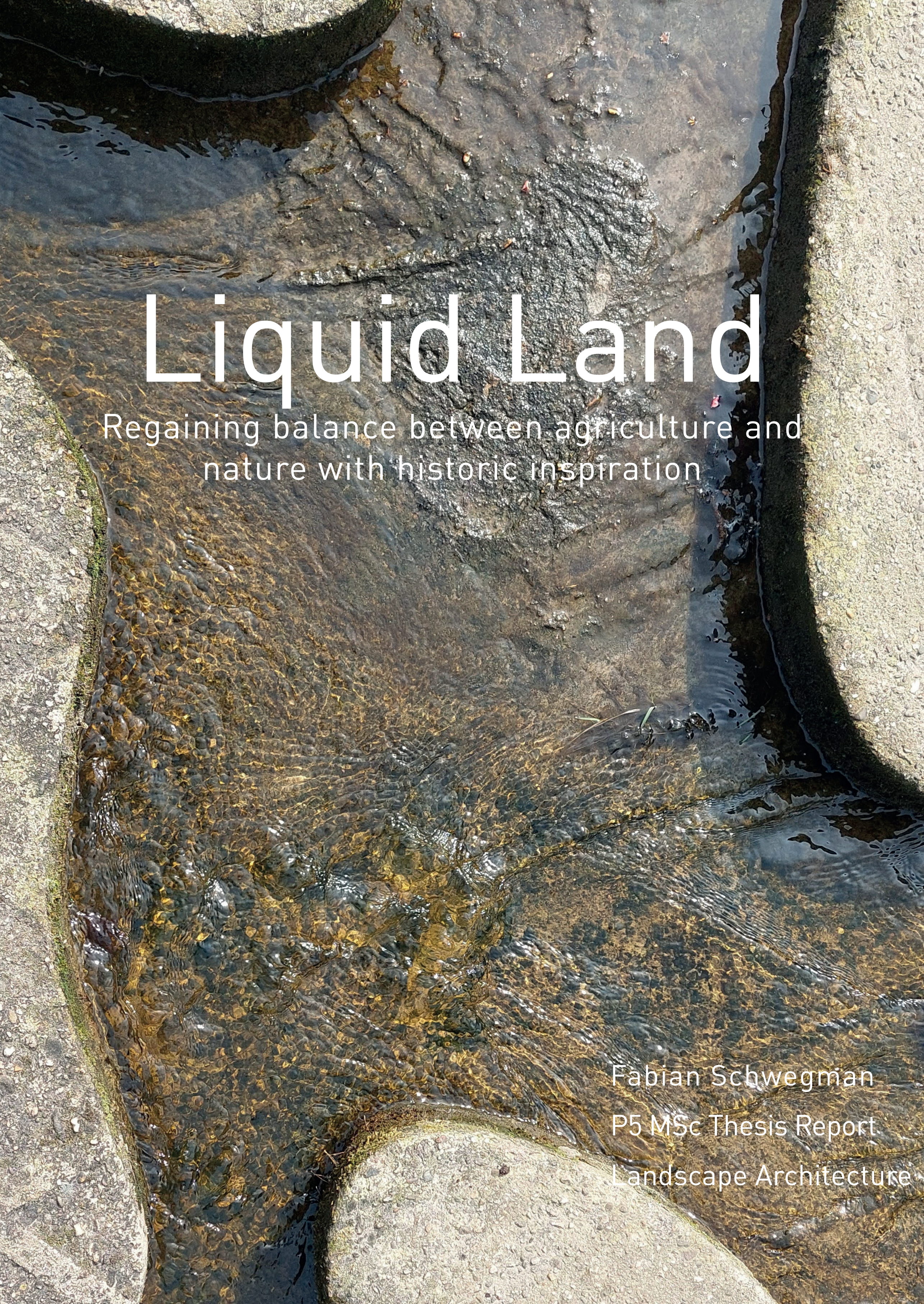

# Liquid Land

Regaining balance between agriculture and nature with historic inspiration

Fabian Schwegman

P5 MSc Thesis Report

Landscape Architecture

# Liquid land

## Regaining balance between agriculture and nature with historic inspiration

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Academic year 2023-2024
January 2025

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Figure 1: Floodplain of the IJssel river, Zutphen (author, 2024)

## Abstract

Keywords: Landscape Architecture, nature-inclusive farming, climate resilience, historic water systems, flowing meadows

The Achterhoek region of the Netherlands, with its sandy soils and elevated terrain, faces significant climate challenges, particularly droughts caused by changing weather patterns. Agriculture and nature in this area depend heavily on water, yet the intensification of industrial farming has disrupted the balance between these systems. This research addresses the question: “How can landscape architecture reintegrate water management, nature, and agriculture to enhance climate resilience, increase biodiversity, and secure a sustainable future for farmers?”

Through historical analysis, it is evident that traditional farming methods once maintained a natural balance between agriculture and the environment. However, industrialization has disrupted this harmony. By drawing inspiration from past systems like flowing meadows and cooperative farming communities (Marken), modern design strategies can help restore this balance. Projects such as Urtica de Vijfsprong and het Lankheet offer examples of how nature-inclusive approaches can improve biodiversity and drought resilience, while diversifying income sources for farmers.

A water-based design strategy is proposed, adapting land use to natural water levels to ensure long-term sustainability. This includes raising groundwater levels, reintegrating natural habitats into farmland, and encouraging cooperative farming models to enhance nutrient recycling and reduce costs. With these strategies, a blueprint is proposed for the region of Nettelhorst, transforming it into a model of sustainable agriculture, balancing the needs of nature, water management, and farming. Landscape architecture can play a crucial role in restoring this balance by addressing core issues and offering holistic, system-based solutions.

# Chapter 1 Introduction



# Chapter 2 Methodology



# Chapter 3 Research for Design



# Chapter 4 Research by Design



# Chapter 5 Conclusions

# Chapter 1: Introduction



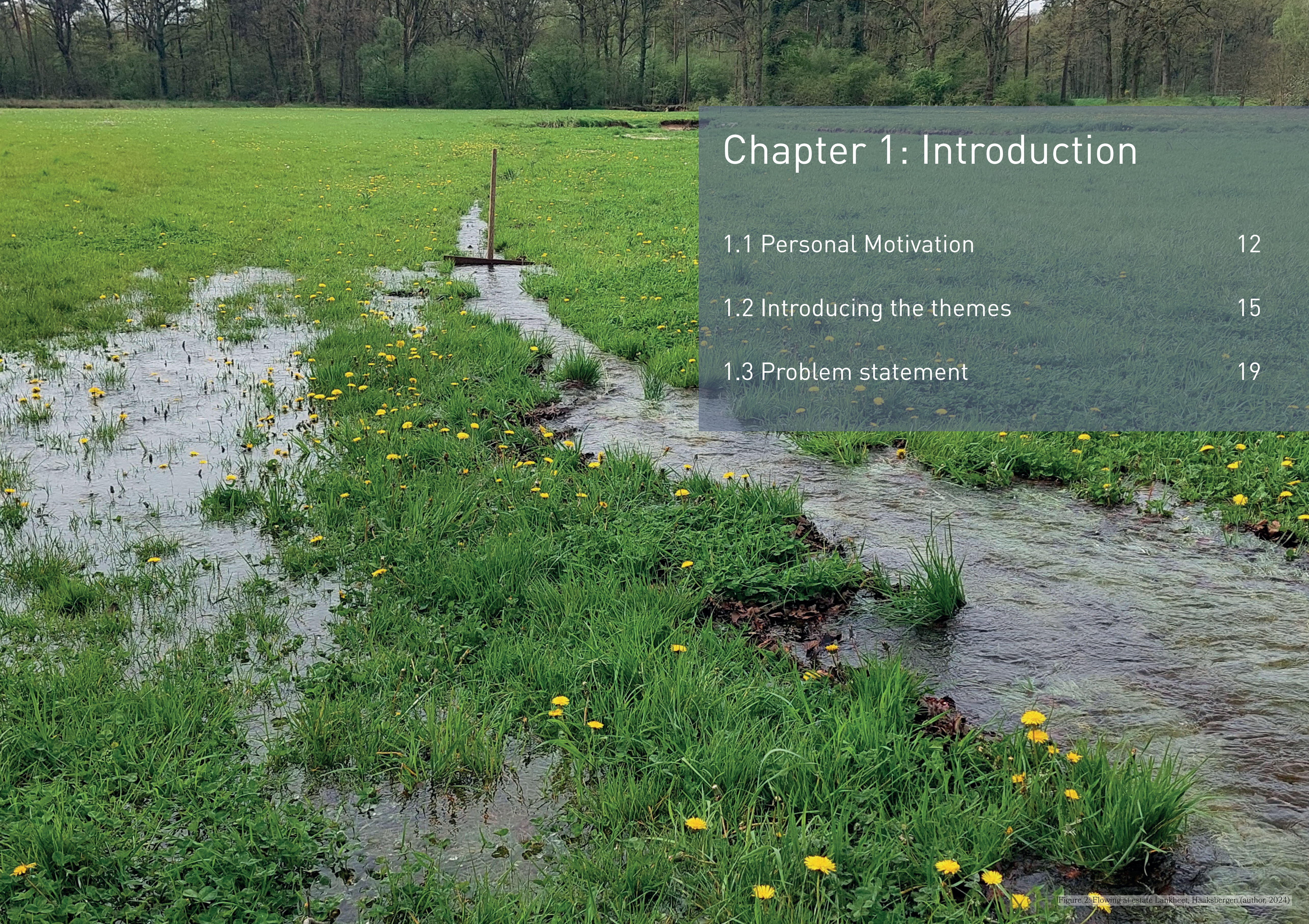


Figure 2: Flowing at estate Lankheet, Haaksbergen (author, 2024)

## 1.1 Personal motivation

My personal connection to nature and agriculture started early. As the son in an organic agricultural family, I was introduced to nature and agriculture at an early age. This sparked my first interest in the beauties of nature, and learning how to steer natural systems for agricultural purposes. By helping my father in the vegetable garden and going on mushroom and hazelnut hunts, I quickly learned to appreciate and respect nature.

When I was 10 years of age, we moved from the rational, linear landscape of the Flevo polder to the old cultural landscape of the Achterhoek. The contrast could not have been bigger: forests, bendy roads, soft flowing hills, historic estates. Even though I hated leaving my friends behind, the area could not be hated.

In my first years in university, I chose architecture as my topic. It took me several years to realize that buildings were not my calling, and therefore I decided to try out designing with plants and trees. This turned out to be the best decision for me, as I felt I could make a bigger difference with topics that already interested me more. Tackling climate change issues and looking at more versatile water systems became my favourite challenges.

For the graduation thesis, I therefore chose a topic that combined my three biggest interests of water, agriculture, and nature in an area I knew well by then: The Achterhoek. Tackling climate change and the disconnect between farmers and nature in this area was a perfect combination of these factors, especially when introducing history as an inspiration for the future.

I hope my project will be able to provide an image of what can be done, and hopefully paint a brighter picture for the future ahead.





Figure 3: Little Fabian in the vegetable garden, Dronten (author, 2002)

Figure 4: Flowing meadows in Austria (Tiefenbrunner, 2018).

Figure 5: Flowing meadows in Lankheet, Haaksbergen (Brinckmann, 2021)

Figure 6: Markesteen (Overijssel, n.d.)

Figure 7: Wooded hedges in agricultural land (de Winter, n.d.)

## 1.2 Introducing the themes

*As mentioned in the previous chapter, this thesis focuses on three main topics or themes: Water, Nature, and Agriculture, but most importantly their interrelation. In this chapter, we will introduce these three themes one by one, highlighting their relevance and general context, while also going into overlapping factors that connect the three together.*

### Flowing Water

'Water is the driving force of all nature,' Leonardo da Vinci already recognized the importance of water. But even before him, societies have risen and fallen from the presence or lack of water (Solomon, 2010). Without the substance, there would be no life on this planet to begin with. Throughout centuries humans learned to adapt to it, use the available water to their advantage, and change their lifestyles accordingly. This has enabled societies to rise in the most barren circumstances, from the heights of the Himalayas to the Sahara deserts (Solomon, 2010). When there is water aplenty, it is used in different ways to extract benefits from it. From trading over water to the redistribution of water over rice fields for irrigation. The nature and agriculture in the Netherlands are adjusted to its humid climate, with species used to the humid conditions. To optimally use the available resources, different techniques were used. One of them was traditional irrigation, otherwise known as Flowing Meadows (Baaijens et al., 2011). This agriculturally developed system used the available water, flowing it over the land to extract nutrients and sediments. The system was used in at least seven different countries in Europe and was recently recognized as UNESCO World Intangible Heritage (Unesco, 2023). In other countries in Europe the higher elevations helped distribute water over the flanks of the hills (see figure 4), but in the Netherlands, the subtle differences in height needed to be utilized by using small canals, ditches, and weirs (figure 5). Due to radical changes in agriculture, the system has been abandoned in the past hundred years, and slowly been forgotten. This is unfortunate, as it is a unique example of the connection between farmers and their surroundings, and how they were able to extract the most out of their limited resources. In this thesis we will further explore the techniques of the Flowing Meadows, and whether they can still be beneficial in the modern world.

### Nature

The approach to nature has changed a lot throughout history as well. Where "nature" once was simply part of the whole context, where humans and animals lived together, nowadays nature is seen as a separate entity that must be protected (Sharma & Buxton, 2018). Humans have an increasing impact on their existence, altering the landscape and changing the natural balance, as Charles Darwin and George Perkins Marsh already recognized in the 19th century (Marsh, 1864). This meant humans and nature needed to find a new balance together. Examples in the Netherlands can be found in the way cultural elements are integrated into the agricultural landscape. Drinking pools for cattle provide breeding grounds for species such as the Crested Newt (Ravon.nl, n.d.), and wooded hedges provide shelter for small land animals and birds, see figure 7 and 8 (SLG, n.d.).

Currently in the Netherlands, nature is approached as something separate, that must be protected by laws and organizations. It has a recreational purpose, allowing people to enter specific areas while some are prohibited. However, the interconnection between nature and water is ever prevalent. In this report, we approach nature as the natural development of the combination of the availability of water, the climatic and soil conditions.

**Agricultural Marken**

Closely related to water and nature, agriculture is another major factor in the development of civilizations. As one of the oldest professions, the art of steering natural processes for personal gain has been a part of human development since 3000 a.d. in the Netherlands (van Geelen et al, 2020). In a similar time period to the development of the flowing meadows, agriculture in the sanded areas was often organized in a social structure called Marken (Bieleman, 2008). In these communities, farmers worked together on common goals such as the maintenance of fields, herding cattle, jurisdiction, and water management. They owned and maintained an area of land together, marked by "markestenen" (figure 6), from which they grew all their crops and herded their animals. By working together in this way, they were able to cultivate more land together, be more resilient to fluctuating productions, and have a bigger voice in local politics (Bieleman, 2008). However, this system also disappeared around 150 years ago, due to the industrialization of the agricultural business, which was focused on large-scale production and efficiency and did not leave room for these inefficient communal operations. However, with problems such as climate change and nitrogen emissions, a new approach to agriculture is necessary. Old systems such as the Marken could still give inspiration for the system of the future, where nature and agriculture are back in balance.

Figure 8: Drinking pools are a biodiverse nursery for several species (SLG, n.d.).

Figure 9: Cows in a nature-inclusive meadow (Natuurmonumenten, 2023).

Figure 10: Draught at estate 't Klooster, Zelhem (RTV, 2023).

Figure 11: Agriculture right next to the Berkel river, Almelo (author, 2024)



## 1.3 Problem statement

*The delicate balance that once existed between the themes of nature, agriculture, and water management is now under significant threat due to multiple factors. In this chapter, we will outline the threats to the themes stated before, organized from global to regional issues.*

### A changing water balance

In recent years, extreme climatic events have become more fierce and common. The catastrophic floods in Limburg and Germany in 2021, alongside the severe droughts experienced in the summers of 2019 and 2022, are an indication of the more extreme weather we will have to deal with in the future due to climate change (Hendriks & Mens, 2024). These extreme weather events disrupt the natural water balance, leading to a heightened risk of both flooding and drought (Hendriks & Mens, 2024). Longer droughts in summer pressure agriculture and natural ecosystems ( see figure 10). The drying up of water supplies during these critical periods results in considerable damage to crops and the surrounding environment, creating a pressing need for adaptive water management strategies that can respond to these new climatic realities (van Nieuwenhuijze & Klijn, 2021b). At the same time, extreme rainfall in winter causes flooding and saturation of farmlands, making it difficult to work the land in early spring with heavy machinery in order to prepare it for crop cultivation (van Nieuwenhuijze & Klijn, 2021b). But our water usage has changed significantly as well. While the water usage per person has remained stable in normal years, the dryer summers cause an increase in water usage (Drinkwaterplatform, 2022). Agricultural water usage changes a lot with dryer weather as well, with the usage doubled compared to a normal summer (Brand, 2022). While agricultural water usage is only 1% of the total usage, it largely consists of groundwater usage, which needs a long time to replenish and has a larger impact on nature (RIVM, 2023).

### The Fragmentation of Nature

Over time, nature has been increasingly compromised to accommodate agricultural expansion. In the past one hundred years, cultural elements such as hedges and coppice groves were removed for land reallotment programs, aiming to increase agricultural efficiency (Barends, 1981). This has resulted in shrinking habitats and diminishing biodiversity, and a separation between the formerly intertwined agriculture and nature. As a result, nature now faces the challenge of maintaining biodiversity within smaller, more isolated habitats (IPO & LNV, 2021). On top of that, intensive agriculture, pollution, and climate change further threaten the ecosystem's health, leading to a decline in biodiversity and the degradation of natural ecosystems (IPO & LNV, 2021). The need for special protective measures and regulations for these natural areas becomes evident, yet these are often in conflict with the interests of neighbouring agricultural activities. This disconnection underscores the growing division between nature and agriculture, each now operating under different sets of rules and pressures.

### Agriculture in a split

As mentioned, the evolution of agriculture has seen a significant shift towards upscaling, driven by the need for higher efficiency and competitiveness (Barends, 1981). However, this has come at a considerable cost. The intensification of agricultural practices has led to increased emissions, pollution, and the over-exploitation of land, resulting in the degradation of cultural landscapes that were once integral to the regional identity (Natuurkennis, 2022). But the problems are not just caused by farmers themselves. People are increasing their consumption, demanding a low price while export remains a key factor in the Dutch economy (Bos et al., 2023). This meant a need for upscaling and innovating in order to maintain a competitive position on the market. The push for upscaling has put farmers in a difficult position, burdened by large debts and strict regulations, all while striving to remain competitive. This financial and regulatory strain not only impacts the viability of farming operations but also contributes to the broader misbalance in the landscape, as agricultural practices increasingly clash with environmental sustainability.

### Conclusion

Where once, the elements of water, agriculture and nature were deeply intertwined, developments in the past century have started to create a mismatch between them, as is visualised in figure 12 and 13. The changes in the water balance, biodiversity, and agricultural practices are creating a significant imbalance in the landscape, disrupting the harmony that once existed between these elements. The trend of these factors has led to a landscape where nature, agriculture, and water management are no longer in balance, each struggling under the weight of modern pressures. Addressing this imbalance requires a holistic approach that considers the interrelationship of these elements and seeks to restore the equilibrium that is vital for a sustainable future.

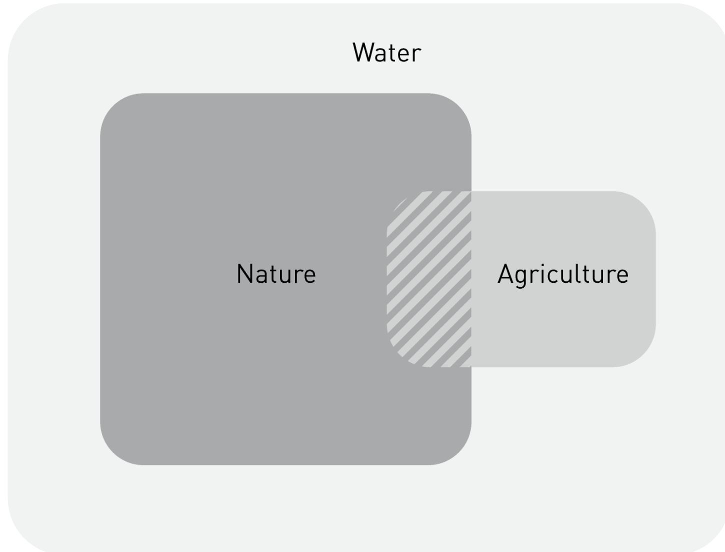



Figure 12: Relation of water, nature and agriculture in the past

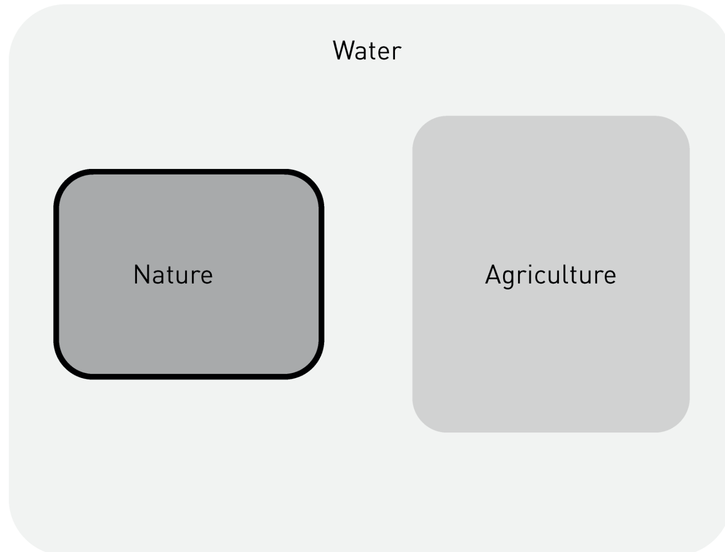



Figure 13: Isolation of nature and agriculture

# Chapter 2: Methodology



Figure 14: the revitalised Berkel near Almen (author, 2023)

## 2.1 Research aim

The primary aim of this research is to bring back balance between the three main elements of this thesis: Water, Nature, and Agriculture, as is visualised in figure 15. The current separation is leading to conflicting interests and is causing problems as mentioned in the previous chapter.

Each theme will have its own goal, focused on the specific issues that arise:

**Adaptive Water Management: Building Resilience to Floods and Droughts in a Changing Climate**

The water management should be adjusted to accommodate the impact of climate change, allowing for a more resilient system. The need for a robust water system that can withstand extreme conditions—such as floods and droughts—has never been more urgent. By providing adequate space to accommodate for floodings while also storing water to mitigate droughts, this adapted water system will enhance the resilience of both natural ecosystems and agricultural practices.

**Restoring Nature: Expanding Habitats through Integrated Landscapes**

The trend of shrinking habitats and diminishing biodiversity can still be reverted. Expanding habitats are necessary for nature to thrive, and in order to achieve this there is a need for shared space with the agricultural practice. With less intensive agriculture, nature can be interwoven back into the landscape. This does not only increase the size of the natural areas but also allows for symbiosis between agriculture and nature.

**Sustainable Farming: Reducing Impact through Diversification and De-intensification.**

De-intensification and diversification stands central in the agricultural transformation. A different farming method must be found that has a lower impact on the surroundings, with less pollution and a more balanced water usage. At the same time, the dependence on the market needs to be lowered to change from production for quantity to quality, with additional income from other sources that offset the potential loss caused by a less intensive farming method.

In this integrated approach, nature and agriculture are no longer seen as competing interests but as complementary components of a holistic system. New agricultural methods to support and enhance the natural environment, it enables both to thrive. The historical examples of Marken and Flowing Meadows offer inspiration for implementing such an integrated approach in contemporary settings. By drawing on these historical examples, the current challenge of integrating water management, nature conservation, and agriculture can be effectively addressed, ensuring a sustainable and resilient future for all three elements.

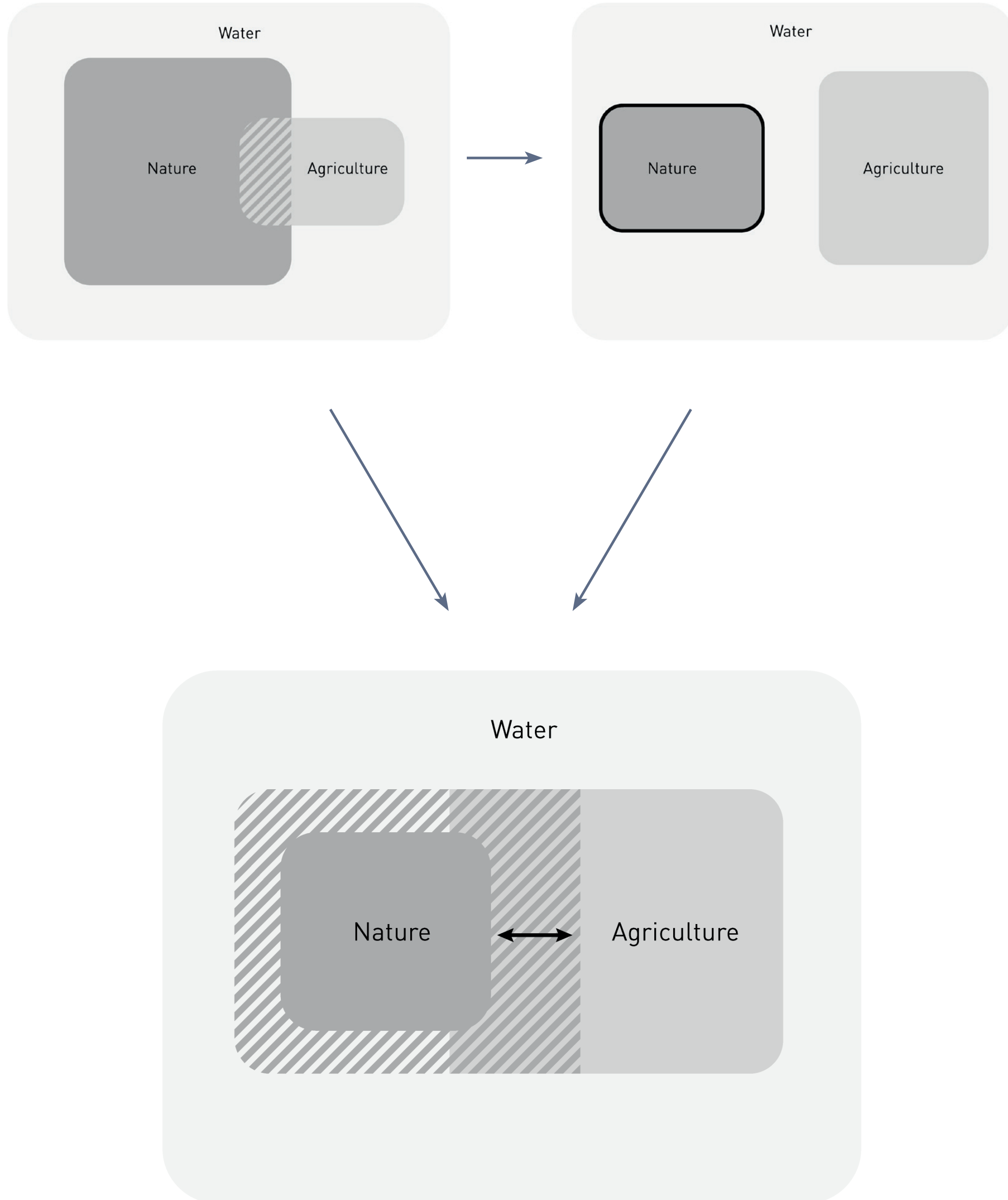



Figure 15: Sharing space and fading the borders

## 2.2 Research questions

Following from the problem statement and design aim, we come to the main research question:

> *"How can landscape architecture help to reintegrate water management, nature, and agriculture in order to enhance climate resilience, increase biodiversity, and ensure a sustainable future for farmers?"*

This research question aims to focus on the restoration of the connection between the three themes that has gone lost in recent history. We subdivided this research question into three sub questions, which relate to the present, past and future developments of the main research question.

> *"How has the disbalance between water management, nature and agriculture developed?"*

> *"What design strategies can be employed in order to rebalance water management, nature and agriculture?"*

> *"How can the alternative strategies be implemented into the agricultural landscape?"*

The first research question is aimed to help in the analysis of the problems, while the second question helps to guide us towards a solution by performing case studies and further research. The final question tries to focus on the integration of the gained information in the specific landscape of the design location.

Figure 16: Artwork at estate Lankheet, Haaksbergen (Author, 2024)

## 2.3 Research Framework

The thesis is structured into five chapters: “Introduction”, “Methodology”, “Research for Design,” “Research by Design,” and “Conclusion and Reflection,” following the design process from theoretical research to practical application and reflection.

The first and second chapter are aimed at introducing the topic and create a basis for the research and designprocess, with a framework to create guidance throughout the project.

The third part, Research for Design, focuses on the theoretical research necessary to understand the project’s aspects before the design process begins. It incorporates a holistic approach, the Landscape Logic method by Steffen Nijhuis (Nijhuis, 2022; van der Horn & Meijer, 2015), which analyzes interrelationships between landscape components and stakeholders. Historical context, GIS data, and maps are used to understand the evolution of layers like soil, water, nature and agriculture. Interviews with local stakeholders help to identify their needs, which informs the design. Additionally, several case studies are conducted in order to find alternative views on the topics and problems, and provide create a basis for a design concept.

The second part, Research by Design, focuses on practical research and design development. It considers a general concept that is appliccable, which can then be applied in a design location. Additional research is conducted on this design location, in order to understand local boundary conditions to local needs, resulting in a vision plan for the regiion. This future vision is further detailed in a zoom-in location, where eye-level perspectives are used to connect the three main components in the human scale.

The final part, Conclusion and Reflection, revisits the research questions from chapter 5 and critically reflects on the findings.

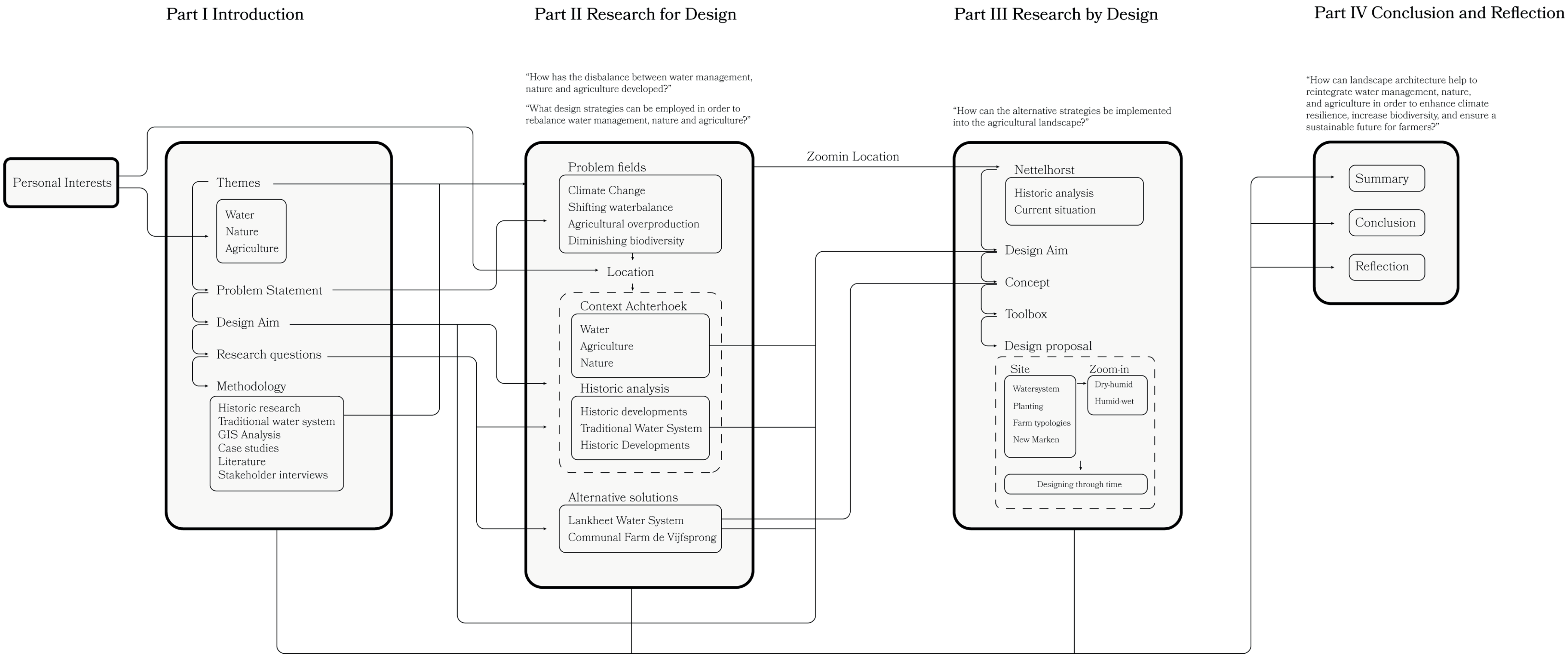







Figure 17: Scheme of the research framework (Author, 2024)

## 2.4 Reading guide

Following from the research framework, the report is structured in a similar way. The report is divided into five chapters:

Chapter 1: Introduction. In this part, the general outline of the report is introduced, with the themes and problems that are tackled in this thesis report.

Chapter 2: Methodology. The theoretical framework of the design is laid out in this chapter, with the used themes, method and design aims. This is meant to form a first step in the design process, and create the boundary conditions of the project moving forwards.

Chapter 3: Research for design. The content in this part focuses on the theoretical research done, by making use of various sources such as historical maps, GIS data, case studies and literature. The chapters start from a broad perspective on the current situation, introducing the region of the Achterhoek and highlighting its characterstics, while further detailing the problems facing the region. The following paragraph researches the historic evolutions, and how the landscape has developed into the current situation, uncovering the origins of the issues. In the final paragraph, case studies on alternative approaches to the current systems are researched, giving a new and broader view on how to approach the current system in a new way. From this catalogue of knowledge, a conclusion condenses the main important findings which can be used in the design concept.

Chapter 4: Research by design. This part is where the practical designing comes into play. With the knowledge gained by the previous chapter, a new concept on the approach towards water, nature and agriculture is drawn up. This concept is applicable to a multitude of situations, but must be tested in order to find its real life implications. A region is chosen based on several criteria, and further research is conducted to find the local boundary conditions. Zooming in to an eye level perspective allows for further detailing in the landscape experience and the interaction between the layers of water, agriculture and nature.

Chapter 5: Conclusion and reflection: Lastly, we will go back to the beginning of the report and conclude on the findings by answering the research questions stated in the beginning. In combination with a critical reflection, we can then determine whether this design could be implemented in the current situation.

