Land and Farmers Equilibrium

Restoring balance between land and human in northern Friesland

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Terp Jannum.
Photo: Author, 2022.

There, at intervals of twice every day and night, with a stupendous gait, moves the outflowing Ocean over immeasurable expanses, covering what is a shoreless discussion of nature, and ***(it remains) doubtful whether it is part of the land or of the sea. .***

There, a pitiful people, they sit on high humps or "podiums," built with their own hands to where, in their experience, the highest tide reaches. With their houses set upon them, they resemble sailors when the water covers the area, but castaways when the water has receded*, and round their huts they hunt for fish that flee with the sea.*

Plinius, Naturalis Historia, (23—79 A.D.)



Outer dike salt marsh.
Photo: Author, 2022.

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Abstract

The agricultural landscape in the Netherlands has changed drastically over the course of the last 70 years. After World War II, it was governmental policy that pushed the transition to intensive farming by giving out subsidies. These developments have also had an impact on the province of Friesland, where agriculture has a long history and is thereby embedded in the province's landscape identity. However, years of scaling up have caused a loss of small-scale structures in the landscape. The result is not only the disappearance of a historic cultural landscape but also the rapid decline of a biodiversity. Fertilisers and pesticides are the two biggest polluters of Dutch surface water, both secondary effects of intensive agriculture. Today, the balance between ecology, the landscape and intensive agricultural practice is lost.

This thesis has two main objectives. First a study, to understand the agricultural developments that have taken place since World War II in the Netherlands and specifically Friesland. This study will examine the effects these developments have on ecology, social structures, and the cultural heritage found throughout Friesland. Secondly, a research-by-design assignment aims to find a solution to how a new balance between agriculture, ecology and the landscape can be found through design. Three strategies are developed which are emphasising cultural-historical structures, strengthening ecological values and working with the vernacular.

The strategies are implemented on a regional scale in Friesland and on a local scale in dialogue with a local farmer.

Through various scales, ecological corridors are strengthened in the area by introducing nature-friendly banks along waterways. These ecological corridors will connect routes on both land and water with cultural-historical structures in the area. In addition, a small-scale farmers' nature network is implemented. On a local scale, a water-purifying helophyte field will be constructed which filters agricultural water run-off before it discharges into a local waterway.

This project can serve as a reference to how we can move towards a newfound balance between ecology, the landscape and agricultural practice in the Netherlands.

Keywords:

#nature-inclusive agriculture
#northern Friesland
#cultural heritage
#ecological corridors
#social structures

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Introduction

Introduction

Agriculture is a practice that is very characteristic of the Frisian landscape and is embedded in its history. The historic terp-landscape, a relic when the sea largely had free reign over most parts of the province is linked to the agricultural history. Cattle grazed on the plains when the sea had temporarily retreated, and gradually people began to grow crops on the fertile creek ridges. To this day, a large part of Friesland is made up of dairy farming. Crops are still primarily cultivated along the coast. Many remnants of this rich history can still be found in the landscape. During a visit to the province, suddenly you might find yourself confronted with a thirteenth-century church. Adding to the rich history of the area is a sense of silence and tranquillity, as if time stood still.

However, time has hardly stood still in Friesland, especially in the past 70 years. After the Second World War, agricultural policies have been set in place, driven by the government, to ensure a steady food supply. This spur up the upscaling of farms, whom many have been small-scale until then. The usage of the landscape became more and more efficient, and yields increased. Small-scale structures in the landscape were increasingly lost as a result, and the waste of industrial upscaling ended up in the surface water. This has had a detrimental effect on biodiversity. There are fewer places for nature to take its course, e.g. for animals to hide. Also, the well-known meadow birds in Friesland suffer, an animal species that the Frisians hold dear. In addition to the effects on the landscape there is an ever increasing disconnect between

farmers and consumers. The number of middleman inbetween harvest and the time the produce reaches the designated households has increased a lot. Most consumers nowadays do not know where their food comes from, let alone have any knowledge of the embedded labour. In addition, due to pressure from wholesalers and their efforts to increase their profits the farmers are left with small profit margins. With these small margins the farmers ability to invest, in for example making their business more sustainable is limited. The balance between landscape, ecology and agricultural practice is lost. Luckily this is not the case for all farmers, there are also farmers in Friesland who do things differently. They strive to be involved in nature-inclusive farming, a farming practice in which people farm together with natural processes. Their way of organizing the agricultural practice is increasing biodiversity.

This thesis examines how, together with nature-inclusive agriculture, the relationship between landscape, ecology and agricultural practice can be brought into balance again. This thesis combines an analytical study with a research-by-design assignment. First, the agricultural practice in Friesland and the cultural-historical landscape are studied. Then the state of nature in the province will be examined, and finally the social structures related to agriculture are being looked at. Three strategies will be developed, which will be translated into a design. Through this process, a site-based approach is used where local inhabitants are seen as the experts of the area.





Young milkcow at Hans Kroodsma's farm.
Image: Author, 2022.

Methodology

Research by design approach



Small waterway along agricultural fields.
Photo: Author, 2022.

In this chapter, the backbone of the thesis will be elaborated upon. It is first relevant to outline the problem statement, which includes three themes related to agriculture: its economic, ecological, and cultural effects on the landscape. The thesis argues that a balance has been lost between these three factors and agriculture, hence the thesis' research question. After the research question and sub-questions, the research objectives will be defined. Research strategies include desk research, mapping processes, exploring site-specific knowledge in the field and talking with stakeholders. Parallel and integrated with this, a research-by-design is carried out. Lastly, the theoretical framework will be explained, focusing on nature-inclusive agriculture and its four components.

Problem statement

When investigating the subject of agriculture, problems arise with the effects of contemporary agricultural practice on the surrounding landscape and the environment. Despite agriculture being a culturally rich activity, where farms have been in families for decades and farms have passed from fathers to sons and daughters, the practice has changed as a result of government influence, subsidies, and globalization. Changes are rapidly increasing the impact of farming on the environment. It appears that the balance between agricultural practice, ecology, and topography has been lost.

The problem statement can be subdivided into three themes. The three themes are economic, ecological and cultural as translated through the landscape.

Economy_ Agriculture practice has evolved through numerous developments since the rebuilding after the second world war. It has become more efficient and is targeting higher yields. In order to compete in the global market, farmers will have to keep scaling up. After the abolishment of the milk quota in 2015, the number of cows in the Netherlands shot up while the number of farms fell down (CBS, 2021). Although upscaling in economic terms seems to be of high interest it also brings risk. Other countries such as China are also rapidly expanding their milk production which can destabilize milk prices and put Dutch farmers in a vulnerable position, especially regarding the big

investments that are involved in scaling up farms (Moai Fryslân, 2014). In the meantime, banks that provide financing for expansions see upscaling as a lucrative activity. Decreasing farm activity, for example, moving towards a biological farming practice, is not seen as lucrative by banks, as they do not see this as a viable economic model yet (van den Berg & Hotse Smit, 2022).

Ecology_ The agriculture system has a big impact on the ecological qualities of water, nature and agricultural lands in the Netherlands. The agricultural system is also under pressure due to climate change and is under the threat of salinization.

The surface water quality in the Netherlands has been decreasing for many decades and is classified as being bad to not sufficient (Compendium voor de Leefomgeving, 2020). The two biggest causes for the degrading of the quality of surface water are excessive use of fertilizer and manure (Natuur en Milieu, 2019). The phosphor and nitrogen surplus has increased in recent years due to droughts in summers. When washed out into the surface water, it can decrease biodiversity and this leads to numerous problems. Also, when phosphor and nitrogen infiltrate into the ground, they can affect the quality of drinking water (RIVM, 2020).

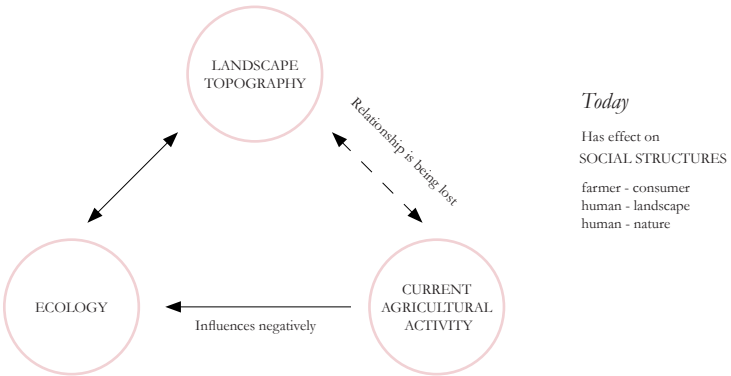
On top of this pollution, biodiversity on agricultural land is at a record low due to the monoculture nature of contemporary agricultural practice (Wageningen University & Research, 2017). This leads to decreasing soil quality, which affects agricultural practice in the long run negatively. Also

experiential qualities in the landscape decrease. For example, there has been a 40 percent drop in the number of meadow birds since 1990 (Bouma, 2019).

Focusing on Friesland, the coastal area of Friesland is facing the risk of salinization. In this area, a lot of potato farmers are located on the fertile grounds of old creek ridges. Salinization occurs because of two main reasons. First of all, by constantly pumping water out of the polders, salty ground water finds its way up. Secondly, due to rising sea levels, the contact area for salt water to infiltrate is getting progressively larger, which is a development which will keep increasing due to climate change (Rijkswaterstaat, 2021).

Culture_ Upscaling and focusing on the highest yields have also influenced the journey from farmland to the consumer's plate. Consumers and farmers have become more and more disconnected from each other, affecting their relationship. The changes to which the landscape is subject also alter the relationship humans have to the farm landscape and the relationships between humans and nature.

These trends have had a direct impact on the landscape and the identity of the Frisian landscape. Upscaling as a result of globalization is drastically changing the landscape in Friesland. Allotments are merged and larger cowsheds are built, affecting the sight lines in the landscape. (Kernteam De Nije Pleats in Fryslân, 2009). This has an effect on how the landscape is perceived and threatens a loss of identity, as small-scale historical structures fade away.



Although these problems are present, agriculture in Friesland is a cultural-rich activity which dates back to the first settlements of the terps around 500 B.C. It is an activity which gives the province its identity, and its wide grasslands a characteristic destination for tourists.

Therefore, this thesis is titled "Land and Farmers Equilibrium". How can a renewed balance be found in Friesland between agricultural practice, ecology and the landscape topography?





The Wadden Sea at ebb.
Photo: Author, 2022.

Research Questions

How can a new balance be found between agricultural practice, ecology and the landscape in the northern province of Friesland?

Research Objectives

Sub-questions:

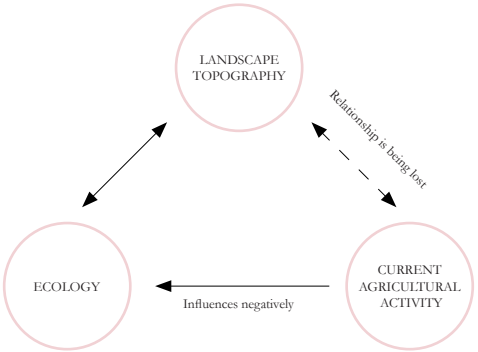
_How is current agricultural practice organized in Friesland and what is its history?

_What cultural heritage can be found in the province related to agriculture?

_What effect does current agricultural practice have on ecology and landscape topography?

_How are social and economic structures related to agriculture organized?

_How can a new balance between agriculture, ecology and the landscape be found in design?

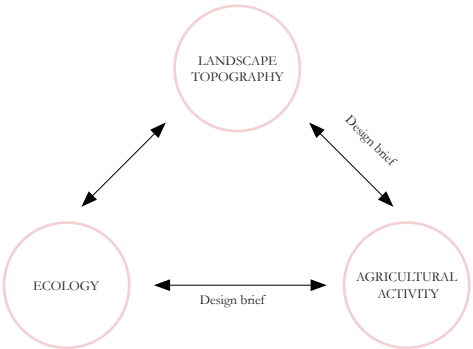


Today

Has effect on

SOCIAL STRUCTURES

farmer - consumer
human - landscape
human - nature



Tomorrow

Has effect on

SOCIAL STRUCTURES

farmer - consumer
human - landscape
human - nature

Diagram visualizing the balance that is sought in the project.
Diagram: Author, 2022.

This design assignment is aimed at creating a spatial reflection on the future of the Frisian landscape in which sustainable agriculture is the universally accepted strategy for achieving an economically, socioculturally, and ecologically viable society, by balancing agricultural practice, the landscape, and ecology.

This is done through a site-based approach where local inhabitants are seen as experts on the area, as they are both the creators and caregivers of the landscape.

Research Strategies

To be able to understand the site, its components and its people several analysing techniques were used. General knowledge about the province Friesland was derived from data in the form of (historical) maps, figures, news articles and readings about the province. PDOK and QGIS were mostly used to collect maps and data related to the research topic. The CBS provided statistics and figures on the state of affairs in the field of agriculture and economics. As Friesland is a province with a rich cultural history and landscape, numerous books were available. These included 'Vloeiend Landschap' by Peter de Ruyter and 'Friesland Vandaag' by Hans Koppen, giving rich descriptions and knowledge of the province. The province's own vision and strategy for the future of agriculture called 'de Friese Landbouwagenda 2021 - 2030' gave a relevant situational insight into the threats and opportunities for the province. The knowledge derived from the data and information provided a base to start further understanding the site.

By overlaying and combining the found data, patterns and relationships were identified. This exploration helps with further understanding the site and interpreting information. This is done using computer software, but also by tracing patterns by hand. In this way, several relationships were discovered and it gives a better feeling of the landscape. Google maps was also a useful tool, by zooming in and relating the patterns found in the landscape to knowledge by data.

To deepen site-specific knowledge, several actions were undertaken. Together with the Wadden Sea Lab, we explored the province and Leeuwarden to gain a sense of place. Driving around the landscape gave insights into the feeling of the area, and activated the senses such as hearing and site-specific scents. In Leeuwarden, we visited the provincial house of Friesland and talked with its landscape architect Stephan Smeijers and water expert Joca Janssen of the province. On another site visit, the vastness of the Wadden Sea was experienced through a visit to the island Texel and an excursion on the 'wad', called 'mudflat walking' (wadlopen). Visiting the 'Fries Landbouwmuseum' (farming museum Friesland) and the exhibitions 'ferhaal fan fryslan' and 'de terp' at the Fries Museum situated in Leeuwarden gave a further comprehension of the province's history related to agriculture, as well as the documentaries Fryslân DOK: De flecht nei it ljocht' and 'Moai Fryslân: Lânbou'.

To gain insights from local agricultural practices and people living and working at the site, the agricultural collective Waadrâne was contacted. The collective is active in the northern coastal region of the Wadden Sea. They are committed to the preservation of nature, landscape and biodiversity and work together with more than 145 members to reach their goals. Regular meetings were held with chairman Hans Kroodsma, a dairy farmer himself in Jannum, running a farm with 150 dairy cows. In these meetings, his input was

gained on agricultural practice, (economic) systems in place, nature-inclusive agriculture, cultural heritage in the area and input and reflections on the design which is situated partly on his agricultural lands. Also, a site visit to his farm was carried out and relevant site-specific documents and information was supplied. These conversations and the visit have been invaluable in better understanding the vernacular landscape and being able to work with stakeholders themselves has given enormous input to the project.

The project takes form through a 'research-by-design' method. Design is a simultaneous process along with desk research, site visits and conversations with a local farmer. This interchange will result in a design which is explored through maps, sections, details and visuals.



13th century church at terp Jannum.
Photo: Author, 2022.

Theoretical framework

In the theory of nature-inclusive agriculture, food is produced within the boundaries of nature and the environment, with a positive effect on biodiversity. It is formed by four elements that are interconnected.

1. Functional agrobiodiversity.
Functional agrobiodiversity is the enhancement of the natural ability to control pests and diseases in cultivated crops by promoting biodiversity. Healthy soils and closed cycles are fundamental to forming a functional agrobiodiversity. The soil beneath the landscape determines the form of agriculture that can be successfully practiced. A healthy soil is essential, which is able to retain and supply sufficient water and that can contribute to the supply and management of nutrients.

2. Landscape diversity
Diverse landscape elements support agrobiodiversity and habitat species. These diverse landscape elements have a double function: on the one hand, they form the basis for functional agrobiodiversity, such as pollination and pest control, and on the other hand, they form the habitat for species that are specific to the rural area.



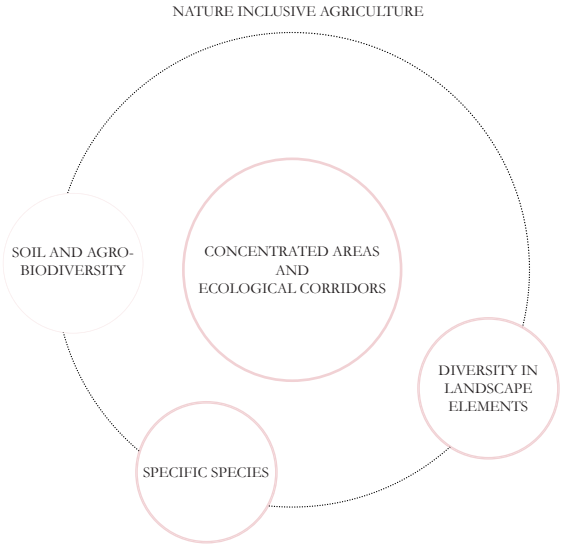
Outlook from the farm owned by Hans Kroodsma in North Friesland.
Photo: Author, 2022.

3. Stepping stones and ecological corridors to nature
Cooperation in the region to create a landscape with an interlacing green and blue network is key. Farmers, water boards, and managers of nature areas can enhance biodiversity in an area if they work together effectively. This helps in creating a firm foundation for a productive biological farm, but also for specific animal species in the area.

4. Specific species require specific measures.
Additional measures can be taken to preserve specific species. Some of these measures will be at the expense of the farm's production. For example, when mowing the grass is postponed for the benefit of meadow birds which lay their nests in grasslands during spring. A reward for this from society is then desirable.

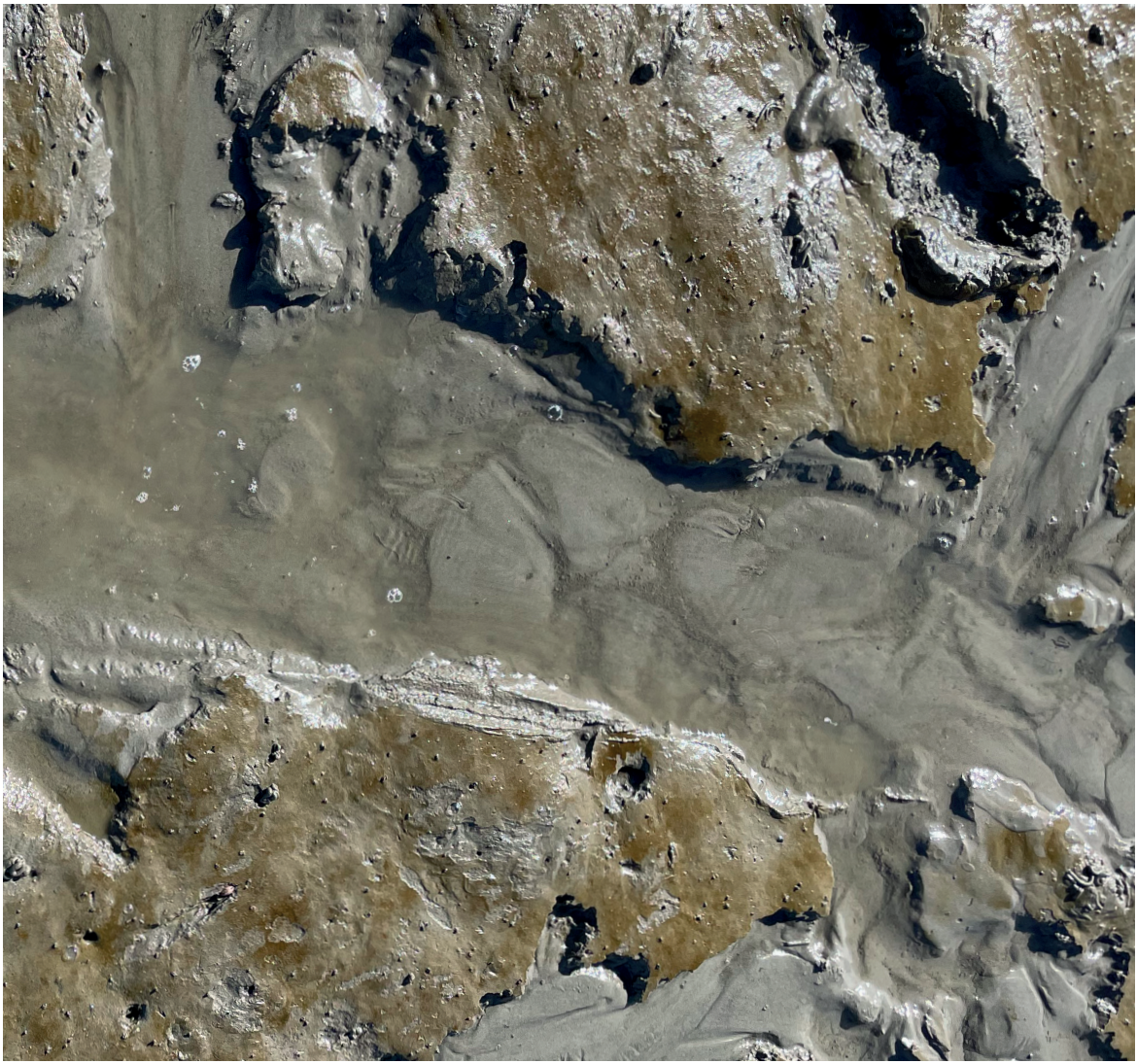
According to the theory, the cohesion between these four elements creates a robust system for agriculture and nature (Erisman & Slobbe, 2019).

In the scope of this project, three of these elements will be touched upon: Diversity in landscape elements, concentrated areas and ecological corridors and specific species. They form the basis for a resilient agricultural system, where a renewed balance is found between agriculture, the landscape and ecology.



Nature inclusive agriculture diagram.
Diagram: Erisman & Slobbe, 2019. Visual adjusted by author.





The Wadden Sea at ebb.
Photo: Author, 2022.

The productive landscape

The farm practice under pressure

This chapter focusses on the shaping of Friesland, its landuse and how the province's landscape has changed through the years.

Friesland's coastline is part of the Wadden Sea region, which stretches from the Netherlands, along Germany to Denmark. The Wadden Sea is the biggest mudflat system in the world. It has become UNESCO world heritage in 2009 and houses delicate shallow water habitats. This mud flat system has been shaped over years of geomorphological development, eventually shaping the Netherlands and after building dikes, the coastline of Friesland. This development is recognisable in the soil types that can be seen in this area. Along the coast, formations have been formed of salt marshes and river plains consisting of clay, more inland lower situated peat area and even more east the higher sandy areas. The province of Friesland is home to a wide variety of soil types.

Looking at Friesland's land use, crop production is largely concentrated on these higher clay formations. Most of the food produced here is potatoes, grains, and sugar beets. The other part of Friesland consists mainly of grasslands, which is a distinctive characteristic of the province, consisting of an open landscape with long sightlines. Here, most of these grasslands are occupied by cows. Dairy farms are highly present in Friesland and dairy farming is strongly embedded in Friesland's history. It is no surprise that the top two biggest export products from Friesland are potatoes and milk which are exported all over the world.

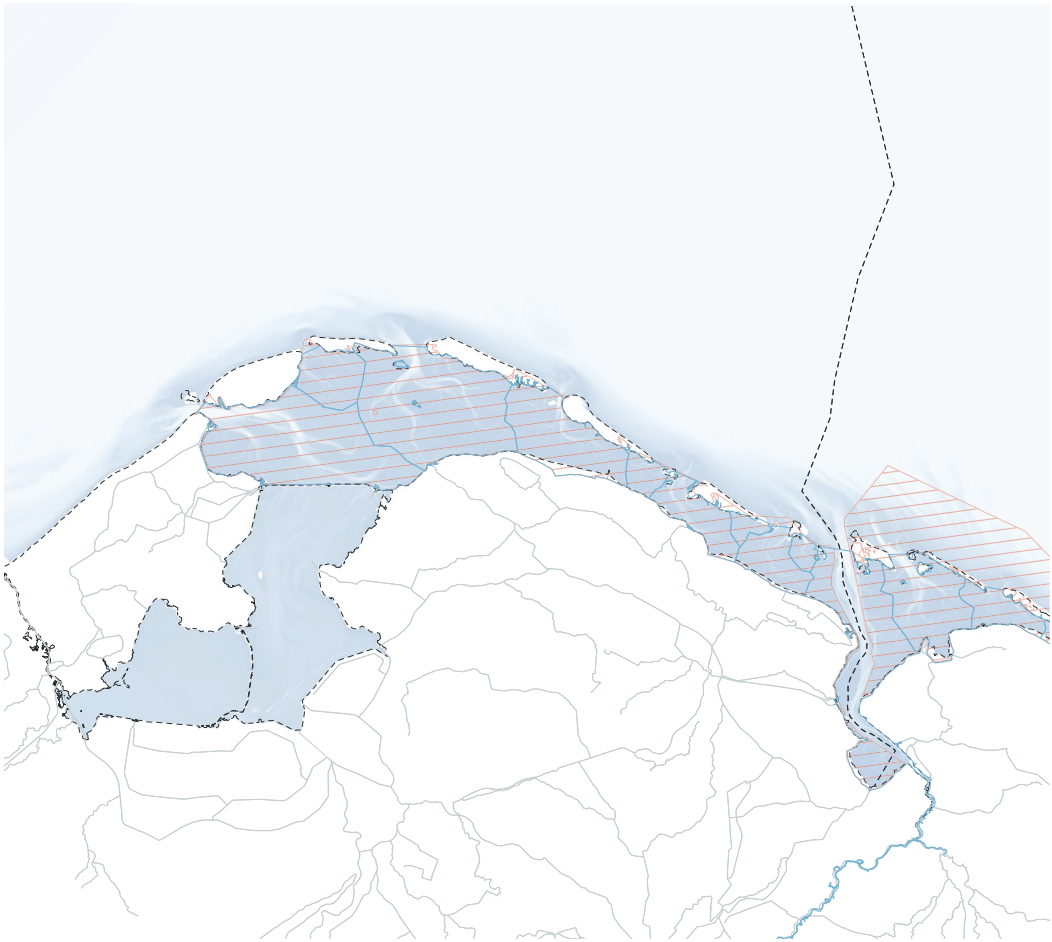
So, farming is a big part of the Frisian landscape identity. It is strongly intertwined with the national economy, politics and innovation development. But it is also more and more characterized by modernization and upscaling which is rapidly changing the landscape.

After WW2, farming was heavily subsidized to ensure that everyone had food on their plate. From this time on, a lot of developments happened rapidly. Due to the subsidies, there was enormous overproduction, which resulted in the so-called "butter mountain.". To make sure this didn't happen again, the milk quota was introduced in 1984 which worked well. With the growing global economy, dairy demand kept growing and it was announced that the milk quota would disappear. The dairy sector exploded in anticipation of the market release by upscaling their farms. The milk quota was abolished in 2015. The trend has also given rise to more expansive farms. The number of big farms in Friesland, sometimes called 'mega' farms, has grown from 61 to 112 in 7 years. This has a tremendous effect on the landscape in Friesland.

Small plots were merged to form wider meadows and crop production fields, as a result of the so-called "ruilverkaveling", which means land consolidation. Through the years this has also led to a loss of diversity in landscape elements and subsequently, in biodiversity.

The Wadden Sea

Data: UNESCO World Heritage



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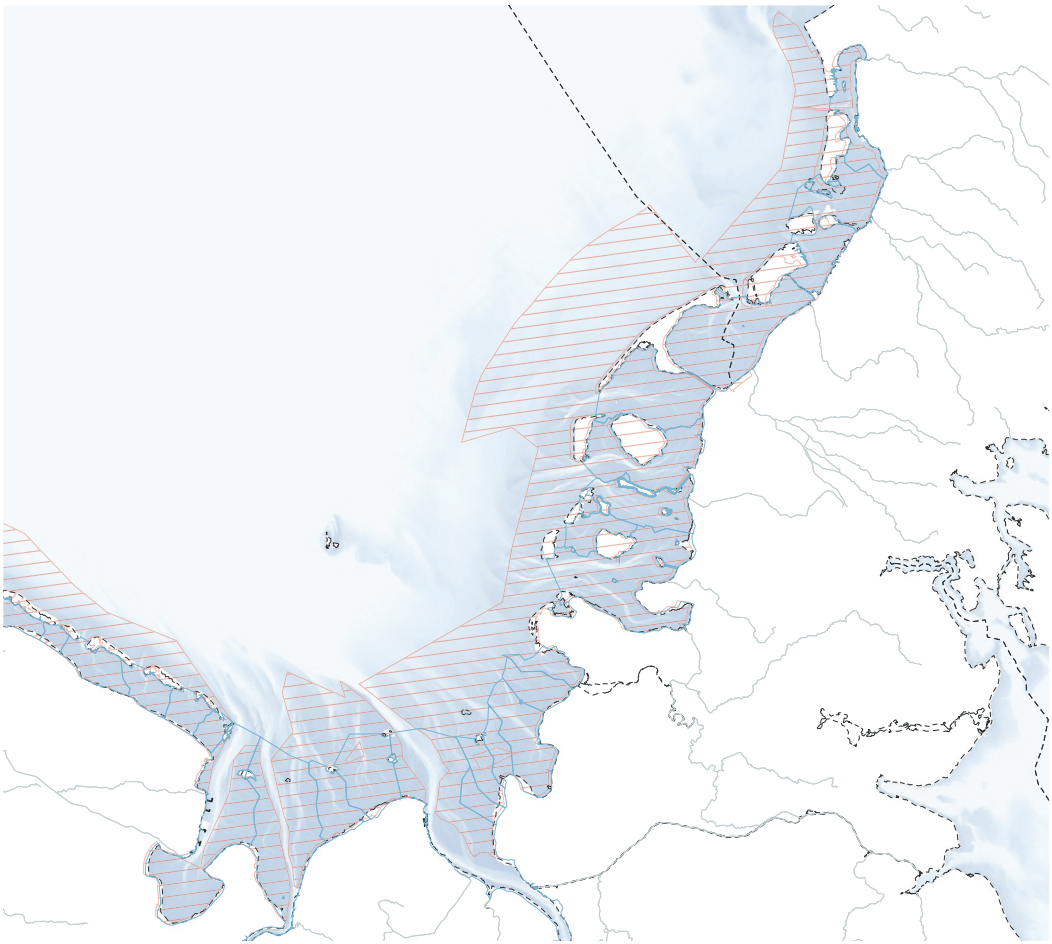


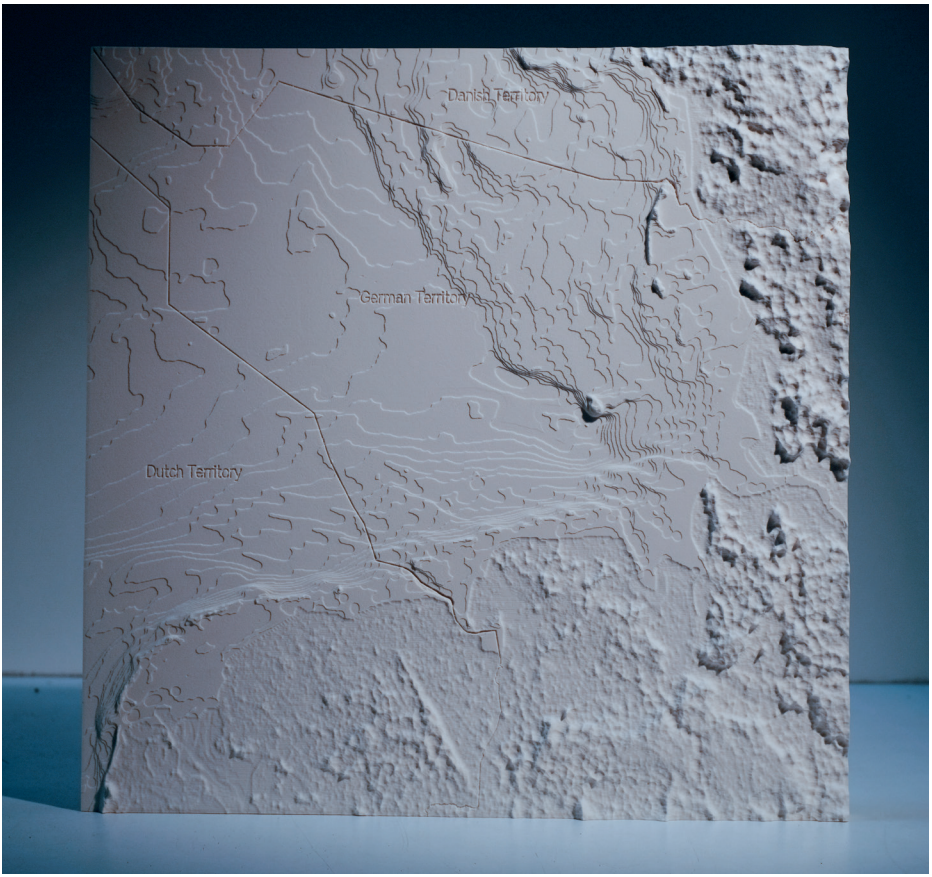
UNESCO World Heritage boundary

Main waterways

Jurisdiction boundaries

Tidal basins Wadden Sea

Territorial site model the Wadden Sea



Model of the Dutch, German and Danish Wadden Sea, horizontal scale 1:750.000, vertical scale 1:7500 (model size 500 x 500mm)
Photo: Keyan Tang, 2021. Workshop Thinking with Maps.
Students: Heather, Keyan Tang, Madelief Dekker, Hanneke Wander.
Professor: Laura Cipriani. CAMlab: Bob de Boer.

