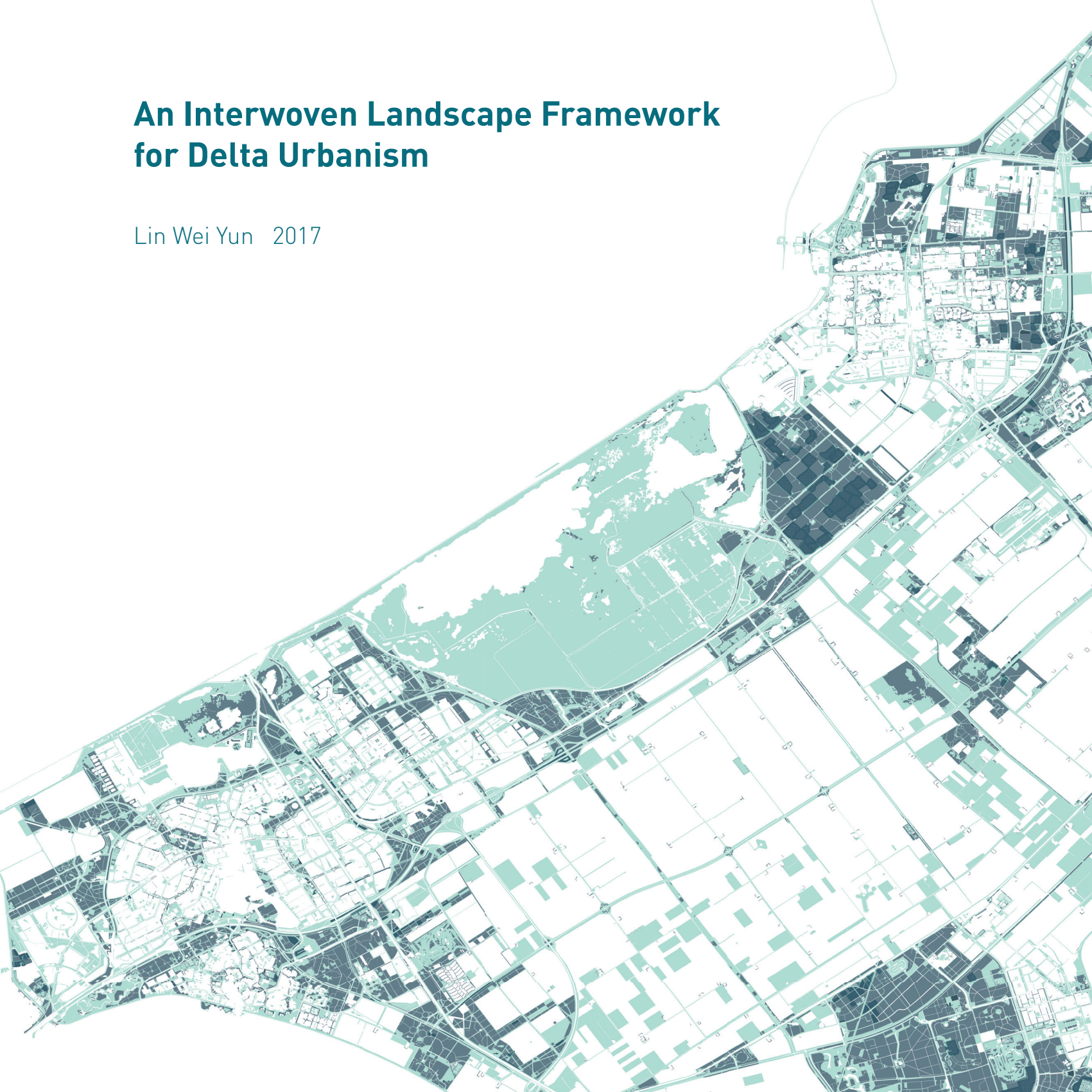


An Interwoven Landscape Framework for Delta Urbanism

Lin Wei Yun 2017





European Post Masters in Urbanism_
Strategies and Design for cities and territories

An Interwoven Landscape Framework
for Delta Urbanism

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2017

ABSTRACT

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REFERENCE

An Interwoven Landscape Framework
for Delta Urbanism

The thesis aims to discuss the possibility of introducing a new relationship between urban landscape, agricultural landscape and natural landscape, as an interwoven infrastructure that could be used as a framework in the field of delta urbanism. Reflecting on the issues of the loss of natural resoration power in the Netherlands, the metropolitan development ambition and the uncertainty of climate change, the landscape framework generates a new perspective on how to achieve sustainability through spatial design.

The territory of Flevopolders is selected as the test case. Through designing a robust ecological backbone that owns the ability to restore natural power as the first step towards sustainability, the role of “nature” was re-thought as a carrier of multifunctionality based on ecosystem services in the landscape.

1 INTRODUCTION

1.1 Problem field

The landscapes in the Netherlands

The Netherlands, a country established through a series of human intervention due to its unique natural settings, has been through several shifts regarding the relationship between human and nature, (Fig. 1) especially in the lowland part of the country in the west. From adjusting the water dynamics to defending, reclaiming, recovering, and in recent years started the progress of returning the space back to nature. Because of the fact that the natural landscape has been constantly shaped to better the living environment in a very unsustainable way, today infrastructure such as dikes and dams are fundamentally powering the living. (Hooimeijer & Meyer & Nienhuis, 2009) Most of the surface in the delta area is covered by urban or agricultural landuse, while the environment has become vulnerable because natural system is no longer able to grow and develop on its own, which resulted in more human effort is required to deal with the impact. (Meire, 2017) In this sense, natural landscape could only be seen as degrees of naturalness within a landscape. (European Environment Agency, 1995)

In the thesis, the term would still be used with clear definitions to distinguish the nature, urban and agriculture landscape patches that form the current Dutch territory. (Fig. 2) Below are the definitions of landscapes:

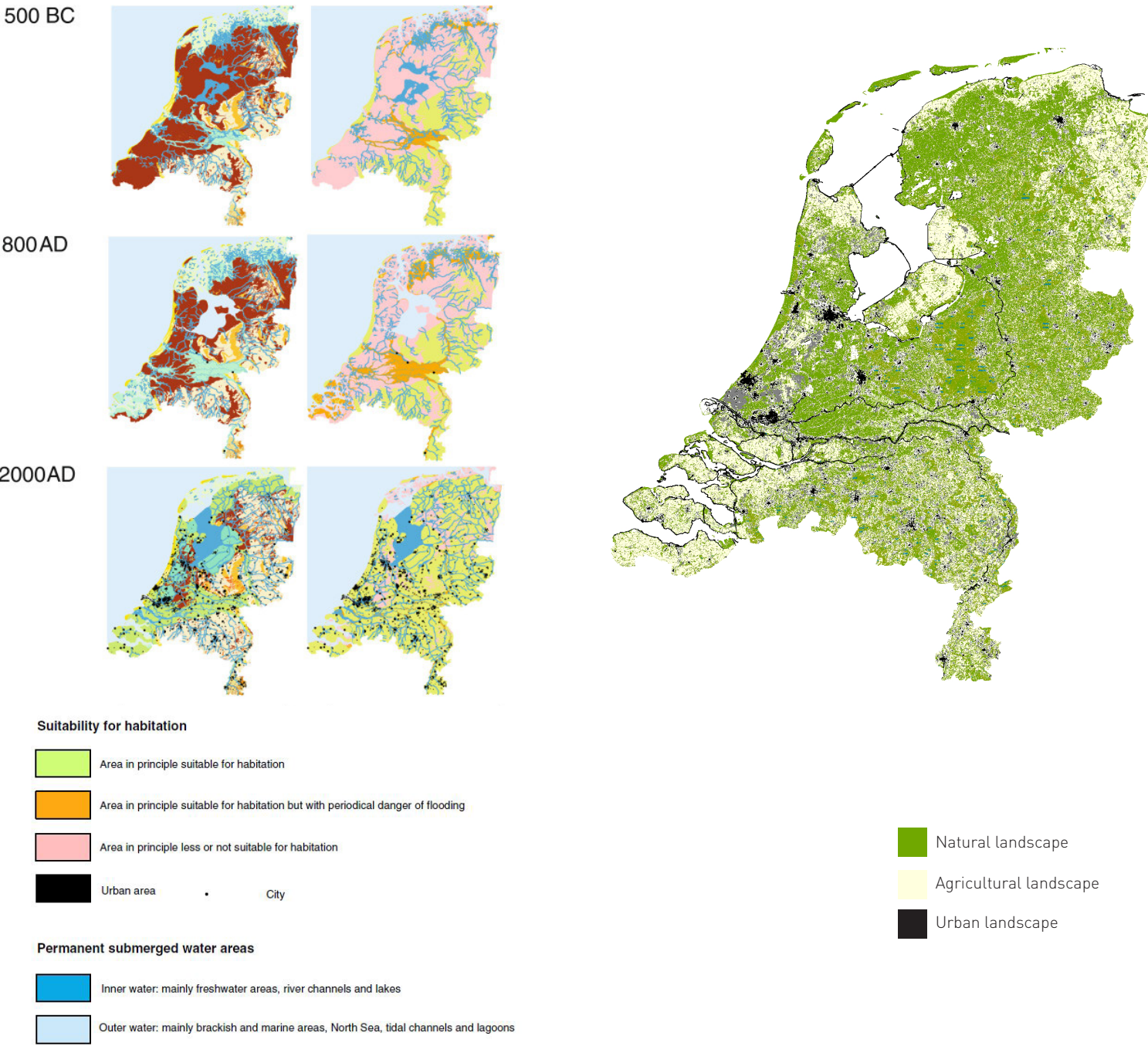
Natural landscape: A process over time that forms an environment not engages mainly in human economic activity. It can be either original or man-made.

Urban landscape: A process over time that forms a built environment that provides the setting for human activity.

Agricultural landscape: A process over time that forms a productive environment, enclosed or otherwise, dedicates to agricultural purposes such as cultivating crops, enclosure for livestock, etc.

On one hand, the natural landscape is being under the guideline of European strategic plan “Natura 2000”, which in the Netherlands assigned more than 160 areas to form a network for preserving natural habitats and species. (EC, 1979) On the other hand, the concept of “working with nature” in the Netherlands has shifted the paradigms in terms of land management, and has been implemented through various projects in different topic, location and scale in order to guide the urban development towards sustainability and resilience. (PBL, 2017) While agricultural landscape, being the first step of human civilization, and occupying more than 45% of the surface in the country (EC, 2016), holds an awkward position. Even though it is a totally man-made landscape, but the overly transformed natural landscape and the feature of having crops, animals and fresh air in the open fields made people often perceive agricultural land as “nature”. Spatially, the intense agricultural production has resulted in environmental degradation and the loss of landscape variety. (UN, 2008) The European commission thus initiated a synergy with Dutch government to start a rural development programme in all aspects from year 2014 to 2020. Among, improving biodiversity, water and soil management are listed as the aims to enhance landscape qualities. (EC, 2015) However, in all the funded projects so far, the focal points are on sustainable energy, sustainable food chain or relate to agricultural organisations and market, (EC, 2017) instead of the spatial transformation of landscape.

Despite the fact that three landscapes are guided by strategies and policies, in the space they are still treated as separate entities that function on their own. Hence forming spatial transition in between landscapes has been advocated for decades from both academic and practical perspective. In recent years, several important projects of landscape transition had been planned in the Netherlands. For instance, Rotterdam and the province of Zeeland are under the transformation of forming a network of urban wetland to minimize the impact of flooding, to increase biodiversity and to promote an innovative, high quality living environment. While the plan Mooi Zuid-Holland in 2008 revealed the concern for the fragmented and unintegrated agricultural land in the province of South Holland. The plan intended to improve accessibility and experience in the rural areas, meanwhile conserve important cultural elements in the landscape. All of these examples show the effort of trying to recover the



1 Paleogeographic maps of the Netherlands

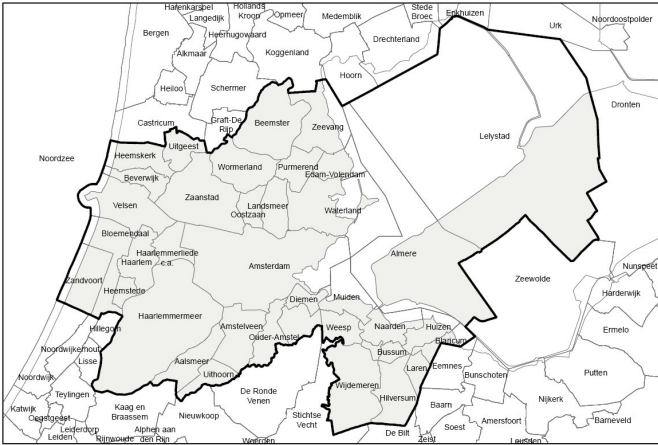
Source: Clinal distribution of human genomic diversity across the Netherlands despite archaeological evidence for genetic discontinuities in Dutch population history, 2013

2 Landscape patches in the Netherlands

Source: Made by author.
Data source: TOP10NL from Kadaster

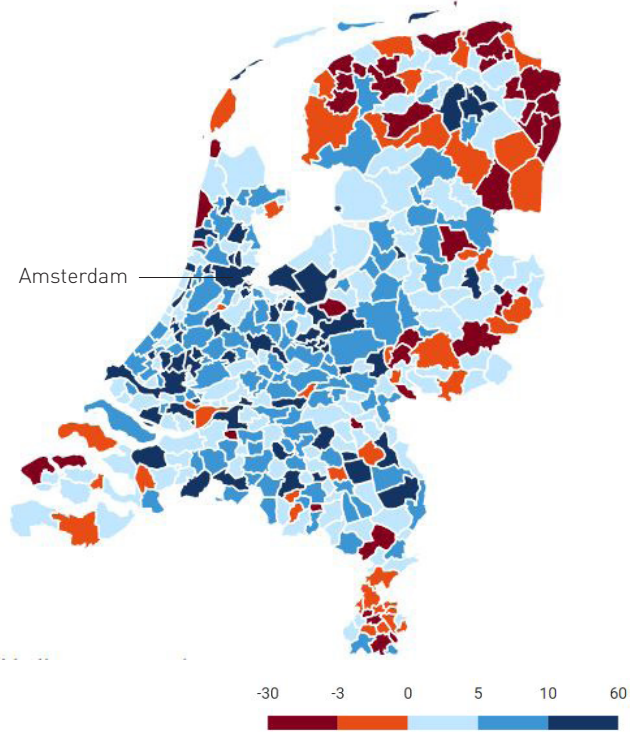
The MRA metropolitan challenges

Within the territory of the Netherlands, the most well-known and attractive city is no doubt the capital Amsterdam. The city itself together with the 31 municipalities around has formed an informal metropolitan grouping, which today accommodates more than 2 millions of inhabitants. (CBS, 2016) The Amsterdam Metropolitan Area (Dutch: Metropoolregio Amsterdam, MRA) (Fig. 3) belongs to the European top five economically strong regions. (MRA, 2017) Today, MRA is growing fast in terms of its population. Amsterdam itself has around 850,000 inhabitants, and owns some 18.1 of population growth in every 1000 people, which is 3 times of the national growth. (CBS, 2016) (Fig. 4) The population explosion as well influenced the nearby cities. In the province of Flevoland in the east, the city of Almere has 13.5 / per 1000 people of population growth, while the adjacent Zeewolde has 14.2 / per 1000 people. Being aware of the facts, the MRA intends to release the metropolitan pressure towards the east. According to its housing plan, until 2020 there will be 125,000 new housing being built, with 35% in the extended urbanized area, while from 2020 to 2040 another 135,000 housing will be finished, among, 67% is planned in the urban extension. (MRA, 2017) (Fig. 5)



