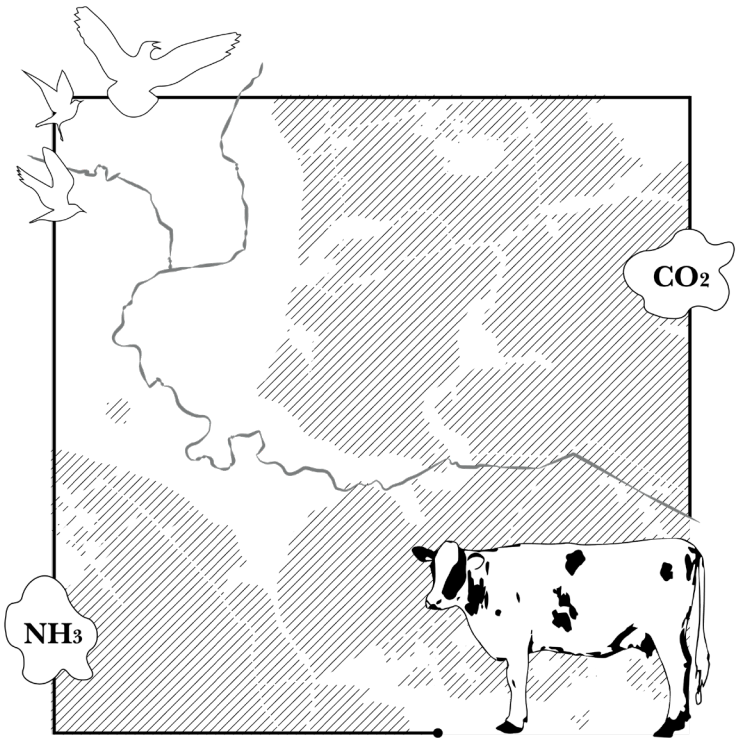
Re - Peating Nature

Ruralities in Transition



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Thesis Academic Year 2022-2023

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Re - Peating Nature
Ruralities in Transition

Friesland Pastures, 2022.
Photo: Xinjian Jiang.

Friesland Pastures, 2022.
Photo: Xinjian Jiang.

Acknoledgements

The thesis graduation project is an important stepping stone in a Landscape architect's academic life. It has been an incredible journey, which could not have been possible without the immense support and guidance of my dear mentors Laura Cipriani and Diego Andres Sepulveda Carmona, to whom I will be forever grateful for their commitment, professional knowledge, and continuous encouragement during the past nine months of the academic year 2022-2023, at Delft University of Technology.

I would like to thank Stephan Smeijers from the municipality of Friesland and Joca Jansen from Wetterskip Friesland for their input on the understanding of the local Frisian context and for kindly providing me with data and resources, which have greatly contributed to the research and design.

I would like to express my special gratitude to Zhaolei Li and Xinjian Jiang, my teammates from the "Water Landscapes of Crisis and Hope" graduation lab for their companionship, optimism, and inspiration. I would like to thank all landscape colleagues 2021-2023 and tutors. I will cherish all the memories we have created together in the past two years.

I would like to thank all my friends and family for your unconditional love and for always being there for me, especially in times of great turbulence and uncertainty. Without your support, love, and encouragement this would have been a very different time.

Friesland Pastures, 2022.
Photo: Xinjian Jiang.

Abstract

The Wadden Sea Region spans the Dutch, German, and Denmark coasts, creating one of the most culturally and environmentally rich areas, recognized as a UNESCO World Heritage in 2009 (Centre, U. W. H, 2009). The natural and cultural value of the heritage site possesses unique features and characteristics that are important to preserve for future generations. Like many other places in the world, the Wadden Sea region is facing significant uncertainty in the future. Climate change plays a vital role in planning such a vulnerable region. It is a complex landscape that has already been impacted by climate change and is awaiting big decisions and changes for its resilient future.

Due to its unique history, the Frisian landscape has developed into the largest dairy producer in the Netherlands. Years of scaling up and production growth created a situation in which the productive landscape conflicts with Friesland's cultural and natural heritage and contributes to climate change. The Frisian agricultural practice puts immense pressure on the peat soils in the province, resulting in significant carbon emissions and is likely to contribute to water shortages in the future. "Peatlands are the largest terrestrial carbon store on earth, storing about 25% of global soil carbon, which is twice as much as forests" (UN Environment Programme, 2019). Peatlands have immense value both for the region's natural and cultural development.

The graduation project looks into the past, present, and future of the agricultural landscape of Friesland. It aims to envision an alternative resilient future for its peatscapes, in which the productive properties of the landscape are not lost but strengthen the cultural and natural Frisian narrative of the future. The future scenarios are formed based on different outcomes related to agricultural practices, through which the most desired one is explored further. The thesis seeks an in-depth analysis of the productive landscape, resulting in a strategic design proposal for peat restoration and preservation. The strategies are implemented in close conversation with the local stakeholders on a regional and small scale-design. The alternative scenario involves strategies that strengthen ecological connectivity and cultural heritage while proposing acts for climate mitigation and adaptation. Further exploration on forming carbon banks, paludiculture corridors, and people nature is all part of the project for peat restoration and preservation for future generations.

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Wadden Sea Region, 2020.
Photo: Journal of Geophysical Research.

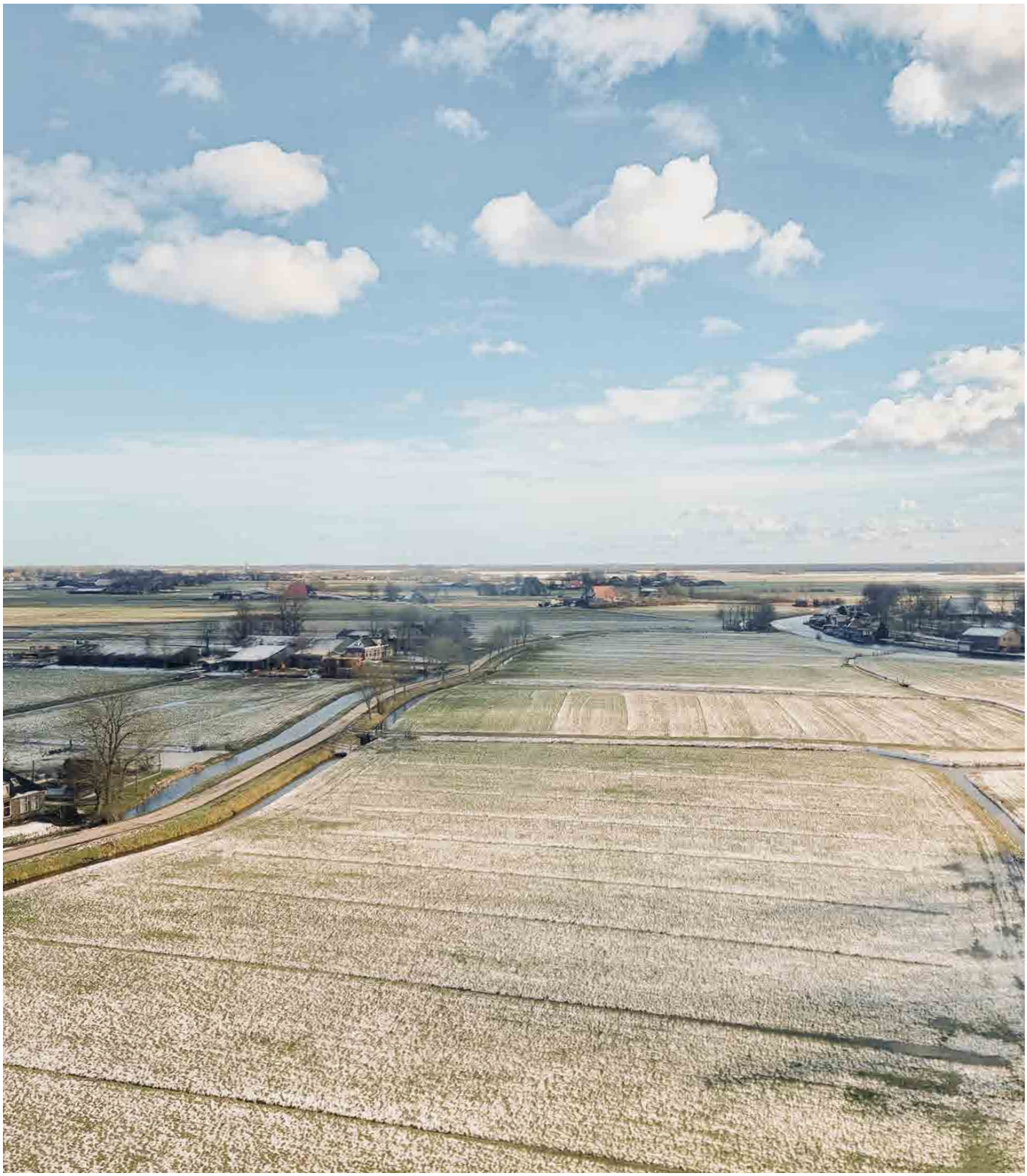
Introduction

"Water Landscapes of Crisis and Hope" is a graduation studio led by Laura Cipriani based in the Wadden Sea region. One of the main reasons for choosing the lab was my initial fascination with the area: rich cultural history, the openness of the landscape with an endless horizon, and proximity to the sea, while being extremely vulnerable and sensitive - under a threat of climate change, overexploitation, pressure on biodiversity, etc. My initial fascination with the complexity of the area and my curiosity about tackling the vulnerabilities lead me to choose the graduation studio.

The Wadden Sea Region spans the Dutch, German, and Denmark coasts creating one of the most culturally and environmentally rich, valuable yet vulnerable landscapes, recognized as a UNESCO World Heritage in 2009 (Centre, U. W. H, 2009). The region has developed mainly in the past 150 years under the human desire to battle the sea, grow and expand. The new land, which lost its dynamic properties created more opportunities for agricultural development turning Friesland and Groningen into the largest dairy and potato seed exporters in the past 70 years (Agrifood, 2023).

Nowadays, the historic-cultural traces of the dynamic past can still be seen mainly in the landscape in the form of water interventions used for trade and transportation and old dynamic settlements - terps, which poetically could be compared to elevated islands surrounded by vast agricultural land. With the agricultural scaling up of the recent past the cultural heritage has been under a great threat, further homogenizing the diversity of traces and rich agricultural history. The scaling up and homogenization, subsequently bring further pressure on biodiversity. The region is a vulnerable fragile ecosystem that requires further protection and appreciation (van der Windt & Swart, 2017). The reduction in the meadow bird population could be seen as a direct result of the homogenization of agricultural landscape, during which ecological structures that contribute towards the ecoservices have been lost. Agricultural practice, in this capitalistic society and its current development model with the never-ending desire to grow and expand, creates a situation where cultural and natural heritage becomes difficult.

Climate change is a highly pressing threat to our society. It directly impacts the natural environment and intervenes with natural processes, causing even higher threats to our existence. Climate change plays a vital role in the region. Climate change plays a vital role in the region. It brings great uncertainty in the future of the Wadden Sea.



Friesland Peatscapes, 2023.
Photo: Author.

The recent upscaling of agriculture adds to the uncertainty of the region as it contributes to the climatic changes, in which soil subsidence, drop in groundwater levels, soil desiccation, droughts, and peat oxidation are the direct result of poor soil and water management in favor of agricultural practices. The current agricultural practices create an unsustainable cycle in which there is an immense threat of complete future peat loss, resulting in water shortages, biodiversity loss, higher greenhouse emissions, further sea level rise threats, etc (VeenWeideFryslan, 2021). With the increasing climatic threats, there is a growing uncertainty for the productive landscape to maintain its productive properties for future generations. Changes need to be made now to secure sustainable food production, and natural and cultural heritage for future generations. Preserving the peatscapes of Friesland that act as one of the largest carbon stores in the region should be seen as one of the primary goals in climate mitigation and adaptation. Therefore, looking into possible strategies for adapting agriculture and mitigating climate change is highly relevant to our society (VeenWeideFryslan, 2021).

Landscape architecture involves planning, designing, managing, and nurturing the built and natural environments. With their unique skill set, landscape architects work to improve human and environmental health in all communities. The thesis investigates the issues and challenges the agricultural landscape faces and creates a narrative around the relationships between the past, present, and future of agriculture, nature, and culture. The thesis explores the impacts of climate change on the agricultural landscape in Frisian peatscapes. It aims to derive different strategies to respond to climate change to create a new resilient, biodiversity and cultural-heritage-inclusive rural agricultural landscape.

Methodology & Research Analysis

Chapter I

Friesland Pastures, 2022.
Photo: Xinjian Jiang.

Methodology & Research Analysis

The Graduation project uses various methods, in which regional scenario-making and engaging different stakeholders play a vital role in the design process. The Graduation studio "Water Landscapes of Crisis and Hope" aims to create a site-sensitive design that responds to the chosen area across regional, local, and small-scale interventions. The landscape planning approach in the graduation studio values the importance of a site-specific approach in which the issues and design opportunities arise from direct engagement with the area. The graduation project continuously engaged with the municipality of Friesland. Stephan Smeijers, the municipality landscape architect, has kindly followed through with the thesis development and offered immense guidance as someone very familiar with the global issues Friesland is facing and the landscape architecture background. Joca Jansen - representative of Wetterskip Friesland has shared insights about the water management intricacies of the area and provided invaluable input into the understanding of Friesland water issues and challenges. During my thesis, I have also contacted Agrarian cooperatives, which kindly shared their input regarding the constraints and challenges the dairy farmers are currently facing in the governmental desire to reduce carbon emissions. Engagement with the local stakeholders played a vital role in the research and design formation of the thesis.

This chapter explores the complexity of the area in the form of problem statements, defines research questions and objectives, and further looks into the methods and research framework. The complexity of struggles that the agricultural landscape brings to the table has been explored in the problem statement of the chapter, which further elaborates on the conflict between agriculture, nature, and culture and explains the climatic threats related to agricultural practices. Identifying the site challenges allowed us to define the research question and objectives of the thesis project, which then contributed to the methods and the research framework.

Problem Statement

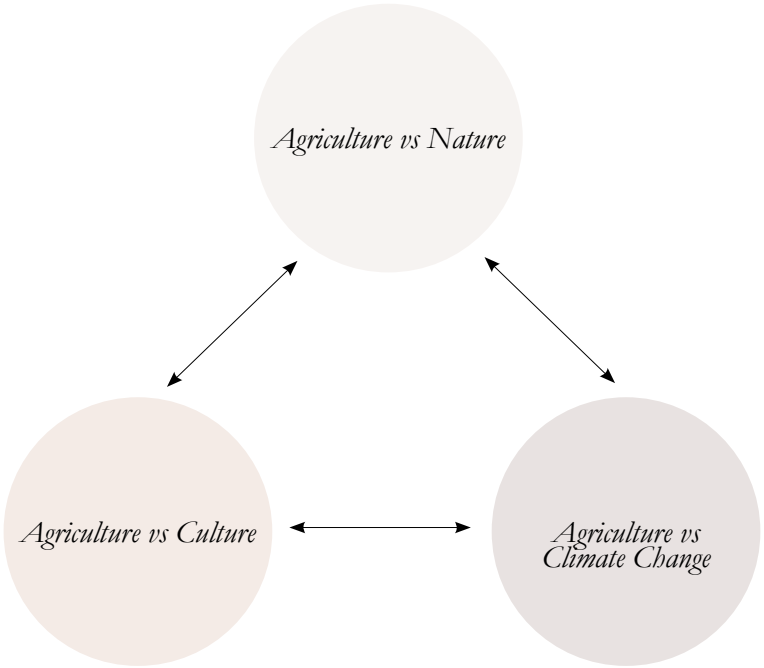
The Wadden Sea Region is an extensively complex landscape that has developed over the past 150 years through the influence of mankind. Mankind acted as a geological force, shaping the land in an ongoing battle against the sea. As time passed, the landscape lost its dynamic relationship with the water. It became significantly more static, changing the human relationship with the landscape and creating more agricultural and urban expansion opportunities. With the increasing human desire to grow and develop, Friesland and Groningen became the country's largest dairy and potato seed exporters, turning over 70% of the landscape into agricultural land (Agrifood, 2023).

Climate Change has already impacted the Wadden Sea region. Due to sea level rise, water management is becoming progressively more difficult in Friesland. The arable land along the coast is experiencing salinization, pushing the current agricultural practices to search for new salt-resistant crops (VeenweideFryslan, 2021). Due to soil subsidence, the natural areas are experiencing droughts as they are becoming increasingly elevated compared to the subsiding urban and agricultural lands. Due to the excessive agriculture, the groundwater levels are steadily dropping resulting in excess water accumulating further inland and in the desiccation of sandy soils leading to further salinization (VeenweideFryslan, 2021). The drop in groundwater levels and accumulation of excess water also leads to peat oxidation resulting in greenhouse emissions pushing the current policymakers to pursue radical CO2 reduction goals, especially in peat areas, putting immense pressure on farmers to transition into more climate adaptive and sustainable practices.

The Wadden Sea Region forms a unique coastal line spanning 500 km with a greatly diverse and valuable natural ecosystem, one of a kind worldwide. "Up to 10-12 million birds pass through the region each year" (Centre, U. W. H., 2009). The dairy industry highly impacts soil and surface water quality by releasing ammonia and phosphate into the environment, contributing to biodiversity decline and climate change.

The increasing competition between agriculture and nature puts ammonia and nitrogen-sensitive species under a declining threat (van der Windt & Swart, 2017). The homogenization of the landscape primarily due to the modern upscaling of agricultural farming creates a threat to biodiversity and the cultural landscape. The homogenization of the landscape contributes to the climate vulnerability of the region.

Nowadays, the ruralities of Friesland, especially in the peatlands, are facing a significant challenge to transition to become more resilient, mitigating and adapting to climate change, whilst being biodiversity and cultural heritage inclusive leading to the research question and sub-research questions…



Research Question

How can the agricultural landscape transition into becoming more resilient in Friesland ?

Research Objectives

The project aims to create a new narrative for the productive landscape in the peatscapes of Friesland, the most climatically vulnerable and sensitive area in the province, that will respond to climatic changes and bring natural and cultural values into the area.

Sub Questions:
CHAPTER II - *A Dynamic Past*
What historical development of the Wadden landscape contributed to modern agricultural expansion?

CHAPTER III - *A Homogenized Present*
What is the recent history of the agricultural landscape in Friesland and its current state?

What are the environmental, cultural, and socio-economic threats and opportunities related to the agricultural landscape in Friesland?

CHAPTER IV - *An Uncertain Future*
What are the climatic threats to agriculture, and how will these issues impact the agricultural landscape in the future?

CHAPTER V - *Designing Future Peatscapes*
How to create a natural and cultural heritage-inclusive resilient agricultural landscape in the peatlands of Friesland?

What is the alternative agricultural landscape, which could adapt to and mitigate future climatic issues in the peatlands of Friesland?

Methods

Multiple research strategies have contributed to the understanding and speculation of the area.

- What historical development of the Wadden landscape contributed to modern agricultural expansion?
- What is the recent history of the agricultural landscape in Friesland and its current state?

Describing

To have a comprehensive understanding of the region, descriptive tools are being used, specifically in collecting geo data that resulted in the collection of cartographic maps, articles, news and figures, etc. PDOK and QGIS were mainly used to spatialize the collected data and to produce maps and sections for the Netherlands region. CBS, Friesland. Databank and Fryske Academy were used for statistics and figures within the Netherlands. The European Environmental Agency and Geofabric were used for the geo data necessary for Denmark and Germany and Eurostat provided the necessary statistical data. The research strategy allowed the initial understanding of the area, its history, and its current socio-economic structure.

Observing

The primary area visit to the Frisian ruralities allowed a better understanding of the area through active immersion into the landscape. Tools like photographing and sketching contributed towards a better perception of the area. Combining the primary visit with descriptive data collection allows for a better connection with the land. The visit allowed us to collect less attainable data through other descriptive tools and contributed towards raw data collection that could later be interpreted and speculated upon. The primary visit identified unique landscape features like openness, vast horizon view, and a sense of "exposure." I have visited the peatscapes of Friesland for a more comprehensive understanding of the area, where I am aiming to do my small-scale design. Issues such as the accumulation of excess water and homogenization of the cultural and natural landscape have been identified. The collected information has been used in the design phase to create an experiential landscape.

- What are the environmental, cultural, and socio-economic threats and opportunities related to the agricultural landscape in Friesland?
- What are the climatic threats to agriculture, and how will these issues impact the agricultural landscape in the future?

Interpriting
Interpreting the collected data and overlapping maps and statistics allows us to identify vulnerabilities and critical areas. Superimposing and merging different geo data allows for constructing a narrative around different relationships and patterns, which could impact the landscape's future. The research strategy allowed me to identify conflicts between current productive land use and Natura2000 areas, which are competing, and areas prone to peat oxidation and salinization that are further impacting local agricultural practices. Moreover, croplands are usually located in the fertile clay area, which is located on the coast, and land subsidence occurs in the peat landscapes, where most of the Dairy farming is located. The research strategy allows for linking different patterns and locating threats impacting the design decisions.

- What are the climatic threats to agriculture, and how will these issues impact the agricultural landscape in the future?

Modeling and Interpreting
Using predictions not limited to QGIS, such as government reports regarding future peat oxidation, salinization, and soil subsidence, will allow spatialization of the critical areas and, thus, areas needing implementing necessary climate adaptation/mitigation strategies. Moreover, it allows one to visualize and speculate on the future and derive challenges and opportunities for climate adaptation and mitigation in the project. Interpretive modeling is a vital research tool in deriving conditions to which a resilient landscape must respond.

- How to create a natural and cultural heritage-inclusive resilient agricultural landscape in the peatlands of Friesland?

Classifying
Classification of different historical and cultural patterns and typologies such as terps - first human settlements and water management structures such as dikes, mills, etc., used for agriculture has a positive impact on constructing a better image of the current cultural heritage landscape and, thus, will create a base for creating necessary strategies for its preservation and empowerment as it has been dramatically homogenized due to agricultural expansion. Classification of cultural heritage existing in Friesland allows a better understanding of the cultural landscape.It later will act as a base for constructing existing and future relationships between culture, nature, and agriculture and the impacts of climate on it.

Evaluating

Looking into the proposed government ambitions for the area serves as a basis for understanding issues and dilemmas that the government is confronting. A great addition to understanding the issues and dilemmas of the area is to talk to the local stakeholders. The Frisian landscape architect Stephan Smeijers and Wetterskip representative Joca Jansen kindly shared information about Friesland and the current pressing agricultural challenges of the region. During the third quarter of the graduation project, the graduation lab organized a co-designing stakeholder workshop, which became a basis for the design, as local people are the main caregivers and creators of the landscape. Understanding how the local stakeholders have been working on peat preservation and managing soil and water to see what has been done, the impacts of the implemented strategies on agriculture, and what could be done on the site for climate adaptation/mitigation and nature and culture preservation. The evaluation research in close engagement with the local stakeholders allowed me to derive design strategies for making the landscape more resilient, finding the middle ground between agriculture, nature/ culture, and climate threats. It allowed me to foresee the agricultural landscape capacities of the government transition goals, further highlighting possibilities and opportunities in the design stage.

- What is the alternative agricultural landscape, which could adapt to and mitigate future climatic issues in the peatlands of Frieslands?

Design Projecting

Using projections to speculate on the landscape changes based on the "what if" scenarios in the coming 100 years to propose short-term design strategies for climate mitigation/ adaptation of agriculture in the Frisian peatlands. Working through multiple scales (Wadden Sea, North Netherlands, Friesland, East Friesland, Farm) to establish design strategies that are linked with each other and communicate well both on regional and small scales whilst showcasing the impacts of the regional strategies on the ground through detailed small-scale design. Design projections are the speculations on what could the Frisian landscape look like under different conditions with no peat future, fully accepted water, and a middle ground in which the productive properties are maintained and provide new opportunities.

To summarize, description, observation, interpretation, classification, and modeling were used for the initial regional and large-scale research of the

area contributing to the general understanding of the existing and pressing issues and future threats. The methods allowed me to construct the preliminary narrative and identify the Frisian agricultural hinterland's current and future vulnerabilities and possibilities. Evaluation of the collected information allowed me to further go down in scale and explore the capacity of the Frisian hinterland, peatlands, to respond to future climatic changes. The design projection method allows visualizing the future conditions to which the hinterland needs to respond to. Communicating with the local stakeholders (description, observing) is a vital part of the research and the design process for identifying the capacities of the local landscape in implementing regional strategies and reducing the gap in reaching the governmental transition goals. Continuously using the description, observation, interpretation, and evaluation methods throughout different scales' design processes allows for a more robust design narrative.

Research Framework

Research by design is a primary method in which research goes hand in hand with the design and explores vulnerabilities, opportunities, and capacity of the landscape to respond to the identified risks through time and scale.

Resilient Agricultural Landscape

... maintains its productive properties under changing conditions...

General Process / Steps

0.1 INTRODUCTION

- Preliminary Stage

0.2 PROBLEM STATEMENT

- Loss of Biodiversity
- Homogenisation of Cultural Heritage
- Agriculture and Climate Change

- Salinisation
- Ammonia Cycle
- Peat Oxidation/ Subsidence

0.3 RESEARCH QUESTION

How can the agricultural landscape transition in becoming more resilient in Friesland ?

0.5 ANALYSIS

- Literature Review
- Friesland Municipality Meeting
- Site Visit
- Data Collection
- History Review
- Mapping
- Interpretation
- Evaluation
- Classification

Agricultural Impacts/ Threats

- Nature
- Culture
- Climate

Past
- Geomorphology
- Soil Types, Regions
- Soil Structure
- Loss of Dynamic Past

Present
- Socio - Economy
- Land Use
- Upscaling
- Biodiversity Loss
- Cultural Heritage Loss

Future
- Salinisation
- Ammonia Cycle
- Peat Oxidation/ Subsidence

0.6 DESIGN STRATEGIES

- Semi - Interviews
- Scenario Building
- Local Stakeholders
- Co Design Workshop

Design Principles

- Nature Inclusive Agriculture
- Valuable Heritage
- Climate Responsive Agriculture

Design Strategies

- Strengthening ecological connections in the hinterland
- Honoring agricultural cultural heritage
- Developing new agricultural landscape for climate adaptation and mitigation

0.7 DESIGN

Time

Regional Scale

Local Scale

Farm Scale Design

A Dynamic Past

Chapter II

Hegebeintum, 2019.
Photo: www.noarderljocht.com.

A Dynamic Past

This Chapter explores the dynamic past of the Frisian landscape, which is not only a symbol of the Dutch resilience and never-ending fight against the sea but is also a living history and a stepping stone in soil formation and modern agricultural expansion. The chapter explores further the Dutch landscape transformation and reveals the historical development, which, nowadays, could easily be traced in the landscape.

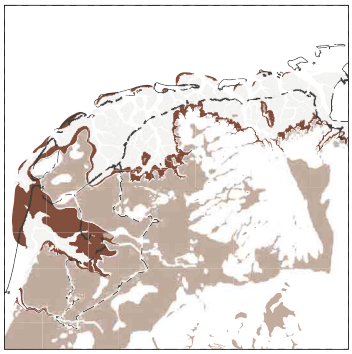
The chapter investigates the Dutch Wadden Sea development over the past centuries and reveals that the most visible and greatest transformations could be attributed to the recent 200 years. The Wadden region started its formation during the Holocene sea level rise deceleration, around 8000 years ago, which contributed to the unique natural value of the Wadden Landscape (Oost, Winter, Vos, et al, 2017). The dynamic nature of the Wadden region allowed the formation of a highly valued natural landscape.``Up to 10-12 million, birds pass through the region each year'' (Centre, U. W. H., 2009). The first human settlements - terps could be traced to 500 BC, which before the loss of the dynamic features of the Wadden landscape served as an active mobile refuge for Frisian people during storm surges (Schroor, Enemark , Fischer. & Guldberg, 2017).

The dynamic properties of the landscape have been largely lost with the construction of dikes and the closure of the Zuiderzee starting in 1200 AD (Oost, Winter, Vos, et al, 2017). The loss of the dynamic properties allowed people to expand their settlements and cultivate the land, during which many agricultural economies developed (Knibbe, Merijn, 2011). Nowadays, terps and other cultural heritage arise in the landscape as islands and active traces, surrounded by vast agricultural land (Schroor, Enemark, Fischer. & Guldberg, 2017).

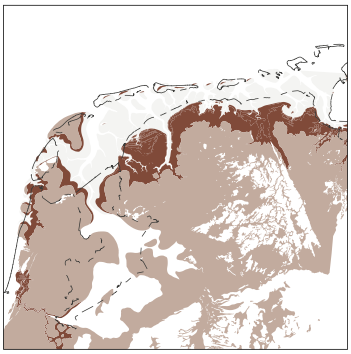
Geomorphological Development

Data: www.pdok.nl , www.openstreetmap.org, 2022.

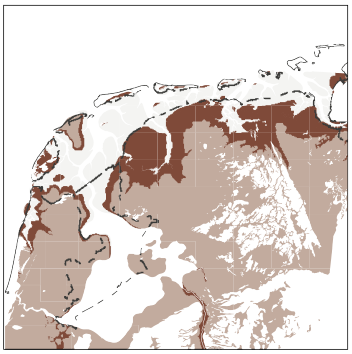
Timeline



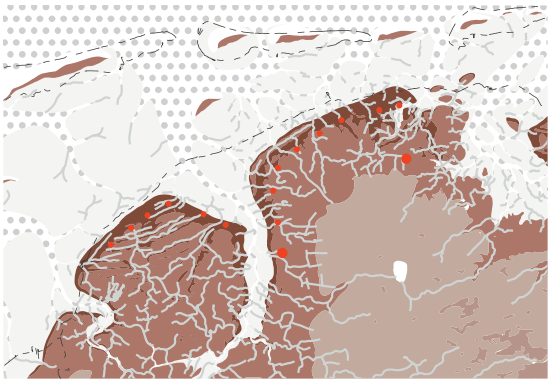
3500 BC



100 AD



800 AD



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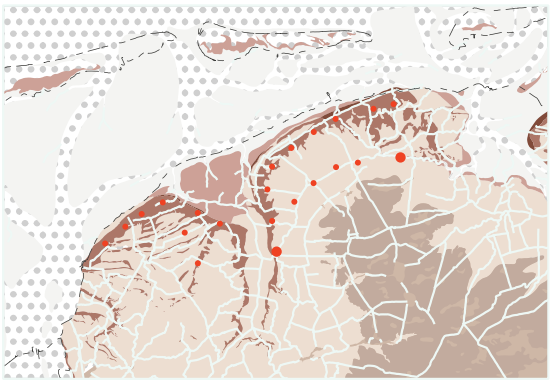
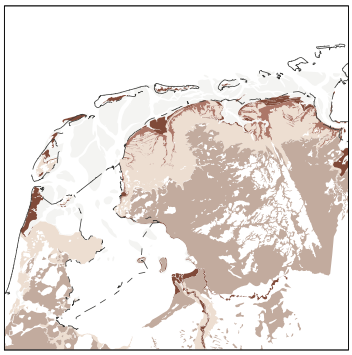


1500

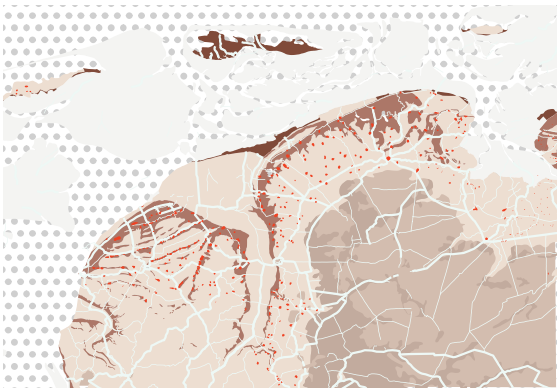
Peat
Inland Salt Marsh
Salt Marsh
Embanked Land
Tidal Deposits
Reclaimed Land
Coastal Line
Pioneer Settlements



1500

1850

2000



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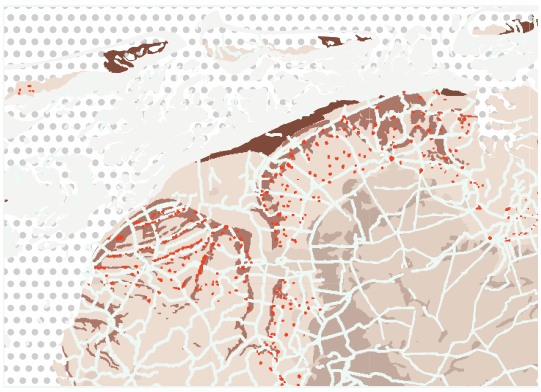


2000

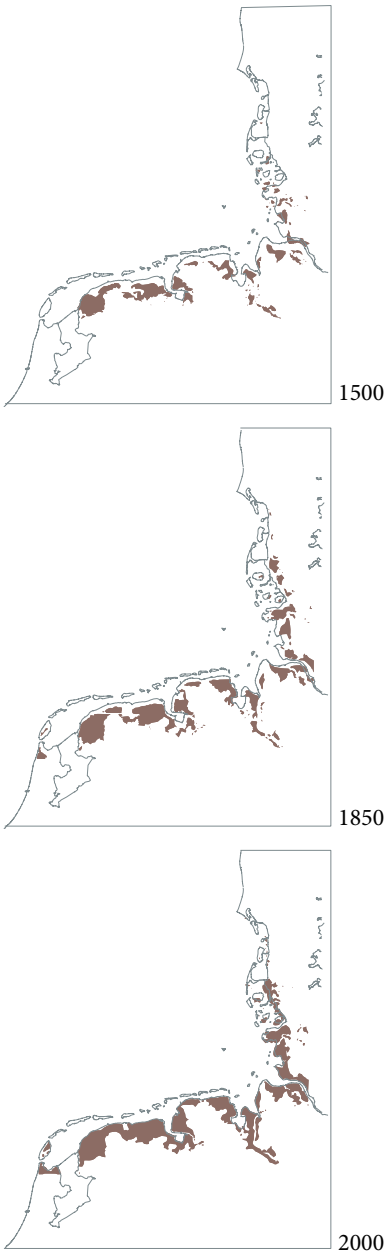
The Wadden Sea as we know it most likely first appeared 8000 years ago, at the beginning of the period when the post-glacial sea-level rise began to slow down. During the process, the largest coherent tidal flats evolved creating a truly unique landscape with dune islands, sandy shoals, and salt marshes (Recording Holocene History, 2012). "The current Wadden Sea landscape is almost a complete product of the last three glacial periods and their interglacial phases" (Recording Holocene History, 2012).

Around 2000 BC, the deceleration of the sea level rise allowed the salt marshes to expand seaward, and coastal peat marshes increased in size (Oost, Winter, Vos, et al, 2017). In the period of 500 BC to 1500 BC, the hinterland marshes subsided, lowering the peat landscape, after which clay soils were deposited at the coast leading to further subsidence in the hinterland (Oost, Winter, Vos, et al, 2017). The end of the Holocene period - recent geomorphological development could be highlighted with further subsidence due to land reclamation, embankment and expansion of agricultural activities, and significant storm surges. (Oost, Winter, Vos, et al, 2017). The tidal flats have been getting smaller since the Middle Ages as a direct result of land reclamation. The enclosure of the Middelzee had a huge impact on the geomorphological structure of the Wadden Sea and the development of the present-day Dutch provinces of Noord-Holland, Friesland, and Groningen (Oost, Winter, Vos, et al, 2017).

As the geomorphological development has been highly impacted by mankind in the form of land embankments it had a big impact on the soil structure of the region, where clay soils are spanning along the sea coast and the sandy and peat soils are located further inland. The embanked salt marshes formed a unique landscape, allowing further agricultural development (Schroor, Enemark, Fischer. & Guldberg, 2017).

The regional soil map depicts the soil structure of the Wadden Sea Region.

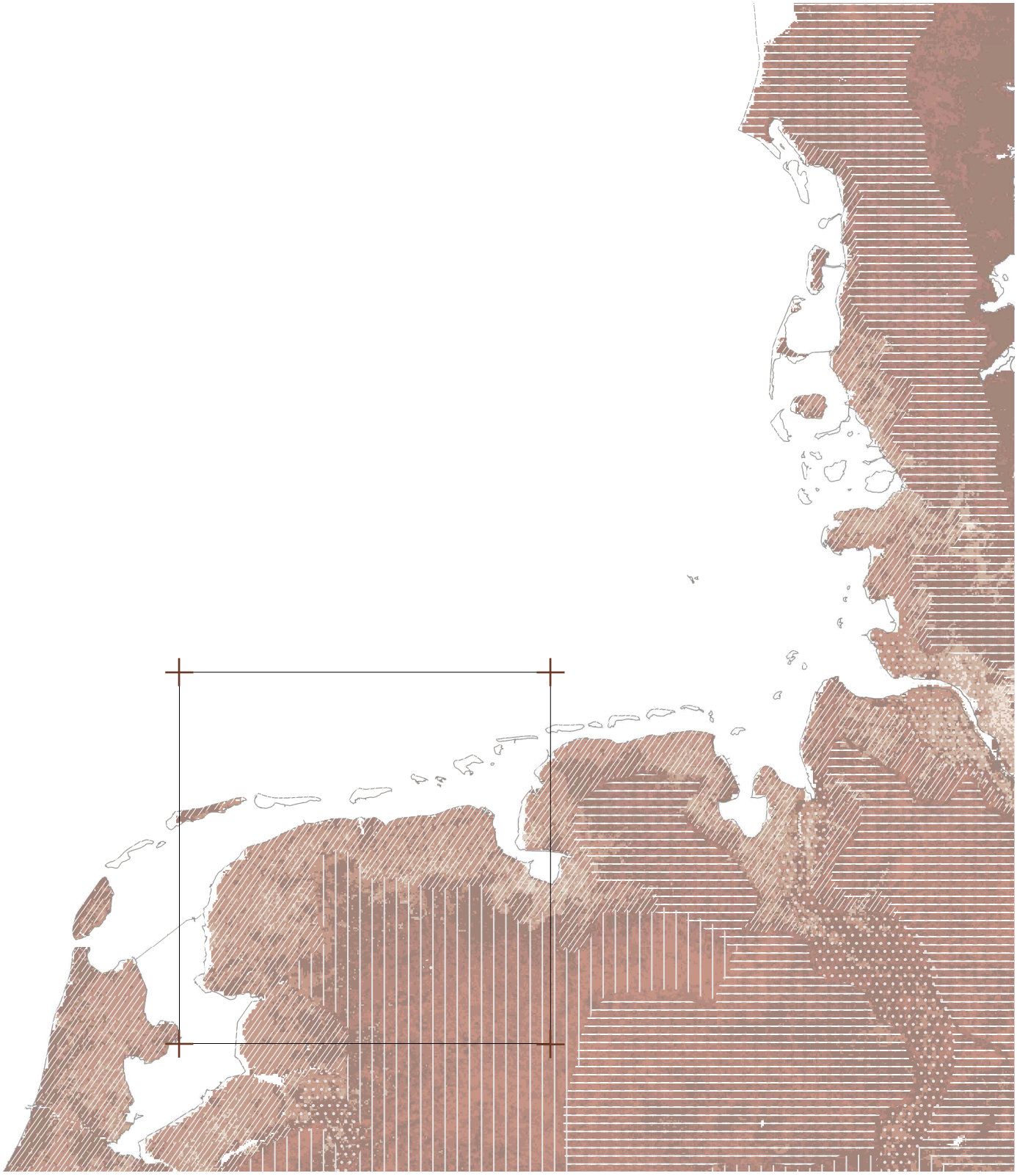
Embanked Salt Marches



Embanked Salt Marches

Soil Types and Soil Regions

Data: www.pdok.nl , www.openstreetmap.org, www.eea.europa.eu, 2022.



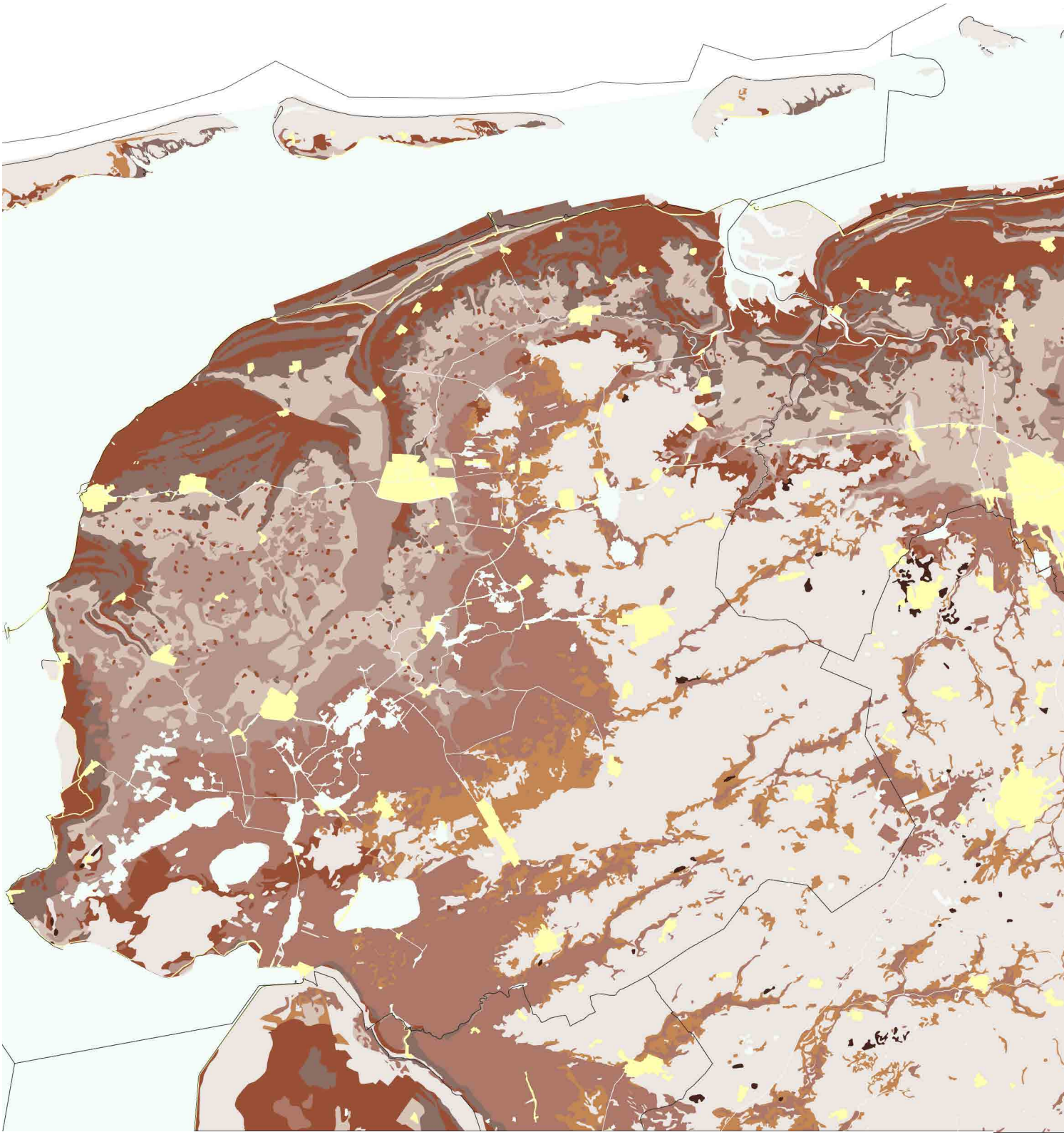
Quaternary Marine Deposits
Fluvial Deposits
Glaciofluvial Deposits
Eolian Sand
Silt-Loam
Loam
Sand

Loamy Sand
Sandy Loam
Clay
Silty Clay
Silty Clay - Loam
Sandy Clay
Sandy Clay - Loam

0 40 km 100 km N

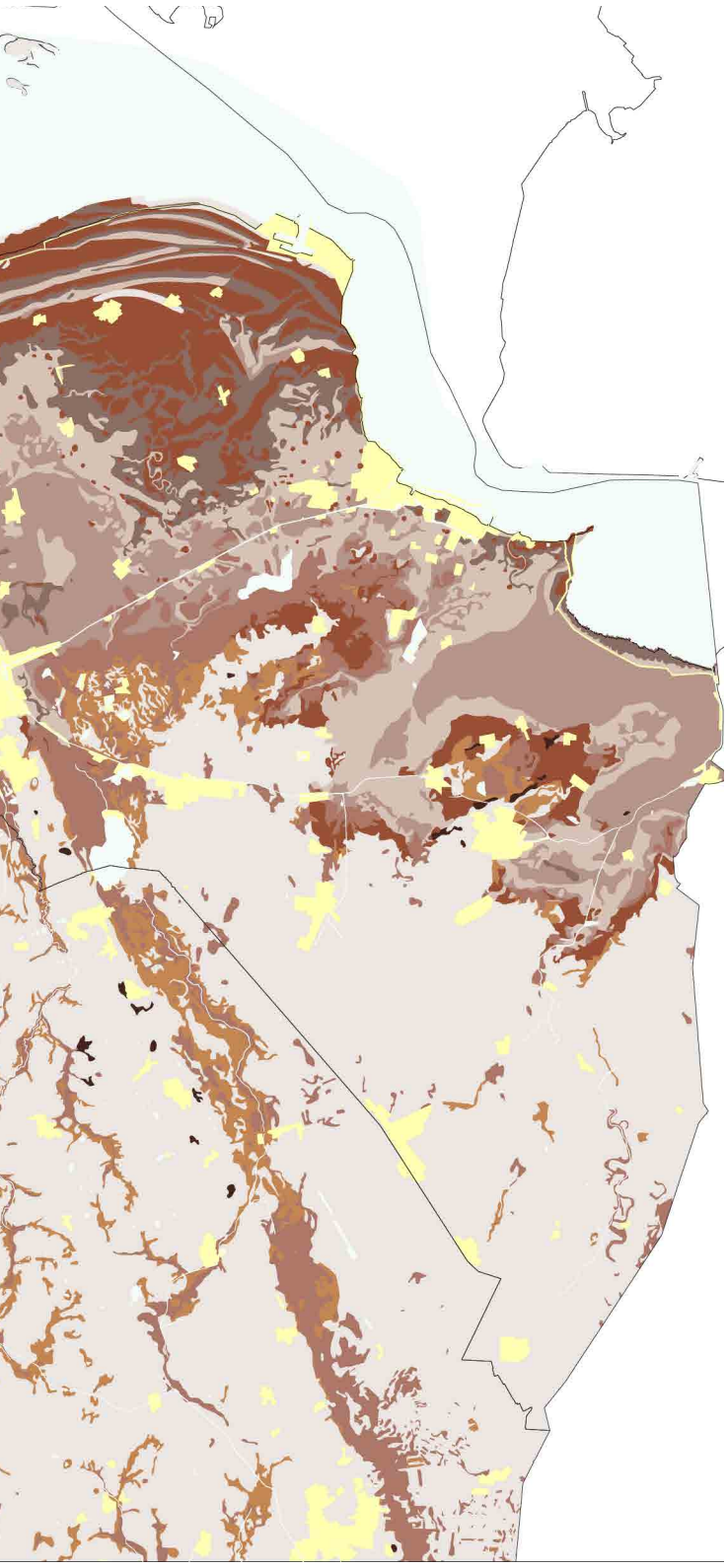
Soil Structure

Data: www.wur.nl, www.pdok.nl , www.openstreetmap.org, 2022.