Figure 18: Flowing in spring at estate Lankheet (Author, 2024)

# Chapter 3: Research for Design



Figure 19: Flowing meadow with an excess of the undesirable plant "*Juncus effusus*" or common rush (Author, 2024)

# 3.1 Current context

*In the previous part, the foundational themes, problems, and contextual background of the research were introduced, setting the stage for the next chapter. We dive deeper into the identified problem fields and their position in the current context, as well as explore their historical development and uncover design opportunities, by aiming to answer the following sub question:*

> *"How has the disbalance between water management, nature and agriculture developed?"*

*By analysing the developments of the the themes in layers, this chapter aims to provide an understanding that will inform the subsequent design process, ensuring that the solutions are both contextually relevant and effectively address the challenges identified.*

### 3.1.1 The backyard of the Netherlands

The Achterhoek is a region in the Netherlands, located in the eastern part of the country. Its rural character with only a few cities and primarily agricultural land, is loved by tourists for its varied landscape with forests, meadows and historic towns. The tourism website of *achterhoek.nl* reads: "a varied coulisse landscape with meadows, wooded hedges, trickling streams and forsts. Castles and cities where history is still felt. But also: modern musea, cozy restaurants and amazing attractions. The Achterhoek has it all." (achterhoek.nl, n.d.) While this might be true in some areas, several problems are threatening this rural region. Climate change, drought, pollution and biodiversity challenges are big topics that face this region. In this chapter we will take a deeper look at the characteristics of the Achterhoek, and problems that arise, based on the three themes mentioned in paragraph 1.2: Water, agriculture and nature.

Figure 20 and 21: the eastern region of the Achterhoek, with its characteristic coulisse landscape (Swart, 2019)



Figure 22: Characteristic bordered fields with grazing cattle (Hollanders, 2018)

Figure 23: Estate Hackfort in Vorden, one of the countless estates in the Achterhoek (author, 2024)

Figure 24 and 25: Historic traces are scattered throughout the landscape, such as this watermill in Vorden (l) and entrance lates to (former) estates (r, author, 2024)

*The high sandy regions*

The Achterhoek is positioned on the edge of the IJsselvalley (1, see figure 26). This valley is located between the Veluwe-massiv (2) and the Eastern Dutch Plateau (3). The highly fertile valley is consisting of clay soil, brought by the river, while the Achterhoek is predominently sand, which is much less fertile with a better drainage capacity. This soiltype creates alkaline conditions which affect local wildlife and farming (Spek, Kiljan, Moorman, Geertsema, & Steingröver, 2010). Due to the geological formation of these sandy regions, which is further elaborated on in paragraph 3.2.1, it is also located on a slightly elevated above the adjacent valley, creating a drainage of the water system from east to west.

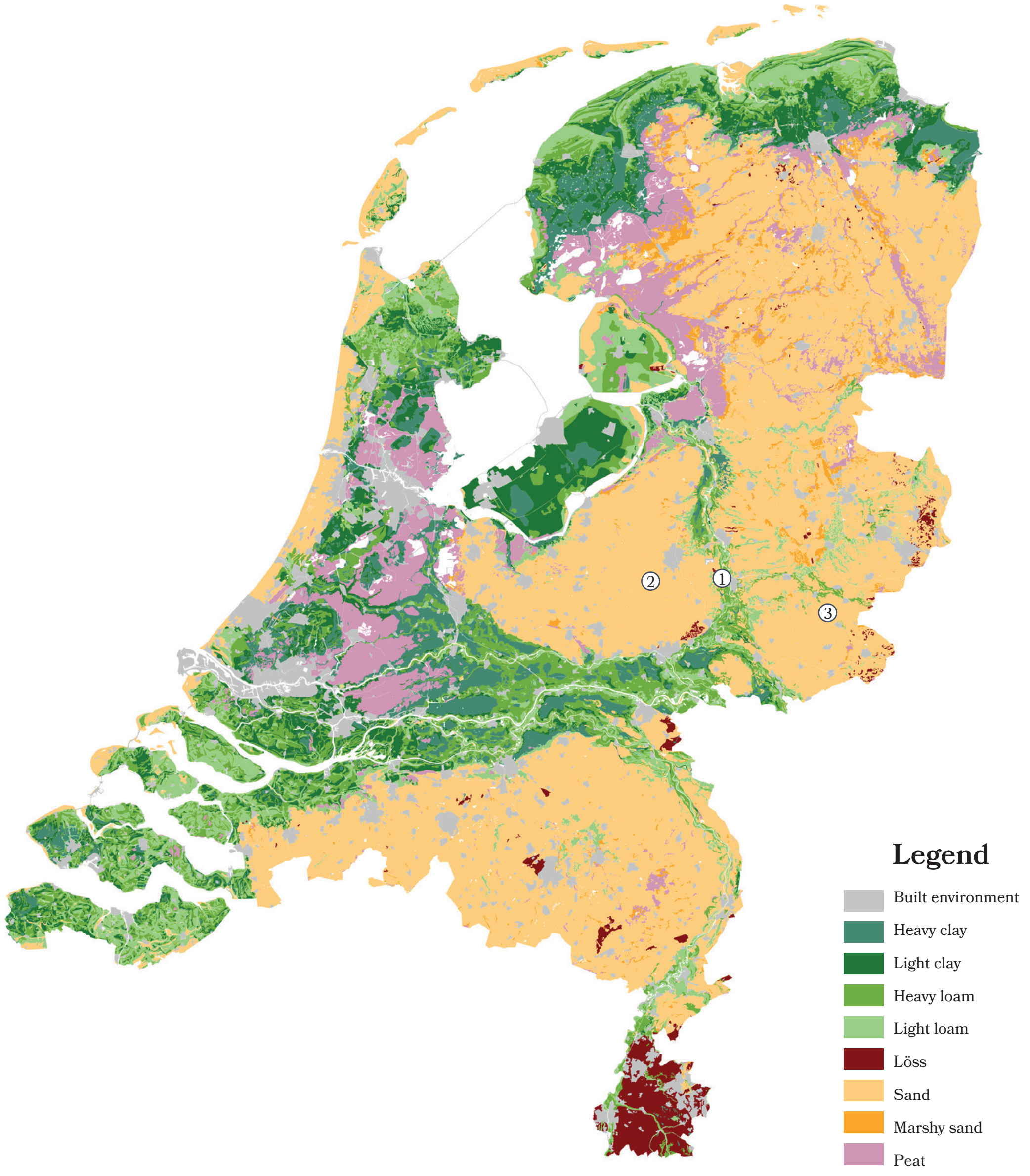



Figure 26: soiltypes in the Netherlands (WUR, 2006)



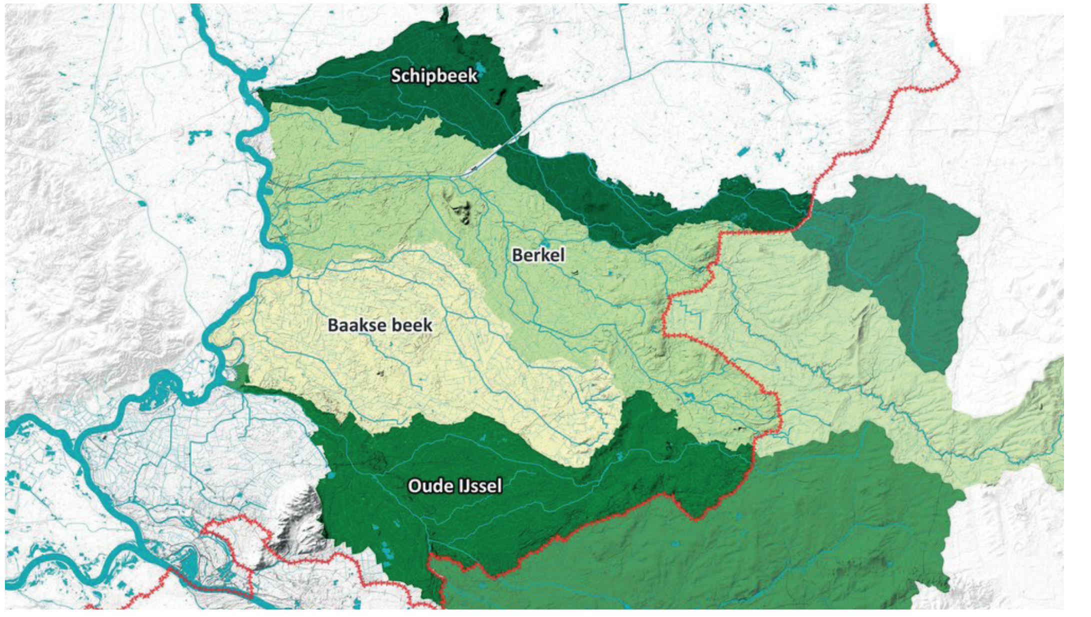



Figure 27: Watershed areas of the river systems in the Achterhoel (van Nieuwenhuijze & Klijn, 2021)

*Water veins*

This water system consists of four main river systems: the Oude IJssel, Baakse Beek, Schipbeek and the Berkel, as visualized in the map in figure 27 (van Nieuwenhuijze & Klijn, 2021a). The watersheds of these rivers partially originate over the border in Germany, making the Achterhoek dependent on external sources for water provision, such as rainwater and the influx from these river systems. To narrow the scope of the research, the watershed of the Berkel is chosen for further analysis.

The river Berkel is currently a very canalised system (see figure 28). Due to industrialisation, the water system has been altered to meet agricultural needs, with a focus on high drainage to create dry, solid land. This allowed machines to traverse the terrain more easily and provided better control over the water levels. However, this resulted in many problems concerning drought and biodiversity loss. To negate some of these effects, meanders in the river have been reinstated in places along the river, like near the town of Almen (figure 29)

Figure 28 and 29: Canalisation of the Berkel near Lochem (author, 2024) and the reinstated meanders in Almen (Abendroth, 2021)

*Monocultural agriculture*

The region of the Achterhoek is also known for its rich agricultural history. The coulisselandscape mentioned before is part of the agricultural tradition, with wooded elements used for fencing, wood production and tools see figure 32 and 33). However, the Achterhoek is also a very monocultural landscape, with the sandy soil being primarily used for agricultural grasslands and dairy farming. Over 86% of the agricultural land is dedicated to dairy farming, consisting of grassland and supportive crops such as corn sillage, with only a small portion dedicated to crop cultivation and other agricultural branches, as can be seen in figure 30 (CBS, 2023).

Most dairy farms are aimed at efficiency, with cows typically housed in open barns. Their diet includes silage (fermented grass and corn) and concentrated protein-rich feeds like soybeans, alfalfa, and food industry byproducts, mostly imported from South America (ZuivelNL 2020; NZO n.d.). The foreign products cause an oversaturation of nutrients in the Dutch system, as a manure surplus is created in the Netherlands. The manure is used as fertilizer on grasslands as much as is legally allowed, but the excess needs to be processed, often through burning, palletisation, or export (van Beek 2009; RVO 2020). Most of the produced milk is processed into cheese (54%) and milk powder (15%), with the rest used for drinking milk, butter, and other products (ZuivelNL, 2020).

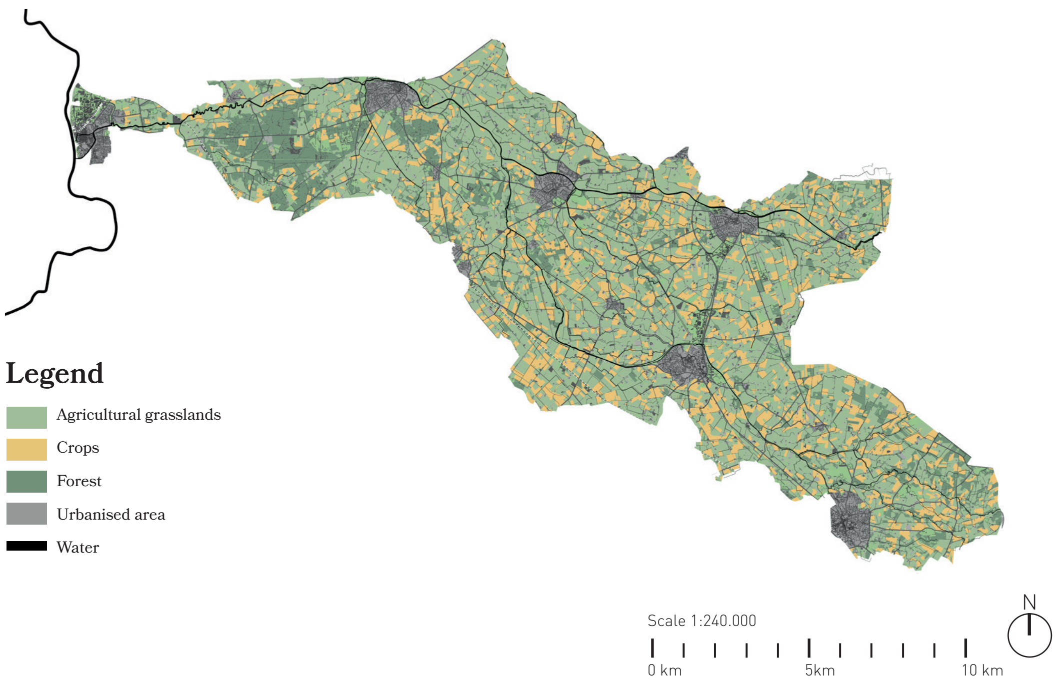



Figure 30: Current landuse in the Berkel region (LGN, 2023)

*Nature*

Nature in the Achterhoek is diverse, from wet marshlands to dry heathlands, raised bogs and forests. The diverse nature means a wide range of species that benefit from this. Characteristic species such as the garlic toad, treefrog, partridge and little owl are unique to the sandy regions (nederlandsesoorten.nl, 2023).

These species have adjusted to the agricultural landscape, relying on the cultural elements in the Achterhoek:

- Coppice groves, forests used for firewood, are shelter to nesting birds and larger land animals such as the wild boar and deer.
- Wooded hedges, pollard trees such as Elm and Willow and treelines give shelter to smaller animals such as mice and hedgehogs.
- Drinking pools are vital for amphibians such as the treefrog and crested newt, which use it as hunting and breeding grounds (Natuurkennis, 2022).

Figure 31: Drinking pools were used in dry heathlands for cattle (author, 2024)

Figure 32: Hawthorn hedge used as fencing (cruydthoek, 2022)

Figure 33: Coppice groves used for firewood or tools (Ecopedia, 2023)

Biodiversity in the Netherlands is maintained through strict legislation, with areas allocated for different ecological purposes. Three main structures are in place that protect the ecosystems: Natura2000 areas, Natuur Netwerken Nederland (NNN) and Ecologische Verbindingszones (Evz's). These designated areas have the following priorities:

<u>Natura2000</u> is a European network of protected sites, with the purpose of maintaining the diversity of the landscape throughout Europe (Natuurmonumenten, n.d.)

<u>NNN</u> is a national network of protected sites, with serving as both buffers and connectors between seperated natura2000 sites, while maintaining flora and fauna of national importance (Atlas Leefomgeving, 2022)

<u>Evz</u>'s are connecting elements between natural areas, where extensive agriculture is allowed. These zones provide corridors for species to traverse through the landscape, protecting the biodiversity and serving as buffer zones. Evz's are often created around creeks and rivers, as these areas combine various gradients which serve more species, creating so-called "greenblue veins" (Provincie Gelderland, 2024).

These networks snake through the landscape, creating a mix between agricultural land and nature reserves. The map in figure 34 shows the complex mix of verious different ecological areas, with all their distinct rules and legislation.

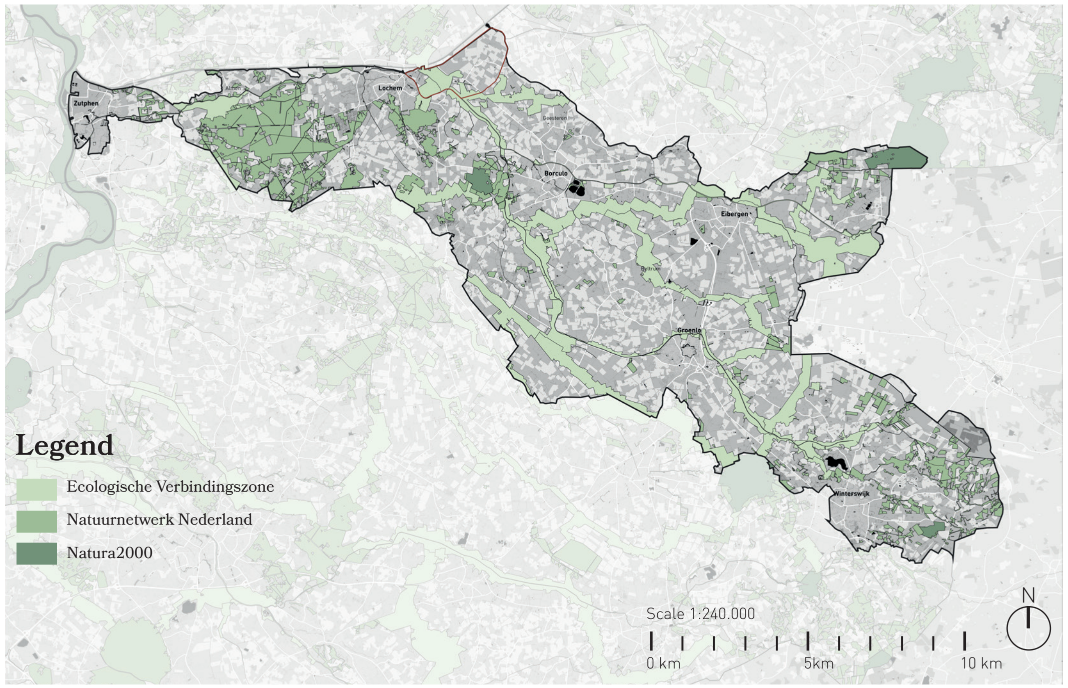



Figure 34: The three distinct zones in the berkel region



### 3.1.2 Threats to the integrated landscape

*The Achterhoek is rich in many aspects, but the tension between agriculture and nature can be felt. In theory, these two are integrated and intertwined into each other, but this can also lead to conflicting goals and needs, when one becomes dominant over the other. Other threats loom as well, mentioned in paragraph 1.3, such as climate change, increasing droughts, pollution and biodiversity loss. In the following paragrap, these threats will be researched in further dept, showing their impact on the landscape layers.*

*Changing climates*

One of the most pressing issues in the Achterhoek is climate change. While this affects the whole of the Netherlands and the rest of the world, the Achterhoek with its unique characteristics is particularly vulnerable compared to the rest of the country. In order to understand the full scope of the problem, we first analyse the current climate in the Netherlands and the Achterhoek, and research its changing aspects.

The Netherlands experiences a temperate maritime climate, characterized by moderate temperatures and consistent humidity. Currently, average annual temperatures hover around 10 degrees Celsius, with summer peaks reaching up to 24 degrees and winters dipping to approximately 0.5 degrees on average. The climate is notably wet, receiving between 800 and 875 millimetres of rainfall annually, accompanied by an average humidity level of 82% (KNMI, 2023).

However, a shift in climate conditions is happening due to climate change, which will have significant impacts on the future boundary conditions of our design. The Royal Dutch Weather Institute (KNMI) has projected the potential effects of climate change on the Netherlands, considering both high and low CO2 emission scenarios. With these scenario's, a more concrete result in the shift can be predicted.

In their projection, annual rainfall is expected to remain stable, with a shifting distribution between seasons (figure 35). Winters are projected to become significantly wetter, with up to a 24% increase in precipitation in the worst-case scenario, while summers are likely to become drier, potentially seeing a 29% decrease in rainfall. Despite these seasonal variations, the average annual rainfall may only decrease by around 4% in the worst-case scenario. The higher temperatures also cause more violent weather, resulting in flash floods and hailstorms (KNMI, 2023).

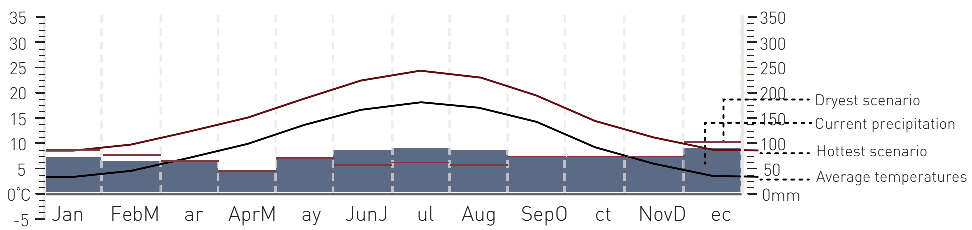



Figure 35: current and future climate scenarios (KNMI, 2023)

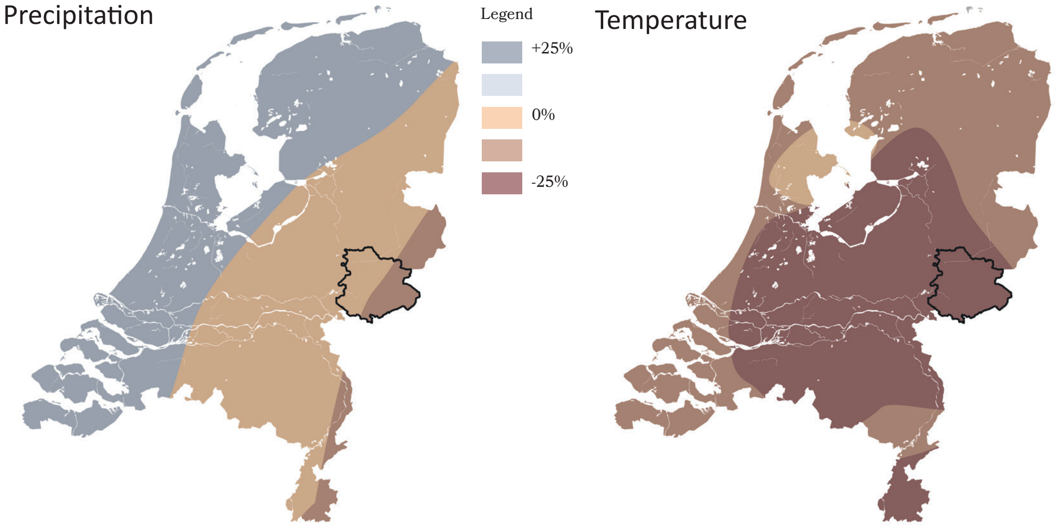



Figure 36 and 37: Expected change in rainfall and temperatures in 2050 (KNMI, 2023)

But why is the Achterhoek even more vulnerable then the rest of the Netherlands, which is already affected significantly? This has to do with multiple factors. First, the inland positioning of the Achterhoek means its climate is changed slightly more drastically then in the rest of the country, as can be seen in figure 36 and 37. In the projected scenario for 2050, the coastal regions receive similar or more precipitation, up to 20% compared to the current precipitation, while inland regions see a decrease of up to 20% (KNMI, 2023). The eastern Netherlands, where the Achterhoek is located, is projected to be the most affected by these changes due to its inland location. At the same time, the Achterhoek is located in the zone with the most significant change in temperatures, with potentially a change of up to 25% by 2050 (KNMI, 2023).

This means that the Netherlands, and especially the Achterhoek, is facing big weather changes, which has a direct effect on the availability of water, and the way the current water system is working. On top of that, the sandy soil conditions, as was highlighted in page 36, strengthens the effects of climate change. Due to the larger particle size of sand, water drains more quickly and is harder to be retained for dryer periods (Spek et al, 2010). Add the natural drainage towards the Ijsselvalley and elevated position of the region, and the relatively high vulnerability to droughts becomes evident.

*Shifting waterbalance*

Over the past decade, there has been a significant shift in water use, leading to notable changes in the water system's balance. Historically, the Netherlands received less rainfall than it does today, yet groundwater levels are currently lower. This paradox can be attributed to several factors, including increased evaporation due to rising temperaturesm, changes in vegetation, but mostly because of a dramatic increase in drainage (van Nieuwenhuijze & Klijn, 2021b).

Since the beginning of the 19th century, the landscape has been increasingly drained. To accomodate the high demand for agricultural products, more arable land was needed, which resulted in this shift in water extraction. The increased extraction of water has contributed to drier soils and reduced groundwater levels. As a result, there is less water infiltrating the soil, combined with higher rates of evaporation and an increase in groundwater extraction, as can be seen in figure 24 (van Nieuwenhuijze & Klijn, 2021b). A comparison map highlights the changes before and after canalisation: the river systems once flowed freely, but have since become highly drained, controlled, and canalised (figure 38 and 39).

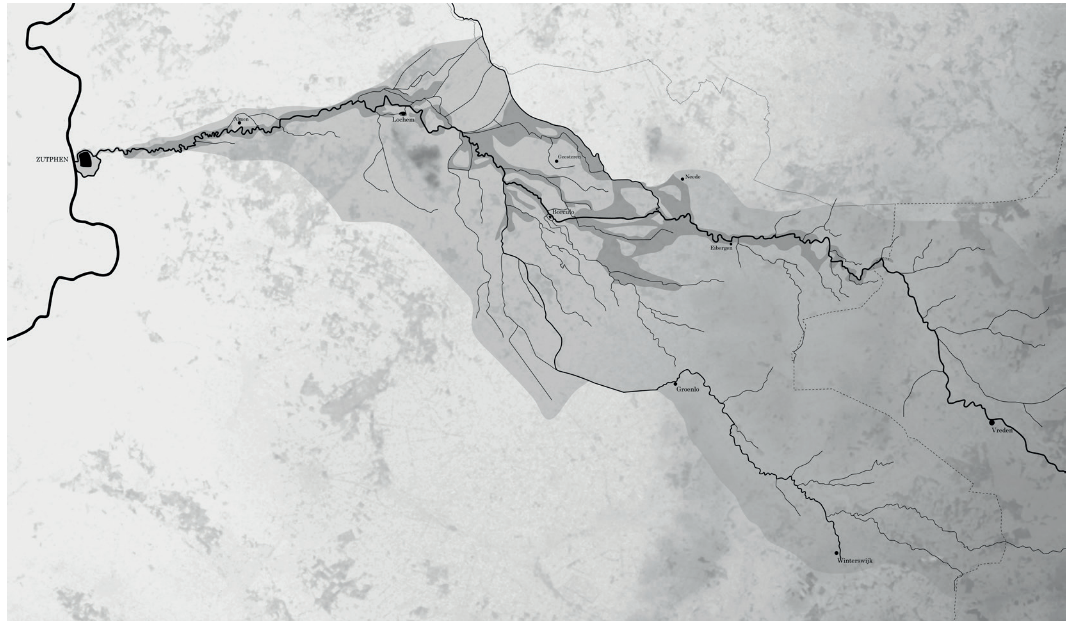


Figure 38: The free flowing Berkel in 1850 (Staring, 1844)

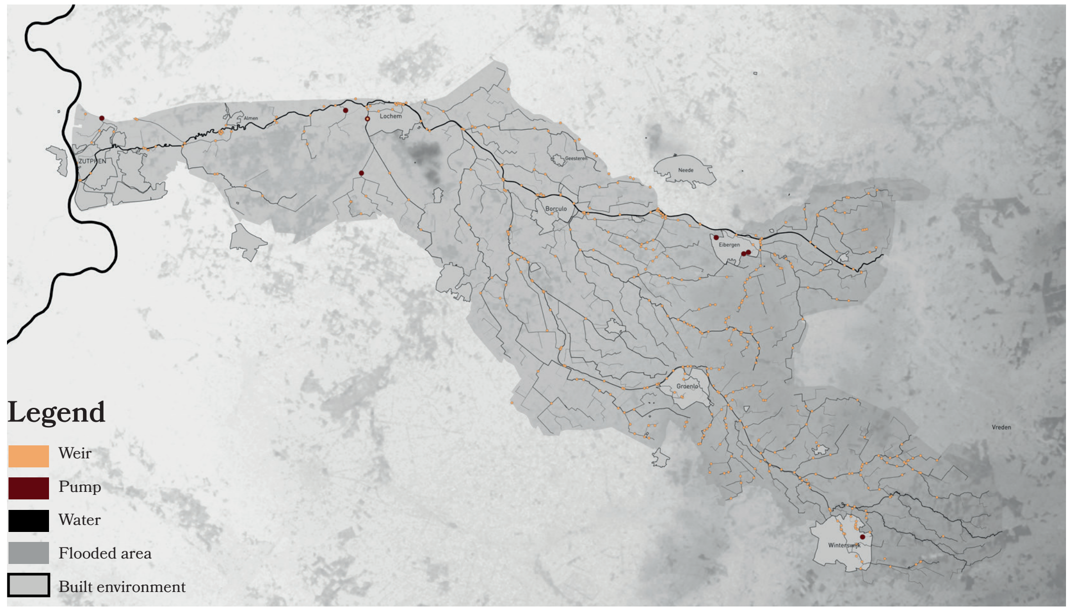



Figure 39: The current controlled system of the Berkel (WRIJ, 2024)

This transformation offers certain advantages, such as better control over water levels which prevents swampy fields during periods of high precipitation. However, this also comes with disadvantages. A lower water table, an increased need for mechanical irrigation, and challenges during droughts, result in drying landscapes and stressed natural environments.

However, the high level of control in the Achterhoek means flexibility can be achieved as well. With the right measures, the available water can be used more efficiently. Research done by landscape architectural bureau HNS resulted in the recommendation of a minimum 100mm extra groundwater storage in the region, to overcome the draughts of the future. Their analysis resulted in various recommendations in order to achieve this goal, ranging from biggest impact to small incidental measures (van Nieuwenhuijze & Klijn, 2021b):

- The biggest measures (+30mm of storage) are focused on improving infiltration in the soil, by increasing the supply of water in the area and adding more infiltration basins.
- Measures with less impact, but still an effective result (10-30mm of storage) include changing vegetation, from new agricultural crops to changing pine-forests into heathlands and deciduous forests.
- The recommendations with the smallest impact (<10mm of storage) but a relatively easy implementation include compensation of irrigation water in winter, lowering water usage of residents and increasing the sponge capacity in urban environments by adding more permeable surfaces (van Nieuwenhuijze & Klijn, 2021b).

These recommendations will be taken into consideration during the design process.

*Agricultural intensification*

The last decade has seen a large intensification in the agricultural land use as well. New innovations and improvements have led to an explosive growth of the sector, making the Netherlands one of the lead agricultural exporting countries in the world (FAO, 2022). However, this growth has come at a cost. Nitrogen emissions are one of the highest compared to other countries in Europe, with four times higher emissions per hectare then the average of European countries (TNO, 2019).

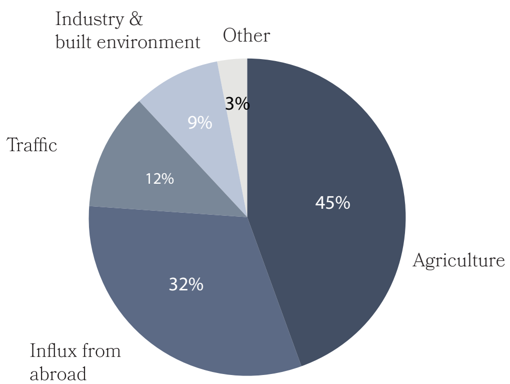



Figure 40: Nitrogen origin in the Netherlands (CBS, 2021)

Emissions in the Netherlands are largely caused by agriculture (45%), followed by foreign emissions (32%), while traffic is only responsible for 12% (figure 40; CBS, 2021). This has significant impact on nature, as nitrogen provides nutrients for certain species, therefore leading to competitive exclusion of species that are not dependent on nitrogen (Bobbink, 1998).



In 2019, the Dutch High Court decided that the Dutch government needs to take more measures in order to limit its emissions and impact on nature (RVS, 2019). This means the sector will have to reduce its emissions significantly (see figure 41), which will have a massive impact on the current farming method. Farmers have already had to go through generations of innovations and upscaling to keep up with the competition and be able to remain a competitor on a volatile market. This has caused unrest and uprising among farmers, as they feel to be the scapegoats of modern society, while the government always pushed them for increased production and efficiency (ZLTO, 2022). Politics, farmers, and nature conservation organisations are now in an impasse, unclear of what direction to take next. But in order to farm sustainably, with nature and agriculture in balance, changes will be necessary.

The Achterhoek as an agricultural region will need to make radical changes in order to become future proof and resilient to climate, with a lower impact on its surroundings. However, the agricultural tradition is vital for this area and cannot simply be replaced. Alternative scenarios for a more inclusive system, integrated with nature and water management, need to be formulated, and researched. Wageningen University and Research (WUR) created four possible scenarios, ranging from production focused to nature inclusivity (Lesschen et al., 2020). The main recommendations in the document include:

- Using the potential of technical solutions to lower emissions, such as low-emission barns and innovations in feed production, lowering the demand on foreign sources.

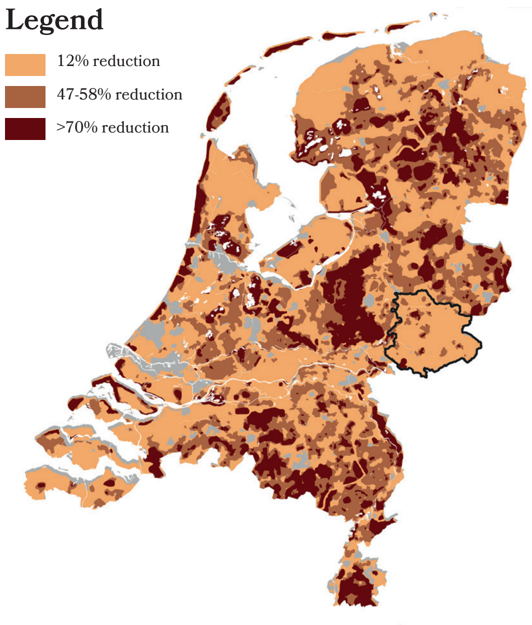



Figure 41: Recommended nitrogen-emission reduction (LNV, 2022)

- Lowering the livestock numbers to reduce the emissions and manure surplus, leaving more arable land for other uses.

The reliance on the government for financial backing can be risky, with political views shifting constantly. For more financial stability and independence, farmers could also explore diversification of its business. Different options such as touristic activities, recreation or product processing can increase the financial stability and lower the reliance on subsidies and harmful agricultural practices (Meraner, Heijman, Kuhlman, & Finger, 2013).

Alternative agricultural methods provide possible solutions as well. Nature-inclusive farming approaches such as organic, biodynamic or circular agriculture reduce the need for pesticides and artificial manure, with less manure production and nitrogen deposition as a result. At the same time, these farming methods consider the living environment it is practiced in, and increase soil health and biodiversity instead of pressuring it (Stichting Deltaplan Biodiversiteitsherstel, 2023; IUCN, 2024). This topic is further researched in paragraph 3.3.1.

*Pressured nature*

As mentioned, the agricultural intensification has led to a pressure on biodiversity. While certain nitrogen loving species are thriving, others are under threat. Globally, the biodiversity is diminishing, with over a million species facing extinction in the near future (IPBES, 2019). This is also visible in the Netherlands, where biodiversity in agricultural farmland has decreased by over 40% since 1990, and over 35% in natural areas (CLO, 2024). Main causes of this decrease include the increased intensification of agricultural practices, drying soil, monocultural crops and pesticides, leading to low water quality (figure 45). Another factor is the disappearance of cultural elements in the landscape, such as hedges and coppice groves, due to the upscaling of the plots (CLO, 2024).