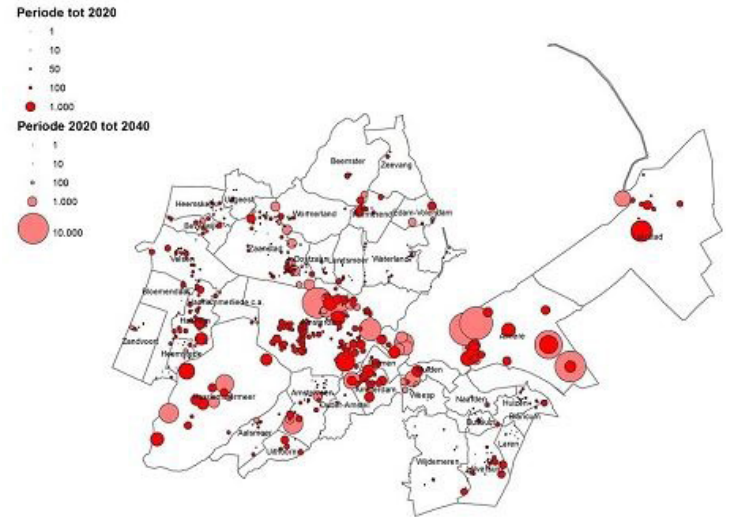
3 The Amsterdam Metropolitan Area (MRA)

Source: <http://www.amsterdammade.org>



4 Municipality population development in every 1000 people

Source: CBS, 2016

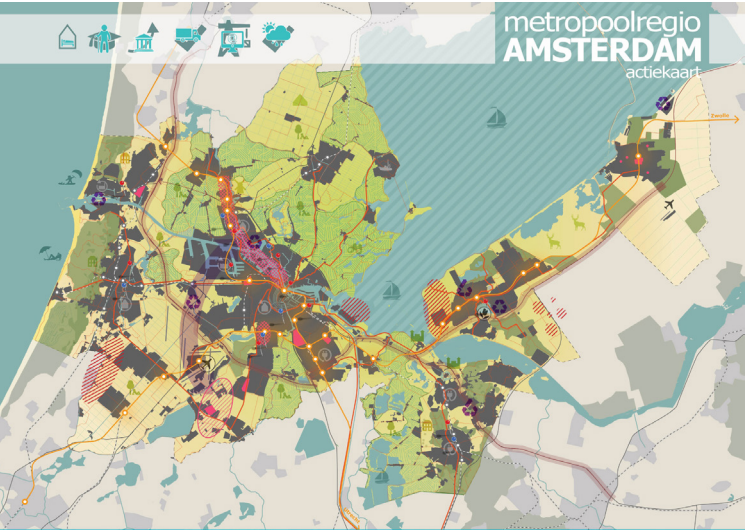


5 Housing plan in MRA until 2040

Source: Metropoolregio Amsterdam

The existing and anticipated population flow boosts the process of urbanization. Besides the housing program, in 2012 MRA also intended to increase the regional connection between Schiphol airport, Amsterdam and Almere (SAA) (Rijkswaterstaat, 2012) to facilitate the growth in Almere. (Fig. 6) The RRAAM program (Structure of Amsterdam - Almere-Markermeer) (Fig. 7) also shows the ambition to develop the east periphery of Amsterdam in all aspects as a whole.

The ambition of expanding the urbanization, strengthen inner cooperation and international competitiveness within MRA facilitated the consideration of sustainable development. Main themes such as landscape, water resource, energy and infrastructure are addressed with structural plans to highlight the value, function and inner connectivity of important elements within the metropolitan area. (Fig. 8)



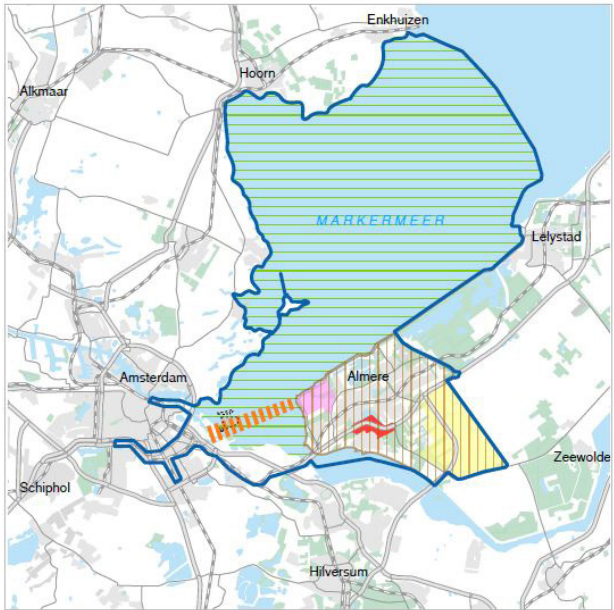
8 Structural plan of MRA

Source: Metropoolregio Amsterdam



6 SAA program

Source: Rijkswaterstaat



7 RRAAM program

Source: Rijksstructuurvisie Amsterdam - Almere - Markermeer

Islands of sustainability

Despite the fact that the MRA is putting much effort to sustainable development, it is still implemented within an administrative boarder. Whilst such a major urbanization project could create great influence in the local scale. One of the main influences comes from the intense housing program, which may put pressure on the existing dominant agricultural landscape in the in province Flevoland. (Fig. 9) In all the anticipated new housing, 60,000 housing had already been included in the plan Almere 2.0 in 2009 to be placed in the city in both existing and expanding urban areas. (Gementee Almere, 2009) Today, these housings have started to be built in several areas in different stages. (Fig. 10) As figure 10 shows, only the area around the waterfront corner is in the final stage (indicated with red), the rest are still preparing or just planned as potential areas. However, on the other side of the city there lies an area (Oosterwold) under preparation (indicated with purple) which occupies around 43 km² of surface that was originally dedicated to agricultural land use, it will be transformed to accommodate 15,000 new housing.

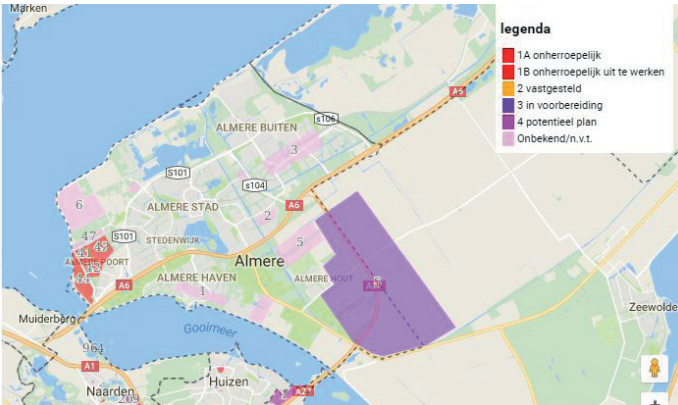


9 Landscapes of Flevoland

- Natural landscape
- Agricultural landscape
- Urban landscape

Source: Made by author
Data source: TOP10NL

The plan of Oosterwold will be carried out by a sustainable hybridization model that provides the freedom of choice for new inhabitants to decide the land use of the plot within the framework of 18% construction, 8% roads, 13% public green, 2% water and 59% urban agriculture to maintain the original characteristic of the land. (MVRDV, 2011) Nevertheless, there is no spatial transition between the project and the surrounding agricultural landscape, and the sustainability it intended to introduce remains in the boundary of the project. Similar situation can be observed in the ongoing project Floriade 2022. Also located in Almere, the project took the similar approach of the hybrid functionality. (Fig. 11) The



10 Housing plan in Almere

Source: <https://www.plancapaciteit.nl>



Floriade 2022

Oosterwold

11 Hybridization model of housing plan

Source: MVRDV

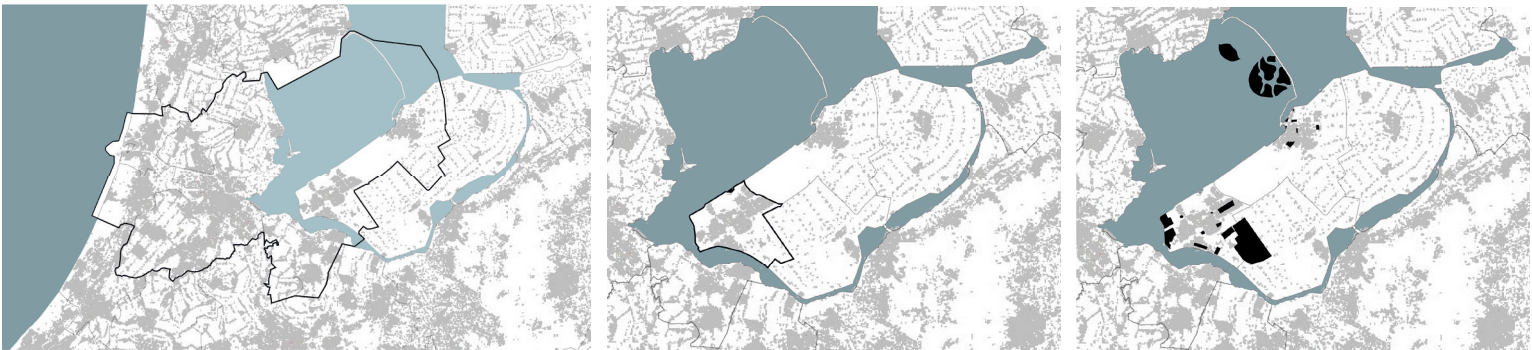
original woodland on the island was transformed into a residential-based district, (Fig. 12) therefore inevitably it also faces the challenge of preserving local characteristic and the transition with the adjacent landscapes.

Concluding from the development and plans proposed in different scales, including the MRA structural plan, Almere 2.0, plan Oosterwold and plan Floriade, sustainability could be said as the priority and final goal of the future development, while trend of hybridization of functions and spaces could be identified under the sustainable framework. Even so, in the current plans there exist a lack of consideration of the impact that could lie on the surroundings outside the administrative boarders. The missing spatial transition between different types of landscapes may result in the sustainability being limited within an invisible boarder defined by man. Moreover, it is uncertain how urbanized area could change in the future, hence how the province of Flevoland could embrace the upcoming urbanization challenge in a short term and how it could adapt to the future uncertainty in a long run within a sustainable spatial development that is not limited by the boarders becomes a very relevant task.



12 Transformation of the site Floriade 2022

Source: Stay-in-Almere, NL 360 MEDIA, MVRDV



MRA

Almere 2.0

Independent projects

13 Islands of sustainability

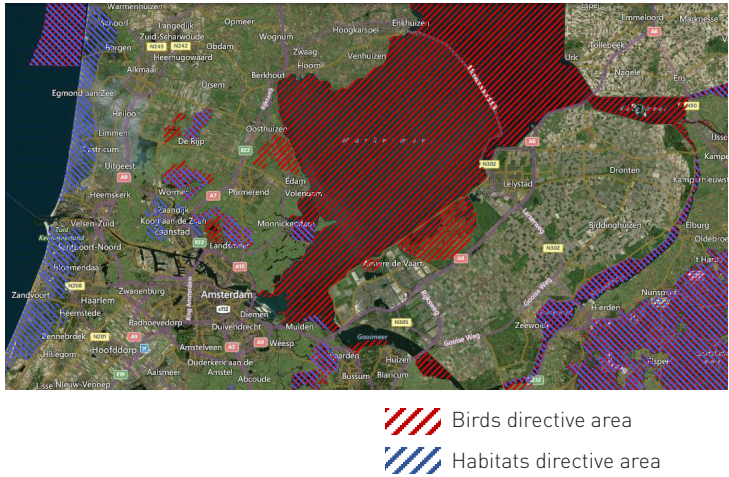
Source: Made by author

The ecological concern in Flevoland

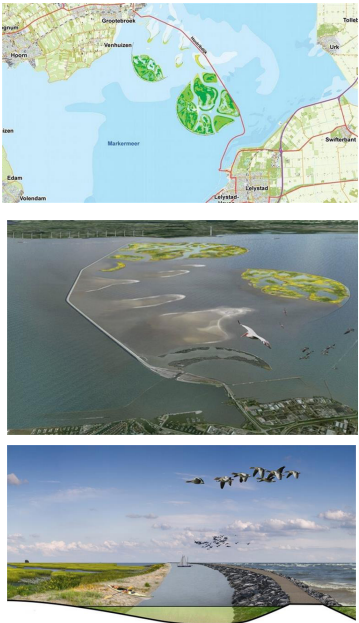
Flevoland is founded on the biggest polder in the country reclaimed in 1950s', benefited from the sea clay soil, agriculture has become the dominant landscape. Being close to water system IJmeer, Markermeer and IJsselmeer, the territory attracts wild bird species by default. As a result, these water systems were assigned to the bird directive conservation areas of Natura 2000 (Fig. 14), a strategy proposed by European Commission. Realizing the importance of preserving natural resources, the project of Marker Wadden was initiated in 2012 to create an archipelago for bird habitat. Adopting the concept of building with nature, the archipelago aims to restore the degraded ecological condition and natural dynamics in the Markermeer lake by introducing minimal human intervention such as sand dams and under water current. (Natuurmonumenten, 2017) (Fig. 15)

Besides the Marker Wadden, another nature reserve named Oostvaardersplassen that lies in between Lelystad and Almere stad, also drew the attention. It belongs together with the water systems to part of the Natura 2000 plan. Originally, the nature reserve was planned to connect forest Horsterwold and farther to forest Veluwe in the south (Fig. 16) by an ecological corridor that serves ecological conservation, water storage and recreational use (Fig. 17)(Provincie Flevoland, 2010). However due to financial problem the project was halted in 2012, which resulted in a waste of large amount of public money. (Giezen, Driessen, Spit and de Gier, 2013) Recently the project was restarted again, with the debate on whether the overgrown large herbivores in the nature reserve should decrease, and if the area should be more accessible for public recreation or not (Fig. 19). Overall, the project is now stuck in a stalemate of the strict rules from the plan Natura 2000, the public voice of opening the space for tourism, and the health of existing ecosystem.

All in all, in a country like the Netherlands that has its identity of nature lost due to human intervention, the ecological restoration becomes extra crucial and challenging. Since the ability of restoring natural power had disappeared in the landscape, the new strategy for recovering nature should be constructed on introducing minimal intervention that could initiate the dynamic of nature on its own.