0 | 10 km | 20 km | 30 km

N



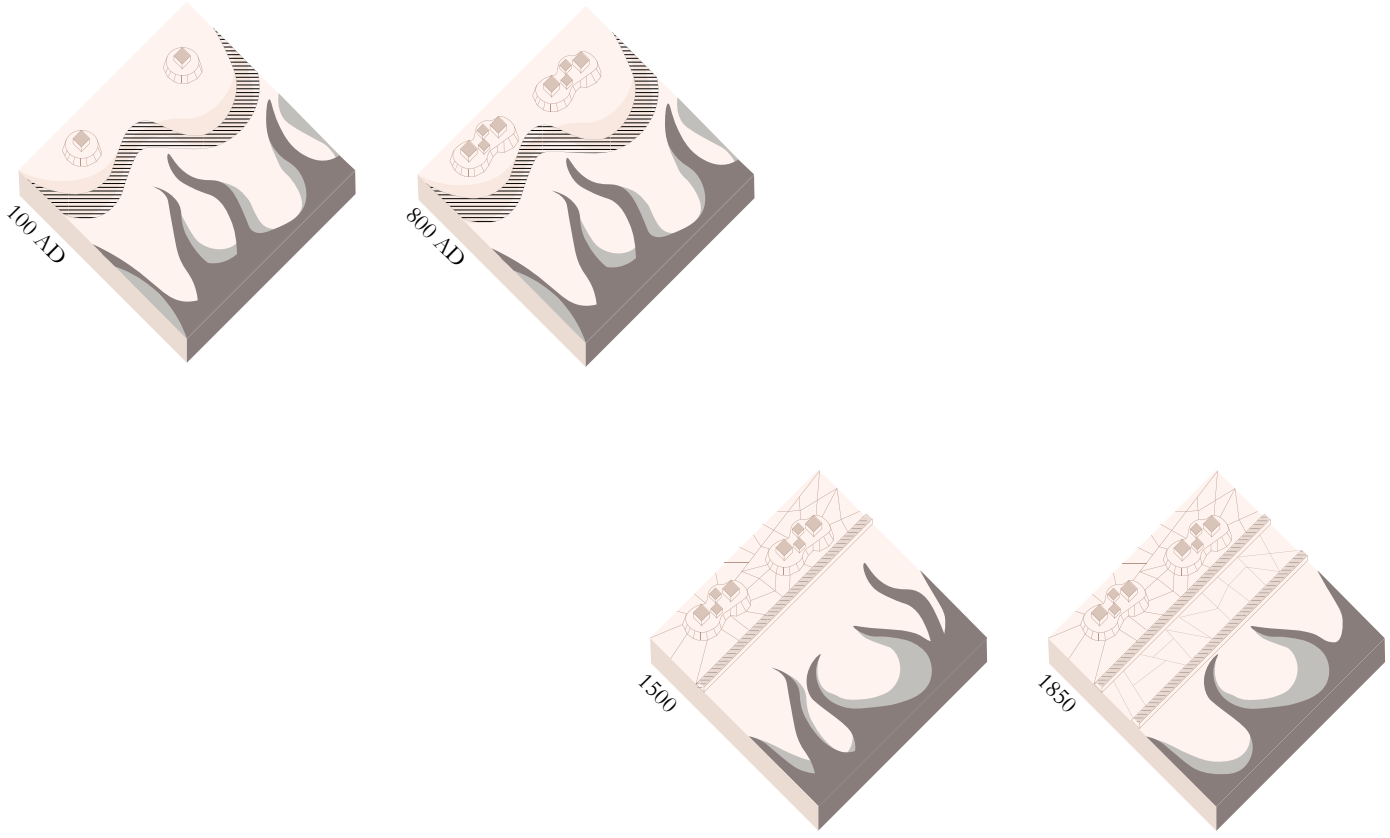
The marine clay soil belt spans across the Wadden coast and is located much higher than the subsided Wadden hinterlands.

As a result of the geomorphological development the soil structure of Friesland and Groningen responds to that of the Wadden Sea. As a result of natural anthropogenic causes, during which due to the "penetration of tidal creeks, which drained and lowered the peat leading to further subsidence, the marine clay soils deposited at the coast creating a naturally elevated coastal clay belt" (Oost, Winter, Vos, et al, 2017).

The Dutch geomorphological development and soil structure reveals the cultural Frisian history. As people started to settle in the salt-marshes of Friesland and Groningen in 600 BC, they would inhabit the area temporarily, only during summers, and would retreat to their old villages in the elevated sandy soils during winter to avoid storm surges (Vollmer, Guldberg, Maluck, Marrewijk, Schlicksbier, 2001). Arable farming was very difficult as salty storm surges would be disastrous for arable crops. The settlers relied on livestock that they would bring with them and temporarily grew crops until the next storm surge would destroy the harvest (Vollmer, Guldberg, Maluck, Marrewijk, Schlicksbier, 2001). With the embankment of salt marshes, the arable agriculture was no longer in danger and people started to settle permanently. To fight the increasing sea level rise and the threats of storm surges and flooding the settlers raised their settlements, which now were surrounded by vast agricultural landscapes (Vollmer, Guldberg, Maluck, Marrewijk, Schlicksbier, 2001).

Historical Agricultural Land Expansion and Loss of Dynamic Past

Data: www.fryske-academy.nl, 2022.



Die Gartenlaube ,1862.
Photo: www.rijksmuseum.nl

Hallig, Germany, 2019.
Photo: www.wadden-academy.com

Terp, Fryslan, 2016.
Photo: www.waddensea-worldheritage.org

The fertile clay soils and vast embanked hinterland incentified the development of the agricultural landscape. The beginning of the heavy cultivation in the arable clay soils could be attributed to the sixteenth century, during which markets labor, clear use of land, "free rent", trade of agricultural by-products, and, as a result, free capital flow developed (Knibbe, Merijn, 2011). With the development of transportation in the 1650s, agricultural expansion continued in the hinterland allowing further expansion of pastures and dairy agriculture. During the same period, dairy farmers started to use peat for heating and cooking instead of manure contributing to large peat extraction and trade in the country (Knibbe, Merijn, 2011).

The Wadden Sea landscape represents a unique relationship between the Frisian people and the sea - the constant battle to overcome nature. The last 200 years of human interventions with the landscape influenced the expansion of agricultural land. As the land lost its dynamic properties and became more static allowing cultivation of the land, the region became more populated allowing further urbanization and expansion. The geomorphological history reveals that the earliest settlements could be traced further inland supporting the argument that the coast is newly reclaimed and cultivated land (Vollmer, Guldberg, Maluck, Marrewijk, Schlicksbier, 2001).

The loss of dynamic properties settled the Wadden landscape leaving the historical dynamic traces of the past visibly surrounded by the vast agricultural land-sea. "The still existing variety in the cultural landscape is constantly threatened by standardization and scaling of agricultural practices and buildings" threatening the cultural values of the Wadden Sea Region (Schroor, Enemark, Fischer. & Guldberg, 2017). The homogenisation threat of the static present is further explored in the following chapter

Friesland Sea Dike, 2022.
Photo: Xinjian Jiang.


Honden aangelijnd
Voorkom
(graaf)schade
aan de dijk

A Homogenized Present

Chapter III

Friesland Peatscapes, 2023.
Photo: Author.

A Homogenized Present

The chapter looks into the administrative and socio-economic structure of the Wadden landscape. The chapter compares the Dutch Wadden Sea to the rest of the Wadden Region and starts a dialogue regarding the disparities that the Northern Dutch regions, including Friesland, battle with. The chapter touches upon the issue of fragmentation of the Wadden Region when the diversity of administrative borders and bodies hinders the natural and cultural protection of the region. As a result, the preservation of cultural heritage has been greatly hindered by the lack of recognition from UNESCO and general differences in the management in the three countries (Vollmer, Guldberg, Maluck, Marrewijk, Schlicksbier, 2001).

As part of the socio-economic discussion, the chapter looks further into the present Dutch structure of the Wadden Sea Region and discusses the impacts of recent historical development in Friesland on the current land use allocation. The Chapter explores the Dutch policies impacting the agricultural landscape that has faced significant changes in the past decades, during which an immense scaling up has occurred. This has resulted in many issues that the agriscape has faced or yet to face. The chapter discusses issues related to these intense developments and changes in the landscape.

One of the most apparent issues one could attribute to the agricultural expansion is a significant homogenization of landscape that puts immense pressure on the cultural and natural diversities of the Wadden Sea Region (Schroor, Enemark, Fischer. & Guldberg, 2017). Issues such as the loss of structures providing natural eco-services and the loss of culturally valuable traces are a direct impact of immense agricultural expansion (Schroor, Enemark, Fischer. & Guldberg, 2017). The chapter sheds light on the homogenization and standardization threats that the agricultural industry brings.

The Wadden Sea Region spans three countries: the Netherlands, Germany, and Denmark. 63% of the Wadden Sea Area belongs to Germany while the Netherlands and Denmark share the rest, with only 7% being attributed to Denmark (Schroor, Enemark, Fischer. & Guldberg, 2017). The Wadden Sea coast stretches across approximately 500 km and covers 10 0000 km² in area (Common Wadden Sea Secretariat, 2016). The region spans three international borders and gained UNESCO World Heritage status in 2009 in Germany and the Netherlands, whereas Denmark joined only in 2014 (Common Wadden Sea Secretariat, 2016). The inscription of the Wadden Sea as a UNESCO World Heritage site signified its universal importance, subsequently bringing additional protection and preservation to the site for future generations (Common Wadden Sea Secretariat, 2016).

The UNESCO heritage borders are not only different from that of the Trilateral agreement but also exclude the cultural heritage properties of the region from its protection, bringing additional challenges in managing such a fragile ecosystem. The complexity of the shared administrative borders contributes to the difficulties in the management of the Wadden Region (Baerends, 2020). One could see administrative borders and entities as part of the regional modern fragmentation. Friesland, being part of the Wadden Region and having a direct relationship with the UNESCO heritage site, can positively or negatively impact the future of the Wadden Sea that is in desperate need of further recognition, protection, and preservation (Common Wadden Sea Secretariat, 2016).

In 2014 the University of Groningen conducted socio-economic research of the international Wadden Sea Region, which has revealed that there are major differences in the socio-economic structure across the international coast. The study has revealed the following: "the coast of the Dutch Wadden Sea shares one of the highest aging and unemployed population rates" (Sijtsma, Broersma, Daams, Mehnen, Oostra, & Sietses, 2014).

Data
CBS.nl

GRONINGEN AREA
2 960 KM²
GRONINGEN POPULATION
583 990

Data
CBS.nl

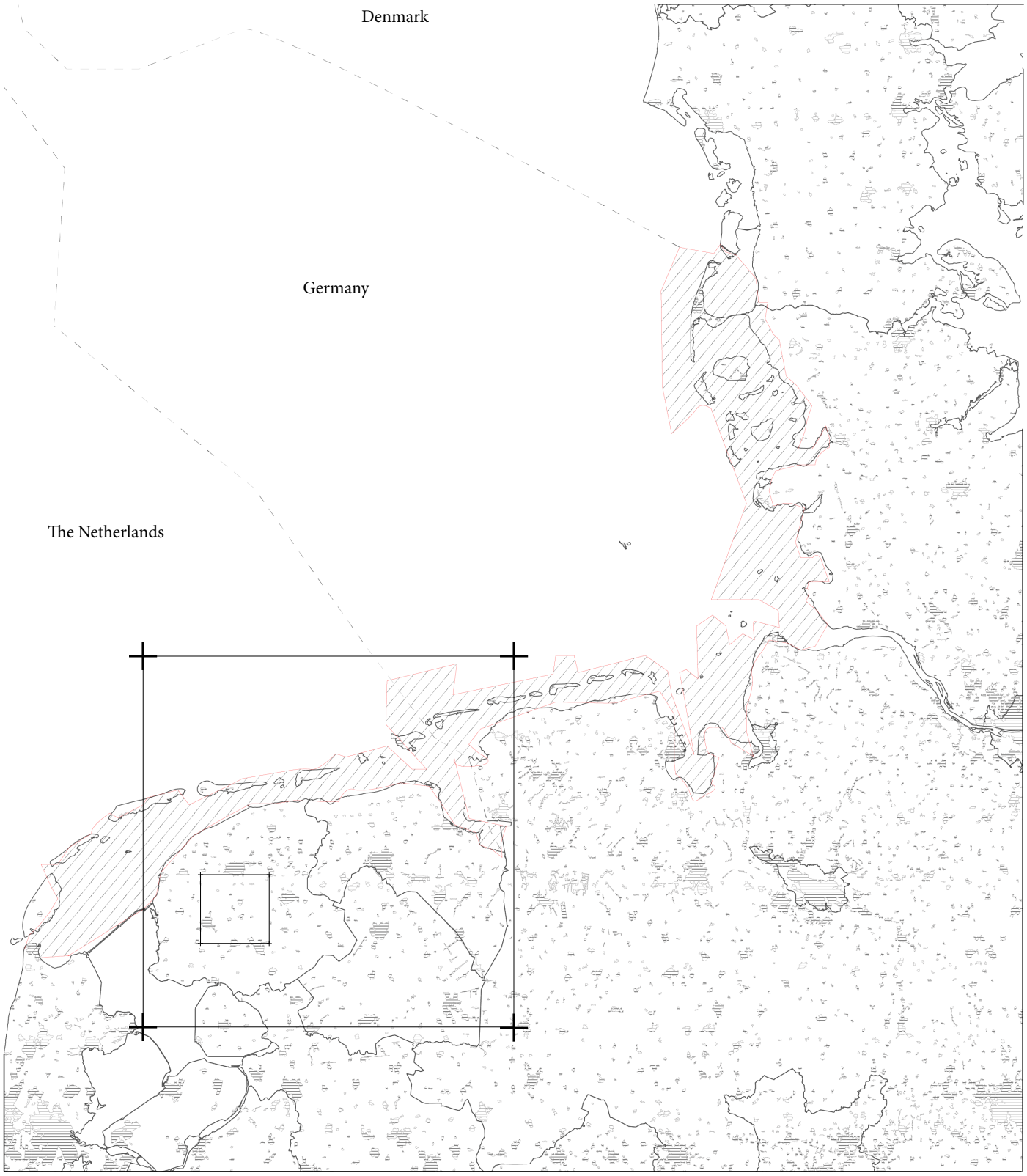
FRIESLAND AREA
5 740 km²
FRIESLAND POPULATION
649 944

Data
CBS.nl

WADDEN SEA COAST AREA
10 000 km²
WADDEN SEA COAST LENGTH
500 km

Administrative Borders and Unesco Heritage

Data: www.pdok.nl , www.openstreetmap.org, 2022.



0 | 40 km | 100 km

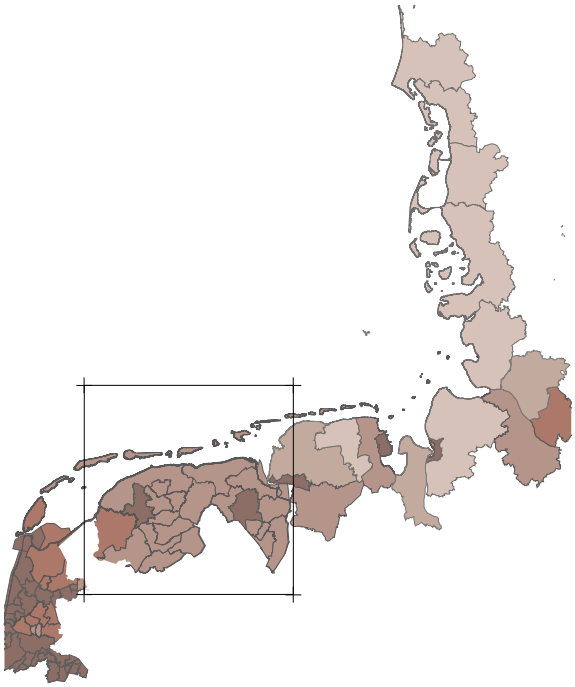
N

National Border
Municipality Border
Trilateral Agreement
Urban Area

Socio - Economic Structure

Data: www.ec.europa.eu/eurostat, 2022, (Sijtsma, F., Broersma, 2014).

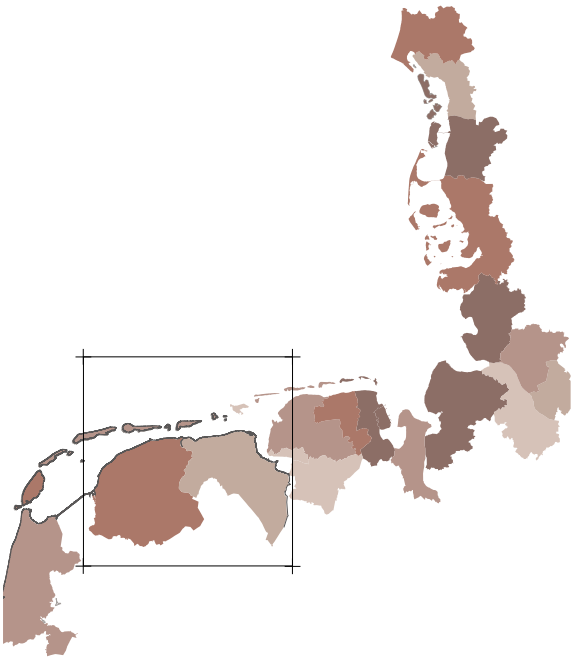
Population Density



People / km²

> 850
300-850
150-300
100-150
75-100
0-75

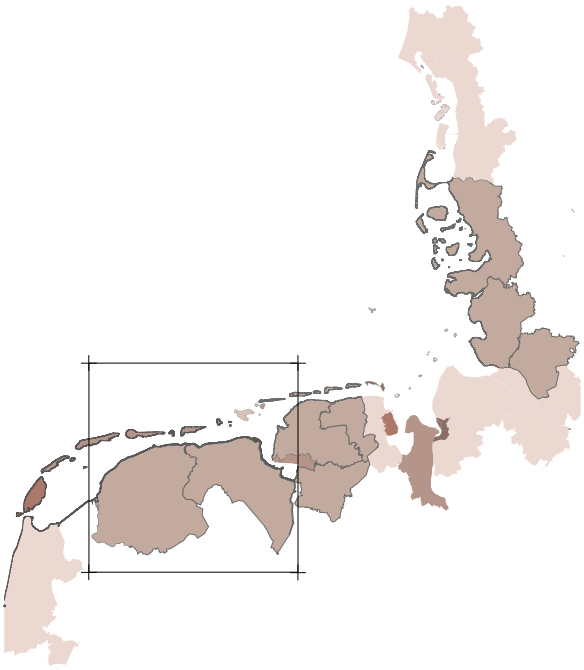
Ageing Population



Rate of Ageing Population

> 3%
2-3%
1-2%
0-1%
< 0%

Unemployment



Rate of Uemployment Development

> 3%
2-3%
1-2%
0-1%
< 0%

The study revealed the higher rates of socio-economic vulnerabilities on the Dutch coast in comparison to its German and Danish counterparts, which further emphasized the socio-economic vulnerabilities and disparities within the Dutch Wadden region.

People inhabiting the coast of the Wadden Sea constitute "a mean population density of 160 persons per square kilometer", which is a significantly lower density average in comparison to the " inland of the Netherlands (502) and Germany (227)" (Common Wadden Sea Secretariat, 2016). Such relatively low population density of the region adds to the identity of the Wadden Sea, it being a vast and open landscape.

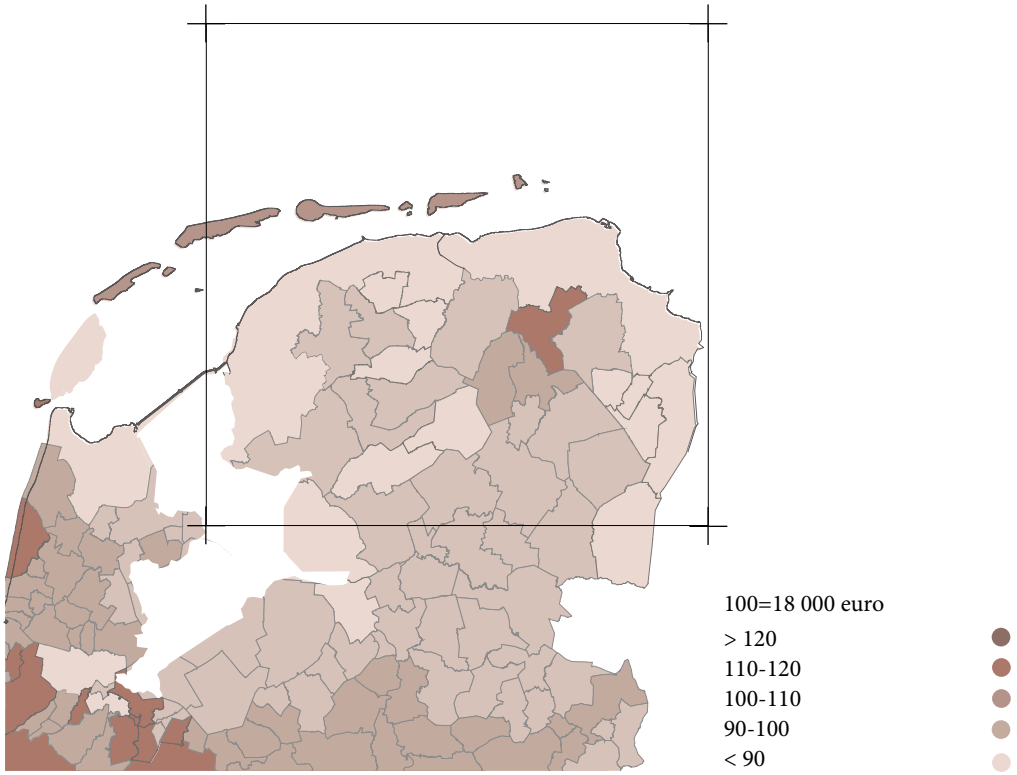
Following the socio-economic study conducted by the University of Groningen, the data obtained from CBS (2022) reveals that the Dutch Wadden Region consists of 3 provinces (Friesland, Groningen, Noord Holland) socio-economically differs from the rest of the country. The CBS data (2022) demonstrates that the income index in Friesland and Groningen is one of the lowest in the country, speculating that people residing in these provinces have one of the lowest purchasing power in the Netherlands.

Looking further down in scale the difference between the economic power of the coast of Friesland and Groningen and its major cities differs highly in comparison to the hinterland of these provinces. The income of Terschelling Island and Leeuwarden is much higher than that of the Frisian and Groningen ruralities further implying the socio-economic vulnerabilities of the hinterland (CBS, 2022). It is important to note that employment in the agricultural sector in Friesland accounts for 4,7% of the total Frisian population, which is much higher than the national average of 2.6% (Molema et al., 2017).

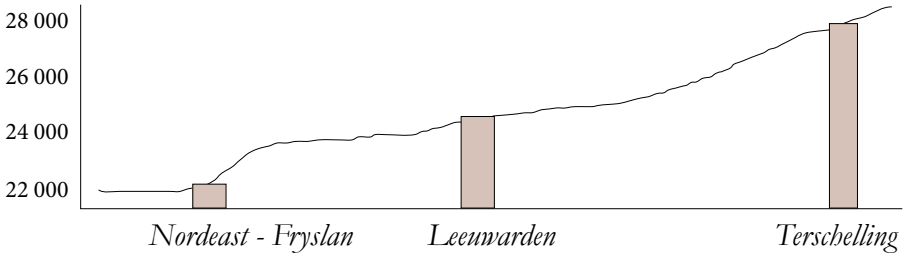
Socio - Economic Structure

Data: www.CBS.nl, 2022.

Income Index



Income Comparison Friesland



Friesland Peatscapes, 2023.
Photo: Author.

Recent Timeline

Data: www.fryske-academy.nl 2022, Agri&Foodscan Fryslân, 2018.

1993
48% of the Netherlands dedicated to agriculture.

1990
Nature Policy Plan and Ecological Main Structure

The nature policy plan introduced an integrated plan for long-term nature management in the Netherlands.

1958
Establishment of EEC and the Common Agricultural Policy

From the early 1960s, the CAP formed an important part of the EEC. Price subsidies contributed to a common market for agriculture products, but led to overproduction.

1975
Relatienota

In the Relations Memorandum, the national government provided an integrated vision for the first time on the relationship between agriculture and nature. Farmers were given a role as nature managers.

1984
Introduction of super levy and the milk quota

Overproduction in the 1960s and 1970s had led to unsaleable stocks of agricultural products. From 1984, each farm was allocated a maximum quantity of milk that could be produced in a year.

1994
Regional Plan Friesland and EHS in Friesland

The Regional Plan Friesland 1994 links up with the EHS as established by the State. In Gaasterland, the announcement of the EHS led to protests, after which it was decided to give those involved more of a say in its implementation.

2016
43% of the Netherlands dedicated to agriculture.

2017
77 % of land was used by agriculture in Friesland.

2000
Review of Nature Policy

After 2000, the criticism of top-down nature management was translated into new policy. Agricultural nature management was thoroughly revised between 2013 and 2016, because it had not produced sufficient results.

2004
Provincial Agriculture Economic Policy

General trends and developments in agriculture are translated into three successive agricultural agendas.

2022
National Program Rural Area, Transition Goals

The Ministry of Agriculture has presented nitrogen emission reduction targets per area, especially in the peatlands, for the benefit of the integrated area-oriented approach as it is being designed by the National Program for Rural Areas.

1997
First Meadow Bird Memorandum

Provincial meadow bird policy Since the mid-1990s, the province of Fryslân has been actively involved in the preservation of meadow bird populations.A combination of nature reserves, agricultural nature management and protection by bird watchers is used.

2014
Agriculture Agenda 2014-2020

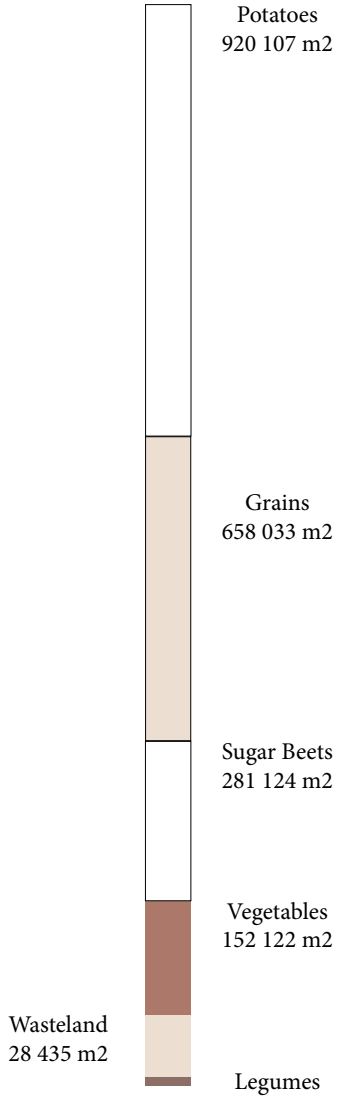
The province is committed to raising local water levels and innovation projects focusing on natureinclusive agriculture, sustainability. resistance to subsidence.

2018
Vision: Agriculture, Nature and Food

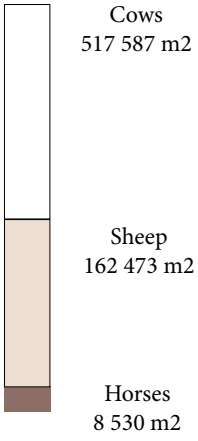
In the latest agriculture vision of the Ministry of agriculture is even more committed to sustainability. The Dutch Agri & Food sector will make a transition to circular agriculture.

Agricultural Land Use Friesland

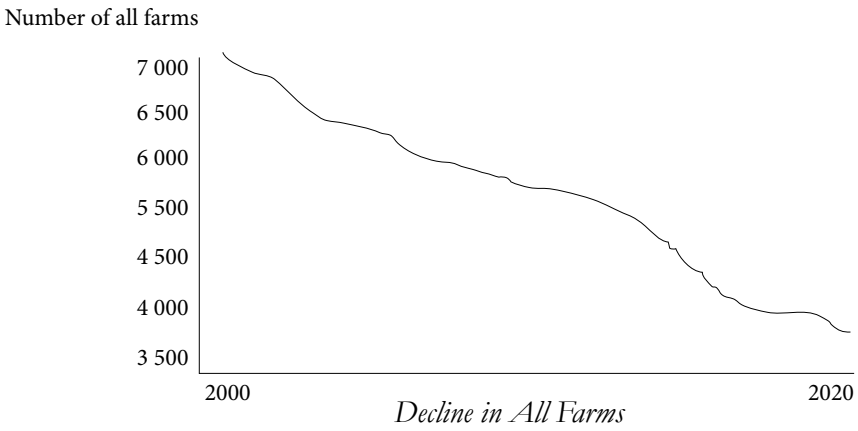
Data: www.cbs.nl, 2022.



Arable Land Allotment



Pastures Allotment



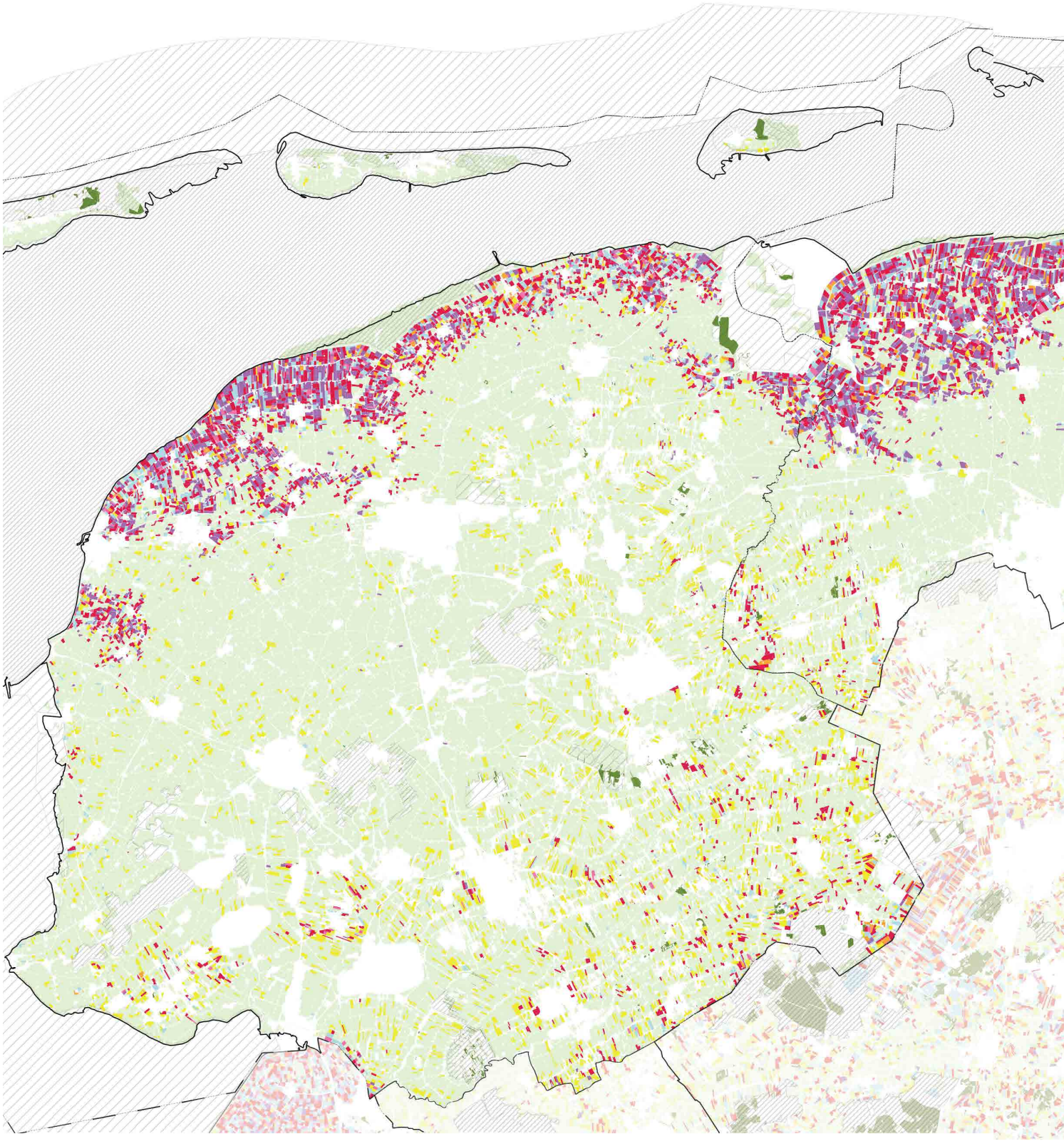
Decline in All Farms

Friesland Land Use

Friesland Farm, 2023.
Photo: Author.

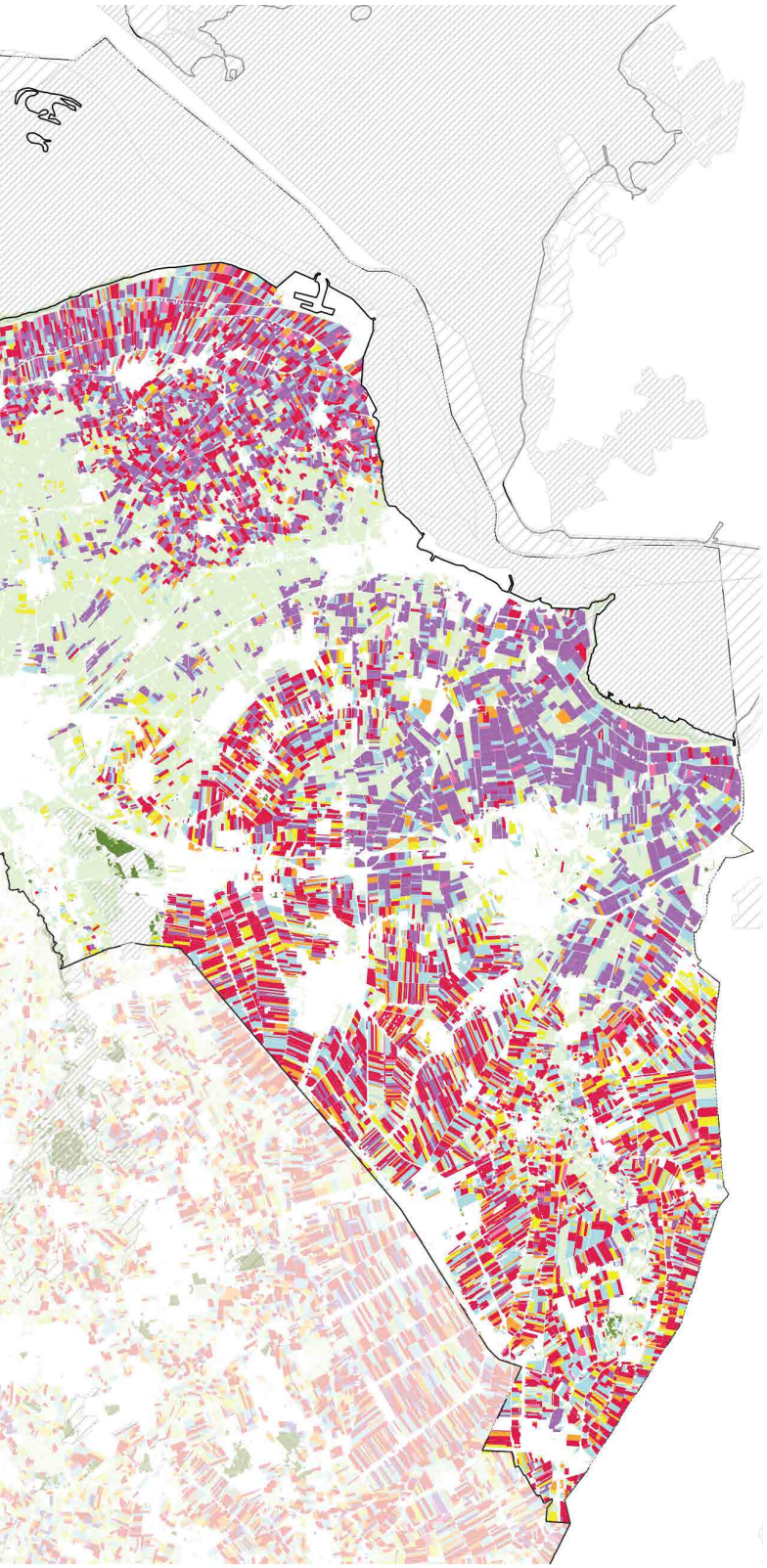
Agriculture

Data: www.pdok.nl , www.openstreetmap.org, 2022.



0 | 10 km | 20 km | 30 km

N



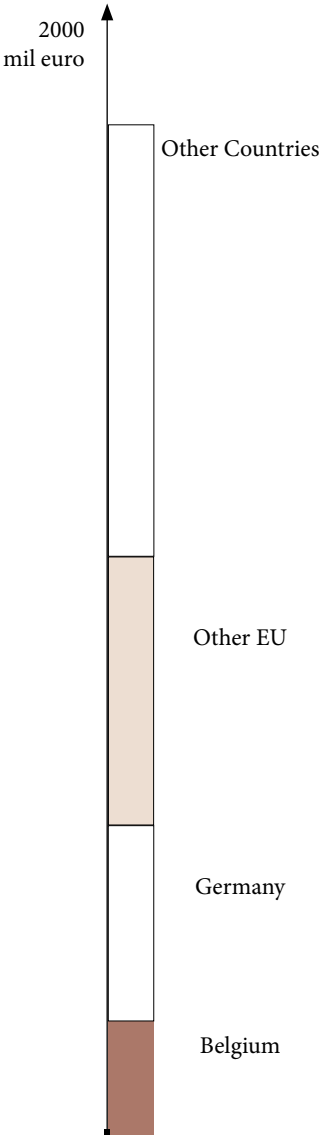
The most recent history reveals that the subsidies implemented by the EU and Dutch governments had a huge impact on the recent expansion of Frisian agricultural land (Plantinga, Molema, 2020). As the EU anticipated the global economic demand for dairy products it abolished the "milk quota" in 2008 that aimed to control the expansion of the dairy market further contributing to the upscaling of agriculture (Plantinga, Molema, 2020). The abolishment of all quotas resulted in the growth of average farm sizes and megafarms significantly dropping the number of all farms in Friesland. In 2021, 77% of the Frisian landscape was dedicated to agriculture. Almost one million square meters of land is attributed to the growth of potato seeds and dairy cattle take up to half a million square meters (CBS, 2022).

The soil structure of the region influences the land use of the area. The clay soils are extremely fertile in comparison to the peat and sandy soils of the hinterland turning the coast into a "potato valley" as it is the main crop being produced on the fertile coast. The inland of Friesland is used mostly for dairy farming with occasional corn and fodder grass production (Agrifood, 2023).

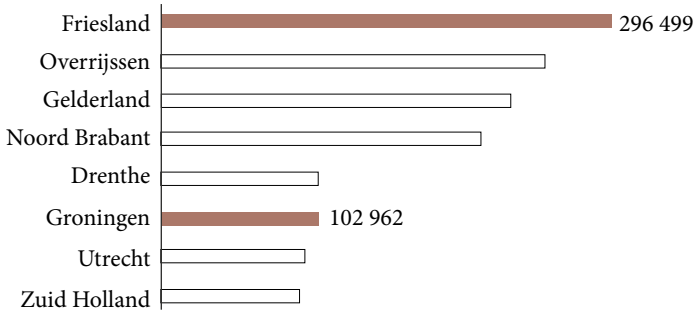
The abolishment of all the implemented restrictions created an economic environment in which the upscaling of agriculture became significantly easier. Nowadays, Friesland and Groningen are one of the largest exporting provinces for the markets outside of the EU. 23% of all seed potatoes in the world come from Groningen (Agrifood, 2023). Friesland, in 2021, had the highest population of dairy cows in the country (CBS, 2022). The upscaling led to larger farms turning the small family lead businesses into mega agrarian corporations.

Upscaling and Export in Friesland

Data: www.cbs.nl, 2022.



Export Friesland



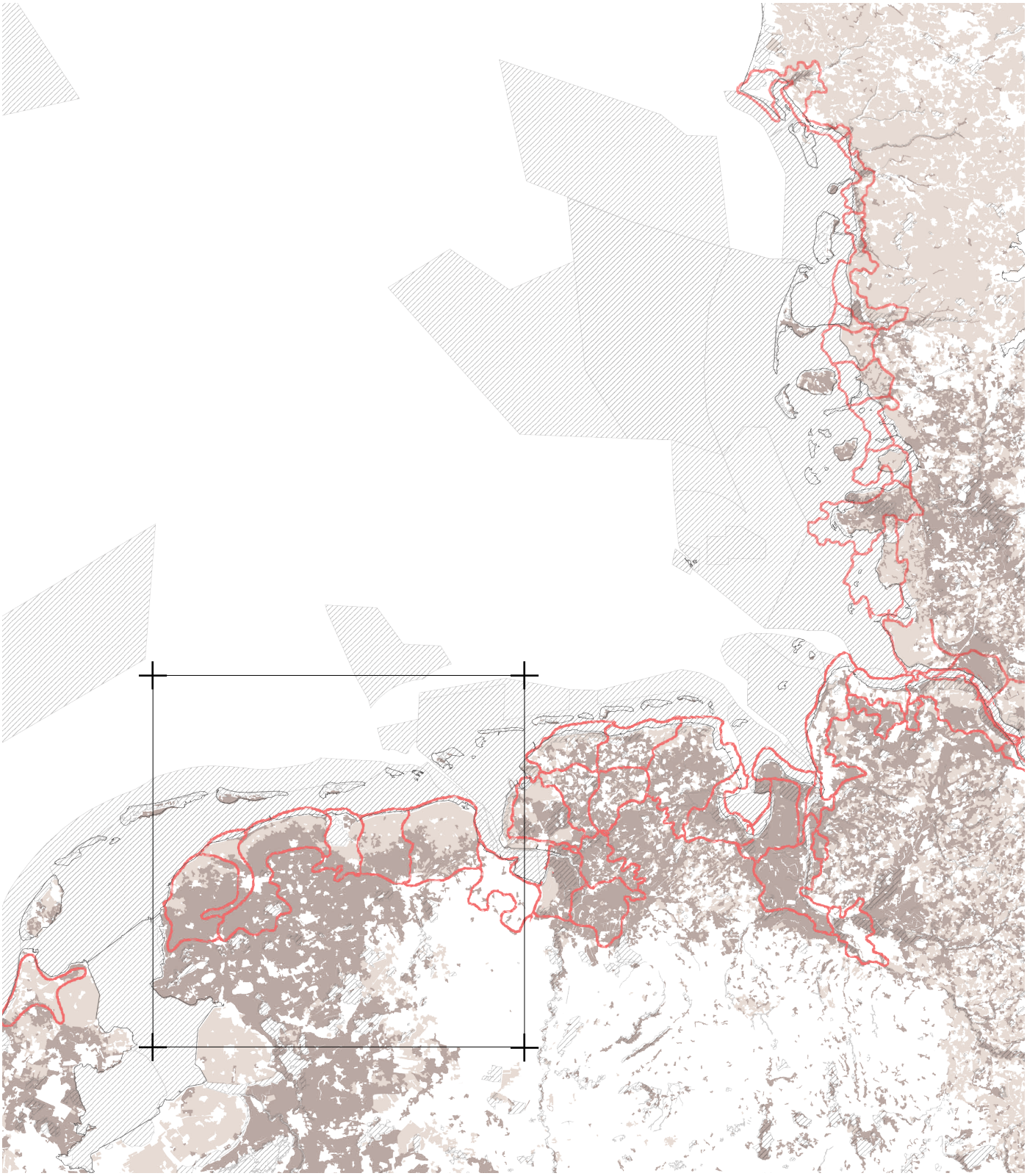
Dairy Cows Population Comparison

Main Export Products

Friesland Farm, 2023.
Photo: Author.

Agriculture vs Biodiversity

Data: www.pdok.nl , www.openstreetmap.org, 2022.