Areas which were mostly impacted by this large-scale restructuring of the landscape were the elevated regions of Noord-Braband, Gelderland and Drenthe, as these have a long history of agricultural practices (see figure 43). The small scaled agricultural landscape that developed in the decennia before got adjusted radically, with a rationalised, open landscape as a result (Blom & Raap, 2022). The loss of agricultural elements, combined with industrialised agriculture, drying soil due to climate change and less rain in the future, results in vulnerable nature in the area, such as can be seen in figure 46. (Klimaateffectatlas, n.d.).

Figure 42: Revitalisation strategies are attempted in order to restore biodiversity (author, 2024)



Figure 43: Land reallotment changing the dutch landscape (Heidema, 1960)

But there are also opportunities for recovery, combined with agricultural and water system adjustments. With new, nature-inclusive farming methods, the agricultural land canbe shared again between nature and farmer. Natural enemies need to be attracted to limit plagues and pests, which can be achieved by adding back cultural elements and flower borders. By allowing space to be shared, the shattered natural areas can be reconnected once again (Spek et al., 2010).

Research done by the International Union for the Conservation of Nature (IUCN) suggests that recovery is still possible, when taking certain targets into account. These targets include 30% of the land area dedicated to protected nature as the core of the natural environment, 10% dedicated to nature inclusive agricultural practices, and 10% green-blue structures (using rivers as connecting green corridors between different areas). Meeting these criteria gives a chance of recovering from recent biodiversity loss, and creating a shared landscape between farmers and nature.

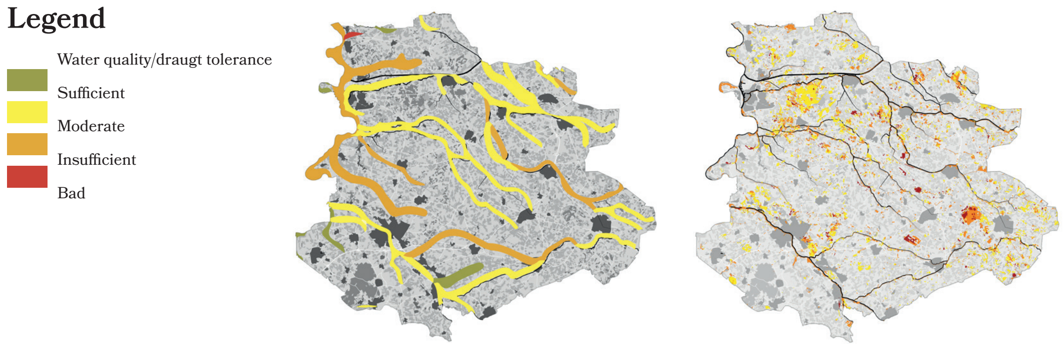



Figure 45 & 46: Water quality and draught tolerance of nature in the Achterhoek (IHW & PBL, 2022; Klimaateffectatlas, n.d.)

### 3.1.3 Summary and conclusion

The Netherlands is experiencing significant climatic and environmental changes that demand urgent attention. The current tempered maritime climate is slowly shifting into one with more extremes. Over the past decades, changes in water use and agricultural practices have further disrupted the balance of the water system. Increased evaporation, shifts in vegetation, and the extraction of groundwater for agriculture have resulted in lower groundwater levels and drier soils. This imbalance has not only impacted the natural landscape but has also intensified the need for irrigation.

The region of the Achterhoek particularly suffers from these problems. Due to its positioning on the elevated sandy soil, water drains even quicker in these areas. The intensive agricultural focus of this region creates additional pressure on the water system, as well as pollution and the loss of cultural elements, which are vital to the local wildlife to survive.

Historically canalized river systems have improved drainage for agriculture but also caused issues like lower water tables and increased irrigation needs during droughts. To adapt, strategies such as enhancing groundwater storage and adjusting vegetation are recommended.

Agriculture, particularly dairy farming, dominates the region, but this reliance on monoculture, nutrient importation, and excess manure creates environmental pressures. Moving forward, integrating more sustainable practices, reducing livestock, and exploring technical innovations is crucial. Furthermore, nature in the Achterhoek, though rich, is vulnerable due to habitat fragmentation and climate impacts. A promising path involves combining agricultural and natural restoration efforts, such as nature-inclusive farming, to restore biodiversity and reconnect fragmented ecosystems.

The region must balance its agricultural heritage with future environmental resilience by adopting sustainable water, land, and nature management strategies while considering diversified income sources like tourism.

Concrete recommendations can be concluded based on this research, with each of the themes facing their own challenges:

Water:

- Improve water infiltration into the subsoil
- Adjusting vegetation such as crops and trees to accommodate water retention
- Lower reliance on groundwater usage

Agriculture:

- Embrace (technical) innovations that lower the need for artificial manure and pesticides
- Lower livestock numbers
- Diversify the agricultural practice with additional activities on the farm
- Integrate extensive agricultural methods

Nature:

- Restore lost cultural elements
- Share the landscape with farmers through extensive farming methods
- Expand connecting corridors and natural areas to strengthen ecological structures

With these recommendations, the current separated landscape, as visualised in figure 47, is able to be reconnected again.

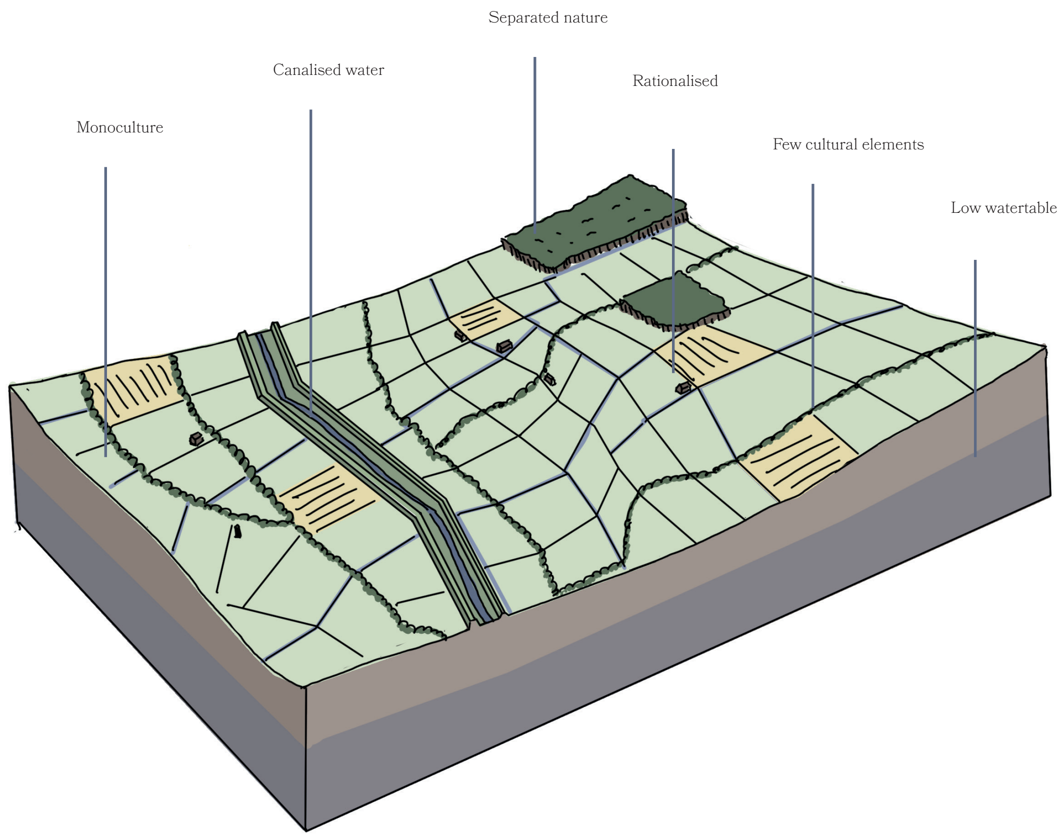



Figure 47: The current monocultural landscape in the Achterhoek (author, 2024)

## 3.2 Historic developments

*In order to understand how the current landscape developed, the geological basis of the area, we need to understand its development. In the case of the Netherlands and the Achterhoek, the biggest part of the story starts around the last Ice Age, around 11.000 years ago, and slowly evolved to the situation as we know it today.*

### 3.2.1 Evolution of the Achterhoek landscape

*Early developments*

During the Saalian period (until ~100,000 years ago), an ice formation from the north pushed up material to create the Veluwe and Montferland moraines, with the Achterhoek valley between them (see figure 48). The ice's weight compressed the material into watertight clay layers in the valley (Wassink 1999). In the subsequent Weichselian period (70,000-10,000 years ago), cold polar winds deposited sand from the North Sea, covering the landscape (Wassink 1999, Kokshoorn n.d.). When the climate warmed up again, a wet marshland developed due to poor and shallow drainage. Sand dunes, elevated above the marshlands, were the only places where people were able to settle, forming small villages (see figure 49). These villages developed further, and people learned to adapt to the marshy conditions, cultivating the drier soil. Slowly the agricultural fields expanded, due to the influx of more people and demand for more land, as can be seen in figure 50.



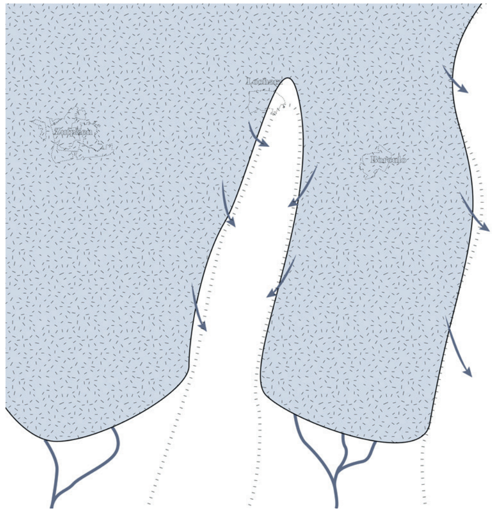


Figure 48: Ice movements in the forelast ice age (100.000 a.d.)

Figure 49: First settlers arriving in the Achterhoek (30.000 a.d.)

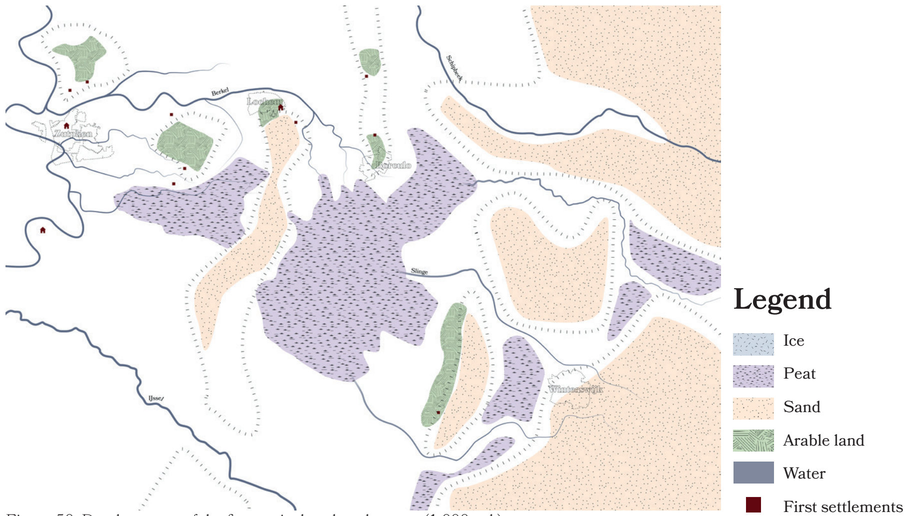



Figure 50: Developments of the first agricultural settlements (1.000 a.d.)

*Specialisation in diversification*

When space became scarce, new land was needed. Farmers developed a method that utilized each part of the landscape, called the “potstal” method. Dry heathlands were used for grazing sheep, while wet grasslands housed cows, as these lands were unsuitable for agriculture. The elevated, dry soil was fertilized using the manure from the cattle and used for crop cultivation (see figure 51 and 52). This method was developed throughout the years, and used until the 19th century (Neefjes, 2006). However, where initially the landscape was utilized as it was, throughout the years adjustments were made to make more land suitable for agriculture. This was done by increasing the drainage by connecting streams and digging new ones, as can be seen in the development from figure 51 to 52. This partially dried out the marshes, which increased the arable land and therefore agricultural production. This also increased the demand for fertilizer, but manure was scarce. Therefore, nutrients in the water were extracted by using so-called flowing meadows. With a clever system of canals and weirs, water was directed over grassland, which led to the deposition of nutrients and sediments (Baaijens et al., 2011; Neefjes, 2006). The complex system was not maintained by individual farmers but was often organised in Marken. These were agricultural communities, who shared the workload together and had a bigger voice in the local community. These systems are explained in more detail in paragraph 3.2.2.

*The servant landscape.*

When the industrial revolution hit the Netherlands, these systems quickly became obsolete. Modern technologies to cultivate the land, such as mechanical irrigation and chemical fertilizers, put an end to both flowing meadows and the communal Marken. The industrialisation program, initiated by the gov-ernment, gained momentum after the second world war, when agricultural produce became scarce. The land was reorganised and industrialised, in order to increase the agricultural efficiency and produce enough food for the whole country. Largescale land reallotment programs combined small, unreachable plots into large, rational fields, and drainage was increased. Farmers were pushed to specialise and up-scale, leading to increased pollution and a monocultural landscape. The cultural elements, once needed in the old system, were removed to increase the arable land (Barends, 1981; Blom & Raap, 2022). The approach towards the landscape shifted from a system which utilized each available aspect, to making a servant out of the landscape for agricultural need.

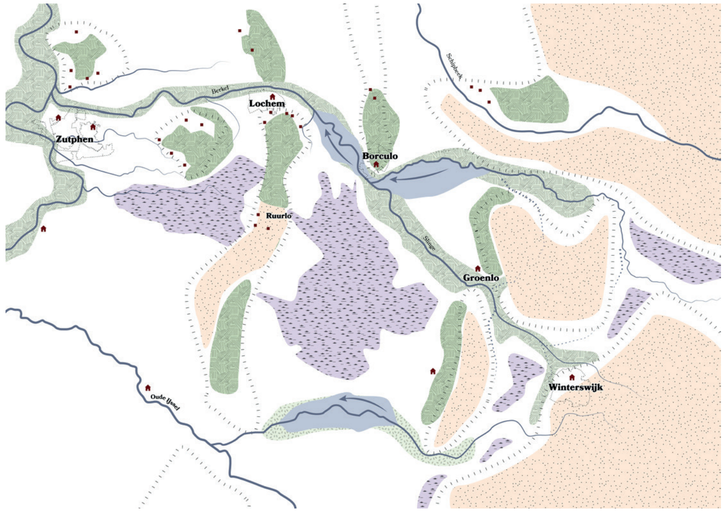



Figure 51: The development of the potstal-method (500-1000)

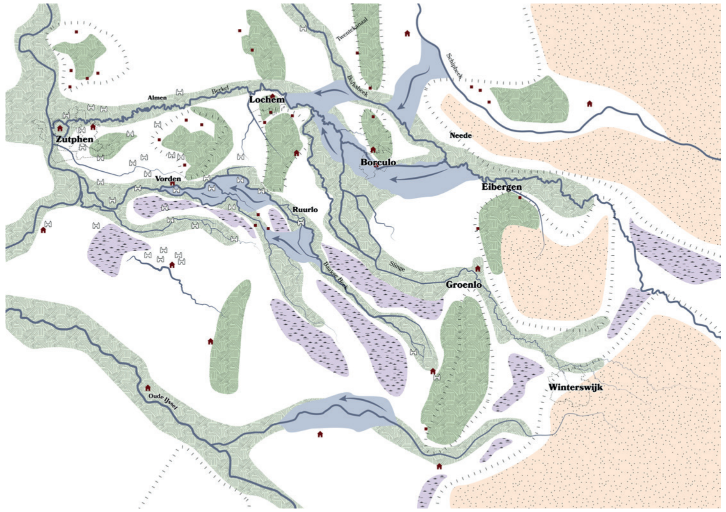



Figure 52: Fowing meadows in full effect (1500-1700.)


Figure 53: Transforming to an industrial landscape (1800-1900)

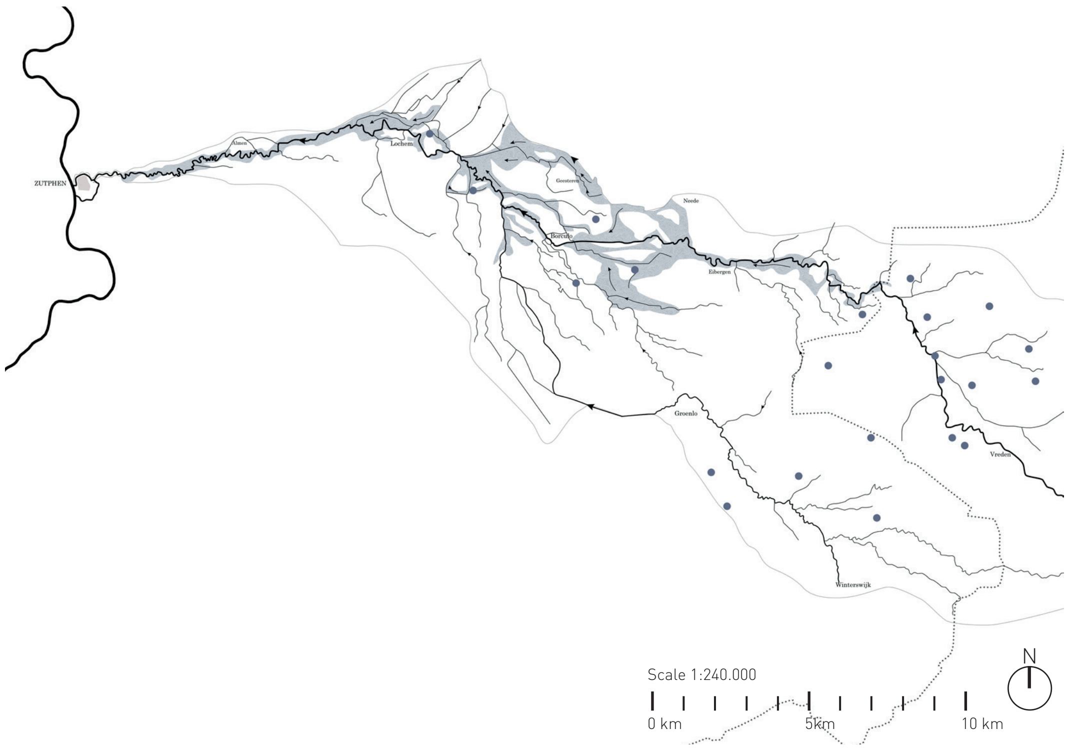



Figure 54: Traces of flowing meadows (Baaijens, Brinckmann et al. 2011)

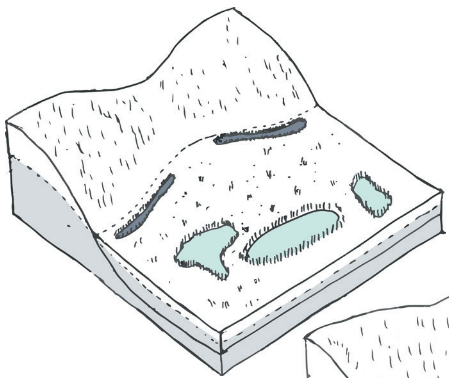


Figure 55: Two types of water

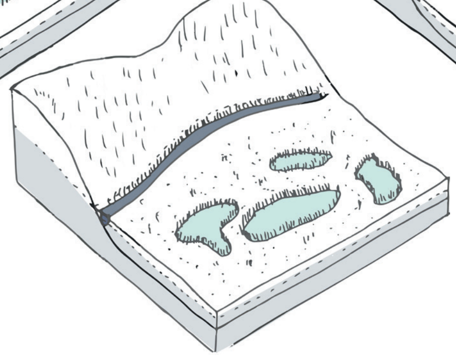


Figure 56: Extracting nutrient rich water

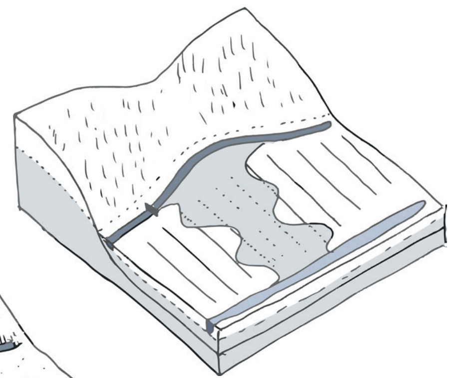


Figure 57: Flowing extracted water



### 3.2.2 Development of the themes

*In this paragraph we will explore the development of the themes of water, nature, and agriculture in more depth. Flowing meadows and Marken were examples of men using and working together with nature, to make the most out of the limited resources that were available. These aspects will be analysed in more detail in this chapter.*

*Flowing water*

The "flowing meadows" irrigation method, used historically for agricultural purposes, can be found throughout the Netherlands and several other countries. The Dutch system has recently been recognized as UNESCO World Intangible Heritage, together with six other countries in Europe where similar systems can be found (Unesco, 2023). Traces of this technique, which utilizes natural elevation to guide water across fields from high to low, are also found in our research area in the Achterhoek (Baaijens et al. 2011).

In this report we will focus on the Dutch version of this irrigation system, though it has been used in many parts of Europe, highlighting its widespread historical significance. In the Achterhoek, many traces have been found regarding the system. From historic sources such as maps and written documents, to landscape elements related to the system (see figure 54).

Flowing meadows were an agricultural irrigation and fertilization system, which made use of the natural elevations in the terrain. Water, which contained valuable nutrients, was directed over grassland to harvest these nutrients. The nutrients sedimented on the grass, leaving a tiny layer of fertile soil which improved the yield from the grassland. This was primarily done in winter when water levels were higher. Sometimes flowing was done in drier periods, for irrigation purposes (Baaijens et al., 2011).

As mentioned, the system developed in the Middle Ages. It is unknown exactly when, but traces go back to the 13th century (Baaijens et al., 2011). The development of the system came out of necessity, due to the limited availability of arable land. Fertile and dry soil was scarce, and all the available manure from cattle was needed on the most productive fields. To improve grass production to help feed the cattle and get more manure, grass was fertilized using the flowing meadows. Two types of water quality were found: acidic swamp water, which plants despised, and nutrient and mineral rich springwater, springing from hills in the landscape. The springwater was alkaline and contained minerals from the soil, which had the benefits farmers needed (Baaijens et al., 2011; Neefjes, 2006).

This water comes to the surface at the edge of sand ridges (figure 55) and needed to be harvested to be able to make use of it. Springs were deepened and connected (figure 56) before it could be used for flowing purposes (figure 57). Sometimes small ridges were constructed in order to prevent the low- and high-quality water to mix (Baaijens et al., 2011).

The flowing on the fields is explained in the next diagram (figure 59). The nutrient rich water was transported downstream to areas where farming was executed. Using a system of canals, the water was directed along the flanks of a hill (1). The water is transported in natural looking creeks, provided with artificial meanders that slow down the waterflow and prevent erosion and extra maintenance (2). Using weirs, the height of the water can be controlled (3). An inlet next to the weir can be opened during high availability of water, which flows water into a small channel, and directed over the land with a large, half-moon shaped shovel called a "kroef" or "kruufke"(see image 50) (4), and allow it to flow over the grasslands (5). At the lowest part, a collection ditch (6) collects the water again and transports it to a larger canal (7), which joins up with the original river further downstream. This process of collecting, raising, flowing, and collecting again can be repeated multiple times in the same river, however the nutrients will decrease as well (Baaijens et al. 2011).

<u>What benefits did flowing meadows bring?</u>

Numerous benefits were gained from flowing with water (Baaijens et al. 2011):

- Frost protection: in winter, the soil would normally freeze and prevent growth in early spring. The flowing of water insulates the ground and prevents frost.
- Nitrogen deposition: Plants that help binding nitrogen in the soil, are protected from frost, which increases the nitrogen deposition they can provide.
- Fertilization: sediments from the river contain important nutrients for the soil, such as calcium, magnesium, nitrogen, phosphate, and potassium.
- Weed control: weeds are suppressed with iron in the water, such as mosses.
- Pest control: Moles, grubs, and wireworms, damaging to crops and grass, do not enjoy wet feet.
- Spreading the workload: flowing one field meant mowing the other. Alternating between fields allowed for a more balanced workload.
- Attracting birds: grassland birds come to feast on the worms and pests that float to the surface, bringing additional nutrients with their droppings.
- Irrigation: In drier periods, water could be used for irrigation, with less focus on the sedimentation benefits.

One person could not maintain the complexity of the system. Local agricultural communities called Marken worked together on this system, developing, and maintaining it. Together they were able to cultivate more land, harvest more water and share the workload among the community (Baaijens et al. 2011). We will take a more detailed look at Marken in the following paragraph.

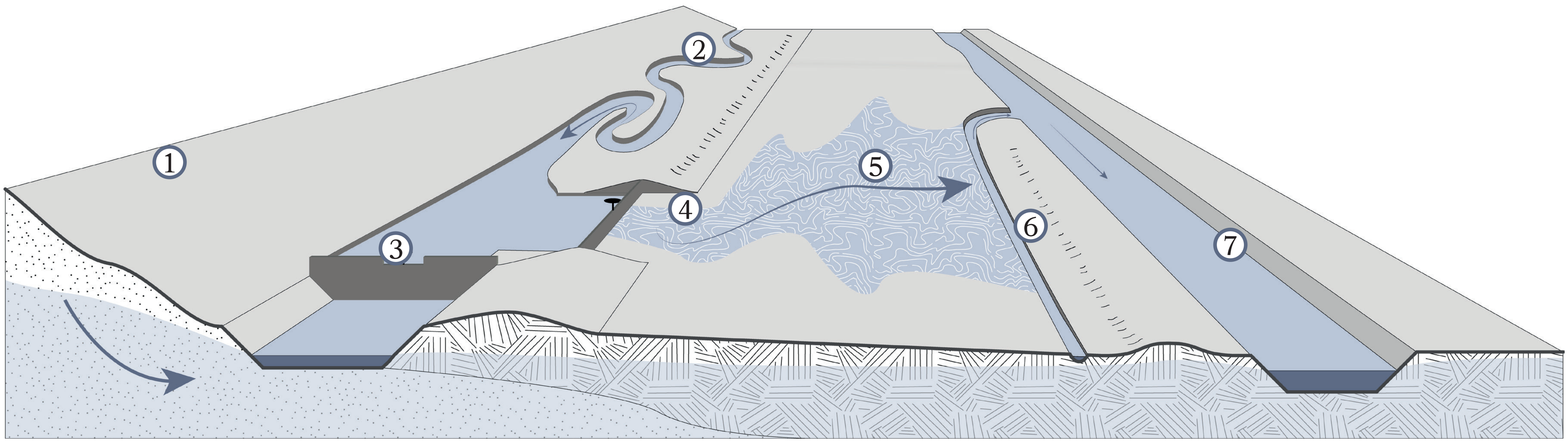



Figure 59: Various aspects of flowing meadows

Figure 60: A “Kruufke” inserted in the flowing canal, forcing water over the land (Author, 2024)

*Agriculture and nature*

As mentioned in paragraph 3.2.1, the medieval landscape of the Achterhoek mostly consisted of wet marshlands and a couple of dry sand dunes suitable for agriculture. This limited availability of space meant the farmers had to be inventive and utilize every part of the landscape in order to survive. Initially, farmers cultivated the land individually, with small agricultural plots. However, with a growing population, people started organizing themselves in so called "Marken." These were agricultural communities, consisting of a couple of families that owned a larger piece of land together, usually provided by the ruling lord of the region (Bieleman, 2008).

Farmers collaborated to cultivate larger areas of wild nature into arable land, but they faced challenges due to the scarcity of manure. The poor, sandy soil required fertilization, and the system of flowing meadows, which farmers developed and maintained together, played a vital role in manure production. To maximize agricultural output with limited resources, the Potstalmethode, or "deep litter" method, was introduced (Raap, 2022). Cows grazing the grasslands were kept indoors at night, and their droppings were collected using heath sods dug from the dry heathlands, which were part of the Marke. These enriched sods were then used to fertilize the agricultural fields (Bieleman, 2008; Neefjes, 2006). Manure was a scarcity, and therefore natural fertilization through flowing meadows provided valuable nutrients to otherwise unvaluable grasslands. The higher grass production meant more manure production, which resulted in more yield from the fields. The complexity of the system required the cooperation of several farmers however, making the existence of both Marken and flowing meadows deeply intertwined (Baaijens et al., 2011).

Seasonal water management was crucial to agriculture, providing different benefits throughout the year. In winter, when water availability was highest, flowing meadows helped start the growing season earlier, allowing for an early yield of grass. From March to November, cattle grazed the fields, enriching the soil with nutrients to support year-round crop growth. Fluctuating water levels in winter facilitated this, while stored water was used to combat summer droughts, ensuring a steady supply during the hotter months (Baaijens et al., 2011).

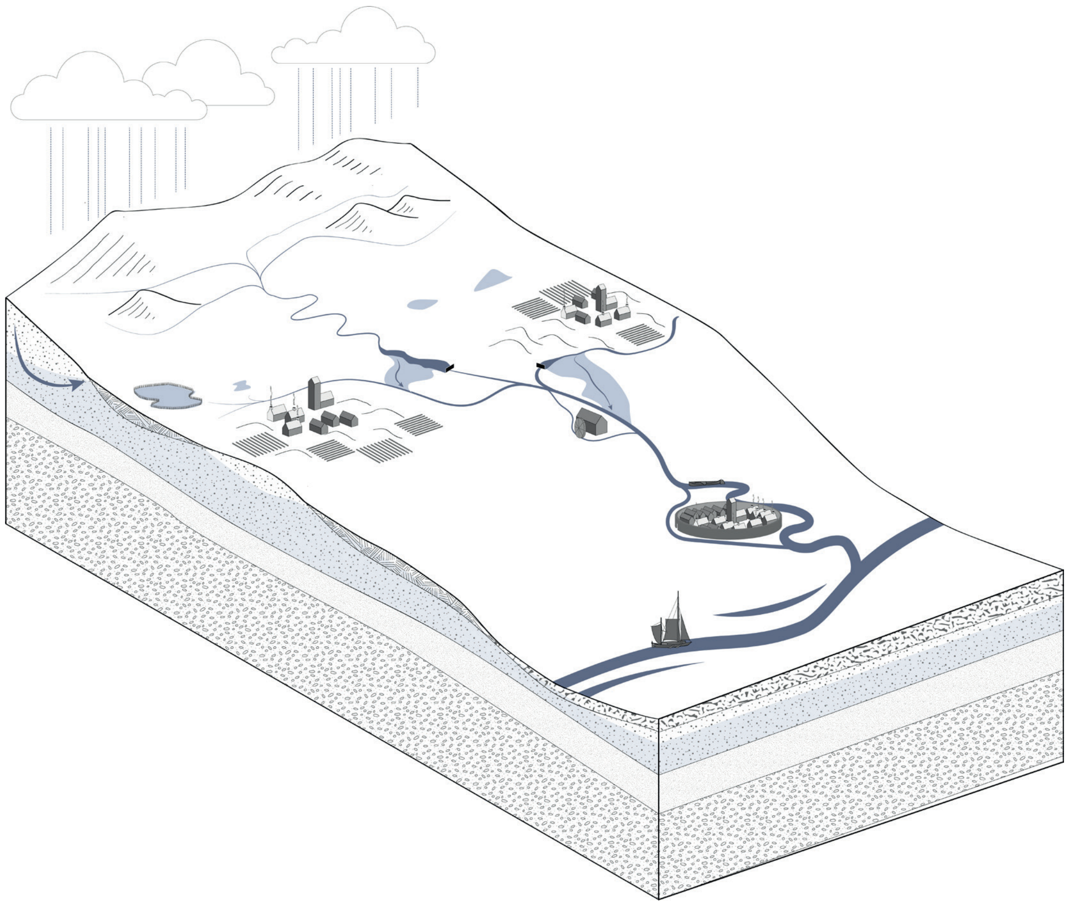


Figure 61: Agricultural communties maintaining the flowing meadows

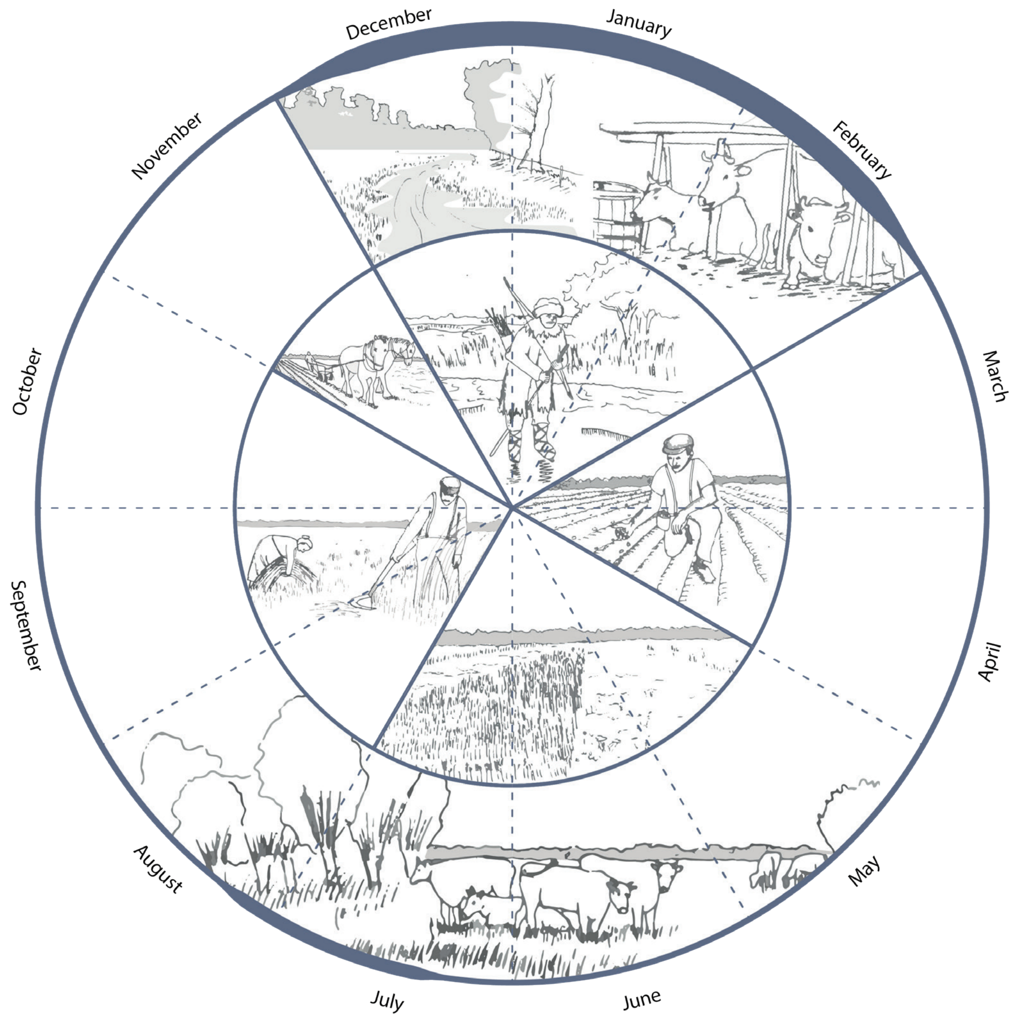



Figure 62: Seasonality of the system

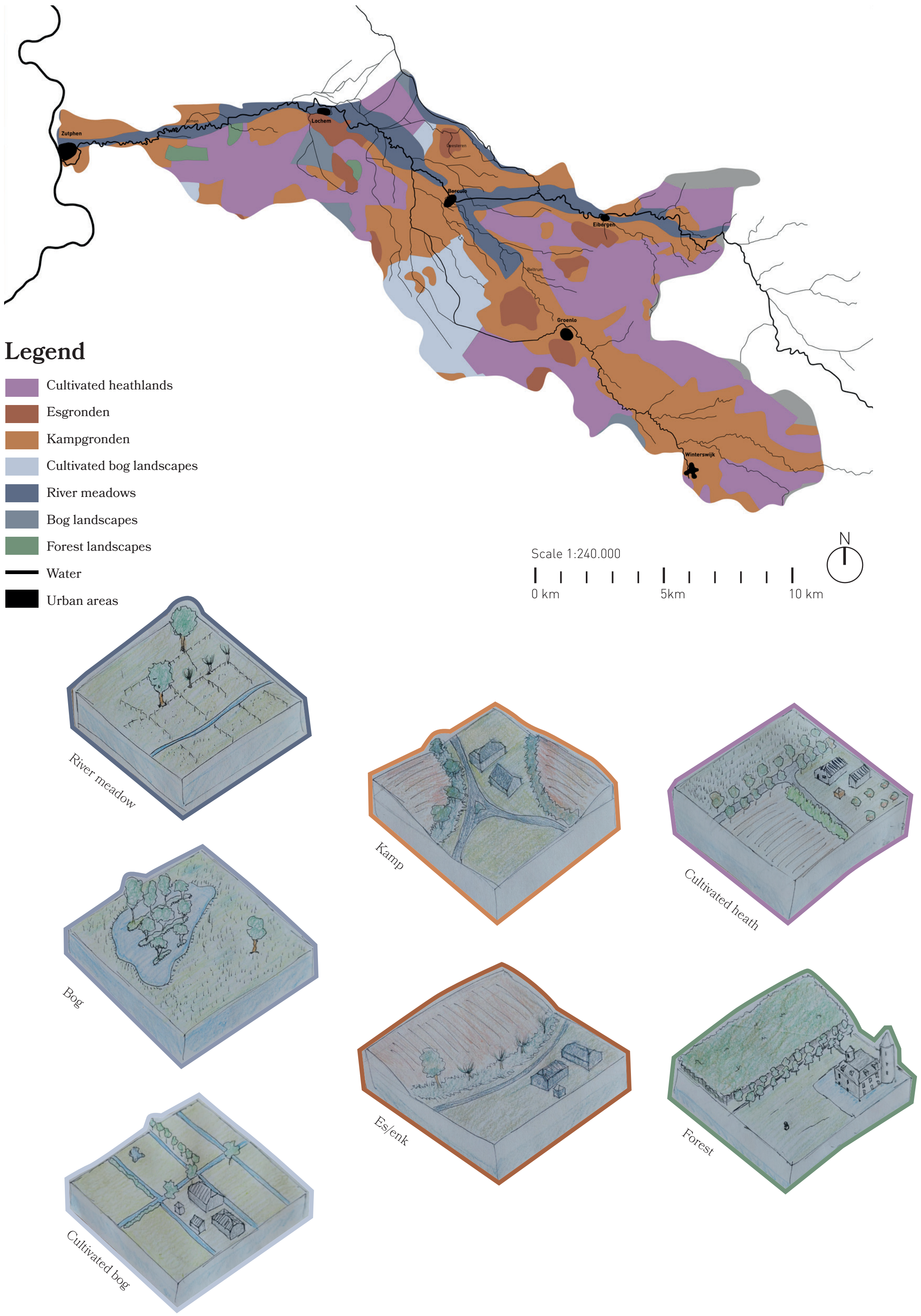





Figure 63: Landscape typologies in the Berkel region (SLG, n.d.)

