The Forest of the Future

A reinvention of the forest as we currently know it into a multifunctional sustainable spatial structure, on land and in the sea

2024, Delft University of Technology
MSc Architecture, Urbanism and the Building Sciences
Track Urbanism

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Abstract

This report introduces The Forest of the Future, a transformative visionary that reimagines European forests as multifunctional, sustainable spatial structures extending over land and sea. It confronts current environmental challenges, including deforestation, biodiversity loss, and climate change, by proposing an innovative spatial strategy for the BeNeLux bioregion within a broader European context. The strategy aims to integrate forestation within other land uses enhancing ecological, social, and economic values towards a sustainable future by 2100. Based on conceptual frameworking and a multi-criteria decision analysis, it evaluates current land use, soil quality, climate zones, biodiversity, and the state of marine environments, proposing new forest types and forestry-based regenerative agricultural practices. The envisioned forest network serves not just as a carbon sink but as a catalyst for biodiversity, sustainable agriculture, and community well-being. This report also outlines a strategic implementation plan, involving stakeholder engagement, policy recommendations, and a phased approach towards realising this vision. It concludes with an evaluation of potential impacts on greenhouse gas emissions, suggesting significant contributions towards Europe's climate goals of climate neutrality.

Keywords: Forest of the Future, sustainable land use, carbon capture and storage, CO_2 emission, agroforestry, marine forestry, BeNeLux region, European forests, spatial strategy, land use, biodiversity, climate change, soil quality, climate regions

Figure 0.1: Twitter message from Harry the squirrel

Content

01 | Introduction

The Current Forest

Problem Statement

Climate Urgencies

Introduction

In the past, Europe's vast forests were so large that folklore suggested a squirrel could traverse from Spain to Russia without touching the ground. This image of a continuous, unbroken forest across the continent now exists only in stories, as the present reality strongly contrasts with the past.

Forests and other wooded areas across Europe face significant challenges due to the pressures of human activity (EC, 2021). Agricultural expansion and urbanisation have reduced and fragmented wooded land use (FAO, UNEP, 2020). The situation is particularly dire in the Netherlands where, by the year 1900, deforestation had nearly eradicated forest cover, leaving forestry to account for just 9% of land use today (Mohren, Vodde, 2006).

Why it matters

The pressure on Europe's forests holds great implications, as these ecosystems are invaluable for humanity, nature, and the climate (EC, 2021). Forests contribute positively to the health and well-being of European citizens, offer essential ecological services by sustaining habitats and biodiversity, and play a critical role in carbon storage and sequestration (EEA, 2020a). The encroachment of forestry by other land uses indicates a larger problem: an imbalance in the distribution of land within Europe (OECD, 2020). Given that land is a finite resource, it faces increasing pressures from conflicting spatial claims (EC, 2021).

Agriculture, an intensive form of land use, is a primary pressure on forests and the global environment. It occupies half of the world's usable land and is a significant driver of climate change and environmental degradation (Ritchie, 2019). This exhaustive use of land threatens the ability to meet future needs and to secure human and ecological well-being over time (OECD, 2020).

In light of the environmental challenges facing Europe, we are in an era where the ecological and social fabric of Europe faces unprecedented challenges due to climate change (IPCC, 2022). We are confronting biodiversity loss and the threat of catastrophic ecosystem collapse (Hermoso et al., 2020). These challenges are deeply intertwined with global crises, highlighting the urgency for a comprehensive solution in the fight against climate change to safeguard the needs of future generations.

Aim and objective

The aim of this project is to develop a spatial strategy for the BeNeLux bioregion, that reimagines forestry as a vehicle for multi-layer sustainable land use practices that integrate within a European context. It seeks to investigate the synergy between forestation and other land uses as means to enhance social, economic, and ecological value for the future and implement this in a larger European vision for a sustainable future in the year 2100. This project explores how forests could be instrumental for European society, aiming for climate neutrality.

The project's objectives are to establish a foundation in sustainable land use theories, focusing on sustainable land use, spatial justice, agroforestry, and marine forestry, and to synthesize these into a unified Forest of the Future concept. It then aims to conduct a comprehensive spatial and environmental analysis of Europe and the BeNeLux bioregion, assessing current conditions and performance and identifying opportunities for sustainable land use improvement. Finally, the study will develop a strategic plan with actionable steps for implementing this vision, including scenario planning and stakeholder engagement, to guide the transition towards a sustainable future by 2100.

The Current Forest | Climate Urgencies

1/5 species face extinction

Figure 1.1: Algae bloom in the baltic sea. From "Baltic Blooms" by ESA, 2019 (https://www.esa.int/ESA/Multimedia/Images/2019/12/Baltic_blooms). Licensed under CC BY-SA 3.0 IGO.

Ecosystem loss

The biodiversity in the world continues to decline at an alarming rate due to human pressures of mainly agriculture, but also urbanisation and leisure activities (EEA, 2020a). As a consequence one in five species face extinction due to habitat loss (UNEP-WCMC, 2024). Not only habitat loss plays a role, 80% of Europe's oceanic coast is in problematic condition and suffers ecological degradation due to intense eutrophication (nutrient excesses caused mainly by agriculture), chemical pollution and acidification (EEA, 2023). In Europe, most protected species and habitats have been assigned a poor conservation status (EEA, 2020a). In the last four decades alone, global wildlife populations have fallen by 60% as a result of human activities, causing nature to rapidly decline worldwide (Hermoso et al., 2022).

0 by 2050

Climate change

The IPCC has reported that 23% of global anthropogenic greenhouse gas emissions were attributable to agriculture from 2007 to 2016 (IPCC, 2022). The goal is to reduce emissions by 55% by 2030 (EC, 2024) to be able to reach climate neutrality by 2050 (EC, 2024).

Figure 1.3: Fossil fuel emissions. From "Air Emissions and Pollutants - Mining Company" by Tony Webster, 2019 (https://commons.wikimedia.org/wiki/File:Air_Emissions_and_Pollutants_-_Mining_Company_%2848659848652%29.jpg). Licensed under CC-BY-2.0.

10 milllion hectares of annual deforestation, globally

Figure 1.2: Dense tropical forest. From "Depths of Forest" by Bobulix, 2011 (https://www.flickr.com/photos/bobulix/6379255773). Licensed under CC BY-NC-ND 2.0 DEED.

Deforestation

Agriculture is the main driver of global deforestation, a third of the global forest has been lost due to agricultural expansion. While the highest level of deforestation takes place in developing countries (World Population Review, 2024) consumers in high-income countries also contribute to the loss of forests overseas by buying agricultural products that were produced on deforested land (Ritchie, 2021).

Numbers: (Equal the size of South Korea) 10 million hectares of annual deforestation, globally (FAO, UNEP, 2020).

87% of agricultural land is used for cattle

Unsustainable land use

Agriculture is the dominant land use globally. Half of the worlds habitable land is used for agriculture (Ritchie, Roser, 2019) of which 87% is intended for raising cattle for meat and dairy (Poore, Nemecek, 2018). While meat, dairy and farmed fish provide just 17% of the world's calories, and 38% of its protein (Poore, Nemecek, 2018), 80% of the European Union's Common Agricultural Policy supports emissions-intensive animal products (Kortleve, 2024). Researchers estimate that if the world adopted a plant-based diet, we would reduce global agricultural land use from 4 to 1 billion hectares (Ritchie, Roser, 2021).

Figure 1.4: Greenhouse horticulture in the Netherlands. From "Dutch greenhouses being heated" by Edo Dijkgraaf, 2013 (https://www.flickr.com/photos/combron/9151465974). Licensed under CC BY 2.0 DEED.

02 | Approach

How To Grow A Forest

Research Question

Methodology

Theoretical Framework

Conceptual Framework

Approach | Research Question

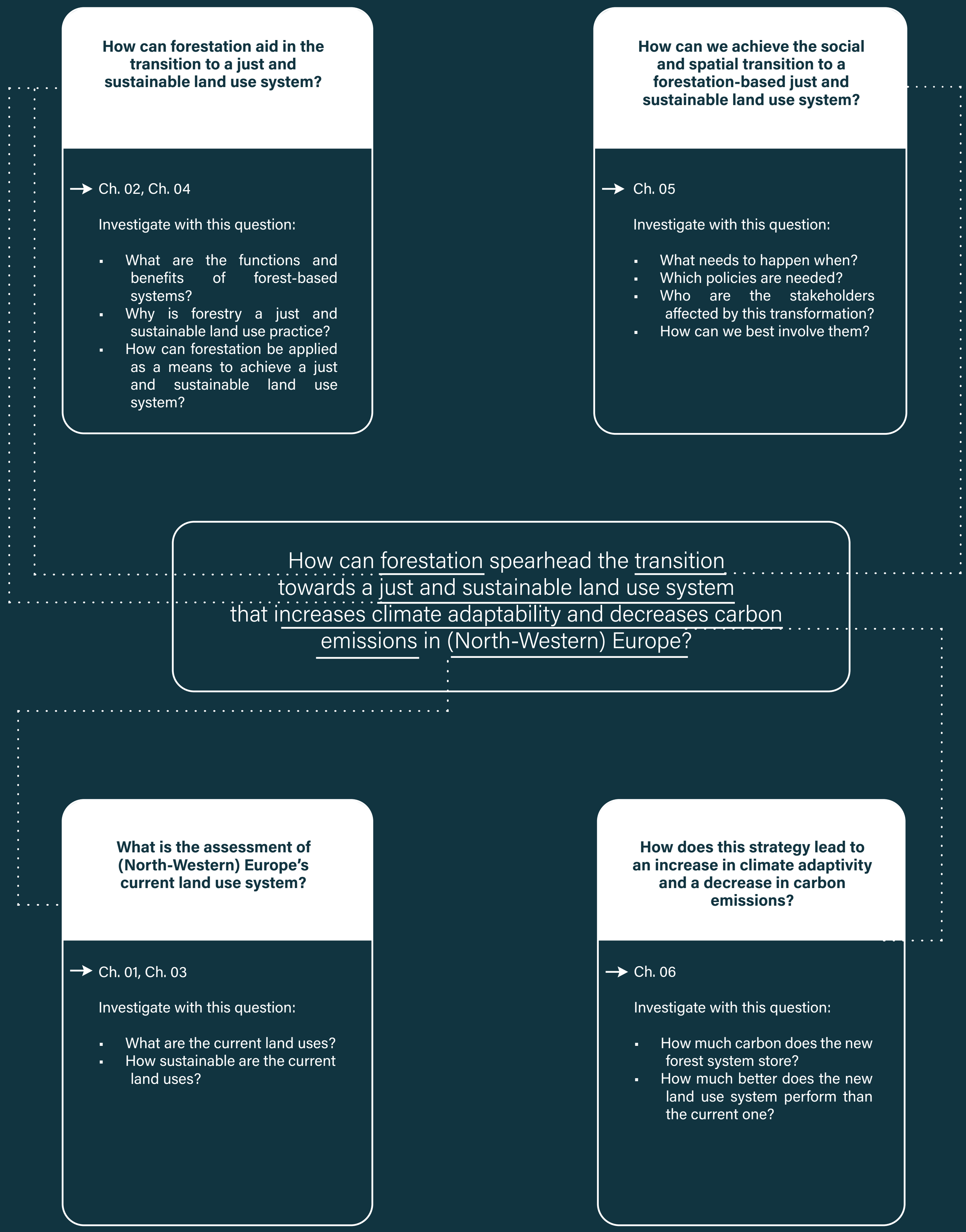
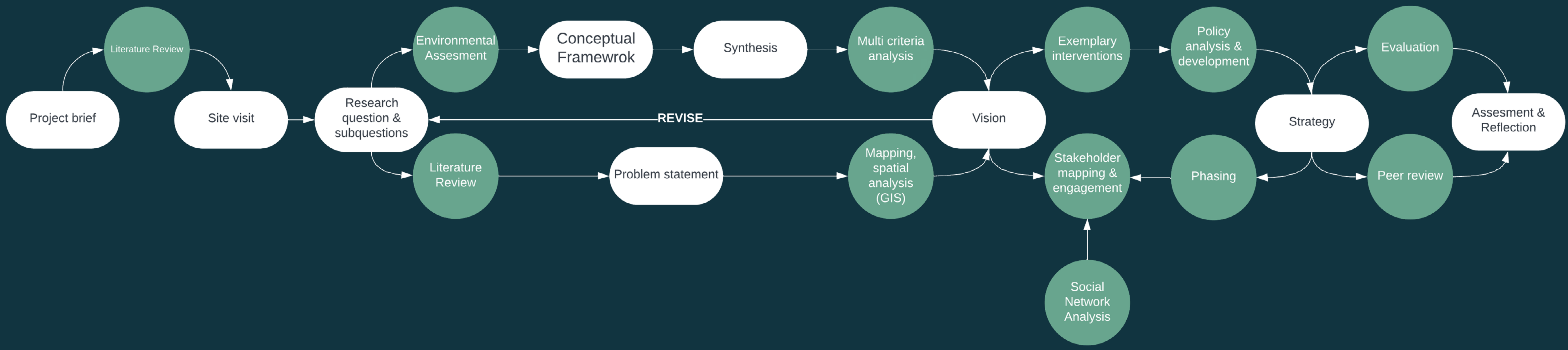


Figure 2.1 The relation of the reserach question and sub research questions to the chapters of the report

Approach | Methodology

The methodology diagram shown in figure 2.2 shows all the steps taken into forming this research and design project to answer the main research question. The diagram highlights the circular nature of this project. Through this process we have continuously revised to realign the research with the goals and vision originally outset.



Theoretical framework

A theoretical framework is formed based on literary research. The theoretical framework is established to lay a foundation in theories about sustainable land use, agroforestry, and marine forestry. This provides an overview of the knowledge this project is built on and highlights significant relationships between theories, explaining how they inform our work. These theories are to be applied and used in the conceptual framework.

Conceptual Framework

The conceptual framework is developed to present a novel concept of the Forest of the Future that integrates and synthesises theory into a cohesive framework of interlinked concepts. These will be used to guide the research and design.

Analysis

A spatial analysis of Europe and the BeNeLux bioregion through mapping using geodata research in conjunction with literary research. An environmental analysis is also conducted to serve as a basis for the multi-criteria decision analysis. This represents the main body of research.

Vision

A spatial vision is developed as a desirable 2100 future imaginary for the BeNeLux bioregion to backcast from. It provides a detailed description of the desired future state that the project aims to achieve. The vision also serves as a motivational and guiding beacon for the project, outlining what success looks like.

Strategy

The strategy outlines actionable steps for transitioning and showcases three different spatial scenarios within the EU focussing on the BeNeLux biogeographical region that illustrate the desired transition. Since we are mainly researching ecosystem-related questions, we consider it important to look at a region that exceeds national boundaries. Due to the limited scope of our research, we only focus on the BeNeLux area as its characteristics are generalizable across a great share of other regions in Europe. Once the basis for the research question and the vision was formed, we developed a strategy by exemplary intervention development, stakeholder mapping and engagement, policy forming and phasing.

Figure 2.2 Main steps taken (white) and methods used (green)

Approach | Theoretical Framework

Sustainable Land Use

Sustainable land use (SLU), also referred to as sustainable land management (SLM) in scholarly literature, is defined by Wageningen University as ensuring "a fair and balanced distribution of land, water, biodiversity, and other environmental resources among the various competing claims, to secure human needs now and in the future" (WUR, 2024). This principle contains the dual need for environmental protection — to conserve, protect, and restore natural resources and the natural environment, along with ecosystem services — and to maintain the productivity of agriculture and forestry, particularly given the increasing pressures of human activity, and demographic and economic growth. Intensive land management is one of the main biodiversity pressures.

Forestry and agriculture represent the primary land uses in the EU (EPRC, 2020). The importance of sustainable land use practices for these sectors is underscored by alarming environmental statistics: the UN estimates that 25% of animal and plant species are at risk of extinction, partly due to the loss and degradation of ecosystems (UNEP-WCMC, 2024). Furthermore, the IPCC has reported that 23% of global anthropogenic greenhouse gas emissions were attributable to agriculture from 2007 to 2016 (IPCC, 2022). In response to climate change, the selection of appropriate land uses for given conditions and the implementation of sustainable land use practices are crucial. These practices aim to minimise land degradation, rehabilitate degraded lands, ensure the sustainable use of land resources (i.e., soil, water, and biodiversity), and maximise resilience to environmental challenges (OEC, 2020). A logical outcome for this is moving towards a system of diversified, multi-layered land use over unsustainably intensive monofunctional land use.

Agroforestry

Agroforestry is recognized as an important sustainable land use practice that integrates forestry with agriculture on the same parcel. By incorporating trees and shrubs into agricultural landscapes, it leverages natural interactions between these components to enhance ecosystem services and deliver multiple benefits. It offers a multitude of ecosystem services and potentially enhances the provision of these services when compared with conventional monoculture crops (Udawatta, Jose, 2021).

It is an ancient agricultural practice practised globally that has almost disappeared (current adoption is only 9% of all utilised agricultural area in the EU) from the EU in the 1960s due to the modernization and intensification of agriculture (EPRC, 2020). Due to its ecological benefits and important role in the fight against climate change, there is now renewed interest in the subject. The European Union recognizes the importance of agroforestry and offers aid under the Common Agricultural Policy (CAP), providing financial support for farmers to adopt agroforestry systems.

Despite the recognized benefits, the adoption of agroforestry is slow due to its perceived complexity, knowledge intensity, and initial investment costs (Udawatta, Jose, 2021). In the short term, farmers might be discouraged due to the trade-off between decreased caloric yield and near-term profit for the farmer or landowner (Udawatta, Jose, 2021). However, by adopting agroforestry practices, landscapes are not only optimised for agricultural productivity but also for ecosystem resilience, and the encapsulated costs of mitigating the damages of climate change (Udawatta, Jose, 2021). Overall, it represents a strategic investment in the long-term sustainability and productivity of agricultural lands.

Spatial Justice

Spatial justice concerns "the fair and equitable distribution in space of socially valued resources and opportunities to use them" (Soja 2009). This relatively recent theory involves the societal impact of urban planning. It focuses on the significance of the spatial aspect in pursuing justice and dealing with societal and democratic inequalities. The theory covers various societal necessities, such as employment, healthcare access, clean air, but also walkability and accessibility. Spatial justice aims for "just cities" that also enhance diversity, equity, and inclusion.

The concept of spatial justice is closely linked with sustainable land use, with both arguing for the equitable distribution and sustainable use of resources, natural and societal. We consider the fair distribution and access to ecosystem services a vital part of spatial justice. Equally so, we consider spatial justness an integral part of sustainable land use, and integrate this concept under sustainable land use moving forward.

Traditional Forestry

Forestry is the economic utilisation of wooded areas. Forests produce mainly wood-goods for building material and energy production, paper production and other uses but also non-wood goods such as mushrooms, cork, honey. Forestry also facilitates public recreation and ecotourism (Forest Europa, 2020).

Marine Forest

Marine forests are dense underwater ecosystems, primarily made up of kelp and seaweeds. These underwater ecosystems serve as the ocean's version of land forests. Research suggests that oceans store about half of the world's CO_2, although precise measurement is challenging (EUOMOFA, 2018). Managing these marine forests could enhance their role in capturing carbon, aiding in the fight against climate change (Ross et al., 2023).

Underwater ecosystems are vital for their biodiversity and productivity, providing essential habitats, food, and breeding grounds for diverse marine species (Duarte, 2022). However, marine forests face threats from ocean warming, pollution, and overfishing, leading to their decline, while in some polar areas, seaweed habitats are growing due to climate change.

Marine Farming

Marine forestry, also known as aquaculture or aquafarming, involves the cultivation of aquatic plants, algae, and organisms such as fish and crustaceans. This field is attracting increasing interest, with seaweed aquaculture, in particular, emerging as the fastest-growing segment of global food production (Duarte, 2022). The European Union recognises the significance of marine farming in ensuring food and nutrition security, as highlighted in the EU's 2017 Food from the Ocean Report.

Despite the vast potential of the European coastline for seaweed farming, it currently contributes to less than 0.25% of global human-led seaweed production, including farming and harvesting (EUMOFA, 2018). This indicates that the sector is still in its infancy but holds significant potential.

Approach | Conceptual Framework

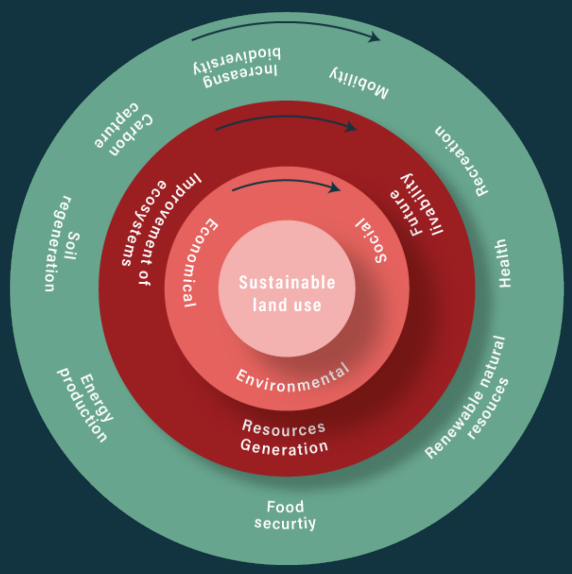


Figure 2.3: Conceptualisation of sustainable land use

Figure 2.4: Conceptualisation of spatial justice

The conceptual framework (Figure 2.5) introduces the project-specific model of the Forest of the Future. This model represents how the project incorporates the theoretical groundwork into a conceptual framework, as developed by Jabareen (2009). It guides the project's methodology and analysis towards the development of a cohesive strategy. Our research innovates by combining ideological concepts of sustainable land use (Figure 2.3) with spatial justice (Figure 2.4) into a new notion of forestry.

The model of the Forest of the Future represents a land use that integrates regenerative agriculture, sustainable economic utility, and ecosystem services within forestry. It also synthesises traditional forestry, modern regenerative agroforestry practices and innovative marine forestry under one singular concept. These future forestry practices represent diversified, multi-layered land use alternatives for unsustainably land uses that align with our ideological basis and deal with the urgencies identified on pages 10-11.

Theoretical grounding

We have integrated the key concepts as identified in the theoretical framework, namely of sustainable land use and spatial justice, in our conceptual framework under the three pillars of sustainability: environmental, social and economical, as defined by World Commission on Environment and Development (1987). This shows that sustainability is not just an environmental concern but encapsules more. These key concepts serve as the building blocks for the framework.

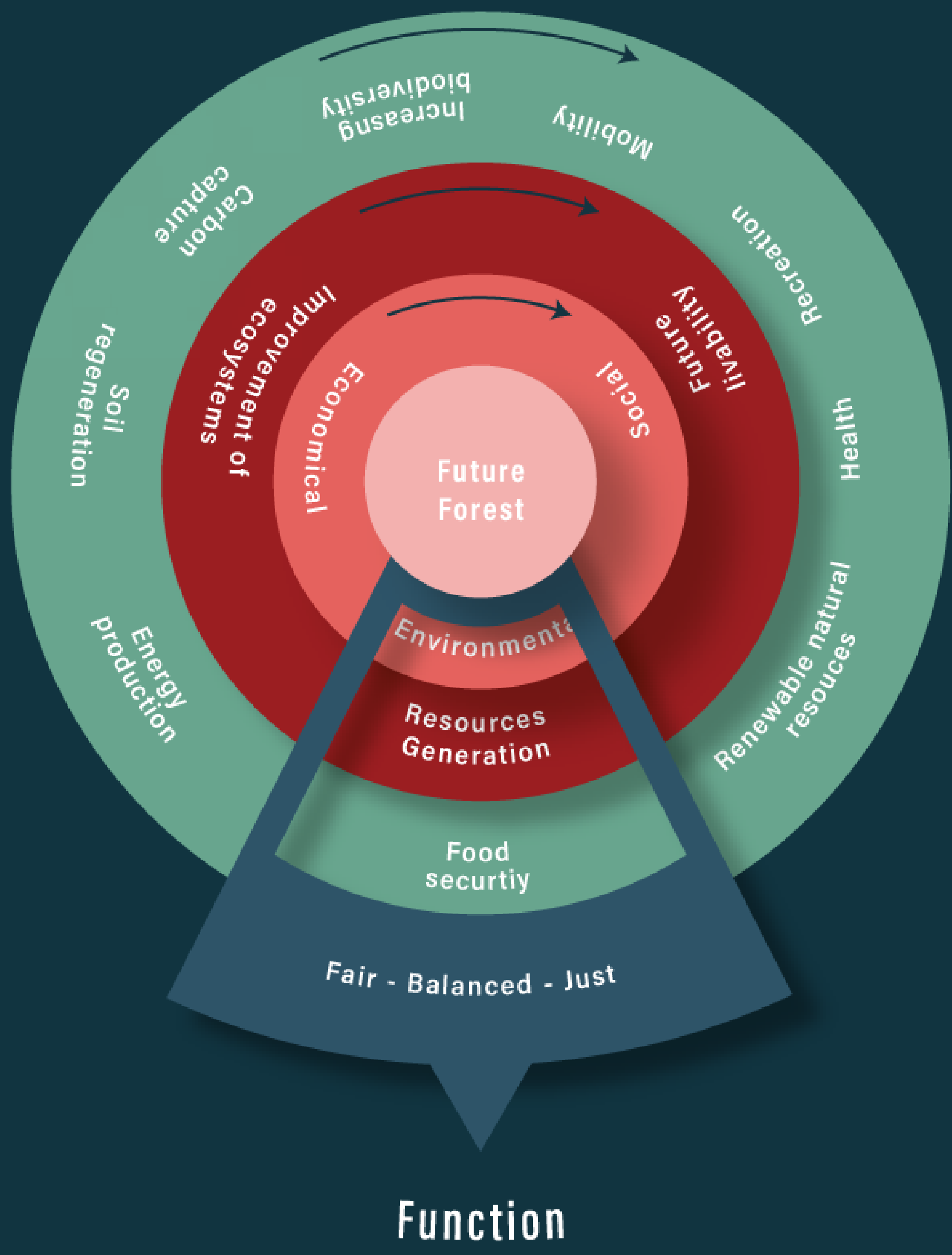
"We consider the notion of sustainable land use and the fair distribution and access to ecosystem services a vital part of spatial justice. Equally so, we consider spatial justness an integral part of sustainable land use, and integrate these concepts under sustainable land use moving forward "
Ch2. Theoretical Framework

Operationalisaiton

The conceptual framework works as a spinning wheel with rotating layers. The outcome of the wheel changes when spinned and represents different functions of a forest to be applied as future forest-based land uses. The outcomes represents a specific specialisation of this land use that aligns with different needs and urgencies. This model is used to operationalise the theory and vision to come to new types that align with our defined goals and vision.

The first layer we based our concept on are the three pillars of sustainability: Environmental, Social and Economical (Purvis at al., 2018). The second layer holds the goals we want to achieve with the sustainable land use concept: Resources generation, Future livability and Improvement of ecosystems. The last layer are the tools we found at the base to achieve the goals: Food security, Renewable natural resources, Health, Recreation, Mobility, Increasing biodiversity, Carbon capture, Soil regeneration and Energy production. They stem from the urgencies identified in chapter 1 and the properties of the synthesised forestry land uses.
The outer layer: To operationalise the term spatial justice we adapted the spatial justice triangle shown in figure 2.4. In this triangle the terms fair, balanced and just are explained and the interrelation between them is shown. These act as the ideological basis that guides our design decisions.

We used the conceptual framework to create new forest types to operationalise the vision (chapter 4.1), to assess land use change propositions (chapter 4.2) and as a base for just stakeholder assessment and the project phasing in chapter 5.



Forest as a biodiverse ecosytem
Forest as a carbon sink
Forest as a means to prevent degradation
Forest as a means to improve soil quality
Forest as an ecological corridor
Forest as a resilient ecosystem
Forest as a means to keep the planet habitable

Forest as a means to ensure energy security
Forest as a food supplier (agroforest)
Forest as a water filterer
Forest as an air purifier/carbon capturer
Forest as a recreational place
Forest as a timber source
Forest as an educational space
Forest as a securer of livelihoods

Forest as a means of flood protection
Forest as a protector against uncomfortable climate
Forest as a part of the culture
Forest as a producer of biomass
Forest as a source of medicine
Forest as a workplace
Forest as a closed system (circular)

Figure 2.5 The conceptual framework as a wheel of forest functions

03 | Analysis

Ploughing The Earth

In this section we strive to answer "What is the assessment of Europe's current land use?". To do this we examine the current state of Europe's land use through a qualitative geodata and spatial analysis of Europe and the BeNeLux bioregion in conjunction with literary research. A quantative environmental analysis is conducted in the second part to to serve as a basis for the multi-criteria decision analysis, that is going to serve as a foundation for our transition to the Forest of the Future.

Analysis | Land Use

Land cover

- Artificial surfaces
- Agricultural areas
- Forests and semi-natural areas
- Wetlands
- Waterbodies

Land is an integral part of ecosystems and very much linked to biodiversity and the carbon cycle. Land can be divided into two concepts that are interlinked.
On the one hand we speak of land cover, which refers to the biophysical coverage of land (e.g. crops, grass, or the built environment). On the other hand, there is land use, which refers to the socioeconomic use of the land (e.g. agriculture, forestry, recreation).

Land use and land cover data form the basis of analysis used for spatial and territorial planning. It becomes increasingly important for the planning and management of agriculture, forests, urban areas, and waterbodies. Which also implies management of nature, biodiversity and the prevention and mitigation of natural hazards and climate change. The implications of changes in land cover and land use are a fundamental part where we can learn about planning for sustainable development (Eurostat 2021).

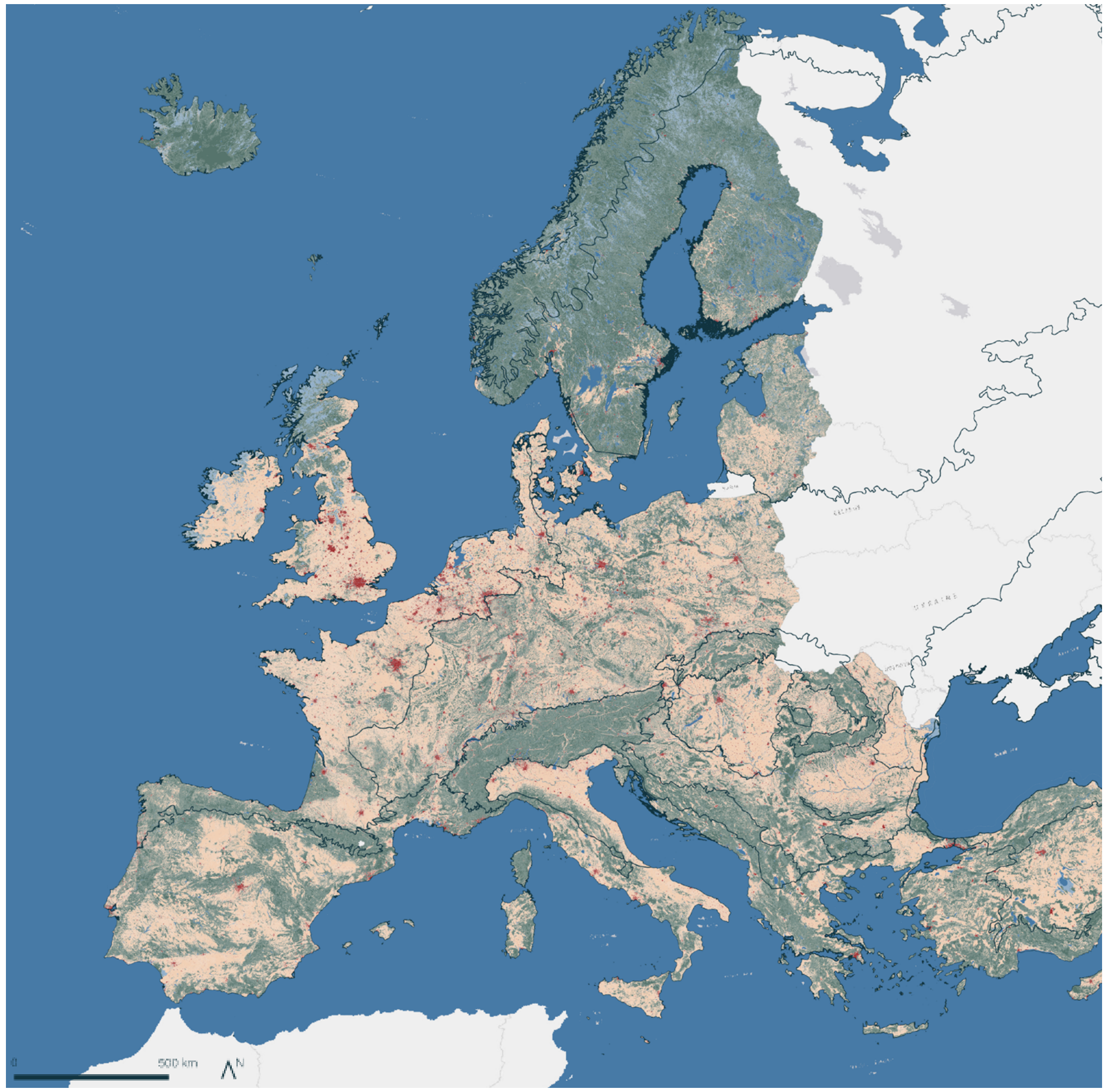


Figure 3.1: Land cover map of Europe (based on EEA, 2019)

Europe

Europe is one of the most intensely used landmasses on the planet. The highest share of land is used for agriculture, followed by forests and then - to a lesser extent - the built environment. The way we use land has an impact on the environment and climate change. The land use remained quite stable over the years, only the artificial surfaces increased by over 6% during the last 20 years (EEA, 2019). The increase of artificial surfaces is not a preferred trend, since an unsealed (non-built on) soil can support biodiversity, carbon sequestration and climate change adaptation (EEA, 2022). Agriculture and urbanisation represen the main pressures on forestation (Agriculture's environmental impact is profound, particularly 38% of its protein (Poore, Nemecek, 2018). Additionally, the sector is marked by inefficiency, with up to 40% of produced food never consumed (UNEP, 2021).This intensive and unsustainable use of land for agriculture, characterized by significant ecological damage and high emissions, contrasts starkly with its relatively limited economic benefit and substantial waste. Whilst the sector is vital for food security the current agricultural practices necessitate an urgent reconsideration to to ensure sustainability and reduce environmental footprint.