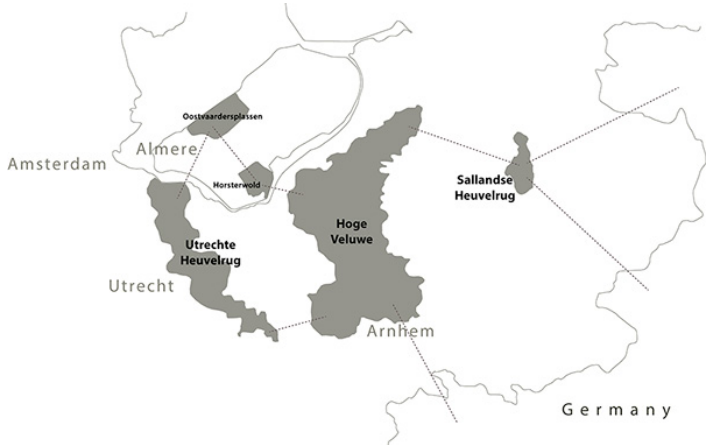
14 Natura 2000 designated area
Source: Natura 2000 Viewer



15 Project of Marker Wadden
Source: <http://www.omroepflevoland.nl>



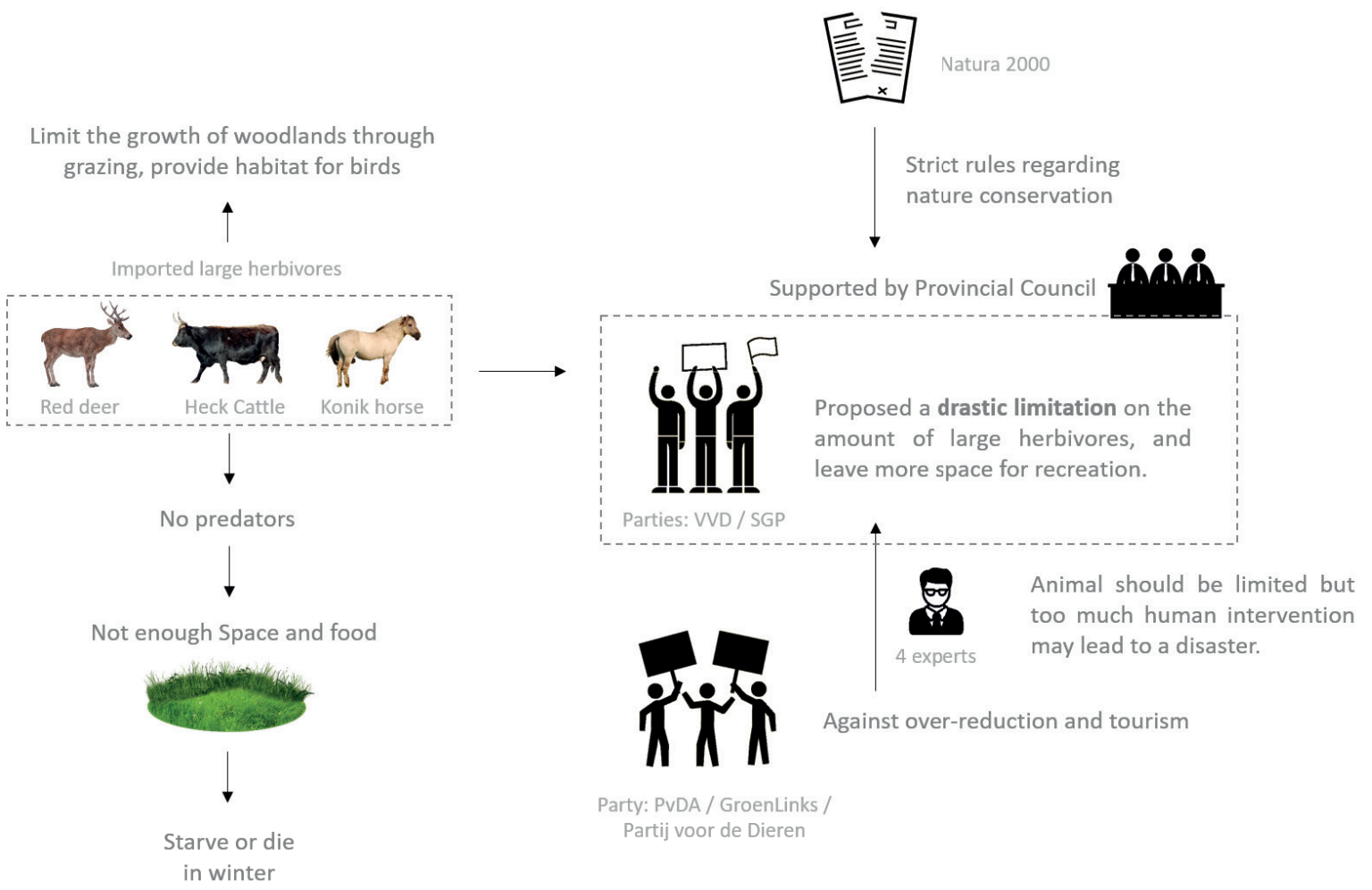
18 Photos of Oostvaardersplassen
Source: Staatsbosbeheer / Siebe Swart



16 Regional connection of Oostvaardersplassen
Author: Carlos Dias, Joyce Lokate, Silko van der Vliet, Yokal van Boeckel



17 Plan of ecological connection of Oostvaardersplassen
Source: Ontwerp Provinciaal Inpassingplan, Province Flevoland



19 Dilemma of Oostvaardersplassen

Source: Made by author

Timeline of the plan of Oostvaardersplassen:

- 2006 The task of forming robust ecological connection between Oostvaardersplassen and Veluwe was initiated as part of Natura 2000
- 2008 Provincial council drafted a regulation with conditions for future landuse
- 2009 The structural Oostvaarderswold is adopted
- 2010 The provincial executive plan is fixed
- 2011 Zoning and integration plans were completed
- 2012 Provincial council announced that the cost for project was halted

1.2 Problem statement

The extreme spatial transformation in the Dutch territory has resulted in a vulnerable environment in which natural system is no longer able to grow and develop on its own. Among the already intense cultural landscape, the fast growth of urbanization in Amsterdam Metropolitan area has brought up the demand of accommodating new functions in the current urban and rural landscape in Flevopolders, which leads to a through-scale implementation of sustainable development, with the concept of hybrid functions and re-naturalization being tested-out. However it is mostly still within an administrative boarder that lacks of the consideration of landscape continuity. Therefore a requisite exists for rethinking the spatial relationship in between different landscapes, accompanying with the reconsideration of identity, role and power of “nature”.

1.3 Research question

Main question:

What spatial transformation is required in the current cultural landscape in Flevopolders to condition a new landscape framework that forms an interwoven system includes both natural and cultural processes, with the ability to restore its force and adapt to change in long term.

Sub questions:

- 1. What is the existing ecosystem in the urban, agricultural and natural landscape in Flevopolders? (Ecosystem here represents a complex network or interconnected system in general)
- 2. What are the drivers of change that may influence the future development in Flevopolders?
- 3. What implementation had been done in other places to re-naturalize the cultural landscape?
- 4. What tools could be introduced to create or maintain the new landscape framework?

1.4 Relevance

Academic relevance:

The research is on one hand aligned its focal point of introducing new relationship between different landscapes in the Netherlands with the theme Delta Urbanism under the Urbanism Research Program, which focuses on developing new approaches to balance urbanisation, port development, agriculture, environmental and ecological qualities. On the other hand, the exploration of extending the function of agricultural landscape in the research is aligned with two of the key issues in EMU program, including the Territories of Dispersion and Cultural Landscape. The former deals with extended use of territory, rethinking new ways of working and living, while the latter focuses on the concept of conservation through transformation, putting emphasis on the re-evaluation of heritage, resources and identity.

Environmental relevance:

In a wider sense, the research promoted the establishment of a peaceful relationship between nature and human in the Netherlands, which represents a possibility of nature being reintroduced to a land that has been through extreme ecological destruction, and could therefore be a showcase to the field of practise. Secondly, the research reflects on the importance of transforming agricultural landscape in the Netherlands, which in the current situation has been deeply influenced by the trend of mechanization of agro-production worldwide, resulted in the landscape being spatially developed towards a mono-functional and monotonic direction.

In the local scale, the research contributes to finding possible means of restoring nature in Flevoland, which has an important role in preserving natural resources as well as sustainable development. In fact, Flevoland sits in a strategic location that holds national importance of connecting the surrounding nature patches.

Social relevance:

Firstly, Due to the metropolitan pressure, more inhabitants will move in Flevoland in the future, which represents a social influence in terms of demographic change and the accompanied spatial demand such as infrastructure, recreational space, public spaces, etc., which would require a plan to integrate with the existing urban spaces.

Secondly, as stated previously, the halted project of Oostvaardersplassen had been through a series of complicated administrative process and public debate (Fig. 9), which involved in various stakeholders and concerned the cost and benefit in both public and private sectors. Two major social issues were brought to discussion, including the waste of public money that was being used to acquire approximately 750 hectares of agricultural land from companies in order to execute the project, and the enhancement of public accessibility of the nature reserve.

Staten: meer recreatie in Oostvaardersplassen

Flevoland 8 februari 2017



Provinciale Staten willen dat wordt onderzocht hoe natuurgebied de Oostvaardersplassen geschikt kan worden gemaakt voor meer recreatie. Gedeputeerde Staten moeten vóór 1 juli met een voorstel daarvoor komen. Daarin moet ook staan voor hoeveel grote grazers er ruimte en voedsel is in het natuurgebied.

Een meerderheid van de Staten stemde in met een voorstel van de VVD en de GOP. Die partijen gaven eerder al aan dat het aantal grote grazers in de Oostvaardersplassen flink naar beneden moet. PvdA, Partij voor de Dieren en GroenLinks stemden tegen het voorstel.

Gedeputeerde Rijsberman heeft gezegd dat hij juridisch laat toetsen wat er in het gebied wel en niet mag. De Oostvaardersplassen is een beschermd Natura2000-gebied en daar gelden speciale regels voor.

Vraagtekens bij voorstel Oostvaardersplassen

Flevoland 9 februari 2017



Het is zeer de vraag of de nieuwe ideeën voor de Oostvaardersplassen wel echt kunnen worden uitgevoerd. Dat zegt gedeputeerde Michel Rijsberman.

Hij doet daarmee op het voorstel dat woensdagavond door Provinciale Staten is aangenomen, met richtlijnen voor een andere aanpak. De Staten denken er aan om het aantal grote grazers in het natuurgebied drastisch te beperken. Daarnaast moet het gebied meer geschikt worden gemaakt voor recreatie.

Gedeputeerde Rijsberman moet daarvoor een concreet plan maken, maar hij twijfelt of dat wel kan, gezien de strenge regels die voor het gebied gelden. Rijsberman gaat nu eerst onderzoeken wat wel en niet mag.

11 APRIL 2012 / NIEUWS / NATUUR EN MILIEU

P VAN GERVEN: 'VERKOOP NATUURGROND OOSTVAARDERSWOLD IS PURE VERNIETIGING'

SP-Kamerlid Henk van Gerven wil staatssecretaris Bleker aan de tand voelen nu blijkt dat de verkoop van het Oostvaarderswold de provincie Flevoland circa 30 miljoen euro gaat kosten. Van Gerven: 'Verkoop van de gronden is maatschappelijke kapitaalvernietiging en niet in het belang van Flevoland. Bleker moet inzien dat hij op een doodlopend spoor zit en Flevoland het Oostvaarderswold op een fatsoenlijke manier laten aftmaken.'

Uit het provinciale rapport 'Analyse en scenario's Oostvaarderswold' blijkt dat het scenario met het ontmantelen van het Oostvaarderswold en het verkopen van de grond aan boeren, de provincie 72 miljoen euro kost. Doorgaan met de natuurontwikkeling op reeds vervorven gronden kost de provincie 35 tot 40 miljoen euro.

Verkoop van natuurgronden is vooral duur omdat de provincie Flevoland verplicht is natuur te ontwikkelen. De verdwenen natuur voor onder andere de eekhoorn asinog van de Ad, uitbreiding van Almere en Lelystad en de ontwikkeling van industrieterreinen moet worden gecompenseerd. Van Gerven: 'Het is onbegrijpelijk en onverstandig om nu gronden die duur gekocht zijn voor een habbekrats te verkopen. De provincie wordt gedwongen om in een later stadium andere gronden weer aan te kopen. Zelfs een natuurbaar zal inzien dat dit je reinste verspilling van gemeenschapsgeld is.'

1.5 Aim of study

The aim of the thesis is to

1. Study the design principles and instruments that contribute to introducing a new relationship between urban landscape, agricultural landscape and natural landscape that interweave in the space of Flevopolders.

2. Build up a toolbox to provide spatial conditions to ensure a minimum condition for the formative power of landscape could take place in a long term, and to provide guidelines with flexibility for different themes (housing, infrastructure, energy, etc.) in the various degrees of urbanization that follows the new landscape structure.

1.6 Method

Research methods are proposed according to the sub question listed.

1. *What is the existing ecosystem in the urban, agricultural and natural landscape in Flevopolders?*

Method: Mapping analysis, fieldwork observation

Mapping analysis involves in second hand data collection and interpretation, which could help construct quantitative and qualitative layer analysis of the site. While fieldwork requires first hand observation from the author, which facilitate the understanding of situation in reality as well as the important factors and elements in the environment.

2. *What are the drivers of change that may influence the future development in Flevopolders?*

Method: Literature review

In order to identify the drivers of change, the history of Flevoland and its surroundings would be studied to understand the process of the formation of current landscape. In addition, main concerns and trends in the development in the Netherlands would also be studied and be taken into consideration.

3. *What implementation had been done in other places to re-naturalize the cultural landscape?*

Method: Case study

Case studies could provide an insight of successful implementation in the reality, hence could play the role of offering reference, being showcase, or help with the enhancement of feasibility in the design process.