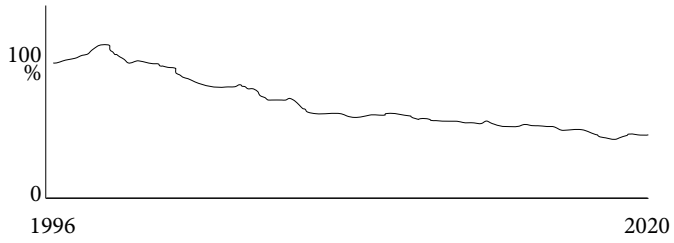
0 | 40 km | 100 km

N

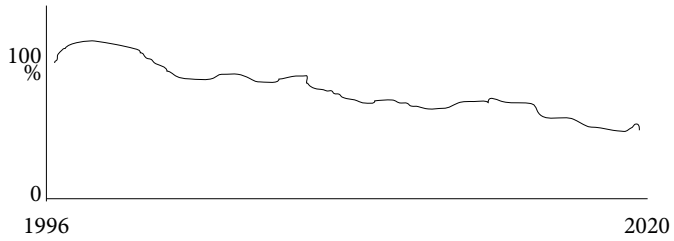
Coastal Line
Pastures, Agriculture
Arable Land, Agriculture
Natura 2000
Tidal Basins

Common Meadow Bird Species

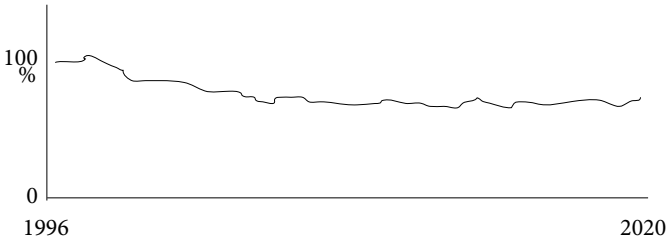
Population Trends



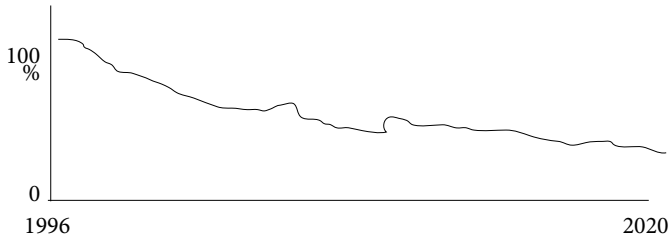
Grutto average annual decline 3.7%



Kievit average annual decline 2.8%



Tereluur average annual decline 1.4%



Scholekster average annual decline 4.0%

The protection of natural habitats in the Wadden Sea Region often follows larger-scale legal instruments such as EU directives, Natura 2000, Water Framework Directive (Molema et al., 2017). The upscaling of agriculture created a higher conflict with the natural environment. The agricultural land often shares its borders and even land with the conservation and Natura 2000 areas, breeding conflict and higher pressure on biodiversity. There has been an alarming decline in the common meadow bird population (Boks, 2022).

The transition into a more nature-inclusive environment is a long process. The process of implementing nature-based solutions often involves a multi-scalar framework for different stakeholders which greatly complicates the process of transitioning into a more nature-inclusive environment (Ruangpan, Vojinovic, Plavšić, et al, 2021). The agricultural industry contains a rich variety of stakeholders, whose values do not always align, greatly politicizing the decisions regarding any changes related to the damaging industry (Vermunt, Wojtynia, Hekkert, Van Dijk, 2022).

One of the ways Friesland has been attempting to create nature-inclusive agriculture is by incentifying nature-inclusive practices and subsidizing farmers that choose to transition to more sustainable practices. The local nature management has been outsourced to seven Agrarian collectives, "which in turn outsource it to their members - the majority of which are local farmers" (Molema et al., 2017). "In 2013, more than 30 percent of Frisian farmers had landscape management as an extension activity, while that was barely 11 percent nationally" (Molema et al., 2017).

The eternal battle against the sea required significant landscape amendments, in which terps-pioneer settlements, dikes, ditches, canals, mills, etc all had a role in the process. The historical traces of the past could still be highly seen in the landscape forming a unique cultural heritage (Vollmer, Guldberg, Maluck, Marrewijk, Schlicksbier, 2001).

The Wadden Sea not only possesses a biodiversity heritage but is one of the most valuable cultural regions in the EU. Although only the natural aspect of the Wadden Sea is considered a part of the UNESCO Heritage, the cultural aspect of the landscape plays a vital role in the identity of the Wadden land (Vollmer, Guldberg, Maluck, Marrewijk, Schlicksbier, 2001).

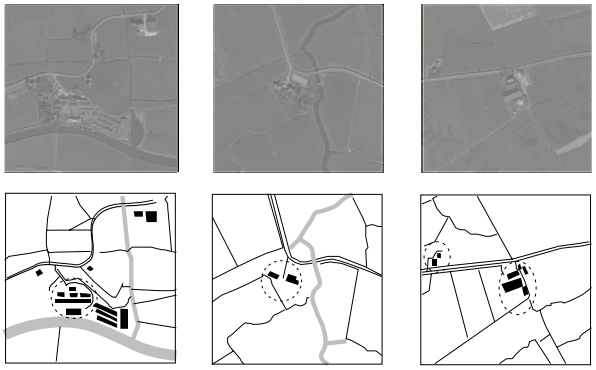
The upscaling of agriculture creates a conflict between cultural heritage, that nowadays has little to no international legal protection in which due to the upscaling the diversity of the landscape is often lost (Vollmer, Guldberg, Maluck, Marrewijk, Schlicksbier, 2001). The homogenization of the cultural landscape carries a great threat to the Wadden landscape. Although many attempts were made in the desire to preserve the cultural heritage the differences between Dutch, German, and Danish definition of cultural heritage has greatly hindered the management and opportunities the cultural preservation of the Wadden landscape (Vollmer, Guldberg, Maluck, Marrewijk, Schlicksbier, 2001).

Infrastructure

Wind Mill

Old Sea Dike

Water

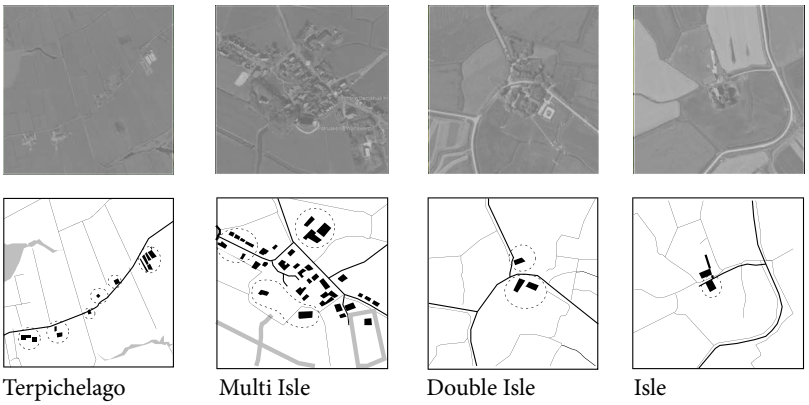


Major Canal

Secondary Canal

Minor Waterway

Terpscape



Terpichelago

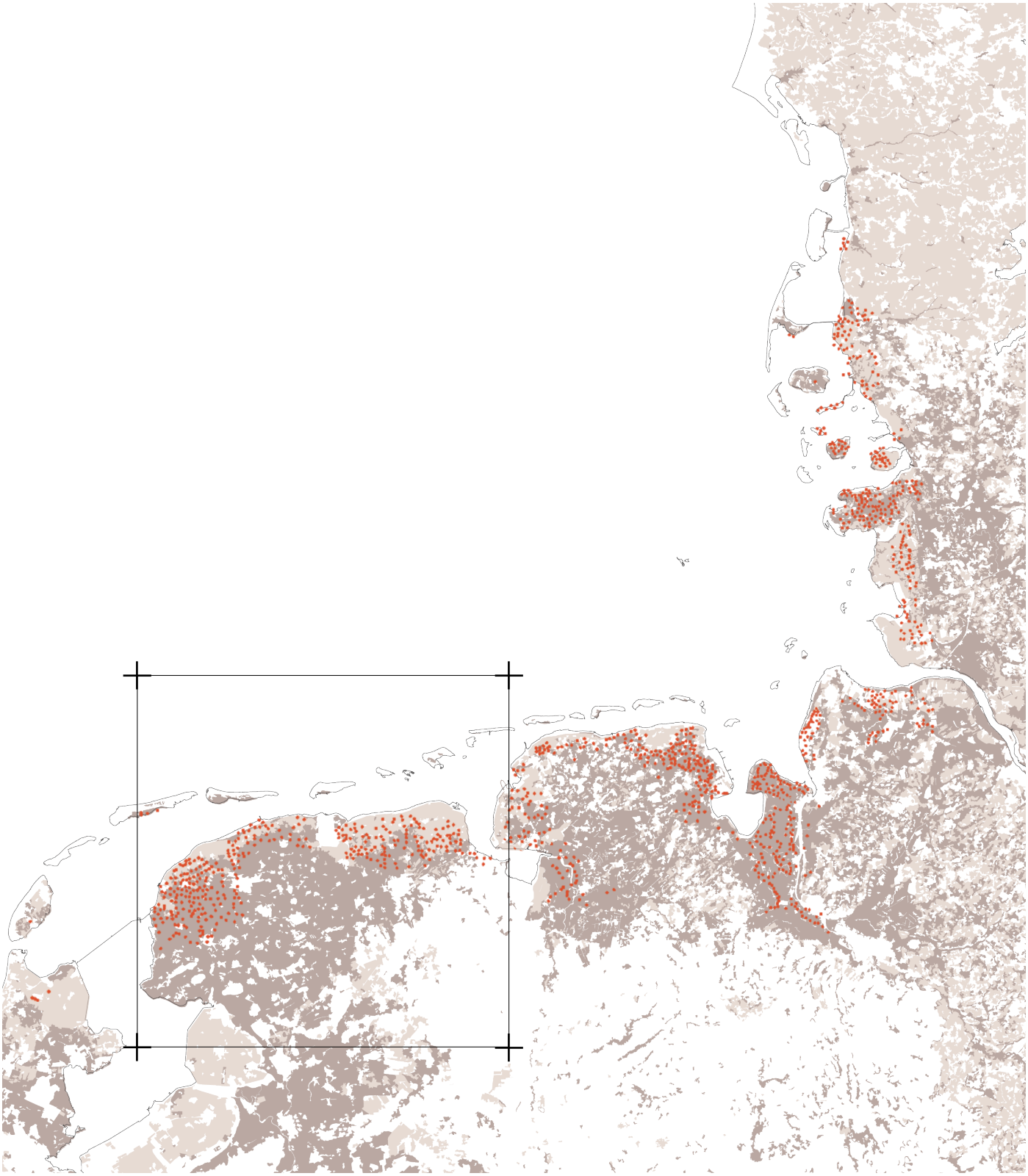
Multi Isle

Double Isle

Isle

Agriculture vs Cultural Heritage

Data: www.pdok.nl , www.openstreetmap.org, 2022.



0 | 40 km | 100 km

N

Coastal Line
Pastures, Agriculture
Arable Land, Agriculture
Pioneer Settlements - Terps

Friesland Peatscapes, 2023.
Photo: Author.

An Uncertain Future

Chapter IV

Friesland Peatscapes, 2023.
Photo: Author.

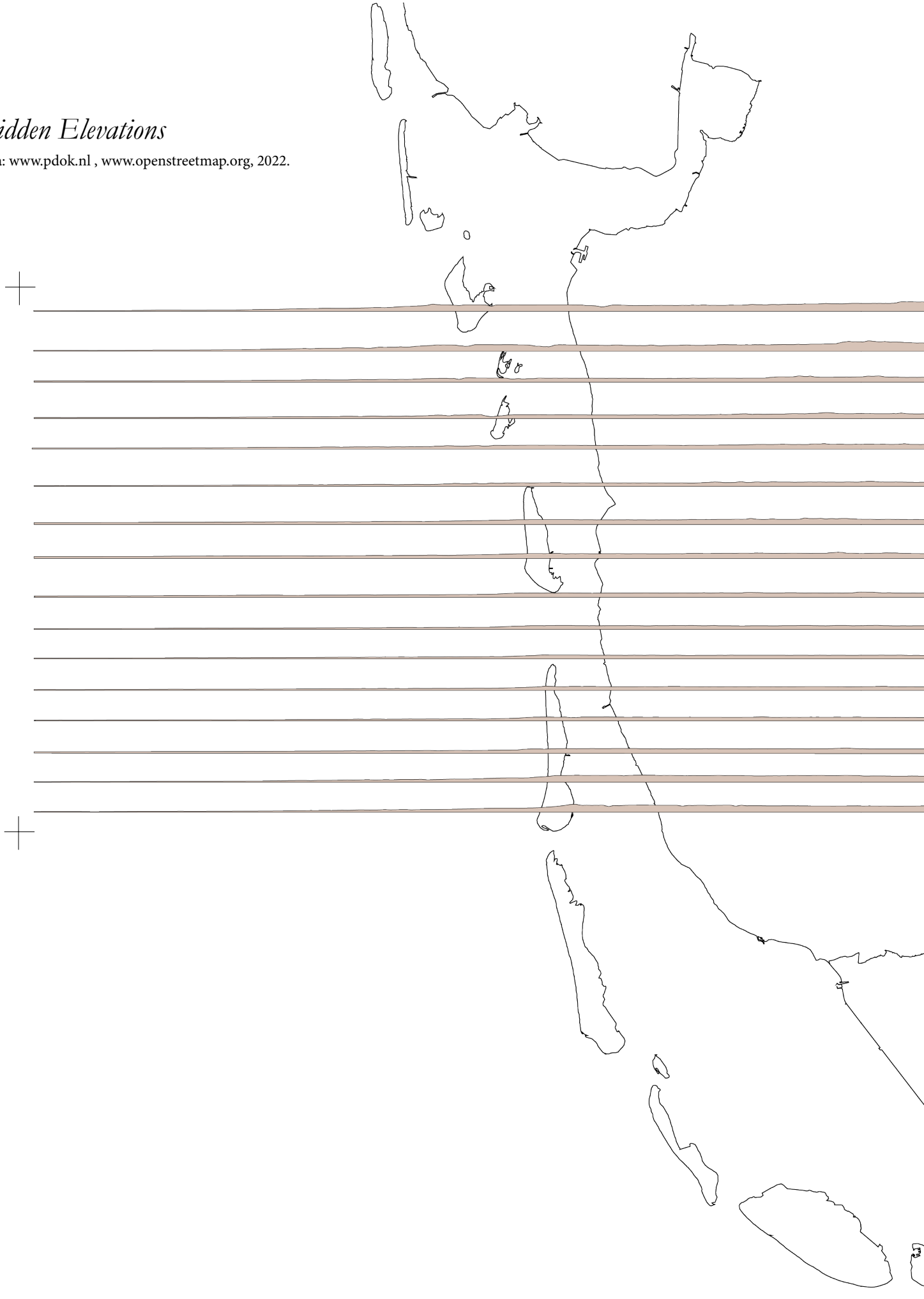
An Uncertain Future

The productive landscape of Friesland is facing great uncertainty in the future. This chapter compiles the uncertainties related to agriculture, climatic threats, and dangers. It touches upon the climatic challenges and impacts of agriculture on the climatic cycle and its contribution towards the uncertain future. The chapter begins a conversation regarding the direct and indirect impacts of agriculture on the ruralities of Friesland and emphasizes its vulnerabilities. Issues such as sea level rise, salinization, drop in water ground levels, ammonium and nitrogen threats, soil and water pollution, soil subsidence, and peat oxidation that increase the fragility of the rural landscapes and bring immense uncertainty to the Frisian rural future are explored in the chapter (Hoekstra, Philippart, 2021). The chapter discusses the Frisian hinterlands in three different parts (coastal agriculture, peatlands, and elevated sandy soils)and argues through the lens of agriculture that the areas are experiencing different challenges. The focus of the coast lies on salinisation, the focus of the peatlands lies within the threat of peat oxidation and greenhouse emissions and the southern sandy soils worry about future water shortages.

Peat oxidation and future peat loss are the focus of the "Uncertain Future" chapter. The process of peat oxidation could be attributed to unsustainable agricultural practices in which accumulated excess water is drained further causing soil subsidence and groundwater level drops in the peatlands. Massive CO2 emissions could be attributed to the process of peat oxidation. As the process continues, agriculture is expected to battle with severe droughts and water shortages in the future, especially in the increasingly elevated sandy soils (VeenweideFryslan, 2021). Increasing sea level rise and a hotter environment will contribute to future water challenges and shortages. Coastal agriculture is facing salinization threats. Agriculture in close proximity to Natura 2000 areas, especially in the Frisian peatlands, is becoming greatly politicized due to governmental concerns with nitrogen emissions and nature vulnerabilities. The peat is expected to disappear in the coming 100 years, which raises urgent questions about what the region can do to become more resilient (VeenweideFryslan, 2021).

Hidden Elevations

Data: www.pdok.nl , www.openstreetmap.org, 2022.



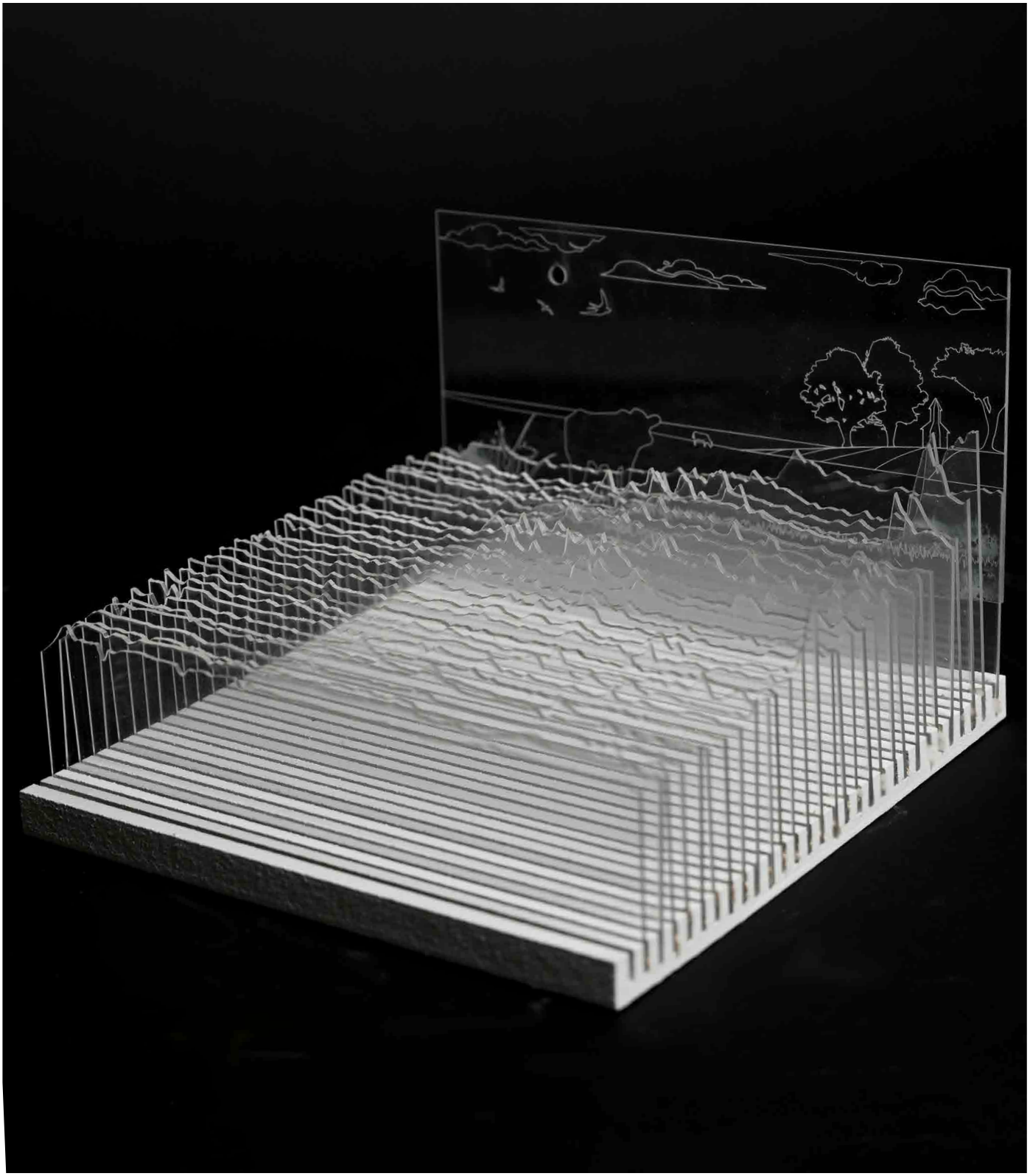
0 5km 15km 25km

N

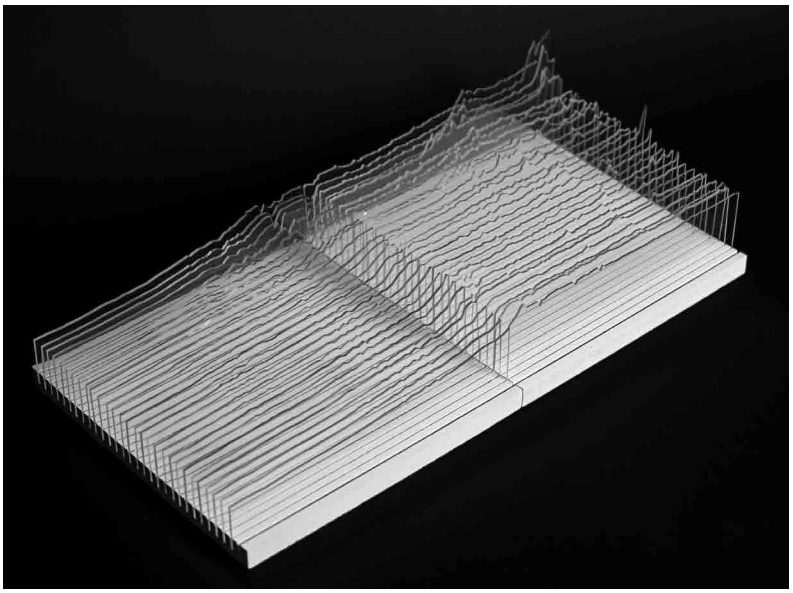
The seabed and hinterland elevation study demonstrates that despite the general notion that the Dutch landscape is considered as very open and “flat”it still contains major elevation differences, which depending on the proximity to the sea experience different climatic challenges. The lowest part of the hinterland is located in the middle ground of Friesland, which due to mainly soil subsidence experience accumulation of excess water that is being actively pumped out into the sea contributing to the process of peat oxidation (VeenweideFryslan, 2021).

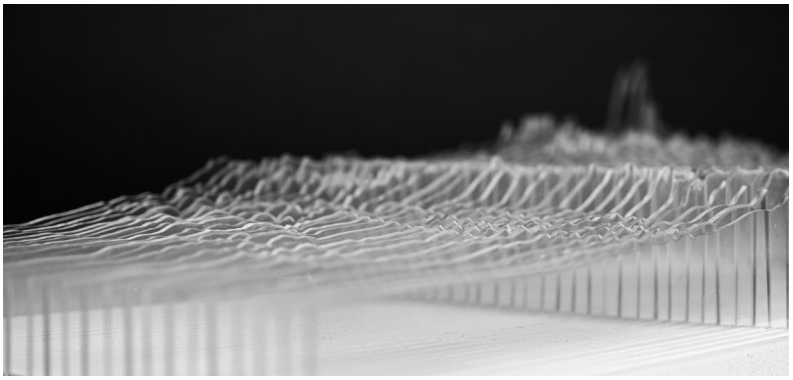
Hidden Elevations: Seabed and Hinterland

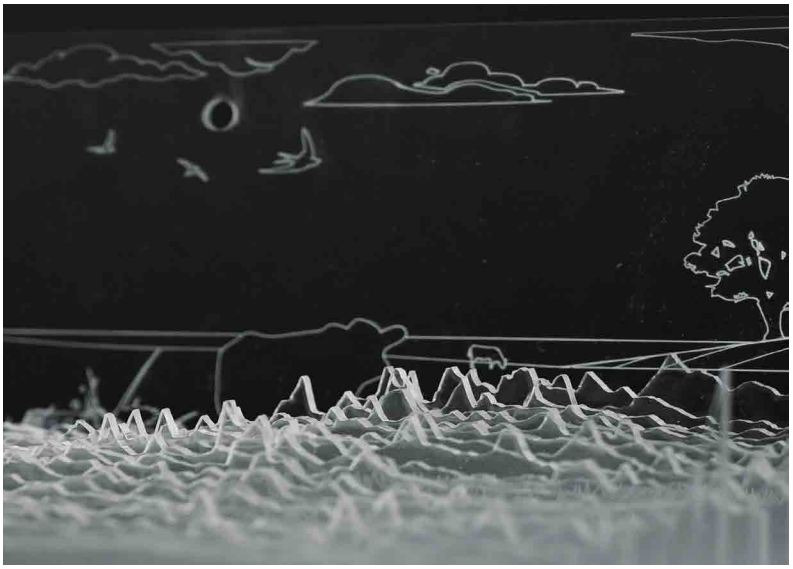
Data: Anna Gorokhova, Xinjian Jiang



0 5km 10km 15km N



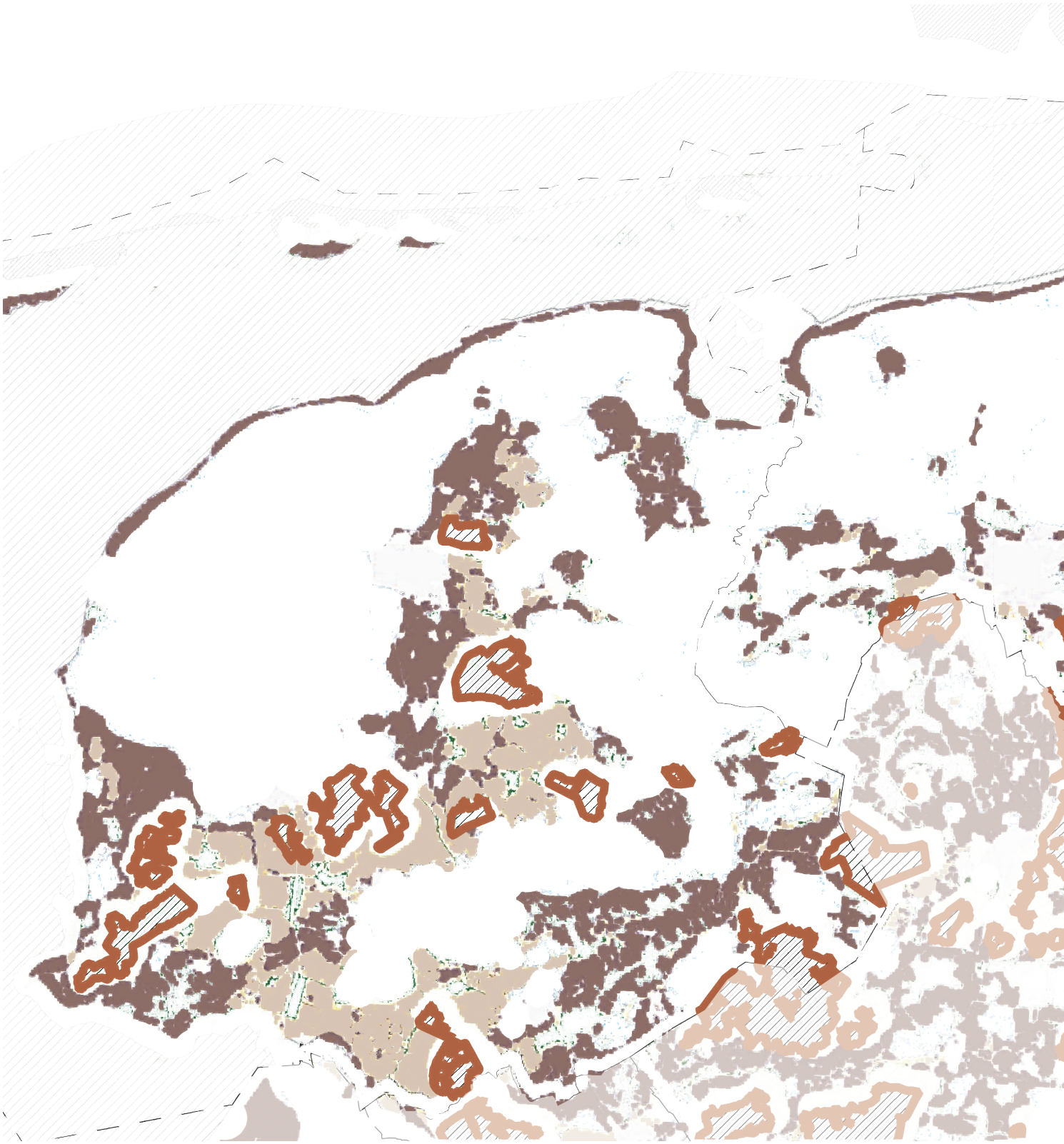




The 25x 25 cm hinterland elevation and seabed elevation models further support the study, demonstrating that the south of Friesland - sandy soils are located much higher in comparison to the peat middle grounds and clay coast. The models complement each other, communicating the landscape shift between the hinterlands and the seabed. As the sea level rises due to lower elevated features the coastal line and middle grounds are more prone to flood opportunity damages and sea level rise threats (VeenweideFryslan, 2021). The model further communicates the notion that different parts of Friesland and its agriculture are likely to struggle with different climatic issues.

Goverment Transition Goals

Data: https://www.rijksoverheid.nl, 2022



0 10 km 20 km 30 km

N

Nitrogen Reduction 47%
Peat Transition 47%
Buffer Zone Natura 2000
Natura 2000

"Fifty years ago a major shift in the public perception of the Wadden Sea commenced" (Kabat et al, 2012). Stakeholders started to view the region as more than a mere "intertidal wasteland from an agricultural perspective" and shifted in perceiving it as a "natural wetland of global importance, threatened by pollution and other human activities" (Kabat et al, 2012).

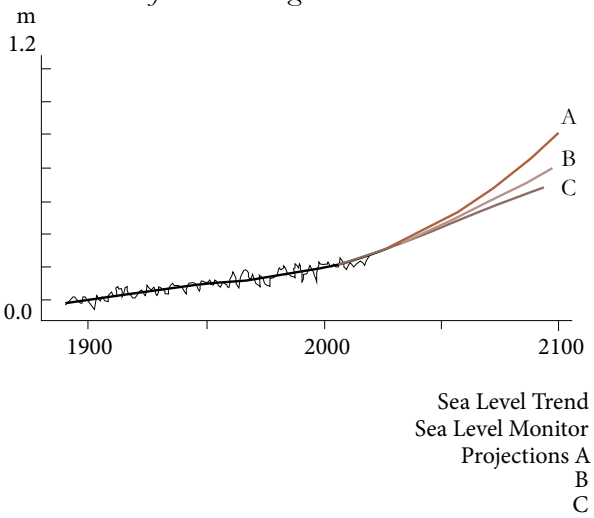
In the summer of 2022, the Dutch government announced the transition goals affecting different landscapes in the Netherlands. The map depicts the governmental goals to reduce nitrogen emissions in Friesland and Groningen. It becomes apparent that the peatlands - natural Frisian wetlands are affected the most by governmental aspirations to reduce the impacts of agriculture on the natural ecosystems of the Dutch Wadden Region. The government is intending to reduce nitrogen emissions in the peatlands by 47%.

Following the EU directives, the transition goals aim to bring buffer zones surrounding the Natura 2000 areas, expecting the affected agricultural areas to change (rijksoverheid, 2022). Such ambitious goals have not been taken lightly as people now are expected to transition their farming models into something else bringing political uncertainty and protests. A little less than a year later the FarmerCitizenMovement (BBB) was established and won many provincial electives as of March 2023 (Camut, 2023).

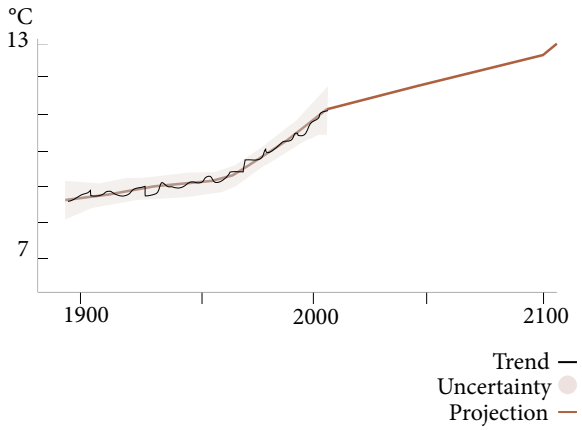
Agriculture and Climate Change

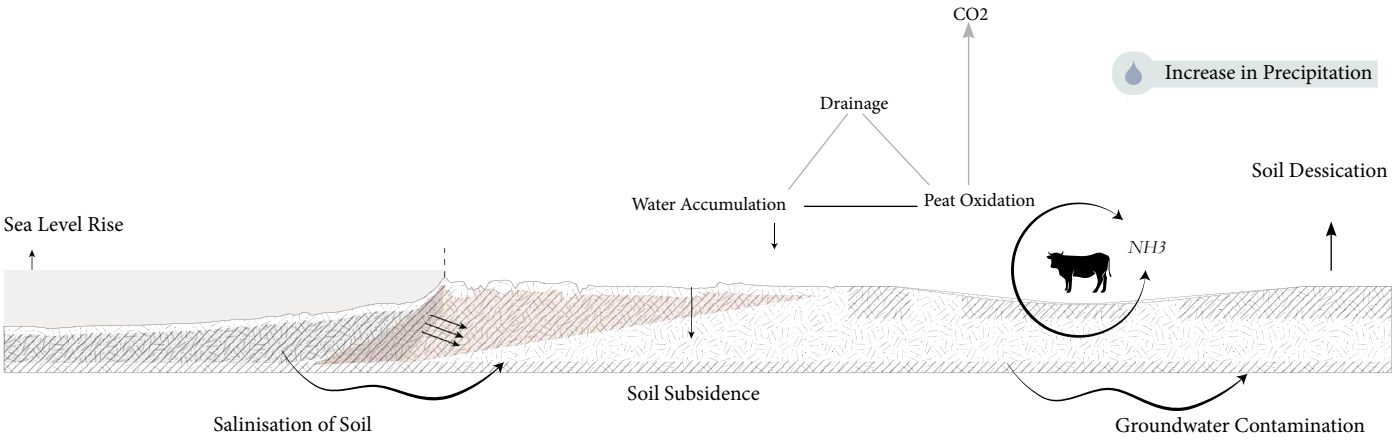
Data: www.klimaatinfo.nl, 2022

Projected rise in global mean sea level



Mean temperature trend





One of the greatest contributors to the uncertainty of the Wadden Sea is climate change (Kabat et al., 2012). Effects of climate change such as temperature and sea level rise are expected to impact the region. The temperature change is expected to impact the seasonal pattern and, subsequently, will be reflected in the Wadden distribution and provision of habitats (Kabat et al., 2012). "The Global sea level is linked to global temperature by thermal expansion and glacier ice loss" (Kabat et al., 2012). Accelerating Sea level rise majorly threatens the safety of habitats and inhabitants in the Wadden Sea Region (Kabat et al., 2012).

Current unsustainable water and soil management in the region not only threatens the natural and cultural heritage but brings great climatic uncertainty and contributes to global climate change. As the low-lying peat marshes accumulate more water with their subsiding lands, the dairy farmers drain the excess water and pump it into the Sea. During the process the peat layer oxidizes and releases carbon emissions into the atmosphere, contributing to global temperature rise (VeenweideFryslan, 2021). "In 2019, global emissions of fossil CO2 reached a new record value of 36.7 gigatonnes in 2019. This means that the emissions are 62% higher than in 1990" (Hoekstra, Philippart, 2021). The debate regarding alternative land use has been around, which included ideas mentioning aquaculture, bringing terps back, and accepting water for the new dynamic future (Kabat et al., 2012).

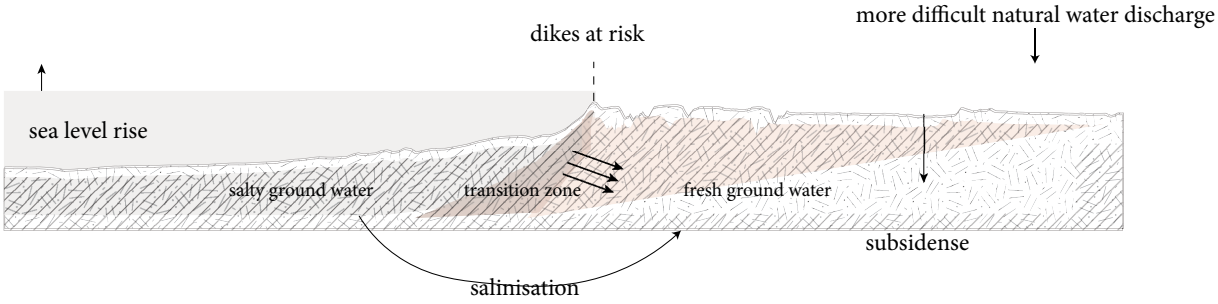
"Peatlands are the largest terrestrial carbone store on earth, storing about 25% of global soil carbon. That is twice as much as forests!"

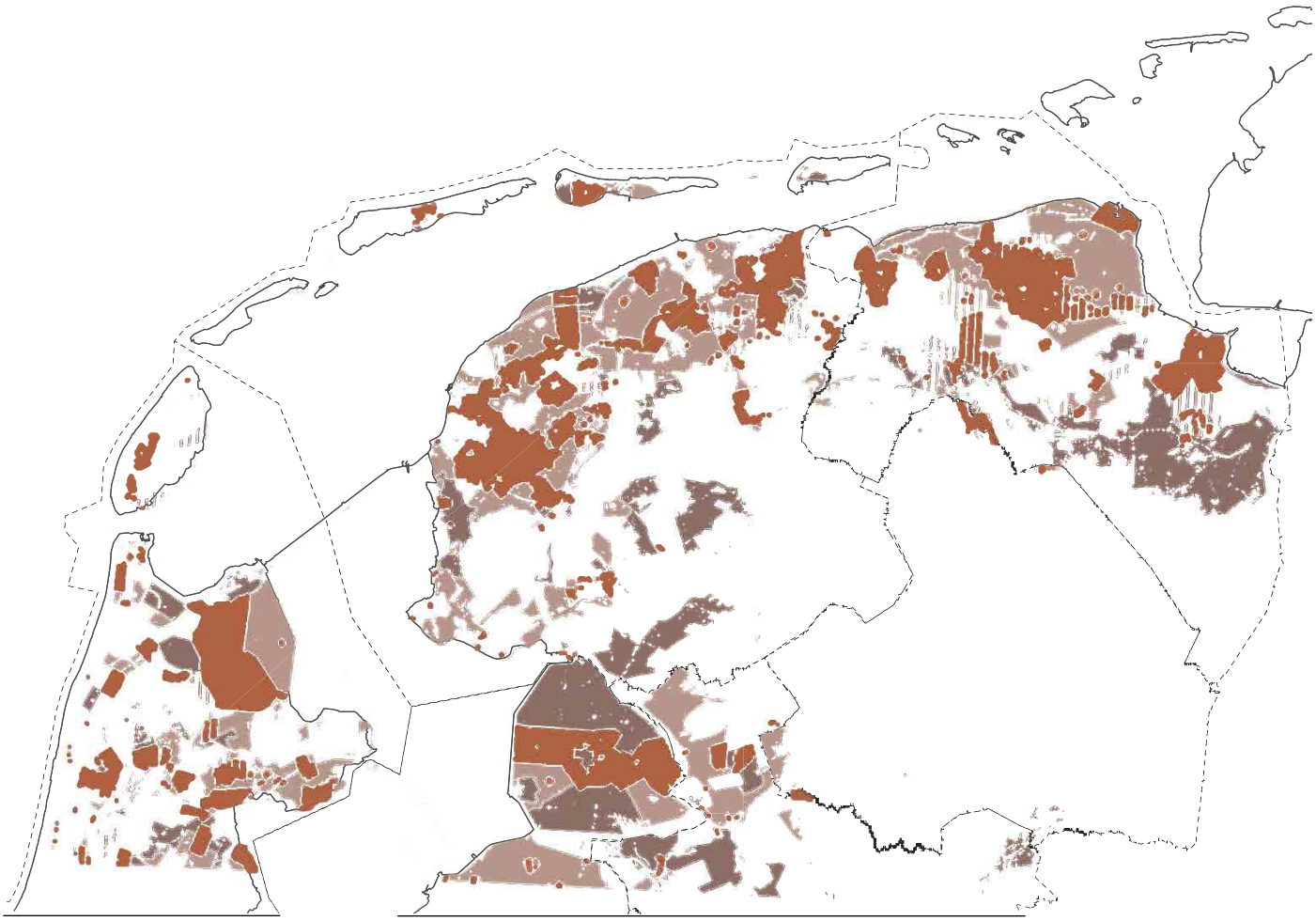
www.iucn.org

Sea Level Rise and Flood Damage Opportunity

Data: www.deltaprogramma.nl, www.pdok.nl , www.openstreetmap.org, 2022, Zhaolei Li

Sea level rise risk





0 | 10 km | 30 km | 50 km

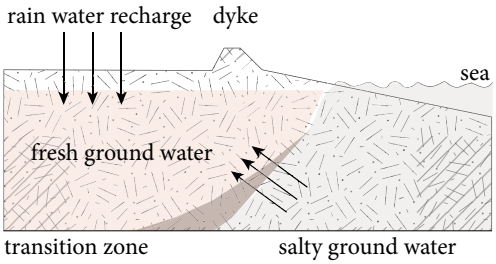
N

Limit damage at 0-20 cm flooding
Limit damage at 20-50 cm flooding
Limit damage at > W200cm flooding

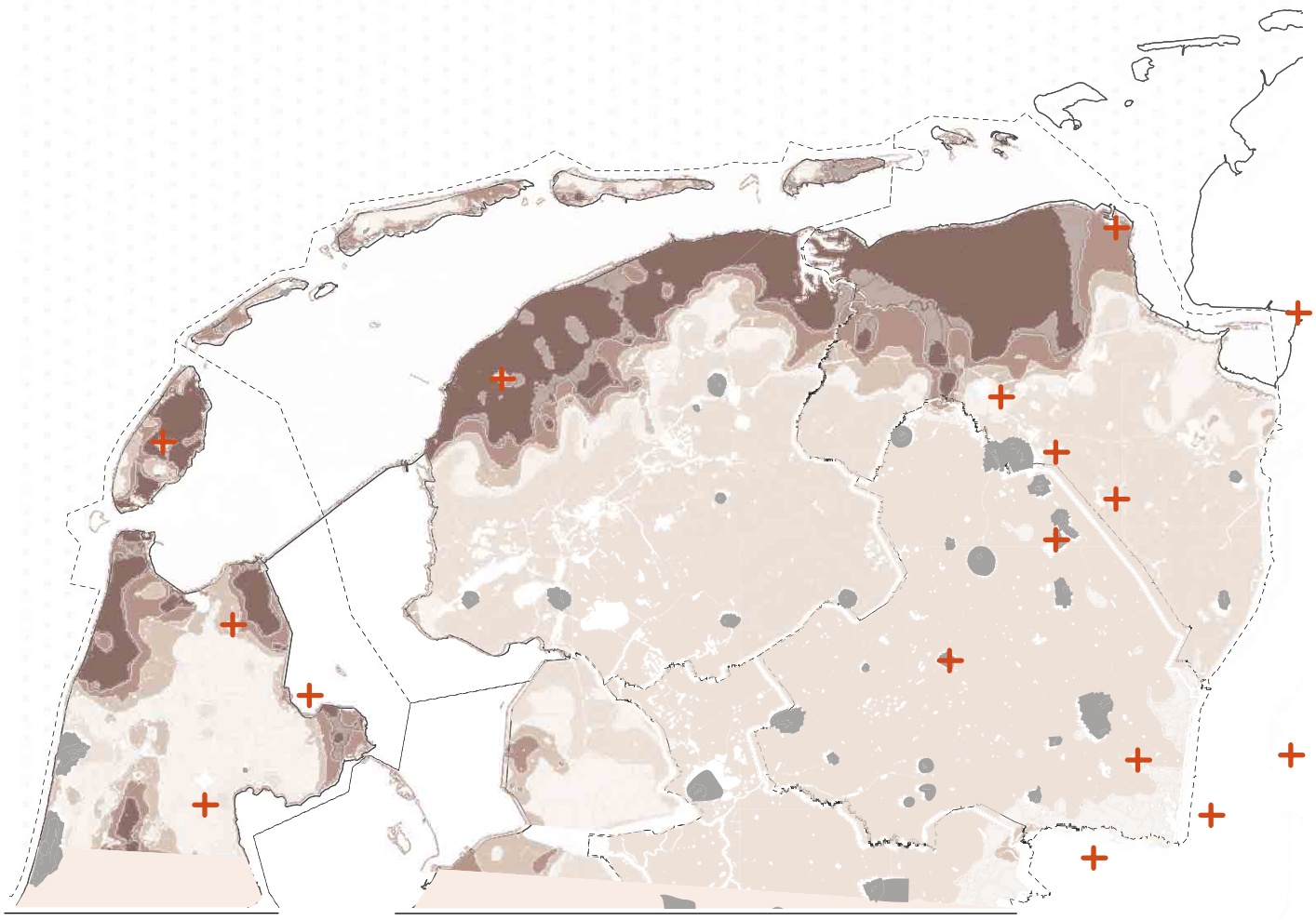
Sea Level Rise and Salinisation

Data: www.deltaprogramma.nl, Zhaolei Li

Salinisation Process



Salinization is one of the major threats to coastal agriculture. Through the process of saltwater intrusion and due to the increasing sea level rise the ground waters are contaminated further polluting soils and increasing pressure on the freshwater supply (Tzemi et al, 2020). The Dutch coast has been battling with the presence of saltwater intrusion for quite a while and expects coastal agriculture to transition to growing more salt-resistant crops (Salt Farm Foundation, 2019). "Strong fluctuations in local salinity will have an impact on the estuarine circulation, variations on silt transport and turbidity, the presence or absence of freshwater lures" further impacting the provision of adequate habitats and threatening agriculture in the future (Klimaatverandering Nederland, 2021).

