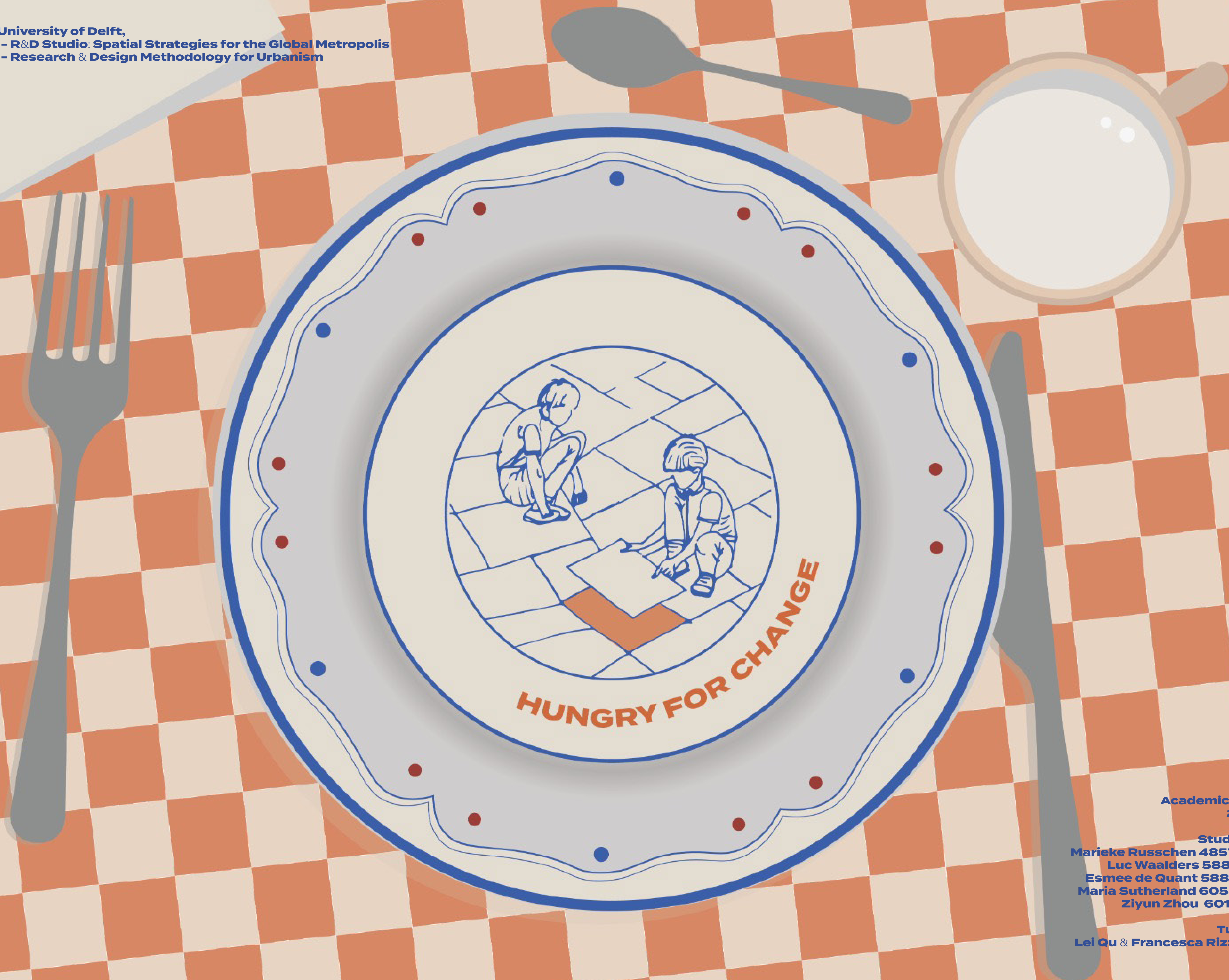
TU Delft
Technical University of Delft,
AR2U086 - R&D Studio: Spatial Strategies for the Global Metropolis
AR2U088 - Research & Design Methodology for Urbanism



HUNGRY FOR CHANGE

Academic Year:
2024

Students:
Marieke Russchen 4857607
Luc Waalders 5881536
Esmee de Quant 5884772
Maria Sutherland 6058337
Ziyun Zhou 6016561

Tutors:
Lei Qu & Francesca Rizzetto

1. Abstract

The Nitrogen Crisis has become a focal point for the global community, with the related European policy stirring uncertainty in the agricultural sector. This political unrest has been clearly manifested in the Netherlands, while natural areas remain exposed to high emission levels. Society calls for systematic solutions to the nitrogen issue that conserve the existence of farmers, the preservation of nature and the national economy.

This report focuses on the agricultural sector, as it accounts for 52 per cent of emissions (RIVM, 2022). We investigate opportunities to mitigate NH4 and NO3 surplus in soil caused by current agricultural practices and we spatially explore a systemic approach to cut emissions caused by livestock farms and inefficient use of fertilisers within field crop farming in the Eurodelta region.

Through document review and archival research, followed by spatial analysis and mapping, we investigate what changes in agricultural practice can restore balance in the nitrogen cycle. A vision for the Netherlands' primary agricultural production future is formulated. This vision focuses on sustainable land use, alongside nature protection, research development and community engagement. We elaborate on this through a spatial strategy, which concentrates on five strategic projects used to assess the interventions on-site and demonstrate their potential to all stakeholders.

Our proposal involves the recognition of natural protection zones in areas where agriculture borders natural habitats. Actions and policies are suggested to facilitate land conversions and support the farmers in this transition. Furthermore, we propose a network of living labs and community centres aimed at applying sustainable farming methods and connecting the city and agriculture.

We conclude that to prevent harm to human health and the environment we need to explore ways to combine the farmers' and the environment's interests. The systemic approach requires equitable regulations governing permissible emissions for farmers throughout the Netherlands. However, it should allow farmers to autonomously shape emission reduction initiatives locally.

Keywords:
nitrogen crisis; agricultural sector; nitrogen emissions mitigation; circular agriculture; environmental preservation; sustainable land use; land regeneration;

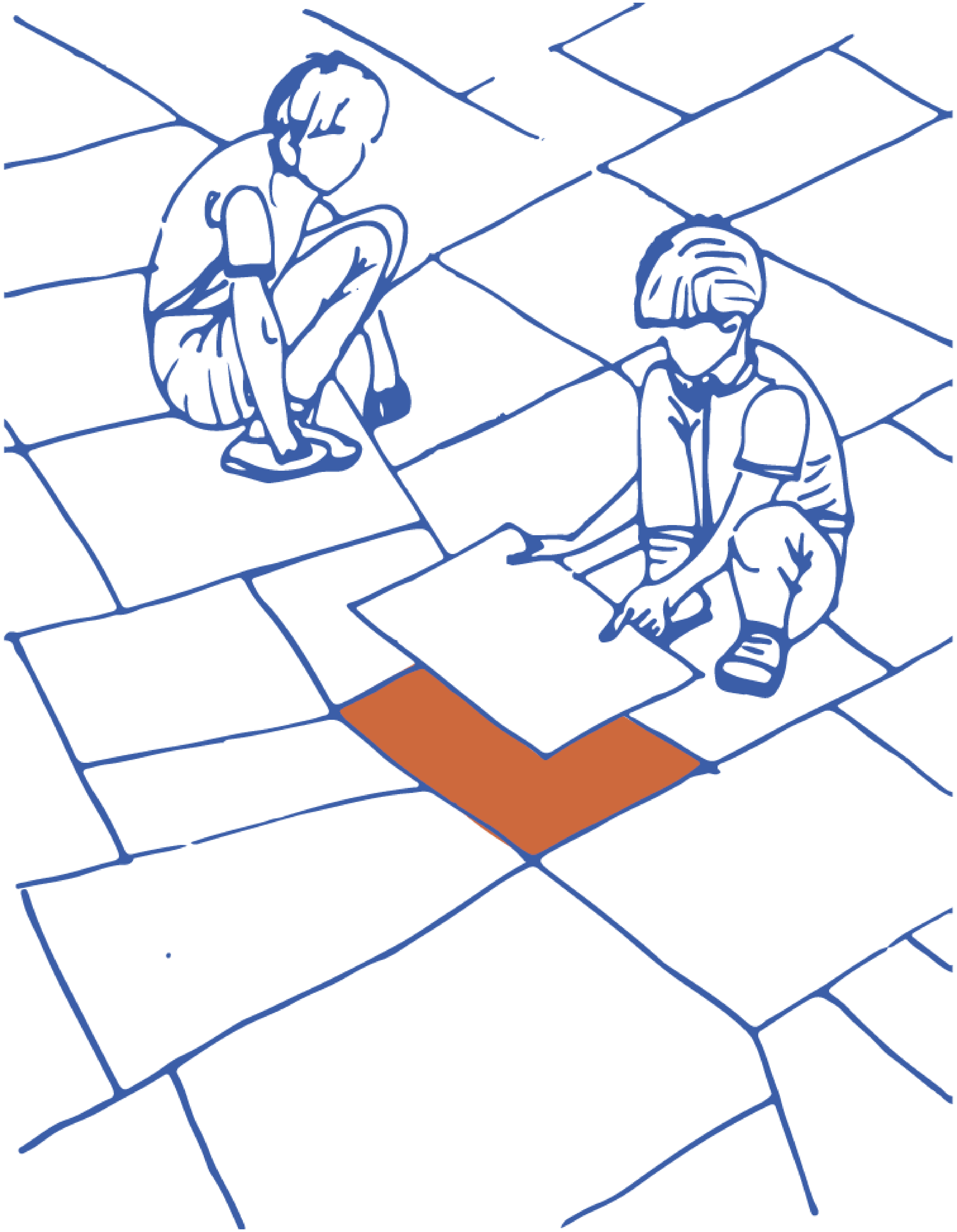


Table of contents

2. Introduction

'Hungry for change' is a project that seeks for strategic interventions that decrease the surplus of nitrogen related emissions in order to regain balance within the nitrogen cycle in the context of the Netherlands.

Due to the current imbalance in the nitrogen cycle, the Netherlands has gone through a nitrogen crisis in recent years. This has led to a significant environmental and socio-economic challenges. Sparking debates, policy reforms, and public outcry. Nitrogen, an essential element for life, plays a crucial role in various natural processes. However, excessive nitrogen emissions, primarily from agricultural activities, transportation, and industry (RIVM, 2022), have led to a multitude of environmental issues, threatening ecosystems, biodiversity, and human health (Schillewaert, 2021).

Over 54% of the Dutch surface area is currently utilized for agricultural production (CBS, 2020). This area is primarily dedicated to the production of floriculture, meat, dairy products, eggs, and vegetables (Rijksoverheid, 2023). The nitrogen emissions that are released during the production are harmful to biodiversity and can acidify the soil (Staatsbosbeheer, 2022). In humans, these substances can cause irritations in the nose, eyes, throat, and lungs, which can lead to lung inflammation and cardiovascular diseases (Schillewaert, 2021).

To act on these consequences, significant political decisions were made in 2019 in order to limit the nitrogen emissions (Planbureau voor de Leefomgeving, 2023). This marked the starting point of strong political and societal unrest, particularly among farmers.

In this project, we aim to spatially envision the reduction of nitrogen emissions within the agricultural sector. The objective is to bring the boundaries of protected nature, farmers, cities, and rural areas closer together.

Fig. 2.1: Visibility of pollution , Image scources: The Orinex , n.d.

2.1 Problem statement

In a world of 8 billion people, producing enough food for everyone is essential. Within the Euro Delta region, the Netherlands has a crucial role in the global agri-food chain as it consists of various types of farming (Rijksoverheid, 2024). Large-scale grass fields with cows and endless rows of greenhouses filled with flowers, as well as small-scale organic and local farms, all play a vital role in providing food for our growing world population.

However, high NOx and NH3 emissions caused by the farming industry, industrial activity, traffic, and emitters from foreign countries have formed the basis of the ongoing nitrogen crisis (RIVM, 2022). The highest emissions are connected to NH3 emissions caused by livestock farming activity. The problem of high nitrogen emissions started with the industrialisation of the farming sector after the Second World War and is generally applicable to all highly industrialised farming environments (CBS, 2021). First attempts to reduce emissions have aimed to provide farmers with new technical solutions, such as low-emission stable floors (WUR, 2022). Still, they lack a more holistic approach towards the future perspective of farming in the Dutch context.

A governmental report by Remkes (2022) describes that the need for reducing emissions is important as nature is currently being irreversibly damaged. Besides, the high emissions pose a threat to the Dutch economy because new building permits can no longer be granted if the emission guidelines are not met. The drastic decrease in biodiversity and human health that the nitrogen crisis creates is especially evident in the Euro Delta (UN Environment Programme, 2023). It contaminates soil, rivers, and oceans, leading to issues such as eutrophication, affecting the biodiversity of nature reserves, and impacting human health. Moreover, the funds invested in mitigating nitrogen pollution pose a significant burden on the socio-economic aspects of society.

The water-dominated landscape of the Netherlands puts the problem into the context of an extraordinarily strong interconnection of the water and nitrogen cycles. Addressing this issue on a Dutch scale could serve as a pilot for tackling intensive monoculture agriculture across Europe, Asia, and Africa, particularly in delta areas (UN Environment Programme, 2019). This endeavour could have a profound impact on fostering more sustainable agriculture, food industries, economies, and lifestyles, including dietary habits.

The aim of this research is to explore opportunities to adapt current systemic patterns in agricultural practices in order to reduce nitrogen-related pollution. This transition in the agri-food chain seeks to restore balance in our ecosystem and ensure that nutritional requirements are met through just decision-making.

2.2 Research question:

What systemic changes in the agricultural practice can contribute to decrease the imbalance in the nitrogen cycle in the Eurodelta region?

Sub-questions:

Analysis:

1. What is the current state of farming practices in the Euro Delta region, and how have historical, technical and socio-economic factors shaped these practices?
Methods: Literature review, data analysis, statistical analysis

2. What are the causes and dynamics of the nitrogen crisis and how do these impact the environment and human health?
Methods: Literature review, statistical analysis

3. How are current farming practices in the Euro Delta region enforcing the nitrogen crisis?
Methods: Literature review

Vision:

1. How can we protect natural habitats better against the impact of the surplus in nitrogen emissions?
Methods: Literature review, data analysis, design analysis

2. How can we adapt agricultural practices in order to regain balance in the nitrogen cycle?
Methods: Literature review, data analysis, design analysis

3. How can technical innovations transform current agricultural practices in order to decrease nitrogen emissions?
Methods: Literature review, data analysis, design analysis

4. How can we preserve food production in the Netherlands while decreasing nitrogen emissions?
Methods: Literature review, data analysis, design analysis

Strategy:

1. How can the vision be translated to the agricultural practice in specific locations?
Methods: Design analysis

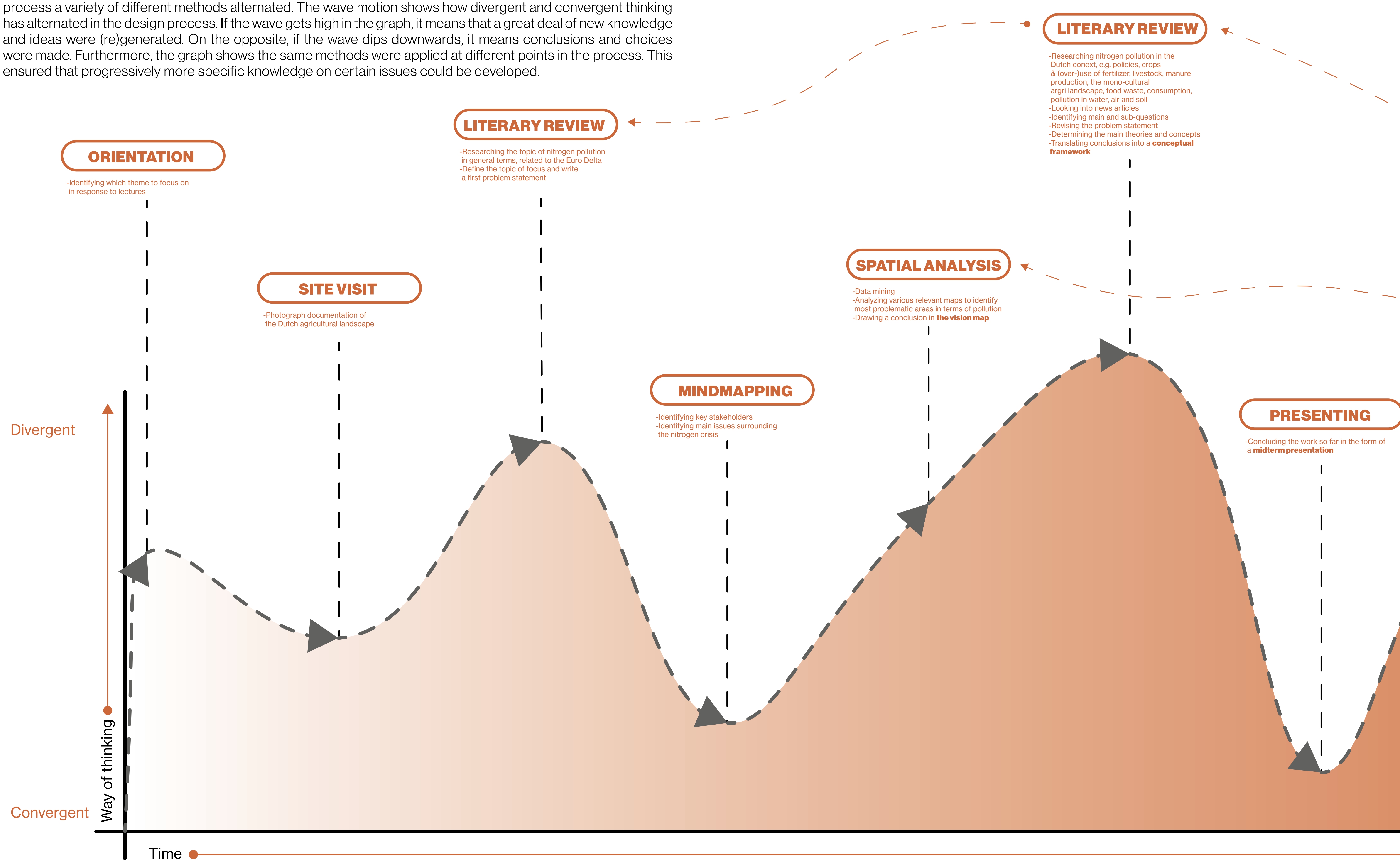
2. What are strategic locations to start pilot projects?
Methods: Design analysis

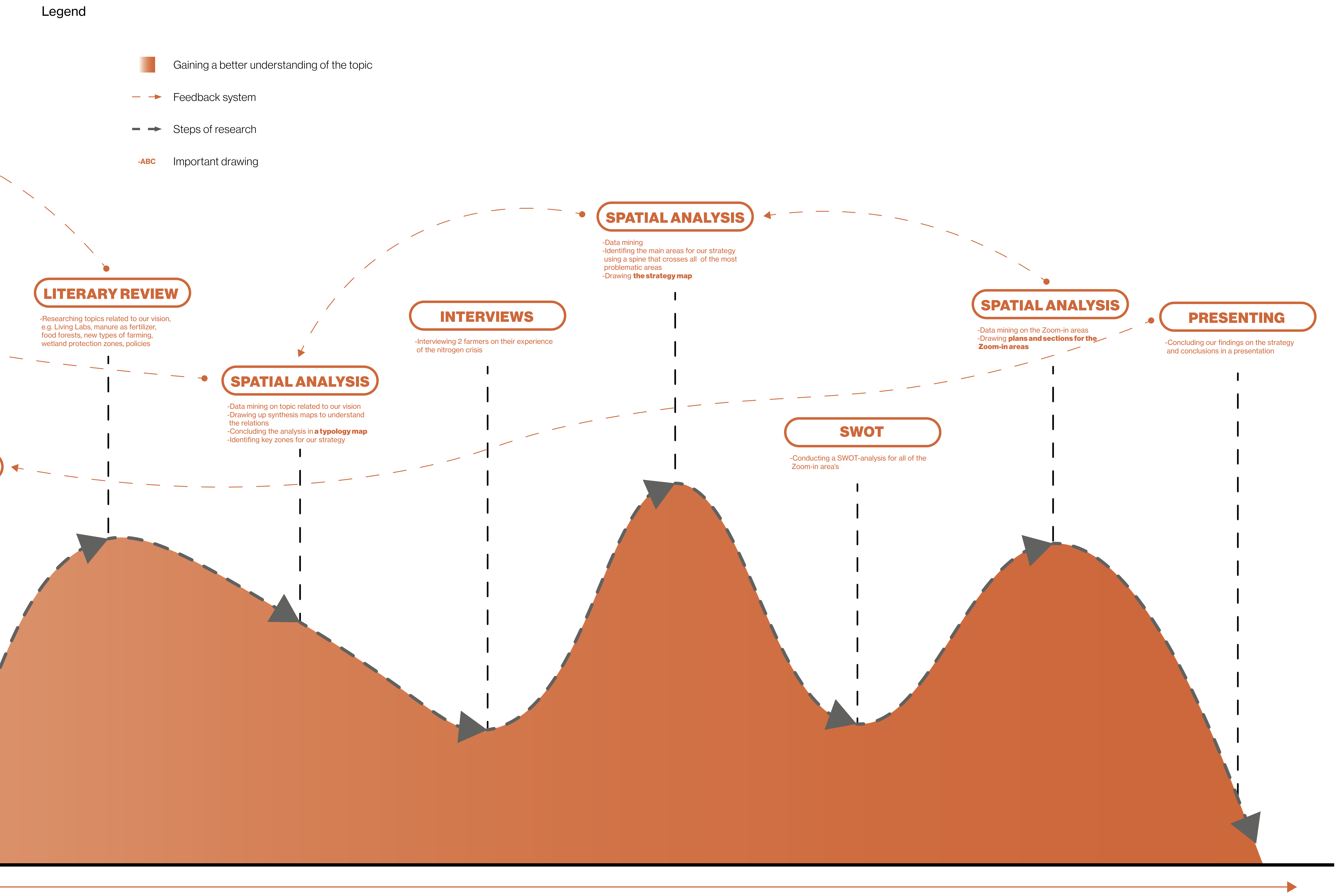
3. Which actions and policies need to be taken in order to facilitate a sustainable change if the agricultural practice?
Methods: Design analysis

4. On what timespan could these actions and policies be effectively implemented?
Methods: Design analysis

3. Methodology

This graph shows the system of methods used in the research and design process. It becomes clear that in the process a variety of different methods alternated. The wave motion shows how divergent and convergent thinking has alternated in the design process. If the wave gets high in the graph, it means that a great deal of new knowledge and ideas were (re)generated. On the opposite, if the wave dips downwards, it means conclusions and choices were made. Furthermore, the graph shows the same methods were applied at different points in the process. This ensured that progressively more specific knowledge on certain issues could be developed.




Legend
Gaining a better understanding of the topic
Feedback system
Steps of research
-ABC
Important drawing
LITERARY REVIEW
-Researching topics related to our vision, e.g. Living Labs, manure as fertilizer, food forests, new types of farming, wetland protection zones, policies
SPATIAL ANALYSIS
-Data mining on topic related to our vision
-Drawing up synthesis maps to understand the relations
-Concluding the analysis in **a typology map**
-Identifing key zones for our strategy
INTERVIEWS
-Interviewing 2 farmers on their experience of the nitrogen crisis
SPATIAL ANALYSIS
-Data mining
-Identifing the main areas for our strategy using a spine that crosses all of the most problematic areas
-Drawing **the strategy map**
SWOT
-Conducting a SWOT-analysis for all of the Zoom-in area's
SPATIAL ANALYSIS
-Data mining on the Zoom-in areas
-Drawing **plans and sections for the Zoom-in areas**
PRESENTING
-Concluding our findings on the strategy and conclusions in a presentation

3.1 Theoretical Framework

In addressing the Nitrogen crisis and formulating a spatial vision and development strategy for sustainable urban development and nitrogen cycle restoration, we focus on specific theoretical bodies to guide our research. Through this process, we have created the following theoretical framework:

Systems Thinking

Systems thinking is a method to comprehend the roots of systems that form the interconnected character of our global society. The importance of systems thinking lies in the complex and powerful ties that feedback loops create between different nations and sectors. (Arnold & Wade, 2015)

The Nitrogen crisis belongs within and affects multiple systems. Systems thinking allows us to understand where the nitrogen crisis originates from and who is involved in it. It is an approach that provides us with the capability to look at problems from different perspectives, understand how different systems can affect each other and make suggestions on feasible solutions to complex issues. (Introduction to Systems Thinking: Report of GSE and GORS Seminar, 2012)

In the following report, we use this method to recognise systems we need to focus on in order to contribute to the mitigation of nitrogen emissions and to investigate the crucial stakeholders we need to engage with and connect to create a viable transition.

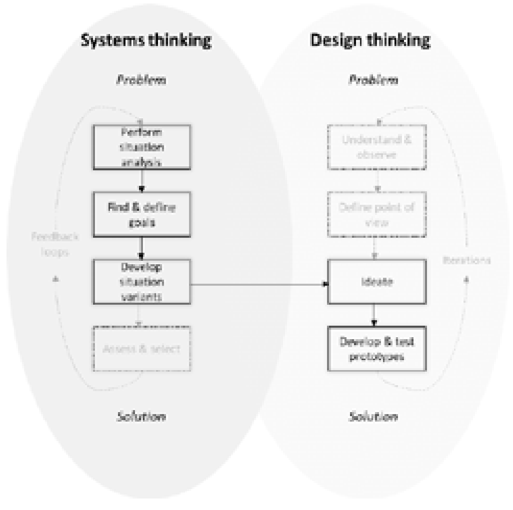


Fig. 3.1.1 :
Systems Thinking Diagram
Source:
Relling, T. (2020) Processes in systems thinking and design thinking. [Diagram]

Social-Ecological Systems Theory

The Social-Ecological Systems theory emphasises the importance of humans being part of Nature, and the capabilities created by relating their systems. It describes strong and sustainable synergies between ecological and societal elements that are organised on different scales and use each other's resources. (Redman et al., 2004)

To achieve sustainable development it is crucial to strive for ecological sustainability. Moreover, the assessment of these two variables is assisted by the Social-Ecological Systems Theory aiming to promote sustainable use of resources and their efficient management. (Leslie et al., 2015)

The SES framework provides the theoretical basis to investigate how we can enhance connections between the food supply chain and its stakeholders with nature, aiming for their simultaneous prosperity.

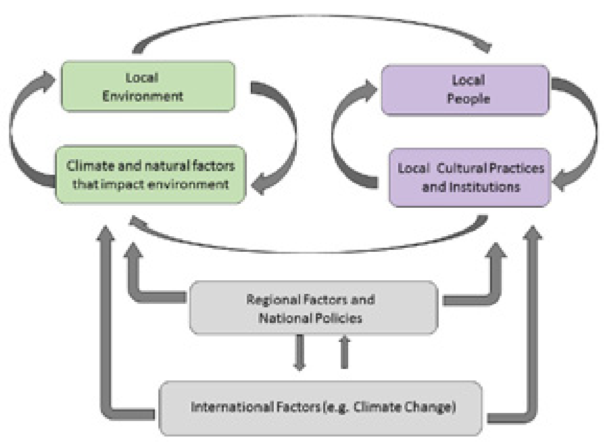


Fig. 3.1.2 :
Social-Ecological Systems Diagram
Source:
(Social Ecological Systems, Key Definitions | GEOG 430: Human Use of the Environment, n.d.)

Circular Economy

Circular economy is a system of processes that keep in circulation the products and materials to end exploiting activities related to consumption. Its focus is centred on three principles: 1. To eliminate waste and pollution, 2. To circulate products and materials, and 3. To regenerate nature. (Ellen MacArthur Foundation, 2024)

The imbalance in the nitrogen cycle is a result of the inefficient use of our resources in the food supply chain. Therefore, mitigating nitrogen pollution demands adjustments within food production. As Kishna and Rood state in their report for PBL Netherlands Environmental Assessment Agency, "A circular economy is aimed at keeping resources within the production chain for as long as possible, through optimal use and reuse – with the greatest value to the economy and the least amount of damage to the environment" (Rood & Kishna, 2019)

In conclusion, a circular economy can support our goal for zero hunger while we safeguard our natural environment and our health.

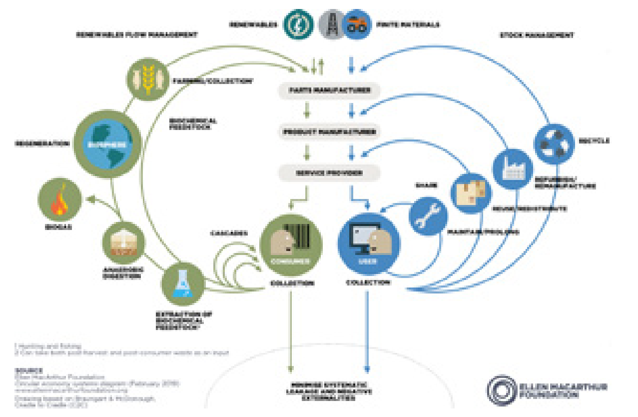


Fig. 3.1.3 :
Circular Economy Butterfly Diagram

Social Justice

Spatial Justice is a theory that provides a spatial perspective to social justice through the provision of understanding of the spatial dimensions of burden and benefit distribution, alongside the governance behind it. In Spatial Justice, there are three dimensions of focus: (1) Recognition Justice, which describes the acknowledgement of our needs, interests, histories and aspirations, (2) Procedural Justice, which refers to the importance of achieving justice in the procedures of negotiating, planning and decision-making, and (3) Distributive Justice, that encaptures the idea of creating, allocating and providing access to public goods, resources and services fairly. (Rocco, 2021)

The Nitrogen Crisis became a central focus point for global society due to the conflicting interests between different stakeholders. mitigation of nitrogen emissions aims for environmental sustainability, food safety, and water quality preservation among other things. From this perspective, the transition to a nitrogen surplus-free future is fair for all beings and generations. On the contrary, the current food supply chain is a complex socio-economic system. This means that any changes within it will indirectly affect the distribution of public goods and resources among certain groups. To achieve our sustainability goals while ensuring justice we need to include Spatial Justice principles in our systemic approach.

Fig. 3.1.4 :
Spatial Justice Principles Diagram
Source:
"The Idea of Justice", Rocco, R., (2024)

3.2 Conceptual Framework

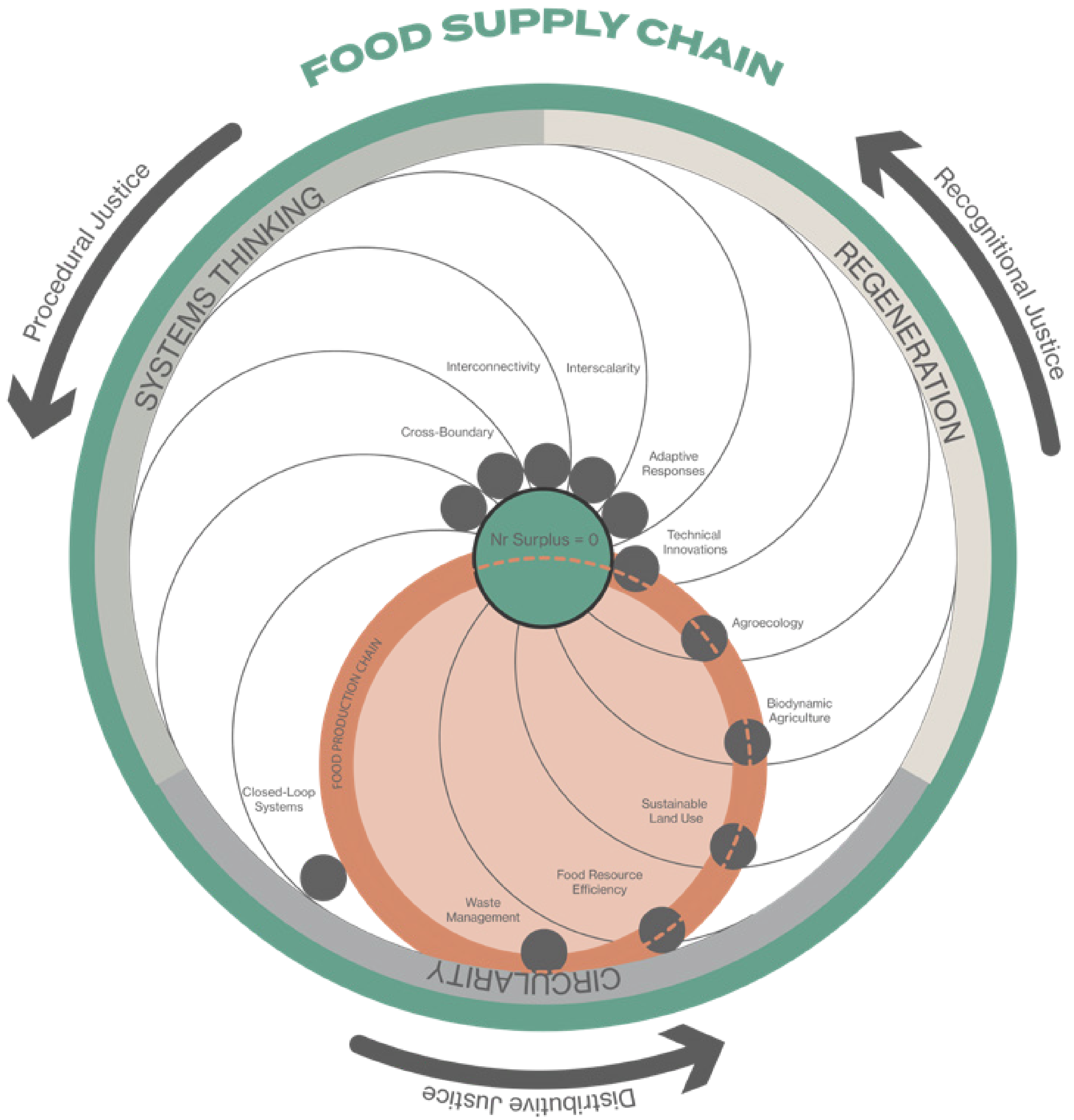


Fig. 3.2.1 :
Conceptual Framework, (own work)

Let's eliminate Nitrogen surplus, restore balance in its cycle and keep the food supply chain working sustainably for a safe, but still productive future.

The following Conceptual Framework is an assemblage of our core ideas and underlying principles in envisioning a sustainable food supply chain. Drawing inspiration from Leonardo Da Vinci's "Perpetual Motion Machine", we represent our vision and strategy as the action that will kickstart the transition to a sustainable food supply chain. The three main principles of Spatial Justice ensure that the food supply chain keeps rotating fairly.

Regeneration, circularity and systems thinking form the basis of our transition to a sustainable food supply chain. Our approach focuses on food production within the supply chain with an emphasis on the production of raw materials. We keep this perpetual motion of the sustainable food supply chain with the help of methods and theories like biodynamic agriculture, sustainable land use, closed-loop systems and interconnectedness.

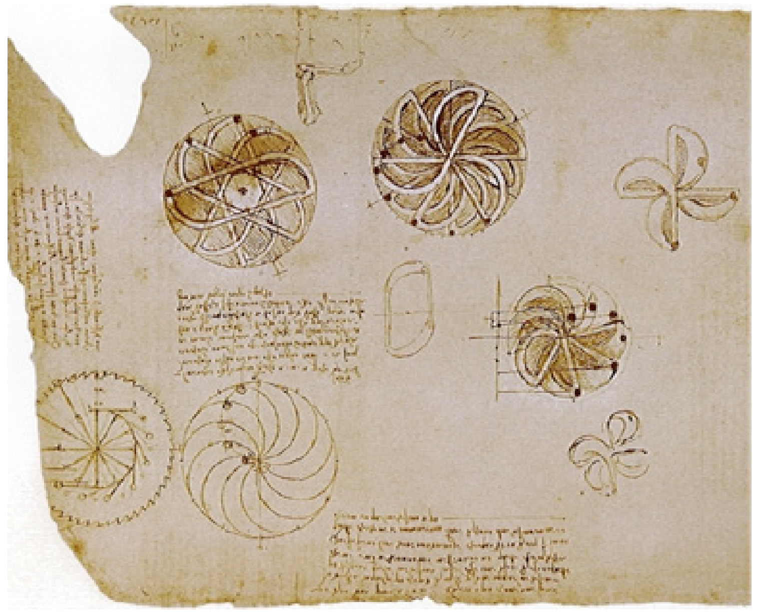


Fig. 3.2.2 :
Leonardo Da Vinci's Perpetual Motion Machines,
Source: Leonardo da Vinci's Elegant Design for a Perpetual Motion Machine | Open Culture. (n.d.). Retrieved 9 April 2024, from https://www.openculture.com/2019/08/leonardo-da-vincis-elegant-design-for-a-perpetual-motion-machine.html

Chapter 4 Analysis

4.1 Discovering how the Dutch landscape is shaped by agriculture

fig.4.1.1: Site visit (Maasland Satelite Image, n.d.)

In order to gain an understanding of how farmers shape the Dutch landscape, we went on a site visit to the Westland area, an area located in the west side of the Netherlands. During the bike trip from Delft to Maasluis, we cycled past different types of farmland. We saw greenhouses, pastures and farms. We were also confronted with the small but present differences in height in the flat landscape. We realized while cycling that these height differences are only present, because of the polders system.

During this trip it became clear that the Dutch landscape is shaped by farming practices.

1 fig. 4.1.2 Greenhouses (own work)

2 fig.4.1.3 Sheep on a field (own work)

3 fig.4.1.4 Height differences & sluice (own work)

4 fig.4.1.5 Water level in landscape (own work)

4.2 The role of the Netherlands in the global food chain

The Dutch agricultural sector plays a significant role in international food provision. This is driven by the country's fertile soil types, the wet maritime climate and technological innovation. Within Europe, the Netherlands is the largest exporter of agricultural products (Eurostat, 2022), and globally, the Netherlands ranks second after the United States (Reiley, 2022). Through its advanced expertise in agronomy, genetics, biotechnology, and the high degree of automation in Dutch agriculture, the country is capable of producing food for significant portions of the rest of the world despite its small land area. This position is attributed to the extensive floriculture, meat production, dairy and egg production, and crop horticulture in the Netherlands.

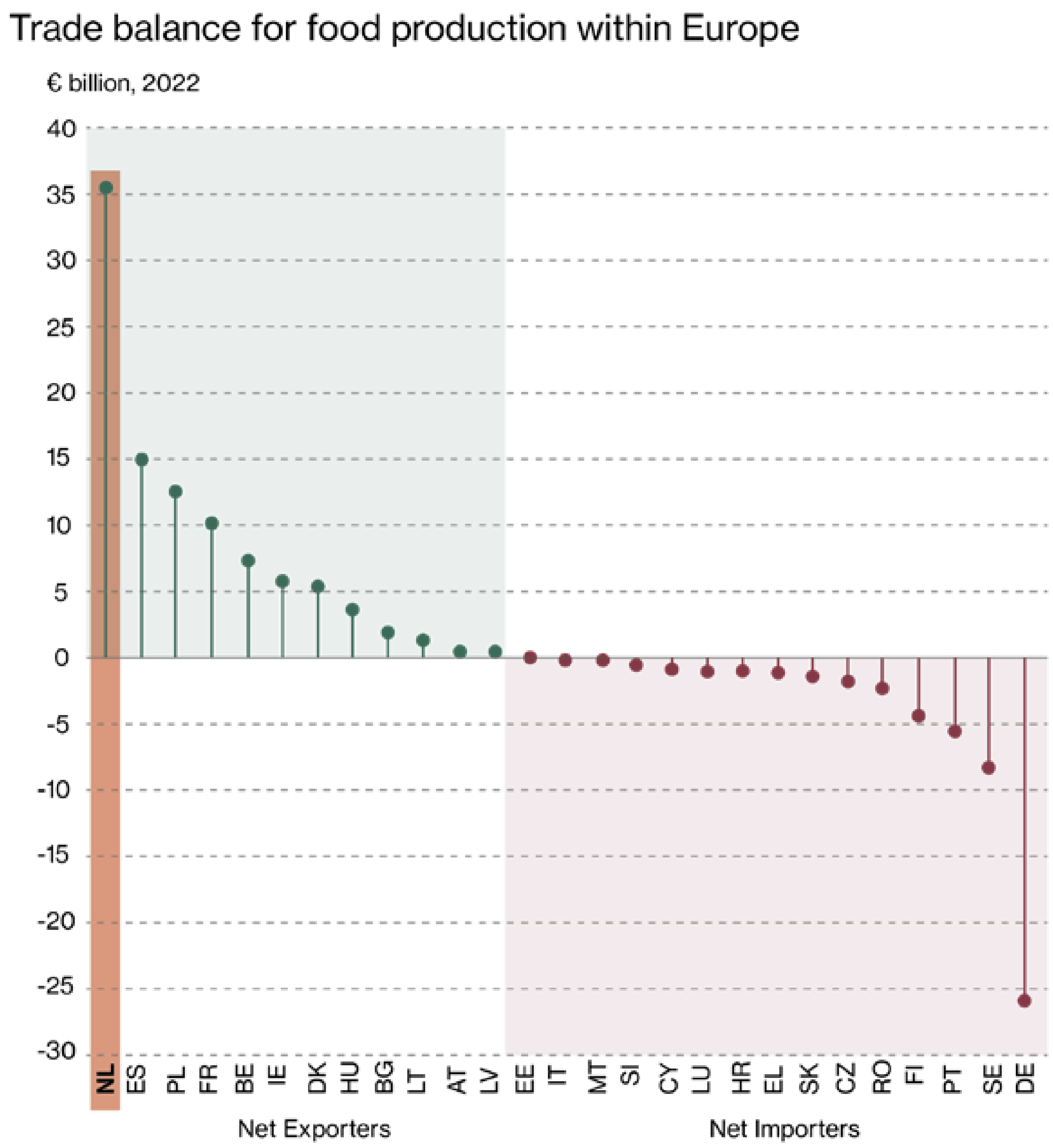


Fig 4.2.5 Trade balance for food production within Europe, Image source: Eurostat, 2024

Fig 4.2.1 Dairy and egg production, Image source: Holland.com, n.d.

Fig 4.2.2 Dairy and egg production, Image source: Wallmonkeys, n.d.

Fig 4.2.3 Meat production, Image sourse: Adobe Stock, n.d.

Fig 4.2.4 Vegtable production, Image source: ANP, n.d.

4.3 Spatial Analysis

4.3.1 Nitrogen pollution

Nitrogen is an essential to life, and a key nutrient for plant growth (Cranitch, 2021). Therefore, nitrogen-based fertilisers are widely used in food production (Kanter et al., 2019), especially with the large demand for export there is in the Netherlands. However, an excess can be harmful to the environment. In this chapter we will dive deeper into these causes and effects.

The nitrogen cycle

The nitrogen cycle explains how nitrogen moves through the air, soil, water and organisms. The air we breathe consists of about 78% out of N_2 (Wageningen University and Research, 2022). Therefore, it is important to know that N_2 is not what is causing pollution, it is the reactive nitrogen that is produced by human activities that is polluting (Ghaly & Ramakrishan, 2015). N_2 from the air is fixated onto the earth via nitrogen-fixating bacteria (Cranitch, 2021) or lightning strikes (Fields, 2004). In the soil N_2 is transformed into ammonia (NH_3) (Cranitch, 2021). Other bacterias convert ammonia into amino acids and proteins, which plants will take up for their growth. These nitrogen compounds return to the soil through animal and plants waste, where bacteria will convert the waste nitrogen back to N_2.

Causes of nitrogen pollution

The explanation of the nitrogen cycle is how the cycle is supposed to be. However, human activities create a lot of reactive nitrogen that is not supposed to be in the environment. In figure x.x the main reactive nitrogens our shown. In the Netherlands the main contributor to pollution is agriculture, from cow manure and fertiliser application (RIVM, 2023). Other polluters are industry and mobility. As seen in figure x.x, about 30% of the pollution comes from neighbouring countries as well.

As agriculture is the main contributor to the nitrogen pollution, our project focuses on this part. Moreover, as can be seen in figure x.x and x.x, the Netherlands is one of the biggest appliers of fertilisers and producers of cow manure (Potler & Ramankutty, 2011). However, the issue is that farmers add too much fertiliser on the land in order to create sufficient yield. The plants do not use all of the nitrogen, and the excess goes into the soil (Cranitch, 2021).

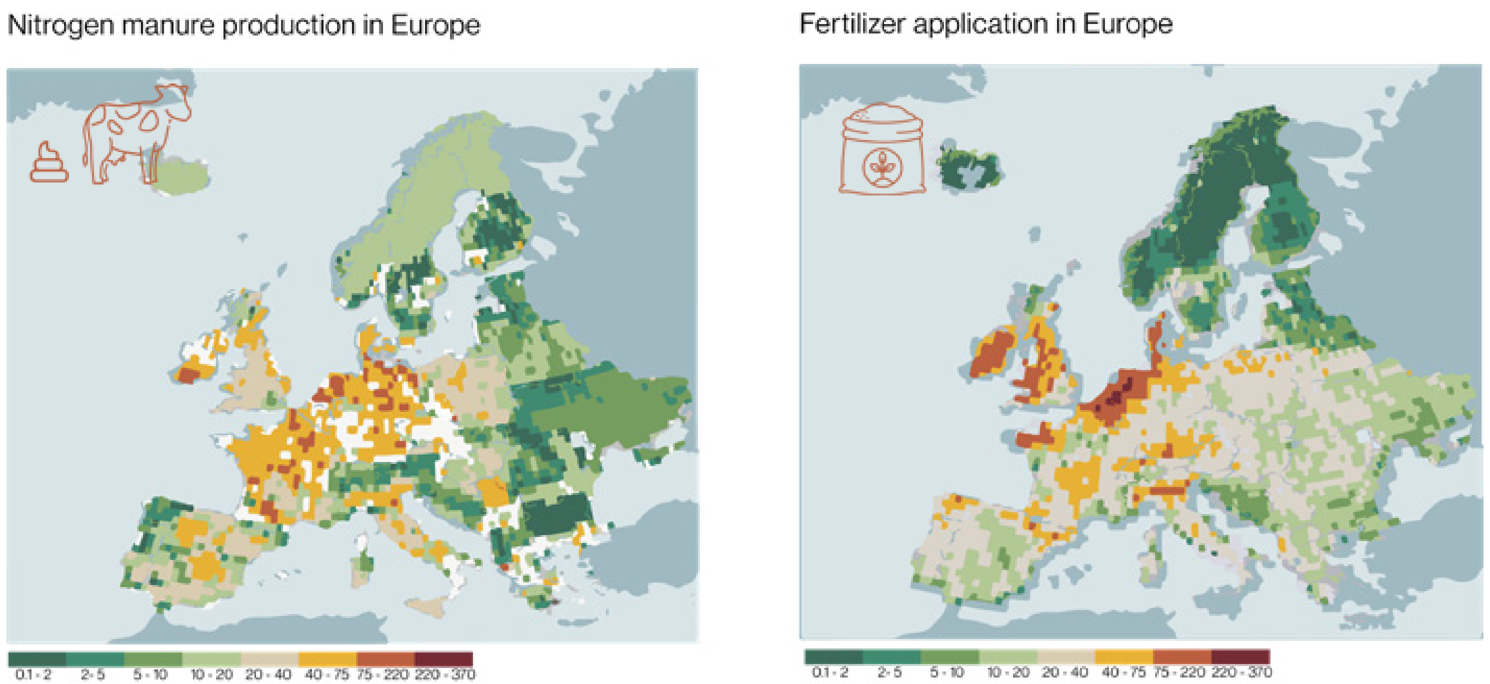


Figure 4.3.1.1
Nitrogen manure production and fertiliser application in Europe (Potler & Ramankutty, 2011).