4. *What tools could be introduced to create or maintain the hybrid landscape?*

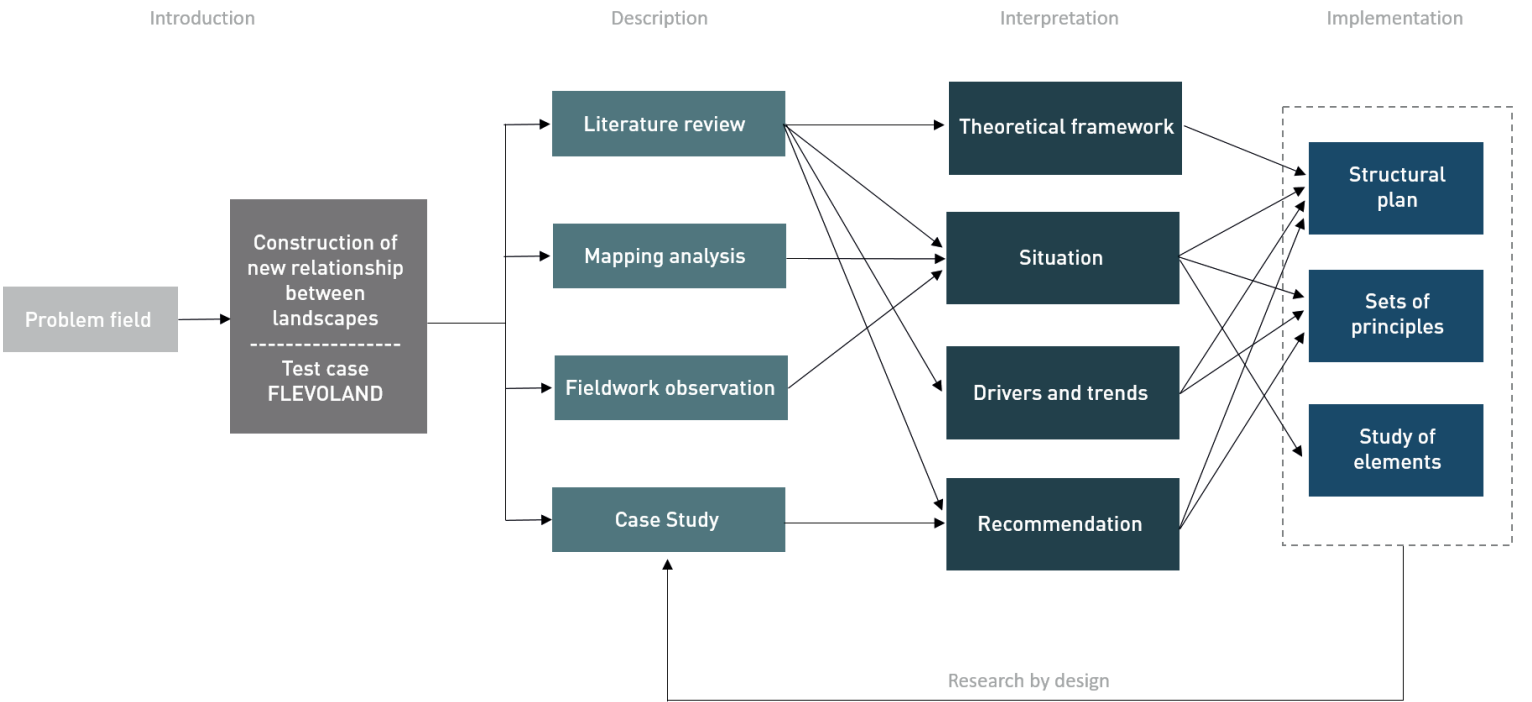
Method: Conclude from case study, literature review

On one hand, in the process of case study, instruments being used would be studied, on the other, literature review provides a way to study the existing toolboxes that had been already developed or even implemented. The result from both methods would then be extracted and modified as a foundation for constructing the new toolbox.

20 News relate to the plan of Oostvaardersplassen

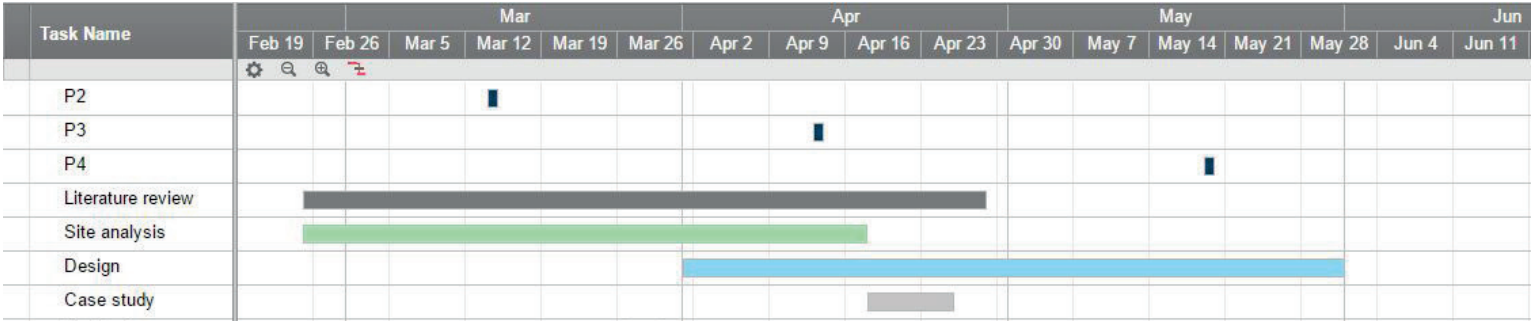
Source: <https://www.omroepflevoland.nl>, <https://www.sp.nl/>

1.7 Research structure and planning



21 Research structure and planning

Source: Made by author



22 Research schedule

Source: Made by author

1.8 Expected product

Toolbox

The toolbox contributes to providing the means and instruments for the transformation of current cultural landscape and the spatial integration between landscapes in different local context.

Structural plan

The structural plan indicates the space that should be given priority to transform, to preserve, to maintain or to go under other treatments. Several areas with zoom-in design details would be presented as examples for different types of spatial transformation. Besides the main structural plan, 4 sub-structural plan will be developed according to different themes, including housing, agriculture, energy and infrastructure.

Visionary images

Visionary images support the visual expression of the design. They would be created base on the design of zoom-in areas.

The studies of the elements

Important natural and cultural elements in the Flevoland landscape such as flora, fauna, dike, ditches, etc. would be studied in terms of their lifecycle, rhythm, function, value and spatial perception in the landscape. The relationship and interaction between elements would also be investigated and presented.

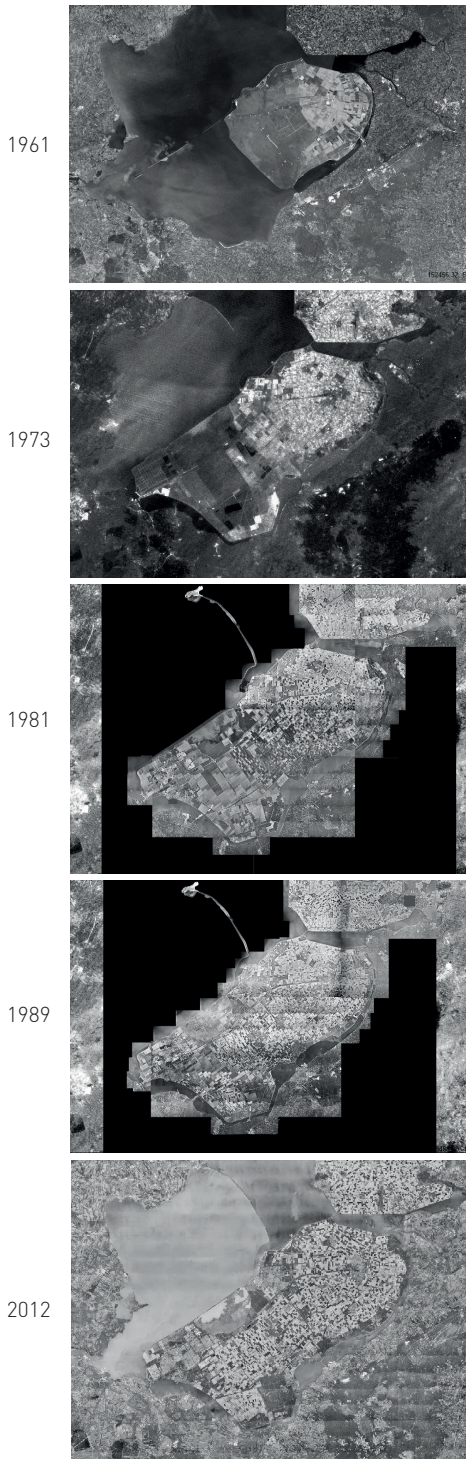
2 THEORETICAL FRAMEWORK

2.1 Overview of main problems

The loss of natural power

The unique natural settings in the delta system in the Netherlands has facilitated its development to root on a collective yet intense infrastructural base. Tackling with one of the most powerful elements on the earth, water, the invention of infrastructure such as dike, dam, ditch, windmill etc. has enabled a safer environment for agriculture and urban growth, even to reclaim land from water to accommodate more population, such as the province of Flevoland that was reclaimed in the 50s'. (Fig. 24) Nonetheless, the constant transformation on the delta landscape has severely weaken the natural dynamic that used to provide various ecosystem services like tide control, natural buffer zone, biodiversity and such. (Meire, 2017) In the case of Flevoland for instance, the construction of Houtribdijk that separates the IJsselmeer and Markermeer has resulted in a re-suspension silt in the Markermeer, which led to the decrease of biodiversity. (van Gogh, 2012) In general, more investment is needed in the delta area to constantly reinforce or upgrade the man-made infrastructures to control the environment in order to ensure the safety of the cultural landscape.

The temporarily safe but extremely vulnerable delta landscape is also facing the uncertainty of global climate change, which is not a new issue at all but still, and will, play a significant role in the natural and cultural landscape worldwide. For the Netherlands, it could mean more flooding, salinisation, drought, change in crop growing rhythm, even an increase in human diseases in the unknown future. (PBL, 2012) Therefore besides the technical and temporary solutions, a perspective from ecosystem services should be generated as the foundation of dealing with problems so as to restore the natural processes that benefit the global ecosystems in short and long term. (Meire, 2017)



23 Historical satellite images of Flevopolders

Source: Provincie Flevoland

The challenge of sustainable metropolitan development

The fast growing Amsterdam metropolitan area (*Dutch: Metropoolregio Amsterdam, MRA*) has dropped pressure on the territory of Flevopolders. The original purpose of the Flevopolders is to release the intense urban pressure in the north wing of Randstad. As a result, Almere Stad and Lelystad were established as the two main cities on an agricultural-based land, with a relatively low density. (Amsterdam 4,908 inh/km², Almere 1,528 inh/km²)(CBS, 2015) For the upcoming years, there is an anticipated need to release the pressure again to the east side of MRA based on the fact that Amsterdam, Almere and Zeewolde have in average some 15.3 of population growth in every 1000 people. (CBS, 2016) A housing plan was therefore proposed to accommodate new population. (Fig. 25) Almere itself is planning to build 60,000 housing in both existing urban area and the planned urban expansion, which would possibly pressure the surrounding landscape by occupying more space, building more infrastructure and gaining more need for recreation areas. For Flevoland, an ecological issue that also concerns the public accessibility to the nature reserve already exists in the proposal of connecting Oostvaardersplassen to Holsterwold. While the new urbanization may generate a need to solve this issue as fast as possible.

The ambition of expanding the urbanization, strengthening inner cooperation and international competitiveness within MRA facilitated the consideration of sustainable development. Main themes such as landscape, water resource, energy and infrastructure are addressed with structural plans to highlight the value, function and inner connectivity of important elements within the metropolitan area. Despite the fact, the projects in different scales are still implemented within an administrative boarder. (Fig. 3) Whilst such a major urbanization project could create great influence in the local space. Therefore In this complex situation of space, scale and time, a strategy is needed in the limited space of Flevoland to deal with the existing issues, the impacts and possible spatial conflicts that may occur in a short timespan, but also be prepared to the uncertain urbanization process in the future.



24 Housing plan until 2040 in Flevopolders

Source: MRA

2.2 Hypothesis and supporting theories

The problems directed the research towards a discussion on how the space in Flevoland could be arranged in a way that guides the development of territory towards sustainability, which in a broader sense addresses the relationship between human and nature, and is defined here as a human-ecosystem equilibrium (Shaker, 2015) that Improves the quality of human life (IUCN & UNEP & WWF, 1991) while living within an adaptive supporting ecosystem that holds the ability to restore its natural dynamics in any condition.

Under this perspective, design hereby plays a role to incorporate fields of knowledge and understandings on the situation, to propose possibilities regarding the function and spatial relationship of elements in the site, and to reflect on how the spatial transformation would influence space in different scale and time frame. To approach sustainability, the design started with a hypothesis that: By introducing a landscape framework which is based on a robust ecological backbone across the territory, with agricultural and urban functions being blended in certain areas under specific conditions, natural processes would be gradually restored and would be able to support human culture as an infrastructure by providing ecosystem services in a long term, while human culture would develop without depleting natural resources. The hypothesis is supported by five key theories, including urbanized deltas in transition, landscape urbanism, design with nature, landscape infrastructure and landscape ecology. Some provides the fundamental concept for the hypothesis, others help to construct the method on how to design.

Urbanized deltas in transition

Key author: Han Meyer, Steffen Nijhuis
The study framed the scope of the thesis with its emphasis on the extremely dynamic but sensitive characteristics that delta areas own. Urbanized deltas in general have become vulnerable due to the transformation process in the past, and nowadays they are facing the challenges from rapid urban growth and climate change, which led to a necessity to generate new perspectives for sustainable development.

Landscape urbanism

Key author: Charles Waldheim, Stan Allen, James Corner
Landscape urbanism provides a way of reading urbanism through the lens of landscape. (Waldheim, 2016) It argues that by using landscape as a medium of design and intervention in the city, a horizontal integration in terms of social, ecological and economic performance in the city could be developed, which helps to generate a responsive and flexible structure. The theory is integrated in the design of Flevopolders as a foundation to consider landscape as the carrying structure.

Landscape infrastructure

Key author: Pierre Belanger, Steffen Nijhuis, Daniel Jauslin
Two literatures were included in this theme. On one hand, Landscape as Infrastructure reflects on the change of relationship between urban economy and environment, from separated to inseparable. Base on this notion, infrastructure is redefined from a traditionally hard technological system into a collective system of hard technology, biophysical resources, agents and services. (Belanger, 2013) Landscape is therefore seen as an infrastructure that serves as index and interface which could synthesize the disciplines involved in this collective system, and could guide the ecology in different context and scale towards future spatial development. On the other hand, Urban Landscape Infrastructures proposed a design concept to provide operative force for infrastructure as landscape. (Nijhuis & Jauslin, 2015) Through integrating landscape processes into physical space with a focal point on the interaction of the two, design could jump out of the box of an architectonic approach that focus on object itself or focusing only on the dynaimc processes. Hence value and identity could be enhanced through a tangible relationship. The design concept took into account the space of flows that could be directed through the arrangement of space of places and generate qualities in various aspects. The space of places thus should be formed into a robust and adaptive system which could maintain its characteristic while open to change. Based on the concept, in the design of thesis, spatial structures along with their associated values and flows would be arranged into a network to integrate natural, agricultural and urban landscapes in a sustainable way.