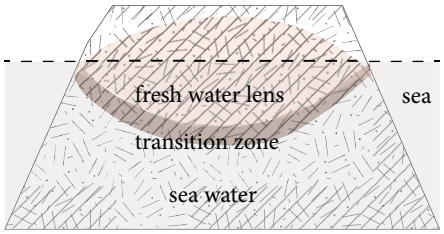


Surface Water Pollution

Data: www.atlasleefomgeving.nl, www.pdok.nl , www.openstreetmap.org, 2022, Zhaolei Li

The map depicts toxicity levels across the province highlighting the main issue of groundwater contamination in Friesland. There is a significant issue of groundwater pollution which could be considered a direct impact of saltwater intrusion and unsustainable human activities. As the sea level rises so does the process of saltwater intrusion into the soil and groundwater levels (Tzemi et al, 2020).

Salinisation Process



0 10 km 30 km 50 km

N

Very High Toxicity
High Toxicity
Low Toxicity
Very Low Toxicity
No Toxicity

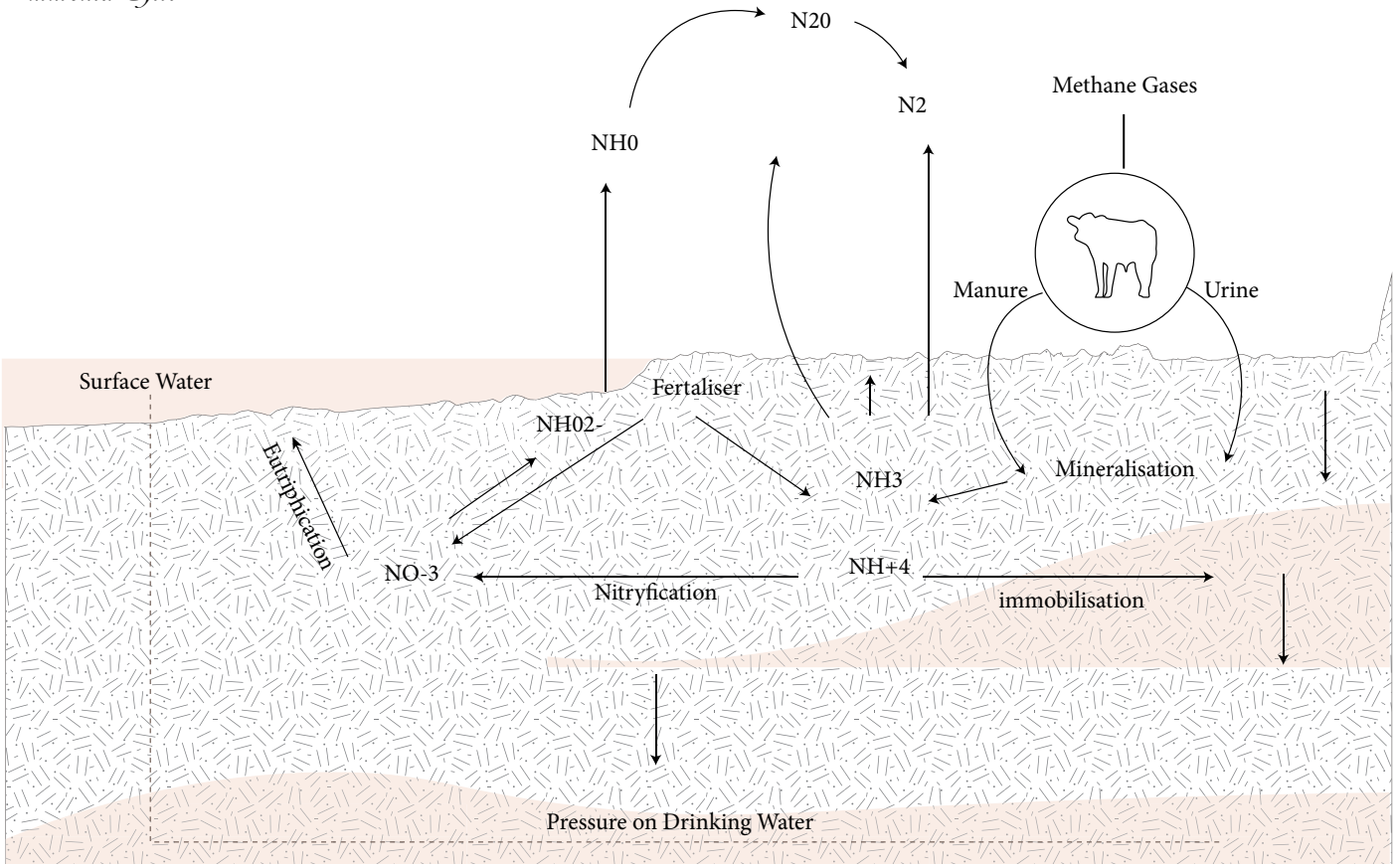
Friesland Farm, 2023.
Photo: Author.

Ammonium, Nitrogen and Climate Change Cycle

Data: https://www.rijksoverheid.nl, www.sciencedirect.com, 2022.

The Frisian water quality has been hugely hindered by the agricultural sector in which the nitrate and phosphate are released into the soil from animal manure (Natuur en Milieu, 2019). As Friesland has the highest dairy population in the country the issue of manure processing is very high and requires additional measures in tackling the issue. Other contaminants of the soil come from the chemical runoff of agricultural land related to soil fertilization, which further contaminates water (Rijksoverheid, 2020). Moreover, the soil and water contaminants in the form of manure and fertilizers release nitrogen and ammonium into the atmosphere further contributing to climate change (Rijksoverheid, 2020).

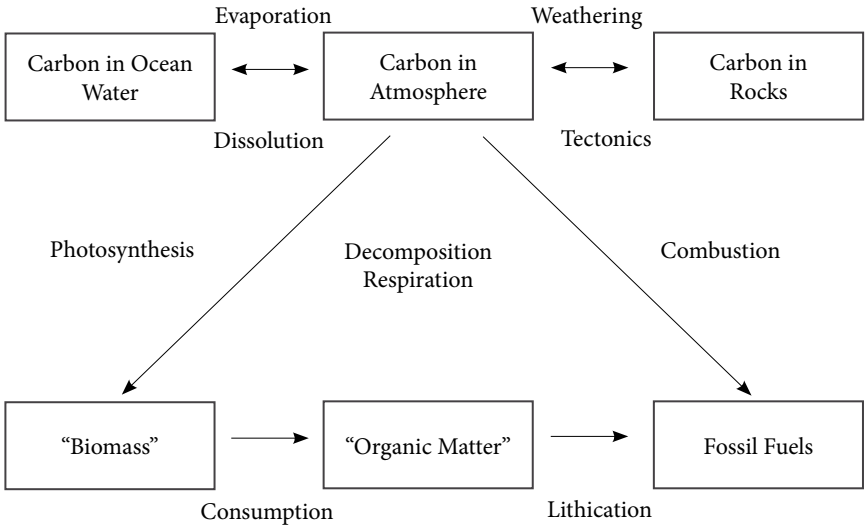
Ammonia Cycle



Carbon Cycle

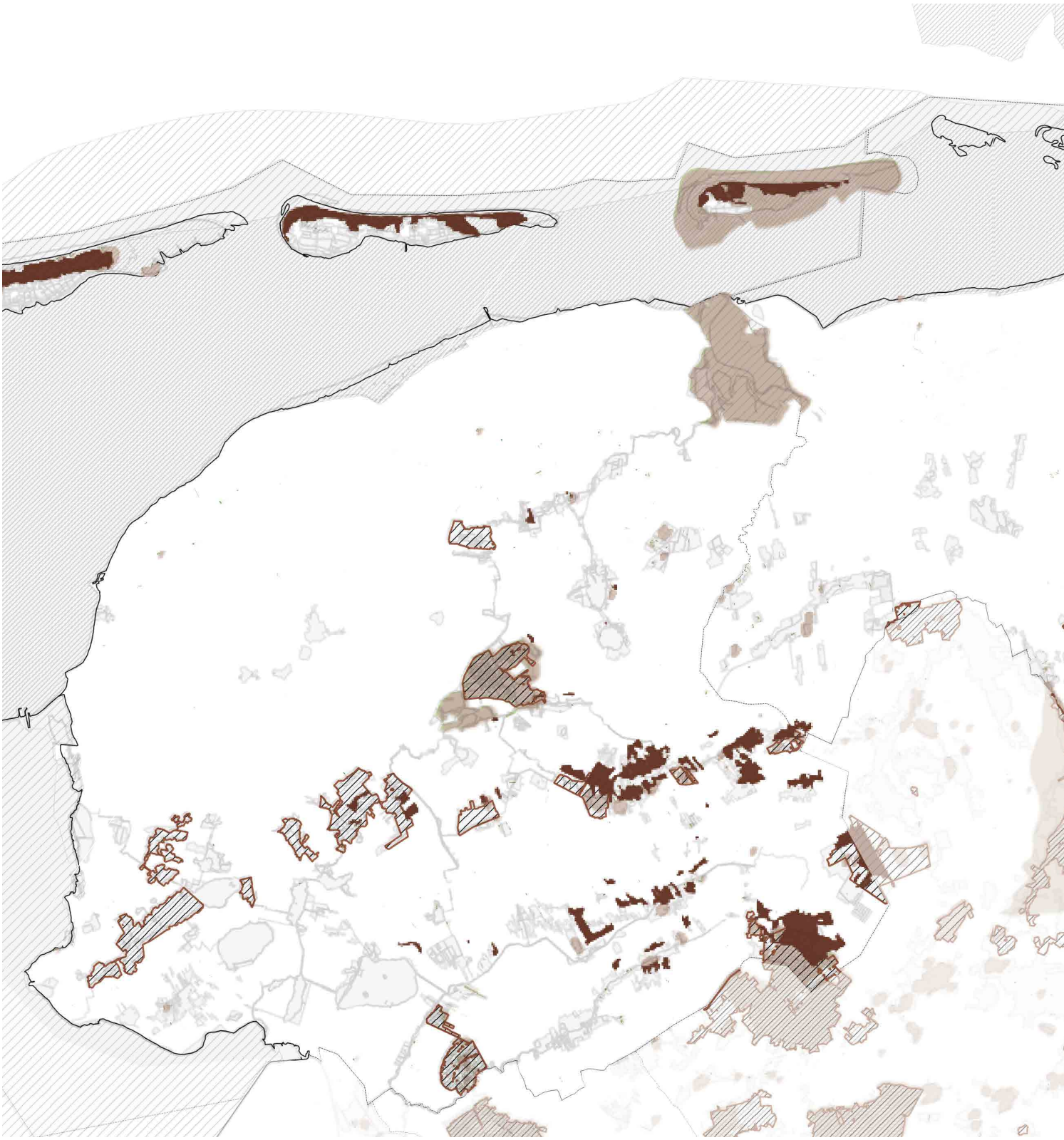
Data: National Oceanic and Atmospheric Administration, 2019.

The carbon cycle - is a cyclical process during which "carbon atoms continually travel from the atmosphere to the Earth and vice versa" (National Oceanic and Atmospheric Administration, 2019). The location of carbon is constantly in flux. Carbon is stored in soils, rocks, sediments, living organisms, oceans, etc., and is released into the atmosphere during different processes such as the death of living organisms, the eruption of volcanoes, and human activities, etc. (National Oceanic and Atmospheric Administration, 2019). The diagram demonstrates the carbon cycle. As peatlands have an "enormous potential in carbon storage", it's important to preserve peatscapes for maintaining carbon balance (Zhong, et al., 2020).



Nature Network & Ammonia Restrictions Map

Data: www. fryslan.maps.arcgis.com, www.pdok.nl , www.openstreetmap.org, 2022.



0 | 10 km | 20 km | 30 km

N

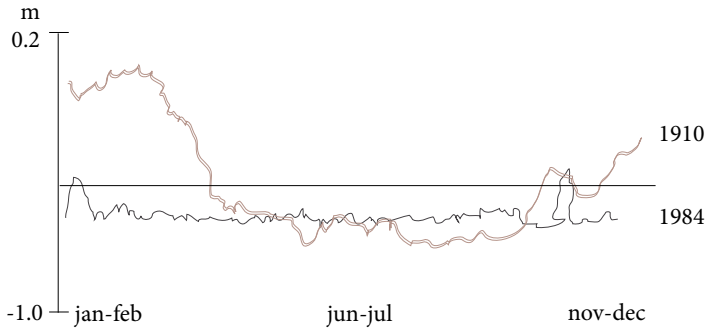
Nature Network
Ammonia Restrictions
National Nature Network
Buffer Zone Natura 2000
Natura 2000

As a result of the high conflict between the agricultural industry and the natural environment Ammonia and Nitrogen Sensitive areas were introduced, where farming is facing higher restrictions (Plantinga, Molema, 2020). The map depicts the Natura 200 areas, the existing Nature Network, and the Ammonia and Nitrogen Sensitive Areas. With the announcement of the nitrogen transition goals, it is expected that the Nitrogen Sensitive Areas and restrictions impacting agriculture are expected to grow (Rijksoverheid, 2022).

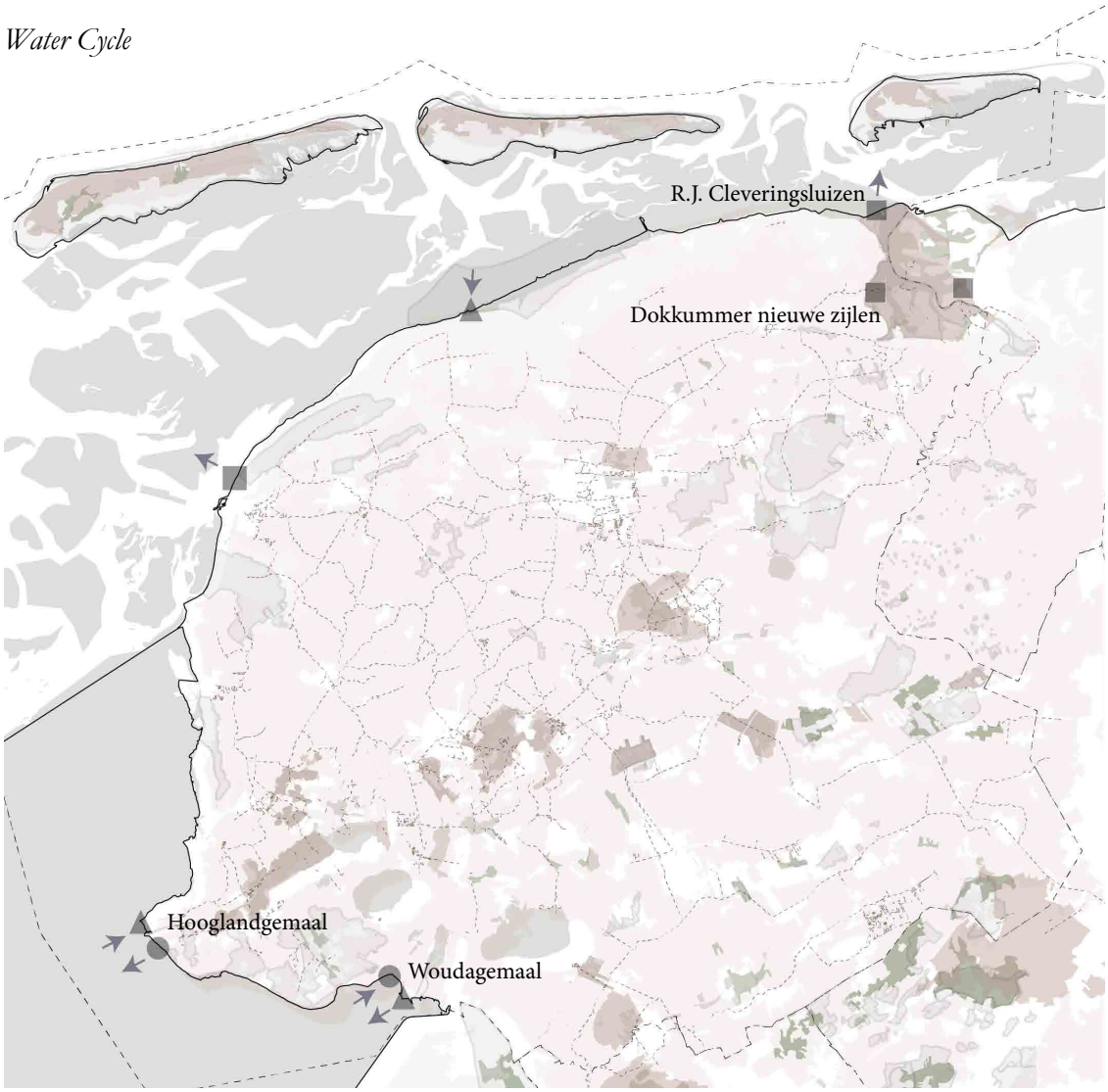
Water Cycle Friesland

Data: www.veenweidefryslan.frl, 2022.

Annual Groundwater lelvel changes



Water Cycle



Pumping Station
Sluice
Inlaat
Nature
Natura 2000
Water - Boezem System

0 5km 15km 25km N

The Frisian Boezem is an extensive water management system, which is responsible for controlling the water table and freshwater supply in Friesland and Groningen (Van Huet, 1991). It consists of canals, lakes, waterways, Natura 2000 wetlands, sluices, pumping stations, etc., through which Wetterskip controls water levels in the province (Van Huet, 1991). In the past decades, Wetterskip reduced seasonal fluctuation differences in water levels. The Boezem system allows Wetterskip to pump accumulated excess water out into the Wadden Sea and Ijsselmeer during the winter, wet season, and pump the water back in during the summer, dry season (Van Huet, 1991). The three main locations for pumping water in and out are located in the South West of Friesland, close to Genemuiden; the North - West of Friesland, near Harlingen; the North, Lauwersoog. The province has more than 100 pumping stations that are responsible for discharging water into the Boezem system (Van Huet, 1991). The target level range for the Boezem is -0.51 - 0.54m, whereas the water levels in the polders could reach - 0.6m - 2.5m (Van Huet, 1991). The Boezem system has immense value for the agricultural industry in the province, as farmers rely on the ability to dry their soils for cattle and fodder grass. However, the process of such high water management contributes to low water quality in the region.

R.J. Cleveringsluizen
1969

Dokkummer nieuwe zijlen
1729

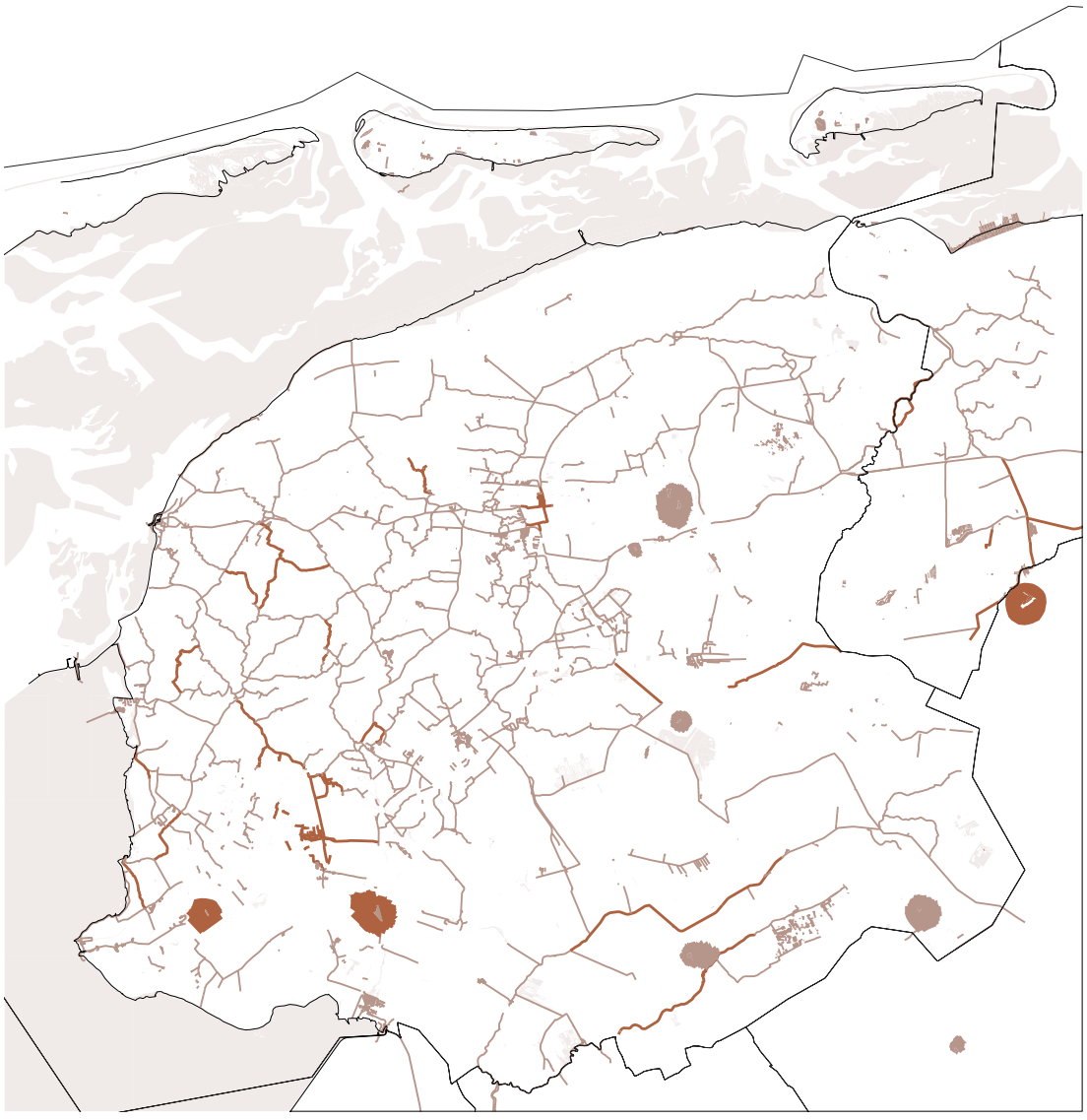
Woudagemaal
1920

Hooglandgemaal
1967

Ecological Surface Quality

Data: www.rijksoverheid.nl, 2022

Ecological and surface water qualities were identified as the demand for higher water quality grew and two studies were conducted in 2009 and 2015 by the newly established WFD, during which the low results stated that the Dutch waters are below the EU expected average quality and 60% of the identified water structures did not meet the quality needs (Rijksoverheid, 2020).



0 | 10 km | 20km | 30km

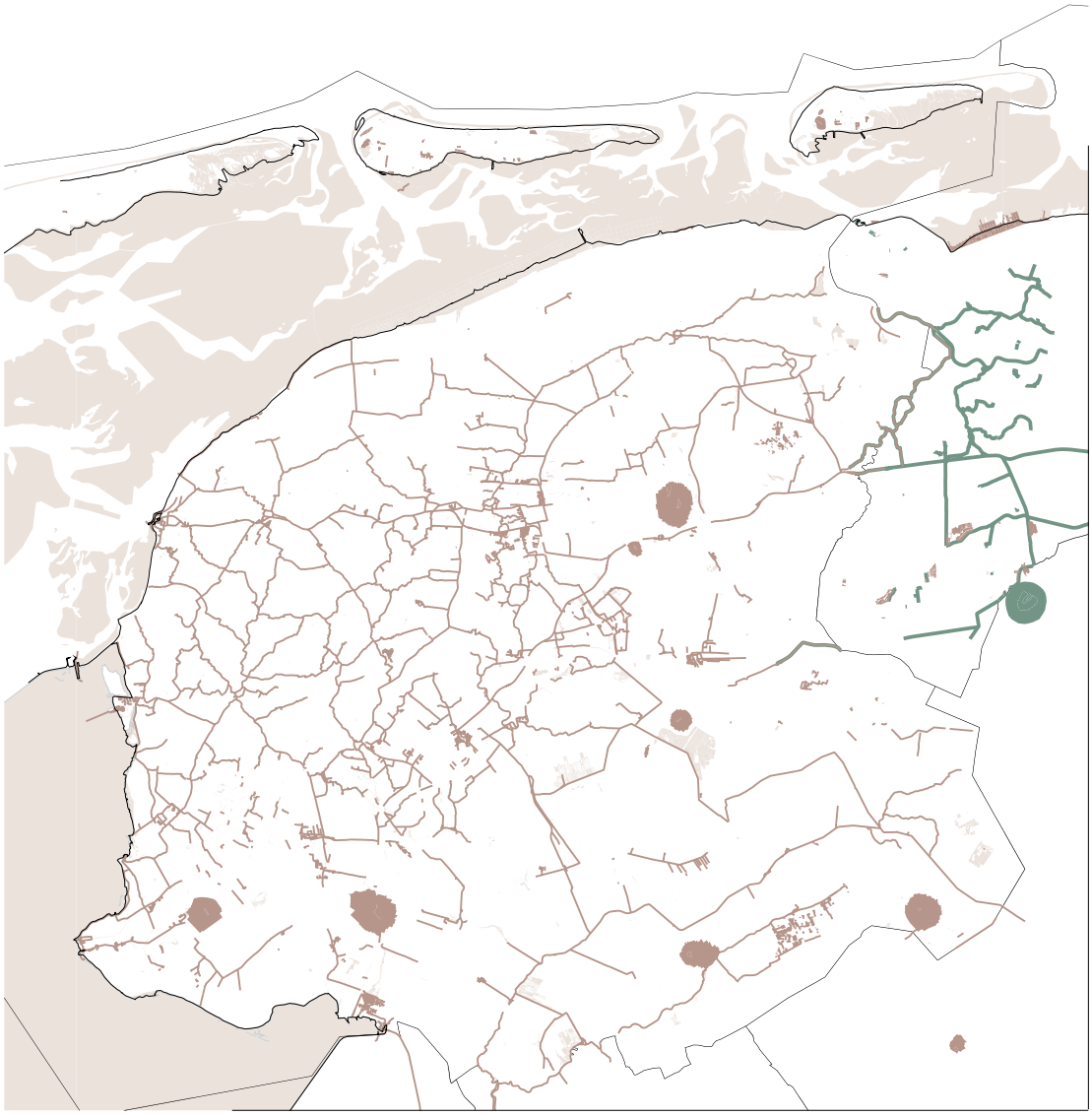
N

Bad
Inadequate
Mediocre
Good

Chemical Surface Quality

Data: www.rijksoverheid.nl, 2022

It is obvious that the high cattle population in regions like Friesland and large land use being dedicated to agriculture negatively contribute to the Dutch water quality. The two maps demonstrate that the major water structures in Friesland do not meet the EU quality guidelines.



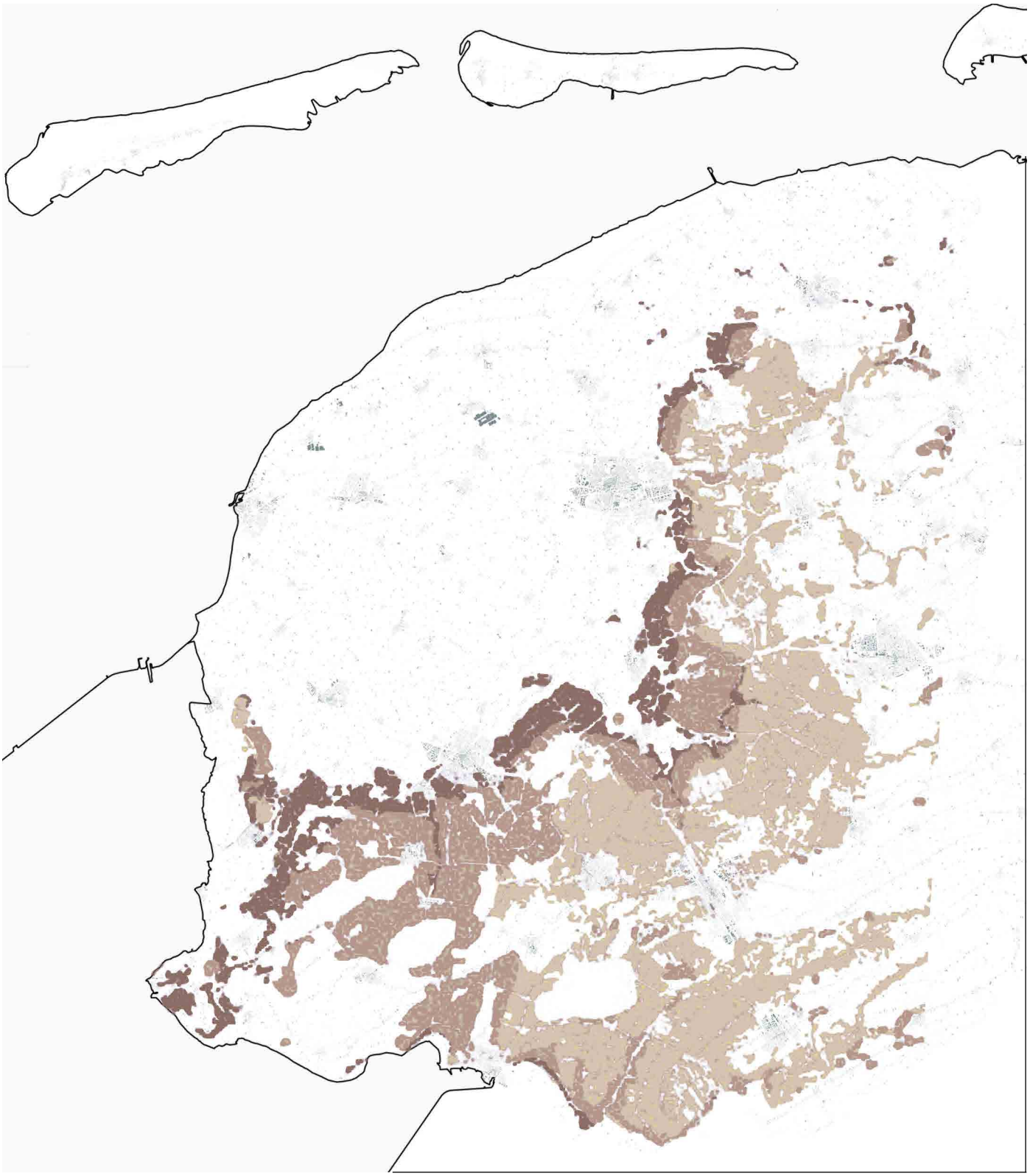
0 | 10 km | 20km | 30km | N

Does not suffice

Suffice

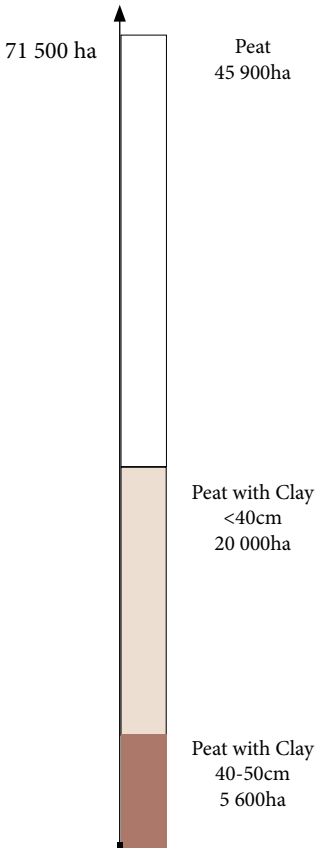
Peat Structure

Data: www.wur.nl, www.pdok.nl , www.openstreetmap.org, 2022.



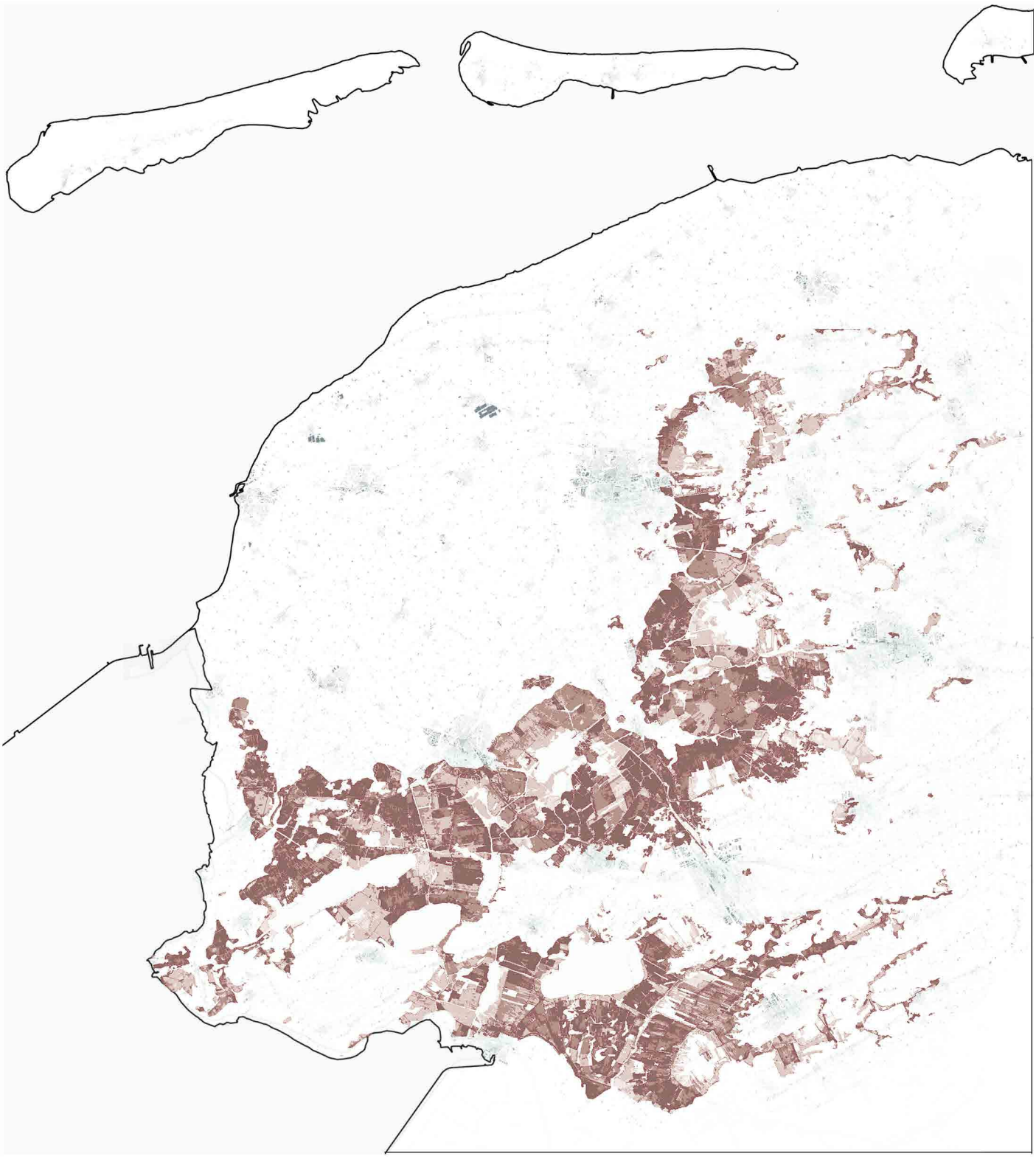
Peatlands - “wetlands with partially decomposed plant material” (Zhong, et al., 2020). The map depicts the peat structure of Friesland, where the peat covers approximately 71 500 ha. Pure peat spans across 45 900ha, whereas peat with clay below 40cm covers 20 000 ha, and peat with a concentration of clay of 40 to 50 cm covers 5 600ha (VeenweideFryslan, 2021). The peat belt lies in the lower elevations of Friesland and faces majorly different climatic issues. “Peatlands have an enormous potential role in global carbon cycling” (Zhong, et al., 2020). There are two scientifically classified types of peatlands: fen and bog. Fens are created by “nutrient-rich surface run-off and groundwater” and are considered minerotrophic. Bogs are created by precipitation and are “often isolated from the surrounding watershed” making them ombrotrophic (Zhong, et al., 2020). Long-term carbon accumulation in peatlands is “ascribed to the imbalance of two counteracting processes, carbon fixation from primary production and carbon loss from decomposition under high water level regime” (Zhong, et al., 2020). In the process of peat oxidation due to lowered water levels, the stored carbon is released into the atmosphere.

Peatscape



Water Draining

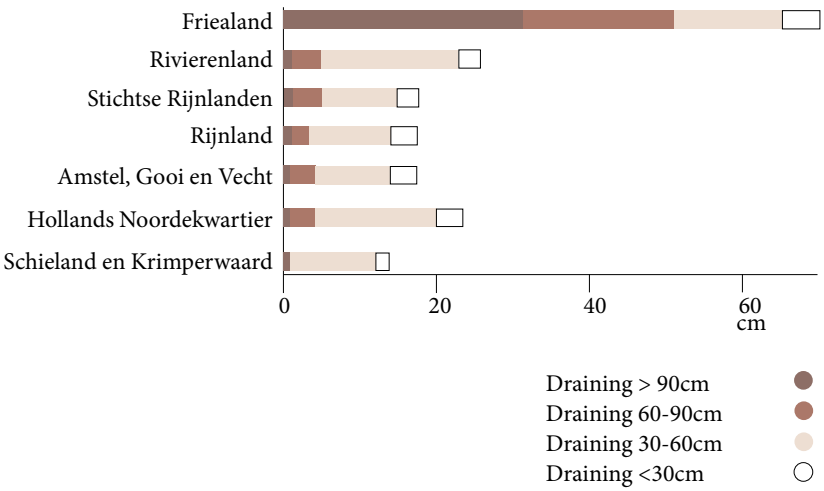
Data: www.pbl.nl 2022, www.pdok.nl , www.openstreetmap.org, 2022.



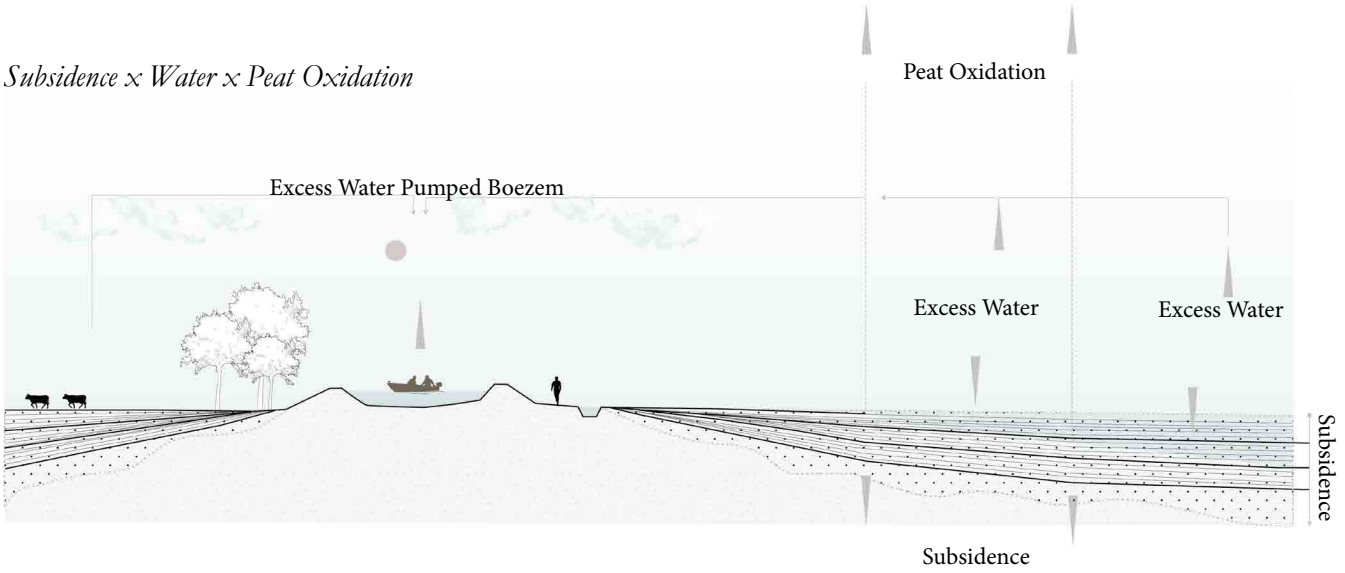
"Centuries of drainage and peat cutting have resulted in a major loss of peat soils in the Netherlands" (Brouns, et al., 2015). "Peatland ecosystems once covered a major proportion (40 %) of the Dutch land surface, but the area of peat soils has been reduced to less than 10 % since drainage started in the 11th century"(Brouns, et al., 2015).

As the peatlands of Friesland progressively accumulated more water, the agricultural industry soon became the largest water drainer in the country. The Frisian water management to this day experiences significant pressure from farmers to maintain low water levels and has been pumping the excess waters into the Ijsselmeer and the Wadden Sea in an attempt to dry the low-lying peatlands (Van Huet, 1991). Since the beginning of drainage, the agricultural practices underwent significant industrialisation "allowing access of heavy machinery" (Brouns, et al., 2015). Unfortunately, "deep drainage facilitates rapid soil subsidence up to 2 cm/year" (Brouns, et al., 2015). As a direct result of lowering of the water table, which causes "soil shrinkage, compression, and oxidation" up to "85% of subsidence could be attributed to lowering of the water table" (Brouns, et al., 2015).

Water draining by regions



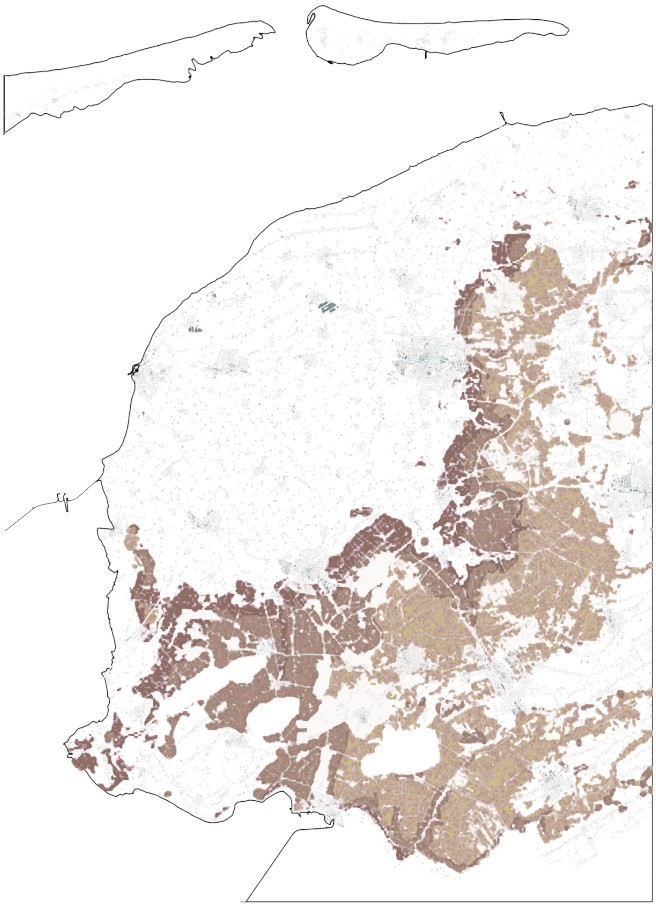
Subsidence x Water x Peat Oxidation



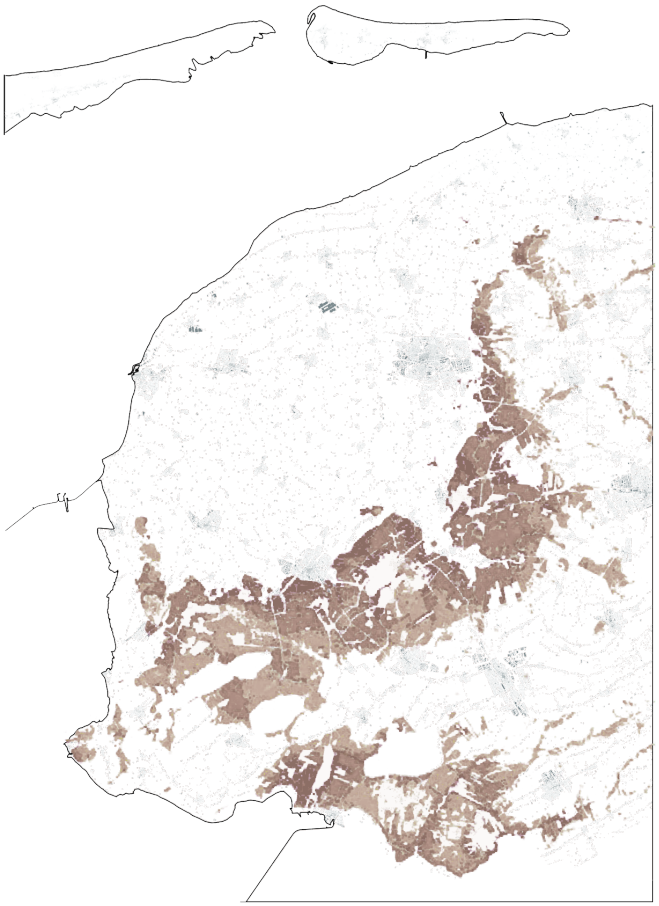
Peat Oxidation

Data: www.regiodealnatuurinclusievelandbouw.nl, www.pdok.nl , www.openstreetmap.org, 2022.