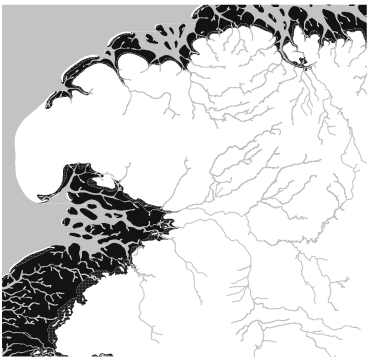
The Wadden Sea is over 500 km long, has a width of 20 km and stretches over three countries: the Netherlands, Germany and Denmark. The continuous tidal flat system of the Wadden Sea is a vast system full of ecological and hydrological processes. It is always changing and houses 39 tidal basins. These intricate interactions facilitate a multitude of habitats. Unfortunately, this vastness does not ensure the Wadden Sea's resilience. The area became an UNESCO world heritage site in 2009 (Waddenvereniging, z.d). Threats that need attention to protect the area are among others fisheries activities, industry such as oil and gas rigs, harbour development and maintenance and tourism (UNESCO, 2021).

For the moment, three countries have taken individual actions managing ecological conservation in the Wadden Sea. National parks are established in Danish and German territories, which aim to conserve natural habitats by zone division and activities regulation. For the Dutch territory, protection by Nature Conservation Act 1998, Flora and Fauna Act and Ecological Main Structure are taking place. In Dutch territory, the part of the Wadden Sea which lies between the Wadden islands and the coast falls under the province of Friesland. The sea and the land are separated by a sea dike, which illustrates the harsh boundary that has been risen between the delicate tidal area of the Wadden Sea and the land behind the dike. Water from the Frisian polders is discharged into the Wadden Sea, but its interrelation is lost. Still, people visit the sea dike and the salt marshes behind with its wide open views.

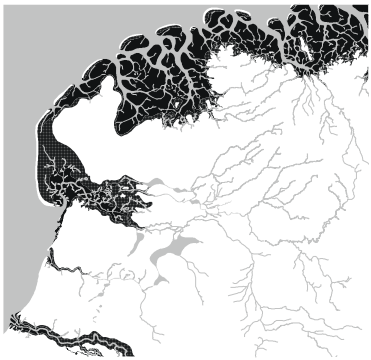
This 1:500.000 scale level model conveys the Wadden Sea's unbroken system in relation to the contemporary cultural layer added by humans.

Geomorphological development

Data: Rijksdienst voor het cultureel erfgoed, Ministerie van Onderwijs, Cultuur en Wetenschap, 2021



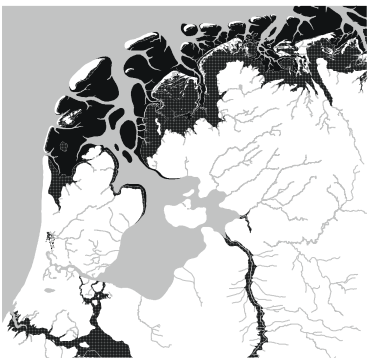
5500 B.C



2750 B.C



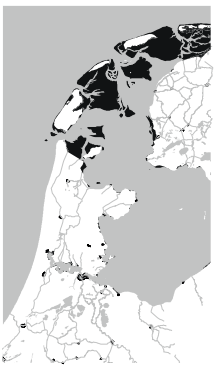
500 B.C



800 A.C



1500 A.C



1850 A.C

0 10 km 50 km 100 km

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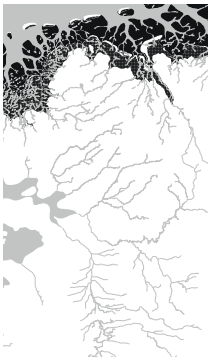
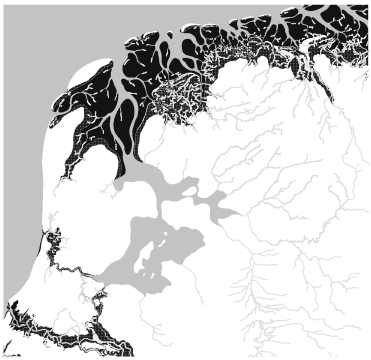
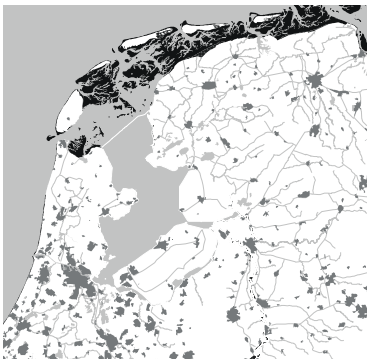




250 B.C





2000 A.C

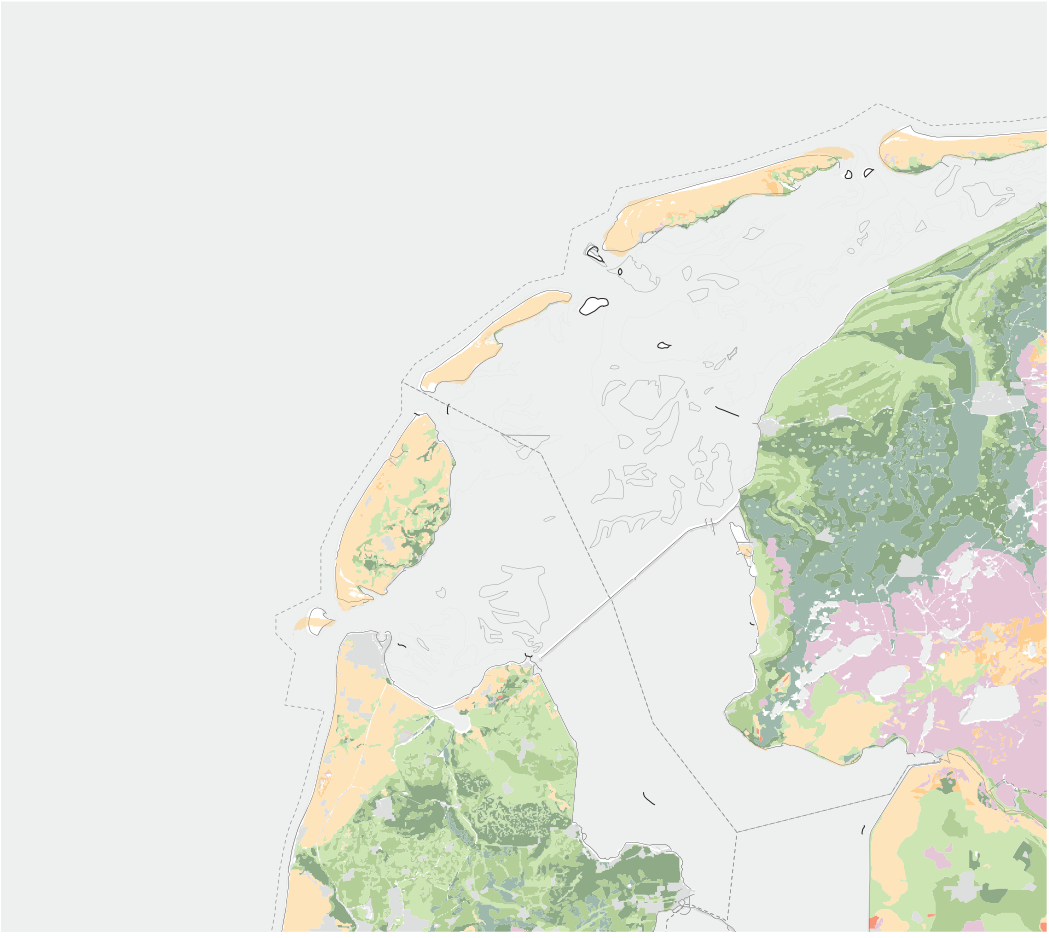
Cities
Land
Sea
Lakes & rivers
Salt marshes and river plains
Mudflats

The mud flat system of the Wadden Sea has been shaped over years of geomorphological development, eventually shaping the Netherlands and after building dikes, the coastline of Friesland.

This development is recognisable in the soil types we see in this area. Along the coast, formations have been formed of salt marshes and river plains consisting of clay, more inland there is a lower situated peat area and even more east the higher sandy areas are located. It makes up a diverse scale of soil types in one province.

Soil

Data: Grondsoortenkaart 2006, Alterra Wageningen UR



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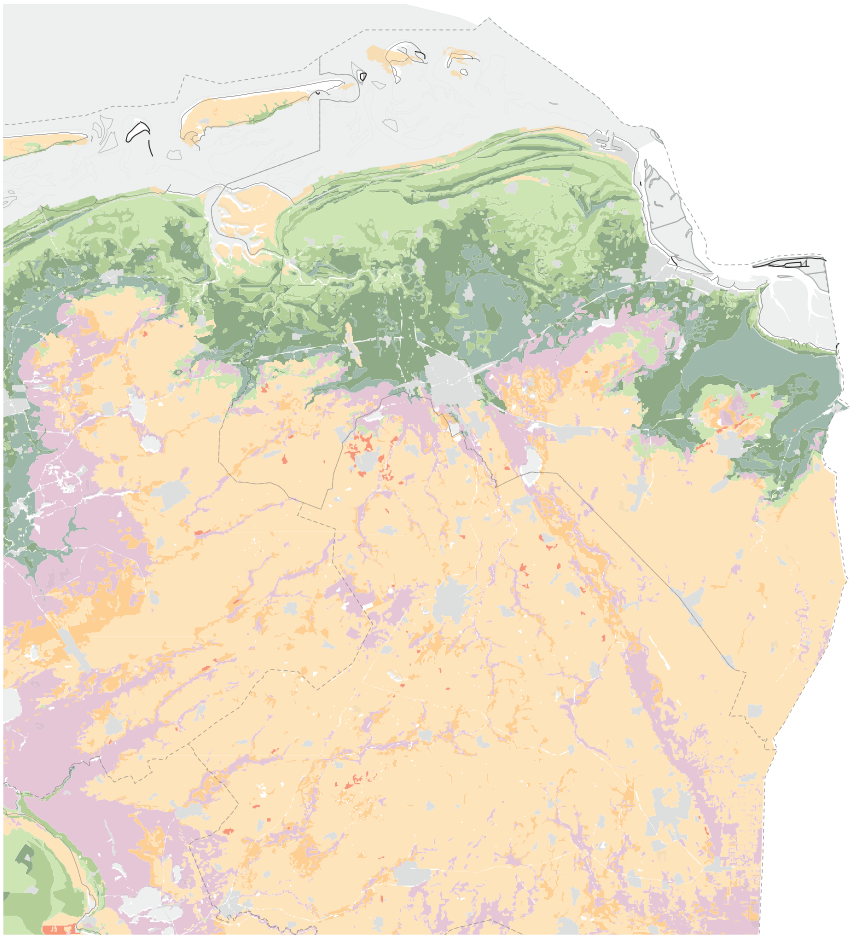
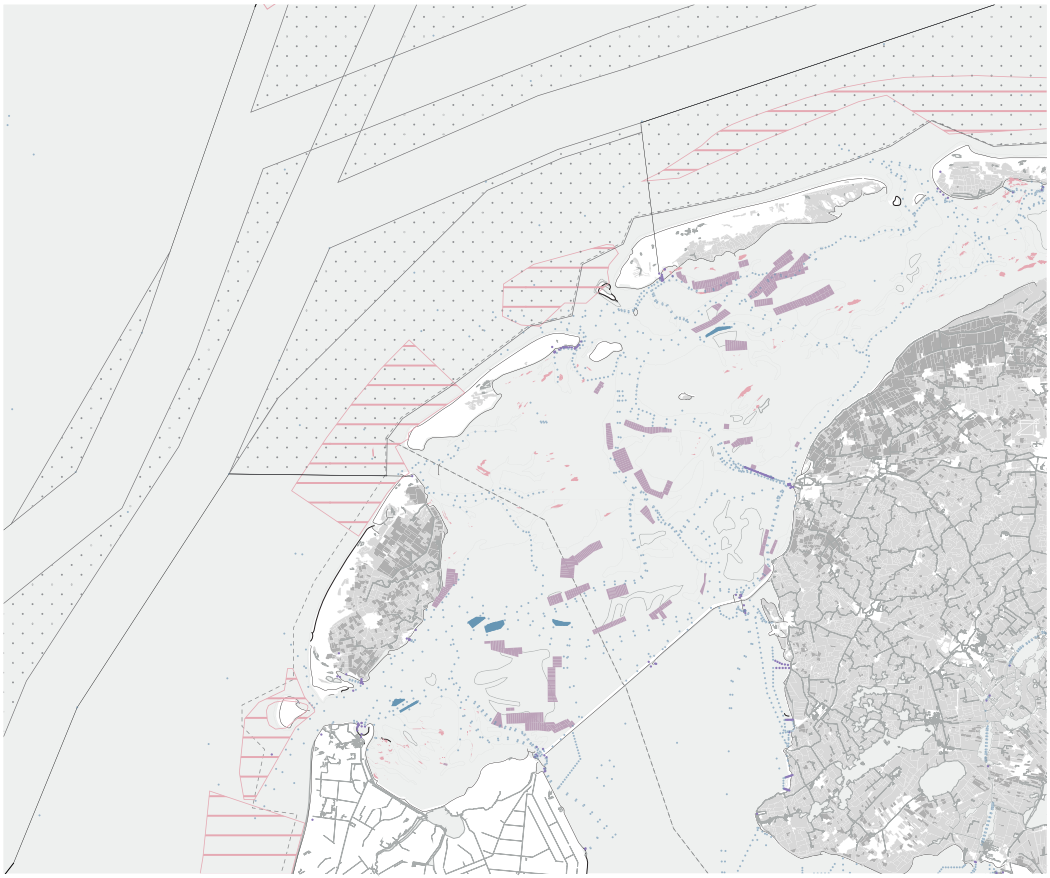


Sabulous clay
Light clay
Heavy clay
Peat
Sand

Agricultural land-use
Data: BRP Gewaspercelen, PDOK



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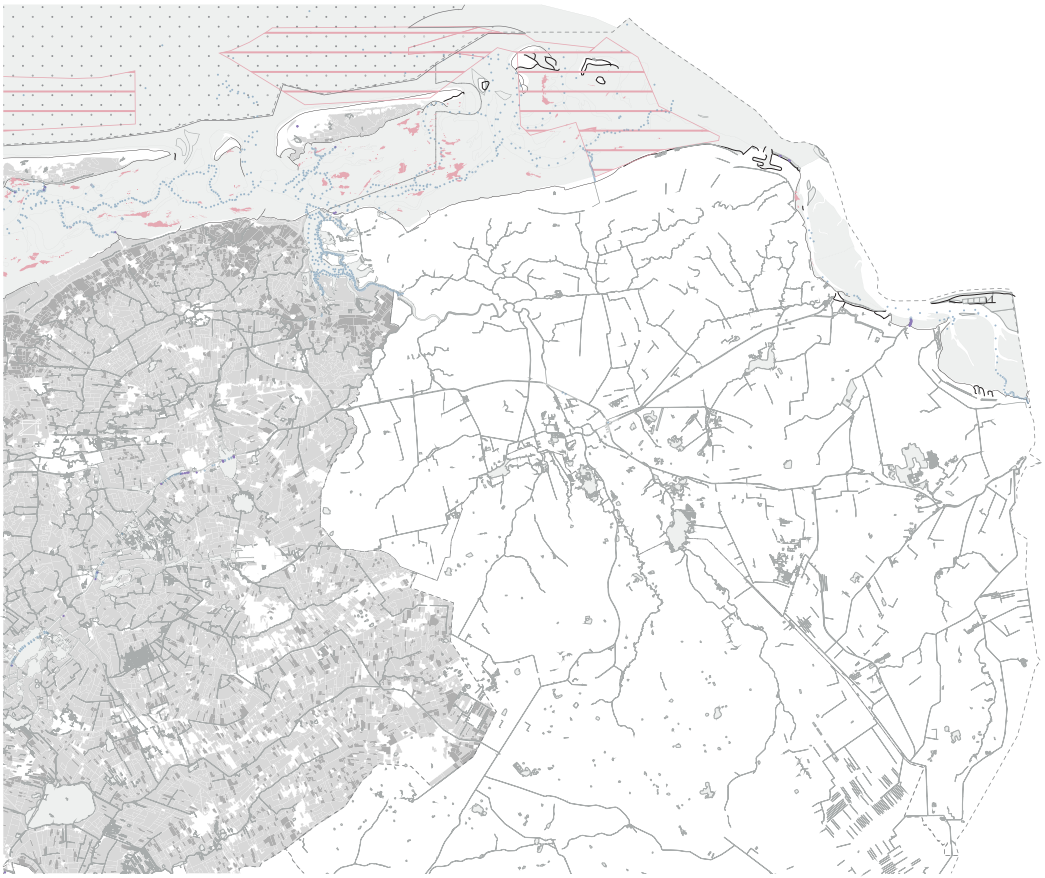


Anchor areas

Fixed waterway marks

Floating waterway marks

Traffic separation scheme

Crop production

Grasslands

Closed areas for fishing

Shellfish plots

Mussel and oyster habitats

Mussel seed capture installations





View from the edge of Hans Kroodsma's farm.
Photo: by author. 2022.

Agricultural land-use in Friesland

Looking at Friesland's land-use, crop production is highly concentrated on the higher clay formations along the coast of Friesland, also recognisable in the previous soil map. Production here consists for a large part of potatoes, grains and sugar beets. The other part of Friesland consists mainly of grasslands, which is a highly typical characteristic for the province, which mainly consists of an open landscape with long sight-lines.

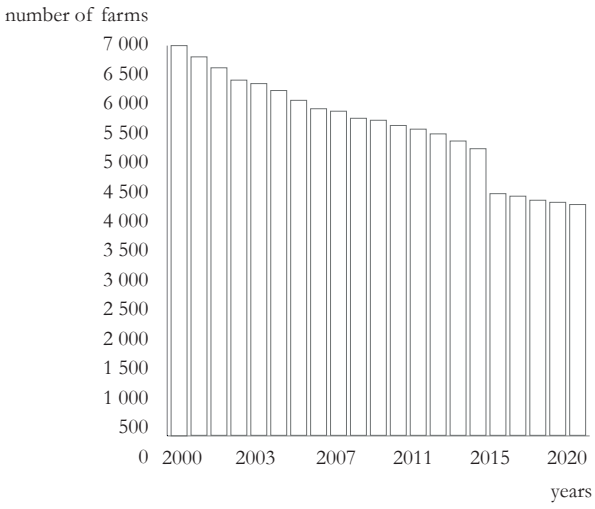
When looking at statistics for the whole Netherlands, it can be seen that the total area of the Netherlands is 4,152,800 hectares. In 2000, a total of around 48 % was in use for agriculture. The total percentage of agriculture is slightly declining, as in 2016 still around 43% was in use for agriculture. (Nederlandse Akkerbouw, 2017).

When looking at the province of Friesland, it is seen the agricultural sector makes up most of its land-use. 77% of land in Friesland was in use by agriculture in 2017, which is well above the Dutch average of 43% in 2016. Also in Friesland there is a slight decline in agricultural land-use. Over the last fifteen years, it has decreased by almost 3 %. Other forms of land-use have been growing, such as urbanized areas, recreational areas and nature areas. In most cases, the agricultural land was transformed into one of these types of land-use (Nederlandse Akkerbouw, 2017).

From agriculture in Friesland, dairy farming and secondly arable farming are the top two uses of these lands. Dairy farming requires a lot of grasslands to produce grass for the cows. These wide grasslands are a known characteristic

	2000	2017	2000	2017
Total land area Friesland in km2	3.349	3.336	100%	100%
Infrastructure	87	84	3%	3%
Build area total	153	180	5%	5%
Residential areas	113	122	3%	4%
Business parks	34	51	1%	2%
Recreation area	46	55	1%	2%
Forest and natural open terrain	387	412	12%	12%
Agricultural land	2.649	2.576	79%	77%

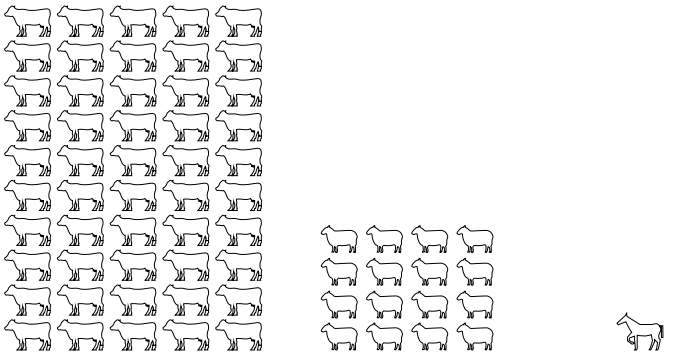
Land use trends in Friesland in km2.
Data: CBS, 2022.



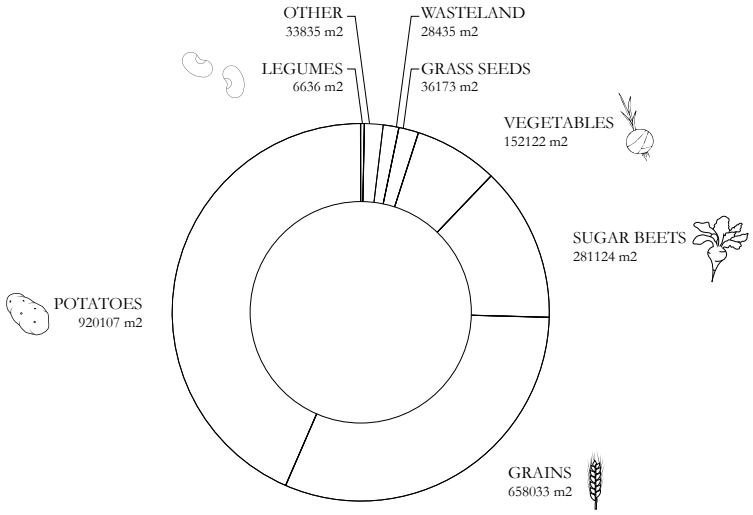
Number of farms in total in Friesland.
Data: CBS, 2022.

for the province. They make up 90 % of the agricultural lands and are present throughout the province, but its concentration is highest in the southwest and southeast of the province. Arable farming is concentrated in the northern clay area of Friesland, and covers 9.2 percent of the total agricultural land. In this part of the province, 82 percent of the total arable acreage is concentrated. (Plantinga et al., 2018)

Horticulture is almost not present in Friesland and the horticulture that is there, is concentrated in the north west of the province (Plantinga et al., 2018).



Number of farm animals in Friesland.
Data: CBS, 2022.



Division of crop production in friesland in m2.
Data: CBS, 2022.

Upscaling and higher profits

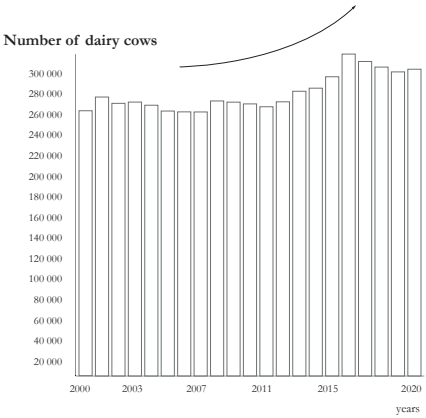
After the Second World War, the ordinary farmer, with a fairly small business, started to scale up. The government encouraged this. Everyone had to have enough to eat after the years of food scarcity. People also started earning more. So a piece of meat on your plate every day was suddenly an option. Therefore, efficiency became important. Large fields and large stables turned farming into an industry. This caused the amount of meat, milk and eggs produced to increase incredibly. Intensive livestock farming had begun. The Netherlands exports most of what we produce in the stables (Felix, 2017).

In the whole Netherlands, the number of farmers has decreased rapidly in the last 16 years. At the same time, the average farm size and its production is increasing. In the year 2000 there were 97,390 farmers in the Netherlands, while in 2016 there were 55,680 farmers left. (Nederlandse Akkerbouw, 2017). This same trend can be seen in Friesland. The number of dairy farms fell sharply in this province: from just under 4,000 farms in 2000 to 2,772 dairy farms in 2017. During the same period, the average number of cows per dairy farm grew strongly, from an average of 65 to 114 cows per farm. In 2016 there was a trend break and the number of cows per farm fell again. This is related to the measures taken against the phosphate surplus (Plantinga et al., 2018).

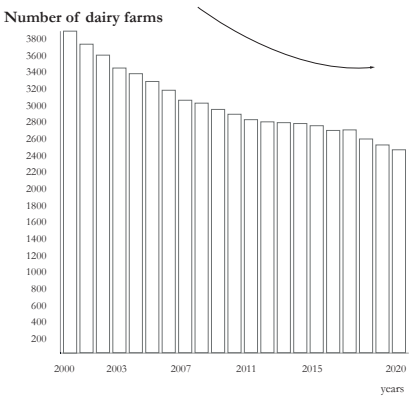
International goods trade from friesland by country

Of all the provinces, Fryslân exports the most to countries outside the European Union. It concerns almost half of everything that is exported, mainly dairy products. Nationally, this concerns almost 28 percent of exports (Centraal Bureau voor de Statistiek, 2016).

For Fryslân itself the export of agricultural products is of great importance. In 2017, the total export value amounted to more than 2 billion euro, and corresponds to 39% of the total export value of the province. (Factsheet Friesland CBS, 2016).

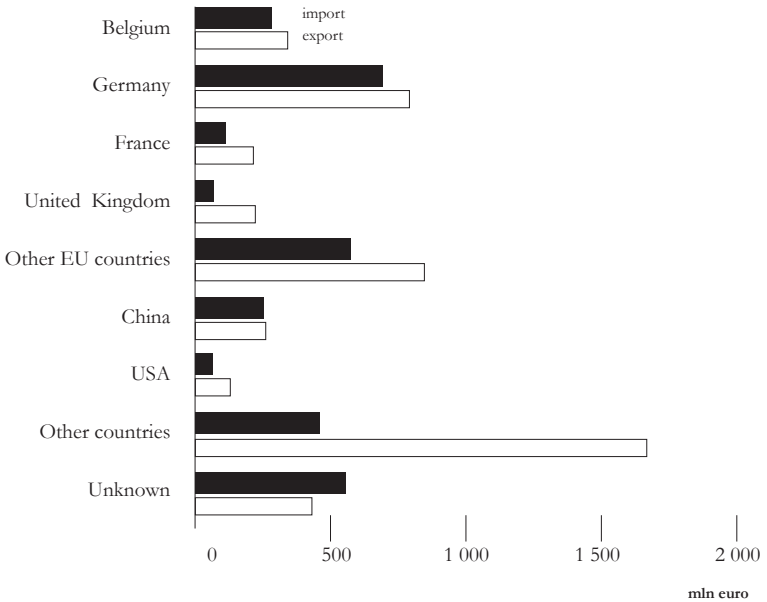


Number of dairy cows in friesland



Number of dairy farms in friesland

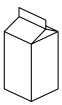
Left: Trend of number of dairy cows in Friesland.
Right: Trend of number of dairy farms in Friesland.
Data: CBS, 2020.



International goods trade from Friesland to country expressed in million euro
Data: Factsheet Friesland, CBS, April 2016



Potatoes



Milk

Main export products Friesland
Data: Omrup Fryslan, April 2016.



Traditional milk transport to the milk factory.
Painting: unknown, z.d. Collection Fries Museum.

Agricultural timeline after World War II



Subsidies led to enormous overproduction in the longer term. The guaranteed minimum price for cow's milk made it attractive for farmers to produce as much as possible. This overproduction resulted in the so-called 'butter mountain' and 'milk pool'. The surplus European milk was brought onto the world market at dump prices by means of an export subsidy.

1960 onwards

1957

The Common Agricultural Policy was established through the Treaty of Rome. The policy was aimed at guaranteeing both the quality and the quantity of the European food supply. It provided subsidies to ensure the income of farmers.

Painting by Gerben Rypma (1878-1963)



1980

To counteract the overproduction and the disruption of the international dairy market, the European Community proposed production restrictions in the early 1980s.

The "milk quota" is introduced. Restricting European milk production through the milk quota worked well. Milk prices remained fairly stable and the disruption of the international dairy market due to European subsidy policy was negated.

1984

Reformatorisch Dagblad 17 Januari 1985 page
"The Emmeloord company Gascoige Melotte
has found a gap in the market for automation i
livestock farming. This concerns a milking robo
that was invented by two teachers from the pra
cal school for livestock farming in Oenkerk in
Friesland."


Kans op honderd banen in Emmeloord door melkrobot

1983

The milking robot is invented in friesland by two teachers from the practical school for livestock farming in Oenkerk in Friesland.



1990

1993

First m
market

A total
for all ag
is around

There are

40

5 page 18 -
elotte BV
ıation in
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erk in

1993

First milk robot on the market

A total of 1,975,504 ha was in use or all agriculture combined, which around 48% of the Netherlands.

here are 97,390 farmers in total in the Netherlands.

400 milk robots in use in the Netherlands

2000

79 percent of the province Friesland land area was used by agriculture.

There are 4,000 dairy farms in Friesland with an average of 65 cows.



The recovery of the global economy, and in particular the growth in prosperity in countries such as China and India, has resulted in an enormous growth in the demand for dairy. Because global dairy production continued to increase as a result, the European Union decided that the milk quota could disappear.

This decision was definitively announced in 2008. The dairy sector has exploded in anticipation of the market release by upscaling their farms.

2008

2010

61 farms with 250 cows or more

77 percent of the province Friesland land area was used by agriculture. This share is well above the Dutch average.

There are 2,772 dairy farms in Friesland with an average of 114 cows.

112 megafarms

2015

The dairy sector has exploded in anticipation of the market release by upscaling their farms. The milk quota was definitely abolished in 2015.



2016

2017

A total of 1,796,261 ha was in use for agriculture, which is around 43% of the Netherlands.

There are 55,680 farmers in the Netherlands

2019

The total of 15,662 dairy farms in the Netherlands run 4,583 automatic milking systems (29%)

2020

The milk quota

The milk quota is a policy originating after the second world war. During this war, food shortages were common and it induced European talks about a common European agricultural policy. This would make sure for everybody to have food on their plate and food shortages wouldn't happen again. This European agricultural policy established in 1957 formed one of the pillars of the European partnership. Through the policy both the quality and quantity of European food supply would be guaranteed. All kinds of subsidies were introduced, ensuring the income of farmers.

Although this was a great development, particularly in the dairy sector this resulted in enormous overproduction of products. The policy included a guaranteed minimum price for cow's milk. This made it attractive for farmers to produce as much as possible.
The surplus milk was often processed into butter, which was stored in warehouses. This phenomenon was later called 'the butter mountain'. The surplus milk was also put onto the world market at dump prices, by means of an export subsidy.

These events were the inducement for European production restrictions. This was later called the milk quota, officially introduced in 1984. This quota would counteract the overproduction and disruption of the international dairy market. The restriction would, in original plans, only be in force for five years, but stayed in place until 2015.

The milk quota meant farmers had to buy production rights and were only

allowed to produce up to the maximum production amount. If a farmer produced too much, a levy had to be paid. This discouraged overproduction.

Looking back, the milk quota worked to keep milk prices stable and negate the disruption of the international dairy market due to the European subsidy policies. Eventually, the world wide economy has kept growing and so has dairy demands on a global scale. Global dairy production continued growing, for example in countries such as China.

These developments induced the decision by the European Union to abolish the milk quota. This decision was definitively announced in 2008. The dairy sector partly exploded in anticipation of the market release, for example by upscaling their dairy farms. In 2015, the milk quota was definitely abolished.

In this free market, supply and demand determine the price of the product and now that market regulation is largely abolished, the milk price will be influenced a lot by developments in the global market. Countries such as for example China are expected to highly increase their own milk production, causing more fluctuations in global milk prices. (Hadders, 2015).

The milking robot

The milking robot was invented around 1983 by 2 Frisian teachers of the practical school for livestock farming in the Frisian Oenkerk. At the same time, there were also other companies with this development. The prototype of the first milking robot is on display in the agricultural museum in Friesland.

The milking robot has had a slow start due to many teething problems. Mechanics have to spend a lot of time on the milking robots and the maintenance costs were sky rocketing. As a result, the milking robot has been struggling with an image problem for years, according to the trade journal "Veehouderij Techniek". Through the years this image changed. In 2000, the Netherlands had about 400 milking robots. In 2019, this increased up to 4,583 automatic milking systems running on Dutch farms (Redactie Groen Kennisnet, 2020). According to researcher Harm Wemmenhove of Wageningen Livestock Research, the reason for the increase in the number of milking robots is as follows: 'Labour is expensive, which also means that farmers are more likely to go for robots these days'. This is also seen by KOM foundation director Peter Huijsman. 'It is difficult for livestock farmers to find good staff. Larger farms are therefore more likely to opt for an automatic milking system.' (Bloemberg- van der Hulst, 2020).

The advantages of a milking robot are that a milking robot can take a lot of work off the farmer's hands. This enables him to work more efficiently. Also, health problems are immediately signalled when milk production decreases. Lastly, the farmer has access to the production data of each cow at all times. Disadvantages are that not all cows can get used to working with a milking robot and the investment in a milking robot is high.



Milk robot at Hans Kroodsma's farm.
Photo: by author, 2022.


GEEN BEDRIJVEN
DOOR SUPERHEFF
JONGE BOEREN
willen TOEKOMST



Protest against the milk quota in 1984.
Photo: collectie Anefo, 1984.

Bigger farms

Over the years, an enormous dynamic has taken place within the agricultural building plot. Previously, all livestock, feed and machines could be housed within the original head-neck-rump farm or stelp farm. The free standing stall barn was introduced in the 1960s and 1970s and provided a new way of doing business. The layout was also adapted accordingly. This development can be seen as the first leap in scale for the agricultural business. In addition to the scaling up of existing farms, new farms in the form of a detached house with an attached cubicle barn were also realised.