This agricultural method exemplifies the interaction between farmers and nature. Farmland and nature were intertwined, as the land was shared between the two. Woods provided firewood and tools, and drinking pools in the heathlands became breeding grounds for certain species. But there were more elements part of the agricultural landscape in the Achterhoek, that benefited both nature and agriculture. These elements are currently not in use anymore, but still define different typologies in the landscape. The map in figure 63 shows the distribution of these different elements in the Achterhoek.

## Kampgronden

The oldest agricultural fields in the Berkel region are characterized by small, circular-shaped areas, typically surrounded by hedges and treelines. These fields represent the earliest agricultural developments in the area, created on the high grounds, which were not as wet and swampy as the surroundings. They were established by individual farmers who settled on the lower ground adjacent to the "Kamp". These early farming practices shaped the landscape, creating a distinct pattern that reflects the region's agricultural origins. Nowadays, most of the Kampen have disappeared, but the elevations in the landscape are still a clear indication of former fields. Another sign of this landscape type are the twisted roads, which would meander in between the high grounds in order to provide access to the agricultural fields.

## Esgronden/Enken

Similar to "Kampen" were the "Esgronden" or "Enken". These were larger, communal agricultural fields, sometimes the result of multiple Kampen growing together, or a larger high spot that was cultivated in one go. The Es was surrounded by a hedgerow, in order to keep cattle from destroying the crops. The difference between Essen and Kampen were that multiple families maintained the Essen, without a clear division. On the edge of the Es, often a small village or hamlet developed. Nowadays, the former Essen can be recognized by a larger circular patch of agricultural fields, which have been subdivided into rational plots. An elevation change and the proximity of a rural town are other indicators for former Esgronden.

## Forest landscapes

Forests were much more common in the Middle Ages then they are now, as they had multiple purposes. Initially they were often planted to prevent the lose sandy soil from blowing away, providing protection for farmlands and wood for heating and tools. Halfway the Middle Ages they were often incorporated in the grounds belonging to an estate, where the local lord or duke could use them for hunting grounds. Nowadays these woods are attractive recreational spaces for cyclists and pedestrians. Long lanes of oak and beach in the middle of the forest are indicators of the presence of a (former) estate, as can be seen in the forests around the castle of Ampsen..

## Bog landscape (broeklandschap)

The bog often surrounded the rivers or concentrated in lower spots in the landscapes, with standing water most of the year. They were uninhabitable lands and used for the grazing of cows whenever possible. The only trees that were able to grow in these harsh conditions were eldar trees, which were commonly planted on small ridges that were dug from the wet peat, called "Rabbatten." The wood from this tree was used for firewood and tools. In this way, even the lowest quality land was able to be utilized. Currently there are no remaining bog landscapes, as they have all been cultivated and drained. In some places, a historic Rabbat Forest remains.

## River meadow landscape

The river meadows were, as the name suggests, meadows along the river. This area was often too wet to be cultivated for crops or lived on. Therefore, this was used for growing grass for cattle to graze on. The landscape was typified by an open landscape, with pollard trees and solitary, wet tolerant trees such as Eldar and Willow. Cultivation patterns were often perpendicular to the river, making them easy to recognise. These cultivation patterns are nowadays still recognisable, as well as the relative openness of this type of landscape.

## Cultivated heath landscape

In the Middle Ages, most of the landscape consisted of woodlands, bogs, and heath. Heath is a drought loving plant, which thrives in poor soil types such as sand. The heathlands were often utilized for grazing sheep and digging out sods from the soil, which were used in the sheds to collect the droppings of the cattle. When there was a high demand for new cultivated grounds in the 1900s, these heathlands were rationalised and cultivated using machinery and chemical fertilizers. Nowadays, these cultivated heathlands are recognisable by their small, linear cultivation patterns, with very few ditches and located on the more elevated grounds.

## Cultivated bog landscape

Similar to the cultivated heath landscapes, the cultivated bog landscape is a relatively new landscape type. In the 1900s, drainage of the swampy bogs, as described before, was improved with pumps and ditches. A rational landscape with canals, some rows of trees and new houses emerged. Nowadays these cultivated bog landscapes can be typified by their openness, and large plot sizes.



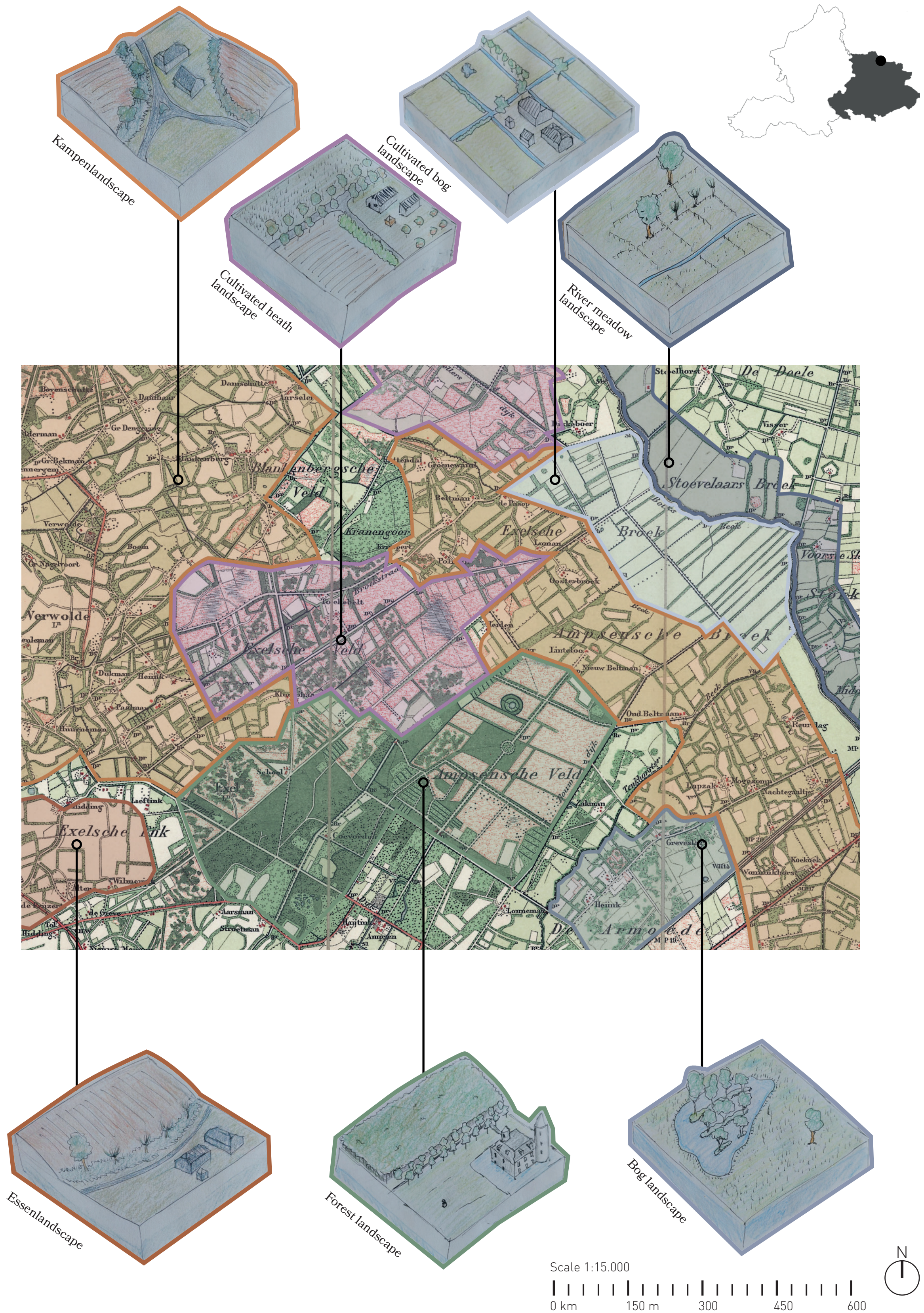





Figure 64: Different landscape typologies in the area around the castle of Ampsen, Lochem (Author, 2024)

*Downfall*

When the industrial revolution of the 19th century reached the Netherlands, it brought substantial changes to the water management, agriculture, and landscape. Chemical fertilizer meant that the flowing meadows became redundant. Suddenly the wilderness became available for agriculture, when the shortages of manure were supplemented with the chemical fertilizer (Baaijens et al., 2011). New insights in water management and mechanical drainage helped to dry the soil, ensuring even more arable land for farmers. At the same time, the government promoted land reallotment programs, in order to rationalize the inefficiency of the cultural landscape. With a push for industrialised agriculture, the Marken were divided into individual farms, further improving the agricultural production. Farms became specialised in one practice, such as agriculture, cattle farming, or horticulture. Bigger was deemed better, ensuring the national supply of food (Raap, 2022). With the problems that evolved from this trend in the past one hundred years, we can see the downsides of the new system.

### 3.2.3 Summary and conclusions

The landscape of the Achterhoek in the Netherlands developed over thousands of years, beginning with the Ice Age, and evolving through natural and human interventions. The Saalian ice formation created the Veluwe and Montferland moraines, with the Achterhoek valley in between, and subsequent periods saw the deposit of sand and formation of marshlands. Early human settlements were limited to sand dunes above the marshes, and as agriculture developed, people adapted to the wet, marshy environment. Farmers used innovative techniques like the Potstalmethode, which involved using manure to fertilize dry heathlands for crop cultivation, as is visualised in figure 65. They also expanded agriculture by improving drainage systems, creating new arable land from previously unusable marshes. Flowing meadows, a communal system that used nutrient-rich water to fertilize grasslands, played a key role in the region's agricultural productivity.

However, with the industrial revolution in the 19th century, these traditional agricultural methods became obsolete. The introduction of mechanical irrigation and chemical fertilizers allowed for large-scale land reorganization, making flowing meadows and communal farming structures like the Marken unnecessary. The government promoted land consolidation programs to increase efficiency, and farms began to specialize in monoculture practices. This shift transformed the landscape, resulting in the loss of many of the natural and cultural elements that had once been central to sustainable farming. Today, these changes are seen as a major factor in the environmental and agricultural challenges the region faces.

To conclude, we will answer the sub question stated in chapter 5:

> *"How has the disbalance between water management, nature and agriculture developed?"*

The evolution of the balance between water management, nature, and agriculture reveals a shift from the integrated practices of the past to the more segmented and often disruptive approaches of today. The Marken system, despite being labour-intensive and inefficient, effectively utilized the entire landscape gradient, aligning agricultural practices with natural conditions. This created a harmonious relationship between nature and agriculture, where diverse landscapes supported various species that, in turn, contributed to pest control and soil fertilization, offsetting nutrient deficiencies.

Over time, the modern agricultural system has introduced greater productivity, allowing the Netherlands to exceed its local needs and supply beyond its borders. However, this advancement has come at a cost, with current practices often disrupting the environment and straying from the symbiosis seen in earlier methods. The challenge now is to address these limitations by bridging the gap between the nature-inclusive practices of the past and the productivity-focused methods of the present. Achieving this balance involves integrating ecological benefits from traditional systems with the efficiency of modern agriculture, paving the way for a more sustainable and resilient future.

To explore how this balance can be achieved, we will examine alternative solutions presented by two projects and assess their potential advantages and drawbacks in the following chapter.

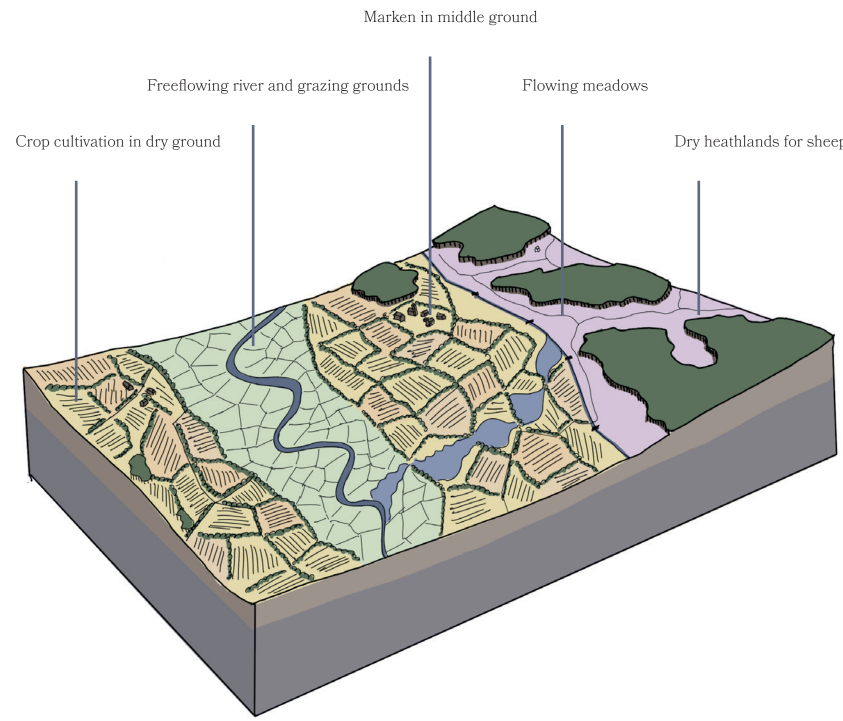



Figure 65: The former balance in the agricultural landscape, relying on each available aspect (author, 2024)

Figure 66: Communal buildings of the farm at Urtica de Vijfsprong (Author, 2024)

FIgure 67: Picking garden at Urtica de Vijfsprong (author, 2024)

## 3.3 Alternative approaches

*As mentioned in paragraph 3.1, water management, agriculture and nature need an innovative approach. Inspiration for a potential future was drawn from the past, with the soil-based approach of farmers in the medieval Marken, where communities worked together to sustain themselves with limited resources, and flowing meadows, which were a nature-based solution for a problem of the time.*

*But the current situation is not comparable to the past. There are new boundaries and limitations in place, which prevent the re-implementation of these old systems. As concluded chapter 3.2, we might not want the literal restoration of these old systems, as they would not serve the same purpose today.*

*In this chapter, we look at alternatives in the fields of agriculture and water systems, through three case studies: communal farm Urtica de Vijfsprong, organic seed production farm Vitalis and the water system of estate het Lankheet. The analysis will help us to answer the sub question:*

> *"What design strategies can be employed in order to rebalance water management, nature and agriculture?"*

### 3.3.1 Alternative agricultural practices

As a reaction to the increasingly industrial practice in the end of the last century, althernative forms of agriculture started to develop, with a focus on balancing the system in various degrees. Different approaches to this were founded and developed over the years, but they can be grouped in four different categories:

<u>Integrated agriculture</u>

The aim of this form of agriculture is to integrate nature management into the agricultural practice, in order to balance the system and limit the footprint on the earth. Minimizing use of artificial manure and the use of pesticides, using renewable sources of energy and integrating ecological elements in the landscape are the main rules in integrated agricultural practice (Milieu Centraal, n.d.).

<u>Organic agriculture</u>

Organic agriculture takes this a step furter and strictly prohibits the use of chemical fertilizers and artificial manure, but use tools to control weeds. On top of that, crops are grown in soil, and animals are allowed more space and is able to roam outside more often then in the previous forms of agriculture (Milieu Centraal, n.d.).

<u>Bio-dynamic agriculture</u>

This form of agriculture considers every aspect of nature and the cosmos to be part of a holistic system. Bio-dynamic farms are a mix of crops and cattle farming, as the feed is circulated on the farm itself, limiting the amount of cattle to the amount of feed that can be produced on its own land. The manure is then circulated back onto the land, closing the cycle. Other organic rules still apply, such as the ban on artificial manure and pesticides (Milieu Centraal, n.d.).

<u>Circular agriculture</u>

This relatively new form of agriculture aims to prevent the waste production. Residual products from farms and the food industry are circulated between farms and used as cattle feed, while the agricultural land is mainly used to produce food for people. Furthermore, the use of artificial manure is limited, keeping the soil conditions and fertility in mind. Resistant crops are chosen to prevent the use of pesticides, while the amount of cattle is limited by the amount of manure that can be spread no the land (Milieu Centraal, n.d.).

Other forms of agriculture exist as well, such as nature inclusive agriculture, agroforestry, paludiculture, permaculture etc. These forms of agriculture can mostly be grouped under one of the categories above, but all have their own rules and aims.  In the interest of this thesis we focus on the typologies mentioned above. To understand the functioning of different types of farms, we researched two different farms with each a different approach to agriculture. The first one is a bio-dynamic farm combined with a healthcare branch, while the second one is an organic breeding farm that employs various innovations in order to develop new sustainable crops and methods.

*A communal farming method*

Urtica de Vijfsprong is a biodynamic farm in the Achterhoek near Vorden. We visited the location and spoke with the farmer, Guus van Imhoff, and director, Bram van den Esker, to understand the complex organisation of the farm and healthcare institute.

The farm consists of two main organisations: Urtica, the healthcare branch, and de Vijfsprong, which is the agricultural branch. The two work independently on a financial level but live in symbiosis with each other (see figure 68).

The farming branch is the core of the farm's operations, producing a range of dairy products and crops. It focuses on maintaining the land according to biodynamic practices, where nature stands central in the decision making. Grass fields are maintained sustainably, combining ecological areas alongside more conventional grasslands. This branch generates its own revenue, supporting the farm's continued growth and sustainability.

The healthcare branch serves individuals with mental health needs, providing meaningful work and therapeutic engagement. People in this branch contribute to a variety of farm activities, which supports the farmer in his daily needs, as well as running a shop that sells local produce, participating in cheesemaking, and wool spinning. By integrating into the farm's daily operations, individuals in the healthcare branch not only support the farming activities but also gain valuable skills and a sense of purpose.

Together, the two branches create a holistic environment where farming and care for people and the land come together in a mutually beneficial way.

*Pros and cons*

While the interaction between the two branches provides a lot of advantages, the downsides must be acknowledged as well.

Mixing the organisations creates a field of tension when it comes to sharing the workload. Collaborating with clients can result in variations in available workforce on the farm, while the workload has its own fluctuations unrelated to that. But on the other hand, involving clients in a functioning business adds to the therapeutic value as well, as a certain amount of responsibility gives a sense of purpose in their daily lives. At the same time, the extra hands on the farm support the farm and helps sustain the business.

Working with nature can have both its advantages and disadvantages. Nature is considered a part of the philosophy of Urtica de Vijfsprong, with the responsibility for taking care of the earth is seen as the basis. This is reflected in their holistic

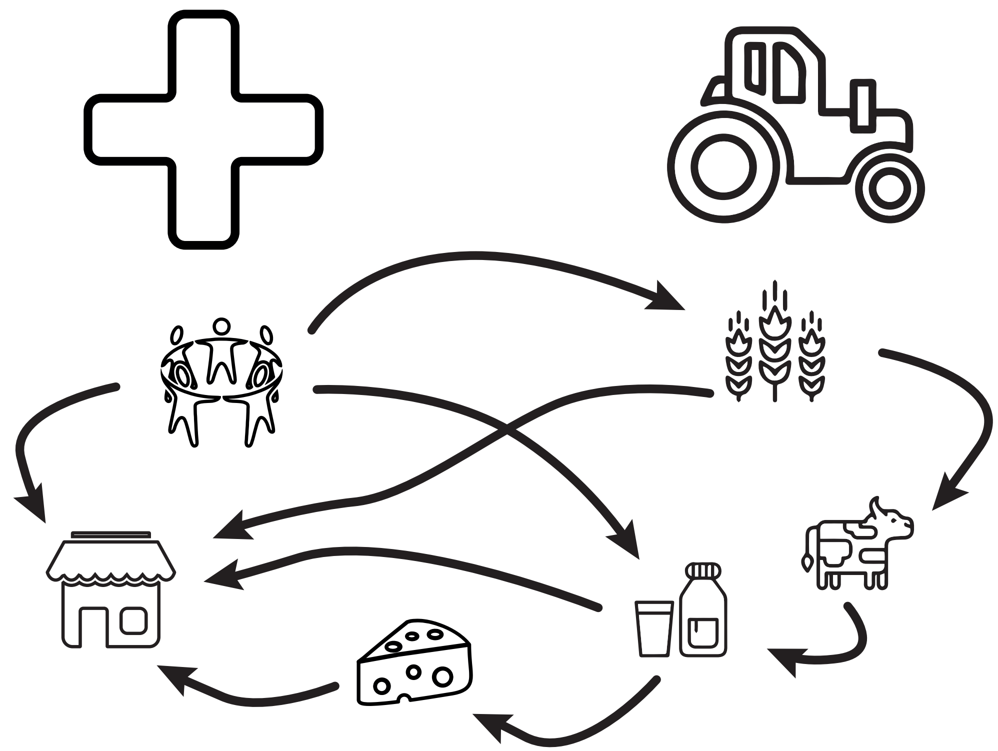


Figure 68: Schematic representation of the different activities at Urtica de Vijfsprong

biodynamic approach, where the whole biosphere and beyond is part of the decision-making process at the farm. While the farm consists of grass meadows for cattle, part of these meadows is maintained as "herb meadows," a mix of wild plants and grasses. This, in combination with plots of forest, boosts biodiversity at the farm. However, by farming in this way, fluctuations in production are inevitable. There is less control in the system then in conventional farming, which can result in lower milk production when cows experience harsh weather or other natural fluctuations. This affects the entire farming operation and requires a flexible approach.

Diversification through the healthcare branch brings both challenges and advantages. While specialization is essential for maximizing production and ensuring financial stability for individual farmers, diversification typically results in lower yields—too low for a conventional farmer to sustain. However, by incorporating a healthcare branch into the organization, extensive farming becomes viable. The additional financial support from the healthcare branch offsets the inefficiencies of extensive farming, making it a sustainable approach despite its lower productivity. At the same time, the value for the local community increases as well, with the farm shop, activities organised and a picking garden, on top of the benefits of clients at Urtica. However, combining the two operations requires an administrative section, which demands additional personnel.

*Sustainable innovations*

The second example of an alternative approach to agriculture comes from organic crop breeder Vitalis, a farm located near the small town of Voorst near Zutphen in the Netherlands. This farm is different from other farms, as it does not focus on the production of crops, but the cultivation of new varieties and the production of seed for certain crops, such as pumpkin, lettuce, carrot and other vegetables.

The farm has an organic label, meaning that it does not use pesticides or artificial manure, but also limits the amount of manure used in general, while thinking about maintaining ecological elements and implementing new ones such as flower borders, drinking pools and hedges. Weeds are removed by hand, which is labour intensive but does not disturb the subsoil or leave a lasting impact, compared to pesticides. Sometimes biodegradable plastic is used to cover bare soil around the crops, to limit unwanted growth.

To prevent deseases and exhaustion of the soil, crops are on a four year rotation. Each year, crops are placed in a different plot, in order to prevent diseases such as phytoftera to remain in the soil and harm the plants next season. Once every four years, a "resting" crop is grown, aimed at restoring nitrogen levels and giving the soil time to recover. Lupine and clover are examples of plants that are sown, which help fixing nitrogen in the soil in their roots. At the same time, at no point the soil is left barren. After harvest, mixes of clover, grain or lupine are sown to maintain the soils health and nutrient levels.



Figure 69: different crops live in symbiosis in strip cultivation (author, 2024)

Figure 70: Plant breeder Marcel van Diemen showing the complexity of the planting scheme on Vitalis (Velema, 2023)

Another interesting aspect about Vitalis is its testing ground for new agricultural methods. The small scale of the farm, with the large variety of crops compared to more conventional agricultural farms, make it uniquely suitable for the testing of new innovations. Wageningen University and Research (WUR) performs tests on the application of strip cultivation, a relatively new farming method where different crops are planted in rows next to each other (see figure 69 and 70). Different crops have different strengths and weaknesses, which can benefit other varieties of crops. Natural enemies are attracted to a particular species, which helps to prevent pests in others, for example. Tests are still ongoing, but results are promising, showing a decrease in the spread of diseases and pests.

*Main takings*

These two approaches are vastly different from each other, with one gaining more value through the cooperation between different elements in the farm, benefitting people, nature and the soil, and the other focusing on alternative solutions to maintain production efficiency in a nature inclusive manner.

Integrating different elements in the farming practice, such as a healthcare branche for example, does bring complexity to the business. However, the focus shifts from production quantity to quality, with the users of the landscape in a central position. This is not the most cost-effective solution for the farms but does bring significant benefits in the long term, with less dependence on production and more space for nature inclusive agriculture.

On the other side of the spectrum, productivity can be maintained through innovative solutions such as strip cultivation. Implemented with an organic approach, this results in a balance between production and inclusivity.

Both approaches provide inspiration for future agricultural developments, depending on the situation of the farm and ambitions of the farmer itself.

Figure 71: Collection point of flowing water, Lankheet (Brinckmann, n.d.)

Figure 72: Manual dam which can be opened to allow for flowing over the field in the background (author, 2024)

### 3.3.2 Flowing water at Lankheet

While flowing meadows have vanished from the memories and landscapes, they are often still traceable for the trained eye. In a couple of locations, they have been restored in order to research their potential in the current system, analysing their flaws and advantages.

One of these locations is on estate het Lankheet, near Haaksbergen, Overijssel. When beer brewery Grolsch investigated the property for water reserves for the brewing process, the owner of the property, Eric Brinckmann consulted local stakeholders to avoid ecological consequences. These engineers proposed the use of flowing meadows to help replenish the groundwater supply, using flowing meadows. Traces of this old system were then found on the property as well. Grolsch found a better source elsewhere, but the interest in the old system remained.

With help from the local water board Rijn en IJssel and Wageningen University and Research, a project was piloted in order to restore the old system. However, due to the agricultural intensification, the water quality was not what it used to be. Therefore, a filter was needed in the updated version. With a large system of reedbeds, most of the phosphate and nitrogen were filtered out of the water, to not oversaturate the grassland with it.

From these filters, the water is transported through a system of canals and weirs, down to the flowing fields (see figure 75-77). On the highest point of each field, a side channel can let water run freely over the fields, when the right lever is pulled. Each year in winter, the fields are flooded by opening a valve and allowing the water to flow. In spring and summer, this process can be repeated as well, when water levels suffic.

The project is still running 25 years after its initial revitalization. It has gone through several alterations, and knowledge is still gained each flowing season. However, the results can give an indication of the pros and cons of the system in the modern world.

*A social project*

Because of the complexity of the system, it cannot exist without the help of countless volunteers. A group of 50 volunteers helps to construct and maintain the system. Guided tours and activities for locals are organised, creating a value for both visitors and the neighbourhood. One of the reasons the flowing meadows were abandoned was the labour-intensive maintenance, in order to keep the ditches open and the weirs in working order. The project at estate Lankheet shows this does not have to be a downside, but can work to improve social cohesion in the neighbourhood while providing an example for others.

Figure 73: Map of estate Lankheet, with the main river Buurserbeek, the reed filter (7) and flowing fields (A) (Bobbink et al, 2022)

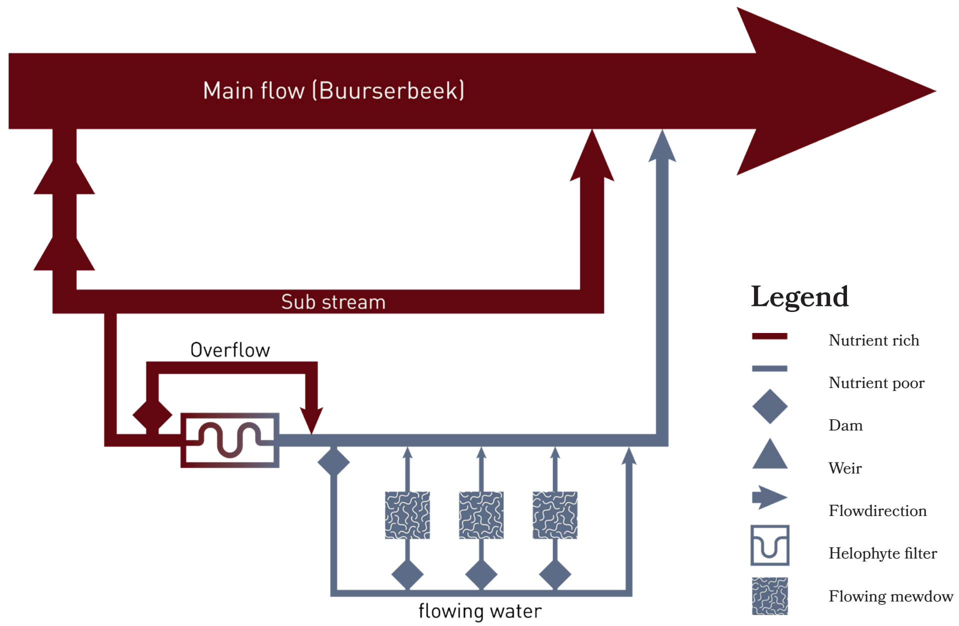



Figure 74: Schematic overview of the water system of the flowing meadows at estate Lankheet (author, 2024)

*Main takings*

As mentioned in paragraph 3.1.2, the water quality is much worse than it was when the system was still widely in use. The water is oversaturated with nitrogen and phosphate, which would lead to an overload of nutrients on the fields. The reedbeds filter out most of these nutrients out, but still leave a considerable amount in the water. Therefore, the grass produced is lower in protein, which makes it more suitable for young then mature cattle. A possible solution for this is the addition of duckweed or azolla in the purification system. This plant converts nitrogen into digestible protein, which can be added to the cow's diet to achieve a healthy diet.

Restoring the system is labour intensive, due to its detailing and adaptation to the terrain. While farmers relied on the system in the past for survival, this necessity is no longer felt. Farmers used to cooperate to maintain the system, but the modern farmer is not used to this anymore. A shift in focus is needed to explain the necessity and bring farmers together once again to reinstate the old system. At the same time, the lower water table due to deeper extraction (1m lower since the 19th century) makes this method of irrigation less effective. This can be mitigated by working together with the local water board, raising water levels, and changing the depth of drainage pipes and ditches.

The flowing, though labour intensive, provides significant benefits. With winter flowing in times of a water surplus, the groundwater levels can be restored, and additional water can be stored for dry periods, linking with the recommended action by HNS (paragraph 3.1.2.). The winter flowing is conducted until February, giving farmers time to resume their agricultural activities in spring. Additionally, farmers do not have to irrigate as much in summer, with the higher water table and larger supply to last the draughts. Socially, the benefits should not be ignored as well. Even though het Lankheet relies on a lot of volunteers, people gain personal benefits from working together on this project.

This system also helps to preserve biodiversity. While some worms drown, they lay their eggs in drier areas. This leads to a reproductive boost in spring and summer. Soil structure improves as well, since running water increases the amount of air in the soil, unlike standing water. By alternating flowing with dry periods, the long-term health of the ecosystem is supported.

