition, the National Action Plan to Combat Desertification (“Plano de Ação Nacional de Combate à Desertificação”, PANCD 2014-2020) indicates Castro Verde as a critical territory for national environmental networks to work together and promote soil recovery and conservation actions. Furthermore, LPN, national authorities (e.g., Institute for Nature Conservation and Forests, ICNF), academic institutions, and other non-governmental organisations have been monitoring wildlife populations, like the great bustard, the little bustard, the lesser kestrel, the roller (Coracias garrulus), the black-bellied sandgrouse (Pterocles orientalis), the red kite (Milvus milvus), the Montagu’s harrier (Circus pygargus), the Iberian imperial eagle (Aquila adalberti) and the common crane (Grus grus).

Additionally, within farming and livestock activity, sustainable agricultural practises have been implemented to minimise the impact of agriculture on the environment and combat desertification. These collaborative efforts, which involve entities such as the Campo Branco Farmers Association (AACB), LPN, and public and private institutions, have played an important role in the promotion of sustainable development of Castro Verde.

In short, the Castro Verde Biosphere Reserve aims to support the management policy of the whole territory, following the guidelines and directives of different international, national, local and regional authorities:

- The Alentejo Regional Land Management Plan (“Plano Regional de Ordenamento do Território do Alentejo”, PROTA, approved in the Resolution of Council of Ministers No. 53/2010 of 2 August, with changes made by the Declaration of Rectification No. 30-A/2010 of 1 October);
- The Municipal Master Plan of Castro Verde (“Plano Diretor Municipal”,PDM, approved by Resolution of the Council of Ministers No. 59/93 of 13 October, with changes approved by Resolution No. 2271/2010, of December 7) – the PDM is currently under development.
- The Natura 2000 Sectoral Plan (“Plano Setorial da Rede Natura 2000”, PSRN 2000, approved by Resolution of the Council of Ministers No. 115-A/2008 of 21 July)

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- The Legal Framework for Nature Conservation and Biodiversity ("Regime Jurídico da Conservação da Natureza e da Biodiversidade", Decree-Law No. 242/2015 October 15)
- The National Strategy for Nature Conservation and Biodiversity ("Estratégia Nacional da Conservação da Natureza e da Biodiversidade", ENCNB)
- The European Union Biodiversity Strategy for 2020;
- The National Action Program to Combat Desertification ("Programa de Ação Nacional de Combate à Desertificação", 2014-2020);
- The Tourism Strategy for the period 2017-2027 (ET 27).

Geographic Coverage:

- Country: Portugal
- Region: Southern Alentejo
- Coordinates Extent (Min-Max Lon-Lat):
    - Min Lon (western boundary): 08° 14' 47.48" W
    - Min Lat (southern boundary): 37° 33' 40.46" N
    - Max Lon (eastern boundary): 07° 50' 56.48" W

Max Lat (northern boundary): 37° 49' 38.45" N.

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Basic telecoupling elements

Annex Table 49: Basic telecoupling elements

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending (local) Castro Verde Municipality (LAU)	• Agriculture • Grassland • Agroforestry	• Agricultural companies • Local and regional governments • NGOs • Local producers of cattle • Farmers associations • Environmental protection authorities	• Soil productivity constraints • Economic shifts • Abandonment of traditional practices • Climate pressures • Mining expansion	• EU agri-environmental policies • Market demand • Scientific and conservation initiatives • Local stakeholder engagement • Policy frameworks	• Biodiversity conservation • Landscape resilience • Socio-economic revitalization • Knowledge transfer
receiving (regional/national) Southern Alentejo NUTS 3 Alentejo NUTS 2 Portugal NUTS 1	• Agriculture • Grassland	• External markets and consumers • Scientific and conservation networks (Academia and NGOs) • Environmental protection authorities	• Agricultural transformation • Environmental and ecological impacts • Other factors	• Environmental • Cultural • Historical • Economic • Institutional	• Refined agri-environmental policy design • Increased access to sustainable products • Knowledge transfer and replication of best practices

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Causes in detail:

These are the underlying conditions and pressures that have led to landscape vulnerability and biodiversity decline:

- **Soil productivity limitations**: Low natural fertility, shallow depth and lower organic matter reduce agricultural productivity.
- **Economic shifts**: Transition from traditional cereal farming to more profitable and intensive crops.
- **Abandonment of traditional practices**: Decline in rotational grazing and seasonal mowing disrupts ecological balance.
- **Climate pressures**: Increasing aridity and desertification risks in southern Portugal.
- **Mining expansion**: Land-use competition and ecological fragmentation near Neves-Corvo mine.

Drivers in detail:

These are the active forces and agents influencing land-use change and conservation dynamics:

- **EU agri-environmental policies**: CAP subsidies and Natura 2000 designations incentivize biodiversity-friendly practices.
- **Market demand**: External demand for agricultural products (e.g., olive oil, cereals) shapes land-use decisions.
- **Scientific and conservation initiatives**: LIFE projects, biodiversity monitoring, and pilot programs guide adaptive management (particularly the League for Nature Protection LPN and Alentejo's University of Évora and Polytechnic Institute of Beja).
- **Local stakeholder engagement**: Farmers' associations and NGOs promote sustainable practices and community-based conservation.
- **Policy frameworks**: National strategies (ENCNB, ENAAC, PANCD) drive climate adaptation and desertification mitigation.

Effects in detail:

These are the observable outcomes and consequences of the interactions:

- **Biodiversity conservation**: Improved habitat conditions for steppe birds and Mediterranean species, although balancing productivity with conservation continues to be a complex negotiation.
- **Landscape resilience**: Restoration of rotational agroecosystems and ecosystem services (e.g. species conservation, pollination, water regulation).
- **Socio-economic revitalization**: Enhanced rural livelihoods through sustainable farming and eco-tourism.
- **Knowledge transfer**: Castro Verde may serve as a model for other Mediterranean regions facing similar challenges.

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Key flows: These are the main exchanges between systems:

- **Material flows**: Agricultural products (cereals, olive oil), livestock, and ecosystem services.
- **Financial flows**: CAP payments, LIFE funding, national conservation investments.
- **Information flows**: Land-use data, biodiversity assessments, policy innovations, and scientific research.
- **Ecological flows**: Migratory birds, pollinators, and ecosystem services across regional ecosystems.
- **Cultural flows**: Traditional knowledge, community practices, and conservation values shared across networks.

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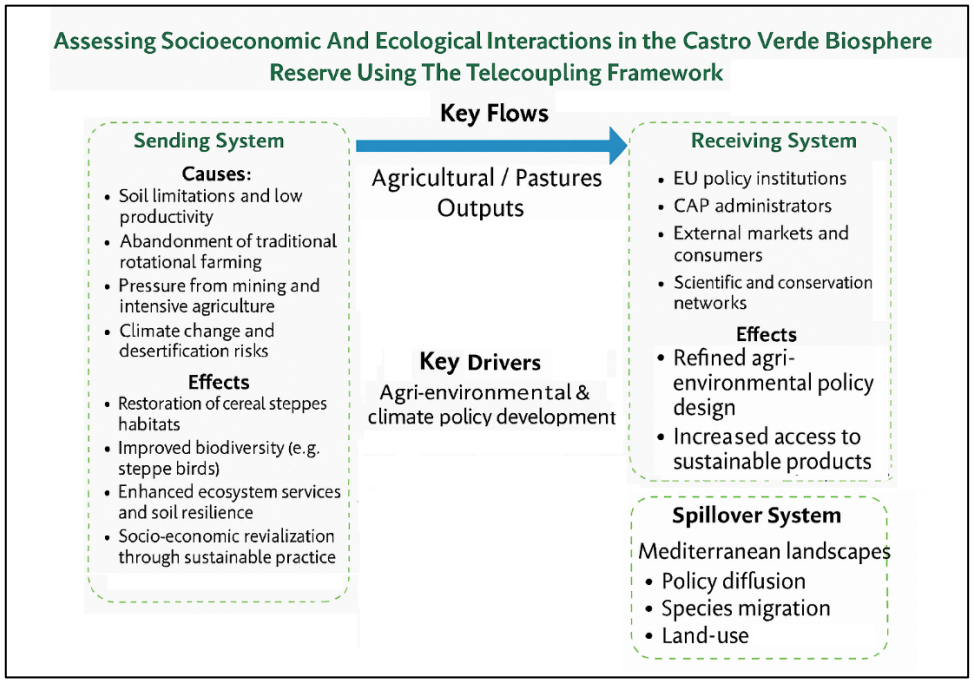
Key outputs of the Telecoupling Framework assessment in the Castro Verde Biosphere Reserve:



Annex Figure 50: Key outputs of the Telecoupling Framework assessment in the Castro Verde Biosphere Reserve

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Secondary data

- IACS Portuguese data
- Portuguese Statistics Institute

Annex Table 50: Secondary data

Source	Data category	Indicator	Framework affiliation	Unit	From year	To year	NUTS level	System (sending/ receiving/spillover)	Causes (domains)	Drivers (domains)	Effects (domains)
IACS Portuguese data	Land Use	Agricultural production under CAP funding scheme	Land cover and Land use	m^2 / ha	2011	2024	LAU	Sending (LAU)	Agricultural transformation	Environmental Economic	Agriculture, Economic, Environmental
Portuguese Statistics Institute	Socioeconomic	Agricultural census	Socioeconomic	Pax / EUR	2009	2019	LAU	Sending (LAU, NUTS 3)	Agricultural transformation	Economic, Demographic	Agriculture, Economic, Industry

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C. Spillover system - Governance / policies (regional/national/EU)

Annex Table 51: C. Spillover system - Governance / policies (regional/national/EU)

Sector (select from the drop-down list)	Title of document in national language	Title of document in English	Type of document (select from the drop-down list)	Link	Institution/Publisher	Year	Language/s	Level of document (select from the drop-down list)	General remarks regarding instruments/incentives
agriculture	Plano Estratégico da Política Agrícola Comum (PEPAC) para Portugal	Strategic Plan for the Common Agricultural Policy for Portugal	strategic	https://www.gpp.pt/index.php/pepac/pepac-documentos	Ministry of Agriculture and Food	2021	Portuguese	national	Financial instrument for Agriculture policy in Portugal in agreement with EU's CAP
climate change	Plano Nacional Energia e Clima 2021-2030 (PNEC 2030)	National Plan for Energy and Climate 2021-2030	strategic	https://www.dgeg.gov.pt/media/go2fm4fb/pnec-2030-rcm-53_2020.pdf	Ministry of Environment and Climatic Action	2020	Portuguese	national	Strategic document with the objectives and targets, in terms of energy and climate, defined for Portugal until 2030
forestry	Estratégia Nacional para as Florestas (ENF)	National Strategy for Forests	strategic	https://files.dre.pt/1s/2015/02/02401/0000200092.pdf	Ministry of Agriculture and Food	2015	Portuguese	national	This strategic document has as main objective the sustainable management of forests, in line with the new European Union Strategy for Forests and the Forestry Sector
biodiversity and nature protection	Estratégia Nacional de Conservação da Natureza e Biodiversidade para 2030 (ENCNB 2030)	National strategy for Nature and Biodiversity Conservation for 2030	strategic	https://files.diariodarepublica.pt/1s/2018/05/08700/0183501880.pdf	Ministry of Environment and Climatic Action	2018	Portuguese	national	This strategic document aims the recognizing that natural heritage contributes to achieving a development model based on the valorization of the territory.
spatial planning	Programa Nacional da Política de Ordenamento do Território (PNPOT)	National Spatial Planning Policy Program	strategic	https://pnpot.dgterritorio.gov.pt/pcat/ficheiros/SQ_Vconc_PNPOT_1.pdf	Ministry of Environment and Climatic Action	2019	Portuguese and English	national	This strategic document is the leading instrument of the territorial management system. It defines objectives and strategic options for territorial development and establishes the organization model of the national territory.
climate change	Estratégia Nacional de Adaptação às Alterações Climáticas (ENAAC)	National Strategy for Adaptation to Climate Change	strategic	https://files.diariodarepublica.pt/1s/2020/07/13300/0000200158.pdf	Ministry of Environment and Climatic Action	2020	Portuguese	national	This strategic document establishes objectives and the model for implementing solutions for the adaptation of different sectors to climate change
other	Plano Nacional de Gestão Integrada de Fogos Rurais 2020-2030 (PNGIFR)	National Plan for the Integrated Management of Rural Wildfires 2020-2030	strategic	https://files.dre.pt/1s/2020/06/11501/0000200145.pdf	Ministry of Agriculture and Food	2020	Portuguese	national	This stratetic plan introduces an innovative risk governance model, identifies strategic objectives and measures to be operationalized to face rural wildfires.
agriculture	Estratégia Nacional para a Agricultura Biológica (ENAB)	National Strategy for Biological Agriculture	strategic	https://files.dre.pt/1s/2017/07/14400/0420704231.pdf	Ministry of Agriculture and Food	2017	Portuguese	national	This strategic plan has the main goal to foment and present the action plan for the production and promotion of agricultural products and organic foodstuffs
other	A Estratégia Nacional de Educação Ambiental (ENEA)	National Strategy for Environmental Education	strategic	https://files.diariodarepublica.pt/1s/2017/07/13200/0353303550.pdf	Ministry of Environment and Climatic Action	2017	Portuguese	national	This strategic document aims to establish a collaborative, strategic and cohesion commitment in the construction of environmental literacy in Portugal.
biodiversity and nature protection	Sistema Nacional de Áreas Classificadas (SNAC)	National System for Classified Areas	implementation (operational)	https://files.diariodarepublica.pt/1s/2015/10/20200/0898109000.pdf	Ministry of Environment and Climatic Action	2015	Portuguese	national	This national figure encompasses the National Network of Protected Areas (RNAP), plus the classified areas that are part of the Natura 2000 network and the other areas classified under international commitments assumed by the Portuguese State (such as UNESCO's Biosphere Reserves and Geoparks designated areas, RAMSAR areas, and others).
other	Plano de Ação para a Bioeconomia Sustentável (PABS)	National Action Plan for Sustainable Bioeconomy	implementation (operational)	https://files.dre.pt/1s/2021/12/25000/0001000131.pdf	Ministry of Environment and Climatic Action	2021	Portuguese	national	This action plan aims to accelerate the implementation of a sustainable national Bioeconomy, in order to maximize its targeted contribution to the 2030 Agenda, as well as for the Sustainable Development Goals (SDGs) and the Paris Agreement.
spatial planning	Reserva Ecológica Nacional (REN)	National Ecological Reserve	implementation (operational)	https://diariodarepublica.pt/dr/detalhe/decreto-lei/124-2019-124256708	Ministry of Environment and Climatic Action	2008 (revised in 2019)	Portuguese	national	The REN is a biophysical structure that integrates a set of typologies that, due to their ecological value and sensitivity or exposure and susceptibility to natural risks, are subject to a special protection regime.
spatial planning	Reserva Agícola Nacional (RAN)	National Agricultural Reserve	implementation (operational)	https://files.dre.pt/1s/2009/03/06300/0198802000.pdf	Ministry of Agriculture and Food	2009 (revised in 2015)	Portuguese	national	The RAN is a territorial management instrument, which is embodied in a restriction of public utility by establishing a set of conditioning limitations on the non-agricultural use of soil, and which plays a fundamental role in preserving the soil resource and its allocation to agriculture.
biodiversity and nature protection	Plano de Ação para a Conservação do Lince -Ibérico (*Lynx pardinus*) em Portugal (PACLIP)	Action Plan for the Conservation of the Iberian Linx (*Lynx pardinus*) in Portugal	implementation (operational)	https://www.dgav.pt/wp-content/uploads/2021/02/Despacho_no_8726-2015_07-08_novo-PACLIP.pdf	Institute for Nature Conservation and Forests	2015	Portuguese	national	This action plan aims to promote the conservation of the Iberian Lynx in national territory, reversing the process of continued population decline.
biodiversity and nature protection	Plano de Ação para a Conservação das Aves Necrófagas (PACAN)	Action Plan for the Conservation of Scavenger Birds	implementation (operational)	https://files.diariodarepublica.pt/2s/2019/08/153000000/0005500079.pdf	Institute for Nature Conservation and Forests	2019	Portuguese	national	This action plan has the main objective to guarantee the recovery and conservation of scavenger birds
biodiversity and nature protection	Plano Zonal de Castro Verde	Castro Verde Zonal Plan	implementation (operational)	https://files.diariodarepublica.pt/1s/2008/03/05001/0000200050.pdf	Ministry of Agriculture and Food	2008	Portuguese	regional	The Castro Verde Zonal Plan is an Agri-Environmental Measure, prepared specifically for the Campo Branco region (Castro Verde), based on the payment of a landscape and threatened bird conservation service to farmers who practice an agriculture compatible with the conservation of the natural heritage.