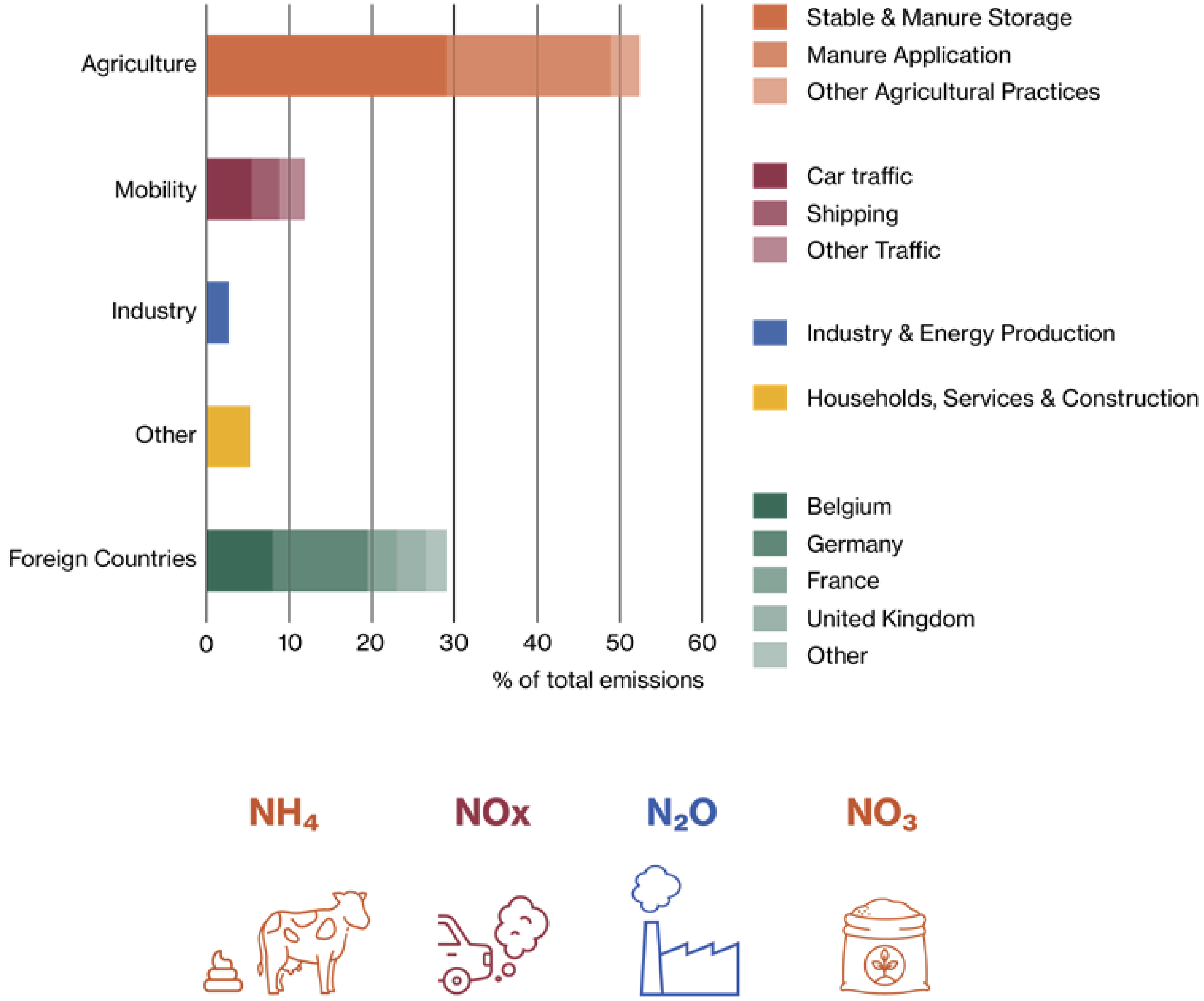


Figure 4.3.1.2
Sources of nitrogen pollution in the Netherlands in 2022 (RIVM, 2023).

The nitrogen surplus

In figure x.x the current nitrogen cycle with the surplus is schematically illustrated. Chemical fertiliser produced from fixating N_2 with CH_4 (Fertilizers Europe, 2023) is added in large amounts on the land, creating an excess of NH_4 and NO_3 into the soil. These reactives can turn into NO_2 and NO_3. However, all these reactive nitrogens have severe effects on the ecosystem and human health (Ghaly & Ramakrishan, 2015).

Effects of nitrogen pollution

Nitrogen pollution effects ecosystem and human health, as shown in figure x.x. For human health the main dangers are pollution of drinking water, air pollution and in extreme cases like the industrial revolution, acid rain (Ghaly & Ramakrishan, 2015). For ecosystem health the main issue that arises is the loss of biodiversity. When there is an excess of nitrogen in the soil, fast growing plants will thrive on these nutrients and outcompete other species, thus taking over the land (Ghaly & Ramakrishan, 2015). When nitrogen leaches in groundwater to water bodies, algae will bloom, creating a lack of oxygen in the water which would make the body inhabitable for other plant and water-animal species. This process is called eutrophication. Figure x.x and x.x show what this looks like.

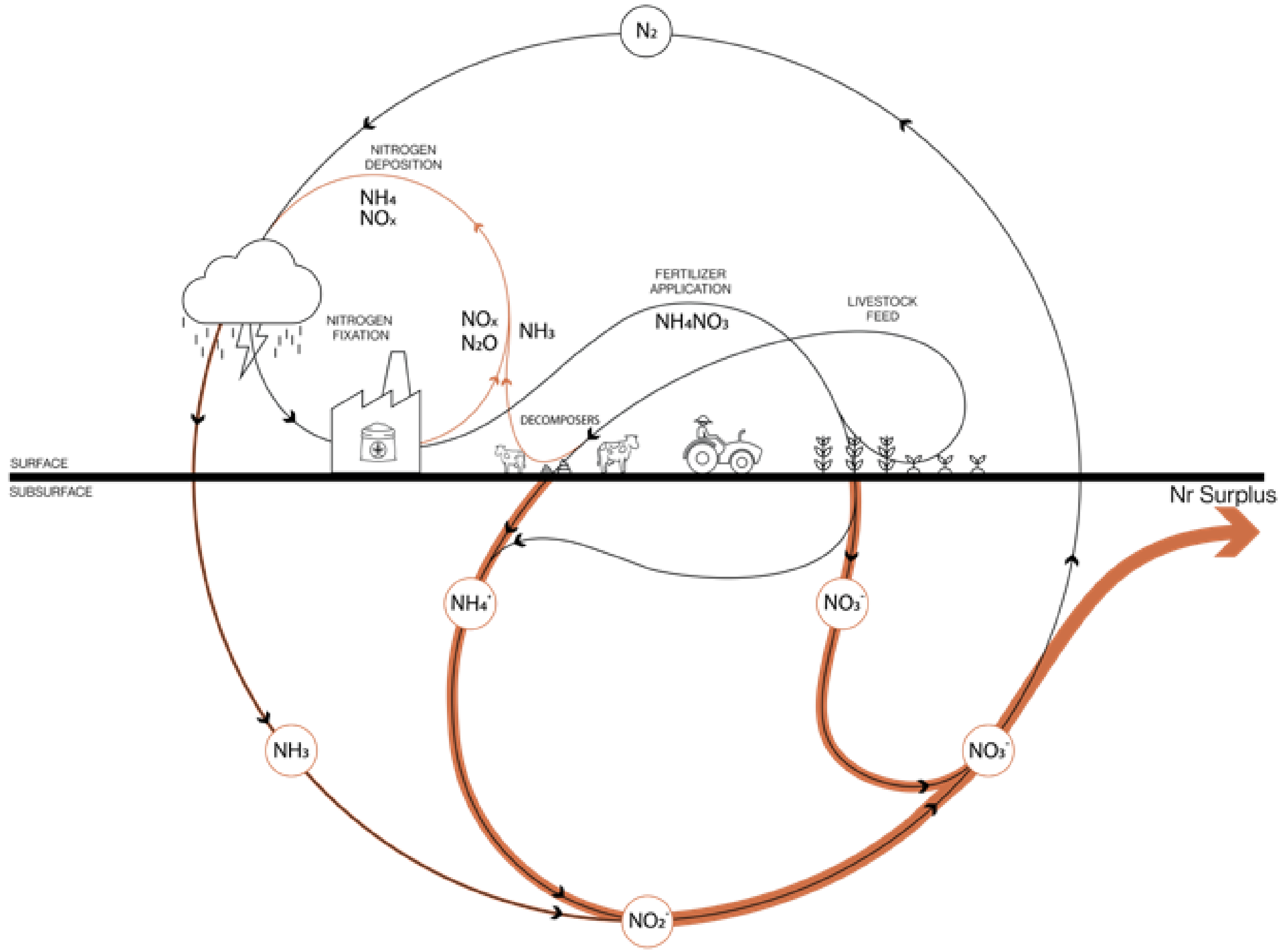


Figure 4.3.1.3
Schematic illustration explaining the nitrogen surplus in the soil from agricultural practices (own work).

Figure 4.3.1.4
Eutrophication (Alen Thien/Shutterstock.com).

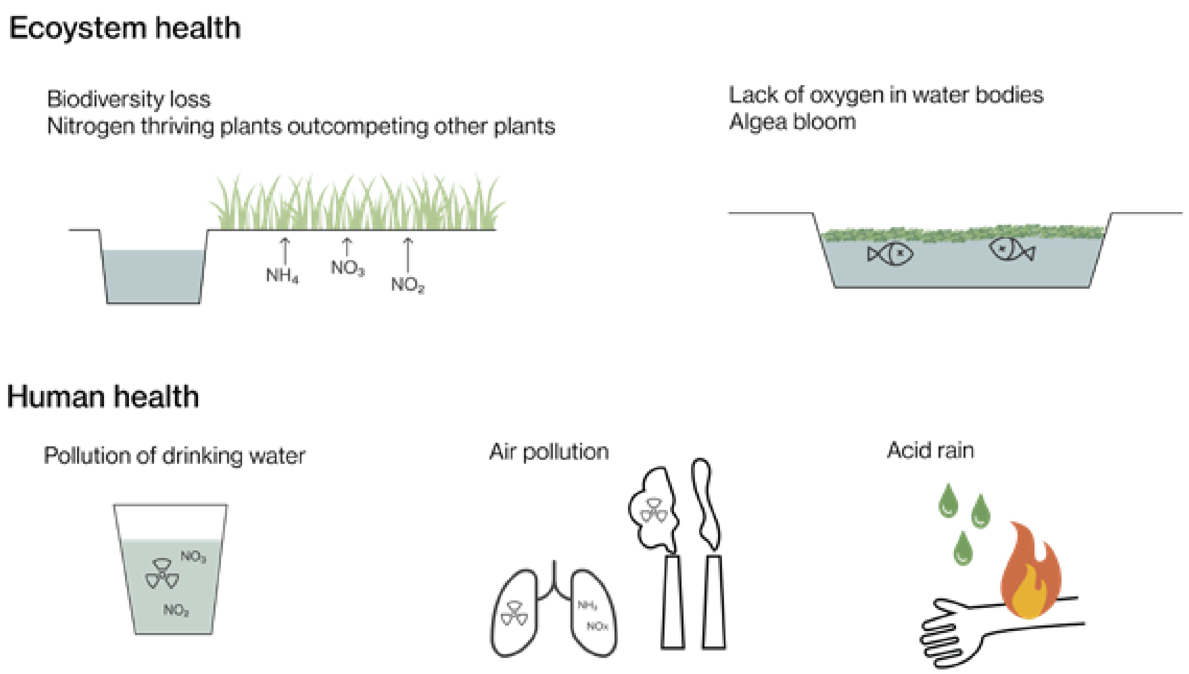


Figure 4.3.1.5
Effects of nitrogen pollution on ecosystem and human health (own work).

Pollution flows in the Eurodelta

This figure shows the flow of nitrogen pollution at the Euro delta scale. Nitrogen surplus from urban and agricultural sources travels from the air to the land, from the land to the groundwater, and from the groundwater to surface waters. From upstream countries to downstream countries. From surface water flow such as the Rhine, the Maas, and other rivers in Europe such as the Seine, and finally to the ocean. Eutrophication from nitrogen pollution will seriously damage the health of the aquatic ecosystem.

Where does the flow come from?

Local pollution

The sources of pollution are diverse; however, atmospheric deposition is a significant additional source of nitrogen in the Greater North Sea, contributing about 30% of the total nitrogen input (OSPAR, 2017). Nitrogen surplus in the air can take various forms, such as ammonia volatilized from livestock areas (indicated by the orange circles in the figure) and nitrogen oxides from urban transport and industry (indicated by the blue circles in the figure). They can enter the soil, groundwater, or surface water nearby through precipitation or atmospheric deposition.

In natural areas, such as ecological wetlands and forests, there is a healthier nitrogen cycle system (Sprent, 1987,). There is no excessive use of fertilisers, high-density livestock farming, or any industrial waste, so these areas do not have significant nitrogen surplus. Therefore, in the figure, you can see that natural areas are represented by closed green loops.

Transboundary pollution

However, the nitrogen pollution problem in the Rhine-Meuse delta in the Netherlands is not only from domestic pollution but also from upstream countries of the Rhine and Meuse rivers, such as France, Belgium and Germany. (EEA, 2019).

Therefore, besides addressing domestic nitrogen pollution issues, it is also crucial to cooperate and negotiate with upstream countries and control nitrogen pollution from the perspective of the entire Euro Delta.

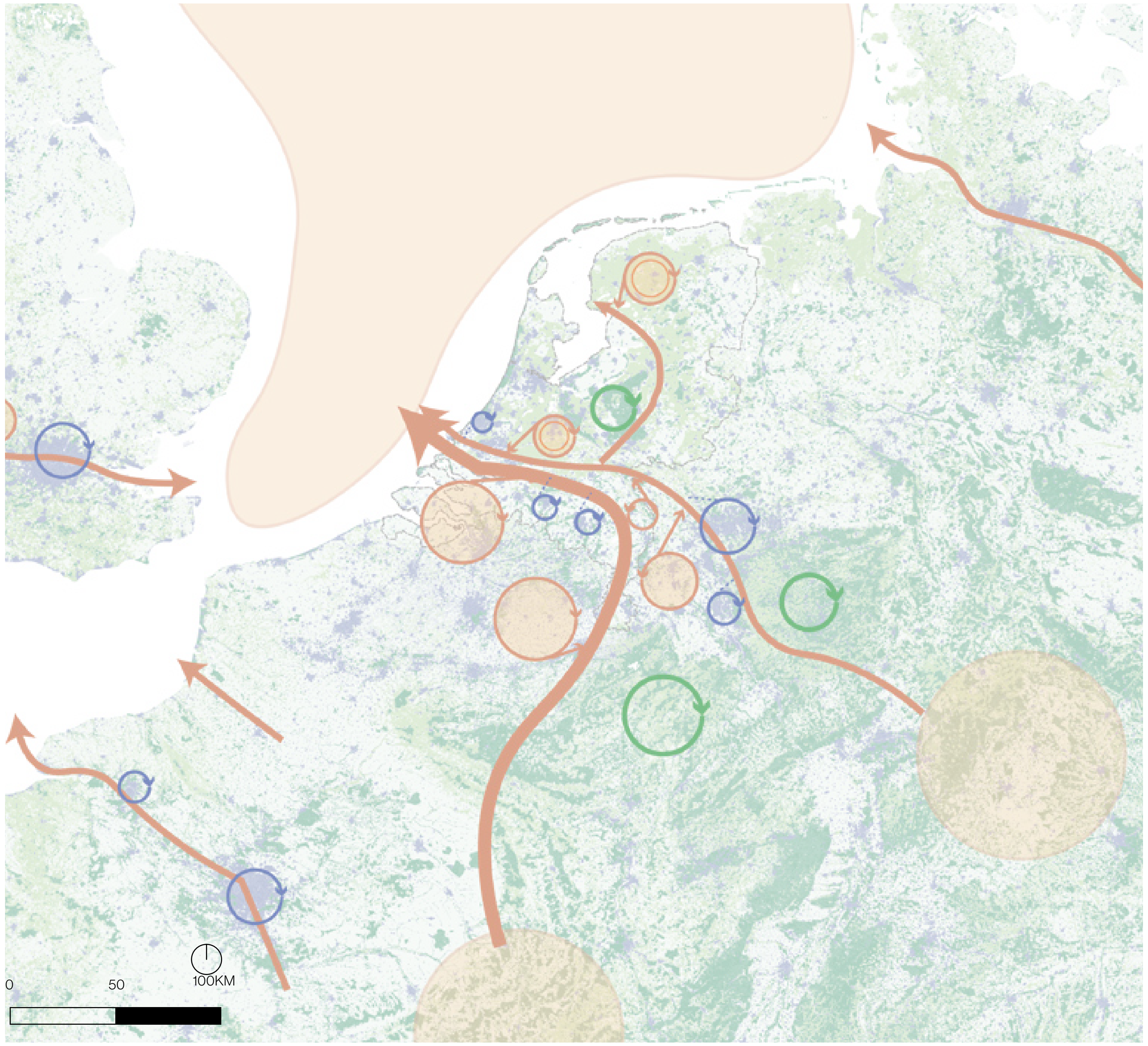
Where does the flow go?

Nitrogen pollutions from river bodies will flow via the water into oceans and seas.. Most of the pollution in the North Sea region of Europe comes from the Dutch coast, and the Rhine-Meuse river basin is one of the major contributors to this pollution. (EEA, 2019) As shown in the figure, besides the severe eutrophication in the Baltic Sea, there are also “problem areas” along the Dutch coast of the North Sea.

Where are we now?

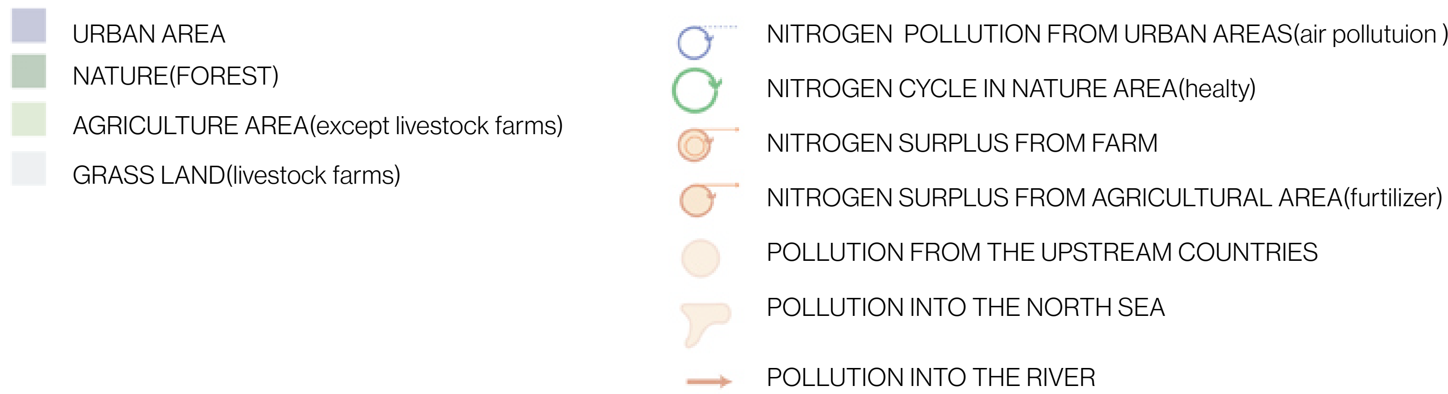
Since the end of the last century, the European Union has been paying attention to the eutrophication of water bodies and nitrogen and phosphorus pollution. Some policies and treaties are formulated, such as The EU Water Framework Directive, the EU Marine Strategy Framework Directive andThe Nitrates Directive,(European Environment Agency, 2019). Meanwhile, nutrient enrichment is included in the global 2030 Agenda for Sustainable Development (UN, 2015). Nutrient pollution is included under SDG14.1, which sets a target to prevent and significantly reduce marine pollution (including nutrient pollution) by 2025. Since 1990, nitrogen pollution in the Rhine River Basin has been decreasing (European Environment Agency, 2019), and everything seems to be moving in a better direction.

However, these are mostly top-down policies, mainly aimed at limiting nitrogen emissions from farmers and the discharge of sewage, and have not fundamentally changed the agricultural cultivation patterns. What we need is systematic change.



NITROGEN FLOW MAP

Fig. 4.3.1.6
NItrogen flow map, (own work)



Pollution intensity in the Netherlands

Ammonia -air pollution

Figure X illustrates the distribution of Ammonia in the Netherlands based on RIVM data, with units taken as µg/m³(RIVM, 2024). Ammonia can quickly dissolve in water, but it is held or retained in soil by clay and organic matter (Sawyer, 2020). Through the process of leaching, the pollution in the soil enters the groundwater and surface water. The ammonia emission level in the air can reflect to some extent the nitrogen contamination in the soil as well as in the groundwater (Sawyer, 2020). Therefore, we also consider that this map provides a more comprehensive picture of the extent of nitrogen pollution contamination present in water, air, and soil.

The annual long-term critical values are 1 µg/m³ for lichens and red-leaved plants and 2-4 µg/m³ for higher plants (UN ECE, 2007). Based on this criterion, we select areas with ammonia levels above 5 µg/m³ as "problematic areas", as these ecosystems are highly threatened by nitrogen pollution

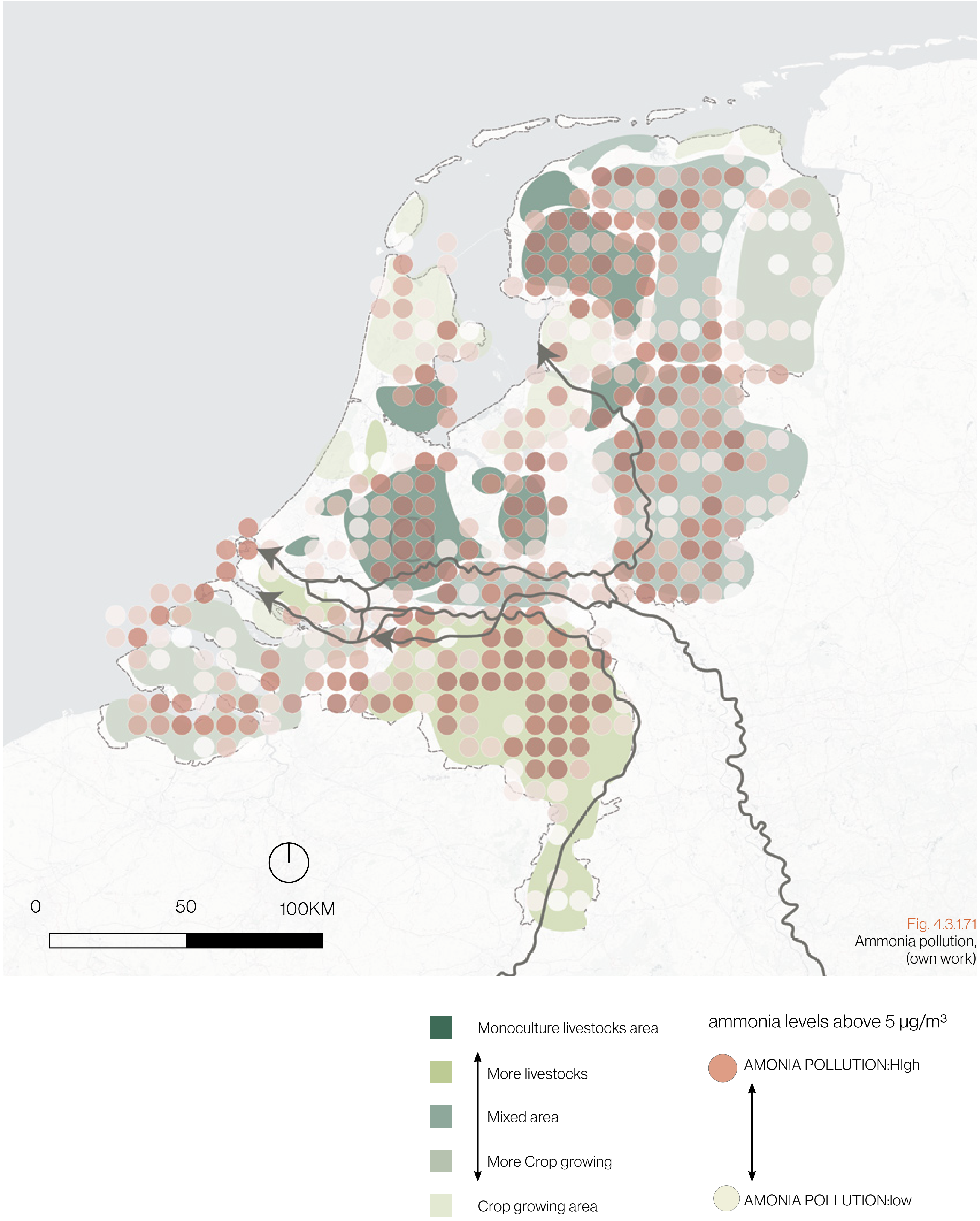


Fig. 4.3.1.71
Ammonia pollution, (own work)

Soil biodiversity-Soil pollution

This map shows soil biodiversity.

Soil biodiversity reflects the fertility of the soil to a certain extent. When we overlay the degree of soil biodiversity with the agricultural land-use map, we find that lower soil biodiversity shows some positive correlation with arable crop growing area. And soil biodiversity is higher in livestock pasture area. This is due to the degradation and reduced fertility of soils caused by too intensive farming activities and chemical fertiliser (mainly nitrogen and phosphorus). These soils require changes in agriculture typology to achieve regeneration

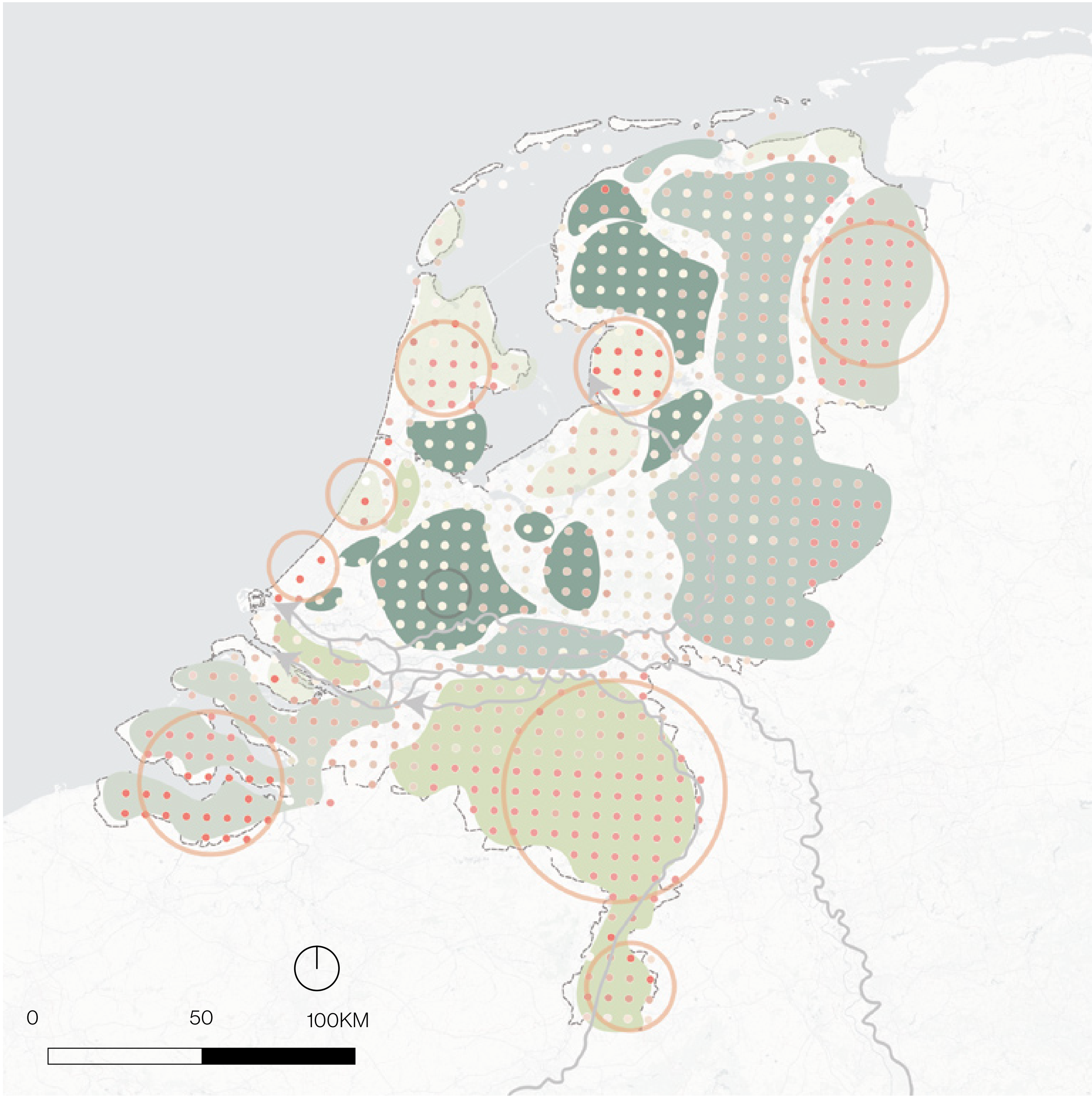


Fig. 4.3.1.8 Soil BIodiversity,
(own work)

Monoculture livestocks area
More livestocks
Mixed area
More Crop growing
Crop growing area

BIODIVERSITY IN SOIL:low
BIODIVERSITY IN SOIL:high

Eutrophication-water pollution

This map shows Eutrophication caused by atmospheric nitrogen deposition (European Environment Agency, 2021), which mainly reflects the extent to which surface waters in the Netherlands are polluted by nitrogen and phosphorus. In this graph, it is clear that water bodies are more polluted in the east than in the west. Pollution of water bodies is related to water management, irrigation methods and soil type.

So when we overlay the soil type map and the map of eutrophication. Despite the presence of large areas of agricultural land on both the eastern and western coasts, water pollution is higher in the east than in the west. This is because sand soil is predominantly present in the east, and the more permeable the soil is, the more leaching occurs (Duchatelet, 2019). This also means that more Nitrogen surplus enters the groundwater and surface water.

In addition, the severity of eutrophication didn't shows a high relevance to livestock pasture. This may be due to the fact that livestock farming is more frequent in areas where leaching is weak, such as clay soil and peat soil(Duchatelet, 2019), and where artificial irrigation is relatively infrequent.

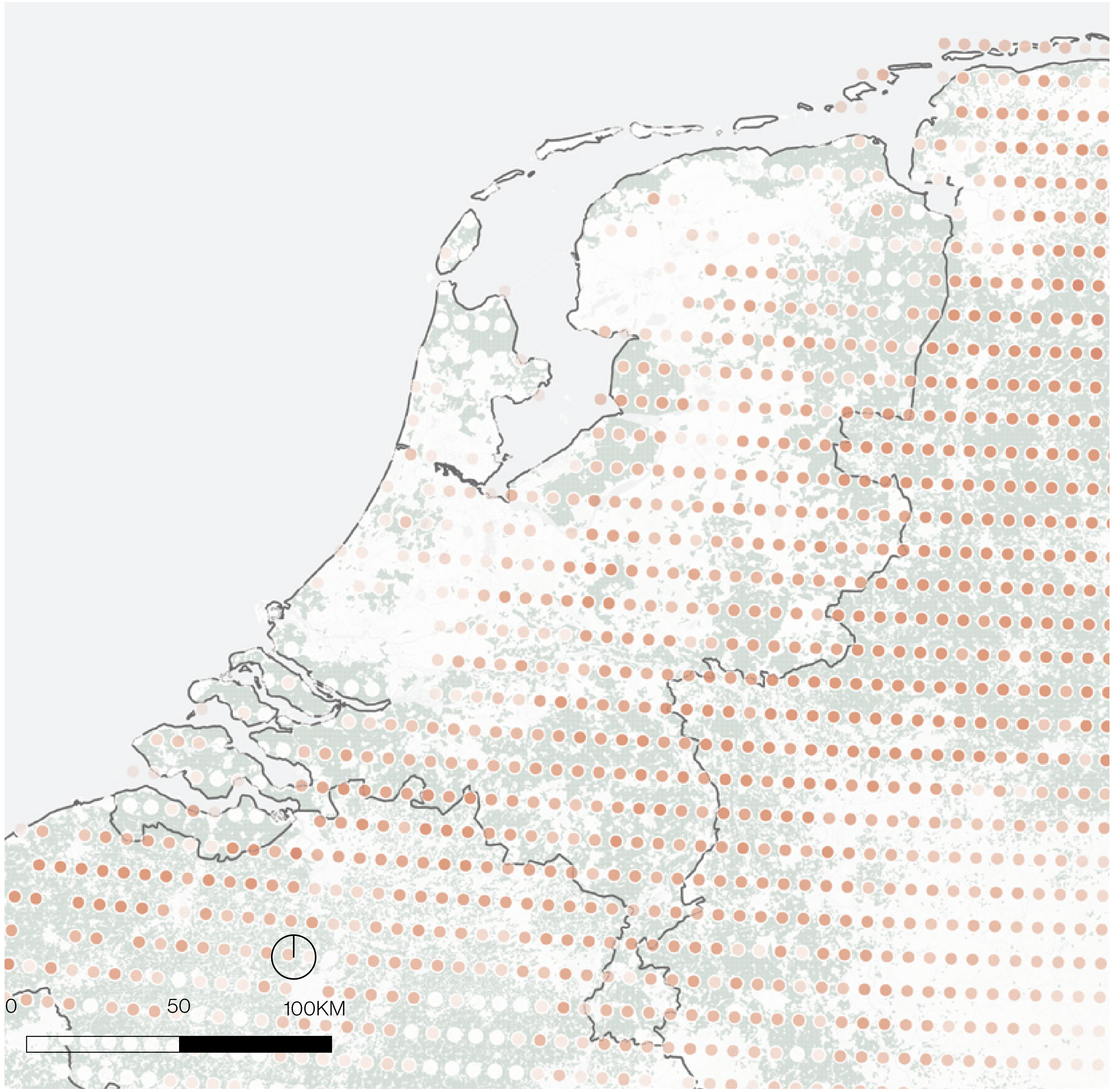


Fig. 4.3.1.9 Etropication map, (own work)

Agriculture crops planting area

Nitrogen equivalents per hectareand year

0 - 92
92 - 269
269 - 456
456 - 691
691 - 1081
1081 - 1803
1803 - 3354
3354 - 4882

4.3.2 Agriculture typology analysis

Soil analysis

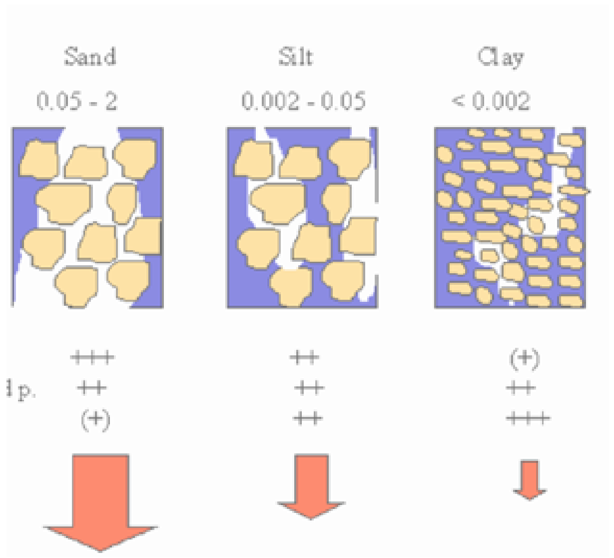


Fig. 4.3.2.1
Soil Type and leaching
(Duchatelet, 2019)

The data for this mapping is from BOFEK2020. The Netherlands has a wide range of soil types, but we have simplified the data according to the BOFEK Report for similar soil types, which is summarised in five soil types: loam soil, peat soil, clay soil, sand soil (sand mixed with clay), and moist soil .The five soil types are summarised as follows: loam soil, peat soil, clay soil, sand soil (mixed with clay), and moist soil (Heinen et al., 2021). Among them, peat soil, clay soil and sand soil are the three most important soils, as shown in the figure above, their water permeability from low to high(Duchatelet, 2019). From this figure we can also see that sand soil is mainly found in the eastern part of the country at higher elevations, while clay soil and peat soil are mainly found in areas below sea level and areas along rivers.

Fig. 4.3.2.2
Soil Type,
(own work)

CLAY SOIL
PEAT SOIL
MIRE SOIL
LOAM SOIL
SAND SOIL
SURFACE WATER

Land use analysis

On the land use map, livestock farming occupies a great deal of land in the Netherlands. And belonging to a very monoculture agricultural model, these lands are basically entirely covered by grass and almost exclusively a single grass species: Ryegrass (Verloop & Geerts, 2007). In some areas perhaps fodder crops such as maize are grown, at the same time we can find some arable lands in the Netherlands, where crops such as wheat, corn , onions, carrots, sugar beet, are grown. Crops are mixed in these areas.
In the livestock areas, there are grassland based livestocks, which are mainly cattle and sheep, and landless livestocks, which are mainly chickens and pigs.There are also holticulture areas in the Netherlands, where flowers are grown(Verloop & Geerts, 2007).

When we overlap the data for the Dutch agricultural land types(data from EURO CROP) with the soil types, it t can be noticed that agricultural farming is mainly located in clay and sand soils, where leaching is more severe and artificial irrigation is more frequent. Therefore, nitrogen from fertilisers is more likely to enter groundwater and surface water. Livestock farming is mainly located in the clay soil and peat soil areas. The permeability of these soils is poor, leaching is relatively weak, and nitrogen pollution in these areas mainly exists in the form of ammonia in the air, and then enters the soil and surface water.

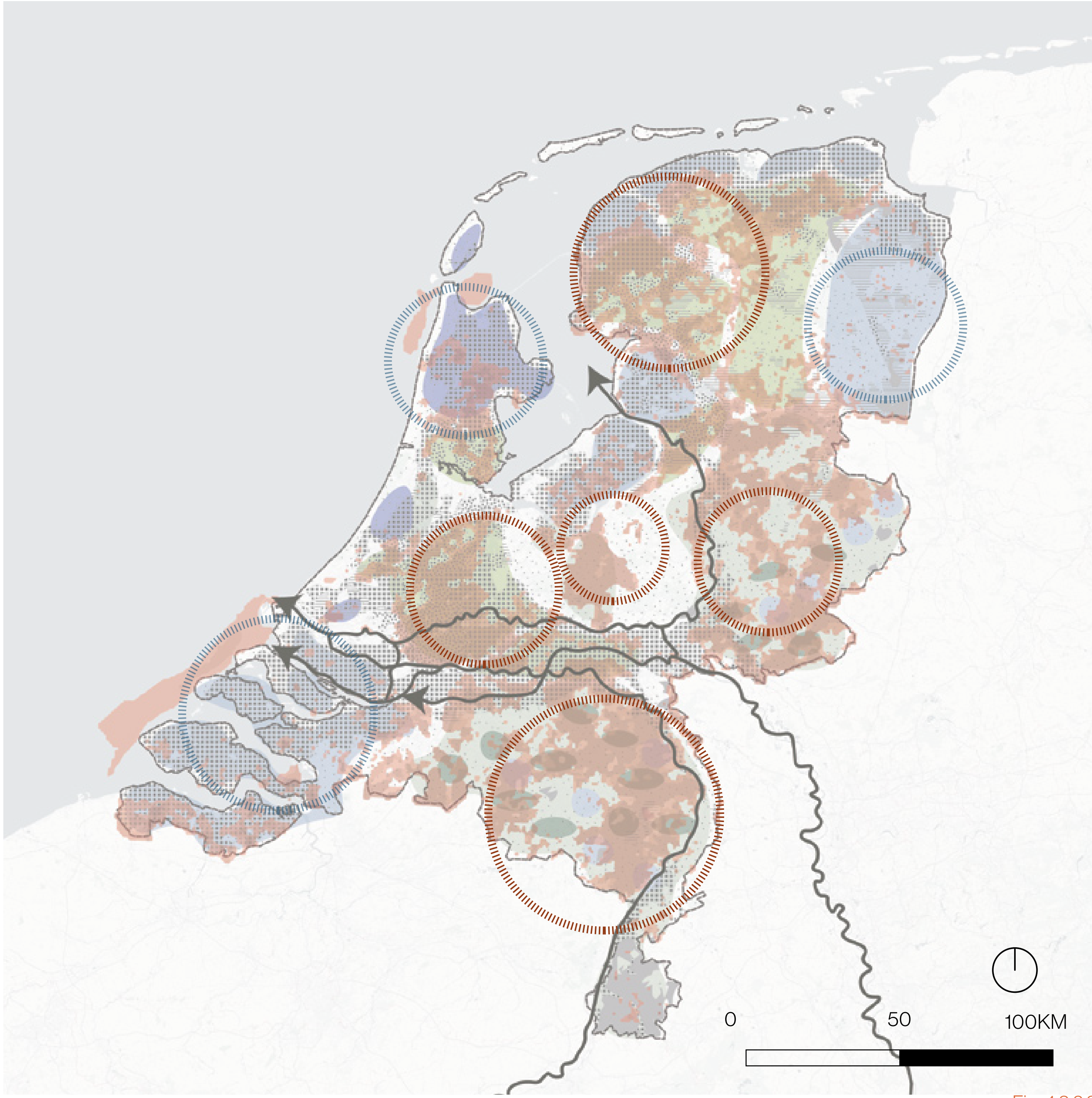


Fig. 4.3.2.3
Land use compined with soil type and ammonia pollution,
(own work)

HORTICULTURE
ARABLE CROPS
PERENNIAL CROPS
GRASSLAND BASED LIVESTOCKS
LANDLESS LIVESTOCKS

CLAY SOIL
PEAT SOIL
MIRE SOIL
LOAM SOIL
SAND SOIL

AMONIA POLLUTION
HIGHLY POLLUTED
LESS POLLUTED

Conclusion on agriculture typologies

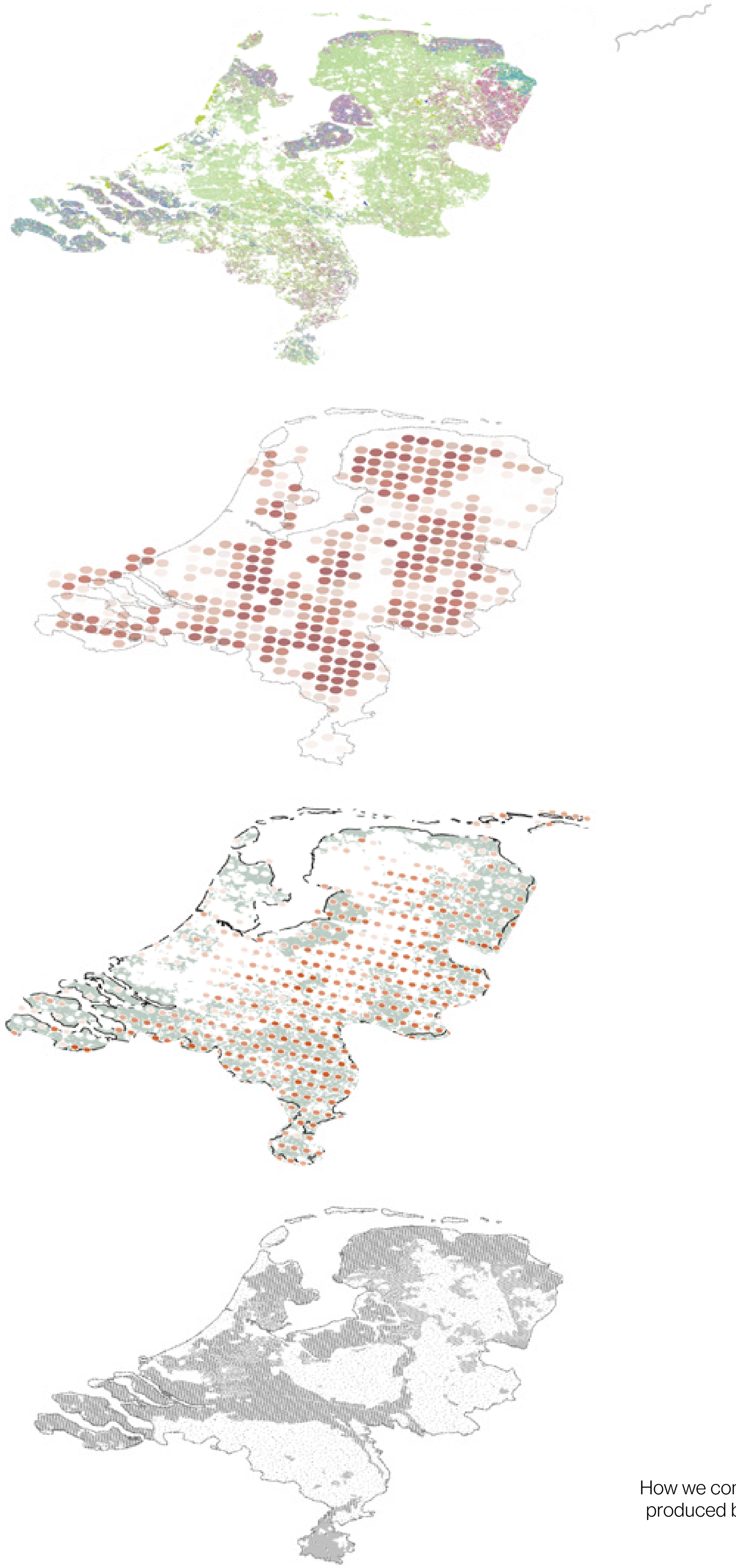


Fig. 4.3.2.4
How we combined the layers
produced by group member

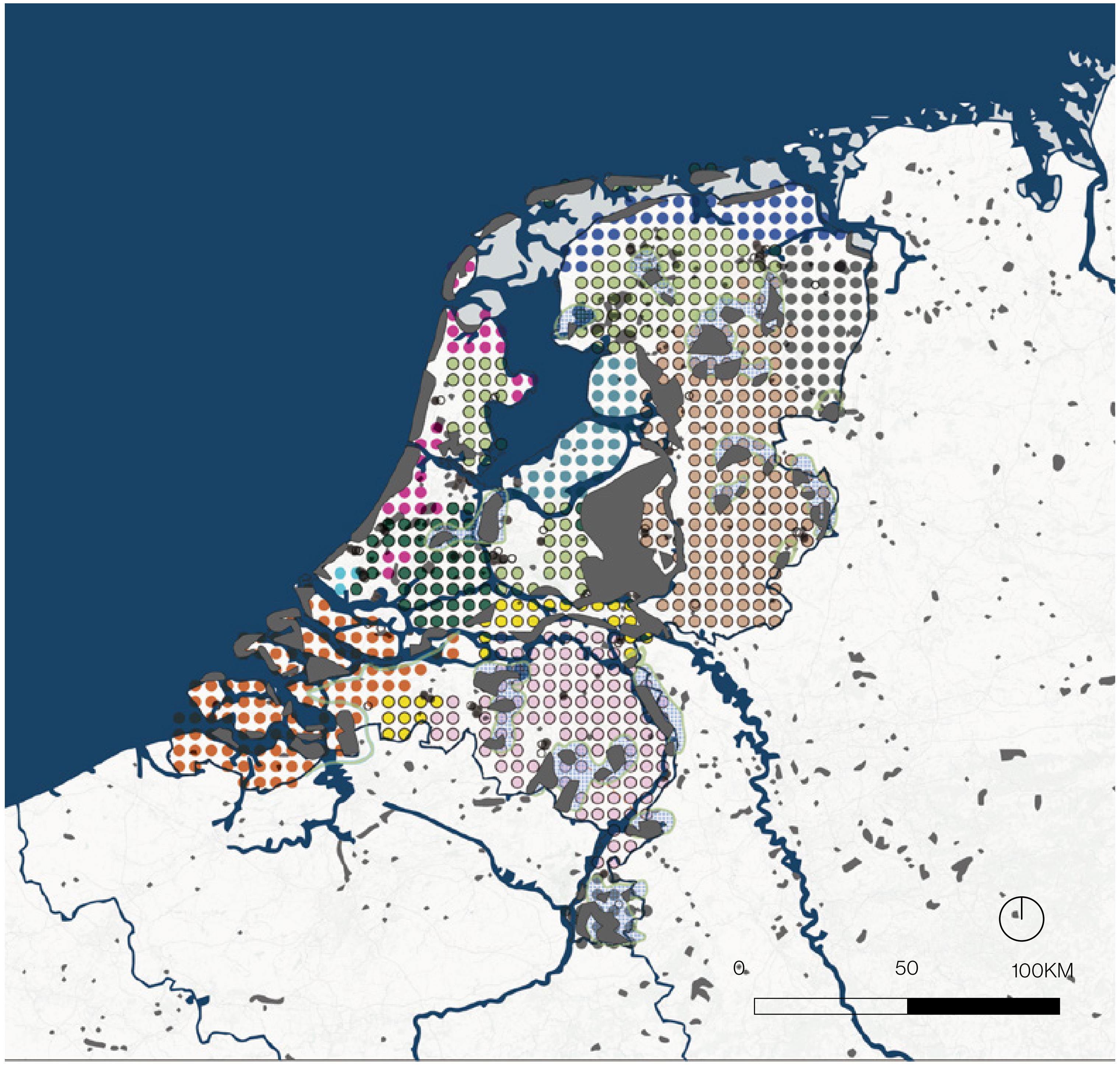
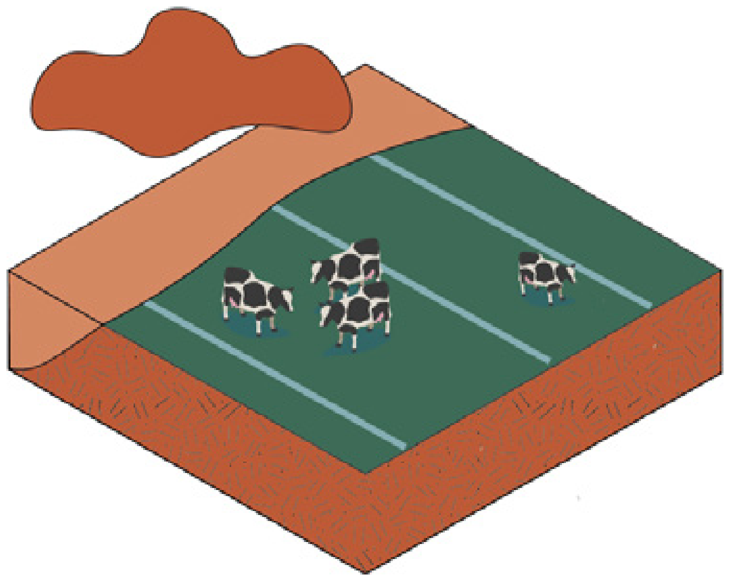


Fig. 4.3.2.5
typology map,
(own work)

Based on the analysis of soils (clay, sand, peat), land use patterns, and forms of nitrogen pollution (air, soil, water),we have summarized the agricultural typology of the Netherlands. The geographical extent of these typologies is distributed as shown in figure above, among these typologies, we found the most polluted typologies to be 1, 2a, 4, 5 &6 respectively. These typologies will be the areas we prioritise for the strategy.