Timeline



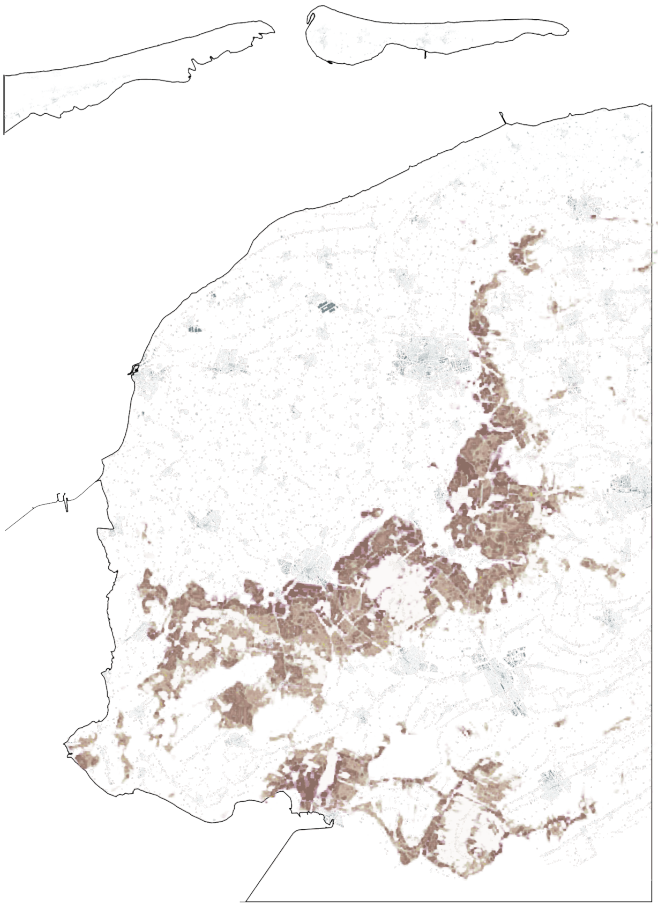
2015



2050

0 10 km 30 km

N



2100

Water
Urban
Peat
Peat with Clay Layer <40cm
Peat with Clay Layer 40-50cm

One of the major climatic impacts of agriculture due to the draining of excess water is peat oxidation. "Peat soils cover only 3% of the world's land surface but store one-third of the world's soil carbon" (de Jong, et al., 2021). As "the water table is lowered for making peat more suitable for cultivation, drainage exposes peat to oxygen, which causes it to rapidly decompose and reduce in volume" (de Jong, et al., 2021). The loss of the peatscape is expected to impact climate change through the process of peat oxidation, during which CO2 emissions are released into the atmosphere. The government predicts that the unsustainable process of draining excess water in the peat landscapes most likely will result in the massive loss of the peatscape (VeenweideFryslan, 2021). "Drained peat soils emit on average 19 tonnes of CO2/ ha/ year" (Brouns, et al., 2015). The government has made attempts in tackling the process of peat oxidation by raising groundwater levels and other strategic implementations (VeenweideFryslan, 2021).

"Peat subsidence and change in peat properties have been widely observed after drainage, which further accelerates microbial decomposition and carbon loss" (Zhong, et al., 2020). "It has been predicted that the peat areas will subside between 40 and 60 cm between 1999 and 2050" and is very likely to significantly reduce in size and disappear in the coming 100 to 200 years (Brouns, et al., 2015).

Friesland Peatscapes, 2023.
Photo: Author.

(Co) Designing Future Peatscapes

Chapter V

Friesland Peatscapes, 2023.
Photo: Author.

(Co) Designing Future Peatscapes

The final chapter focuses on the Design assignment, in which the climatic threat of peat oxidation is explored further. I have decided to focus my design on the peatland heart of Friesland, an area enclosed by four Natura 2000 areas (De Deelen, Alde Feanen, Van Oordt's Mersken and Sneekermeergebied), which is expected to transition into a new sustainable landscape that follows the nitrogen reductions goals announced by the government in the summer of 2022.

The chapter reintroduces the site-specific issues and results in the design assignment that is explored through a scenario-based approach in which different scenarios related to future agricultural possibilities are explored. "Scenario-based landscape planning (SLP) is arguably well positioned to support decision processes concerning sustainable landscape development" as the position considers a multiscalar approach in which a framework for stakeholder engagement is taken into account (Albert, C, 2011).

The "No Peat 2100" scenario is introduced, which explains one of the more severe climatic outcomes during which as a result of continuing current unsustainable water management practices, peat is expected to disappear resulting in higher rates of soil subsidence and severe water shortages in the region.

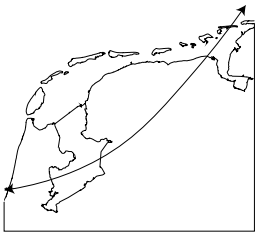
The second "What If We Stop Pumping 2100" scenario speculates on the future of complete loss of agricultural properties under the situation during which the process of current water management is abandoned resulting in the formation of a peat bog landscape due to ecological succession.

The third " What If We Develop Nature 2100" scenario - design outcome proposes an alternative soil and water management system in which the natural environment is developed for peat preservation and restoration and carbon sequestration. This scenario explores an ideal outcome, which manifests the development of 3 types of nature, each having a different ecological value with a common goal to reduce carbon emissions, bring natural value into the area and value the local cultural heritage. It results in a short-term design proposal that aims to establish short-term 2035 strategies that will lead to the 2100 ideal scenario. The" What If We Develop Nature 2100" aims to envision a new resilient future for the agricultural landscape, in which the productive properties are not lost but transition into something new.

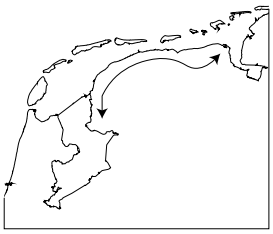
.

Design Process

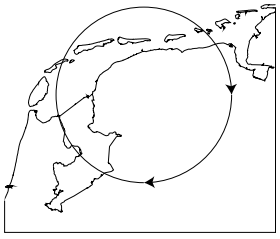
Design Principles



Stronger Eco Corridors
- Nature Inclusive Agriculture



Stronger Cultural heritage
-Valuable Heritage



Mitigation and Climate Adaptation
- Climate Responsive Agriculture

Goals

EU ····· *National Gov* ····· *Regional Gov*

Sub - Goals

Strategies

- Strengthening ecological connections in the hinterland
- Honoring agricultural cultural heritage
- Developing new agricultural landscape for climate adaptation and mitigation

Sub - Strategies

Regional ····· *Local* ····· *Site*

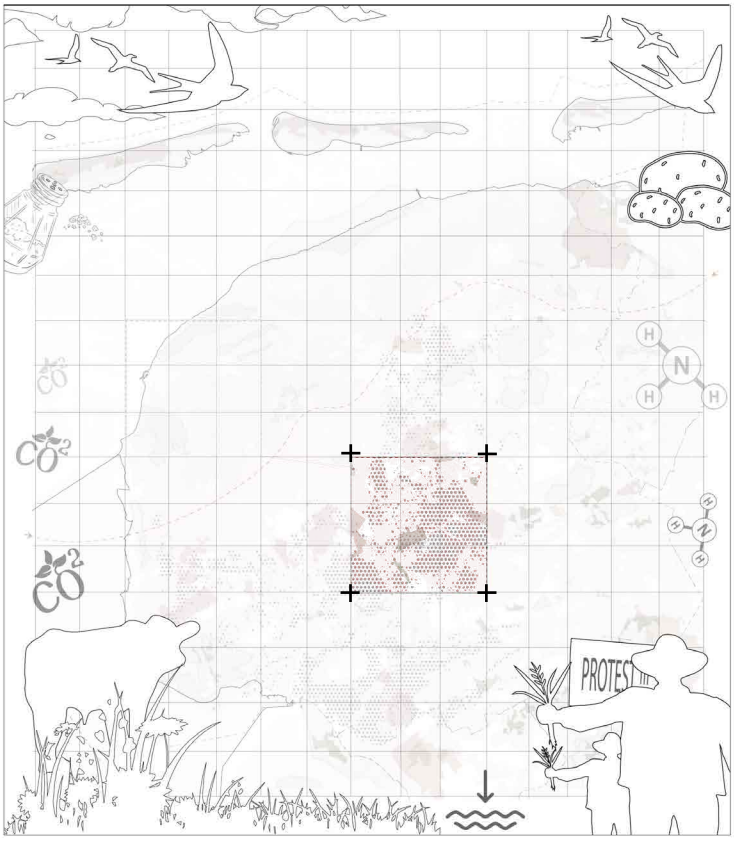
Time | *Regional Scale*
Local Scale
Farm Scale Design

Landscape management often lacks a holistic approach and as a result overlooks "the broader context within the physical landscape (Schepers et al., 2021). This leads to a major "gap between physical, geographical, biological, and cultural (historical) approaches" contributing to fragmentation and division in policies and often strategies (Schepers et al., 2021). Landscape management in practice often brings higher biodiversity disregarding possible cultural values leading to "serious problems regarding the management of heritage and the readability of our landscape" (Schepers et al., 2021). "This is exemplified by UNESCO, which often separates natural from cultural and awards sites based on either of the categories" (Schepers et al., 2021).

The three main design principles are defined that dictate a holistic approach to the development of the Frisian landscape: nature-inclusive agriculture, culture-inclusive agriculture, and agriculture that adapts and mitigates climate change. The design principles respond to the ideal scenario that has been developed together with the local stakeholders. Using the design principles and aligning goals of different legislative entities/ stakeholders I propose strategies and sub-strategies that result in a 2035 vision for the area, which is further explored in the chapter

Location

The chosen site is located in the Peatscapes of Friesland and is surrounded by four Natura 2000 areas: De Deelen, Alde Feanen, Van Oordt's Mersken, and Sneekermeergebied. The chosen site is a highly valuable natural and cultural area under a great threat of climate change in the form of peat oxidation and subsidence. The agricultural landscape is in growing competition with the Natura 2000 areas, governed on the EU scale, and is expected to change in order to reduce its impacts on nitrogen and ammonia-sensitive species under the Dutch Government's proposal to reduce nitrogen emissions almost by 50%. There is a growing tension between the governing bodies and local farmers that have already expressed their disagreements with and lack of understanding of policies that in their eyes push them to lose their traditional livelihoods.



Site

Akkrum, Grou, Jirnsum, and Aldeboarn are the major towns in the area, the largest being Grou, which is famous for hosting annual water sports competitions. The chosen site approximately accounts for 270 square kilometers, the majority of which is dedicated to agriculture. The site mainly consists of grassland dedicated to dairy cattle, growing of fodder grass, monoculture, and wetland/ bog landscape that is under Natura 2000 protection. Individual farms are scattered across the landscape, many of which are in direct proximity to Natura 2000 areas. The farms are often situated along canals and follow a clear linear placement. The site is a vast open landscape with an endless horizon which with the combination of unpredictable weather conditions creates a unique feeling of a powerful Frisian nature.

0 2 km 4 km N

Grassland
Water

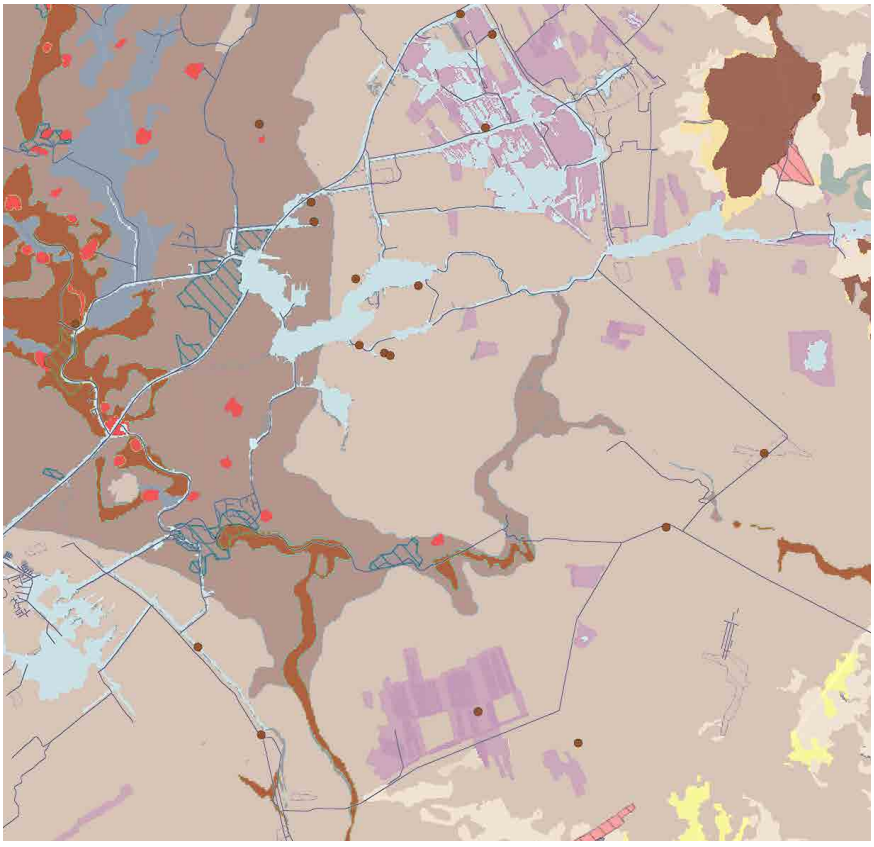
Friesland Peatscapes, 2023.
Photo: Author.

Friesland Akkrum, 2023.
Photo: Author.

Natural System Map

Data: https://storymaps.arcgis.com/stories/ba85aa49141040bda0d088da11cf518e, 2022.

The geomorphological development of the Wadden Sea impacted the soil structure of the area. The deposited marine clay soils create a clay belt where pioneer settlements - terps are located (Oost, Winter, Vos, et al, 2017). The clay soil penetrates the site and creates a slightly elevated belt, which oxidizes and subsides much slower than the pure peat. The Natura 2000 peat bog and wetland landscape have been developed due to historical peat excavation for energy production.



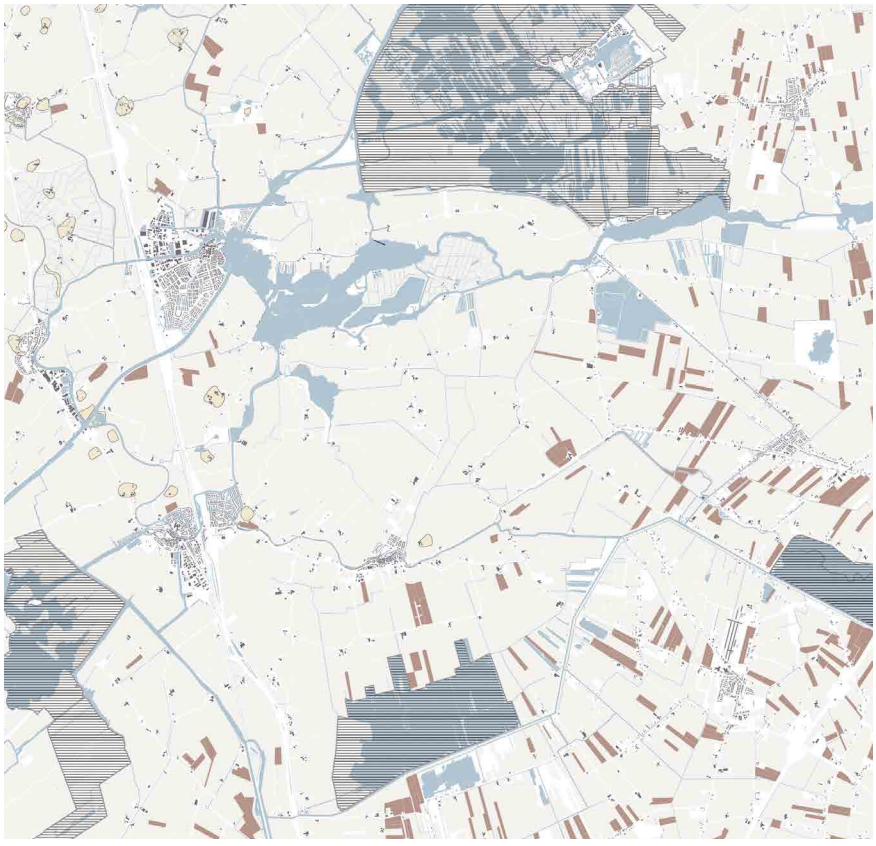
Low peat plain
Creek ridge
Cover Sand plain
Dust Dune
Sea Clay Plain
Terp
Excavated Peat

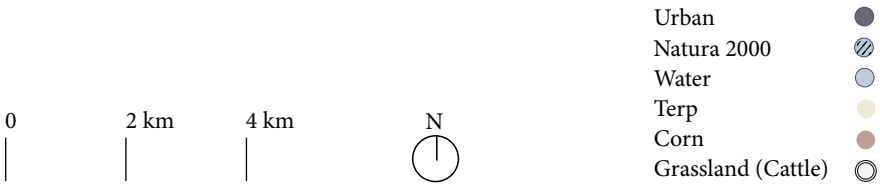
0 2 km 4 km N

Land Use Map

Data: www. fryslan.maps.arcgis.com, www.pdok.nl , www.openstreetmap.org, 2022.

The soil structure dictates the land use of the area. Clay-infused peat and pure peat create desirable conditions for fodder grass and the monocultural growth of corn. Over 70% of the landscape is dedicated to agricultural purposes. The wetland landscape with the extensive Boezem system creates perfect conditions for water transport and water sports. Although the wetlands have been awarded Natura 2000 status, the natural blocks are largely segregated and fragmented by the agricultural landscape from a larger natural system creating independent zones with little ecological connectivity.

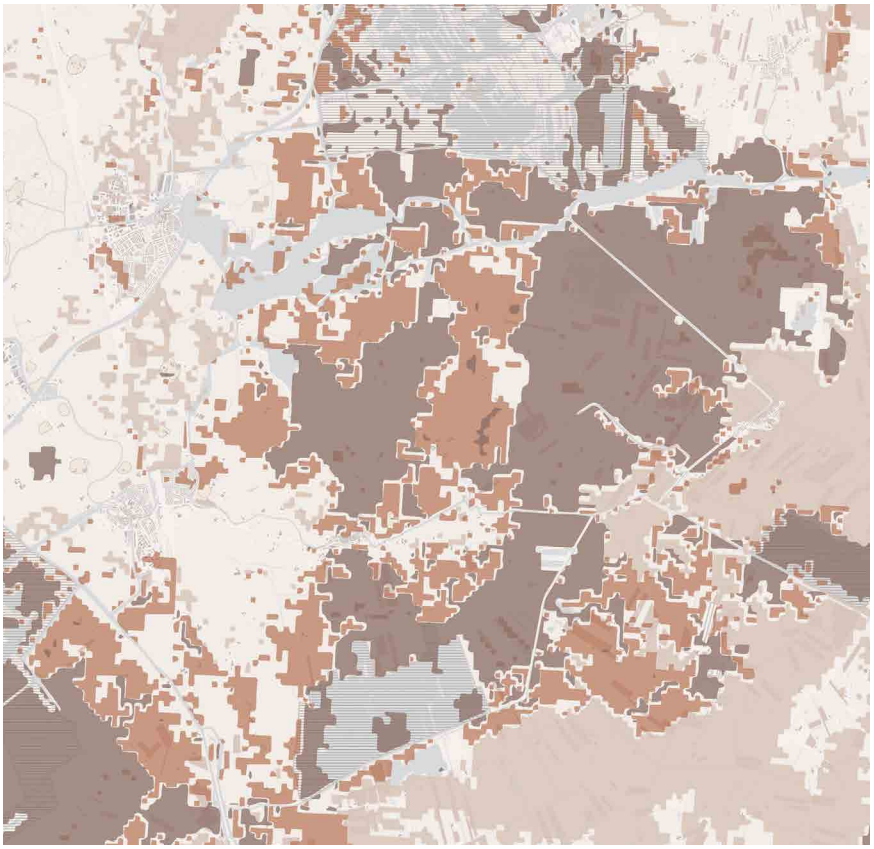




Subsidence Threat

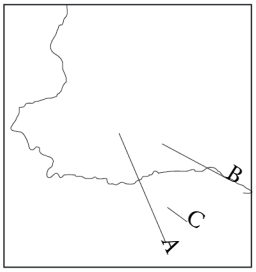
Data: www.veenweidefryslan.frl, 2022.

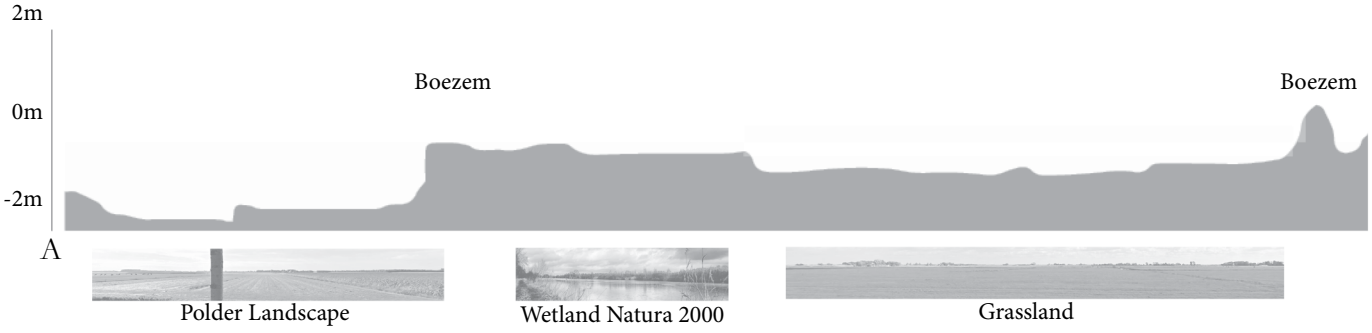
Subsidence has been occurring in the Dutch peatlands since the 11th century as a result of "peat decomposition, shrinkage, and compression" (Brouns, et al., 2015). The current rate of subsidence amounts to >60cm per year. "Water management in these areas is complex and costly, greenhouse gasses are being emitted, and surface water quality is relatively poor" (Brouns, et al., 2015). Future higher temperatures and dryer summers are likely to enhance peat decomposition and, subsequently subsidence, in the area (Brouns, et al., 2015). The map demonstrates the subsidence risks of the site.

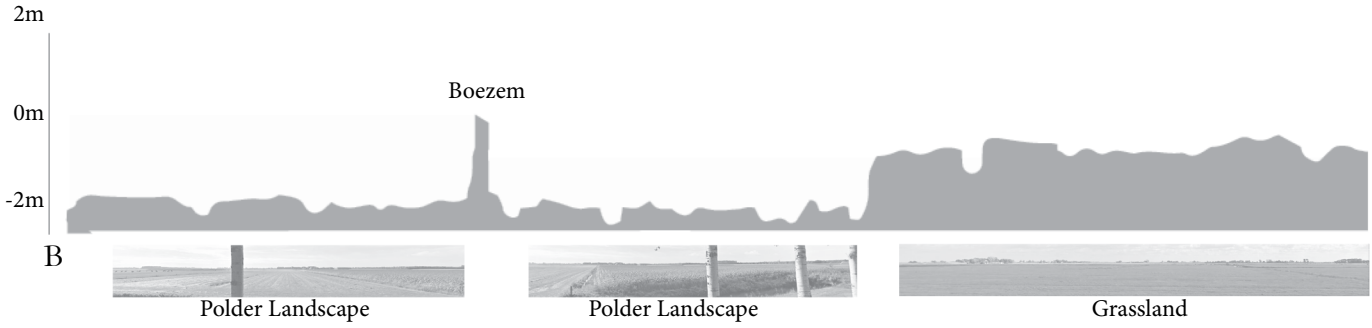


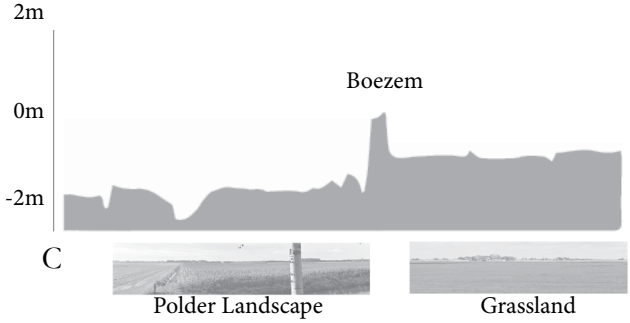
Ground Water Elevations

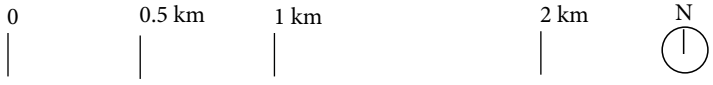
Data: www.pdok.nl , www. ahn.arcgisonline.nl, www.openstreetmap.org, 2022.





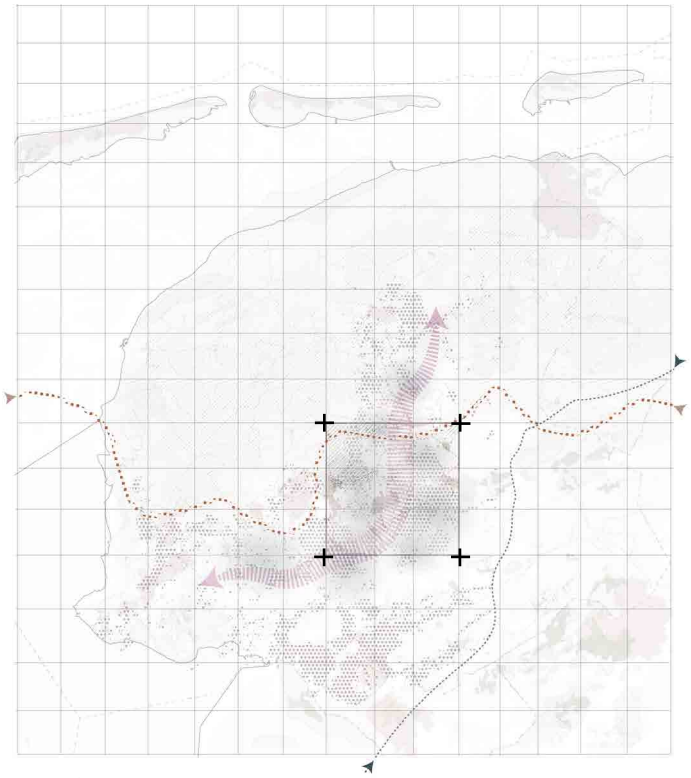




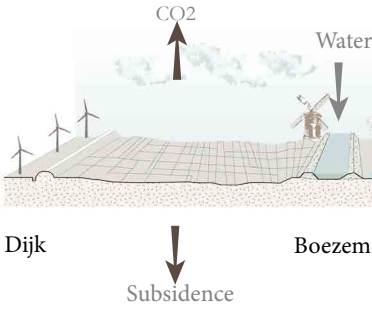


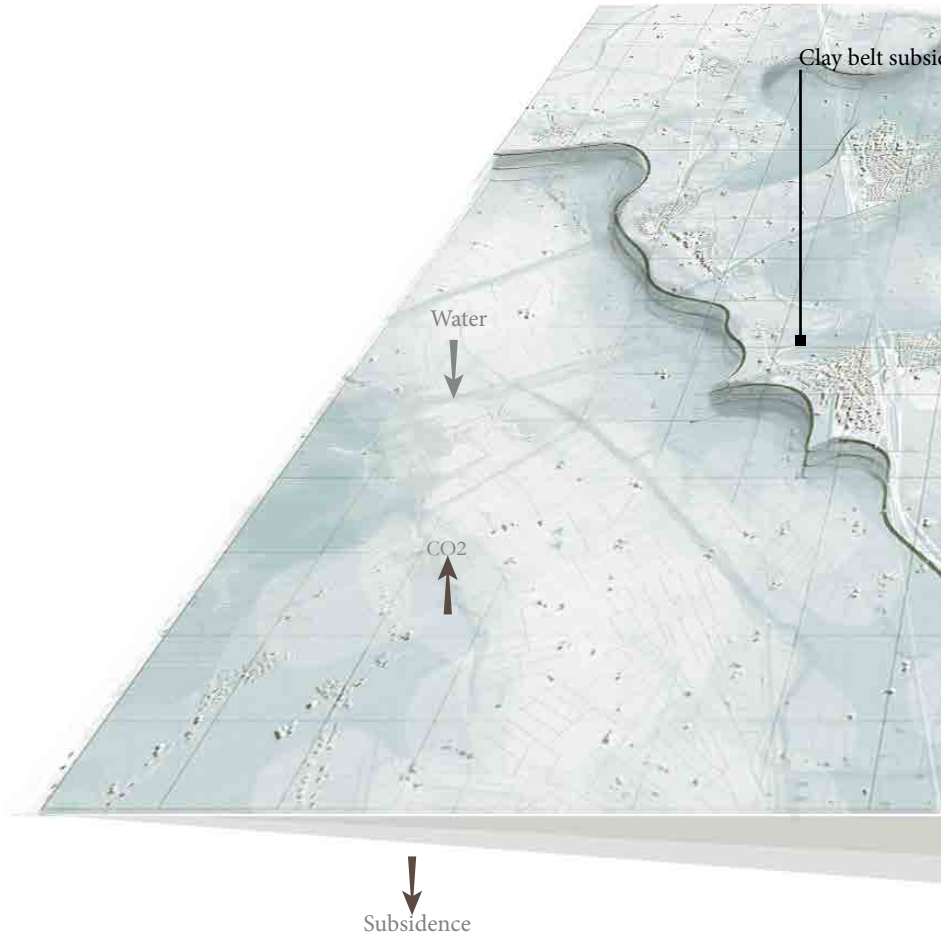
What if we do nothing ? No Peat, Beyond 2100 Scenario

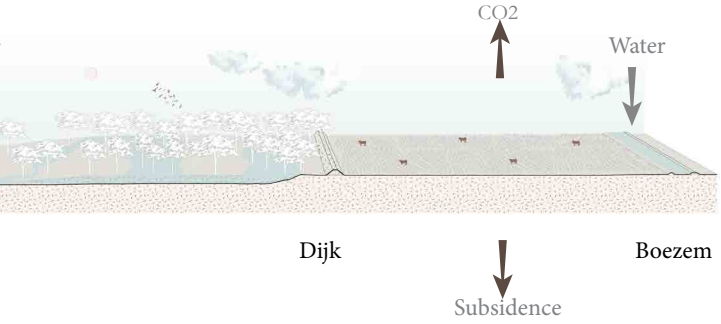
System Limits



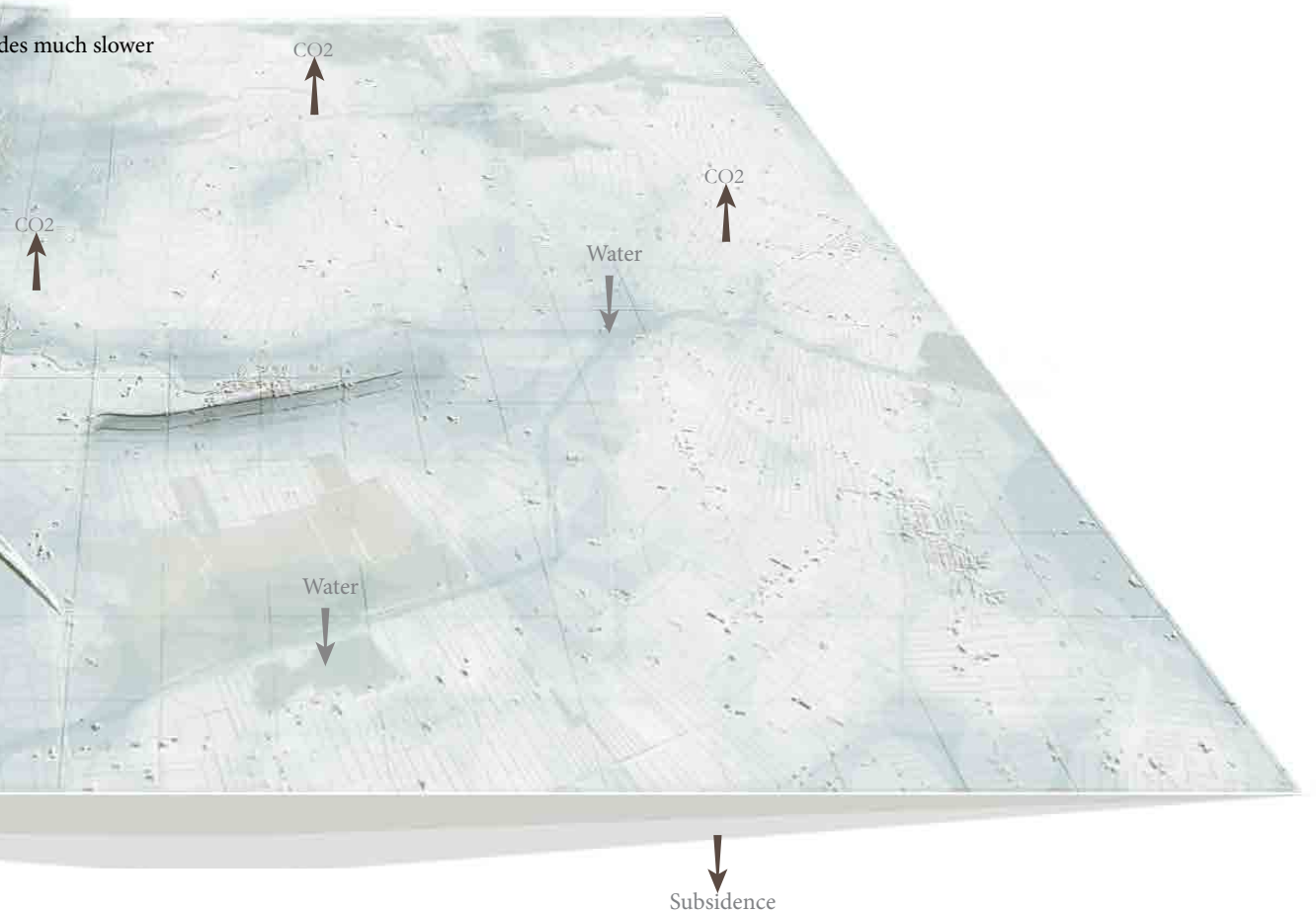
Droughts
Peat Oxidation
Subsidence
Salinisation





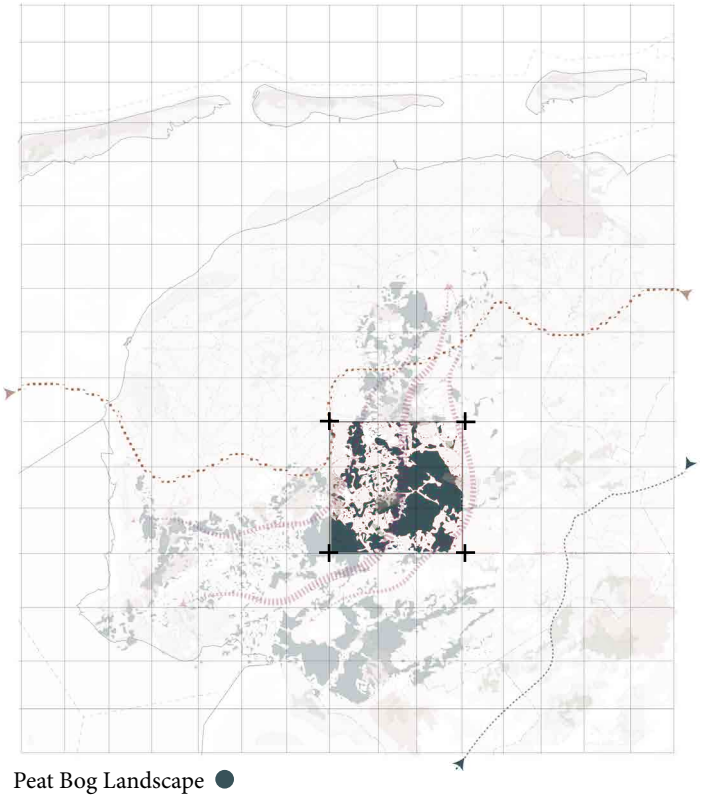


If current unsustainable soil and water management practices continue, that prioritize the needs of dairy farming over the preservation and appreciation of the unique Frisian peatlands, the peat is expected to disappear in the coming 200 years (Brouns, et al., 2015). In this scenario Friesland is expected to experience "damage to building foundations, desiccation of nature reserves, emission of greenhouse gasses, increasing costs for water management and infrastructural maintenance, deterioration of surface water quality and, finally, loss of the characteristic landscape" (Brouns, et al., 2015). As a direct result of increased subsidence due to lowered water tables, the cost of water management will rise. The scenario also speculates that increasing pressure to obtain freshwater from Ijsselmeer will result in immense freshwater shortages in the region, threatening the productive landscape and livelihoods of people.

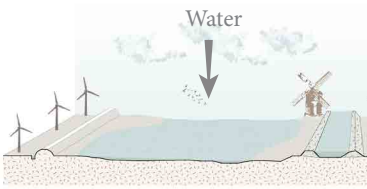


What if we stop draining ? Beyond 2100 Scenario

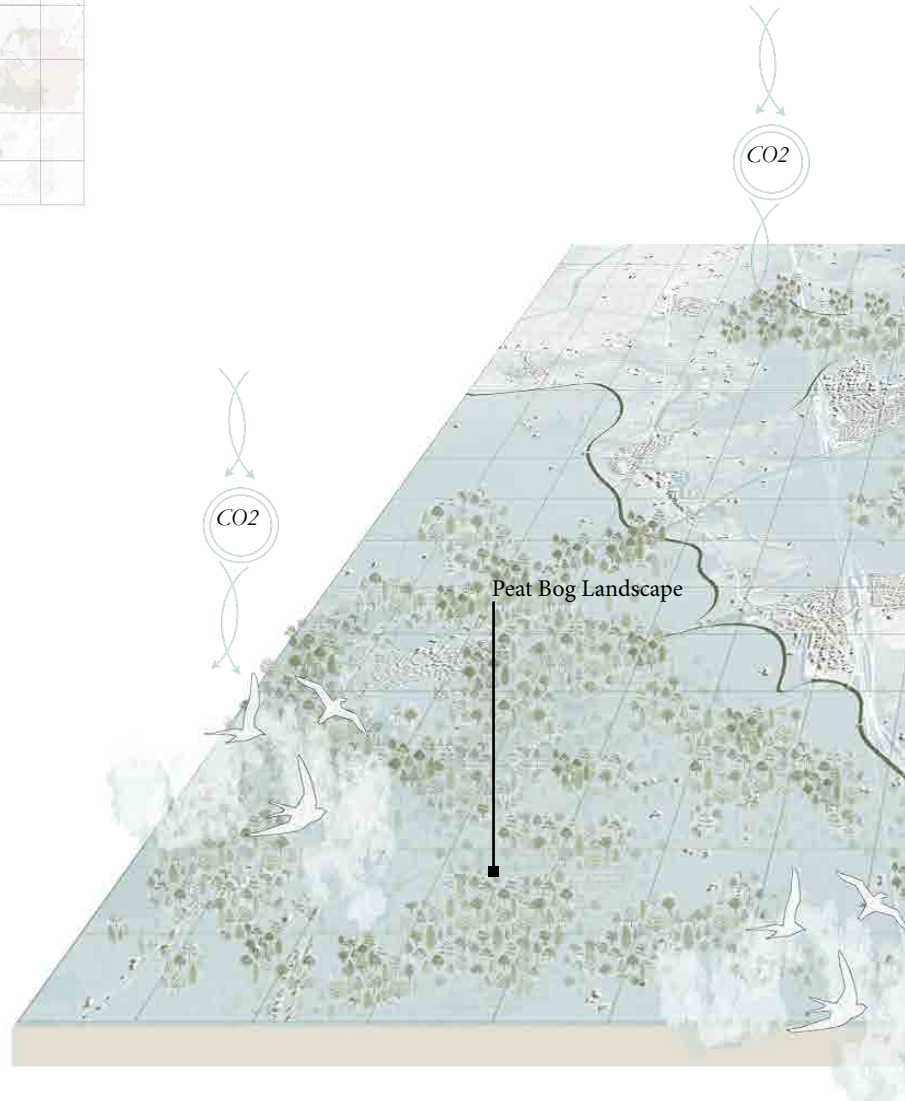
System Limits

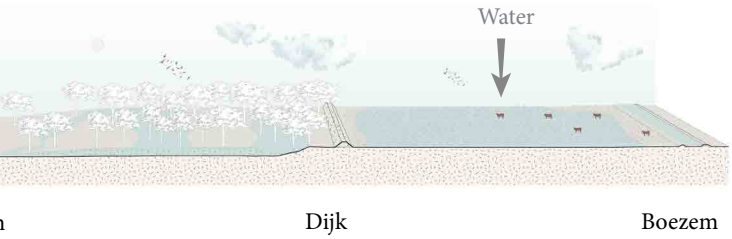


Peat Bog Landscape
Peat Oxidation
Subsidence
Salinisation

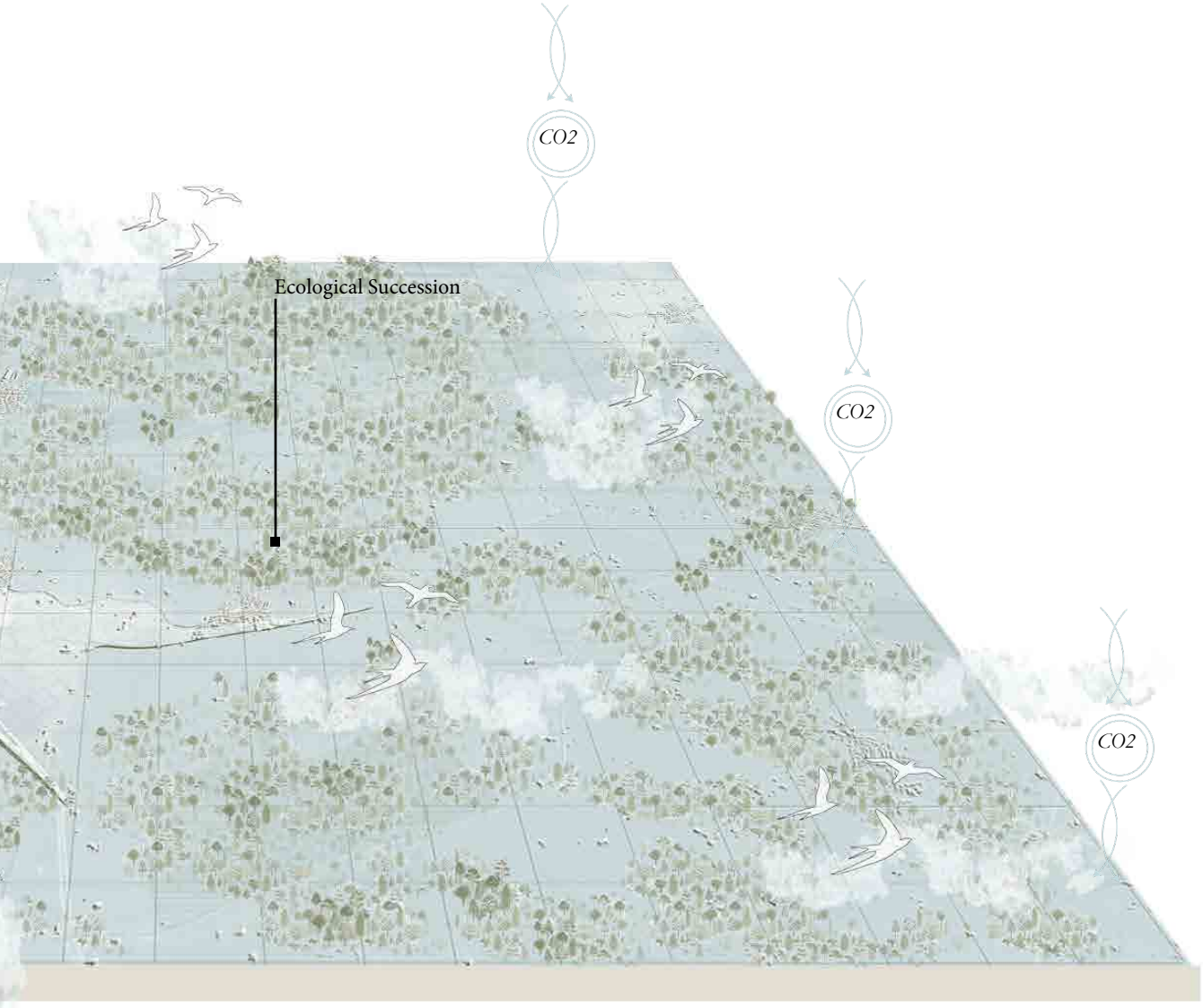


Dijk Boezem





With the complete abandonment of the current water/soil management system, the low-lying peatlands are expected to accept water, balancing the water table across water bodies. Under such circumstances, an increased water table will reduce subsidence and peat oxidation. However, the establishment of the natural peat wetland system will lead to a complete loss of modern agricultural landscape and loss of agricultural practices, currently operating in Frisian peatscapes, unless they won't transform into something else. In 100 years the fen peat scapes are expected to ecologically succeed into a peat bog landscape - an ecosystem of high biodiversity value.



Design Workshop, 2023.
Photo: Laura Cipriani.