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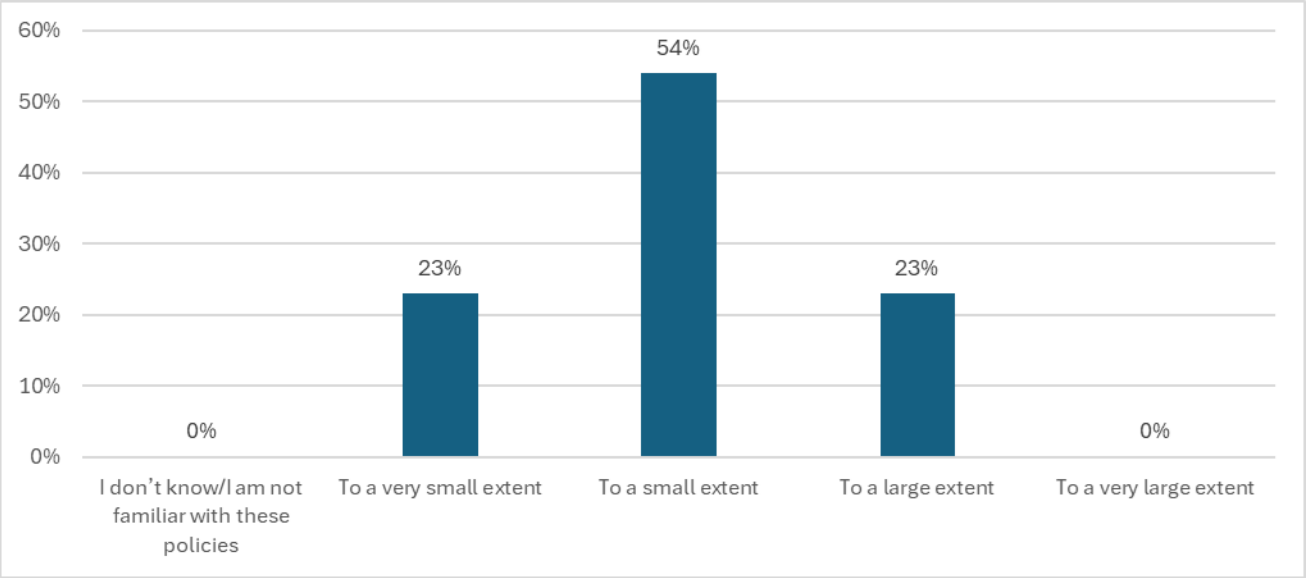
Stakeholders' opinion on support of the current policies to sustainable land management (Mirror workshops)



Annex Figure 51: Stakeholders' opinion on support of the current policies to sustainable land management (Mirror workshops)

Summary of the discussion on POLICIES

The key sentences and notes that resulted from the discussion over policies were the following:

- "Inconsistency between public and private policies and money. For example, some areas have to be watered at the same time. Sometimes it is prohibited and mandatory to water at the same time."
- "Conflicts between different policies for the same area. Example, water"
- "Regulation of monoculture. There is a tendency to cultivate a single crop, without regulation. For example, avocado plantations are not regulated, but vineyards are."
- "Better regulation in the use and occupation of soil and agricultural crops. In the same way that there is regulation of urban land, there should be regulation for agricultural land and improve the ecological restoration component."
- "Legislative differences between public and private irrigation"
- "The pandemic changed perspectives on the environment"
- "More political financing"
- "More investment from private initiatives. Mainly due to consumers being charged for various "stamps" - Carbon footprint, sustainability, etc."
- "Reduce the difference between operators and decision makers. Decision makers don't always listen or want to hear"

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- "There is not enough data (studies) that quantitatively support the services that the areas provide (e.g. carbon from pastures). Example: Conversion of water-use to what will be produced. How do you measure this? What are the trade-offs?"
- "The role of science on public policies: 1) Lack of broad and open communication with those who apply (farmers) and make decisions (politicians), communication between science and community; 2) Scale is a challenge; 3) Scientists lack experience on the ground. Lack of visibility of success stories; 4) Science is heard, but not enough."
- "Nature Restoration Regulation - Seize the moment and legislation to reduce biodiversity loss"

Overview: The workshop highlighted a significant disconnection between public and private policies, particularly regarding resource use and agricultural practices, which often results in conflicting regulations and management issues leading to confusion and inefficiency. Participants voiced concerns over the lack of regulation in monoculture practices, pointing out that crops like avocado receive minimal oversight, unlike regulated industries such as vineyards. There was a call for improved land use policies, advocating for agricultural regulations similarly to those in urban development, with a stronger focus on ecological restoration. The discussion also revealed gaps in policy communication, noting that decision-makers often disregard the insights from operators and scientists, while limited quantitative data hinders evidence-based policymaking, particularly regarding ecosystem services like carbon sequestration in pastures. Participants stressed the need for enhanced political and private financing, along with the creation of platforms for open dialogue and increased visibility of successful projects. The Nature Restoration Regulation was seen as a pivotal opportunity to address biodiversity loss, signalling a critical moment to bridge science, policy, and practice for sustainable environmental management.

Key insights from expert interviews

Annex Table 52: Key insights from expert interviews

	Which aspects are the most dynamic?	**What conflicts exist or are likely to arise?**
Regional socio-economic development	- The most relevant and important economic activity is mining, despite its small scale in terms of land use; - The population has had a small decrease during the last years; - Tourism is underdeveloped and has great potential for further growth.	- Tourism is out of regulation which leads to conflicts between some activities (particularly birdwatchers) and landowners; - Mining salaries makes it difficult for other sectors (e.g., tourism, agriculture) to compete for labour.
Agriculture	- The largest area of Castro Verde's territory is under the Natura 2000 Birds Directive	- Farming systems and biodiversity conservation (particularly steppe birds);

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	regulation, which have high constraints for farmers leading to extensive and restricted types of crops and manures in the pasturelands; - The CAP pillar 2 agri-environmental subsidies, which have in this territory the particularity of the Zonal Plan of Castro Verde for its regulation and management	- Lack of regulation outside Natura 2000 areas and conflicts within the Municipal Master Plan and its implementation.
Policies	The agriculture practices are fully dependent on CAP.	The restrictive regulation of CAP leads to issues between nature conservation (particularly steppe birds) and economic productivity for farmers.
Climate Change and biodiversity	- The water scarcity is the main and most related CC impact in the territory; - The populations of protected steppe birds are being affected by the extreme events such as heat waves, water scarcity and desertification of fields.	- The need for strict measures for biodiversity conservation and the impacts from CC such as the decrease of fields productivity (due to lower organic matter in soils) are leading to issues among farmers, who have very few options; - Farmers struggle to balance conservation rules with worsening climate pressures.
Future	- The mining activity maintenance is crucial for the region's and particularly for Castro Verde municipality in terms of social-economic development and people's well-being; - Young farmers are rare, raising concerns about who will manage the land in the future.	- The ongoing measures for steppe birds conservation and farming systems within the territory of Castro Verde may have to be adapted to the increasing impacts of CC; - There is the increasing need for regulation of the touristic activities, particularly the birdwatching; - Farmer fear losing CAP agri-environmental subsidies, which are their main income source.