Land, being a limited resource, faces growing pressures from the need for more living spaces, increasing economic activities, and expanding mobility. This has led to the depletion of natural resources and environmental degradation in some instances, stressing the need for sustainable land use.
To look at the land use, we used the dataset from the European environment agency named CLC 2018. It shows 44 different land covers which can be subdivided into five main land uses. It then showed the percentage of land use per country. The division of land use for Europe is shown in Figure 3.3.

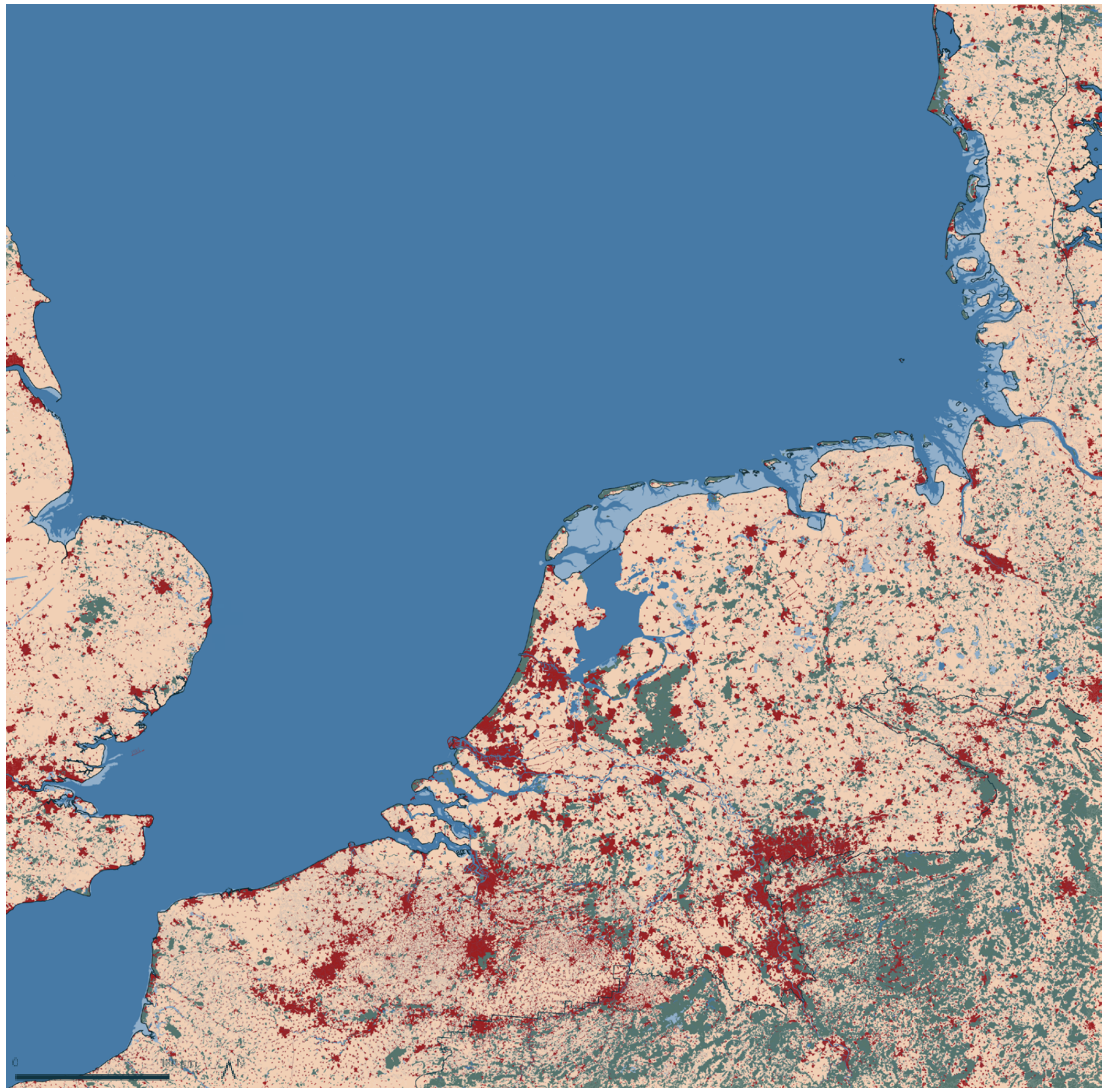


Figure 3.2: Land cover map of the BeNeLux area (based on EEA, 2019)

BeNeLux

The BeNeLux area is highly urbanised, as can be seen by the percentages for Artificial areas in Figure 3.3 , and the Agricultural practices in the BeNeLux take up much of the area. Forests and semi-natural areas are present to a lesser extent.

The BeNeLux is a formal international intergovernmental cooperation of three neighbouring countries in western Europe: Belgium, the Netherlands and Luxembourg. BeNeLux is known for being an economically dynamic region. Next to the BeNeLux we also show the western part of Germany (Ruhrgebiet), an area characterised by an equally high density of artificial surfaces, of which industry holds a large share.

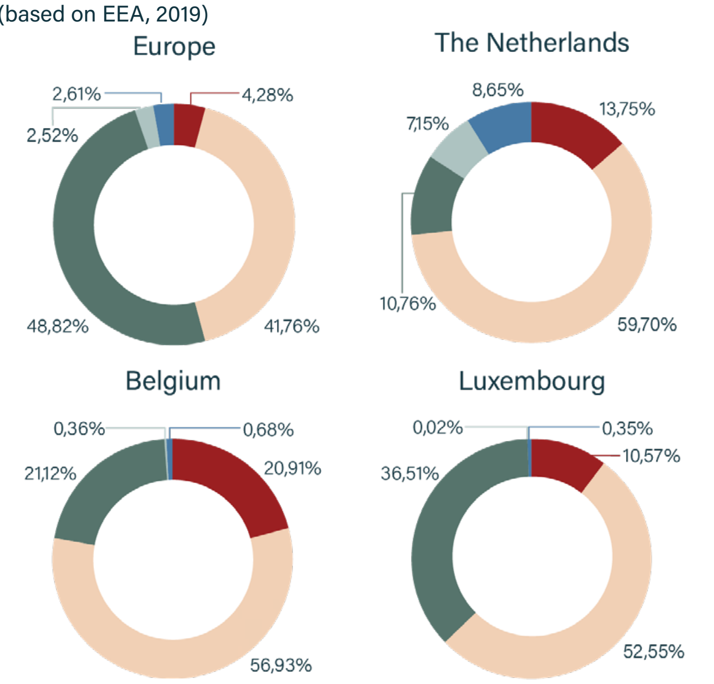


Figure 3.3: Ratio of land cover in percentages (%)

Analysis | Soil

Soil provides numerous key environmental, social and economic functions that are vital for life on earth. Crops and plants are dependent on soil as medium for growing and for nutrient and water supply. Next to that soil stores, filters, transforms and buffers substances that are introduced to the environment. This capability of soil is crucial for the regulation of greenhouse gases. Research indicates that soil captures approximately 20% of the carbon that is emitted into the atmosphere annually by humans. Soil also produces and protects our water supplies so that we have clean ground- and surface waters. Furthermore soil serves a habitat function and is considered a large pool of biodiversity. Finally, the soil is our main provider of raw materials (Soil Atlas of Europe, 2005).

A strong connection exists between agricultural land use and soil, one can find pastoral agricultural activities focused in areas with challenging conditions for crop cultivation, such as arid regions or locations where forests have been cleared. Soil with high fertility and good agricultural workability is often used for crop-agricultural purposes to fully utilise the economic potential of the soil (EC, 2020).

Soil Fertility
Soil fertility depends on multiple factors, such as texture, structure, organic matter content, and the ability of the soil to hold nutrients and water. Based on general soil characteristics, Table 3.1 shows how the groups can be graded on fertility.

Soil and agriculture
The most productive agricultural soil can be found along the major river valleys in Europe such as the Rhine and the Seine. Additionally, soils in arid areas of Europe are vital for producing high-value, but non-essential agricultural products such as wines and olive oils, thanks to their response to management practices.
The impact of agricultural practices on soil quality, biodiversity and humans, calls for urgent consideration of the soil. For example, the excessive use of fertilisers and pesticides leads to soil degradation and the heavy machinery leads to compaction of soil.

Soil and forests
Soil plays a critical ecological role in forest ecosystems, acting as a foundation for plant growth by providing moisture, nutrients, and physical support, as well as filtering toxins and absorbing natural wastes. In the context of forestry, soil is the primary resource, with trees considered as crops. Forest soils create a unique microclimate and host a diverse range of organisms distinct from those found in agricultural soils. This diversity is partly because the most fertile soils are typically used for agriculture, leaving less ideal soils (characterised by poor drainage, steep slopes, or rocky conditions) for forestry. These conditions, while not suitable for agriculture, often meet the requirements for growing forest trees, illustrating the complementary use of land based on soil characteristics (Soil Atlas of Europe, 2005) .

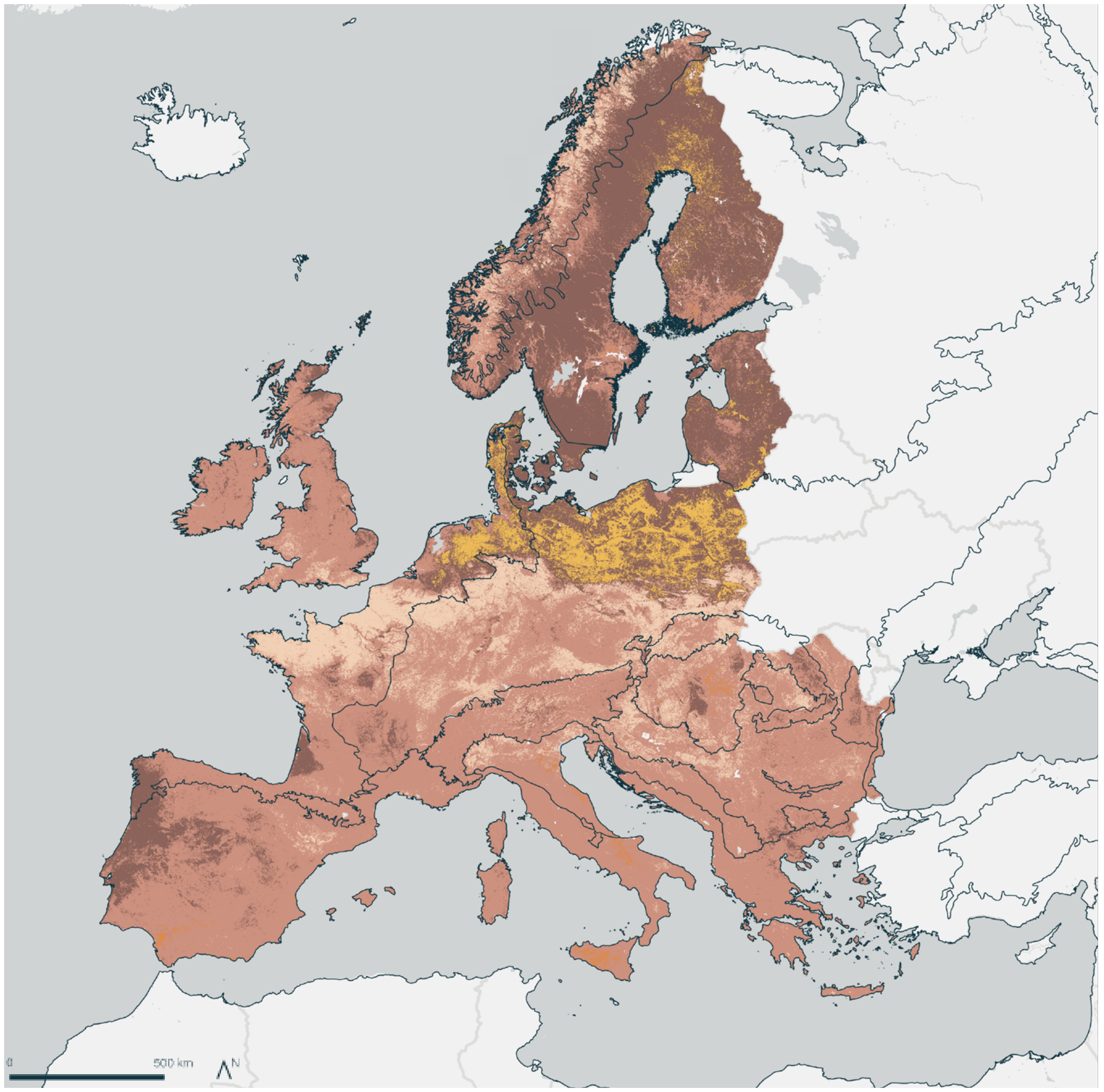


Figure 3.4: Soil map of Europe (based on Ballabio et al., 2016)

Europe

To determine soil quality on a European level, we used a dataset that harmonised different research on soil into 12 different categories which we simplified into five soil types. Soil quality can be determined by looking at pH, Nitrate, electric conductivity, Carbon and Phosphorus (USDA Natural Resources Conservation Service, 2015). We categorised them based on the dominant texture component (clay, silt, or sand), along with consideration for loam, which is a relatively balanced mix of sand, silt, and clay. Sandy loam formsan individual group because its high sand content with characteristics of loam makes it a very specific soil type. The simplification into 5 groups can be seen in Table 3.1.

BeNeLux

Zooming in on the BeNeLux scale, we distinguish the soil types more accurately by the properties of the soil per area. In Figure 3.6, we look at the carbon storage potential of the topsoil layer in the Netherlands. On this map, it is shown that carbon storage potential seams to correlate directly with the soil type. The areas with peat soil have a high storage of carbon (dark orange on the map). This level of detail tells us about fertility bound to an area and the carbon storage potential more accurately.

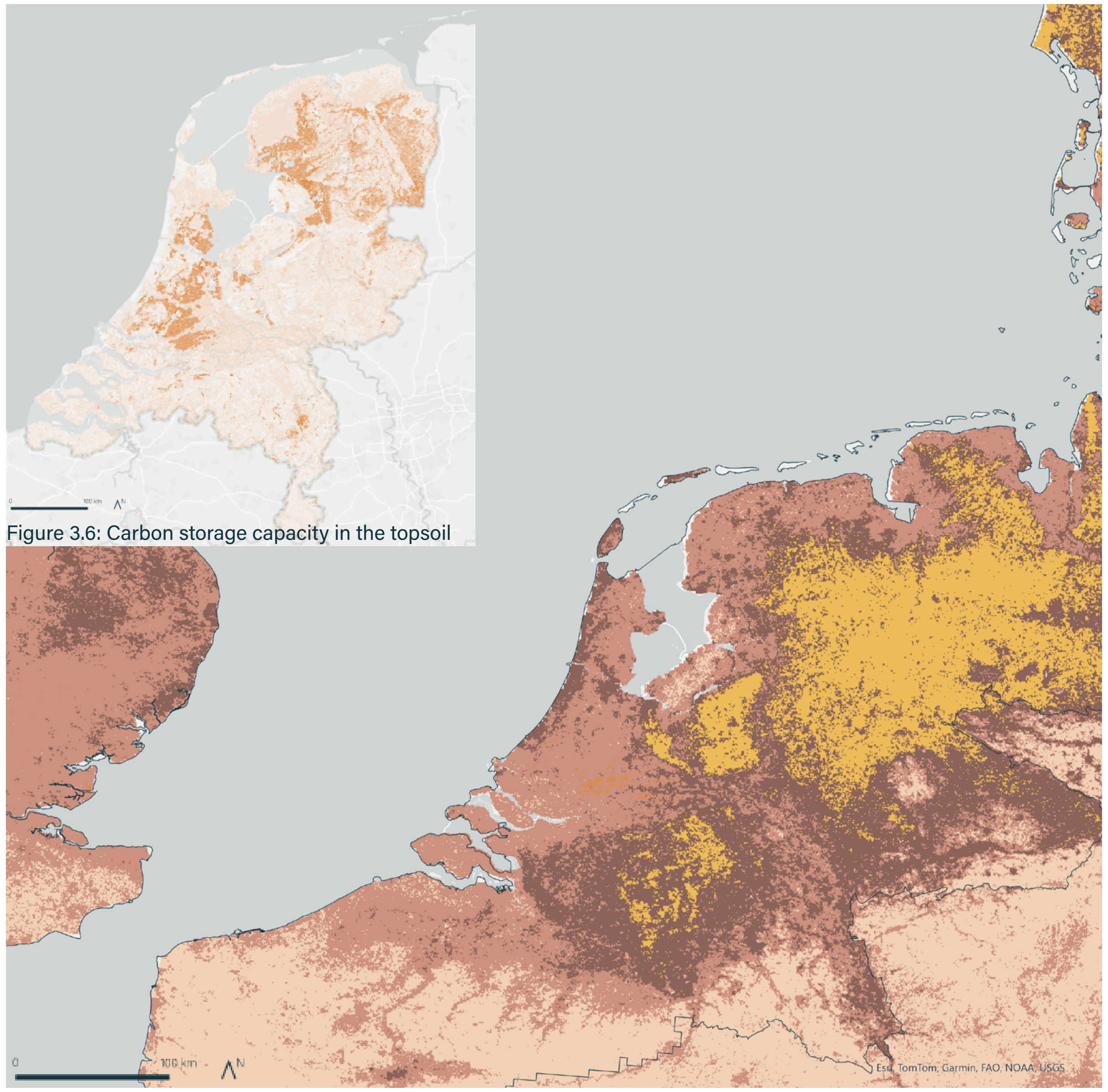


Figure 3.6: Carbon storage capacity in the topsoil

Figure 3.5: Soil map of the BeNeLux area (based on Ballabio et al., 2016)

Table 3.1: List of soil types and fertility indication

Soil Group	Clay	Loam	Silt	Sand	Other
Simplification	Clay	Silyty Clay Loam	Silt	Sand	Sandy Loam
	Silyty Clay	Sandy Clay	Silty Loam	Laomy Sand	
		Sandy Clay Loam			
		Clay Loam			
		Loam			
Fertility	High	Highest	Good	Low	-
Explenation	Ability to retain nutrients and water, but can have poor drainage and aeration.	Optimal balance of clay, silt, and sand, allowing for good nutrient retention, water holding capacity, and drainage.	Fine particles that can hold nutrients but may face issues with waterlogging and compaction.	Drains quickly and cannot hold onto nutrients well, often requiring more frequent fertilisation and water.	-

Analysis | Climate Zones

Climate zone

- Arid
- Temperate
- Cold
- Polar

Europe spans a wide area, so temperature and climate changes drastically depending on latitude, the proximity to the oceans and other possible water bodies, and the proximity to mountain ranges. Climate changes over time and is relevant for land use and vice versa. Different land use practices contribute to climate change through for example through soil degradation and emissions however, farmers might choose a particular crop instead of their customary crop because it is more climate resilient. This makes climate regions a relevant signifier for our research.

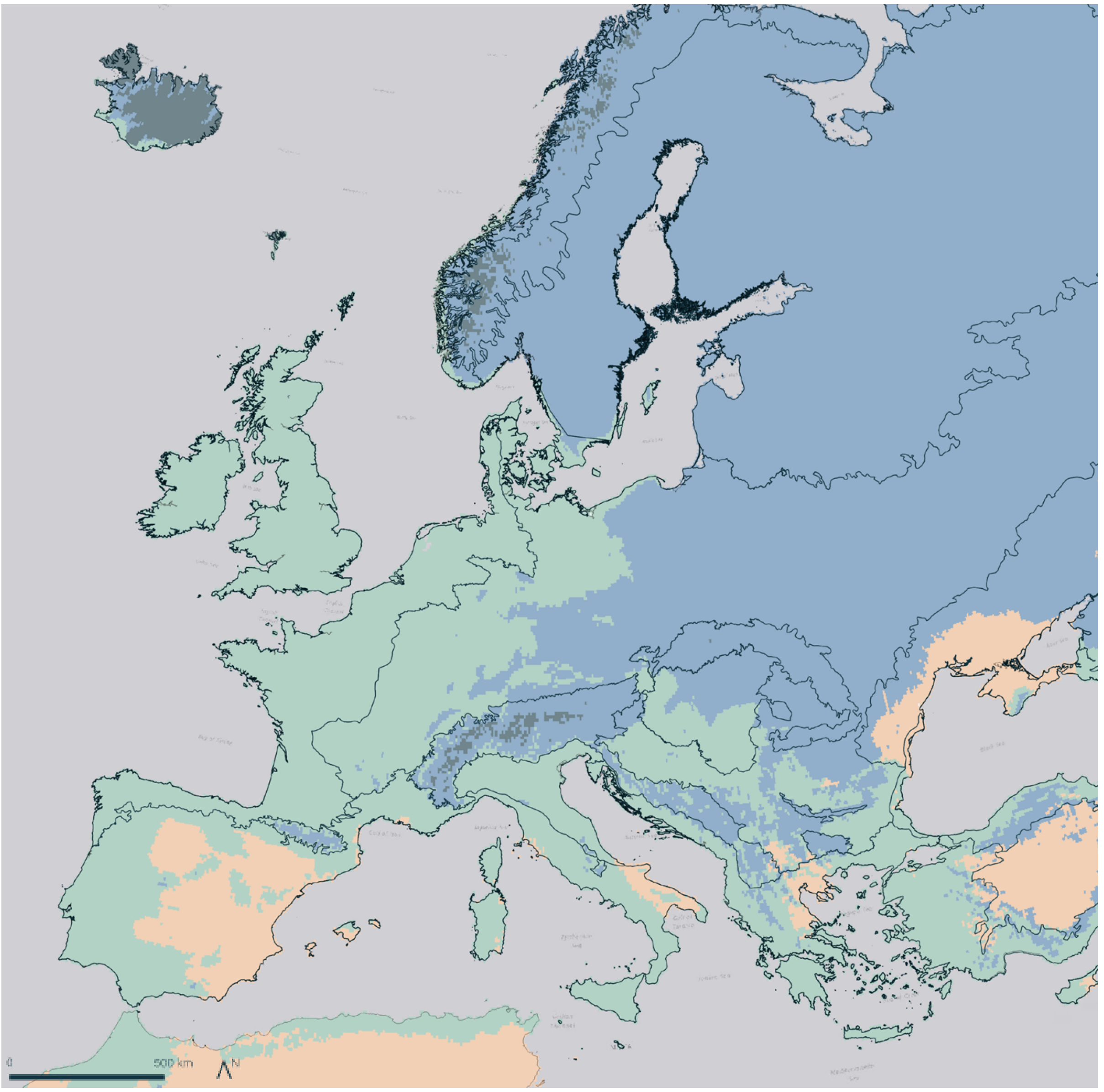


Figure 3.7: Climate regions map of Europe 1999 - 2020 (based on Beck et al., 2023)

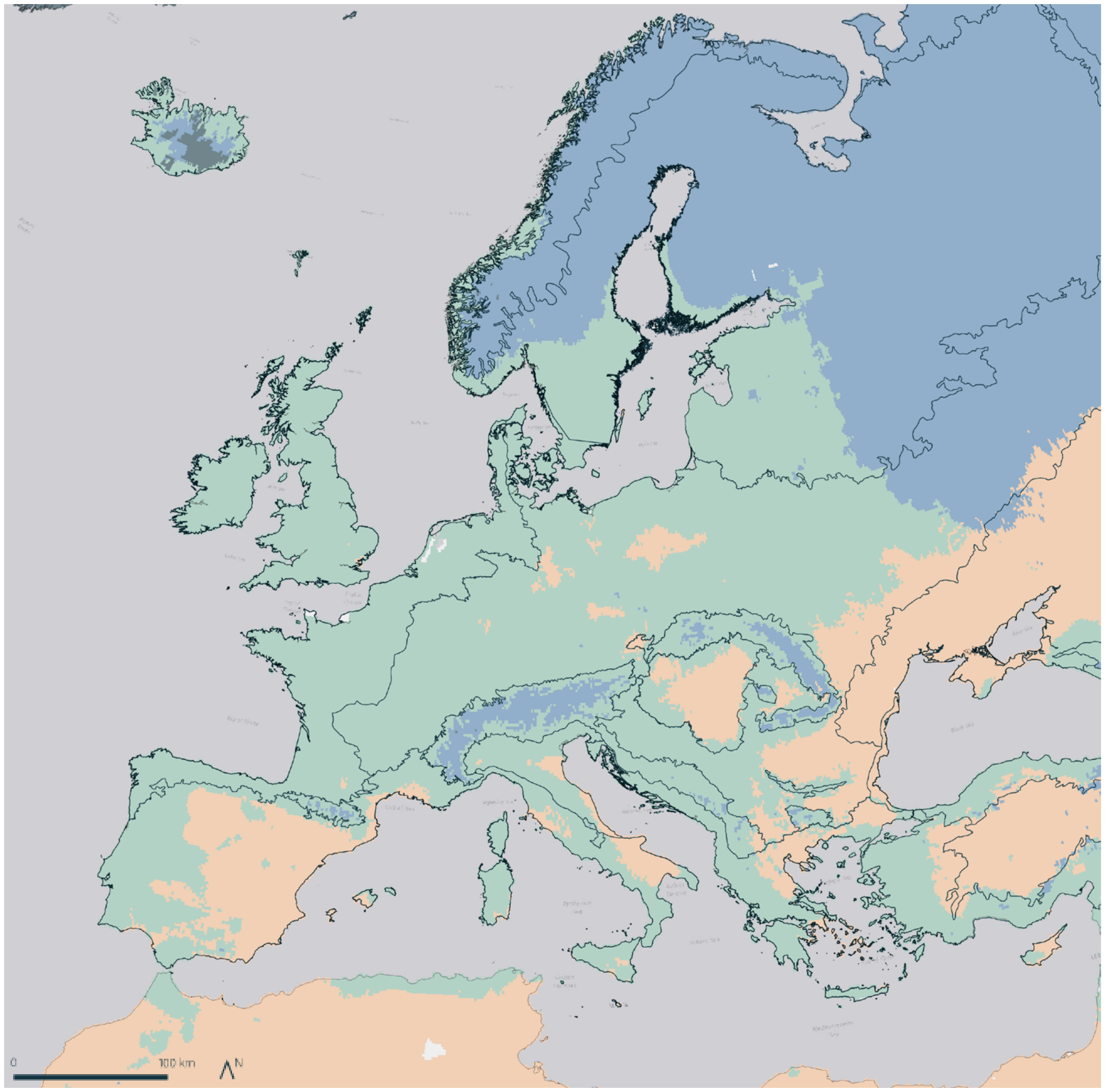


Figure 3.8: Expected climate regions map of Europe 2077 - 2099 (based on Beck et al., 2023)

Europe

For the classification of climate zones in Europe we use the 'Koppen Geiger' classification (Beck et al., 2023). We divide the climate zones into five main ones. The five groups are: A) Tropical, B) Arid, C) Temperate, D) continental and E) Polar. In the map underneath we can distinguish between the first four groups mentioned. One can see that there are a few areas of Arid climate and that all land along the coasts have a temperate climate. The more Northern, Eastern and the countries largely covered by the Alps have a cold climate. The type of forests and their management is significantly influenced by the climate. Northern Europe with its colder climate is mostly covered by boreal forests, while central Europe with its temperate climate supports mixed forests with both coniferous and deciduous trees. The southern part of Europe is known more for its drought resilient species.

When looking at the climate regions over time (up until 2100), it can be seen that the cold climate zones move more to the north-east and that the area with an arid climate increases strongly in the south-west of Europe. The region around the alps keeps its cold climate although the area decreases. In general, an increase of temperature is likely for Europe in the future. This has a direct influence on the type of forest and its management.

BeNeLux

The BeNeLux area is part of a single climate region, namely the temperate climate, which remains the same over time.

Analysis | Natura 2000

Degree of biodiversity

- >500 species
- >600 species
- >700 species

EU-protected areas

- Natura 2000

Natura 2000 is a network of protected areas that are designated as Europe's most valuable but also threatened habitats and species.
The network extends across all 27 EU member states and the sea and is the largest coordinated network of protected areas in the world.

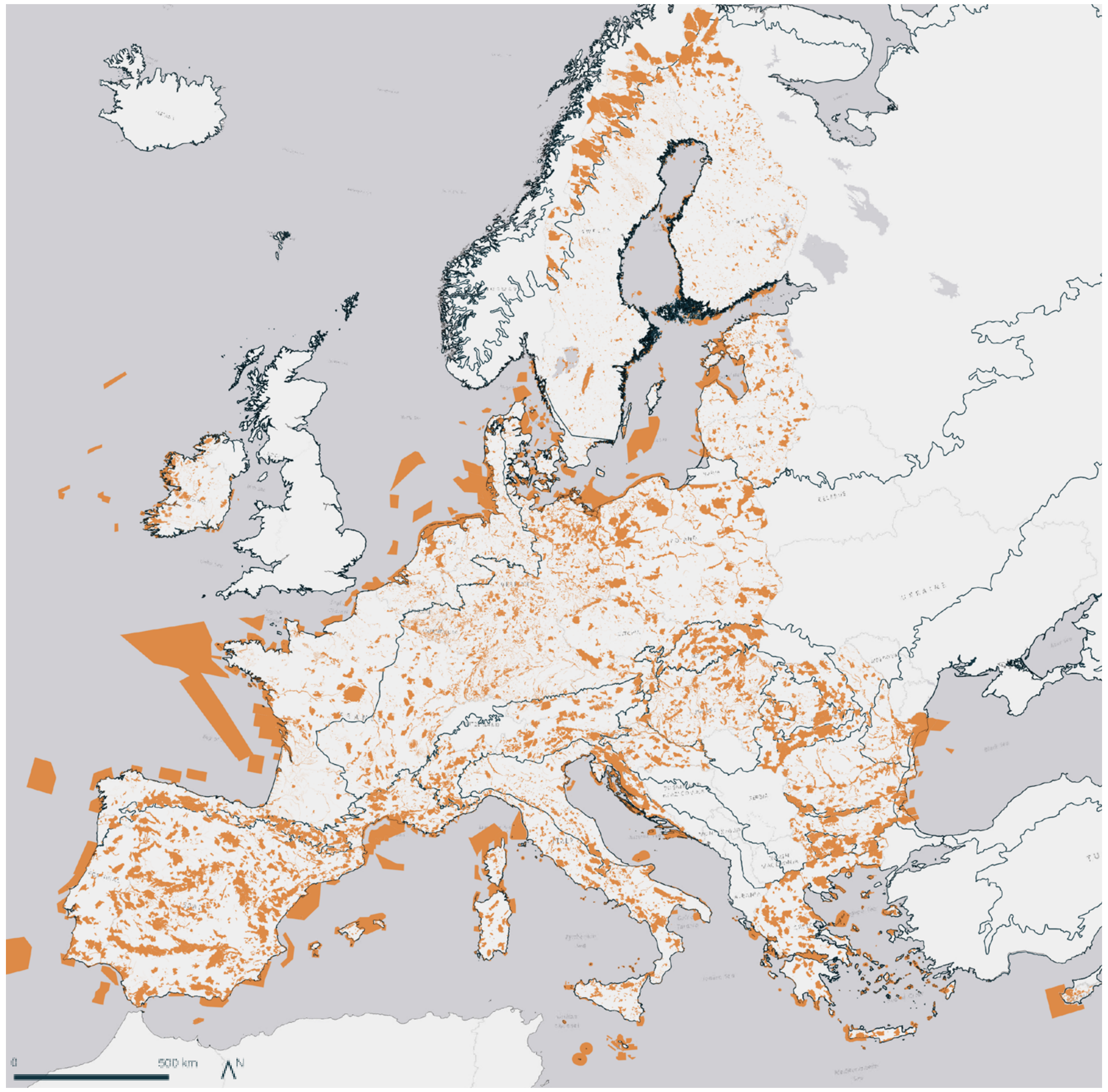


Figure 3.9: Natura 2000 map of Europe (based on EC, 2022)

Figure 3.11: Areas with high biodiversity in relation to Natura 2000 areas in the Netherlands

Figure 3.10: Natura 2000 map of the BeNeLux area (based on EC, 2022)

Europe

The areas of the Natura 2000 network are designated by the EU under the 'Nature directives', i.e. the Birds and the Habitats Directives. To achieve the 2030 biodiversity strategy of the EU (EEA, the Nature Directives and Natura 2000 together form the backbone. The strategy also includes more on the marine environment, where the marine habitat and species are currently not adequately protected. The European Union updates the list of new areas of the Natura 2000 every year. For proposed new sites, the member states are required to take protective measures.

In 2021, the Natura 2000 network occupied over 18.6% of the EU's land area and 9% of its marine area. In total, this consisted of 27.000 sites covering an area of 1.219.416 km2 (EEA, 2021). What needs to be noted is that these sites are not wild areas and human activity is not excluded. The main purpose of these protected sites is to prevent activities that disturb and affect species and habitats for which the site is designated. A Natura 2000 classification requires member states to take measures to restore habitat and species if necessary. This strategy encourages considerate management of the land but it is still subject to pressures. This can be in the form of land use change, intensification but also abandonment of the area, which can affect the unique biodiversity and structural features irreversibly.

The way in which the sites are managed is decisive for the efficiency of the strategy. Around 40% of the Natura 2000 area consists of farmland and 50% of forests (EEA, 2019). The European environment agency emphasises the importance of incorporating Natura 2000 objectives into spatial planning. In particular, connecting the sites and maintaining the connectivity. One can see in the accompanying map that the sites are mostly scattered all over Europe (EEA, 2021).