Design Workshop
Engaging Stakeholders

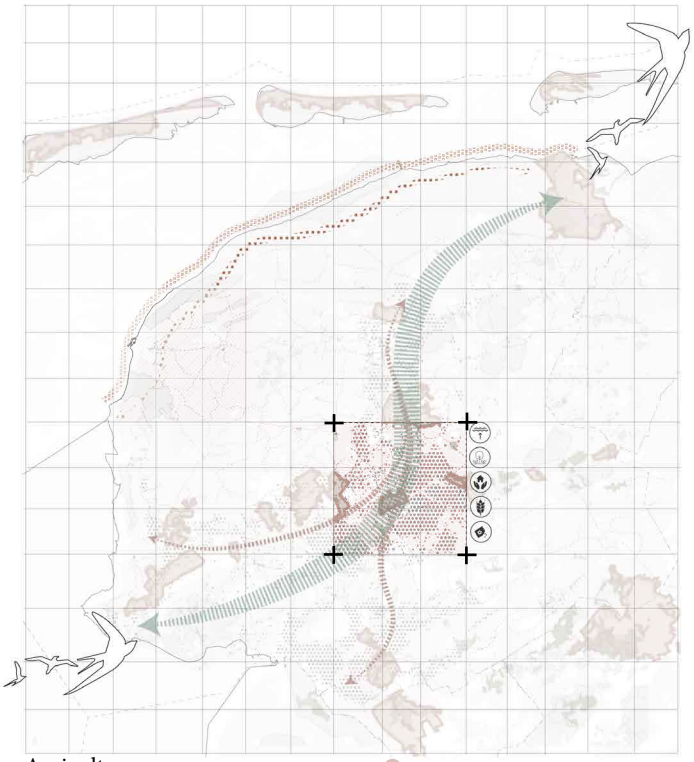
"Water Landscapes of Crisis and Hope" is a graduation studio led by Laura Cipriani that highly values the input of local stakeholders for understanding the local context, its nuances, and intricacies. Together with the experts from Friesland and TU Delft, the graduation studio speculated on the possible ideal future of Frisian peatscapes. As any decisions regarding the future of agriculture in Friesland is a highly sensitive topic, working together with the local stakeholders, and "co-designing" together is a highly valuable step in tackling issues and threats on the site and regional scale.

The design scenario, developed together with the local stakeholders and experts, speculates on the alternative future of the Frisian Peatscapes and represents a combination of the previous two extreme scenarios. On a regional scale, the Frisian peatlands are envisioned to turn into a green-blue regional backbone, reducing the existing gaps between fragmented Natura 2000 areas, and providing significantly higher eco-services for the vulnerable natural Wadden ecosystem. The newly established green-blue infrastructure is expected to act as a carbon-sequestering belt.

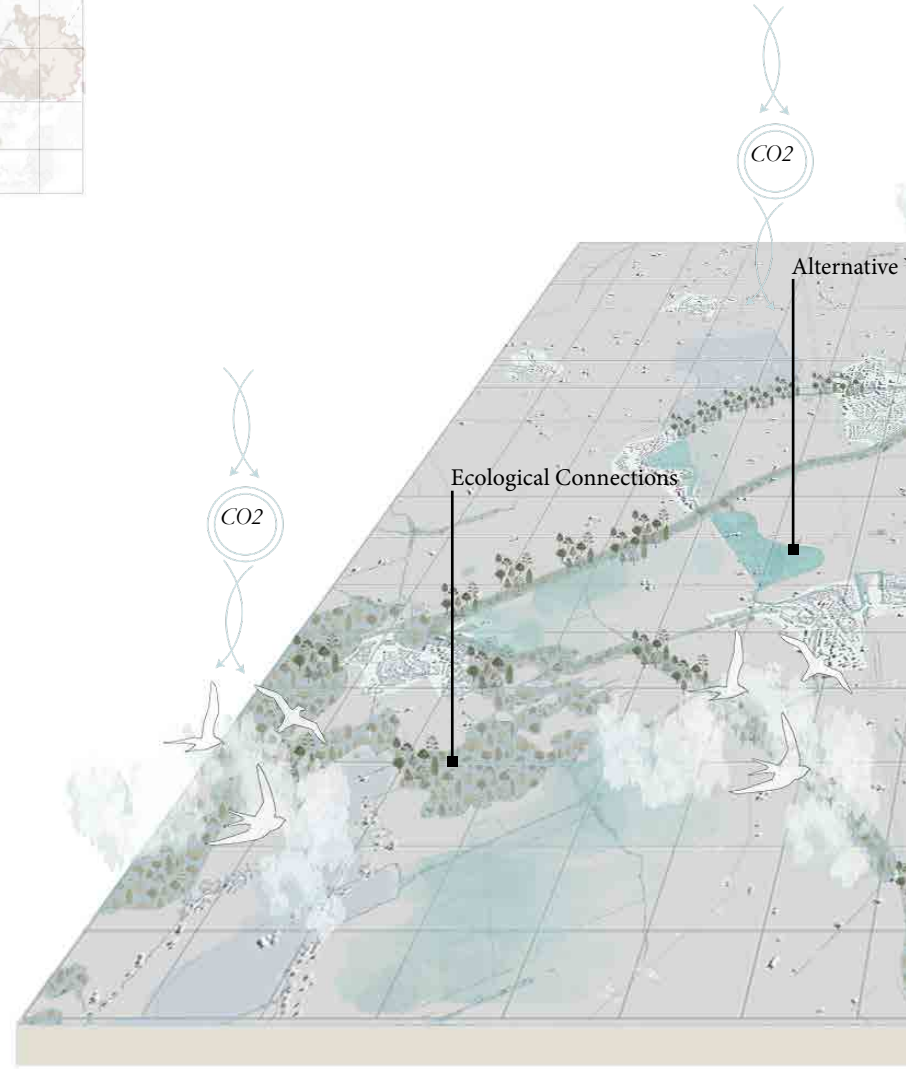
On a site scale, nature development plays a vital role in the alternative future of the region. For the agricultural landscape to withstand the climatic and socio-economic uncertainties of the future and to maintain its productive properties, it is envisioned to transition into a new sustainable and future-responsive productive landscape.

What if we develop nature? Beyond 2100 Scenario

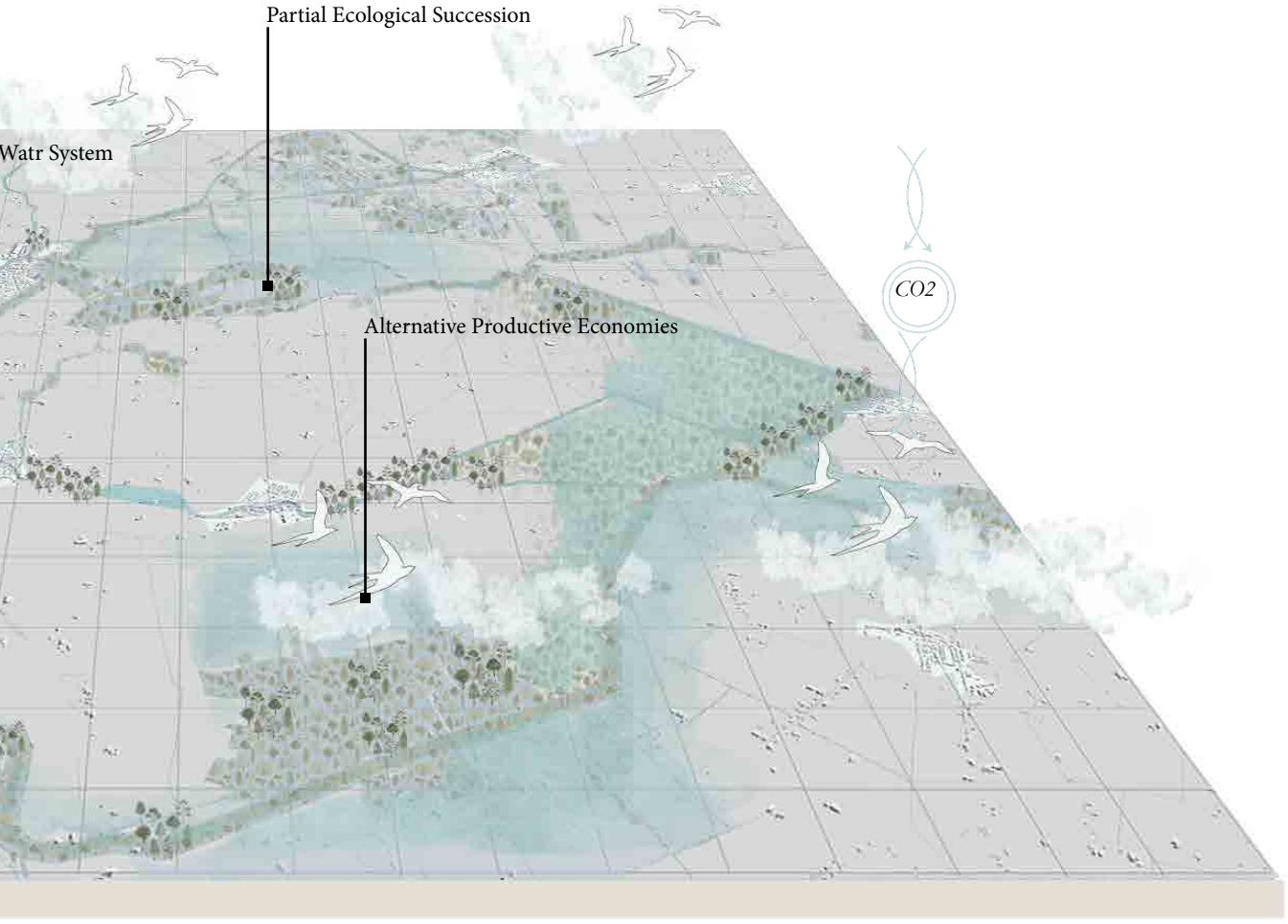
System Limits



Agriculture
Defence x Agriculture
Saline Agriculture Belt
Raised Water Level Belt
Natura 2000 Buffer
Green Blue Belt
Secondary Green Blue Network



The establishment of ecological networks, strengthening of Natura 2000 zones, carbon sequestration through peat preservation and restoration, the establishment of new sustainable nature-inclusive economies, paludiculture, the establishment of a water purifying system, and strengthening of the cultural landscape is pictured in the 2100 scenario. The new landscape is expected to act as carbon storage with three distinct nature types of different nature values: carbon banks, where major carbon sequestration happens; paludiculture, representing new forms of a sustainable productive landscape; people nature, water purifying system for ensuring higher water quality provision in the future.



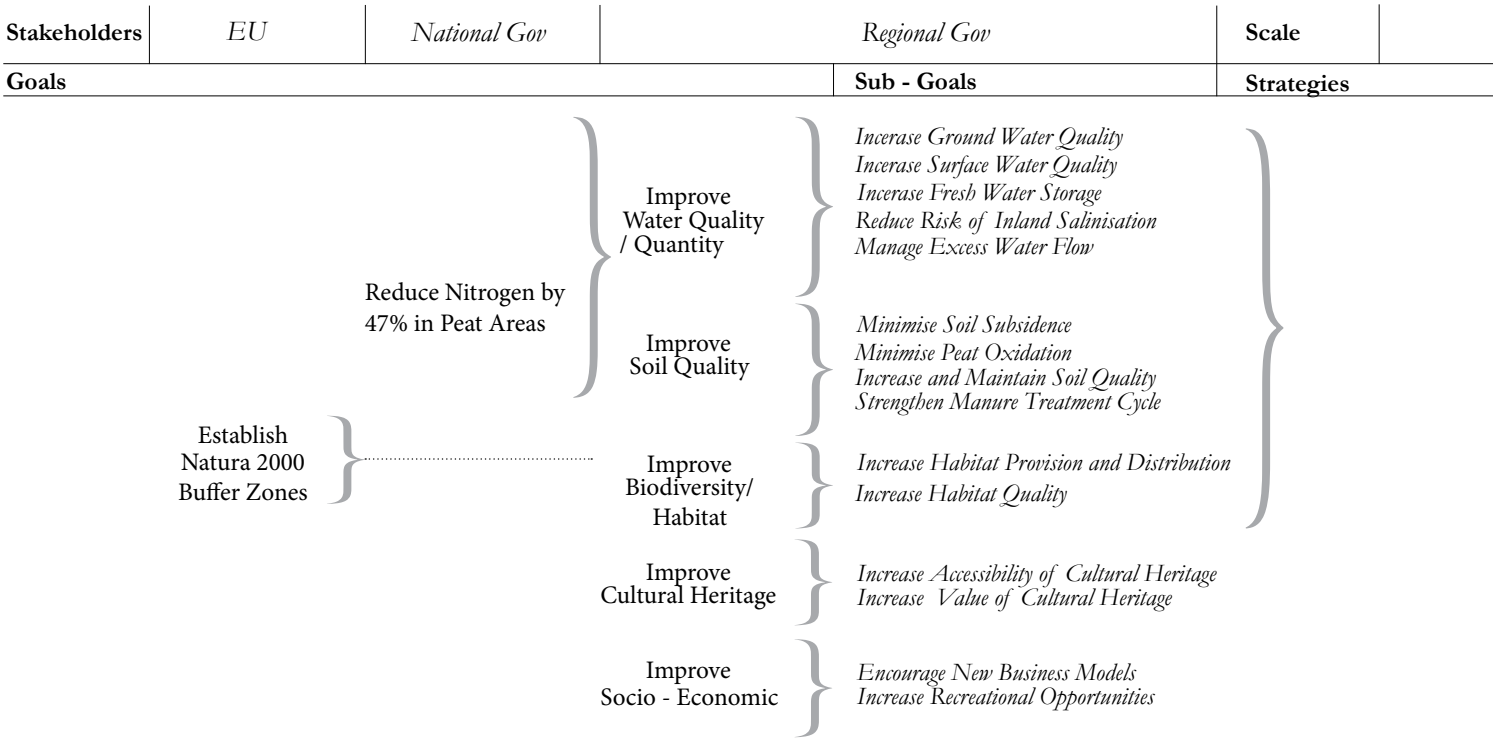
Friesland Peatscapes, 2023.
Photo: Author.

Friesland Peatscapes, 2023.
Photo: Author.

Expanded Strategies

One of the ways to ensure the establishment of Nature Based Solutions is understanding the complexity of the interests of different legislative entities, and stakeholders (Ruangpan, Vojinovic, Plavšić, et al, 2021). The diagram aligns multiscalar goals and strategies that could respond to these goals of different stakeholders involved in the area.

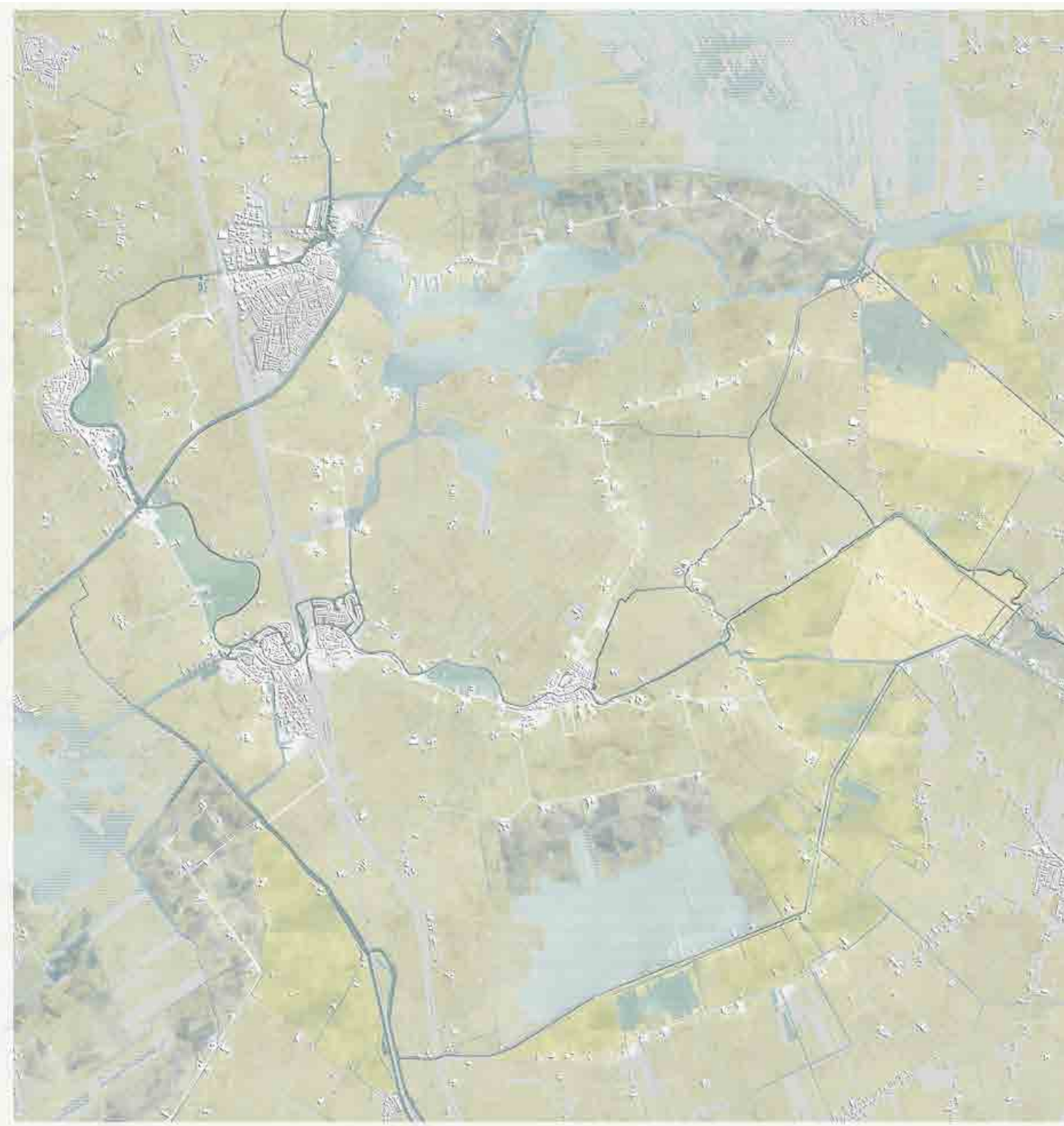
Goals and Strategies



Regional	*Local*	*Farm*
Green Blue Infrastructure Backbone	*Water Storage* *Wetland Establishment and Enhance ment* *Raising of Water Levels* *Blocking of Drainage Channels* *Nature Bank Stabilisation* *Natura 2000 Buffer Zone* *Primary, Secondary, Tertiary Green Blue Network*	*Peat Restoration* *Paludiculture*
Cultural Heritage Network	*Reconnected Cultural Heritage Network* *Valuable Cultural Heritage Routing* *Local Agro Heritage Network*	*Small Scale Leisure* *Agrotourism*
New Economies	*Green Blue Recreation Netwrok* *New Job Opportunities*	*Carbon Credit Model* *Biomass Energy* *Valuable by Agro production*

What if we develop nature ? 2035

Alternative Future



0 2km 4km N

Natura 2000
Grassland
Water
Buildings

Polder Palu
Grassland
Purification
(Re) Peat B
Cultural Ne

udiculture
Paludiculture
n Wetlands
uffer
etwork

3 Natures

Carbon Bank

Paludiculture Corridor

People Nature

The graduation thesis responds to the 2100 scenario, developed together with the local stakeholders, and introduces a short-term 2035 vision to prepare for the alternative future. The proposal suggests developing nature for short and long-term carbon sequestration and introduces strategies for ecological, cultural, and climate-responsive development. The three types of nature are:

Carbon Bank

As a response to the EU desire to strengthen Natura 2000 areas and to develop buffer zones surrounding the protected ecological zones, the proposal suggests converting the agricultural land in direct proximity to the Natura 2000 border into a 1 km buffer zone for peat preservation and restoration. The proposal re-envisions the productive economies existing in the buffer and prepares the farmers for the uncertain future. Waterways existing on the site act as ecological connectors and ensure the provision and distribution of local habitats.

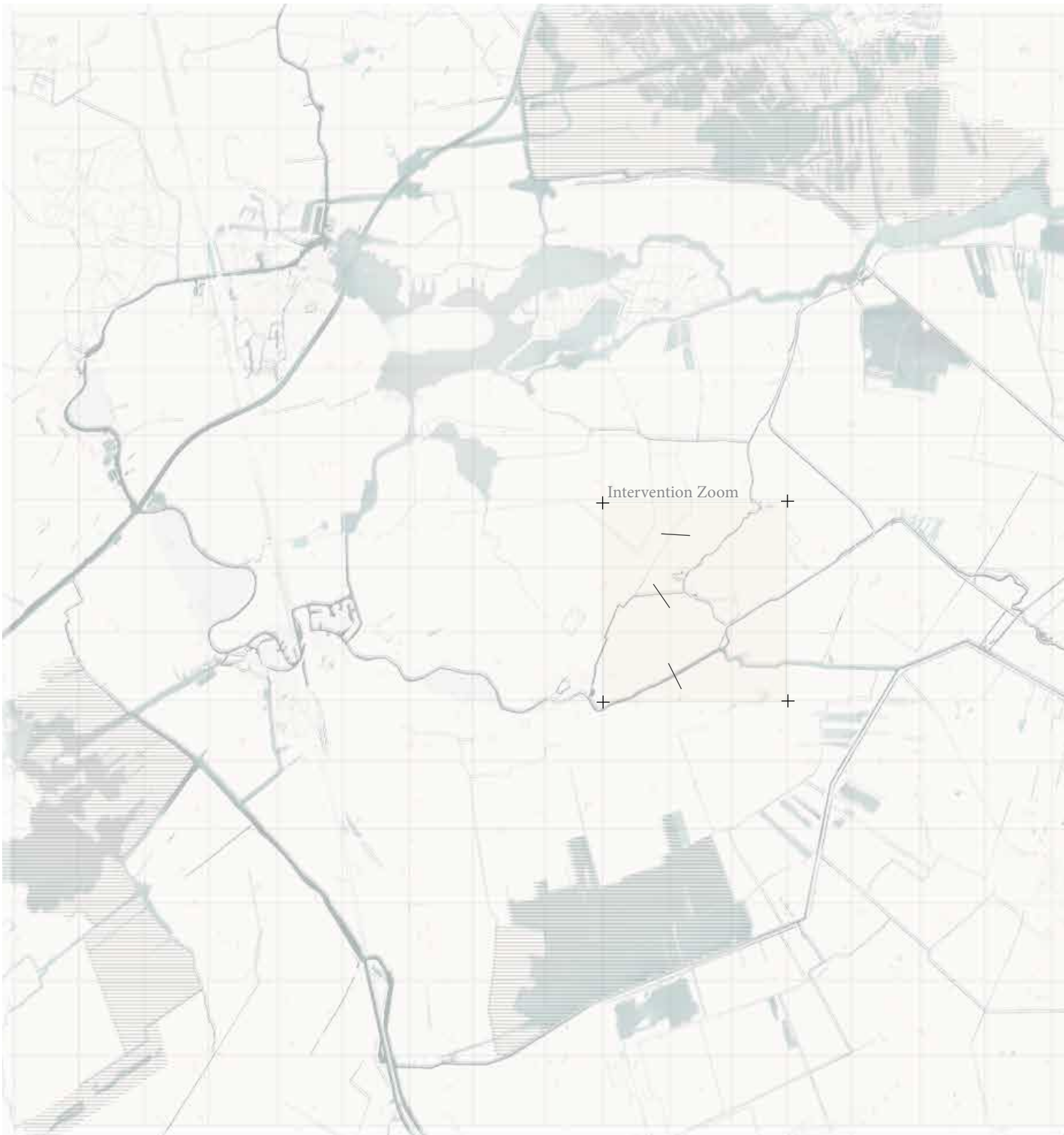
Paludiculture Corridor

Peatlands - "wetlands with partially decomposed plant material" (Zhong, et al., 2020). A high water table plays a vital role in peat restoration and preservation. Paludiculture is "the cultivation of crops on rewetted peatlands" (de Jong, et al., 2021). Paludiculture "is a valuable climate mitigation option that reduces greenhouse emissions and provides novel agricultural solutions" (de Jong, et al., 2021). The project proposes to create a paludiculture corridor in the embanked deep-lying polders that have higher water retaining capacity and for strengthening ecological connectivity between the carbon banks.

People Nature

To tackle the urgent issue of low water quality and homogenized cultural landscape, people nature aims to create a water purification network, whilst providing new recreational opportunities and enhancing the connectivity between cultural structures on the site. The proposal appreciates the cultural values of the local landscape and enhances the existing experiential qualities.

Carbon Bank Ecological Connectivity 2035



0 2km 4km N

Water Ecologcical
Na

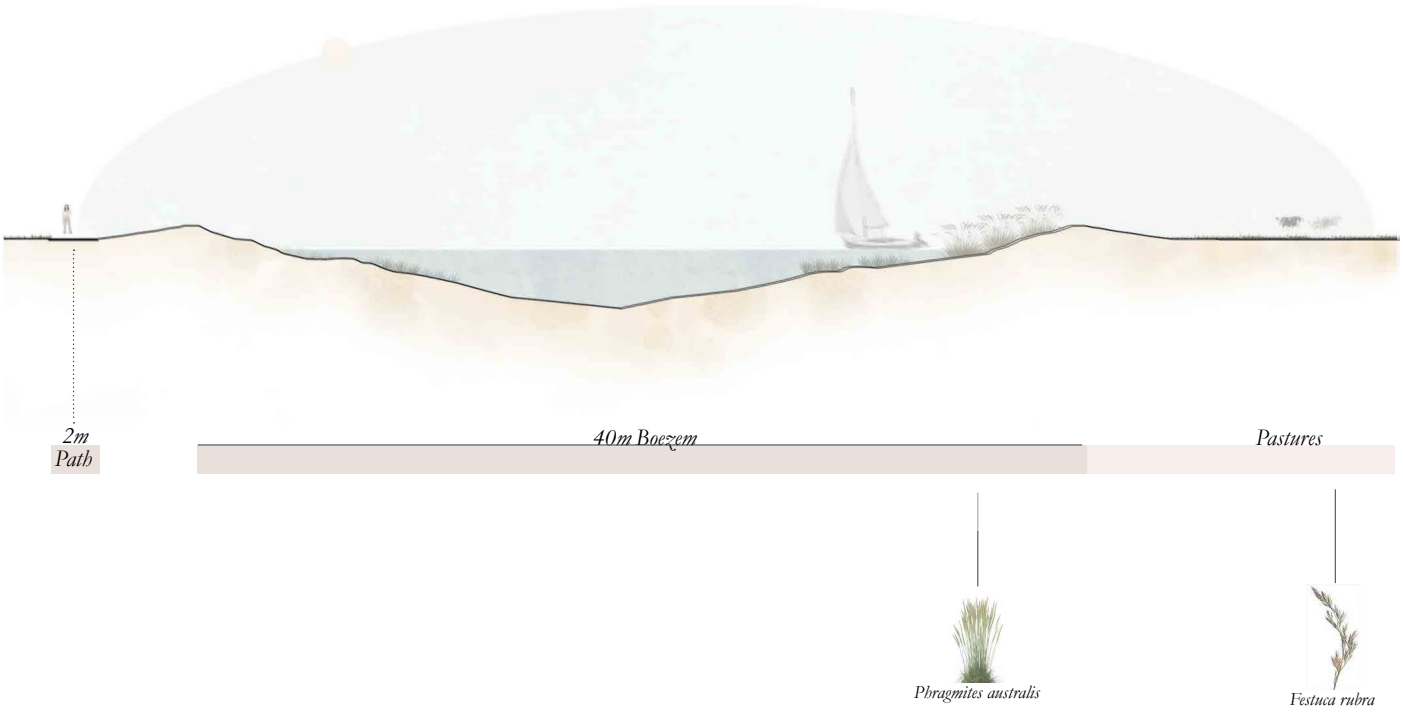
With the declining biodiversity and shrinking natural values, the establishment of an ecological corridor network plays a vital role in the design proposal. As the "surface ecological and chemical water qualities in the region are below the expected EU standards", treatment of the existing water bodies is of high necessity for future regional resilience (Rijksoverheid, 2020). Water plays a vital role in adequate habitat provision and distribution. I envision the connecting water bodies (boezem, canals, ditches) between the four Natura 2000 areas to turn into newly established ecological corridors that would reduce the fragmentation of the local nature and ensure adequate provision and distribution of the vulnerable local habitats. The usage of water-purifying plants would ensure a higher water quality supply in the future whilst providing food and shelter for vulnerable species.

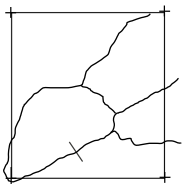
Corrdiors
tura 2000

Carbon Bank Ecological Connectivity
Primary Ecological Corridor

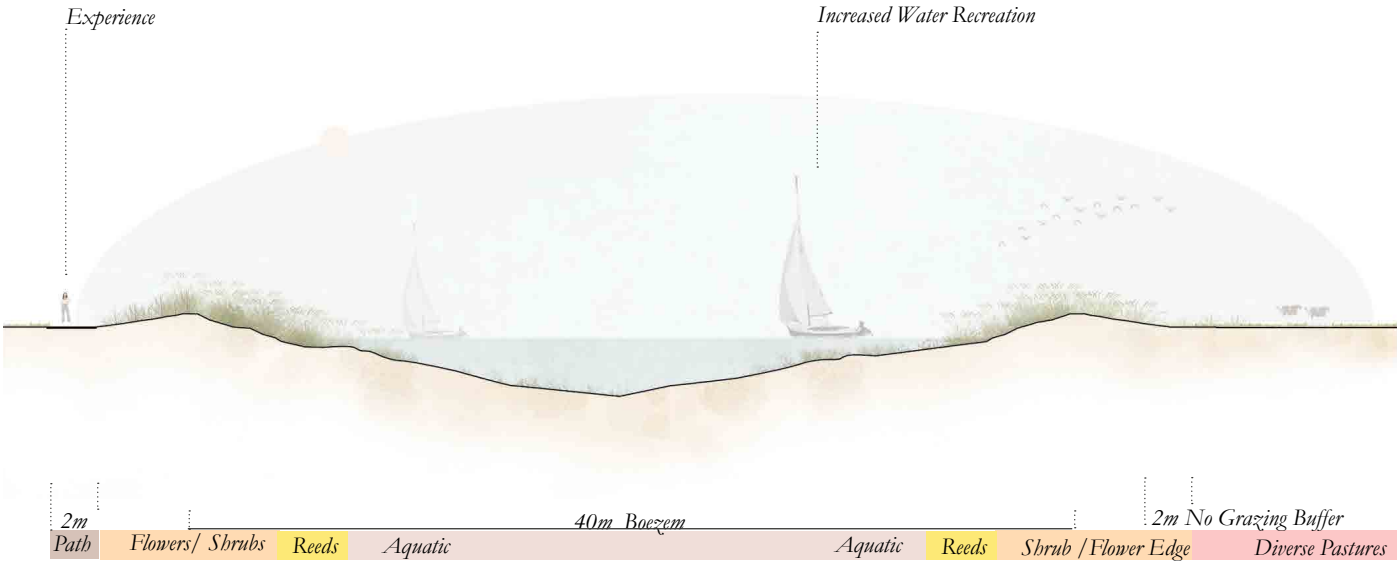
There is an opportunity to use the banks of the Boezem water network for providing biodiversity eco-services. The average width of a Boezem on the site is 40 m. Currently, the banks are managed by Wetterskip Friesland and prioritize accessibility over providing eco-services. Bringing diversity through local Frisian species by replanting the Boezem banks will create an ecological network connecting fragmented Natura 2000 areas.

2023





2035



Flowers

Rhinanthus angustifolius

Myosotis scorpioides subsp. scorpioides

Purple loosestrife

Lysimachia nummularia

Shrubs

Cornus sericea

Sambucus nigra

Aquatic

Iris pseudacorus

Nasturtium officinale

Mentha aquatica

Reeds

Phragmites australis

Schoenoplectus lacustris

Typha latifolia

Grasses

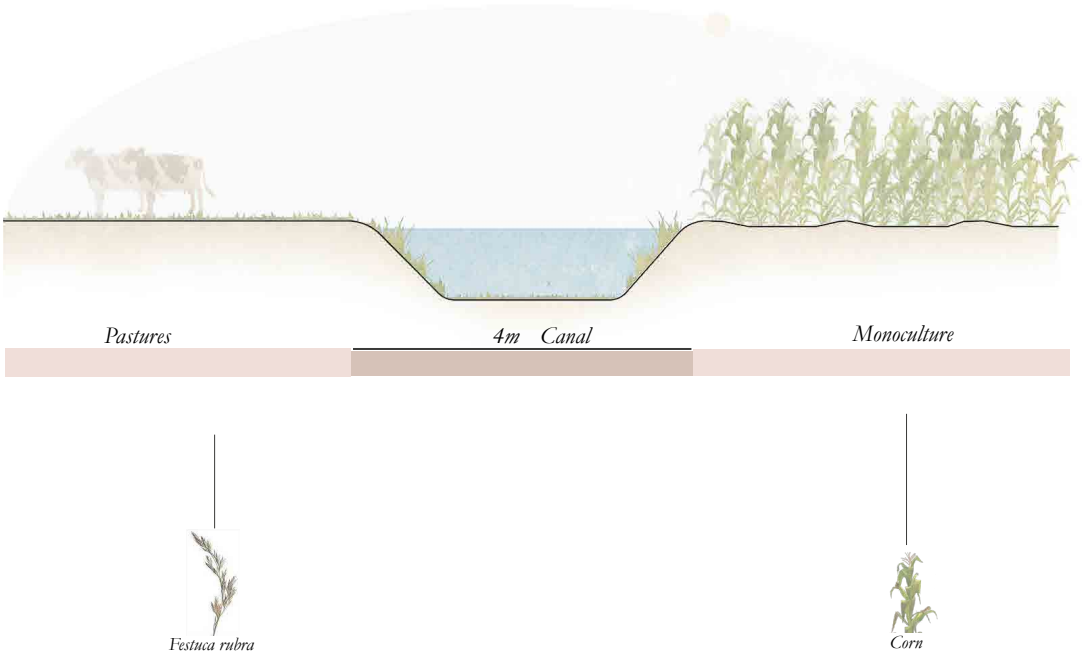
Festuca rubra

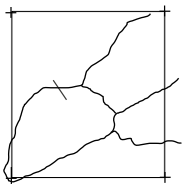
Cynosurus cristatus

Carbon Bank Ecological Connectivity
Secondary Ecological Corridor

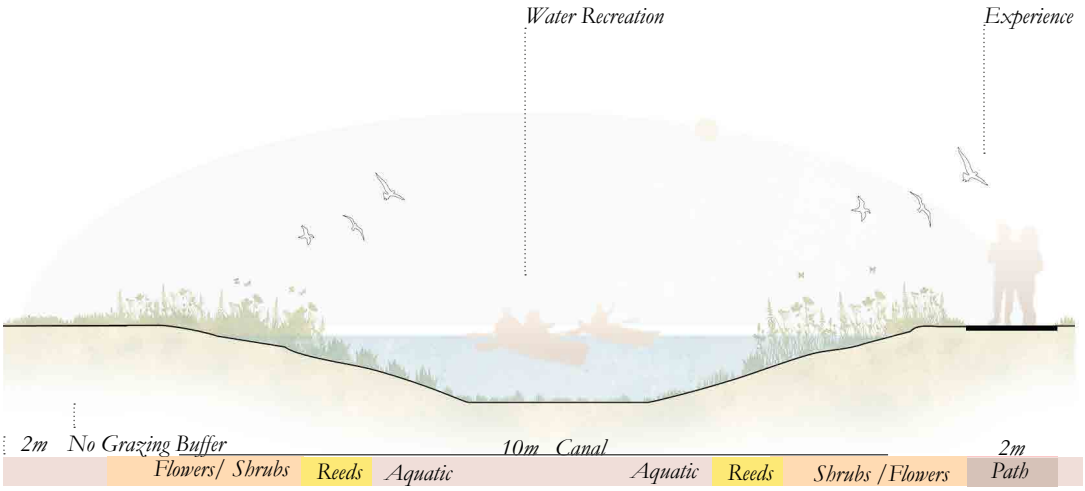
A secondary ecological network is created by widening the canals on the site for higher water storage and the provision of recreation. The banks are replanted with local Frisian species that contribute to habitat provision and distribution. Species like Mentha aquatica and Iris pseudacorus purify the low-quality waters.

2023





2035



Grasses

Festuca rubra

Cynosurus cristatus

Reeds

Phragmites australis

Schoenoplectus lacustris

Typha latifolia

Aquatic

Iris pseudacorus

Nasturtium officinale

Mentha aquatica

Flowers

Rhinanthus angustifolius

Myosotis scorpioides subsp. scorpioides

Purple loosestrife

Lysimachia nummularia

Shrubs

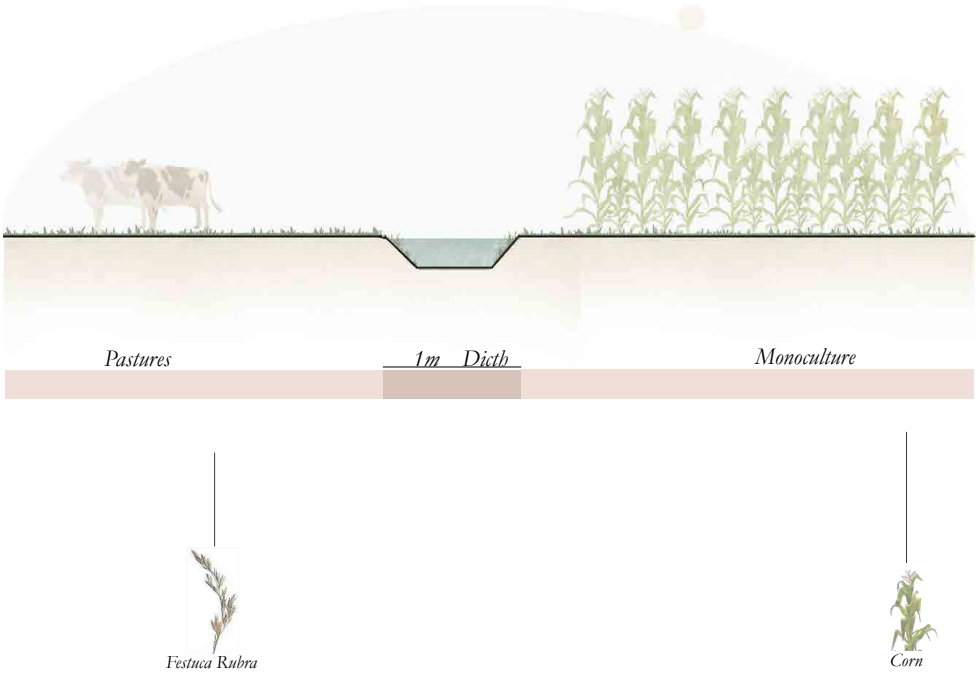
Cornus sericea

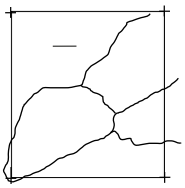
Sambucus nigra

Carbon Bank Ecological Connectivity
Tertiary Ecological Corridor

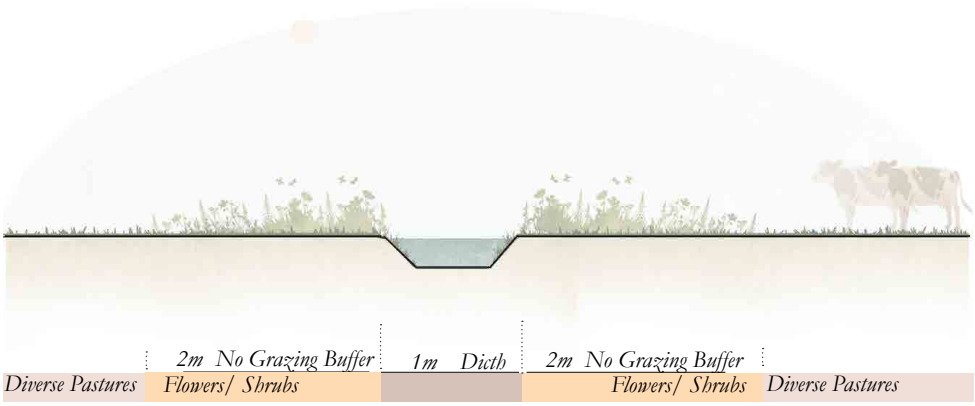
Tertiary ecological corridors use ditches and use non-grazing buffer zones for providing ecological services. The tertiary ecological network ensures adequate habitat provision and distribution throughout the site.

2023





2035



Grasses

Plantago lanceolata L

Melilotus officinalis

Festuca rubra

Cynosurus cristatus

Flowers

Rhinanthus angustifolius

Myosotis scorpioides subsp. scorpioides

Lysimachia nummularia

Shrubs

Cornus Ssricea

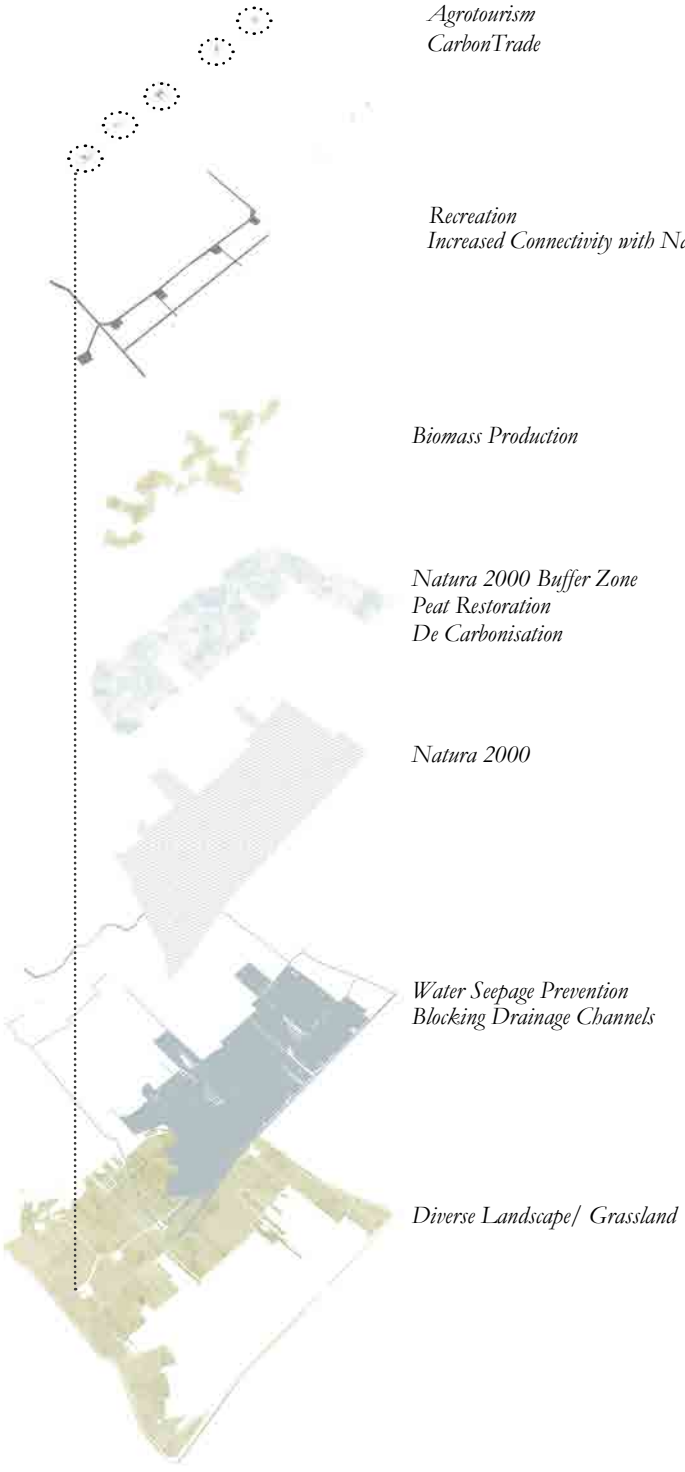
Sambucus nigra

Establishing Carbon Banks 2035

0 2km 4km N

Natura 2000 B
Na

Structure



As Natura 2000 areas are in higher competition with the agricultural landscape, the rigid borders between two competing land-use types breed conflict and not only create increasing threats to the biodiversity but politicize the land and create increasing tensions between managing legislative bodies such as the EU, national-local governments and farmers. Establishing 1 km buffer zones surrounding the Natura 2000 areas that value the importance of economic resilience and proposing a new form of productive landscape that restores and preserves the oxidizing peat is at the core of the proposal. The thesis project looks into the opportunity to restore the peat surrounding the Natura 2000 zones for long-term carbon sequestration whilst ensuring that farms that reside in the areas that are expected to transition will go through the process with minimized economic loss. Rewetting fen peat by blocking drainage channels and balancing the water table is the main technique used for the establishment of carbon banks that in 100 yeast are expected to ecologically succeed into a peat bog landscape, strengthening the existing Natura 2000 areas and playing an immense role in long term carbon sequestration.

uffer Zone
tura 2000

De Deelen Peat Bog Natura 2000, 2023.
Photo: Google Earth.

De Deelen Carbon Bank

0 400m 800m N

Directionality
Biomass Production

Diverse Fields, Pastures

Agrotourism
CarbonTrade

Blocking Drainage Channels

Natura 2000 relationship
Recreation
Increased Connectivity

Biomass Production

Natura 2000 Buffer Zone
Peat Restoration
De Carbonisation

View Points

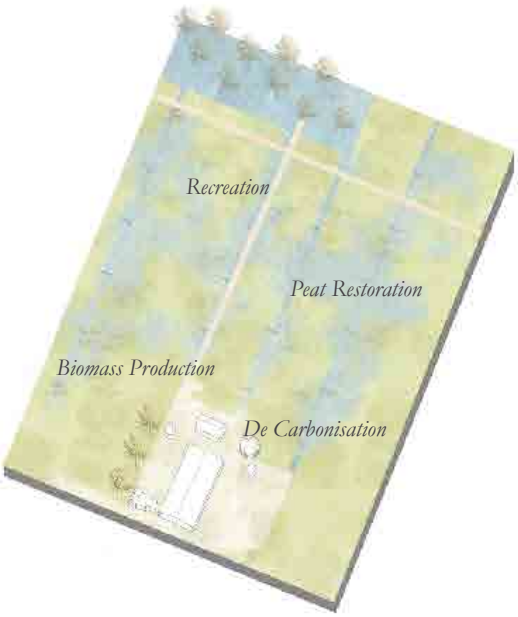
De Deelen "is one of the few remnants of an extensive peat bog landscape that once covered north-western Overijssel and Friesland"(Ramsar Sites Information Service, 2022). The site consists of former "petgaten" - open waters developed as a result of peat excavation, "reedbeds, shrubs, and wet meadows"(Ramsar Sites Information Service, 2022). In 2013 De Deelen entered Natura 2000 jurisdiction as "it provides a breeding ground for nationally threatened species (Botaurus stellaris, Chlidonias niger) and supports more than 20 000 wintering waterbirds" (Ramsar Sites Information Service, 2022). One of the main threats to the site is drainage and nutrient pollution coming from farmland near the area (Ramsar Sites Information Service, 2022).