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Key agents / stakeholders

A. Identification

Annex Table 53: A. Identification

Stakeholder	Geographic coverage/Level	Main category	Sub-category
Municipality of Castro Verde *(a)*	Local	Policy/Government	Local management and policy
Parish Council of Castro Verde and Casével	Local	Policy/Government	Local management and policy
Parish Council of Entradas	Local	Policy/Government	Local management and policy
Parish Council of Santa Bárbara de Padrões	Local	Policy/Government	Local management and policy
Parish Council of São Marcos da Atabueira	Local	Policy/Government	Local management and policy
Alentejo Tourism ERT	Regional	Policy/Government	Regional management (tourism)
Alentejo Regional Agriculture and Fisheries Directorate	Regional	Policy/Government	Regional management (agriculture and fisheries)
Alentejo Regional Directorate of Culture	Regional	Policy/Government	Regional management (culture)
The Institute for Nature Conservation and Forests (ICNF) – Alentejo delegation	National, regional	Policy/Government	National management and policy
Association League for nature protection *(a)*	National	Societal actors/Community	Nature conservation and environmental education/awareness
ACOS – Association of Southern Farmers	Regional	Societal actors/Community	Farmers association centred on livestock management
Esdime Association – Agency for Local Development in Southwest Alentejo	Regional	Societal actors/Community	Social development NGO

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Alentejo XXI – Association for Integrated Rural Development	Regional	Societal actors/Community	Nonprofit organization for rural development
Campo Branco Farmers Association *(a)*	Local	Societal actors/Community	Farmers association centred on agricultural management
Campo Branco Meat Producers Group	Local	Societal actors/Community	Farmers association centred on livestock management (meat production)
Cortiçol - Information and Culture Cooperative, CRL	Local	Societal actors/Community	Citizens association for local socio-cultural dinamization
Polytechnic Institute of Beja *(a)*	Regional	Academia	Higher Education institution in the study area region
Schools of Castro Verde	Local	Societal actors/Community	Administrative entity of Castro Verde's schools (primary, basic and high levels)
Senior University of Castro Verde	Local	Societal actors/Community	Nonprofit organization for Castro Verde's elderly well-being development
Manuel da Fonseca Municipal Library	Local	Societal actors/Community	Municipal library of Castro Verde town
Mining and extraction company Somincor	Local	Industry	Industrial mining and extraction company

(a): Expert interviews

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B. Assessment of stakeholders' land dependence level (at local, regional / national level)

C. Assessment of their influence level in decision making

Local level

Annex Table 54: Local level

Key agents[48]	Stakeholder category[49]	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
C Agricultural companies	Land users (farmers)	high	5	low	2
D Local and regional authorities	Local authorities	medium-moderate	3	high	4
E Non-governmental organizations	NGOs	high	4	medium-moderate	3
F Local producers of cattle	industry/business	high	5	medium-moderate	3
G Farmers associations	Land users (farmers)	high	4	low	1
H Environmental protection authorities	National and regional authorities	low	2	high	5

[48] According to tables in part I./A, I./B of this dataset.

[49] According to the Figure 3 in *Internal guide for application of the Europe-Land telecoupling framework in case-studies*.

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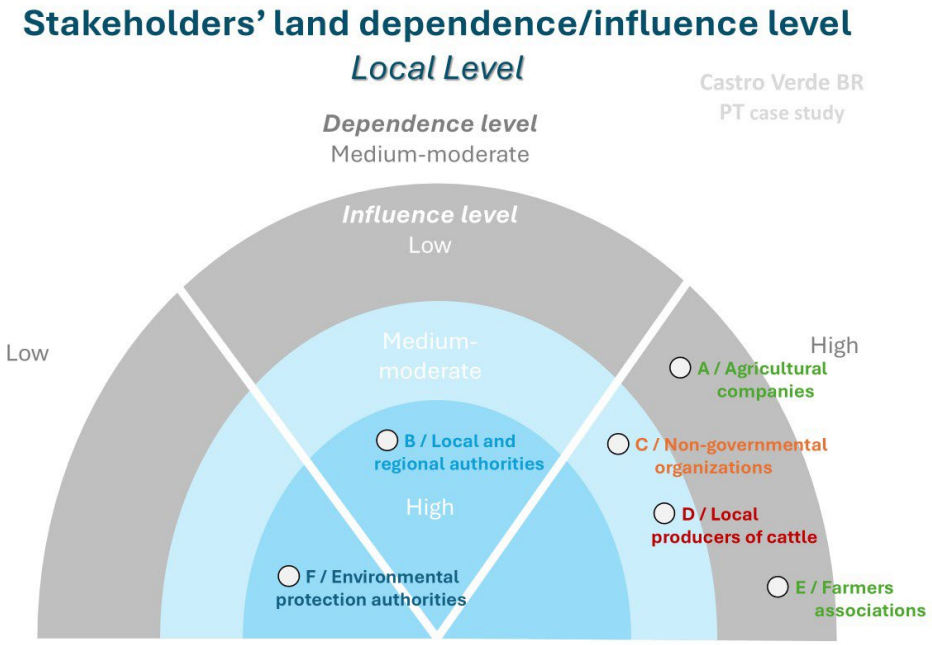
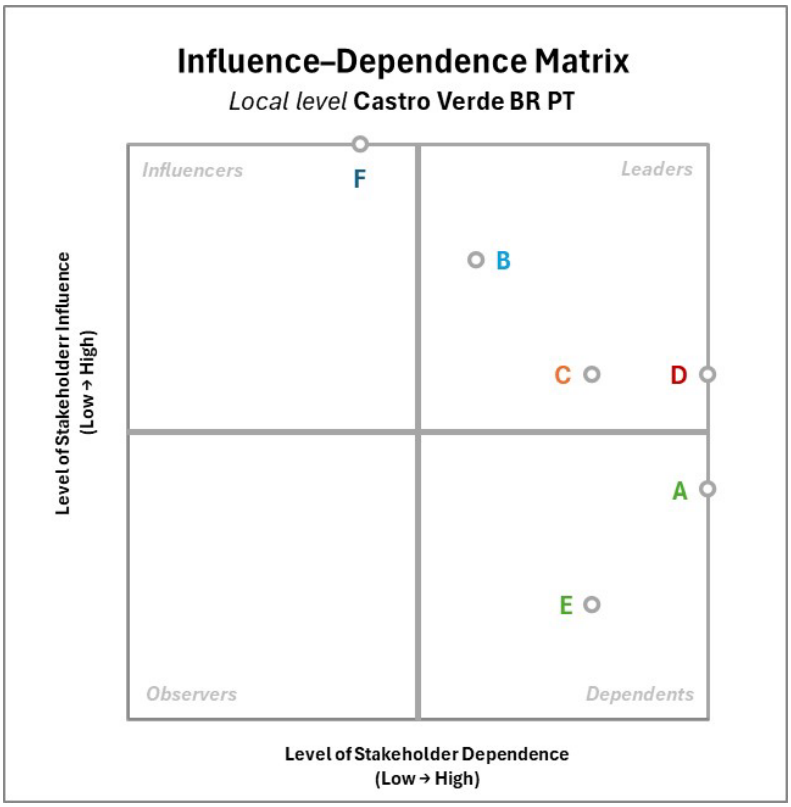