BeNeLux

In the BeNeLux, we can see that the marine environment is well represented in the Natura 2000 areas (Figure 3.10). Various patches in the North Sea are already protected and the Wadden Sea along the Northern coast is also a protected area. This already shows a commitment to protecting marine ecosystems, and addressing threats such as overfishing and pollution. Furthermore, it can be seen that on this scale the Natura 2000 sites are sparsely connected. The lack of connectivity between these terrestrial protected patches highlights the challenge of creating a comprehensive connected ecological network.

When combining a map of biodiversity in the Netherlands and the Natura 2000 areas of the Netherlands, it can be seen that the Natura 2000 areas are not per definition the areas with high biodiversity (Figure 3.11). It can thus be concluded that the Natura 2000 sites rather have a protective and preservative function for the biodiversity and habitat that is there. In the context of Natura 2000, forestry interventions must be carefully planned to make sure that they have a positive impact.

Analysis | Forest

Type of forest

- Coniferous forest
- Decideous forest
- Mixed forest
- Fruit trees and berry plantations

A forest is a terrestrial ecosystem consisting of a dense collection of trees. In the Dutch legal explanation, as defined in the 1961 Forestry (Beerman, 1961) act, a forest can be defined according to two spatial forms:

Patch: as a wooded area of at least 10 are ($1000m^2$)
Linear: a forest is at least one or more rows of 21 trees.

The forest have social, economic and environmental value by allowing for forestry and recreation. The forest sector in the EU provides more than 2.6 million jobs (Forest Europa, 2020). About 70% of the forest is open to the public for recreation. However, the ownership of the forests within Europe is split between private and public sectors.

In the period 1990-2015, carbon sequestration of the forest in the EU correspond to around 10% of gross greenhouse gas emissions. This number shows the significant value of forests for the climate change.

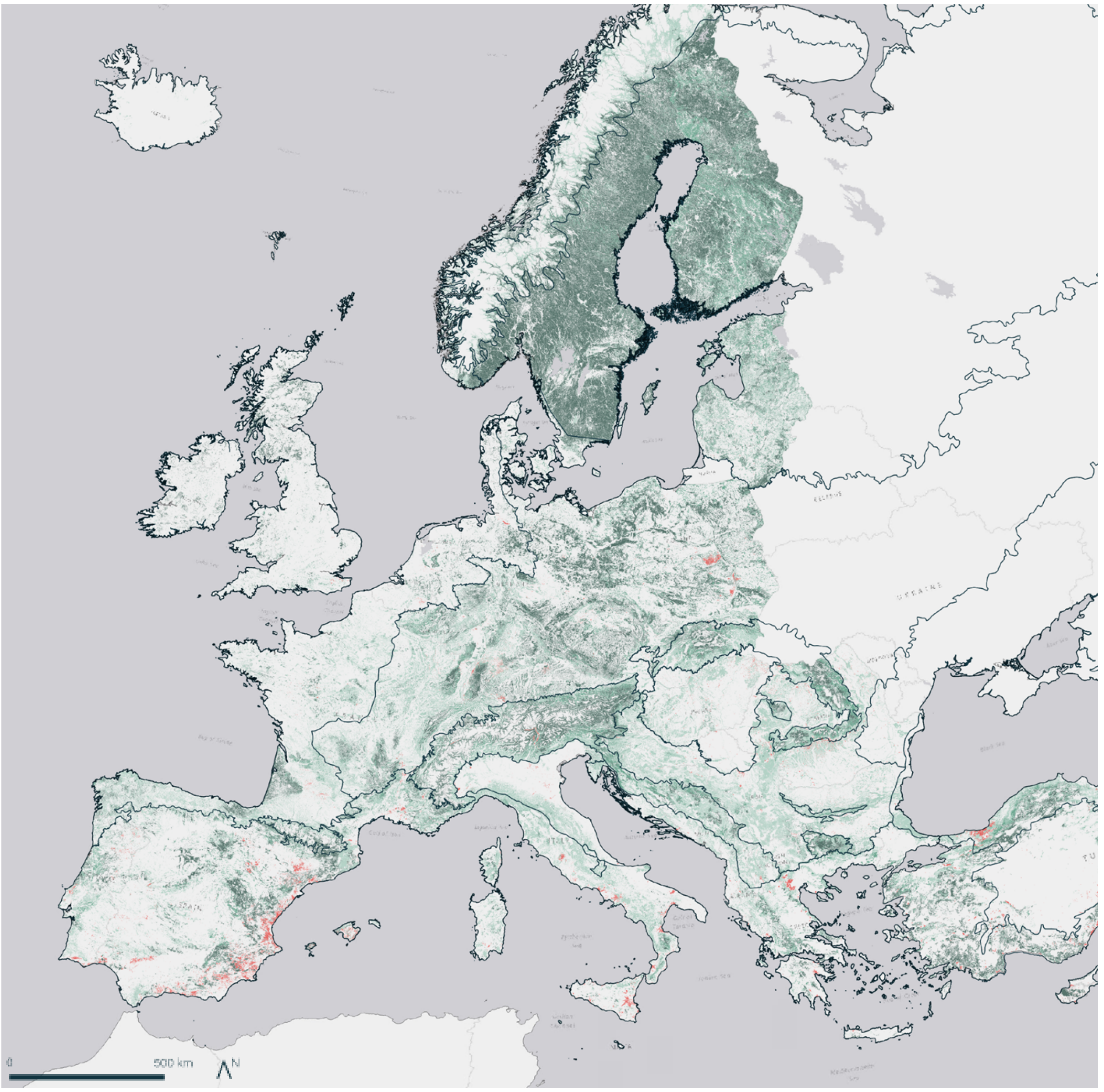


Figure 3.12 Type of forest map of Europe (based on EEA, 2019)

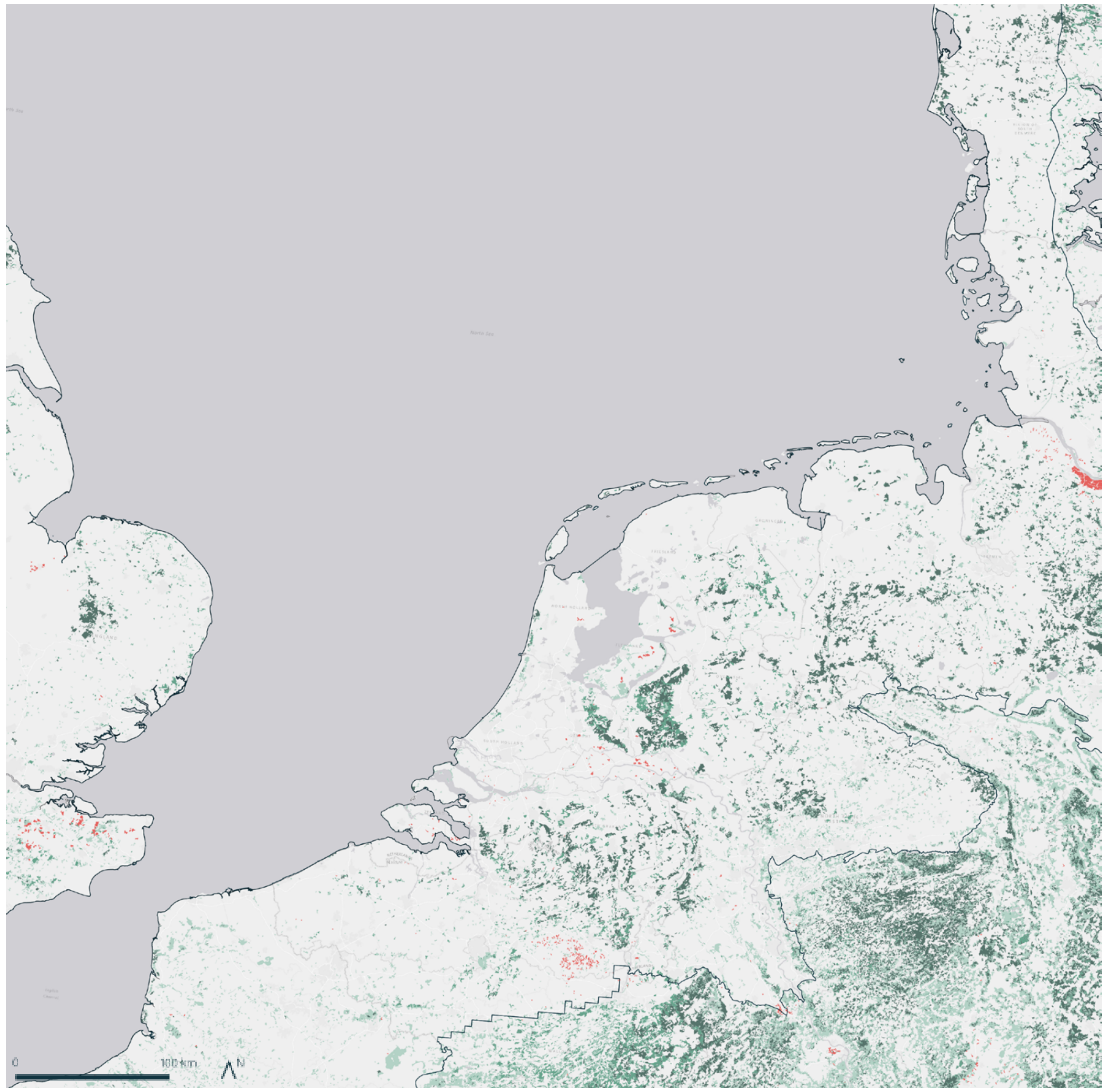


Figure 3.13: Type of forest map of the BeNeLux area (based on EEA, 2019)

Europe

Just 2.2% of Europe's forests remain untouched by human activity, found mainly in Poland and parts of the Scandinavian Taiga. Recognizing the importance of tree and forest conservation is key to Europe's sustainability efforts. However, area with dense forests often overlap with regions of high wood production, mainly in central and northern Europe (Figure 3.12).

Forest coverage differs widely across Europe due to different land use priorities. Northern Europe, especially its far north and mountainous areas, has the most forests. By 2018, Sweden and Finland were cover by forests to almost 70%, while Slovenia's mountain regions had over 60%. However, six EU countries had less than 30% forest cover, with Denmark, Ireland, Hungary, and Belgium ranging between 20% and 30%. The lowest forest covers were in Malta (16.9%) and the Netherlands (16.8%), mainly because of their high urban areas and agricultural land use (EC, 2018).

Next to the density of trees, Figure 3.12 also shows what kind of forest grows where in Europe. This is most affected by climate region, soil type, and land use.

BeNeLux

On a BeNeLux scale we can determine more accurately if tree- and forest density is high, and the degree of interconnectedness. It is noticeable on the map (Figure 3.13) that the trees and forests are scattered in this highly urbanised area. As stated before, the forests and semi-natural areas take up a small percentage of the land In the BeNeLux. The percentage of land uptake by forests and semi natural areas for the BeNeLux can be seen in Figure 3.14.

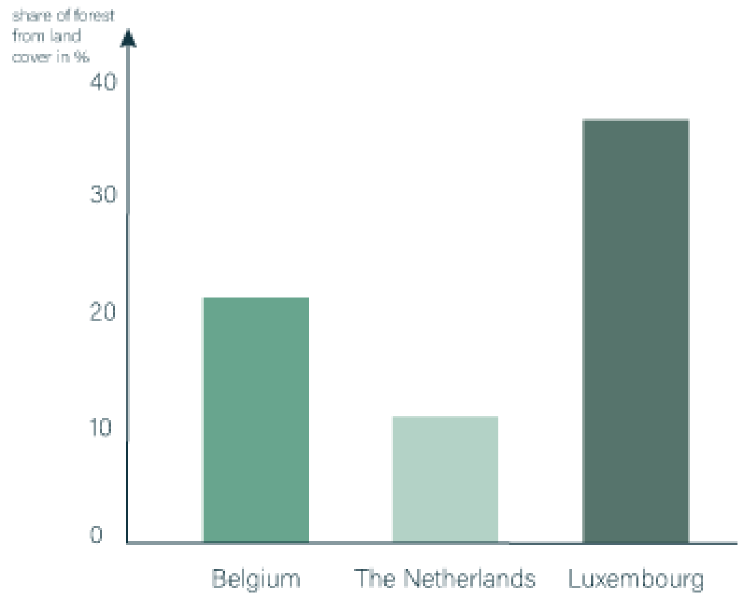


Figure 3.14 Ratio of forest from total land cover in the BeNeLux states

Analysis | Marine

Marine uses

- Maritime waterbody
- Shipping route
- Wind park
  - in use
  - under development
  - envisioned
- area suitable for seaweed

The Atlantic Ocean and the Mediterranean Sea are main marine areas. They support fisheries, shipping, and recreational activities. The Atlantic Coast presents a favourable climate for seaweed growth. However marine farming, especially for seaweed along the European coastline, is minimally utilised. Despite its vast potential, this sector accounts for less than 0.25% of worldwide seaweed production, both farmed and harvested (EUMOFA, 2018).

Marine ecosystems within these waters face serious challenges. The European Environmental agency considers the state of Europe's seas to be dire, mainly due to overfishing and climate change. (EEA, 2015) By 2023, about 80% of Europe's oceanic coasts were experiencing ecological degradation due to intense eutrophication—primarily from agricultural runoff—chemical pollution, and acidification (EEA, 2023). Additionally, agriculture was identified as the source of 50% of all marine pollution (EEA, 2020a).
The EU has stressed the critical need to mitigate biodiversity loss and ecosystem service degradation to prevent catastrophic ecosystem changes.

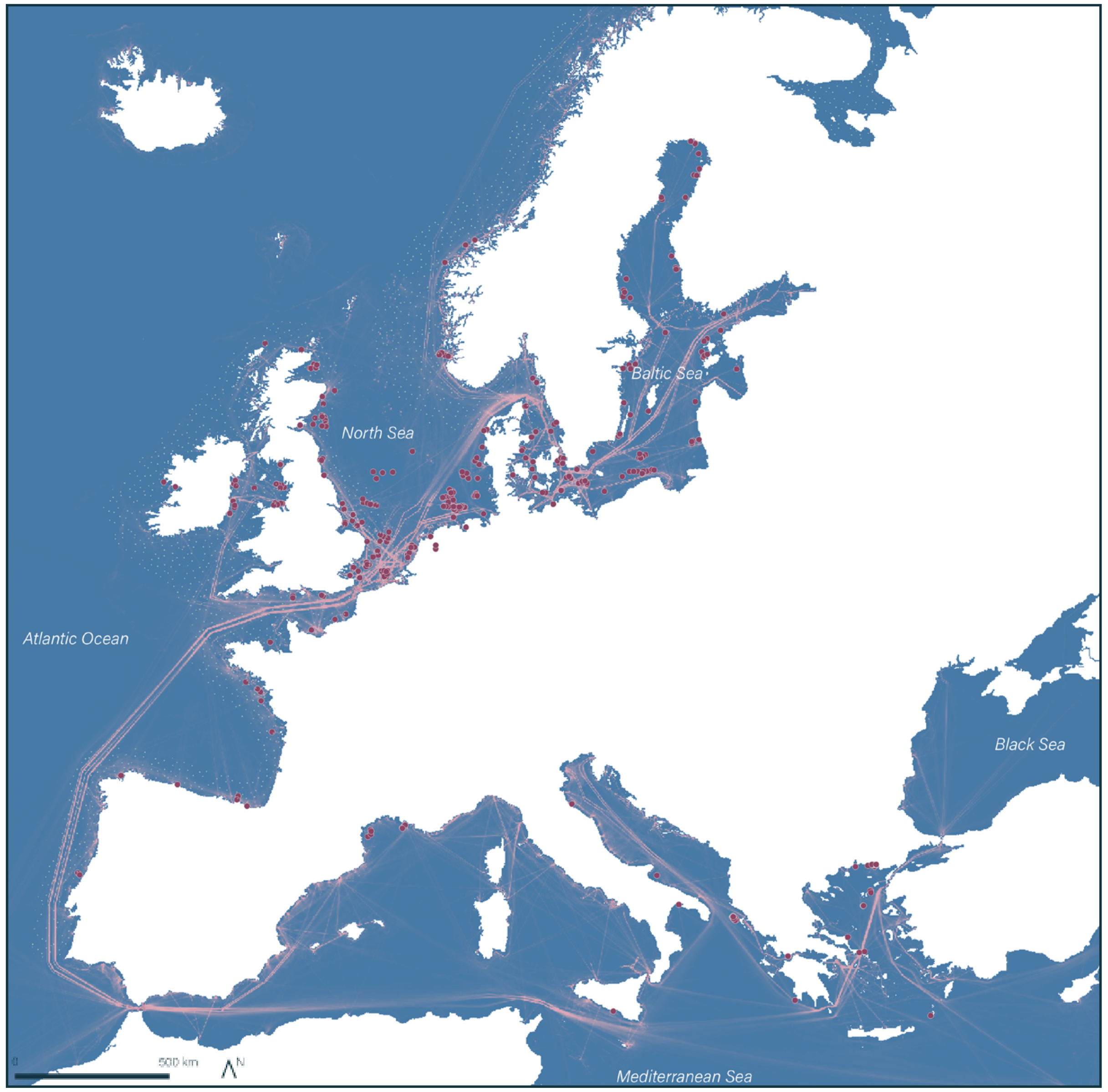


Figure 3.15: Marine uses map of Europe (based on 4C Offshore, 2024, EMODnet, 2019, EMODnet, n.d. and Froehlich et al., 2019)

Figure 3.16: Marine uses map of the BeNeLux area (based on 4C Offshore, 2024, EMODnet, 2019, EMODnet, n.d. and Froehlich et al., 2019)

Analysis | Synthesis Europe

To assess Europe's and the BeNeLux's bioregion current land use we have developed a framework to quantitatively assess the sustainable performance of the land use, to expand on the qualitative assessment in the previous section. We have developed assessment metrics that align with the Future Forest ideal as outlined within the conceptual framework. This quantitative assessment allows us to systemically propose Future Forest-based alternate land uses that outperform current land use.

The five analysis layers presented form the base for our assessment of the current land use system, providing information on given conditions as well as performance. The conditions can be derived from the soil type, and the climate zones. The soil type gives us an indication about the fertility, adding data on climate zones, it gives information about the resilience to temperature change and the water availability. Next to these conditions, performance indicators can be derived from the geodata analysis and the literary research in the previous section. The degree of carbon sequestration is related to the tree density and the soil type in an area. The degradation of the soil is linked to the land use, and lastly the biodiversity is linked to land use, tree density and whether or not the area is protected under Natura 2000 regulations.

Based on these conditions and performance indicators, we construct a spider diagram for a certain area to show how it 'scores' on these six metrics. To create those spider diagrams we can ask the questions in Table 3.2 for every condition and performance indicator. In Table 3.2 a schematic overview is given where the questions are coupled to the corresponding analysis layers.

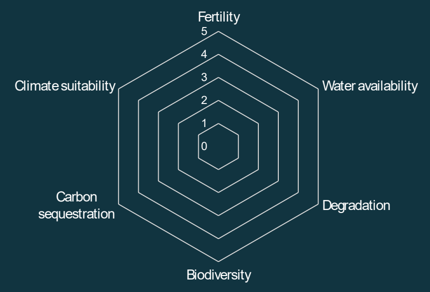


Figure 3.17: Template of the spider diagrams

Overlaying maps and coding

With the use of the collected assessment data an overlay of maps is made to see the spatial relations between the conditions and performance indicators.

An overlay map of all the analysis layers created by dividing the areas in patches, where each patch roughly contains the same conditions and performance indicators (most dominant condition and performance indicator). After dividing the overlay map into patches, each patch was assigned with a code. The code corresponds to the analysis maps used to form the patch. The first letter denotes the soil type of the patch, the second letter is for the land cover, thirdly a letter for the forest type, then a letter corresponding to the climate region and finally a letter (or not) for if the patch is Natura 2000. Hence, the code for the European map contains five items and the code for the BeNeLux map contains four letters since the area lies in the same climate zone. The result can be seen in Figure 3.18. This way, 23 different codes were generated for the European scale and 16 different codes for the BeNeLux bioregion scale.

Table 3.2: Overview of conditions and performance indicators with the corresponding analysis layers for the multi criteria analysis

	Type	Corresponding Question	Analysis layers
Conditions	Fertility	*Can it grow on infertile soil?*	Soil type
	Water Availability	*How much can it thrive without additional water supply?*	Climate zone, Soil type
	Climate Suitability	*How much trouble does it have with changing climates?*	Climate zone, Soil type
Performance indicators	Biodiversity	*How high is the biodiversity?*	Land use, Tree density, Natura 2000 or not
	Carbon Sequestration	*How much carbon can it store?*	Tree density, Soil type
	Degradation	*How healthy is this land use for the soil?*	Land use

Figure 3.18: Synthesis coding map of Europe

Code legend:

Letter 1: Soil
S sand
C clay
L loam

Letter 2: Land cover
A agroforest
F forest
U urban
S sea

Letter 3: Forest type
C coniferous
D decideous
M marine
- none

Letter 4: Climate region
B boreal/artic
C continental
A atlantic
M mediterranean

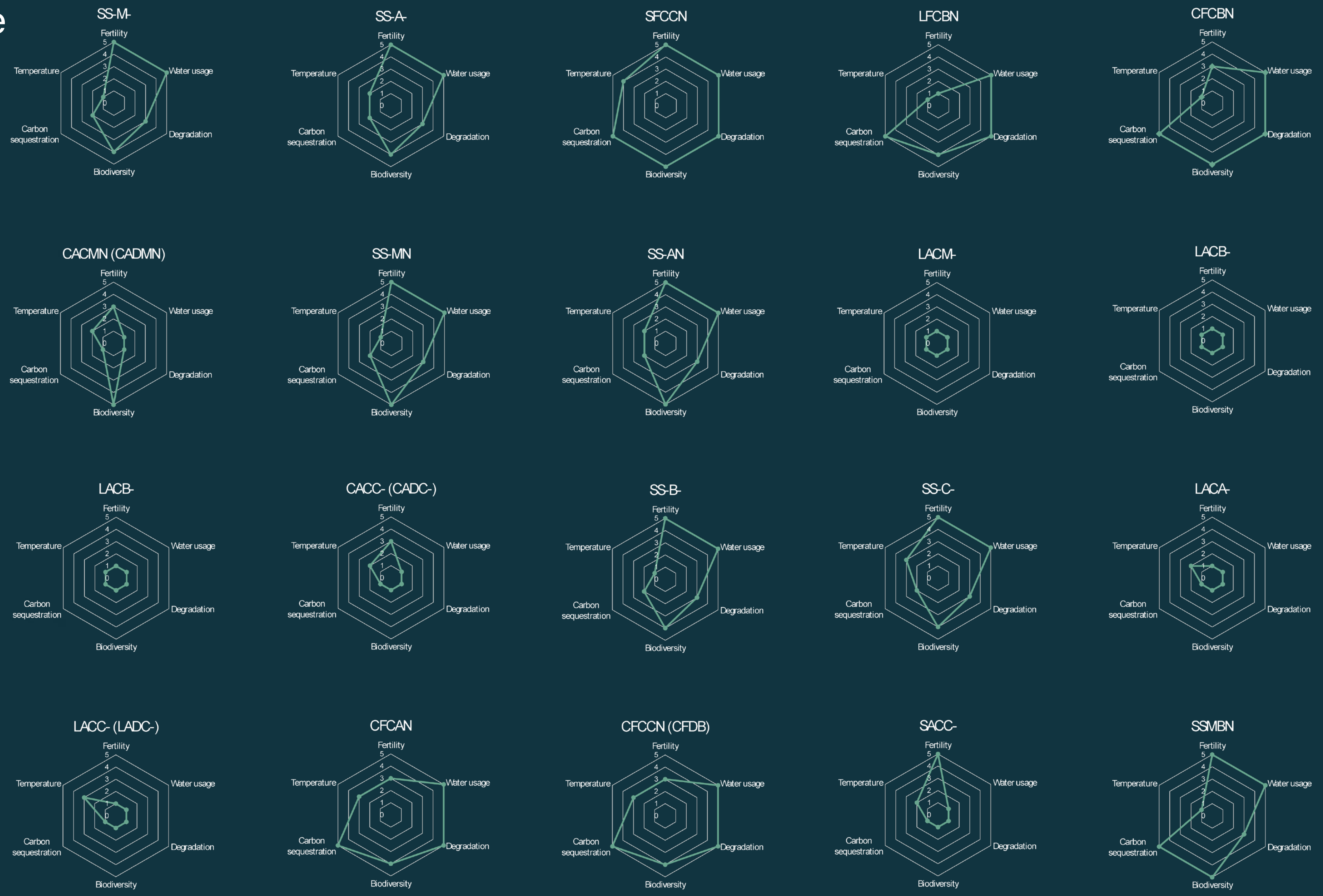
Letter 5: Habitat
N natura 2000
- no protected status

Analysis | MCA Europe

Multi criteria analysis

The coded maps give us information about each patch about the spatial conditions and performance indicators. By assessing each patch, based on the code, we get insights in the consequences of the current land use.

We assessed every code combination with the use of our multi criteria analysis which in our case is represented in a spider diagram. A multi criteria analysis (MCA) is used to make an evaluation, and later a choice based on analysis (Department for Communities and Local Government, 2009). In our case the analysis is made by the six questions mentioned in Table 3.2. This way we created a spider diagram for every patch. Each spider diagram represents a score for the area that is represented as a coded patch. The score goes per condition and/or performance indicator and goes from 1 (lowest) up until 5 (highest).



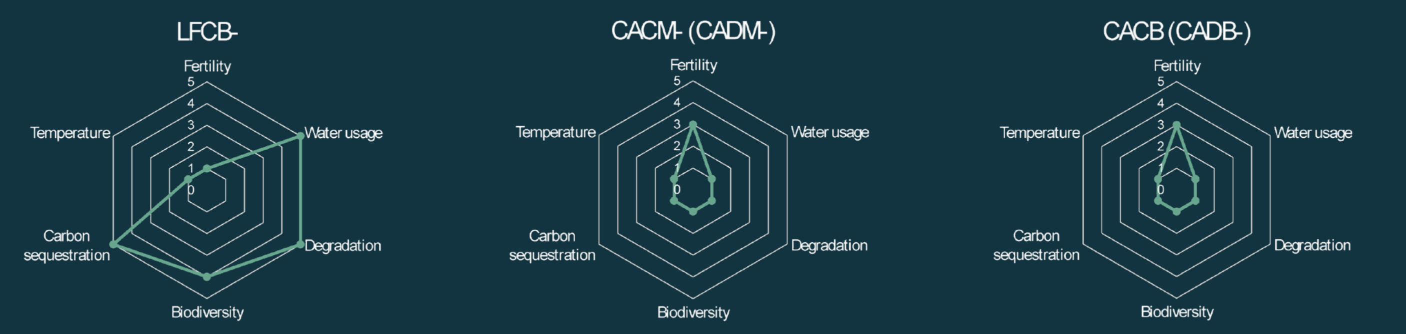


Figure 3.19: Outcome of the spider diagrams of each code of the Europe synthesis map

Table 3.2: Overview of conditions and performance indicators with the corresponding analysis layers for the multi criteria analysis

	Type	Corresponding Question	Analysis layers
Conditions	Fertility	*Can it grow on infertile soil?*	Soil type
	Water Availability	*How much can it thrive without additional water supply?*	Climate zone, Soil type
	Climate Suitability	*How much trouble does it have with changing climates?*	Climate zone, Soil type
Performance indicators	Biodiversity	*How high is the biodiversity?*	Land use, Tree density, Natura 2000 or not
	Carbon Sequestration	*How much carbon can it store?*	Tree density, Soil type
	Degradation	*How healthy is this land use for the soil?*	Land use

Analysis | Synthesis BeNeLux

For the BeNeLux bioregion scale we used the same systemic approach. Here we also divided the area in patches, with a given code corresponding to the different analysis maps. At the smaller BeNeLux bioregion scale, we were able to do this more granularly and accurate because of the smaller scale. The urbanised areas are assigned a separate patch without coding on this scale. This is because they are relatively large and sometimes interconnected (e.g. randstad) on a more zoomed in scale.

Code

1st letter: soil type
S Sand
C Clay
L Loam

2nd letter: Land use
A Agriculture
F Forest
P Pasture
S Sea

3rd letter: Forest type
C Coniferous
D Decideous
no forest

4th letter: Habitat
N Natura 2000 (or UK equvialent)
no protection staturs

0 100 km N

Figure 3.20: Synthesis coding map of the BeNeLux area

Analysis | MCA BeNeLux

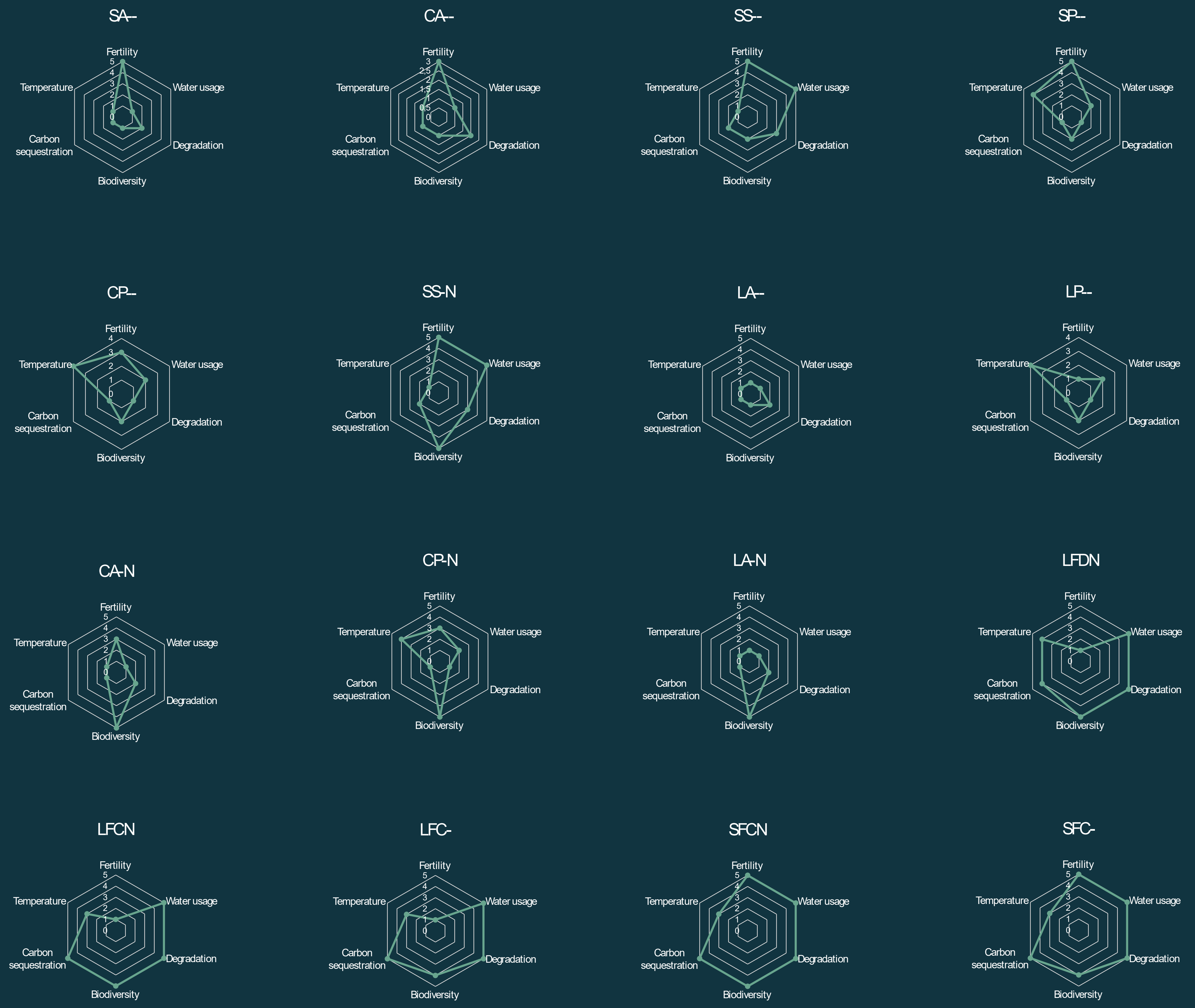


Figure 3.21: Outcome of the spider diagrams of each code of the BeNeLux area synthesis map

In conclusion, among the analysed patches there is hardly one that performs great on all conditions and performance indicators. On the contrary, a reasonable amount perform insufficient on all assessment criteria and only very few perform good on more than four criteria. Sufficient room for improvement on the different indicators remains.The assessment of the current conditions and performance indicators can later be used to justify choices made for a transition towards the future forest.

Table 3.2: Overview of conditions and performance indicators with the corresponding analysis layers for the multi criteria analysis

	Type	Corresponding Question	Analysis layers
Conditions	Fertility	*Can it grow on infertile soil?*	Soil type
	Water Availability	*How much can it thrive without additional water supply?*	Climate zone, Soil type
	Climate Suitability	*How much trouble does it have with changing climates?*	Climate zone, Soil type
Performance indicators	Biodiversity	*How high is the biodiversity?*	Land use, Tree density, Natura 2000 or not
	Carbon Sequestration	*How much carbon can it store?*	Tree density, Soil type
	Degradation	*How healthy is this land use for the soil?*	Land use

04 | Vision

Planting The Seeds

The Future Forest of 2100 will cover all of Europe and is more than a collection of trees:

spanning over land and sea, it leads the sustainability transition

In 2100, citizens of BeNeLux will live in close connection with a forest network that spans the continent of Europe and extends into the sea. This Forest of the Future is invaluable for humanity, nature, and climate, leading the spatial transformation of Europe towards sustainability. The forest is not merely a collection of trees but a showcase for a new model of sustainable land use that integrates regenerative agriculture, economic utility, and ecosystem services. Deeply integrated into Europe's transition to a sustainable future and counteracting the pressures of climate change, the Forest of the Future enhances habitats and biodiversity, both on land and in the water. It plays a critical role in carbon storage, enhancing climate resilience, preventing land degradation, and contributes positively to the health and well-being of European citizens. People will have a mostly vegan lifestyle, negating the need for intensive livestock farming, use only renewable materials and live in urban cores with a forest within 15 minute cycling distance of their homes.