From here on, developments went fast. The barns became larger or a second barn was added. More storage capacity for food storage was also realized on the farm property. New phenomena such as manure fermentation installations, algae nurseries and the like are also making their way onto the farmyard. This means the farmyard is getting more and more industrial in character. The original farm had already lost its functional value for the agricultural business, but also its image defining value in the landscape is slowly overshadowed by big industrial farms. (Kernteam De Nije Pleats in Fryslân, 2009).

The upscaling of dairy farms is not only necessary due to the increase of the number of animals on the farm and higher yields. It is also because animal welfare restrictions have become more strict. In this light, a change in farm type has also been a necessity. It would be unlivable to now keep cows in a traditional kop-hals-romp farm. For example, over the past 10 to 15 years, the average surface area per cow in the barn has increased by 25% (to 10 m2 per cow). Also, for animal welfare reasons, the modern farmer strives for an occupancy rate of 80% instead of the usual 120%. The cow's rest is beneficial, which has a direct impact on milk production. The aisles have also become wider over time, so that there is more peace in the barn.



Kop hals romp farm, (>1600), mostly in clay areas

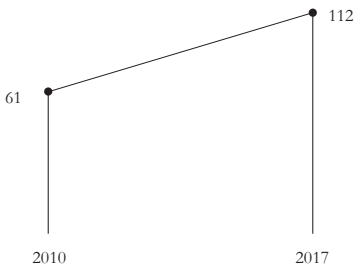
The biggest farms

The total number of 'mega' stalls in the Netherlands has increased by 76 percent in seven years, from 456 in 2010 to 801 in 2017 (Felix, 2017). They are farms with 250 cows or more. The most big stalls with dairy cows are located in Friesland (112), North Brabant (66) and Groningen (55) (Wakker Dier, 2019). Friesland had a total of 112 big barns in 2017, 14% of all big barns in the Netherlands. This means Friesland has the most big stalls with dairy cows in the Netherlands. About 12% of the dairy cows in Friesland are in a big stall. Placing many animals close together creates a risk of diseases, a lot of gasses and manure. From 2014 stricter safety requirements were implemented for all new mega stalls in connection with gas formation that can lead to highly flammable circumstances.

THE NUMBER OF MEGAFARMS IN FRIESLAND HAS GROWN FROM 61 TO 112 IN 7 YEARS.

4 %
OF TOTAL FARMS IN FRIESLAND IS A MEGAFARM IN 2017

12 %
OF ALL COWS IN FRIESLAND LIVE IN A MEGAFARM



Effects on the landscape

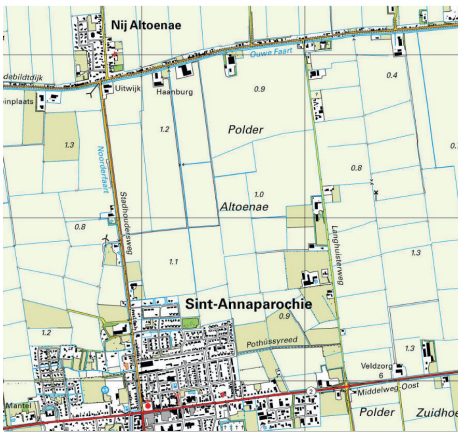
The upscaling of farms has an effect on how the farm-landscape is seen and perceived. Bigger farms and its installations change view lines in the landscape. Were the open landscape was first only interrupted by terps, gathered trees, and traditional farms or newer small scale farms, now more often big farms can obstruct this view. The design of buildings in both dairy farming and arable farming is largely determined by functionality and construction costs. The buildings are usually traditionally built in 1 storey with a saddle roof (Kernteam De Nije Pleats in Fryslân, 2009).

Increase in scale in agriculture also has an effect on traffic on and around an agricultural company. First, the size of machines is increasing. To be able to work efficiently, machines are getting bigger and bigger. This is facilitated by the ever-expanding plots. Secondly, the number of traffic movements to and from agricultural holdings is increasing. When more is produced, more raw materials are needed and more products will be removed. This includes diesel, animal feed, manure and products produced at the farm. This increased and heavier traffic makes use of public roads. The road structure in rural areas is formed by a small scale network of agricultural roads. The road profile of these roads has long been adequate for the type and numbers of traffic movements in the rural area, but is becoming more and more insufficient to support the heavier traffic. Also, the foundations of these roads are not designed for the increasingly larger and heavier machines. Adapting infrastructure is not always possible or feasible (Kernteam De Nije Pleats in Fryslân, 2009).

Lastly, during the so-called 'ruilverkaveling', small plots were merged to form bigger meadows and crop production fields. After the Second World War, when the Netherlands was being rebuilt, also sufficient food production was being secured. Agriculture had to be set up as rationally as possible and that also meant an increase in scale. The small scale agricultural plots were not efficient and land consolidation was one of the instruments to secure the higher production yields. Loose pieces of land belonging to various farmers were merged together to farm bigger allotments.
This process resulted in the removal of many older landscape elements, such as ditches, rows of trees and old paths and roads. It has tremendously changed the agricultural landscape. Through the years this has led to a loss in diversity in landscape elements, and as a result also in biodiversity (De Fryske Kanon, 2013).



Allotment structure in Friesland in 1932.
Image: Topotijdreis.

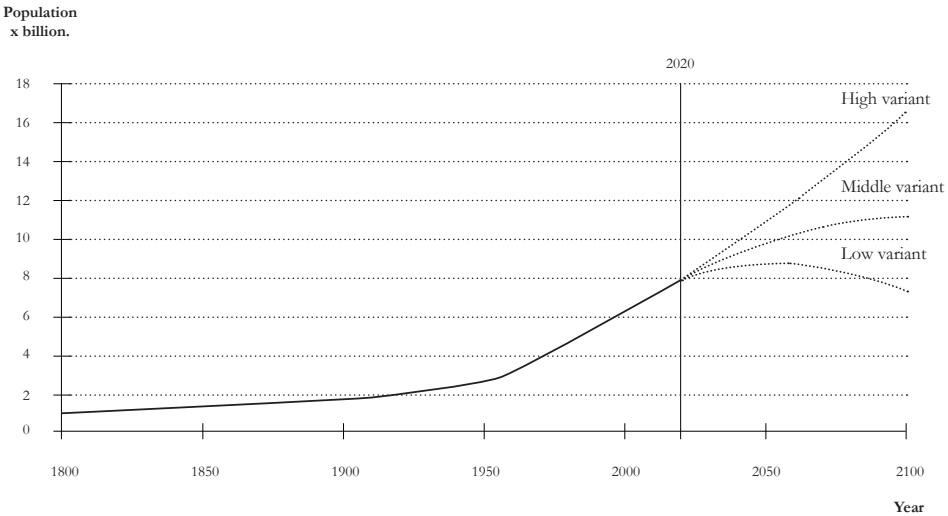


Allotment structure in Friesland in 2020.
Image: Topotijdreis.





Megafarm in Winsum, Friesland.
Photo: Dagblad van het Noorden, 2020



Estimates of the historical and forecast of the future size of the world population from 1800 to 2100. Data: United Nations, 2020.

Mouths to feed

While pressure is high on agriculture to decrease its pollution, CO2 emissions and negative effect on biodiversity, it is a vital industry feeding the worlds population. According to the United Nations, the world population will continue to grow from around 8 billion people to an expected number of 11 billion people in the year 2100 (United Nations, 2017).

Where in Europe the total population is likely to decrease, on continents Africa and Asia the population will increase most. 80 % of the population in 2100 will live on one of these continents, according to prognosis (Oxfam Novib, z.d.)

To keep feeding the rising world population while decreasing agriculture's emissions and soil depletion, is a huge challenge. According to Jonathan Foley, a researcher from the Institute on the Environment at the University of Minnesota, it is not necessary to choose between local bio-dynamic agriculture and agriculture on an industrial scale. Both practices can be part of the solution. Knowledge and innovations producing higher yields can be employed while organic agricultural practices help improving fertility without the use of fertilizers and pesticides (Foley, z.d.).

The cultural landscape

Timeless treasures in the Frisian province

In this chapter, the cultural history of Friesland related to water and agriculture will be elaborated upon.

The province of Friesland is rich in cultural history, as from about 400 to 200 BC gradually a Proto-Frisian culture began to emerge. In an agricultural sense, different allotments can be found in Friesland following the different soil types throughout the province. Due to Friesland's focus on dairy production, remnants from a smaller-scale production structure can be found in the shape of old dairy factory buildings which used to be high in numbers throughout the province. Also, remnants from the practice of catching ducks can be seen in the landscape in the duck decoys which are often still present, and are now an oasis of flora and fauna. As related to water, a lot of interesting structures can be seen. Terps are found in northern Friesland, on the higher salt marsh ridges. In the appearance of dikes built before the 17th century the contours of the Middelzee are represented which used to lay in a big chunk of Friesland. Churches dating back to the middle ages can be found on top of terps. These are a treasure for archaeologists as each layer of soil represents a different period in time illustrating life on terps.

Canals were dug to connect terps with each other. Until the 19th century, almost every village was accessible by water. The intricate system of waterways was traditionally the most important infrastructure. When constructing the village canals, sometimes partial use was made of natural watercourses. More often, new waterways were dug. Some dug canals consist of straight lines, which stand out in the irregularly parcelled landscape.

The canals are no longer used today. An opportunity lies here which is also expressed in a vision by the province to revive these waterways, making them navigable again and completing route networks. In addition to a revived function for the canals, it would also mean a new tourist dynamic in the region.

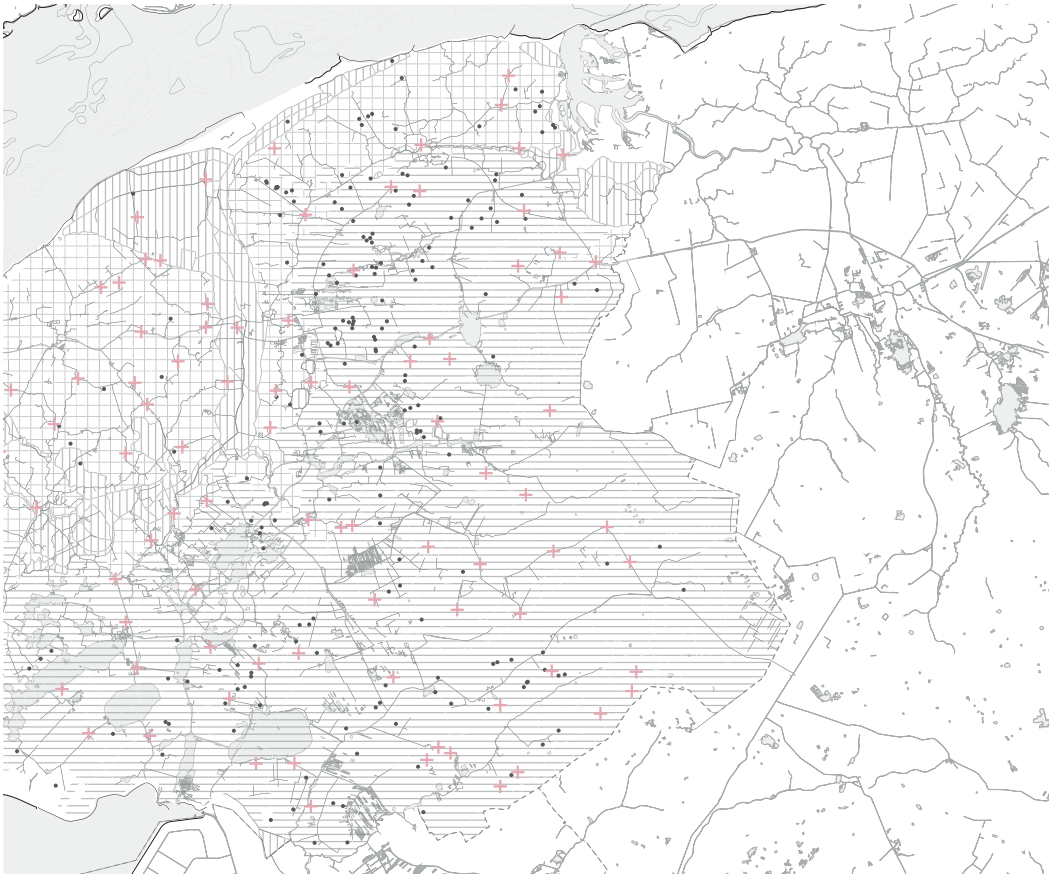


Dairy farm in operation
Photo: Collection Robert Visser, photographer unknown

Agricultural cultural heritage
Data: Provincie Friesland



0 10 km 50 km N



Dikes built in 17th century and earlier

Closed dairy factory buildings

Duck decoys

Polder allotment

Block allotment

Strip allotment





Duck decoy in Engwierum, Friesland
Photo: Kooikersvereniging, 2018.

A rich cultural heritage

Friesland's coast has been a dynamic are which has given rise to a lot of cultural historic structures to be found. In the dike structure, older dikes can be seen laying more inland now and they form an interesting juxtaposition to the high sea dike which keeps the land safe from the seawater nowadays. In the shape of the older dikes, the outlines of the Middelsea (the Middelzee), can be seen, which used to take up a chunk of the province before being msde into polder. Scattered through the landscape duck decoys are positioned, small lush green patches where ducks were being caught. In line with the different soil types present in the province, and with the different stages of poldering different types of allotments can be seen through the province.

Before the sea dikes existing, settlements were being built on terps which are still present in the landscape, though partly excavated when they weren't necessary anymore and the fertile soil of these terps was worth a lot of money. To connect these terps, small waterways were dug and were used as an important infrastructure.



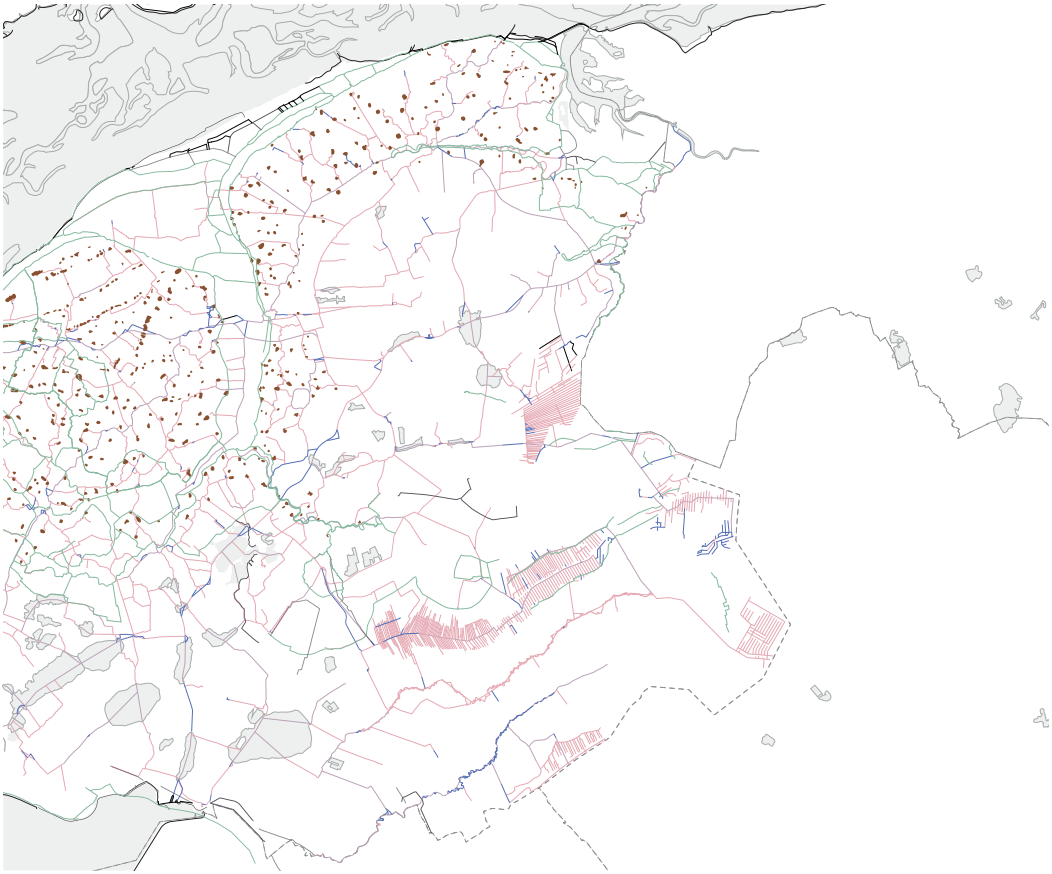
An old canal in northern Friesland.
Photo: by author. 2022.

Water cultural heritage

Data: Provincie Friesland



0 10 km 50 km N



Dikes built after the 17th century

Dikes created in the 17th century and before

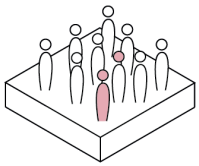
Waterways created between 1900 - 2000

Waterways created between 1800 - 1900

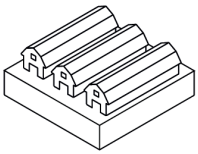
Waterways created before 1800

Terps

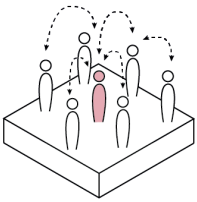
Frisian farming characteristics



11% of Frisian employees work in the agri-food sector.



Characterized by modernization and upscaling



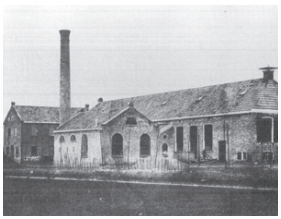
Strongly intertwined with the national economy, politics and innovation



Butter and cheese were traded in the weigh house, such as in Sneek or Leeuwarden. This was an economic centre, employing many workers.



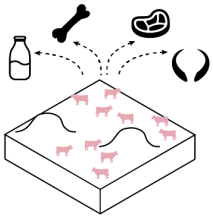
Harlingen was an important export port to, for example, England of dairy products and seed potatoes. In the right down corner of the photo butter barrels are ready for export. Photo taken in 1925.



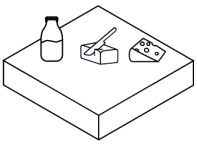
After 1850 the quality of Frisian dairy deteriorated, but it increased again when the dairy factories appeared. Dairy cooperatives were established from 1900, many of which later merged into Friesland Campina, a large dairy group. Photo: The cooperative steam dairy in Warga, photo from 1886/87.



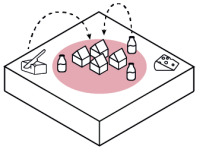
The Slachtedijk, an old dike in Friesland.
Photo: Toeristisch Platform Bestemming Noardwest, z.d.



Cows have been kept since the terp dwellers, for their milk, meat, skin, horns and bones



After the Middle Ages, butter, cheese and milk were the main products of livestock farming



The distance to the consumer often determined which dairy product was made. Milk had to be as fresh as possible. Until the end of the 19th century, dairy products were produced on the farm



There is relatively little horticulture in Friesland, but there are a few greenhouses centred around Berltsum, where horticulture probably originated from a courtyard of the Lidlum monastery. Drawing made in 1961.



The Frisian-Dutch black-and-white cow has long been the icon of Frisian multi-breeding. Later it was be replaced by the Holstein-Friesian cow.





Canal through the Frisian landscape
Photo: Google maps, 2021.

Terpen

From about 400 to 200 BC gradually a Proto-Frisian culture began to emerge, which were called Frisii by the Romans. In the fourth century the number of Frisii decreased so dramatically that around 400 the area was practically uninhabited. Germanic tribes from the North, presumably Angles, Saxons, and Jutes, populated the area and became known by the name of their predecessors. In the 10th century, Old Frisian gradually began to emerge. In the year 1006 the County of Midden-Friesland came into existence. Friesland long remained a region where government is only governed at the local level, which offered local chieftains the opportunity to further expand their local power. Besides the chieftains, it is mainly the monasteries that dominate Frisian society in this period.

Until 1000 AD. Friesland is not dyked. The seawater carries sand and clay particles with it every day. These fertile pastures along the Frisian coast were an attractive place to settle. However, periods of flooding and periods in which the land was largely dry alternated. Although the inhabitants of this area often chose already existing natural elevations such as salt marsh ridges and embankments as a place to settle, many people lived at ground level in the early period of colonization. To be able to be safe from the incoming water, inhabitants raised their settlements until they gradually reached heights of sometimes nearly ten meters.

Terpen are characteristic in the Frisian landscape, and they also contain a lot of information about the history of the province. Because the existing mounds had to be constantly raised due to the continuous sea level rise,

many layers were created which all tell a story about a certain period. Objects excavated in these layers over the years have played an important role in reconstructing the early history of Friesland and its inhabitants.

After the year 1000 Friesland is dyked and the mounds are no longer needed as protection against seawater. At the end of the 19th and the beginning of the 20th century, almost all mounds were excavated. The fertile mound mud is worth a lot of money and is transported by ship to areas with sandy soil. The fertile soil of the mounds comes in handy to improve the quality of sandy and peaty soils (De Friese terpen en Groningse wierden, z.d.).





Terp of Hegebeintum.
Photo: Visit Friesland, z.d.

Terp Jannum

A terp close to the site where the design in this graduation work will take place, is called terp Jannum. The surroundings of Jannum are typical for the clay region, which consists of a historical cultural landscape with an open and wide character.

The building history of Jannum's church goes back at least to the 13th century. It is often said that Jannum was a farm out of the Cistercian monastery Klaarkamp, but this is not known for sure. According to experts it is likely that the knowledge of monks from this monastery was used in the construction of the church. Klaarkamp was founded around 1165 and was located at the Ee about two kilometres from Jannum. The terpchurch is nowadays a small museum, (Kerk en omgeving, z.d.).

Vaarten

As mentioned before, canals, in Dutch "vaarten", were dug to connect terps with each other. Until the 19th century, almost every village was accessible by water. The intricate system of waterways was traditionally the most important infrastructure. Transport over water was much faster than over land. From the 16th century, many waterways were improved and widened. The villages on the higher marshes along the Wadden coast were connected to the Dokkumer Ee via their own village canal, which are very recognisable structures in the landscape.



Inside the small church on terp Jannum.
Photo: by author, 2022.

When constructing the village canals, sometimes partial use was made of natural watercourses. For example, old tributaries of the Peazens river, or even parts of the old upper Peazens itself were used. Much more often, however, new waterways were dug. For example, the waterway to Hallum, the Hallumer Feart, was straightened and equipped with a towpath. These are straight lines that stand out in the irregularly parceled landscape. Many of these village canals were constructed on village boundaries. The maintenance of the waterways was the responsibility of the individual landowners. Later, the villages and municipalities took over (Worst & Coppens, 2021).

Nowadays, the canals are not so much used anymore. They are on a lot of places not longer connected due to the interruption of locks. This is a pity, as Friesland is a province known for its water recreation. Therefore, the province has made a vision for the year 2025, called "Waterrecreatie Noordoost Fryslân 2025". In this vision, a plan is presented to create a water network with sufficient cross-connections and circled routes. The now underused, historical waterways, connected many villages in northern Friesland, form an important part of this. Making and keeping these waterways navigable again completes the route network. The canals also connect the region to the Wadden Sea, which means a new found relationship with the sea can be established. Next to a revived function for the canals, it would also mean a new tourist dynamic in the region (Feenstra et al., 2021).



The former course of the Peazens, a former marsh gully that drained the water into the sea until the Middle Ages, is still clearly visible in the landscape.
Photo: Landschapsbiografie van Noardeast-Fryslân, 2021.

The natural landscape

Biodiversity on a low

This chapter focusses on the nature and biodiversity present in Friesland, whereby the influence of intensive agriculture is being noted.

The nature networks called Natura 2000 and the NNN in Friesland are present, but near Friesland's coastal area their numbers are scarce. A harsh line is dividing the protected nature area of the Wadden Sea, which became UNESCO world heritage in 2009, with Friesland behind the sea dike.

There are a lot of grasslands in Friesland, but biodiversity is declining rapidly since the Netherlands started measuring its biodiversity. At this moment in the Netherlands, biodiversity is at an all-time low, well below the European average. Only 15 percent of the indigenous plant and animal species that were present in the Netherlands in 1900 are remaining. The European average is 40 percent. The main cause is a lack of living habitats for a diversity of species partly due to intensive agriculture. The number of meadow birds is also rapidly declining. They are a valued species of bird for the province of Friesland. The four main species of meadow birds in Friesland are the black-tailed godwit, lapwing, redshank and oystercatcher.

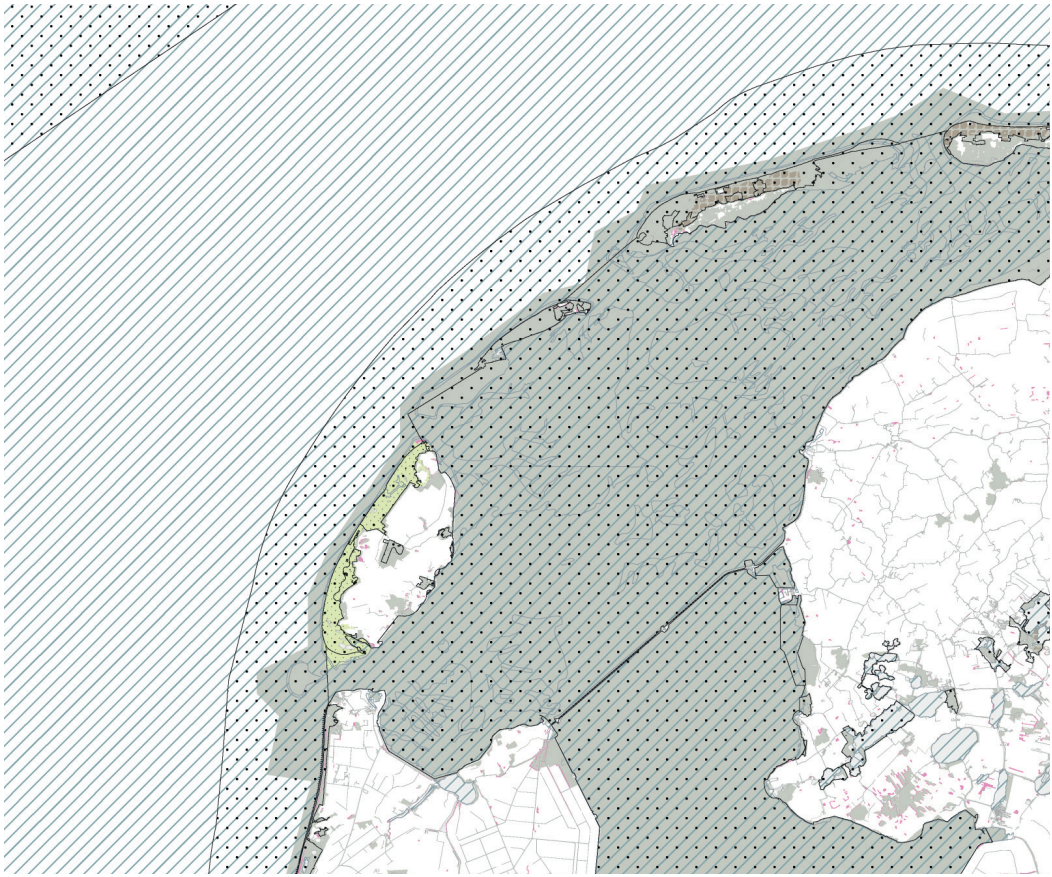
The extensive use of pesticides and manure is having a detrimental effect on the water quality in the Netherlands. The seeping of pesticides and manure into the surface water is the main reason for its poor quality, according to a report from Natuur & Milieu. Bad water quality has been a returning problem in the Netherlands. From the 1970s onwards a series of interventions have been taken to improve the water quality. Factory discharge was to be

regulated, houses were being connected to the sewage systems and more water treatment plants were introduced. Still, in the water quality report from 2015 it is stated that about 60% of the Dutch waters did not meet EU regulations.

Lately the emissions of nitrogen and phosphorus have increased. Since 2018 this has been reinforced by the dry summers. During drought, plants grow less well, so that they take up less nitrogen and phosphorus from the soil. Also, less nitrate is broken down in the soil, which means that more leaches to ground and surface water. For example, the nitrate concentration in ditch water on farms doubled in the period 2016 to 2019. This has a negative influence on the biodiversity. The changes in agricultural practice have influenced the landscape around us a lot. Small scale structures in the landscape have faded away and has been replaced by a more monotonous landscape. This has an effect on our experience while moving through the landscape. In addition to current agricultural practices threatening biodiversity, agriculture itself is threatened by the salinization of groundwater. It is especially a threat to the crop production in northern Friesland, because of the limited salt tolerance of crops. Livestock farming is also affected due to the salinization of ditches.

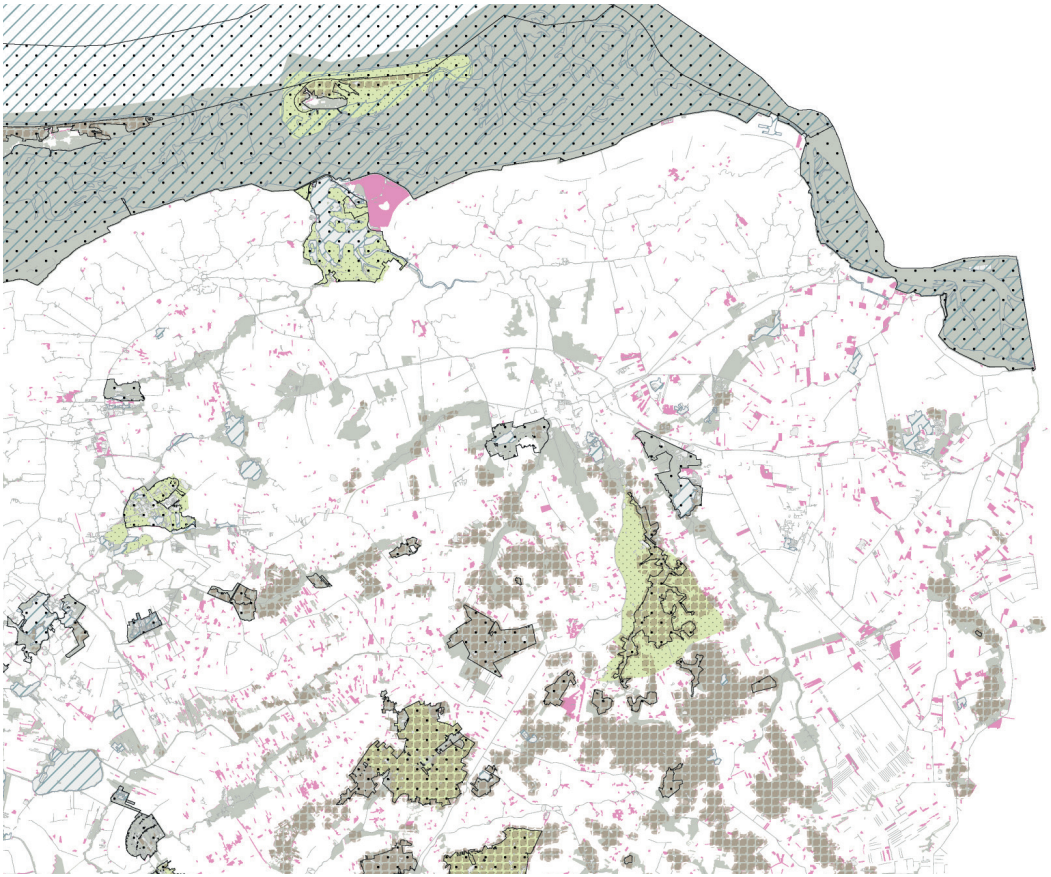
Nature network

Data: Nationaal Georegister



0 10 km 50 km

N



Nature areas outside NNN
National parks
Wav (Ammonia and Livestock Farming Act)
Main water bodies
Natura 2000
Dutch Nature Network (NNN)

Designated nature areas

Natura 2000 is an European network of protected nature areas. In these Natura 2000 areas, certain animals, plants and their natural habitats are protected in order to preserve biodiversity. Biodiversity in Europe has been under pressure for years, therefore the European Union decided that sustainable protection of flora and fauna is badly needed. In this way, nature preservation is managed on an European level. All EU Member States designate protected areas for specific habitats of animal species. These form the Natura 2000 network (Ministerie van Landbouw, Natuur en Voedselkwaliteit, z.d.).

All Natura 2000 areas are part of the Nature Network of the Netherlands, also called NNN for short. The NNN also includes other existing and planned nature areas and safeguards the quality of the natural values present. The protection of the Natura 2000 areas is stricter than that of the NNN, as the latter does not have European targets set for the preservation of species and habitats (Provincie Zuid-Holland, z.d.).



Walking into Natura 2000 area national park Lauwersmeer.
Photo: Daphne van der Vorm, 2022.