Annex Figure 52: Stakeholders' land dependence/influence level Local Level



Annex Figure 53: Influence-Dependence Matrix Local level

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Regional / national level

Annex Table 55: Regional / national level

Key agents	Stakeholder category	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
J National Authorities	National authorities (land use management and nature conservation)	low	2	high	5
K Non-governmental organizations	NGOs	low	2	low	1
L Farmers associations	Land users (farmers)	high	5	low	2
M Industry business	Industry/business	medium-moderate	3	low	2
N Universities, Research / Academia	Research and academia	low	1	low	1

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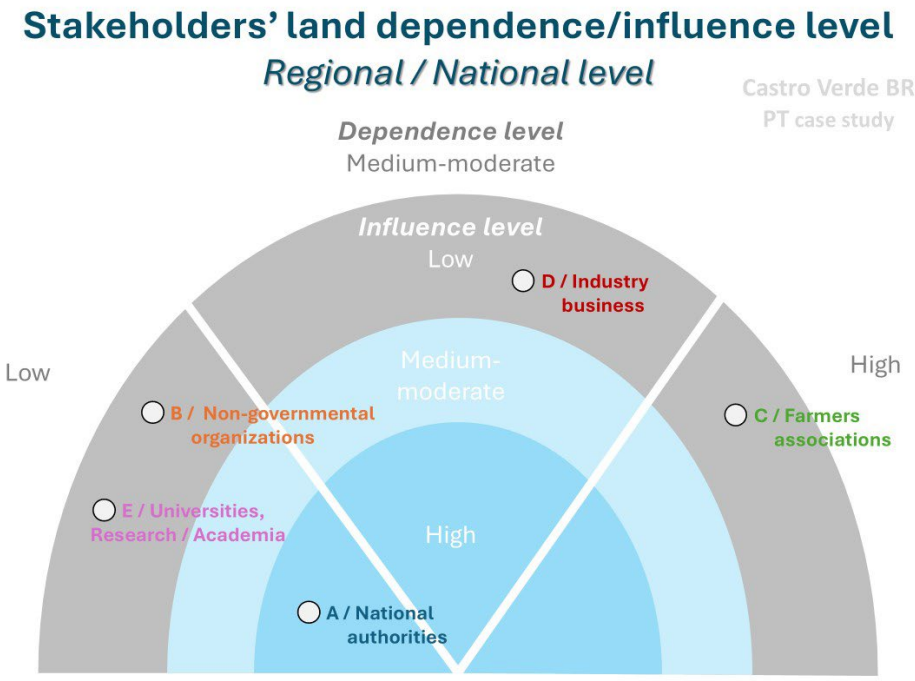
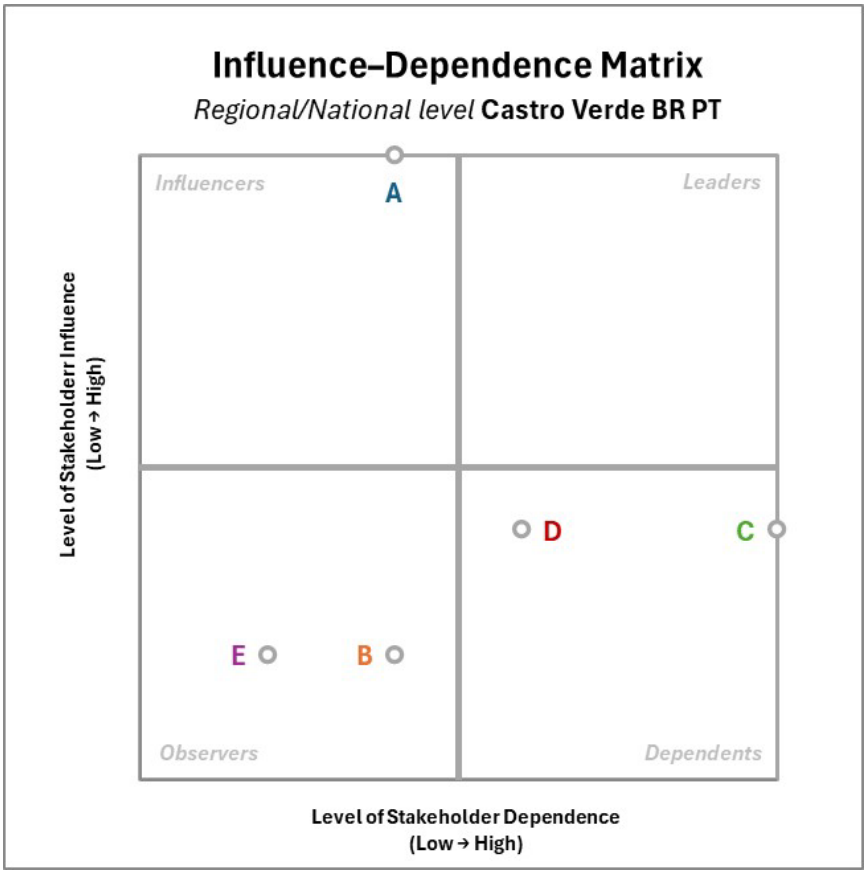


Annex Figure 54: Stakeholders' land dependence/influence level Regional/National level



Annex Figure 55: Influence-Dependence Matrix Regional/National level

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Basic matrix for SNA[50]

Annex Table 56: Basic matrix for SNA

Key agents[51]	National Authorities	Local and regional authorities	Non-governmental organizations	Farmers associations	Environmental protection authorities	Industry/ business	Universities, Research /Academia	EU governance
National Authorities		1	1	1	1	1	1	1
Local and regional authorities	1		1	1	1	1	1	1
Non-governmental organizations	1	1		1	1	0	1	1
Farmers associations	1	1	1		1	1	1	1
Environmental protection authorities	1	1	1	1		1	1	1
Industry/ business	1	1	0	1	1		0	1
Universities, Research / Academia	1	1	1	1	1	0		1
EU governance	1	1	1	1	1	1	1	

1=weak relationship; **1**=medium relationship; **1**=strong relationship

[50] A cell with a 1 indicates a relationship (influence/dependence) between agents is present, while a 0 indicates no relationship.

[51] Categories of agents (stakeholder categories as in step B.) at all levels (local + regional/national) + EU governance (spillover system).

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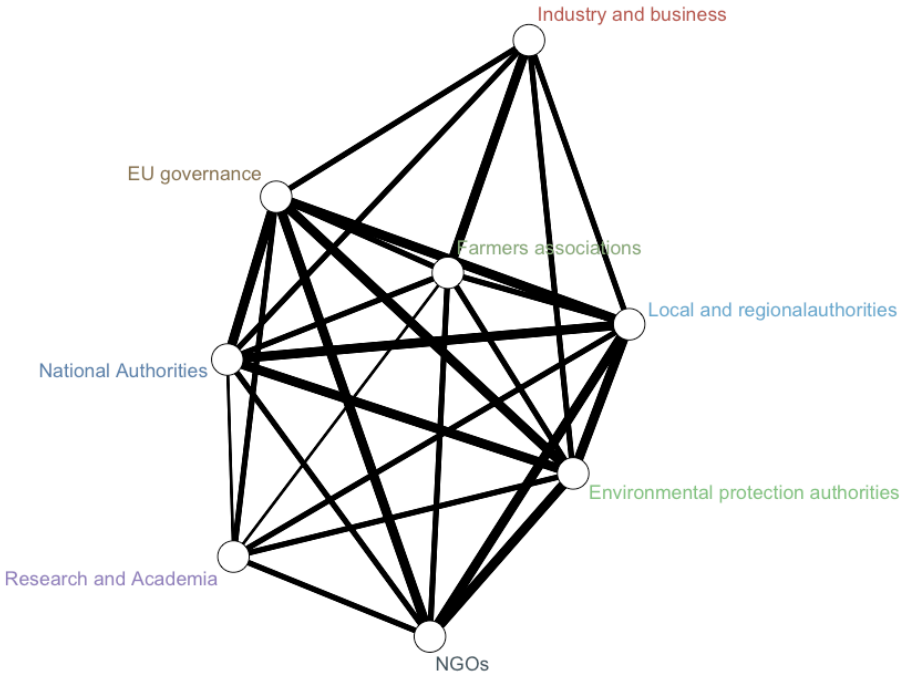

Annex Figure 56: Visualization of relationships among key agents / stakeholders

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1.8 Germany: Schorfheide-Chorin Biosphere Reserve

Introduction

The Schorfheide-Chorin Biosphere Reserve, one of Germany's largest protected areas with 1,291 km², was designated an UNESCO Biosphere Reserve in 1990. The northern part in the Uckermark is predominantly arable land with many lakes while the south-western part is characterized by sandy soils and forested landscapes. One third of the forest areas of the biosphere reserve is covered with near-natural mixed beech forests, frequently intersected by swamps and open landscape elements.