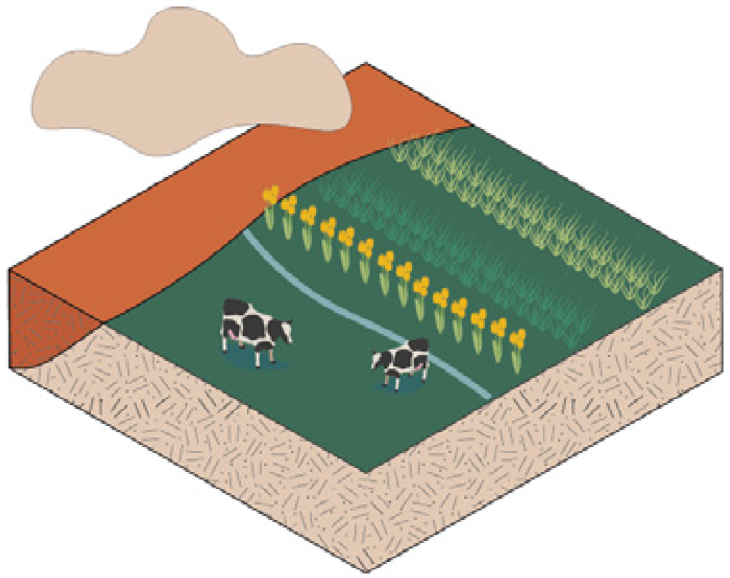
Typology Tiles

1



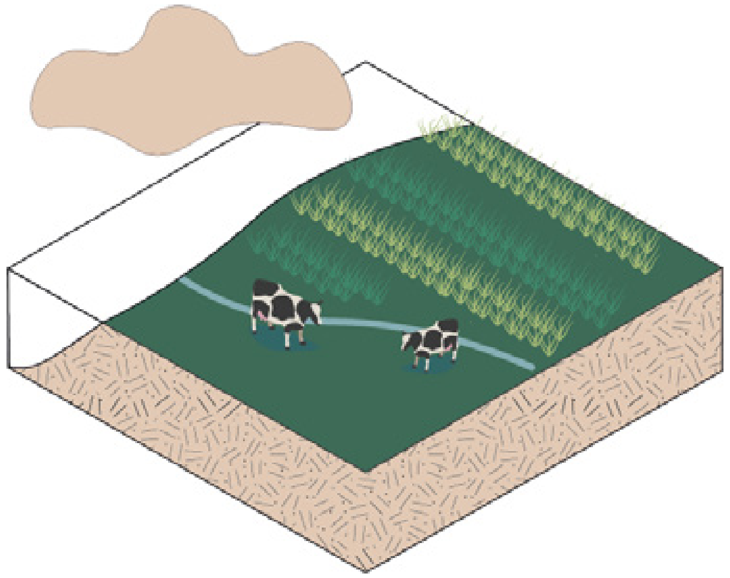
This typology manily consits of pasture land, with dairy farms. There are a lot of cows present. The soil is made up out of clay and peat.

2a



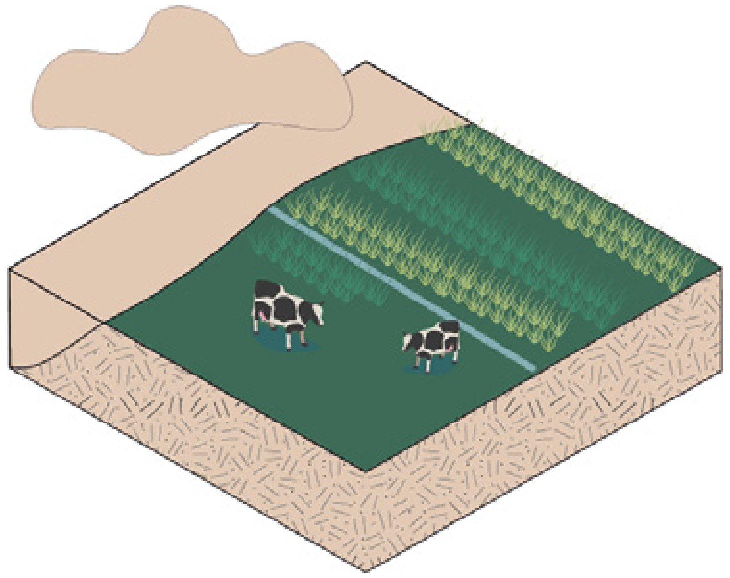
This typology consists mainly of crops. Among other things, potatos, onions, wheats and sugarbeets are cultivated. Furthermore, there are some pastures present. The soil is made up out of clay.

2b



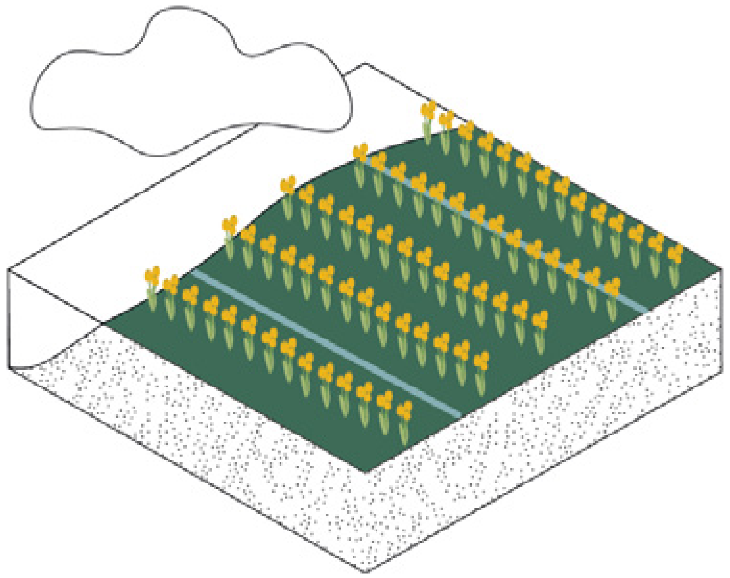
This typology consists mainly of crops. Among other things, potatos, onions, wheats and sugarbeets are cultivated. Furthermore, there are some pastures present. The soil is made up out of clay.

2c



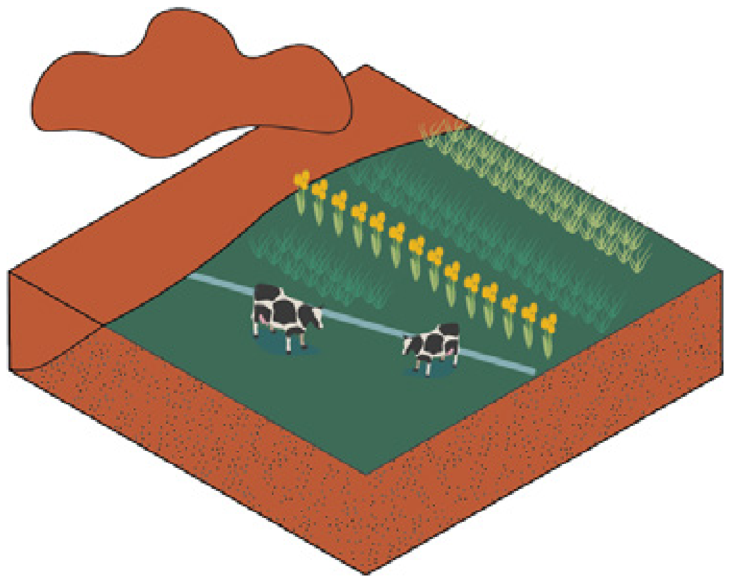
This typology consists mainly of crops. Among other things, potatos, onions, wheats and sugarbeets are cultivated. Furthermore, there are some pastures present. The soil is made up out of clay.

3



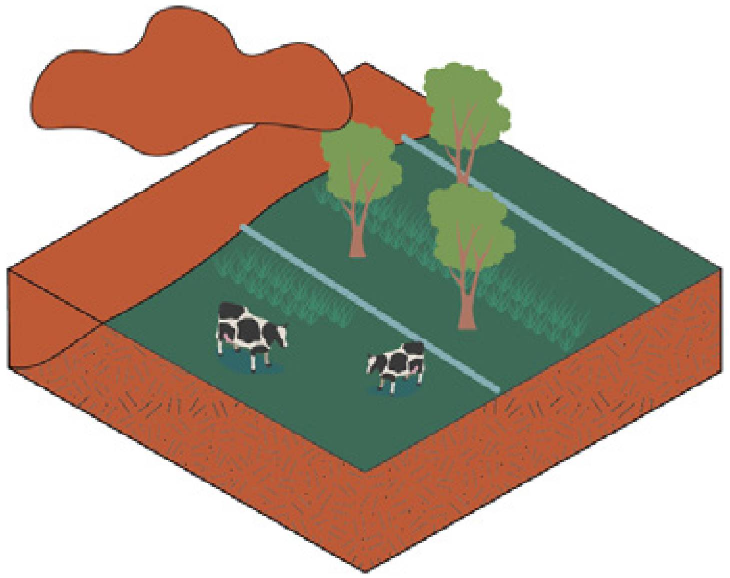
This typology manily consits of flower fields. The soil is made up out of sand.

4



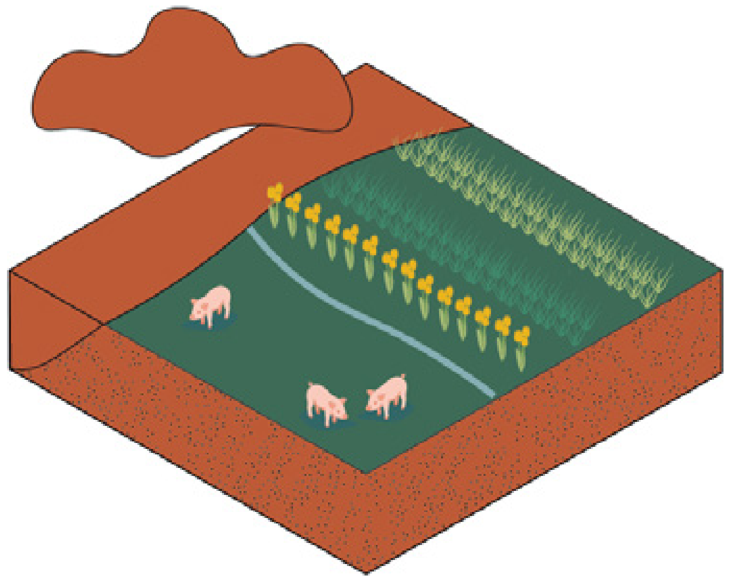
This typology is characterized by a very mixed agricultural landscape. Among other things, flowers, corn and potatos are cultivated. Furthermore, there are some pastures present. The soil is made up out of sand.

5



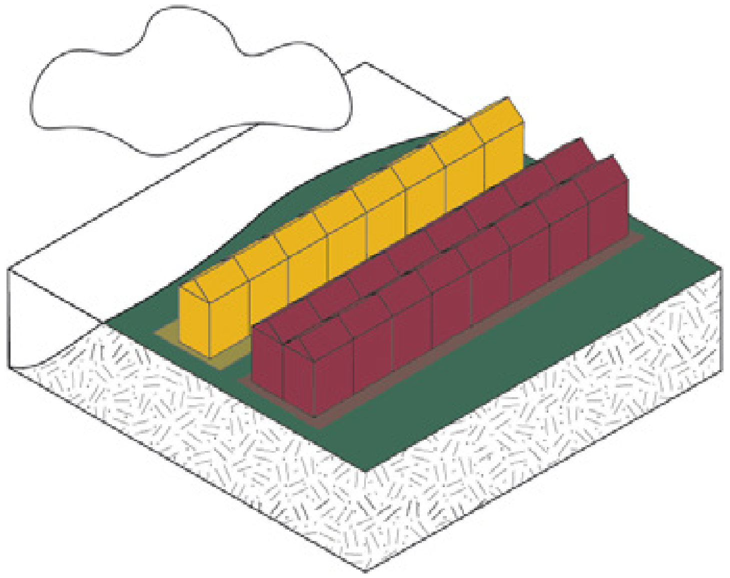
This typology is defined by pastures with cows and forests a number of types of plants are also grown, including corn and no leguminous plants. The soil is made up of clay.

6



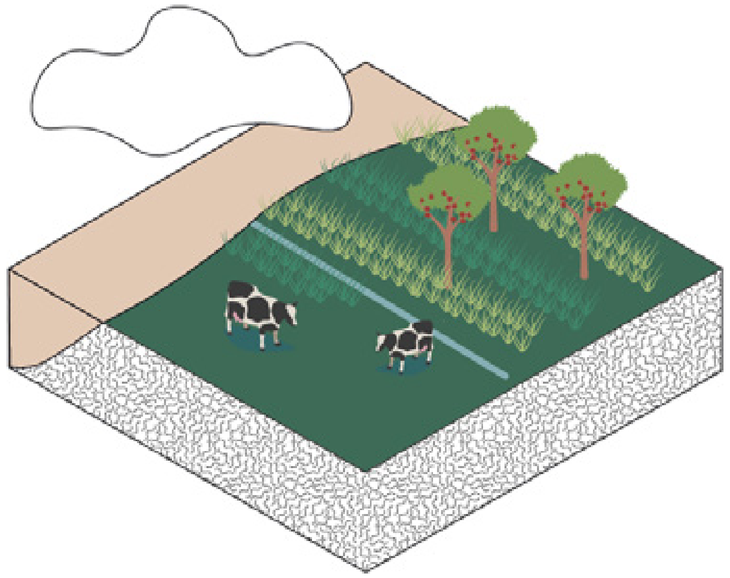
This typology is characterized by a very mixed agricultural landscape. Among other things, stawberries, corn, potatos, onions, carrots, wheats and sugar beets are cultivated. There are alos some flower fields in the area. Furthermore, a lot of pigg farms are present in the area. The soil in this region is made up of sand.

7



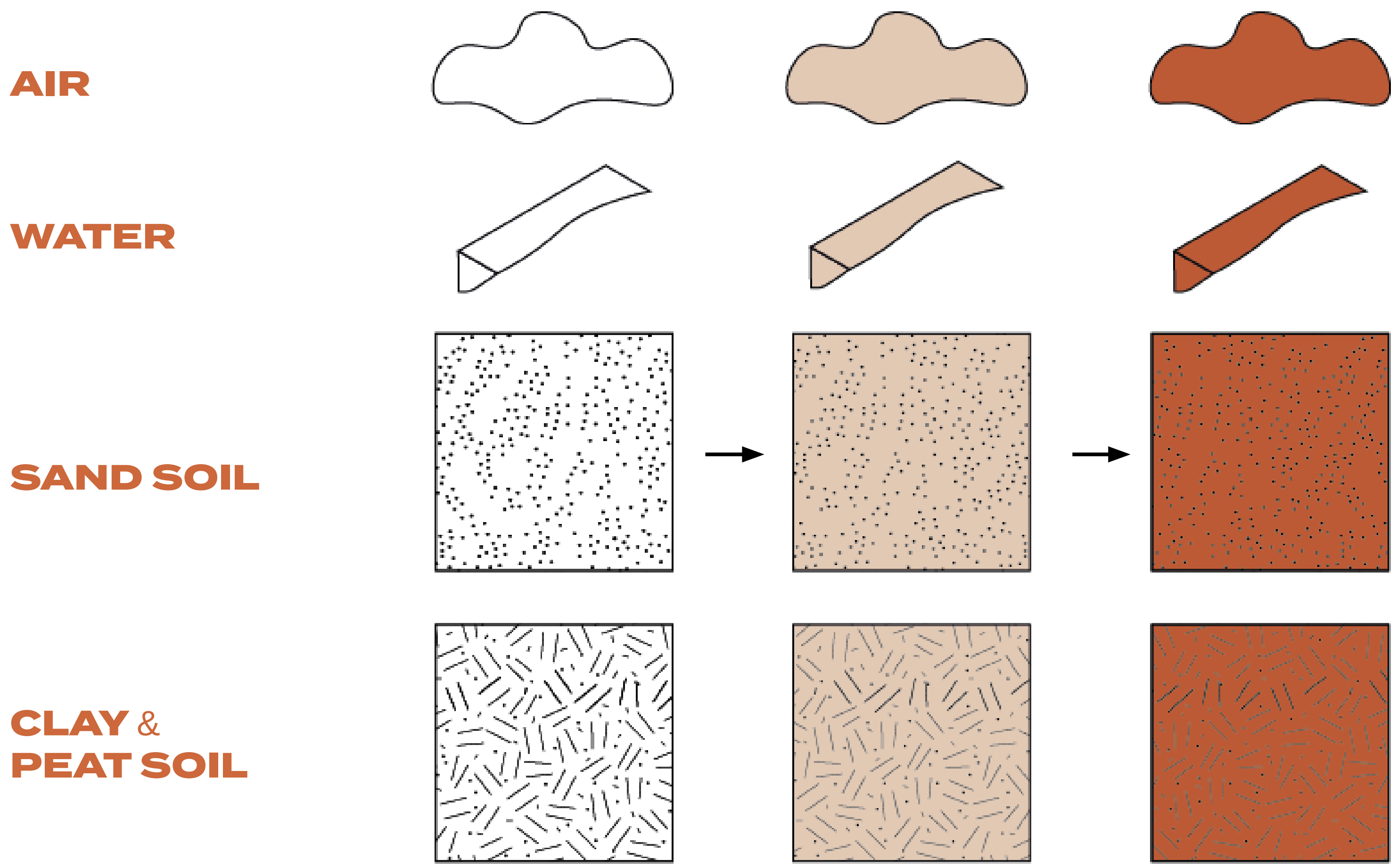
This area is mostly home to greenhouses in which a variety of crops are grown. Furthermore, flowers are cultivated in the greenhouses. The soil consists of clay.

8



This typology is characterized by a very mixed agricultural landscape. Among other things, apples, corn and wheats are grown in the area. There are also pasturelands with cows present. There is a loomy soil present in the area.

Level of nitrogen pollution



Explanation of the different typlogies

In the analysis, we have gotten a more comprehensive understanding of the Dutch agricultural landscape. After the analysis on soil types (clay, sand and peat), land use patterns and forms of nitrogen pollution in the air, soil and water, we were able to divide these factors into typologies. This provides a more systematic understanding of the current situation.

4.4 Origin of the surplus and flows

Nitrogen pollution within the food chain is related to various practices and involves many actors. In order to acquire a better insight we analysed these relations through three systemic sections. They are divided into material flows, nitrogen flows and social flows.

Material flows

In the material flows of the food chain, nitrogen moves through the products. This section breaks down into three key phases: production, processing, and consumption. During production, nitrogen becomes part of the food as it is grown. Then, it enters processing. For livestock, the feed produced for cattle returns to agriculture, aiding in the production of dairy and meat products. Finally, products or consumed within the Netherlands, or being exported.

The most important part of this section is the production phase, as it is where nitrogen pollution originates from as well. We will elaborate on this in the nitrogen flows section.

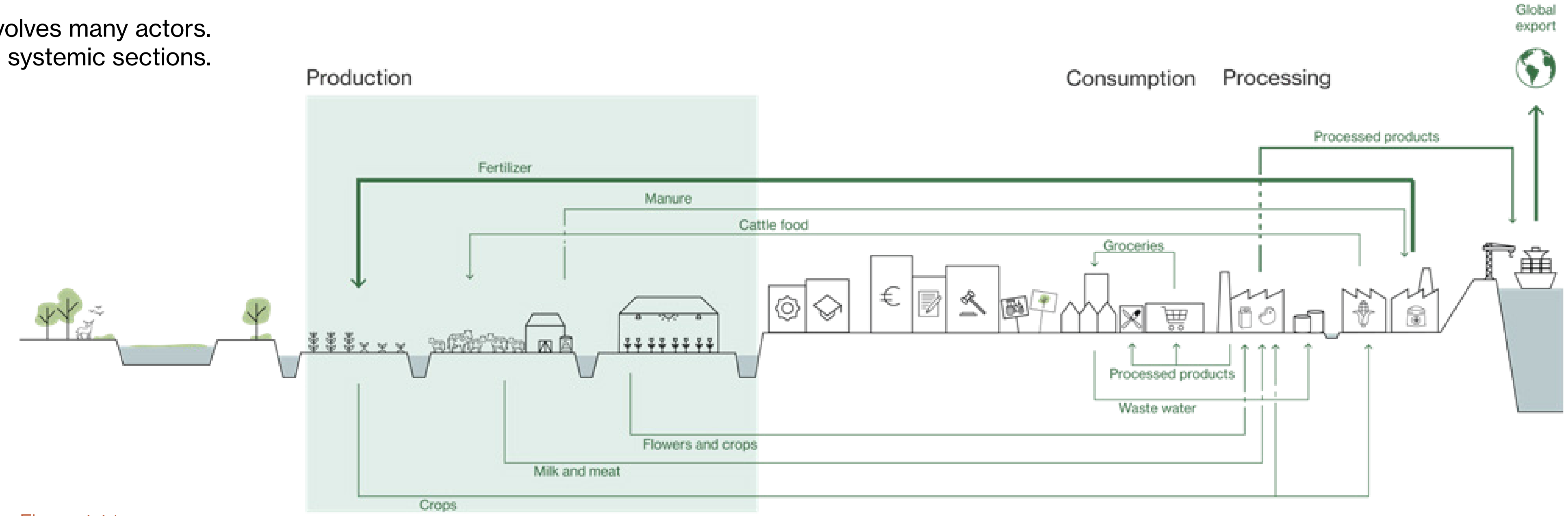


Figure 4.4.1
Schematic section illustrating material flows (own work).

Nitrogen flows

In this section, the movement of the reactive nitrogen through the processes is illustrated. As previously mentioned, the main nitrogen pollution occurs during the production phase. Crop farms use an excessive amount of (chemical) fertiliser to gain sufficient yield. This surplus of reactive nitrogen in the soil leaches into groundwater which will reach water bodies, resulting in eutrophication. A similar issue arises with cow manure.

Therefore, this section expands upon the material flows, showing how reactive nitrogen enters the environment via agricultural practices.

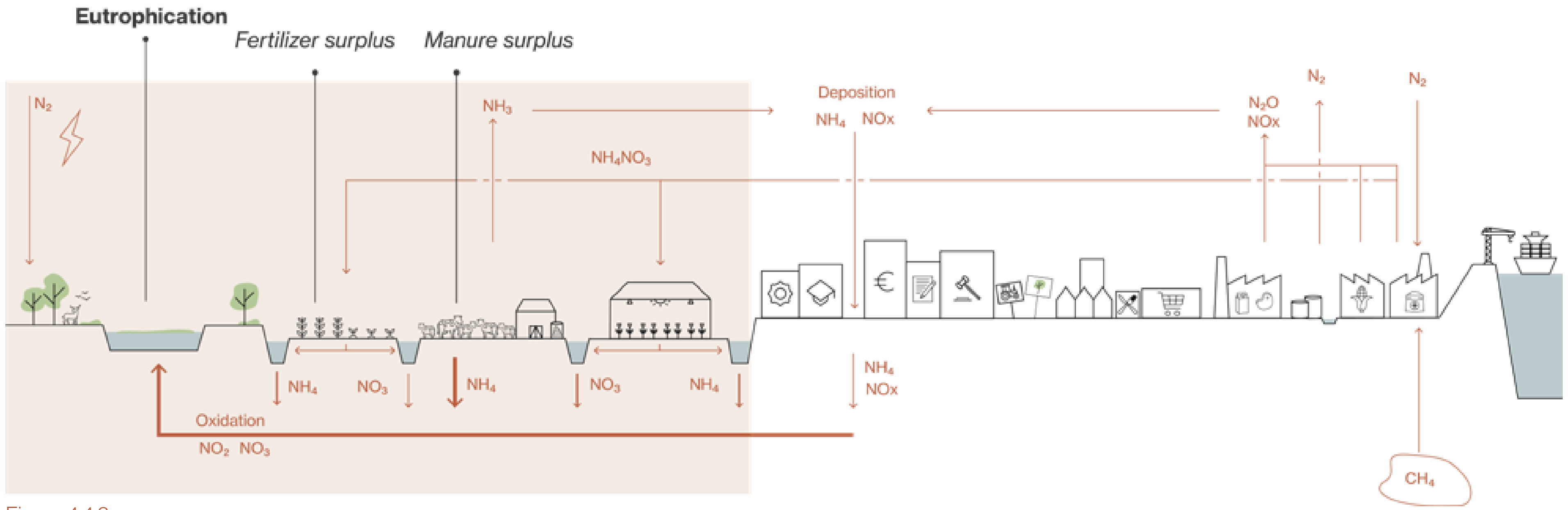


Figure 4.4.2
Schematic section illustrating nitrogen flows (own work).

Social flows

Agricultural practices are influenced by a lot of different stakeholders. Firstly, consumption patterns decide the products farms cultivate, with export playing a major role in the Netherlands. Ofcourse farmers respond by supplying what is needed to earn enough money. Secondly, policy makers play a crucial role in the current nitrogen crisis as they are responsible for formulating regulations on this issue. These have a large impacts on what farms can produce.

The social flows are a complex problem not easily shown in a schematic section. Therefore, we further elaborate on this topic in the stakeholder analysis. However, it is evident that the agricultural world is more than just farming, it has become an entire industry.

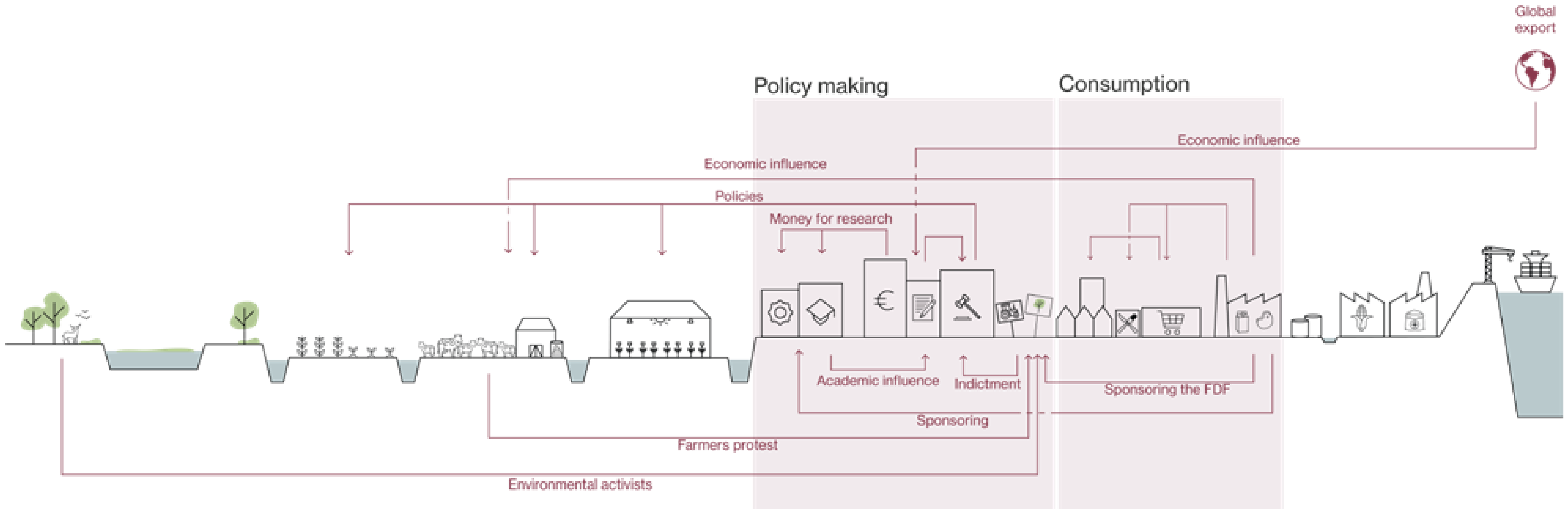


Figure 4.4.3
Schematic section illustrating social flows (own work).

4.5 Social Analysis

4.5.1 Stakeholders Analysis

In complex systems implementing internal changes results in transformations within the social, economic and ecological sub-systems. This is also reflected in the food supply chain. Therefore to achieve our goal of restoring balance in the nitrogen cycle we need to take into account the involved stakeholders. It is crucial to recognise who these are, their involvement and position towards our envisioned future and the relationships between them.

We focus our attention on agricultural practices as the main source of nitrogen pollution is included in the production phase. The following table states the main stakeholders that influence how pollutant our agricultural practices are:

EU	Farming Corporations
Banks	Fertiliser Companies
National Government	Supermarkets
Provincies	Local Markets
Municipalities	Farmer's Defence Force
Waterboard	LTO
Research Institutions	Farmers
Academic Institutions	Consumer
NGOs	Wildlife

After looking at their degree of power and interest in the transition we categorised the stakeholders based on their attitude towards it. This allowed us to group stakeholders based on their current position and explore necessary actions implemented in different sectors. Additionally, this assisted in making decisions that could ignite key ties between stakeholders from different positions.

Following Murray-Webster's and Simon's methodology on mapping stakeholders, this diagram compares the power and interest of each stakeholder. Additionally, it portrays their attitude, to holistically comprehend their position, and indicates existing groups of stakeholders. (Murray-Webster & Simon, 2007)

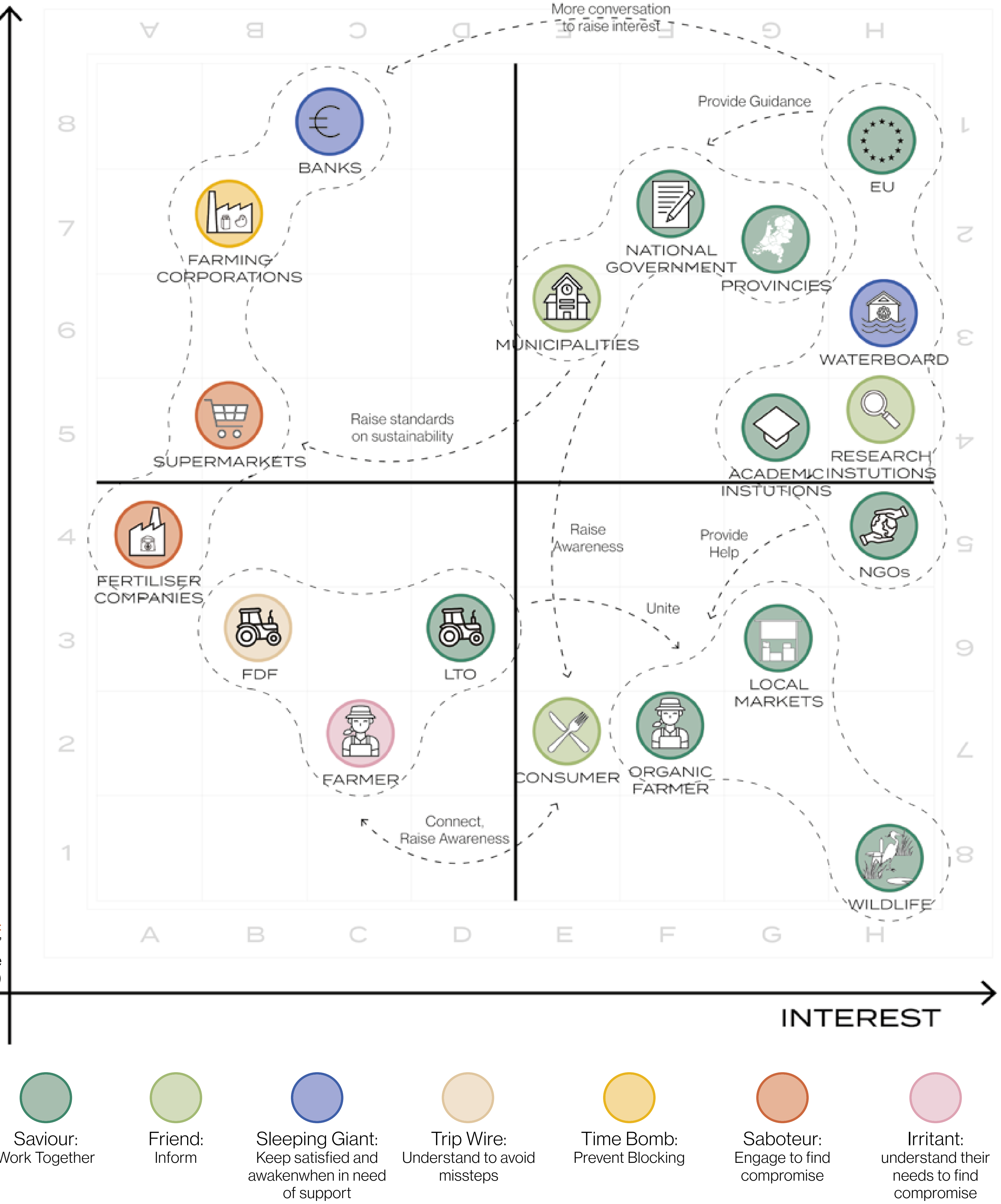
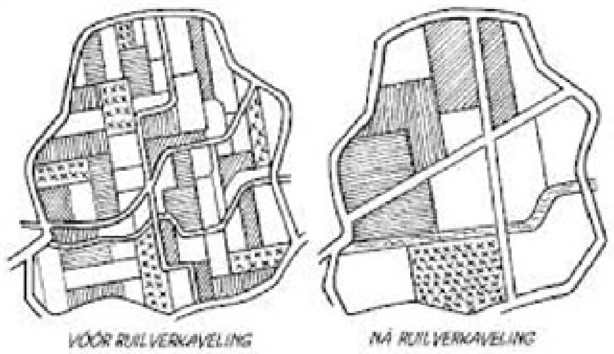


Fig. 4.5.1.1: Diagram of stakeholders' power, interest and attitude (own work)

1950

Ruilverkaveling/Land Consolidation

Due to the land consolidation in 1950 individual farmers received larger plots. Farmers established large-scale monocultures because they are easier in the maintainance. This caused drasic changes in the appearance of the landscape. The larger plots also cause that farmers are taking **more cows**.



1984

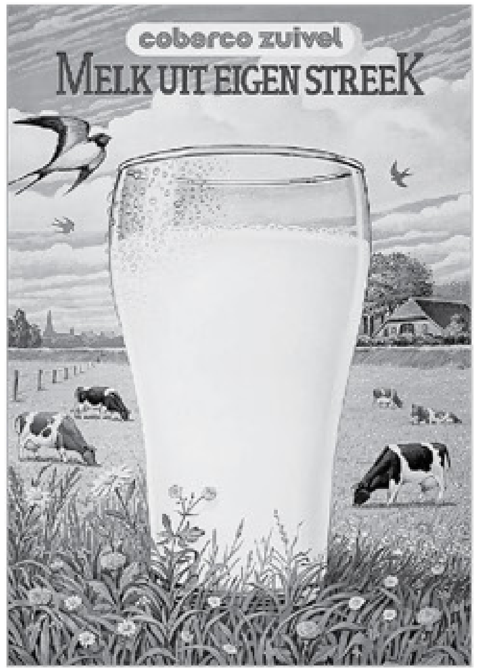
Milkquotum

A European milkquotum is set for farmers to limit the dairy production per farmer. This causes frustration among farmers and protests arise. The quotum forces farmers to **reduce their livestock** herds because the overproduction becomes unprofitable.

1992

Mac-Sharry Reform

The Mac-Sharry reform causes a **drastic decrease in dairy prices**. To compensate farmers, **high subsidies** are introduced that farmers receive **per cow**. the dependence on subsidies causes new protests among farmers.



1960

Minimum Price for Milk

The introduction of a minimum price for milk causes high overproduction in the dairy industry. Farmers increase their farms and take **more cows** because because the overproduction is made financially profitable. The "boterberg" and "melkplas" are produced and larger advertising campaigns are being set up to get rid of the production surplus.

1987

Fertiliser Law

The fertiliser law is meant to decrease the phosphate emissions caused by fertiliser production and over-fertilisation. On average, farmers have too many animals per hectare and therefore have to **reduce their livestock**.

1994

Uitrijverbod/Fertiliser Ban

The use of feriliser is banned for a short period due to acid rain in Europe. Farmers have to **invest in expensive new technology** that cuts phosphate and nitrogen emissions.

1997

Pig Law & Swine Fever

The pig law includes many economic and environmental restrictions that makes pig livestock less profitable. In addition, the swine fever causes eviction of 12 from the 15 million pigs in Netherlands. in exchange for the pigs, **many farmers switch completely to cow livestock**. The number of cows in the Netherlands is increasing drastically as a result.

2015

Abolition Milk Quotum & Low Emission Stable Floors

The abolition of the milk quotum causes that **overproduction of dairy becomes profitable** again. the government minimizes its involvement in the agricultural industry. it becomes profitable for farmers to take **more cows**. the scaling up of stables is largely financed by subsidies. At the same time, a new requirement for low-emission stable floors is being introduced, which requires investments from farmers. This means they have to take out high loans from banks.

2017

Phosphate Reduction Plan

As a result of the increased production, too much phosphate is emitted. **The overproduction must be reversed**. Farmers have to **reduce their livestock**, their debts to the banks are high, their new enlarged stables are empty and the trust in the government is low.

2019

Nitrogen Policy & Farmers

regulatory permits for highly emitting farmers are revoked, resulting in the **legal non-compliance of numerous farming enterprises** as adjudicated by the court. Farmers start protesting and Farmers Defense Force is established.

2022

Agriculture Perspective Report

Since the protests in 2019, agricultural **policy implementation has stagnated**. In an effort to **reorient perspectives**, an independent report is being commissioned to underscore the congruence between farmers' inquiries and policy objectives. The report recommends expeditious acquisition of peak loaders, thereby establishing a reserve for smaller-scale farmers, affording them extended periods to sustainably transform their farms. Farmers are in need of a **systemic** and **reliable** governmental approach.

Fig. 4.5.2.1 Policy timeline (Image scources in figure bibliography)

Interview | Mixed agricultural business

To gain a better understanding of farmers' views on the nitrogen issue, we interviewed two farmers and asked about their experiences with the issue on their own farms.

The first farmer is 43 years old. He has a mixed agricultural business with 700 pigs and he grows red cabbage, sugar beets, wheat, onions and potatoes. The farm covers 25 acres. He says he struggles a lot with everything related to nitrogen and finds it impossible to comply with all the laws and regulations. He feels that the focus on nitrogen is too much on the agricultural sector, while he believes it is a problem for the whole of the Netherlands. This approach frustrates him (Anonymous farmer A, personal communication, 27 March 2024)..

He is also frustrated by the fact that there is no fair price paid for his products and that it is difficult to make his farm more sustainable and still earn a decent living. He also feels that the excesses in agricultural businesses have affected people's willingness to pay more.

In an effort to make his farm more sustainable, he has installed an air scrubber in his pig barn. He mentions nothing about making his way of growing vegetables more sustainable. He says,

‘I don't understand what nitrogen has to do with growing vegetables; don't they just produce oxygen?’

He perceives a lack of connection between farmers and policy makers in The Hague.

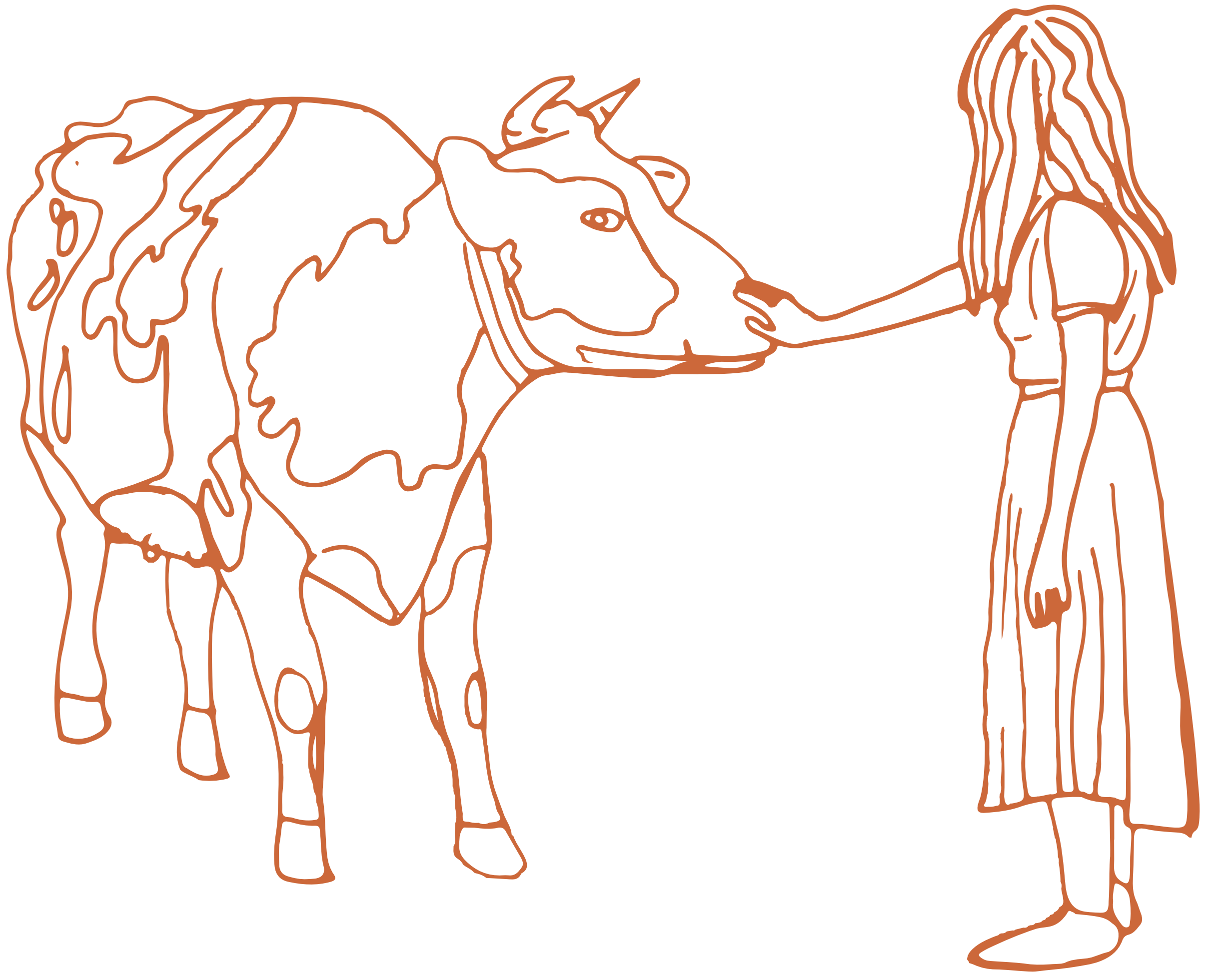
‘The people there have no feeling for the sector,’ he says. ‘The things they come up with are just not feasible.’

He would like to see policymakers and other relevant parties engage in more on-site discussions (on the farms) and connect with “ordinary farmers” and not just the good and bad examples.

‘Start a working group!’

He also mentions that when making choices for making farms more sustainable, it is very important for a farmer whether he has prospects of handing over his farm to a successor or not. If a farmer has perspective for a successor, it is more interesting for him to make the farm more sustainable.

Beyond that, he says he is open to collaborating with researchers: indeed, he already sends a soil sample to a research lab every year to know what he can best grow in the coming year (Anonymous farmer A, personal communication, 27 March 2024).



What is a PAS-melder?

PAS-melders are companies and entrepreneurs who reported to the government for the Nitrogen Action Programme (PAS), for example a notification of an expansion. They did not have to apply for a permit to do so; a notification of the calculated nitrogen load was sufficient. But due to a ruling by the Council of State in 2019, PAS-melders must now nevertheless have a permit. As a result of this ruling, PAS-melders are in violation if the notification made is executed. This has left PAS-melders in great uncertainty beyond their control. (PAS-melders, z.d.)