Carbon Bank intervention aims to change soil and water management of the bordering 5 farms and use blocking of drainage canals and ditches for peat preservation and restoration, which subsequently benefits long-term carbon sequestration. As a result, the direct impact of farming on the nutrient-sensitive Natura 2000 is reduced. The newly established buffer zone not only restores peat but turns into an area where residents of Alderboarn and other nearby towns can experience Natura 2000 and appreciate Frisian peatlands. To compensate for the land that has been taken away from the farmers new forms of economies are established such as: the production of biomass, agrotourism, and sequestrated carbon trade.

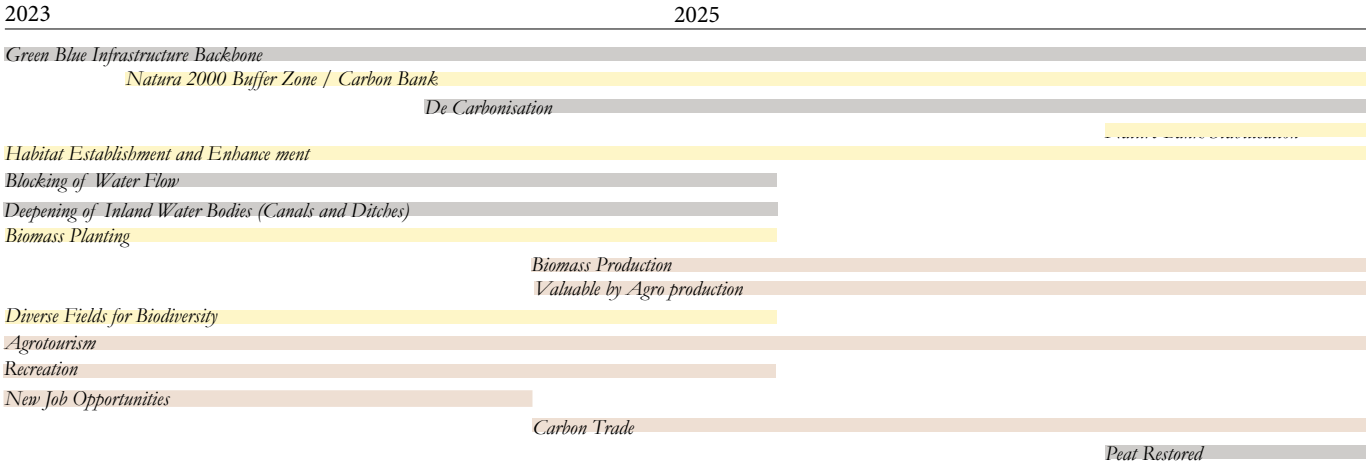
De Deelen Carbon Bank

2023

2025



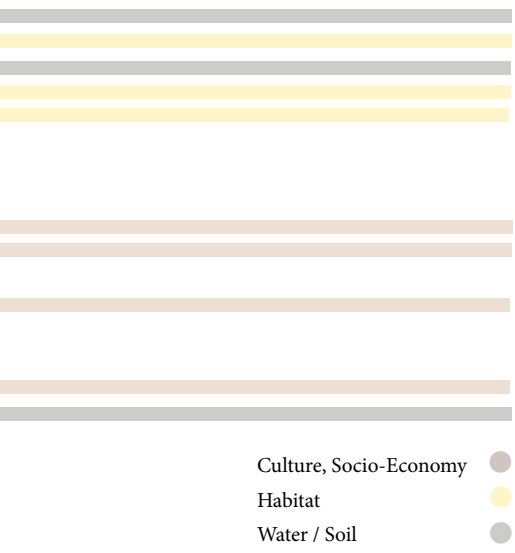
Timeline



The green-blue backbone infrastructure, which contributes to peat restoration, is expected to develop as soil and water managing strategies are introduced. Within 10 years the area is expected to fully transition into a new form of economy, where dairy farmers rely on biomass production, agrotourism, and sequestrated carbon credit trade. As time passes, the agrotourism strengthens allowing the residents of Aldeboarn and other visitors to appreciate the Frisian peatlands.

2035

2035



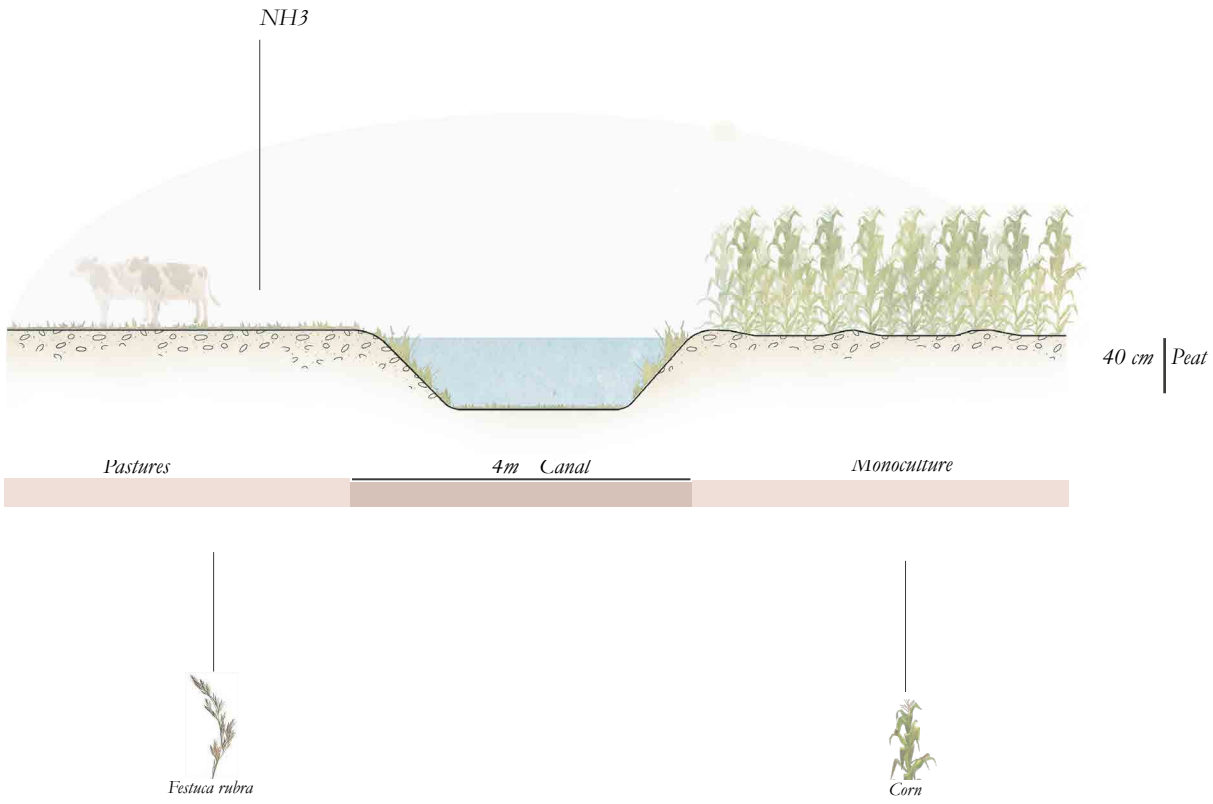
Culture, Socio-Economy
Habitat
Water / Soil

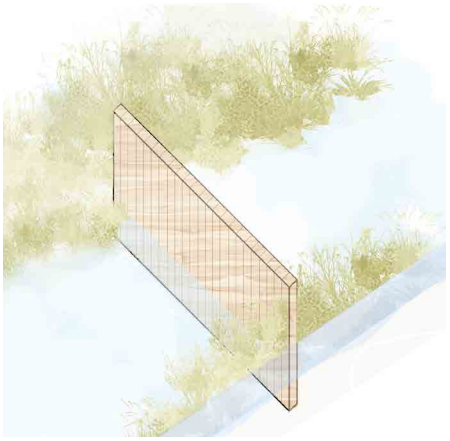
De Deelen Carbon Bank

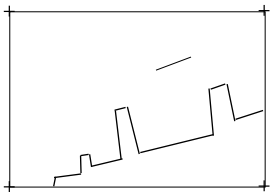
Blocking of Drainage Channels

One of the main ways for restoring degraded peat "is to restore their hydrological functions"(Dinesen, Hahn, 2019). Ditch and canal water drainage blocking is the main technique used on the site for hydrological function restoration. The introduction of peat growing species such as sphagnum moss is part of the restoration process.

2023

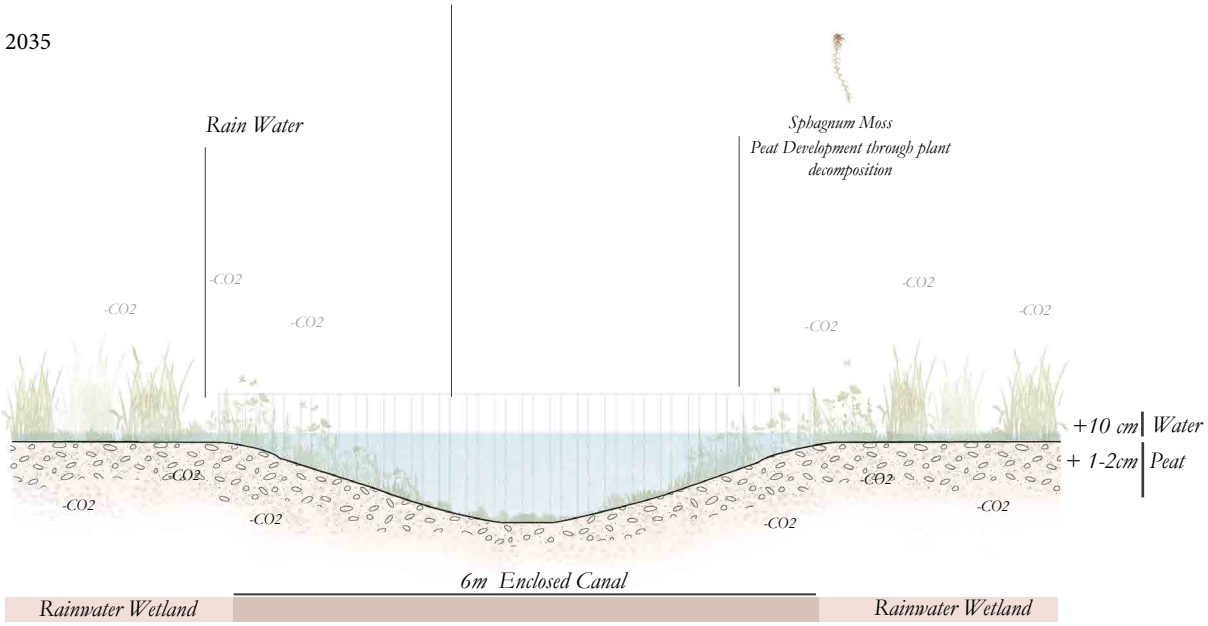






Water Flow Blocked
Wooden Plank

2035



Peat Species


Typha latifolia


Molinia caerulea


Sphagnum moss


Rhinanthus angustifolius


Phragmites australis


Deschampsia cespitosa


Carex disticha


Myosotis scorpioides subsp. scorpioides


Schoenoplectus lacustris

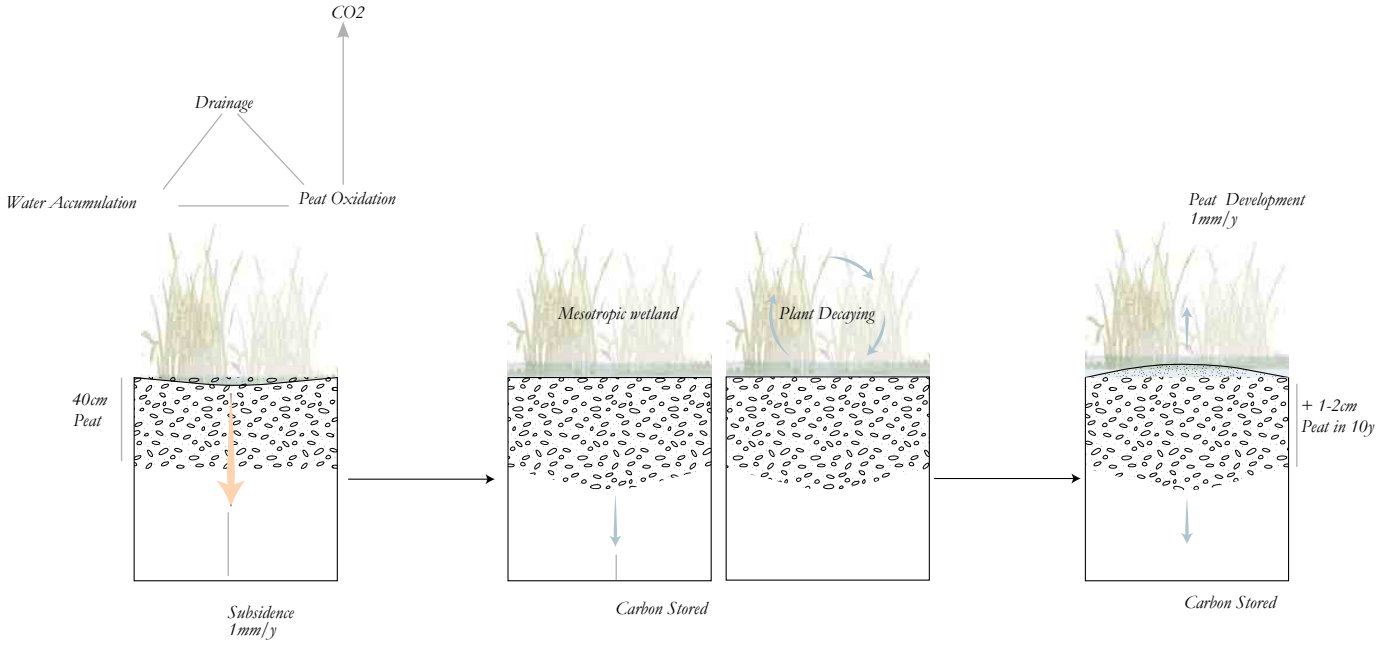

Eriophorum angustifolium

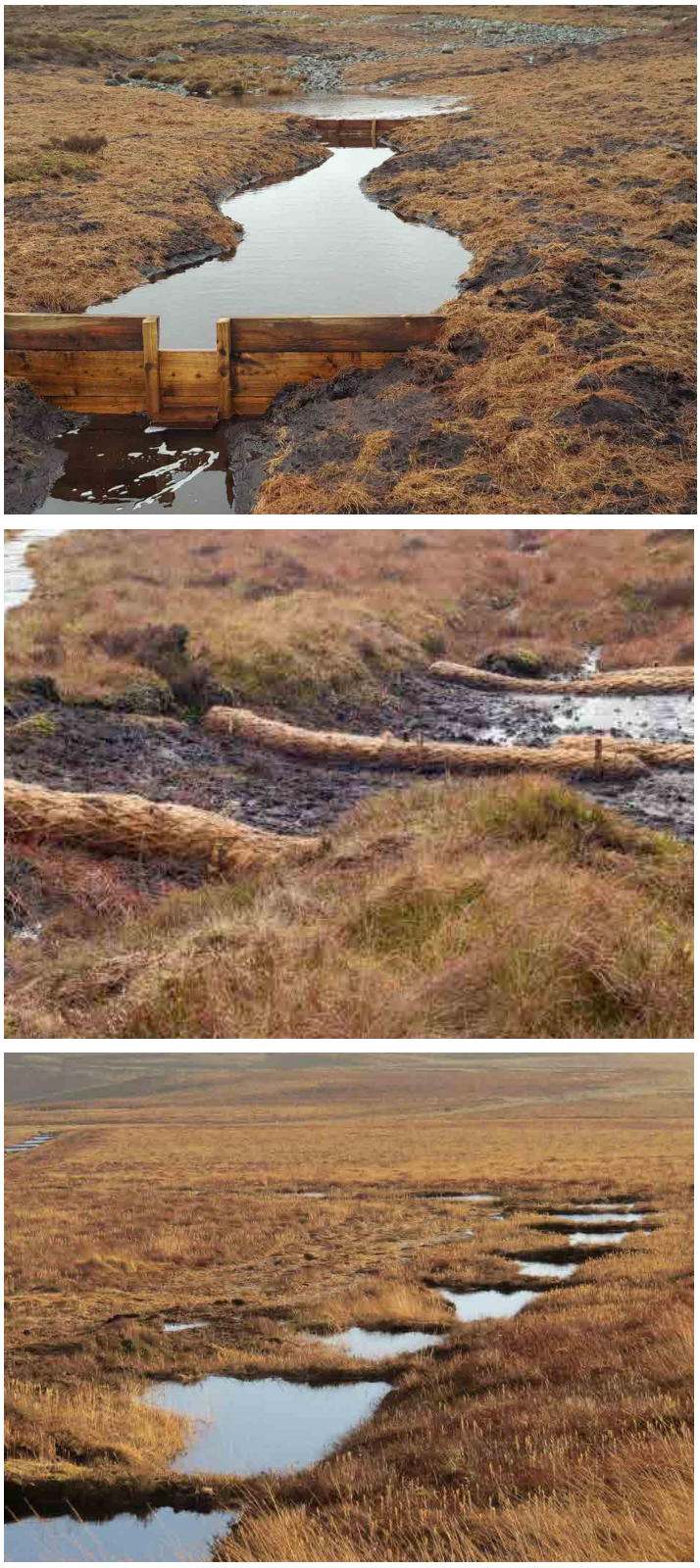

Lysimachia nummularia

De Deelen Carbon Bank

Peat Restoration

As the water table is restored, submerged plants decay under mesotrophic wetland conditions that the blocked drainage ditches and canals create. In the process, decaying plants contribute to carbon sequestration and peat restoration. The average peat restoration rate under such conditions is 1mm/year or 1-2 cm in 10 years (Dinesen, Hahn, 2019).

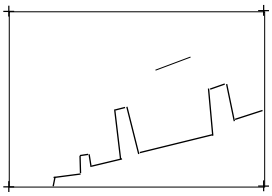




Forest of Bowland, UK 2015.
Photo: Lancashire County Council.

De Deelen Carbon Bank

Peat Restoration Biodiversity



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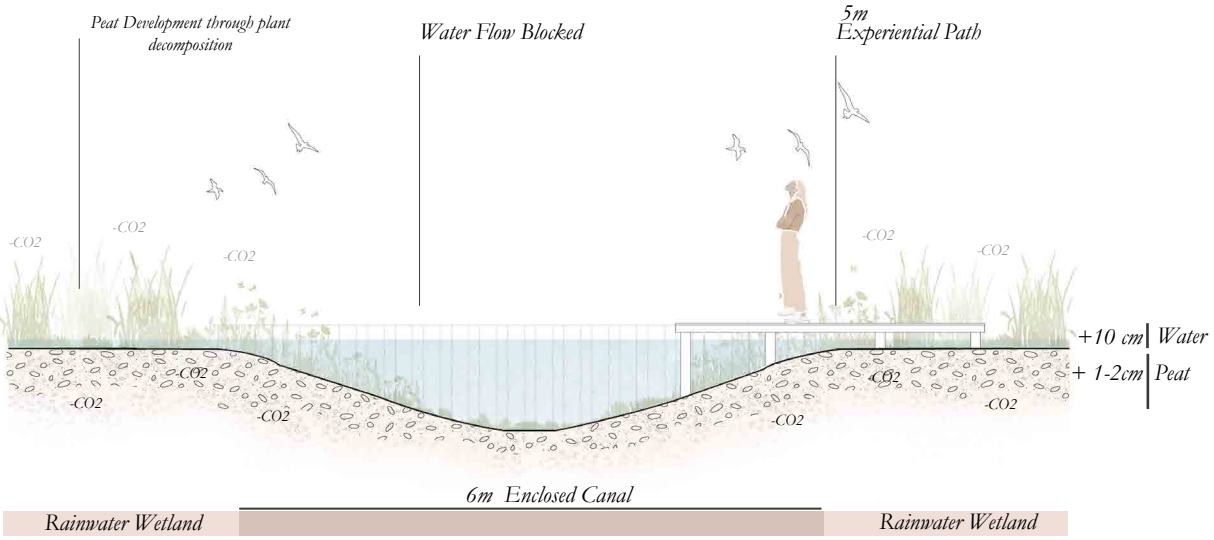


Reptiles

Rana temporaria

Bufo bufo

Lissotriton vulgaris

Invertebrates

Euphydryas aurinia

Circus aeruginosus

Birds

Grutto

Kievit

Tereluur

Scholekster

Circus aeruginosus

Botaurus stellaris

Acrocephalus arundinaceus

Tachybaptus ruficollis

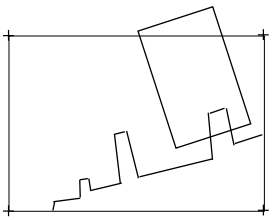
"Restoration of ecosystems is increasingly becoming an important tool for mitigating biodiversity loss and safeguarding ecosystem services including climate change mitigation"(Dinesen, Hahn, 2019). Peatland restoration relies on the objective of "returning degraded peatlands by human activities to or as near to their natural state" for "improving quality of species habitats, thus contributing to slowing or halting the rate of biodiversity loss". Peatland restoration has been "widely recognized as an important tool for climate mitigation" including the Climate Change Convention (UNFCCC). The restoration of peat will be highly valuable for habitat provision and distribution and for providing new experiences for people visiting the site. Elevated wooden paths and bird-watching towers reestablish the relationship of the visitors with the natural peat landscape.

Wombat Pool, 2006.
Photo: Clinton Barnes.

Brooklyn Navy Yard, 2017.
Photo: www.flungmagazine.com.

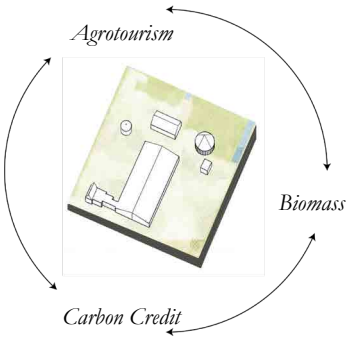
Carbon Bank

Carbon and Biomass Farming



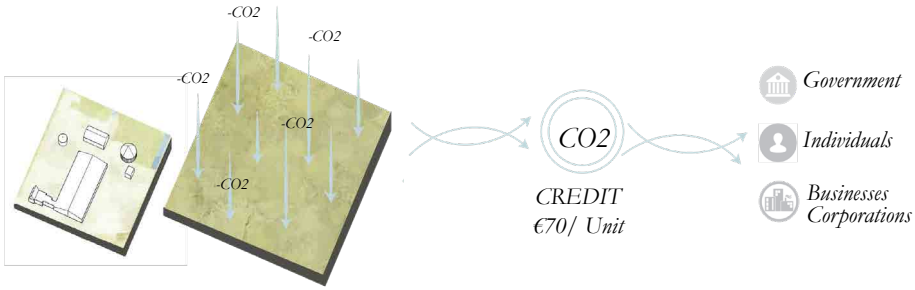
0 40m 80m N

Alternative Economy



Experimental Carbon Farm

Carbon Credit Model



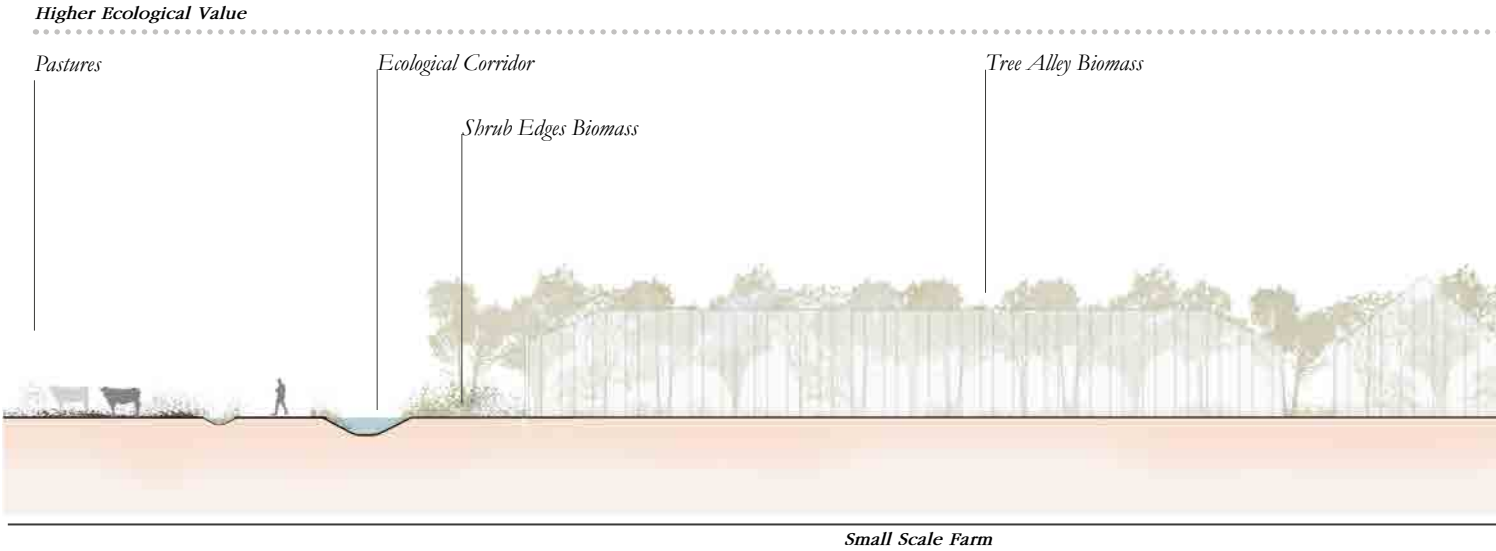
Going down in scale, the proposal suggests the five farms transition into a new economy that relies on sustainable practices and has minimal impact on local biodiversity. The farms, while becoming an agritourism hotspot for Aldeboarn citizens to access the restored peatlands and De Deelen Natura 2000, also rely on biomass production and trade of sequestrated carbon. The alternative economy model suggests that restored peatlands due to their ability to store carbon will allow the farmers to sell carbon credits to governments, businesses, and individuals. Nowadays, to the North of the site, the "Lytse Deelen" farm has sacrificed part of the land for peat restoration and participates in the scheme, where carbon is sold for 60 euros/ carbon. Biomass planting not only contributes to the alternative economy model but creates an experiential landscape for the visitors contributing to site agrotourism and peat restoration as it relies on active plant decaying processes. To ensure the resilience of independent farms, biomass energy production is taken into account. As climate change is further impacting the way we live there will be an increasing opportunity for biomass production in Frisian peatlands (Kuhlman, et., 2011). Species local to Frisian peatscapes such as willow and typha are most suitable for biomass cultivation.

Carbon Bank

Carbon and Biomass Farming
Alternative Future

Agrotourism	**Biomass**	**Carbon Credit**
Lodging *Experience*	*By Agroproduction* *Biomass Energy*	*De Carbonisation Credits*

2035



Shrubs Biomass Species


Erodium cicutarium


Tanacetum vulgare


Geranium robertianum


Rumex acetosa

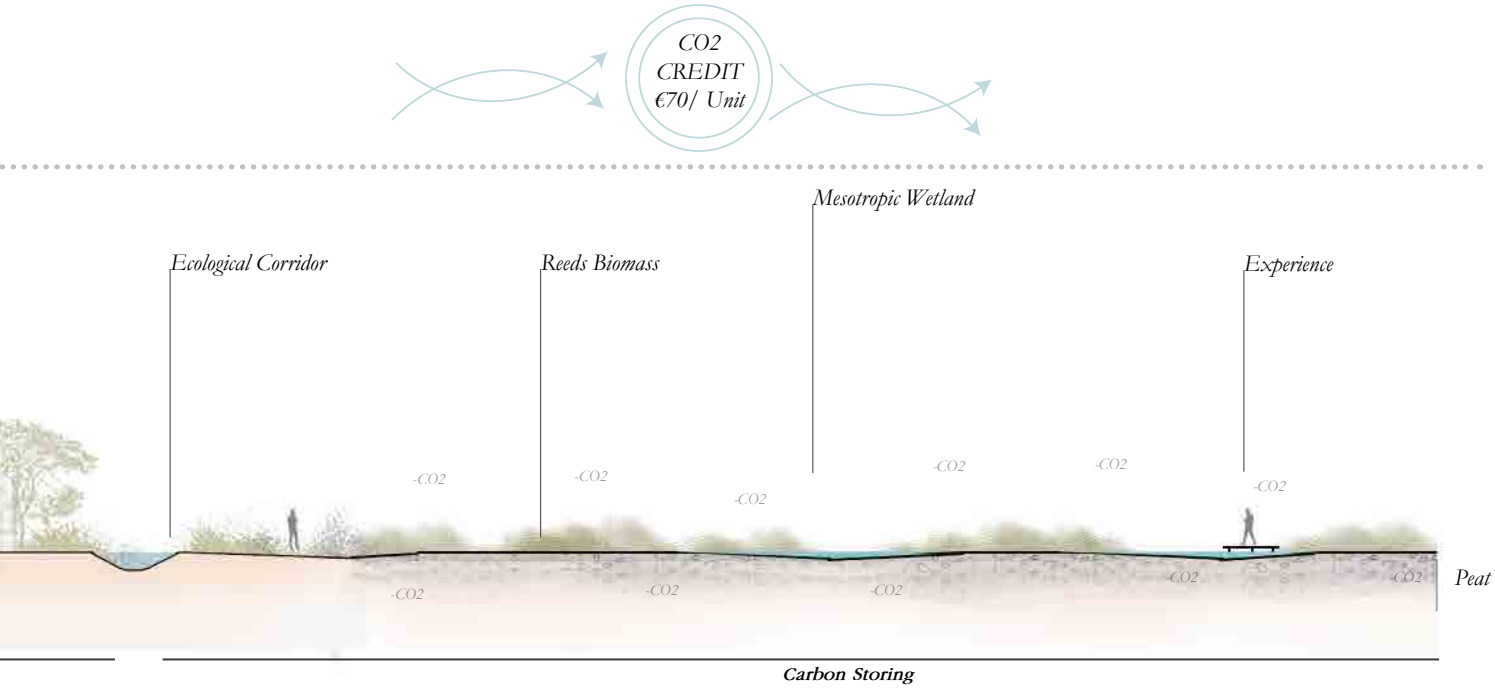
Tree Biomass Species


Salix Alba


Sorbus Aucuparia


Alnus Glutinosa

The ditches and canals act as ecological corridors serving the local biodiversity. The North of the farmland as it is located in clay soils remains as land dedicated to dairy farming, whereas the South of farms turns into biomass and carbon cultivation. The restored peat landscapes provide a perfect opportunity for recreation and re-establish the relationship of local people with the Natura 2000. In addition to willow and typha, other biomass species participate in the development of the De Deelen Carbon Bank. Peat restoration on site acts as long-term carbon sequestration in the proposal.



Reed Biomass Species

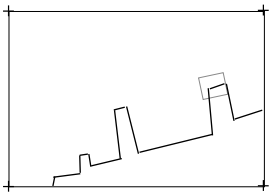

Schoenoplectus lacustris


Typha latifolia


Phragmites australis

Carbon Bank

Detail

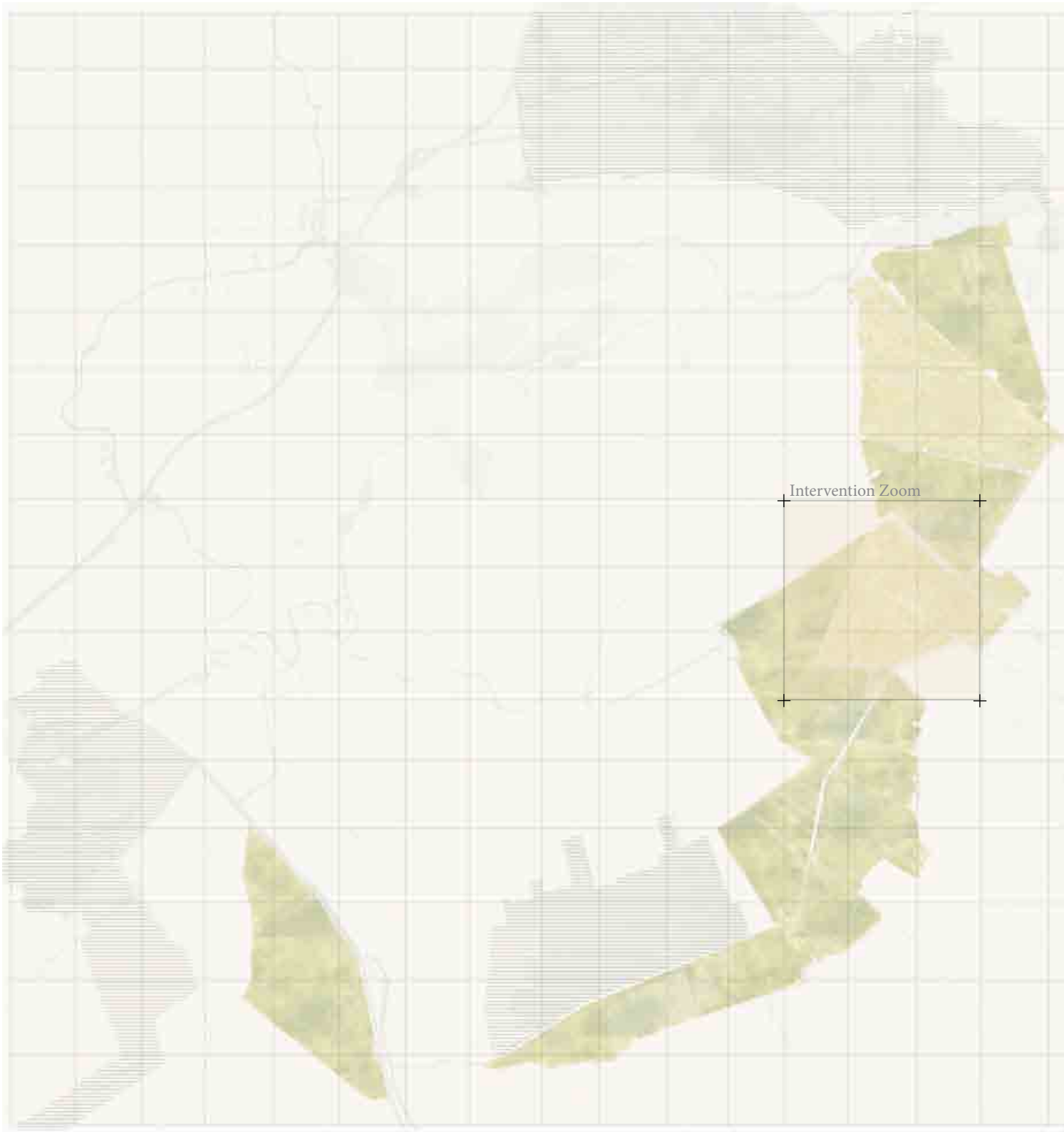


The viewing platform establishes a stronger relationship of people with the Natura 2000 and provides additional opportunities for the visitors to appreciate restored peatlands and/or to access the Natura 2000. As De Deelen is a temporary home for more than 20 000 different winter bird species, the viewing platform becomes a great opportunity to experience such a unique natural environment.

Tipperne Natural Complex, 2017.
Photo: Rasmus Norlander.

Matsalu National Park, 2020.
Photo: www.birdingplaces.eu.

Paludiculture Corridor 2035



0 2km 4km N

Rice Pal
Cranberry Pal

One of the ways to mitigate land subsidence and the release of greenhouse gasses is to stop draining peat soils. “However, rewetted peat soils are less suitable for agriculture and dairy farming, as common crops are not adapted for higher water levels” (de Jong, et al., 2021). Paludiculture is a form of agriculture that accepts the importance of rewetted peat and looks into non-conventional crops that grow in higher water levels (de Jong, et al., 2021). Rewetted peat has a high value for peat preservation and restoration, and plays a significant role in providing eco-services for the local habitants.

The thesis proposal suggests creating a paludiculture corridor, located in the low-lying embanked polder landscape in the South of the site as it has a higher water retaining capacity, and therefore, is much more suitable for crops that prefer higher water levels. The thesis speculates that the paludiculture corridor will act as a secondary connecting landscape between the newly established Carbon Banks and will contribute to long-term carbon sequestration and nature-inclusive agriculture.

Experimental Wet Farm
“Better Wetter”

Oryza sativa

Vaccinium macrocarpon Ait.

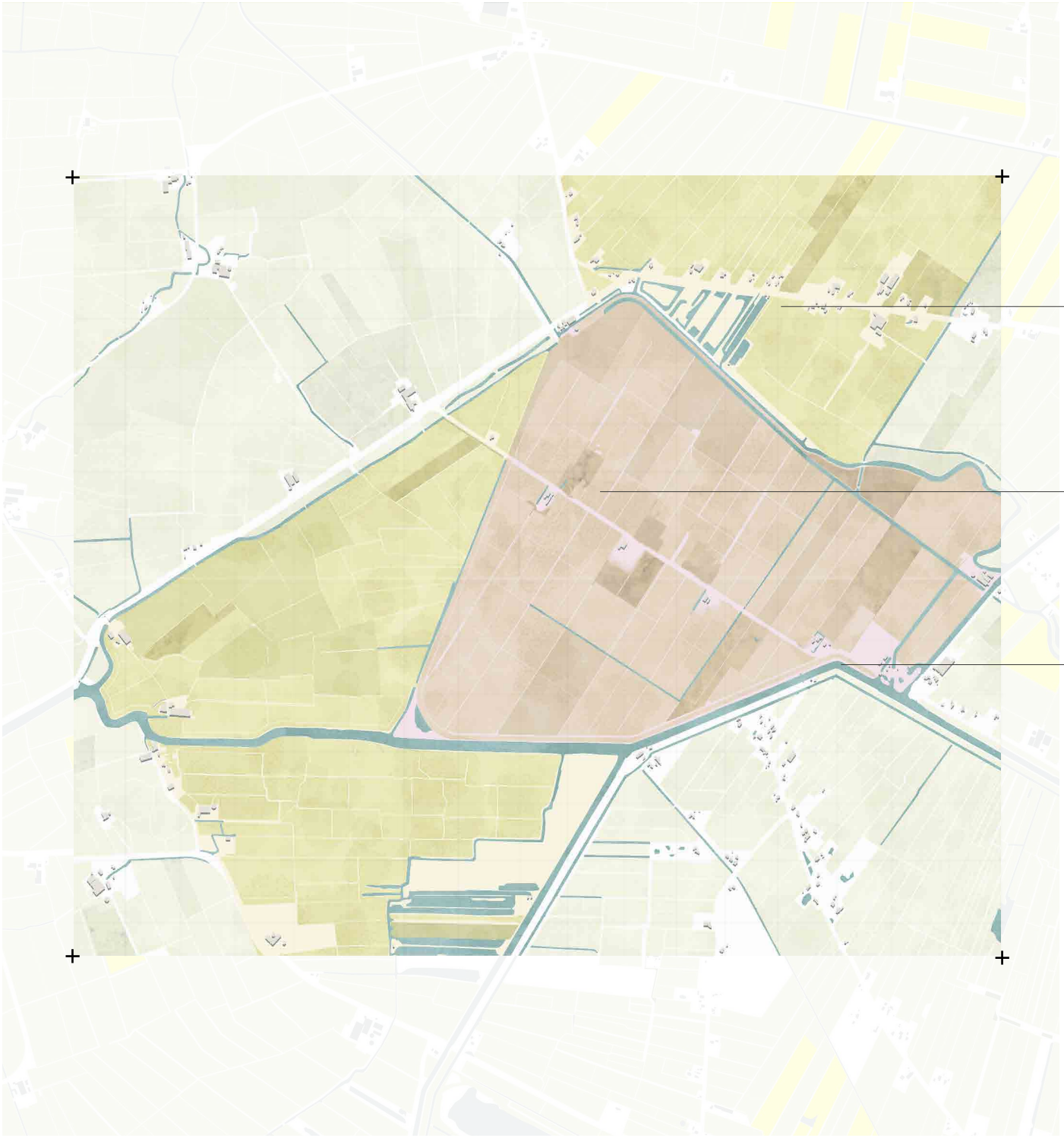
Typha Latifolia

Phragmites australis

udiculture
udiculture

Niuwe Diep, 2023.
Photo: Google Earth.

Paludiculture



Low water table crops such as rice have minimal impact on the infrastructural landscape and, therefore, require less in the transition into paludiculture. Whereas high water table crops such as cranberry require the land to be embanked with dikes and are more likely to appear in deep-lying polders. As a result, the substantial paludiculture corridor intervention involves low-water table crops with minimal impacts on farms.

Farms located in the deep-lying polders will be under the threat of moving elsewhere, however, the use of temporary dams to protect structures during the high-water level harvesting season reduces the risks of flooding and property damage.

The newly established paludiculture landscape due to its unique properties not only becomes a resilient productive landscape of the future but provides new opportunities for the local farmers. Cranberry harvesting season is appreciated for its beauty and is very likely to establish a new economic flow into the region.

Rice Fields, Pastures
Peat Restoration
Agrotourism
Recreation

Cranberry Wet Crops
Peat Restoration
Agrotourism
Recreation
Protected Farms

Primary Ecological Corridor

Italy Rice Fields, 2017.
Photo: www.sustainableeurice.eu.

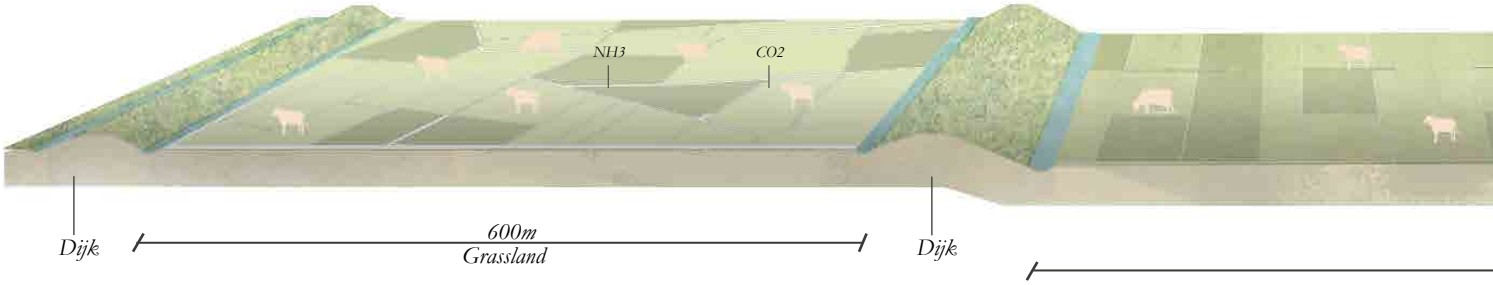
New Jersey Cranberry Fields, 2020.
Photo: Dave Smith.

Yazoo river flooding temporary dam, 2011.
Photo: Mark Tomasovic.

Paludiculture

The sections demonstrate the water acceptance capacity of the landscape and speculate that dikes, ditches, canals, and boezem may act as paludiculture corridor boundaries. Low-lying lands - polders have much higher water acceptance capacity and rely on dikes for water retention.