The region experiences a transitional climate between temperate-oceanic and sub-continental, with average annual temperatures of 8-9°C and annual rainfall between 480 mm – 580 mm, making it one of the driest regions in Germany. Conservation efforts have prevented substantial vegetation changes and facilitated an increase in large mammals, particularly wolves. Wetlands and water bodies play a crucial role in maintaining ecological balance and serve as a habitat for diverse plant and animal species, as well as an important natural carbon sink. Renowned as a birdlife haven, the Reserve's forests, wetlands, and water bodies attract both local and migratory species, making it a vital stopover point for migrating birds.

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Basic telecoupling elements

A. Period 2004-2019

Annex Table 57: A. Period 2004-2019

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
sending (local) Schorfheide region NUTS 3	• Agriculture (mostly extensive pastures and fields, almost half of the area under organic production) • Forestry • Transport • Residential • Conservation areas	• Agricultural enterprises (conventional and organic) and cooperatives • Local and regional governments • Biosphärenreservat Schorfheide-Chorin • Tourist sector (hotels, restaurants, guest houses etc) • Investors and developers • Industry • NGOs • Local producers of food • Landowners • Environmental protection authorities (NABU etc)	• infrastructure expansion (proximity to Berlin) • agricultural transformation • industrial development until Biophere status • change in land ownership (eg former collective land used by private farmers)	• Global warming • EU schemes that support extensive (organic) land use • Peat land conservation schemes • Political–institutional, environmental	• Agriculture and Industry • Environmental • Increasing share of organic farming; stable agricultural land area • Slight loss of agricultural area; grassland increase
receiving (regional/national)	• Agriculture • Forestry	• Farmers associations	• infrastructure expansion • agricultural transformation	Economic	• Increased demand for

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North-East Germany NUTS 2 Germany NUTS 1	• Urban food markets, processing	• Industry • Business • National • Authorities • NGOs • Large agricultural enterprises • Small farmers • National transport operators and infrastructure • Universities, Research Academy • Retailers, food processors	• industrial development • other factors • Market demand and integration		organic products • Increased land competition
Spillover (EU/national)	• CAP, agri-environmental schemes, Natura 2000 • Spatial planning	• EU institutions, federal/state authorities	• Policy incentives	Political–institutional	• Incentives for extensification and organic farming • Support for permanent grassland and biodiversity measures

Causes in detail:

- Poor soil quality in the Schorfheide causes difficult conditions for productive agricultural production… low yields.
- Agricultural transformation: new ag technologies (eg combines and new crops) triggered new land use systems/regimes.
- Competition for land between agricultural commodities and energy crops.
- high Fragmentation of land ownership. Large enterprises must deal with many land owners and dispersed fields.
- infrastructure expansion limited by strict laws in the Schorfheide protection are.

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- change in land ownership (eg former collective land changed to land used by private farmers).

Drivers in detail:

- Dry and warm conditions during summer, and climate change puts the region under more pressure
- EU schemes that support extensive (organic) land use. Conventional production has been pushed aside in the Schorfheide during the last years. Proximity to Berlin (strong market) proved to be beneficial for higher value organic production, which partly explained the success story of organic production in the Schorfheide.
- Peatland under agricultural land use is (politically) desired to be abandoned for env. reasons

Effects in detail:

- In the first period (2005-2019), a clear increase in permanent grassland can be observed, especially between 2014 and 2017. This seemed to happen at the expense of arable land. From 2017 on the area of both classes remained rather stable.
- Share of land under organic cultivation increased between 2005 and 2019 from 25% to 39%.
- Stable farm numbers & slight size reduction- In contrast to other areas in Germany, the average area per farm decreased between 2011 and 2022 in Schorfheide (as well as in Barnim)
- poor access to land for new farmers, particularly at small scale (land is expensive and large companies put pressure on the ag land market)
- Decline in agricultural labor force
- Land buying by foreign investors and farmers who use land regardless of local needs.

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B. Period 2020-2024

Annex Table 58: B. Period 2020-2024

System	Main land-use types	Agents	Causes (domains)	Drivers (domains)	Effects (domains)
Sending (local)	• Agriculture, grassland, forestry	• Organic farmers • Cooperatives • Municipalities • developers	• Agricultural transformation • Infrastructure expansion	• Political–institutional, environmental • Demographic, political	• Stabilisation at high organic share • Continued pressure on agricultural land
Receiving (regional/national)	• National organic markets • Regional housing and labour market	• Processors, retail chains • Urban planners, housing developers	Market expansion	Economic	Strong market integration of organic products
Spillover (EU/national)	• Green Deal, CAP reform • Regional development programmes	• EU, federal policy bodies • Planning authorities	• Policy reform • Regulation	Political	• Eco-scheme expansion • Land-use zoning, compensation measures

Causes in detail:

- Reform of CAP eco-schemes.
- Strengthened environmental conditionality
- Ongoing suburbanisation processes.
- Infrastructure development.

Drivers in detail:

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- European Green Deal.
- Climate and biodiversity policies.
- Proximity to Berlin labour and housing market.
- Regional spatial planning frameworks.

Effects in detail:

- Organic farming remains above 50%.
- Share of land under organic cultivation: Between 2020 and 2024 the increase continued (41% to 52%) but levelled off since 2023.
- The number of organic farms rose steadily between 2005 and 2022.
- The total area of fallow areas experienced a notable increase between 2020 and 2024.
- Farm structure remains stable.
- Continued slight decline in arable land.
- Stabilisation of grassland.

Key flows:

- Policy implementation flows (EU → national → local)
- Supply chains for organic products
- Economic migration → land demand
- Planning decisions → local land-use regulation

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Secondary data

Annex Table 59: Secondary data

Source	Data category	Indicator	Framework affiliation	Unit	From year	To year	NUTS level	System (sending/ receiving/spill over)	Causes (domains)	Drivers (domains)	Effects (domains)
IACS (GSA)	Agriculture	Agricultural area	Effect	ha	2005	2025	NUTS 3 / local	Sending	Agricultural transformation	Economic	Land-use change
IACS (GSA)	Agriculture	Crop types	Effect	ha	2005	2025	NUTS 3 / local	Sending	Agricultural transformation	Economic	Land-use change
IACS (GSA)	Agriculture	Farm size	Effect	ha	2005	2022	NUTS 3 / local	Sending	Agricultural transformation	Economic	Farm structure
IACS (GSA)	Agriculture	Share of organic farming	Driver	%	2005	2022	NUTS 3 / local	Sending	Agricultural transformation	Political / Institutional	Environmental impact
IACS	Livestock	Number of cattle per farm	Driver	heads	2005	2022	NUTS 3 / local	Sending	Agricultural intensification	Economic	Structural change
ALKIS (Jänicke & Müller 2024)	Land ownership	Share of land by ownership type	Driver	%	2020	2020	Local / municipality	Sending	Other factors	Institutional	Farm structure

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CORINE	Land cover	Built-up area	Effect	ha	1990	2018	NUTS 3	Sending	Infrastructure expansion	Demographic	Urbanisation
CORINE	Land cover	Forest area	Effect	ha	1990	2018	NUTS 3	Sending	Other factors	Environmental	Biodiversity
Regionaldatenbank Deutschland	Agriculture	Number of farms	Driver	number	2010	2020	NUTS 3 / federal state	Sending	Agricultural transformation	Economic	Farm structures, farm sizes,
Regionaldatenbank Deutschland	Agriculture	Land Use Type	Effect	area	2010	2020	NUTS 3 / federal state	Sending	Agricultural transformation	Economic	Farm structures, farm sizes,

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C. Spillover system - Governance / policies (regional/national/EU)

Stakeholders' opinion on support of the current policies to sustainable land management

- Only very limited perspective (only three stakeholders from two institutions) on this topic.
- Too much bureaucratic burden on farmers (small farmer suffer in particular).
- GAP is not adequate to address tremendous environmental and economic challenges (but hope that policies will change).
- Some stakeholders argued in favour of area-based subsidies.
- Some stakeholders believe that Brussels is literally too far away from realities in the Schorfheide – very dysfunctional EU policies.