Design with nature

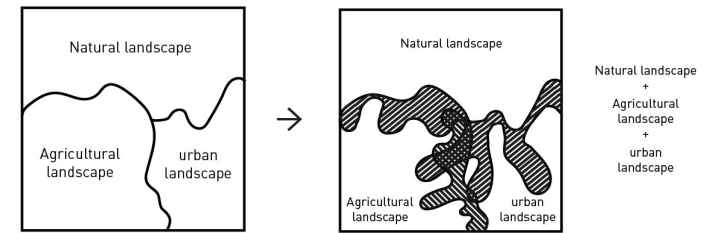
Key author: Ian McHarg
The theory started from the point of view of considering the carrying capacity of the land as priority when planning and design. Through analysing geological components, physiography, hydrology, plant associations, environmental issues, etc., the value and suitable function of landscape could be identified, and further contribute to the management of resources by designing strategies through multidiscipline integration. The theory supports the importance of landscape framework in the hypothesis, and provides practical knowledge and examples for understanding the key elements that influence the dynamics of natural and urban landscape, as well as how to visualize the dynamics and analyse the compatible landuse.

Landscape ecology

Key author: Richard Forman
The theory is built upon the understanding of landscape in reality consists of numerous fragmented habitats that formed naturally or culturally, as a mosaic across periods of time and scales of space. It focuses on the improvement of relationships between ecological processes in the environments by integrating structures, functions and dynamics. Landscape ecology contributes to both construction of hypothesis and methods for design. In the book Landscape Ecology Principles in Landscape Architecture and Land-use Planning, the spatial pattern of landscape were categorised into patches, corridors and matrix with principles that help to understand and design the arrangement of elements.While the book Land Mosaic explicitly look into each pattern in terms of the function, types, elements, and how the patterns respond to the changing landscape mosaics, finally principles for land management that could contributes to sustainability.

2.3 The goal of design

By testing out the hypothesis under the theoretical framework, the design should explore the spatial structure and dynamics of each type of landscape (natural, agricultural and urban), their potential in terms of multifunctionality, and the possibility to interweave these landscapes into an infrastructure in the territory which could enhance both natural and cultural qualities in a sustainable way. And this infrastructure could eventually become a framework for future spatial design in the delta areas, but also could reflect on general issues regarding how a landscape framework approach could be considered as a perspective to deal with short term impact and long term uncertainty resulted from urbanization and climate change. Finally, the interwoven landscape generated from the framework should lead to a possible redefinition of “natural landscape” and “cultural landscape” in the Netherlands.

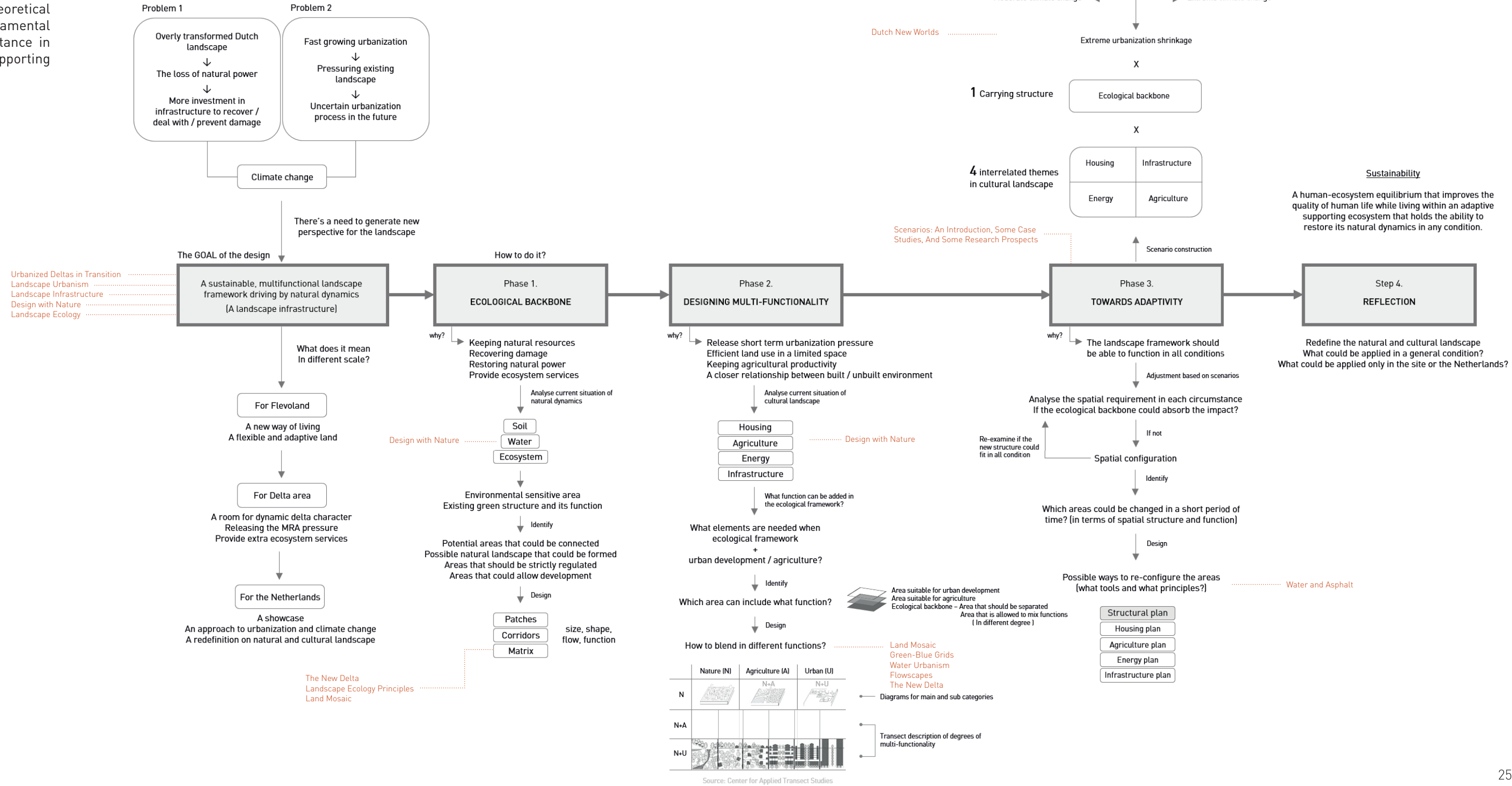


25 Diagram of hypothesis

Source: Made by author

2.4 Design structure and method

The figure explains how theoretical goes along with the fundamental concept, method and importance in each step of design. The supporting theories are indicated in red.



2.5 Integration of theories

The table shows the how theories are integrated in this thesis. The theories are categorized according to their supportive theme in the design process.

Theme Theory	Fundamental concept	Analysis	Design principle	Reflection
Design with nature McHarg, 1969	Consider the carrying capacity of the land as priority when planning and design.	Suggest important theme to analyze for different types of landscapes.	Decide compatible landuse base on the suitability of land.	The theory holds an opposition between urban development and natural environment, while the design of thesis aims to propose a harmonious relationship between the two.
Dutch new worlds Salewski, 2010		Provides scenario construction on Flevoland during the reclamation of the polder.		
Flowscapes Nijhuis & Jauslin & van der Hoeven, 2015			Provides project examples in designing water, green and transport landscape infrastructures	The focus is on the general concept that could be integrated in the Dutch delta context
Green-blue grids Pötz, 2016			Provides tools to integrate natural processes into urban areas	Depending on the theme, tools could vary in terms of scales
Landscape urbanism Waldheim, 2006	Design landscape continuity could enhance both natural and cultural performance.			
Landscape infrastructure Belanger, 2013 Nijhuis & Jauslin , 2015	Integrate landscape process and physical space in a multi-disciplinary way could enhance local identity and various qualities in a tangible relationship, and further guide the future development			
Landscape ecology Forman, 1986	Design the spatial structure of landscape could contribute to the improvement in functions and dynamics in the environment.	Suggest the structure and function of landscape could be analysed through their patterns. (patches, corridors, matrix)	Principles were provided for each pattern, as well as how to create a network in different circumstances.	The theory would be mostly integrated in designing and adjusting ecological backbone.
Scenarios: An Introduction, Some Case Studies, And Some Research Prospects Vettoretto, 2000	Introduce how to use scenarios to approach uncertain future.			Scenario here is used as background which eventually contribute to the development of a set of design principles.
The new delta de Vlieger, 2017			Provides project examples in Dutch delta area that focus on natural processes and multi-functionality	
Urbanized deltas in transition Meyer & Nijhuis, 2014	The vulnerable deltas require a perspective to design towards sustainability.	Indicate important themes for analysing delta dynamics.		
Water and asphalt Viganò & Fabian & Secchi, 2016		Provide means and inspiration for describing natural and cultural development in a territory and constructing scenarios	Develop possible principles base on scenarios	The study was established in the Veneto region, which has a different dynamic with the Dutch delta, therefore the focus would be on the process of generating design principles base on scenarios.

3 PHASE I: ECOLOGICAL BACKBONE

3.1 Natural dynamics in Flevopolders

To design the ecological backbone for Flevopolders, an understanding of its formation and transformation of natural dynamics is necessary. Four subjects were selected to conduct the overall understanding, including the history, soil, water and ecosystem.

Before Flevopolders

7000 years ago, between 5,800 and 3,300 B.C., the land where Flevopolders currently locate was inhabited by the last Stone Age people. According to the archaeology findings in Swifterbant, the inhabitants were living on the banks of the IJssel delta in large communities, adjusting their lives to the delta dynamics by cultivating crops in peatland and possibly moving to higher ground during winter flood. (Brand & Merkelyn & Doesburg, 1988) Despite of the unsafe living environment in the delta, the abundant natural resources in the wetland landscape provided incentives for settlements. Gradually, the villages took advantage of Zuider Zee and transformed into trading centers in around 9th century, which brought prosperity to the whole region. However the wide entrance channels of Zuider Zee and the storms coming from the North had constantly damaged the dikes. Therefore raised the plan of closing Zuider Zee in 17th century and finally was completed in 1932 with plan Lely.

Besides the traces of ancient civilization, there are also traces of earlier landscapes. Elements such old trench systems and river dunes, rare peat remains and ancient soils could be found in this ancient fossil landscape. In the Flevopolders, main geographical values include levees of river Eem in Almere and river in Swifterbant, (Fig. 28) which is a heritage that represents the history of land formation and history of human culture. (Provicie Flevoland, 2006)



26 A reconstruction of the dwelling in Swifterbant civilization

Author: Roeland Paardekooper



27 Shipwreck found during polder reclamation

Source: Holland. com



28 Areas with geographical values

Source: Made by author

Data source: Provincie Flevoland

Soil

Flevopolders are by far the largest artificial island in the world. (Wikipedia, 2017) Through the Delta Works the Dutch reclaimed the swampy land that was under water, and resulted in gaining large amount of fertile sea clay soil (Fig. 31) that could easily keep water and nutrients between layers underground and support the growth of plants. (DuPont, 2012) Combining the feature with advanced drainage system, the land became very suitable for agriculture. However, areas that contain high clay content were observed to be one of the main factors to soil subsidence. (Fig. 33) Because that clay is highly responsive to volumetric change due to its molecular structure, (Landmark Information Group, 2017) the higher content of clay, the higher degree of subsidence was observed. Base on the observation and the condition of groundwater extraction, the subsidence in Flevopolders could be anticipated, which is discussed in the next theme.

The cultural activities conducted by man throughout history have brought numerous negative influence on the soil. Even though there is no heavy industry involved in the Flevopolders, the process of agriculture production has still left some contamination to the land. (Provincie Flevoland, 2017) One of the most serious contamination came from asbestos, a type of mineral that could cause deathly disease when the fiber is inhaled. During 1945 to 1983 asbestos was used as housing materials for insulation, flooring, pipes, etc. and only banned in 2005 by European Commission. As a result, numbers of housing and farm house in Noordoostpolder have included asbestos as building materials while Flevopolders have less. (Fig. 34) However the structures that contain asbestos could represent a risk of serious contamination, especially when a building would be demolished and asbestos fiber could be released into the air. Therefore strategies for asbestos management have been proposed, which require absolute caucious when burying it into the ground to prevent from further soil contamination. (NSW, 2014)

Another serious contamination lies in Ketelmeer, where river IJssel drains slib (toxic sludge) into the waterbody. Therefore

IJsseloog, a permanant storage for the polluted silt dredged from the bottom of Ketelmeer was built and designed as also as a recreational area and natural conservation area. (Fig. 30) (Rijkswaterstaat, 2016)



29 Recording soil profile through ditches

Author: J. van der Laan



30 IJsseloog

Source: <http://www.anteagroup.nl>



- Sea clay
- Calcareous sandy soil
- Peat moor
- Peat land
- Podzol
- Mixture of clay and peat
- Wetland
- Building