In conclusion, the restoration of flowing meadows at estate het Lankheet provides valuable insights into the integration of historical irrigation practices into contemporary agriculture. Despite the significant changes in water quality due to agricultural intensification—necessitating modern filtration systems like reed beds—the project has managed to address nutrient overload effectively. While the restoration process remains labour-intensive and relies on the cooperation between farmers and local water authorities, as well as a large group of volunteers, it offers notable benefits. These include the replenishment of groundwater levels, reduced irrigation needs during dry periods, and enhanced biodiversity through improved soil structure and species regeneration. Although restoring and maintaining these



Figure 75 and 76: Water is filtered from nutrients, and then transported through canals along the highest edge of the land (author, 2024;Brinckmann, n.d.)

Figure 77: A "Kruufke" (flowing spade) placed in the field, forcing water over the land (Brinckmann, n.d.)

systems presents challenges, their ability to improve resilience, water management, and environmental conservation highlights their importance in addressing today's climate issues. Ongoing research and potential innovations, such as incorporating nitrogen-absorbing plants like duckweed, will continue to refine and sustain these practices in the future.

### 3.3.3 Summary and conclusion

The three cases show how alternative strategies to the current industrialised methods of farming and strict regulation in water management can still create successful results. The communal farm of Urtica de Vijfsprong gives valuable insights in the method of diversification in agriculture. By adding an alternative source of income in the shape of a healthcare branch, a more flexible and sustainable business model is achieved, while at the same time adding value to biodiversity, clients and the local community. The reinterpreted flowing meadows at het Lankheet are a beneficial addition to the farming practice as well, as it helps to increase the resilience against draughts, while maintaining biodiversity and improving soil-health. Even though the flowing meadows require a lot of work, this can be transformed into a social benefit, bringing communities together.

Figure 78: The water flowing over the field (Brinckmann, n.d.)

Figure 79: Flowing in progress (Brinckmann, n.d.)

## 3.4 Conclusions

The agricultural landscape is facing multiple threats, that developed in the past century. The changing climate and resulting change in water balance is a direct threat to both agriculture and nature, with increasing demand and decreasing supply. The increasing demand is also caused by the industrialisation of the agricultural practice in the past century. The ever continuing trend of increased efficiency and production is having a negative impact on the surroundings, with biodiversity dwindling. Both the use of chemicals and oversaturation of nitrogen in the landscape, and the removal of cultural elements to increase agricultural efficiency are creating a pressure on flora and fauna.

A difficult task lays ahead to restore the balance between water management, agriculture and nature. The goals to achieve this new balance include raising the groundwater level by at least 100mm in order to create a larger buffer to accomodate for future climate shifts, while also implementing a more nature inclusive agricultural method with lower livestock numbers and a healthier nutrient balance. The restoration of the cultural landscape is vital as well, to restore biodiversity and allow the landscape to be shared once again between farmers and nature.

In the middle ages, the elements of agriculture, nature and water management were much more in balance. The people utilized the landscape to its maximum capacity, using every gradient for different agricultural practices. The approach back then was to make the best use of the landscape as is, while currently we alter the landscape to suit the most profitable landuse, disregarding the needs of other users of the landscape such as flora and fauna. The use of flowing meadows are an example of the integration between water, nature and agriculture, and utilizing the available ingredients of the landscape to maximise the agricultural yield. This balanced approach came with some drawbacks however, with low economical stability, high workloads and a high dependence of the climatic conditions.

Case studies show that modern approaches to historic systems can be beneficial for a more integrated landscape. The example of diversification in the agricultural business helps to create less reliance on a single source of income, while providing extra helping hands on the farm and creating more room for a nature inclusive approach. Modern innovations can help with this as well, such as strip cultivation. And while the original purpose of flowing meadows are obsolete, they provide new opportunities in increasing the water infiltration, which helps to create a more robust future proof system, and achieve the 100mm extra buffer.

While the extensive farming method and more space for water systems and ecological implementations are at the expense of production quantity, the focus shifts more towards increased quality. The existence of examples such as the case study of Urtica de Vijfsprong are an indication that these methods are financially viable, while at the same time creating benefits for people and nature. However, these alternative methods are often dispersed in the landscape, in between conventional farms. As the two methods reach a different public, their coexistence creates less of a competition between each other. Imagining a larger area where multiple farms apply similar extensive methods, diversification is necessary to ensure financial stability for all the farmers in that area. This creates additional benefits of cooperation, where different farming types can work together in order to strengthen their own position and their mutual relations. The bond with the landscape can also be strengthened by giving the farmer more responsibilities in maintaining the cultural elements in the landscape, shifting from a pure farmer to a new profession: the landscape caretaker.

In the next part, we will translate our findings into a concept and design principles, where they will be applied on a smaller scale, and detailed further until an eye level perspective. There, we will answer the subquestion stated in the beginning:

*“What design strategies can be employed in order to rebalance water management, nature and agriculture?”*

# Chapter 3: Research for Design



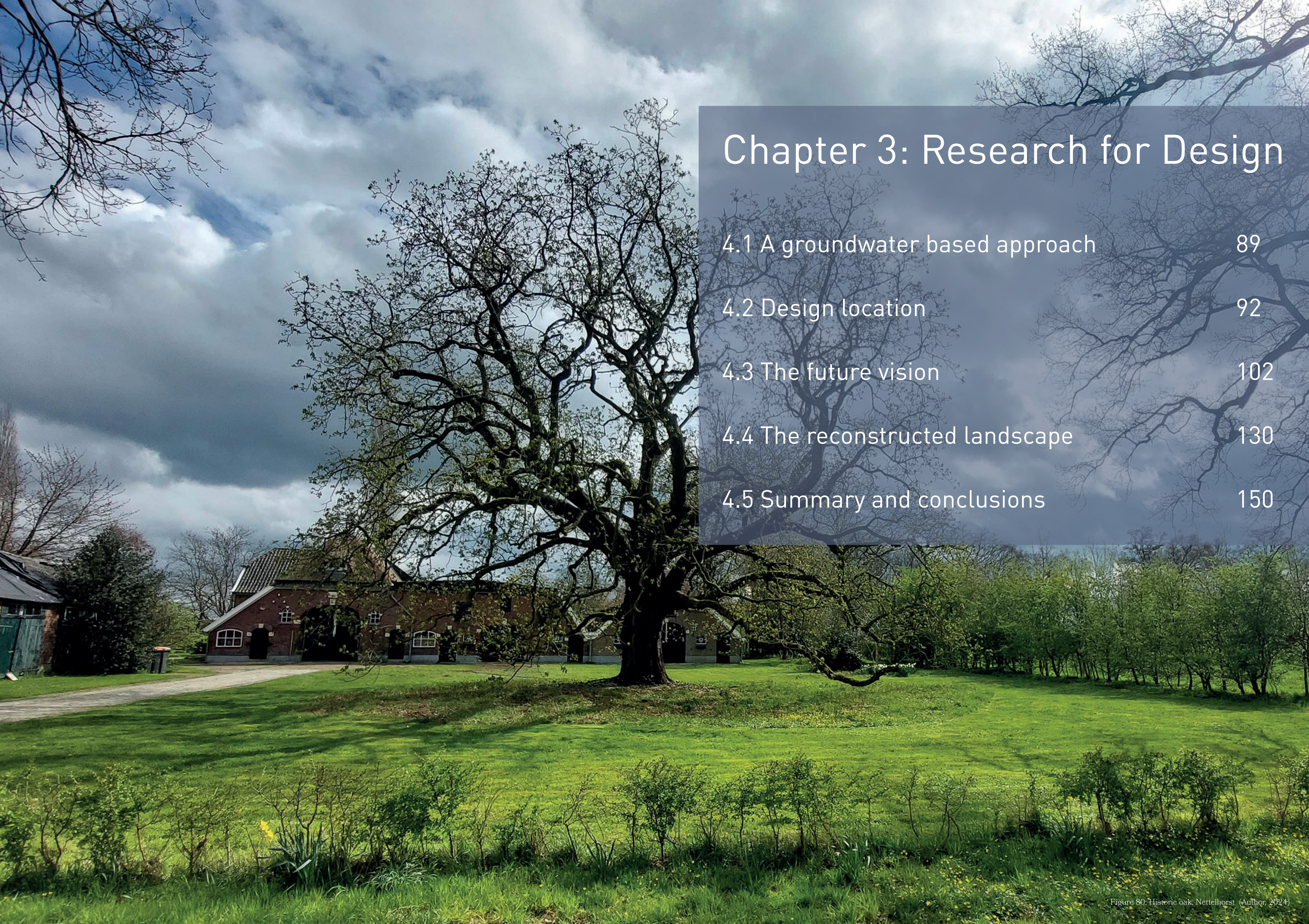


Figure 80: Historic oak, Nettelhorst (Author, 2024)

*In this section of the report, we aim to answer the following two sub questions:*

> *"What design strategies can be employed in order to rebalance water management, nature and agriculture?"*

*To answer the first question, we translate our findings from the previous section into a concept and design strategy. The aim is to create a design language that is applicable in multiple situations, with varying conditions, to create a design that alligns with the conclusions from the previous section: create a robust water system and design a diverse agricultural landscape with a lower impact on its surroundings and space for man and nature.*

> *"How can the alternative strategies be implemented into the agricultural landscape?"*

*The second question is aimed at the application of the design concept in the field. We chose a design location in the achterhoek and research its local conditions, and apply the general concept in the field. By zooming through the scales, different elements are designed and highlighted. One location within the design region is chosen to design in further detail, with four distinct areas picked for an eye level perspective design, showing the details from a visitors perspective.*



## 4.1 A groundwater based approach

To guide the design process, we created a design concept and principles based on the research done in chapter 3. The general concept is to transform the servant landscape into a groundwater-based approach. The subsoil conditions are taken as a basis for the design, looking at topography and soil typology in order to define the landscape. In the early middle ages, this was done out of pure necessity, but it meant that the yield from the existing situation was maximised.

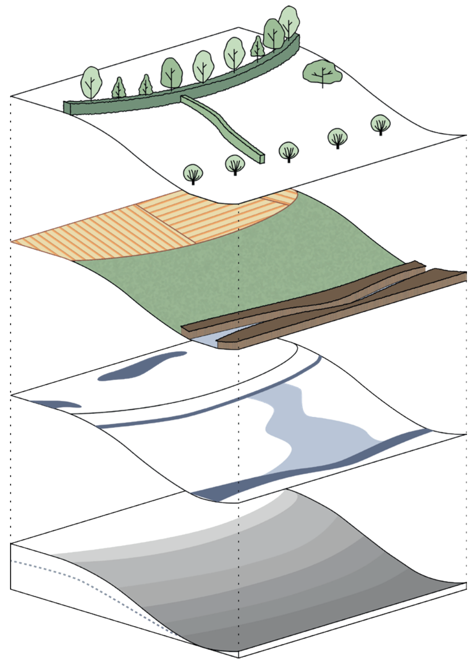


Figure 81: Schematic representation of the design concept

On top of subsoil base, the water system is created. The water level is increased by 100mm, creating humidity gradients in the landscape, with wet, humid and dry. The lowest areas are considered as wetlands with a focus of maintaining a high water level, while the dry areas, located above the  have a focus of water retention, as these are the most difficult to irrigate. In between them, the humid areas are located, which are suitable for irrigation and flowing meadows, as they were back in the middle ages, but now have the purpose of raising the water level as much as possible.

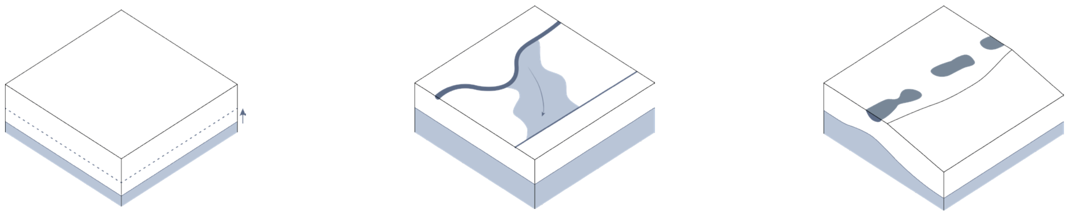
The agricultural practice is adjusted to the water system, and not to the most cost-effective use of the land as was previously the case. Dry areas are more suitable to be used as agricultural land, while the wet areas are too wet for conventional agriculture, resulting in the implementation of paludiculture or nature areas. The humid regions are too wet for crop but suitable to grow grass, and are therefore used for cattle breeding.

To bring nature and agriculture together, cultural elements are reimplemented on top of this new, diverse agricultural landscape. Dry areas are surrounded by a dense hedge, keeping cattle from entering the fields and providing shelter for crops from the elements. The openness of the grasslands is emphasised through solitary trees and low cut hedges, used as fencing between fields, while the wettest areas are planted with trees and shrubs that are suitable for these conditions.

Following this concept and the analysis, several design principles are created that can be implemented in the landscape, based on each of the three themes of water, agriculture and nature:

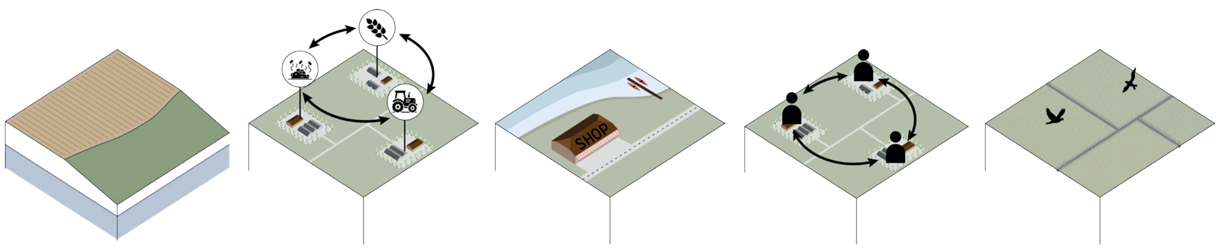
Water :

- Raising water levels to store an additional 100mm of water in the soil, to overcome the dry summers of the future.
- (Re)implementing flowing meadows in order to raise the groundwater level and provide a larger buffer for dry summers.
- Retaining water in elevated areas through wadis and choice of vegetation.



Agriculture

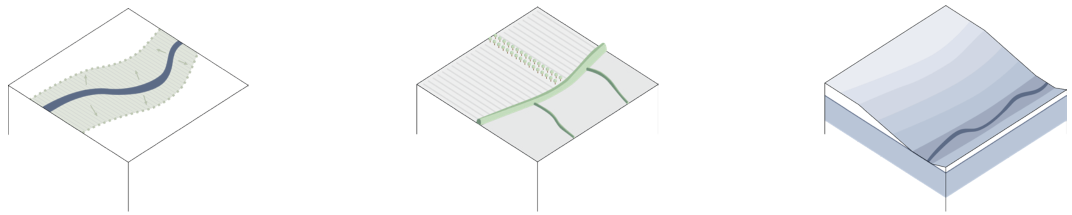
- Adjusting the agricultural practice to the soil- and water conditions, basing landuse on them rather then changing the conditions to the desired landuse, making use of all the different gradients of the landscape.
- Utilizing the diverse agricultural practice to recycle waste streams, reducing the need for import and export of waste such as manure.
- Promote diversification of the farm in order to lower the financial dependence solely on the farming practice.
- Cooperate between farmers in order to maintain the landscape and water system, recycling waste streams and reconnecting them in the “new Marken”.
- Implement extensive farming methods such as circular or organic agriculture, while retaining some of the productivity through strip cultivation.






Nature

- Strengthen the agricultural landscape through cultural elements such as hedges and treelines, as well as biodiverse meadows and fields.
- Create ecological bufferzones along rivers in order to create corridors between protected natural areas.
- Increase biodiversity by adjusting tree and shrub species to the gradient of the landscape.



These elements are inspired by the historic context of the Netherlands and the Achterhoek, while adjusted to the current situation. In the next chapter, a site is chosen to test the implementation of these strategies in the landscape, and experience the transformation to a resilient, future proof agricultural area.

## 4.2 Design location

To apply the design concept and principles in the field, we need to choose a suitable location based on a few criteria, linking to our problem statement in chapter 1.2. The region of Nettelhorst, east of the town of London in the Berkel basin, is a suitable candidate for further research, as this area is characterised by the aspects mentioned in the problem statement.

The area consists of monocultural dairy farming, which as we saw before is responsible for a large amount of the issues arising. The water table is kept low to accomodate the cattle, while nitrogen levels are saturating the soil, pressuring local wildlife.

At the same time, this region has a strong historic connection, with elements such as a former estate, possible flowing meadows and agricultural marken still visible for the trained eye. The area can therefore serve as an interesting case to apply the design concept and principles.

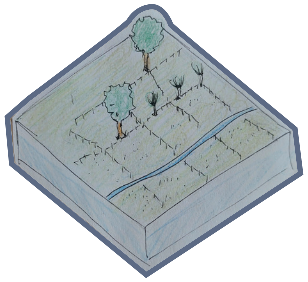

Figure 82: Chosen design location

The site is researched on a couple of key themes. Firstly, we will look at the historic context, what the area used to look like, how it used to function and which landscape typologies can be found. The natural division of dry and wet areas, driven by height differences, also plays a crucial role. Additionally, the transformation of the landscape over the past century, coupled with current practices in water management, agricultural land use, and existing natural elements, offers insight into its evolution.

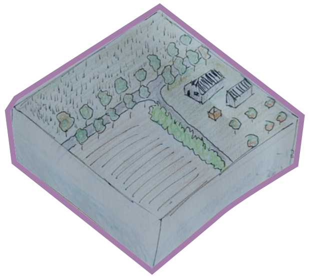
### 4.2.1 Historic context

The map in figure 84 on the next page, based on historic maps from 1900, reveals Nettelhorst as a landscape characterized by a diverse mix of grasslands, crops, and heathlands, enriched with cultural elements like hedges and treelines. Three main landscape typologies can be found in the area. The southern portion near the Berkel River (1) featured a more open river meadow landscape, while areas closer to the centre (2) showed signs of cultivated heathlands, likely due to the early transformation of heathlands. The kampen landscape (3), marked by agricultural fields in yellow encircled by treelines, and the Nettelhorster Laak (4), a central stream likely tied to a flowing meadow system, highlight a deep connection to traditional farming practices. Nettelhorst was once part of a Marke (Nettelhorst-Lange) and governed by the local lord (Reincke, 2006). Estate Nettelhorst is visible in the map as the square section of roads, where several long avenues converge (5).

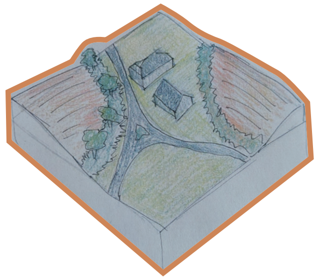
Figure 83: historic farm on an elevated sandridge



1. River meadow landscape



2. Cultivated heath landscape



3. Kampen landscape

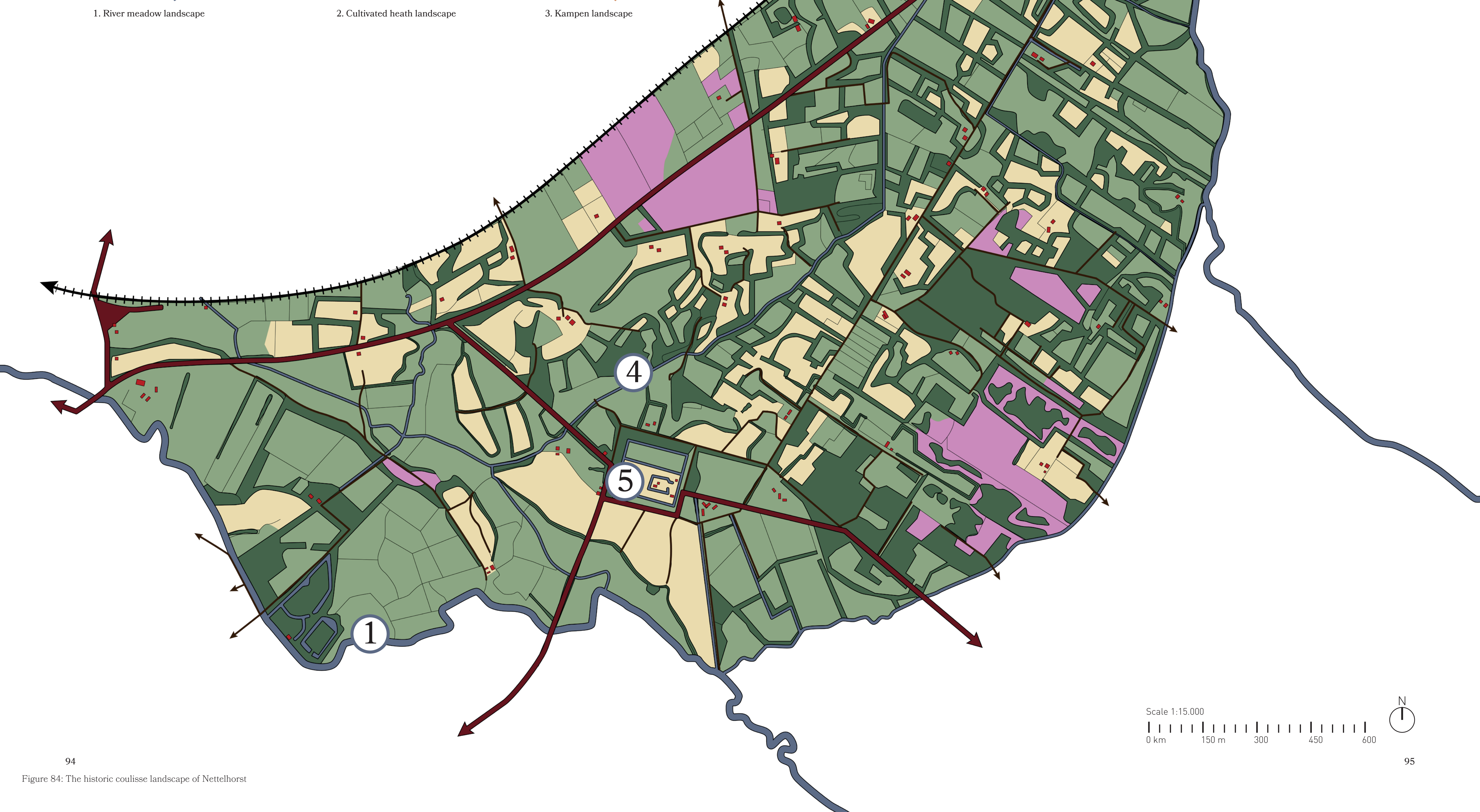







Figure 84: The historic coulisse landscape of Nettelhorst

*Stagnant water*

The historic landuse can be coupled to the height map, as is seen in figure 85. Several river dunes and other height differences are visible, where the farmers used to have their agricultural Kampen. These places are ancient geological formations from the last Ice Age. The raised areas in the eastern area (6) were low spots in the glacial landscape of the last ice age, where moisture collected. This moisture trapped sand sediments that polar winds brought from the north sea, creating dunes where ones were pits, thus naming it an “inversion landscape.” In the Middle Ages, these elevated spots were drier and thus more suitable for early agriculture, which explains why they were the first to be cultivated (van Beek, 2009; Wassink, 1999). Around the Berkel River, river dunes formed by sedimentation are also evident, and estate Nettelhorst sits on one of these larger dunes (7). The central Nettelhorster Laak is clearly located the lowest spot in the area (8), where all the water converges. This indication, in combination with the water map of Staring showing floodings in these areas (figure 54 in paragraph 3.2.2), makes it very likely that a flowing meadow has once been present in this region, and can be reconstructed.


Figure 85: Heightmap of Nettelhorst showing the height nuances in the landscape

Fgure 86: Nettelhorster Laak in the open landscape

Figure 87: Drainage ditch dug through a sanddune

Figure 88: The open landscape at Nettelhorst

### 4.2.2 Current situation

When looking at the changes in the modern land-use map, a radically different landscape emerges compared to figure 84. Trees, shrubs, and cultural elements have disappeared due to land reallotment, creating a rationalized landscape dominated by monocultural dairy farming, as can be seen in figure 89. Most agricultural fields now consist of grasslands, with crops like corn and fodder beets grown to support cattle farming. The natural logic of the landscape's relief has been disregarded, with drainage systems expanded and streams canalized for efficiency (see figure 86). The area still drains through the Nettelhorster Laak, but the drainage of the farmland is increased through additional ditches and canals, which have been dug through the ancient sanddunes (see figure 87)


Figure 89: Transformation of the landscape visible from above

Figure 90: Currently only an overgrown ruin remains of estate Nettelhorst (author, 2024)

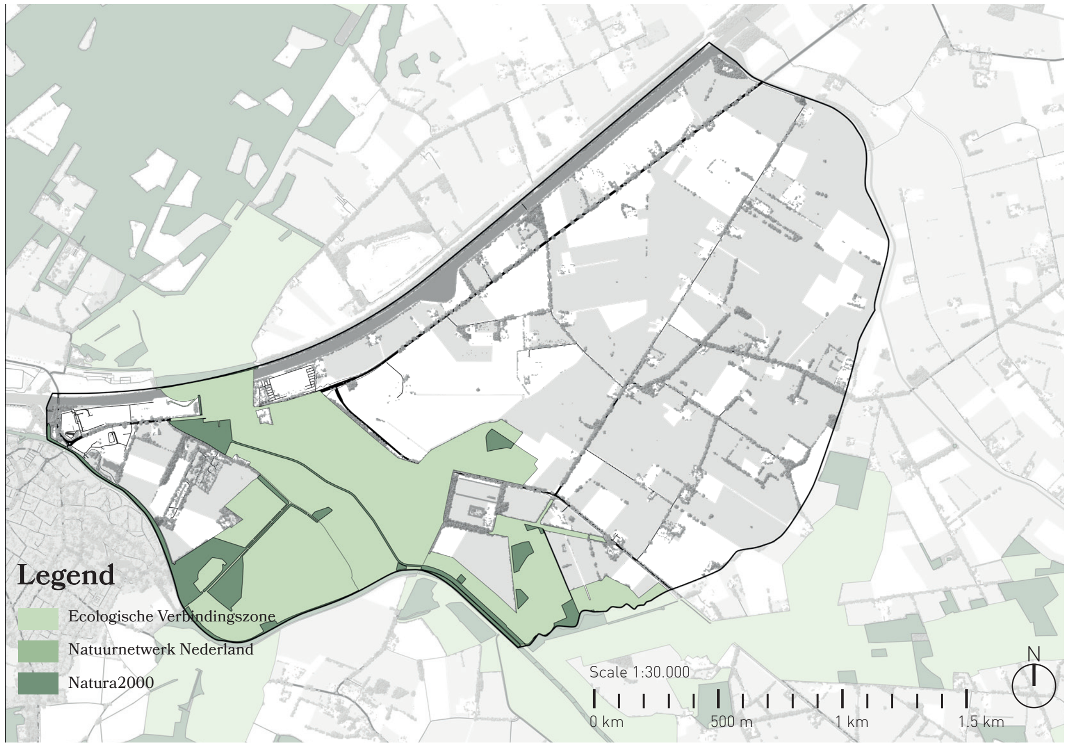



Figure 91: Ecological areas in the Nettelhorst area



Despite these changes, the historic estate Nettelhorst remains visual in a central position, though the main roads now circumvent it. The estate itself is reduced to mere ruins, with only a singular wall remainingas shown in figure 90. In the images on page 97, the monocultural character of the landscape is clear, as well as the lack of cultural elements. Sleight elevation changes are the only visible reminders of the once varied landscape.

Along the berkel in the southern end of the region, an ecological corridor (EVZ) and several disconnected Natura2000 areas are visible. These ecological zones should help boost wildlife, but as is visible in figure 92 and 93, the implementations are minimal and not sufficient, but is more diverse then the monocultural land in the rest of the area.

In conclusion, the region of Nettelhorst has undergone significant changes in the past one hundred years, just like the rest of the country. It is particularly visible here due to the rationalised landscape, however signs of the past are still visible. The elevations remain, giving a gradient in wet and dry. The remains of estate Nettelhorst and the nettelhorster laak also give interesting historic points of reference in the design. The ecological zones can help guide the design concept, with a focus on more biodiversity in the southern region.

Figure 92 and 93: Images of the ecological area near Nettelhorst (author, 2024)

## 4.3 The future vision

In figure 94, the visionmap for the future is drawm, based on the concept explained before. In this map, all the separate elements are woven into each other, taking the local characteristics in mind. By raising the water levels and adjusting the  water system to accomodate flowing meadows, landscape gradients emerge. These gradients are reflected in the varying landuse, from wet paludiculture, to humid dairy farming, with crop cultivation situated on the hightest parts. The transitions between these different landuses are strengthened with cultural elements, weaving nature through the agricultural landscape. With this approach, the landuse is adjusted to the soil conditions, rather than the other way around.

In the following chapter, the three layers of the concept are separated and explained.


Figure 94: Combined visionmap of the Nettelhorst region

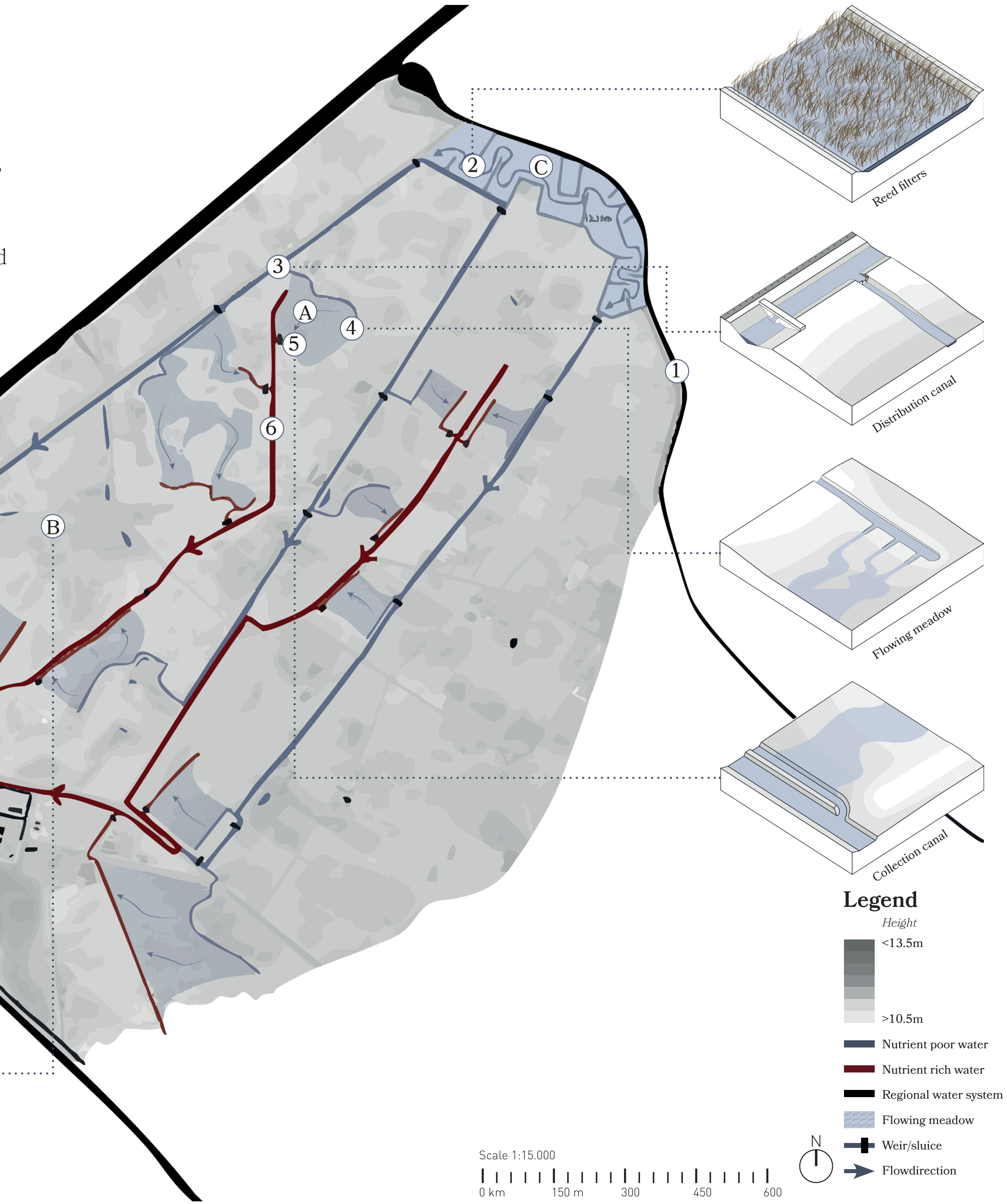
### 4.3.1 Flowing water

The aim of the water system is to raise the water level to accomodate for future draughts, improving infiltration and water retention. Implementing the new water system is the first step in the design process: rais the weir levels with 100mm, and allow water to flow wherever possible, while adjusting the landuse to it.

Firstly, the flowing meadows are introduced in the humid areas (A, see map). Wadis and drinking pools are created on the dry spots (B), while the wettest parts are transformed into filter areas with low drainage and a high water level (C).

The water system of the flowing meadows is quite complex. The water is distributed from the supply river Bolksbeek in the north (1), which has a water level of  From there it flows through a collection of filter basins (2), where the reed filters out the excess nutrients of thes upply water. Filtered water gets distributed over a collection of main distribution canals, which connect to a series of inlets that can be opened manually (3) and allow the flowing to happen (4).

On the lower side of the fields, a collection system recollects the water (5).  Secondary collection ditches then collect the water and distribute it to the main collection ditch of the Nettelhorster Laak (6).



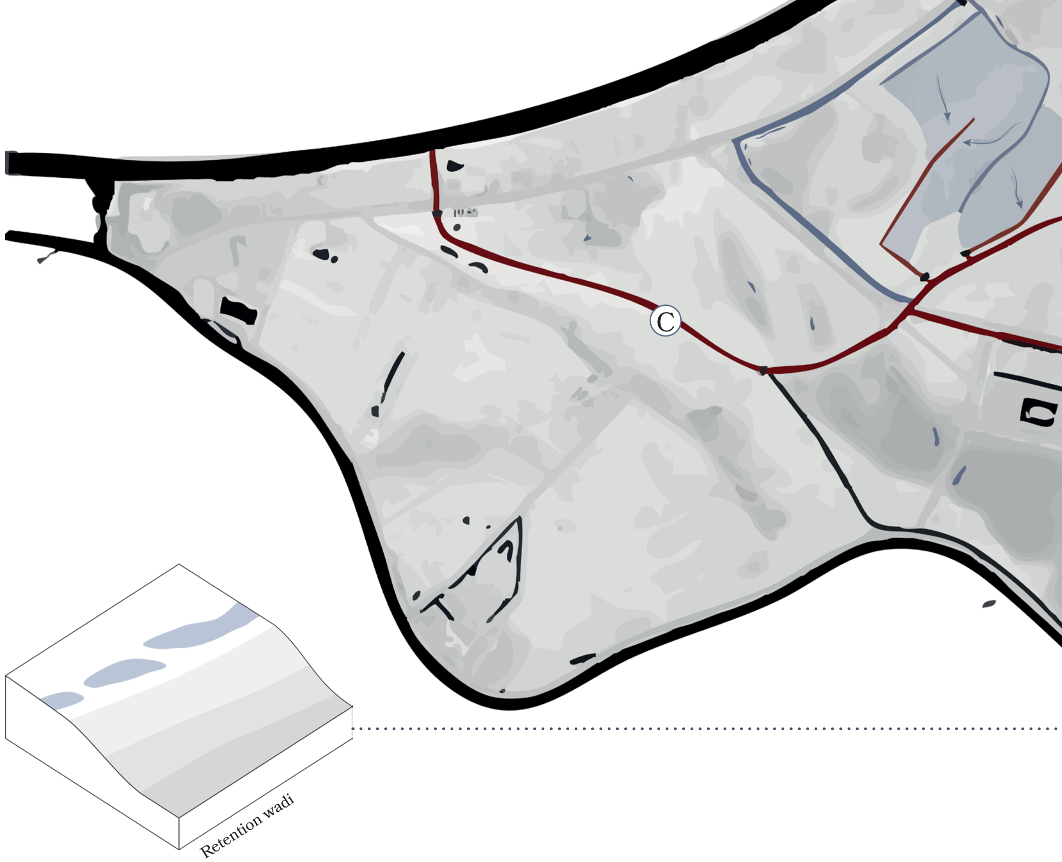




Figure 95: Combined visionmap of the Nettelhorst region

In the southern area, swampy wetlands will support paludiculture and ecological zones, with additional reed filters in order to filter out nutrients and not saturate the nature in this area with nutrients from the agricultural practice. Even though agriculture will have an extensive focus, nitrogen will still wash out from the soil and enrich the water.