Key insights from expert interviews

Annex Table 60: Key insights from expert interviews

	Which aspects are the most dynamic?	**What conflicts exist or are likely to arise?**
Regional socio-economic development	Impact of the internet (online, centralization) and the loss of specialized companies and services Social bubble formation. City dwellers move to cities. Contrast intensifies.	conservationists vs tourism and recreation traditional rural population versus city dwellers (who move to the Schorfheide)
Agriculture	Fewer people are farming larger areas. Fewer farms, larger areas. The biosphere reserve has a major impact on farms and land use. Organic farming has been and continues to be preferred in the region. Existing Organic farming has motivated more people to go organic.	Small vs. large land users; eco-friendly vs. traditional farmers Water use for agriculture leads to lowering of lake levels Small farms find it difficult to market their products Low yields and low support in the area render agricultural production more and more difficult

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Policies	Agricultural subsidies have a massive impact on land use (maximization of agricultural subsidies).	Farmers versus politics (see so called Diesel-Proteste)
Climate Change and biodiversity	drastic weather fluctuations Water management a huge issue in the Schorfheide	biodiversity protection vs climate change impacts and consequences
Future	GAP will have a major impact on land use Weather (precipitation) will be the decisive factor	In the end, it's revenue and sales that count.

Key agents / stakeholders

A. Identification

Annex Table 61: A. Identification

Stakeholder	**Geographic coverage/Level**	**Main category**	**Sub-category**
Brandenburg Farmers' Association	Regional	policy/government industry	national authority (central government, related ministries and agencies)
Biosphere Reserve Schorfheide-Chorin	regional	Academia policy/government	research and academia regional/local authority (regional administration)
Brandenburg Farmers' Association	Regional	policy/government industry	national authority (central government, related ministries and agencies)

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B. Assessment of stakeholders' land dependence level

Local level

Annex Table 62: Local level

Key agents[52]	Stakeholder category[53]	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A Environmental protection authorities	national authority	medium-moderate	3	medium-moderate	4
B Agricultural enterprises	land users (farmers, foresters)	high	5	low	2
C Investors and developers	industry/business	medium-moderate	4	medium-moderate	3
D Businesses in industry	industry/business	medium-moderate	3	medium-moderate	3
E Local producers of food, wine and crafts	industry/business	medium-moderate	4	low	1
F Landowners	land users (farmers, foresters)	high	5	medium-moderate	3
G Local governments	local authority	high	5	High	4
H Regional government	regional authority	high	5	High	4
I Non-governmental organizations	NGOs	medium-moderate	3	medium-moderate	3
K Residents	other	medium-moderate	3	Low	1

[52] According to tables in part I./A, I./B of this dataset.
[53] According to the Figure 3 in *Internal guide for application of the Europe-Land telecoupling framework in case-studies*.

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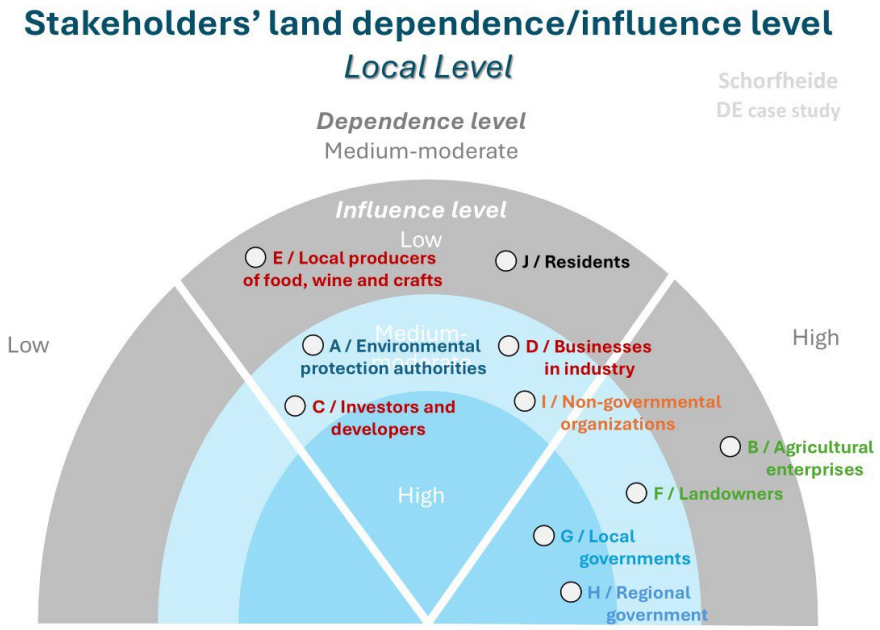
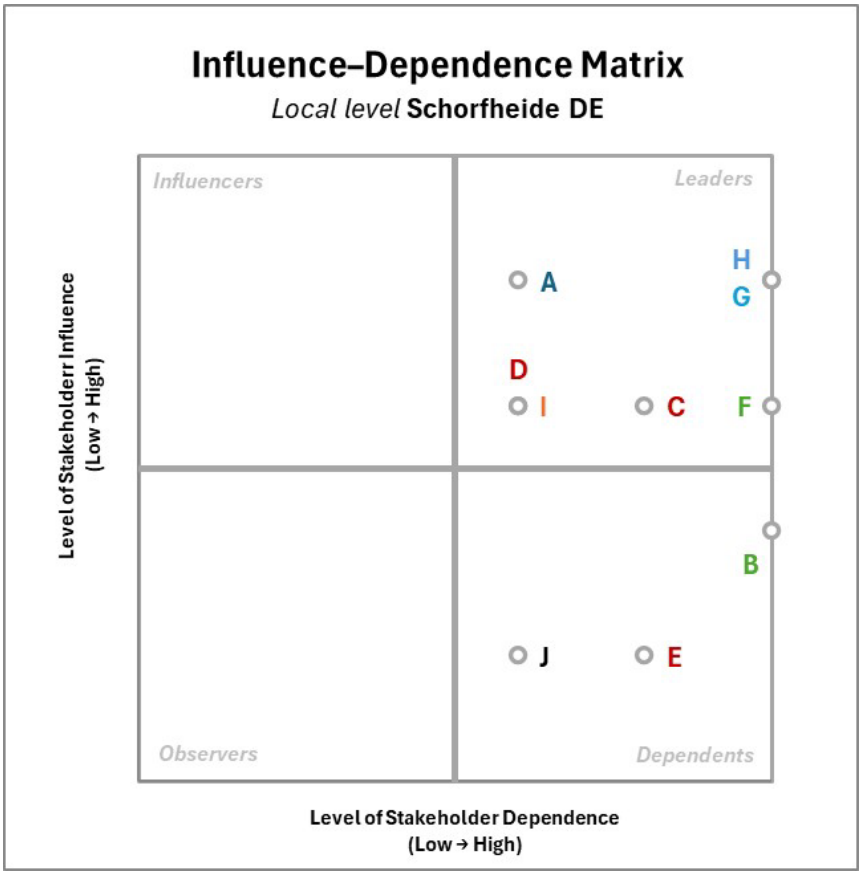