Surface water quality

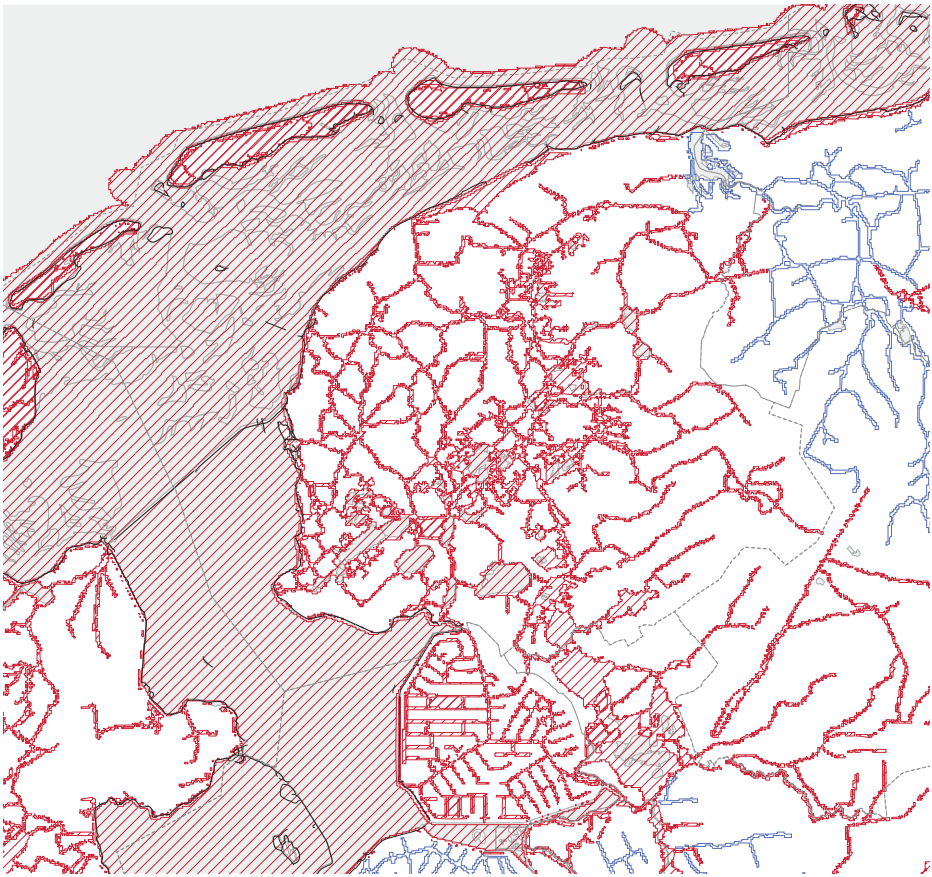
In 2000 a European guideline called the WFD was established to monitor and improve the water quality in the European surface waters. To ensure an improvement in the water quality, the obligation was put to every European member to make sure all water were in 'good quality' in 2015. The Netherlands have made use of an extended deadline, which ends in 2027. The WFD set quality requirements for different types of surface water. They requirements have been divided into 'chemical requirements' and 'ecological requirements.
Since the start of this monitoring, two reports have been made from the Dutch government regarding the WFD quality standards, in 2009 and 2015. In 2019 an interim report has been made.

A bad water quality has been a problem in the Netherlands for a longer period of time. From the 70s onwards steps have been taken to improve the water quality. Factory discharge were to be regulated, houses were being connected to the sewage systems and more water treatment plants were introduced. Still, in the last water quality report from 2015, around 60 % of the Dutch waters that are monitored the water quality does not comply with the EU regulations.

An important side-note is that the water quality report towards the WFD is based only on the main, big water structures. In the other smaller water structures the water quality is scarcely monitored. The responsibility to measure the water quality lays with the local water authorities.

Chemical surface water quality

Data: IHW (waterschappen, RWS); bewerkt door PBL, 2019



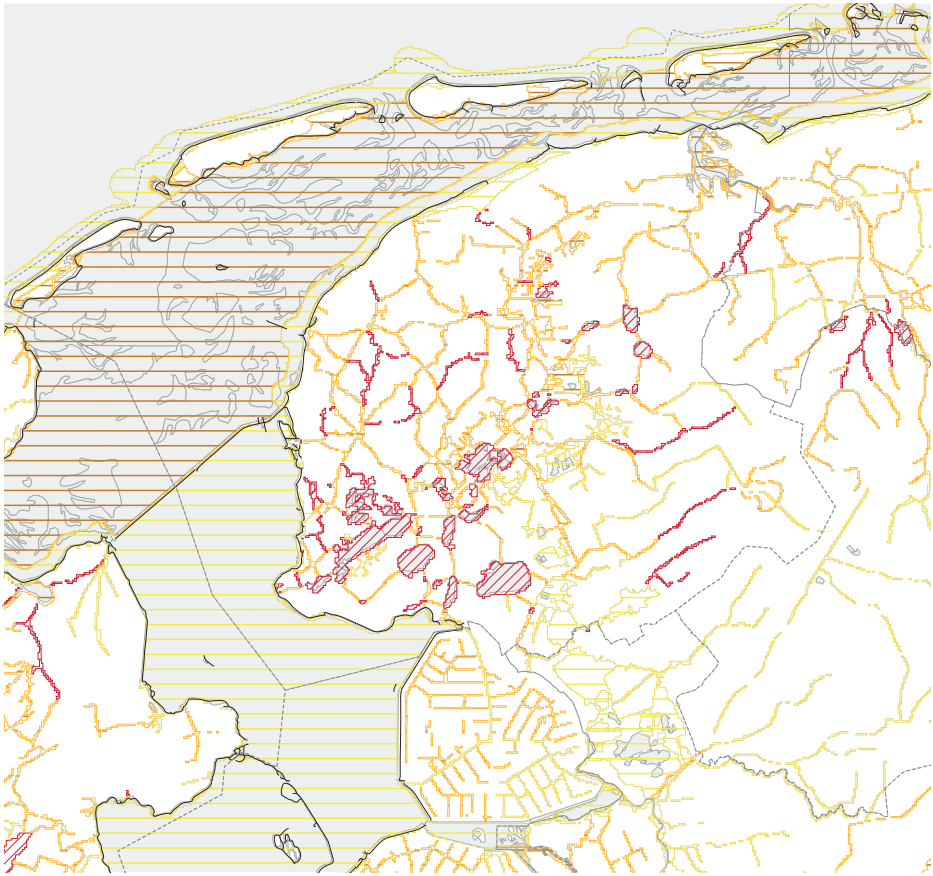
0 10 km 50 km N

Does not suffice

Suffices

Ecological surface water quality

Data: Data: IHW (waterschappen, RWS); bewerkt door PBL, 2019



The poor water quality in the Netherlands is caused by four main sources of pollution: nitrate and phosphate from manure, pesticides, sewer overflow and the so-called 'new substances'. This last group contains medicine residues and other micro pollutants. From this report it is evident that agriculture has a major effect on water quality, as manure and pesticides are in use in agricultural practice (Natuur en Milieu, 2019).

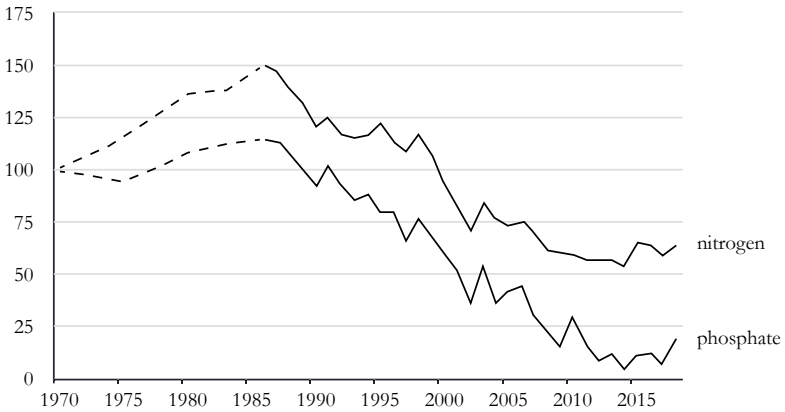
Most nutrients come from leaching and run-off from agricultural land. Some of the nutrients of agricultural land come directly from applied fertilizer or animal manure. In addition, many soils have a stock of nitrogen and especially phosphorus, partly built up through fertilization in recent decades and some are naturally present. The stored phosphorus is steadily leached into the surface water (Rijksoverheid, 2020).

Nitrate and phosphorus surplus

After 2015, the excess of nitrogen and phosphorus increased. Since 2018 this has been reinforced by the dry summers. During drought, plants grow less well, so that they take up less nitrogen and phosphorus from the soil. Also less nitrate is broken down in the soil, which means that more leaches to ground and surface water. For example, the nitrate concentration in ditch water on farms doubled in the period 2016 to 2019.

An important pillar of the Dutch manure policy is the regulation of animal manure production and manure surplus. From 2014, a number of systems were introduced to give shape to these pillars. This was necessary to solve the problems that arose from the gradual expansion of the European milk quotas since 2009 and their abolition in 2015. As a result of these measures, the dairy cow numbers grew from 2012 onwards and the excretion of nitrogen and phosphate increased. As a result, the ceilings agreed with the European Commission were exceeded.

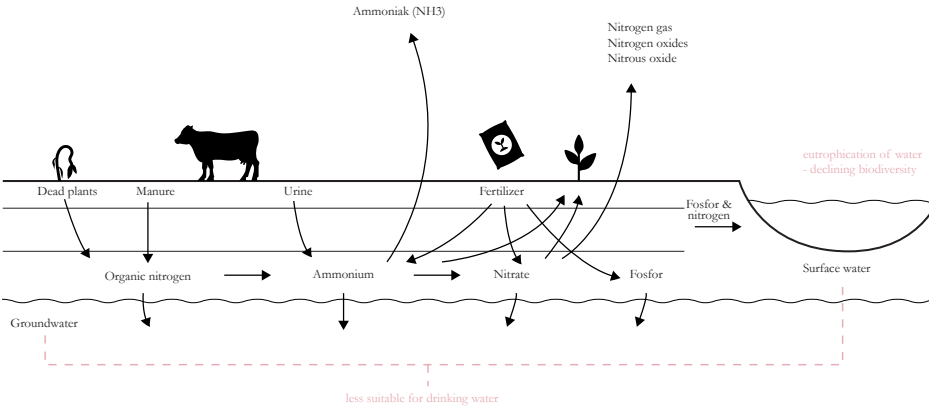
The water quality has slowly been improving over the years. The improved water quality is mainly due to farmers having used increasingly less fertiliser. This reduced the excess of nitrogen and phosphorus in the soil. This also means that less nitrate leaches with rainwater to deeper layers in the soil and ends up in the groundwater. The less nitrogen and phosphorus there is in soil and groundwater, the less flows to surface water. It is important to have clean ground and surface water that can be used for the production of drinking water. Also, high concentrations of nitrogen and phosphate in ditch water can lead to rampant blue-green algae and duckweed. Blue-green algae is poisonous and can lead to health problems. Clean surface water also ensures that a larger variety of plants and animals can live in the water, enhancing biodiversity. (RIVM, 2020).



Trend in the relative nitrogen and phosphate surplus in Dutch agriculture. With nutrient surplus is meant: the amount of nutrients in the soil that could leach to other areas or surface/groundwater.

Data: Landbouwpraktijk en waterkwaliteit in Nederland; toestand (2016-2019) en trend (1992-2019). RIVM-rapport 2020-0121

Effect of nitrate and phosphorus on the environment



Processes in the ground resulting from manure and fertilizer
Image: RIVM, 2020. Adjustments and additions to image by author.

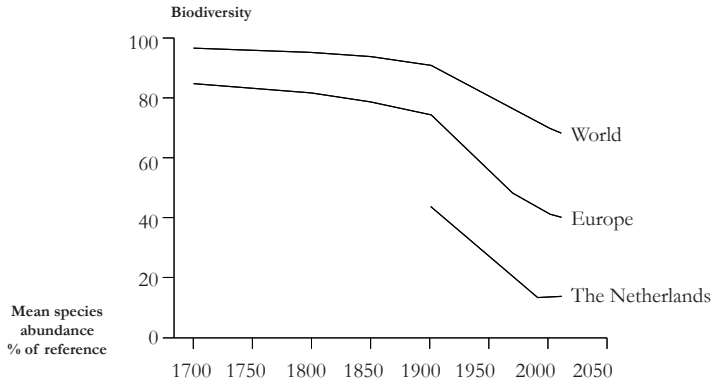


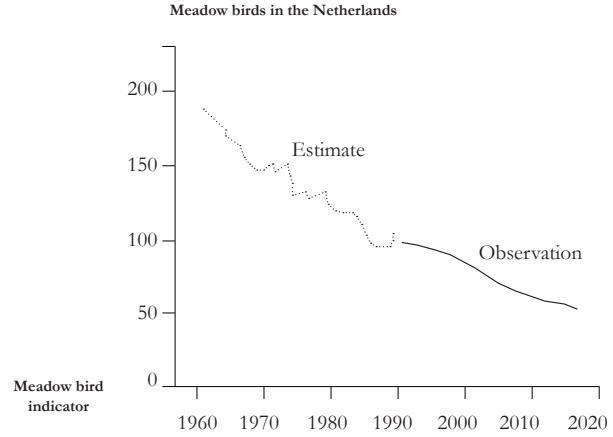
Canal through the Frisian landscape.
Photo: Author, 2022.





A flock of grutto's (the black-tailed godwit).
Photo: It Fryske Gea, z.d.





Data: Compendium voor de Leefomgeving, 2020.

Biodiversity on a rapid decline

Biodiversity is the total variety of life on earth and is therefore not only about individual species, but also about the diversity of ecosystems and the connections between them. Diversity increases the chance of survival when the environment changes. Biodiverse ecosystems are generally more resilient and therefore better able to cope with unpredictable conditions. Loss of biodiversity leads to increased vulnerability, so that the system can no longer perform its functions properly once disturbances occur. The World Food Organisation has warned for the negative effects on our food supply when sharp declines in biodiversity will be ongoing (Erisman & Slobbe, 2019).

As can be seen in the graph on the left, the biodiversity is at a record low in the Netherlands. It is well under the European average. Only 15 percent of the indigenous plant and animal species that were present in the Netherlands in 1900 have remained. The European average is 40 percent. Little living habitats for species and intensive agriculture are the main causes of the loss.

The trend translates to a lot of native animal species, as well as the meadow birds in the Netherlands. Their populations have been declining for years. Numerous campaigns have been held in order to raise awareness for this trend (Birger, 2020).

Meadow birds

Birds that nest on the ground among grasses and herbs are called meadow birds. The black-tailed godwit, lapwing, redshank, oystercatcher, curlew, ruff and snipe are waders who belong to this group of birds. Also types such as ducks and several songbirds belong to the group called meadow birds. The four main species of meadow birds in Friesland are the black-tailed godwit, lapwing, redshank and oystercatcher.

Meadow birds prefer wet, herb-rich grasslands, where they can prick their beaks into the ground and where food lives shallowly in the soil. This requires a high water level in ditches and gutters.

The breeding season of meadow birds runs from early March to mid-July. This is also an important time for farmers to work their land and bring in grass. Several measures can be taken to make sure both can happen. Mowing around nests, leaving strips and/or pieces of grass and mowing from the inside to the outside, for example, are good ways to protect eggs and chicks. Cooperation with the local bird watch is important here (Provinsje Fryslân, 2019).



black-tailed godwit
(grutto)



redshank
(tureluur)



oystercatcher
(scholekster)



lapwing
(kievit)


WELKOM THUIS GR



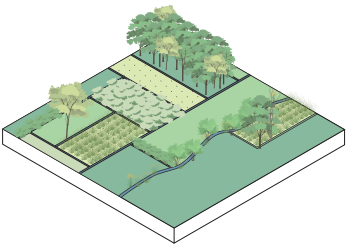
A 'Welcome home black-tailed godwit' banner is put up by meadow bird expert Sip Veenstra.
Photo: It Fryske Gea, z.d.

Loss in landscape diversity

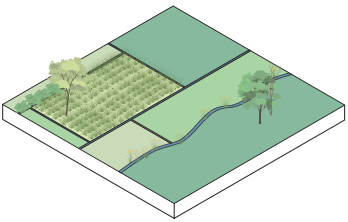
Through the years the agricultural landscape has been transformed and straightened to be able to produce the highest yields. With this, diverse landscape elements have disappeared. It is these elements that can house animal species and form interesting habitats.

Next to the loss on chances for biodiversity, the change in agricultural practice has influenced the landscape around us a lot. Small scale structures in the landscape have faded away and has been replaced by a more monotonous landscape. This influences our experiences while moving through the landscape.

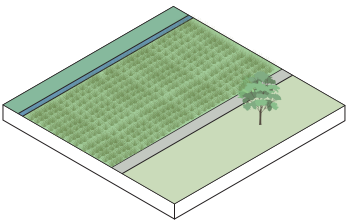
On the page an illustration can be seen of how the diversity in landscape elements have changed through the years.



1950



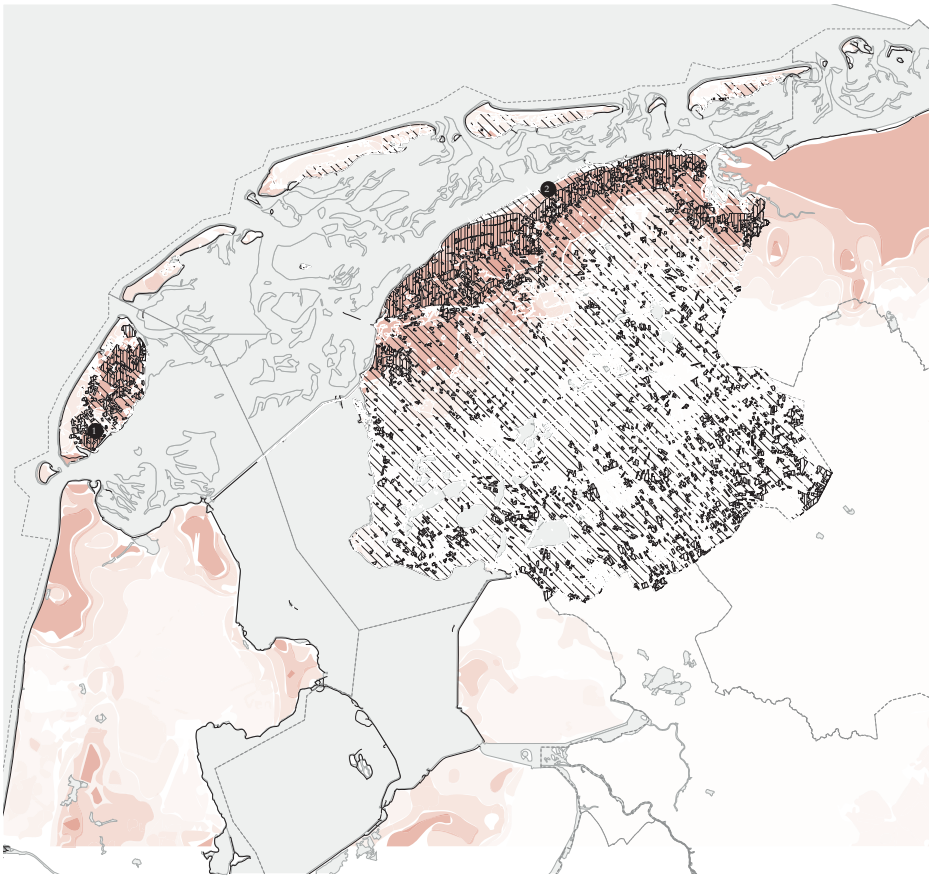
1980



2020

Salinization

Data: Atlas Natuurlijk Kapitaal, z.d.



Saline agriculture initiatives:

- Texel-Saline (bankruptcy in 2019) ❶
- Friesland Buitendijks ❷
- Crop cultivation
- Grasslands for agriculture use

0 10 km 50 km

Depth at which salt or brackish water can be found:

- 0 to 5 m below groundlevel
- 5 to 10 m below groundlevel
- 10 to 25 m below groundlevel
- 25 to 50 m below groundlevel
- 50 to 100 m below groundlevel
- > 100 m below groundlevel

N

The current availability of fresh groundwater in the Dutch coastal area is limited due to the shallow presence of saline groundwater. This salty groundwater is 'old' seawater that was absorbed into the subsoil during the Holocene flooding of the sea. Since the construction of polders by man, this salty groundwater has been flowing back to the surface, called saline seepage. The map on the left shows the depth at which salt or brackish water can be found. As seen on the map, at the coastal regions this is not very far under the ground surface.

Agriculture in the Northern marine clay area is of great economic and social value, particularly due to the cultivation of seed potatoes. Agriculture in this region is increasingly confronted with the consequences of salinization of surface water and groundwater. This increase manifests itself mainly in arable farming, because of the limited salt tolerance of crops. But livestock farming is also affected by this due to the salinization of ditches. Sufficient fresh water is important for all of us (Nationaal Georegister, 2014). The dry and hot summer of 2018 has resulted in agricultural lands in the Netherlands being affected by salinization. This is because a lot of fresh water evaporates during hot periods, giving seawater and brackish groundwater the opportunity to flow up into the soil and surface water. This mainly occurs in low-lying areas, where there is a good chance that brackish water will enter the ground.

The Netherlands has been struggling with salinization for some time, but climate change is accelerating this process. Scientific publications predict a rise in sea level, which will also increase the land area in our country that is affected by salinization. Farmers will notice a lot from this, and the agricultural productivity of the Netherlands will be negatively affected (Salt Farm Foundation, 2019).

The human landscape

The people of the landscape



A local market at the central square in Leeuwarden.
Photo: Author, 2022.

This chapter will elaborate on a network of local farmers who focus on nature-inclusive agriculture and local dairy farmer Hans Kroodsma is introduced. Furthermore, the current food system is being discussed.

In Northern Friesland, the Agricultural Collective Waadrâne is active. This collective is committed to the preservation of nature, landscape and biodiversity. In order to do this, they focus on nature-inclusive agriculture, which means bringing nature management to farmers. Nature and agriculture reinforce each other, resulting in more biodiversity and a sustainable living environment. The chairman of this collective is Hans Kroodsma. He runs a dairy farm in this area, has an innovative approach and emphasises farming with nature. He is in the process of converting his farm to be fully organic. It is on this site where the design later in this booklet takes place.

In the last few decades, the human connection within the food system has been increasingly lost. Because of the many middlemen and traders, consumers often have no idea who produced their food or where it has grown. As a result, they also fail to see the social and ecological implications of the production process. In addition, due to pressure from wholesalers and their efforts to increase their profits the farmers are left with small profit margins. With these small margins the farmers ability to invest, in for example making their business more sustainable, is limited.

It is inevitable that something has to change in the way agricultural practice has been organized, in light of the developments discussed in this report. Many farmers are cornered and they are trapped in the system. To give farmers ownership of their practice again, two recommendations are provided.

Agricultural collective Waadrâne

Agrarisch Collectief Waadrâne is an agricultural collective with about 145 members. The collective is located in the northern coastal strip against the Wadden Sea and works to protect nature. Together, they are committed to the preservation of nature, landscape and biodiversity. To this end, they work together with nature. In this way, they make Northern Friesland even more beautiful by preserving the flora and fauna.

The collective focuses on nature inclusive agriculture, by bringing nature management to the farmers. In this way, nature and agriculture reinforce each other. They carry out responsible management and thus contribute to biodiversity and sustainability in the local living environment. An important focus group for the collective are the farmland birds. They protect nests and postpone mowing so that young chicks can take shelter in the long grass. They also ensure an optimal groundwater level, a good vegetation composition and food availability. In order to provide sufficient foraging areas for meadow birds, they create pond terraces and raise the water level. Another benefit for meadow birds is herb-rich plots and edges, which attract insects. The goal is a healthy meadow and field bird population. The collective acts as a link between farmers, managers and the government and stays close to its members (Agrarisch Collectief Waadrâne, z.d.).



One of the numerous projects of Agraric Collective Waadrâne; planting a 9000 metres long sunflower strip in North Friesland.
Photo: Agraric Collective Waadrâne, 2022.

Hans Kroodsma

Hans Kroodsma has a dairy farm in the north of Friesland. His farm has 150 dairy cows and a total of 85 hectares of land, of which 35 hectares are managed as meadow birds. On this herb-rich meadow he mows later, the water level is higher and he spreads rough manure. This creates good conditions for the meadow birds.

"I think it is wonderful for a farmer to work with nature. The feeling you get in spring when you walk through the meadow with the cows and the many birds around you, that is priceless." Says Hans Kroodsma on the website of the Agrarisch Collectief.

Besides being a dairy farmer, Hans Kroodsma is also chairman of the Agrarisch Collectief Waadrâne. The number of members in the collective is growing steadily, as is the enthusiasm for a nature-inclusive approach. Within the collective, cooperation is very important. For example, they work together with local bird watchers and field bird counters to register the number of nests and birds on the land (Kroodsma, s.d.).

Within his company, Hans Kroodsma emphasises farming with nature and uses an innovative approach. For instance, his cows have access to a spacious, modern greenhouse that lets in a lot of light. His cows are all different. Big, small and with different colours. This is the result of inbreeding Jersey and Scandinavian red pied, as opposed to the well-known black and white Holstein cow. The cows are mainly fed from their own land and receive little concentrated feed. Hans is converting his farm to fully organic. He is switching to full Jersey cows and even more herb-rich grassland. In this way, Hans Kroodsma is creating more diversity on the land and a positive effect on the bird population. Compared to twelve years ago, the number of black-tailed godwits, lapwings and redshanks has doubled (ZuivelZicht, 2020).



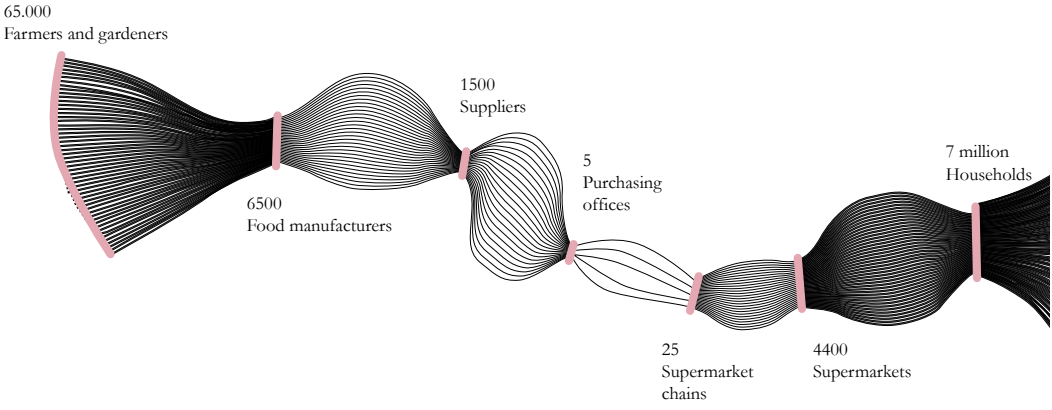
Hans Kroodsma, dairy farmer and chairman of Agrarisch Collectief Waadrâne.
Photo: Agrarisch Collectief Waadrâne, z.d.



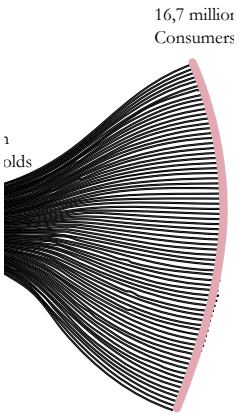


Cows in the barn at Hans Kroodsma's farm.
Photo: Author, 2022.

The distance between consumers and farmers



The middle parties between farmers and consumers.
Image: Planbureau Leefomgeving, 2012. Image edited by author.



In recent decades, the human connection within the food system has been increasingly lost. Because of the many middlemen and traders, consumers often have no idea who made their food or where it comes from. As a result, they also fail to see the social and ecological implications of the production process. Consumers may pick up the cheapest carton of milk from the supermarket shelf, but they do not realise that this creates a monotonous, low-diversity landscape in order to produce this milk as cheaply as possible. On the other hand, farmers often do not know where their products end up, or what a consumer is willing to pay for a certain quality. Margins are very small, and the only thing the farmer can often compete on is price (Fairfood, 2020).

According to former Agriculture Minister Cees Veerman, the current liberalisation of European agricultural policy has become untenable. For him, the abolition of milk quotas, which has led to a collapse in milk prices and a larger manure market, illustrates this is unsustainable. He therefore argues for a return of normative politics, because the prevailing neo-liberal policy does not take into account essential social forces (Beukema, 2016).

As a result of current market forces, most of the profit remains with the intermediate parties between farmer and consumer. This is a shame, because it leaves the farmer less room to implement sustainable developments on his farm, for example changing to organic farming.

These intermediaries earn good money from large-scale agriculture. Together with the farmers' interest group LTO and other representatives of the agro-industry, such as FrieslandCampina, Rabobank, with which 80% of the Dutch farmers are customers, has lobbied the government intensively in order to prevent it from pushing for a reduction in the livestock. And with success. In the coalition agreement of Kabinet Rutte III, all references to shrinkage of livestock have disappeared (Hofs, 2022).



Cows in a field near Jislum in Friesland.
Photo: Jan Dijkstra, z.d.

A change is inevitable

It is inevitable something has to change in the way agricultural practice has been organized, in light of the developments as discussed in this report. Many farmers are cornered and they are trapped in the system. To give farmers ownership in their practice again, two recommendations are done:

_Sustainable, nature-inclusive business management should rewarded, and scaling-up is no longer seen as the norm.

_The farmer is seen as the advocate of the landscape. Local initiatives are rewarded and supported.



View on Friesland's agricultural fields as seen from the seadike.
Photo: Author, 2022.

Earning models

Nature-inclusive agricultural practice means a lower milk yield for the farmer. This is because it focusses more on ecological processes in the landscape. For example, a biodiverse field might be less nutrient-rich for the cows that graze here, but does fit in a more biodiverse ecological system. To be able to function as a nature-inclusive agricultural practice, there must be earning models to balance out the loss in income.

Farmers have been looking for a way to compensate this. Since increased biodiversity, water quality and healthy soil is a social interest that benefits the whole of the Netherlands, you could say that the price should be passed on to the consumer. This would mean a more honest price for the farmer. It might also mean a system change, where many of the middleman in the production process see less revenue and the farmer itself more.

Other ways to compensate the lessened revenue for farmers when producing less milk, could be recreation options for the public, in the form of agrotourism or independently thereof. An example of this is a project Hans Kroodsma is working on, where a small-scale off-grid recreational home will be fitted into the landscape without affecting its surroundings.

It is important to note that a change to nature-inclusive agriculture, which benefits us all, needs to be accompanied by such a revenue model to make it possible.

Design

Land and farmers equilibrium



Drive towards design site.
Photo: Google Maps, 2022.

The aim of the design assignment is to shape a spatial reflection on the future of the Frisian landscape where a new balance is found between agricultural practice, the landscape and ecology. To do so, three strategies are developed; emphasize cultural historic structures, enhance ecological values, and strengthen the vernacular. These are implemented through a design. Ecological corridors are introduced connecting Natura 2000 areas, along with a smaller-scale farm-nature network. This small-scale network consists out of flowery field edges along agricultural plots and stepping stones in the shape of farmyards.

Cultural historic structures and ecological corridors are emphasized by a route design consisting of a boat, a bike and a walking route. The widened ecological corridors are revived to be used by small boats, connecting terps with each other over the water. A biking route connects historic structures, based on the already extensive bike network in the Netherlands. Lastly, a walking route is introduced which crosses through agricultural lands and thus makes the agricultural landscape visible from the inside out.

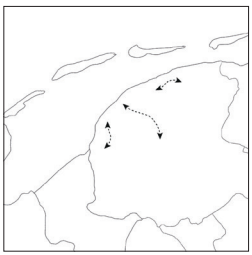
For the site design, we zoom in on the farm of Hans Kroodsma. He has a dairy farm and is part of the Agrarisch Collective Waadrâne, which is committed to preserving nature, landscape and biodiversity. On one of his agricultural lands, a constructed wetland is implemented, functioning as a nature retention area and a water filter. The three route types, walking, cycling and through boat are visible on this small scale. Lastly, a proposal is done on agrotourism types and how they could be implemented.

From the research, three strategies are formulated. They will form a basis for the research by design. The three strategies respond to the research questions and problem statement, and aim to find a new balance between agricultural practice, ecology and landscape topography in the northern province of Friesland.

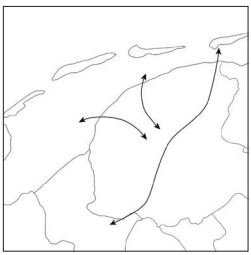
First of all, cultural historic structures are emphasized and function as an inspiration in the design. Friesland has a rich history which is noticeably present in the landscape, which is to be acknowledged and will be a driver in the design.

Secondly, ecological values are enhanced. As seen from the research, biodiversity is declining rapidly. Focussing on ecological corridors, together with nature inclusive agriculture, can influence local ecosystems positively.