31 Soil type

Source: Made by author

Data source: Provincie Flevoland



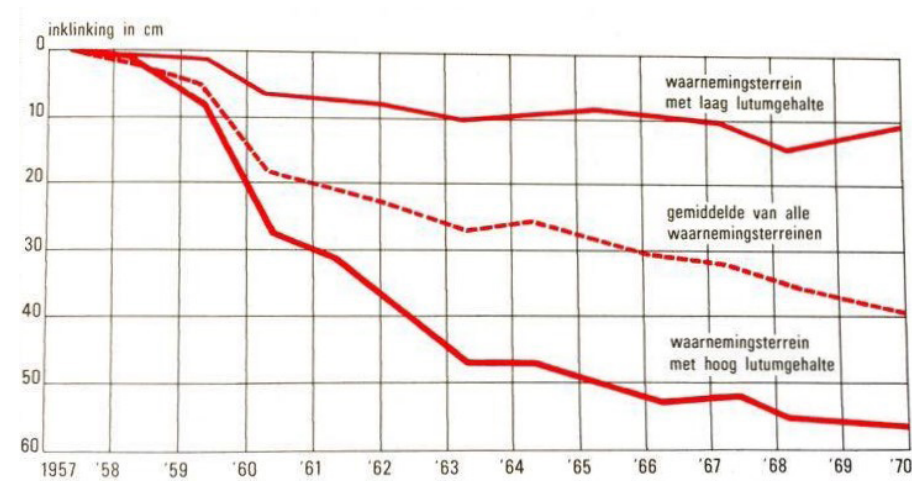
- Soil contamination area
- Building



32 Soil contamination

Source: Made by author

Data source: Provincie Flevoland



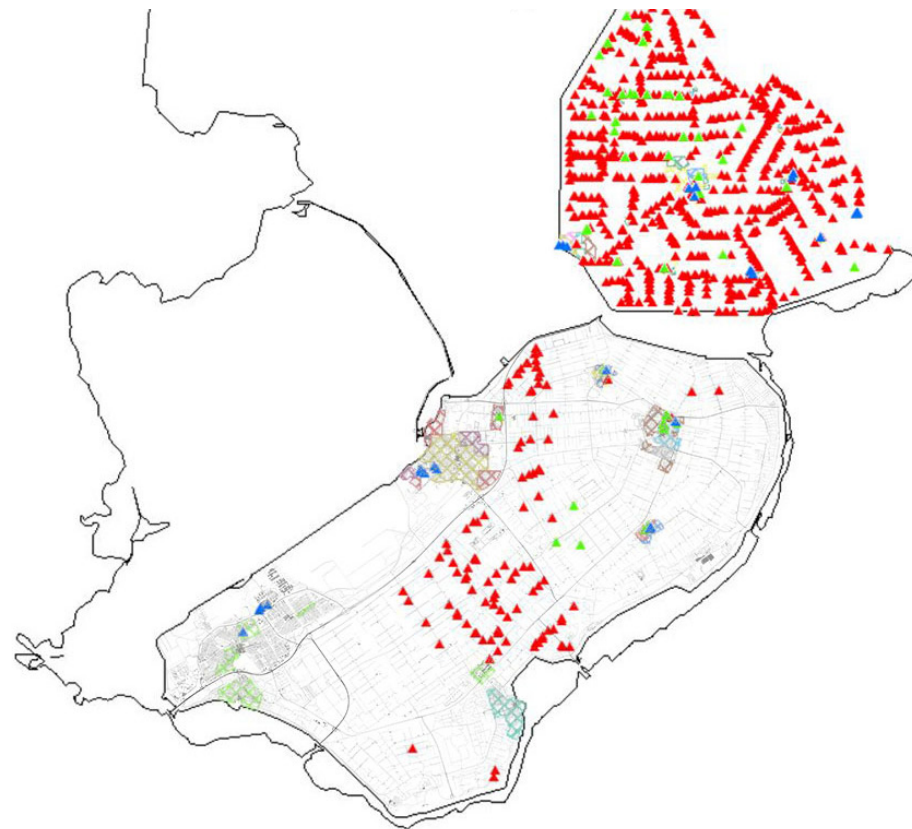
Observation site with low clay content

Observation site with average clay content

Observation site with high clay content

33 Soil subsidence observation in areas with different degress of clay content

Source: Atlas voor Flevoland 1971



34 Possible presence of asbestos

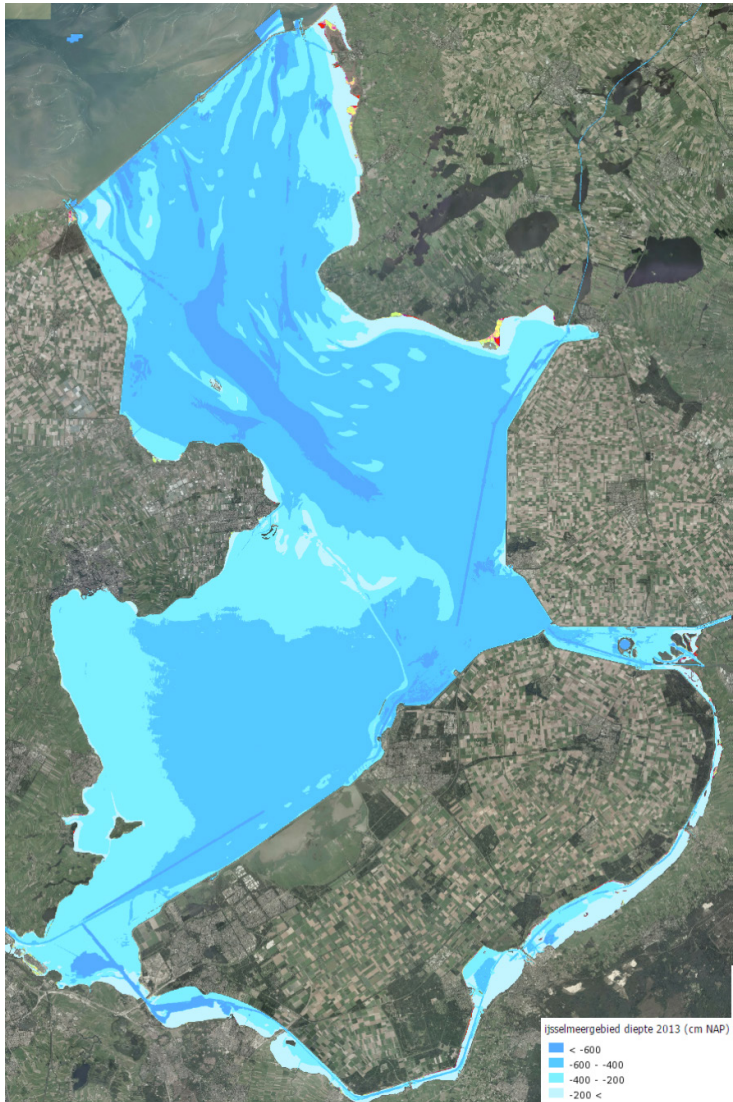
Source: Provincie Flevoland

Water

In dynamics of delta area, hydrology plays an extra significant role. Everything that had happened, that is happening, and that will happen in a polder, has a direct or indirect relation to water. In Flevopolders, the land is not directly in touch of the sea due to the construction of Afsluitdijk and Houtribdijk that closed the water in IJsselmeer region and transformed the once inlet of sea into freshwater lakes. This shallow but vital reservior guarantees great natural and cultural values in the country and therefore a necessary strategy for future adaptation should be formed. (Delta commissioner, 2016) (Fig. 35) One of the greatest uncertainty these large lakes are facing is the sea level rise derives from climate change, which is extremely dangerous for polders that have already been under sea level.

According to Delta Programme Commissioner, it is possible that the process of sea level rise will accelerate even more than what was expected, and climate change may also bring extra water discharge into IJsselmeer from rivers, which would make the drainage in IJsselmeer to Wadden sea even more difficult in the future. To tackle the issue, the strategy that had been proposed is to maintain the water level in IJsselmeer region in winter at NAP -25cm through gravity and pumping at least until 2050. Afterwards water level could be gradually increased up to 30cm if absolutely necessary.

From the Flevopolders point of view, to deal with the sea level rising challenge, diminishing land subsidence is considered as a priority, along with the aim to conserve groundwater resources. (Provincie Flevoland, 2017) According to the record from the province in 1971, the subsidence in Flevopolders happened quite fast at the beginning after reclamation because of the evaporation from pioneer plants, gradually the situation went mild after the soil was more stablized. Because of the difference in soil type, areas on the eastern and southern edge of the polders have a lower degree of subsidence than the rest of the land. (Fig. 36)

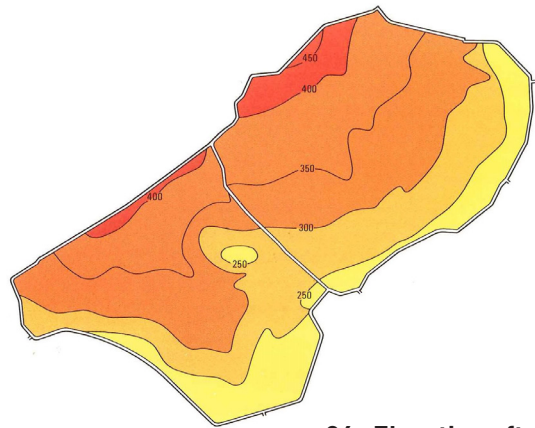


35 Depth of waterbody in IJsselmeer region

Source: Rijkswaterstaat

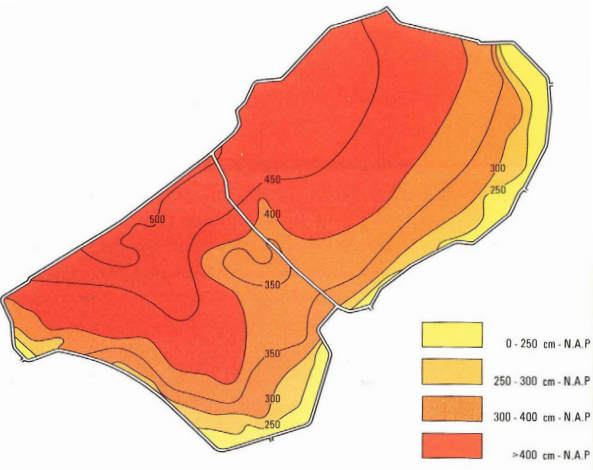
The same year the province made a simulation on how the elevation of the land may become in the year 2050, with factors such as soil, groundwater and the thickness of weaker peat and clay layers formed in Holocene were taken into consideration. The result suggests an inclination towards Markermeer and end up being around -4m on the edge. (Fig. 37) While currently the elevation of Flevopolders is already around -4 to -5 m. (Fig. 38)

In recent years the province made a more specific subsidence anticipation until the year 2030. The same inclination can still be observed but it is clear that there is a stress on the two main cities, Almere and Lelystad. (Fig. 39) There are several main reasons that cause land subsidence, including soil type, groundwater extraction, loading pressure on the ground with heavy buildings, and oxidation of peat bog, etc. (Deltares, 2015) The province in this case determined the main factor to be over extraction in groundwater, which happens to be a common situation in polder areas. (Pellenbarg, 1997)



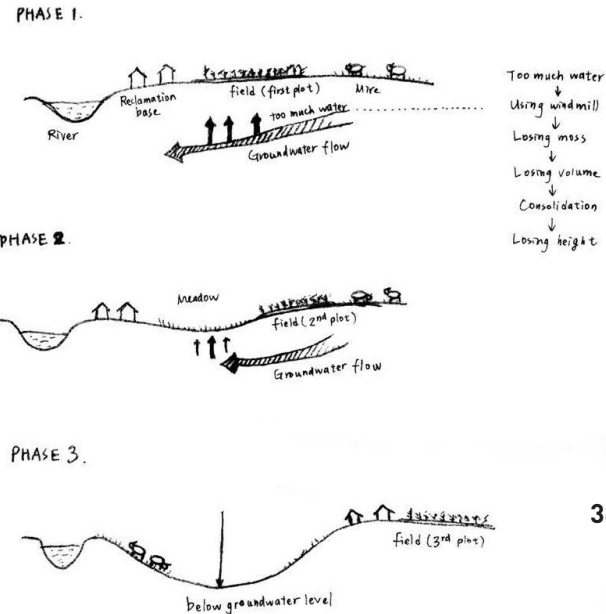
36 Elevation after reclamation

Source: Atlas voor Flevoland 1971



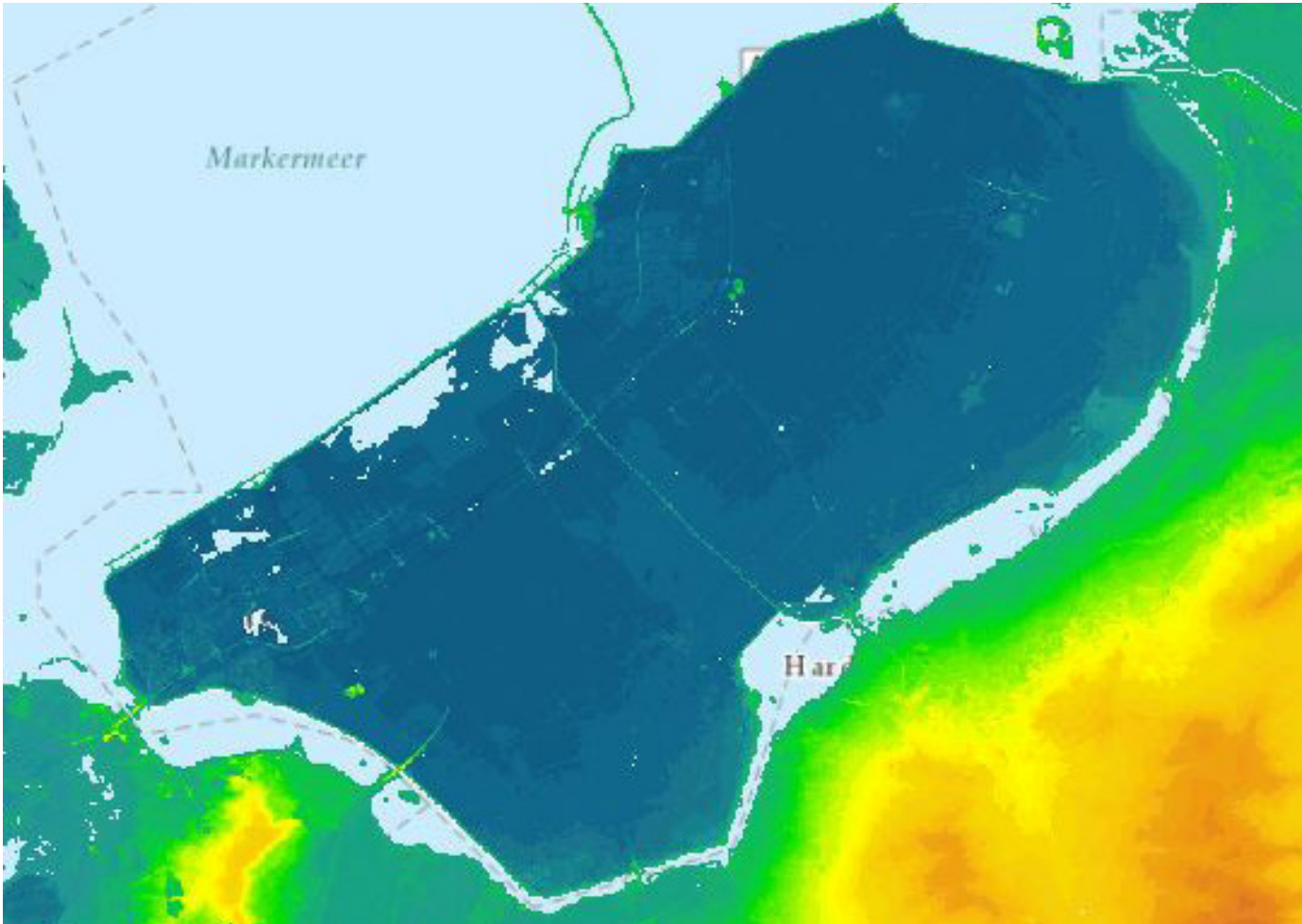
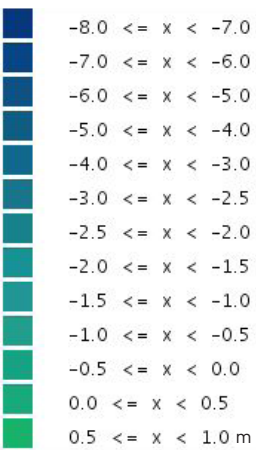
37 Anticipated situation in 2050

Source: Atlas voor Flevoland 1971

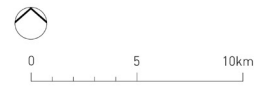
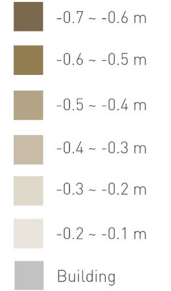