Interview | Dairy farm

The second farmer we interviewed runs a dairy farm with 150 cows and 55 acres of land. His farm is near a nature reserve. He is what is called a 'PAS' melder (PAS stands for Program Approach to Nitrogen, melder means notifier). Currently, he doesn't have a permit to proceed with his agricultural activity next to the natural area. He has tried to apply for a new permit and is now nervously awaiting the outcome (Anonymous farmer B, personal communication, 27 March 2024). On this matter he says:

'This situation is extremely paralysing, I don't know what to do now. I feel that I am not being valued in my work.'

Because of this situation, he is currently unable to apply for financing from a bank or subsidies, to make his business more sustainable.

He finds the present policy very objectionable.

'The discussion about solving the nitrogen crisis focuses too much on buying out farmers and too little on engaging with individuals.'

In the existing policy, he misses the long-term perspective:

'I miss a point on the horizon.'

He mentions that he now feels a great deal of uncertainty in choosing a path for his farm. He has trouble deciding where to invest his money. He thinks that due to this many farmers are ignoring the crisis because of this. Investing in technical solutions to make farms more sustainable is often not affordable for the average farmer right now. The farmer explains that he believes farmers would be open to many changes and would certainly be willing to adapt, as long as the policies are effective and meaningful. He would like to see more clear leadership, not just focusing on keeping the country's economic motor running. He would like to see a solution (Anonymous farmer B, personal communication, 27 March 2024).

'We should have started earlier and need to do this for our children.'

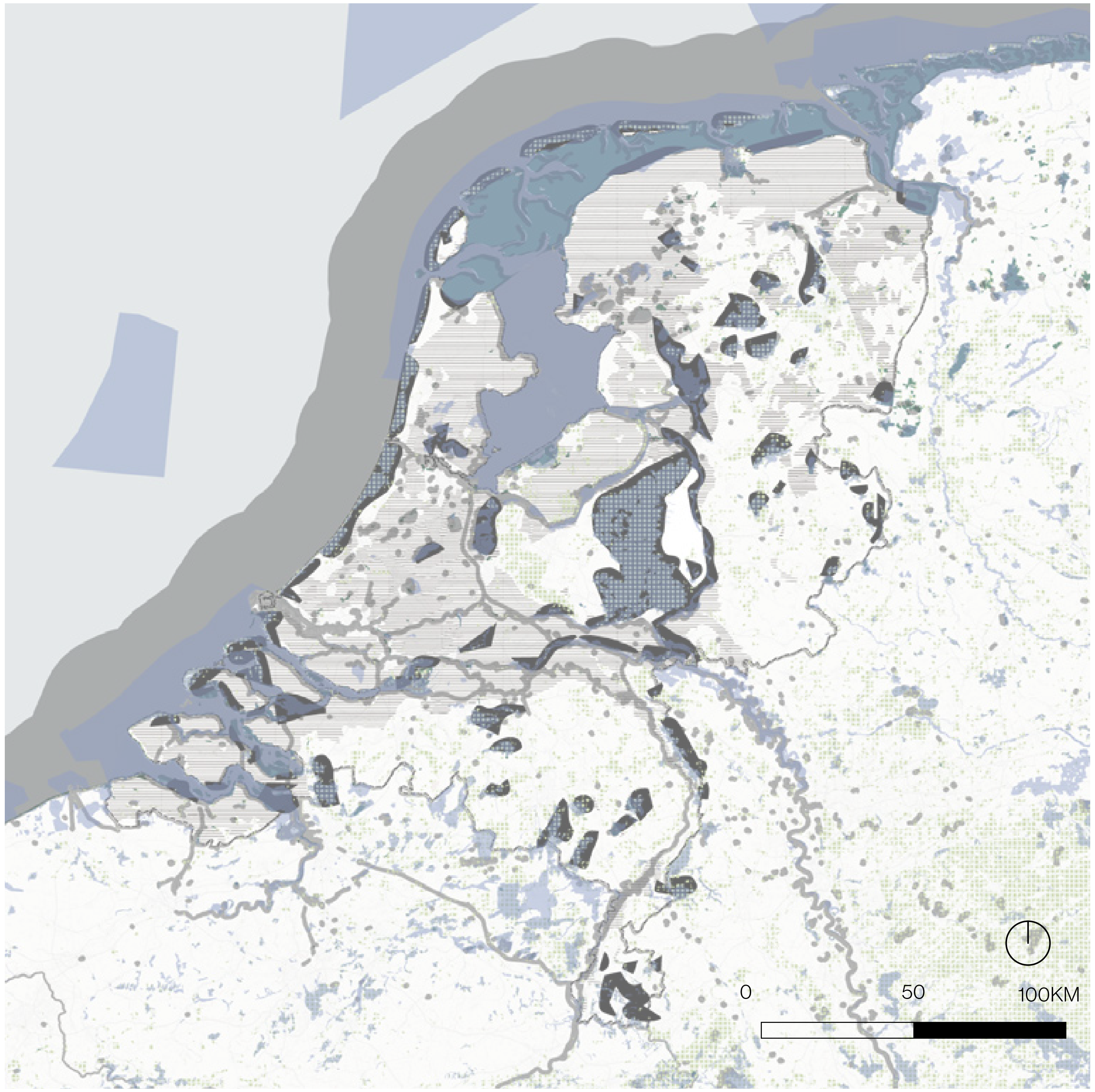
4.6 Analysis Conclusions

Based on the analysis in the previous chapters, this chapter will attempt to link the analysis to the vision we have established using a potential map. the potential map is based on an ecological and social analysis that discusses the possibility of a future land transition. These possibilities will inform the construction of the vision and strategies.

4.6.1 Ecological potential

Potential of Buffer Zones:

Through the study of site soils, we have found that clay and peat soils are suitable for wetland construction, while sandy soils are more suitable for tree growth. Therefore, based on soil types, we have identified potential areas for wetlands as shown in Figure*. Additionally, based on NATURA 2000 and habitats for nitrogen-sensitive species, we have outlined the approximate boundaries of potential buffer zones.



Soil type suitable for wetland: clay and peat soil

Forest and shrub cooverd land

Water body

Natura 2000 area

Nitrogen sensitive habitats

Fig. 4.6.1.1
Potential buffer zone analysis, (own work)

Wetland

Buffur zone(wate-based)

Buffur zone (plant-based)

Fig. 4.6.1.2
Potential buffer zone, (own work)

Potential of Water-Based Planting:

As shown in Figure*, the Netherlands faces a crisis of flooding. However, this crisis also provides more opportunities for water-based planting. As depicted in Figure*, we define water-based planting in the upstream areas of the Rhine and Maas rivers. When there is more water storage capacity upstream, it will increase the resilience of river basins against extreme floods(Van Stokkom et al., 2005).

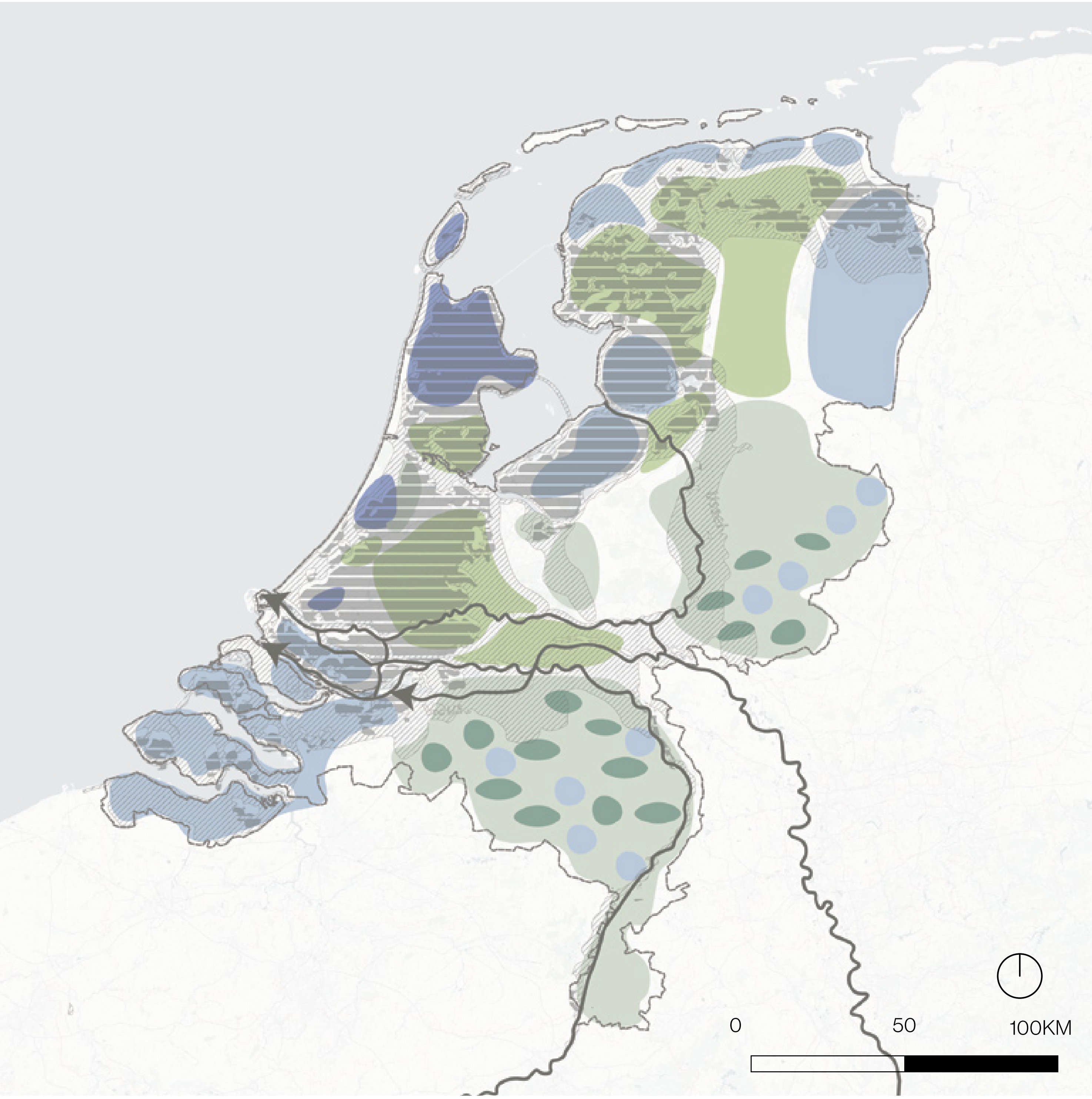


Fig. 4.6.1.3
Potential of Water-Based Planting analysis
(own work)

HORTICULTURE
ARABLE CROPS
PERENNIAL CROPS
GRASSLAND BASED LIVESTOCKS
LANDLESS LIVESTOCKS

AREA UNDER THE NAP
AREA WITH FLOOD RISKS
AREA (almost) WITHOUT FLOOD RISKS

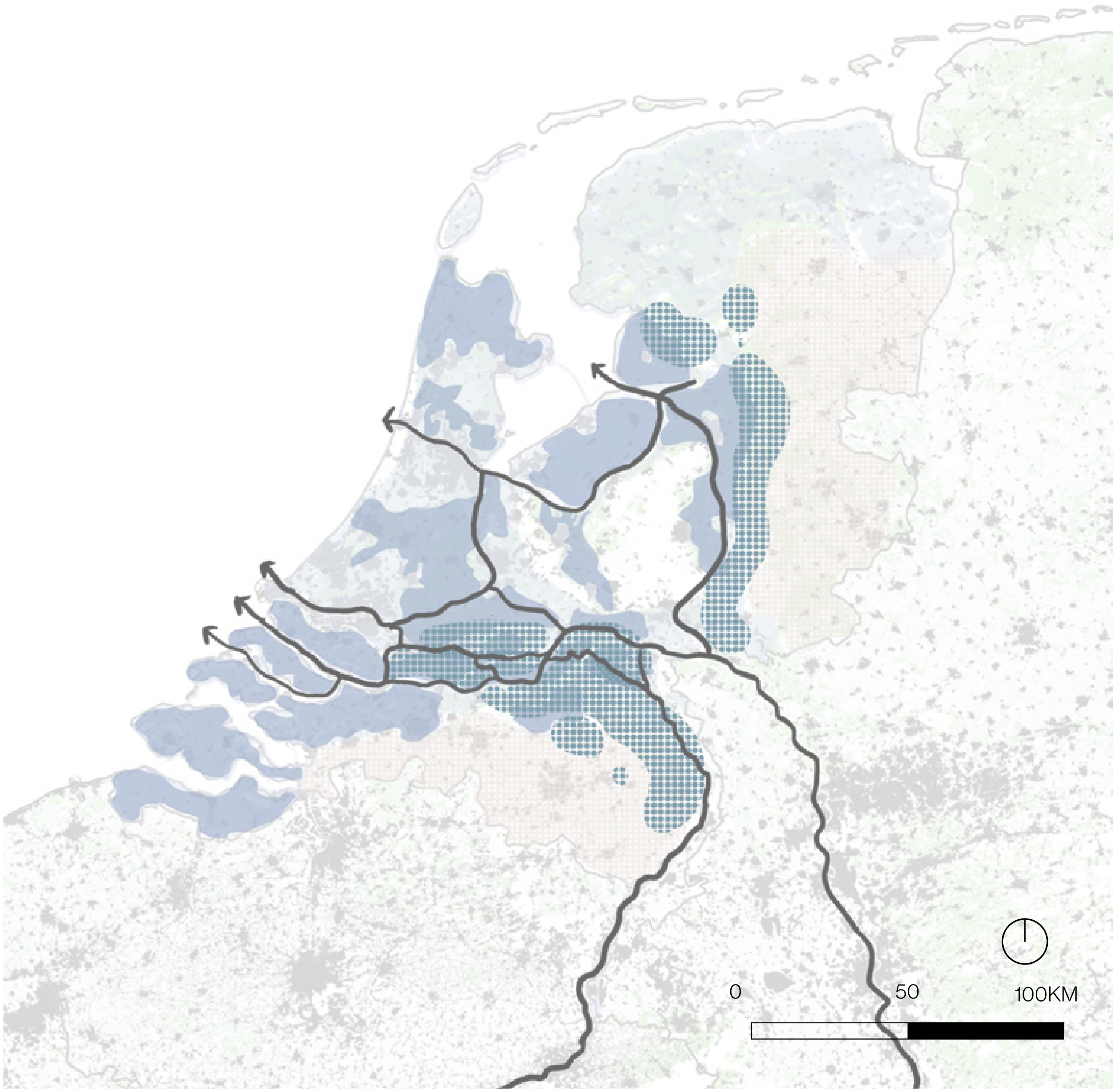


Fig. 4.6.1.4
Potential of Water-Based Planting
(own work)

Flooding area

Room for water

RIver

Potential of Water Management and Manure Management:

The relationship between NATURA 2000 areas and ammonia pollution zones is depicted in the figure. We can observe that these two layers are sometimes very close, almost overlapping. Agricultural activities in these areas pose a threat to ecological reserves. Therefore, as shown in Figure*, the red areas represent the most urgent issues to address. Constructing ecological buffer zones takes time, so these areas require more efficient solutions. Therefore, water management and manure management will be crucial in these areas.

Fig. 4.6.1.5
Potential of Water Management and Manure Management analysis
(own work)

Natura 2000

Amonia pollution area(high)

Fig. 4.6.1.6
Potential of Water Management and Manure Management
(own work)

Pptential for urgent water management

4.6.2 Socio economic factors

The latest elections

In order to gain an understanding of the Dutch context in socioeconomic terms, we looked at a number of factors, namely the last two elections, two maps on the socioeconomic status of the Netherlands at the regional level, the percentage of people struggling to make ends meet and the percentage of households in a low-income area. Furthermore, we examined what part of the Dutch land is made up of agricultural land.

The first election, that for the Provincial Council, was won by the Farmers Citizens Movement (Boeren Burgen Beweging; BBB). They won substantially in this election. First they had zero representatives and now 17 in the Senate. These elections showed great dissatisfaction with current policies, certainly from farmers, but also from people in rural areas in general (NOS, n.d.-a).

In the second election, the national election for the House of Representatives, we see a different party win: the Party for Freedom (Partij voor de Vrijheid ;PVV)(NOS, n.d.-b). Again, this result shows dissatisfaction with the current policy, as the four elections before that another party, namely the VVD, won the elections (Verkiezingen Tweede Kamer 1917-2023, n.d.)

This rapid change in political preference shows that part of the Dutch population is dissatisfied with the way things were ruled before these elections.

We also see a big contrast between cities in both elections, where different parties are winning compared to the rest of the country. In the big cities, either Groen-Links (merged with the PVDA during the national elections) or the VVD were the winners (NOS, n.d.-a) (NOS, n.d.-b).

Socioeconomic status of the Netherlands

In an attempt to get a better understanding of the status of Dutch farmers, we created a map of the area of the Netherlands that consists of farmers' land and overlapped it with the regions in which the most socioeconomic problems seem to exist. In this map, we see that these problems seem to be greatest in the urban areas rather than in the more rural areas.
However, this does not give a picture of how poor or rich farmers are.

Furthermore, it is important to note that farmers cannot be considered as a homogeneous group, but that there are many differences between farmers (Mouissie & Kamphuis, 2024).

The interesting observation is to note that again a contrast between the rural and the urban areas of the Netherlands is evident in this map.

Also, in this map we can see how much the Dutch landscape is shaped by agricultural practices. We see that almost the entire Netherlands consists of farming to some degree.

Overall conclusion

Overall, these maps show a contrast between rural and urban areas of the Netherlands, both in socioeconomic status and political preferences, which presumably are affecting each other.

'Both maps show a contrast between the rural and the urban areas of the Netherlands.'

Provincial States elections March 2023

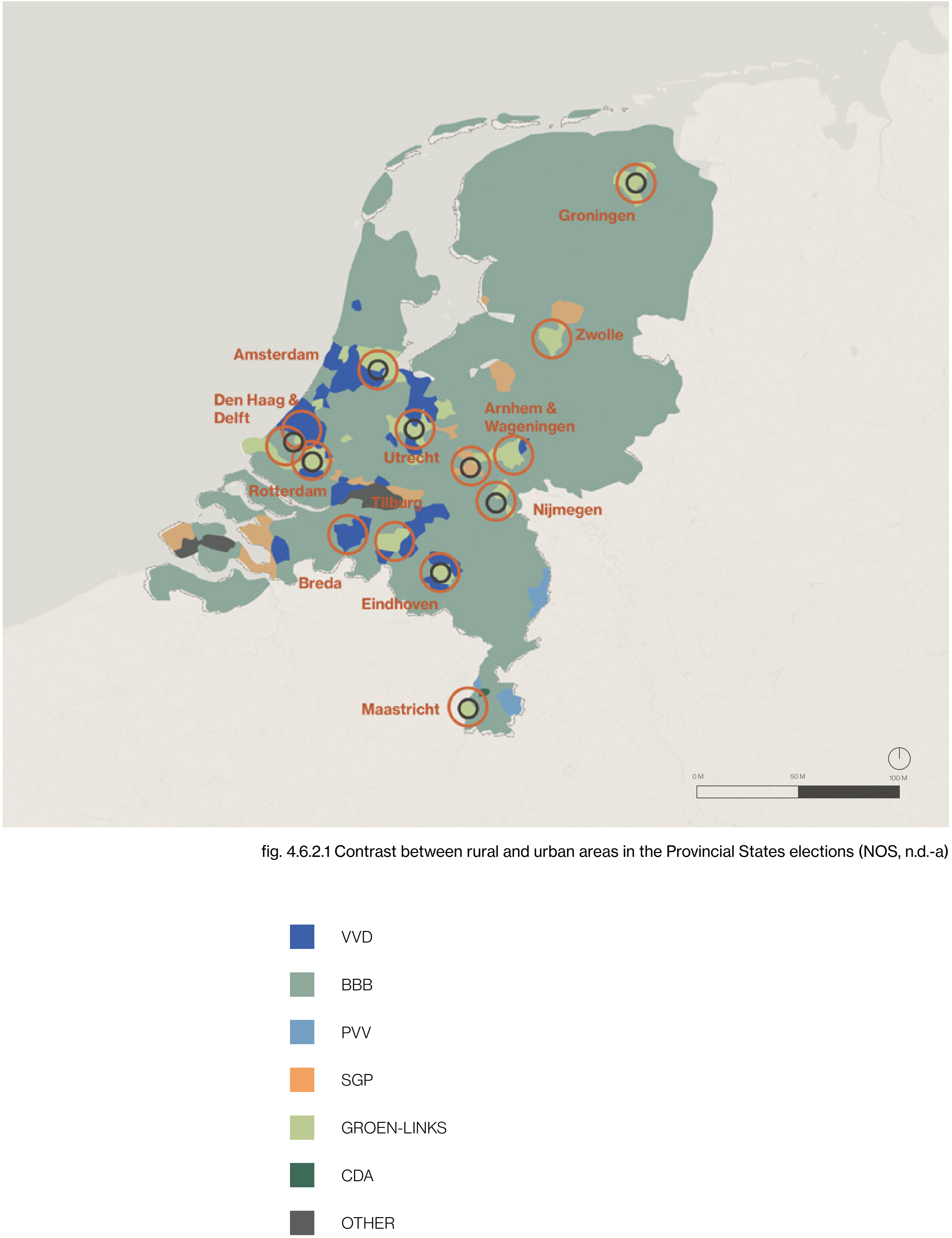


fig. 4.6.2.1 Contrast between rural and urban areas in the Provincial States elections (NOS, n.d.-a)

National elections December 2023

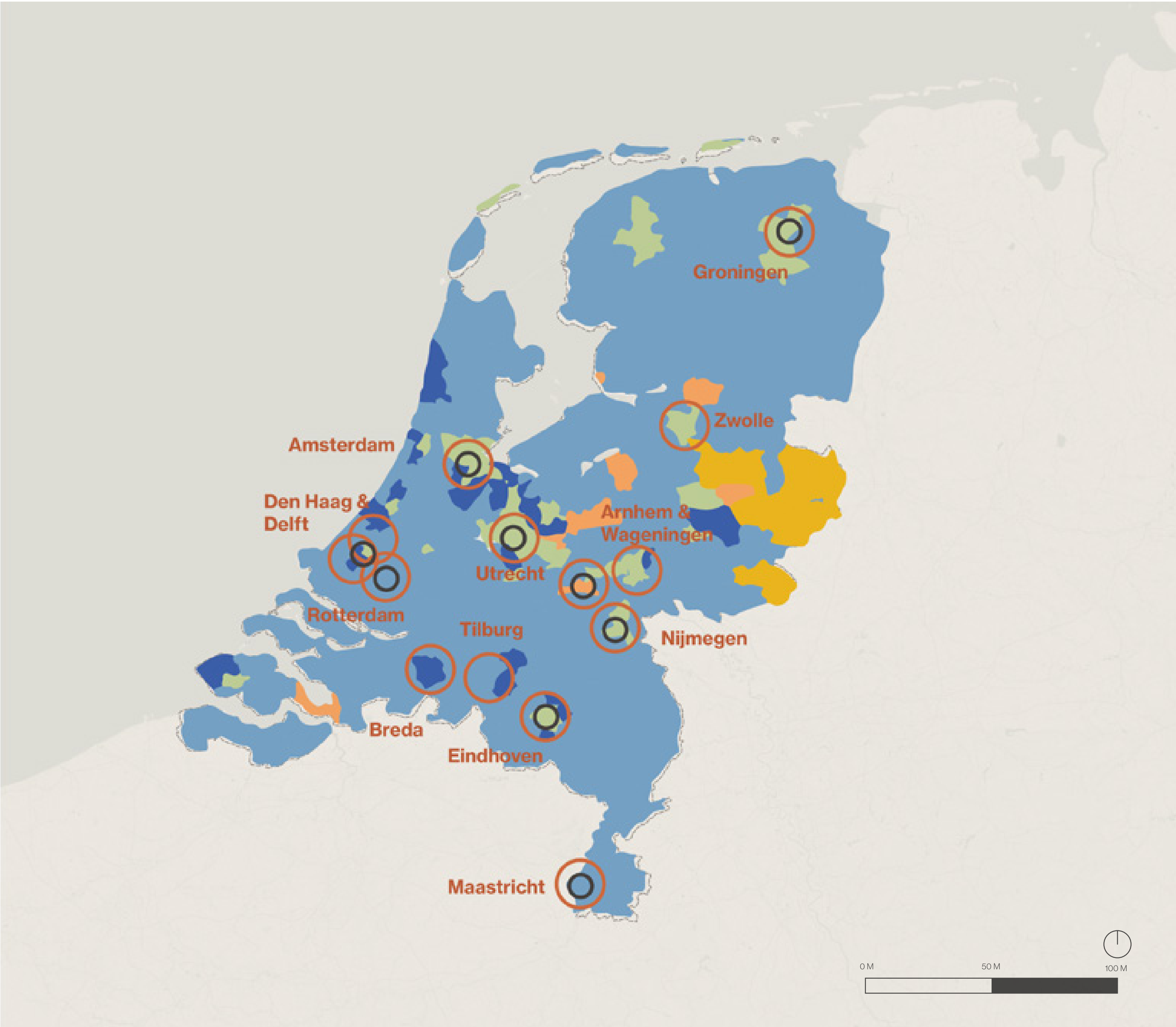


fig. 4.6.2.2 Contrast between rural and urban areas in the National elections (NOS, n.d.-b)

- NSC
- VVD
- BBB
- PVV
- SGP
- GROEN-LINKS & PVDA
- CDA
- OTHER

Farmland in relation to lower income areas

fig.4.6.2.3 Insight on where most people that stuggle financially live (Sociaaleconomische Status | Regionaal | Inkomen, n.d.) (Landbouwgebied, n.d.)

- RESEARCH INSTITUTE
- FARMLAND
- HIGH PERCENTAGE (7-15%) OF LOW-INCOME HOUSEHOLDS
- HIGH PERCENTAGE (15-30%) OF PEOPLE THAT STRUGGLE TO PAY THEIR BILLS
- LARGE CITIES

Chapter 5 Vision

5.1 Vision statement

Our vision focuses on shifting towards sustainable agricultural practices in the Euro Delta region, to restore the nitrogen cycle. This change will follow a systemic approach, emphasising a just transition towards future farming where farmers will play a key role.

The current way of producing food is unsustainable regarding nitrogen pollution and land use. If we continue agriculture the way we are doing now, our lands will face depletion and nature will be severely affected due to nitrogen surplus (de Vries, 2021). These issues are acknowledged by all stakeholders, but the regulations made for the farmers are short-term, one-sighted solutions inconsiderate of the farmer's view. Therefore, our vision consists of a systemic approach. No more short-term, one-intervention solutions, but an approach that looks at every stakeholder and makes the farmer the focal point. Agricultural areas will be investigated before providing solutions, and farmers will have a say in what transition would fit best to their profile. These interventions will not only promote sustainability but also ensure profitability for farmers.

Desirably, in 2075 the disturbed nitrogen cycle by agricultural practices will be in balance again. Agriculture will be sustainable and environmentally responsible thus resulting in thriving, biodiverse nature areas in the Netherlands.

Additionally, innovative farming methods will be introduced in flood-prone areas to sustain agriculture. Next to sustainable agricultural interventions, our vision focuses on actively protecting natural areas through protection zones. These zones will effectively filter nitrogen from water before it reaches natural habitats. Moreover, our knowledge will be spread over our borders, to reduce surface water pollution and create healthy water bodies in the Euro Delta region.

All in all, in 50 years, farmers will **produce** using sustainable practices, ensuring that we not only meet our needs but also safeguard the environment from nitrogen pollution. Moreover, we will actively **protect** natural areas. This commitment to preservation will be realised through **innovative** technologies designed for systemic interventions. Simultaneously, individuals will be **adapt** to the new agricultural norm. There will be a just future consisting of a healthy ecosystem from nitrogen pollution.

Are you hungry for change?

"in 2075 the disturbed nitrogen cycle by agricultural practices will be in balance again"

Figure 5.1.1
Collage of our vision (own work).

5.2 What if...?

In order to balance the interests of farmers and nature, we have examined the consequences of the implementation of varying interests. In order to get a better understanding of these interests, we formulated four "what if questions". These questions form the base of our vision and are primarily intended to provide an overview of strengths, weaknesses, opportunities, and threats of specific interests of stakeholders involved in the nitrogen crisis.

These questions are:

- What if we protect natural habitats better against the impact of the surplus in nitrogen emissions?
- What if we locally adapt agricultural practices to regain balance in the nitrogen cycle?
- What if technical innovations can transform current agricultural practices to decrease nitrogen emissions?
- What if we preserve food production in the Netherlands while decreasing nitrogen emissions?

What if we protect natural habitats better against the impact of the surplus in nitrogen emissions?

In our analysis, we found the natural areas (the Natura2000 areas) in the Netherlands to be threatened by nitrogen pollution. In order to prevent these areas from polluting we looked into ways to expand and protect the existing areas. In giving these areas more body, a larger amount of the country is protected. This requires a nationwide approach that would be impossible without the large-scale buyout of farmers. Additionally, the most efficient way to rebalance the surplus is by reducing production. This would decrease food exports, necessitating an increase in imports.

What if we locally adapt agricultural practices to regain balance in the nitrogen cycle?

The analysis showed that the opportunities for adapting agricultural typologies are highly dependent on the local soil type and natural context conditions. Therefore a local approach could be beneficial for both farmers and the environment. The advantage of a local approach is that farmers can more easily be involved in the process and retain more control over the future of their farms. To support this sustainable and local agriculture, farmers need national support to gather knowledge and establish a business model for smaller-scale and local production. However, this comes at the expense of agricultural exports.

What if technical innovations can transform current agricultural practices to decrease nitrogen emissions?

In the past, we have experienced that the government often relied too much on advancing technological innovation in order to decrease pollution. But by further investing in agricultural innovation to reduce nitrogen emissions, we could in the long term be able to maintain our export position in the global market. It is crucial to develop new knowledge and rapidly disseminate it throughout the agricultural industry. Additionally, it is essential to spatially separate large-scale industries from natural areas to minimise the production's impact on nature.

What if we preserve food production in the Netherlands while decreasing nitrogen emissions?

We have seen that maintaining current agricultural production has shown severe consequences for soil fertility and biodiversity. Preserving this production is only possible through new technological innovations that could lower the agriculture industry's impact on nature. While speculative, it is crucial for farmers and for the international food provision to continue innovating. On the other hand, it is necessary to find a balance between the efficiency of the agricultural practice and the harm that is being dealt to natural environments.

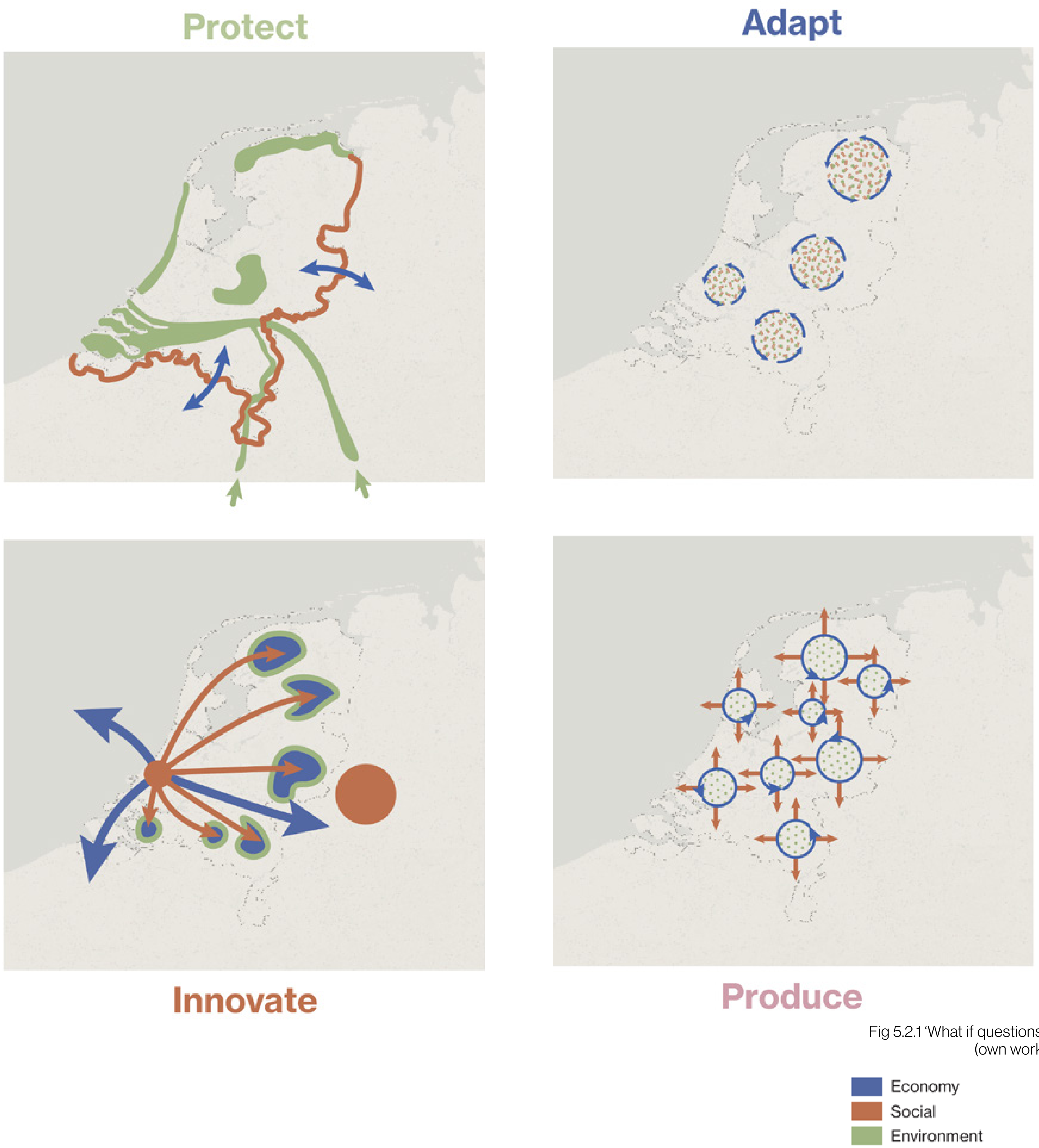


Fig 5.2.1 'What if questions', (own work)

5.3 Spatial Vision

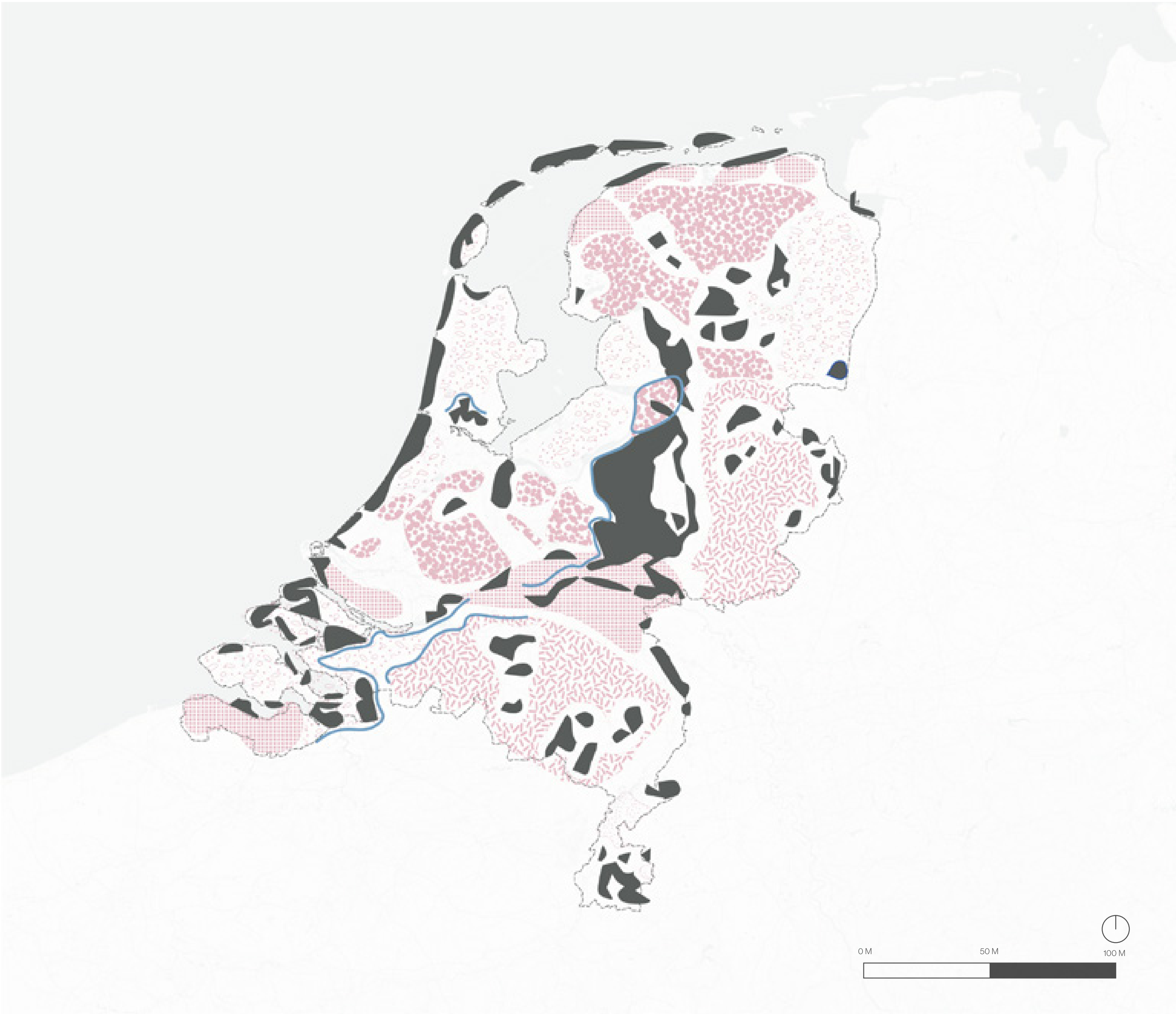


fig.5.3.1 Vision map: the sustainable farming layer, (own work)

BIODYNAMIC FARMING (DIET OF COWS, REUSE MANURE, SEASONAL FARMING)

MULTICULTURAL FARMING (MULTICROPPING, MOSAIC CROPPING)

WATER-BASED PLANTING (RECREATIONAL USE)

REDUCE (USE OF FERTILIZER)

EXISTING NATURA2000 ZONE

WATERMANAGEMENT PRIORITY ZONE

In collaboration towards a sustainable agricultural landscape

The first part of our vision focuses on farmers in relation to the typology of their agricultural practices and the soil, as explained in the analysis. The aim is to examine, for each typology, the possibilities of making the current way of farming more sustainable in order to protect Natura 2000 areas. The design of these new typologies will take into account the fact that part of the Netherlands may flood in the future. The design will include making room for water and also applying ways of water-based planting, to turn the current threat into an opportunity for farmers. In each of these typologies, it will be examined how and to what extent the use of fertiliser can be reduced

The way these new interventions will be implemented will no longer be determined from policy alone. In the interviews with farmers and also in other research, it became clear that there is a disconnect between farmers and policymakers. We therefore suggest engaging with farmers and working with them to determine how agricultural practices can be adapted in the long term in a sustainable way. This will provide clarity to all parties on the future of farming in the Netherlands.

To promote such contact between policymakers and farmers, but also to encourage farmers' contact among themselves, community centres will be built in the different regions. Here, farmers can come together to share their experiences and will also be able to engage with local authorities on relevant topics. Lectures and workshops will also be organised in which farmers can learn more about financing and implementing new techniques of sustainable farming . People living in the area will be able to come here, for instance to buy local products. Furthermore, other local entrepreneurs can contact farmers in this place to start new initiatives together. Thus, the distance between farmers and the urban environment will be reduced.

In the toolbox, the goals related to transforming the current farming practices to reach are summarised.

Farming toolbox

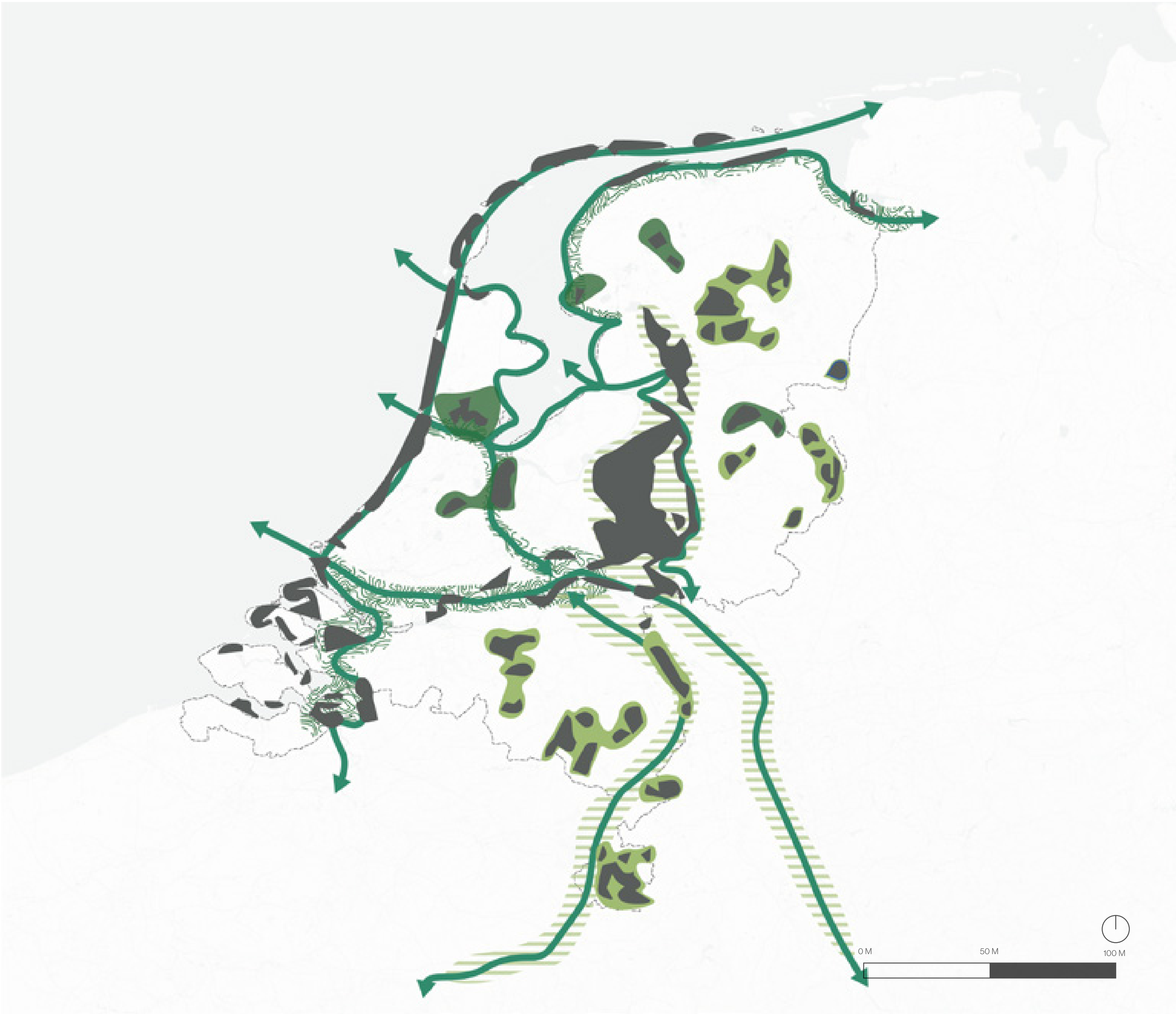


fig.5.3.2 Vision map: the nature protection zones layer, (own work)

NEW NATURA2000 CORRIDOR ALONG THE RIVERSIDES AND COASTLINES

PROTECTION ZONE: WETLAND POTENTIAL

PROTECTION ZONE: FOREST POTENTIAL

PROTECTION CLUSTERS: FOREST POTENTIAL

PROTECTION CLUSTERS: WETLAND POTENTIAL

EXISTING NATURA2000 ZONE

Preserving and protecting Dutch nature

In the analysis, it became evident that Dutch nature is currently threatened by nitrogen pollution. Some of this pollution enters the country from outside the Netherlands via the rivers. Therefore, to protect these rivers from pollution, protection zones will be created along the rivers. These zones will be in the Netherlands, but also in Belgium and Germany. In this way, corridors of protected nature will be created along the rivers, of which the Natura 2000 areas located along the rivers are being included. The Natura 2000 areas not located along a river will be divided into protection clusters. These clusters have a high priority in transforming to a more sustainable way of farming and will include small-scale, customised protection zones.

The protection zones can be divided into two different typologies: wetland protection zones and forest protection zones. These zones can also have a recreational function, to invite people to see what Dutch nature looks like, but also to promote a connection between farmers and the general public.

In the toolbox, the goals related to protecting the nature areas of the Netherlands are summarised.

Nature protection toolbox

fig.5.3.3 Vision map: the research and innovation layer, (own work)

EXISTING RESEARCH INSTITUTES (UNIVERSITIES)

LIVING LABS

KNOWLEDGE FLOWS

INTERNATIONAL KNOWLEDGE FLOWS

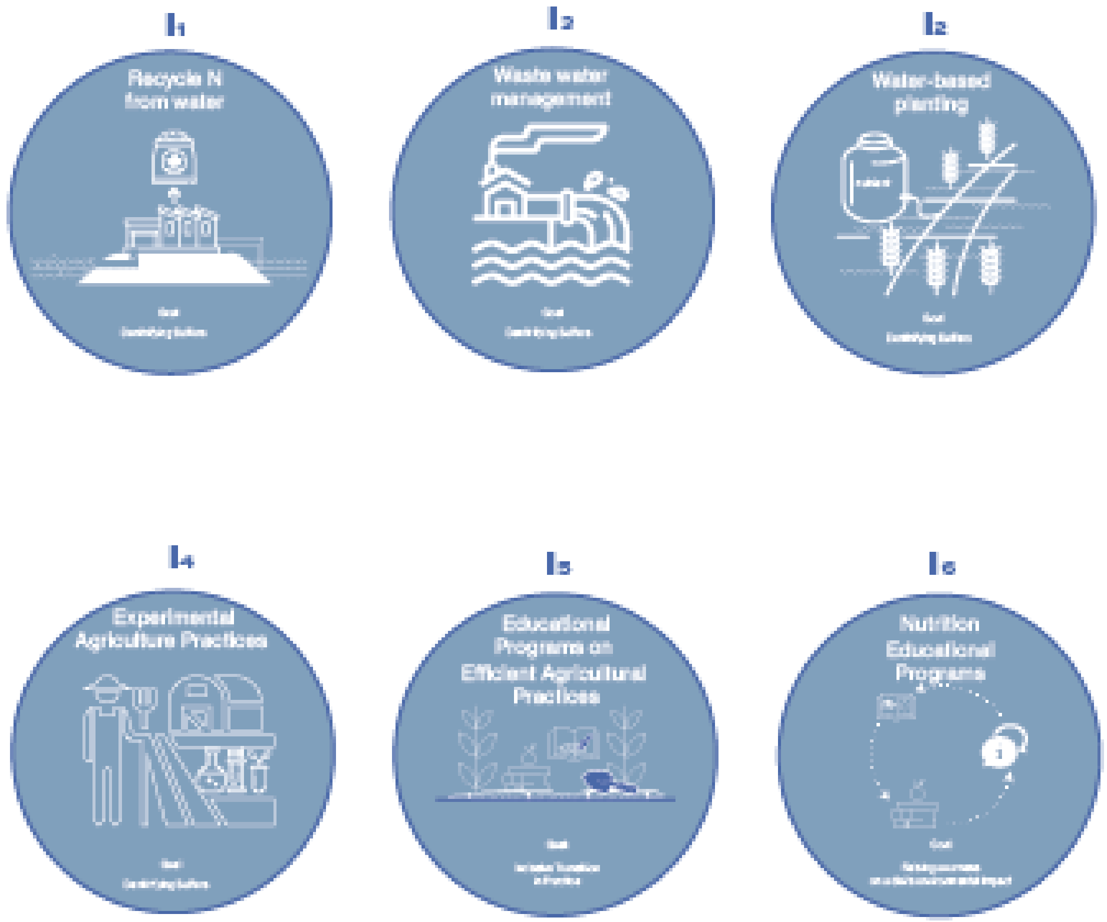
EXISTING NATURA2000 ZONE

Softening boundaries between research and practice

The interview with farmers revealed that farmers often struggle with the pressure of adapting to become more sustainable in their agricultural practices. We therefore propose to strengthen the connection between research and practice. We aim to achieve this by implementing living labs. In a living lab, research institutes can work together with farmers to try out new innovations and develop new ways of sustainable farming. Local farmers can visit these labs to learn more about the possibilities and opportunities of sustainable agricultural practices. The living labs will work together with the community centres to provide workshops and lectures, among other things.