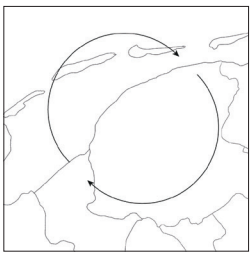
Lastly, a design strategy is to strengthen the vernacular. By working from the site-up, local knowledge is gained. The project aims at celebrating the landscape and the people that live and work here. A routing design aims at showing this to visitors as well, which will also strengthen regional economy.



emphasize cultural historic structures

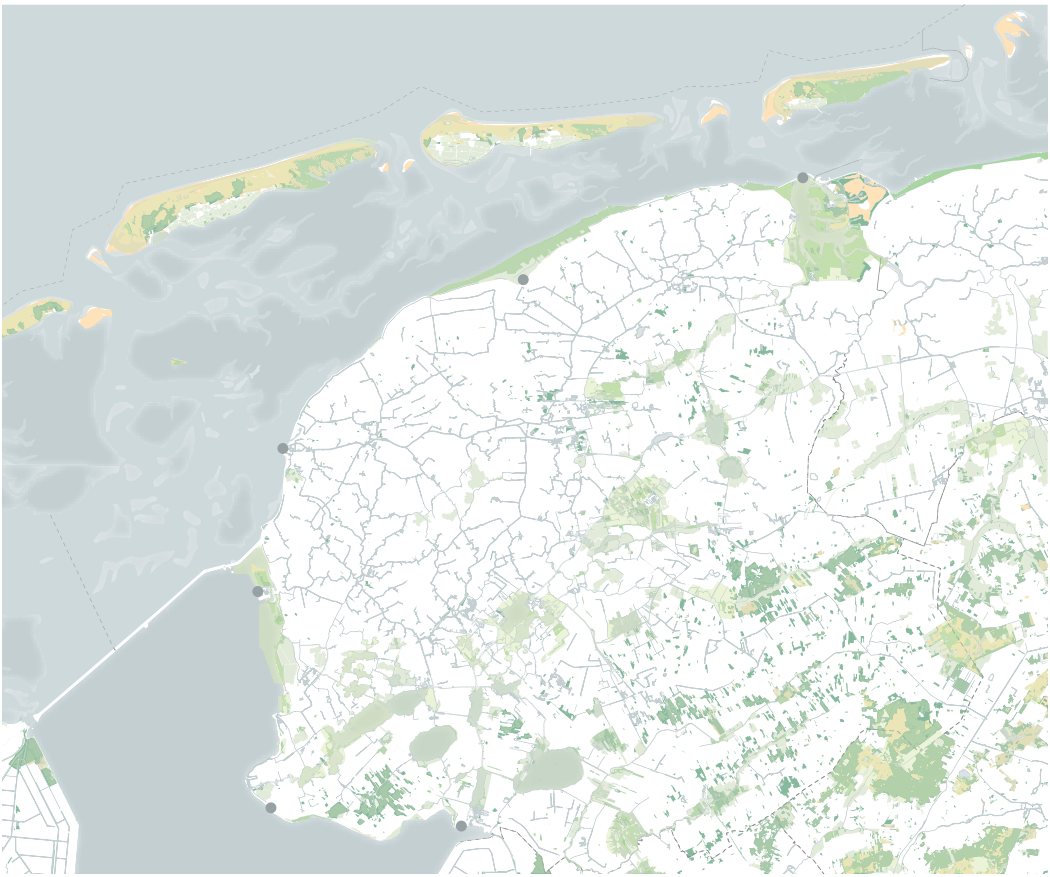


enhance ecological values



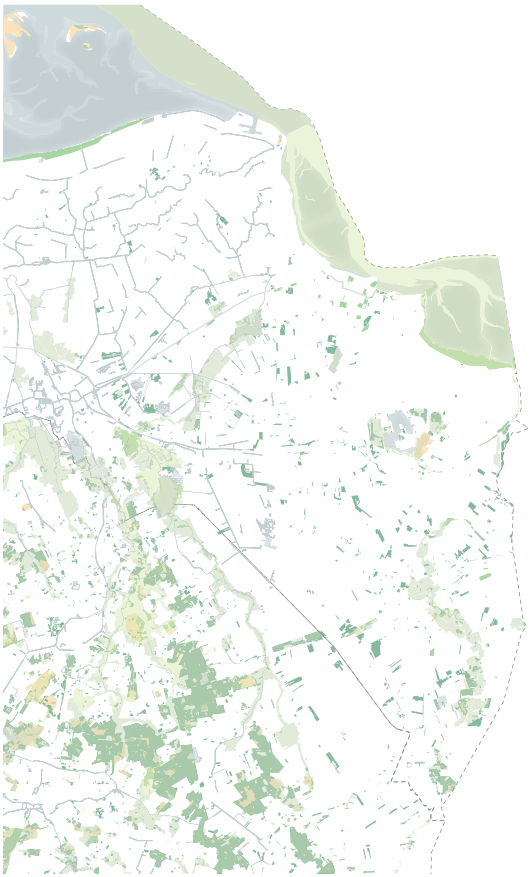
strengthen the vernacular

Existing green structures
Data: Nationaal Georegister



0 10 km 50 km

N

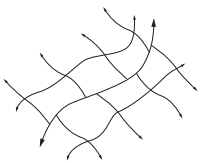


Main water bodies
Natura 2000 Wadden Sea
Natura 2000 and Dutch Nature Network
Sandy nature area
Forest nature area
Wet nature area

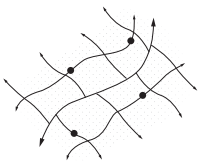
As seen from the analysis, along the coast of Friesland less nature areas can be found. To strengthen this and other regions ecology, ecological corridors are introduced connecting Natura 2000 areas, along with a smaller scale farm-nature network. This small-scale network consists out of flowery field edges along agricultural plots and stepping stones in the shape of farmyards.



main ecological water corridors



small-scale nature network; flowery field edges



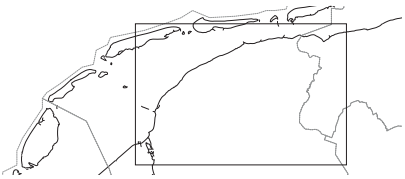
stepping stones; farm yards and biodiverse fields

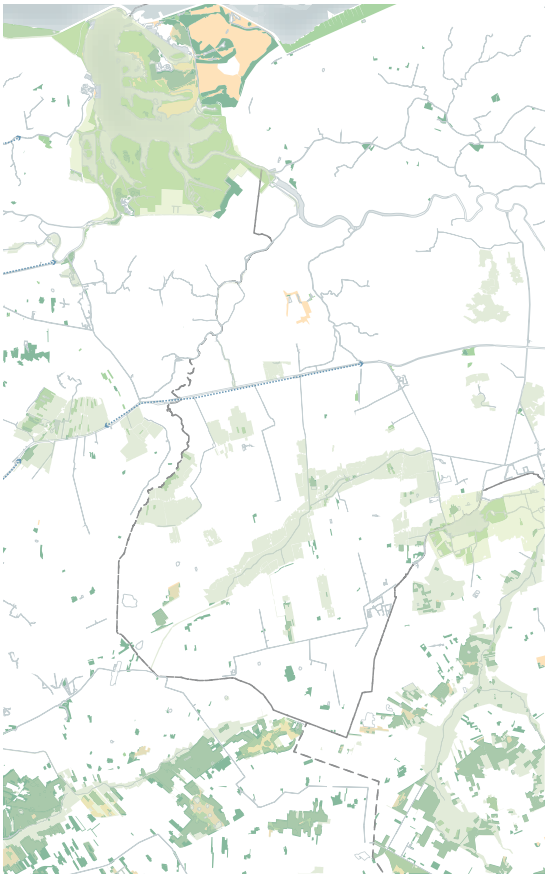
Main ecological corridors



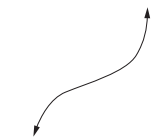
0 10 km 50 km

N





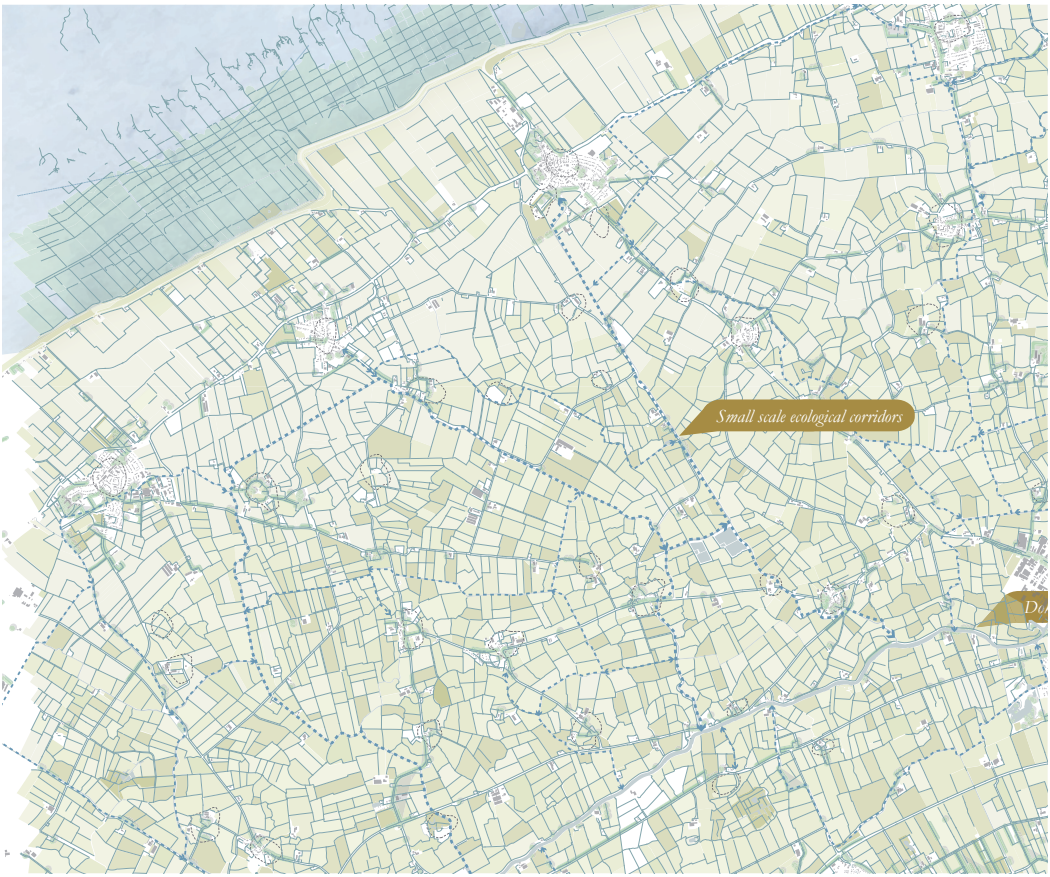
The ecological corridors consist out of existing waterways which will be ecologically improved, connecting Natura 2000 areas. On a smaller scale local waterways will be improved.

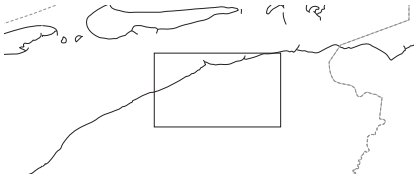


main ecological watercorridors

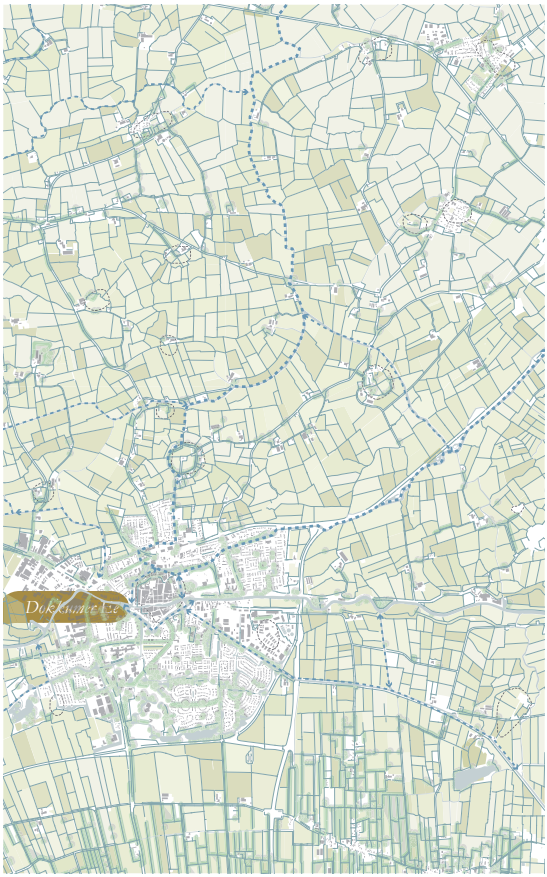
- Main ecological water corridors
- Main water bodies
- Natura 2000 Wadden Sea
- Natura 2000 and Dutch Nature Network
- Sandy nature area
- Forest nature area
- Wet nature area

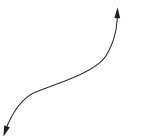
Main and secondary ecological corridors





Zooming in, the main ecological corridor can be seen, the Dokkumer Ee, and the smaller ecological corridors forming a small-scale network in North-Friesland.



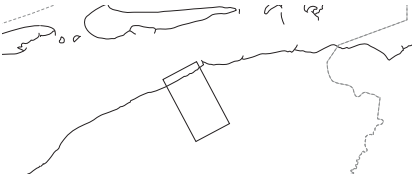


main ecological water corridors

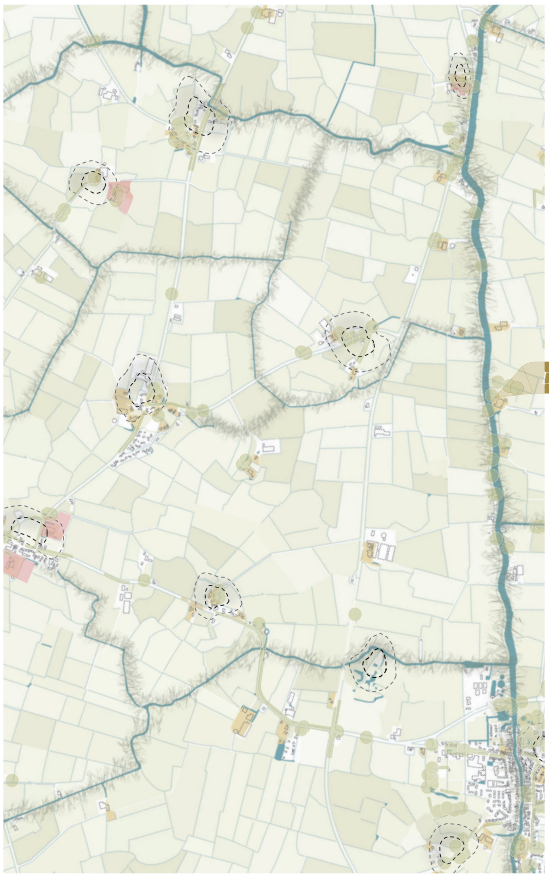
- Main and secondary ecological water corridors
- Trees
- Livestock farming
- Crop production
- Build environment
- Terps

Main and secondary ecological corridors





Zooming further in, the small ecological corridors are visible which are also historic structures. Most were once dug to connect terp villages with each other. Some made use of existing waterways.

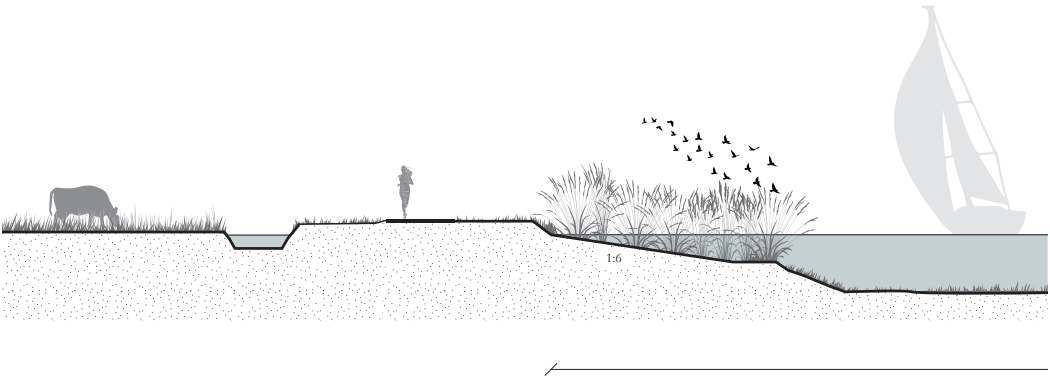


main ecological water corridors

Enhanced ecological corridors
Livestock farming
Crop production
Terps
Stinzen, stanzen and churches
Build environment
Trees
Historical farmyards
Waterways

Ecological corridor the Dokkumer Ee

2022



Fast growing grasses



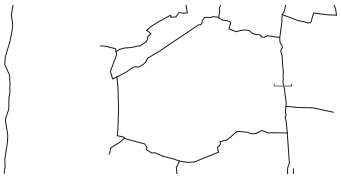
Lolium perenne

Reets

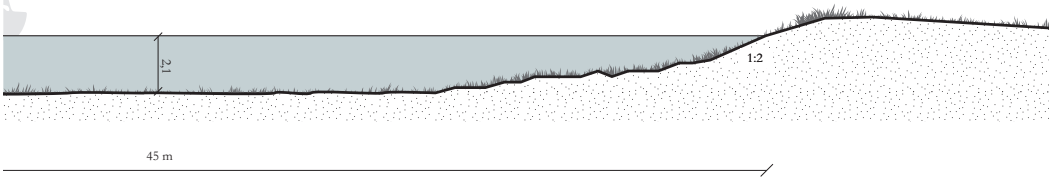


Phragmites australis

0 2 m 10 m

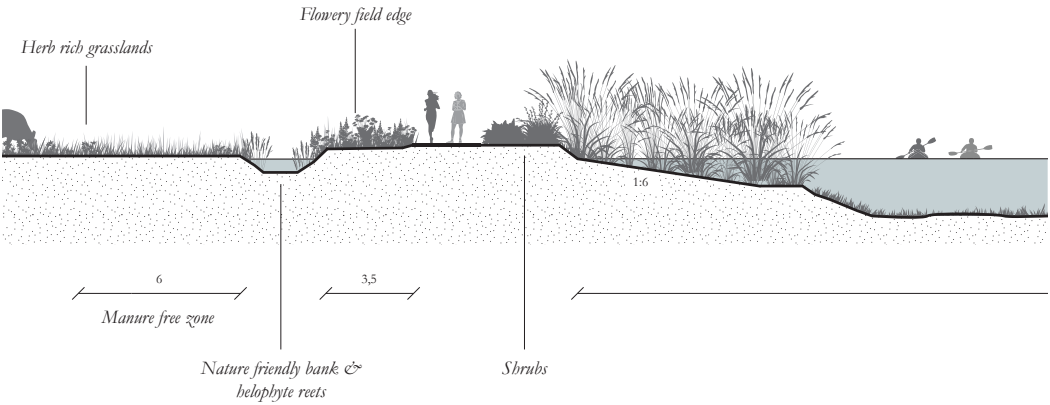


The Dokkumer Ee is a much used waterway and part of a sailboat route through North Friesland. In the current situation, the wide waterway has on one bank a reedbank. The other side can be ecologically improved. On the adjacent grasslands, mostly an non-biodiverse grass mixture is present consisting mostly of English rye grasses.

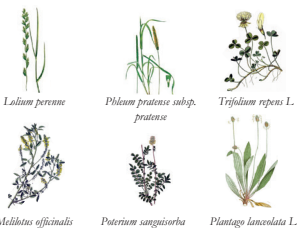


Ecological corridor the Dokkumer Ee

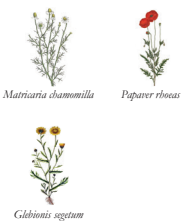
2025



Grasses, herbs and clovers



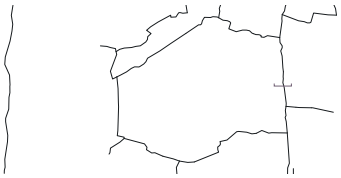
Flower mix



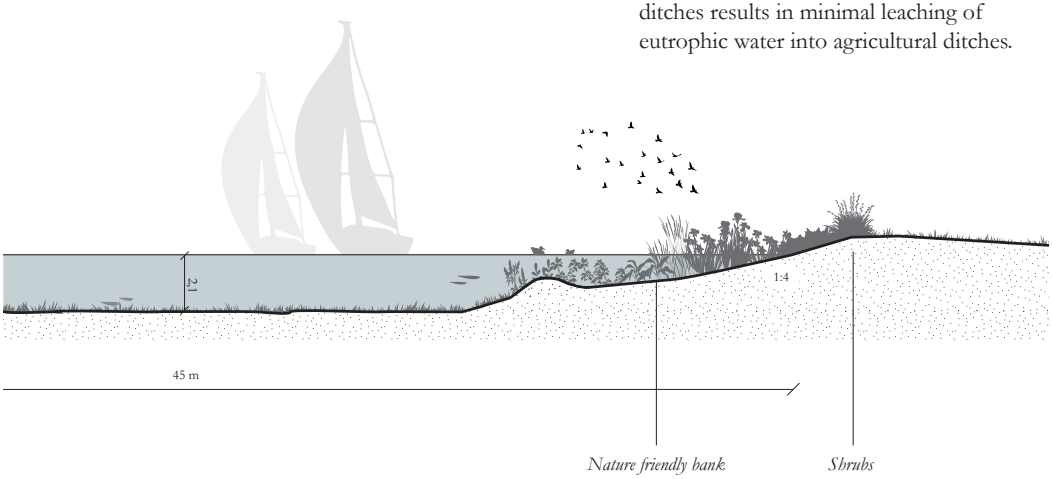
Reets and other helophytes

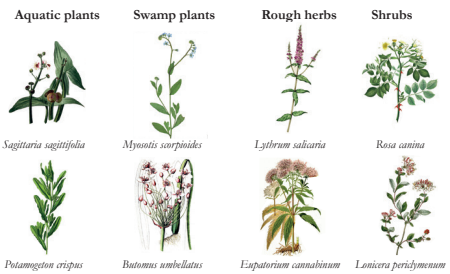


0 2 m 10 m



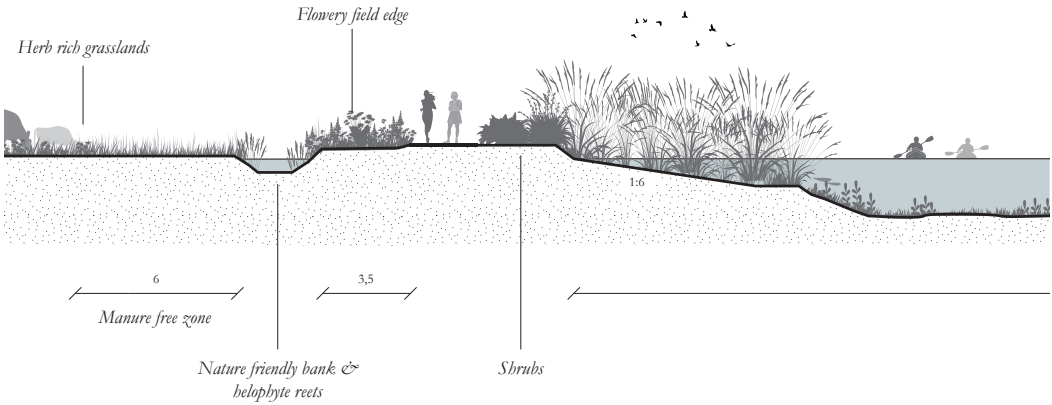
In three years, on the right side a nature-friendly bank is introduced. Flowery field edges, part of the small-scale nature network are seen adjacent to the agricultural fields. The grasslands themselves have a more biodiverse mixture of grasses. A manure free zone next to agricultural ditches results in minimal leaching of eutrophic water into agricultural ditches.



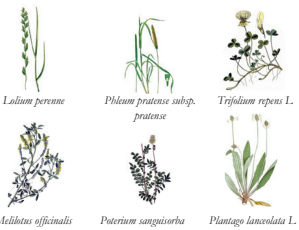


Ecological corridor the Dokkumer Ee

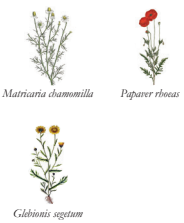
2030



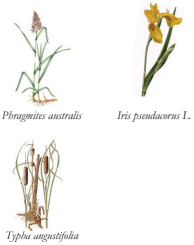
Grasses, herbs and clovers



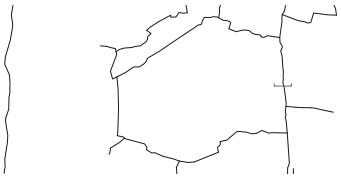
Flower mix



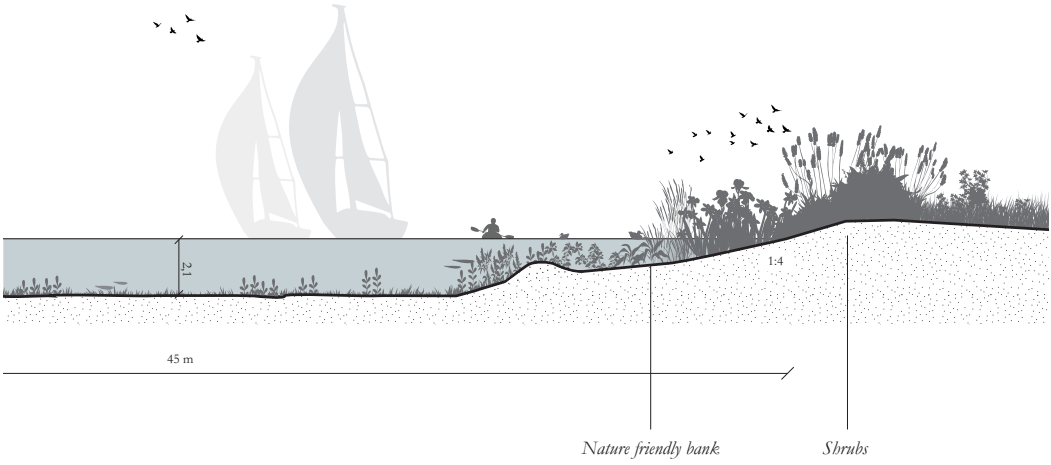
Reets and other helophytes

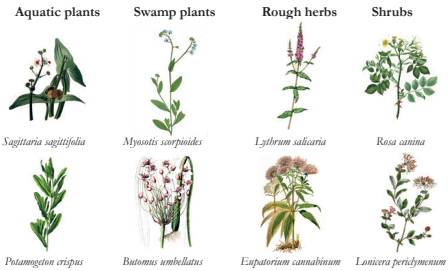


0 2 m 10 m



Next to an ecological improvement, the canal will also be an even more attractive environment to visitors. A canoe route, explained later in this thesis, runs through the Dokkumer Ee and into the smaller scale ecological water corridors.



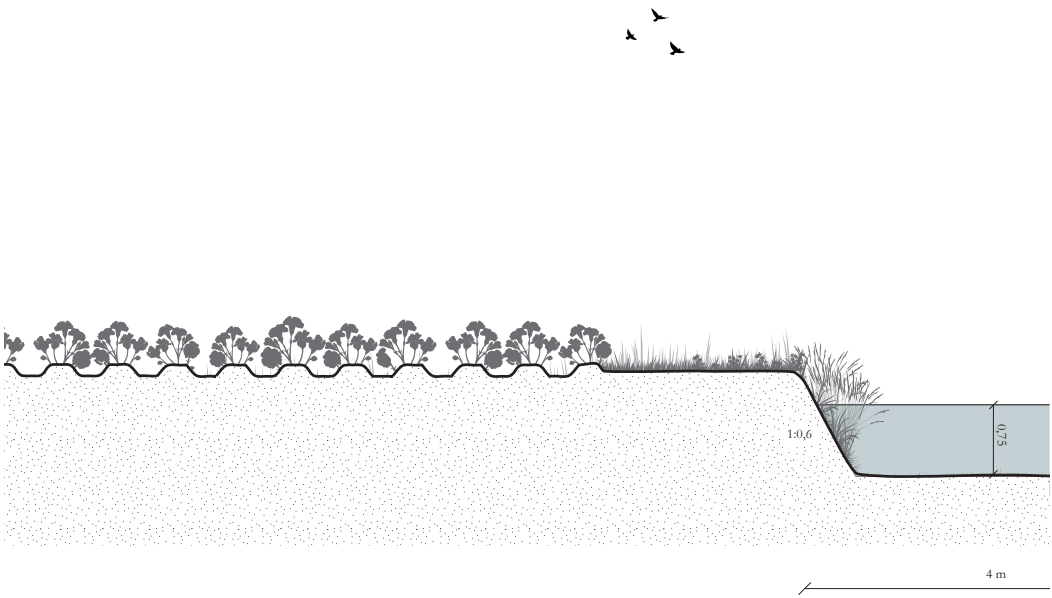






The Dokkumer Ee.
Photo: Mapio, z.d.

Secondary ecological corridor
2022



Crops


Solanum tuberosum


Triticum aestivum

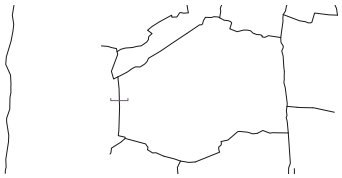

Beta vulgaris subsp. vulgaris


Daucus carota

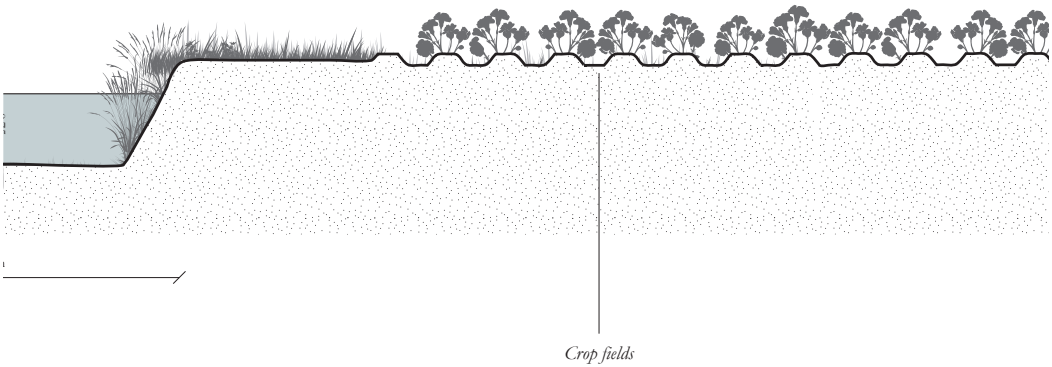
Grasses and reets


Phragmites australis

0 2 m 5 m

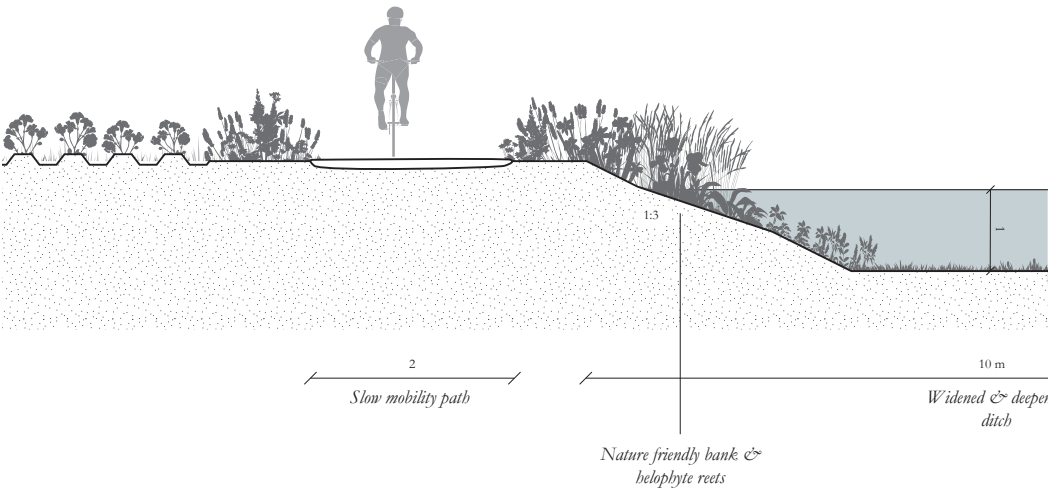


The smaller waterways in the area will also act as ecological corridors. They are now narrow waterways in-between farmlands, with steep banks.



Secondary ecological corridor

2030



Crops



Solanum tuberosum



Triticum aestivum



Beta vulgaris subsp. vulgaris



Daucus carota

Path



Clay shells

Reets and other helophytes



Phragmites australis

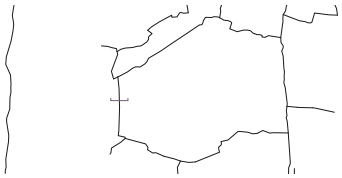


Iris pseudacorus L.

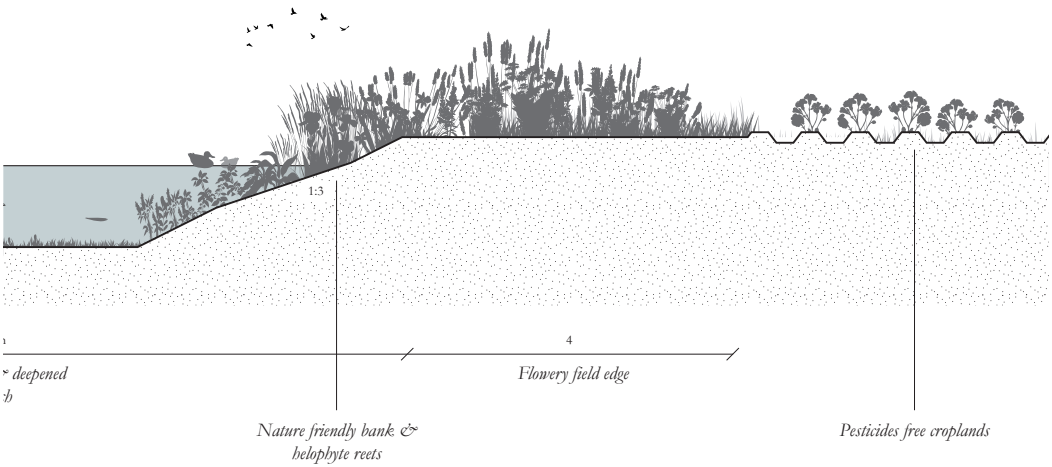


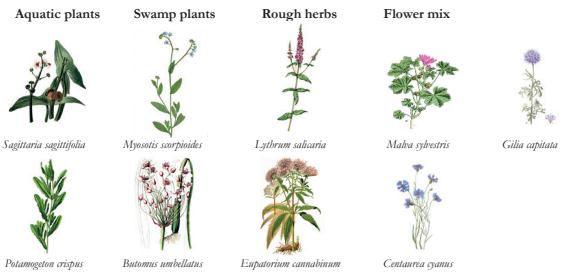
Typha angustifolia

0 2 m 5 m



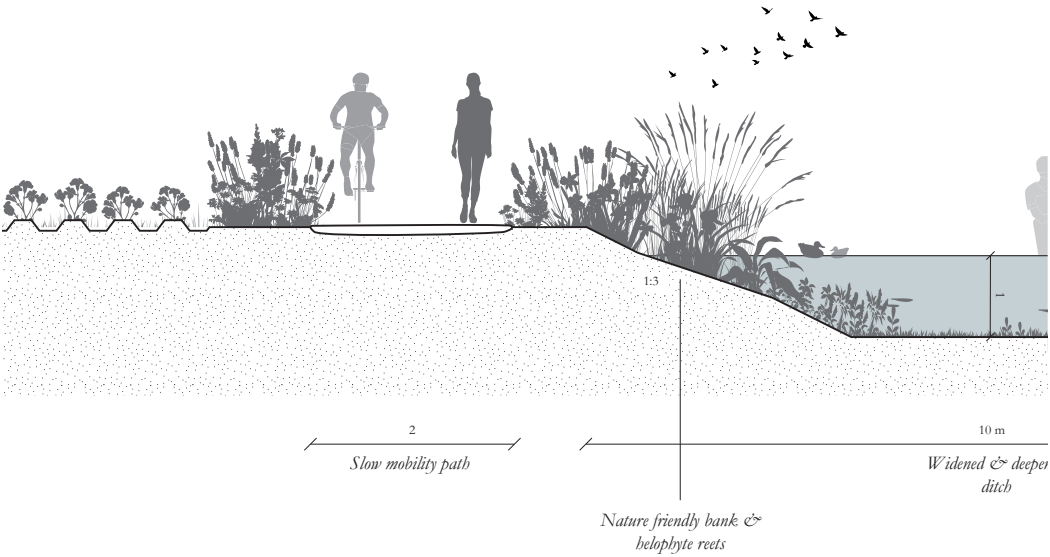
By widening them, more water retention is ensured and this water buffer is a useful source during droughts for farmers. A path next to the water is part of a cultural route through the area. The path is made from clay shells, a by-product from ongoing dredging of the main waterway in the Wadden Sea, next to the coast of Friesland.