38 Diagram describing common relationship between groundwater and land in polder

Source: Made by author



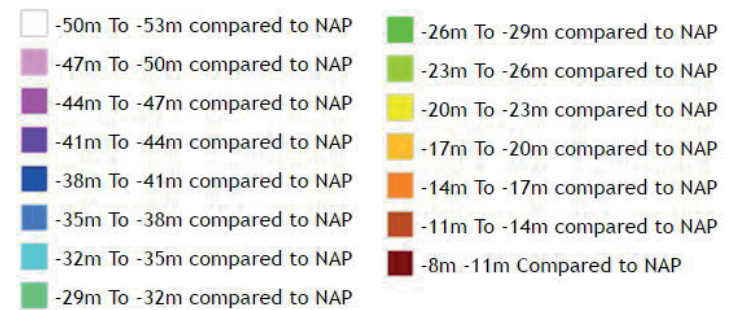
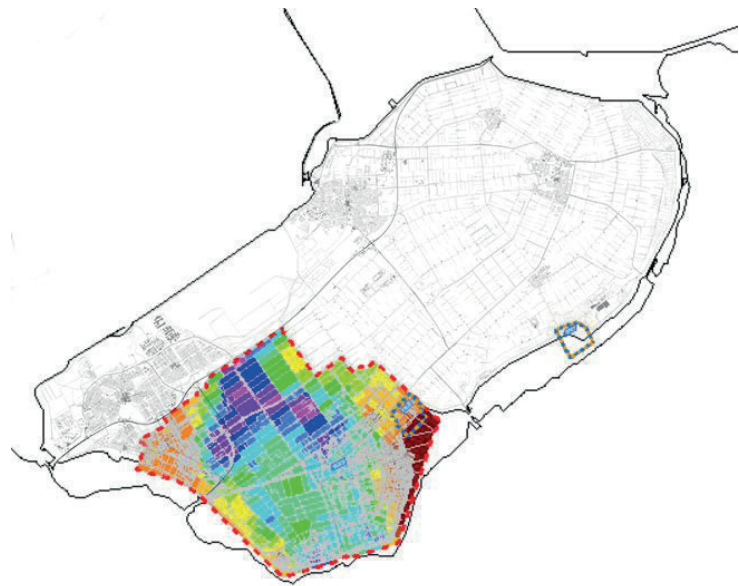
39 Current elevation
Source: Provincie Flevoland



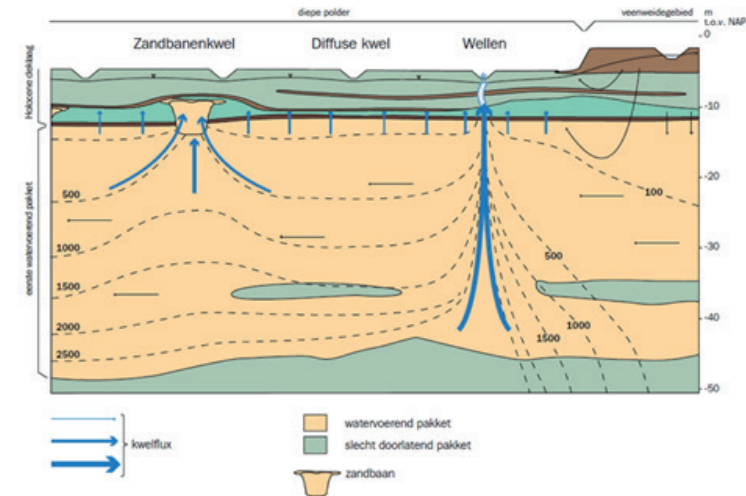
40 Soil subsidence until 2030
Source: Made by author
Data source: Provincie Flevoland

For conserving groundwater, the province proposed a strategy for establishing a bore-free zone between Almere and Zeewolde. (Fig. 41) Since the aquifer is confined, the groundwater resource is worthy to be saved for future, therefore extraction is in general forbidden in the zone. On the other hand, the groundwater coming from Veluwe forest in the east brought large amount of water underground towards the eastern edge of Flevoland, a seepage therefore formed in the boundary zone next to the dike and caused the areas constantly wet. (Fig. 43) While the lake Veluwemeer in between serves as a buffer zone. An interview with the inhabitant verified the difficulty in agriculture there due to the seepage, without the lake situation would definitely worsen. (LandschapsbeheerFlevoland, 2011)

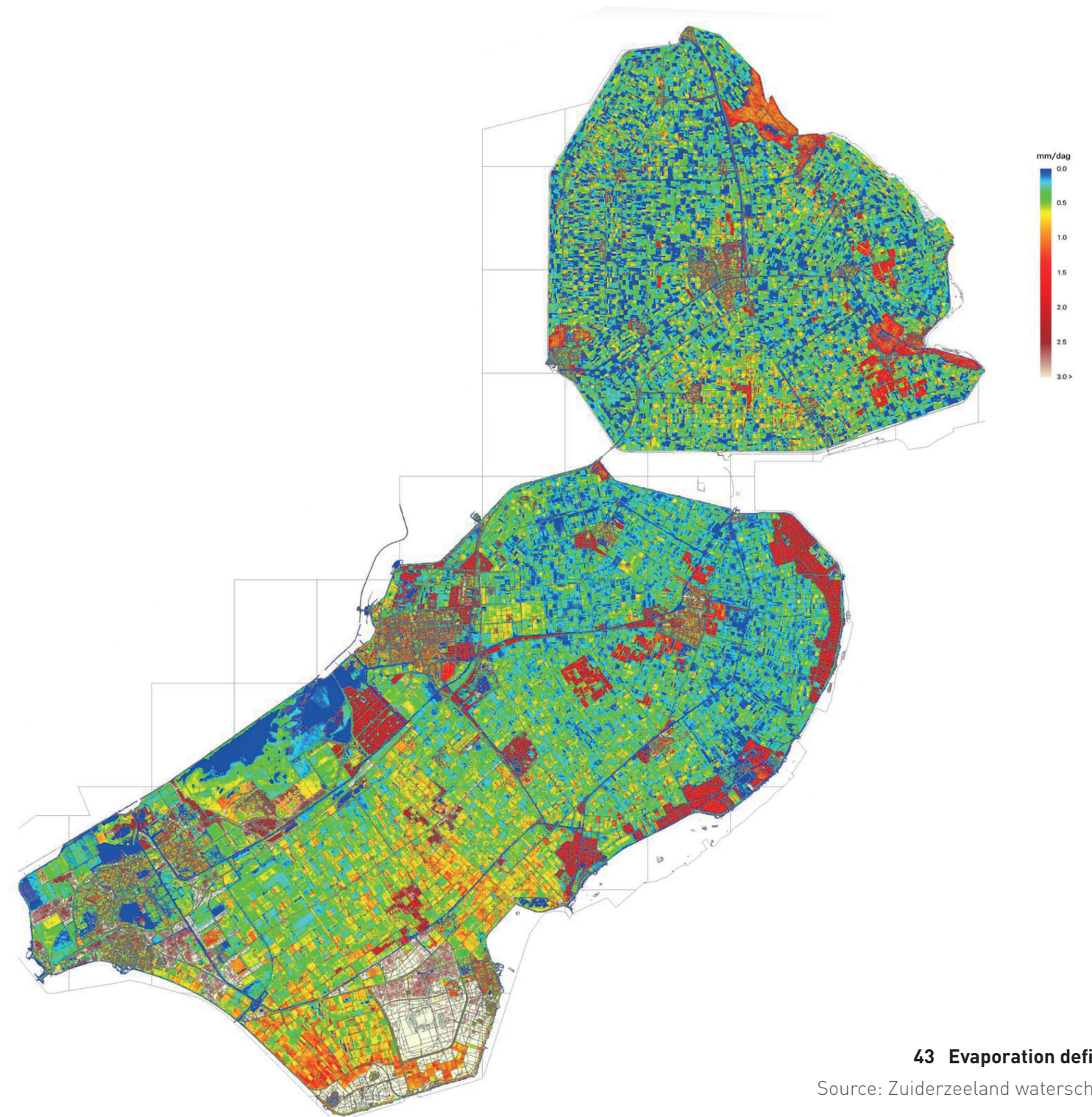
Another type of seepage could occur from salt water, which is the saline seepage. One of the types of saline seepage came from the invading salt water that derived from sea level rise and soil subsidence. It was blended into the fresh groundwater and created a brackish zone that has the chance to reach the surface through ditches and canals like described in figure 42. Saline seepage could deeply influence the agricultural performance in the area.



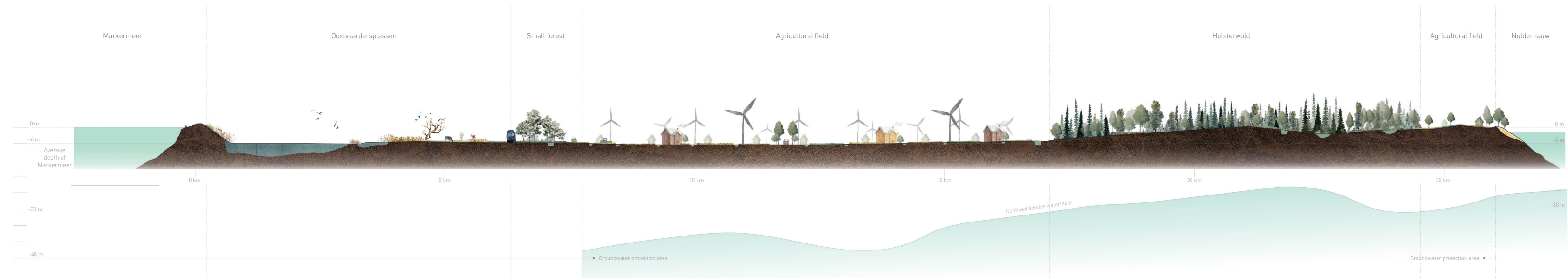
41 Bore-free zone
Source: Provincie Flevoland



42 Diagram of saline seepage
Source: Deltafact



43 Evaporation deficit
Source: Zuiderzeeland waterschap



41 Diagrammatic section from Oostvaardersplassen to Horsterwold

Source: Made by author



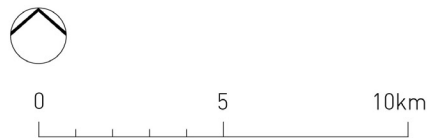


- Bore-free zone (Boringsvrijze zone)
- Groundwater conservation area
- Water extraction
- Natura 2000 area
- Area with desiccation
- Area with geological value
- Subsidence
- Building

23 Soil subsidence until 2030

Source: Made by author
Data source: Provincie Flevoland

By overlaying layers regarding environmental sensitivity, It can be observed that the west part of Flevopolders has a higher concentration of various issues. As a result, the design of ecological backbone should especially consider the future development and relationship between Almere, Oostervaardersplassen, Horsterwold and Zeewolde together.



Ecosystem

The Netherlands falls in the biome of temperate deciduous forest. (Fig. 42) The feature of the type is a constant change with the season. Flora has an evident cycle such as the color change in leaves, while some animal may migrate or hibernate. (NatureWorks, 2017) Taking the biome into account, in Flevopolders only certain types of plants are suitable to be grown on the land. In the document from Province of Flevoland, during the beginning of plantation some difficulties were encountered. First, the polder right after reclamation absorbs direct sun without any shelter, and therefore the land was dehydrated, only plants that feed on groundwater could survive. Second, the agriculture quickly took place in the land, making the trees hard to blend in. Third, the space which each type of seed needs to grow on is different, hence it was difficult to select the species and calculate the distance in order to make the plan. (Fig. 43) Finally, when the tree started growing, windshield was needed to fight against the windy environment. (Fig. 45) The effort paid off and nowadays the Horsterwold forest is the largest deciduous forest in Europe with abundant naturalness. (Fig. 44)

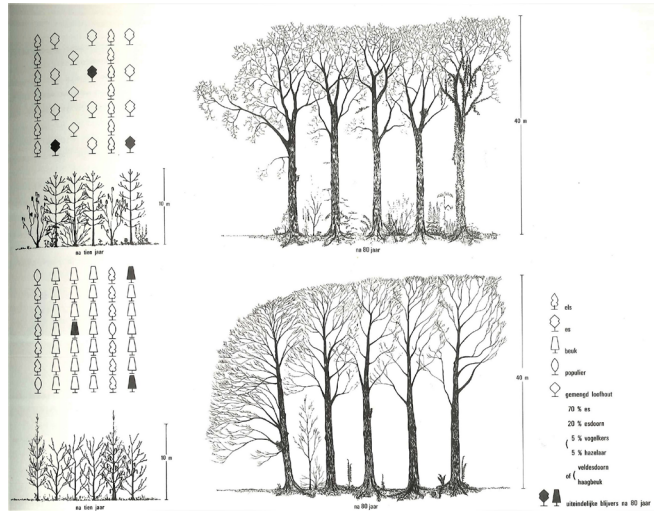
Occasionally, the growth of ecosystem did not follow the plant scheme. Several areas, such as the places along dikes, were occupied by large amount of pioneer plants due to its seepage, and formed environment such as reedland that is attractive to birds. The nature reserve Oostvaardersplassen also fell into the category. It was planned to be an industrial zone but the wetland naturalness it gained put forward the awareness and respect of ecosystem. (Hara & Nijhuis & Hooimeijer & Ryu & van Timmeren, 2014)

To understand the spatial relationship in different ecosystems in Flevopolders, structure of green were analysed according to the location, spatial pattern and function. (Fig. 47 & Fig. 48) Overall, Flevopolders owns abundant natural resource, and the ambition of integrating urban and green structure while setting up the plan had led Almere going towards a unique and environmental friendly development. Nevertheless, the forest and wetland patches are still fragmented or merely connected through roadside greenery, which has the potential to be improved and form a complete network of ecosystem.