The humidity zones of wet, humid and dry areas are determined based on their relative position the groundwater level (gwl) and supply river, the Bolksbeek in this case. The wet zone is all the area that sits 50cm above gwl, with the humid zone positioned 50-100 cm compared to gwl, and the dry zone 100cm above gwl, visualised in figure 97. The highest level of the humid zone (and lowest of the dry zone) are determined by the level of the supply river, as this is the maximum height from where flowing can take place without mechanical help.

Figure 96 shows the diagrammatic system of flowing meadows, with the supply river providing nutrient rich water, from where an adjustable dam water is supplied into the system. The filter area does both serve as a nutrient filter, and a buffer which can be filled up during flash floods. Through a system of canals, weirs and manual dams, the water is then directed over the land. Several bypasses are in place in order to accomodate for extreme levels of rain, in which case the whole area of Nettelhorst can serve as temporary waterbuffer.

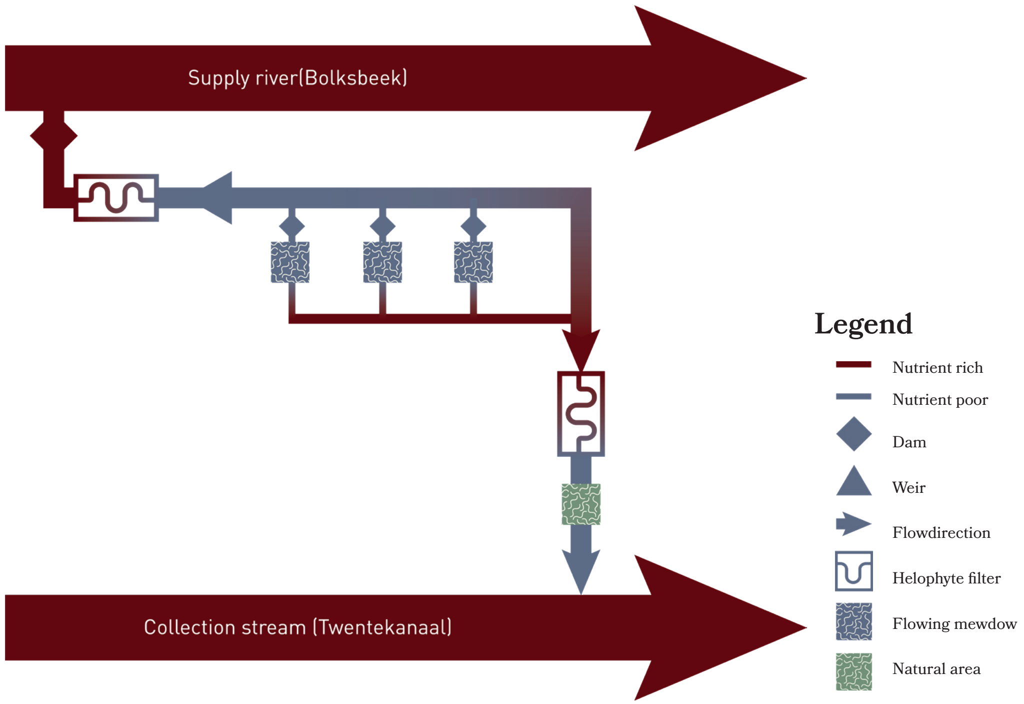



Figure 96: Schematic representation of the new water system of Nettelhorst

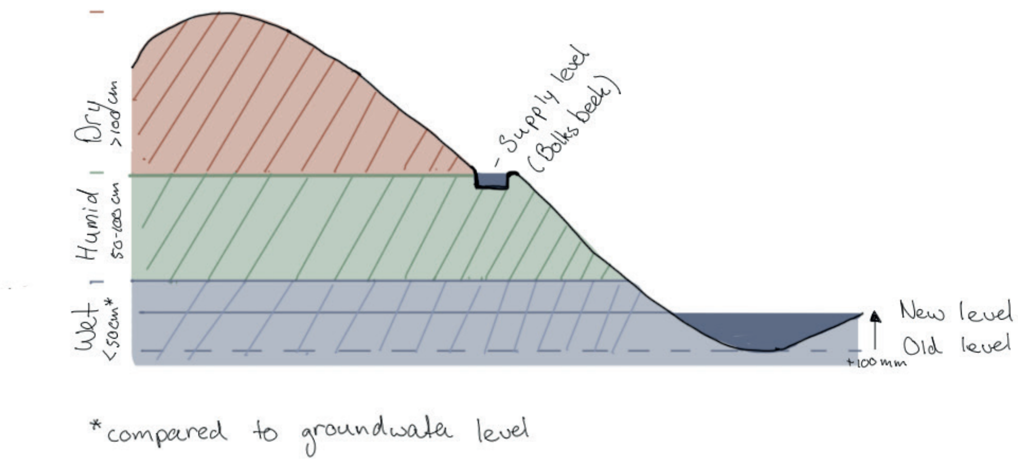



Figure 97: Diagrammatic section of the humidity zones in the new plan.

At the end of the chain, a second filtration system is added, in order to supply clean, nutrient poor water to the nature area located in the southern part of the plan. This also means that clean water gets supplied to the river Berkel. While the water in the Berkel is of a much lower quality, the nutrients that are flushed out from the soil are captured in the filter and can be recycled within the area of Nettelhorst, helping to close the nutrient cycle.

While the system provides benefits to water infiltration and spunge capacity, it also adds a lot of necessary maintenance. Keeping the weirs functional, ditches clean and filters mowed are all practices that will need to be adopted by the farmer. However, this can become a social practice, with farmers cooperating within the system in order to maintain and carry out the flowing practice.

In average winters, the flowing cannot be carried out on all the fields simultaneously, due to capacity of the system, which is limited by the capacity of the filter. Therefore a rotation between farmers is necessary, flowing two fields at the same time, while other fields remain dry. This can help farmers to keep more stock outside as well, utilizing the drier fields while others are flowed. This adds to the communal character of the flowing meadows, requiring local cooperation and organisation.

The different elements in the landscape all add their own character and qualities. The reedfilters (figure 98) have both a functional and recreational purpose, with the possibilities of adding walking paths and boardwalks. The wet conditions suit certain fauna as well, adding a nature typology back in the landscape.

The manual weirs are operated by the farmer (figure 99), giving them full control over the flowing practice. Farmers coordinate their flowing practice together, circulating every couple of weeks during the winter months.

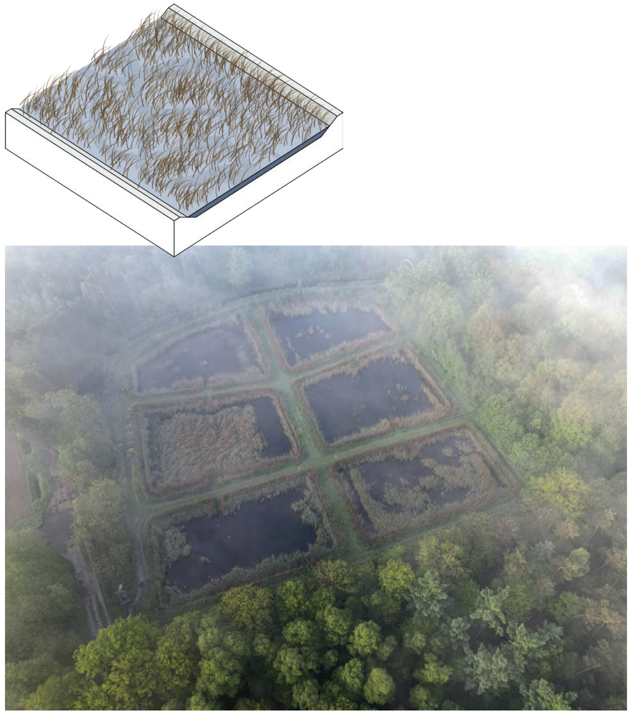


Figure 98: Helophyte filter at estate Lankheet (Dolfing, 2021)

This cooperation is necessary as well in order to maintain the intricate ditches and dikes, removing plants and debree in fall before the flowing season can take place. The blind ditch (figure 100) then fills up with water, raising the level in the ditch and forcing it over the edge, down the slope of the field.

On the bottom side of the field, small dikes direct the water towards the lowest point (figure 101), where an opening allow water to be collected in a collection ditch before being transported down to the Nettelhorster Laak.

Figure 99: Manual weir, allowing water into the distribution ditches (author, 2024)



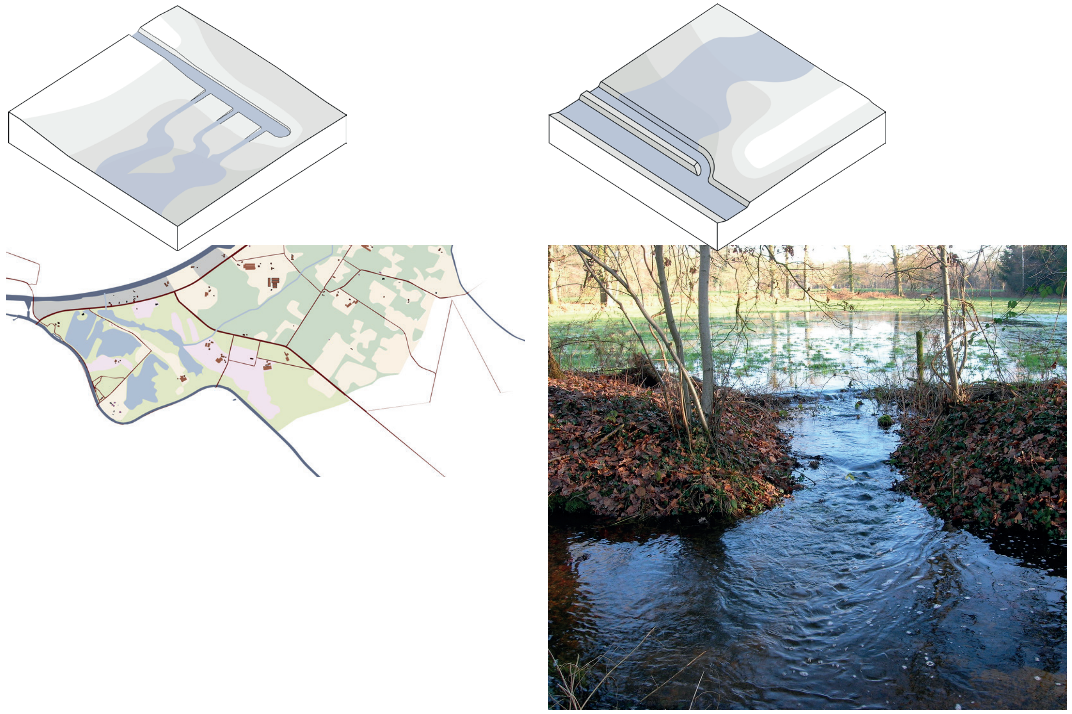


Figure 100 and 101: a blind distribution ditch and collection ditch at the bottom of the field (author, 2024; Brinckmann, n.d.)

In the dry areas, a different approach is applied. Since this area is located higher then the flowing meadows, water retention is key. Therefore wadi's are introduced to collect water during rainfall, allowing for infiltration into the soil and a small supply for occasional irrigation.

These wadi's provide important habitats for species as well, which we will further elaborate on in paragraph 4.3.3.

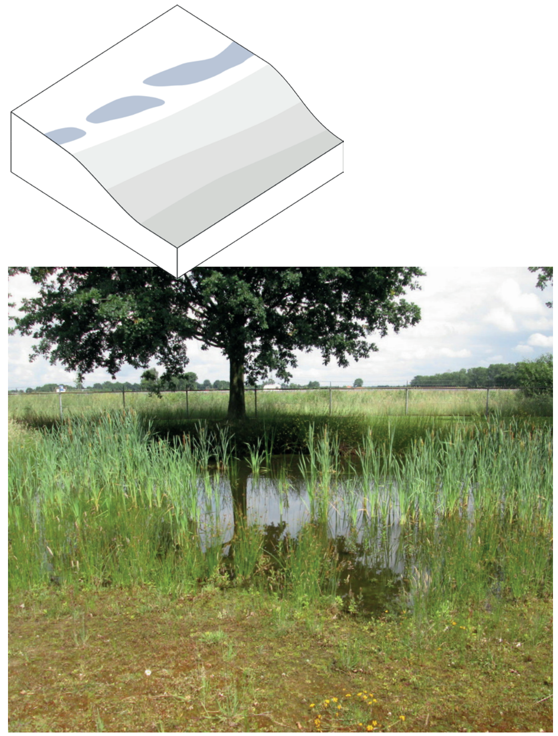


Figure 102: agricultural wadi (Jonkers, 2018)

### 4.3.2 Farming for the future

Due to the new water levels, conventional dairy farming is no longer possible in this region. The three zones each require a different approach, creating three distinct farm typologies, such as paludiculture in the wet zone (1), extensive dairy farming in the humid zone (2) and agriculture in the dry zone (3).

The southern area (4) is located in the ecological corridor along the Berkel (figure 91), and is therefore primarily focused on nature conservation with some additional farming, to maintain the grass by mowing and grazing. This area is not the primary focus of this thesis, therefore we will primarily look at the production focus of the norther area.

The farms in this region are positioned along the higher parts of the landscape. Most farms are from the 19th century, when the water levels were significantly higher, thus requiring dry soil to build on. Therefore the farms in this area do not have to be relocated to higher ground. Some houses have been built in the humid areas, however they are placed leveled with the roads, which are slightly higher then the surroundings as well.

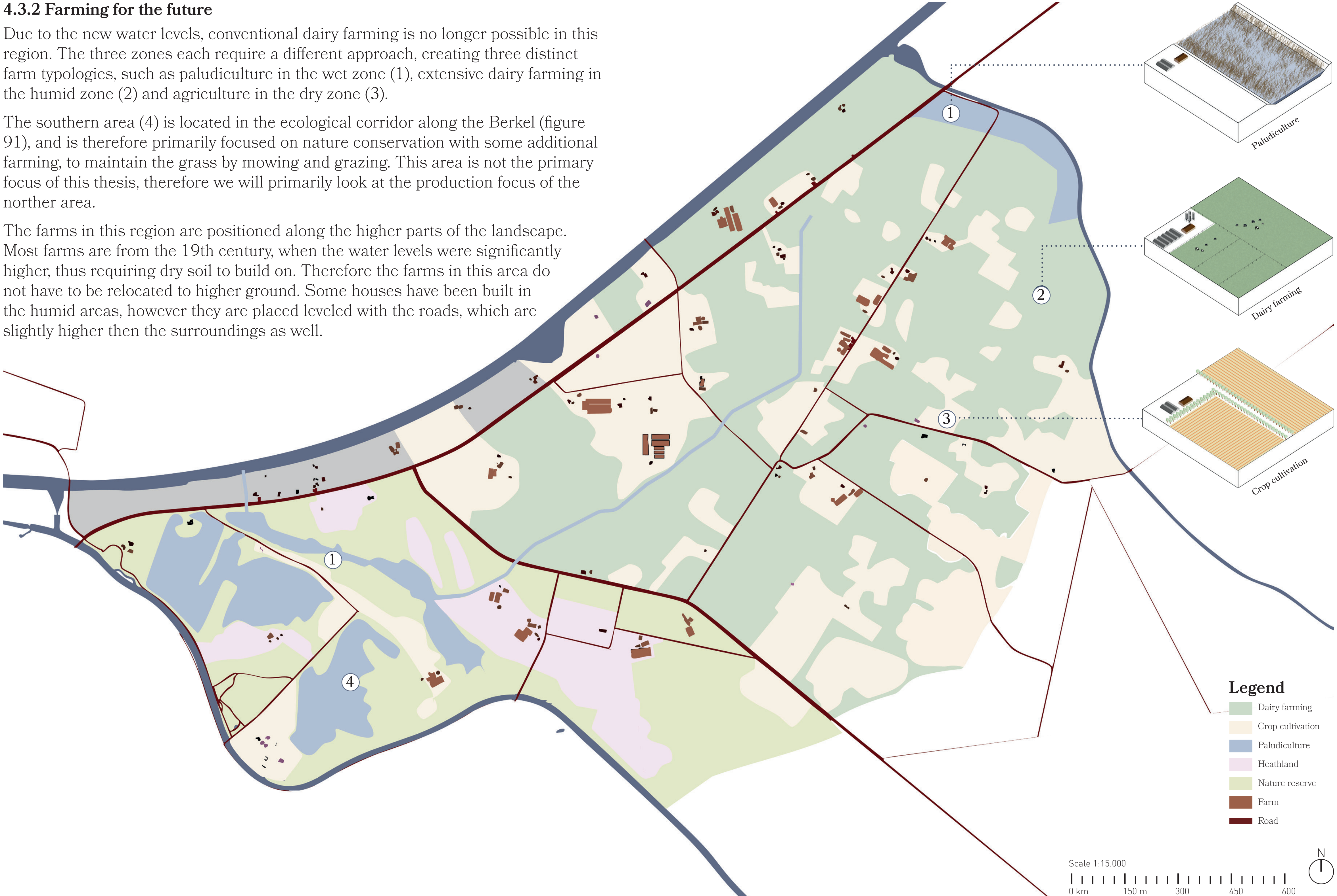



Figure 103: agricultural diversification

The landscape is now diversified into three main farm typologies:

<u>Wet Agriculture (Paludiculture)</u>

Located in the wettest areas where conventional farming is not possible, these farms blend agriculture with natural ecosystems, typically maintaining a large area of 50ha, due to their low profits from the land. This method helps maintain Reedlands, serving as natural filters.

Crops:

- Reed: Grows in shallow water, purifies nutrient-rich water, and is used for insulation, fuel pellets, and dairy farm straw.
- Bulrush: A filtering plant used for insulation and biomass, common in natural areas.
- Alder Trees (Agroforestry): Adapted to wet soils, promoting biodiversity, and providing high-quality wood.

<u>Humid Agriculture (Extensive Dairy Farming)</u>

The flowing meadows are ideal for grass cultivation and dairy cattle. These farms require 25 ha of grassland, supporting 38 cattle (1.5 cows/ha). By maintaining the new cultural elements in the landscape (further elaboration in part 4.3.3), additional income is made on subsidies, allowing for more extensive dairy farming. The produced cow manure is applied to the grasslands, while the surplus can serve the agricultural farms in the region. Dairy products are sold at local farm shops, or sold

Figure 104-106: Extensive paludiculture, dairy farming and strip cultivated agriculture (Dahms, 2021; Colenbrander, 2016; Cuperus, 2021)



to supermarket as (made of) organic or meadow milk, which has higher profits per liter.

<u>Dry Agriculture (Arable Farming)</u>

The driest land on the Kampen is best suited for crops, fertilized with the manure from dairy farms. The crops are more drought resistant as irrigation is minimised, therefore the following species are suitable:

- Grain: For flour and straw, which can be sold to dairy farms
- Potatoes, soy, cabbage: Drought-tolerant and the plant matter can serve as cattle feed.
- Silage corn, sorghum or millet: Can be sold to dairy farm as cattle feed, with sorghum being more drought resistant then corn.
- Winter grain/field beans: allowing for additional crops at the end of the season.

By applying strip cultivation with varying crops, a higher resistance against pests and diseases is built up, limiting the need for pesticides. Organic agriculture becomes the norm in this region, showcasing the possibilities to comparable areas in the Netherlands.

*The new Marke*

Central in the new agricultural approach is the focus on cooperative farming, creating a modern interpretation of the former Marken. The Marke Nettelhorst is all about working together on demanding and labour intensive tasks, such as:

- maintenance: trimming hedges, pruning willows and clearing pathways
- operating the flowing meadows: digging and freeing ditches, carrying out the flowing, organizing the rotation of the fields.
- exchanging goods: waste from one farm, such as manure and plant matter, can serve other farms as fertilizer or feed.

Through this new connection with the landscape, the farmer becomes much more then just the farmer. The additional landscape management creates a new job title: the Landkeeper

While the farming method in itself is extensified, the local cooperation adds to the de-intensification of the system. The farmer is currently reliant on imported exotic feed and chemical fertilizer, which cost a lot of money and add to the nitrogen deposition in the landscape. But when cooperating with neighbouring farms in order to get rid of excess manure and use waste of one farm as cow feed on another, both the need for import of feed and the need for export of manure is (partially) solved. This will save a lot of money, but at the same time help decrease the deposition of nitrogen, as the cycle is closed.

*Diversification of the farming practice*

In addition to the extensive farming method, alternative sources of income are implemented in order to create more financial stability. These “side-branches” are not dependent on the soil conditions but can rely on possible activities in the area:

### Tourism

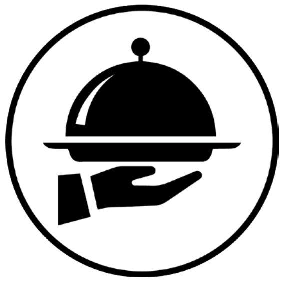
Several types of touristic activities can be accommodated on the farmland. the following examples can be used:

- accommodations/campsites: With a spare field or barn, a farmer can easily generate revenue with diverse types of accommodations. This will benefit the touristic sector in the area as well, as the amenities for tourists improve.
- bike/canoe rental, depending on the position of the farm.
- Farm shop: a shop with local produce can both serve the neighbourhood, generate a larger profit for farmers and attract tourists.

### Healthcare branch

Similar to Urtica de Vijfsprong, various kinds of healthcare can be used to both generate revenue and have additional hands available on the farm. Arable farms can benefit more from this, as the work on these farms is more labour-intensive.

- Elderly homes: relatively low maintenance, creating a place for elderly people to rent, either as independent or assisted living.
- Daycare: both suitable as a form of therapy for clients as well as extra hands on the farm.
- After school care: for small kids, playing on the farm is the best day ever.

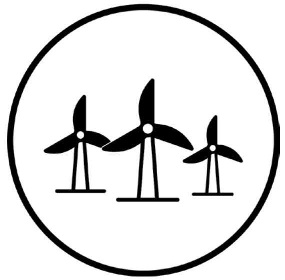


### Culinary recreation

With the variety of local produce, the culinary market cannot be missed.

- Restaurant/cafe: using local produce to create a culinary experience for various budgets.
- Tea garden: for the touristic visitors to enjoy a cup of tea and enjoy the landscape.





### Energy production

To accommodate both the neighbourhood with electricity and other forms of energy, two variants can be used to generate income:

- Green gas production: Agricultural plant waste and matter from the helophyte filters can be utilized to create green gas.
- Solar power: large barns can be filled with solar panels to accommodate the farm.

*Old versus the new*

Comparing the current agricultural landscape with the future, we can see a big difference in landuse. Currently, around 30 functional farms occupy the landscape, with an average of 27 ha of land. This land is largely used for grass cultivation (75 %), and some corn and other crops used for feed (25%). These farms have an average of 48 cattle per farm, with a total of over 1400 cattle for the whole area.

In the future scenario, the area is divided into a nature area with extensively maintained fields along the Berkel, and more “conventional” grassland in the rest of the area. This results in 23% nature coverage, where previously there was only 2%. The remaining land consists for 42% of grassland, 20% agriculture with the rest being roads and farmyards.

This results in a similar amount of farms, with a different distribution of the landscape. The dairy farmer now maintains only 38 cattle due to its extensive approach, and can buy its corn and cattle feed from his agricultural neighbour. With the additional subsidies from maintaining the landscape, and secondary sources of income from diversification, this still comes down to a profitable organisation. And since the neighbour is now producing crops rather than dairy, the amount of cattle in the region is reduced even further, to a total of around 500 cattle for this area. These changes to the landscape both close the nitrogen cycle within this region, and provide a sustainable future in both financial and ecological perspective.

### 4.3.3 Restructuring ecological elements

With the humidity levels and restructured agricultural landscape in place, the planting is introduced in order to integrate nature with agriculture. Six main planting typologies are followed: Wooded hedges, low hedges, solitary trees, open tree lines, orchards and streamside vegetation. While priority is given to native species, some foreign species were added to adjust to the future climate.

The character of the new agricultural Kampen is strengthened through the addition of dense wooded hedges, creating enclosed rooms in the landscape. These rooms are divided by orchards that serve as ecological steppings stones and break up the open space. The open flowing landscape is examplified by trimmed hedges, which maintain the open character while dividing the fields into seperate plots. Pollard trees planted along these hedges create more ecological stepping stones. To emphasize certain highlights in the area or create landmarks, large solitary trees are planted or maintained in the fields.

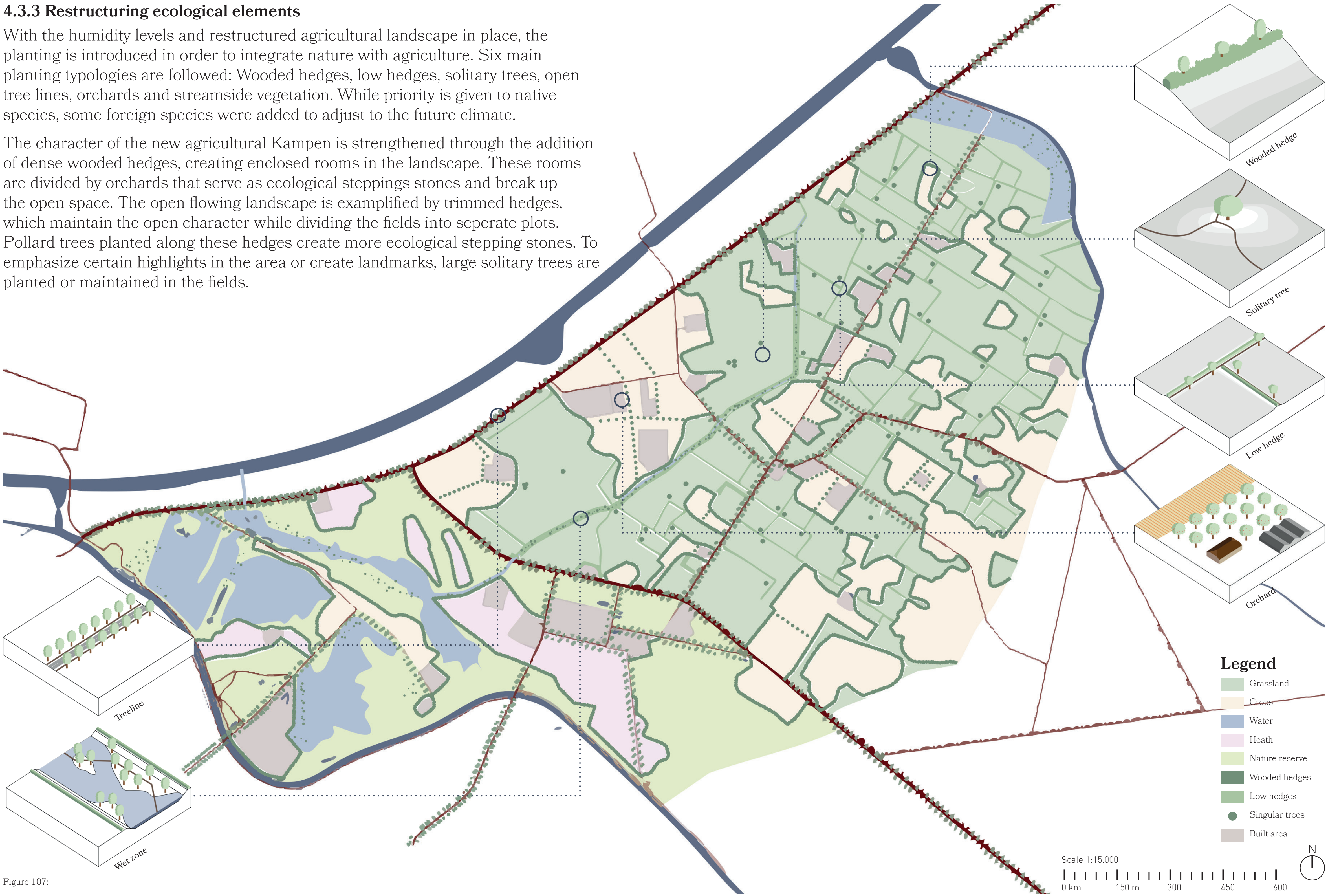



Figure 107:

Wooded hedges

The wooded hedges create a border around the dry agricultural fields and must therefore be more tolerant to draught. The enclosing qualities of these treelines mean that a mix between tall trees and dense shrubs is chosen. The tall trees have a columnar shape and are planted on the northern side, to block less sun but still provide enclosing elements, while providing nesting places for birds.

Orchards

While the agricultural fields are enclosed by a dense wooded hedge, to further intertwine the ecology with the agricultural landscape, orchards are placed to break up the open space. They are mostly used near farms, which are also situated in the dry areas of this landscape, and separating fields within the agricultural “kampen”.

Low hedges

Maintaining the openness of the meadows, low hedges are implemented to still be able to fence off different fields and elements in the landscape. The hedges are trimmed yearly by machine, into a squared shape. Pollard trees are used as ecological stepping stones every 10-20 meters, which do not need to be maintained as often.

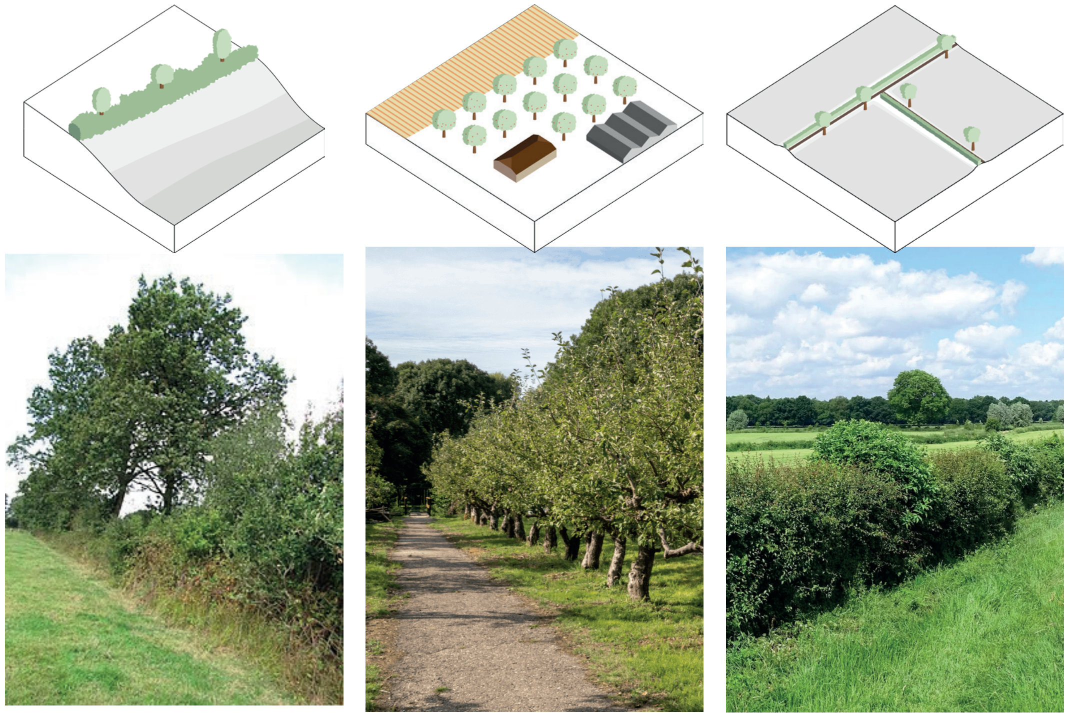


Figure 108-110: The wooded hedge, orchard and low hedge in the agricultural landscape (Theun, 2009; Vissers, 2019; Post, 2022)



Singular trees

The open meadows are characterized by grand solitary trees and low, trimmed hedges as fencing. The trees need to be tolerant to a moist soil as these are located in the flowing meadows, yet positioned on slightly elevated soil to prevent permanent wet feet. Some trees are already present in the current landscape, others will be added to highlight places of interest.

Streamside vegetation

Along the streams, the wettest vegetation is planted. Trees with a high tolerance to wet roots are needed, but some differences in elevation allow for different species with varying moisture tolerance. The corridor along the stream is enhanced by a dense, low hedge, similar to hedges in the meadows.

Open treelines

The roads are distinguished by the open treelines, creating open tunnels through the landscape. The roads cut through the enclosers of the agricultural fields, but at the same time form a sheltered tunnel. The character of the trees should be tall, round/oval with an open trunk, to both provide shelter and maintain the view of the landscape.