Secondary ecological corridor

2050



Crops



Solanum tuberosum



Triticum aestivum



Beta vulgaris subsp. vulgaris



Daucus carota

Path



Clay shells

Reets and other helophytes



Phragmites australis

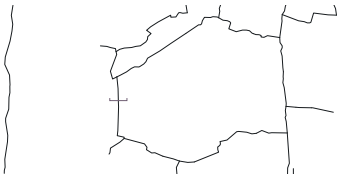


Iris pseudacorus L.

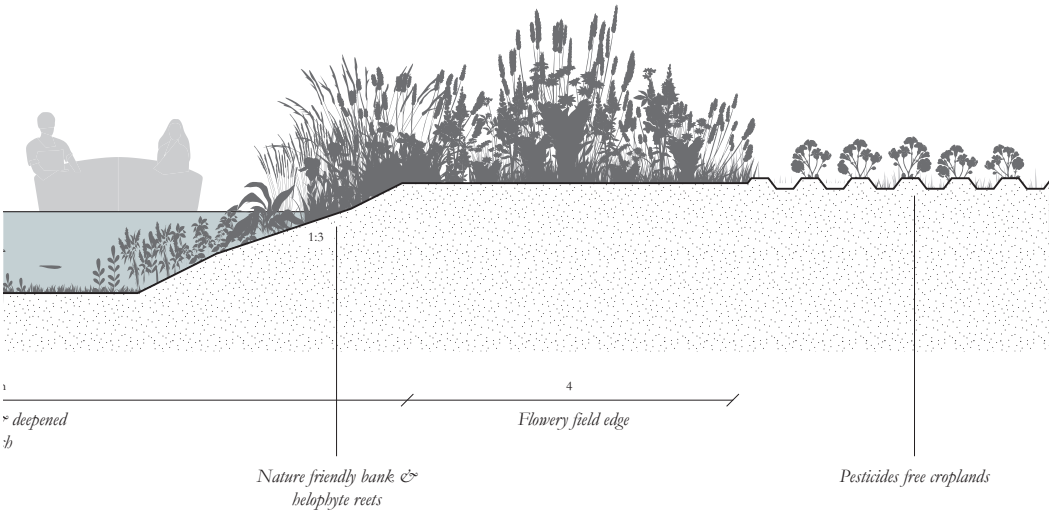


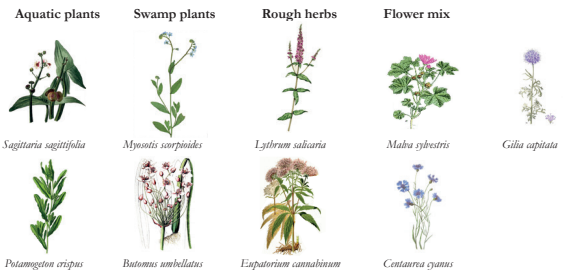
Typha angustifolia

0 2 m 5 m



Next to water retention, a widened waterway also gives opportunities to make the waterways accessible again for small boats and canoes. Once these waterways were the main infrastructure in the area, connecting the terp villages with each other.





Ecological corridor the Dokkumer Ee

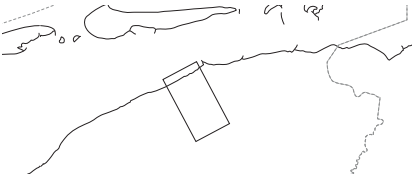


Agricultural nature network



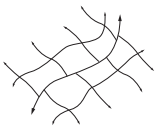
0 1 3 km

N

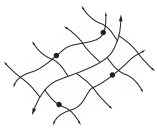




Next to the main ecological corridors a small-scale nature network is implemented. As this network consists out of flowery field edges along agricultural fields, the term agricultural-nature-network is introduced, “boeren-natuurnetwerk” in Dutch. It is a term first mentioned by Hans Kroodsma during our conversations about the area. Next to the flowery field edges, farms themselves are appointed as stepping stones. Historically, farm yards were biodiverse sites and attracted many animals. This was due to the green character of the farm yards; often a small vegetable garden was situated next to the house, or a small orchard. Still nowadays farms are typically surrounded by trees and their undergrowth, perfect places for small mammals, as for example the hedgehog, to scurry around.



small-scale nature network; flowery field edges



stepping stones; farm yards and biodiverse fields

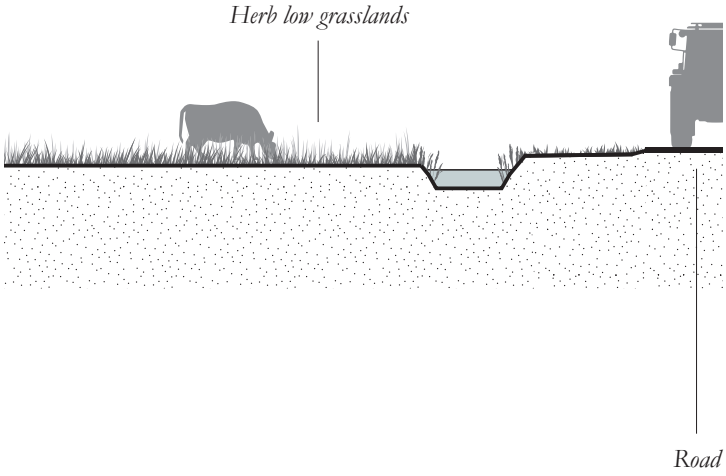
Flowery field edges
Stepping stones
Livestock farming
Crop production
Terps
Stinzen, stanzen and churches

Build environment
Trees
Historical farmyards
Waterways

Flowery field edges

In the current situation, often the edge of grasslands consists only of a ditch. By introducing a flowery field edge, an intricate small-scale nature network is achieved.

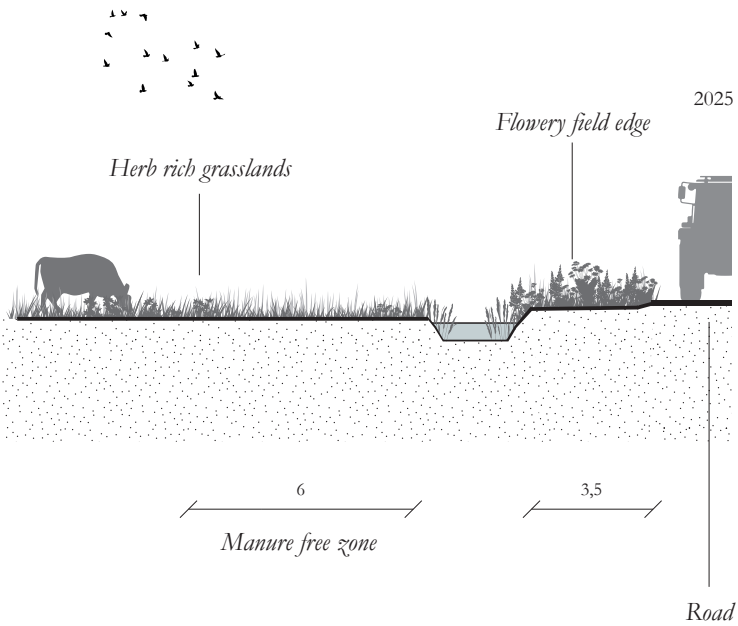
2022



Fast growing grasses



olium perenne



Grasses, herbs and clovers



Lolium perenne



Phleum pratense subsp. pratense



Trifolium repens L.



Melilotus officinalis



Poterium sanguisorba



Plantago lanceolata L.

Flower mix



Matricaria chamomilla

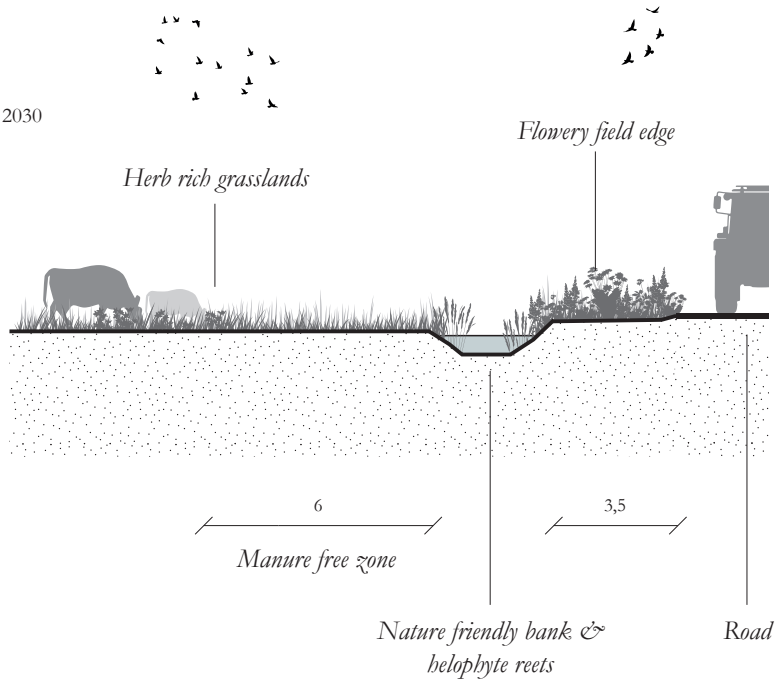


Papaver rhoeas



Glebionis segetum

2030



Grasses, herbs and clovers


Lolium perenne


Phleum pratense subsp. pratense


Trifolium repens L.


Melilotus officinalis


Poterium sanguisorba


Plantago lanceolata L.

Flower mix


Matricaria chamomilla


Papaver rhoeas


Glebionis segetum

North-Friesland is an area of great value for meadow birds. Originally it was an open landscape, which has generally been preserved well. Important meadow birds are the black-tailed godwit, lapwing, oystercatcher, redshank, yellow wagtail and meadow pipit. Meadow birds are especially positively effected by biodiverse grasslands, and even more when water levels are kept higher. This makes it easier for them to find food such as worms. Nest protection and delayed mowing are also of great value to these birds. These are all measures that the Agrarisch Collectief Waadrâne is actively focussing on.

Flowery field edges attract numerous animals. Due to the large variety of flowers and herbs in these edges, they automatically attract insects and they in their turn, attract birds and small mammals. The presence of insects also cause farmers to have to use less pesticides as a natural balance will be put in place by the diversity of insects.



black-tailed godwit
(grutto)



redshank
(tureluur)

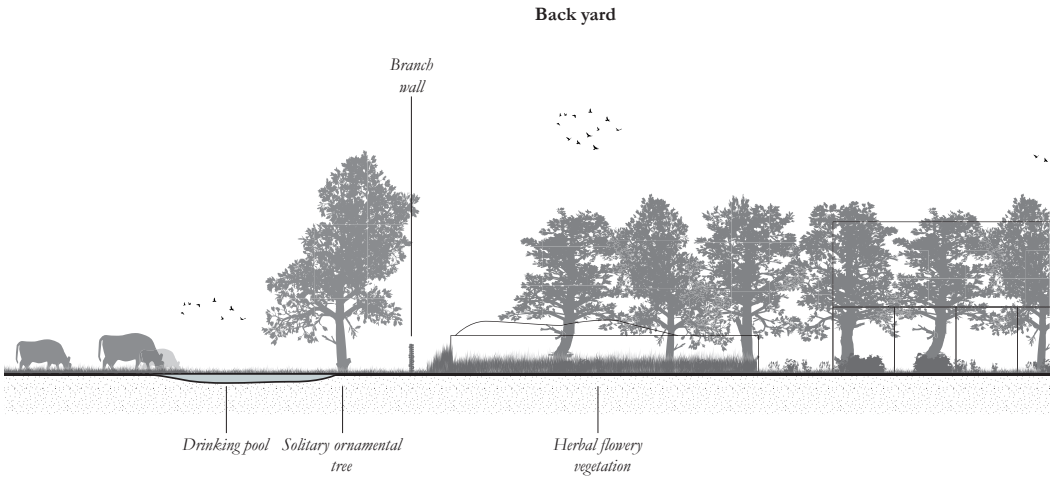


oystercatcher
(scholekster)



lapwing
(kievit)

The farm as a stepping stone



Historically seen, farmyards were quite biodiverse places in the landscape. Characteristically the Frisian farm had a front, side and a backyard. Each of these had a different function, such as ornamental plants in the front, a small vegetable garden or orchard at the side, and a connection with the surrounding landscape in the back. By using this as an inspiration for the modern farmyard, the farms will increase their function as a stepping stone in the landscape for numerous birds, insects and mammals.

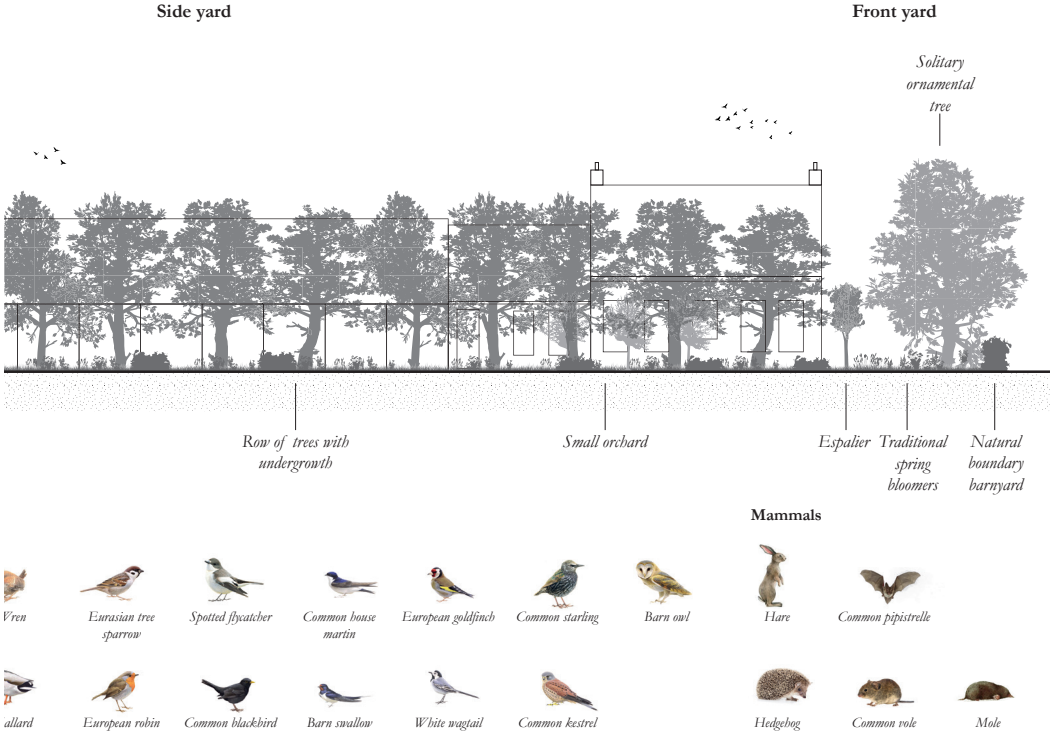


Image by author. Inspiration taken from the project 'Bioferskaat op it Fryske boerehiem: Sa kin dat!'
Data: Living Lab Fryslân, 2021.

Farmers nature network

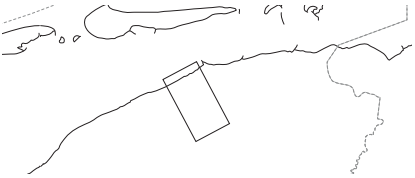


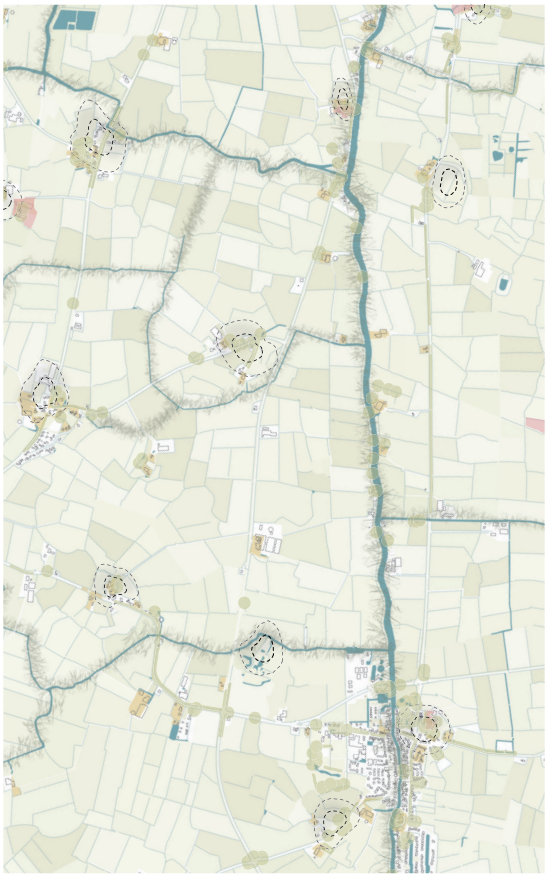
Route design



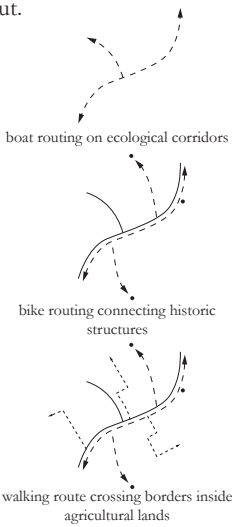
0 2 5 km

N



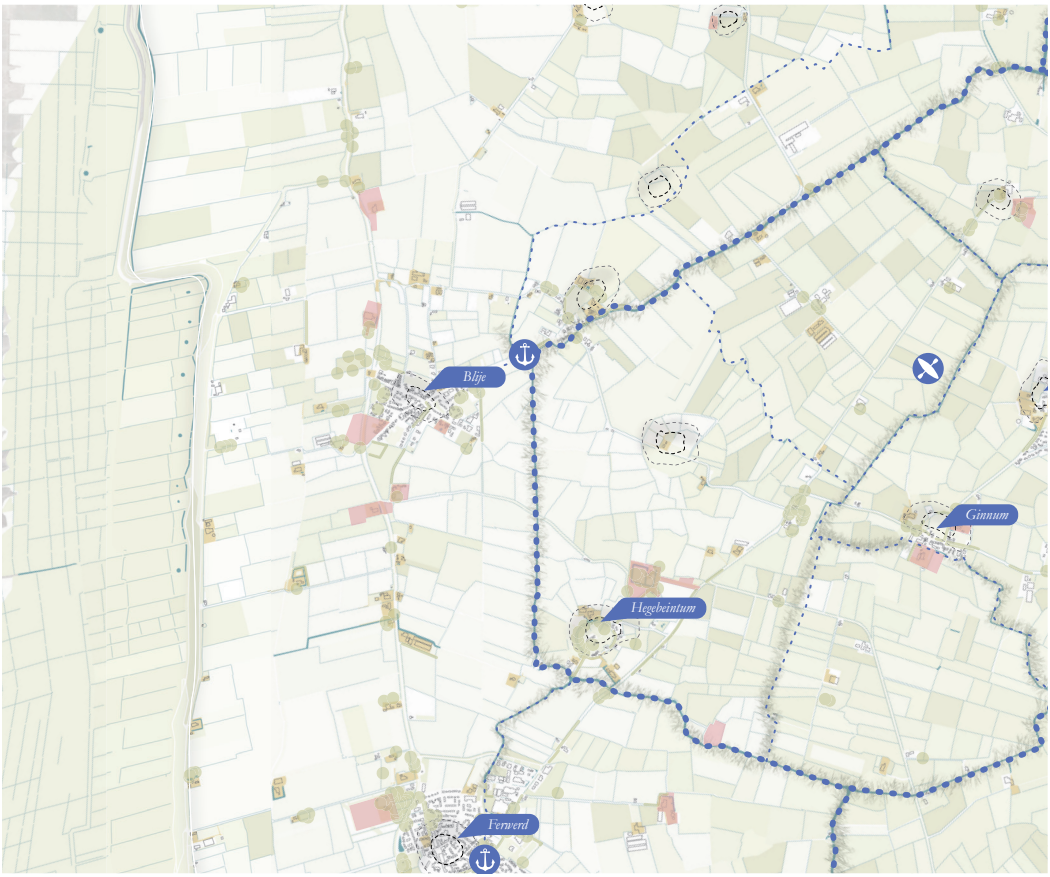


Cultural historic structures and ecological corridors are emphasized by a route design consisting of a boat, a bike and a walking route. The widened ecological corridors are revived to be used by small boats, connecting terps with each other over the water. A biking route connects historic structures, based on the already extensive bike network in the Netherlands. Lastly, a walking route is introduced which crosses through agricultural lands and thus makes the agricultural landscape visible from the inside out.



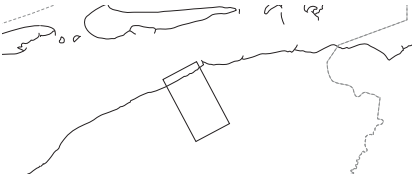
Enhanced ecological corridors
Livestock farming
Crop production
Terps
Stinzen, stanzen and churches
Build environment
Trees
Historical farmyards
Waterways

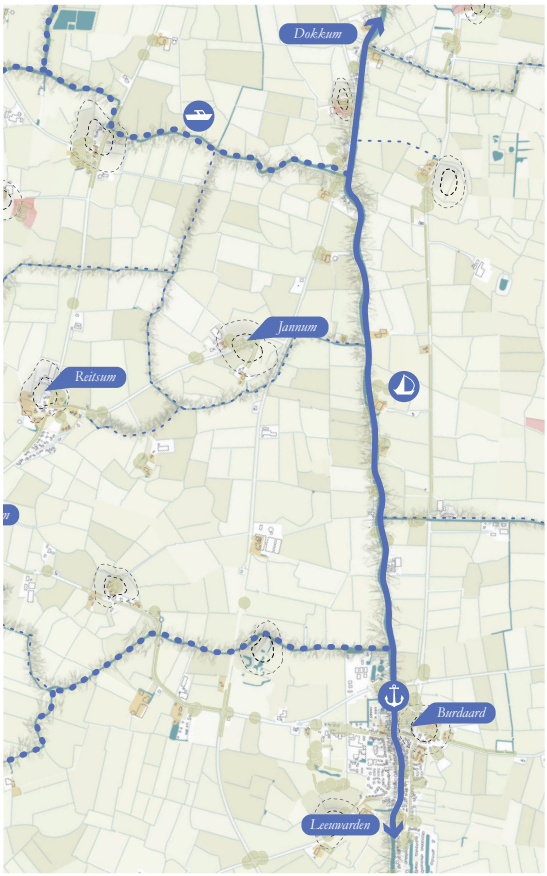
Boat routing



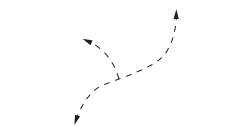
0 2 5 km

N





The boat routing takes course over the main waterway the Dokkumer Ee. This canal is part of a sailing route. From this route several smaller waterways branch into the landscape. One circle route is created for small boats of around 10 km. From this route again smaller waterways branch which are accessible for canoes. The historic terp infrastructure is in use again, but this time with a touristic purpose. Existing harbours in small villages are places to dock and small platforms can be used along the way for this purpose.



boat routing on ecological corridors

Existing boat route
New motorized boats route
New canoe route
Harbours
Small docks
Enhanced ecological corridors
Build environment

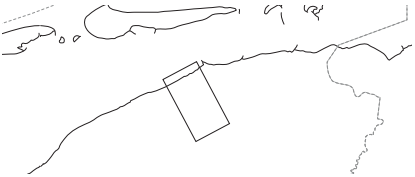
Trees
Historical farmyards
Waterways
Lifestock farming
Crop production
Terps
Stinzen, stanzen and churches

Bike routing



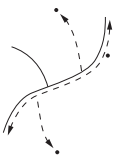
0 2 5 km

N





The Netherlands has an extensive bike network with numbered nodes. In the route on the left the biking route connects historic structures and the ecological corridors in the area, while linking to the larger scale bike network. The area is accessed through often used routes as the bike path on the sea dike, and the bike path along the Dokkumer Ee.



bike routing connecting historic structures

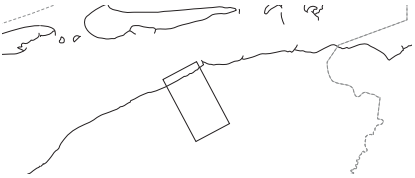
Existing bike route
New bike route
Resting stop
Dairy farm visit
Crop farm visit
Enhanced ecological corridors
Build environment

Trees
Historical farmyards
Waterways
Livestock farming
Crop production
Terps
Stinzen, stanzen and churches

Walk routing

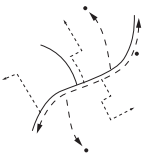


0 2 5 km





Lastly, walking paths are introduced through agricultural lands. They connect further on with the bike network and cross borders of allotments. Generally, agricultural lands are seen from the outside looking in; by turning this around a new landscape is discovered from the inside out. It could also introduce a new relationship between farmer and consumer; people are invited on agricultural lands to experience the viewpoint from the farmer, and its relationship with the landscape. Agrotourism can play a role in this. Organizing excursions on a farm can introduce a deeper understanding to consumers about the work of a farmer, its care of the agricultural, cultural landscape and might encourage consumers to buy their food through a shorter food chain.



walking route crossing borders inside agricultural lands

Existing walk route
New walk route
Resting stop
Dairy farm visit
Crop farm visit
Enhanced ecological corridors
Build environment

Trees
Historical farmyards
Waterways
Livestock farming
Crop production
Terps
Stinzen, stanzen and churches





Excursion at Hoeve 't Boschend, Noord-Brabant.
Photo: Hoeve 't Boschend, z.d.

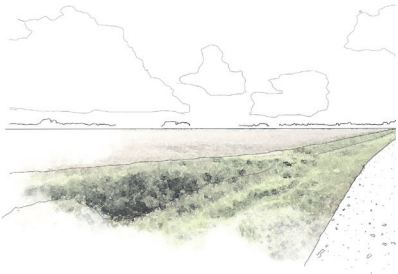
Serial vision

Walk routing

During the walking route a cultural historic landscape crossed, where its experience is expressed in this serial vision.



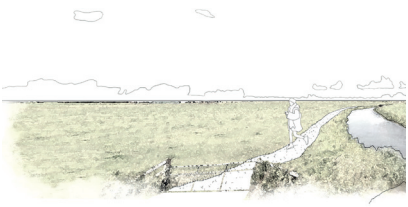
1



2



4



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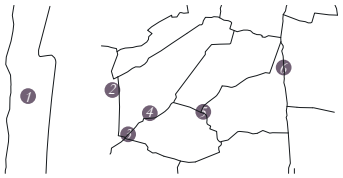
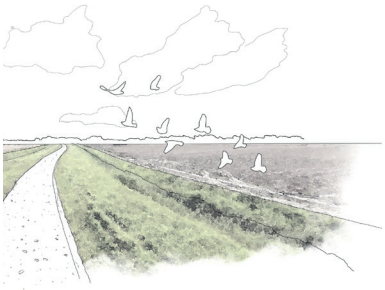






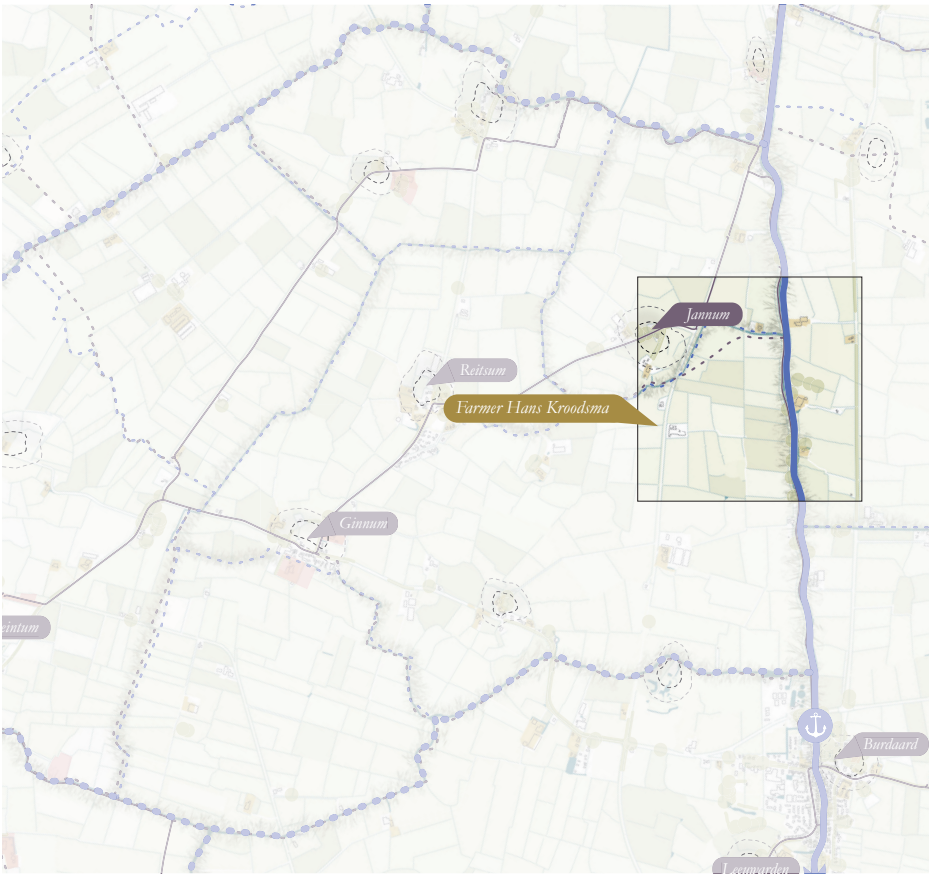
3





6

Site design



0 2 5 km

For the site design, we zoom in on the farm of Hans Kroodsma. As mentioned earlier, he has a dairy farm and is part of the Agricultural Collective Waadrâne, which is committed to preserving nature, landscape and biodiversity. Hans Kroodsma has numerous ideas for the landscape surrounding his farm, with a focus on enhancing biodiversity and emphasizing cultural historic structures. He sends me a sketch with some of his ideas, one part of which consists of a retention area on one of his agricultural lands.



Sketch landscape ideas
Sketch: Hans Kroodsma, 2022.

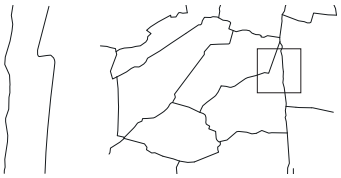
Constructed wetland



Walking path
Marshland helophytes
Reeds and marshland helophytes
Reeds helophytes
Grasslands
Ecological water corridor
Biodiverse field edges

0 200 500 m

N



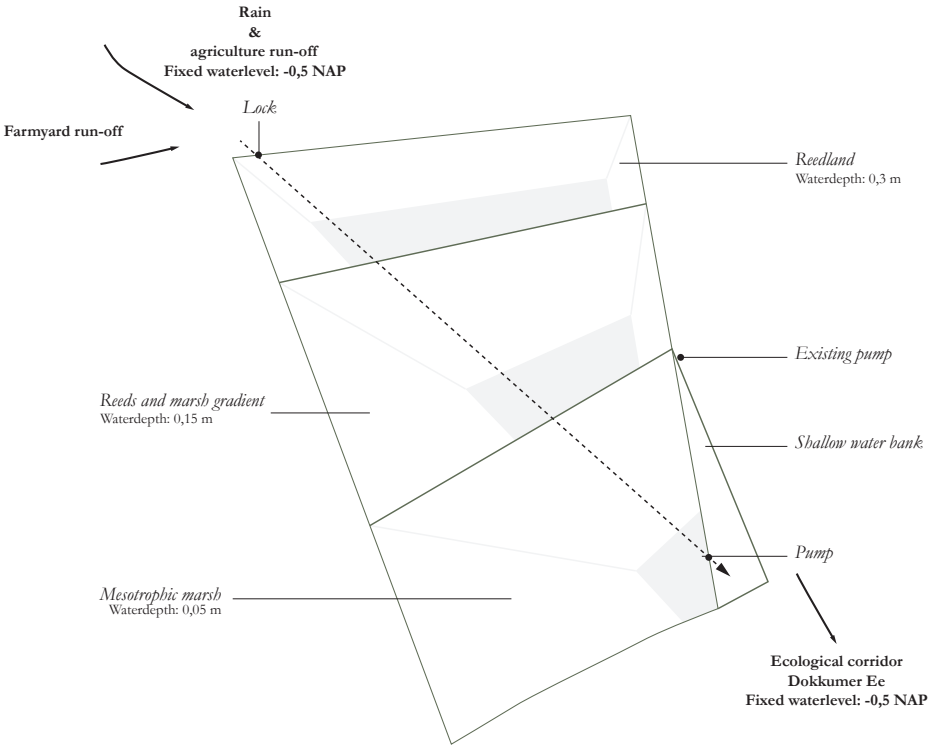
After a conversation about the retention area, Hans elaborates that he sees it as a wet grassland area with the goal of enhancing the meadow birds habitat. Focussing on this area, this idea is elaborated on by incorporating a water filtering function to it. A constructed wetland, also called a helophyte filter, is projected onto this area, making use of the allotment structure already present.