Achieving this vision requires large-scale land use transformations to expand and unite the current fragmented forest land cover, which constitutes 40% of the EU's land use. This can be done through transformative land use strategies that for instance incorporate forestry within agriculture. This involves converting current agricultural practices — 43.5% of Europe's land use — to regenerative ones based around agroforestry, thereby creating forestry corridors that act as a bridge between the larger forest structures. This strategy interconnects the two dominant land uses: agriculture and forestry. This transformation effort is part of a broader pan-European vision focused on (bio) regional specialisation.

Applying the transformative strategies will result in all of the current agricultural land cover being transformed into new forest types and all habitats being connected in 2050. By doing so the carbon emissions of most European countries will be negative, biodiversity numbers are at an all-time high and once depleted and polluted soil will be either recovered or recovering.

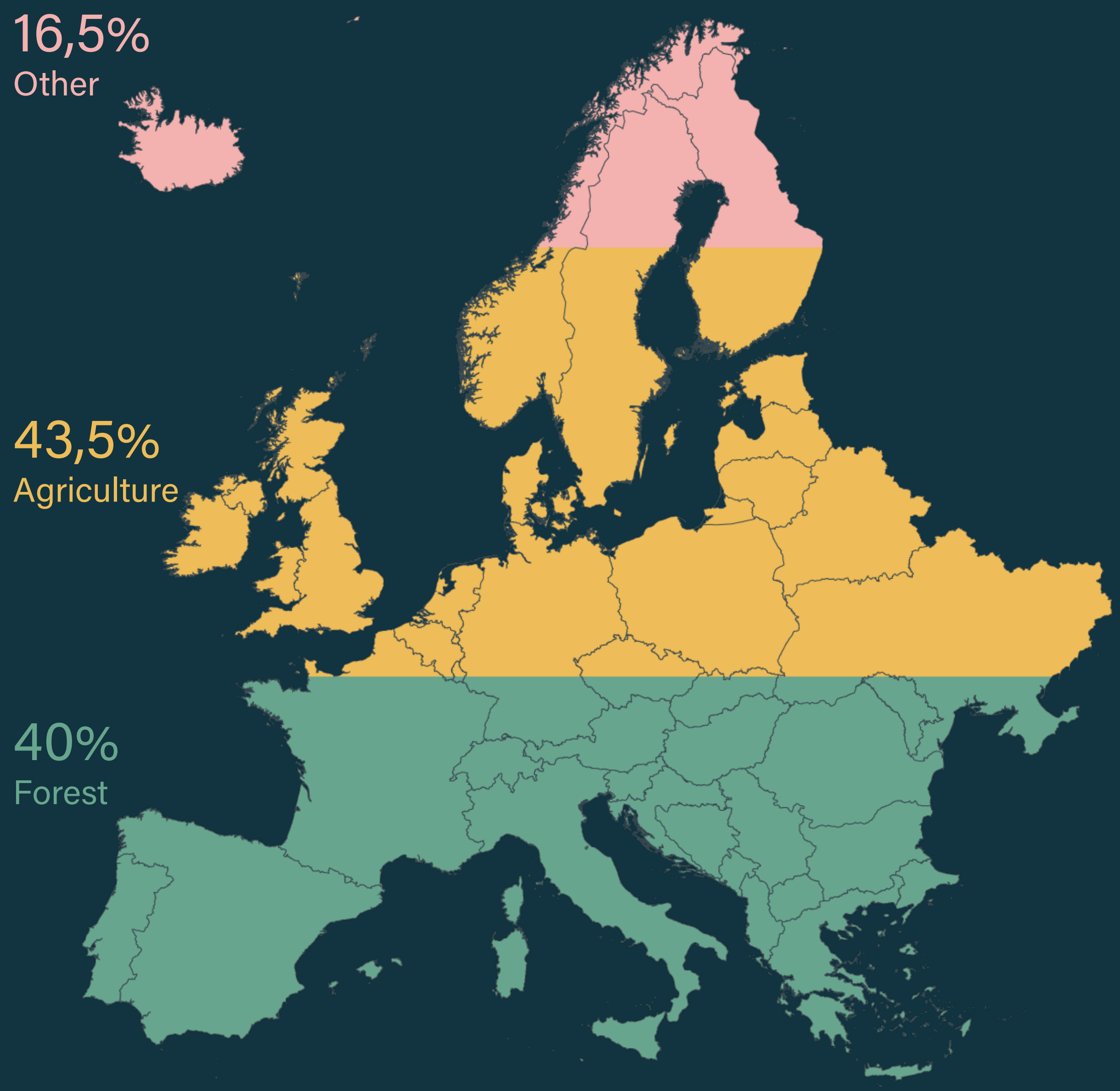


Figure 4.1: Ratio of land cover of Europe in percentages (%)

Vision | Creating Forest Types

Moving towards the Forest of the Future

The vision statement provides a desirable future imaginary that we can backcast from. It serves a motivational and guiding beacon for the project and outlines what successful implementation looks like.

At the basis of achieving the Forest of the Future vision is the question "How can forestation aid in the transition to a sustainable land use system?". The answer to this question lies in using the conceptual framework and its assessment made in chapter 03 and proposing alternative land uses to apply in a transformative strategy. These alternative land uses represent the different ways a forest functions, derived from the Forest of the Future conceptual framework, in the form of Future Forest types.

Future Forest types represent specialisations of the Forest of the Future and the ecosystem services they can provide, in alignment with our desired goals. These types reinforce ecosystems and provide ecosystem services to Europe's citizens. This goes beyond the traditional ecosystem services forestry can provide as we expanded this concept in chapter 02 with regenerative agriculture, economic utility, and ecosystem services, to provide essential resources, sustain future liveability, and improve ecosystems, whilst ensuring the baseline three dimensions of spatial justice.

Creating types

The types represent different outcomes of the conceptual framework (Figure 2.5). The combination of the three pillars of sustainability, the three goals and the nine tools resulted in 24 distinct functions the Forest of the Future has (Figure 4.2). While some functions are common to all forests e.g., carbon storage, the improvement of soil or air conditions, we grouped the remaining 16 functions into six distinct types. It is essential that each forest type comprises multiple qualities due to the inherent complexity and versatility of a forest ecosystem. This underscores a key feature of our envisioned Forest of the Future: the just and sustainable land use system is based on the layering of functions.
Other than land use a spatial implication is the shape of the types: some forests have the spatial form of a patch (e.g., resource forest), while others are corridors (e.g., riverine forest). Some types can also appear in both forms, such as the recreational forest. For the types originated from the conceptual framework they touch upon the different pillars of sustainability, this differs per forest. For example, while the resource forest and the agroforest lean towards economic sustainability, the protected forest focuses more on ecological preservation, and the social and the riverine forest primarily cater to social well-being. This leads back to the specific qualities the types have, a more detailed background on the generation of the qualities can be found in the appendix.

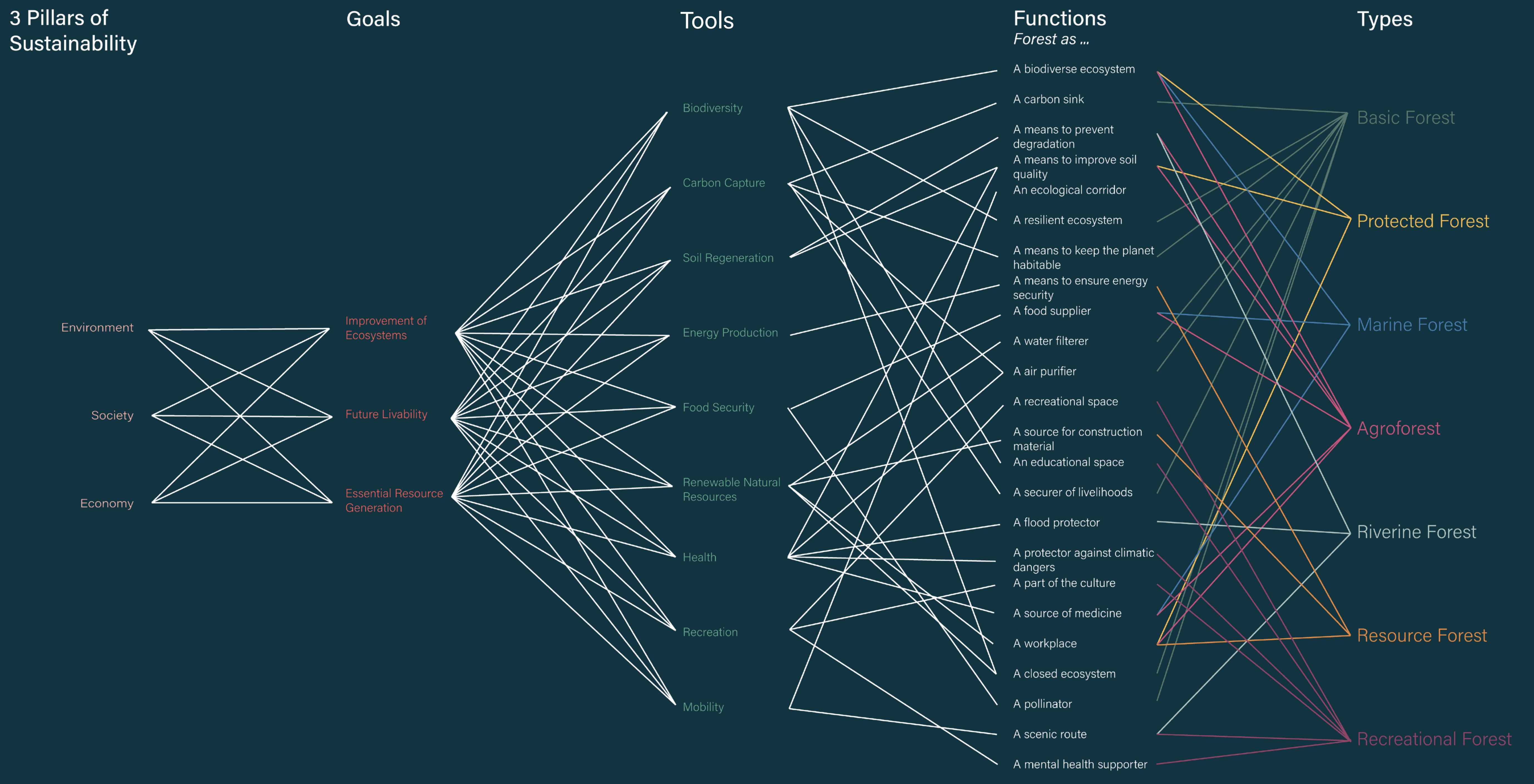


Figure 4.2: Tree diagram of forest types created from the conceptual framework

Vision | Benefits of Forest Types

The integration of regenerative agroforestry and the expansion with marine forestry activities expands the ecological resilience and ecosystem services of the traditional forest type These uses provide many benefits and are underutilised in current European land use. A core part of our vision is to upscale the implementation of these land use systems to maximise the following benefits that we identified in the literature:

Agroforestry

Agroforestry, as a forestry integrated practice within agriculture, provides significant synergistic benefits over conventional agricultural and forest production methods. The main advantages, as listed by Udawatta & Jose (2021), are listed on the right.

Sub-types of Agroforestry

There are multiple classification systems for agroforestry due to the variability of its components and specific local variants. In this report, we adapt the classification used by the EPRS (2020), from Losada et al. (2018), identifying 4 basic spatial agroforestry practices:

Silvopastoral:

Combination of trees and shrubs, in rows or corridors, with forage and animal production, with silvopasture being the main system. This type of agroforest is used for pastoral land use. It is more seen as a bridging type since we envision the protein transition with marine farmed seaweed to make livestock farming obsolete.

Silvoarable:

Trees and shrubs, in rows or corridors, intercropped with annual or perennial crops. Agricultural fields will transition into this type of agroforest.

Forest Farming:

Patch forested areas used for production or harvest of naturally standing specialty crops for medicinal, ornamental, or culinary uses, a known variation of this type is the food forest. We will mainly have this type of forest integrated in other patches of agroforestry.

Climate Buffers:

Such as riverine buffer strips, hedgerows, windbreaks: lines of natural or planted perennial vegetation (tree/shrub) bordering croplands/pastures and water sources to protect livestock, crops, and/or soil and water quality. As the land along rivers is usually very fertile, we make use of this synergy (can be seen in chapter 5: strategy).

Climate Change Mitigation:

Agroforestry systems, by incorporating more biomass than conventional agriculture, store more carbon in plants and soils and prevent soil erosion and CO_2 release.

Soil Fertility and Water Retention:

Agroforestry maintains and restores topsoil and its nutrients, improving nutrient cycling and the storage and retention of rainwater.

Climate Change Resilience:

The shade from trees helps maintain local microclimates by retaining water in the soil, keeping temperatures lower, and preserving humidity, making agroforestry systems robust against extreme weather.

Increased Agricultural Productivity:

Through efficient resource capture (e.g., solar radiation, water), agroforestry can lead to increased productivity, although this varies by region.

Biodiversity Support:

Agroforestry provides food, shelter, and habitat for birds and insects, reducing or eliminating the need for harmful pesticides and fostering a rich biodiversity.

Reduced Need for External Inputs:

Soil fertility improvements and natural pest management in agroforestry reduce the need for fertilisers and pesticides.

Pest and Weed Control:

The diversity of plant and animal species in agroforestry systems leads to natural pest and weed management, reducing the need for pesticides.

Economic Diversification:

Agroforestry allows for diversified farm production, offering annual and periodic revenues from multiple outputs and reducing the risks associated with single commodity production.

Soil Erosion Prevention:

The forest canopy, roots, and leaf litter in agroforestry systems protect the soil from wind and water erosion.

Community Benefits:

Diversification of local production can stimulate the local economy, create jobs, and provide recreational opportunities, enhancing the diversity and attractiveness of the landscape.

Marine forestry

As contesting spatial claims increasingly overlay each other - especially in the BeNeLux region - expanding our view of land use to the sea can provide a solution to that matter. The sea presents an underutilised territory that holds significant potential for marine forestry which according to the EU's Blue Bioeconomy report (2018) can play a crucial role in:

Re-wilding natural environments and rebalancing the seas through regenerative ocean farming

Mitigating climate change and contributing to carbon capture or sequestration and reuse efficiency

Reducing land use and degradation

Providing alternatives to animal- and fish-derived proteins and oils for human food, pet food, and animal feed

Offering alternatives to land-based biomass for food, feed, and fuels

Serving as alternatives to petrochemicals for various industrial and consumer applications

Pre-empting and reducing plastic waste from packaging, textiles, and other products

Sub-types of the marine forest

We differentiate the marine forest according to use.

Protected marine forest:

This comprises valuable marine ecosystems protected under regulations like Natura 2000 with minimal human intervention. These systems provide valuable ecological functions but also effectively sequester carbon

Marine agroforest:

Marine agroforests are composed of different species of aquatic plants and grow in shallow coastal areas (2 to 40 metres depth) (EC, 2018). When applicable, they can grow in offshore wind parks since these areas are not used for ship traffic and already provide infrastructure from which maintenance and harvesting of the marine forest can be organised This type serves a economical ecosystem purpose mainly, because human activity in the form of harvesting negates its potential to store carbon.which maintenance and harvesting of the marine forest can be organised.

Vision | Land Use Transitions

Crop agriculture

Pastoral agriculture

Forest

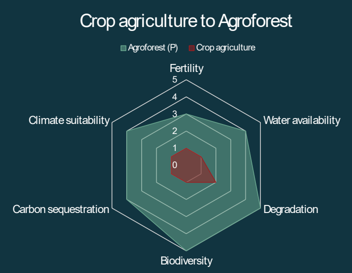
Figure 4.3: Current land use

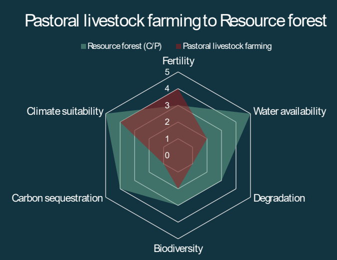
Silvoarable agroforest

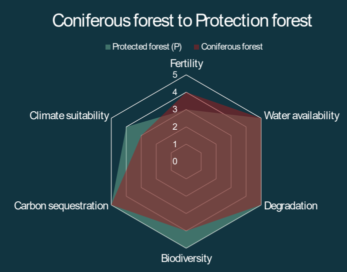
Resource forest

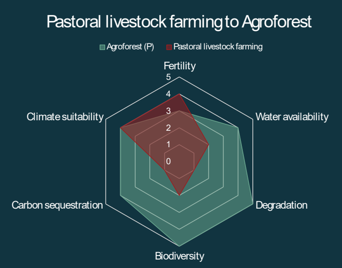
Protected forest

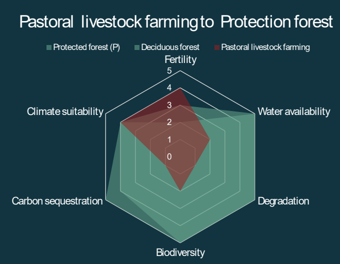
Figure 4.4: Future forestry-based land use











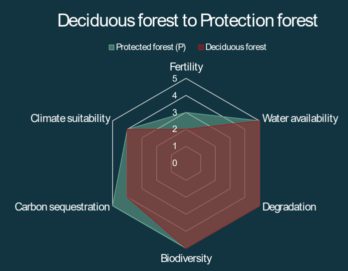
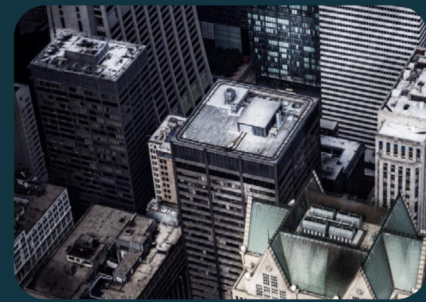


Figure 4.5: Comparison of current and future land use performance

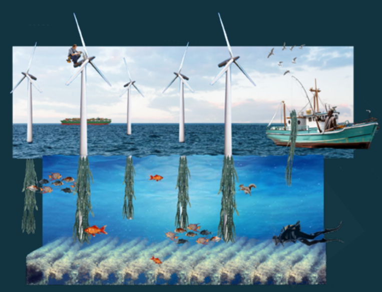
Sea

River

Urban

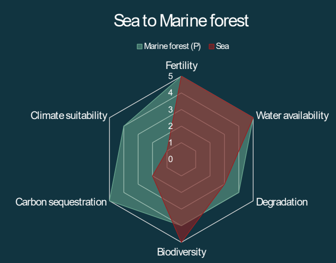


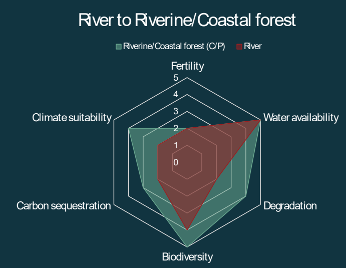
Marine forest

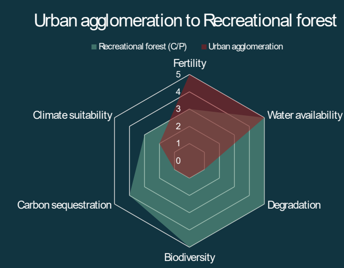


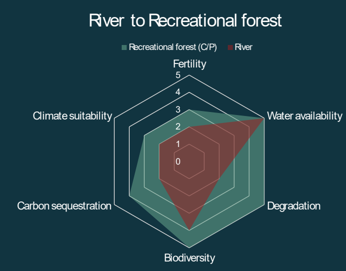
Riverine forest

Recreational forest
(in and around the urban)



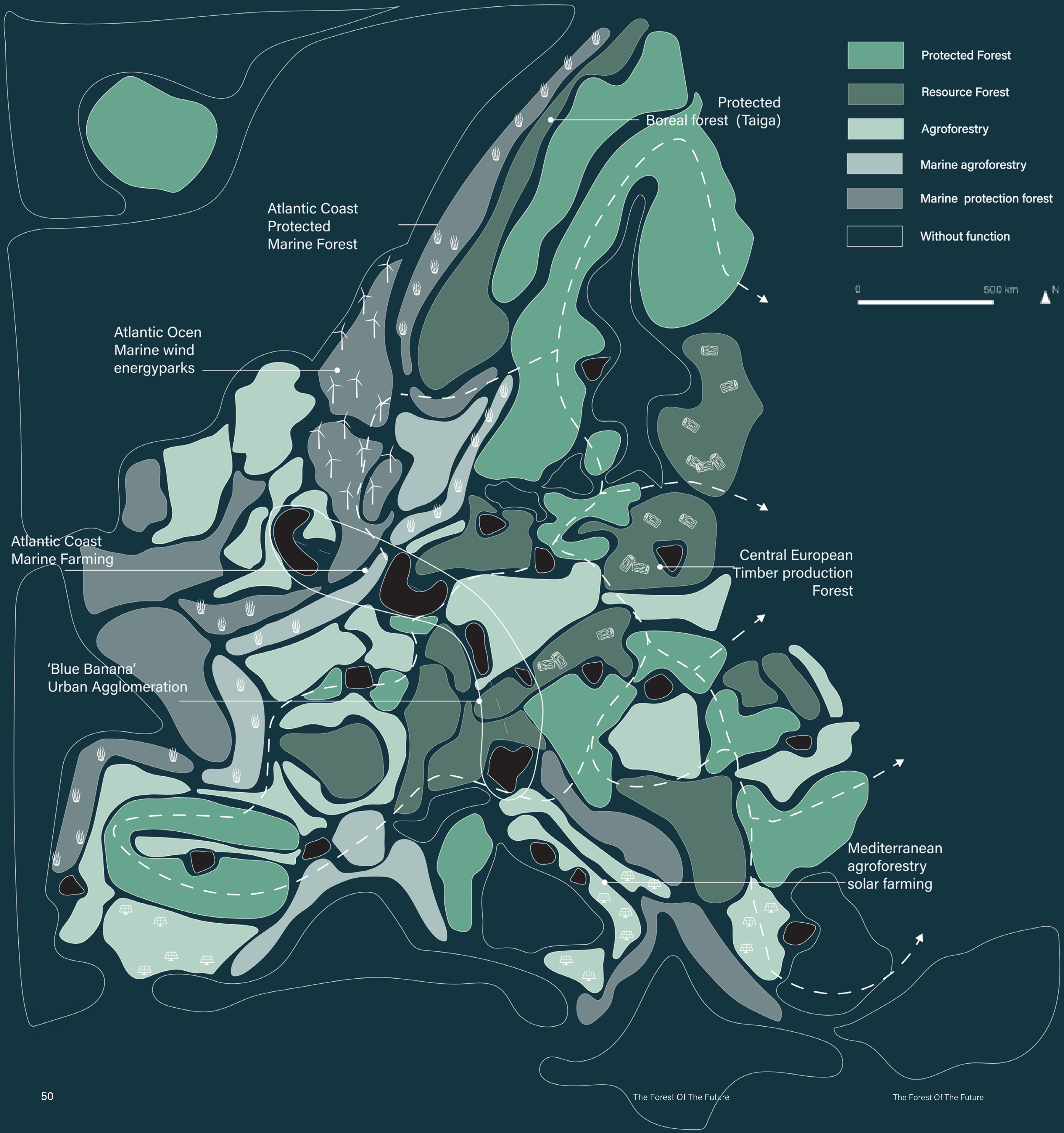






The multilayered future forest types will expand and replace current monofunctional land uses. Figures 4.3 and 4.4 show the main transformative strategy, corresponding to local conditions. One code in the synthesis maps can correspond to multiple future forest types. With the multi criteria analysis as described in chapter 03, we determine the improvement they generate compared to the current land use, as per our desired performance metrics. All forest types improve the conditions to a certain extent. However, there are also trade-offs e.g., in marine forestry. There, applying large-scale seaweed plantations leads to a decrease in biodiversity over protected marine forests which we accept for a strong increase in carbon storage capacity and climate adaptivity.

Vision | Europe Map



For our European vision the Forest of the Future extends over land and sea and reshapes the European continent (see Figure 4.6). Within the new forest landscape, the three pillars of sustainability guide the main spatial interventions.

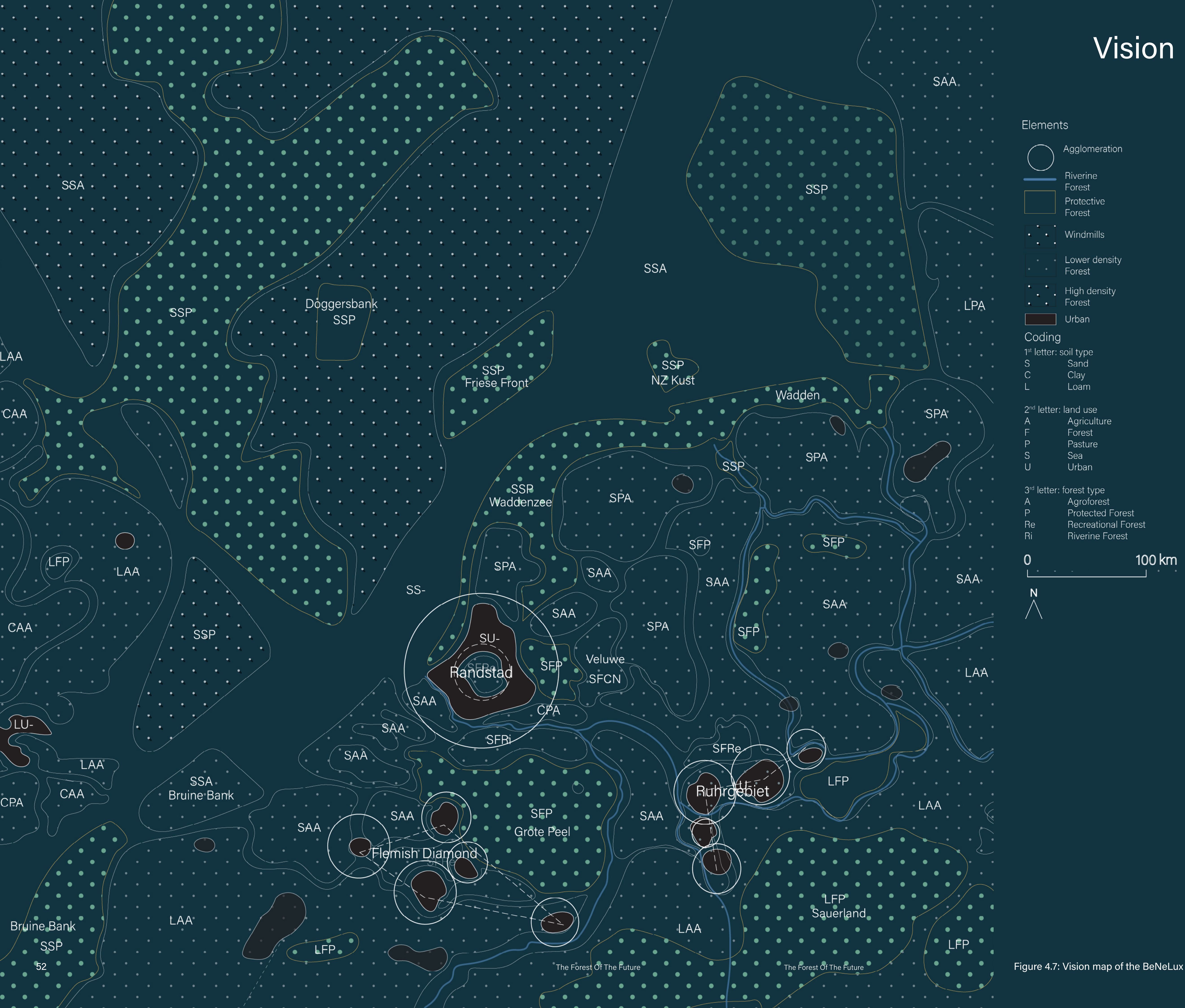
Looking from the perspective of social sustainability, recreational and protected forests are mostly clustered around urban areas, which are exemplified by the 'blue banana', Europe's economically most productive and most densely inhabited region. Now in renewed close contact with nature, there they provided essential ecosystem services to citizens that aim the goal of 'just' cities. This proximity to the forest enhances the quality of life and engages the daily lives of people with nature.

From an economical point of view, we differentiate large bioregional specialisation. For instance we enhance existing productive landscapes such as the forests of Eastern Europe which are primarily focused on timber production and the Atlantic coast which presents an underutilised economic opportunity for large-scale seaweed forests and forestry. The bioregional specialisation is not mutually exclusive from facilitating local production, short chains are preferred. By diversifying bioregional economies, we lay the groundwork for a sustainable economic future that harmonises with the environment.

The extensive boreal forest stands out as a significant protected area, since it plays a crucial role in sequestering a substantial part of Europe's carbon emissions. For ecological sustainability, the protected forests form a network of highly biodiverse forests connected by green corridors across the continent.

Figure 4.6: Vision map for Europe

Vision | BeNeLux Map



On the scale of the BeNeLux, we foresee three main transformations. Firstly, to concentrate urbanisation and stop urban sprawl into valuable natural areas. In 2100, the citizens of the BeNeLux area will live in larger urban agglomerations like the Randstad or the Flemish Diamond but have close contact with the forest network via Urban Forestry. Secondly, the forest grows from the existing habitat cores along ecological corridors to form a network filled with patches of agroforestry systems. In the delta region, these corridors are mainly riverine forests, which simultaneously also serve as means for flood protection. Lastly, at sea, the expansion of the marine forest is led by the development of new wind power parks at the bottom of which the marine agroforest is planted.

The forest typologies assigned to patches correspond to a dominant land use for that patch. The vision map on BeNeLux scale (Figure 4.7) exemplifies that within those patches, local conditions (the coded patches of Figure 3.20 - the BeNeLux code map) as well as human settlements strongly influence the land use system. This also implies that even though economic specialisation for timber production lies in Eastern Europe, there will also be resource forests in the BeNeLux area but they are comparatively small. This nuanced approach envisions that every patch of land, informed by its unique characteristics, contributes to a harmonious multi-layered sustainable land use system.

Figure 4.7: Vision map of the BeNeLux area

05 | Strategy

Growing The Forest

Strategy | Introduction

This chapter outlines the steps for transition towards the envisioned Forest of the Future in 2100 in the BeNeLux bioregion. We showcase three different spatial scenarios within the BeNeLux bioregion, namely the agricultural countryside, urbanised Maasdelta and the to-be industrialised North Sea coast. These scenarios visualise three different implementations of the Forest of the Future types at three different scale levels. We further develop the governance dimension of the strategy with stakeholder mapping and engagement, policy forming and a timeline.

Strategy | Stakeholder Analysis

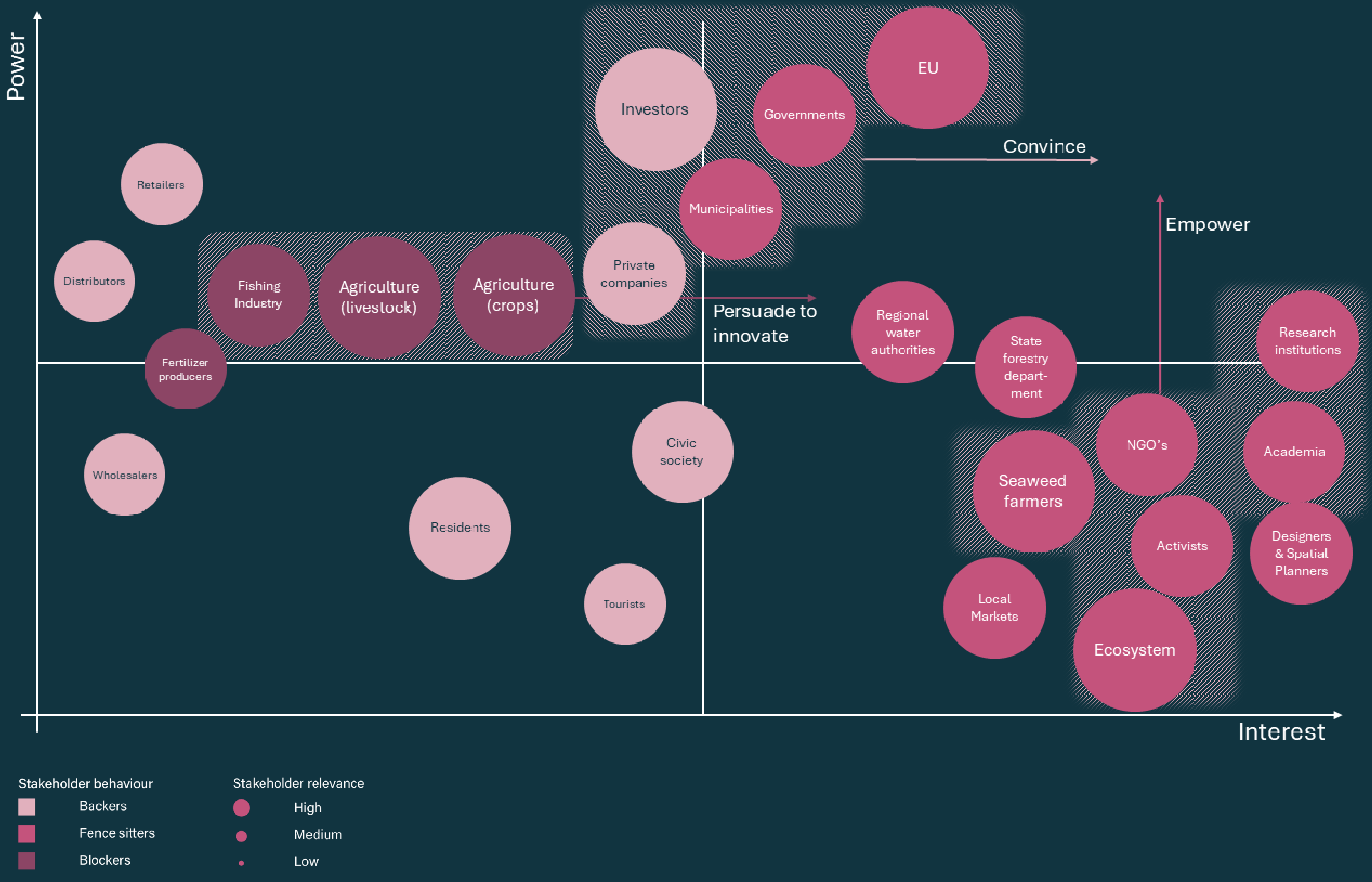


Figure 5.1: Power-interest diagram from the stakeholder analysis of the BeNeLux area

To analyse and engage the stakeholders in the BeNeLux bioregion, Mendelow's (1991) power-interest matrix is used. A selection of the most important stakeholders have been represented in this matrix. Figure 5.1 represents how the interest of the stakeholders for this project should be assessed and managed. Furthermore, we show the current attitude towards the project for each stakeholder. A stakeholder can be a 'Backer' (Positive attitude towards project), 'Fence Sitter' (Neutral) or 'Blocker' (Opposed our project). Next to that we show stakeholder strategies must be implemented.