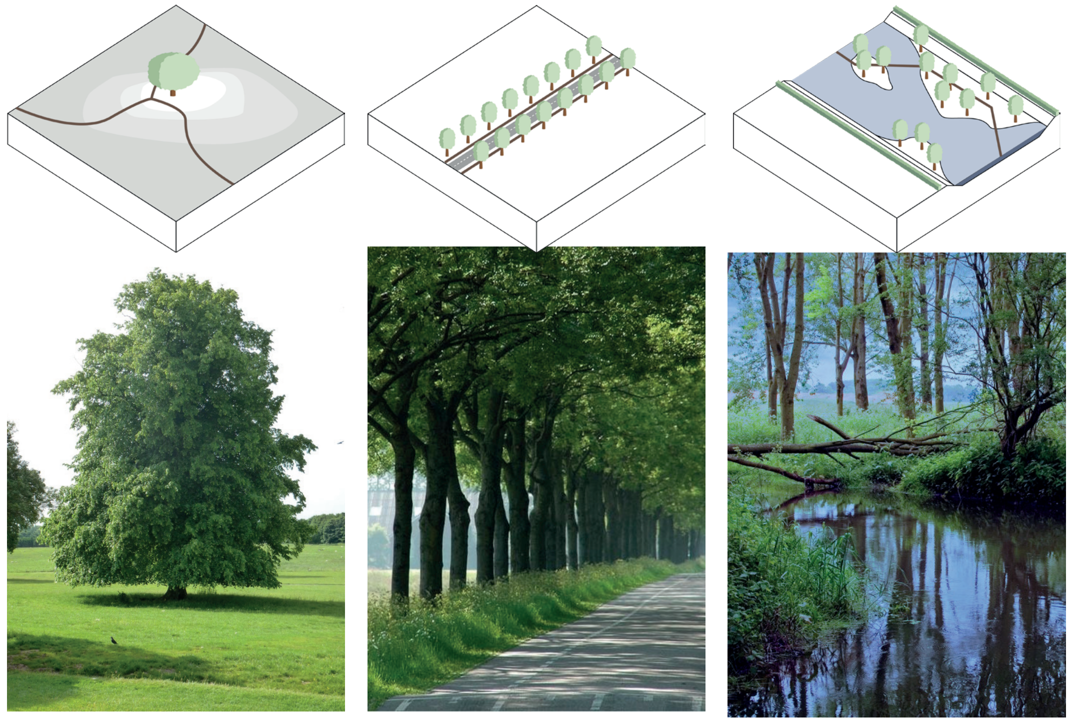


Figure 111-113: Solitary trees, tree lanes and wet nature typologies (Belleplant, 2018; Drongen, 2021; Staatsbosbeheer, 2018)


Figure 114: List of characteristic target species for the agricultural landscape of the Achterhoek. (VALA, 2024)

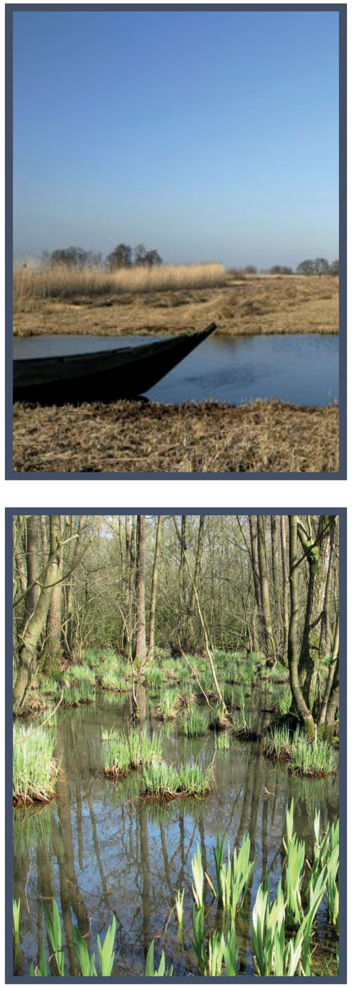


Figure 115/116: Maintained reedlands and Alder forests (OBN, 2011;Giesen, 2008)

Figure 117/118: Humid haylands and flowery roughs (OBN, 2011;OBN 2011)

Figure 115/116: Dry heathlands and wooded hedge (OBN, 2011;Theun, 2017)



*Biodiversity*

While the planting typologies mainly describe physical features, restoring biodiversity is the main priority. For this, 10 characteristic target species are chosen (see figure 114), typical for the agricultural landscape in these elevated sandy regions, but endangered through the loss of their habitat. These species use different elements of the landscape for hunting or nesting, making it important that all elements are provided (VALA, 2024). For example, the Crested newt relies on a wet environment for its breeding grounds, while pastures provide a source of food. The Kestrel on the other hand nests in larger trees on the edges of a forest or treeline, while open grasslands are needed for its hunting grounds. The Subterranean vole is also reliant on these open meadows to forage for food, but requires the small cultural elements such as hedges for additional shelter from predators such as the Kestrel. Providing these different elements in the landscape helps creating the new ecological balance of the region (VALA, 2024).

This is partially achieved through the implementation of the gradients in the landscape, but these gradients need to be strengthened with the planting typologies mentioned on the previous page. At the same time, a continuous supply of food needs to be provided, which adds to the importance of the chosen species. Different flowering periods for different trees and shrubs provide a foodsource throughout the year, as can be seen in figure x. This diagram only shows the flowering periods of the planted species, but additional undergrowth, which develops over time, helps to bridge any gaps in foodsources throughout the year.

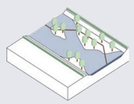
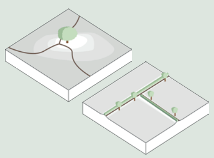
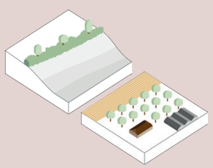
While the humidity of the soil determines which trees and shrubs can be planted there, the undergrowth of flora has to develop over time. Creating specific circumstances can help the development of certain nature typologies, but need time and maintenance for the ideal typologies to develop.

The wettest zones in the landscape are developed into reedlands and alder forests. Reedlands are simultaneously used to extract nutrients from the water, which helps the further development of this area. By mowing and extracting the reed from the area, nutrients are taken out of the system, which creates better circumstances for a variety of flora. Alder forests develop from these reedlands, but a helping hand is provided by planting these alder trees in the wettest area to speed up the process. Little further maintenance is required as the natural processes take over from there (Jansen, 2022).

The humid areas largely consist of meadows. Therefore the area is made suitable for humid flowery roughs and humid hay meadows (see figure x and x). These two typologies are maintained through regular grazing and mowing, in order to keep the nutrient levels low. A minimal use of manure is required, to not oversaturate the soil in nutrients (Jansen, 2022).

The dryest zones are most suited to heathlands and dry grasslands, with additional oak- and beechforests or treelines (Jansen, 2022). However, in the agricultural area, the dry zone mainly consists of agricultural fields. Through the addition of dense wooded hedges and orchards, ecological stepping stones are created, while also providing shelter for various species of birds and small mammals.

# *Tree selection table*

| AREA CHARACTERISTICS | LATIN NAME | ENGLISH NAME | PLANTING TYPE | HEIGHT | GROWTH RATE | NATIVE | J | F | M | A | M | J | J | A | S | O | N | D | UNIQUE PROPERTIES | ECOLOGICAL VALUE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WET  | *Alnus incana* | Grey alder | Tree | M | ▶ | ✗ | | | | | ✿ | | | 🍐 | 🍐 | | | | Wind tolerant | Insects on flowers |
| | *Alnus glutinosa* | Black alder | Tree | L | ▶▶▶ | ✓ | ✿ | ✿ | ✿ | | | | | 🍐 | 🍐 | | | | Flood tolerant | Early flowers for insects |
| | *Crataegus monogyna* | Hawthorn | Shrub | S | ▶▶ | ✓ | | | | | ✿ | ✿ | | | 🍐 | 🍐 | | | Becomes dense hedge when trimmed | Flowers for butterflies and bees, fruit for birds and shelter for small birds and mammals |
| | *Magnolia virginiana* | Sweetbay magnolia | Tree | S | ▶▶ | ✗ | | | | | | ✿ | ✿ | 🍐 | 🍐 | | | | Shade tolerant / rich fragrance bloom | Source for insects and butterflies |
| | *Prunus padus* | Bird cherry | Tree | M | ▶▶▶ | ✓ | | | ✿ | ✿ | | | 🍐 | 🍐 | 🍐 | | | | Pioneer / wind tolerant | Flowers for insects and butterflies, fruit for birds |
| | *Salix alba* | White willow | Tree | L | ▶▶▶ | ✓ | | | ✿ | ✿ | | | 🍐 | 🍐 | 🍐 | | | | Pioneer / wind tolerant | Flowers for insects |
| | *Salix babylonica* | Weeping willow | Tree | M | ▶▶ | ✗ | | | | ✿ | ✿ | 🍐 | | | | | | | Flood tolerant | Flowers for insects, shelter for larger birds |
| | *Salix fragilis* | Crack willow | Tree | M | ▶▶▶ | ✓ | | | ✿ | ✿ | | 🍐 | 🍐 | 🍐 | 🍐 | | | | Flood tolerant / pollard tree | Flowers for insects |
| | *Taxodium distichum* | Bald cyprus | Tree | L | ▶▶ | ✗ | | | | ✿ | | | | 🍐 | 🍐 | 🍐 | 🍐 | 🍐 | Very flood tolerant / accustomed to future climate | Fruit consumed by small mammals and birds, shelter for larger birds |
| HUMID  | *Carpinus betulus* | Hornbeam | Tree/Shrub | M | ▶▶ | ✓ | | | ✿ | ✿ | | | | 🍐 | 🍐 | | | | Evergreen / suitable as trimmed hedge | Provides shelter, smaller birds in hedge form, larger birds in tree form |
| | *Corylus avellana* | Hasel | Shrub | S | ▶▶▶ | ✓ | ✿ | | | | | | | 🍐 | 🍐 | 🍐 | | | Biodiverse / moisture tolerant | Early source for insects, fruits important for small mammals |
| | *Crataegus monogyna* | Hawthorn | Shrub | S | ▶▶ | ✓ | | | | | ✿ | | | | 🍐 | 🍐 | | | Becomes dense hedge when trimmed | Butterflies and bees make use of flowers, fruit are loved by birds, provide shelter for small birds and mammals |
| | *Fagus sylvatica 'atropunicea'* | Red beech | Tree | L | ▶▶ | ✗ | | | | ✿ | ✿ | | | 🍐 | 🍐 | | | | Striking red crown | Source for insects, fruits important for small mammals |
| | *Prunus avium* | Sweet cherry | Tree | L | ▶▶ | ✓ | | | | ✿ | ✿ | | 🍐 | 🍐 | | | | | White fragrant bloom | Brief flowering period for insects, fruit loved by birds and mammals |
| | *Prunus spinosa* | Blackthorn | Shrub | S | ▶▶▶ | ✓ | | | ✿ | ✿ | | | | 🍐 | 🍐 | | | | Moisture tolerant / suitable as trimmed hedge | Source for insects, fruits important for small mammals |
| | *Quercus robur* | Summer oak | Tree | L | ▶ | ✓ | | | | | ✿ | | | 🍐 | 🍐 | | | | Wind tolerant | Source for insects, fruits important for small mammals, provides shelter for larger birds |
| | *Tilia cordata* | Small-leaved linden | Tree | L | ▶▶▶ | ✓ | | | | | | ✿ | | | 🍐 | | | | Wind regulating | Source for insects, fruits important for small mammals |
| DRY  | *Acer campestre* | Field maple | Tree | M | ▶ | ✓ | | | | ✿ | ✿ | | | 🍐 | 🍐 | | | | Striking red in autumn | Source for insects |
| | *Betula pendula* | Silver birch | Tree | L | ▶▶▶ | ✓ | | | | ✿ | ✿ | | | 🍐 | 🍐 | | | | Draught tolerant / low needs | Provides shelter for larger birds |
| | *Corylus avellana* | Hasel | Shrub | S | ▶▶▶ | ✓ | ✿ | | | | | | | 🍐 | 🍐 | 🍐 | | | Biodiverse / moisture tolerant | Early source for insects, fruits important for small mammals |
| | *Frangula alnus* | Alder buckthorn | Shrub | S | ▶▶ | ✓ | | | | | ✿ | ✿ | ✿ | ✿ | 🍐 | 🍐 | | | Easy to grow / biodiverse | Both flowers and fruit are important sources for birds and insects |
| | *Malus domestica* 'Elstar' | Apple | Tree | S | ▶▶ | ✓ | | | | | ✿ | ✿ | 🍐 | 🍐 | | | | | Fruittree | Both flowers and fruit are important sources for birds and insects |
| | *Populus nigra* 'Italica'' | Lombardy poplar | Tree | M | ▶▶ | ✗ | | ✿ | | | | | | | | | | | Columnar shape / draught tolerant | Shelter for smaller and larger birds |
| | *Prunus avium* | Sweet cherry | Tree | M | ▶▶ | ✓ | | | | ✿ | ✿ | | 🍐 | 🍐 | | | | | White fragrant bloom | Both flowers and fruit are important sources for birds and insects |
| | *Prunus domestica* | Plum | Tree | S | ▶▶ | ✗ | | | | ✿ | ✿ | | 🍐 | 🍐 | | | | | Fruittree | Both flowers and fruit are important sources for birds and insects |
| | *Pyrus communis* 'Charneux' | Pear | Tree | S | ▶▶ | ✓ | | | | | ✿ | | 🍐 | 🍐 | | | | | Fruittree | Both flowers and fruit are important sources for birds and insects |
| | *Quercus petraea* | Sessile oak | Tree | L | ▶ | ✓ | | | | | ✿ | | | | 🍐 | 🍐 | | | Draught tolerant | Source for insects, fruits important for small mammals, provides shelter for larger birds |
| | *Sorbus aucuparia* | Rowan | Tree | S | ▶▶ | ✓ | | | | ✿ | ✿ | | | 🍐 | 🍐 | | | | Shade tolerant / biodiverse | Both flowers and fruit are important sources for birds and insects |

Legend

| | | | | |
|---|---|---|---|---|
| S | Small | <10m | ▶ | Slow |
| M | Medium | 10-25m | ▶▶ | Medium |
| L | Large | >25m | ▶▶▶ | Fast |

Figure 117: Tree selection table with species selecteed for the design based on various criteria (author, 2025)

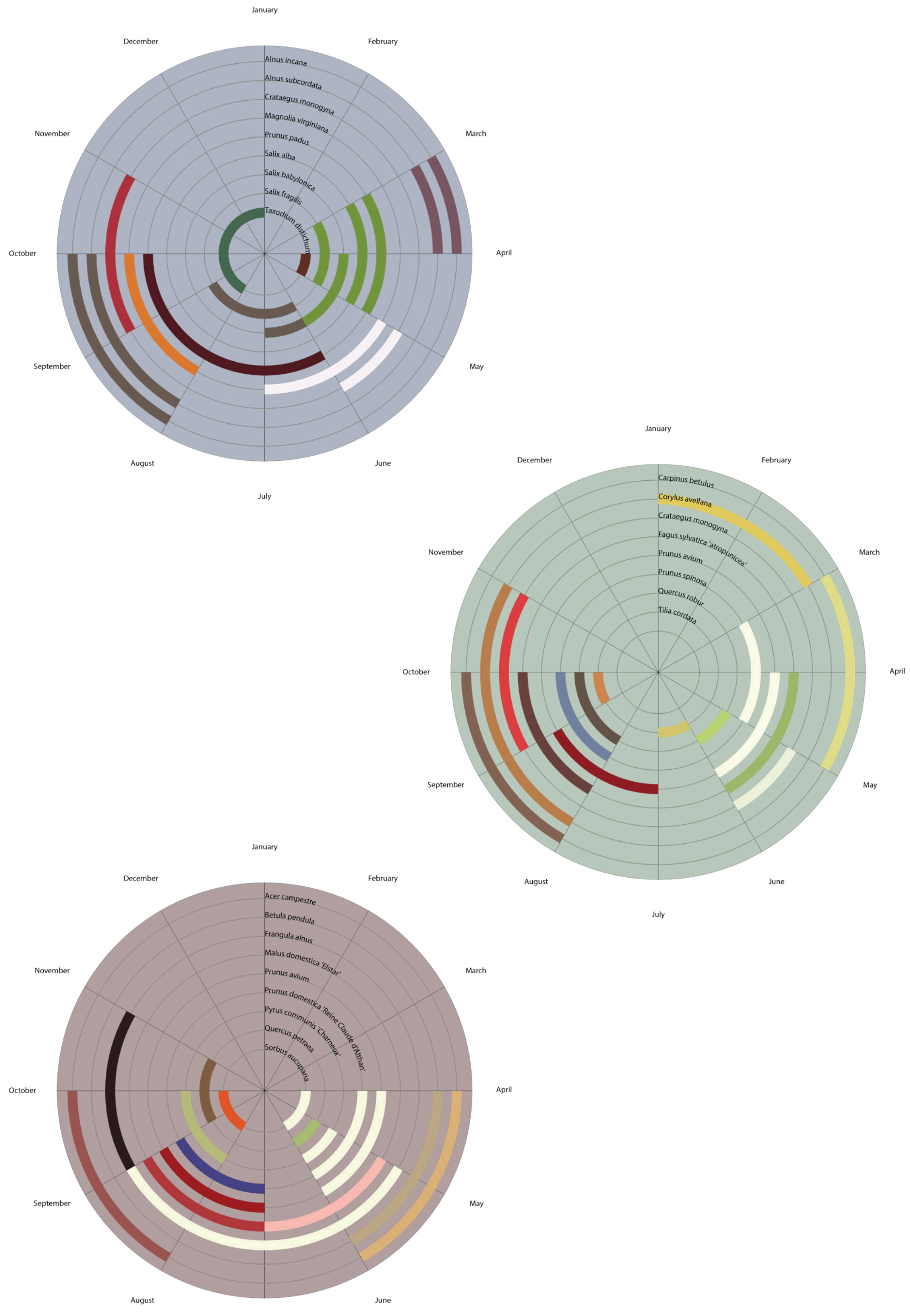



Figure 118-120: Production diagram of selected species in the wet, humid and dry zone (author, 2024)

*Tree selection*

A continuous supply of food is important for biodiversity growth in the agricultural landscape. The winter period is generally a period where birds migrate and mammals go dorment for months, but early flowering species are therefore even more important when these species wake up, starving after the long sleep. Species such as the *Corylus avellana* or Hazel, which flower at the end of winter or early spring are therefore selected to provide in the earliest periods. Each humidity zone provides food throughout the year, as some target species rely on one zone to survive (see figure 118-120)

The selected species, which can be found in figure 117, has been based on four main aspects:

<u>Humidity tolerance:</u> The first criteria is based on the tolerance to the soil humidity, with a separation between dry, humid and wet areas, as is the case in the future situation. Other aspects such as soil typologies are taken into account as well.

<u>Production period:</u> A spread in flowering and fruiting period is important for afforementioned reasons. While some periods are less productive then others, we only consider planted species in this case. Additional undergrowth, which develops over time, helps to fill the gaps. Some flowers, such as that of the willow species, are not directly benefitting target species, but help attract insects and butterflies, which are a food source as well. Figure x-x shows the fruiting periods of selected trees, and their colouring which has an affect on the pallette of the landscape as well.

<u>Biodiversity aspects:</u> While available flowers and fruit is important, shelter for various species is needed as well. Some species provide less in flowers or fruit but more in shelter and nesting places. An example of this is the *Salix alba* or White willow, which has very small flowers which are of lesser importance to the food supply. Yet, especially in its pollard form, these trees are providing shelter to many insects, mammals and birds.

<u>Unique properties:</u> Other properties are considered as well, such as the tolerance to flooding in the wet areas, or the fast growthspeed in order to generate a quick transformation of the landscape. A mix in height helps creating wind barriers, while providing shelter for different species as well. A mix of native and imported species have been selected, since native species are generally much more biodiverse then non native ones. On the other hand, due to the changing climate, more southern species are imported in order to accustome to the futurte climate.

**Phased Transition to a Mixed-Use Agricultural Landscape**

The plan cant be implemented in one go, for multiple reasons. First of all, it involves too many steps to be able to complete in one smooth transition. Secondly, the landscape needs time to repair, structures need to grow and ecosystems rebalance, which takes time. And last, but most important, as the proposal is a radical transition from the current agricultural landuse, it requires adaptation time. A gradual introduction of elements helps to create a movement of transition, which helps to get people on board rather than create resistance to the plan. Therefore, the project is structured into three key phases, each building on the foundation of the previous one, to ensure ecological, social, and economic resilience. The full transition can take up to 50 years or more, into the next generation.

*Phase 1: Preparation stage (Year 1-5)*

The primary goals of Phase 1 are to enhance biodiversity by creating ecological corridors and stepping stones and to lay the groundwork for the next phases of transformation. This includes establishing Marken communities, which will foster collaboration among farmers and volunteers and give them responsibility for managing the transformed landscape. The early focus is also on integrating cultural elements that strengthen the landscape's ecological and aesthetic value, supported by subsidies for cultural landscape management.

Implementations:

Adjusting Water Levels:

- Raise water levels to establish a buffer for dry summers.
- Convert overly wet farmland for non-cultivated use, selling these areas to water management authorities (Waterschappen) for future flowing meadow development.

Planting Wet Zones:

- Introduce trees and plants suited to wet conditions, creating habitats and stabilizing the new hydrological gradient.

Marken Communities:

- Organize farmers and volunteers into local cooperatives (Marken) to oversee cultural landscape elements, supported by subsidies.

Cultural Element Integration:

- Plant lower hedges, pollard willows, and solitary trees in meadows.
- Line roads with additional trees to enhance aesthetic and ecological value.



*Phase 2: Embracing fluidity (Year 6-15)*

Phase 2 focuses on further extensifying farming practices and deepening the integration of biodiversity within the landscape. By this time, the responsibilities of the Marke community will be expanded, and the replanted open landscape will provide a foundation for flowing meadows. The introduction of these meadows complements extensive dairy farming practices that avoid artificial fertilizers and prevent water pollution. Initially, only a few farms are connected to these flowing meadows, which can be expanded from the main structure, constructed by de Waterschappen. As the advantages of flowing meadows are proven in in the field, more farmers can be persuaded to join and connect their fields to the flowing meadows. Phase 2 also aims to attract tourism, leveraging the area's biodiversity and sustainable farming practices to encourage economic diversification. This will support farmers in developing side businesses such as campgrounds, bike rentals, or nature excursions, contributing to the region's economic resilience.

Implementations:

Flowing Meadows:

- Establish flowing meadows as extensive dairy farming phases out artificial fertilizers, preventing water pollution and fostering natural biodiversity.

Marken Growth:

- Expand Marken communities by recruiting more volunteers to maintain and monitor flowing meadows and other ecological features.

Farm Diversification:

- Encourage side businesses such as campgrounds, bike rentals, and nature excursions.
- Capitalize on increased visitor interest in sustainable and biodiverse farming practices.

Landscape Enhancements:

- Continue planting and developing wet zones to strengthen biodiversity corridors and create an ecological structure around the flowng meadows.

*Phase 3: Transformation into a Mixed-Use Landscape (Year 16-50)*

Phase 3 represents the final stage of transformation into a balanced mixed-use agricultural landscape. The focus shifts from extensive dairy farming to diversified crop cultivation and sustainable agricultural practices. Over this period, a gradual reallocation of land occurs through farmer buyouts and inheritance transitions, as transitioning within the same generation is a big ask. The overarching goal of Phase 3 is to create a landscape that balances agricultural productivity with biodiversity and community well-being, supported by regional resource-sharing systems. By the end of this phase, the landscape will reflect a harmonious integration of nature, agriculture, and tourism, with the emphasis on a balanced landuse between all the connected elements.

Implementations:

<u>Agricultural Farming:</u>

- Shift focus to diversified crop cultivation and sustainable farming practices.
- Establish orchards, wooded hedges, and other field separators to enhance biodiversity and protect crops.

<u>Regional Exchange Systems:</u>

- Facilitate the exchange of waste such as manure, plant waste, and biogas among local farms, fostering a circular economy.

<u>Water Retention in Dry Areas:</u>

- Add wadis to retain water and manage dry regions, ensuring agricultural resilience during droughts.

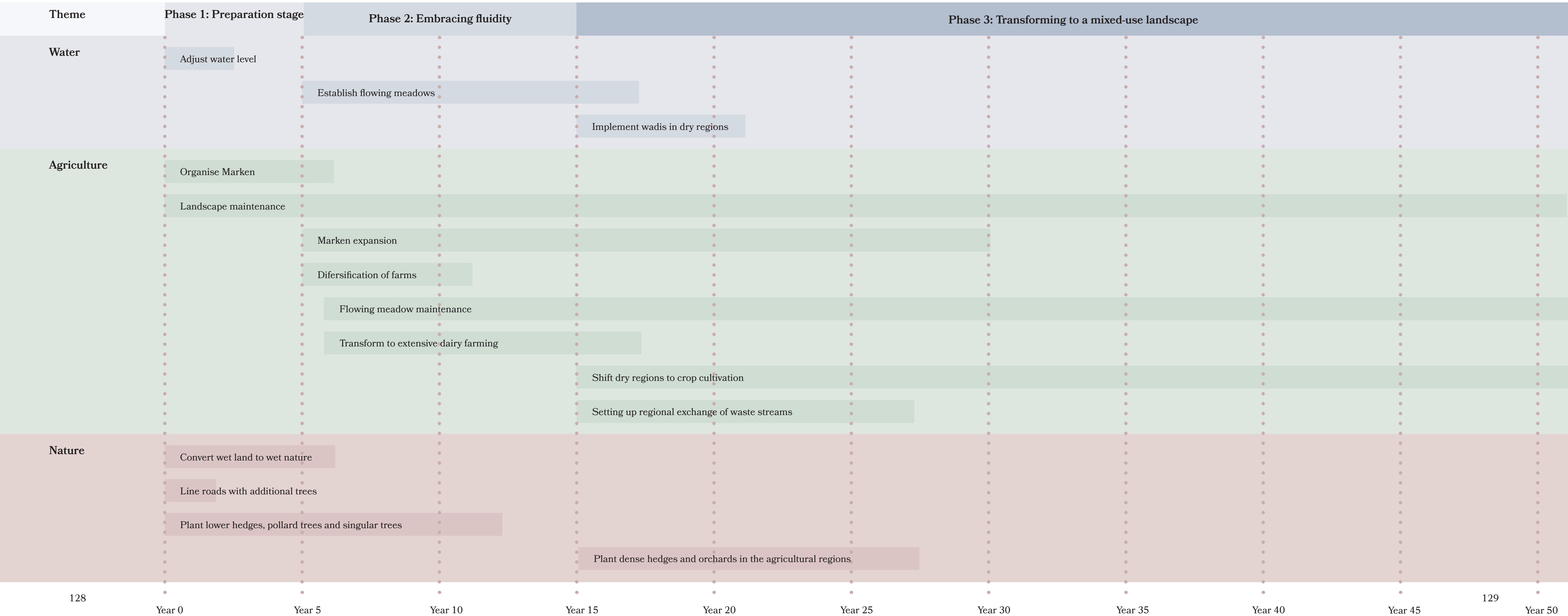
<u>Orchards and Hedgerows:</u>

- Plant dense hedges and orchards to serve as windbreaks, enhance biodiversity, and add to the aesthetic and ecological value of the region.

## Conclusion

This phased approach ensures that the transformation is gradual and adaptive, minimizing disruption while maximizing ecological and economic benefits. The establishment of Marken communities and the integration of cultural and ecological elements will create a sustainable and vibrant landscape that balances agricultural productivity with environmental stewardship and community well-being.

Figure 121: Phase diagram of the project implementation (author, 2025)



## 4.4 The reconstructed landscape


Figure 122: The combined design proposal for the region of Nettelhorst

## 4.4.1 Zooming in

Looking at the zoomin site, the different elements in the landscape become even clearer. The linear agricultural fields enclosed by a dense hedge, where orchards seperate fields and farms. The open meadows where vegetation is more spread out, emphasising the openness and freedome for water to flow. The water system which is now much more prevelent in the landscape, emphasised by a wet ecological zone, beneficial for both nature and visitors of the landscape. The walking paths are situated along the edges of the landscape, on the transitions between wet and dry and leading to highlights of the newly implemented water system. To get a better understanding of the new character of the landscape, four sections are highlighted in further detail below.


Figure 123: Zoomin location dry - humid

Figure 125: Current area around the Nettelhorster Laak (author, 2025)

1. Purple heron

2. Crested newt

3. Tree frog

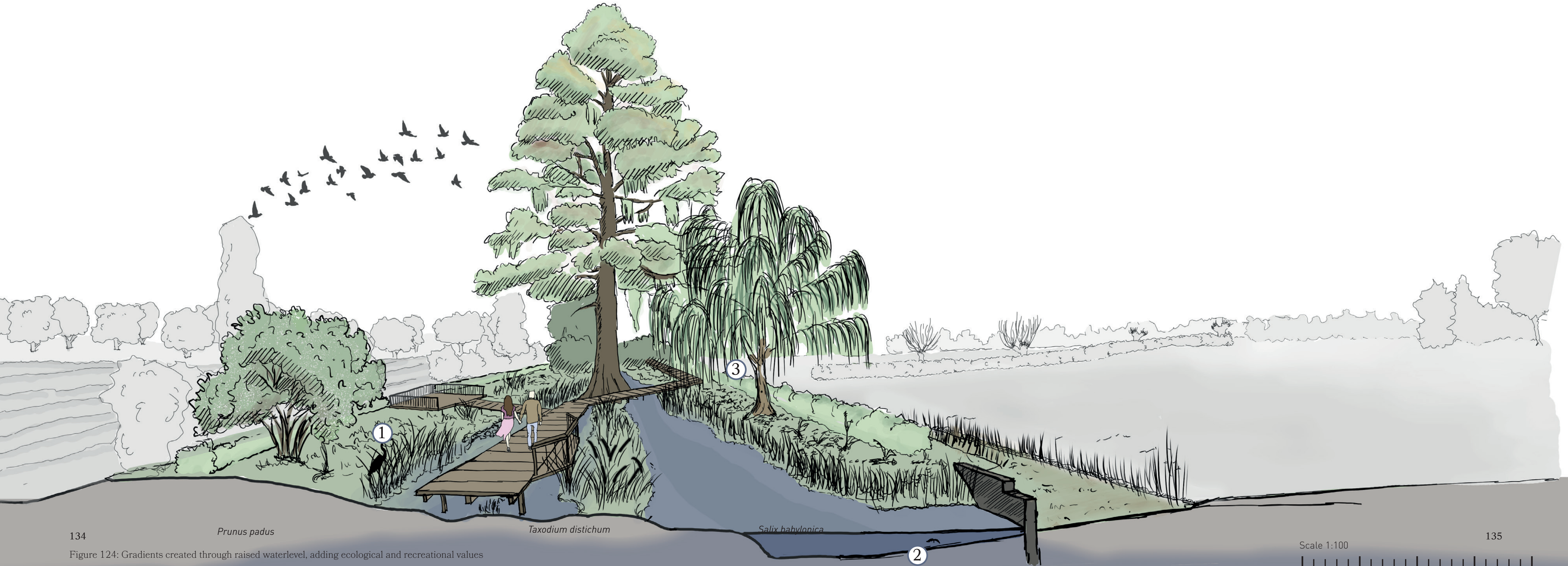





Figure 124: Gradients created through raised waterlevel, adding ecological and recreational values

## Wet zone - winter

In winter, the water level raises and floods large parts of the canal. The bald cypress is now fully submerged, which it is able to sustain for longer periods of time. Water is flowing in from secondary collection ditches as the neighbouring field is used as flowing meadow. A small extension of the boardwalk creates a vantage point from where visitors are able to spectate and experience the intricacy of the flowing meadows, and the changing of the landscape. While the raised levees on the sides are planted with low shrubs to create an enclosed space, openings created by the weirs and side paths with viewpoints sticking through the dense bushes create changing views of the different aspects of the landscape.

Figure 127: Current area around the Nettelhorster Laak (author, 2025)

1. Purple heron

2. Crested newt

3. Tree frog


Figure 126: During the flowing season, the area gets a different character through the dynamics of the water

### 4.4.3 Flowing meadow - summer

Further along the path, the visitor is walking through the open agricultural landscape. This area is located on a higher level then the collection channel, but is still able to be used as flowing meadow. In summer however, a diverse agricultural grassland stretches out. Low shrubs serve both as ecological corridors for small fauna such as the yellow hammer and shrew, as fencing between fields and as a water border. The roots of the shrubs push up the soil and create micro-levees, enough to prevent water from flowing in the wrong direction in winter. Along these shrubs paths are leading visitors throught the landscape. On local elevations, large species of trees are planted as both landmarking elements and ecological stepping stones. Tall, imposing species such as *Quercus robur* or *Fagus sylvatica* 'atropunicea' (summer oak and red beech) are chosen for this. Pollard trees such as *Salix alba* (white willow) are planted along the hedges, creating further ecological stepping stones through the otherwise open landscape.

Along the highest parts of the flowing field, a dry ditch is visible. This is part of the flowing system, but is not operational in this part of the year. Though the ditch, located closer to the groundwater level, is a more moist environment where different flora is able to thrive. In places where flowing practices are in operation, viewing platforms are created to emphasize these points of interest.

Figure 129: Current monocultural grassland, with none of the subtle gradients distinguishable (author, 2024)



Figure 128: Extensive agriculture accessible for visitors and other fauna

## Flowing meadow - winter

In winter, the flowing is in full swing. Cattle is kept inside during this time of year, giving room for the flooding of the fields. The once dry ditch is now cleaned out and filled up with water through a main channel elsewhere. The ditch is a “blind ditch”, meaning it is not connected to anything else, causing water to fill up and get forced over the edge along small slits in the bank of the ditch. As the ditch is located on the highest part of the field, water then flows down over the grassland towards the collection ditch we saw in paragraph 4.4.2. The viewing platform overlooks this flowing practice, with an open metal grid to stand on, giving a clear view of the flowing water underneath.

Figure 131: Current monocultural grassland, with none of the subtle gradients distinguishable (author, 2024)

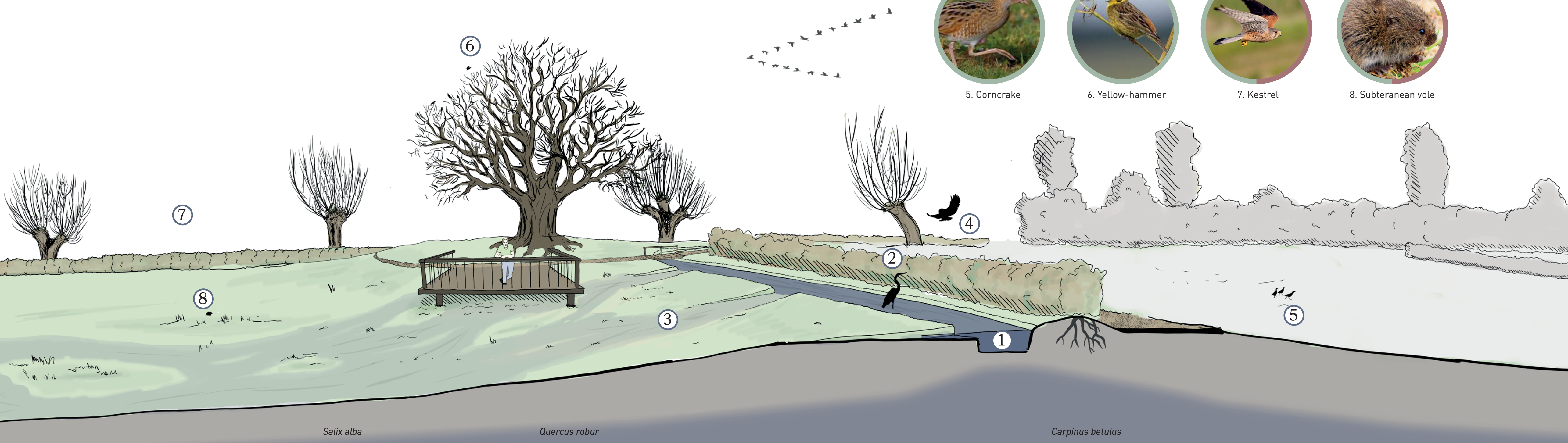




Figure 130: The flowing brings new dynamics to the landscape

Scale 1:100

0 1 m 2 3 4

## 4.4.4 Enclosed wooded hedge - summer

Along the highest parts of the landscape, dense tall wooded hedges are planted, seperating grassland from agricultural fields. The hedge serves several purposes. Firstly, cattle is unable to cross into the fields and destroy the crops. Secondly, shelter is created for these crops, blocking wind from drying out the soil and damaging crops. The hedge serves ecological purpose as well, creating nesting grounds and shelter for species such as the little owl, kestrel yellowhammer and garlic toad. A mixture of tall species like *Betula pendula, Populus nigra* 'Italica' (silver birch and lombardy poplar) and undergrowth of *Sorbus aucuparia* and *Frangula alnus* (rowan and alder buckthorn) create a layered hedge, while maintaining an open character in the top layer in order to limit shadow on the agricultural field.