In the toolbox, the goals related to improving and innovating current research practices are summarised.

Innovation and research toolbox



Synthesis: Farmers at the core agricultural developments

If we overlay these various layers, the relationships between the different aspects of our vision become clear. Our overall goal is to reduce nitrogen-related pollution as much as possible, by providing a systematic approach on the national Dutch scale. In this approach, the farmer is at the centre. From a research and policy perspective, appropriate and profitable solutions will be sought in dialogue with farmers. In this way, we ensure that we can continue the tradition of farming in the Netherlands, while also protecting our nature.

Society will need to adapt to the limits, but also possibilities of the Dutch landscape. New types of food will appear in supermarkets, for example new vegetables extracted from water-based planting.

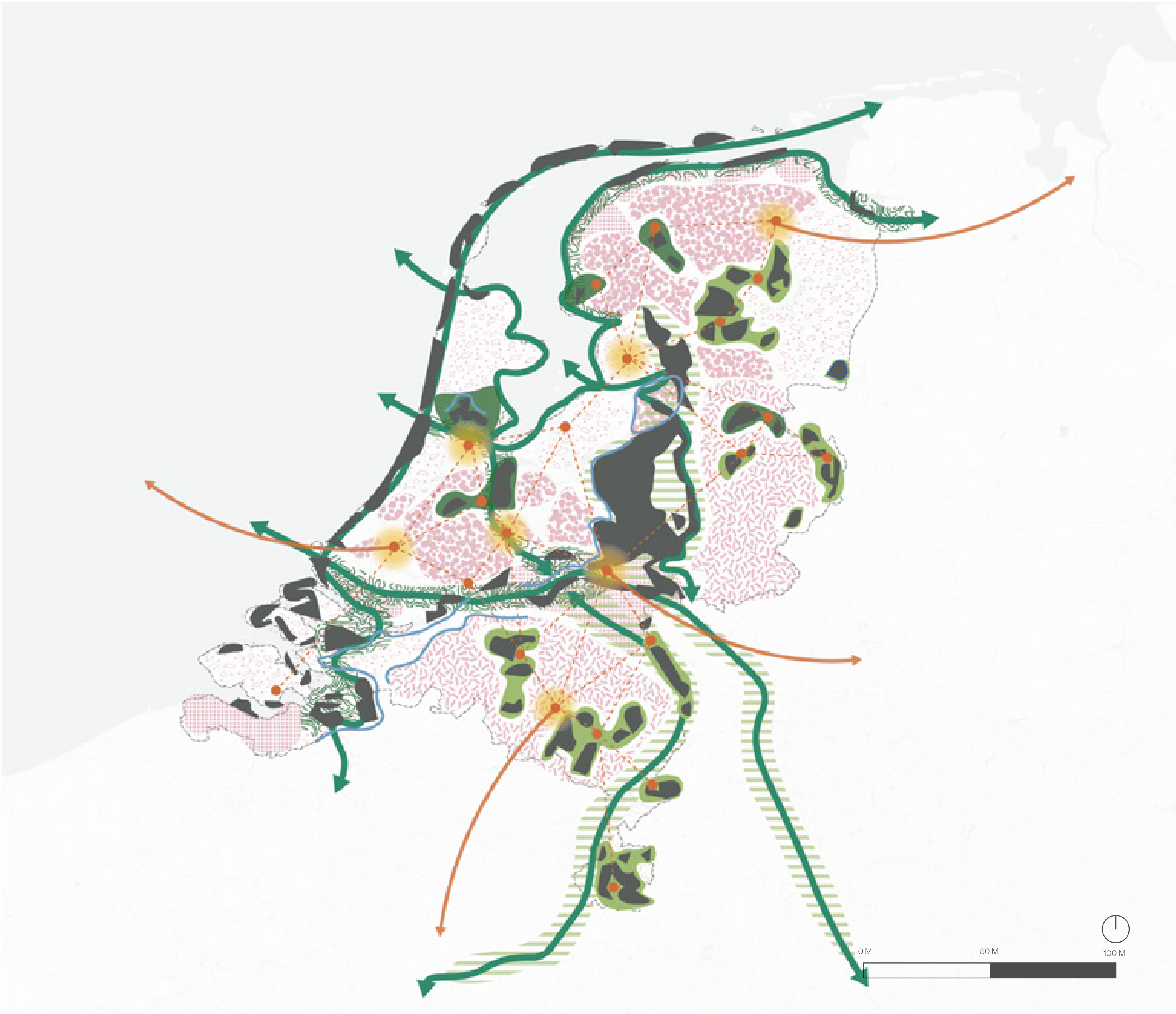


fig.5.3.4 Vision map: all aspects combined, (own work)

- NEW NATURA2000 CORRIDOR ALONG THE RIVERSIDES AND COASTLINES
- PROTECTION ZONE: WETLAND POTENTIAL
- PROTECTION ZONE: FOREST POTENTIAL
- PROTECTION CLUSTERS: FOREST POTENTIAL
- PROTECTION CLUSTERS: WETLAND POTENTIAL
- BIODYNAMIC FARMING (DIET OF COWS, REUSE MANURE, SEASONAL FARMING)
- MULTICULTURAL FARMING (MULTICROPPING, MOSAIC CROPPING)
- WATER-BASED PLANTING (RECREATIONAL USE)
- REDUCE (USE OF FERTILIZER)
- EXISTING NATURA2000 ZONE
- WATERMANAGEMENT PRIORITY ZONE
- EXISTING RESEARCH INSTITUTES (UNIVERSITIES)
- LIVING LABS
- KNOWLEDGE FLOWS
- INTERNATIONAL KNOWLEDGE FLOWS

5.4 Farmer's Profile

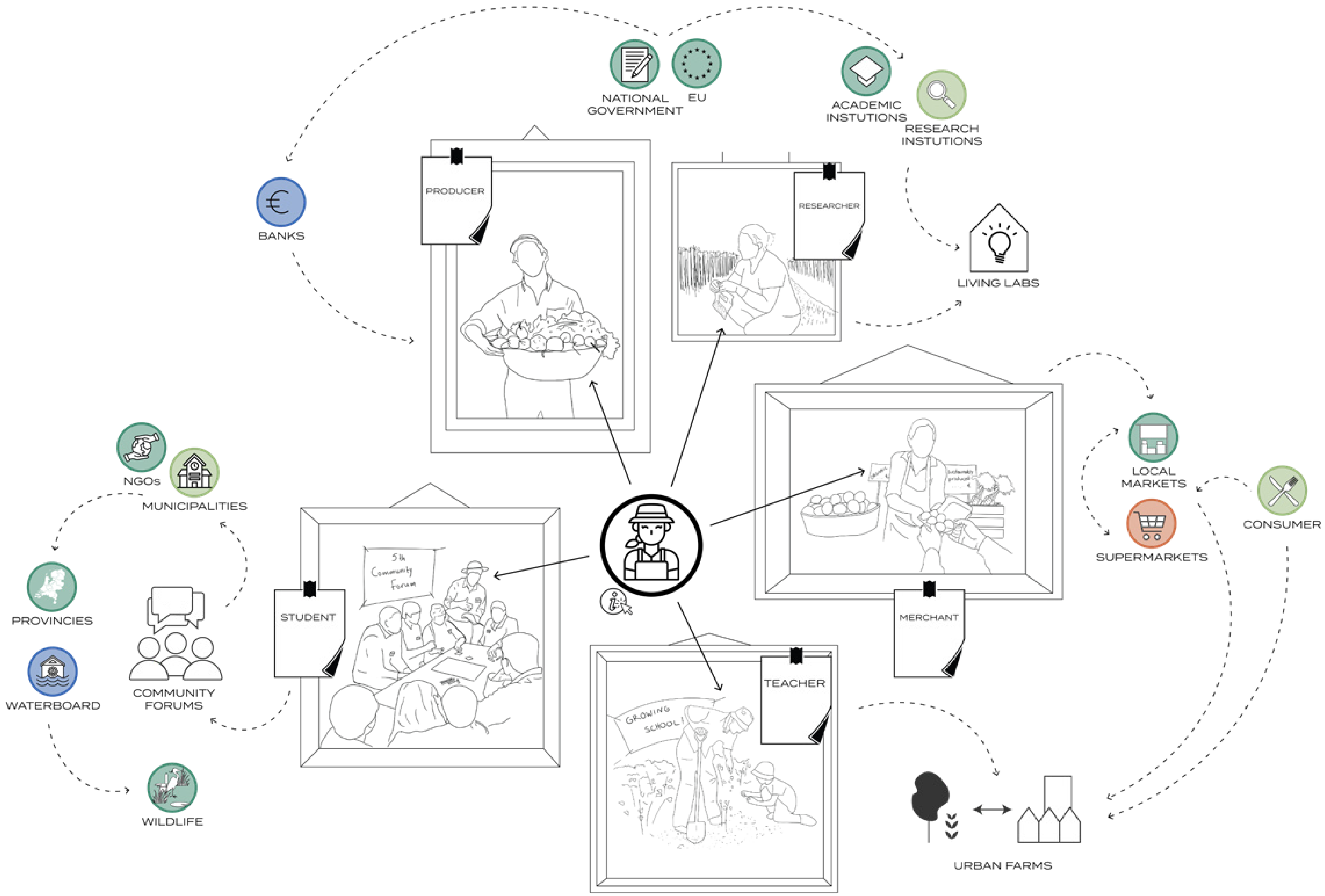


Figure 5.4.1
The farmer's profile, (own work)

What our vision portrays for the future of agriculture does not only shape the Dutch agricultural landscape but it also generates multiple roles for the farmers. The farmer's profile visualised in figure x.x represents some key roles of the farmer that joins actively the sustainability transition.

With the farmers' involvement in the living labs and the conversion of their farmlands into research fields, they incarnate the role of the researcher. This clarifies our need to create spaces for academic and research institutions to come in contact with the farmer-researcher.

We envision a future with strengthened local markets to shorten the food supply chain and ensure control over the efficiency and sustainability of our agricultural practices. To achieve this we imagine that the farmers support local markets and become merchants in their local communities.

Where farmland meets the urban fabric the farmer becomes the teacher. We picture increased consumer engagement in the transition and a relationship between farmer and consumer with the character of knowledge exchange.

Collaboration between stakeholders is a fundamental aspect of our vision. Through community engagement in decision-making forums, and with farmers actively participating in these discussions, there is an opportunity for farmers to not only serve as teachers but also as learners. This dialogue between stakeholders implies that farmers will have to become both students and educators.

In the diagram, it is also elaborated on how different actors' actions and spaces are connected with each role of the farmer. This way we envision the future of agriculture with the farmers as the centre of our transitional system.

5.5 Conclusion of the vision

In our vision, we strive to mitigate nitrogen pollution through soil and water by implementing a systemic approach for 2075. As illustrated through the four layers of the vision, farms will transition to sustainable production and natural areas will be actively protected. We will realise this systemic approach through the innovation of new tools specifically designed for each area where every stakeholder will be included ensuring they will adapt.

The section below builds upon the sections from chapter 4.1, where stakeholders were mapped out to show the flows of the origin of the nitrogen crisis. This systemic section shows the desired future outcome designed through our vision. The emphasis of this illustration is on the importance of collaboration of all stakeholders for a successful implementation.

In current times, there is a huge surplus of reactive nitrogen in the soil. However, with our vision we aim at closing this cycle again. Although, reactive nitrogen is still present in the soil from farming, only organic manure from cattle is used, and reactive nitrogen is filtered in protection zones making sure other natural areas are protected and can thrive in biodiversity again.

As shown in the figure below, our desired outcome proposes a new circular way of farming. The excess of nitrogen that is still present will be taken up by vegetation planted for denitrification and N2 will be brought back to the air.

Our vision focuses on the Netherlands, as we are one of the biggest contributors of nitrogen pollution. However, this vision focuses on creating a new approach from where will gain a large amount of new knowledge. This knowledge can be collected and shared with other nations within the Eurodelta region and globally. Consequently, there will be a decrease in nitrogen pollution entering water bodies through rivers. Our goal is to transition into a knowledge-based country rather than the food-export country the Netherlands currently is. By sharing this expertise, we can encourage the adoption of local farming practices in other countries and of course, our own.

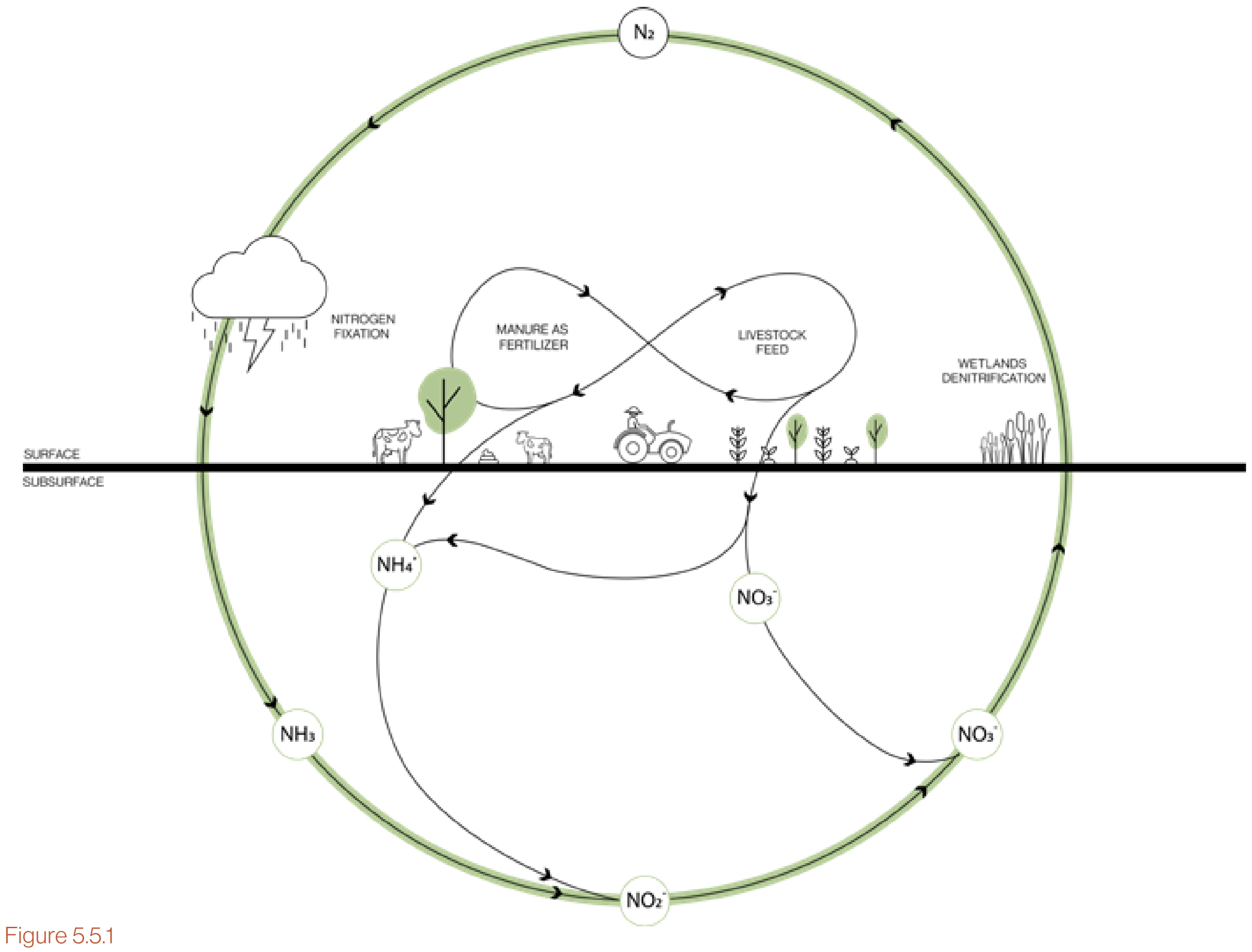


Figure 5.5.1
Schematic illustration showing a balanced nitrogen cycle.

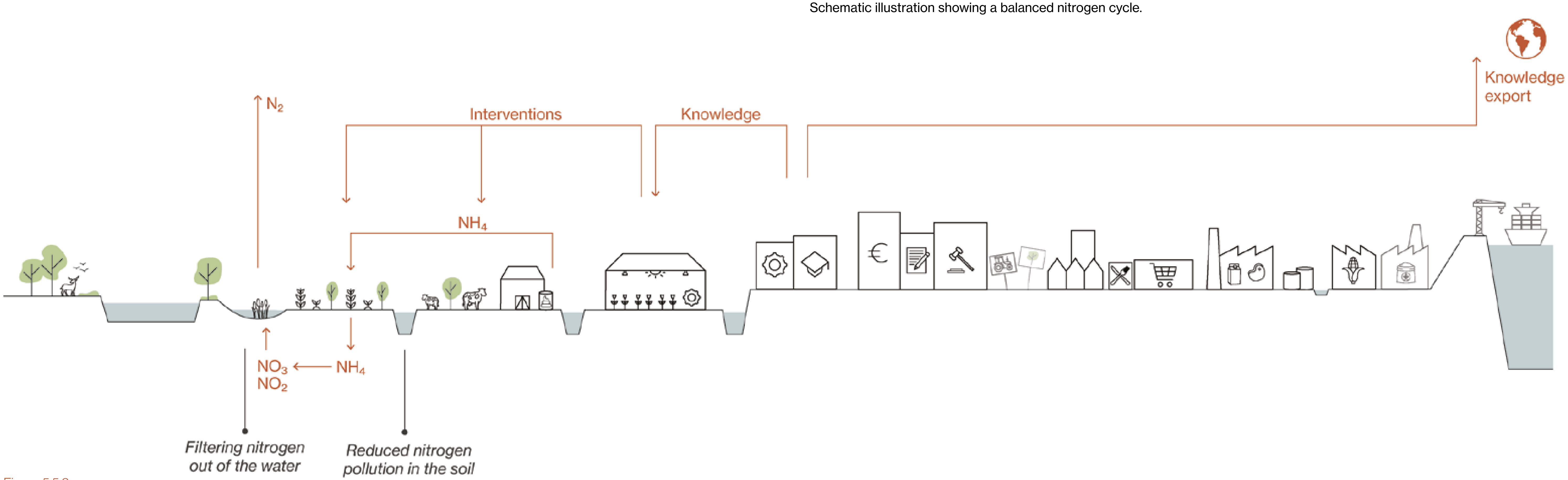


Figure 5.5.2
Schematic section illustrating future flows resulting from the vision (own work).

Chapter 6 Strategy

6.1 Spine Strategy

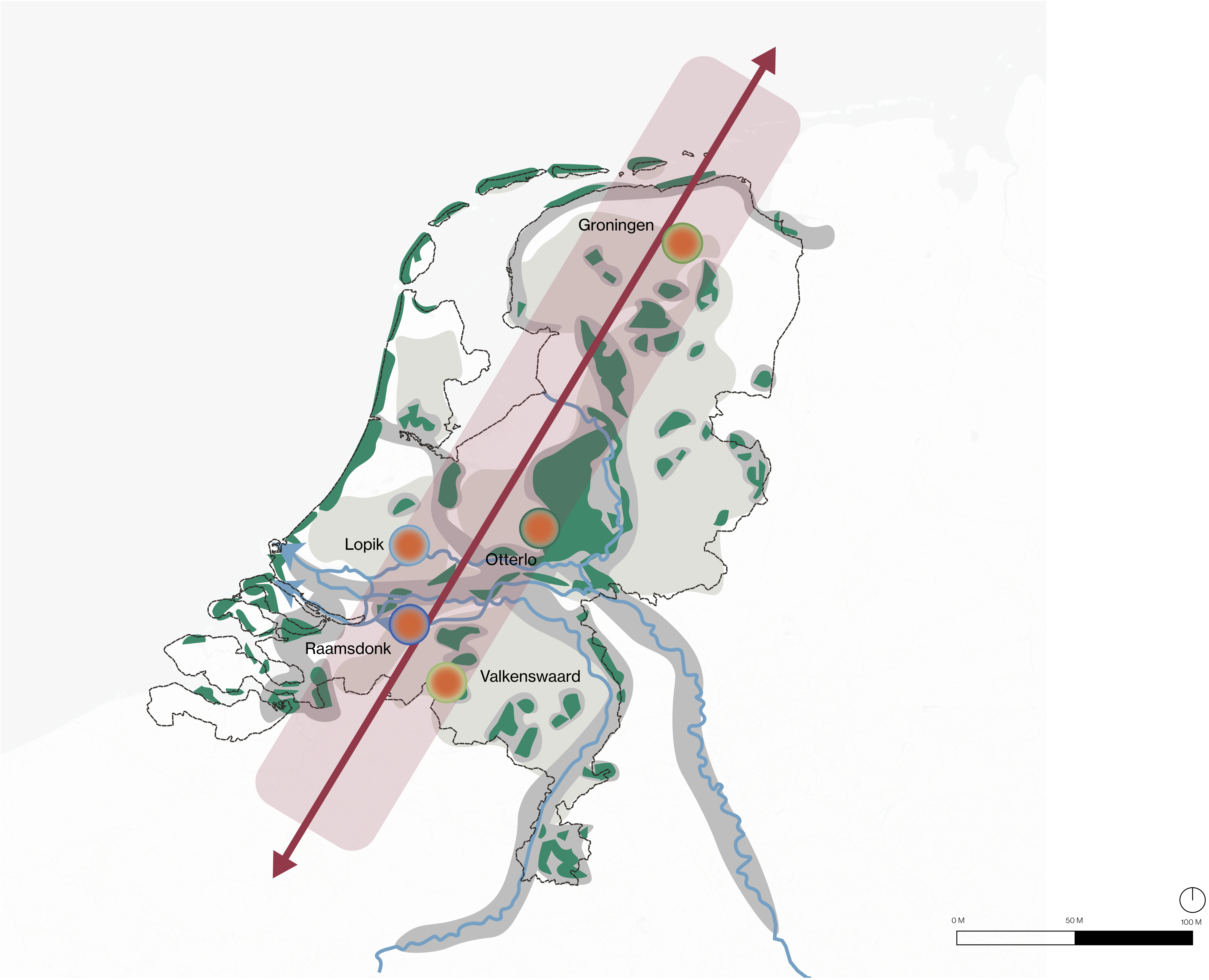


Figure 6.1.1
Spine Strategy, (own work)

Explanation of the spine diagram and the zoom-in areas

In our vision, we explain that it is important to look at the whole system. However, it is not possible to change an entire system overnight. Transforming the current landscape to a new, more sustainable version requires a strategic approach.

The way we designed our strategy is by looking at which areas are currently most problematic. In the analysis chapter, it became clear that the Netherlands can be divided into different typologies, each of which has different levels of nitrogen pollution. In our strategy, we focus on the most problematic areas. Altogether, we mention five different typologies in our strategy. These typologies are linked together by a 'spine', from which our vision develops outwards. In order to find an appropriate solution for each of the typologies, we focus on one zoom-in location per typology.

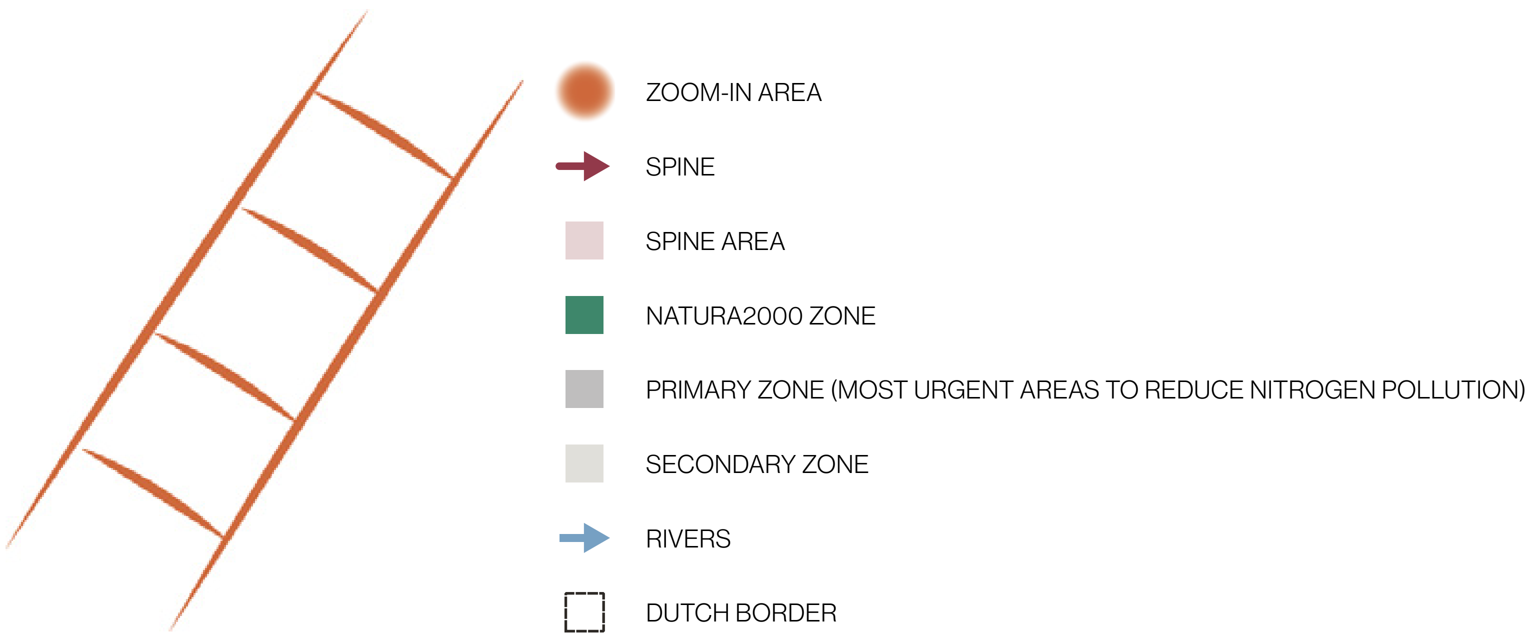
These zoom-in locations are model representations of the challenges faced in each typology. The zoom-in locations thus cover all soil types and agricultural landscapes. The peri-urban locations we have identified for this purpose are (from North to South) Groningen, Otterlo, Lopik, Raamsdonk and Valkenswaard.

We elaborate on two of these locations in detail as we see the greatest contrast between them. In Lopik, we are dealing with an area threatened by flooding and mainly consisting of pastures with cows. The area has the potential to create wetland protection zones inside it. This zoom-in also explores how these protection zones can be constructed if there is a polders system.

In Otterlo, we are dealing with sandy soil and a large natural area, namely the Veluwe. In this area, there is mixed agricultural activity. The site will illustrate how urban areas can collaboratively be involved in this transition. Additionally, the area has the potential to create forest protection zones. In this location, there is no polder system.

The three other locations that will be examined will test how the ideas of Otterlo and Lopik can be translated in a different context. In Raamsdonk, for instance, there is also flood risk. The Groningen context was chosen because there is an opportunity to approach the contrast between rural and urban areas. In Valkenswaard, there is also a large city nearby, namely Eindhoven, where there is the possibility of placing a forest protection zone.

Conclusions drawn about the practices in these five zoom-in locations can then be translated to the rest of the region in which they are located. Here, we suggest translating these findings first to corridors and clusters around Natura2000 sites as these have more urgency. After that, the findings can be adapted to the rest of the Dutch agricultural landscape. The knowledge gained in the zoom-in areas could also be transported across the Dutch border, to other countries facing similar challenges.



6.2 Actions and Policies

Agricultural interventions

In our strategy we focus on changing the agricultural landscape of different locations. However, every plot of land is different and needs a different approach. Therefore, we provide a set of agricultural interventions, based on the main soil types sand, clay and peat. For the new farming practices, examples of crops have been added to provide information on which crops could grow best in these circumstances. Additional crops would be feasible, but further research would be required to know for certain.Options for protection zones have been added, as well as examples of living labs.

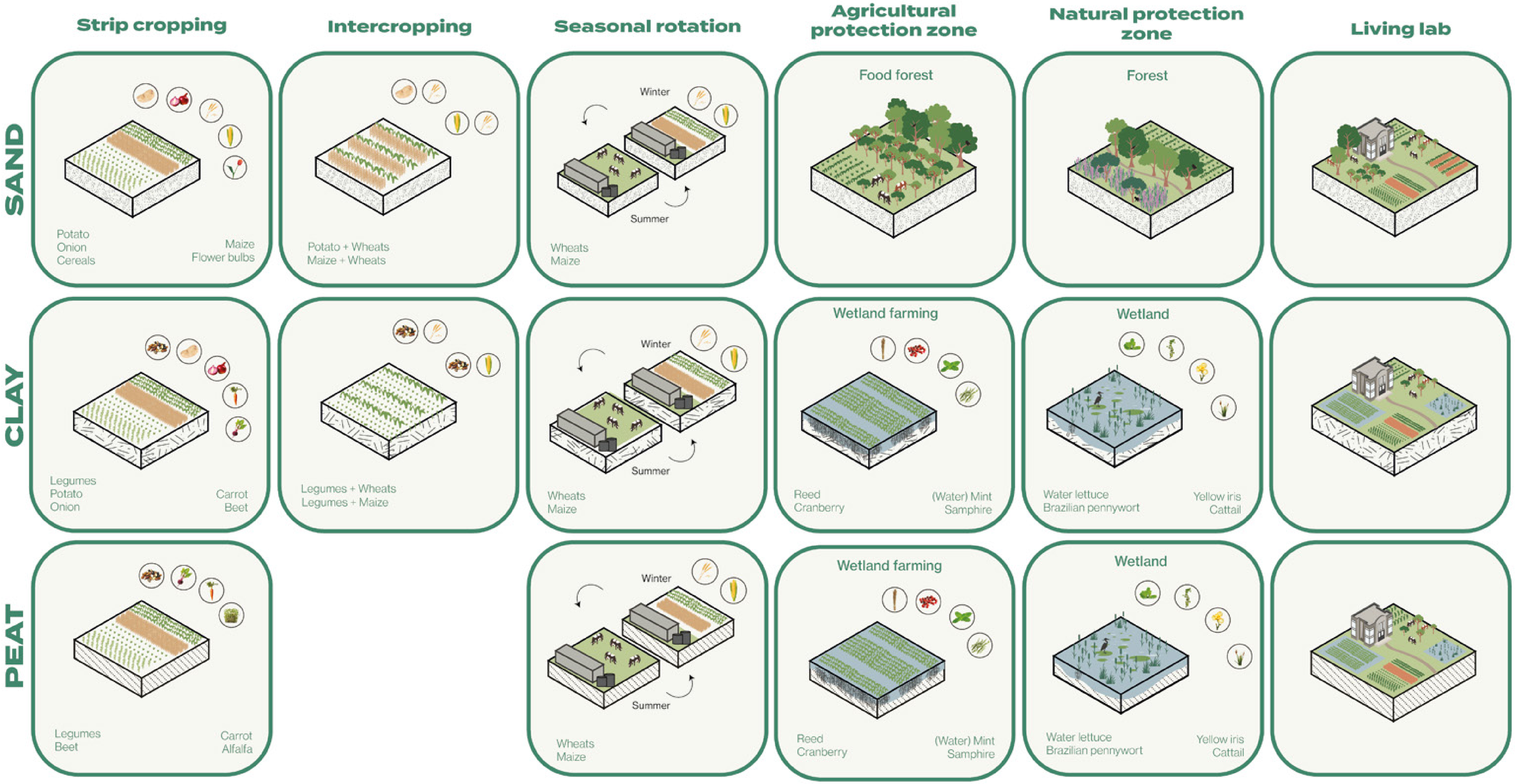


Figure 6.2.1
Agricultural intervention tiles divided into soil type and intervention type.
Own work based on(Wageningen University and Research, 2023), (Watson et al., 2020), (FAO, n.d.), (Kogut, 2022), (Isleib, 2013), (Palomo & Fiske, 2022), (Jo et al., 2002) and (Gu et al., 2022).

Actions

If we want to change the whole system, all stakeholders must be involved in the process. Therefore, to achieve our goal, we have set up a number of actions.The actions are divided into education programmes, research programmes, financial security and awareness.

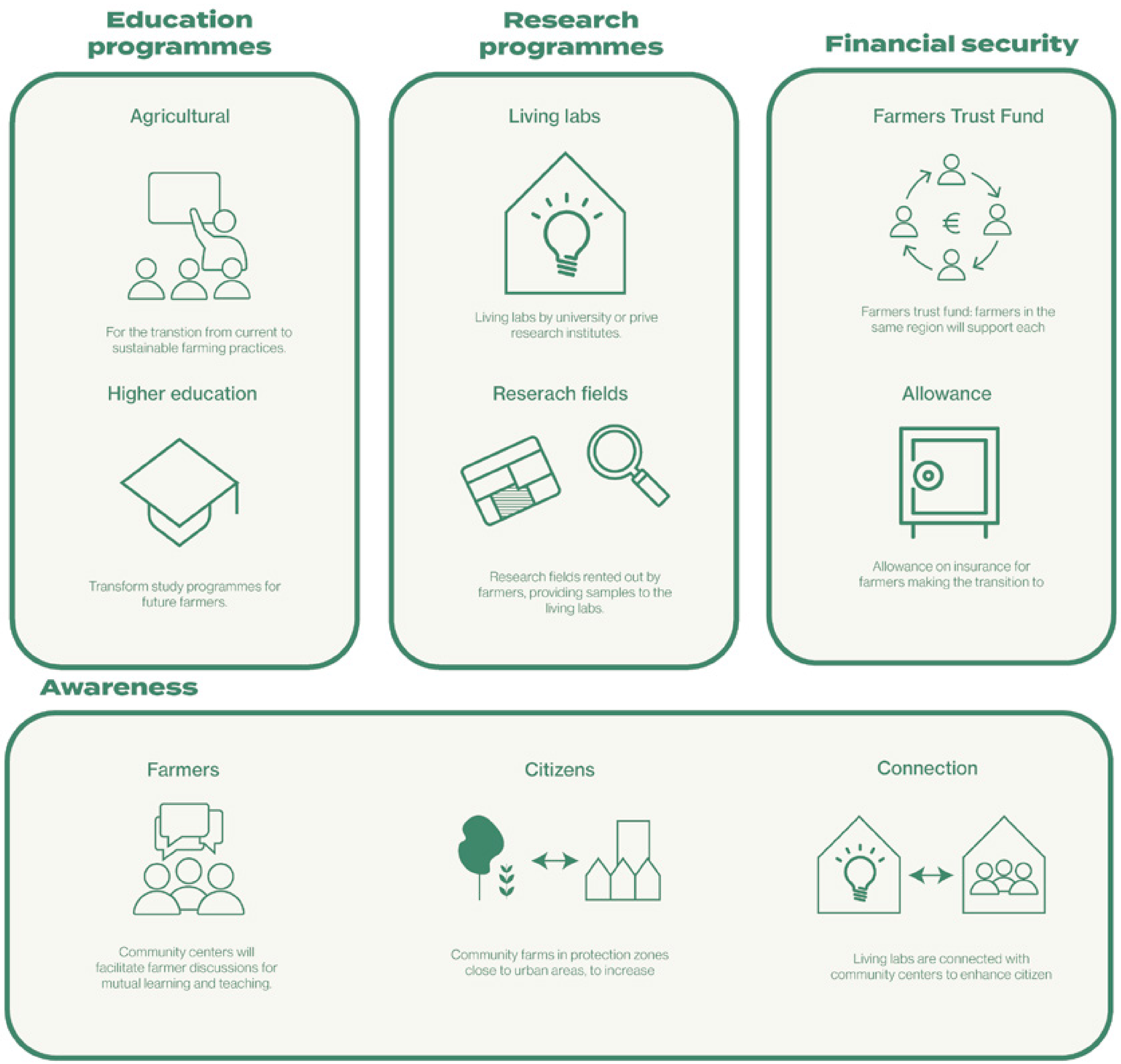


Figure 6.2.2
Actions divided into education programmes, research programmes, financial security and awareness (own work).

The living lab

Figure 6.2.3
Comic explaining the living labs, (own work)

Within our actions we propose having living labs where on-site research is conducted. Moreover, we propose combining them with community centres where farmers and citizens can come for education or just to visit. In the comic the concept of the living lab is explained in more depth.

New policies

We propose a new set of policies, to make sure the interventions and actions will be implemented.. They are divided into four themes: nature protection zones, sustainable agriculture, cooperation and research and education. It should be noted that further research would be needed into creating well-formulated policies. However, we believe these policies are needed for our systemic approach and aim at giving the farmer more decision-making as well.

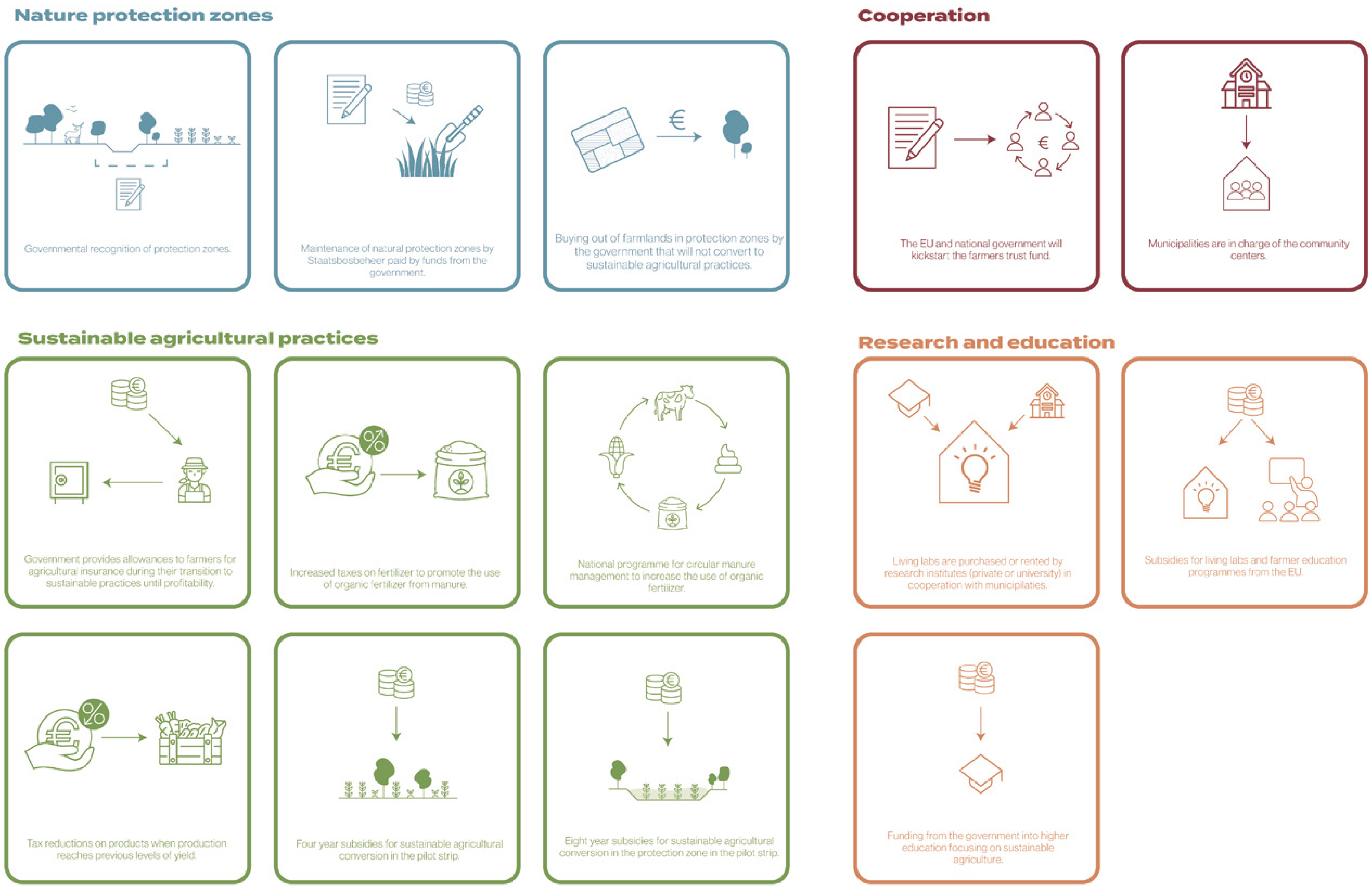


Figure 6.2.4
Policies divided into nature protection zones, sustainable agricultural practices, cooperation and research and education (own work).

The perfect fit for the farmer

In our systemic approach we aim at finding a perfect fit for each farmer towards sustainable food production. Therefore, we designed this pamphlet to show the process a farmer would go through.

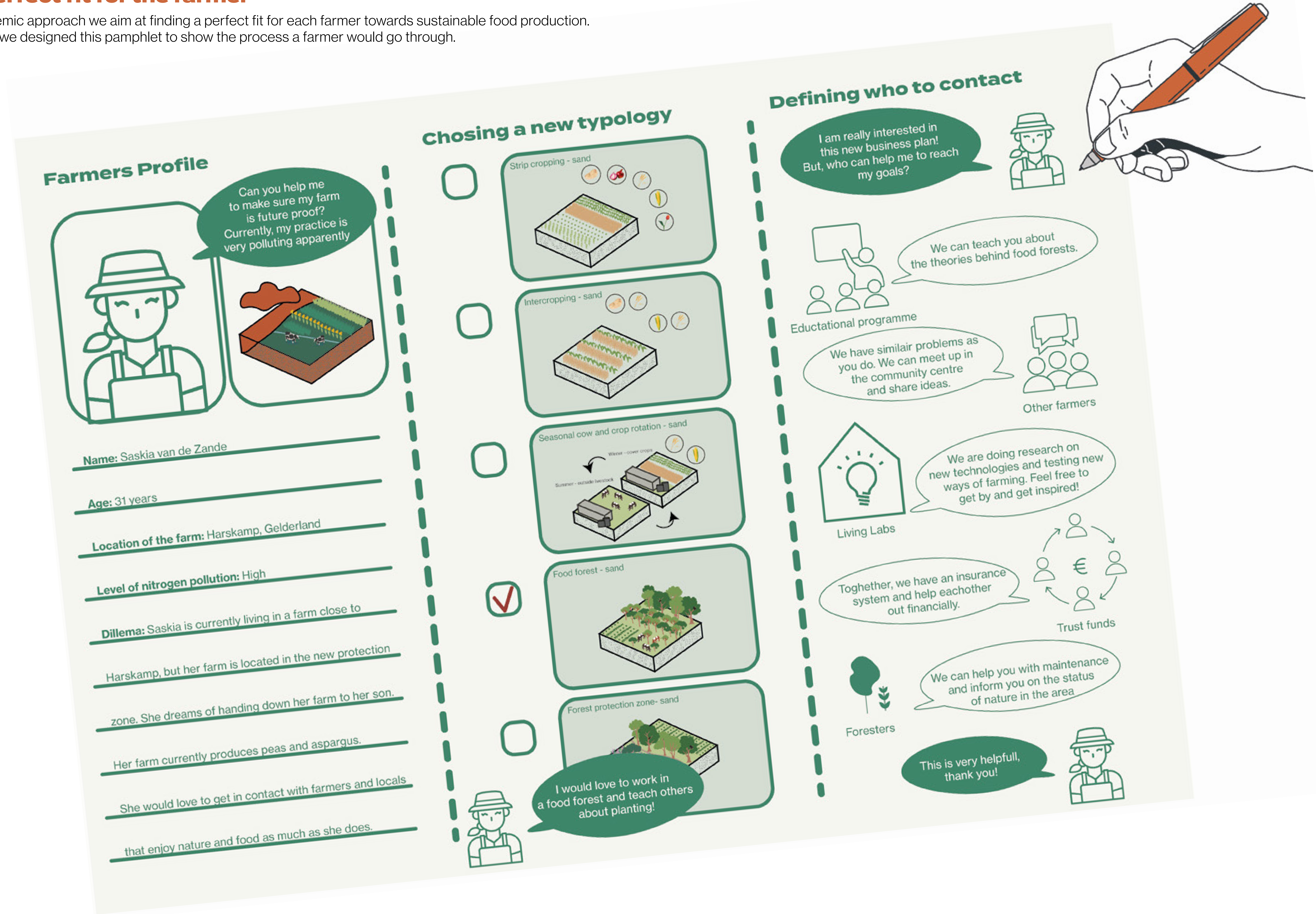


Figure 6.2.5
Pamphlet showing the process a farmer would go through and the choices they can make when transitioning towards a sustainable practice (own work).

Phasing

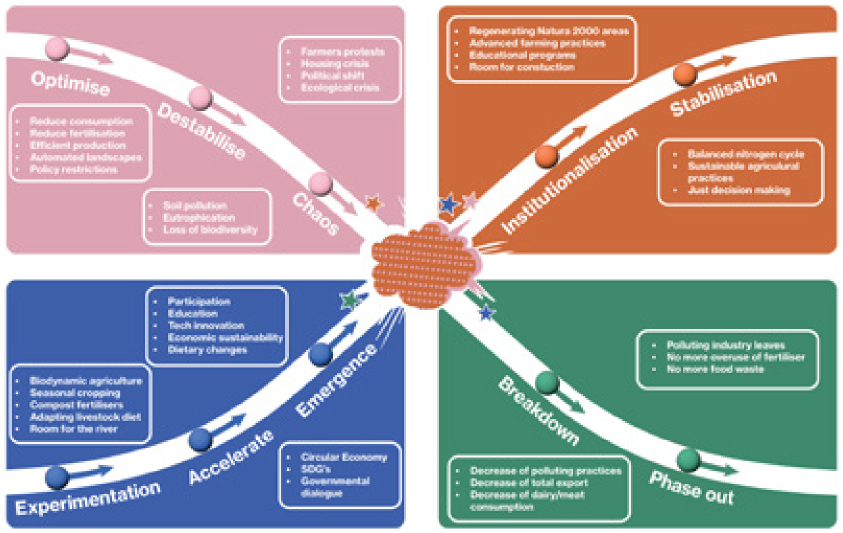
To ensure that a long-term strategy like this one can develop effectively and to avoid miscommunications with the different stakeholders involved, it is crucial to phase it. Overall, in this strategy, we are planning a transition for the next 46 years. This plan is separated into three phases with a gradual increase in their duration as we expand spatially.

Phase 1 (the " Pilot Strip") kickstarts the transition with five strategic projects that are distributed on an axis across the Netherlands from South to North. These five areas have been chosen to elaborate to the Nation and the Eurodelta, through practice, how we can mitigate nitrogen emissions on different soil types. They act as models for individuals and collectives to adapt to their land conditions.