There are several different types of helophyte filters, but the simplest type is the flow field which is applied here. A flow field is a shallow, wide water passage through which the water to be treated flows. The flow field has a depth varying from 30 to 80 cm and is overgrown with helophytes. These are plants such as for example reed plants, which is the most commonly plant for this goal. Many biological, physical and biochemical processes take place in the flow field which filter the water. The purification effect of the flow field is mainly based on diffusion and sedimentation of suspended matter to the water bed. Organic material is broken down and nutrients are absorbed and converted by bacteria, micro-organisms and plants.



Orthogonal photo of design site.
Sketch: Google Earth, 2022.

Workings constructed wetland



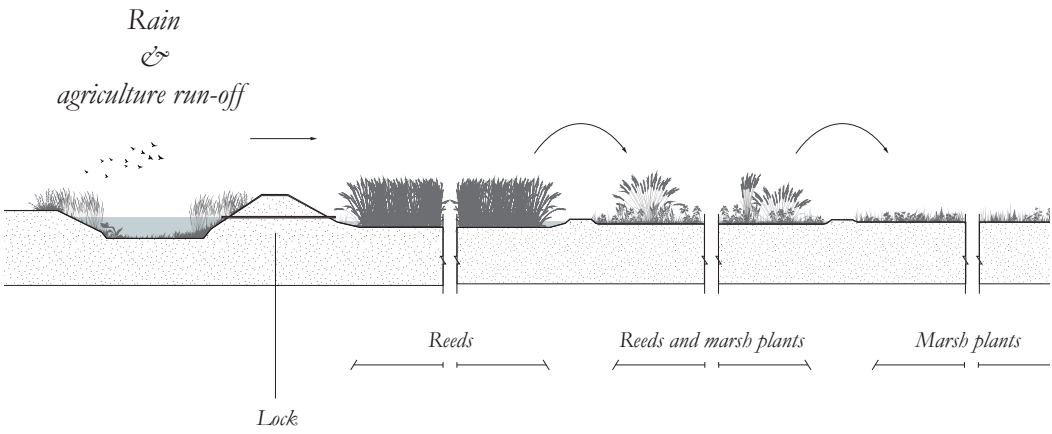




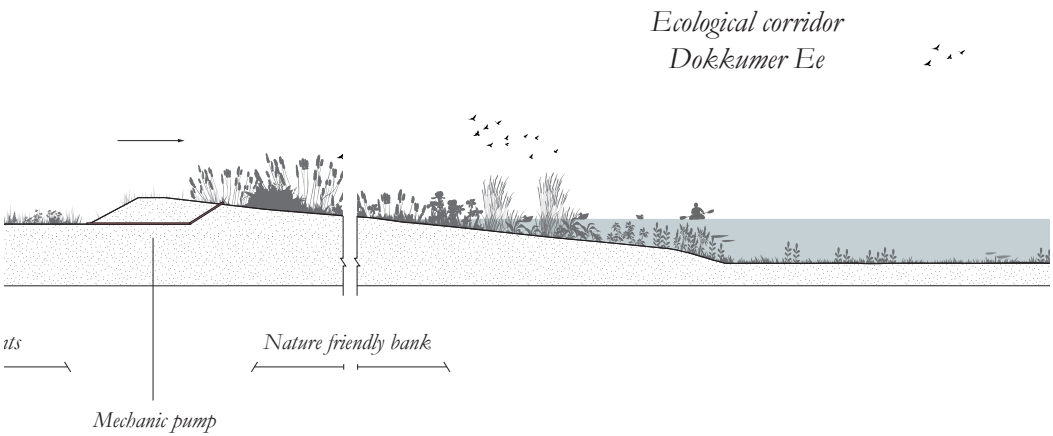


The agricultural water run-off from farmland in the area and water run-off from the farmyard of farmer Hans runs through the plants across the bottom of the swamp, until it is discharged at the end of the flow field into the Dokkumer Ee. Eventually the water in North Friesland is discharged into the Wadden Sea. This extensive natural treatment can help remove excess nutrients in the water, such as nitrogen and phosphorous and micro pollutants. To work correctly, a high amount of surface is needed for the flow field, which is present here in the form of agricultural lands. Next to the result of cleaner water, the constructed wetland adds value to the land as being a natural filter and an enrichment to the environment and biodiversity. As water flows through the filter, it gets more clean along the way. This is visually noticeable in the types of plants present. At the start of the filter, a bed of reed plants is present, which does most of the filtering work. At the end of the beds, before entering the Dokkumer Ee, there is a mesotrophic marshland present which houses different kinds of plants. In-between these 2 beds, a gradient is seen in these types of plants.

Workings constructed wetland
Section 2050

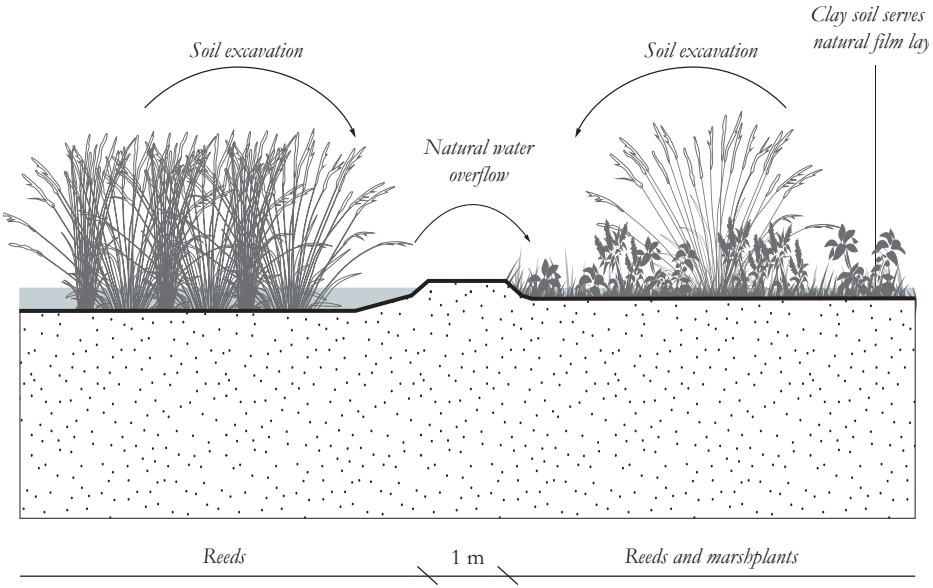


On the left, water is brought in from an agricultural ditch. Instead of immediately discharging into the Dokkumer Ee, the water flows through the constructed wetland from bed to bed by use of small dikes which overflow when the water gets higher. Water is brought into the wetland by use of a lock, and water is discharged into the Dokkumer Ee by a mechanic pump.



Workings constructed wetland

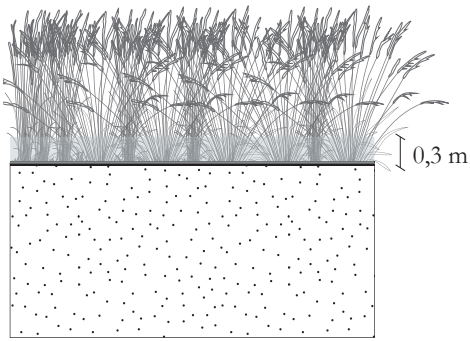
Detail

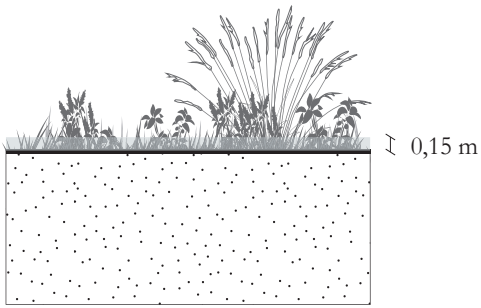


The soil in North-Friesland consists out of clay, and forms a natural film layer to prevent water seepage. During construction of the wetland, a thin layer of soil needs to be excavated to construct three different water depths in the beds. The soil excavated is used to build the small dikes separating the different beds from each other.

Workings constructed wetland

Detail winter situation





Reeds ~ 3,5 ha



Phragmites australis



Schoenoplectus lacustris



Typha angustifolia

Reeds and marshplants ~ 8,5 ha



Lysimachia nummularia



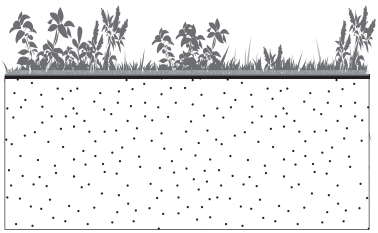
Myosotis scorpioides subsp. scorpioides



Salix repens



Rhinanthus angustifolius



The three different types of vegetation beds present in the constructed wetland are a reed bed, a bed consisting out of reeds and marsh plants and a marsh bed. Bacteria in their roots provide the water filtration. The three types of vegetation all add to a biodiverse wetland, where specifically the last two form interesting and valuable foraging meadows for meadow birds. On the left a winter situation is seen, when there is an excess of water and the wetland has a filtering function.

Mesotrophic marshland ~ 6,5 ha


Parnassia palustris

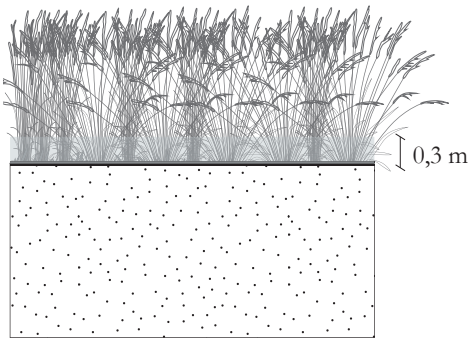

Dactylorhiza praetermissa

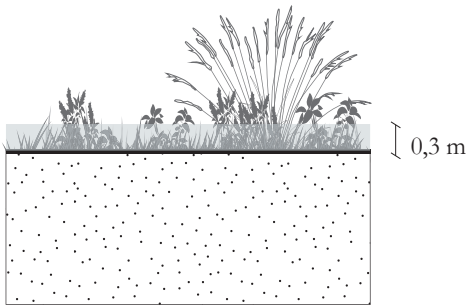

Lythrum salicaria


Rhinanthus angustifolius

Workings constructed wetland

Detail summer situation





Reeds ~ 3,5 ha



Phragmites australis



Schoenoplectus lacustris



Typha angustifolia

Reeds and marshplants ~ 8,5 ha



Lysimachia nummularia



Myosotis scorpioides subsp. scorpioides

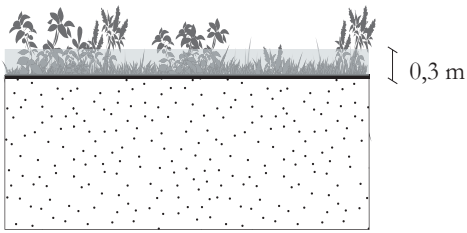


Salix repens



Rhinanthus angustifolius

In summer, farmers might want to retain water to be able to use it during droughts. In this case, the pump facilitates flexibility and the water can be retained in the wetland. Because of this flexibility, the farmer can decide when and how to use the wetland. During nesting periods in spring for example, the wetland can be partly drained to facilitate the meadow birds.



Mesotrophic marshland ~ 6,5 ha



Parnassia palustris



Dactylorhiza praetermissa



Lythrum salicaria



Rhinanthus angustifolius





Het Kleimeer, a meadow area with a high water table and lots of birds.
Photo: Staatsbosbeheer, z.d.

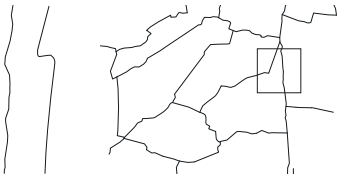
Nature network



Ecological water corridor
Biodiverse field edges
Grasslands
Walking path
Marshland helophytes
Open water helophytes
Reeds helophytes

0 200 500 m

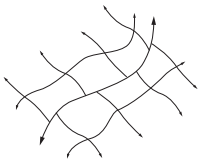
N



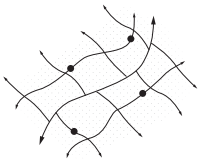
On this smaller scale the farmer-nature network becomes visible. Allotment edges are sown with a diverse flower and herb mixture. Farms themselves form stepping stones in the landscape and a small ecological corridor branches from the Dokkumer Ee; the main ecological corridor in this area.



main ecological water corridors



small-scale nature network; flowery field edges



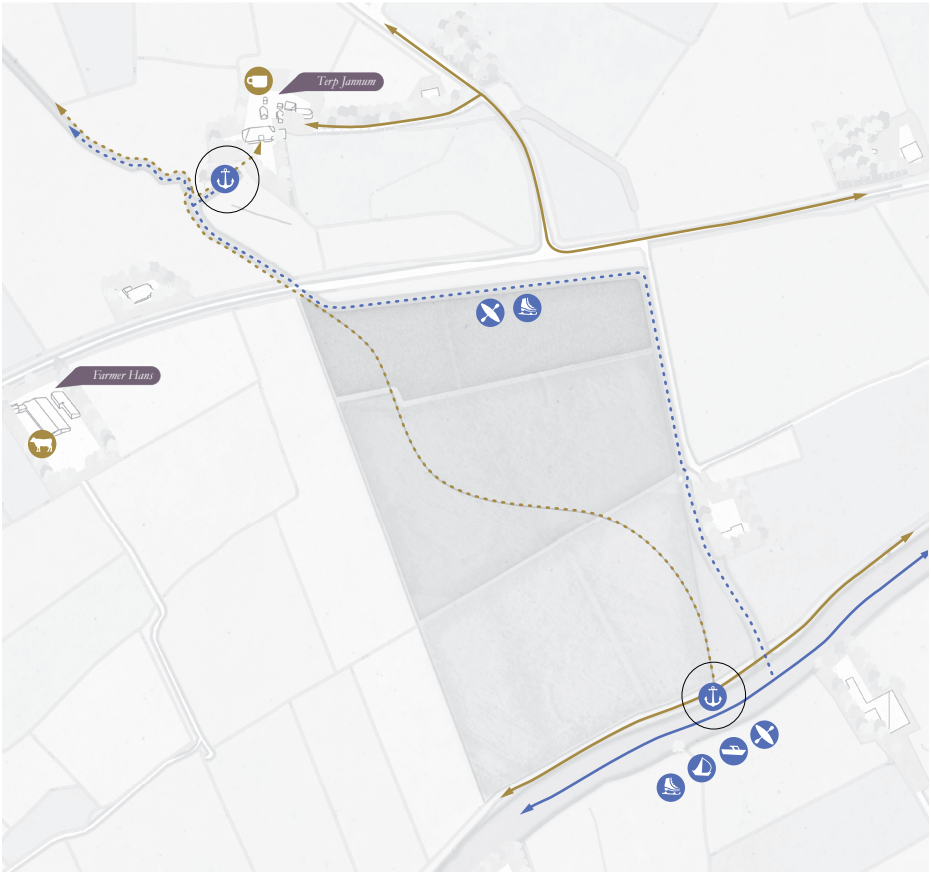
stepping stones; farm yards and biodiverse fields





Flowery field edge in Friesland.
Photo: Cruydt-Hoeck, z.d.

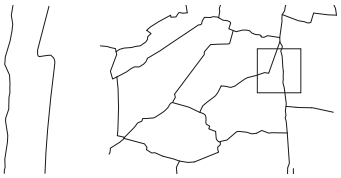
Route design

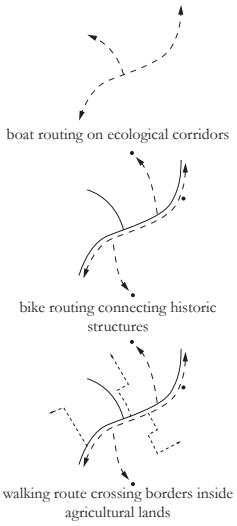


Existing walk & bike route
New walk & bike route
Resting stop
Dairy farm visit
Crop farm visit
Marshland helophytes
Open water helophytes
Reeds helophytes

0 200 500 m

N





The three route types, walking, cycling and through boat are visible on this small scale. A motorized boat route follows the Dokkumer Ee, and it branches out into a canoe route in the direction of terp Jannum. Here, and along the Dokkumer Ee, a small quay can be found for the purpose of docking. Along the Dokkumer Ee, an existing bike and walking path is present. From this, a walking route diverges into the constructed wetland. This route also connects with terp Jannum where a rest spot is present.

Wooden boardwalk

The path through the constructed wetland is slightly elevated to give room to the different water levels in the wetland. The path is made from wood and gives a submersible experience while walking through the wetland.

Reed bed vegetation

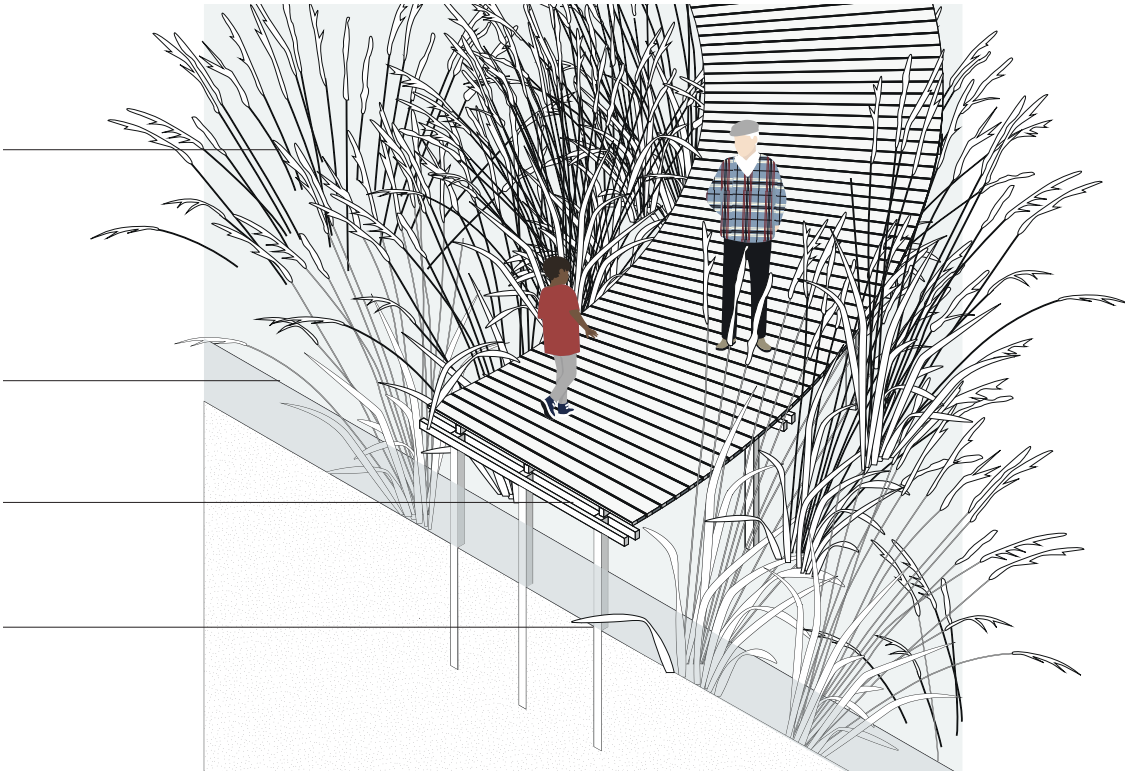


Water level 40 cm

Wooden planks 150x10 cm

Wooden construction

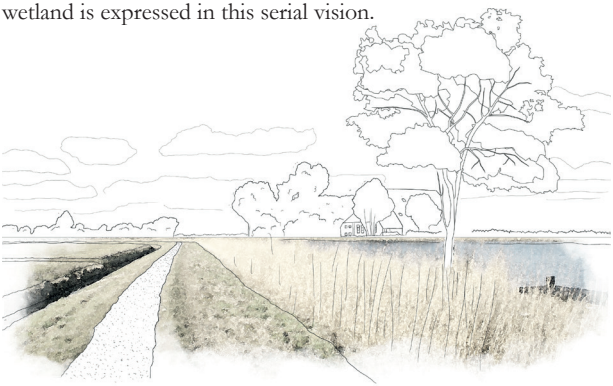
Reference wooden board walk, getijdenpark Brienenoord, Rotterdam.
Photo: Author, 2022.



Serial vision

Constructed wetland

The walking route through the constructed wetland is expressed in this serial vision.



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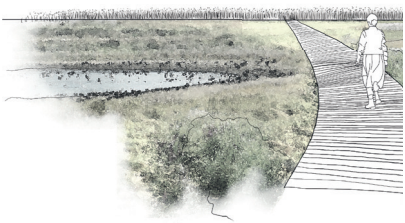

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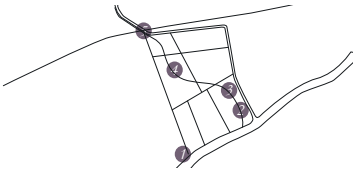
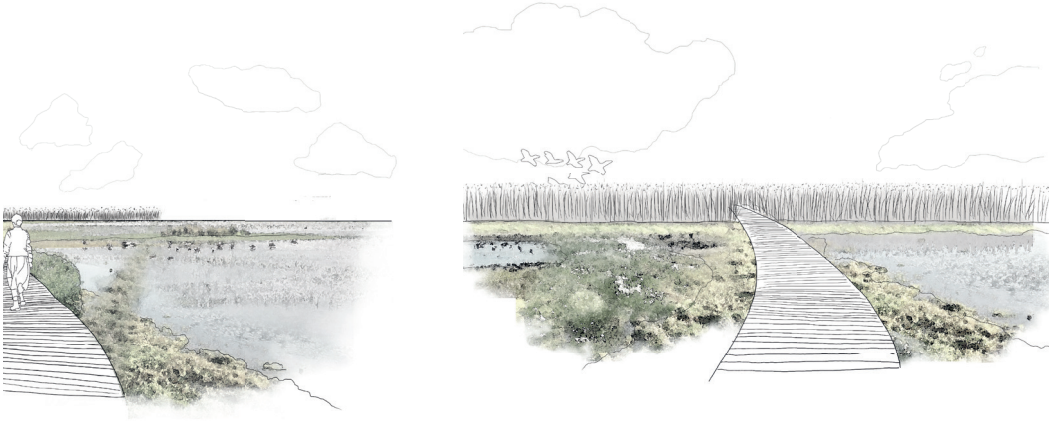


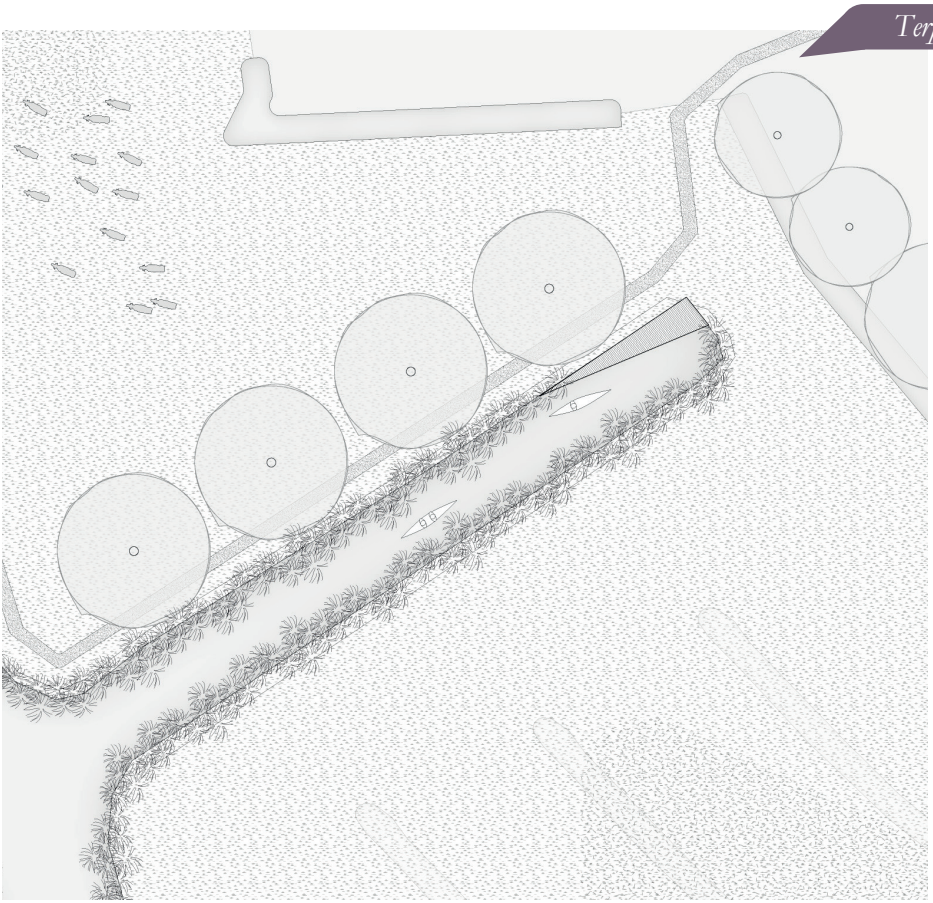


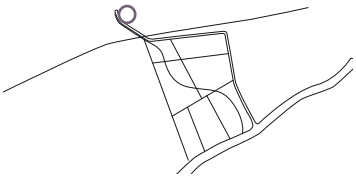
3



5

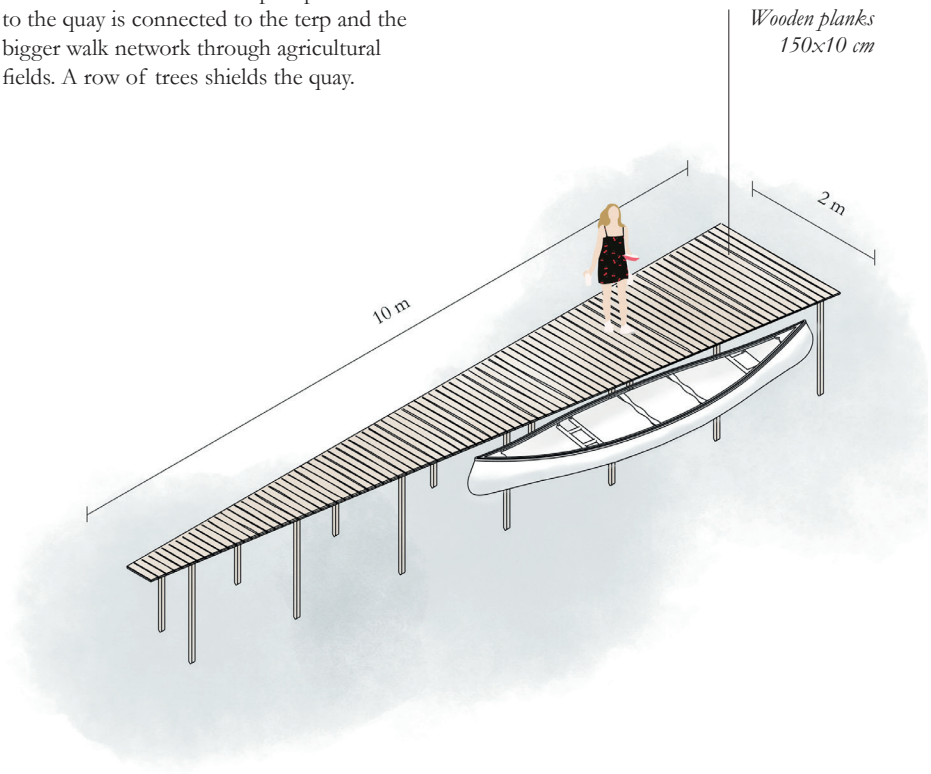
Quay by the terp





um

When following the canoe route, a traveller finds him or herself at a small quay next to terp Jannum. This wooden construction lets people put their canoe in the water or take a short break to visit the terp. A path next to the quay is connected to the terp and the bigger walk network through agricultural fields. A row of trees shields the quay.



Row of Acer platanoides

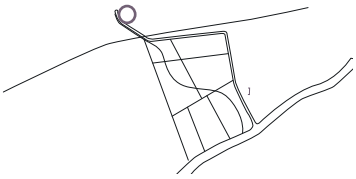


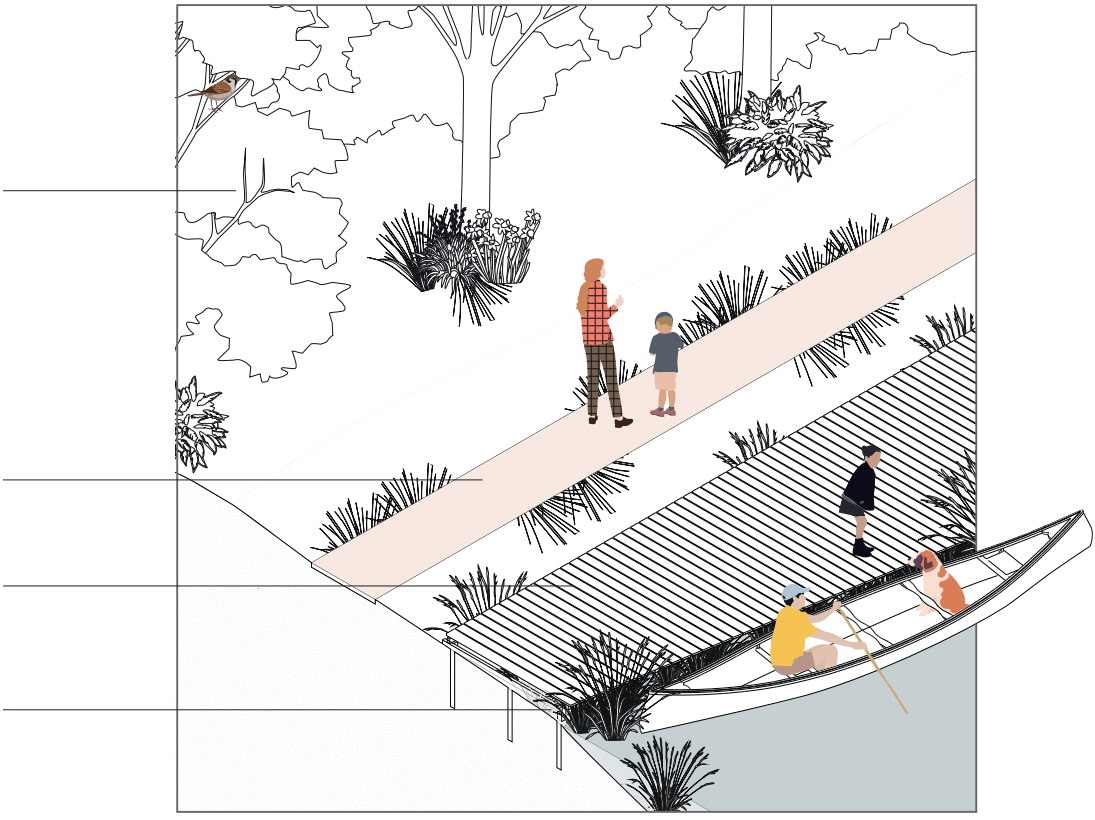
Clay shells path

Wooden planks
150x10 cm

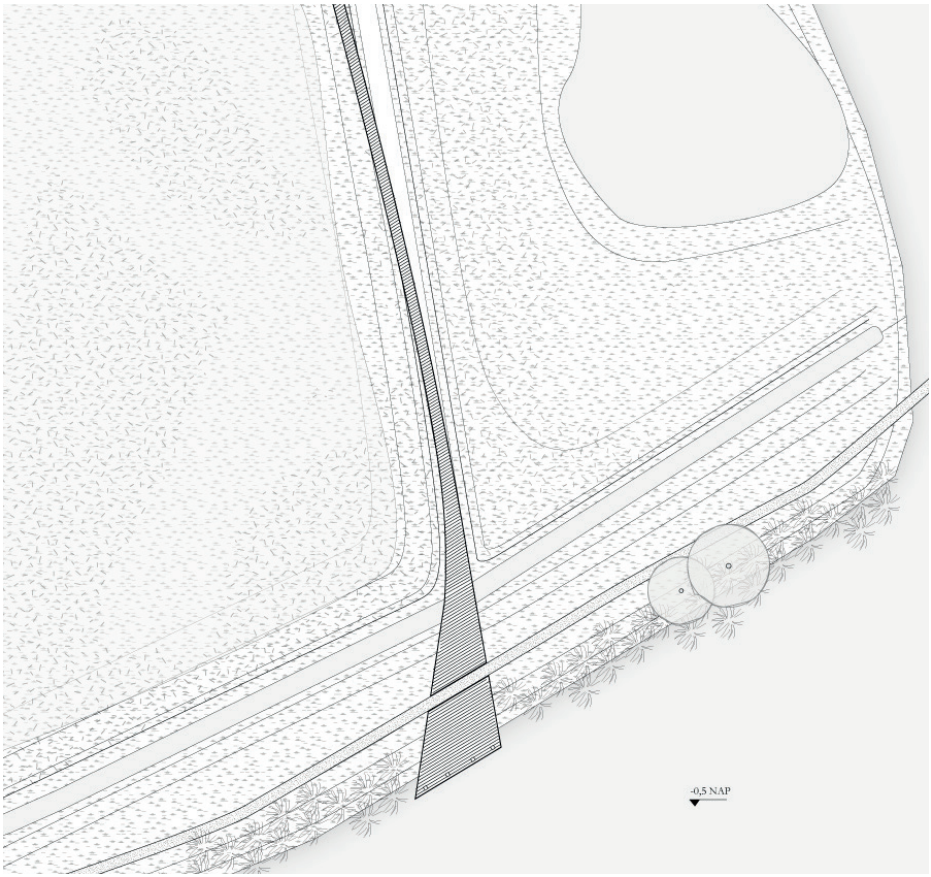
Wooden construction

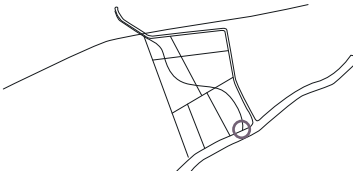
Reference shells path, Edam-Volendam.
Photo: Nieuw Volendam, 2016.