On the lower side of the hedge, the main distribution canal of the flowing meadow is located. This canal is  dry in summers, as flowing is only practiced in winter. A wadi in the dry agricultural field helps to collect rainwater, which benefits local wildlife and helps to raise the water table in this part.

Figure 133: While visible, the heigh differences are only seperated by small grass elements, if at all (author, 2025)

5. Corncrake

6. Yellow-hammer

7. Kestrel


Figure 132: The dry ridge creating borders in the landscape

Figure 135: While visible, the heigh differences are only seperated by small grass elements, if at all (author, 2025)




Figure 134: flowing water changing the atmosphere

Scale 1:100

0 1 m 2 3 4

## 4.4.5 The farmyard

The farms and their yards are located on the dry parts of the landscape, adjacent to the agricultural fields. The enclosed character of the fields helps create a sheltered ambiance of the yard, protected from the elements. An orchard functions as separating element between the farmland and the farm, while providing fruit for the local shop and farmer. At the same time, it breaks up the sometimes large space inside the agricultural Kamp for fauna as well, allowing species to traverse these areas. In this case, the walking path makes use of the orchard as well, guiding the visitors through this peaceful environment towards the farmshop, where local produce can be bought and enjoyed. By getting visitors in contact with the different elements of the landscape and bringing them to the livelyness of the farmyard, the connection is strengthened and touristic capacity can be increased. Other farm diversification such as bike rentals and restaurants will benefit from this as well.

Figure 137: Currently, farms are unprotected in the open landscape

1. Little owl

2. Garlic toad

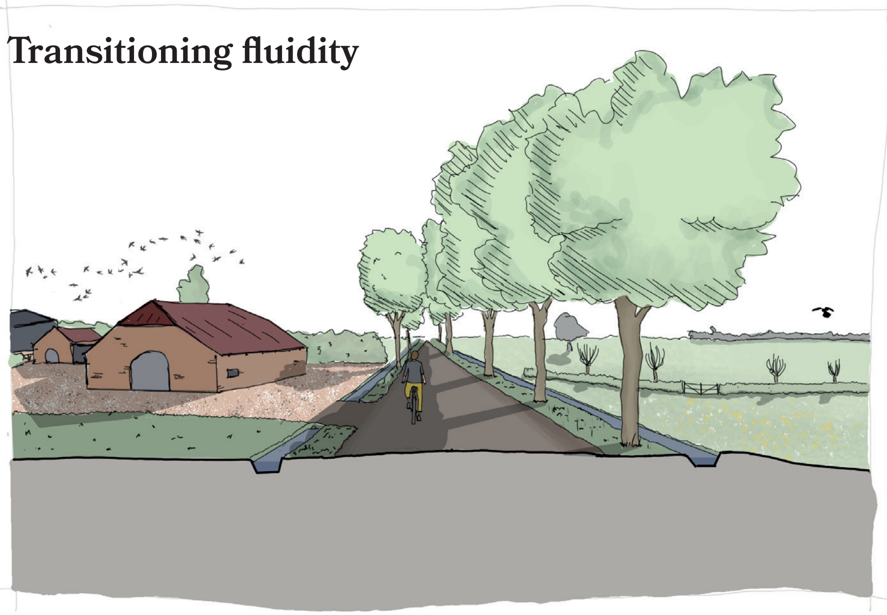
3. Kestrel

4. Subterranean vole




Figure 136: The sheltered farm within the agricultural Kamp, fenced off by an orchard.

## 4.4.6 Transitioning fluidity



Following the linear roads of the landscape, a different perspective of the landscape unfolds. As these linear roads do not follow the natural contour lines of the landscape, they cut through the various elements of the landscape. Alternating open and closed spaces of the meadows and agricultural fields give variating views, ideal for a visit by bike or car. The farms, located along these roads, offer local goods, bike rentals, campsites and other amenities for both tourists and locals, connecting visitors in more then just a visual way to the landscape.

The trees planted along these roads create a gallery view, with different species creating different perspectives depending on the composition of open and closed spaces. Along the open meadows a tunnel effect is created with trees with a high, closed canopy, while the spaces opens up in the agricultural *Kamp,* where the columnar trees create less shade while directing the view towards the agricultural activities on the crop fields.

The main water distribution canals are also located along these roads, with the flowing of water adding sound and livelyness to the space. At the same time, the water creates a bordering element between the visitor and the surrounding landscape, enhancing the effect of the viewing gallery created by the linear trees. Side canals branch off from the main canal, which can be operated manually by a volunteer from the Marken when flowing is needed. Footpaths along these distribution systems are created for people on foot, with stepping stones over the for children to interact with the water.

These transitions between spaces create the variety that the current landscape lacks, introducing all the new aspects of the transition towards to mixed-use landscape of the future.

Figure 138-141: Biking through the landscape allows a different perspective on the new activities (author, 2025)

## 4.5 Summary and conclusion

To conclude, we aim to answer the following sub research question:

*“How can the alternative strategies be implemented into the agricultural landscape?”*

The alternative strategies focus on the aim of a soil-based approach. This approach looks at the soilconditions first, before adjusting the landuse to it, considering the type of soil and natural water level. Dry areas are adjusted to drought tolerant practices while wet areas focus on similarly adjusted land use.

First, a design location was chosen to apply the strategies to. The agricultural landscape of Nettelhorst was chosen for its rich history and the urgent issues of biodiversity loss and monocultural land use. Analysis showed that while Nettelhorst once had a diverse landscape, it has now been largely replaced by modern industrialised cattle farming. Despite this evolution, some historical features, like the topography, the Nettelhorster Laak and remnants of old estates, remain. Current agricultural practices dominate, but there are opportunities for the protection of biodiversity through the re-introduction of landscape gradients.

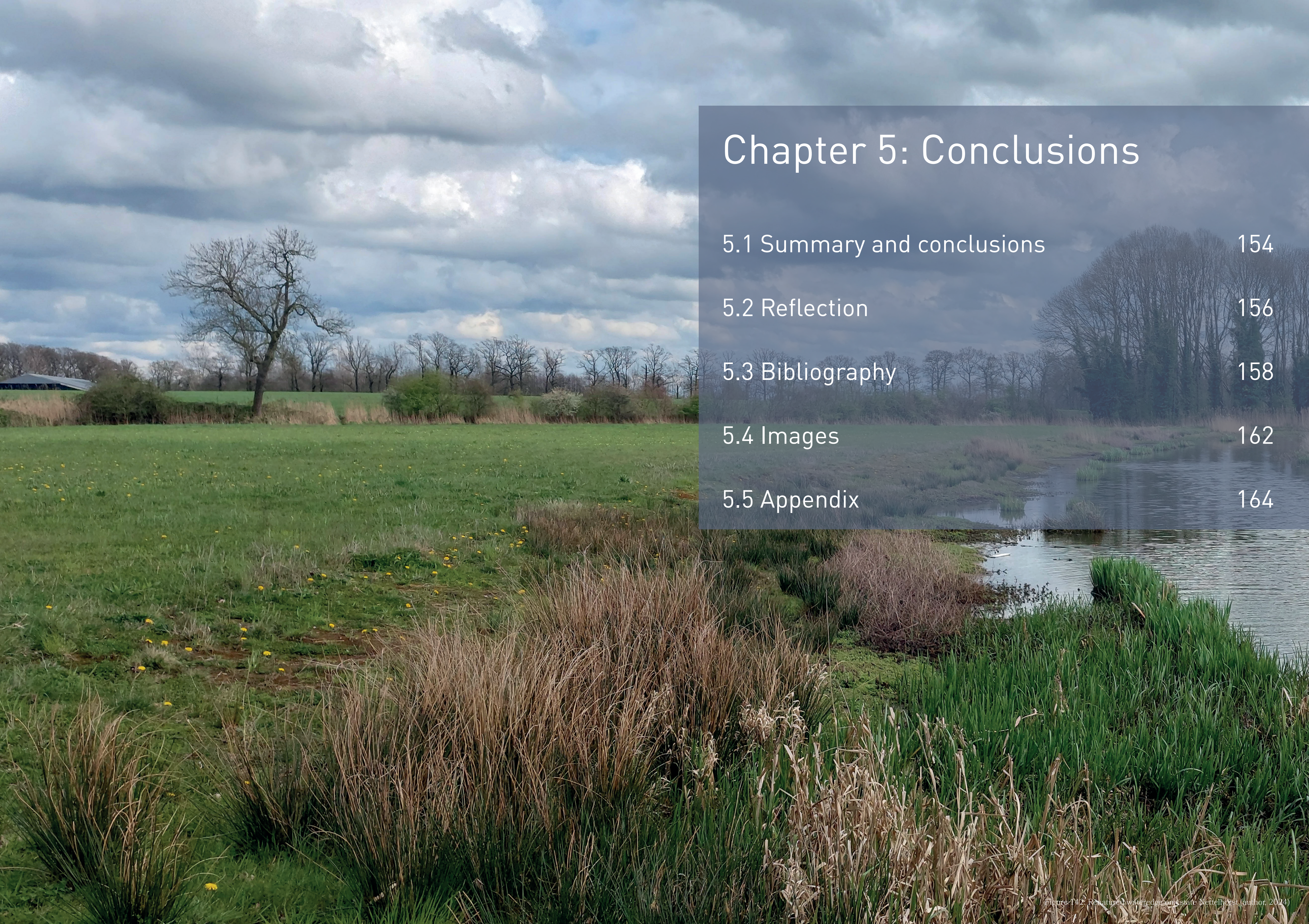
Following the threats and opportunities, a design aim is reformulated, focusing on the soil-based approach. By looking at the natural state of the groundwater conditions, we aim to adjust the landuse to it rather then force the landscape to serve a specified purpose, revitalizing water management, nature restoration, and sustainable farming in the context of Nettelhorst. The aims for water management include raising groundwater levels, reducing drainage and improving the groundwater infiltration. Nature restoration efforts aim to expand habitats through the reintegration of nature in the farmland, while sustainable farming practices encourage diversification and a reduced reliance on external imput through the cooperation between farmers on a local level.

The concept and design principles are applied on the Nettelhorst region, first showing their theoretical implementation, before zooming in and looking at the eye level perspective in order to test the details. The design principles and concept helped to colour in the landscape from the larger scale, but the detailing revealed the new qualities this approach could have when implemented. The different humidity zones each have their own character, with the dry agricultural areas shaped like biodiverse chambers, in which nature-inclusive agriculture can take place. The humid areas are the most alike the original landscape, yet the implementation of flowing meadows gave a new character to this otherwise static landscape. The addition of cultural elements along this new water system helps to break up the open space and provide corridors for visitors and animals to traverse the landscape. The wettest areas provide their own character through the implementation of a new planting typology to the region, with species tolerant to the fluctuating humidity levels. Additionally, these areas help to filter the water, becoming as vital as kidneys to the plan.



This new model provides benefits for nature and a new approach to farming, but does require a lot more manual labour in order to maintain these systems and their qualities. Therefore cooperation is necessary between the farmers, creating a new Marken organisation that organises the farmers, whom have become Landkeepers.  Additional diversification helps limit the reliance on subsidies and the farmproduction, leaving more room for extensive farming practices.

Looking ahead, the vision for Nettelhorst is a long journey of transformation, not only in the physical infrastructures, but mostly in the adjustments to the new system. A phased approach is needed, not only to be able to manage the adaptation from a physical perspective, but also to adapt the idea of what agriculture needs to be like. A gradual transition can help to create a basis in society, and adjust to future developments. The Marken can play a key role in this transition, planting the seed for a landscape responsibility, handing it to the farmer rather then external parties. With that as a basis, the lengthy transitional process towards a sustainable, mixed-use landscape can be fulfilled.



# Chapter 5: Conclusions



Figure 142: Renatured wateredge on estate Nettelhorst (author, 2024)

## 5.1 Summary and conclusion

The climate challenges that face the Netherlands are exemplified in the Achterhoek, where the sandy soil and elevation create a perfect storm for droughts due to changing weather patterns in the future. Nature and agriculture are vulnerable to these changes, as both rely on a constant supply of water. However, nature faces more challenges as increasing industrialisation of the agricultural practice increase pollution and water usage. The three elements are out of balance; therefore, we stated the following main research question:

*"How can landscape architecture help to reintegrate water management, nature, and agriculture in order to enhance climate resilience, increase biodiversity, and ensure a sustainable future for farmers?"*

In order to answer the research question, three sub questions have been formulated:

*"How has the disbalance between water management, nature and agriculture developed?"*

The agricultural landscape used to be a balance between nature and agriculture, where the farmers were relying on all the landscape gradients to survive. The agricultural and natural landscape were one, with both benefiting from each other in symbiosis. Farmers worked together in communities called Marken, to spread the workload and combine strengths. They developed clever systems to harvest all available resources, such as irrigation systems known as flowing meadows, used to extract valuable nutrients from the water. The region's landscape evolved over centuries, but the industrial revolution led to a fast revolution of the farming practice, disrupting the balance between water, agriculture, and nature.

*"What design strategies can be employed in order to rebalance water management, nature and agriculture?"*

While historic examples can serve as important inspiration for the future, we should not aim to go back to the Middle Ages. The Marken and flowing meadows should be reinterpreted in the modern context, combining the natural balance of the past with the productivity of today. Projects like Urtica de Vijfsprong and het Lankheet show how nature-inclusive strategies can restore the balance by improving biodiversity, drought resilience, and diversifying sources of income. These re-interpret historical methods in a modern society, serving as an example how to help modern agriculture adapt to natural landscapes.

*"How can the alternative strategies be implemented into the agricultural landscape?"*

To guide future land use, a soil-based approach is adopted. This approach tailors land use to natural water levels, with dry areas adapted for drought-tolerant practices and wet areas for moisture-suited land uses. By raising groundwater levels and reintegrating natural habitats into farmland, the landscape becomes a multifunctional space between farmers and nature. Flowing meadows are introduced along the natural gradients of the landscape, helping the transition from a monocultural to a mixed land use. The "new Marken" cooperative farming model encourages collaboration and sharing of produce between different farm types, helping to close the nutrient cycle and lowering costs. Additional sources of income can be generated by diversification, such as the addition of a healthcare branch, recreation or energy production. The Marken stand central in the project, creating the basis for the connection between farmers and landscape. By handing the responsibility for land and water management to the farmer, a new job title becomes evident: the Landkeeper.

The vision for Nettelhorst envisions a 50-year transformation where water management and sustainable practices create a balanced landscape that enhances biodiversity and resilience, positioning Nettelhorst as a model for sustainable agriculture. The initial transition focuses on adapting to the most prevalent climate threats, while creating a stronger ecological network through the implementation of cultural elements. The later phases take more time, as they tailor adaptation of the farming practice to a nature inclusive method, which needs to be done gradually to prevent resistance and create a strong basis. The last stage focuses on converting the dryest land to crop cultivation, as this transition has the biggest impact, involving a new land reallotment and big adjustment to the current farming method.

To answer the main question: landscape architecture can help rebalancing the three themes by looking at the landscape in layers, considering their relationship and the underlying issues. When the core issues are diagnosed, the holistic approach helps to reintegrate the delaminated layers and propose a new approach that will help the system as a whole, rather than treat the symptoms.

With this layered approach, other aspects of the landscape benefit as well. The core values of water management, biodiversity, and nature-friendly farming methods enhance the landscape and ensure a sustainable future. On top of that, the social benefits are an important side effect of this implementation. While this approach adds more labour hours and manpower needed to maintain the landscape, this enhances the social structures in the local community. By managing this landscape together, a sense of responsibility is given to the farmers, strenghtening the ties to the landscape and each other. Additionally, visitors gain from this strengthened community by a diverse landscape and several recreational values. This helps to bring more people to this region, which further enhances the value of the diversified farms through additional sources of income, thus securing a healthy future for farmer and nature.

# Reflection

## Approach and methodology

Initially, the goal was to approach this thesis from the farmers perspective by talking to locals and placing myself in their shoes, and create a participatory process. To do this, interviews were conducted with varying views, however they reflected either a historic view or future perspective, and neglected the current situation. This is visible in the end result of the thesis, which is focused on the future with historic inspirations, but does not always consider the current situation and the process a current farmer needs to go through in order to adjust.

However, with the feedback provided, I was steered further into a social approach of the thesis, thinking about cooperation between farmers, and connecting farmers to the landscape. In the end, this is what created the added value of the design. While the direct goals were to create a stronger, more climate robust system, the regional and local cooperation strengthens the bond between farmers, their landscape and nature.

## Connection to the master track

Working through the scales brought the theme of Circular Water Stories with the historic background together with the overall master track of landscape architecture. While taking the water system as a central part of the design, other layers of the landscape were considered as being part of a larger system and their strengths and flaws surfaced. The understanding of the interrelation between the landscape layers helped to identify the larger issues at hand, and think from the regional scale all the way down to the human scale.

## Reflecting the process

The research started for me without a clear goal, looking into historical sources based on personal interests, guided by the tutoring, see figure. With this large database of information i was eventually able to select a storyline, disgarding almost half of the information gathered. Through further research the story could be refined, and a basis for the design formed. By designing, gaps in the research became visible and additional research was needed, but now with a much clearer goal.

This way of working can be time consuming, especially when you find it difficult to create a clear storyline in the pile of topics you have researched like I do, but it can help to broaden your interests when there is no clear initial goal or vision. In the end it feels like you end up with a lot of unused research and wasted time. However, this is part of the process when starting from scratch. Personally, it has been difficult to adjust to this however, as I felt I was doing theoretical research for about 80% of the thesis. This has lead to a more developed backstory and a lot of knowledge, but less development on the design itself. Mainly the implementation over time could have been a bigger aspect of the project, and its social developments as a result.

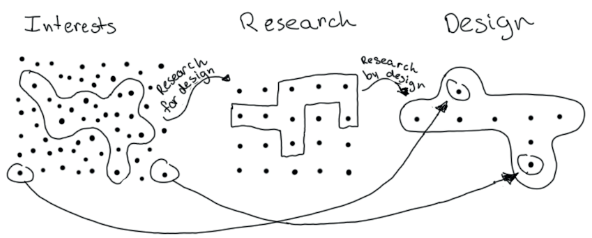



Figure 143: a messy design process

## Assessment of Value and Transferability

Researching the historic aspects of the Achterhoek based on the water system and its connection to the people created a different storyline of hte history in the region. It helped to bring light on nearly forgotten aspects of history, such as the flowing meadows and marken, and created valuable insights in how these historic features can be reapplied in the current landscape. The approach does lead to a radical change in the landscape, which can be considered as going back to the past. It requires significant changes to society and the agricultural system as we know it, and will have an impact to how farming is approached now. While this thesis is just a view on how the past and present can converge into a future perspective, it does make clear that something has to be done to change the way we approach farming today. This results in drastic changes for current farmers, and will have big societal impacts, but is necessary in the long run.

The concept was aimed to create a transferable design, but does require certain circumstances to be applied, such as the landscape typology and the issues it is attempting to solve. In a polder landscape, different issues and landscape characteristics make it less applicable in the situation. However, considering in and outside of the Netherlands there are a lot of similar agricultural sandy regions, with similar threats and opportunities, the concept could be applied elsewhere as well. It does still require a thorough research into the local characteristics and history to create the boundary conditions, but looking at the subsoil in order to adjust the landuse on top is a concept that can be applied anywhere.

## Implementing the project

The implementation of this design does have an impact on society as well. It aims to bring farmers closer to the landscape, but also visitors closer to the farmer. In this way, people become less alienised from the agricultural practice, which can sometimes be the case with people spending their whole life in cities. Experiencing the relation between nature and agriculture can help with this.

The implementation does come with a lot of drawbacks, however. Firstly, the implications for a farmer are massive. The risk of transitioning to a system like this, which does not have any roots in practice yet, can be very challenging. At the same time, as this implementation has never been done to this scale in the current context, many flaws and teething problems can surface, leading to setbacks and demotivation. Therefore transitioning to this concept should be done gradually, slowly adjusting to the new approach, which can take years, decades or perhaps even generations. Just like the landscape elements, the system has to grow.

But naturally, this adjustment will not be for everyone. Not every farmer will agree to dedicating a large portion of its time to pruning trees or maintaining a water system. However, by creating a pilot area in a region such as Nettelhorst, with multiple farmers cooperating, an example can be made upon which future adjustments can be made, in order to convince more farmers to join the movement, becoming Landkeepers.

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**Interview 1: Marke Mallem; Local Working Group for Landscape Management in collaboration with the Rijn and IJssel Water Authority and Local Residents.**

Marke Mallem originated from the water authority's desire for local landscape management, incorporating input from the surrounding community, which began about 10 years ago.

*How does Marke Mallem work?*

Marke Mallem manages 40 hectares of land, which were provided by the water authority. The water management part is handled by the water authority, while the rest is managed by Marke Mallem. The retention area is part of the region and is used as a flood zone. The limit for water flow is over 80 cubic meters per second, after which the land floods. The land belongs to farmers, who are aware that it can be flooded. This started in the 1960s during the canalization of the Berkel River. Problems with flooding led to the installation of retention areas by the water authorities. Today, the interests have shifted from flood control to nature management, a change from the earlier focus on self-interest and extensive management. Often, these initiatives arose from charitable foundations, which received donations to purchase land that farmers could use, helping to form the marken. Nowadays, it is managed by organizations like the Stichting IJssellandschap. In the past, landowners or large farmers (scholtenboeren) often lent the land. Cooperation with the water authority is essential, with land managed under perpetual lease agreements. Other similar examples have emerged, such as in Rekken, and there may be more participation in the future. The water authority reserves a budget for the management, which is transferred to the marke. Larger equipment for execution is provided by external managers.

*Establishment*

In 2010, the water authority sought community participation, especially in areas with watercourses running through inhabited land. The goal was to ensure the safety of farmers and residents, with surrounding land being secondary to water management. The marke's goal was to improve the landscape's accessibility and experience.

*Development*

The area has seen many improvements, including the ecological development of the retention area. With the help of subsidies, many projects became possible, with the water authority making it easier to obtain funding. One example is the creation of an underpass beneath a major road, providing a safer passage for a walking route that runs through the marke area.

*Participation*

Meetings with residents resulted in a list of desires. The marke then assessed the feasibility of these requests. Farmers use fields for grazing, and there are regular stakeholder meetings. They also organize excursions to further involve the community.

*Hof van Mallem*

The Hof van Mallem, once the central point of the marke, has been developed into a labyrinth. It is owned by the marke, though a small portion is still part of the Lankheet area. The Lankheet region was historically part of the Marke Mallem. The entire area, including wild lands primarily managed for grazing, was once collectively managed. Farms were located on the boundary between higher and lower land—lowland for livestock and highland for hay.

*Farmers' Cooperation*

The collaboration with farmers has proven beneficial, especially in cases of land consolidation. Land around rivers must often be exchanged for the development of streams, such as remeandering projects. In some cases, this has worked well, but other proposals have been too drastic, leading to resistance. For example, a plan for remeandering between Borculo and Lochem received harsh criticism. The Strootman Bureau advised on a redesign five years ago, but the plan was rejected as too radical. As long as compensation is clear and the mindset changes, such projects can succeed, but resistance is strong. Many farmers do not support such initiatives.

*Conclusions*

Marken formed by the water authorities represent a new model compared to traditional practices. They act as a bridge between various stakeholders, including birdwatching groups, farmers, hunters, and the water authority.

**Interview 2: André te Brake; responsible for green management and planning at the municipality of Lichtenvoorde.**

The issues faced by farmers are deeply rooted. Manure surpluses are created by large-scale operations, with a maximum amount of manure allowed per hectare. Any excess manure must be sold, and farmers often expand their operations to produce more manure to stay within the limits, even though cows no longer graze outside. The price for manure is around 35 euros per ton. Shifting agricultural practices is difficult due to existing contracts and mortgages, and for pig farmers, the lack of land further complicates the transition. Dairy farmers can more easily make the switch, but since milk remains relatively profitable, they often choose to expand further to produce more manure. Animal manure is allowed up to a certain limit, and any excess is supplemented with imported synthetic fertilizers, creating a bind on all sides.

Ideally, there would be more smaller, extensive farmers rather than fewer large ones. Landscape elements are disappearing, and water quality is declining. A national target of 10% green-blue corridors is set under the "Landscape Action Plan," which is a basic but useful guideline. A key approach, suggested by EO van der Wijden from the Foundation for Geotechnical Fundamentalism, advocates for thinking from the soil—water bodies should be the guiding factor across all areas, including housing, agriculture, and water management.

There is a need for 10% more water storage due to the landscape drying out as a result of drainage. The idea is to have enough water available, as water shortages were not considered a problem, only water surpluses. To address this, there is a need to restore water systems to prevent excess water from washing away and to create more storage capacity in the topsoil. The goal is to hold rainwater on the land rather than relying on imports from abroad. This requires a shift in farming practices and adaptation to changing water levels.

Trials in Winterswijk are investigating these adjustments, but there is a disconnect between local and national authorities. For real progress, commitment from all stakeholders is needed to have a clear long-term vision.



**Interview 3: Bram van den Esker/Guus van Imhoff; Zorgboerderij de Vijfsprong, Vorden (director and farmer)**

*How was the farm established?*

Zorgboerderij de Vijfsprong was founded by Derk Klein Bramel, combining sustainable farming and healthcare through anthroposophy 40 years ago. The aim was to create a therapeutic, symbiotic relationship between the farm and its clients, with farm work at its core. The farm provides therapeutic work, and clients are involved in all aspects of the farm, with their tasks adjusted to their needs. The farm's setup balances the demand for work and the care provided to clients. This model benefits both the farm and the clients, providing hands-on work while fostering an inclusive, supportive environment. The focus is on the well-being of both the clients and the farm as a whole.

*Farm Structure*

The farm covers different areas: 65 hectares of grassland, a portion for grazing cows (including herb meadows and production fields), a grain field for feeding the cows, and some horticulture where subscribers can harvest their own vegetables. There is also a shop selling local products, cheese production, wool spinning, and other small tasks.

*What would the farm look like without the healthcare component?*

Without the healthcare component, the farm would likely operate differently, as the culture allows for a certain scale. However, the work is designed to include clients, so without them, tasks would need to be restructured. The farm has a balanced work setup, offering tasks that suit both the farm and the clients' needs. The combination of work and therapy results in a win-win situation for both parties. This approach also supports small-scale farming, as the work provides more hands, making it financially viable. Without the healthcare aspect, the farm's viability would be harder to sustain, given the market pressures.

*Could this model be applied more widely?*

The model is radically different from the typical farming approach. It requires a complete shift, as the production is too low for conventional farming to be profitable. It involves a cultural and operational change, which can be difficult for the broader farming community. However, the concept of farm diversification, like that of Zorgboerderij de Vijfsprong, could provide an alternative, helping to reduce dependency on farming alone.

*How is the balance between business and nature structured?*

Nature forms the foundation of the farm's operation. The aim is to avoid over-exploiting the land, considering the soil's needs and working with the natural environment. The farm includes 5 hectares dedicated to nature, which is crucial for biodiversity. The cows are allowed to roam freely, unlike conventional farming where they are confined indoors with regulated feeding times. This system fosters sustainability, as it avoids the dependency on artificial fertilizers that degrade the soil. The farm's approach focuses on maintaining the health of the ecosystem, balancing farming with nature conservation.

*What is the relationship with the surrounding community?*

Maintaining a strong relationship with neighboring farmers and the local community is essential. The farm serves as a role model, demonstrating how alternative farming practices can work while maintaining a high standard of care. There is a mutual respect between the farm and the community, but the transition is difficult as many neighbors are entrenched in traditional farming practices. Policy barriers, such as subsidies and loans for expansion, also hinder change. The farm encourages a more diversified approach to agriculture, adding value to reduce dependency on traditional farming. However, for this to succeed, it requires systemic support from the government and financial institutions, such as through True Pricing, which would include climate-related costs in product pricing.

*Does diversification benefit the business?*

Diversification results in a lower return economically, as the Netherlands is focused on specialization, which maximizes efficiency. While diversification makes it challenging economically, for Zorgboerderij de Vijfsprong, it aligns with the farm's circular and cultural goals. The farm doesn't own land or capital, so everything is leased under a different foundation, with specific land use requirements that fit within the circular framework.

*Farm Composition*

The farm spans 80 hectares, with 45 hectares under Nature Monuments management, and 35 hectares dedicated to land management. The land is divided into natural grassland (on Nature Monuments land), production grassland, 10 hectares of grain, 1 hectare of horticulture, and 5 hectares of nature reserve. The rest of the land is used for grazing.



**Interview 4: Eric Brinckmann; director estate Het Lankheet**

*1. Origins and Project Setup:*

The project started when Grolsch Brewery showed interest in utilizing water sources from an estate in the region, which has a large underground water reserve. However, in the Netherlands, land ownership does not grant rights to underground water. To avoid ecological consequences from large-scale water extraction, local stakeholders got involved, leading to the discovery of historic irrigation systems (*vloeiweiden*) mentioned in a book called *Strom het Landschap*. These systems had been used to manage water flow, purify it through sand layers, and reintroduce it into the landscape. Though Grolsch eventually sourced water elsewhere, the interest in these traditional systems remained, prompting a deeper exploration of their origins. An expert traced these systems back to the 14th century, rather than focusing on the industrialized versions from the 19th century.

*2. Restoration of Historical Water Systems:*

The restoration of these systems involved bringing in the local water board to recreate the complex network of water channels and management tools. This initiative expanded with additional research and cooperation with Wageningen University, especially when the region faced a water shortage. Wageningen saw this project as an opportunity to experiment with surface water purification through natural methods. They developed a water purification system using reed beds, which now spans five hectares. This system removes nutrients like phosphates and nitrogen from surface water, which is crucial for maintaining biodiversity in nature reserves and supplying purified water for agricultural purposes.

*3. Water Purification and Agricultural Benefits:*

While the reed bed purification system ensures that water is low in nutrients, it still contains more nutrients than in historical times. This affects the type of grass produced: natural meadows supported by the system have lower nutrient levels, resulting in grass that is adequate for young cattle, though not as rich in protein as that from intensively managed farmlands. The interviewee mentions experimenting with duckweed as well, which both purifies water and serves as animal feed. Organic and extensive farming systems benefit from the purified water, even though it does not support the high nutrient demands of conventional dairy farming aimed at maximizing milk production. A key advantage is that during droughts, areas using this system maintain green grass while others struggle.

*4. Labor-Intensive Practices and Historical Significance:*

The irrigation system restoration involves manual labor, reflecting the historical importance of these systems. Farmers in the past relied on them for survival, carefully managing water to ensure enough fodder for livestock through winter and maintaining manure cycles for crop production. Though less vital for survival today, the restoration project serves as a historical experiment to understand and preserve traditional water management techniques. Back then, the success of these systems was a matter of life and death, but today they offer insights into resilient agricultural practices.

*5. Water Management and Climate Resilience:*

A major theme in the interview is the connection between traditional water systems and modern climate challenges. The interviewee explains that the region's groundwater level has dropped by about a meter since the 19th century, making irrigation systems less effective than before. To counter this, the project involves raising water levels and distributing it across the landscape. This addresses the need to balance water storage and drainage, especially in the context of climate change. Winter flooding is another technique that is being revived. By intentionally flooding grasslands in winter (called *stroomlanden*), water can be stored for dry periods, ensuring soil moisture and maintaining agricultural productivity.

*6. Collaboration and Collective Water Management:*

Historically, water management was a collective effort because water flow did not respect property boundaries. Farmers had to cooperate to maintain irrigation systems, and the interviewee stresses that modern farmers must adopt a similar approach. The shift toward individualism and market-driven agriculture broke these traditional systems, but collective management is essential for reintroducing and maintaining these irrigation methods. Farmers' participation is key, and when they recognize the benefits—such as higher yields during dry periods—they are more likely to collaborate.

*7. Broader Vision for Sustainable Agriculture:*

The interviewee suggests that the restoration of *vloeiweiden* could be part of a vision for sustainable agriculture in the future. While idealistic, it is feasible to use historical landscapes as models for addressing current environmental problems. By creating diverse, resilient landscapes, both agriculture and biodiversity can thrive. The current system of overproduction, where 70% of products are imported or exported, is unsustainable. The project aims to shift agriculture toward a more robust and environmentally friendly model, using nature as a guide.

*8. Winter Flooding and its Advantages:*

The practice of winter flooding is applied on both conservation and agricultural lands. Conventional farmers benefit from this method as well. It allows for higher moisture retention in soils, reducing the need for irrigation during dry spells and leading to higher yields. The flooding typically ends around February, giving farmers enough time to resume farming activities in the spring without significant delays. This technique also helps preserve soil biodiversity, as seen in environmental DNA (EDNA) research, which reveals that microbial communities in the soil are more



diverse and capable of absorbing water after winter flooding.

*9. Soil Biodiversity and Structure:*

Although some worms may drown during the floods, they lay eggs in drier areas, leading to a reproductive boost in the spring and summer. This seasonal cycle helps maintain soil health and biodiversity. The research conducted through EDNA further shows that the soil structure improves, making it better equipped to absorb water and support various plant and animal life. This balance between winter flooding and summer recovery is crucial for the long-term health of the ecosystem.

*10. Support from Water Authorities:*

The local water authority has been highly supportive of the project, viewing it as an experimental zone where innovative water management techniques can be tested. Their involvement has been critical for the success of the restoration efforts. Without their collaboration, the project would not have been possible.

*11. Historical Landscape and Estate:*

The interviewee discusses the historical importance of the Buursebeker stream, which, like many other streams in the region, was dug out to facilitate water management. A system of small sluices and gates is used to control water flow, directing it through the landscape. The interviewee offers to guide a tour of the Hof de Mallem estate, a historically significant area that played a role in the old irrigation system. The estate, once part of a larger landholding, still connects to the Langheed area, highlighting the region's agricultural and ecological heritage.

*12. Looking Forward:*

In conclusion, the interviewee emphasizes that this project offers a model for the future of agriculture and water management. By incorporating both traditional and modern methods, it is possible to create a sustainable, resilient system that benefits both farmers and the environment. The project has been ongoing for nearly 25 years, and its success is evident in the improved soil biodiversity, better water retention, and enhanced agricultural productivity. The interviewee is hopeful that by collaborating with farmers and other stakeholders, the project can continue to grow and contribute to a more sustainable agricultural landscape.