Phase 2 (the "Nature Nexus") contributes to the expansion of sustainable agricultural practices around natural habitats. The two main goals are to shield the Natura2000 and establish green corridors between cities, agriculture and nature. This way we aim to raise the interest and involvement of practitioners and consumers.

The spatial connections between Dutch landscape and urban fabric, along with proof of feasibility in sustainable agricultural practices allow us to move to **phase 3 ("the New Agri-Norm"**). In this phase, we aim for the transformation of the unconverted agricultural landscape in the Netherlands and the export of our obtained knowledge across borders. To transform sustainable agricultural practices into the new normal we need time for its roots to grow. For this reason, phase 3 has the longest duration of all phases in the strategy; to provide all individuals with a chance to join.

Fig. 6.2.7 :
The X-Curve, (own work)



While developing our strategy we looked into the progress of the sustainability transition regarding nitrogen pollution. We recognised that we currently are in the "Chaos" of the breakdown and in the "Accelerate" stage of the build up.

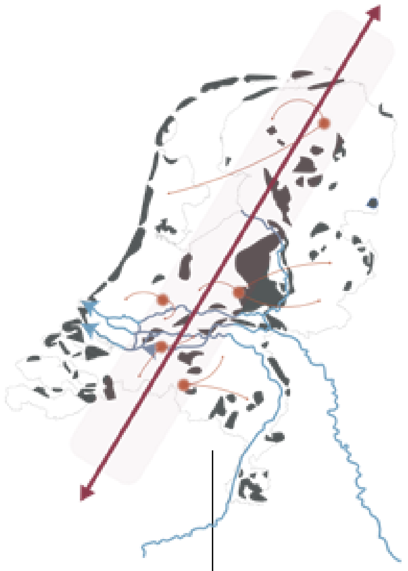


Fig. 6.2.8:
Diagramatic Plan of phase 1,
(own work)

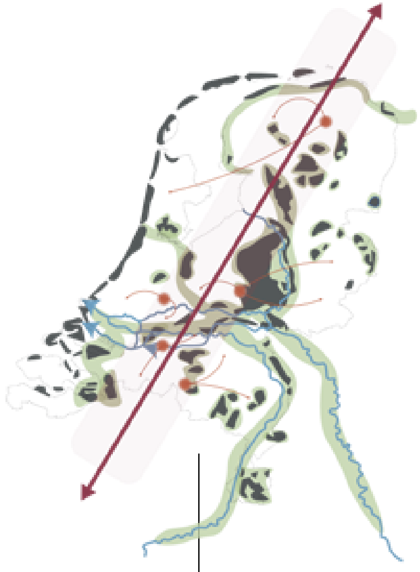


Fig. 6.2.9 :
Diagramatic Plan of phase 2,
(own work)

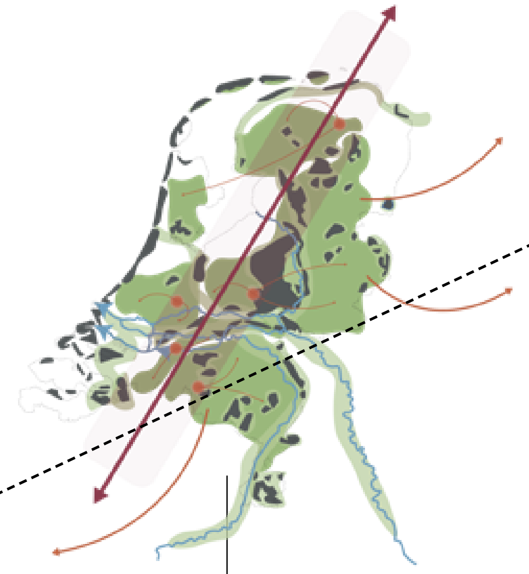


Fig. 6.2.10 :
Diagramatic Plan of phase 3,
(own work)

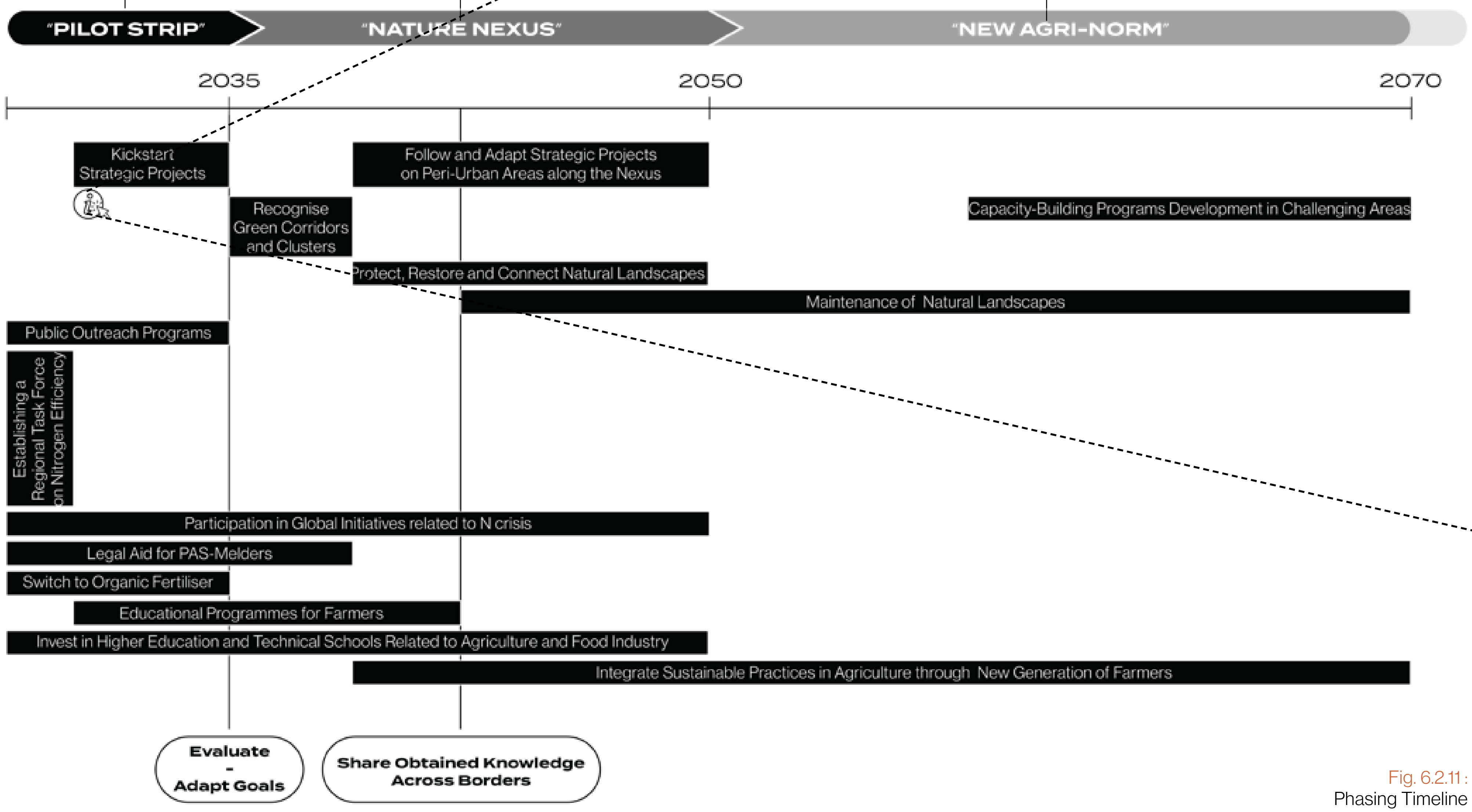


Fig. 6.2.11 :
Phasing Timeline

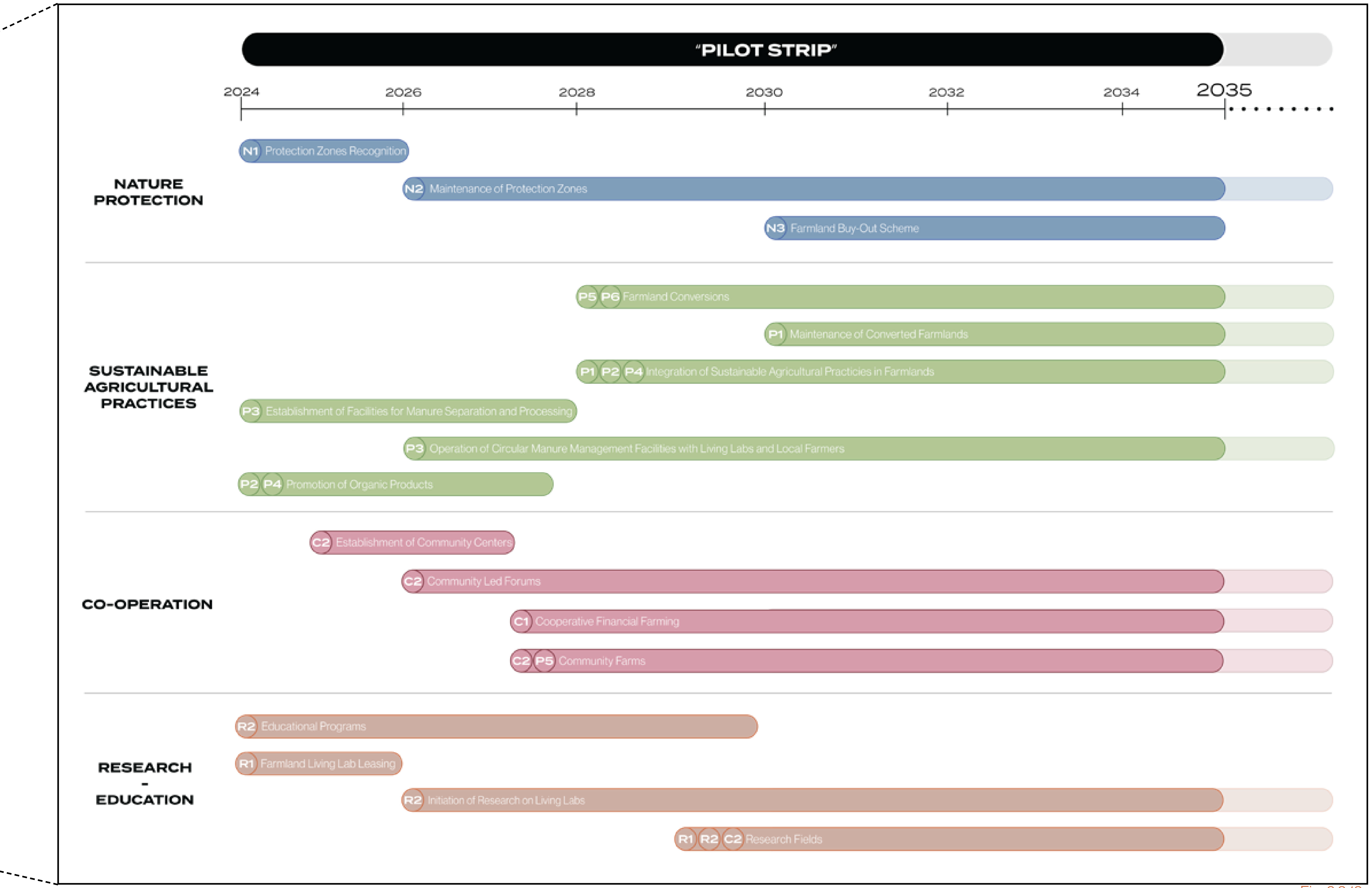


Fig. 6.2.12 :
"Pilot Strip" timeline,
(own work)

For the strategic projects to act as representational models it is important for our strategy to elaborate on the sequence of actions that take place in the Pilot Strip.

Its first steps consist of the recognition of protection zones, the establishment of facilities for manure separation and processing, the promotion of organic products through tax reductions, the initiation of educational programs for farmers and the leasing of land for living labs. All the above create the basis for our suggested policies on land conversion, research and collaboration to develop efficiently into action and change.

Halfway through phase 1, we begin implementing actions that will allow all stakeholders to sustain their new practices and founded relations, while ensuring the safeguard of the Natura2000 areas.


5th
Community
Forum

Stakeholders

Our strategy focuses on raising the stakeholders' interest throughout different phases of the transition. The suggested actions strive to bring actors from different sectors closer. More specifically they create interactions between the more authoritarian stakeholders and the ones that currently have lower power in the system. This is done so that people with different perspectives and interests engage in decision-making processes.

The actions that fall under the theme of "cooperation" allow us to widen the range of existing groups of stakeholders while restructuring them in a way that they overlap. This way we achieve a fairer system where those who practice the change are included in the way it is formulated. With "nature protection" we aim to give power to other species that are exposed to the effects of our exploitative human activities. Actions and policies under "Research and Education" influence academic and research institutions as well as farmers. They support their growth and strengthen their role by providing the necessary knowledge.

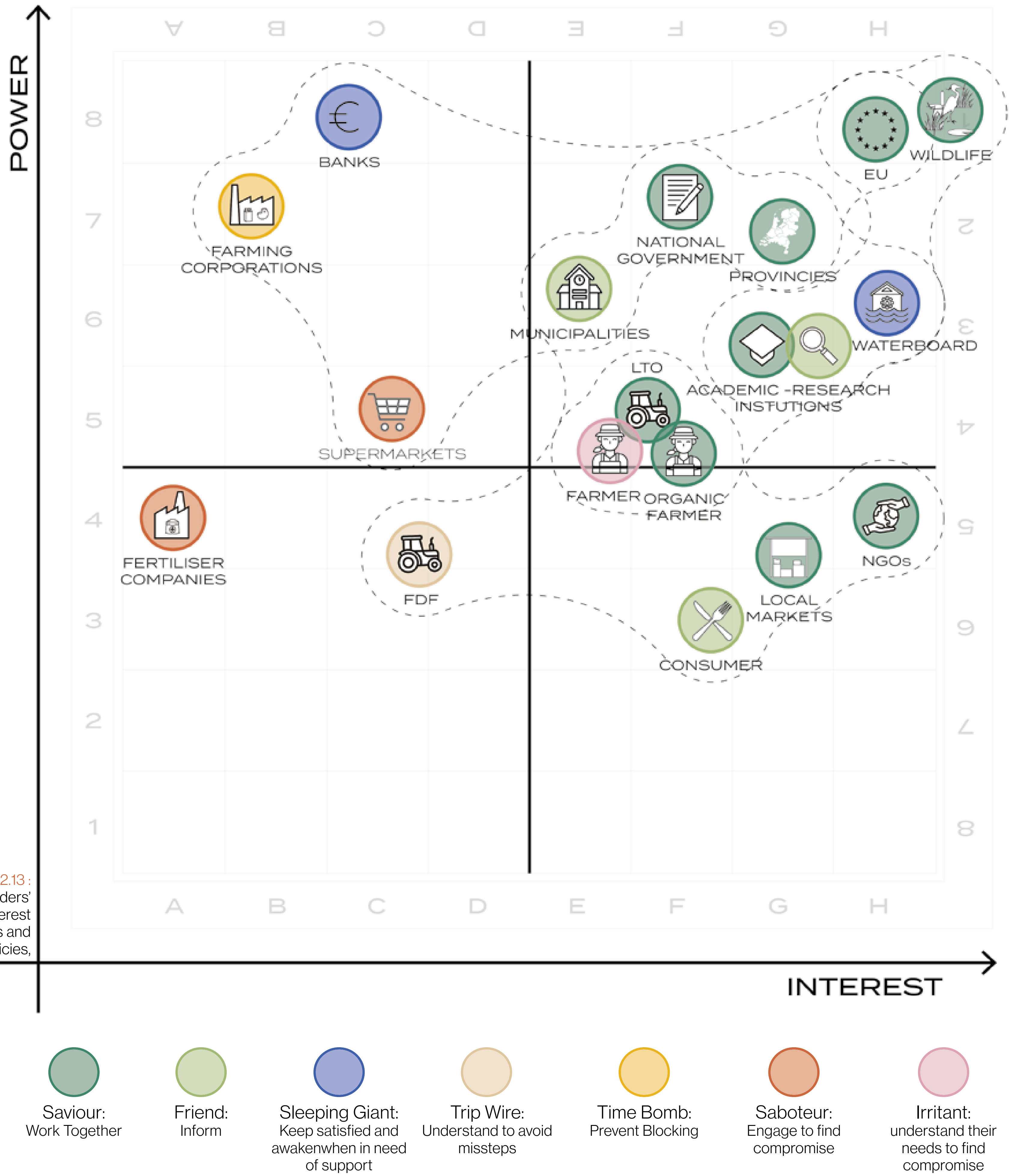
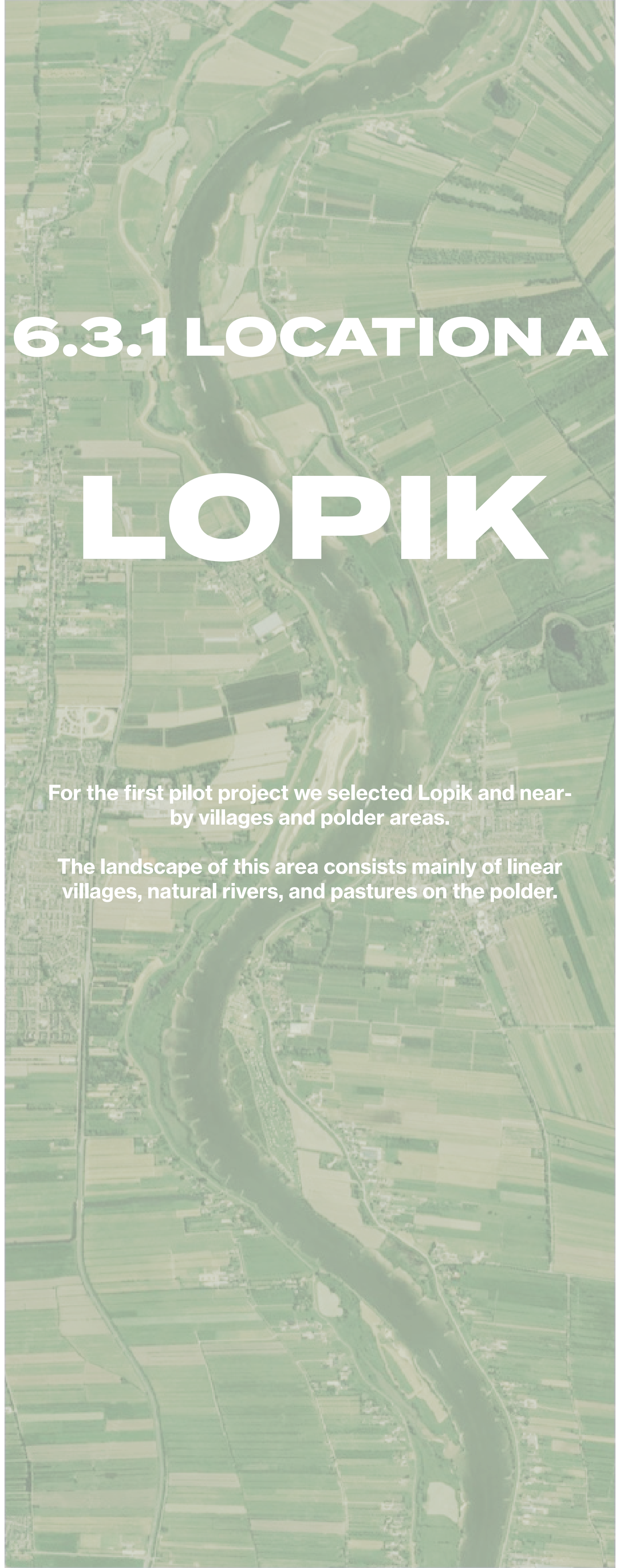


Fig. 6.2.13 : Diagram of stakeholders' power and interest influenced by actions and policies,



6.3.1 LOCATION A

LOPIK

For the first pilot project we selected Lopik and nearby villages and polder areas.

The landscape of this area consists mainly of linear villages, natural rivers, and pastures on the polder.

Fig. 6.3.1.1
source: (Googlemap, 2024)

The location and basic conditions of the pilot site

Fig. 6.3.1.2
The location and basic conditions of the pilot site
(own work)

SOIL TYPE

The site is located in the green heart area of the Netherlands. The soil is mainly peat soil and the landscape type is polder. peat soil is relatively wet and has a high water table.

POLLUTION

As we can see in this figure, this region faces serious nitrogen pollution problems.

TYPOLOGY

The type of agriculture on the site is predominantly pasture on the polder with mainly cattle and sheep. As shown, our pilot project will provide a reference for the green areas marked in the map and spread out to these areas.

SITE ANALTSIS BASED ON SWOT

At the very beginning, SWOT analysis was mainly used to analyze the operation and surrounding environment of some companies in order to develop strategies and plans (Weihrich, 1982). However, this analysis method is also applicable to the design and planning of cities and regions (Yan et al., 2015). The analysis of STRENGTHS, WEAKNESSES, OPPORTUNITIES, and THREATS helps the designer to better understand the internal conditions of the site (STRENGTHS, WEAKNESSES), as well as the external environment (OPPORTUNITIES, THREATS).

STRENGTHS: The site is surrounded by several cities and is connected to major cities such as Rotterdam and Utrecht, accessible by public transportation in 45 minutes from Utrecht, Gouda, etc. This means that the site has a certain accessibility and has the potential to provide recreational activities and exchanges for the neighboring cities.

WEAKNESSES: the weakness of the site is the nature of its soil. peat land has been historically mined and soaked for a long period of time and currently has a serious problem of soil subsidence (Deltares,WEnR&TNO, 2021). And with a high water table in the area (Atlasleefomgeving, 2024), the soil is excessively humid and lacks the potential to be hospitable to many crops. As a result, mono-polder landscapes remain the current, if not future, trend of the local landscape.

OPPORTUNITIES:The site's polder landscapes and grasslands attract many bird species, while the natural river serves as a natural ecological corridor. There is an opportunity for the site to be part of the ecological corridor.

THREATS: Flooding is becoming more of a problem with climate change. And most of the polder is 0.5-1.5 meters below sea level(Topotijdreis,2023)and will bear the brunt of flooding(Atlasleefomgeving, 2024).

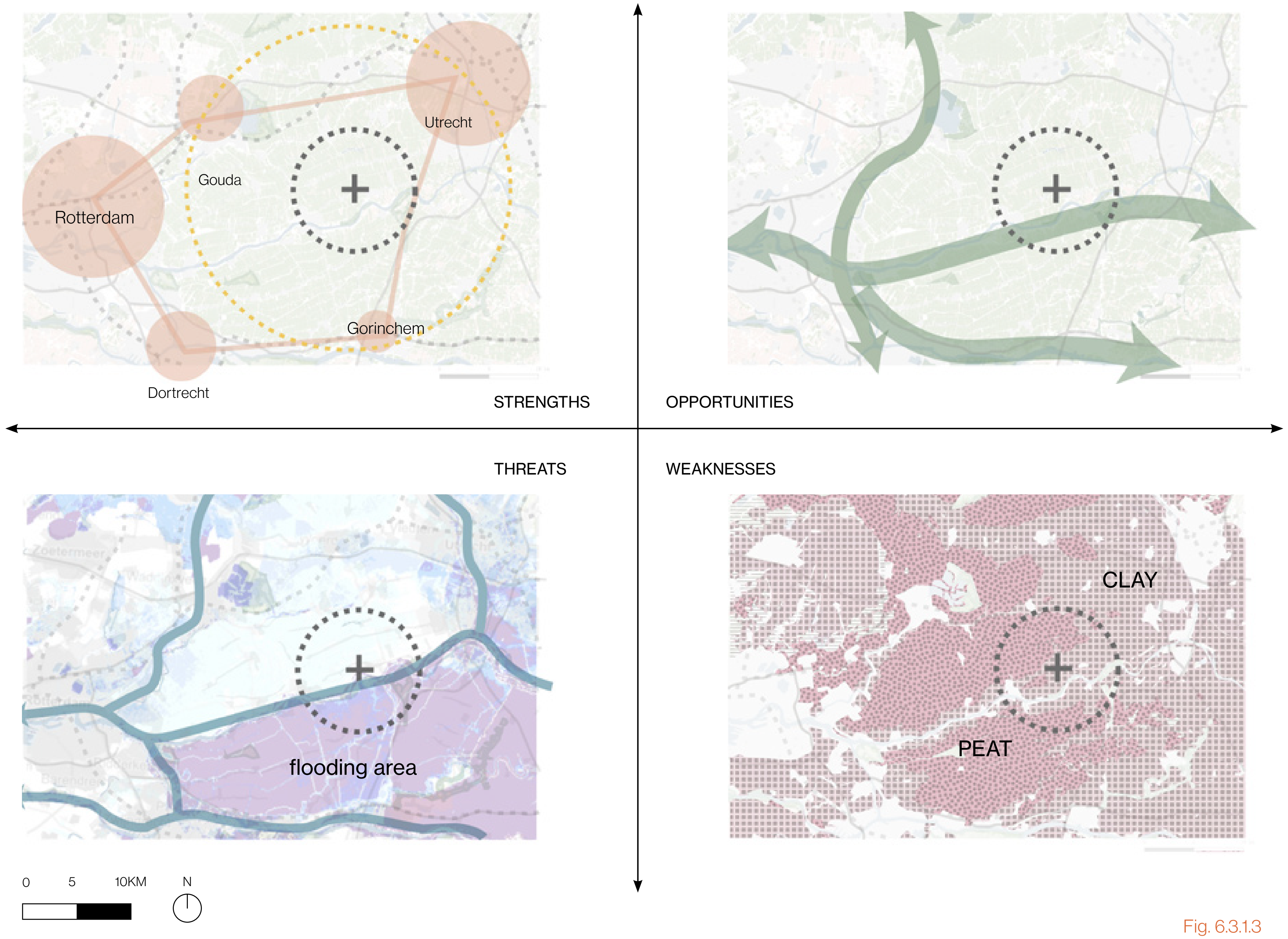


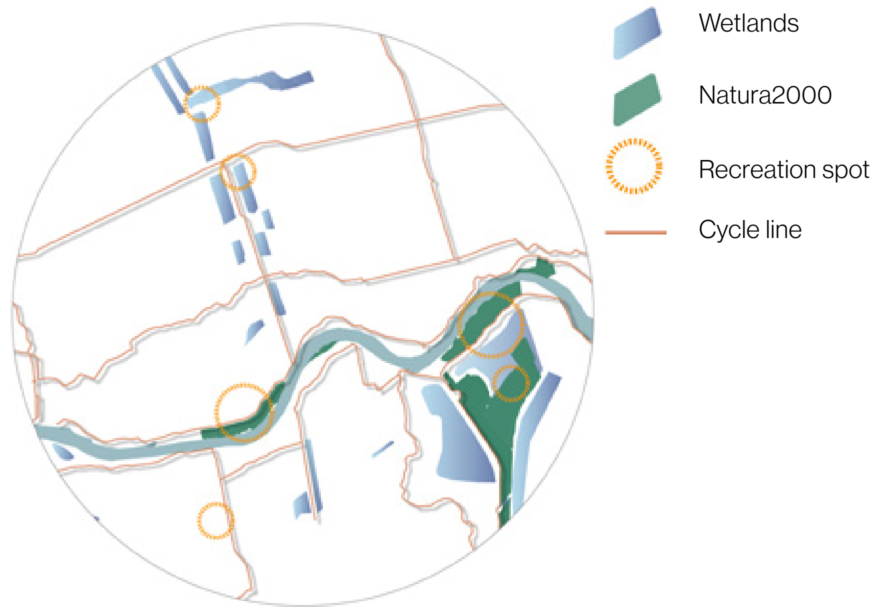
Fig. 6.3.1.3
SWOT analysis of the context of Lopik
produced by group member
Flooding map source:(Klimaateffectatlas, 2024)

SW STRATEGIES AND OT STRATEGIS

The SWOT analysis method will also provide guidance for design strategies, leading to the development of SW strategies from the internals of the site and OP strategies from the surroundings of the site (Yan et al., 2015).

SW strategy: taking advantage of the accessibility of the site, living labs can be set up within the site. due to the fact that the villages of the site present a transverse linear form, the living labs are mainly set up on the longitudinal road network that connects the villages in tandem. Based on the weakness of the soil of the site, we can consider planting vegetables or grains in the clay soil area along the river of the site. And in the peat soil area, we can consider planting some crops that are suitable for this kind of soil. But in general, the pasture is still the main landscape.

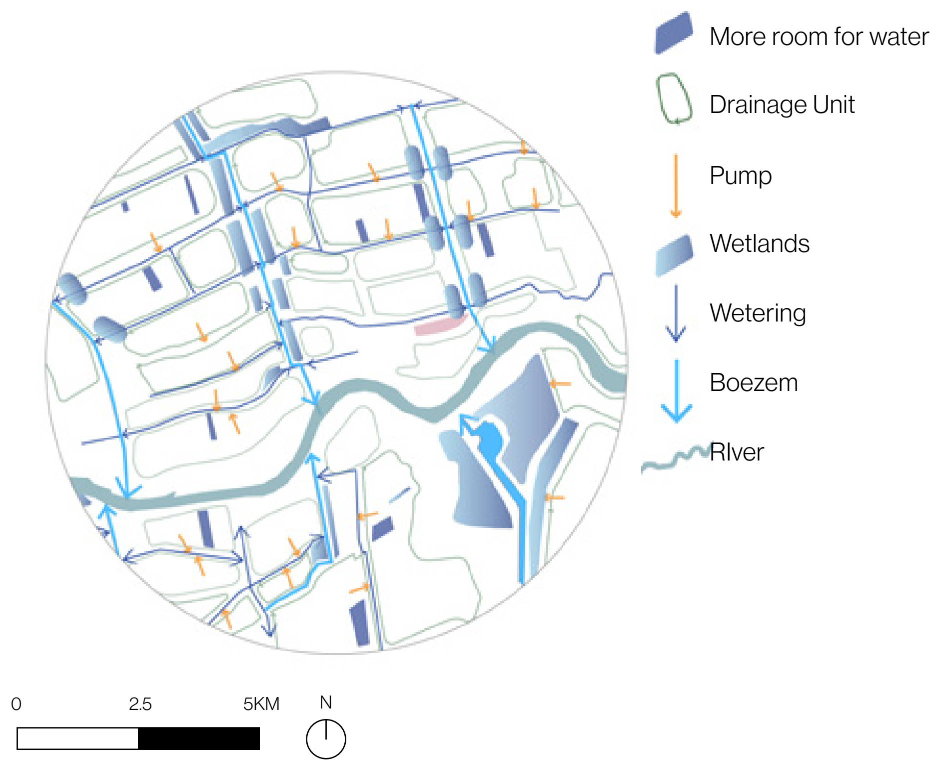
Social connection



Recreation combined with nature ecological corridor

OT strategy: To face the ecological opportunities, we set up a buffer zone around the Natura 2000 area, add more wetlands, and connect the recreational bicycle path with the ecological landscape. To face the threats of flooding, more room for water was made in the polder, and the water system was graded to take advantage of the differences in topography. the polder will be divided into cells, each of which discharges wastewater into the wetering, and pumps will extract the water from the wetering into the wetland. There, the wastewater will undergo a process of dinitrification before being pumped to the boezem and eventually to the river. The water purification wetland will be set at the intersection between wetering and boezem.

Water management go through different levels



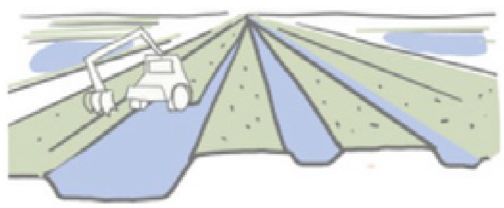
Changing the agriculture typology

Fig. 6.3.1.4
SW, OT strategies of Lopik
(own work)

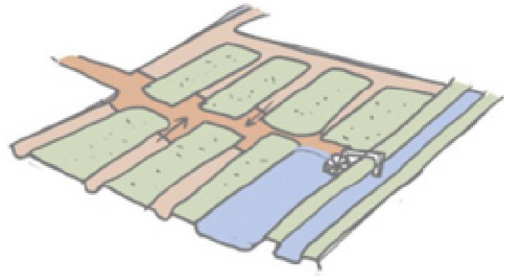
PILOT PROJECT PLAN

Fig. 6.3.1.5
Plan of the pilot project in Lopik
(own work)

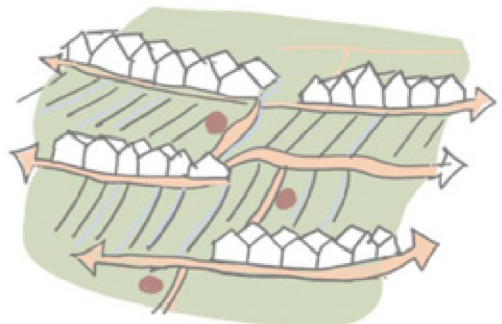
As shown in the plan, we can see the important dikes of the site, the location of the wetlands, and the different types of agriculture along the river area as well as in the lower elevation pasture area. Also, we can see the relationship between the Natura 2000 area and the wetlands, and the surrounding agriculture.



Dredge part of the peat land , make more room for water. this is not only favourable to fight against flooding, but also helps to regulate the height of the groundwater and alleviate soil subsidence.

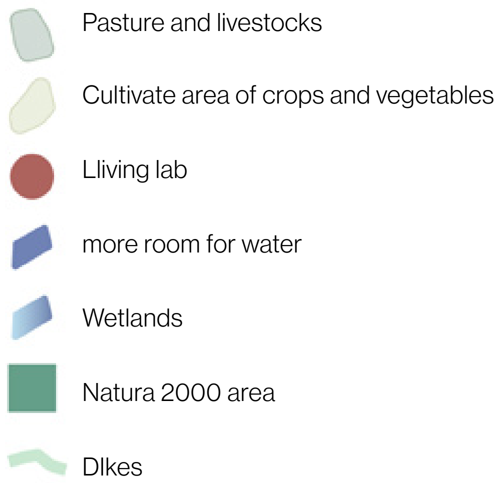


The wetland is located inbetween wetering[1] and boezem[2], the polluted water from wetering will be pump into wetlands first and then the purified water will be discharged into boezem.



The linear villages are connected by roads, which are more suitable for placing living labs around them, so that these living labs can be closer to the agricultural land and easily accessible.

Fig. 6.3.1.6
Three main interventions in Lopik
produced by group member



Note:
1. A wateringue (also known as a watering or watergang) is a ditch or drainage structure designed to drain marshlands, wetlands, or flood-prone areas located in coastal plains below the level of high tides (polders), in the Netherlands, Belgium, and France. (Wikipedia, 2024)
2.The 'boezem' is a term used in water management in the Netherlands, referring to surface water that collects and drains polder water. It doesn't have a fixed water level and is often discharged into rivers leading to the sea or the IJsselmeer. Boezem pumping stations or sluice gates are used for water discharge when natural drainage isn't feasible.

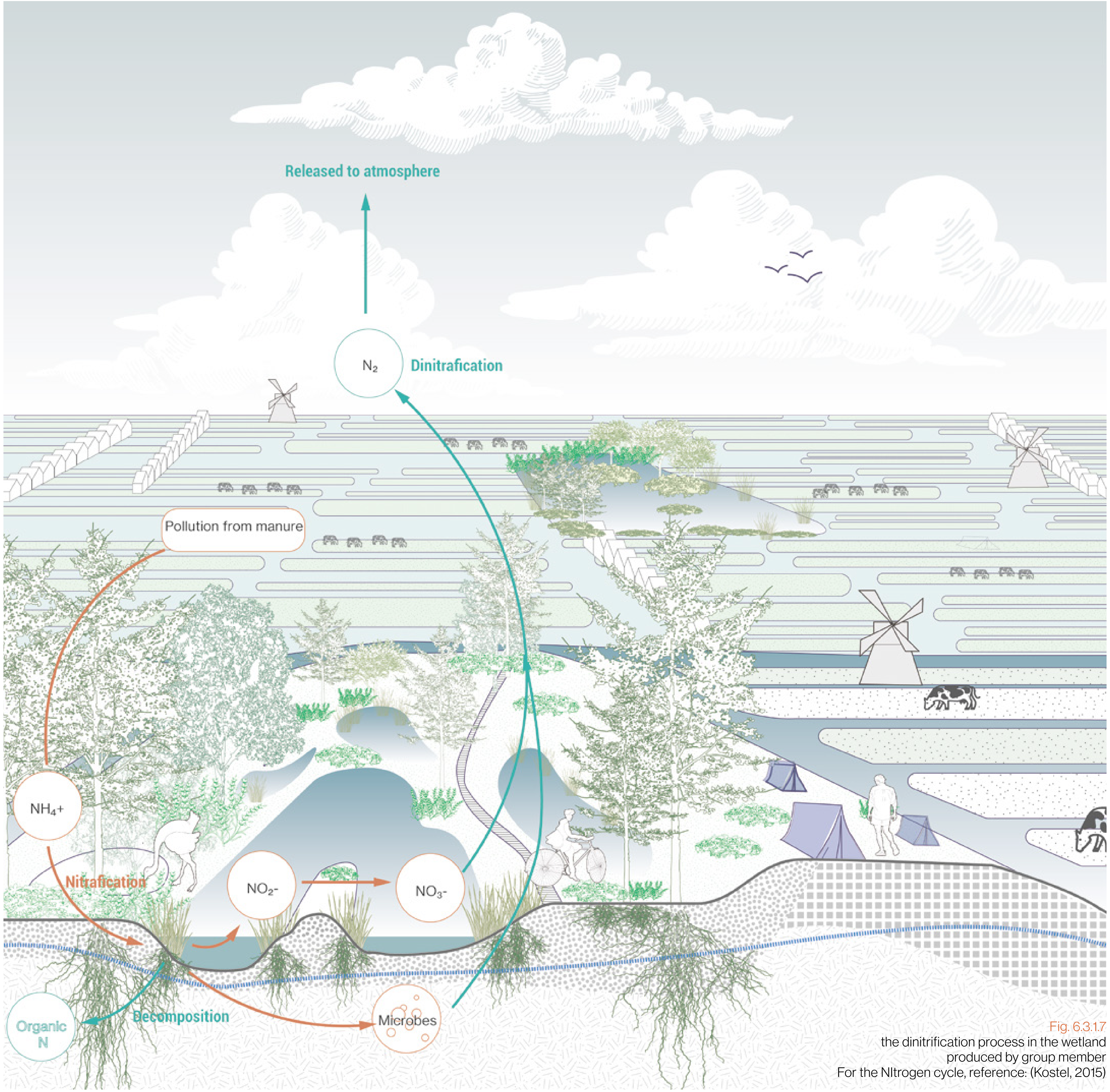
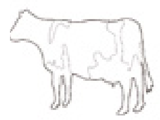


Fig. 6.3.1.7
the dinitrification process in the wetland
produced by group member
For the NItrogen cycle, reference: (Kostel, 2015)

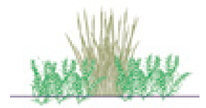
THE DINITRIFICATION PROCESS IN WETLANDS

In this diagram, we can see how the wetland handles the Nitrogen surplus from the polder on a chemical and ecological level. At the same time we can also see the space quality of the future, as it is mentioned in the Green Heart Development Handbook that the landscape of windmills and wide open polder is a unique and typical Dutch landscape. Therefore, while reducing nitrogen pollution with various interventions , we don't want to change the original landscape at the same time. Most of the polder has been preserved.



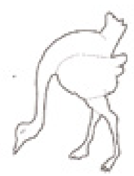
The main source of nitrogen pollution in the polder system is the manure of livestock (cows), and since water is ubiquitous in the polder, ammonia easily enters the water and becomes nitrate (Sawyer, 2020).

Nitrate is discharged with the water into the wetland system.



The water carring nitrate and other pollutants passes through specific wetland plants such as reeds, calamus and etc. With the help of microbes their roots can absorb nitrate and convert it into organic matter or harmless nitrogen (Kostel, 2015)(Kadlec & Wallace, 2009).

In this process, the Nitrogen surplus caused by human activities such as animal farming will be absorbed by the wetland ecosystem, and thus the nitrogen cycle will become healthier and reach an balance.



At the same time, the wetland ecosystem will also provide more diverse habitats and food for birds.

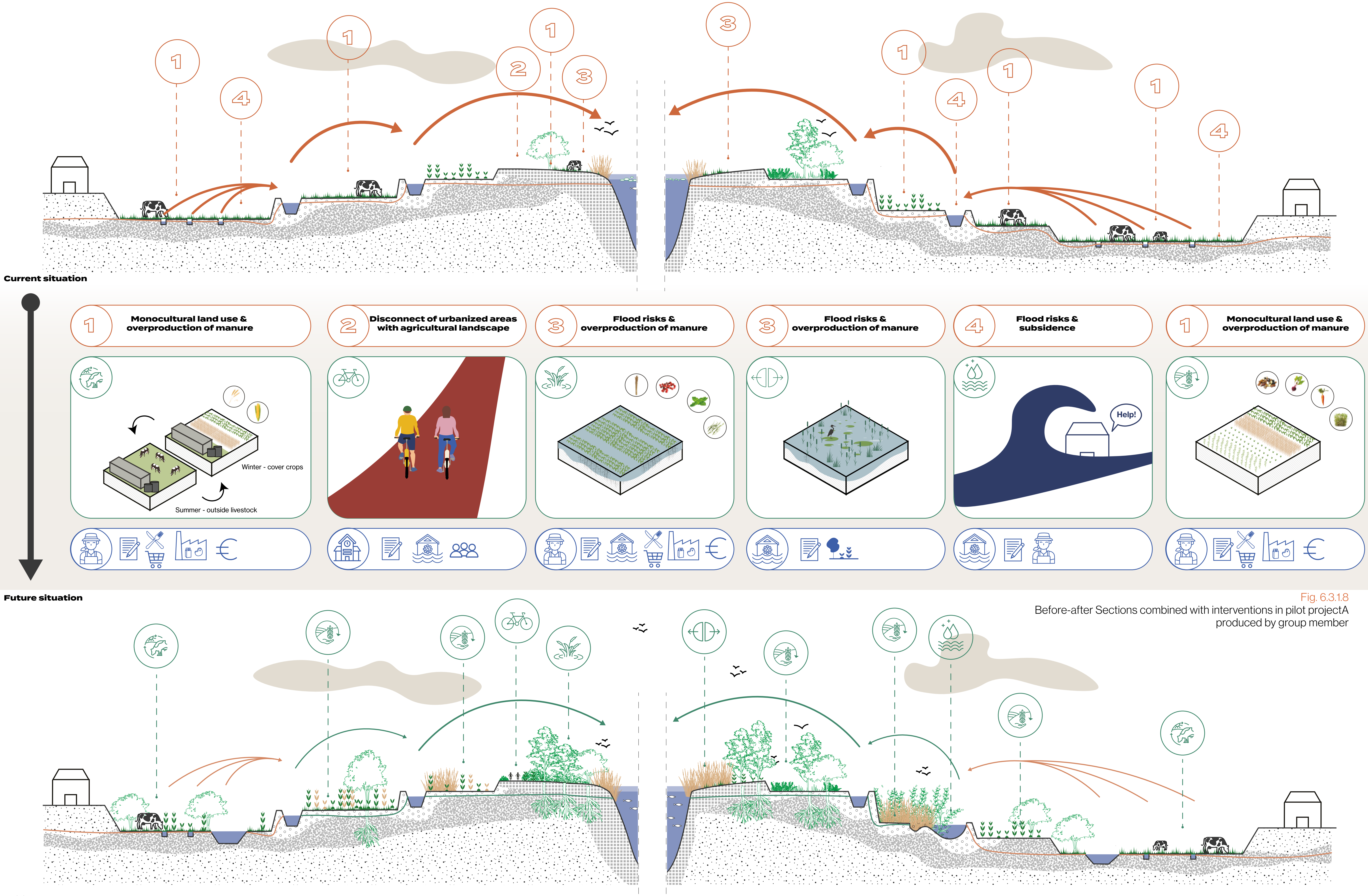


Fig. 6.3.1.8
Before-after Sections combined with interventions in pilot projectA produced by group member

Problems and strategies

There are five main problems with the site, and accordingly, As shown in figure.7.4.1.7， we have strategies that correspond to these problems. Meanwhile, we alsp discussed the stakeholders and policies related to these design strategies.

Problem 1: The problem of monoculture landscape and overproduction of manure.
We can improve this problem by seasonal planting and manure storage. Because through site visit we found out that most of the pasture is unused in winter and cows live in the barn. So maybe some crops like maize and winter wheat can be planted on the grass in winter. Also we should focus on improving the problem of too much monoculture of grass species by enriching the single Ryegrass pasture with plants such as legumes, clover(Cherlinka, 2021). In the caly soil areas along the river, a greater variety of crop species can be grown. New agricultural typologies such as strip farming can also be adopted.

Problem 2: Disconnect of urbanized area with agricultural landscape.
connect the site to the surrounding city through bike paths and integrating recreation with natural wetlands, rivers and other landscapes.

Problem 3: Flood risk
Climate change is making the problem of flooding worse. By making more room for water we can increase the resilience of the environment to facing flooding. This surface water can also be utilised for its agricultural value through water based planting, and surface water environments offer the potential to create artificial wetlands.

Problem 4: Water pollution in the Polder-boezem system
Polder, due to its low elevation, has water level regulation and drainage through sluices, mills and pumping stations (Hooimeijer et al., 2009). And this provides an opportunity: that is, to extract the water before pumping it to natural rivers. In other words, wetlands as filters can be part of the Polder-boezem system.

Problem 5: Soil Subsidence
Soil subsidence is a problem for many peatlands (Deltares et al., 2021). Due to the high water table and wet soil, the variety of vegetation and cereals that can be cultivated in this soil is very limited. However, through water management, more artificial ponds can be created in the polder, which can regulate the water table and increase the resilience of the polder to extreme weather(Kwakernaak & Dauvellier, 2007).

Relevant policies

Fig. 6.3.1.9
Policies emphasized in the pilot project A (own work)

In Lopik's pilot project, most of the policies mentioned in chapter * will be designed, but the most important ones to be emphasised are mainly related to land exchange, i.e. how to exchange farmers' private land for state-owned ecological conservation land. At the same time, 'make more room for water' and the creation of a more multicultural pasture is more dependent on the actions of individual farmers, and it is also important to provide farmers with allowance and increased subsides. With regard to water management, farmers manage their own wastewater in their polder, and a community centre would be more convenient for farmers to learn from each other and communicate with each other, as well as to supervise each other.

6.3.2 LOCATION B

OTTERLO

Fig. 6.3.2.1
Pilot project: Otterlo,
Sattelite Image of Otterlo , Google Earth (2024)

CONDITION

Fig. 6.3.2.2 :
Map of soil types
in the Netherands

In this map we see the soil type of the Otterlo area.

POLLUTION

Fig. 6.3.2.3 :
Map of Nitrogen pollution
concentration in the Netherlands

In this map we see the nitrogen pollution concentrated around the Veluwe.