For high power and high interest stakeholders,such as governmental bodies, private companies and investors, it is crucial to demonstrate to them the project's environmental and personal benefits. Those stakeholders are influential and thus important to cooperate with. In the case of low power and high interest stakeholders, it is important to empower those that have assets that can be used to create support for the project, an example are investors here. Academia, NGOs and activists create support and might provide useful research to support our project.

The ecosystem itself, also nature, can be considered a vital stakeholder in our project. Arguably the most important and its need to be empowered. It can be considered an essential silent stakeholder whose interesterst require amplification.

Farmers, typically low interest but high power, often resist change, favouring traditional practices. Persuading them with the project's benefits is crucial for their participation and the project's success, as their decision power makes them potent project influencers.

Low interest and low power stakeholders need to be monitored and engaged based on if they are affected positively or negatively by the project. We leave them in the bottom left quadrant. Informing them about the project and not causing negative effects is essential.

Strategy | Trends

The phasing diagram shown in Figure 5.3 outlines the steps and the time needed for achieving the Forest of the Future. This diagram presents a structured timeline, segmented into three pivotal phases: 'planting the seeds,' where foundational actions are initiated; 'introducing new types,' where innovative solutions are implemented; and 'standardisation of the types,' signifying the adoption and normalisation of these solutions. The end point is the finalisation of the Forest of the Futrue network and full ecosystem maturation in 2100. The content of the trends are listed below.

1. Economical

Agricultural transformation

1. Transition to regenerative agricultural land uses:
Ban the use of harmful pesticides and reduce monoculture plantations

2. Transition from animal-based protein to alternative sources:
Reduce livestock farming and the consumption of animal based protein to stimulate the self-identification of 95% of EU citizens as vegan in 2050

3. Integration of agroforestry practises within traditional agriculture:
Experiment with agroforestry, change all crops into silvoarable agroforestry and change all pastures into silvopastoral agroforestry

4. Expansion of marine forestry activities with kelp and seaweed farming
Transition towards marine farmed produce for life stockfeed and marine famed produce as a main source of protein

5. Ban harmful and deplative agricultural practices
Phasing out greenhouse horticulture to reduce horticulture to only private small scale practices in 2030

Energy transformation

6. Transition from fossil to renewable energy-sources such as solar and wind:
Refusing fossil fuels and further fossil exploration, expand renewable energy with regional specialisation

7. Transition towards renewable materials:
Phase out and ban the use of non renewable materials and introduce and integrate circular policies

2. Environmental

Forestry transformation

1. Transition towards EU-wide towards integrated forestry network:
Advance, implement and interconnect new forest types resulting in the finalisation of the Forest of the Future in 2100

2. Increase carbon capture:
Protect and expand the current forest cover

3. Decrease carbon emission:
Reduce emission rights together with replacing fossilfueled transportation with renewable energy transportation. This will lead to a net 0 achievement in 2050 which facilitates not giving out any emission rights.

Environmental restoration

4. Regenerate agricultural soils:
Introduce regenerative species to depleated soil and Re-assigning functions and types to regenerated land

5 Use nature-inclusive design to prevent degredation:
Pilot Marine forest patches inbetween windmills to later largely implement

6. Expand and connect natural habitat:
Building of undisturbed corridors between natural habitats by rerouting infrastructure around natural habitatsresulting in all protected forests being connected in 2050

7. Prevent further decline of biodiversity:
Implement zero-disturbance policy to limit human activity, remove invasive species and restrict human contact or interventions in protected areas

3. Social

Societal transition

1. Rapid urbanisation of cities:
Urbanisation of peri-urban areas which will lead the disappearance of peri-urban areas and densify urban cores leading to 90% of the EU population living in urban cores in 2080

2. Strengthening diversity, equity and inclusion:
Involving communities in the urban design and reshape current household structures back to a more communal responsibility

3. Integrate nature in urban areas:
Reintroduce nature in heavily urbanised areas with the help of nature inclusive spatial design with the end goal of a forest within 15 minute cycling distance from every home

4. Participation of stakeholders:
Including actors from the stakeholder diagram in the making of spatial decisions

Strategy | Influencing factors

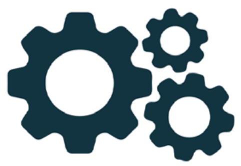
Different from the phasing diagram, the X-curve (Figure 5.2) puts the trends of the project within a larger timeline and trends of a breakdown between systems. The Future Forest can emerge in the breakdown moment in the deep transition that is occurring, where one system is destabilised and phased out, and a new sustainable system is phased in and strengthened. The X-curve represents the steps that need to occur and when within these two ongoing systems changes

Material availability

The availability of materials will speed up a trend if a certain material runs out and stimulates the research for a sustainable replacement, but also has the ability to slow down a trend when a non renewable material is cheaper in use and readily available.

Technological advancement

Technological advancement in renewable energy sources or circulair building materials can speed up a trend while it also has the ability to slow down a trend if the advancement is made in sectors harmful for the environment.



Climate disaster

Climate disasters have shown to speed up sustainable processes and trends by increasing the urgency for a change to happen, think of the ban on CFC after the hole in the ozon (Mulder, 2006). But they can also slow down trends when a climate disaster results in climate harming substances spilling into an environment such as with an oil spil or nuclear disaster.

War

A war breaking out could have a positive effect on the initiation of climate positive trends, take for instance the urgence to diversify the energy supply of many european countries due to the war between Ukraine and Russia. More often it slows down climate positive trends through the pulling of funds from sustainable initiatives (Zakeri et al., 2022).

Economy

Since we live in a capitalistic society, funding has the power to either propell trends forward or drastically slow down certain trends towards global sustainability.

Protests

As can be seen with the recent farmer protests all over Europe, groups of people have the power to slow down sustainable transitions. Protesting and lobbying in favor of the transition would speed the process up.

Strategy | X-Curve

The trend sections place the project within a larger timeline of ongoing processes, organised per theme. In the X-curve (Figure 5.2), we also included (external) influencing factors outlined before which could either start up or slow down the trend on the timeline. With the inclusion of these influencing factors, we show the interaction between the phasing and externalities outside of our control, and the intrinsic insecurities that come with them.

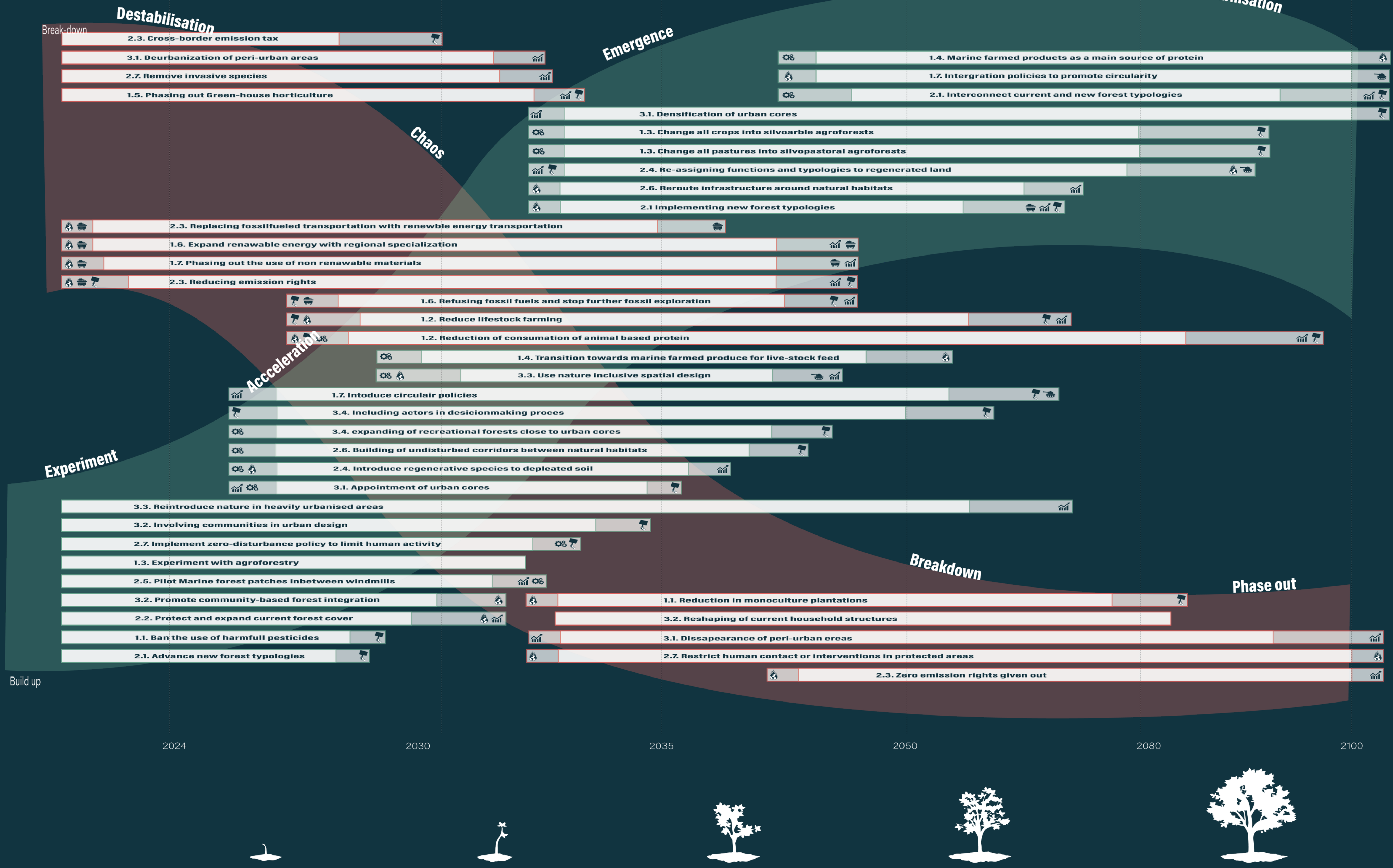


Figure 5.2: X-curve of the break-down of unsustainable land use systems and the build-up of the Forest of the Future

Strategy | Phasing

At the base of the X-curve (Figure 5.2) lies the timeline from today until 2100. Alongside and beneath this timeline (Figure 5.3), we have placed milestones (both qualitative and quantitative), categorised into existing policies and project-specific objectives, to track the project's progress. Achieving these milestones means progress towards our goal, while any issues in reaching them require review and adjustment of the strategies.

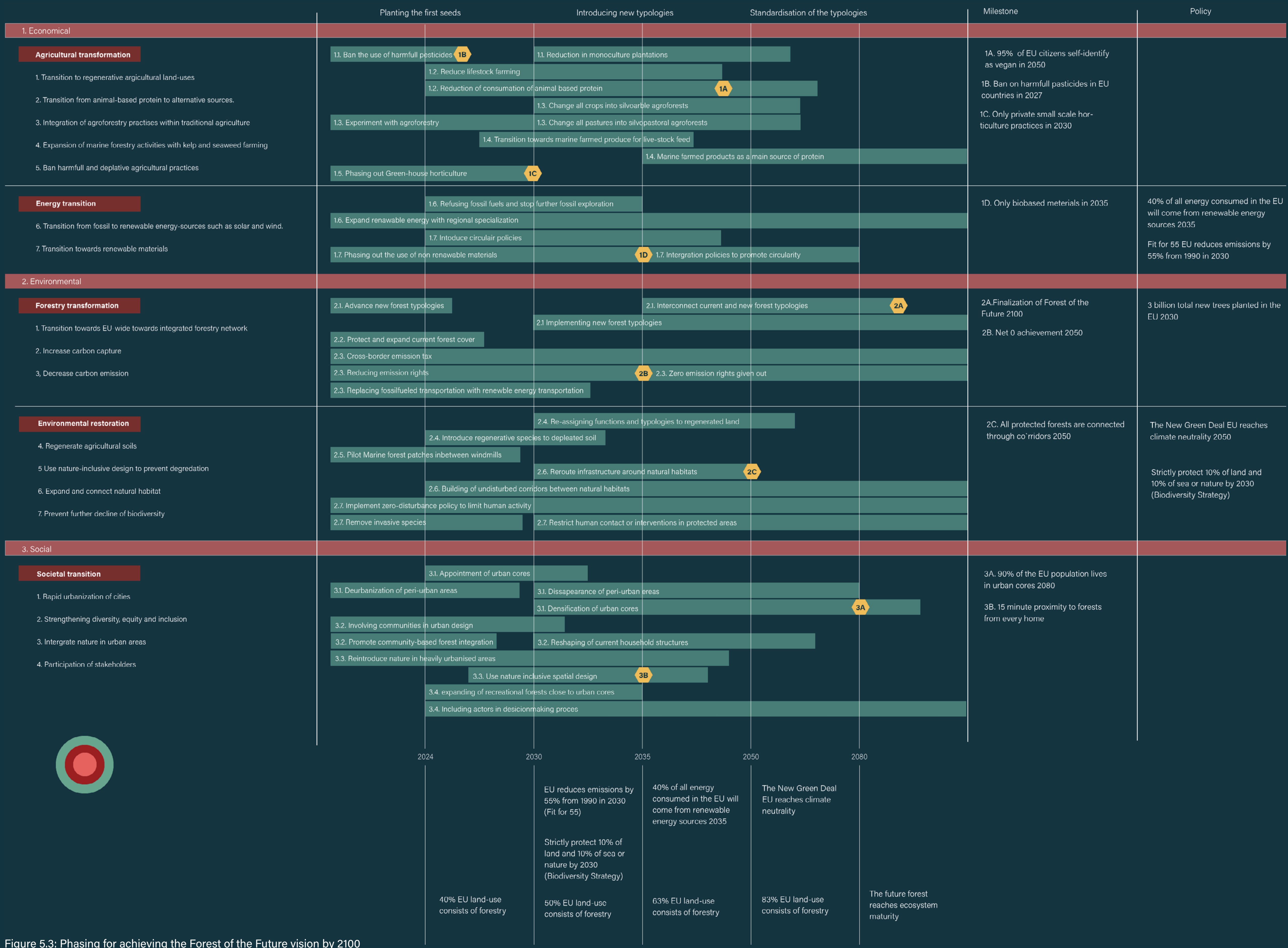


Figure 5.3: Phasing for achieving the Forest of the Future vision by 2100

Strategy | Introduction Strategy Zoom-ins

In this section the spatial implementation of our strategy is discussed. We show the land use shift towards the Future Forest and the spatial implications of this transition. We zoom in on three regions within the BeNeLux bioregion. The selection of these three zooms is made to highlight three different strategic perspectives (rural, urban and marine) and the interventions to be taken in light of our vision, this is also why they are all made on a different scale.

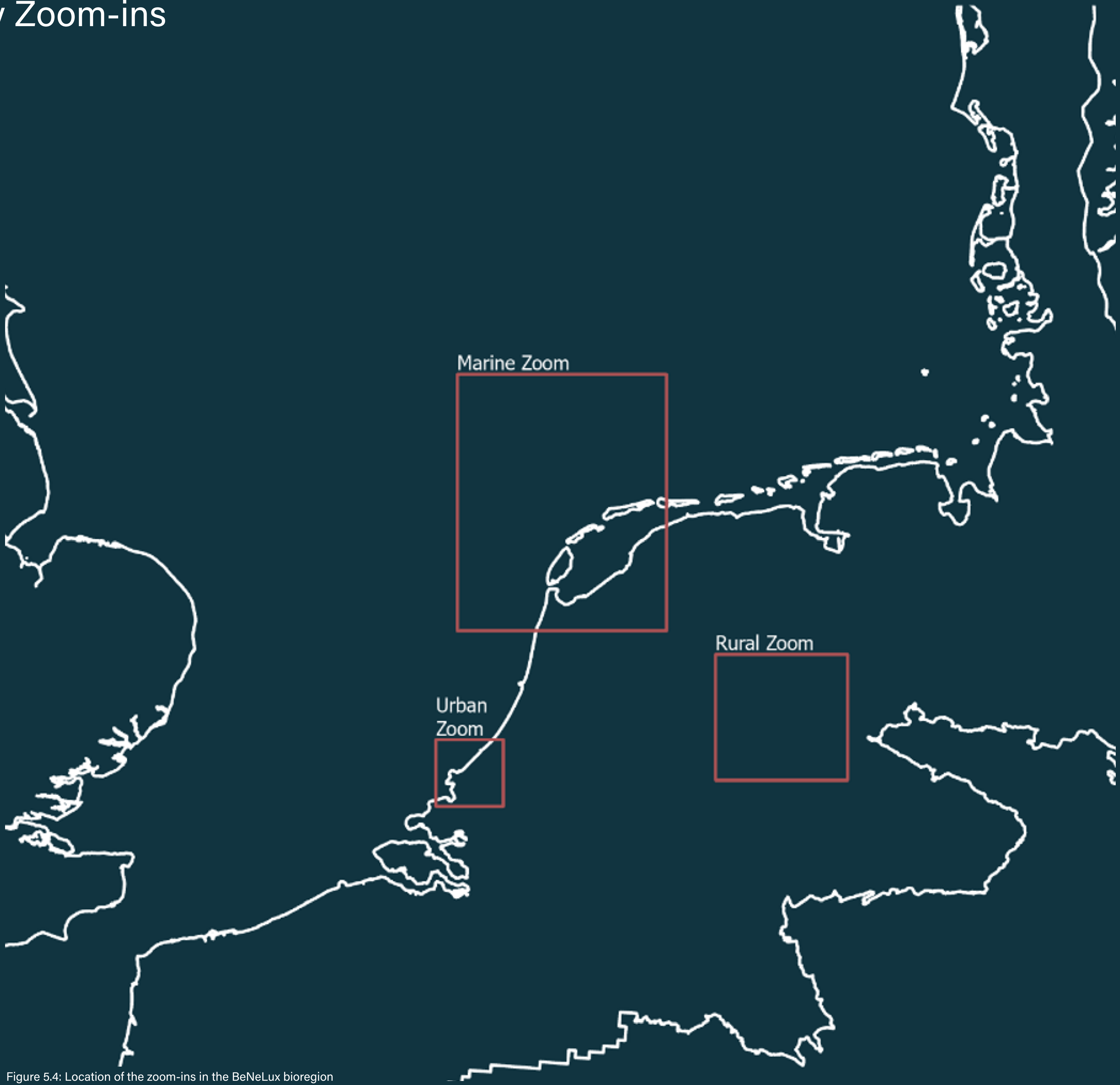


Figure 5.4: Location of the zoom-ins in the BeNeLux bioregion

Strategy | Zoom-in Overview

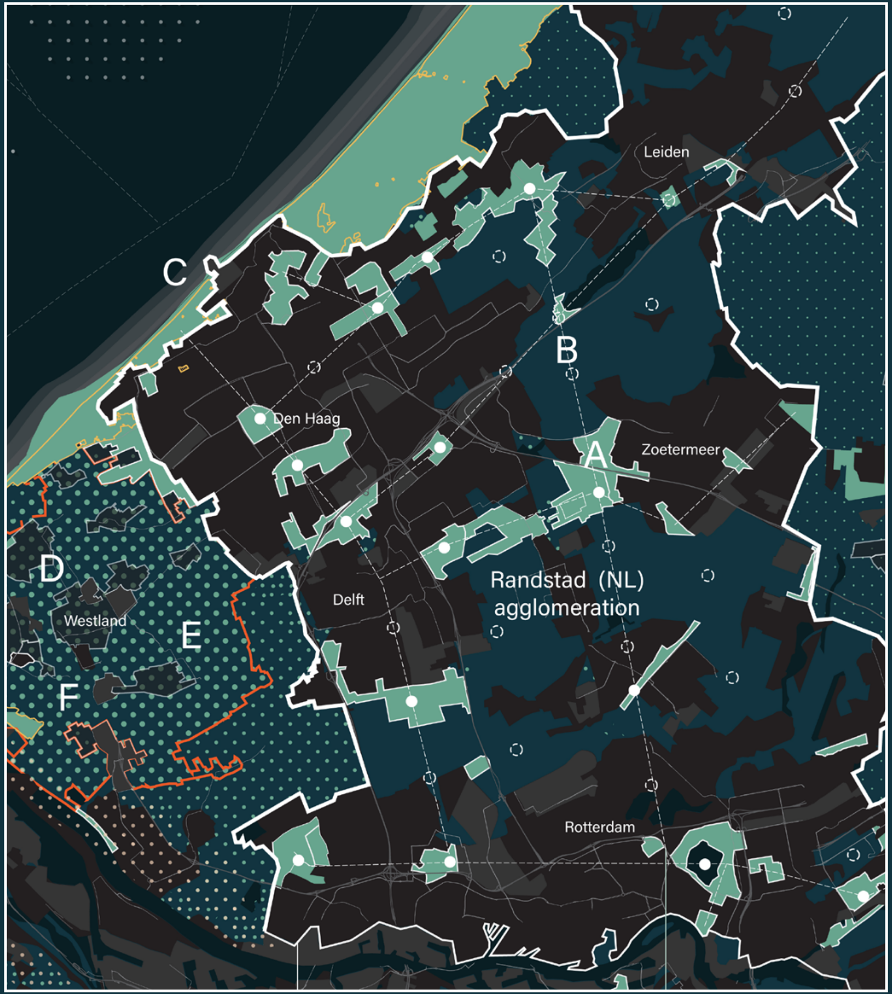


Figure 5.5: Zoom-in on the urban Maasdelta in 2100

Urban Maasdelta (S)

This spatial vision for the Randstad (NL) urban area presents a systematic integration of nature within the urban fabric, bringing the future forest network closer to all urban residents. This vision redefines nature as a public good for future citizenship. With the increasing stresses of city population growth and climate effects, living in close connection with the future forest will enhance urban environments' quality of life by providing ever-more vital ecosystem services to society.

Urban forestry and urban greening will offer essential social ecosystem services to urban citizens by reducing the mental stress of urban environments and improving public health by offering attractive spaces for physical activities. Moreover, urban forestry contributes vital ecosystem services towards the pursuit of "just cities" that enhance diversity, equity, and inclusion by focussing on community engagement with urban forestry.

Key projects include phasing out emission-intensive greenhouse horticulture in Westland for alternative agricultural uses, such as outdoor fruit orchards that leverage the potential of sandy soil. These labour-intensive, yet crucial for food security activities, provide accessible local employment in the peri-urban future forest. Another significant project is mitigating the Maas river's flood risk, a vital European shipping route, through a natural delta integrating a riverine forest. This not only offers climate resilience but also improves spatial quality in the area.

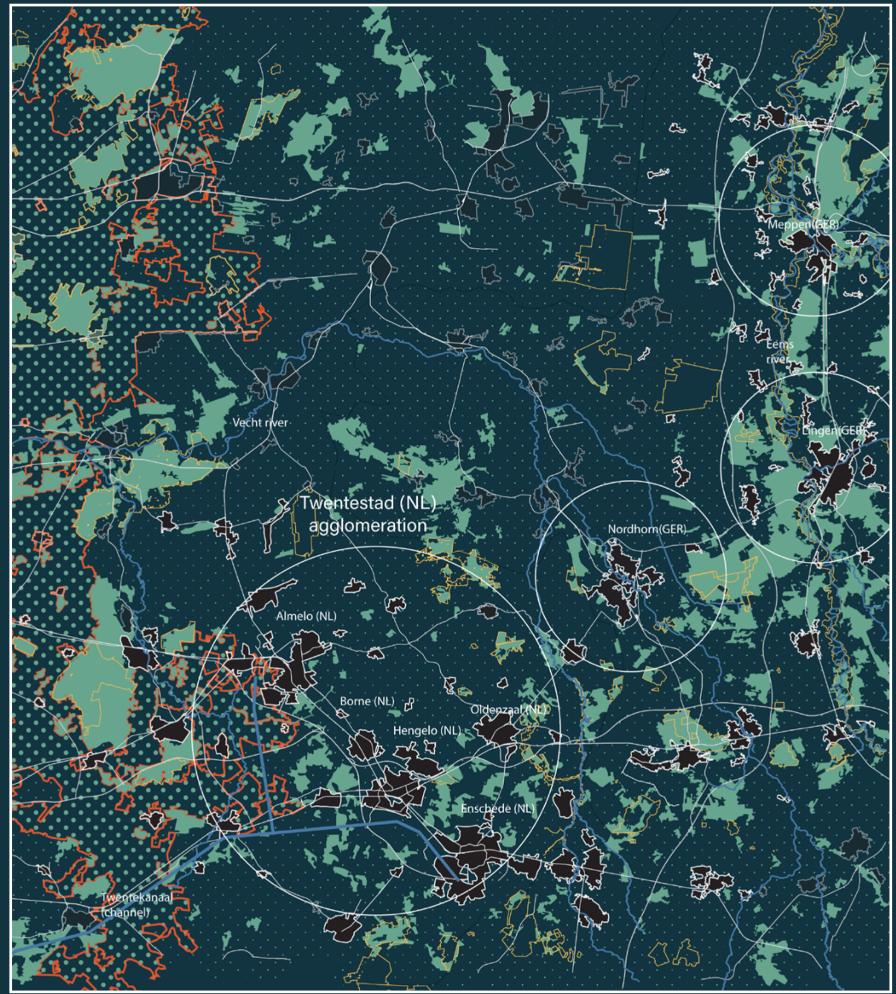


Figure 5.6: Zoom-in on the agricultural countryside in 2100

Agricultural Countryside (M)

The mostly agricultural countryside has been established as critical for a transformation towards sustainable land use. Forestry can support the socio-economic functions necessary for rural areas to thrive and to boost the local economy. A new forest network in rural Europe will be the backbone of ecological restoration, climate resilience, and food security for the continent. This spatial vision sees the fusing of the two classically separated main land uses within the Future Forestry network. It includes a mass integration of agroforestry within crop agriculture, creating a network of low-density forestry. Phasing out of mass livestock farming as part of the protein transition, assisted by reliance on marine-based farming for alternative feed, converts it to high-density forestry, overall significantly increasing the total forest area. The conversion to agroforestry also adds economic diversification for remaining farmers.

From an environmental perspective the Future Forest plays a vital role in strengthening the rural landscape, by restoring ecosystems and supporting biodiversity. It also creates space for nature to thrive and to regenerate autonomously, overall leading to a more resilient ecosystem that aligns with a sustainable future.

The establishment of the future forest will offer alternative economic opportunities with greatly expanding sustainable bio-industrial activities, such as timber production, for circular and long-lived building materials and products. Sustainable raw wood and non-wood materials and products are key in the EU's transition to a sustainable climate-neutral economy (EC, 2021). Also, a refocus on ecotourism will now utilise an underused economic potential (Forest Europa, 2020) and offer employment to the local community and contribute to citizens' physical and mental health.

While the furthering of mechanisation and urbanisation might see a decrease in the total population of the countryside, the concentration of urban living within agglomerations, in conjunction with the future forest offering alternate economic activities, can sustain a necessary level of amenities, quality of life, and employment opportunity for the European countryside and it's communities to thrive.

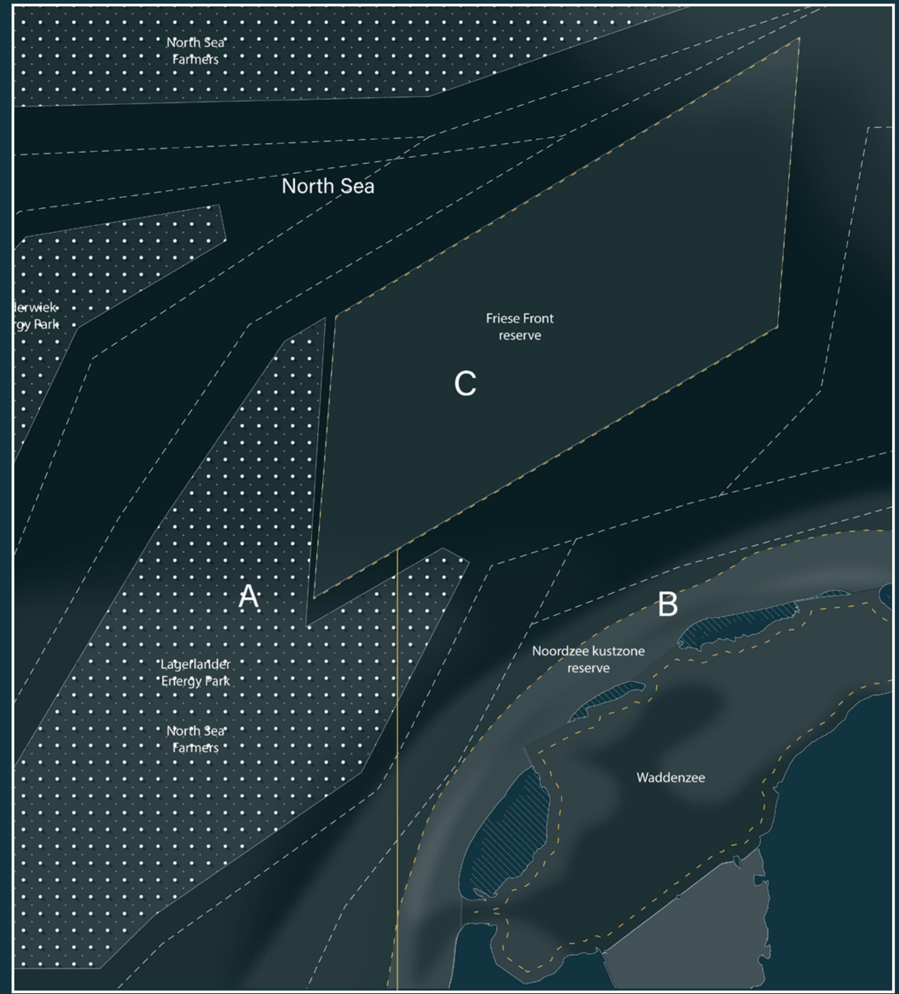


Figure 5.7: Zoom-in on the North Sea coast in 2100

North Sea coast (L)

The North Sea holds untapped potential for sustainable development. This spatial vision provides a blueprint for combining clean energy production, marine agriculture, and ecological restoration.

Key initiatives, like the North Sea marine farms, signal a shift toward a blue bioeconomy with deeper integration into the food chain. The region is set to become a hub for the Netherlands with extensive wind farms, marking a significant move towards clean energy production. There's a synergistic opportunity to merge this with marine farming by using the windmills' structures, allowing for layered use of maritime space. These emerging industries promise national economic diversification and job creation.

An urgent task at hand is the expansion and protection of marine reserves in the North Sea. These reserves are crucial for local biodiversity, serving as nurseries and breeding grounds for various species. The natural seaweed forests growing in these areas, forming a significant part of the Atlantic coastal ecosystem, will capture CO_2, contributing substantially to climate change mitigation.

Similar to the situation on-land, this vision aims to balance contesting spatial claims such as economic growth with energy sustainability and environmental care in the North Sea. Facing climate change necessitates using the natural potential of this region, which will shift how Dutch society views and interacts with the nearby sea.