2023



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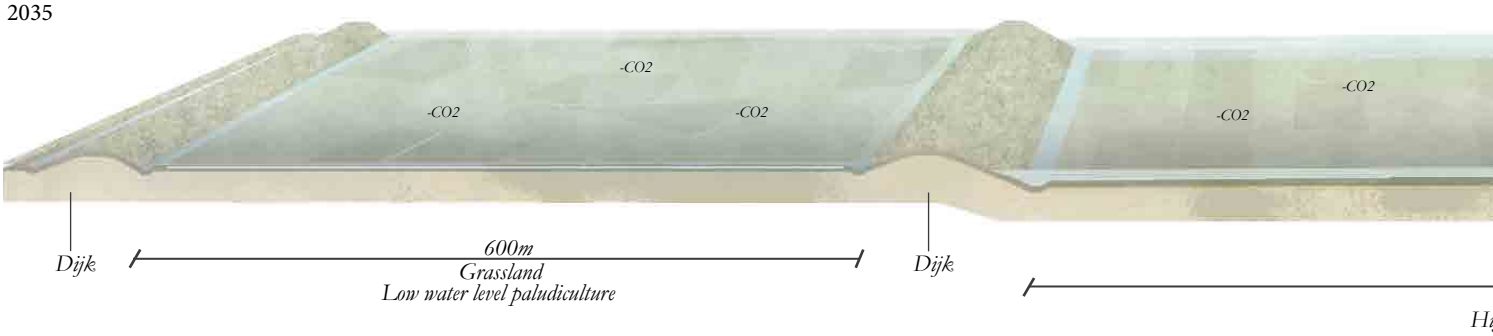
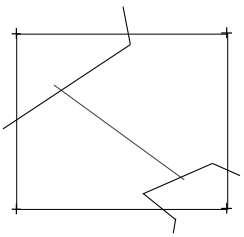
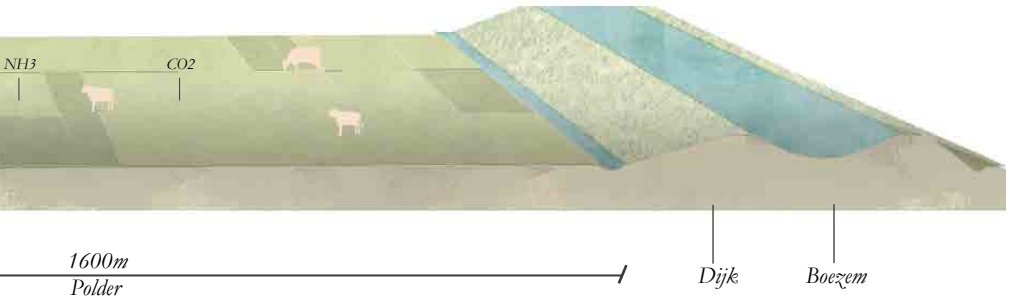
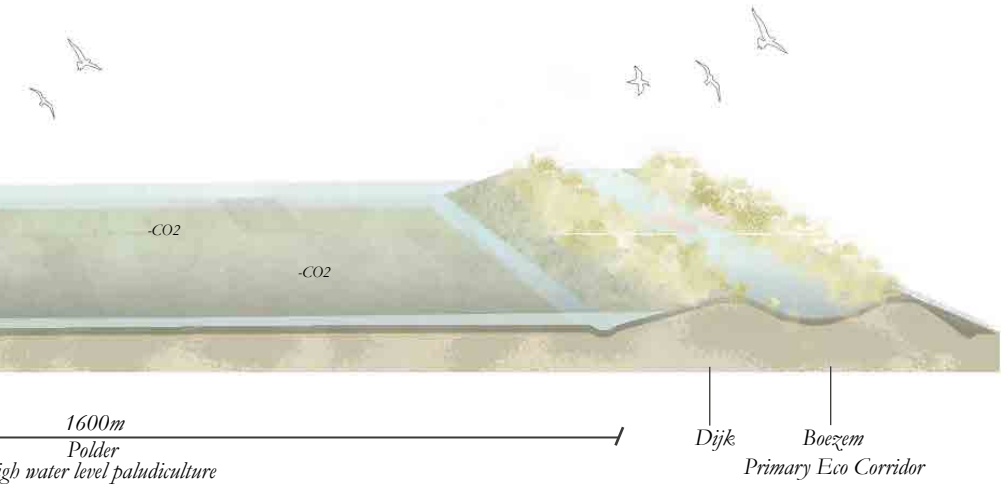






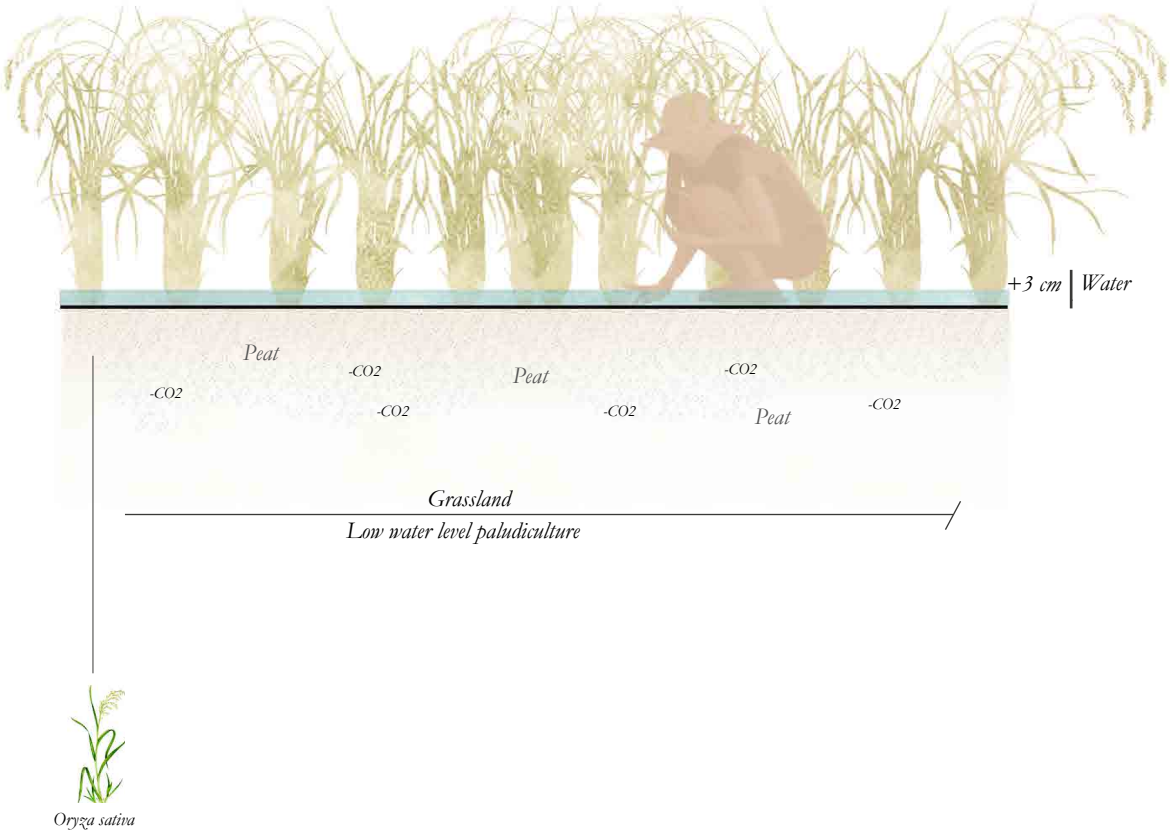


igh water level paludiculture

Paludiculture Crops

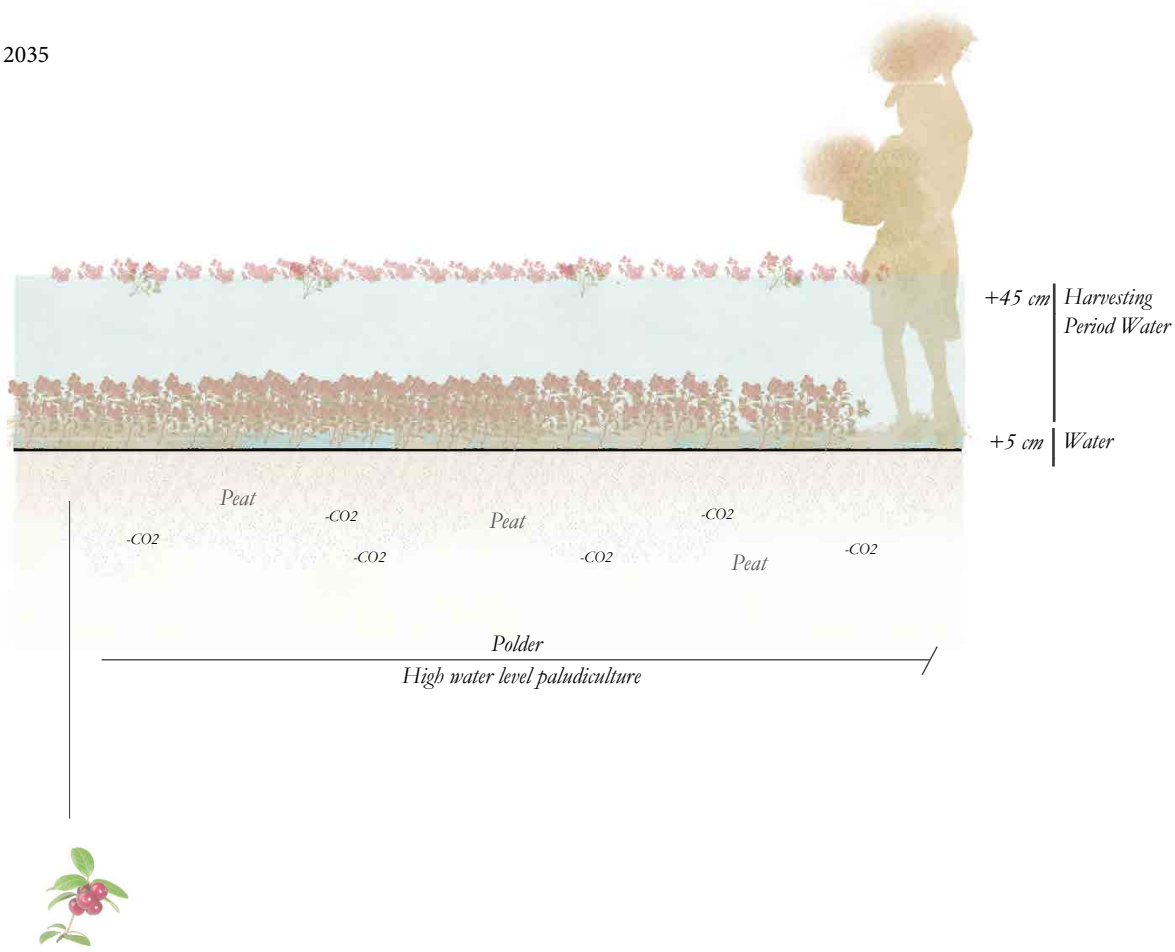
"Better Wetter" is an experimental farm located to the North of the site that has successfully cultivated rice and cranberry. The paludiculture corridor proposal speculates that growing rice and cranberry will create a new resilient productive landscape in Friesland. Rice "is the second most important cereal and staple food in the world" (Monaco, et al., 2016). The crop requires continuous flooding up to 3 cm and up to 10cm during the harvesting season (Monaco, et al., 2016).

2035



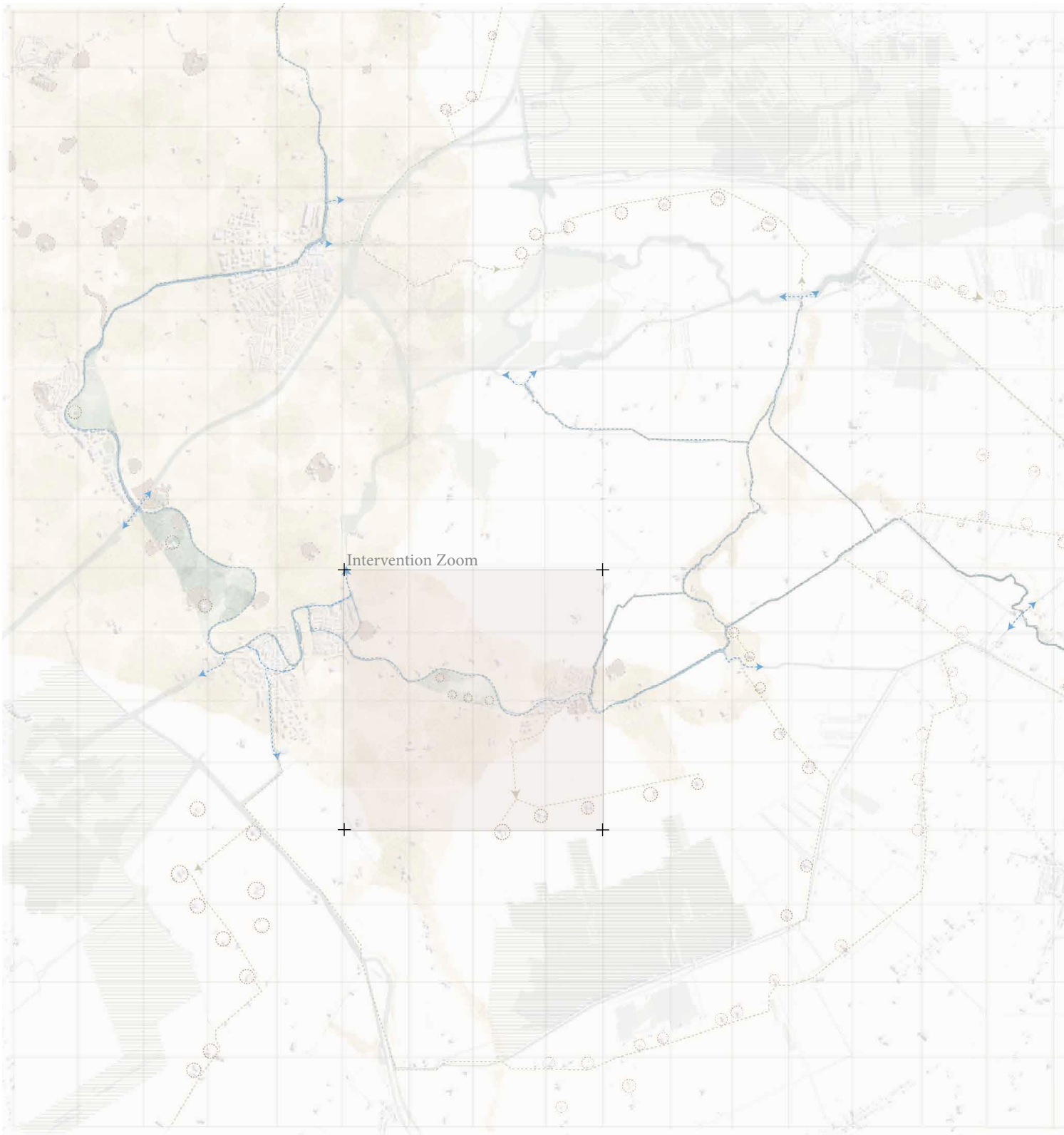
"The most widely-known use of flooding in cranberry cultivation is for harvest" (Cape Cod Cranberry Growers Association, 2001). Up to 90% of cranberry harvesting happens through field flooding, during which up to half a meter of water is accepted. In the process the ready-to-harvest berries float creating a unique water landscape, significantly simplifying the required labor. Water is often recycled and shared between farmers during the harvesting process (Cape Cod Cranberry Growers Association, 2001).

2035



Vaccinium macrocarpon Ait.

Cultural Routing 2035



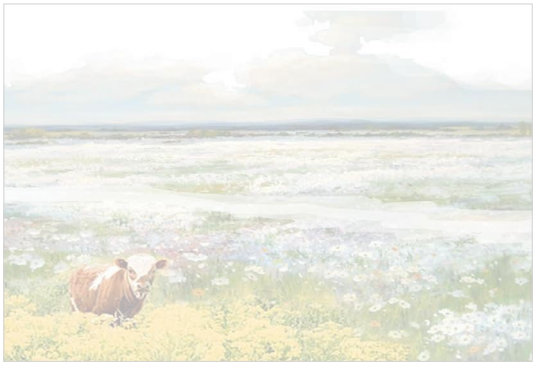
0 2km 4km N

Backbone Cult
Secondary Cultu

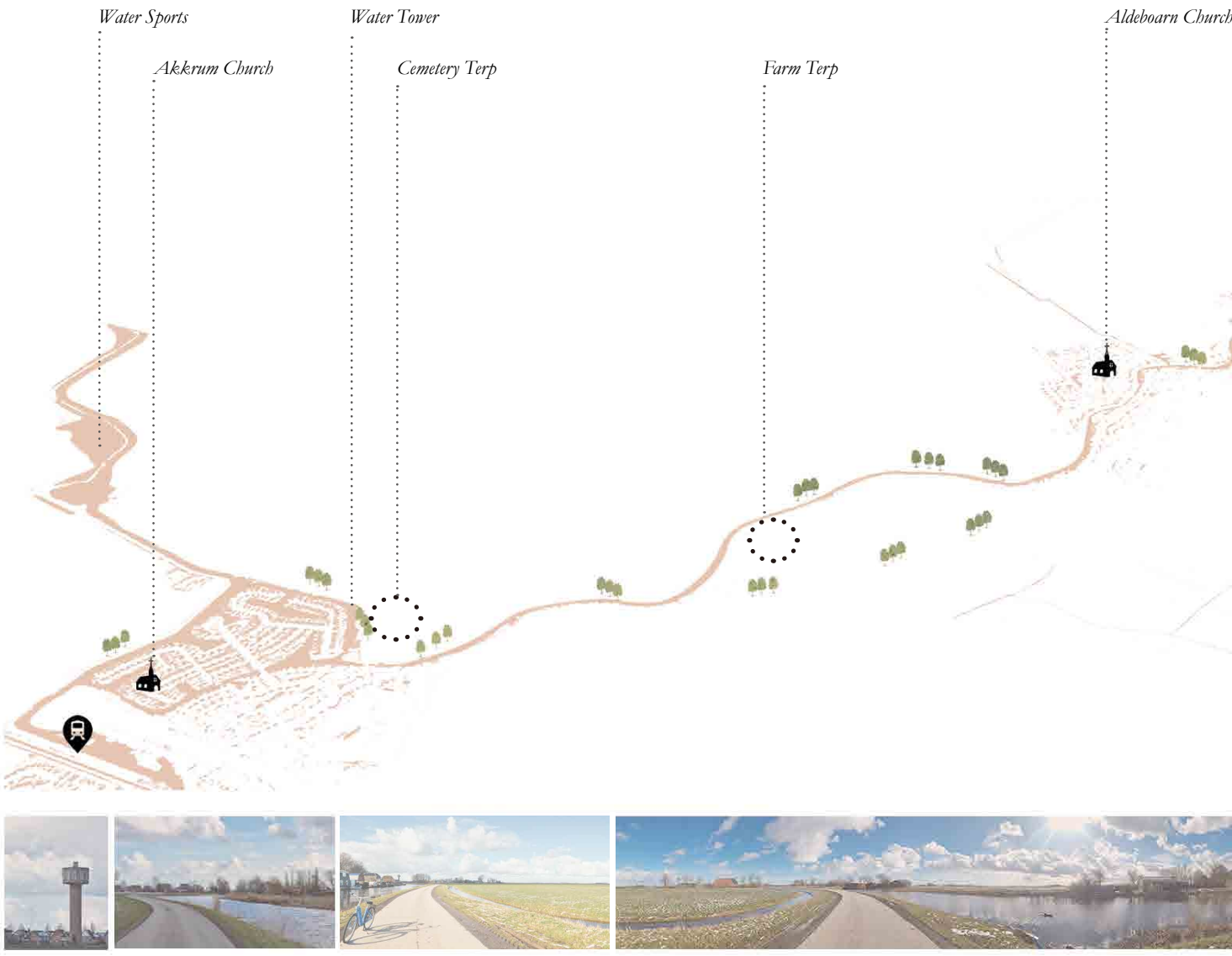
Water Purification
Dairy A

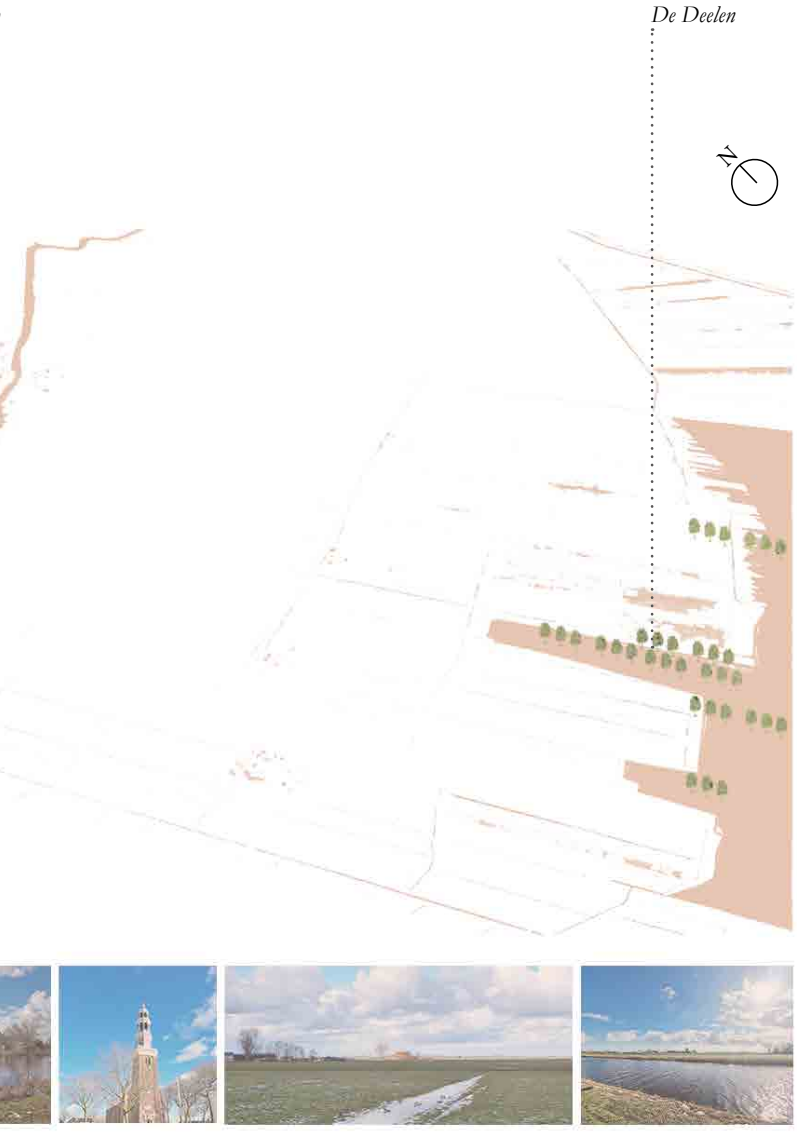
Terps
tural Route
ural Routes
Clay Soil
n Wetlands
Agriculture

Views



Cultural Routing

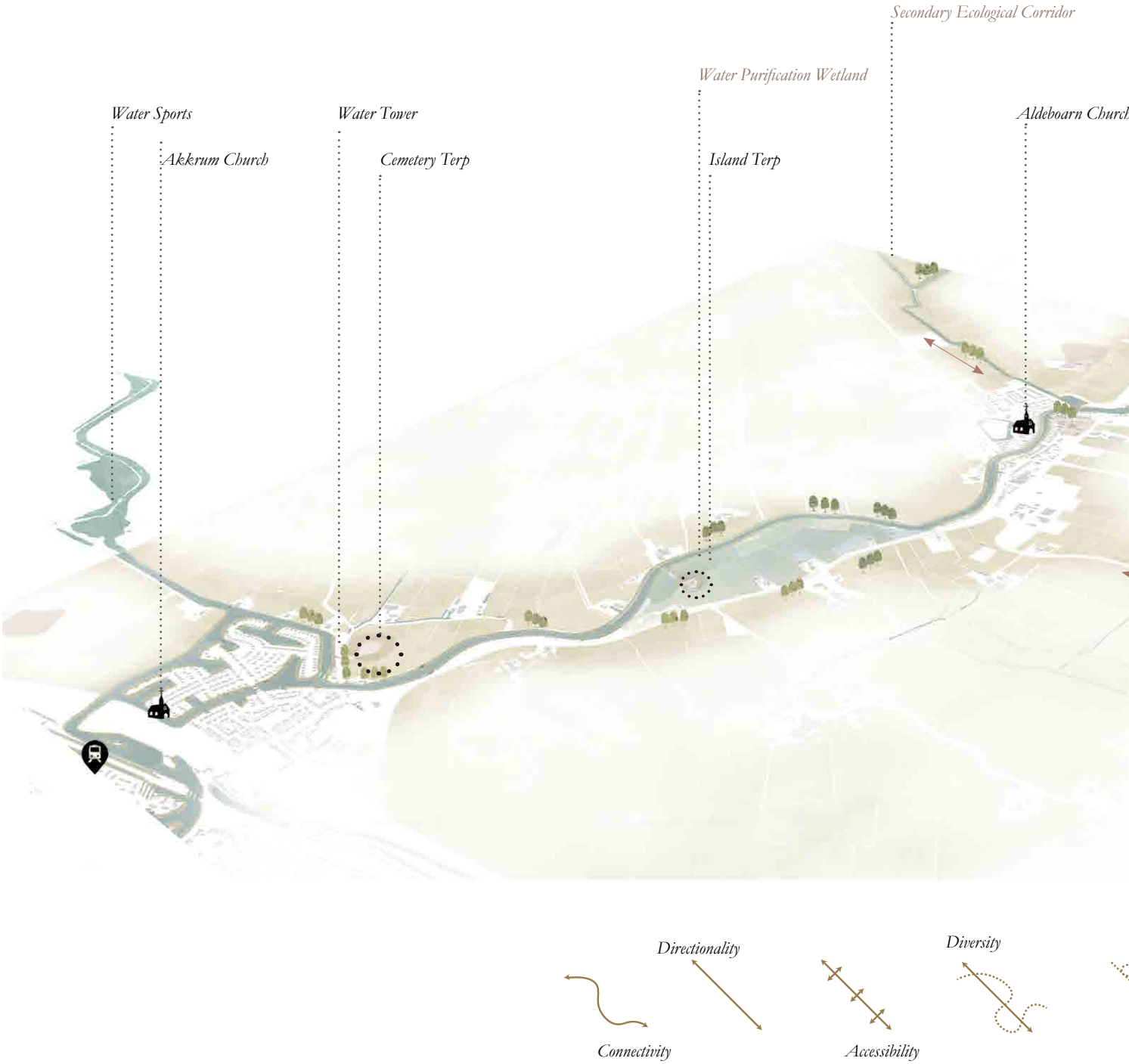


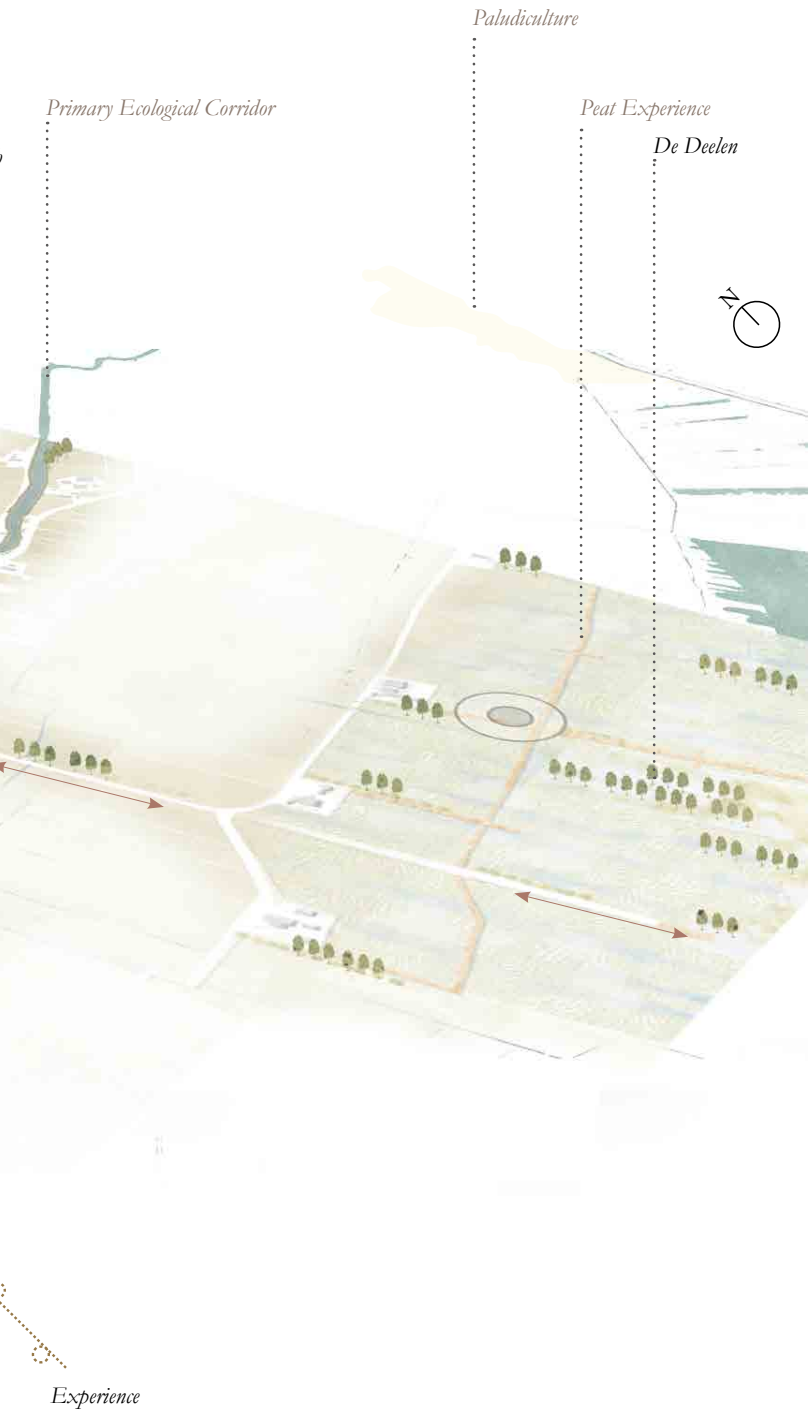


The Frisian cultural landscape could be attributed to its unique geomorphological formation that dictated the development of early livelihoods in Friesland. As the majority of pioneer settlers preferred arable clay soils the traces of terps are still very much visible in the clay belt of the site. Akkrum, Grou, Jirnsum, and Aldeboarn emerged in the landscape as settlers merged terps as the landscape progressively lost its dynamic properties. The current cultural landscape is under a threat of homogenization, as the largely standardized and highly unsustainable modern agricultural practices are competing for more land.

The proposal suggests strengthening the cultural landscape by reconnecting fragmented cultural traces and by re-establishing through increased connectivity and diversity of experiences the relationship of the residents and visitors with the landscape. The clay soil belt of the site is taken as a cultural backbone that reconnects independent interventions and unites the diversity of enhanced experiences in the landscape. As the clay-infused peat soils experience significantly lower oxidation, the agricultural practices remain more or less the same preserving the livelihoods of the local farmers. The clay soils are much more suitable for the establishment of a wetlands purification network, which is a highly necessary intervention for the provision and distribution of high water quality in the region. The wetland purification network acts as a newly established people nature, the goal of which is to bring a new diverse experiential site into the area.

Cultural Routing 2035





During the site to Akkum and Aldeboarn, I noticed that the site is heavily fragmented and lacks experiential landscape diversity. Major visual landscape nodes are the water tower in Akkrum which has been converted into a hotel and a church in Aldeboarn. Unfortunately, although De Deelenis located very close to Aldeboarn it is not accessible to the public from the site unless people travel to the South of De Deelen, which is estimated to be at least a 40-minute travel time. The cultural landscape is under great threat of homogenization.

I have noticed great potential in the landscape to strengthen the cultural traces and reconnect them with one another. By increasing connectivity and accessibility of the site whilst providing a clear sense of direction through establishing a diverse sense of experiences. Planting is used to create a visual and spatial sense of direction on the site whilst reconnecting individual design node interventions aiming to bring new experiences to the landscape. Therefore, Aldeboarn and Akkrum being located on the clay belt cultural backbone become central residential points and highly benefit from the newly established cultural landscape.

Akkrum, Aldeboarn, 2023.
Photo: Google Earth.

People Nature

Dual Constructed Wetland

0 100m 200m N

The people nature wetland uses the existing landscape structure and creates a double wetland system in which the water is purified in both directions. The goal of the wetland is to purify the low-quality water and to provide a new experience for the people residing in Akkrum and Aldeboarn. The farms currently located on the site are expected to transition into an agritourism economy and support local tourism development. The farms will become central hubs for lodging and unique wetland/ water experience outside of the two towns.

Tertiary Ecological Corridors
Diverse Pastures

Primary Ecological Corridor

Terp Farm

Water Purification
Agrotourism
Recreation

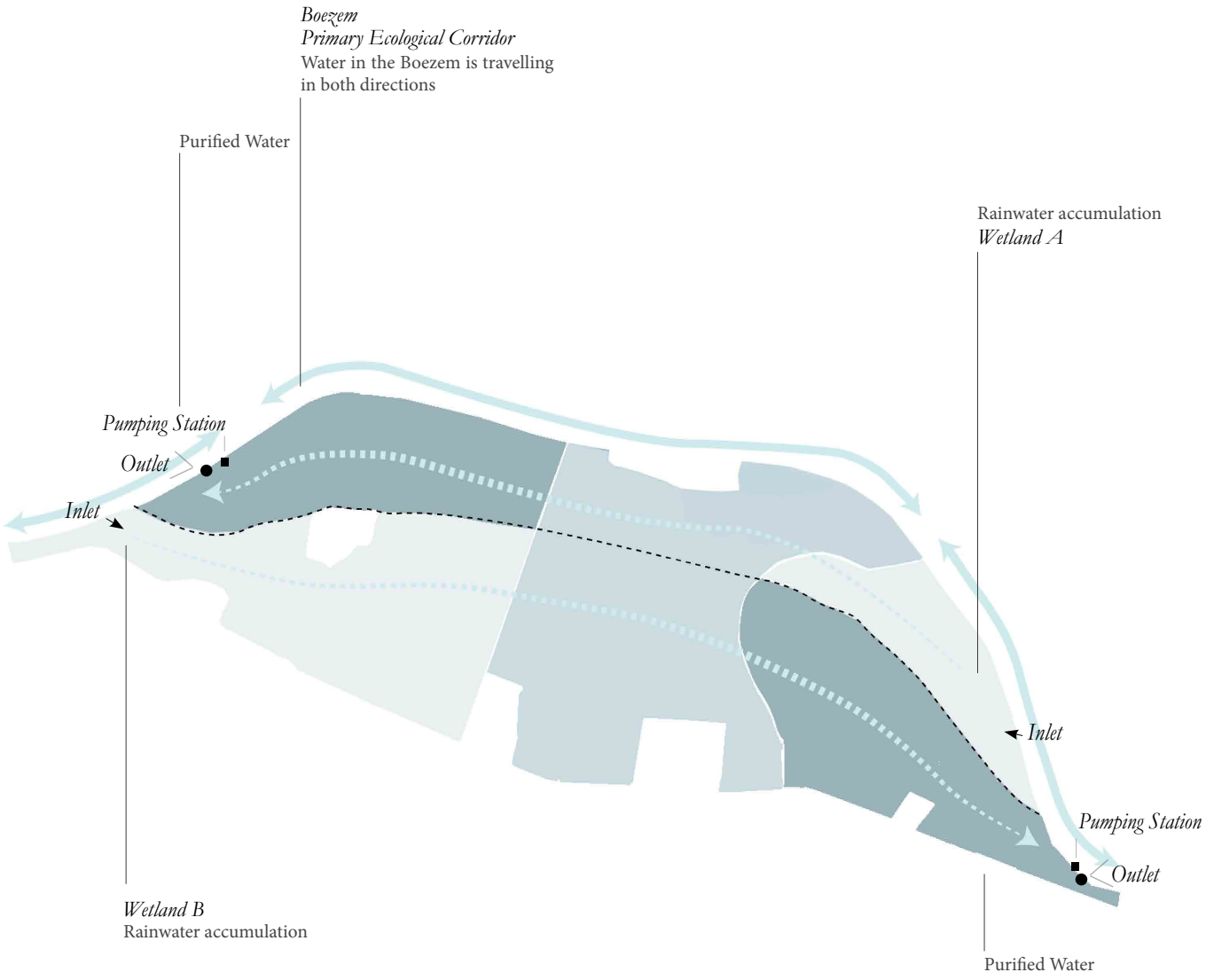
Oregon USA, 2012.
Photo: Gary Austin.

Columbia Missouri USA, 2012.
Photo: Gary Austin.

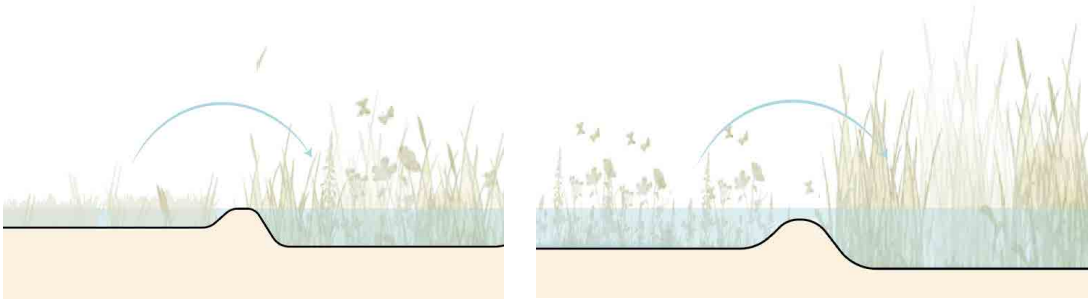
Ontario Canada, 2019.
Photo: Jael Batty.

People Nature

Dual Constructed Wetland



The wetlands use the existing natural landscape pattern for defining the wetland boundaries. Palimpsest is an important tool in ensuring landscape cohesiveness and the preservation of cultural patterns and traces. The two wetlands use clay mounts for creating physical boundaries between different water depths that are created through gentle soil excavation. Clay has low permeability and therefore is suitable for such construction.

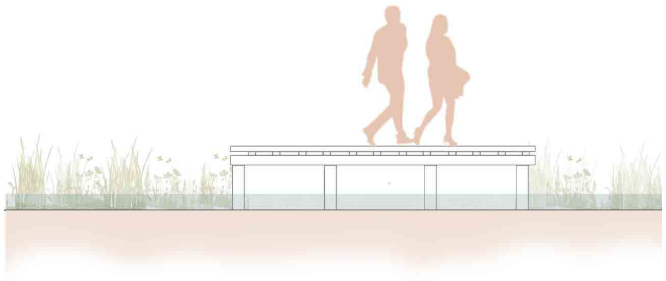


Schematic Diagram

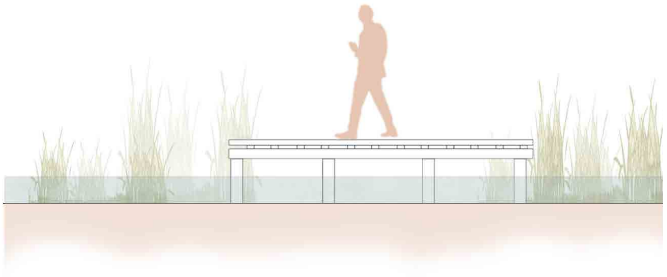
People Nature

Water Depths

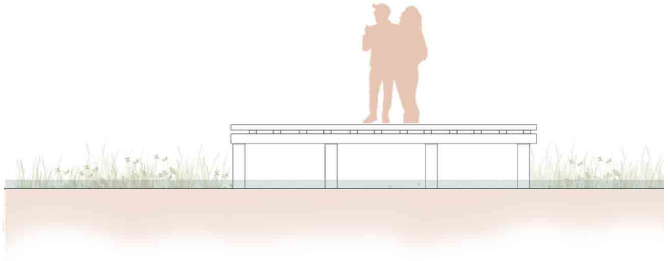
Native to Friesland plants that tolerate different water levels and thrive in clay soil were used in the design. Three main water levels define the two constructed wetlands: the catchment area equating to 0-10cm, the processing area equating to 10-20 cm, and release area equating to 20-30 cm. People Nature is imitating natural wetland conditions and, therefore, becomes a visually appealing new destination for people to come to.



10-20cm



20-30cm



0 - 10cm

Iris pseudocaris

Nasturtium officinale

Mentha aquatica

Phragmites australis

Schoenoplectus lacustris

Typha latifolia

Callitriche spp

Veronica beccabunga

Equisetum fluviatile

Reflection

One of the reasons for choosing the "Water landscapes of crisis and hope" graduation lab led by Laura Cipriani was my personal fascination with the landscape, fascination with its vulnerabilities and opportunities. Participating in the lab has allowed me to grow as an individual and professional, as I believe it was a great opportunity to strengthen my landscape research and design skills.

Research and Analysis

One of the first challenges I faced during the beginning of my thesis is navigating myself through the vast data and information regarding Wadden Sea and refining my project topic. The Theory and Methodology elective that went hand in hand with the thesis production at the beginning of the academic year has allowed me to be more specific and selective about what I can achieve and how. "Theory in Landscape Architecture" edited and compiled by Simon Swaffield was of immense help in beginning to understand the variety of theoretical approaches in landscape architecture. The beginning of the academic year has also involved a GIS training workshop as part of the Visualisation elective, which allowed me to better navigate myself in the Dutch and European GIS data resources. The electives became a stepping stone in my thesis's research process and development. As I further refined my research topic, Friesland's ruralities sparked the most interest and curiosity. Frisian ruralities have been largely politicized with the governmental desire to reduce CO2 and Nitrogen emissions, especially near Natura 2000 areas, and to tackle the immense impacts the agricultural industry brings to the table. Friesland's social, environmental, cultural, and climatic vulnerabilities in the context of past, present and future have been at the core of my research analysis, during which the threats and opportunities of agriculture have been explored.

Research and Design

As I have determined to focus on the peatlands of Friesland for the design assignment, one of the most climatically sensitive areas in the province and Wadden coast, shifting from research to design became another challenge. The "Water Landscapes of Crisis and Hope" highly values and pushes its participants for a site-specific approach, involving communication with the local stakeholders and understanding the local context, intricacies and nuances. The graduation lab incentivizes and pushes the participants to design for a specific site. I have decided to focus my design on the peatland heart of Friesland, an area enclosed by four Natura 2000 areas De Deelen, Alde Feanen, Van Oordt's Mersken, and Sneekermeergebied and announced to transition in nitrogen reductions.

The area contains a clay soil belt that concentrates most of the historical traces and heavily subsides and oxidizes peatlands. Severe water and soil management in the area in favor of the current dairy and monoculture farming create multiple conflicts and raise political tension. Part of the design process is to communicate different scenario outcomes in 100 years during which different possibilities regarding agriculture are explored: no peat scenario in which the current trends continue with no change that results in severe water shortages in the future, complete abolishment of the current productive properties of the landscape in which water acceptance will have an impact on the existing urban fabrics and a middle ground scenario, in which the water, soil, and nature are carefully managed in preparation for the future climatic changes. Development of 3 types of nature (carbon banks, paludiculture productive belts, and people nature) by 2035 to change the direction in which the ruralities of Friesland are heading to transition the peatscapes into becoming more resilient. Creating ecological water corridors, peat restoration buffer zones, and a water purifying network while strengthening the region's ecological and cultural values is the design's primary goal for the future resilience of the Frisian peat ruralities.

Graduation topic, Studio topic, and Master track

The graduation project is part of the "Water Landscapes of Crisis and Hope" led by Laura Cipriani, focusing on the Wadden Sea Regional landscape. It is part of the Landscape architecture track Flowscapes graduation studio. The graduation lab aims to envision an alternative future for the region, facing great uncertainty despite the UNESCO world heritage recognition (Laura Cipriani, 2022). The Flowscapes Studio "explores spatial, societal, and environmental issues by design research and research by design" (Flowscapes guide, 2022). My thesis project, focusing on the Frisian peat ruralities, aims to tackle the Peatscape vulnerabilities highly impacted by unsustainable agricultural practices and envision an alternative future for the agriscape of Friesland. As landscape architecture is a study of nurturing natural and built environments, the graduation project envisions a new future in which productive landscape properties not only mitigate and adapt to climatic changes but bring new ecoservices and support the development of natural (carbon) banks over time contributing towards regional resilience.

Graduation topic, Studio topic, and Master track

I see the graduation project as a site-specific reflection of the peat restoration and preservation in Friesland, Netherlands, in close relation to climate change.

As the former UN secretary general Ban Ki Moon said (2015) that we are the last generation that can end climate change, I believe that as a society, we have the responsibility to change the way we live and exist for the preservation of our vulnerable natural environment and ecosystems for our future generations. The graduation project aims to tackle the productive landscape's environmental, social, cultural, and climatic vulnerabilities for its resilient future.

Ethical Issues and Dilemmas

Despite the attempt to re-envision the future of agricultural landscape in Frisian peatscapes and its focus on natural processes such as soil subsidence and peat oxidation, the graduation project only touches very lightly other climatic impacts that the Wadden Sea is likely to face over time: sea level rise and salinization, which also have a significant impact on productive agricultural properties of the landscape. While the graduation project envisions the future of agriculture on multiple scales, it does not cover the scope of all agriculture-related climatic issues. Therefore, it provides a significantly more focused view of the issues of peatlands and leaves the rest for a generic interpretation and imagination. The decision to bring such focus onto the graduation project came due to increasing time pressure and a desire to fulfill the design assignment. Another ethical dilemma I see in the graduation project is the question of whether I have fully considered farmers' views in my proposal as the local stakeholders that were involved in the project were all of the managerial positions, and despite being very empathetic of farmers' struggles majorly leaned towards to what is deemed a more sustainable future, which involves major changes in the current farming model. The stakeholders that contribute to the design decisions should be chosen carefully.

Feedback and Response

I have noticed within myself and how this graduation project was driven that I have a greater sense of social issues and often use the social aspect to find motivation and inspiration behind my design. I have especially struggled to refine the topic and direction that my thesis should go to, however, with the great support of Laura Cipriani and Diego Sepulveda, who have kindly guided me through the research and design processes, I have found a better narrative for my thesis. The feedback has also actively encouraged me to pursue a site-specific approach, in which site-driven solutions and inspirations were taken.

Limitations, lessons, and recommendations

My graduation project underwent great changes from a singularly cultural

approach in which I've attempted to find inspiration in the shift in agriculture and focus on climate change and peatlands. The past 8 months have been quite a journey in so many ways. If I had attempted the project once again, I would have tried to focus on a narrative and storyline from the very beginning as it is a base for moving down the scale and ensuring that goals and strategies in the project all follow the same storyline.

Final thoughts

The past 8 months have been one of the most academically challenging times of my education career. It has been a huge learning curve in my academic journey. This is my first time doing a project over such a large time frame and relying solely on my motivation and inspiration for completing this assignment versus the usual design studios, during which group projects and teamwork are of a very high value. I am very grateful, especially to Laura Cipriani and Diego Sepulveda, for supporting me during my graduation project and providing me with their immense assistance, guidance, and support. Their generous help throughout this journey, especially during the year of uncertainty, has allowed me to feel more confident and navigate myself through such an important part of an architects' education career - graduation thesis.

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