TYPOLOGY

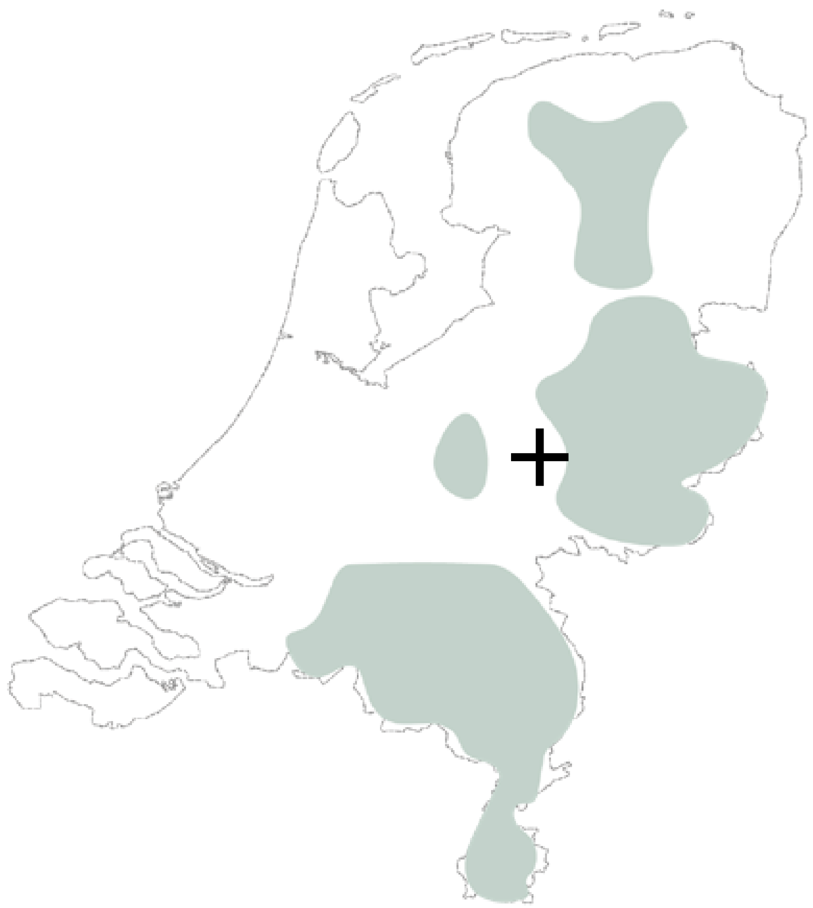


Fig. 6.3.2.4 :
Map of investigated typology

This map indicates the areas that belong in the same typology as Otterlo.

Otterlo is located in the central-eastern part of the Netherlands within the Weluwe region. It belongs in the municipality of Ede and the province of Gelderland. This pilot project explores possibilities, not only for the village of Otterlo but for the wider area it belongs in. This includes the villages Werekom and Harksamp. What is significant in the area is the fact that it borders a zone recognised as Natura2000. In this case we are not dealing with a polder system, but we are looking into an agricultural landscape were water, and subsequently soil pollution, follows the natural morphology.

After completing a SWOT assessment for this pilot project we made the following conclusions:

Strengths

The location of the area in the middle of the Veluwe cultivates the locals' duty of care for the surrounding natural environment and provides a good connection to green corridors. Moreover, the morphology of the land and its sandy soil create an environment where forests can grow.

Weaknesses

The sandy soil of the area limit the agricultural practices as in order to produce sustainably we have to look into specific species that meet tha land requirements. Additionally, constructed wetlands are not recommended in sandy soil. (Otálvaro et al., 2016) For this reason wetlands can not be implemented in the area for natural purification, as demonstrated in the case of Lopik (Pilot Project 1).

Opportunities

The Otterlo area due to its adjacency with the Veluwe nature reserve it acts as an entrance for its visitors. This creates a rising interest in the area and recreational opportunities. It is important to include such areas in our strategy in order to grasp the attention of stakeholders with conflicting interests.

Threats

The increasing interest in recreational development within the area has begun to impact the living and working conditions of local residents. This surge in popularity the regions experiencing poses a threat to the smooth functioning of their daily lives. Simultaneously, the highly concentration of nitrogen surplus in the area is endangering its natural habitats threatening its biodiversity.

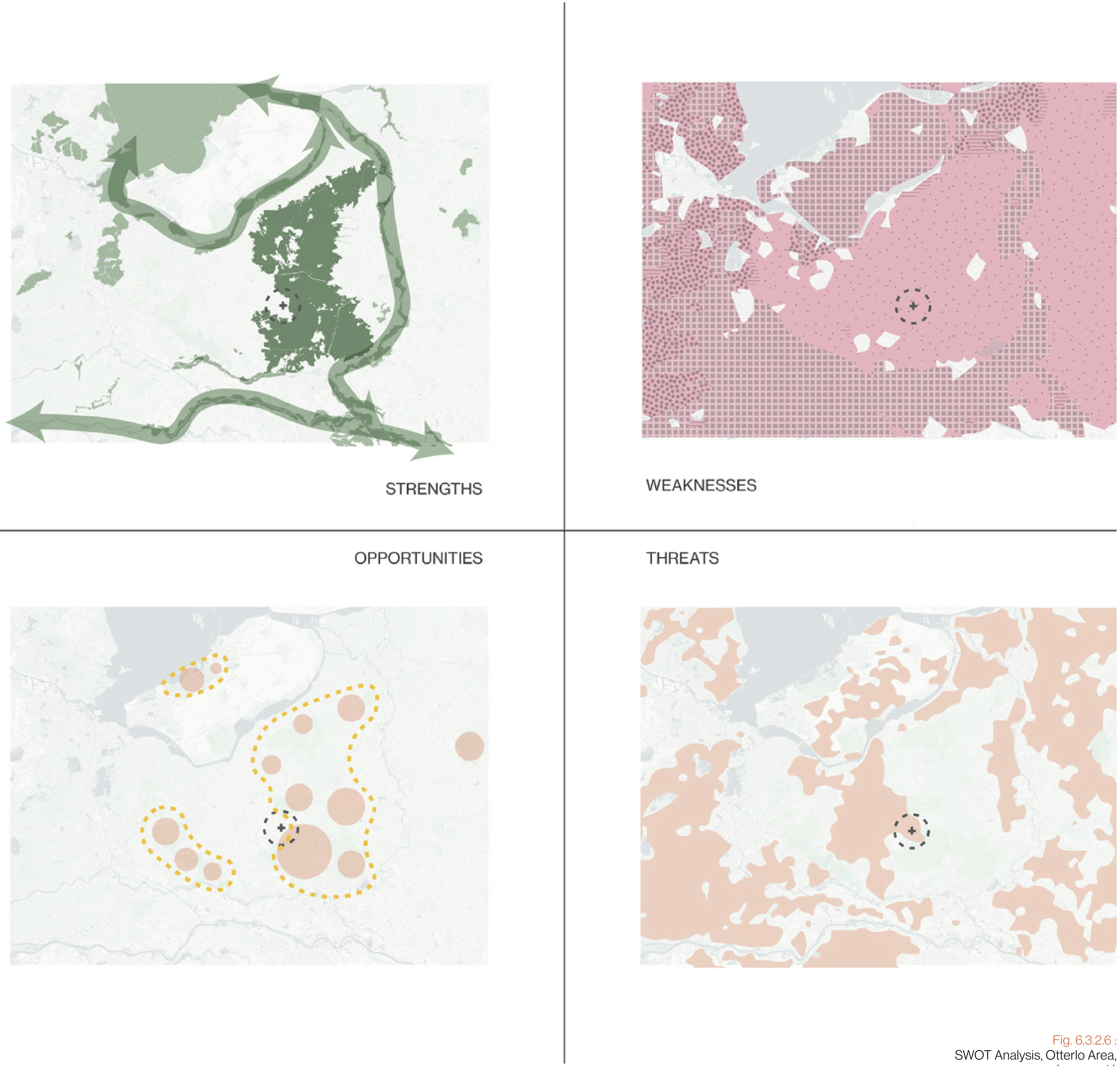


Fig. 6.3.2.6 :
SWOT Analysis, Otterlo Area,
(own work)

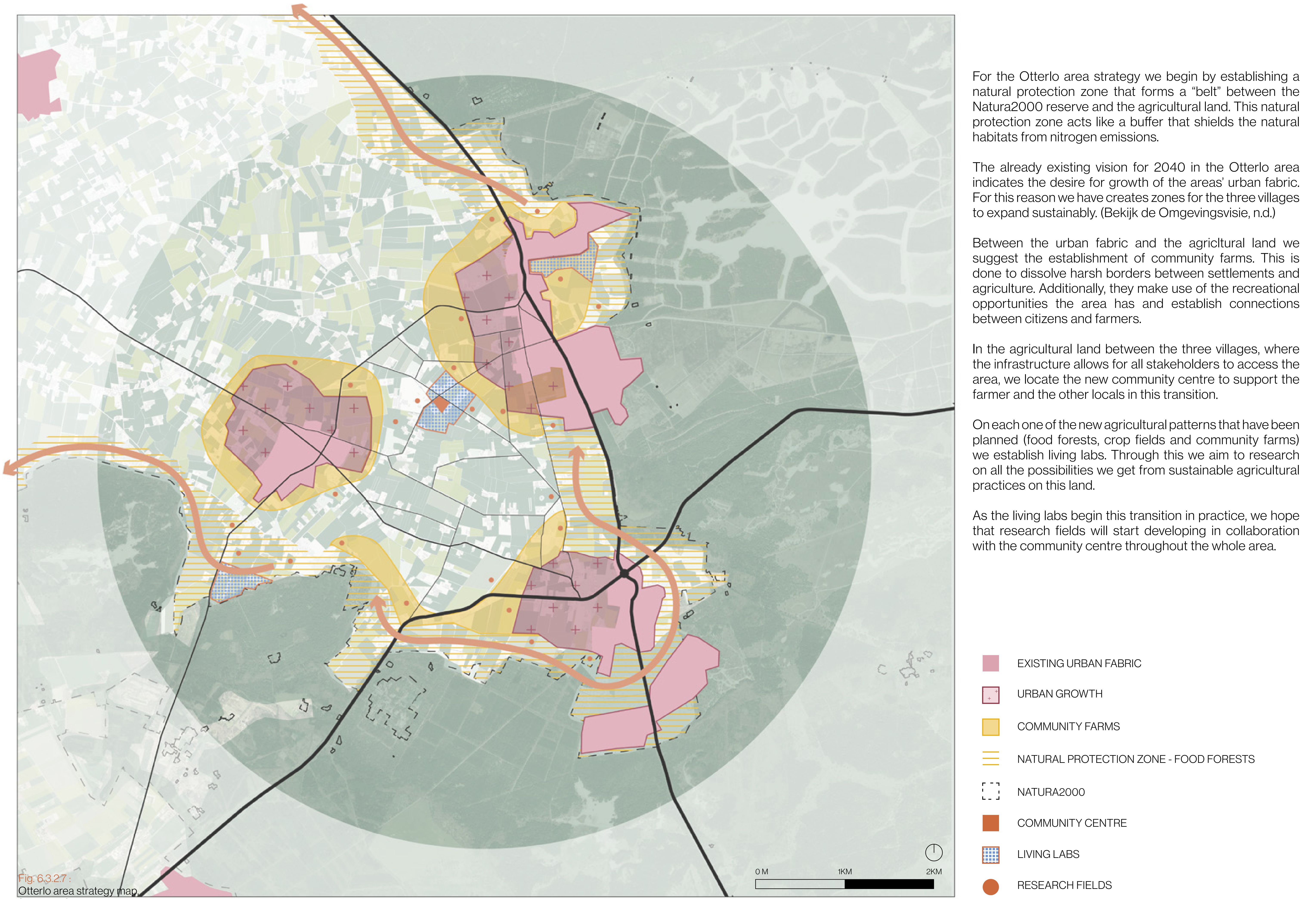


Fig. 6.3.2.7 :
Otterlo area strategy map
(own work)

For the Otterlo area strategy we begin by establishing a natural protection zone that forms a "belt" between the Natura2000 reserve and the agricultural land. This natural protection zone acts like a buffer that shields the natural habitats from nitrogen emissions.

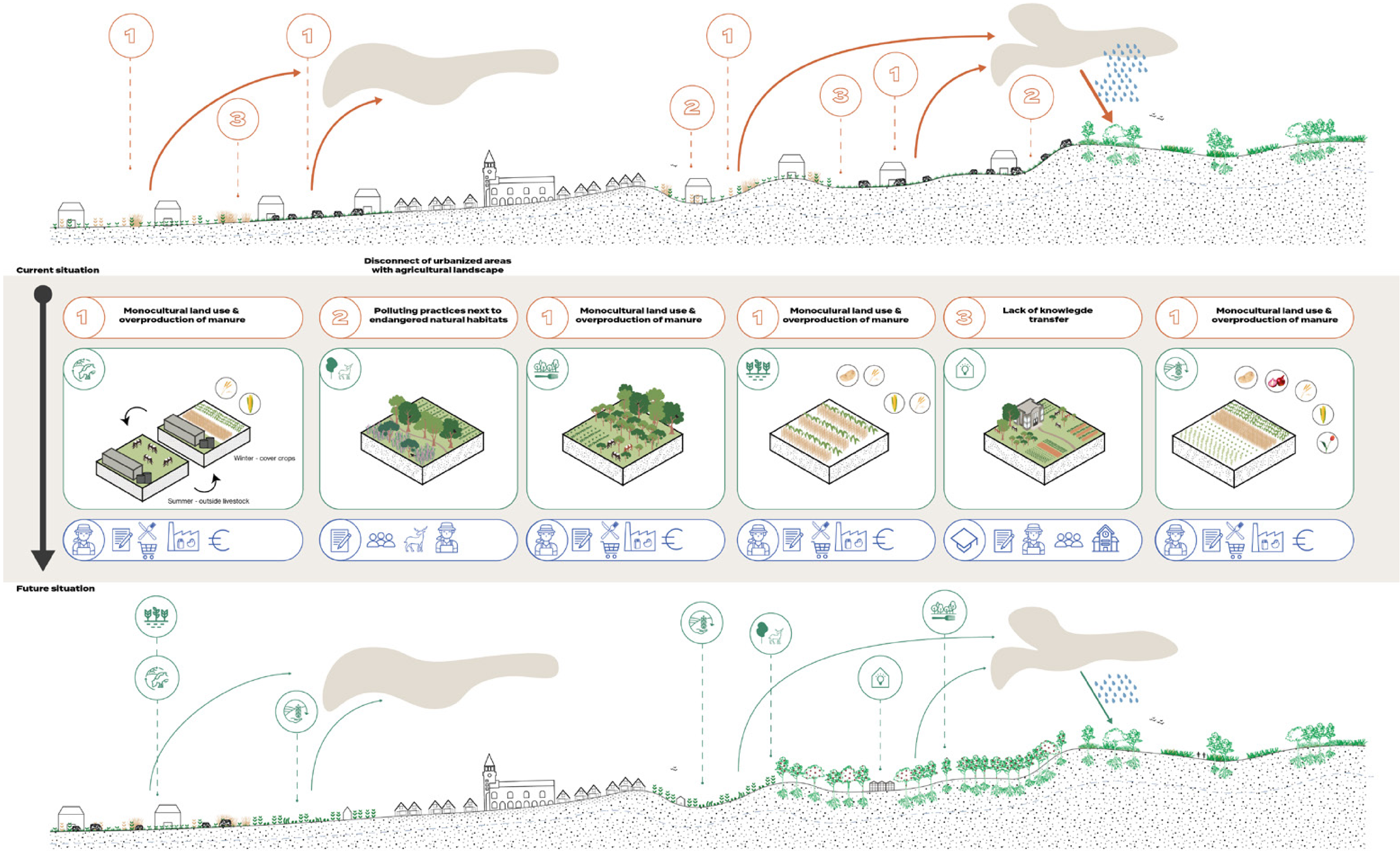
The already existing vision for 2040 in the Otterlo area indicates the desire for growth of the areas' urban fabric. For this reason we have creates zones for the three villages to expand sustainably. (Bekijk de Omgevingsvisie, n.d.)

Between the urban fabric and the agricltural land we suggest the establishment of community farms. This is done to dissolve harsh borders between settlements and agriculture. Additionally, they make use of the recreational opportunities the area has and establish connections between citizens and farmers.

In the agricultural land between the three villages, where the infrastructure allows for all stakeholders to access the area, we locate the new community centre to support the farmer and the other locals in this transition.

On each one of the new agricultural patterns that have been planned (food forests, crop fields and community farms) we establish living labs. Through this we aim to research on all the possibilities we get from sustainable agricultural practices on this land.

As the living labs begin this transition in practice, we hope that research fields will start developing in collaboration with the community centre throughout the whole area.


Current situation
Disconnect of urbanized areas with agricultural landscape
1 Monocultural land use & overproduction of manure
2 Polluting practices next to endangered natural habitats
1 Monocultural land use & overproduction of manure
1 Monoculural land use & overproduction of manure
3 Lack of knowlegde transfer
1 Monocultural land use & overproduction of manure
Winter - cover crops
Summer - outside livestock
Future situation

In these sections we see how our strategy transform the peri-urban landscape of the Otterlo area. In the current situation we demonstrate how in this type of landscape nitrogen surplus affects the nature reserves through deposition.

This strategic project explores the case of mixed farming. The monocultural land-use in crop fields, the overuse of fertiliser and the overproduction of manure in livestock are the main sources of nitrogen pollutants in the area. This project focuses on the reduction of fertiliser application and manure.

The food forests created in the natural protection zone allow farmers to keep producing without the application of fertiliser. Simiultaneously they provide an opportunity to cultivate different species and therefore enahce the biodiversity(de Groot & Veen, 2017) These are supported by the policy on land conversion subsidies. As this conversion demonstrates higher risks regarding regaining profit from the land, we suggest that farmers doing it get a subsidy of longer duration (8 years).

The agricultural land outside of the natural protection zones partake in this transition by shifting their practices to strip cropping and roational crops. This way we can reduce fertiliser application by allowing the land to rest and become fertile again. For those converting their land to sustainable agriculture the duration of the subsidy is shorter (4 years) but enough to support them until they reach their previous yield.

The community farms play a crucial role in creating a more aware and strongly connected community. It is an opportunity for consumers to understand the struggle of the farmer, the origin of their food and their impact on the environment. Bringing the farmer closer to the city develops more opportunities in the local market and strenghtens the farmer's role within the community.

Fig. 6.3.2.9 :
Related policy, (own work)

Fig. 6.3.2.8 :
Otterlo area sections

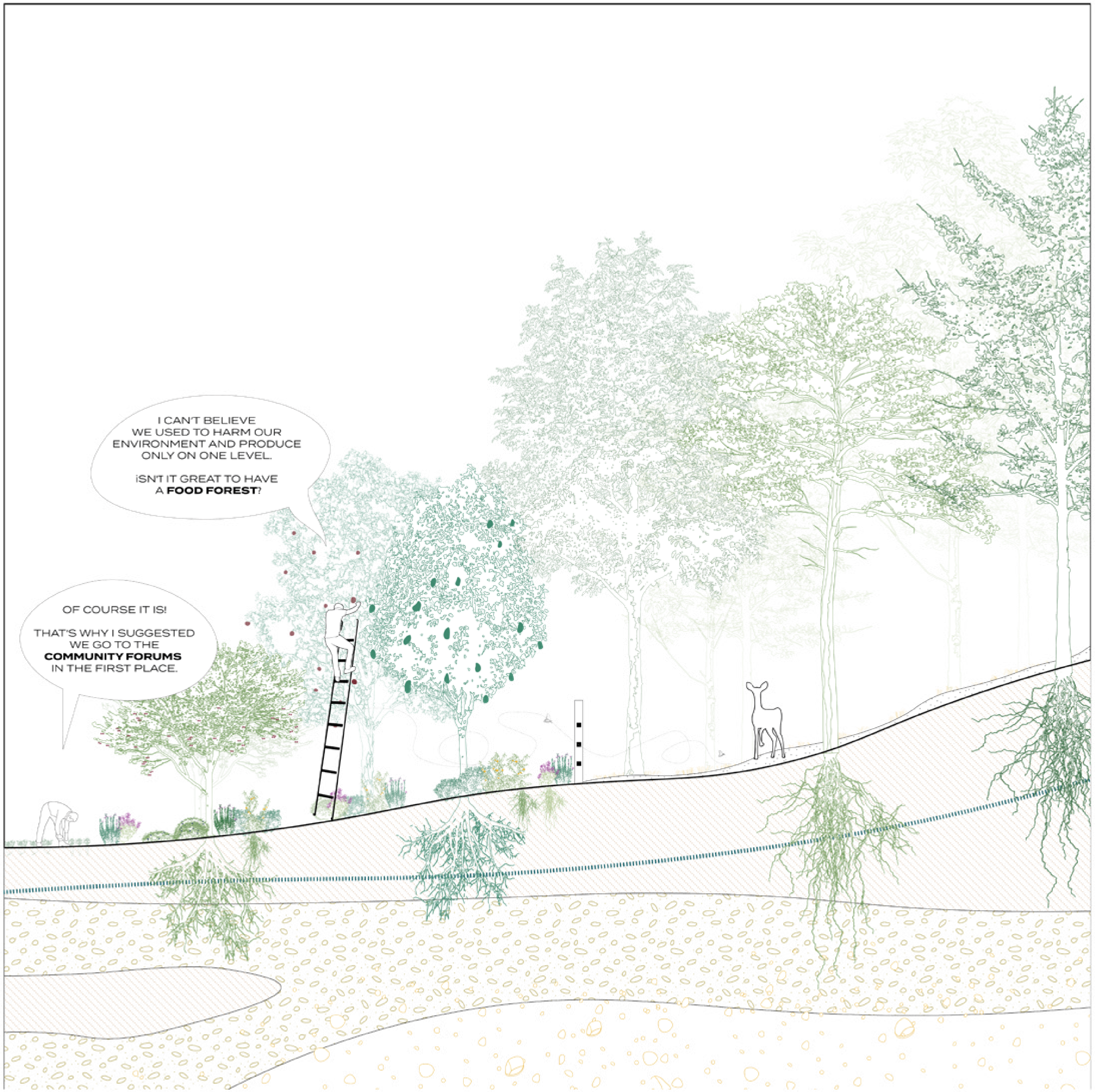


Fig. 6.3.2.10 :
Zoom in section: Food Forest and Natura2000, (own work)

Food Forests

Our strategy focuses on improving relationships not only among individuals but also among the space they interact in. This section translates spatially the enhanced connections between farming activity and biota.

Food forests become a continuation of natural forests and mimic them. Within food forests farmers can cultivate fruit trees, shrubs and plants on different levels. This is explained in detail in fig. x.x. Biodiversity becomes a concern for both natural reserves and farmland as food forests' productivity increases with high biodiversity.

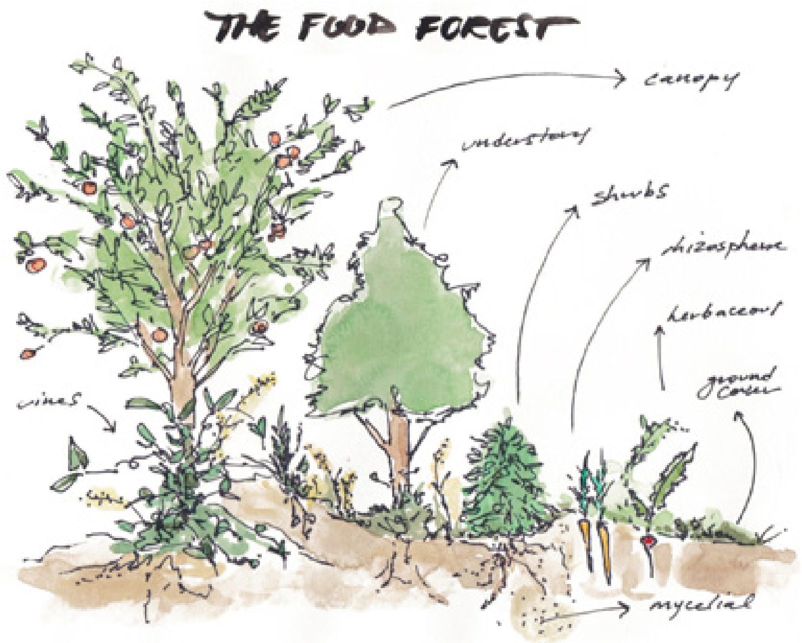


Fig. 6.3.2.11 :
The Food Forest Layers, (What Is a Food Forest?, 2020)

Community Farms

Community farms act as mediatrors between the consumers and the producers. They raise the consumer's awareness and interest and they shorten locally the food supply chain. These sustainable agricultural lands, which integrate with the urban fabric, help stakeholders understand their role in the transition. In this visualisation we encapture how this open dialogue and understanding between city and farmland is enhanced.

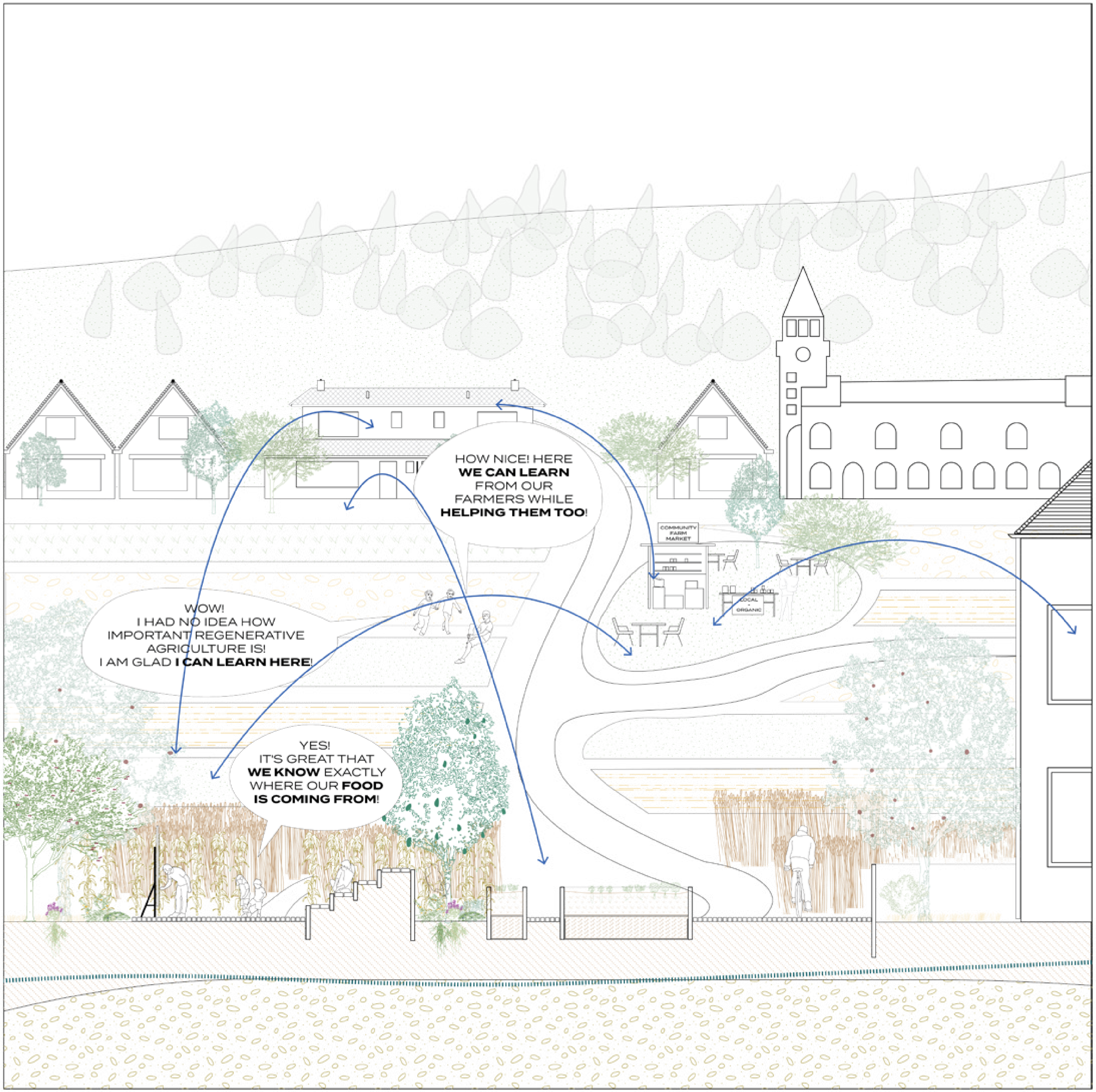


Fig. 6.3.2.12 :
Zoom in section: Community Farms and Urban Activity, (own work)

6.3.3 Location C
Pilot project - Raamsdonksveer

This pilot project is located near Raamsdonksveer between the Bergsche Maas and the Oude Maasje rivers. The area is situated five kilometres away from the Biesbosch Nature Reserve. Due to the sedimentation of clay along the rivers, the area is covered with a thick layer of clay. The main farming typology consists of a mix of livestock and crop farming.

Our proposal aims to reduce the impact of the polluted river on the Natura 2000 area of the Biesbosch. To achieve this, the plan is to transform the agricultural lands along the river upstream of Raamsdonksveer into wetlands that can serve as nitrogen filters for the river. This protection zone could not only function as a filtering mechanism but also as a recreational corridor that connects to the Biesbosch along the river.
Additionally, we aim to flood the area between the Bergsche Maas and the Oude Maasje rivers and make it accessible for wetland farming. A floating living lab is proposed to support farmers in the transformation of their new farming typology.

Currently, the water contaminated by agriculture in the area between the two rivers is discharged into the river through a number of pumps to keep the polder dry. Thus, by transitioning to a less polluting form of wetland farming in this area, the river can be directly relieved of pollution.

Map - current situation

Fig 6.3.3.1 Raamdonksveer location diagram

Current typology

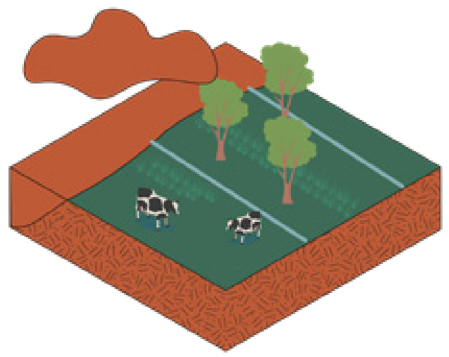


Fig 6.3.3.2 agricultural typology clay

Map - new situation

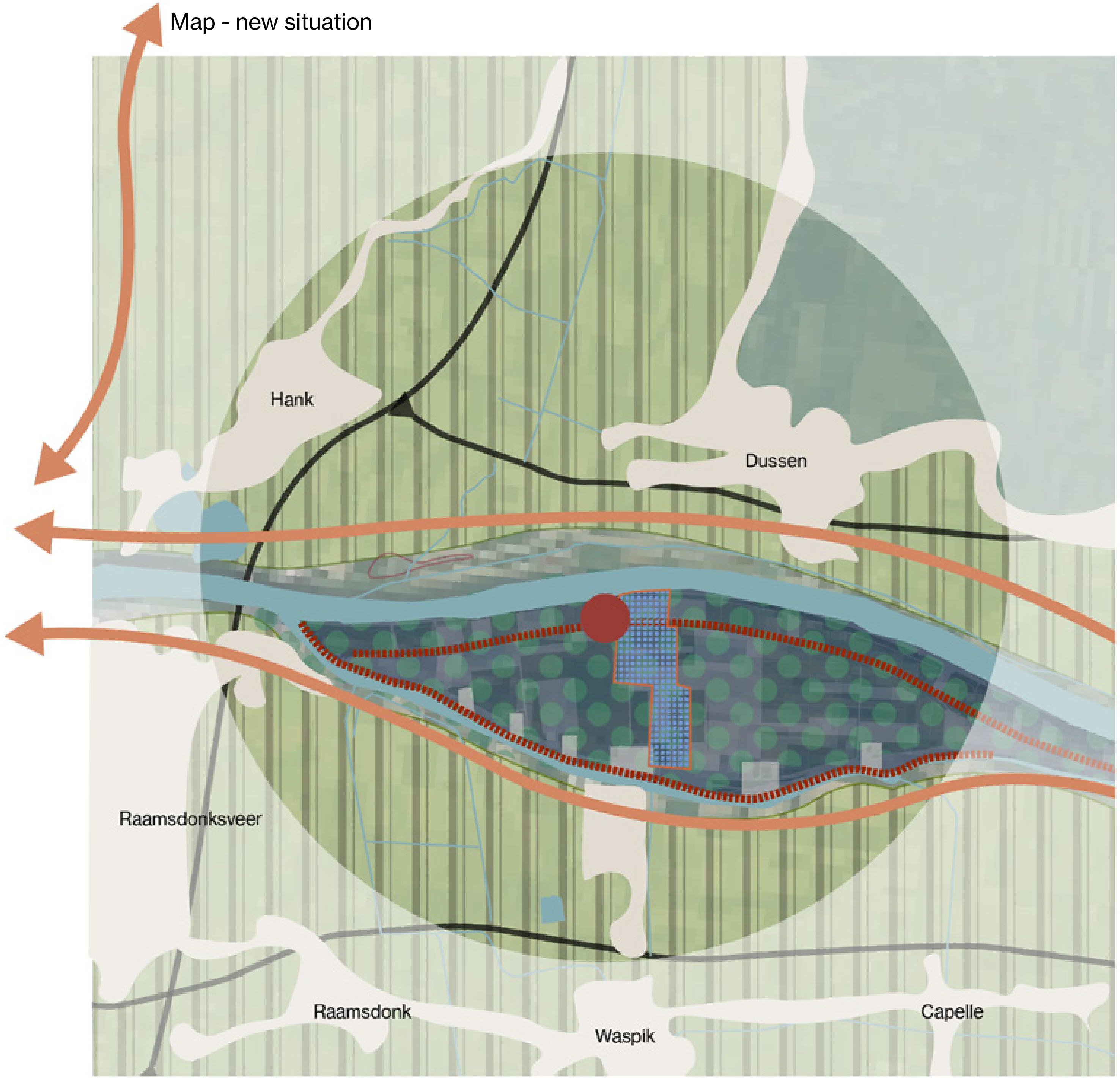


Fig. 6.3.3.4 Raamdonksveer intervention map, (own work)

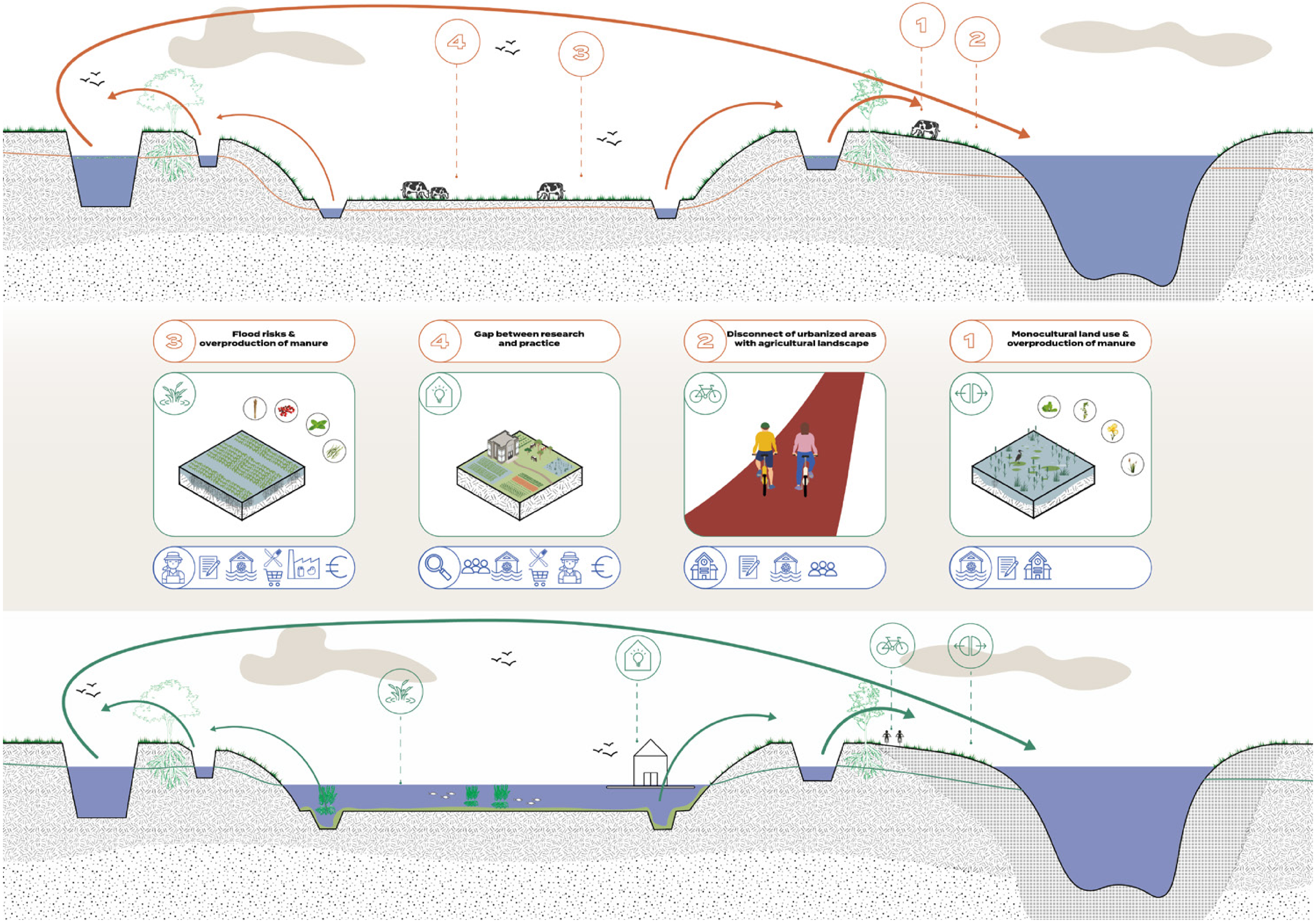


Fig. 6.3.3.5 Raamdonksveer section, (own work)

6.3.4 Location D
Pilot project - Valkenswaard

This pilot project is situated south of Valkenswaard, a town near Eindhoven. The majority of the soil type is sandy and there are large areas of forest. The Natura 2000 area in this location is a heathlandscape, typically found on sandy soils. There is no main agricultural typology, but it is mainly a mix between crop and livestock farming. Agriculture and natural areas are very close to each other in this location which is creating a threat for the forest and heather landscape.

To address this, we propose changes to the agricultural landscape, while ensuring protection for all natural areas. Agricultural patches within natural areas will be converted into nature reserves, while areas surrounding them will become forest protection zones or food forests. Additionally, a living lab with a community center will be established in one of these transformation areas, close to both nature and the town of Valkenswaard, to increase awareness. Monocultural agriculture will transition to practices like stripcropping, intercropping, or seasonal rotation.

Map - current situation

Fig. 6.3.4.1 Valkenswaard location diagram

Current typology

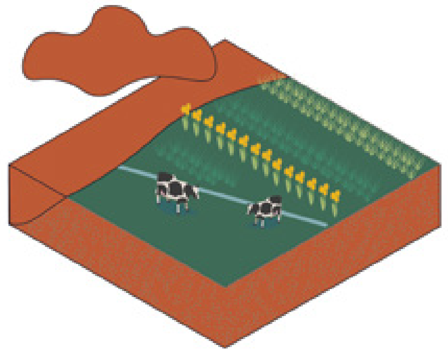


Fig. 6.3.4.2 Agricultural typology sand

Map - new situation

Fig 6.3.4.3 Valkenswaard intervention map, (own work)

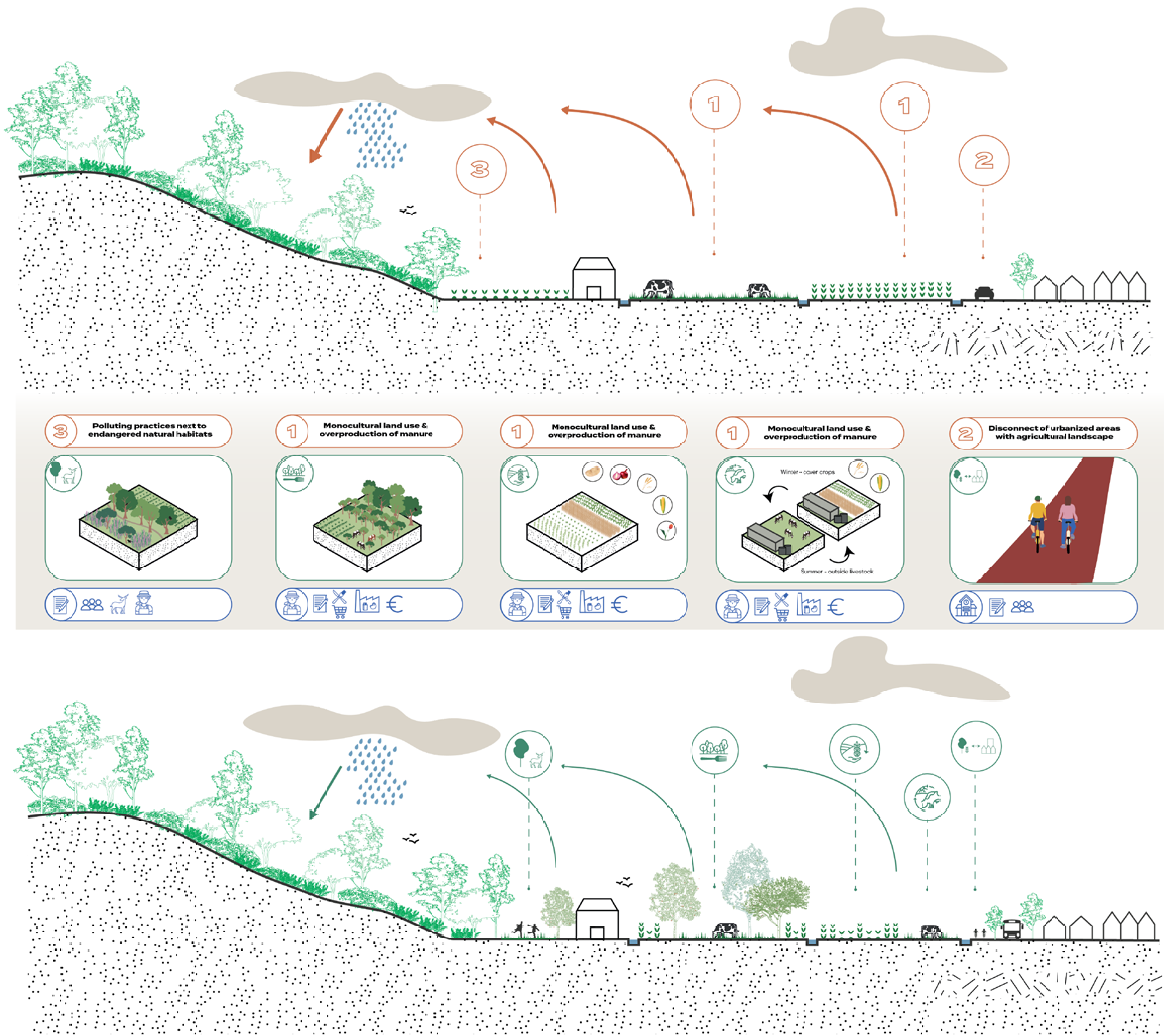


Fig 6.3.4.4 Valkenswaard section,
(own work)

6.3.5 Location E
Pilot project - Groningen

This pilot project is situated along the Onlandsche Wijk, a Natura 2000 wetland area located just outside Groningen. Adjacent to this area, large-scale livestock farming is conducted on a mixture of peat and clay soils. To increase the distance between the protected natural area and the polluting livestock farming, our plan is to transform the peatlands adjacent to the natural area into wetlands. This would serve as an initial protection zone for the protected natural area. Surrounding this, we propose to establish a second protection zone where less polluting agricultural practices are conducted. In this area, we suggest transitioning from intensive livestock farming to a less polluting typology of strip cropping. The limited soil contamination created here could be buffered by the expanded wetlands before reaching the Natura 2000 area. At a distance of 1.5 kilometres from the natural area, livestock farming could continue in a less intensive manner. Here, a seasonal cow and crop rotation could also be implemented. The living lab should be positioned on the edge of the second protection zone so that both farmers within and outside this area can benefit from the knowledge.

Map - current situation

Fig 6.3.5.1 Groningen location diagram

Current typology

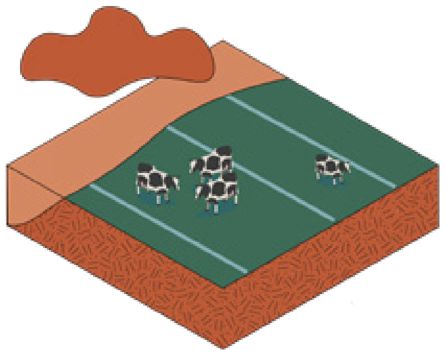


Fig 6.3.5.2 Agricultural typology sand

Map - new situation

Fig 6.3.5.3 Groningen intervention map, (own work)

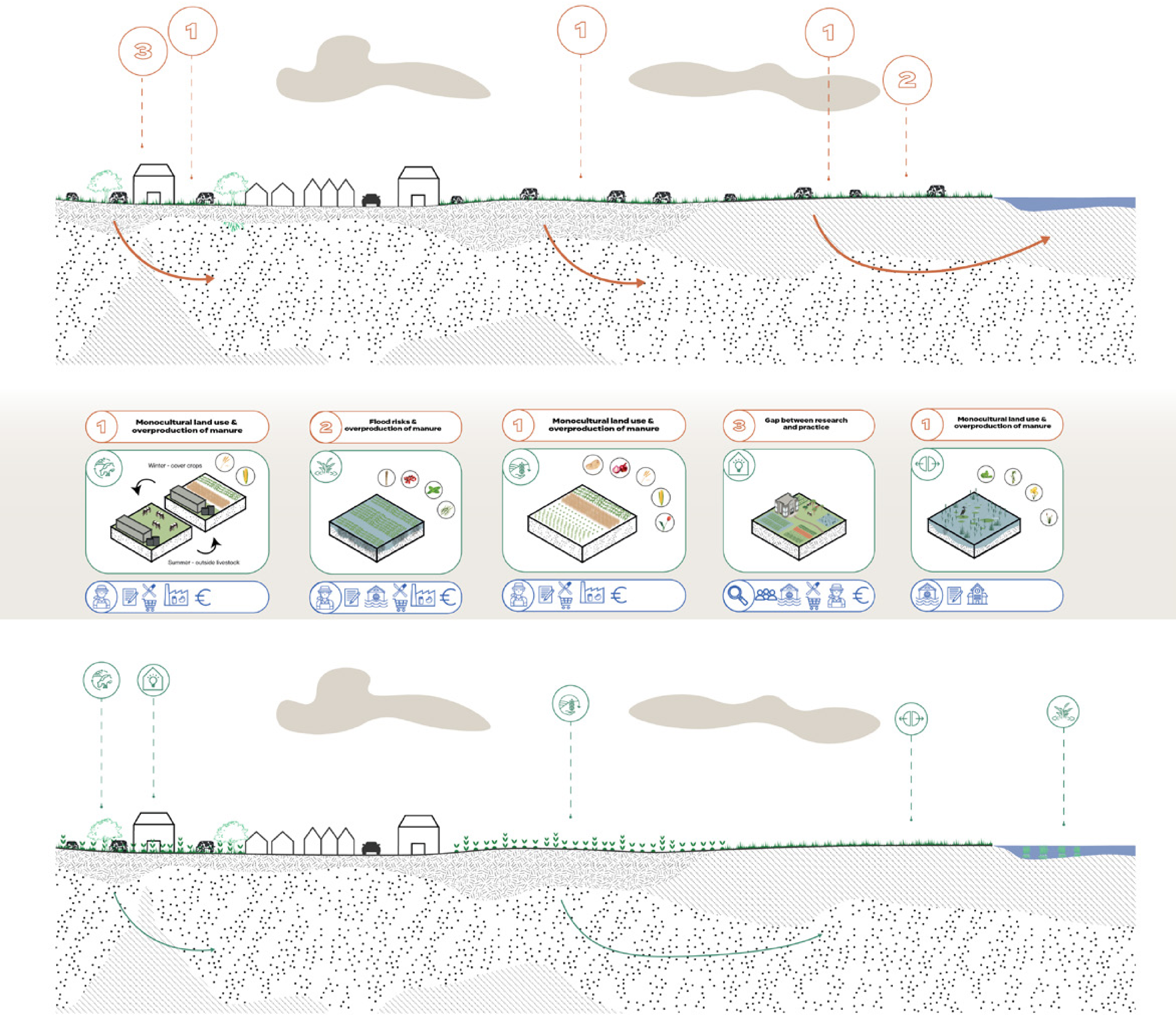


Fig 6.3.5.4 Groningen section,
(own work)

Chapter 7 Conclusion

7.1 Summarising our findings in a conclusion

The analysis has indicated a pressing need for perspective among farmers. Some farmers are even being driven into illegality due to strict regulations on their nitrogen emissions, yet they are not receiving the necessary assistance to transition their farms to more sustainable practices. Other farmers require a long-term perspective and clear tools to transform their land. In this regard, farmers require both technical and financial support. Additionally, farmers emphasise the importance of uniform regulations for farmers across the entirety of the Netherlands.