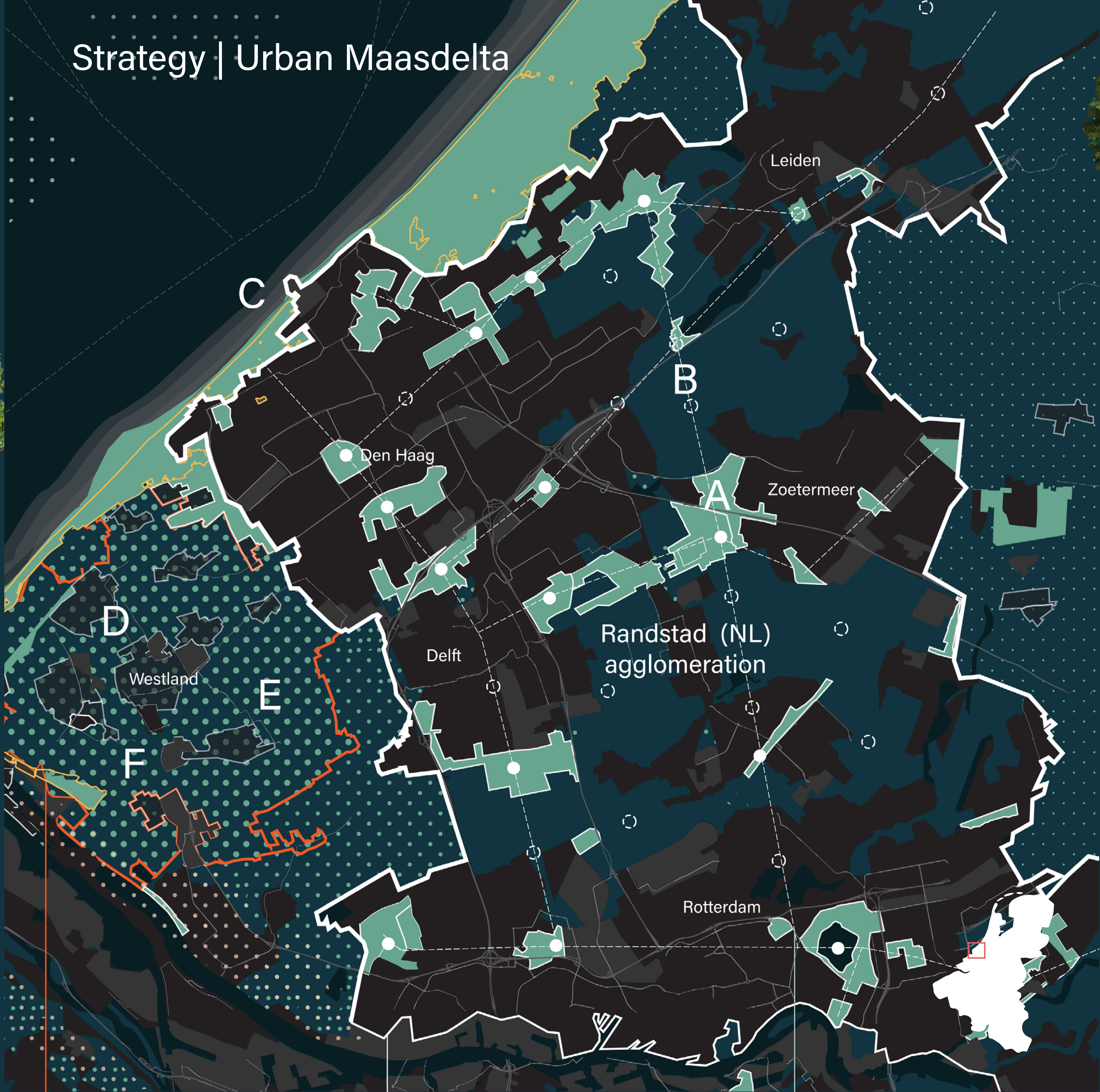
Strategy | Urban Maasdelta

C Figure 5.9: The protected North Sea coast offers an attractive place for sports

D Figure 5.10: Local urban farming engages and involves the community with nature and ecosystems

E Figure 5.11: Local ecosystem education programs empower communities with knowledge and awareness of nature

F Figure 5.12: Public urban micro forestry provides an accessible, attractive place for recreation and de-stressing.of nature.



Mass phasing out of emmision intensive green house horticulture

Concentration of urban expansion with Randstad agglomeration

Expansion and integration of urban green into urban forestry network to offer urban ecosystem services

Figure 5.8: Zoom-in on the urban Maasdelta in 2100

A Figure 5.13: Public urban microforestry provides an accessible, attractive place for recreation and de-stressing

B Figure 5.14: Green urban corridors are not only a means to interconnect urban forestry but also provide a sustainable option for clean, safe mobility, rethinking the traditional commute to work

Strategy | Policy Timeline

A/B/C/D/E/F Recreational Forest

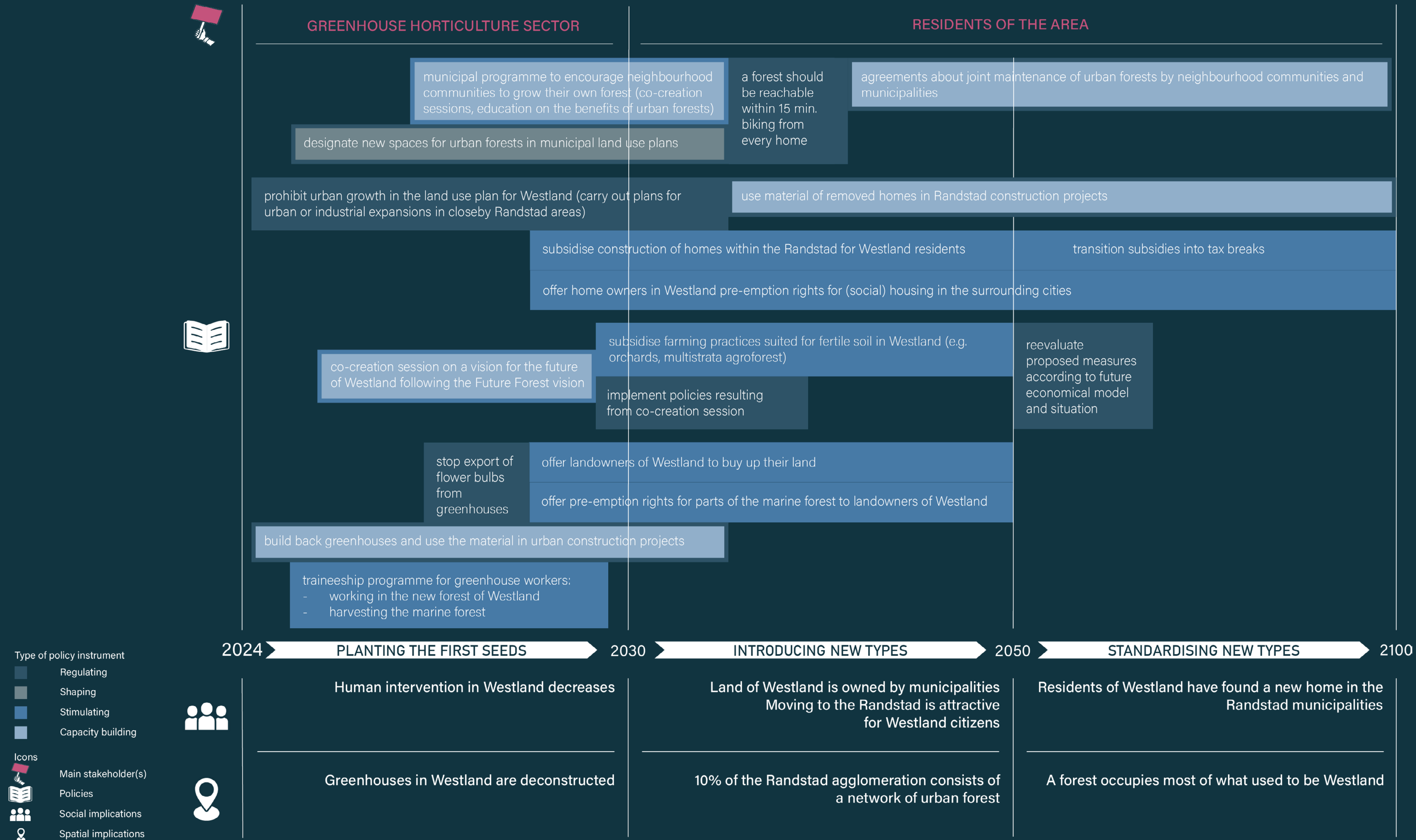
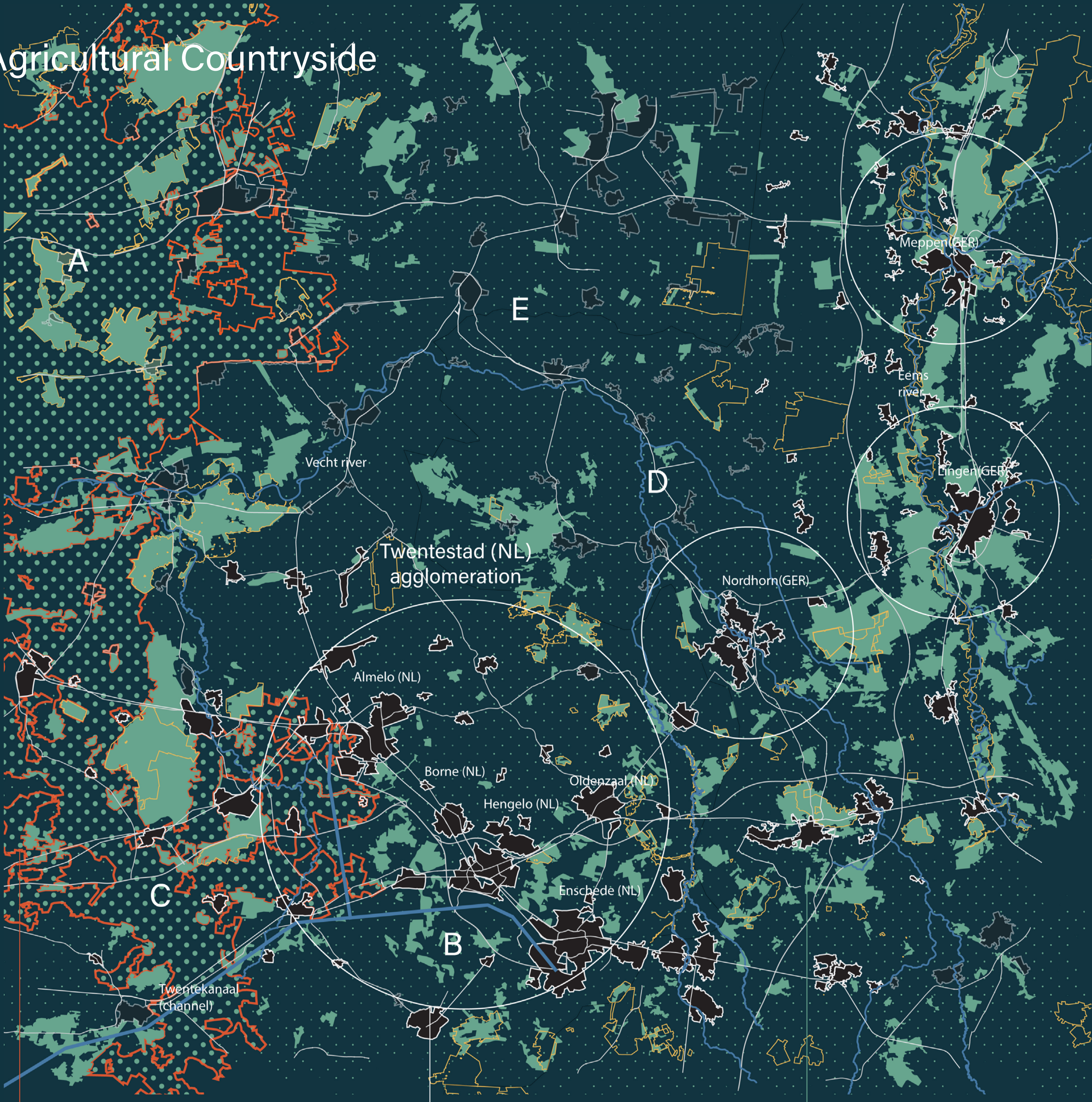


Figure 5.15: Policy timeline for the transition towards recreational forests in the urban Maasdelta

Strategy | Agricultural Countryside



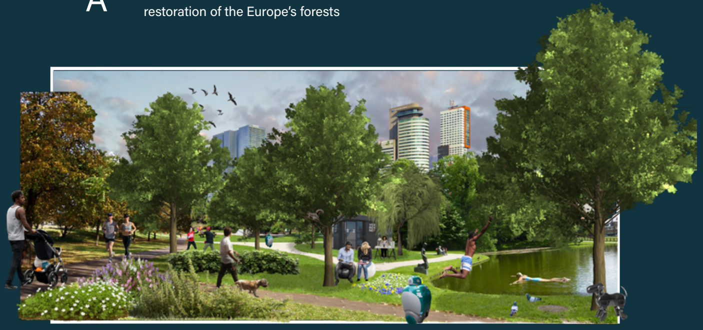
Phasing out of mass livestock farming and conversion to high-density forestry

Agglomeration of urban areas and the integration of forestry within

Integrating fractured patches of existing forest into future forestry network

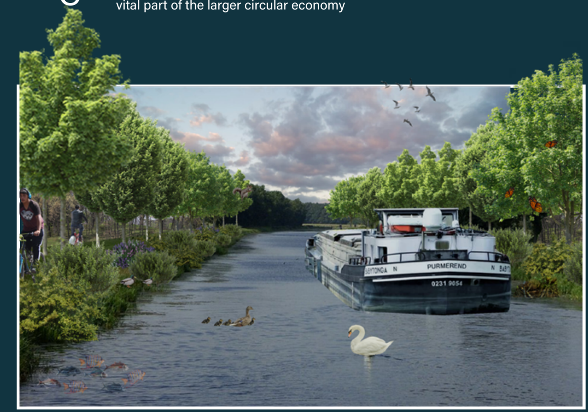
Figure 5.16: Zoom in on the agricultural countryside in 2100

A Figure 5.17: The protected forest forms the basis for ecological restoration of the Europe's forests



B Figure 5.18: Proximity to the future forest network gives opportunity for recreation and ecotourism.

C Figure 5.19: Bio-based industry offers alternative economic functions and forms a vital part of the larger circular economy



D Figure 5.20: Riverine forests offer attractive green areas for ecotourism but also climate resilience

E Figure 5.21: Large-scale shift from intensive agriculture to regenerative agroforestry

Strategy | Policy Timelines

A Protected Forest

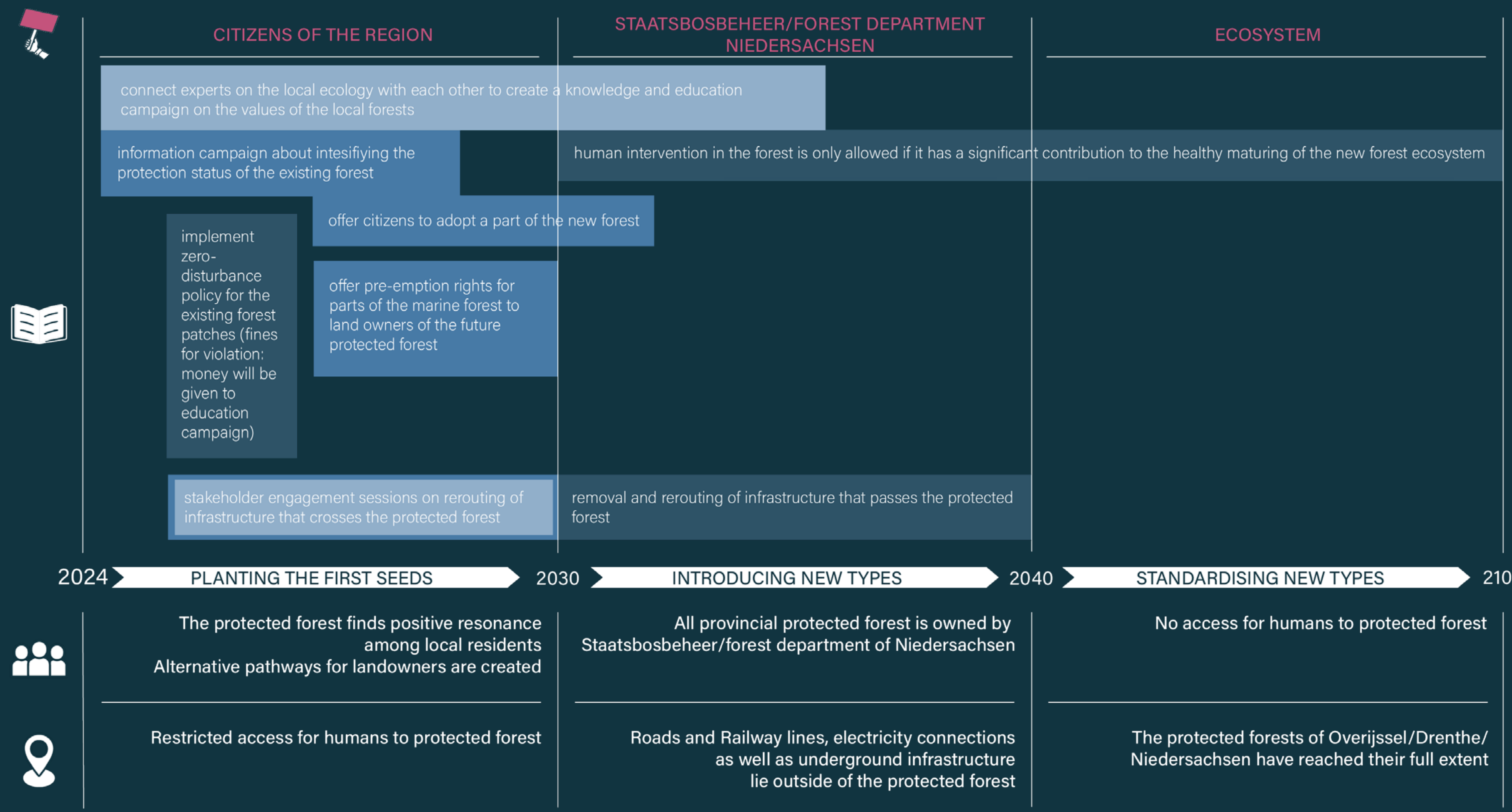


Figure 5.22: Policy timeline for the transition towards protected forests in the agricultural countryside

C Resource Forest

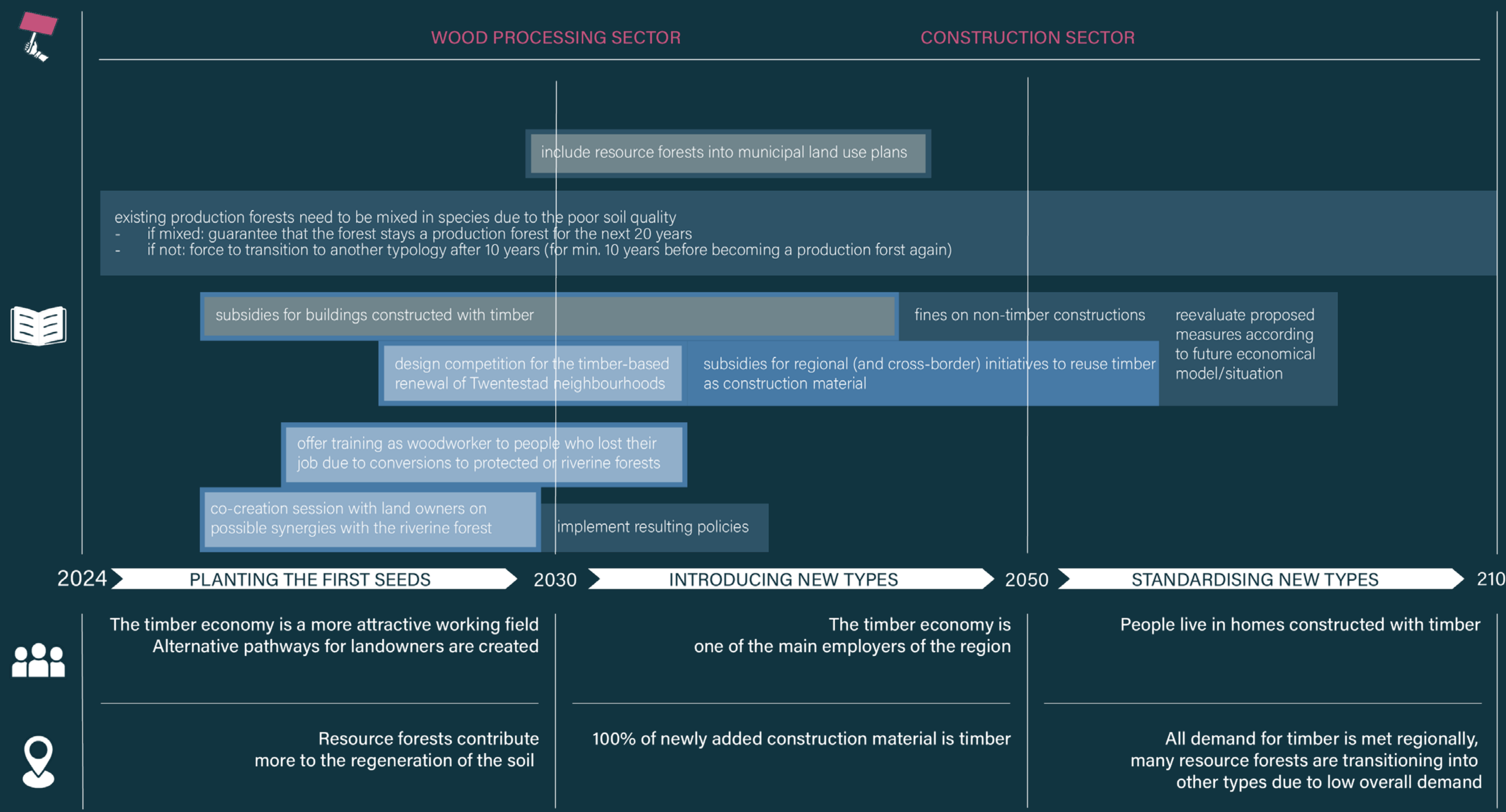


Figure 5.23: Policy timeline for the transition towards resources forests in the agricultural countryside

Type of policy instrument	Icons	
Regulating		Main stakeholder(s)
Shaping		Policies
Stimulating		Social implications
Capacity building		Spatial implications

Strategy | Policy Timelines

D Riverine Forest

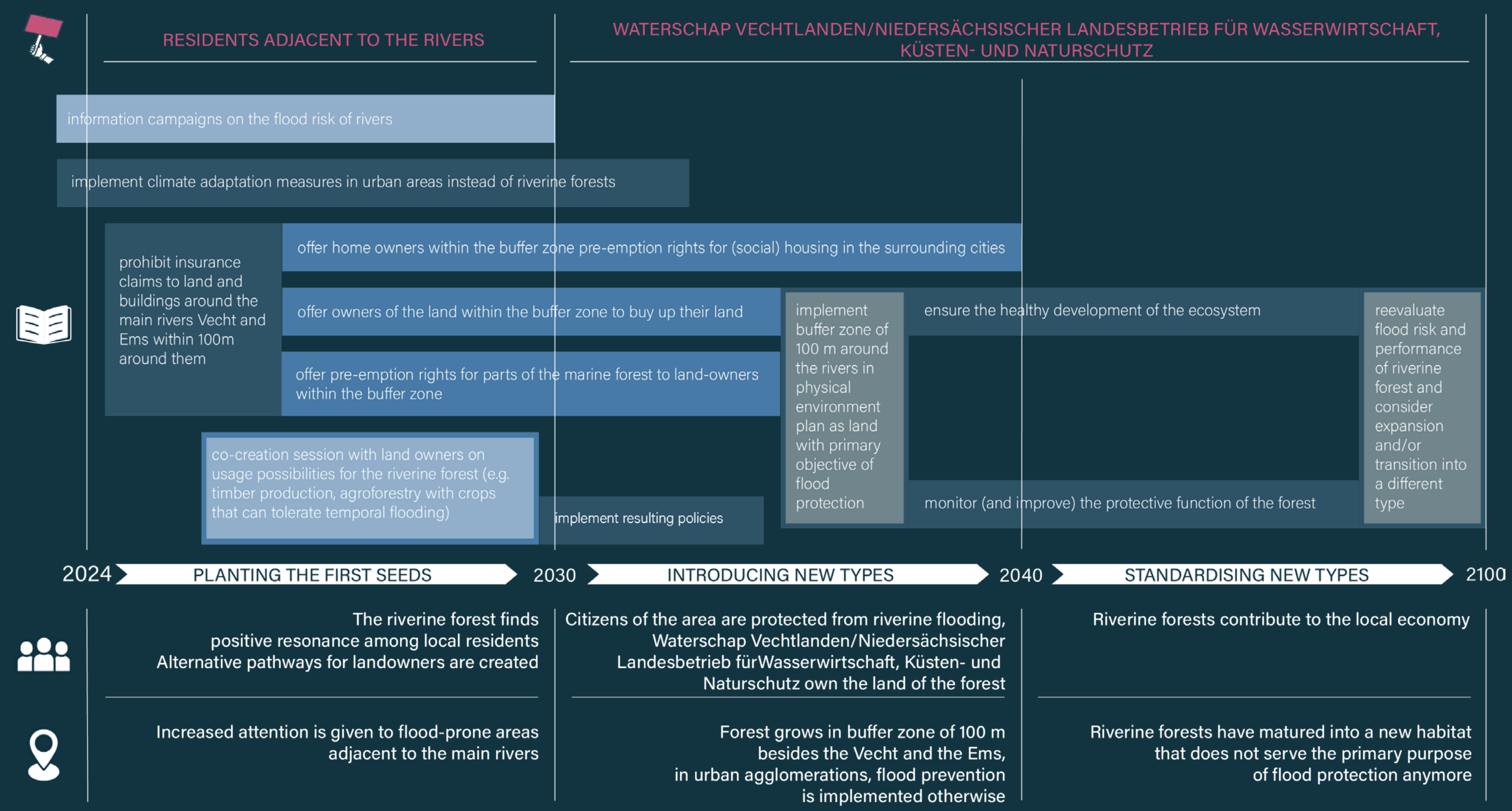


Figure 5.24: Policy timeline for the transition towards riverine forests in the agricultural countryside

E Agroforest

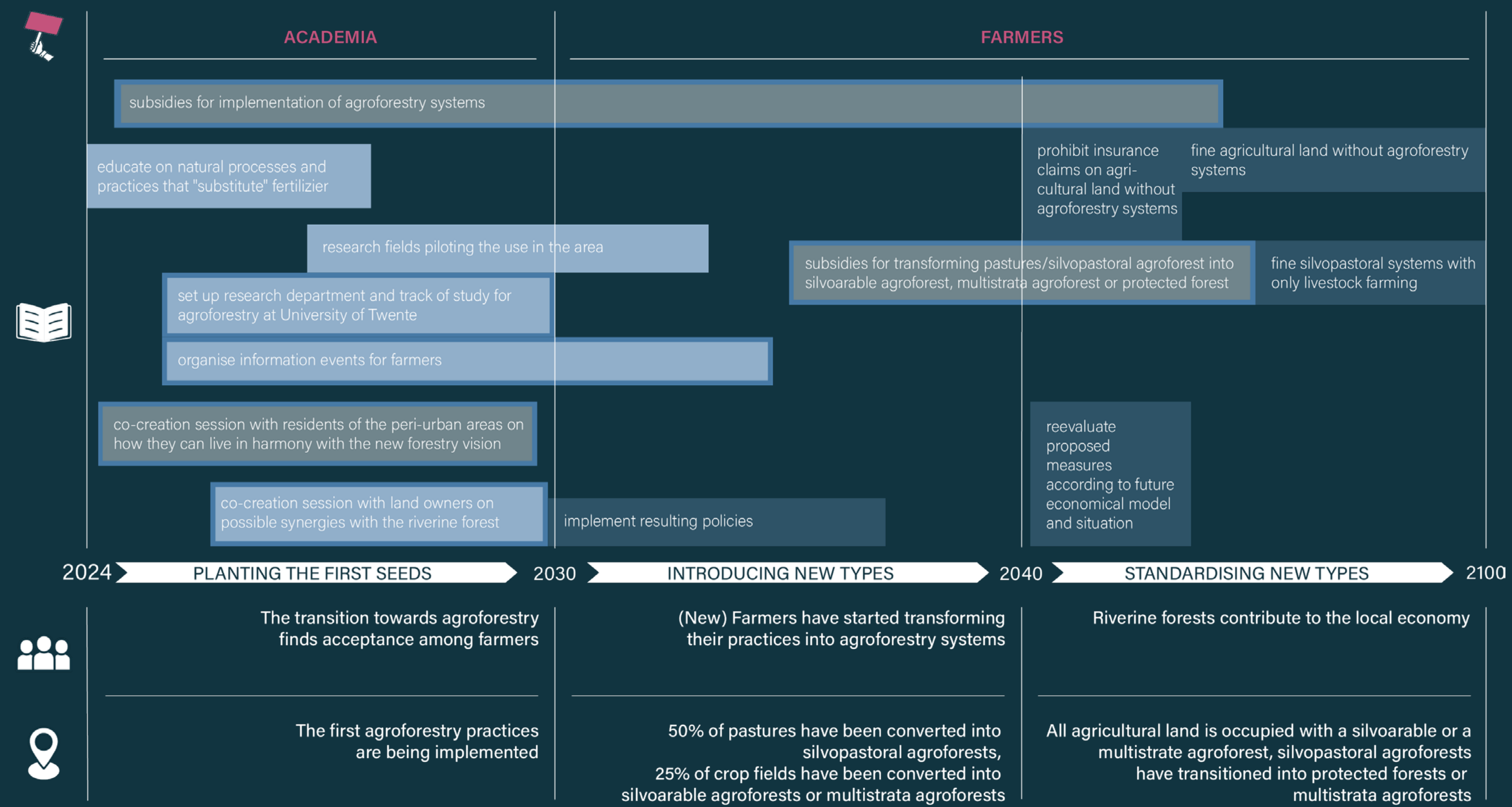


Figure 5.25: Policy timeline for the transition towards agroforestry in the agricultural countryside

Type of policy instrument
- Regulating
- Shaping
- Stimulating
- Capacity building

Icons
- Main stakeholder(s)
- Policies
- Social implications
- Spatial implications

Strategy | North Sea Coast

depth
-2 m; -40m

natura 2000
biodiversity core

shipping route

marine farming

windmill
energy park

silt
agriculture

0 20 km

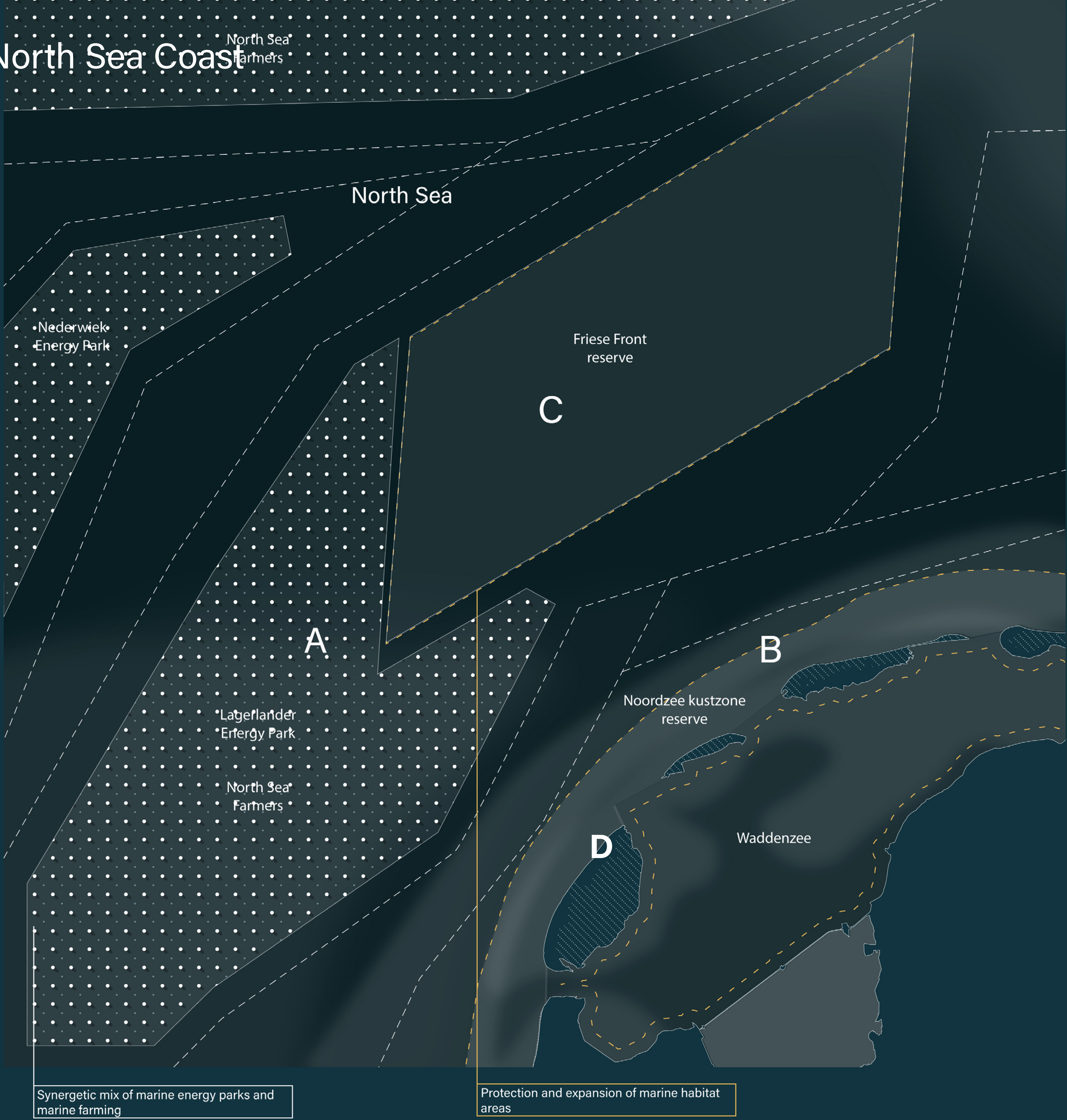
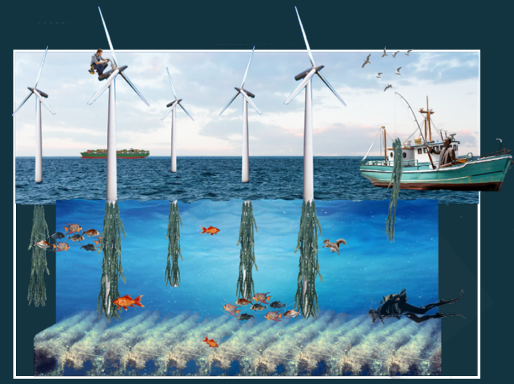
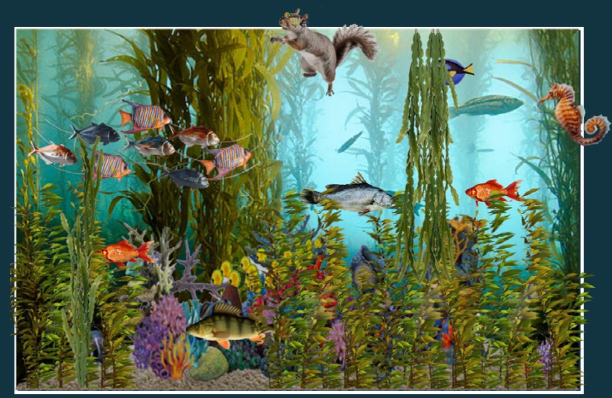