Annex Figure 57: Stakeholders' land dependence/influence level Local Level



Annex Figure 58: Influence-Dependence Matrix

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Regional / national level

Annex Table 63: Regional / national level

Key agents	Stakeholder category	Land-dependence level	Intensity 1=lowest 5=highest	Influence level in decision making	Intensity 1=lowest 5=highest
A Farmers associations	land users (farmers, foresters)	high	4	high	4
B Industry business	industry/business	Low	1	medium-moderate	3
C National Authorities	national authority	medium-moderate	3	high	4
D Non-governmental organizations	NGOs	medium-moderate	2	medium-moderate	3
E Large agricultural enterprises	land users (farmers, foresters)	high	5	high	4
F Small farmers	land users (farmers, foresters)	high	5	low	1
G National transport operators and infrastructure	national authority	low	1	high	4
H Universities, Research Academy	research and academia	low	1	Low	2
I Residents	other	medium-moderate	3	Low	1

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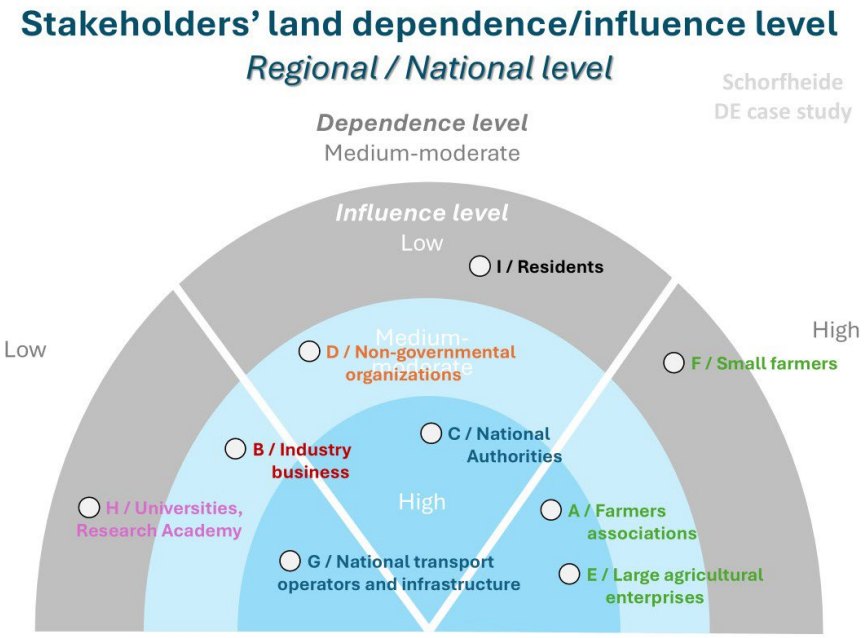
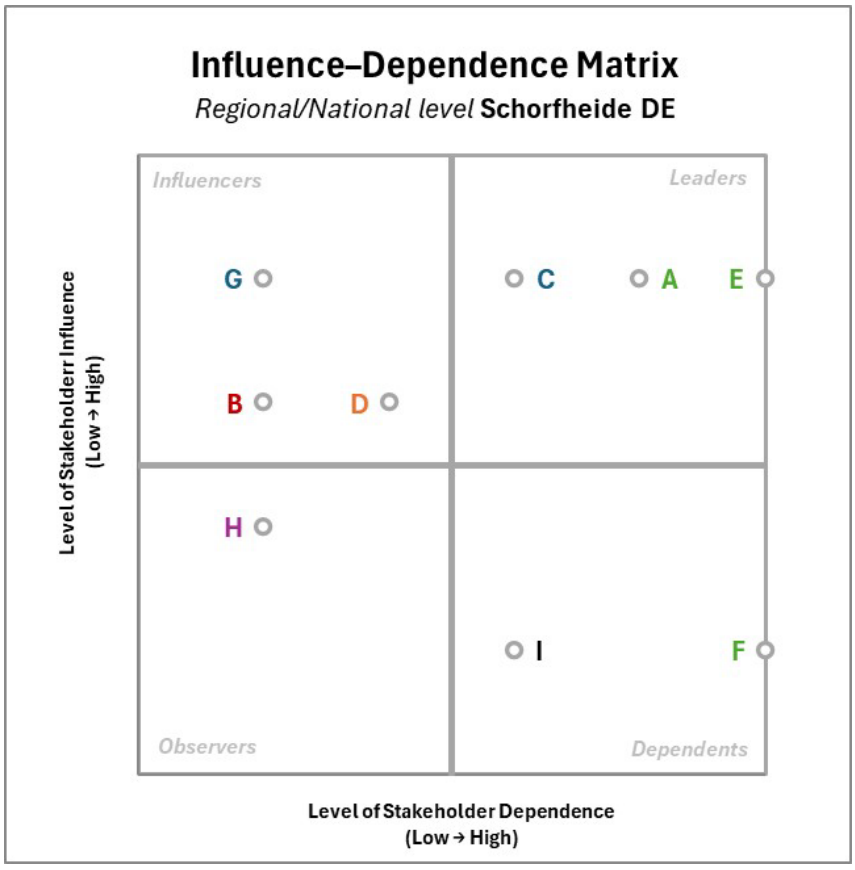


Annex Figure 59: Stakeholders' land dependence/influence level Regional/National level



Annex Figure 60: Influence-Dependence Matrix Regional/National level

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Basic matrix for SNA[54]

Annex Table 64: Basic matrix for SNA

Key agents[55]	land users (farmers, foresters)	Industry business	local authorities	regional authorities	national authorities	NGO	research and academia	other	EU governance
land users (farmers, foresters)	x	1	1	1	1	1	1	1	1
Industry business	0	x	0	0	1	0	1	0	1
local authorities	1	1	x	1	1	1	1	0	1
regional authorities	1	1	1	x	1	1	1	1	1
national authorities	1	1	1	1	X	1	1	0	1
NGOs	1	0	0	1	1	x	1	1	1
research and academia	1	1	1	1	1	1	x	1	1
other	1	0	1	o	1	1	0	x	1
EU governance	1	1	1	1	1	1	1	0	x

[54] A cell with a 1 indicates a relationship (influence/dependence) between agents is present, while a 0 indicates no relationship. 1=weak relationship; 1=medium relationship; 1=strong relationship.

[55] Categories of agents (stakeholder categories as in step B.) at all levels (local + regional/national) + EU governance (spillover system).

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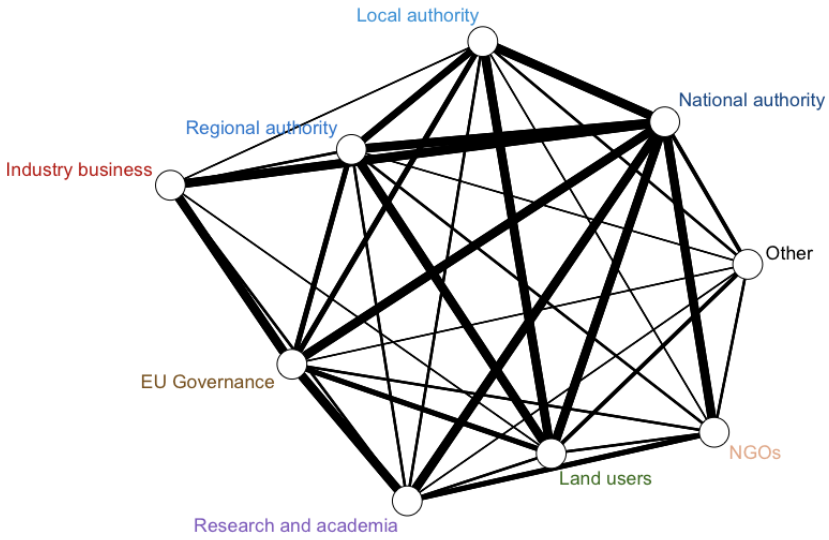

Annex Figure 61: Visualization of relationships among key agents / stakeholders

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