The root causes of high nitrogen pollution are primarily attributed to NH4 emissions resulting from intensive livestock farming and NO3 emissions stemming from over-fertilization, leading to adverse effects such as soil degradation, acid rain, biodiversity loss, and eutrophication. Moreover, high emissions pose risks to human health, including cardiovascular diseases and respiratory infections.

NH4 emissions are particularly high in areas with intensive livestock farming in North Brabant, Gelderland, and Friesland, while NO3 pollution is higher in the eastern part of the country. These burdens are exacerbated by emissions from abroad entering the country through air and waterways.

The vision explores the potential of protection zones and new farming typologies across the diverse Dutch agricultural landscapes, the typologies are based on the already existing structure. Protection zones could take physical form through the establishment of forests and wetlands, which could simultaneously serve as filters for nitrogen emissions transported via water.

These new agricultural typologies describe changes in agricultural practices aimed at increasing resilience against soil degradation and reducing nitrogen emissions. However, the adoption of these circular agricultural forms may lead to a reduction in overall agricultural production. Nevertheless, our vision asserts that such measures are necessary to strike a balance between food production and the protection of natural habitats.

To implement these new agricultural practices, we propose a network of living labs and community centres where farmers can collaborate with experts from the technological and scientific fields to develop local and sustainable agricultural solutions.

In the strategy, this vision is elaborated through a pilot strip consisting of five pilot locations that can serve as examples for the various soil types and agricultural typologies found in the Netherlands. These locations will detail how different solutions can be spatially implemented in a local context.

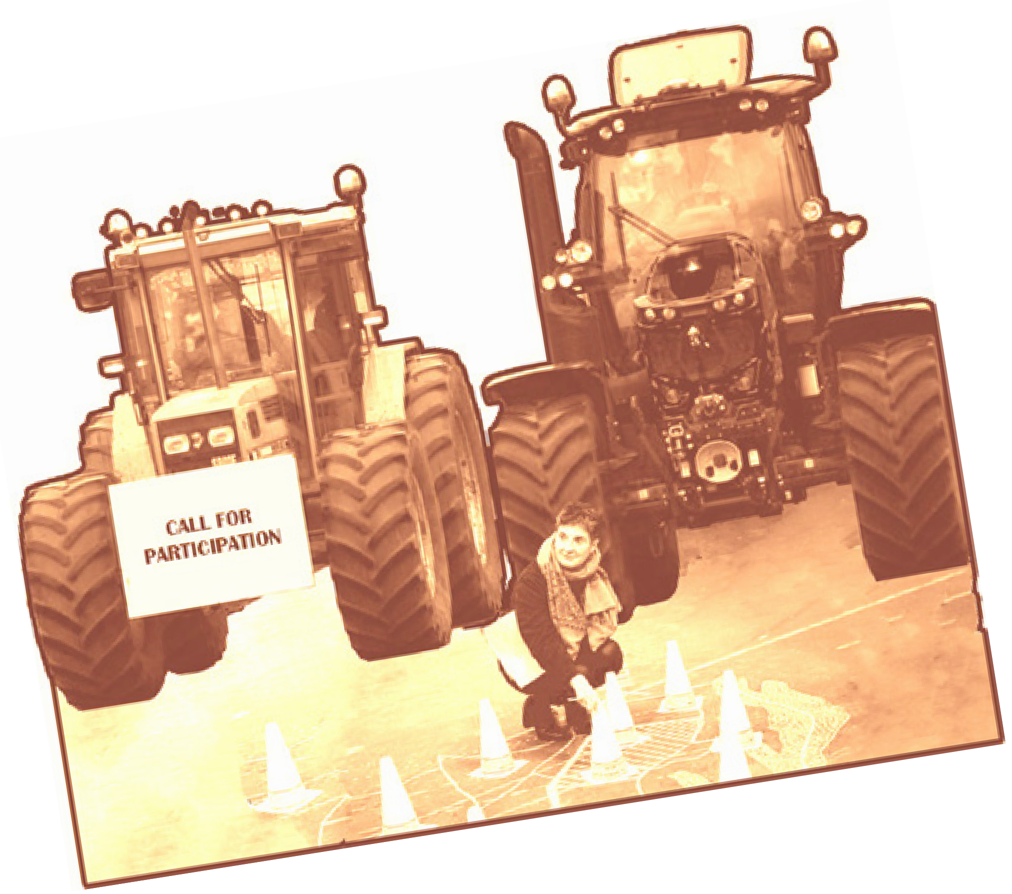
In Lopik, this strategy is characterised by the polder landscape, where more space is allocated to water by placing wetlands along the river. In Otterlo, the focus is on spatially segregating polluting livestock farming from protected natural areas and involving the city in food production through communal gardens and food forests. In Valkenswaard, wetland planting within a polder system along a river can be implemented to relieve pressure on the Biesbosch.

Besides, forest protection is proposed in Valkenswaard to safeguard natural areas, while in Groningen, efforts are directed towards exploring how the transition between peat and clay soil can accommodate new forms of circular agriculture in combination with wetlands in stagnant water. The plan is to realise this pilot strip until 2035 and expand the strategy from there to the rest of the Netherlands.

The following paragraph will explain our conclusion in order to answer the main question of this report, namely:

"What systemic changes in the agricultural practice can contribute to decrease the imbalance in the nitrogen cycle in the Eurodelta region?"

In answer to this question we conclude that in order to prevent harm to human health and the environment, it is imperative to reconcile the interests of farmers and the environment. This requires a systemic approach involving equitable regulations that govern permissible emissions for farmers nationwide while allowing farmers to autonomously shape emission reduction initiatives locally. This approach should be facilitated through living labs and community centres to achieve a more circular agricultural practice and balanced nitrogen cycle within the Eurodelta region. In this approach, we consider participation and collaboration between farmers and other stakeholders as a crucial tool in providing successful and long-term solutions regarding the nitrogen crisis. Moreover, it is essential to allocate more space for nature reserves to facilitate their regeneration.



7.2 Discussion

Scientific Reference:

The analysis of this report provides a comprehensive answer to the questions of how and where the causes of nitrogen pollution in the Netherlands are found. Many of our sources did not distinguish between the emissions of NH4 and NO3. Fortunately, in our analysis maps, we were able to find the data on the types of pollution on individual locations. It shows that NH4 is predominantly found in locations with intensive livestock farming, while NO3 pollution is high in areas with intensive crop cultivation. Therefore, within these different agricultural forms, we focused on limiting the most common form of emissions. This does not preclude the fact that other nitrogen compounds may also be emitted in limited forms in the varying agricultural practices.

The report aims to address the perspective of the farmer. The strategies and policies proposed are intended to facilitate the transition to circular agriculture for farmers. We realize that this also has a significant impact on the industry behind individual farmers. Nitrogen is also produced within this agricultural industry, which is excluded from the scope of this project.

Additionally, nitrogen emissions are a larger problem than just within the agricultural sector, and therefore, further research is needed into other forms of nitrogen emissions in the mobility, housing, and industry sectors.

In addition to nitrogen emissions, this project also considers the context of a landscape threatened by flooding. We believe it is important for projects that look far into the future to also consider such factors. Hence, in threatened areas, we not only looked at reducing nitrogen emissions but also at how this can be combined with projects that allow more space for water within the landscape. The new agricultural typologies emerging from our vision and strategy are primarily intended to provide an indication for the possibilities of changing farming practices per soil type. The ultimate implementation depends on many local factors and should be thoroughly tested in the living labs before being widely adopted. In terms of objectives, the analysis of this research is primarily intended to inform the reader about the various causes of nitrogen emissions within the agricultural sector. The vision and strategy aim to illustrate how contemporary problems could be addressed spatially.

Social Reference:

During this research, we noticed that there is still a lot of unawareness about the causes of nitrogen emissions. Even for farmers, it is not always clear how and where they could limit their emissions. In this report, we have attempted to communicate these causes clearly and make them understandable from the perspective of the farmer. We believe it is of great social importance that all stakeholders are better informed about the functioning of the nitrogen cycle and its consequences for different ecosystems.

Many farmers feel it is unfair that they are primarily targeted in the nitrogen issue. Our research mainly shows that the entire agricultural sector will need to adapt to nitrogen goals since they are responsible for the majority of emissions. However, this does not mean that specific industries with excessive nitrogen emissions outside the agricultural sector should not also be included in the transition.

Furthermore, we observe that different calculation methods are used within the EU to determine nitrogen deposition. This creates an uneven playing field for farmers and, at the same time, undermines trust in institutions. Many farmers feel that the calculation methods they must adhere to are not reliable.

Among farmers, there is considerable resistance to plans to address nitrogen emissions. Given the political history and poor communication between practice and regulation, this resistance is understandable. Nevertheless, we assume that many farmers are willing to embrace this transition as they seek to provide their farms with a sustainable future. We hope that with the support of researchers and technological developments, these farmers will succeed in setting a trend towards sustainable developments within the agricultural sector.

7.3 Evaluation

In this chapter, the vision and aligned strategy are being assessed on the Sustainable Development Goals (SDGs) of the United Nations (2016). These are goals meant to showcase the guiding principles of sustainable decision-making. Within our strategy, we want to reduce nitrogen pollution in soil and water, which is causing major issues to human health and nature. We aim to create a more sustainable and just way of agriculture in the Netherlands.

Within the strategy, we mainly address the following SDGs in our approach:

3 & 6 - Good health and well-being & clean water and sanitation

Nitrogen pollution by agricultural practices is causing contamination of water bodies. Currently in the Netherlands, the most significant effects are visible in nature areas. However, an excess of nitrogen seeps into groundwater, which we extract as drinking water contamination. Moreover, nitrogen pollution has adverse effects on human health. Not only through foul water but also through air pollution. By structurally tackling the causes of nitrogen pollution, we think that our strategy could decrease nitrogen-related health risks in the long term by adapting to more circular forms of agricultural practices.

12 - Responsible consumption and production

With our approach, we aim to produce more sustainably to reduce the nitrogen excess from agriculture. However, to accomplish this, production patterns need to change. For instance, we question the large amounts of production directed towards exports when we could produce more locally. Furthermore, changing production patterns required adjusting our consumption patterns to align with these new agricultural practices.

14 & 15 - Life below water & life on land

As mentioned in the explanation of SDG 3 and 6, nitrogen is polluting our water bodies, soil and groundwater. This pollution impacts the life below water via eutrophication, where huge algae blooms deprive the water of oxygen needed by other species. For life on land, the main issue is the loss of biodiversity. Fast-growing plants will thrive on the excess of nitrogen in the soil, leaving no room for other plants to grow, thus damaging the environment. With our strategy, we aim to mitigate these issues by tackling the emissions at the cause, before leaking into the water bodies. Besides, wetlands are installed along river bodies in order to filter the polluted water from the upstream.

16 - Peace, justice and strong institutions

Our strategy proposes a more systemic approach to creating new agricultural practices. However, it cannot succeed without considering every stakeholder, especially having the farmers on board. Currently, farmers are protesting as they do not feel heard. Therefore, our strategy places a significant focus on establishing a just transition to new practices and engaging farmers and other stakeholders (municipalities, researchers, the community, etc.). Without considering this SDG, our strategy would lack the systemic approach we are trying to achieve.

Fig 7.3 SDGs,
source: United Nations (n.d.). Retrieved from https://sdgs.un.org/goals"

7.4 Ethical reflection

This reflections eleborates on our thoughts on our project regarding ethical objections and remarks

For this project, it is important to look back and reflect on its ethical dimensions. We propose a set of implementations that need contributions from a lot of stakeholders. These include for instance farmers, the government, the EU and the Dutch and European citizens. Moreover, we need to pay for this transition, which we have not discussed thoroughly in our strategy. As we are delving into urbanism and not policy making, it is difficult to make a decision about this. However, within our policies, we propose funding and subsidies from the government. This money would then come from taxes, thus the Dutch citizen. We would argue that this is fair, as agriculture is about food production, and in the end, everybody needs food. Certainly, this should be done via inclusive decision-making in a democratic way. Still, we hope that via our awareness programmes, citizens will understand the struggle better and be willing to help our farmers.

Furthermore, in our project it is crucial that farmers cooperate. Every farmer has a different background, and although we assume that farmers want to transition, in reality this will not be that easy. What is evident is that we do not want to force them anymore with high investments for short-term solutions like policies are currently doing. We want it to be their decision to make the transition, which.is why we created this pathway with education and policies that reward the farmer, instead of 'punishing' them. The most important thing in the first phase is to make them aware of the urgency and possibilities, so that they actually want to change themselves.

However, to realise our project we need farmers to cooperate. When it comes to buying out farms when necessary, it needs to happen. Of course, farmers will get a fair price and it will go with good consultation.

In addition, in our vision we discuss the way of changing the economy of the Netherlands from food-export-based to knowledge-based. We propose producing more locally and providing knowledge globally on agriculture so other nations can produce more themselves and hopefully boost their own economy. Nevertheless, this would mean the food currently exported from the Netherlands will not be imported in other countries in the quantities it is now exported, meaning they might not have enough food.

Although we propose providing knowledge to these countries,it might be the case that not all countries can produce the diet that they desire. Therefore, it is indeed hard to completely go local and it would take a lot of time to transition the Dutch economy as well. We acknowledge these difficulties and that currently export is needed. Yet, we made an attempt at a first step towards a more sustainable local foodscape, which could inspire other countries.

Furthermore, in our proposal, we use the farmer as the starting point of the interventions. However, this could be seen as unfair, since we did not have the time to explore the research from the viewpoint of other stakeholders involved. In this discussion, it is also important to consider the natural areas and animals as stakeholders.

Also, in our research, we were confronted with certain issues that can be considered part of economics, sociology or political sciences. Since we are urban designers, we might not always have been able to interpret data about elections or socioeconomic factors in the most correct manner. We lack knowledge of these kinds of difficult social aspects.

7.5 Individual Reflections

Reflection Esmee de Quant

Starting this project I was excited to work on a bigger scale of urbanism. Just as in the previous two quarters, I have gained a lot of new knowledge and skills. In our project we focus on creating a sustainable agricultural landscape for the Netherlands, for which I have been excited from the beginning of the course. Since I previously studied in Wageningen I have been familiar with agricultural practices and management. However, my study focused a lot on developing countries whereas this course focused on the Euro-Delta and the Netherlands. Although I have made use of my previous knowledge, I quickly discovered the difficulty of planning in the Netherlands, especially on a large scale. Within regional design, involving stakeholders is crucial. With the many institutions in the Netherlands, it feels like it would never be perfect.

Certainly, perfection is not the aim. This became extra clear in the methodology course. Where I thought I knew quite something about governance from my bachelor, I discovered I only knew a small part. Following the lectures and reading the booklets made me very aware of societal issues within the world. Although it could be a bit overwhelming at times, I learned a lot from it and it has pushed me to form opinions on certain matters. I will certainly implement this knowledge into my next project.

Furthermore, I expanded my skillset through the SDS lectures. Conducting an analysis and creating a vision and strategy is not something urbanists just easily do. Within our project we used quite some of the tools that were provided, such as the schematic sections and scenario building. Although some might not be as evident in the project, they certainly helped me understand the project better. However, personally I could still improve on my GIS skills. As the workshops went very quick and we had numerous other tasks to finish, I did not improve in GIS the way I had hoped to.

Finally, looking back on the group work I think it went quite well. We all needed to get used to each other a bit in the beginning, resulting in a slow starting process where nobody took a leading role. However, I think in the end this was perfectly fine and I have been happy with our group work. Not only did I learn a lot on the topic of regional design, but I have also gained a lot of knowledge and new skills through my teammates which I might not have obtained otherwise.

Esmee

Reflection Ziyun Zhou

When I initially approached this QUARTER project, I expected it to be a task that would focus on design and research at a regional scale. However, we chose to take a broader view and explore agricultural types, soil composition, and even water systems throughout the Netherlands. This shift was an excellent learning process as it gave me a more comprehensive understanding of the land. I understand that in a Master's programme there is usually a greater focus on in-depth research and perspectives. During this learning process, I felt somewhat overwhelmed. I must admit that some of my analyses and perspectives fell short of expectations. Maybe this is because as an international student, I need more time to understand the landscape, topography and some basic knowledge of this country. But I am glad that through this QUARTER, I am finally equipped with this knowledge.

Also, it was a great teamwork experience. We had many fruitful discussions as a group and everyone was able to express themselves equally. I have never been very good at presenting, but our group had many rehearsals before the presentation, and my fellow students gave me a lot of feedback. These helped me a lot and made me realise the importance of tone, logic and positive priorities in reporting.

In addition, this project made me think more about the issues between agriculture and pollution. I also realised that there is a disconnect in the relationship between farmers and the city, especially when we discussed pollution flows. I became more aware of the fact that pollution comes from everyone, but ultimately affects the ocean. This is a sad fact, but one that does require attention and effort from each of us. At the same time, solving this problem requires even more cooperation across urban, rural and national borders, and I think this is the part of our project that lacks analysis and design thinking. Because in the analysis of policies, we focus more on discussing how to make the farmers accept the policies better, while in the transnational co-operation, we still need to discuss more, for example, how to solve the problem of pollution brought by the upstream countries, and whether it is just for the downstream countries to solve the pollution brought by the upstream countries, and so on.

Ziyun

Reflection Mary Sutherland

Given the global society's current concern regarding the Nitrogen crisis and the critical role of the EU in navigating sustainability transitions while addressing the farmers' interests, our group approached this project eagerly. It was evident to us that to address this issue we needed to gain a deeper understanding of the problem and the complex system it belongs in. In doing so we came to the realisation that within the scope of this course we would not be able to provide solutions that could resolve the issue entirely. Therefore, the project focused on transitions in agricultural practices and the primal production of food. To ensure that all loops were closed, we investigated the effects of these transitions on the entire system and reflected upon them.

Our research indicated the existence of strong incentives and action implementations regarding the sustainability transition. For this reason, our main argument in the report relates to nature preservation being a method to ensure our society's safety and consequently its development. Therefore safeguarding our natural environment became one of our project's focal points.

The vision we created for a nitrogen surplus-free future in the Netherlands serves as a communication tool for the issues we believe require attention and investigation within our community, as well as the goals set by this project. It illustrates the spatial interconnectedness of the issue we want to address and aims to connect human dimensions to it. This decision was crucial for us to underscore the importance of the issue for all stakeholders involved.

In our strategy, we elaborate in depth on how site-specific the goals we set for this project are. We emphasise the important role of research and education for the strategy to develop efficiently. Moreover, we try to suggest multiple actions and policies to provide our key stakeholders, the farmers, to tailor this transition to their capabilities and to restore trust in their relationship with other stakeholders. It is important to recognise that in phasing our project we rely on the "pilot strip" to achieve a favourable outcome. However, as a group, we collectively positioned ourselves on this and we agreed that to create a more just and inclusive procedure in this transition we needed to limit the restrictions.

Formulating this project as a group allowed us to form arguments from different perspectives and influenced our decision to suggest a vision and strategy that focused on a systemic and cooperative approach.
While there is existing research on nitrogen pollution mitigation, it often lacks relevance to the entire system. This insufficient grasp of the complex system between the food supply chain and Nitrogen by a larger audience signified the importance of our project to elaborate directly and clearly on the issue and our implementations. Simultaneously, working in groups highlighted the significance of our project but also underscored the importance of cooperation in decision-making processes.

Mary

Reflection Luc Waalders

For me, this project has been a very positive experience. From the beginning, the group work proceeded smoothly and harmoniously. I felt very comfortable and valued within the group dynamics. It struck me that discussions and communication consumed the majority of our time. I was not entirely prepared for this. However, it was reassuring that our entire group was almost always present when working on this course. At the beginning of the project, I often felt that during tutor sessions, we were primarily reiterating our own discussions. However, over time, I came to realise that these discussions, along with constant intensive communication, facilitate the rapid and coherent production of visualisations when we work on them collectively.

Furthermore, through extensive research and mutual discussions, I truly feel that our project is grounded in a strong scientific foundation. Regarding the content of the discussions, I am very grateful for the group with whom I had the opportunity to work on this project. I feel that we were fairly aligned in terms of work ethic and shared values, which I believe greatly assisted us in both developing our vision and strategy and executing them. I think that collectively, we have been able to develop a project that aligns well with current societal debate.

Throughout the project, I noticed constant political and societal developments on a European scale in this period leading up to the upcoming European elections. Generally, I found these developments rather disheartening, as maintaining a polluting economy is often prioritised over defending endangered natural areas. This underscores the relevance of our research and highlights the long road ahead to convince people of the need for a better balance between nature and agriculture.

An aspect I would have liked to delve further into is the role of livestock in the agricultural transition we propose. I believe that a just agriculture extends beyond the rights of farmers and nature and that we cannot speak of a just transition as long as animals are confined to cages without daylight for extended periods. Unfortunately, there was no time to explore this further.

Overall, I believe that, like the rest of my group members, I made a valuable contribution to this report. If I were to undertake a similar project in the future, I would like to focus more on spatial data analysis in GIS. This is a skill I would like to develop further. It really became visible to me how valuable people with these skills can be in a team.

Additionally, I found the booklets and lectures to be very informative. I believe that ethics plays a crucial role in our profession, and it is important that we carefully consider how and where we, as urban planners and designers, commit our efforts. The discussions during lectures often prompted me to think deeply, especially in the context of the nitrogen issue, where I previously tended to view farmers purely as polluters. Through this course, I have learned that the root cause of this persistent pollution lies less in farmers' willingness to change and more in the lack of political action, making farmers victims in this regard.

However, I do not want to entirely absolve farmers of responsibility since they are the ones ultimately causing the contamination and should therefore be held accountable.

In conclusion, I am proud of both the process as the result of this project. I feel that both myself and my group mates have developed and gained a lot from the project. Additionally, I feel that delving further into the social structures behind the agricultural sector has helped me to develop greater empathy for the farmers.

Luc

Reflection Marieke Russchen

Overall, I am very pleased with how this course has turned out. In this regard, my group plays an important role. The group atmosphere was good from the beginning. Everyone was motivated and friendly. The only thing that was difficult was that everyone was so preoccupied with providing space for each other, that sometimes we failed to set goals or make decisions.

Fortunately, we talked about this struggle during the peer review. I tried to pay attention to this after this and feel that we did a good job with setting goals and making decisions on this in the second part of the course. I think we were also able to make faster and more substantial progress in the second part of the course because of this change in working method.I would further like to add that I am glad we were able to take decisions in harmony on difficult and complex themes. I think this was a lesson on group work that I will for sure carry with me to a next group process.

I am generally satisfied with the outcome of our project. I am happy that I had the opportunity to be able to interview farmers. Although I am satisfied with how the interview went for now, I still found interviewing difficult. I would like to learn more about interviewing stakeholders in the future. I also did find it complicated that we did not have more time to explore topics in detail, while the scale and complexity of the project raised a lot of questions for me. This has made me more aware of the limits of my abilities as an urban planner and has taught me what I need other types of expertise from other experts for.

In the project, I also found it challenging that we were dealing with wicked problems. Every solution seemed to cause another new problem or make another stakeholder dissatisfied. I am aware that this will also be the reality in the field of work, but I still struggle with the fact that in making decisions, all kinds of valid aspects have to be balanced and have to be just. The lectures and booklets made me more aware of these complexities and helped with the way we could think of creating a just design.

I found this difficult especially after interviewing the farmers. On the one hand, I felt empathy for the farmers, but also found it difficult at times to understand why they were not more engaged in making their farms more sustainable, while on the other hand, I also began to understand better why they cannot so easily implement these more sustainable farming practices.

Moreover, because of this course, the issue of nitrogen pollution seemed to be suddenly all around me. I noticed that I took the topic home (or rather to the supermarket). The question as to where my responsibility as a (future) urban designer begins or, on the contrary, where my responsibility as an individual ends will be something I will still contemplate in the future.

Overall, I am very satisfied with the way we as a group have shaped this project. The combination between academic writing and design was challenging, but I think it came out well. I believe I will be able to use the skills I learned during this period in my future projects.

Marieke

Chapter 8 References

8.1 References

- Arnold, R. D., & Wade, J. P. (2015). A Definition of Systems Thinking: A Systems Approach. *Procedia Computer Science, 44*, 669–678. https://doi.org/10.1016/j.procs.2015.03.050
- Carnevali, O., Santobuono, M., Forner-Piquer, I., Randazzo, B., Mylonas, C. C., Ancillai, D., Giorgini, E., & Maradonna, F. (2019). Dietary diisononylphthalate contamination induces hepatic stress: a multidisciplinary investigation in gilthead seabream (*Sparus aurata*) liver. *Archives of Toxicology, 93*(8), 2361–2373. https://doi.org/10.1007/s00204-019-02494-7
- CBS. (2020). *Hoe wordt de Nederlandse bodem gebruikt? - Nederland in cijfers 2020*. Retrieved April 9, 2024, from https://longreads.cbs.nl/nederland-in-cijfers-2020/hoe-wordt-de-nederlandse-bodem-gebruikt/
- CBS. (2021). Deposition of nitrogen compounds. CBS. Retrieved April 9, 2024, from https://www.cbs.nl/en-gb/dossier/dossier-nitrogen/deposition-of-nitrogen-compounds
- Cherlinka, V. (2021, October 14). Types Of Soil In Agriculture To Grow Crops Efficiently. *EOS Data Analytics*. https://eos.com/blog/types-of-soil/
- Cranitch, G. (2021, September 28). Nitrogen processes and cycle (*Department of Environment, Science and Innovation*). *WetlandInfo*. Retrieved April 9, 2024, from https://wetlandinfo.des.qld.gov.au/wetlands/ecology/processes-systems/nitrogen-concept-model/
- Deltares, TNO, & WENR. (2021). Soil subsidence prediction map - Klimaateffectatlas. *Klimaateffectatlas*. Retrieved April 9, 2024, from https://www.klimaateffectatlas.nl/en/soil-subsidence-prediction-map
- de Groot, E., & Veen, E. (2017). Food Forests: An upcoming. *33*, 34, 35, 36.
- de Groot, E., & Veen, E. (2017). Food Forests: An upcoming. *33*, p.34-36., from https://edepot.wur.nl/448781
- de Vries, W. (2021). Impacts of nitrogen emissions on ecosystems and human health: A mini review. *Current Opinion in Environmental Science & Health, 21*. 100249
- Duchatelet, J. (2019). Etude de perméabilité et problématiques de pollutions. Formation Bâtiment Durable - Gestion des eaux pluviales sur la parcelle, Bruxelles. https://environnement.brussels/sites/default/files/user_files/pres-190328-gepp-2-1-perm-fr.pdf
- Ellen MacArthur Foundation. (2024). *Circular Economy Introduction*. Ellenmacarthurfoundation.org. Retrieved April 9, 2024, from www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview.
- EOS Data Analytics. (2022, October 14). Types Of Soil Used In Agriculture To Grow Different Plants. *EOS Data Analytics*. Retrieved April 9, 2024, from https://eos.com/blog/types-of-soil/
- European Environment Agency. (2019). Nutrient enrichment and eutrophication in Europe's seas: Moving towards a healthy marine environment. *Publications Office*. https://data.europa.eu/doi/10.2800/092643
- European Environment Agency. (2021). Eutrophication caused by atmospheric nitrogen deposition in Europe [Map].
- FAO. (n.d.). Mixed crop-livestock farming. https://www.fao.org/3/y0501e/y0501e03.htm
- Fertilizers Europe. (2023). How fertilizers are made. *Fertilizers Europe*. Retrieved March 12, 2024, from https://www.fertilizerseurope.com/fertilizers-in-europe/how-fertilizers-are-made/
- Fields, S. (2004). Global Nitrogen: Cycling out of Control. *Environmental Health Perspectives, 10*. 10.1289/ehp.112-a556
- Gardner, T. A., Ferreira, J., Barlow, J., Lees, A. C., Parry, L., Vieira, I. C. G., Berenguer, E., Abramovay, R., Aleixo, A., Andretti, C., Aragão, L. E. O. C., Araújo, I., De Ávila, W. S., Bardgett, R. D., Batistella, M., Begotti, R. A., Beldini, T., De Blas, D. E., Braga, R. F., ... Zuanon, J. (2013). A social and ecological assessment of tropical land uses at multiple scales: The Sustainable Amazon Network. *Philosophical Transactions of the Royal Society B: Biological Sciences, 368*(1619), 20120166. https://doi.org/10.1098/rstb.2012.0166
- Ghaly, A.E., & Ramakrishan, V.V. (2015). Nitrogen Sources and Cycling in the Ecosystem and its Role in Air, Water and Soil Pollution: A Critical Review. *Pollution Effects & Control, 3*. 10.4172/2375-4397.1000136
- Gu, X., Chen, D., Wu, F., Tang, L., He, S., & Zhou, W. (2022, January). Function of aquatic plants on nitrogen removal and greenhouse gas emission in enhanced denitrification constructed wetlands: *Iris pseudacorus* for example. *Journal of Cleaner Production, 330*. 129842
- Heinen, M., Brouwer, F., Teuling, C., & Walvoort, D. J. J. (2021). BOFEK2020 - Bodemfysische schematisatie van Nederland: Update bodemfysische eenhedenkaart (*3056*). *Wageningen Environmental Research*. https://doi.org/10.18174/541544
- Hooimeijer, F. L., Meyer, H., & Nienhuis, A. (2009). *Atlas of dutch water cities: Vol. Land out of water (2nd ed.)*. SUN.
- Isleib, J. (2013, September 27). Reasons to consider rye for fall cover. Retrieved April 9, 2024, from https://www.canr.msu.edu/news/reasons_to_consider_rye_for_fall_cover
- Jo, J.-Y., Ma, J.-S., & Kim, I.-B. (2002, June 1). Denitrification in recirculating aquaculture systems: Comparison of aquatic plants - Responsible Seafood Advocate. *Global Seafood Alliance*. Retrieved April 9, 2024, from https://www.globalseafood.org/advocate/denitrification-in-recirculating-aquaculture-systems-comparison-of-aquatic-plants/
- Kadlec, R. H., & Wallace, S. D. (2009). *Treatment wetlands (2nd ed)*. CRC Press.
- Kanter, D. R., Bartolini, F., Kugelberg, S., Leip, A., Oenema, O., & Uwizeye, A. (2019). Nitrogen pollution policy beyond the farm. *Nature Food, 1*, 27-32. https://www.nature.com/articles/s43016-019-0001-5
- Kogut, P. (2022, October 14). Types Of Soil Used In Agriculture To Grow Different Plants. *EOS Data Analytics*. Retrieved April 9, 2024, from https://eos.com/blog/types-of-soil/
- Kostel, J. (2015). Nutrient Removal — the Wetlands Initiative. *The Wetlands Initiative*. Retrieved April 10, 2024, from https://www.wetlands-initiative.org/nutrient-removal
- Kwakernaak, C., & Dauvellier, P. (2007). Ruimte, water en klimaat in het Groene Hart. *H2O : Tijdschrift Voor Watervoorziening En Afvalwaterbehandeling, 22*, 20–22. http://library.wur.nl/WebQuery/wurpubs/360269
- Leslie, H. M., Basurto, X., Nenadovic, M., Sievanen, L., Cavanaugh, K. C., Cota-Nieto, J. J., Erisman, B. E., Finkbeiner, E., Hinojosa-Arango, G., Moreno-Báez, M., Nagavarapu, S., Reddy, S. M. W., Sánchez-Rodríguez, A., Siegel, K., Ulibarria-Valenzuela, J. J., Weaver, A. H., & Aburto-Oropeza, O. (2015). Operationalizing the social-ecological systems framework to assess sustainability. *Proceedings of the National Academy of Sciences, 112*(19), 5979–5984. https://doi.org/10.1073/pnas.1414640112
- Mouissie, S., & Kamphuis, B. (2024, February 11). "De" boer bestaat niet, grote inkomensverschillen tussen bedrijven en sectoren. *NOS*. https://nos.nl/artikel/2508370-de-boer-bestaat-niet-grote-inkomensverschillen-tussen-bedrijven-en-sectoren
- NOS. (n.d.-a). Alle uitslagen Provinciale Staten 2023. Retrieved April 9, 2023, from: https://app.nos.nl/nieuws/ps2023/
- NOS. (n.d.-b). Uitslagen Tweede Kamerverkiezingen 2023. Retrieved April 9, 2023, from: https://app.nos.nl/nieuws/tk2023/
- Palomo, E., & Fiske, C. (2022, April 19). 4 Crops That Grow Well in Clay Soil. *Hunker*. Retrieved April 9, 2024, from https://www.hunker.com/13406959/crops-that-grow-well-in-clay-soil
- PAS-melders. (n.d.). *overijssel.nl*. Retrieved April 9, 2023, from: https://www.overijssel.nl/onderwerpen/natuur-en-landschap/stikstof/pas-melders
- Planbureau voor de Leefomgeving. (2023, May 1). Stikstof- en natuuraanpak in Nederland: feiten, cijfers en consequenties voor

de uitvoering van beleid. *Planbureau voor de Leefomgeving*. Retrieved April 9, 2024, from https://www.pbl.nl/publicaties/stikstof-en-natuuraanpak-in-nederland-feiten-cijfers-en-consequenties-voor-de-uitvoering-van-beleid

- Potler, P., & Ramankutty, N. (2011, January 24). Global Fertilizer Application and Manure Production. https://sedac.ciesin.columbia.edu/data/collection/ferman-v1/maps/gallery/search#
- Reiley, L. (2022, November 21). Netherlands is the second-largest exporter of agricultural products. *Washington Post*. Retrieved April 9, 2024, from https://www.washingtonpost.com/business/interactive/2022/netherlands-agriculture-technology/
- Remkes, J. (2022, October 5). Wat wel kan: Uit de impasse en een aanzet voor perspectief. *Rijksoverheid*. Retrieved April 8, 2024, from https://www.rijksoverheid.nl/documenten/rapporten/2022/10/05/wat-wel-kan
- Rijksoverheid. (2023, January 24). Nederlandse landbouwexport in 2022: gestegen exportwaarde door gestegen prijzen | Nieuwsbericht. *Rijksoverheid*. Retrieved April 9, 2024, from https://www.rijksoverheid.nl/actueel/nieuws/2023/01/24/nederlandse-landbouwexport-in-2022-gestegen-exportwaarde-door-gestegen-prijzen
- Rijksoverheid. (2024). *Agriculture and horticulture | Agriculture. Government.nl*. Retrieved April 9, 2024, from https://www.government.nl/topics/agriculture/agriculture-and-horticulture
- RIVM. (2022, October 24). Monitor stikstofdepositie in Natura 2000-gebieden 2022. Uitgangssituatie voor de Wet Stikstofreductie en Natuurverbetering. *RIVM*. Retrieved April 9, 2024, from https://www.rivm.nl/publicaties/monitor-stikstofdepositie-in-natura-2000-gebieden-2022
- RIVM. (2023). Herkomst stikstofdepositie, 2022. *Compendium voor de Leefomgeving*. Retrieved April 9, 2024, from https://www.clo.nl/indicatoren/nl050714-herkomst-stikstofdepositie-2022
- Sawyer, J. (2020, February 10). Anhydrous Ammonia Application in Dry Soil. *Iowa State University EXtension and Outreach*. https://crops.extension.iastate.edu/blog/john-sawyer/anhydrous-ammonia-application-dry-soil
- Schillewaert, N. et al. (2021, March 3). Wat is stikstof en wat doet het met het milieu en onze gezondheid? *VRT*. Retrieved April 9, 2024, from https://www.vrt.be/vrtnws/nl/2021/03/02/stikstof-stikstofoxiden-en-ammoniak/
- Staatsbosbeheer. (2022, November 8). De rol van stikstof in de bodem: een sluipmoordenaar. *Staatsbosbeheer*. Retrieved April 9, 2024, from https://www.staatsbosbeheer.nl/wat-we-doen/natuurverhalen/2022/11/de-rol-van-stikstof-in-de-bodem-een-sluipmoordenaar
- UN Environment Programme. (2019). Emissions Gap Report 2019. *UN Environment Programme document repository home*. Retrieved April 8, 2024, from chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://wedocs.unep.org/bitstream/handle/20.500.11822/30797/EGR2019.pdf
- UN Environment Programme. (2023, January 16). Four reasons why the world needs to limit nitrogen pollution. *UNEP*. Retrieved April 8, 2024, from https://www.unep.org/news-and-stories/story/four-reasons-why-world-needs-limit-nitrogen-pollution
- United Nations. (2016). *THE 17 GOALS | Sustainable Development*. *SDGs*. Retrieved April 9, 2024, from https://sdgs.un.org/goals
- Van Stokkom, H. T. C., Smits, A. J. M., & Leuven, R. S. E. W. (2005). Flood Defense in The Netherlands: A New Era, a New Approach. *Water International, 30*(1), 76–87. https://doi.org/10.1080/02508060508691839
- Verloop, J., & Geerts, R. H. E. M. (2007). Functionele agrobiodiversiteit op melkveebedrijven (*Plant Research International 154*). *Koeien & Kansen*. https://edepot.wur.nl/42610
- Watson, C., Dordas, C., & Scotland's Rural College, Aberdeen Campus, Crop & Soil Systems. (2020). Intercropping grain-legumes and cereals for improved protein concentration in the cereal. *ReMIX*. www.remix-intercrops.eu
- Wikipedia. (2024, April 9). Wateringue (drainage). Retrieved April 10, 2024, from https://en.wikipedia.org/wiki/Wateringue_(drainage)

8.2 Image References

- Anefo. (n.d.). *Foto van de Dag: protest tegen het melkquotum 1984*. IsGeschiedenis. Retrieved March 22, 2024, from https://isgeschiedenis.nl/nieuws/foto-van-de-dag-protest-tegen-het-melkquotum-1984
- ANP. (2022, July 28). *Protestvlaggen en zakdoeken moeten weg in Deurne, anders doet gemeente het*. NOS. Retrieved March 22, 2024, from https://nos.nl/regio/brabant/artikel/291023-protestvlaggen-en-zakdoeken-moeten-weg-in-deurne-anders-doet-gemeente-het
- Artziniega, B. (n.d.). *The Food Forest Layers* [Drawing]. In *What Is a Food Forest?*. Retrieved from https://www.gardencityharvest.org/the-real-dirt-garden-city-harvest-blog/2020/12/26/what-is-a-food-forest
- Corine Land Cover. (2023, January 22). *European Environment Agency*. Retrieved March 15, 2024, from https://www.eea.europa.eu/en/datahub/datahubitem-view/a5144888-ee2a-4e5d-a7b0-2bbf21656348
- De Jong, A. (2020, July 10). *Parende varkens en een veewagen als disco: zo demonstreerden de boeren in de jaren '80 en '90*. Dagblad van het Noorden. Retrieved March 22, 2024, from https://dvhn.nl/drenthe/Ook-in-de-jaren-80-en-90-demonsteerden-de-boeren-in-Assen-en-de-rest-van-Nederland-25834397.html
- Duchatelet, J. (2019). *Etude de perméabilité et problématiques de pollutions.Formation Bâtiment Durable - Gestion des eaux pluviales sur la parcelle, Bruxelles.* https://environnement.brussels/sites/default/files/user_files/pres-190328-gepp-2-1-perm-fr.pdf
- Ellen MacArthur Foundation. (2019, February). *Circular economy systems diagram* [Diagram]. Retrieved from https://www.ellenmacarthurfoundation.org/
- Eurostat. (2024, March 1). *Fruit and vegetable production in 2022 - Eurostat*. European Commission. Retrieved April 9, 2024, from https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20240301-1
- Glassman, G. (2022, July 11). *Video of Cows 'Yelling' at Their Owner for Being Late to Feed Them Is Priceless*. Pinterest. Retrieved March 22, 2024, from https://ie.pinterest.com/pin/808466570624539989/
- Hadders, R. (2015, March 31). *Afschaffing melkquotum, het einde van een tijdperk*. EenVandaag. Retrieved March 22, 2024, from https://eenvandaag.avrotros.nl/item/afschaffing-melkquotum-het-einde-van-een-tijdperk/
- Hakkenes, E. (2019, Oktober 18). *Wat hebben vijf maanden stikstofimpasse ons gebracht?*. Trouw. Retrieved March 22, 2024, from https://www.trouw.nl/duurzaamheid-economie/wat-hebben-vijf-maanden-stikstofimpasse-ons-gebracht~b771adba/
- Heinen, M., Brouwer, F., Teuling, C., & Walvoort, D. J. J. (2021). *BOFEK2020 - Bodemfysische schematisatie van Nederland : update bodemfysische eenhedenkaart*. (Rapport / Wageningen Environmental Research; No. 3056). Wageningen Environmental Research. https://doi.org/10.18174/541544
- Holland.com. (n.d.). *Flower fields*. Wikipedia. Retrieved April 9, 2024, from https://nl.pinterest.com/pin/379920918575406707/
- Klimaateffectatlas. (2024). *Viewer - Klimaateffectatlas*. Retrieved April 10, 2024, from https://www.klimaateffectatlas.nl/en/
- Klingenberg, H. (n.d.). *Melk uit eigen streek*. Wikipedia. Retrieved March 22, 2024, from https://co.pinterest.com/pin/497647827573128859/
- Kostel, J. (2015). *Nutrient Removal — the Wetlands Initiative*. The Wetlands Initiative. Retrieved April 10, 2024, from https://www.wetlands-initiative.org/nutrient-removal
- Koster, R. (2015, oktober 27). *Advies: samenwerking moet instorten varkenssector voorkomen*. NOS. Retrieved March 22, 2024, from https://nos.nl/artikel/2065387-advies-samenwerking-moet-instorten-varkenssector-voorkomen
- Landbouwgebied. (n.d.). *Atlas van de Regio | PBL Planbureau Voor de Leefomgeving*. Retrieved 9/4/2023, from: https://themasites.pbl.nl/atlas-regio/kaarten/index.php
- Maasland Satelite Image. (n.d.). *Google Maps*. Retrieved 9/4/2023, from: https://www.google.com/maps/place/Maasland/@51.9327304,4.2741139,26402m/data=!3m1!1e3!4m6!3m5!1s0x47c5b4ab78b0b437:0x2c1f3093194f7a16!8m2!3d51.9350968!4d4.2728618!16zL20vMHdiazA?entry=ttu
- NOS. (n.d.-a). *Alle uitslagen Provinciale Staten 2023*. Retrieved 9/4/2023, from: https://app.nos.nl/nieuws/ps2023/
- NOS. (n.d.-b). *Uitslagen Tweede Kamerverkiezingen 2023*. Retrieved 9/4/2023, from: https://app.nos.nl/nieuws/tk2023/
- NRC Handelsblad. (2013, November 21). *Wie veel melk dronk, breekt sneller een heup*. NRC Handelsblad. Retrieved March 22, 2024, from https://www.standaard.be/cnt/dmf20131120_00848372
- Otago Daily Times. (2017, January 18). *Cattle Creek farm death shocks community*. The Country. Retrieved March 22, 2024, from https://www.nzherald.co.nz/the-country/news/cattle-creek-farm-death-shocks-community/PWRUEJYRABIG5RV2MNGB3CK4VY/
- O'Toole, P. (2021, May 29). *When farming changed forever: the MacSharry reforms and why they still matter*. Irish Farmers journal. Retrieved March 22, 2024, from https://www.farmersjournal.ie/news/news/when-farming-changed-forever-the-macsharry-reforms-and-why-they-still-matter-624966
- Oudman, T. (2022, 6 18). *nederland-beschermt-de-natuur-kapot*. decorrespondent. Retrieved 3 19, 2024, from https://decorrespondent.nl/13062/nederland-beschermt-de-natuur-kapot/40787f63-66b4-0bfa-2700-296e5cedb986
- Pigbusiness. (n.d.). *sterke erven*. Retrieved March 22, 2024, from https://www.pigbusiness.nl/artikel/25882-alleen-voor-bouwland-uitstel-uitrijverbod-mest/
- Relling, T. (2020). *Diagram* [Diagram]]. Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/The-processes-in-systems-thinking-and-design-thinking-have-many-similarities-and-Lewrick_fig15_349882415
- Rijkswaterstaat. (n.d.). *Emissiearme vloeren*. Kenniscentrum InfoMil. Retrieved March 22, 2024, from https://www.infomil.nl/onderwerpen/landbouw/emissiearme-vloeren/
- RIVM. (2023). *Herkomst stikstofdepositie, 2022*. Compendium voor de Leefomgeving. Retrieved Maart 9, 2024, from https://www.clo.nl/indicatoren/nl050714-herkomst-stikstofdepositie-2022
- Rocco, R. (2024, April 17). Spatial Justice Principles Diagram [Lecture slides]. The Idea of Justice, AR2U088 - Research & Design Methodology for Urbanism, TU Delft, Delft.

- Sociaaleconomische status | Regionaal | Inkomen. (n.d.). *Volksgezondheid en Zorg*. Retrieved 9/4/2023, from: https://www.vzinfo.nl/sociaaleconomische-status/regionaal/inkomen
- TheOriginex. (n.d.). *Het Geheugen*. Pinterest. Retrieved March 22, 2024, from https://nl.pinterest.com/TheOriginex/
- UN Environment Programme. (2023, January 16). *Four reasons why the world needs to limit nitrogen pollution*. UNEP. Retrieved March 22, 2024, from https://www.unep.org/news-and-stories/story/four-reasons-why-world-needs-limit-nitrogen-pollution
- United Nations. (n.d.). Sustainable Development Goals icons. Retrieved from https://sdgs.un.org/goals
- Van Sabben Rentmeesters. (n.d.). *Advies en hulp bij ruilverkaveling*. Rentmeesters in Zeeland. Retrieved March 22, 2024, from https://www.vansabbenrentmeesters.nl/agriteam/ruilverkaveling/
- Wallmonkeys. (n.d.). *Dairy Products and Eggs Wall Decal*. Retrieved April 9, 2024, from https://www.wallmonkeys.com/products/dairy-products-and-eggs-fot-19261547
- Welink, M. (2022). *Zo ging het toen: machinaal mest verspreiden*. boerderij.nl. Retrieved March 22, 2024, from https://www.boerderij.nl/zo-ging-het-toen-machinaal-mest-verspreiden
- Wikipedia. (n.d.). *Klassieke varkenspest*. Wikipedia. Retrieved March 22, 2024, from https://nl.wikipedia.org/wiki/Klassieke_varkenspest
- Wolters, T. (2020, December 9). *De Stikstofcrisis [2]: Wat is er mis met het stikstofbeleid?* – Climategate Klimaat. Climategate. Retrieved March 22, 2024, from https://www.climategate.nl/2020/12/de-stikstofcrisis-2-wat-is-er-mis-met-het-stikstofbeleid/