Figure 5.26: Zoom in on the North Sea coast in 2100



A Figure 5.27: Combining windmills for clean energy with the growth of kelp farms for a carbon sink. Hereby creating more space for biodiversity and new job opportunities

B Figure 5.28 By flooding parts of the lands a new type of agriculture named silt agriculture can arise



C Figure 5.29 Protected marine forests create a space for more biodiversity in the sea

D Figure 5.30: Windmills on the horizon and a lively beach with both humans and animal species

Strategy | Policy Timelines

A Marine Agroforestry

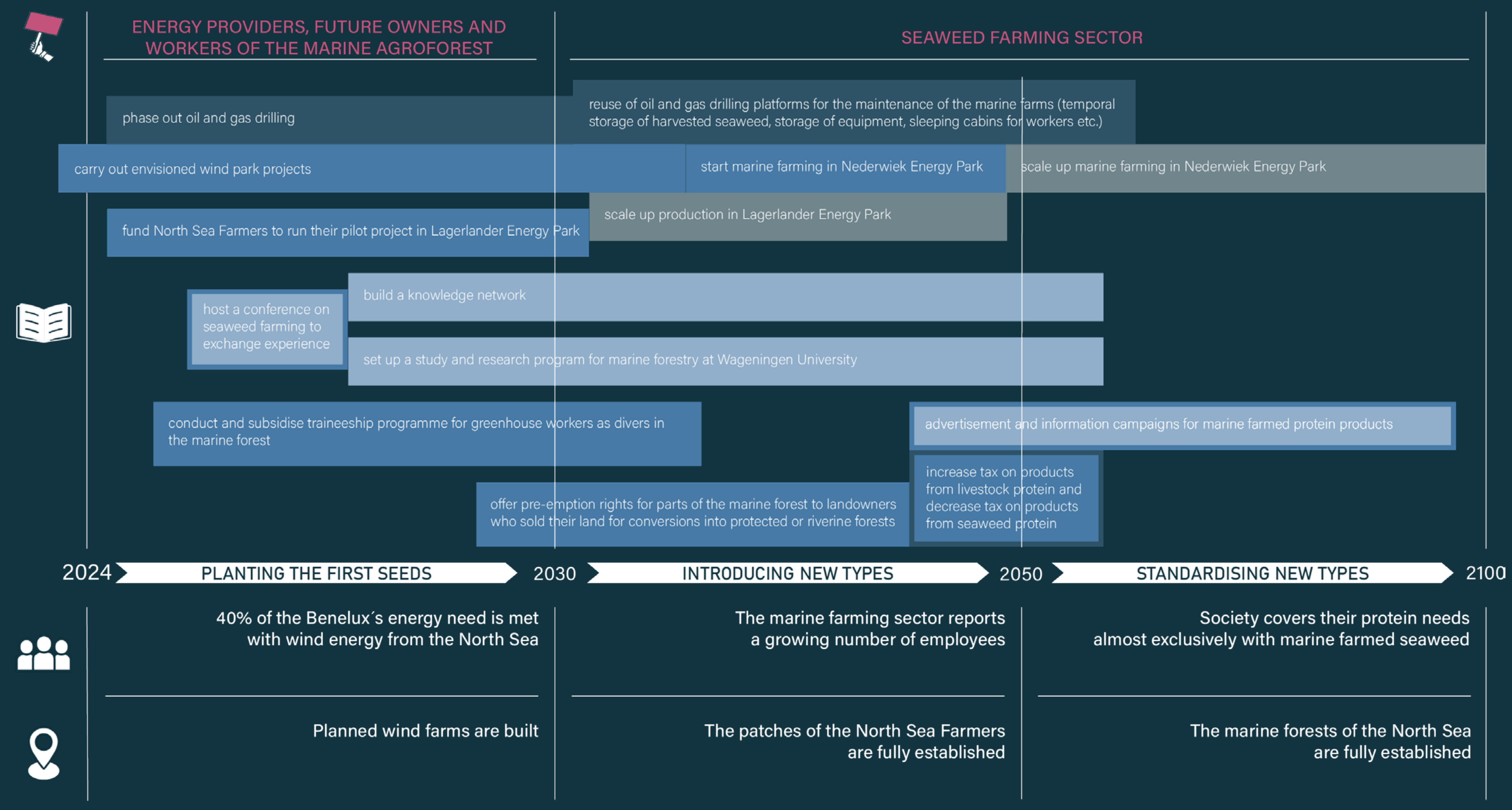


Figure 5.31: Policy timeline for the transition towards marine agroforests in the North Sea

B/C Marine Protected Forest

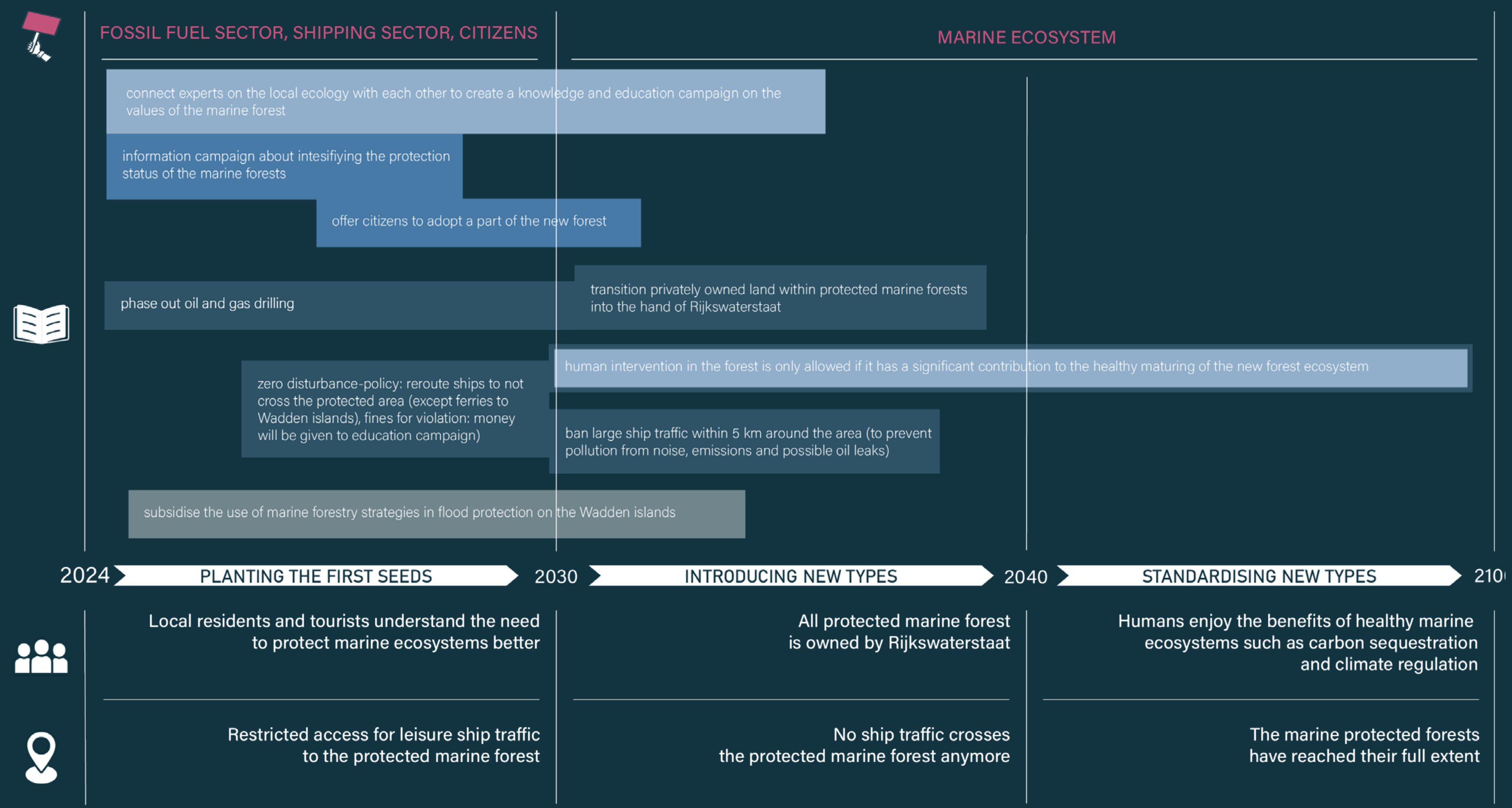


Figure 5.32: Policy timeline for the transition towards protected marine forests in the North Sea

Type of policy instrument
- Regulating
- Shaping
- Stimulating
- Capacity building

Icons
- Main stakeholder(s)
- Policies
- Social implications
- Spatial implications

Strategy | Impressions

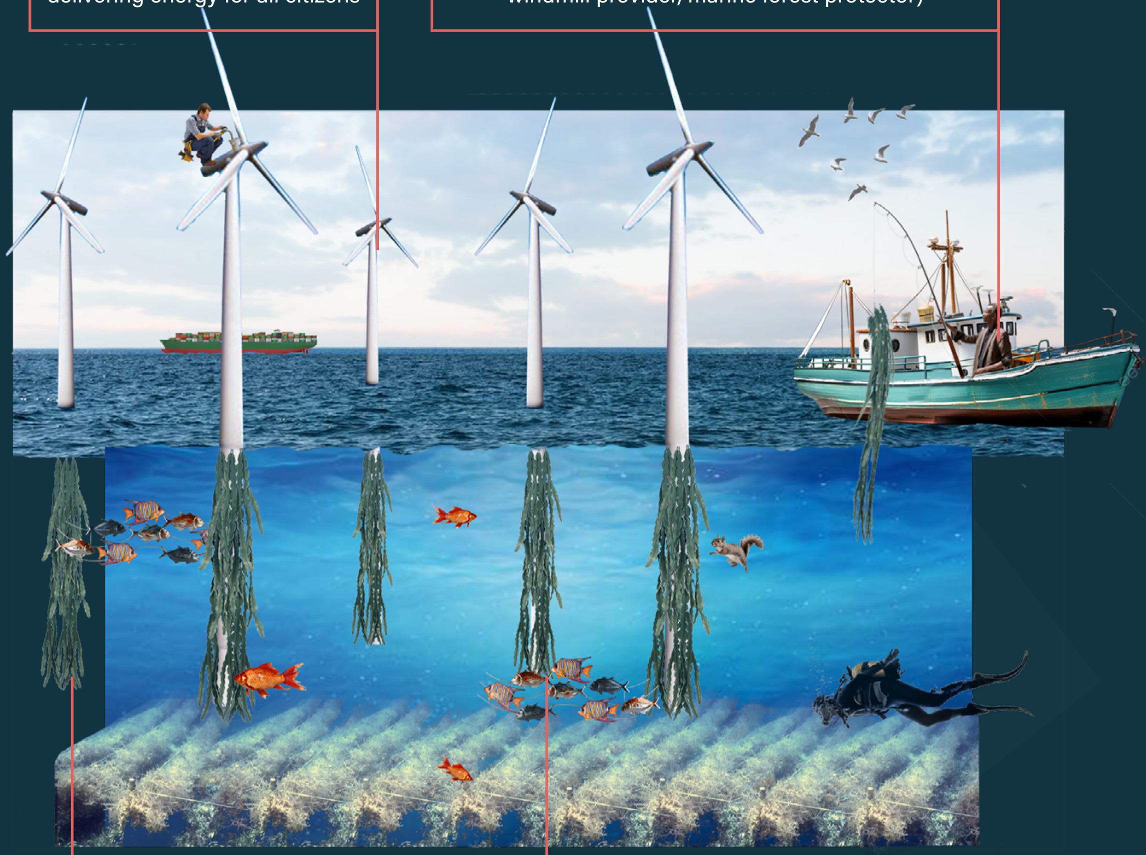


Figure 5.33: Impression of the marine forest

Figure 5.35: Impression of the agroforest

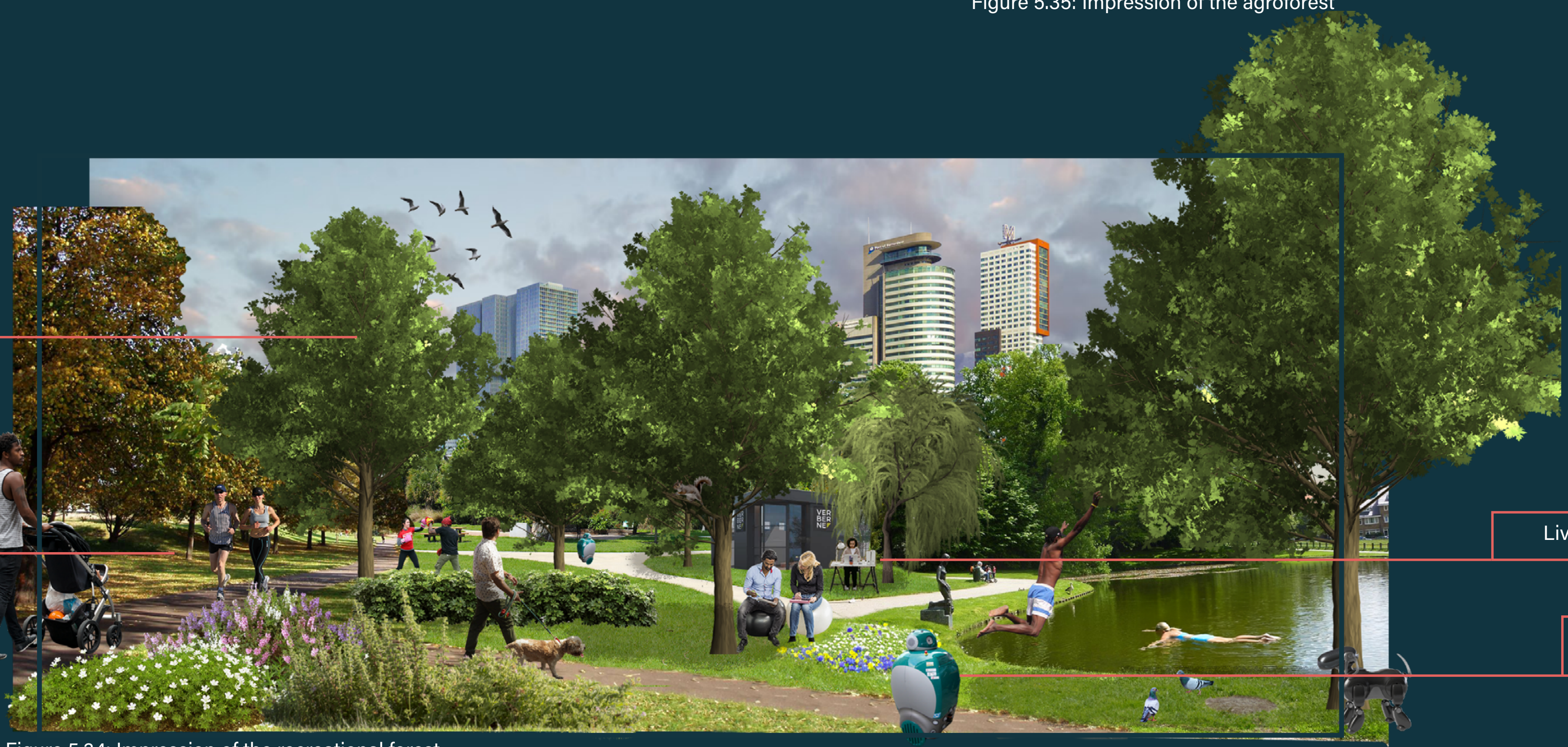


Figure 5.34: Impression of the recreational forest

06 | Evaluation

Watering The Trees

Introduction

Carbon

CO_2 Emission Flows

Climate Adaptibility & Land Use

In this section we are going to evaluate the effects of the spatial strategy to answer the last sub-research question: "How does the transition to a forestation-based just and sustainable land use system help in decreasing carbon emissions and increasing climate adaptability?".

Evaluation | Carbon Emissions

To evaluate carbon emissions we are going to assess how our project can assist in achieving climate neutrality, the EU aim of reaching net-zero emissions. For the evaluation of the project regarding carbon (equivalent) emissions, we are comparing the emissions of greenhouse gases in 2020 with the emissions in 2050. For the 2050 scenario we assume full implementation of our strategy according to our timeline. We do this by assuming certain numbers by means of current and future policies, and by calculating numbers for sectors where our strategy drastically makes changes. The calculations are supported by and based on current scientific research.

The scenario for the emission of greenhouse gases in 2020 is shown in table 6.1, the emissions are given in megatonne (Mt.) CO_2 equivalent.

If we look at the scenario for 2050, we can make assumptions for sectors based on policies and their predetermined targets. The argumentation for the assumptions we made is now added to each row in Table 6.2. 'Y' indicates that these emissions still partly exist in the future. This corresponds in this case to the goals of the transport related emissions. 'X1' and 'X2' indicate sectors where our vision radically changes the emissions. These new emission numbers will be elaborated by means of a calculation.

With our strategy for the Forest of the Future, we intervene directly in the agricultural sector and the land use change and forestry (LUCF) sector. Our strategy in short implies for these sectors that we create more protected forest, put a stop to livestock farming and the use of harmful fertilisers, and convert all conventional crop agriculture to agroforestry. In the calculations for X1 and X2 it will become visible what this means for the emissions of these sectors.

Calculation X1

In the agriculture sector, our strategy intends to put a stop to livestock farming and the use of harmful fertilisers. Together they account for 96% of the emissions caused by the agriculture sector (EEA, 2023). This already reduces the amount of emissions in the sector significantly. The crop agriculture that was usedto feed livestock before can now also be dedicated to food production for humans. The area (mostly grassland) that was first used for livestock becomes protected forest in our strategy. The crop agriculture is turned into agroforestry, which is beneficial for the people and the environment.

The carbon storage potential of different agroforestry systems was extensively researched by Kay et al. (2019). The areas that were selected for the research were the agricultural areas in Europe where the environmental pressure was highest. They looked at nine environmental pressures in total such as rising temperature and loss of soil biodiversity. With the help of experts in agroforestry it was concluded that this area (roughly 8.9% of the total land area in Europe) could sequester on average 22.4 % of the total carbon emission of the agricultural sector dependent on the type of agroforestry.

If we now look at the emissions after applying the strategy, it will be as follows:
*Emission Agriculture sector 2050 (X1) = emission 2020 - 0.96 * emission 2020 - Carbon capture by agroforestry*

We propose to change 24.2% of the total land area in Europe into agroforestry. This implies that (24.2%*22.4%) / 8.9% = 60.9% agricultural emissions could be captured when we apply this strategy. X1 can now be calculated with the number for the emission of 2020.

Calculation X2

For the calculation of X2 we look at the LUCF. In this sector there is already a net minus emission present in 2020. The emissions in this sector are made up out of the increase of emissions due to land use change on the one hand and the emissions captured through to forests on the other hand. Our strategy will increase this deduction of the total emission by increasing the amount of carbon sequestration by forest. Our strategy also implies that there is an increase of 3% of land area that is dedicated to artificial areas in 2050. This area is deducted from the increase in forest. The increase in forest is 17.4% of the total land area of Europe. This is the area that was used before for livestock farming (grassland) (Eurostat, 2021).

The area that is now covered by forest is the old area plus the grassland = of the land area of Europe. We deduct the 3% for the increase of artificial area here to end up with 63.2% land area that is covered with forest in 2050. This means that the 2020 emission for the LUCF sector is multiplied by factor *63.2%/48.82% = 1.29* to gain the emissions for the LUCF sector in 2050.

Table 6.1: European greenhouse gas emissions for 2020 per sector

Sector	Emission GHG 2020 (Mt CO2 eq.)
Electricity and Heat	1960
Transport	1140
Buildings	779,64
Manufacturing and construction	713,96
Agriculture	628,67
Fugitive Emissions	540,44
Waste	276,02
Industry	244,98
Aviation and ship-ping	238,96
Other fuel combus-tion	99,08
Land use change and	-702,01
Total	5919,74

Calculation Y

The transport sector aims to reduce emissions by 90% in 2050. The emission for 2050 can be calculated as follows:
*Emission 2050 = emission 2020 * 0.1*

Table 6.2: European greenhouse gas emissions for 2020 per sector and their assumed future amount with argumentation

Sector	Emission GHG 2020 (Mt CO_2 eq.)	EMISSION GHG 2050	Argumentation
Electricity and Heat	1960	0	All the energy and heat will be provided by means of renewable energy.
Transport	1140	Y	This is in line with the goals set by the International Energy agency. The goal for 2050 is a net zero emissions energy sector (IEA, 2022).
Buildings	779,64	0	The transport sector aims to reduce emissions with 90% by 2050. They want to achieve this goal by eliminating fossil fuels and transition to renewables and biobased fuels. Next to that, reduce the need for it (Raboresearch, 2023).
Manufacturing and construction	713,96	0	Heating, cooling, lightning systems, and installations in buildings should be net zero emission by 2050 according to the Green Deal (European Commission, 2021)
Agriculture	628,67	X1	In line with the EU's climate neutrality goals with the Green Deal, they also aim for a circular economy by 2050. Construction materials and manufacturing processes will be assumed circular by 2050.
Fugitive Emissions	540,44	0	Calculation in more detail below.
Waste	276,02	0	No more unintentional emissions by 2050. Achieved by better and more robust technologies.
Industry	244,98	0	The circular economy of 2050 and thus sustainable waste management will make waste a net zero sector.
Aviation and ship-ping	238,96	Y	Creating of climate neutral technologies and products, driven by renewable energy. This aligns with the goal in the green deal of becoming circular by 2050.
Other fuel combus-tion	99,08	0	Category within Transport sector.
Land use change and	-702,01	X2	No more fuel combustion
Total	5919,74	Mt CO_2 eq.	

Table 6.3: European greenhouse gas emissions for 2050 per sector

Future	Emission GHG 2050 (Mt CO2 eq.)
Electricity and heat	0
Transport	114
Buildings	0
Manufacturing and construction	0
Agriculture	-357,71323
Fugitive Emissions	0
Waste	0
Industry	0
Aviation and shipping	23,896
Other fuel combustion	0
Land use change and forestry	-905,5929
Total	-1125,41013

Conclusion

By inserting the results from calculations X1, X2 and Y into table 6.3 it can be seen that the total greenhouse gas emissions for 2050 are negative in comparison to 2020 (see also Figure 6.1). From this we can conclude that we capture carbon emissions when implementing our strategy. This is also shown in Figure 6.2 where the section for 2100 shows less sources of carbon emissions due to a full implementation of the Future Forest. In our strategy the future forest spans over both land and sea. The marine forests we create are not taken into account in this calculation. Data about the carbon sequestration potential and the area covered by marine forest is scarce and therefore not considered. However, if taken into account the marine forest would enhance the carbon sequestration in the LUCF sector even more.

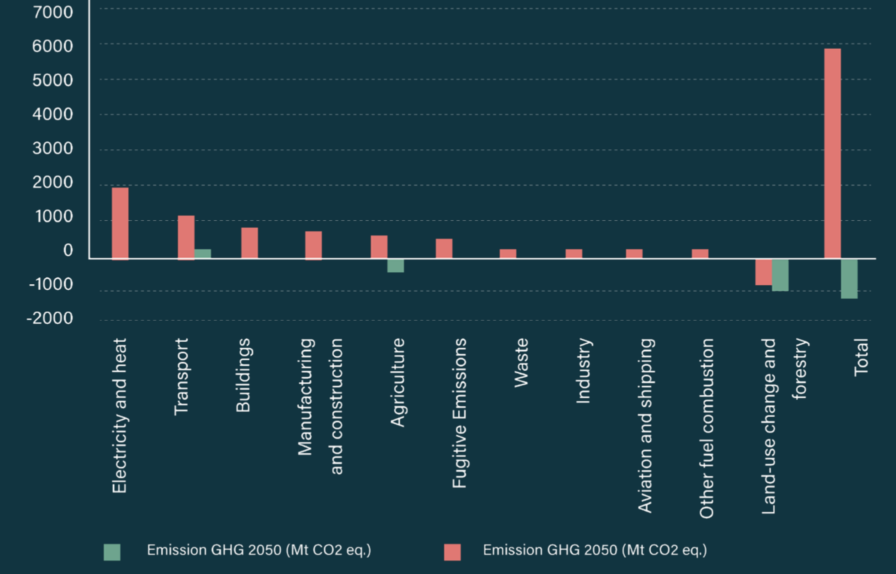


Figure 6.1: Comparison of carbon emissions in 2020 and 2050

Evaluation | CO_2 Emission Flows

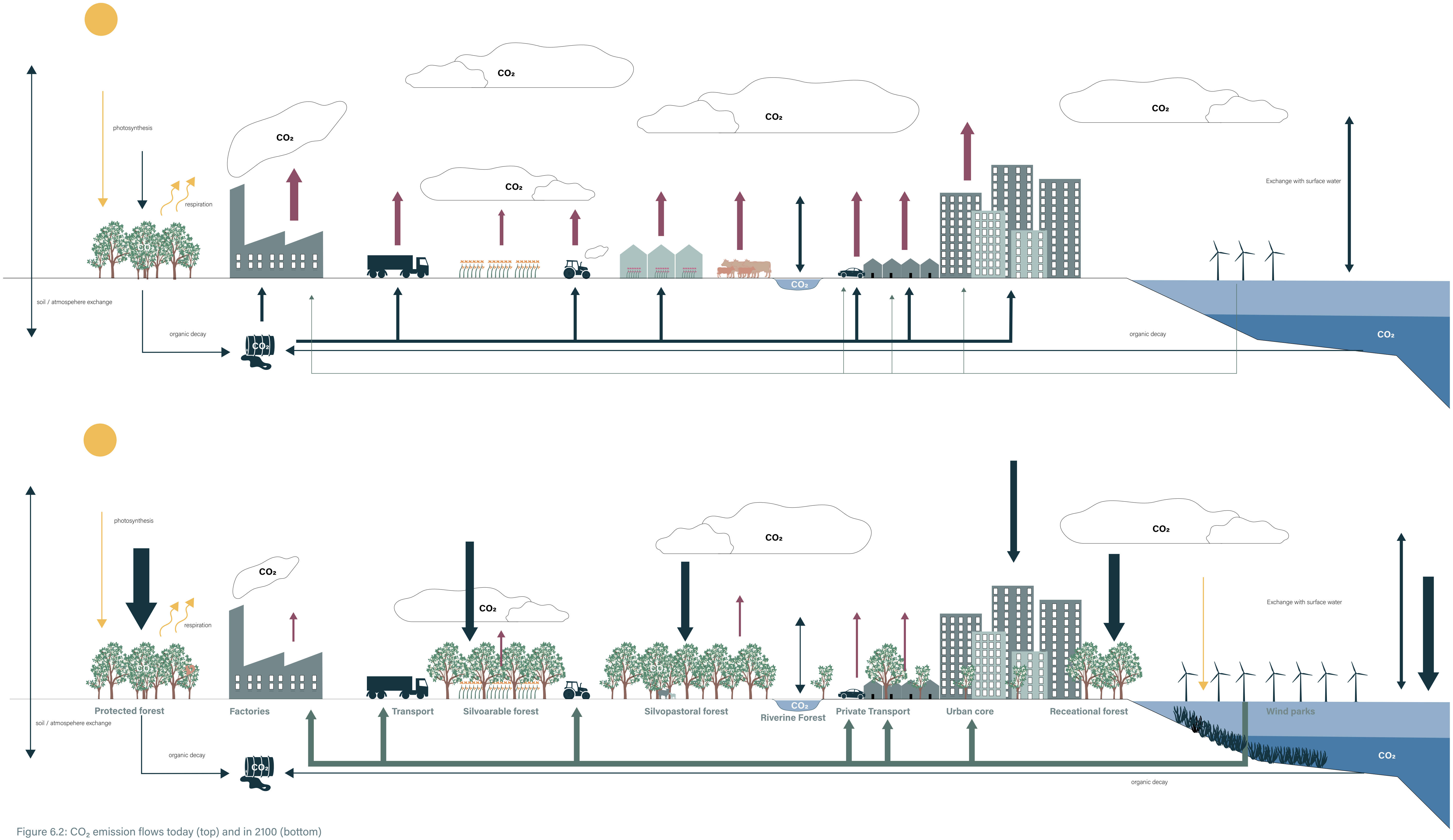


Figure 6.2: CO_2 emission flows today (top) and in 2100 (bottom)

Evaluation | Climate Adaptibility & Land Use

Climate Adaptibility

A comprehensive shift towards more forest, agroforestry instead of traditional agriculture, no more livestock farming and harmful fertilisers will bring several benefits to the climate adaptability of the land in Europe. Strengthened by the principles of the circular economy and climate neutrality in other sectors, both the human and natural systems will become more resilient. Due to the implementation of the future forest, biodiversity is increased, soil health improves and water is protected. These measures create a landscape that is better equipped to handle extreme weather events and changing climate.

This changed landscape can store more carbon and it emits less, which means it helps mitigate climate change. This strategy does not only mitigate the effect of climate change but also builds a foundation for a more sustainable and resilient Europe.

Sustainable Land Use

Our strategy aims to enhance sustainable land use in Europe. To evaluate this we have to go back to the definition for sustainable land use from our theoretical framework. The three pillars of true sustainability have to apply, and distribution or resources should be fair and balanced among all stakeholders.

The social pillar of sustainability is well represented in our strategy. It improves the health of humans by creating cleaner air, soil and water bodies. Next to that we provide better access to green space for everyone. Furthermore, our strategy offers potential for stronger community cohesion through the connected forests and mixed functions it provides. The environmental pillar is at heart in our vision and strategy. Our strategy ensures that air and soil quality improve, ecosystem services increase, and a higher biodiversity is achieved. This transition is meant to relieve the environment of its pressures as well as adapting it more to climatic changes. The economic pillar of sustainability is the most complex one in our strategy. For this we took a degrowth perspective and the uncertainty of the future into account. Jobs related to unsustainable land use are not present in 2100 anymore and a working week might look different in the future. With our strategy, new jobs are created in sustainable practices such as renewable energy and marine forestry, the marine forest, two sectors that will thrive in the future. For the future this demands extensive stakeholder management and making sure no one is left behind in this transition. It calls for training programs, financial support and policies that aim at economic diversification which we implemented within our strategy. However, it is hardly possible to foresee the future transformation of the economy and create policy recommendations accordingly. Therefore, our recommendations leave space for interpretation in the given future context and as a logical consequence can be less effective than envisioned.

The benefits and burdens that come with this transition should be shared equally among stakeholders. We ensure a fair and balanced distribution of access to green space, cleaner air for everyone, and a more resilient system to global market changes. Public goods in the form of forests are expanded significantly in our strategy and are now made in a fairer way, leading to some not being accessible for humans anymore. Disparities in who benefits from this green transition the most should be monitored closely. There should and will be targeted interventions so that everyone can benefit from these new opportunities and resources.

Figure 6.3: AI-generated image of a forestated urban core (OpenAI, 2024)

Figure 6.4: AI-generated image of the agro- and production forest (OpenAI, 2024)

Figure 6.5: AI-generated image of the marine agroforest (OpenAI, 2024)

Evaluation | AI

Finally we fed our ideas into ChatGPT to generate images and check if the outcome would align with the vision. The generated images are shown on the left.

07 | Conclusion

Picking The Fruits

Conclusion

Our study addressed how forestation can spearhead the shift toward a sustainable and just land use system in Europe and how this can enhance climate resilience and reduce carbon emissions. For this we looked at Europe in total and three specific scenarios within the BeNeLux bioregion that showcase generalisable scenarios. In this research we strived to answer the main research question:

"*How can forestation spearhead the transition towards a just and sustainable land use system that increases climate adaptability and decreases carbon emissions in (North-Western) Europe?*".

The assessment reveals substantial ecological challenges, including biodiversity loss, soil degradation, and fragmented forest coverage, driven by mainly intensive unsustainable agricultural land use and also urban expansion practices. We recognized an urgent need for a transition to more sustainable land uses due to the depletion of natural resources and severe environmental degradation.

Just and sustainable land use, as framed in our theoretical work, ensures a fair distribution of environmental resources such as land, water, and biodiversity to meet current and future human needs without compromising ecosystem health. It unites the principles of protecting and restoring natural environments with the fair allocation of space and resources, aiming to balance ecological integrity with societal well-being and economic viability

Forestation aids this transition by restoring ecosystems, supporting biodiversity, enabling sustainable agricultural practices through agroforestry, and enhancing carbon sequestration. Additionally, it plays a pivotal role in providing ecosystem services that contribute to the social dimension of sustainability, including health, wellness, and social inclusivity, through engagement with urban and peri-urban forests. This redefines the traditional concepts of citizenship by creating societies in closer proximity and engagement to nature. It also creates space for nature to thrive and regenerate autonomously.

Achieving this transition requires a multifaceted approach, including policy reform, stakeholder engagement, and the development of a strategic implementation plan that aligns with regional and European sustainability goals. This strategy requires a combination of regulating, stimulating, engaging and capacity building instruments, Additionally, the transition to a forest-based land use system requires a combination of policies tailored to 'planting the seeds' in the near future, launching the Future Forest, and ones ensuring the healthy maturation of those ecosystems over the following decades.

Testing the developed forest types on a local level showcased that the optimal application of the types depends on local conditions. Hence, one patch on the vision map only refers to a dominant land use but allows for differentiation based on the multi-criteria decision analysis. Furthermore, each type is connected to a different set of stakeholders. Therefore, we proposed different approaches in policy making: more regulative policies for the protection of ecosystems and policies focussed on capacity building and stimulating certain decisions for the transition towards new economies like marine forestry.