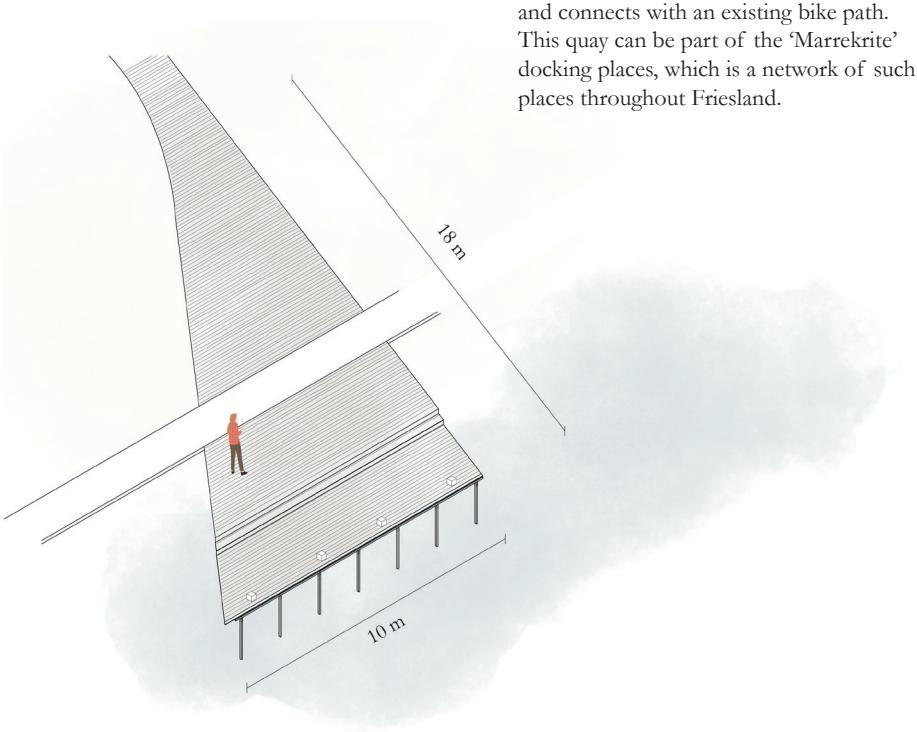


Quay by the Dokkumer Ee





Along the Dokkumer Ee, a small quay will make for a stop along this sailing route. The quay also forms the start of the walking route through the constructed wetland and connects with an existing bike path. This quay can be part of the 'Marrekrite' docking places, which is a network of such places throughout Friesland.



Flowery field edge

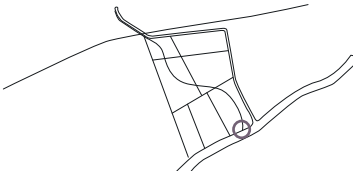


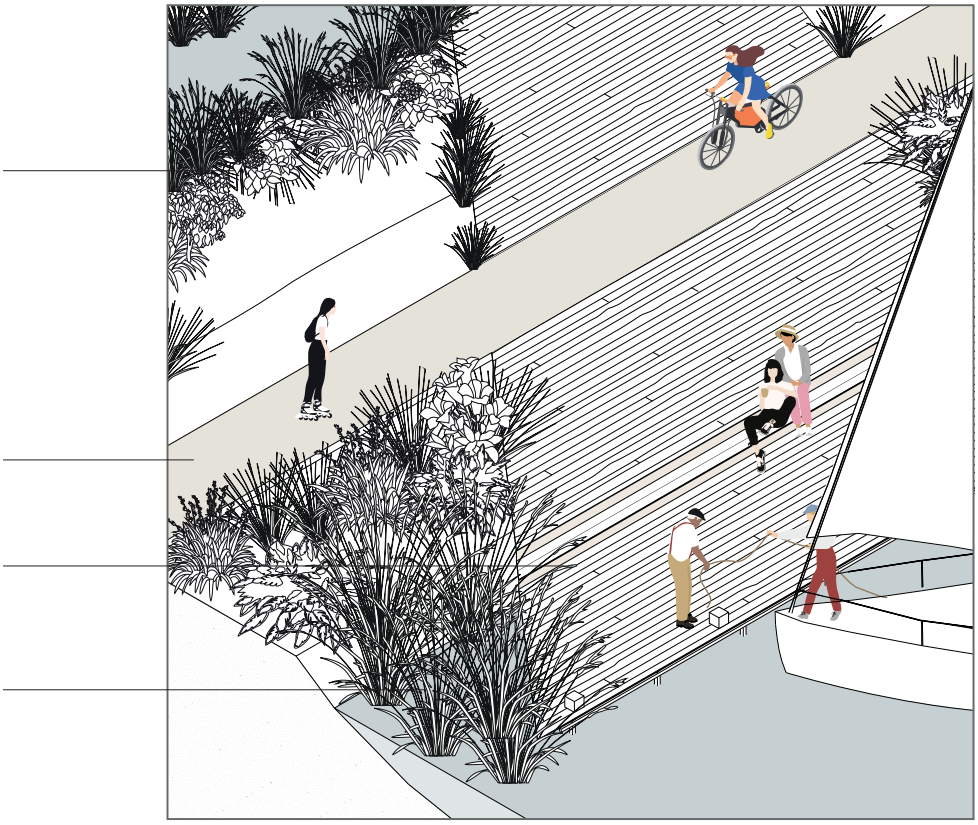
Existing bike path

Wooden planks 150x10 cm

Reed bank

Reference of a Marrekrite docking quay.
Photo: De marrekrite, z.d.



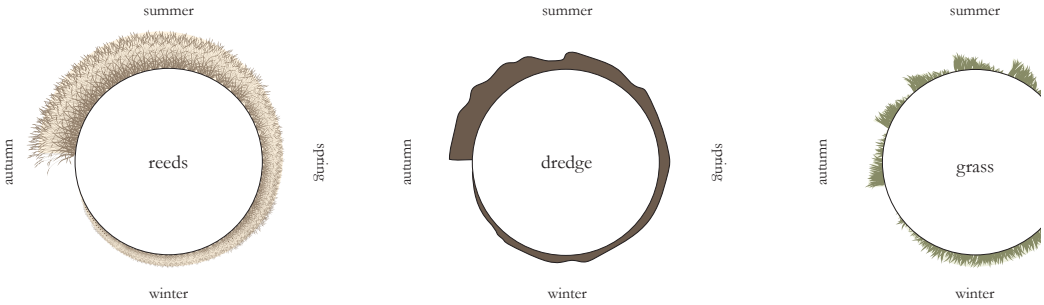


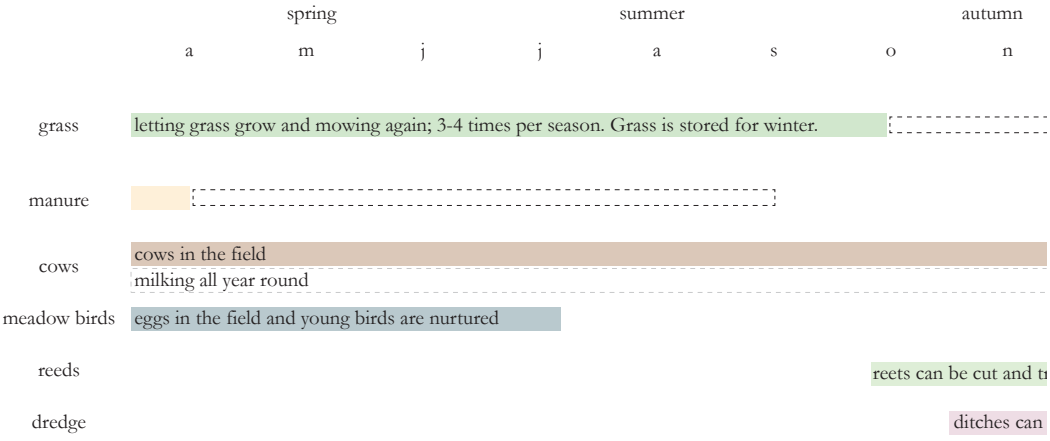


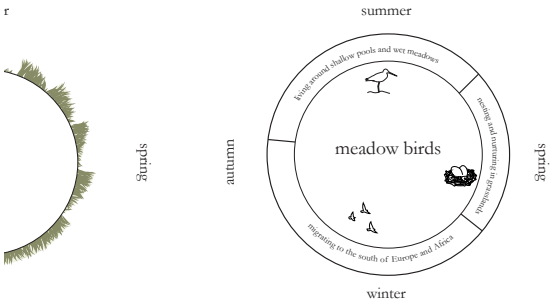


A marrekrite docking spot overnight.
Photo: Suzanne Lampe, 2022.

Processes


summer
autumn
reeds
spring
winter
summer
autumn
dredge
spring
winter
summer
autumn
grass
winter


spring
summer
autumn
a m j j a s o n
grass
letting grass grow and mowing again; 3-4 times per season. Grass is stored for winter.
manure
cows
cows in the field
milking all year round
meadow birds
eggs in the field and young birds are nurtured
reeds
reets can be cut and t
dredge
ditches can



nn winter

n d j f m

buying of seeds and preparing for spring

fertilizing the land

cows stay inside

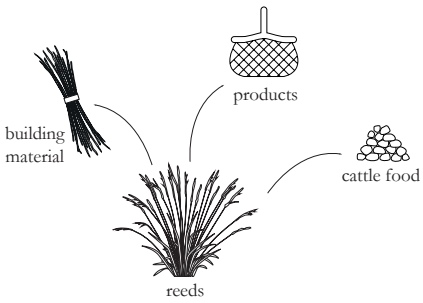
and transported elsewhere

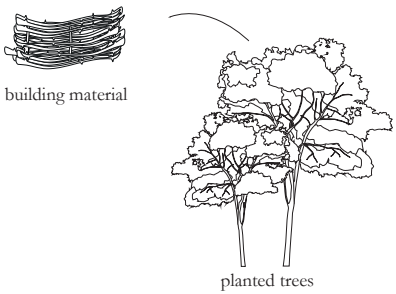
s can be dredged

With an enhanced ecological network, more maintenance comes to play as well. By mowing reeds and other water bank plants and distributing them elsewhere, vegetation is kept biodiverse and the soil nutrient-poor. The mowing is best be done in the fall, when least damage is done to living systems. The same counts for dredging of ditches. This should be done with care; by not dredging everything at once, animals have the chance to move somewhere else and return later.

These interventions are added to the processes already present on a farm. In a nature-inclusive agricultural practice, meadow birds are protected by mowing grass later or being aware of the birds nests.

Reusability



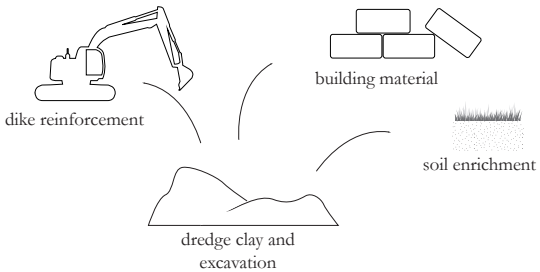




Reed roof.
Photo: Rietdekkerij, z.d.



Natural border from tree branches.
Photo: Moestuinhippie, z.d.





Clay and reed bricks.
Photo: Dreamstime, z.d.

Several materials can be reused and put to a new use. Reeds can be processed into several products. Dredge clay is a valuable product and can be put to several uses. Lastly, branches from trees can be used as a building material for traditional small fences.

Agrotourism

Agrotourism is a term originating from Italy. It refers to the tourism on a farm, for example people visiting working farms for enjoyment, education or a holiday. Agrotourism has been a way for farmers to diversify their practice and find a supplement to their income.

There are several ways to introduce agrotourism on a farm, and totally depends on the farmer's preference and time. For example, the farmer talked to in this project, mentioned he envisions a camping spot on one of agricultural lands. A bird watching tower is also one of his wishes and adjacent to this an educational building.

Next to agrotourism being an extra income for farmers, it is a tool to make consumers more conscious of the processes on a farm and the protection of the landscape that a farmer carries out. Ultimately, a higher awareness with consumers might lead to a shorter food chain, where consumers buy products directly from the farm or a local distributor.



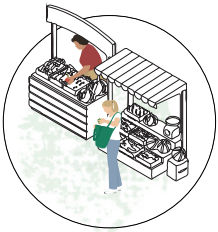
Farm-camping De Koaipleats, Friesland.
Photo: Boerderijcamping De Koaipleats, z.d.



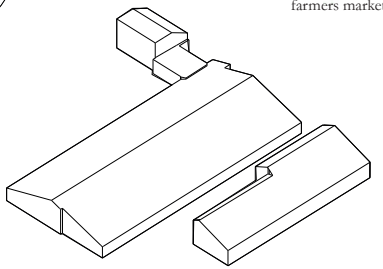
Buying directly at farm Timpelsteed, Friesland.
Photo: Marchje Andringa, z.d.

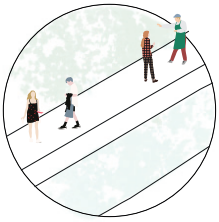


small camping



farmers market

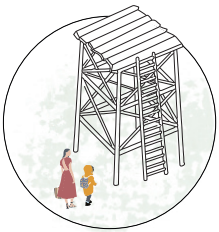




excursions on the farm



education



bird watching tower

Conclusion

This thesis examined how, together with nature-inclusive agriculture, the relationship between landscape, ecology and agricultural practice can be brought more into balance, focusing on northern Friesland. This was done through a research-by-design assignment. During this process, several lessons were learned. First, reaching out and getting into acquaintance with locals working and living in the project area is the start to achieve a new balance. Only by looking at the landscape with a local perspective can you start understand it. This thesis underlines the importance of seeking connections with the inhabitants of the landscape in which you are working.

Second, nature and agricultural practice should not be seen apart from each other. They can very well complement each other and reinforce each other. By implementing ecological structures within the productive landscape, a win-win situation can be established. Agriculture can benefit from natural ecosystems being put back in place and nature has a chance to develop itself. In this design assignment, agricultural land was even put to use to filter agricultural water run-off and function as a habitat enricher for meadow birds. This is a perfect example of how agriculture and nature can be integrated. Because a site-specific approach was taken the design was able to develop in this way; the wishes of people in the landscape alongside wider developments can lead to opportunities that are beneficial to both.

Lastly, policy is very critical in how a new balance can be found. Due to years of Dutch governmental policy, the tension between agriculture and nature has reached this critical point. Last summer, measures were again announced

in a top-down manner on agriculture, which caused much controversy. This research shows that a bottom-up, tailor-made approach can achieve an equilibrium between land and farmers. Future policies on the rural landscape have to balance nature and human needs, regarding local inhabitants as the creators and caregivers of the future landscape.


FRESH
ORGANIC



Reflection

Project description

This graduation is part of the Wadden Sea lab, led by Laura Cipriani and part of the master track Landscape architecture within the department of architecture of the TU Delft. This thesis investigated how a new balance can be sought in the Frisian landscape between nature and agricultural practice. This was done through a research-by-design approach; a socio-cultural investigation was conducted into the transition that agriculture, landscape and nature have gone through in the last century. The conclusions of this research formed the basis for the design part of the research-by-design assignment.

Relation to the master programme

Within the curriculum of the TU Delft, there is a focus on emphasizing the continuity and transformation of landscape systems. Systems are characterized by the continuous interchange between natural processes and ongoing human interventions. In this master's program, the thesis is part of the graduation studio 'The past, present, and future of the Wadden Sea'. In this studio, students are asked to imagine the present and future of the Wadden Sea and its hinterland. The graduation studio states:

"Despite being a UNESCO World Heritage Site of extraordinary environmental value and beauty, the Wadden Sea, its territories and its people, are facing an uncertain future, while currently wrestling with a latent climatic, economic-productive and social crisis. Subsidence increased by gas extraction, soil erosion, saltwater intrusion, eutrophication and industrial and agricultural water pollution testify to a territory in the throes of long-term repossession by the sea."
(Cipriani, Flowscapes guide, 2022).

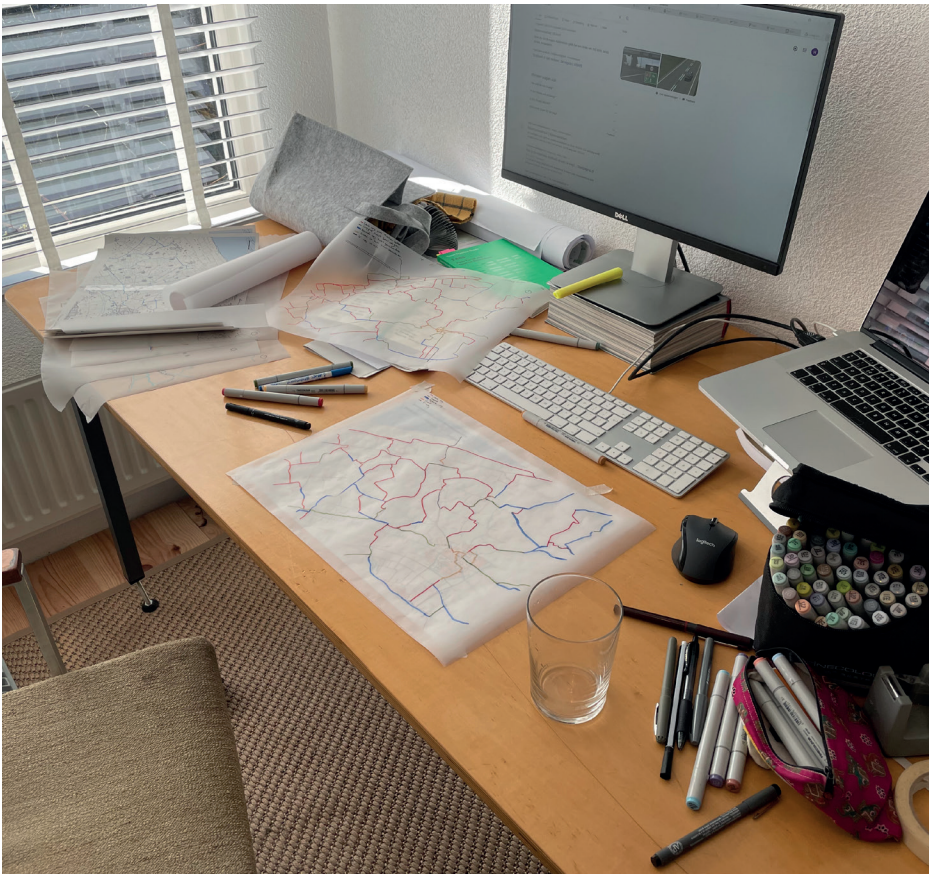
In my graduation thesis, the focus lies mainly on the hinterland of Friesland. This framing comes from the broad site specification at the beginning of the research. I started my research on the topic of water quality in Friesland. From this, I soon arrived at agriculture, a practice that is also strongly intertwined with provincial identity. This caught my attention and became the foundation of the thesis. This does not mean that my project has nothing to do with the Wadden Sea, quite the contrary. As mentioned earlier, landscape architecture is about the continuous interchange between natural processes and ongoing human interventions. However far agriculture has tried to distance itself from nature, this interchange is still clearly present. Land reclamation has ensured that the sea no longer seems to have free rein on the landscape behind the seawall. However, processes continue underground and agriculture is increasingly threatened by the salinisation of groundwater. In turn, fertiliser leaching has a negative effect on surface water in the province, and subsequently on the Wadden Sea. I have particularly enjoyed researching the palimpsests present in the landscape related to natural processes and human interventions, and how they interlock. The most striking example of this are the terps present in the landscape. These terps house a wealth of archaeological information and illustrate how people used to protect themselves from the sea.

According to the graduation studio, the research proposal begins by asserting that the landscape is not simply an environmental resource. It is also a factor that can become an economic resource and an influential driving force for an alternative development of the territory, its cities and its people (Flowscapes

guide, 2022). Up to this day, the agricultural sector plays the most substantial role in the economy of the province of Friesland. Through this development, natural/ecological factors have not been able to take their proper positions, which consequently negatively impacts the Netherlands' biodiversity. Human intervention has therefore outweighed natural processes, resulting in a disequilibrium in the landscape. With this graduation, I investigate how to rebalance this system and seek to capture the contemporary situation in Friesland through the vast and varied developments which have taken place. My design assignment attempts to portray an alternative future situation without losing its connection to the past.

Method and process

The approach taken in the graduation project focuses on design as a method of research. Challenges which are globally relevant are addressed through regional, local and small-scale interventions. To do so, I enlisted the following research methods: data and map collection, mapping techniques using computer software and hand drawings, site visits to the Wadden Sea and its hinterland, visiting relevant museums, interviews with experts such as an ecologist and a landscape architect and water export from the province of Friesland. Lastly, and most importantly, interviews with a local farmer were conducted as well as a visit to his farm. Together, this led to the formulation of three strategies that were translated into an investigative design. It was in line with the graduation lab's approach, which stated that cities and territories affected by several climatic, environmental, and economic crises would benefit from a holistic approach. This has been an iterative process involving constant



Tracing patterns in the landscape.
Photo: Author, 2022

back and forth between the drawing board, the research, and the stakeholders in the area.

Feedback

Graduation is a very educational and personal process. I found communicating and receiving feedback on a design I worked on challenging in the beginning. But by working through it for a full year, I got more comfortable in this position and I have seen myself grow. In the beginning, I did not always find it easy to separate feedback from the personal uncertainty that comes with shaping and directing the thesis. In the moment, it sometimes feels like you have no idea which way you are heading. However, you still have to get on with your thesis. Laura has always been clear and straightforward in her feedback, which I really appreciate.

I see my drawings and writings now more as a product that I made, but not as 'me'. I began to enjoy receiving feedback on how to improve my work as time wore on. By putting a boundary between my graduation and myself I afforded myself to talk to more people about it. As a designer, you are also tasked with filtering out the critical comments that you receive. Everyone you talk to gives feedback from their own angle and motive. In this project, I have spoken with several experts and stakeholders. When working with all these people; a farmer, an expert such as an ecologist, a supervising mentor and, of course, yourself as a designer, there will naturally be conflicting interests. It is the student's task to critically reflect on this, and to be able to integrate the different interests together as a designer. Over the past year, I learned how to take a stance on this and I see this as a core task of the landscape architect.



A farmer protest in Friesland.
Photo: Suzanne Lampe, 2022.

Position in the scientific field

Working between diverse interests is also something we see when we zoom out from this thesis to the whole field of work. After ten months as a student mapping how upscaling in agriculture has changed the landscape, the government published its plans to tackle the nitrogen crisis in the Netherlands. This did not go down well with many farmers who are, for decades, running a multigenerational family business. They are now faced with the prospect of having to stop farming altogether. Demonstrations sprang up across the country and the flag of the Netherlands was hung upside down, with farmers expressing their discontent with the government.

From this point of view, this graduation has become more relevant than ever. It is clear that something needs to change in Dutch agricultural policy. The effects it currently has on the landscape and ecology are too severe. This thesis makes a relevant suggestion on how to accomplish a rebalance in this landscape. The most important aspect of this is engaging with stakeholders. Being a farmer is a profession that relies heavily on the landscape and ecology. Many farmers have these topics at heart and these are also topics that many farmers bring up when asked what they like most about their profession. By starting conversations with these people, interests can be clearly identified and an integrated solution can be put on the table. This takes time, but I believe it is how people take responsibility for their landscape.

Ethical dilemma's

Although this project involved many conversations with a local farmer who also owns the piece of land where the design is situated, one resident cannot speak for all residents in the area. In the thesis, I try to gain an understanding of the landscape, and the people who live there. However, by including one farmer's opinions and insights I automatically exclude other residents' opinions which might be different. Speaking with stakeholders might always pose an ethical dilemma. When trying to gain residents' input on a design, one cannot be totally inclusive unless you talk with all residents present. Nevertheless, I am very grateful for the conversations I got to have with the farmer which resulted in invaluable input for my design. As the farmer is a chairman of the agricultural collective in the area, I do see him as a spokesman for numerous farmers in the area. This does not alter the fact that one should always be careful with this.

Bibliography

Bibliography

Adviesboek De Nije pleats in Fryslan. (z.d.).
Agrarisch Collectief Waadrâne. (z.d.). Agrarisch Collectief Waadrâne. Geraadpleegd 11 augustus 2022, van https://www.waadrane.frl/home/

Beukema, E. (2016, mei 20). Veerman: Liberalisering landbouwbeleid onhoudbaar. Groenten & Fruit Actueel. https://www.gfactueel.nl/veerman-liberalisering-landbouwbeleid-onhoudbaar/

Birger. (2020, maart 18). Hoe gaat het met de biodiversiteit in Nederland? Voor de Wereld van Morgen. https://www.voordewereldvanmorgen.nl/artikelen/hoe-gaat-het-met-de-biodiversiteit-in-nederland

Bloemberg- van der Hulst, M. (2020, november 27). Melkrobot haalt visgraat bijna in. Nieuwe Oogst. https://www.nieuweoogst.nl/nieuws/2020/11/27/melkrobot-haalt-visgraat-bijna-in

Bouma, J. (2019, maart 2). Nederland verliest in hoog tempo zijn weidevogels. https://www.trouw.nl/duurzaamheid-natuur/nederland-verliest-in-hoog-tempo-zijn-weidevogels~b874abd2/

CBS. (2021). Landbouw; gewassen, dieren, grondgebruik en arbeid op nationaal niveau. https://www.cbs.nl/nl-nl/cijfers/detail/81302ned

Centraal Bureau voor de Statistiek. (2016, april 5). Export buiten EU groot in Friesland en Noord-Brabant. Centraal Bureau voor de Statistiek. https://www.cbs.nl/nl-nl/nieuws/2016/14/export-buiten-eu-groot-in-friesland-en-noord-brabant

Compendium voor de Leefomgeving. (2020, juli 30). Waterkwaliteit KRW, 2019. https://www.clo.nl/indicatoren/nl1438-kwaliteit-oppervlaktewater-krw

De Friese terpen en Groningse wierden. (z.d.). RouteYou. Geraadpleegd 8 augustus 2022, van https://www.routeyou.com/nl-nl/location/view/49846621/de-friese-terpen-en-groningse-wierden

De Fryske Kanon. (2013). De ruilverkaveling. De Canon van Friesland. http://www.11en30.nu/de-canon-vensters/de-ruilverkaveling

de Vos, A. (2010). Zilte Landbouw Texel (Leven met Water, Leven met Zout Water).
Erisman, J. W., & Slobbe, R. (2019). Biodivers Boeren. De meerwaarde van natuur voor het boerenbedrijf. Uitgeverij Jan van Arkel.

Fairfood. (2020, mei 5). Rapport: De verbinding tussen boer en consument herstellen. https://fairfood.org/actueel/rapport-het-herstellen-van-de-verbinding-tussen-boer-en-consument/

Feenstra, H., de Vries, D., Bijlsma, J., & Schmeink, H. (2021). Masterplan Opvaarten Noordoost Fryslân.

Felix, N. (2017a, augustus 15). Waarom staan in Nederland zo veel megastallen? NOS op 3. https://nos.nl/l/2188187

Felix, N. (2017b, augustus 15). Waarom staan in Nederland zo veel megastallen? NOS. https://nos.nl/l/2188187

Foley, J. (z.d.). Feeding 9 Billion. National Geographic. Geraadpleegd 31 januari 2022, van http://www.nationalgeographic.com/foodfeatures/feeding-9-billion/

Hadders, R. (2015, maart 31). Afschaffing melkquotum, het einde van een

tijdperk. EenVandaag. https://eenvandaag.avrotros.nl/item/afschaffing-melkquotum-het-einde-van-een-tijdperk/

Hofs, Y. (2022, juli 22). 'Schuldbekentenis' Rabobank over stikstof is allesbehalve dat: 'Schaalvergroting werd ingezet door de overheid'. de Volkskrant.

Kans op honderd banen in Emmeloord door melkrobot. (1985, januari 17). Reformatorisch Dagblad, 18.

Kerk en omgeving. (z.d.). Kerkmuseum Jannum. Geraadpleegd 8 augustus 2022, van https://www.kerkmuseumjannum.nl/kerk-en-omgeving.html

Kernteam De Nije Pleats in Fryslân. (2009). Adviesboek De Nije pleats in Fryslan. provincie Fryslân.

Kroodsma, H. (z.d.). Boerenlandvogelboer Hans Kroodsma. Geraadpleegd 11 augustus 2022, van https://www.vogelbescherming.nl/bescherming/in-de-buurt/boerenlandvogelboer/boer-details/kroodsma

Ministerie van Algemene Zaken. (2015, november 6). Krimpgebieden en anticipeergebieden—Bevolkingsdaling—Rijksoverheid.nl. https://www.rijksoverheid.nl/onderwerpen/bevolkingsdaling/krimpgebieden-en-anticipeergebieden

Ministerie van Landbouw, Natuur en Voedselkwaliteit. (z.d.). Natura 2000. Natura 2000. Geraadpleegd 8 augustus 2022, van https://www.natura2000.nl/

Moai Fryslân (Regisseur). (2014, maart 29). Lânbou. https://www.youtube.com/watch?v=OKq7Tn4_cx0

Nationaal Georegister. (2014). Beschikbaarheid zoet grondwater. Nationaal georegister. https://nationaalgeoregister.nl/geonetwork/srv/dut/catalog.search#/metadata/64909141-3f9f-40d0-b7cc-98ff58ea2610?tab=general

Natuur & Milieu. (2017). Voedselvisie: Naar een gezond en duurzaam voedselsysteem in 2030.

Natuur en Milieu. (2019). Onderzoek Waterkwaliteit & Biodiversiteit.

Nederlandse Akkerbouw. (2017). Akkerbouw van nu. http://www.akkerbouw-van-nu.nl/algemene-informatie/

Oxfam Novib. (z.d.). Het overbevolkingsprobleem. Geraadpleegd 31 januari 2022, van https://www.oxfamnovib.nl/blogs/dilemmas-en-oplossingen/het-overbevolkingsprobleem

Plantinga, R., Molema, M., & Meijer, N. (2018). Agri & Foodscan Fryslân 2018. Leeuwarden, Fryske Akademy/Provincie Fryslân.

Provincie Zuid-Holland. (z.d.). De bescherming van onze Natura 2000-gebieden: Hoe doen we dat? Provincie Zuid-Holland. Geraadpleegd 8 augustus 2022, van https://werkenvoor.zuid-holland.nl/artikelen/de-bescherming-van-onze-natura-2000-gebieden-hoe-doen-we-dat/

Provinsje Fryslân. (2019). Weidevogels in Fryslân.

Redactie Groen Kennisnet. (2020, april 9). Veertig jaar melkrobots. Groen Kennisnet. https://www.groenkennisnet.nl/nieuwsitem/Veertig-jaar-melkrobots-1

Reijnen Rutten, E. (2018, april 18). Nieuw melkquotum voor boeren: 'Dit heeft dramatische gevolgen'. AD.

Rijksoverheid. (2020, juli 30). Fysisch-chemische waterkwaliteit KRW, 2019. Compendium voor de Leefomgeving. https://www.clo.nl/indicatoren/nl0252-fysisch-chemische-waterkwaliteit-krw

Rijkswaterstaat. (2021). Verzilting [Webpagina]. Informatiepunt Leefomgeving. https://iplo.nl/thema/water/beheer-watersysteem/verzilting/

RIVM. (2020). De Nitraatrapportage 2020. https://www.rivm.nl/nitraatrapportage2020

Robotmelken duurder dan traditioneel melken. (2021, september 27). Veehouderij Techniek. https://www.mechaman.nl/veehouderij-techniek/artikel/20210927/robotmelken-duurder-dan-traditioneel-melken/

Salt Farm Foundation. (2019). Verzilting in Nederland. Salt Farm Foundation. https://saltfarmfoundation.com/nl/verzilting-in-nederland/

United Nations. (2017). World population prospects: The 2017 revision; key findings and advance tables.

van den Berg, J., & Hotse Smit, P. (2022, juli 30). Zeven boeren op Schiermonnikoog hebben een deel van hun koeien weggedaan, en lopen zo op de troepen vooruit. de Volkskrant. https://www.volkskrant.nl/nieuws-achtergrond/zeven-boeren-op-schiermonnikoog-hebben-een-deel-van-hun-koeien-weggedaan-en-lopen-zo-op-de-troepen-vooruit~bd54603e/?utm_source=link&utm_medium=app&utm_campaign=shared%20content&utm_content=free

van Velzen, J. (2021, januari 21). Biologische boer worden in Nederland? Het wordt steeds minder populair. Trouw.

Wageningen University & Research. (2017, maart 9). Mengteelt vervangt monocultuur voor duurzame landbouw. https://www.wur.nl/nl/nieuws/mengteelt-vervangt-monocultuur-voor-duurzame-landbouw.htm

Wakker Dier. (2019). Groei megastallen 2010-2017.

Worst, D., & Coppens, S. (2021). Landschapsbiografie van Noardeast-Fryslân. ZuivelZicht. (2020). Nieuwe Wegen. Issuu. https://issuu.com/bduvakmedia/docs/zuivelzicht_3_2020/s/10346880

Land and Farmers Equilibrium

Hanneke Wander