This transition decreases carbon emissions by transforming land use practices to increase carbon sequestration and reduce reliance on carbon-intensive agricultural practices. Coupling the Future Forest vision with policy frameworks aimed at socioecological and socio spatial transformations positions Europe on the path of the climate objectives, achieving carbon positivity Additionally, the transition enhances climate adaptability by creating resilient ecosystems that can better withstand climate change impacts.

In conclusion, to answer the main research question: Forestation can lead the transition in Europe towards a sustainable and just land use system, directly addressing its ecological challenges. It not only aids in restoring ecosystems, enhancing biodiversity, it also integrates wide scale sustainable agricultural transformation through agroforestry and plays a crucial role in sequestering carbon. Significantly, forestation enriches the social dimension of sustainability by offering societal ecosystem services that boost health, wellness, and social inclusivity, especially through urban and peri-urban forest engagement. This reimagines modern citizenship, fostering communities that live in closer harmony and interaction with natural environments and providing spaces where nature can flourish independently. Through collaborative policy reform, stakeholder engagement, and adaptive strategic scenario planning, this approach not only aims to decrease carbon emissions but also enhances overall Europe's climate resilience, underlining the essential role of multifunctional forests in achieving a balanced, healthy, and inclusive future for the continent.

08 | Discussion

Pruning The Branches

Relevance

Ethical Considerations

Personal Reflections

Generalizability

Our strategy is regionally specific since we focussed on the BeNeLux area with our implementation. The area is within one biogeographical region and has the same development status in the countries addressed. Areas with the same conditions and development status could apply a similar strategy and view our project as a relevant case study. For areas in the EU and the rest of the world overarching strategies and insights can be gained from the project. Insights regarding sustainable land use and nature based solutions for carbon sequestration can be applied globally. The challenges we try to overcome apply globally and thus this problem requires global action. Our project can help by providing a region dependent solution with techniques used that need alteration to apply globally.
and the environment (SDG 3). By means of introducing the Forest of the Future, a lot of public goods (e.g. recreational forest) and a healthy environment for everyone is provided. By empowering nature and providing sustainable fair and balanced land use, inequality is tackled (SDG 10).

Scientific relevance

Our project shows a holistic understanding of the interactions between human activities and natural ecosystems. There is potential to advance knowledge in areas of environmental sustainability and it contributes to the global efforts against climate change. The research provides valuable data on the carbon sequestration potential of different land uses. Next to that it gives an insight on how the implementation of forest-based land use types affects ecosystems on a local and regional scale. The project would also be a living lab for innovative land management practices, where productivity needs to be balanced with environmental conservation.

Societal relevance

Our strategy for The Forest of the Future touches upon multiple Sustainable Development Goals (SDGs) and urgencies we stated in chapter 1. By this we show the societal relevance of our project.

Climate change (CO_2)

The Green Deal strives to make Europe the world's first climate neutral continent by 2050 (European Commission, 2021). After agreeing on the Green Deal, natural carbon sequestration decreased between 2015 to 2020 and therefore, Europe does need additional action (UN Secretary General, 2023). The Forest of the Future can play a vital role in this. SDG 13 (climate action) is a major goal we strive after in our project.
Reduction of carbon emissions is coherent with renewable energy production. Therefore, affordable and clean energy (SDG 7) is central in our strategy where we envision reliable and sustainable energy for everyone. In the Green Deal it is also stated that Europe will be net zero and is driven by a circular economy in 2050. This aligns with SDGs 8, 9, 11, and 12. Net zero will be achieved by responsible consumption (SDG 12) and most people living in sustainable cities and communities (SDG 11). Industry, innovation and infrastructure will all be net zero sectors according to the Green Deal (SDG 9) and will only provide what is necessary in line with the principles of a circular economy.

Deforestation, Ecosystem loss & Unsustainable land use

We increase habitat for current and future species by creating new forest types both on land and at sea which is very much linked to climate action. Ecosystem services will improve and increase. By this, the health and wellbeing increases for both humans and the environment (SDG 3). The improvement of air, soil, and water quality due to carbon sequestration and the implementation of solely sustainable land practices can be seen as an example for this. Increased protected habitat ensures that biodiversity can improve and develop again in deprived areas, both on land and at sea.
By means of introducing the Forest of the Future, many public goods (e.g. recreational forest) and a healthy environment for everyone are provided. By empowering nature and providing sustainable fair and balanced land use, inequality is tackled (SDG 10).

Figure 8.1: SDGs related to the Forest of the Future vision (United Nation, 2024)

Ethical considerations

Vulnerable groups are usually not benefiting enough from a green transition. Green transitions are driven mostly by technology which are expensive and thus only available for the people able to afford it. Green technologies such as green energy come with high upfront costs. Vulnerable groups could be benefiting the most from the long term savings of this, but cannot participate in the first place. This can increase the gap between the most vulnerable groups and most powerful groups. It touches upon challenges of spatial justice (Rocco, 2023).

The implementation of a net zero circular economy in the EU thus demands very careful planning which ensures equitable access to the advantages of green growth. It should be an inclusive process where the specific needs and circumstances of all stakeholders are represented. In our vision we provide a wide range of social and environmental services as public goods, available for everyone.

Fair, balanced and just actions are the foundation of our conceptual framework. Throughout our whole vision and strategy implementation they played a significant role in the outcomes. The ecosystem was our most important stakeholder. This resulted in a strategy where social and environmental value strongly increased, for example by clean air, soil, and a significant increase in green space around humans. The economic implications of this strategy mostly show in the form of possible job displacement. People currently working in unsustainable land use practices lose their jobs due to a changed market in our strategy. We should carefully look at re-educating people to fit the skillsets of emerging markets such as agroforestry, the renewable energy sector, and marine farming. We do this in our policy timelines to a certain extent but this can be expanded.

Due to time constraints we did not conduct interviews with stakeholders in the field and can therefore not really conclude on their attitude towards the Forest of the Future. We therefore focussed more on engaging the stakeholders that can help us achieve our vision than on developing a deep understanding of the blockers of our vision. Devoting more time to this would have enriched our project significantly, since they are most affected by the transition. In terms of engagement a knowledge gap in our research remains with the blockers of the project.

Four urbanism students and one MADE student made our team not really multidisciplinary. All of us having a design or technical background left a knowledge gap for the significant socioeconomic part of regional design. Our project encompasses significant policy and change management, which is closely related to its social implications. Though we tried to cover this field with in-depth research, this aspect was sometimes overlooked by us as a group. Although we all share the same core values for design, we have to make tradeoffs eventually to ensure the compatibility of our ideas with socioeconomic processes. In our case we chose the ecosystem as our main stakeholder. The design underlines this and can sometimes fall short on the socio-economic impact of our project.

Recommendations

Future research should approach the forestry transition from a more transdisciplinary perspective. This would add insights from humanities and local knowledge systems to the current perspective of system design, natural and social sciences. In this way an understanding of stakeholders and the solution can be enriched so as to develop a more comprehensive strategy. From that follows that an in-depth stakeholder analysis and the development of specific stakeholder engagement strategies would be a valuable addition to this research. Bottom-up approaches are preferred, though sometimes top-down decisions are required due to the regional scale. A possible question to be asked is: What would be the most effective and most inclusive way of policymaking to implement the Forest of the Future?

Furthermore, a detailed investigation in the infrastructure connecting the Future Forest is necessary. The starting point for our investigation was the land use system, however, rearranging the land uses also requires rearranging the connections between them. With the establishment of more centralised human settlements and new forestry-based economies comes the need for a renewed mobility and transportation system which needs to be elaborated further.

Our test of the local implementation of the Future Forest types showed that types overlap and transition into each other. A more comprehensive approach to the testing of the types can provide valuable insights. This could be done by collaborating with a region within the BeNeLux area and translating the Forest of the Future vision into an environmental development plan.

Besides more strategic research in the BeNeLux area, the insights gathered from this area should also serve as a departing point for research on the implementation of the Future Forest in other areas of Europe in other climate zones. It is particularly interesting to investigate climate zones where high climatic changes are expected. Particular attention should then be given to the availability of water and nutrients and how they influence the growth development of forests.

Discussion | Personal Reflections

Alina

Very quickly, we as a group decided that we wanted our vision to deal with forestry-based land use systems and that land use for us also incorporated the sea. After we did some initial research, we concluded that we had to look at the scale of the whole of Europe if we wanted to understand the functions of (marine) forests and their role in economic and ecological processes. This resulted in the creation of a pan-European vision which posed an interesting challenge in terms of scale. Besides the advice of our tutors, I believe, two things helped us:

1. The development of a strong and comprehensive narrative. Our Forest of the Future is an exploration of a different landscape and a different society. As Carola Hein explained in her research on 'petroleumscapes,' those two domains need to be considered when building strong narratives for a change (Hein, 2018). An additional challenge in that realm was conveying the complexity of our project in a presentation format. Here, it helped the audience and us that we framed our presentation with an anecdote and dissected complex graphics into multiple layers.
2. A very systematic and analytical approach, especially during the vision-making phase. With the backgrounds of our group members being architecture, civil engineering and planning, the strongly research-based step-by-step approach of developing the new sustainable land use system provided everyone with a logic to navigate the complexity of the European scale. That way, our approach acted as a mediator between morphology and value-based design ideas and knowledge gained from research.

The characteristic of strategy-making as guide towards the vision (Balz, 2024, p. 13) posed a very interesting challenge for me during the second half of the quarter; especially the search for a balance between paving the way for a realisation of the vision and leaving enough space for current and future stakeholders to have a voice in the transition. The time horizon of our project lies far in the future, due to a forest being an ecosystem that takes on around 40 years to mature. Additionally, the future holds great uncertainty, and the scope of the project did not provide enough time for a dialogical study of the stakeholder´s perspectives. Even though we analysed the stakeholders and their interest, there is only so much we can anticipate. For instance, if we plan for a collective decision on a given matter to be taken out in 2040, the outcome might be very different from what we envision today. However, it will be tailored to the needs of the planet and the people of the given future and that is most important.

For me personally, it was a very intense time in which I enriched my prior knowledge of regional planning and design with new methods and topics. I noticed at some points that I took on a mediating role within group discussions which was very interesting for me because I still have some respect for enacting this role in a professional setting.

Feline

In this reflection I will look back on the progression of the project and the final result. Doing a project on a regional scale was a first for me. With so many possible directions to go into and topics to choose it took some time to get into the flow. Being able to discuss with the group, hearing other people's perspectives, helped me understand the project better.

Working with a group of people is always a challenge, everyone has their own work pace and expectations. Once we established a general direction and decided on a vision for the project, we were able to divide the work and focus on making products. I decided to focus on the conceptual framework, in our project this was a key step in tying the theoretical framework and the more practical maps together. Working in a group gave space to really dive into perfecting the diagram and making theory and practice come together.

The process of the project can roughly be divided into two parts, the first was the making of the vision and the second was the making of the strategy. Taking the step towards a strategy was again a point where the development of the project slowed down. But as soon as we started to roughly sketch out our ideas and naively put them on paper, the ball started rolling again. When it was time for the phasing we realised we were able to tie it all back to the conceptual framework. This was a great example on how important a framework is for a project.

Our tutors Caroline and Irene really have a gift of giving feedback on work in a manner which stimulates new ideas and motivates to work. Their enthusiasm about our project helped us get through some more difficult parts of the project. Together with the methodology course the project went into more depth and got more tangible.
In the first week we pitched a radical idea about reforesting the land and industrialising the sea. Looking back we find that we did not stray to far away from this concept and managed to create a, although radical, structured plan to actually make this change happen.

To conclude, this project has taught me a lot about working with a team, about all the ways to substantiate a research and most of all about the importance of the opportunities that lay within a radical idea.

Filip

In the following section, I'm going to reflect on my learnings about the use of narratives for an urban designer for internal team dynamics, how I functioned within my team, and what learnings I extract from this for the next project.

My main learning from this period is a deepened understanding of narratives as an important device for urbanists, for instance in vision-making but also for teamwork. In the process, I found myself often advocating for a clear, cohesive narrative. I recognize this is partly due to my Graphic Design background, where crafting visual and verbal narratives is an important part of the work, but also due to a personal preference for clarity and cohesion. My reasoning behind this is that having to relay an idea to someone else exposes logical leaps and forces clarity. This seemed necessary because a well-structured narrative was key to untangling our complex research and facilitating effective cooperation within the team, for instance in allowing for the effective division of labour. An important moment in the process was the external validation we received during the mid-terms. This bolstered confidence and collective ownership of our idea.

Another learning is that I began to see how narrative occupies a crucial space in Urbanism, especially in the shape of imaginaries within vision, which is especially relevant within the scope of regional design. Our project showed me that at a larger scale, the focus can shift from specific spatial configurations to broader overarching ideas. The vision, and the backcasting from that, are important narrative devices that aid with the "complexity, uncertainty, and multiscalarity of spatial planning and design, and the ethical issues involved" (Kraan, Rooij, Balz, & Qu, 2024). When the idea of backcasting from future imaginaries was discussed in the Remon Rooij lecture, it was a significant moment of learning for us. We had a discussion that allowed us to take a strong shared position, bridge personal differences, and find a position from which, in reality, our stances might diverge, but we agreed upon would make for a better normative agenda and future image.

In the personal assessment at the outset, I identified myself with the 'shaper' role according to Belbin's team roles. This role, characterized by a driven nature, a will to perform, impulsiveness, and enjoyment of conflict and debate, closely mirrors my personal and emotional dimensions. This alignment throughout teamwork has taught me the importance of being mindful of personal and cultural sensitivities. My preference for open and direct dialogue (hard on the issue but soft on the person) is not something everyone is immediately comfortable with. We self-assessed our team dynamic at the beginning and, together with the peer review midway, saw great value in learning about personal and group dynamics, and for a shared essential understanding. We found that mutual awareness and understanding of each other's sensitivities and characteristics allowed us to come back together as a group after confrontation.

Discussion | Personal Reflections

Gilles

For this project we had to create a regional design with a focus on peri-urban areas in the river delta of north-western Europe. Our group decided to go for a vision where a nature-based solution, in our case forestation, enhances mitigation of climate change and could aid in carbon sequestration. This led us to an approach where we redefined a forest. For us a forest is not just a collection of trees anymore, it can have multiple functions at the same time and is incorporated in many functions. This vision comes with challenges to be overcome since it is quite radical. The most challenging part was to make the strategy realistic and justified.

The two things that we always had to be aware of during this project are the 3 pillars of true sustainability and the triangle of spatial justice (Rocco, 2023). Since our vision and strategy imply a lot of shifting functions, it is important to take all affected stakeholders into account. More forests and less emissions lead directly to social and environmental improvements, where a healthier environment is created for both humans and the ecosystem. In terms of economic sustainability, unsustainable land use practices and the jobs associated with those practices are absent. New jobs will be created from the vision in theory. However, a more extensive stakeholder analysis in the most affected fields is not conducted. To touch upon all aspects of spatial justice is therefore complicated. The question if we divided the benefits and burdens (Rocco, 2023) equally is partly answered. The benefits of our strategy are for everyone and can be considered public goods in most cases. The burdens however not. Targeted interventions should be in place to ensure equitable access to opportunities. Our strategy implies a large-scale transition of functions, and therefore needs careful long-term planning and inclusive design.

In this case we justified our decisions based on theoretical research and ongoing policies by the EU. In this way we were able to make assumptions by backing the research and policies, to move forward with a justified vision. What I very much liked in our approach is that we were able to show systematically how this can be a viable truly sustainable strategy for all stakeholders[GH1] . By means of this quantitative justification of our vision, the strategy can be used as a spot on the horizon for sustainable land use in the future.

Personally, I really enjoyed this project. Working on a project with such a large scale within a group comes with many challenges. Challenges that will make you grow as a team member and in my opinion will prepare you for the future, where it is likely that we will work in a team. As a group we really had to get to know each other before we were able to work efficiently. With time we managed as a group to get our metaphorical diesel engine running smoothly and it brought us to a great result where we can be proud of.

Manou

At the beginning of the project, I was a little sceptical about the regional scale of the course. It feels vague for me to create a vision for such a big environment that it loses its real meaning. That the human would not really have a say in the process. Throughout this course my mind changed piece by piece. After a few weeks I already saw that the regional approach could be more in a systematic way by for example creating a coding system like we did. Here I discovered the multilayered and complexity of this scale. And then later when creating a strategy and phasing of the project, the social aspect was important. To zoom in on one part and get a better knowledge about how the vision is implemented. By creating this new method of designing and implementing stakeholders bigger than just residents gave me a broader view on spatial design. Without creating a bigger vision would the urban planning be chaotic and aimless. I really learned the value of zooming out on a bigger (Europe) scale to get a broader and complex outcome.

Personally, the hardest part of this course was visualising the ideas and future scenarios in diagrams, collages and a good narrative. How can you visualise a framework or practice in a way that everybody understands? A lot of times in the group meetings I had difficulties with understanding which direction we were going and lost the narrative often. With 5 people a lot of work can be done, but also a lot of changes can be made. But with effective communication and a head of narrative, in the end it was getting much clearer. In addition, the methodology sessions helped by creating the importance of our project. It gave me insights into what the essence and goals are of our project.

The other challenge I was facing was the forecasting of the future environment. How will people live in 80 years and how will technology develop in humans' life? We could interpret what we expect but sometimes it does not seem logical and in what timeframe is it possible. It is interesting to think out of the box of how future generations are going to live. I already learned a lot about forecasting, but I still would like to engage in that in future studies more.

In conclusion, I must say that this course gave new insights in Research and Design of the environment. Looking at spaces outside the urban areas and finding a connection with all land uses. The group work helped a lot with getting more feedback to bring the project to a great result. And hopefully I will meet the squirrel that travels from Spain to Norway in the future.

09 | References

The Roots

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10 | Appendix

Behind The Bark

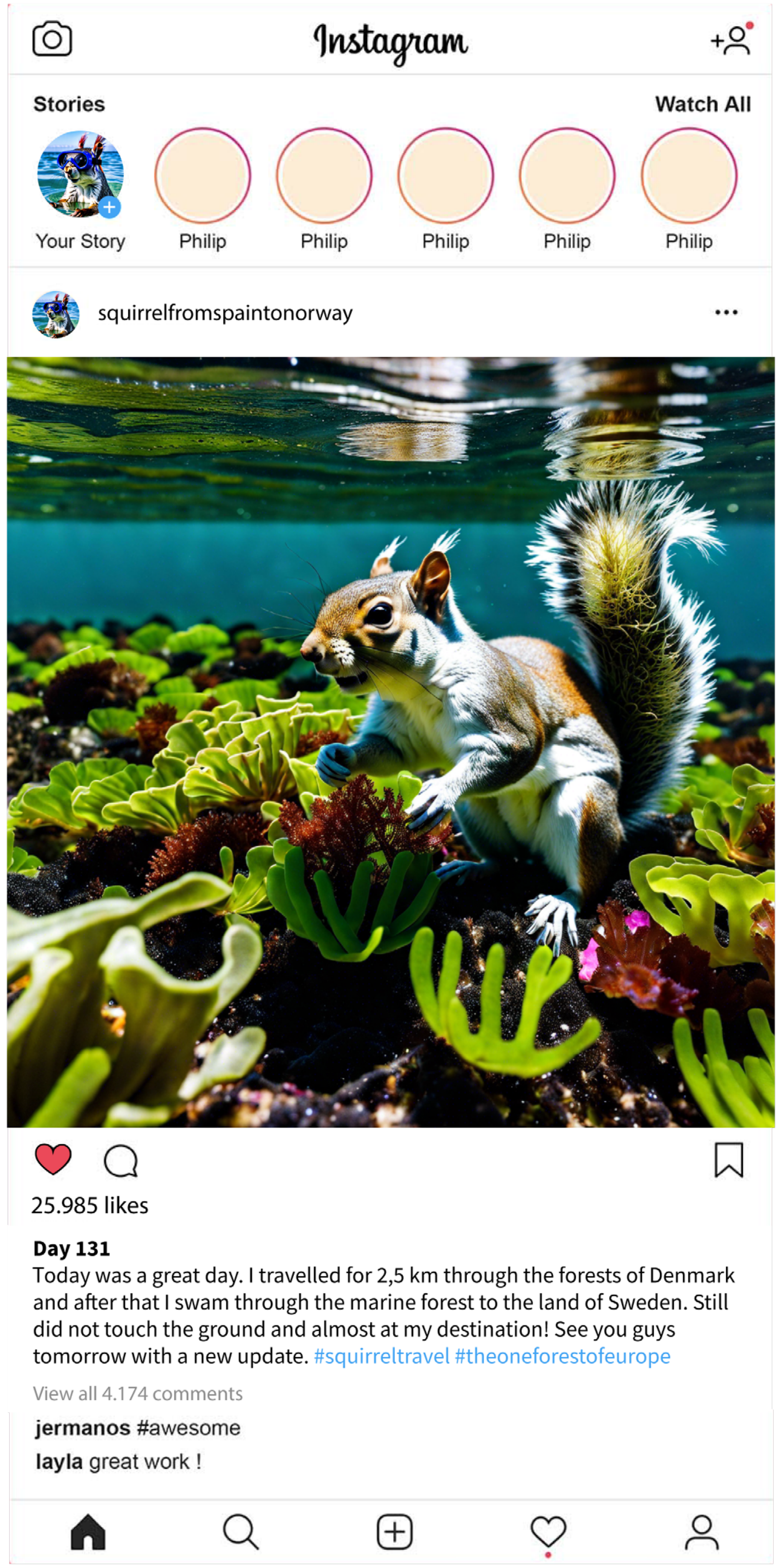
Social Media Post

Forest Type Building Process

Environmental Assessment Process

European Analysis Synthesis

Social Media Post



Forest Type Building Process Step 1 (1/3)

Concept	Pillars	Goals	Tools	Function
Future of Forestry	Environment	Improvement of Ecosystems	Biodiversity	Forest as a biodiverse ecosytem
			Carbon Capture	Forest as a carbon sink
			Soil Regeneration	Forest as a means to prevent degradation/erosion
			Energy Production	
			Food Security	Forest as pollinator
			Renewable natural resources	
			Health	Forest as a means to improve soil quality
			Recreation	
			Mobility	Forest as an ecological corridor
		Future Livability	Biodiversity	Forest as a resilient ecosystem
			Carbon Capture	Forest as a means to keep the planet habitable
			Soil Regeneration	Forest as a means to prevent degradation/erosion
			Energy Production	Forest as a means to ensure energy security
			Food Security	Forest as food supplier (agroforest) for animals
			Renewable natural resources	Forest as water filterer
			Health	Forest as air purifier/carbon capturer
			Recreation	Forest as recreational place
			Mobility	Forest as an ecological corridor
		Essential Resource Generation	Biodiversity	Forest as a closed ecosystem
			Carbon Capture	Forest as an air cleanser
			Soil Regeneration	Forest as producer of healthy/fertile soil
			Energy Production	Forest as a means to ensure energy security
			Food Security	Forest as food supplier (agroforest) for animals
			Renewable natural resources	Forest as timber source
			Health	Forest as an air cleanser
			Recreation	
			Mobility	
	Social	Improvement of Ecosystems	Biodiversity	Forest as an educational space
			Carbon Capture	Forest as securer of livelihoods
			Soil Regeneration	
			Energy Production	
			Food Security	

Forest Type Building Process Step 1 (2/3)

		Renewable natural resources	
		Health	Forest as means of flood protection
		Recreation	
		Mobility	
	Future Livability	Biodiversity	
		Carbon Capture	Forest as a means to keep the planet habitable
		Soil Regeneration	
		Energy Production	
		Food Security	Forest as a food supplier (agroforest)
		Renewable natural resources	
		Health	Forest as protector against uncomfortable climate
		Recreation	Forest as part of the culture
		Mobility	Forest as a scenic route
	Essential Resource Generation	Biodiversity	
		Carbon Capture	
		Soil Regeneration	
		Energy Production	Forest as a means to ensure energy security
		Food Security	
		Renewable natural resources	
		Health	Forest as a source of medicine (herbs etc.)
		Recreation	Forest as a helper with mental health
		Mobility	
Economy	Improvement of Ecosystems	Biodiversity	
		Carbon Capture	
		Soil Regeneration	
		Energy Production	
		Food Security	
		Renewable natural resources	Forest as a workplace
		Health	
		Recreation	
		Mobility	
	Future Livability	Biodiversity	
		Carbon Capture	
		Soil Regeneration	

Forest Type Building Process Step 1 (3/3)

	Energy Production	
	Food Security	
	Renewable natural resources	Forest as a closed system (circular)
	Health	
	Recreation	
	Mobility	
Essential Resource Generation	Biodiversity	
	Carbon Capture	Forest as a supplier of fresh air
	Soil Regeneration	Forest as producer of healthy/fertile soil
	Energy Production	Forest as a means to ensure energy security
	Food Security	Forest as food supplier (agroforest) for humans
	Renewable natural resources	Forest as water filterer
	Health	Forest as a source of medicine (herbs etc.)
	Recreation	
	Mobility	

Forest Type Building Process Step 2

Determined forest functions	General	Specific	Characteristics	Corridor	Patch	Sustainability Pillar
Forest as a biodiverse ecosytem		x	mostly untouched		x	Environmental
Forest as a carbon sink	x			x	x	Environmental
Forest as a means to prevent degradation/erosion		x	situated around open space, on poor soils	x	x	Environmental
Forest as a means to improve soil quality		x	situated on poor soils		x	Environmental
Forest as an ecological corridor		x	linear structure	x		Environmental
Forest as a resilient ecosystem	x			x	x	Environmental
Forest as a means to keep the planet habitable	x			x	x	Social
Forest as a means to ensure energy security		x	forest underwater is combinable with energy generation above water	x	x	Economical
Forest as food supplier (agroforest)		x	focus on edible plants / also a subform for livestock farming?		x	Economical
Forest as water filterer	x			x	x	Environmental
Forest as air purifier/carbon capturer	x			x	x	Environmental
Forest as recreational place		x	actively used by humans	x	x	Environmental
Forest as timber source		x	focus on trees that can be used well for timber production	x	x	Economical
Forest as an educational space		x	actively used by humans	x	x	Social
Forest as securer of livelihoods	x			x	x	Social
Forest as means of flood protection		x	situated in areas prone to flood (coast, major rivers)	x	x	Social
Forest as protector against uncomfortable climate		x	dense on multiple layers, provides shade and/or shelter from wind		x	Social
Forest as part of the culture		x	can be anything, a sacred and untouched place or a place of recreation	x	x	Social
Forest as a source of medicine (herbs etc.)		x	focus on medical plants		x	Social
Forest as a workplace		x	actively used and maintained by humans, agroforest or timber production forest	x	x	Economical
Forest as a closed ecosystem	x			x	x	Environmental
Forest as pollinator	x			x	x	Environmental
Forest as a scenic route		x	actively used by humans, corridor or patch	x	x	Social
Forest as a supporter with mental health		x	actively used by humans, not used for economic purposes		x	Social
24 types	*8 types*	*16 types*				

Forest Type Building Process Step 3

Base (general forest functions)

- Forest as a carbon sink
- Forest as a resilient ecosystem
- Forest as a means to keep the planet habitable
- Forest as water filterer
- Forest as air purifier/carbon capturer
- Forest as securer of livelihoods
- Forest as a closed ecosystem
- Forest as pollinator

Patch types

Protected forest (P)

- Forest as a biodiverse ecosytem (P)
- Forest as a means to improve soil quality (P)

Agroforest (P)	*Sub-types of an Agroforest*
Forest as food supplier (P)	*1. Forest + pasture (Silvopastoral systems)*
Forest as a source of medicine (P)	*2. Forest + crops (Silvoarable systems)*
Forest as a means to improve soil quality (P)	*3. Food forest (Multi-strata agroforestry)*
Forest as a workplace (C/P)	
Forest as a biodiverse ecosytem (P)	
Forest as a means to prevent degradation (C/P)	

Marine forest (P)	*Sub-types of a Marine forest*
Forest as a source of medicine (herbs etc.) (P)	*1. Marine agroforest*
Forest as food supplier (agroforest) (P)	*2. Protected marine forest*
Forest as a biodiverse ecosytem (P)	
Forest as a workplace (C/P)	

Corridor types

Riverine forest (C)

- Forest as an ecological corridor (C)
- Forest as means of flood protection (C)
- Forest as a means to prevent degradation (C/P)
- Forest as a scenic route (C/P)

Mixed types

Resource forest (C/P)

- Forest as a source for construction material (C/P)
- Forest as a workplace (C/P)
- Forest as a means to ensure energy security (C/P)

Recreational forest (C/P)

- Forest as an educational space (C/P)
- Forest as recreational place (C/P)
- Forest as a scenic route (C/P)
- Forest as part of the culture (C/P)
- Forest as a supporter with mental health (P)
- Forest as protector against climatic dangers (P)

Environmental Assessment Process (1/3)

CURRENT LAND USE TYPOLOGIES

Typology	Fertility	Water usage	Degradation	Biodiversity	Carbon sequestration	Temperature
What kind of land-use system is it?	How fertile does the soil need to be?	How much water needs to be added externally?	How much does it degrade the soil?	How high is the biodiversity?	How much carbon can it store?	How vulnerable is it to temperature changes?
Why do we want to know that? Scale: a little (1) to a lot (5)	*Can it grow on unfertile soil?*	*How much can it thrive without additional water*	*How healthy is this land use for the soil?*	*How high is the biodiversity?*	*How much carbon can it store?*	*How much trouble does it have with changing climates?*
Crop agriculture	1	1	2	1	1	1
Pastoral livestock farming	4	2	1	2	1	4
Riverbank	2	5	2	4	2	2
Sea	5	5	3	5	2	1
Deciduous forest	2	5	5	5	4	4
Coniferous forest	4	5	5	4	5	3
Urban agglomeration	5	5	1	1	1	2

NEW FOREST TYPES

Typology	Fertility	Water usage	Degradation	Biodiversity	Carbon sequestration	Temperature
Why do we want to know that? Scale: a little (1) to a lot (5)	*Can it grow on unfertile soil?*	*How much can it thrive without additional water*	*How healthy is this land use for the soil?*	*How high is the biodiversity?*	*How much carbon can it store?*	*How much trouble does it have with changing climates?*
Protected forest (P)	3	5	5	5	5	4
Aiding forest (P)	2	5	5	4	4	4
Agroforest (P)	3	4	5	5	4	4
1. Forest + Pasture (Silvopastoral systems)	4	3	4	4	4	4
2. Forest + crops (Silvoarable systems)	4	3	4	4	4	4
3. Food forest (Multi-strata agroforestry)	3	4	5	5	5	4
Riverine forest (C/P)	2	5	4	5	3	4
Resource forest (C/P)	3	5	3	3	4	5
Recreational forest (C/P)	3	5	5	5	4	3
Marine forest (P)	5	5	4	4	5	4
1. Marine agroforest	5	5	4	3	5	3
2. Protected marine forest	5	5	5	5	5	5

Environmental Assessment Process (2/3)

BENELUX LAND USE TYPOLOGIES

Typology	Fertility	Water usage	Degradation	Biodiversity	Carbon sequestration	Temperature
What kind of land-use system is it?	How fertile does the soil need to be?	How much water needs to be added externally?	How much does it degrade the soil?	How high is the biodiversity?	How much carbon can it store?	How vulnerable is it to temperature changes?
Why do we want to know that? Scale: a little (1) to a lot (5)	*Can it grow on unfertile soil?*	*How much can it thrive without additional water*	*How healthy is this land use for the soil?*	*How high is the biodiversity?*	*How much carbon can it store?*	*How much trouble does it have with changing climates?*
SA--	5	1	2	1	1	1
SP--	5	2	1	2	1	4
CA--	3	1	2	1	1	1
CP--	3	2	1	2	1	4
LA--	1	1	2	1	1	1
LP--	1	2	1	2	1	4
SS--	5	5	3	2	2	1
SS-N	5	5	3	5	2	1
CA-N	3	1	2	5	1	1
CP-N	3	2	1	5	1	4
LA-N	1	1	2	5	1	1
LFDN	1	5	5	5	4	4
LFCN	1	5	5	5	5	3
LFC-	1	5	5	4	5	3
SFCN	5	5	5	5	5	3
SFC-	5	5	5	4	5	3

Environmental Assessment Process (3/3)

EUROPE LAND USE TYPOLOGIES

Typology	**Fertility**	**Water usage**	**Degradation**	**Biodiversity**	**Carbon sequestration**	**Temperature**
What kind of land-use system is it?	How fertile does the soil need to be?	How much water needs to be added externally?	How much does it degrade the soil?	How high is the biodiversity?	How much carbon can it store?	How vulnerable is it to temperature changes?
Why do we want to know that? Scale: a little (1) to a lot (5)	*Can it grow on unfertile soil?*	*How much can it thrive without additional water*	*How healthy is this land use for the soil?*	*How high is the biodiversity?*	*How much carbon can it store?*	*How much trouble does it have with changing climates?*
SS-M-	5	5	3	4	2	1
SS-MN	5	5	3	5	2	1
SS-B-	5	5	3	4	2	1
SSMBN	5	5	3	5	5	1
SS-A-	5	5	3	4	2	2
SS-AN	5	5	3	5	2	2
SS-C-	5	5	3	4	2	3
SACC-	5	1	1	1	1	2
SFCCN	5	5	5	5	5	4
LACM-	1	1	1	1	1	1
LACA-	1	1	1	1	1	2
LFCB-	1	5	5	4	5	1
LFCBN	1	5	5	4	5	1
LACB-	1	1	1	1	1	1
LACC- (LADC-)	1	1	1	1	1	3
CACM- (CADM-)	3	1	1	1	1	1
CACMN (CADMN)	3	1	1	5	1	2
CACA-	3	1	1	1	1	1
CFCAN	3	5	5	4	5	3
CACB (CADB-)	3	1	1	1	1	1
CFCBN	3	5	5	5	5	1
CACC- (CADC-)	3	1	1	1	1	2
CFCCN (CFDB)	3	5	5	4	5	3

European Synthesis of Analysis