42 Temperate deciduous forest biome

Source: Wikispaces



43 Plant scheme 1967

Source: Atlas voor Flevoland 1971



44 Plant scheme 1967

Source: <http://www.oorkflevoland.nl>



45 Young trees that need windshield

46 Forest in 1967

source: Fotocollectie Nieuw Land (RIJP) Potuyt





47 Green structure

Source: Made by author

Data source: Provincie Flevoland

- Wetland
- Forest
- Natural grassland
- Grassland
- Mowed grassland
- Agricultural grassland
- Hedgerows
- Open roadside greenery
- Closed roadside greenery
- Main open water connection



0 5 10km

Wetland

Regulate water
Regulate temperature
Habitat for birds, fish, etc.
Recreation



Swamp ragwort Cane Marsh cudweed Marshelder

Deciduous forest

Regulate water
Regulate temperature
Habitat for mammals
Recreation
Wood cultivation



Beech poplar Fern Moss

Natural grassland

Regulate water
Habitat for birds
Soil purification



Pioneer plants

Grassland

Regulate water
Soil purification
Recreation



Native prairie grass

Hedgerow

Pasture
Habitat for bird and
small mammals



Agricultural grassland

pasture
Regulate water
Soil purification
Organic farming



Open roadside greenery

Windshield
Habitat for birds



Closed roadside greenery

Windshield
Habitat for bird and
small mammal

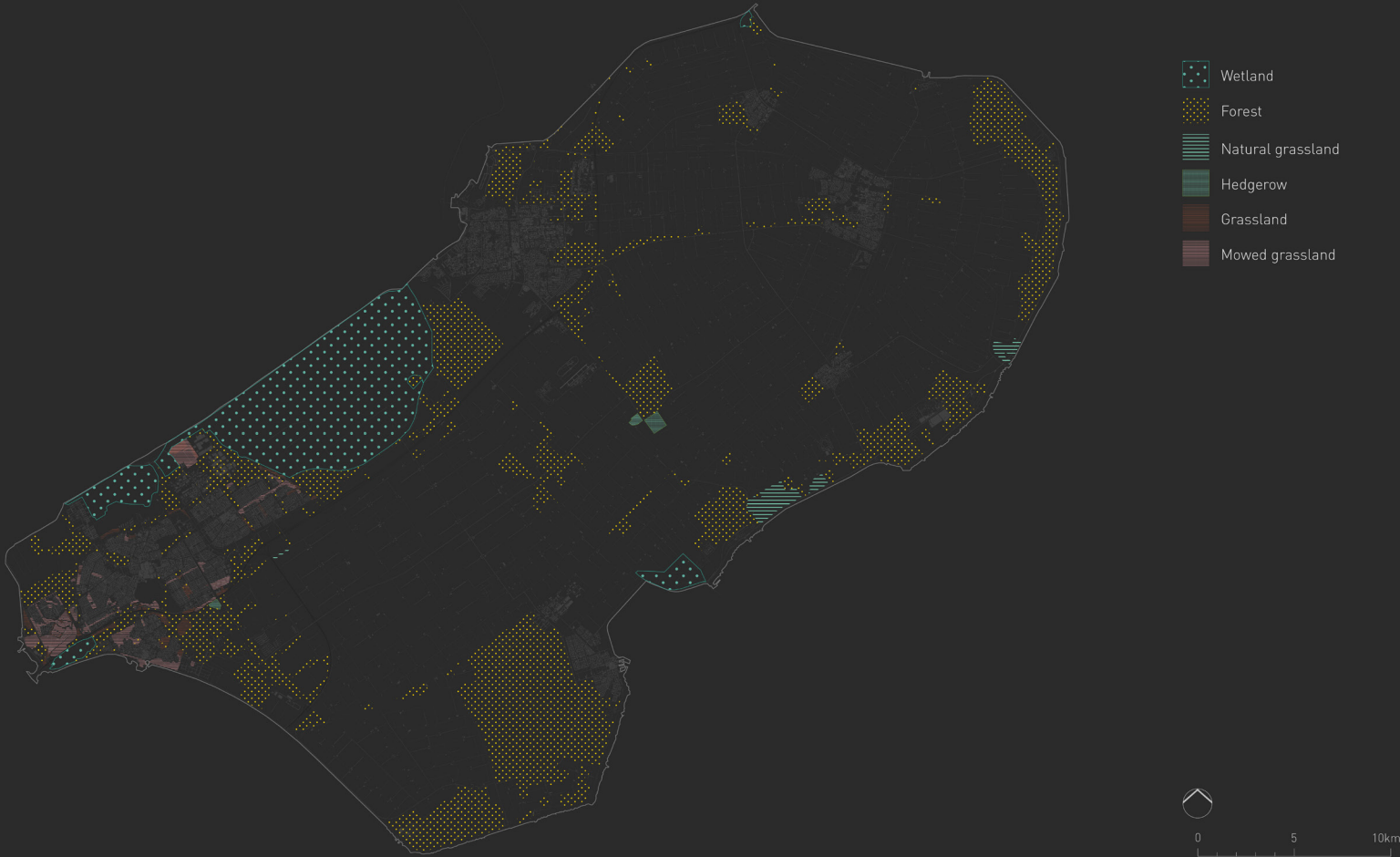
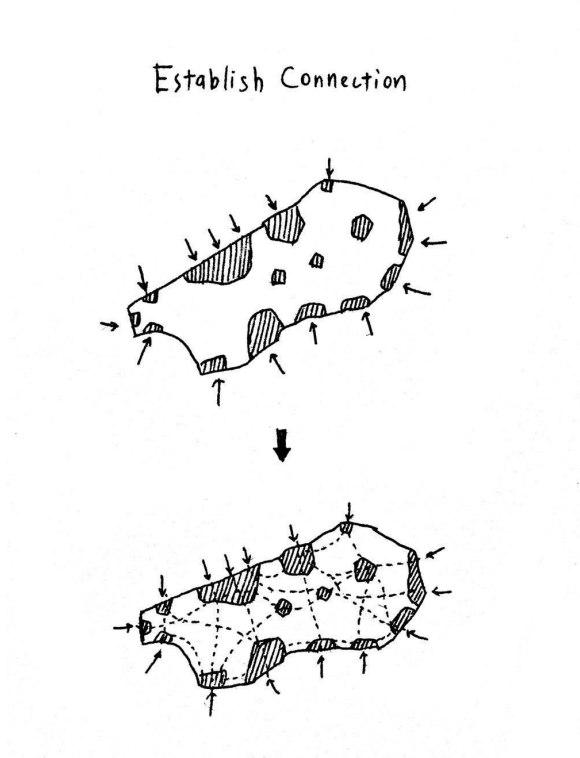


**48 Pattern, function, scenery and
key vegetation of green structure**

www.kiwinurseries.com
<http://rslandscapedesign.blogspot.nl>
alfa-img.com
[Stojan Nejkov](http://www.landstylist.com)
<http://www.landstylist.com>
<http://www.northcreeknurseries.com>
<http://www.prairienursery.com>
<http://www.panoramio.com>

Photo source:
Cola en Pia, google map
<http://hans-hobbies.nl>
<http://www.nhdfl.org>
<http://www.natuurnieuwegein.nl>
<http://www.buzzle.com>
Google earth

3.2 Initial design



49 Reading the ecological patches
Source: Made by author

To understand the spatial structure of the ecosystems better, the spatial pattern concept addressed in Landscape Ecology Principles by Forman is introduced. The first attempt is to look into the “patches”, a space with certain degree of isolation that forms a habitat for certain groups of species with particular dynamics.

In figure 47 and 48 the types of patches that could be found here was already introduced. While in the figure above, by inversing the background color, the location, size and shape of patches were highlighted. It is evident that forest is the dominant type of patch that construct the green structure, and on the edge of polder wetland patches in all sizes could be found. Agricultural grassland was not in the consideration here due to the fact that it is generally used for agricultural purposes and the ecosystem dynamic is therefore not that evident.

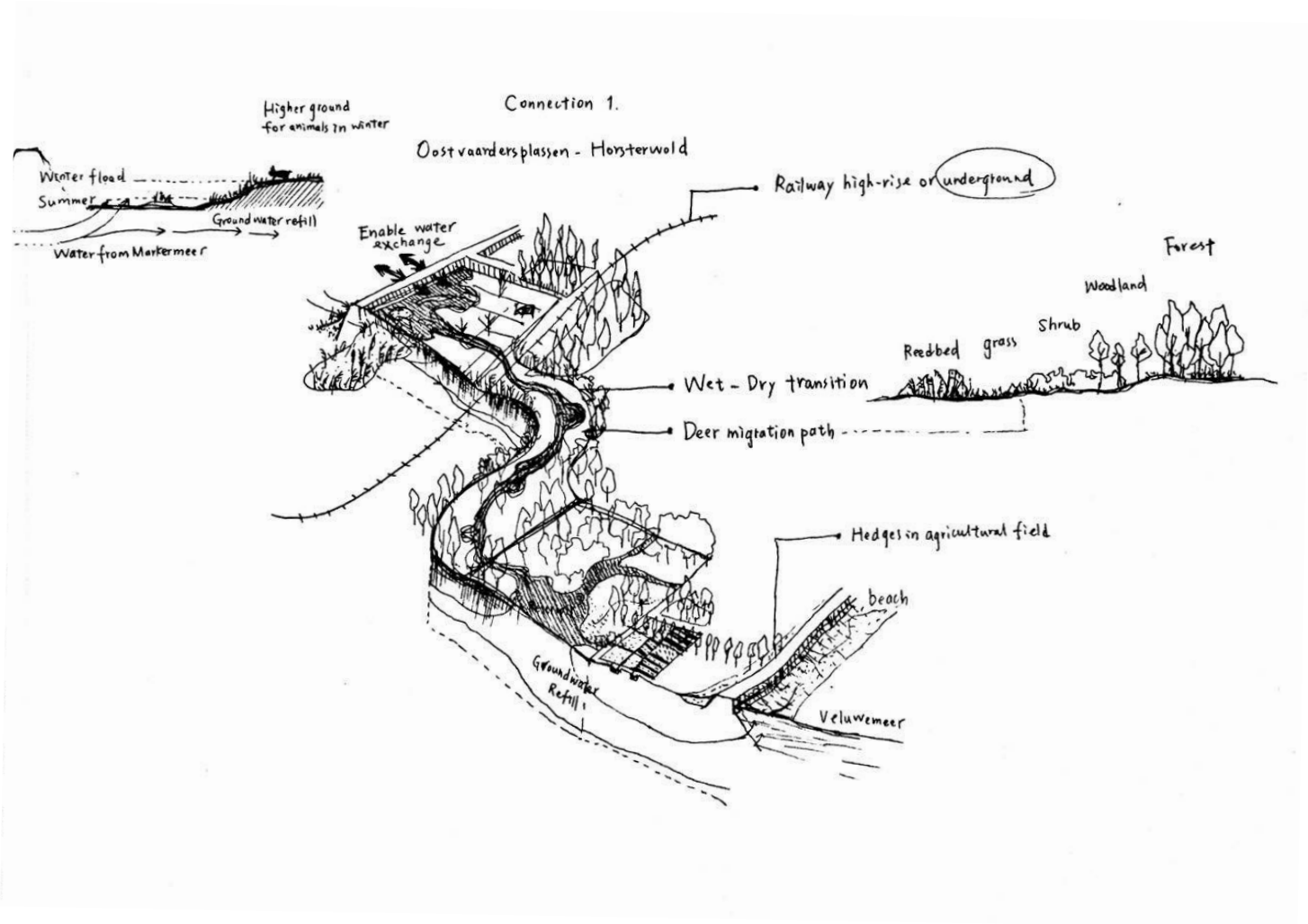
Connection 1: Oostvaardersplassen - Horsterwold



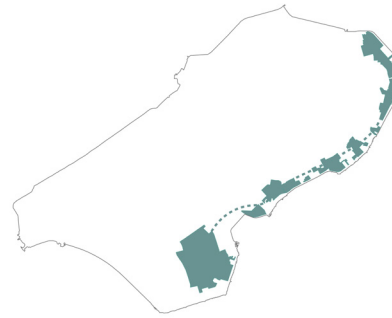
The connection is established between the two biggest patches in the Flevopolders, forming a gradient transition corridor from wetland to a dryer deciduous forest.

An exchange system would be constructed to enable the water body of the wetland to interact with Markermeer despite of the dike enclosure. The water flow would on one hand be directed into underground to refill the aquifer and swell the subsided land, and on the other hand forms a creek on the surface that goes along with the transition zone into the reservoir in Horsterwold and eventually Veluwemeer.

Considering the possible sea level rise in the future, a higher ground would be formed in Oostvaardersplassen for the animals to escape from the winter flood, while the red deers would migrate through the transition zone to the south. The periodic flood would allow the wetland to regain its original dynamics.



Connection 2: Horsterwold - Roggebotsebos

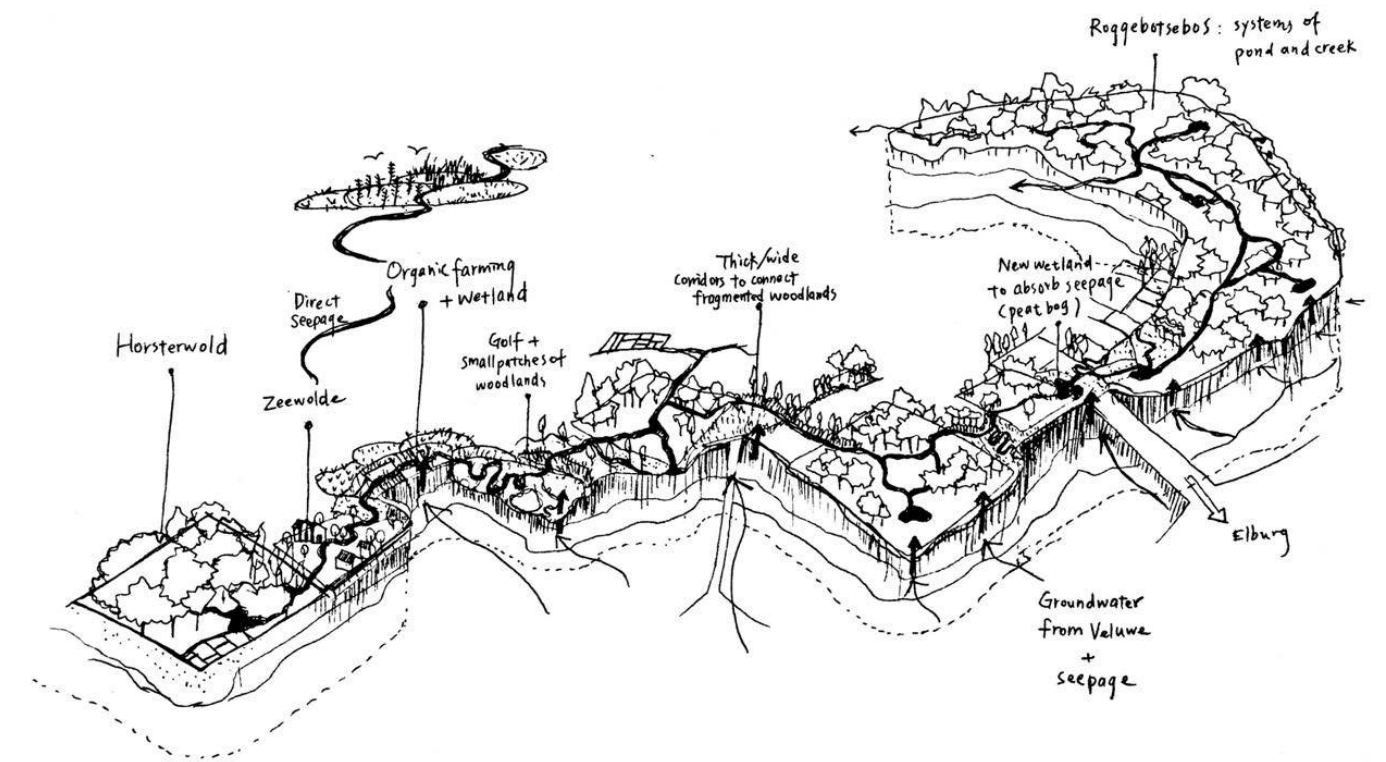


The connection is established between several deciduous forests and some small wetlands. A transition of dry - wet - dry environment would be formed in the corridor.

The gaps between the fragments are linked by using the seepage coming from Veluwe, which often resulted in stagnated water on the boundary zone. The diverse soil types on the edge allows new wetland patches such as peat bogs to be formed and function as sponges. The excessive water and runoff are redirected in between the wetlands and forests, forming a continuous system of ponds and creeks.

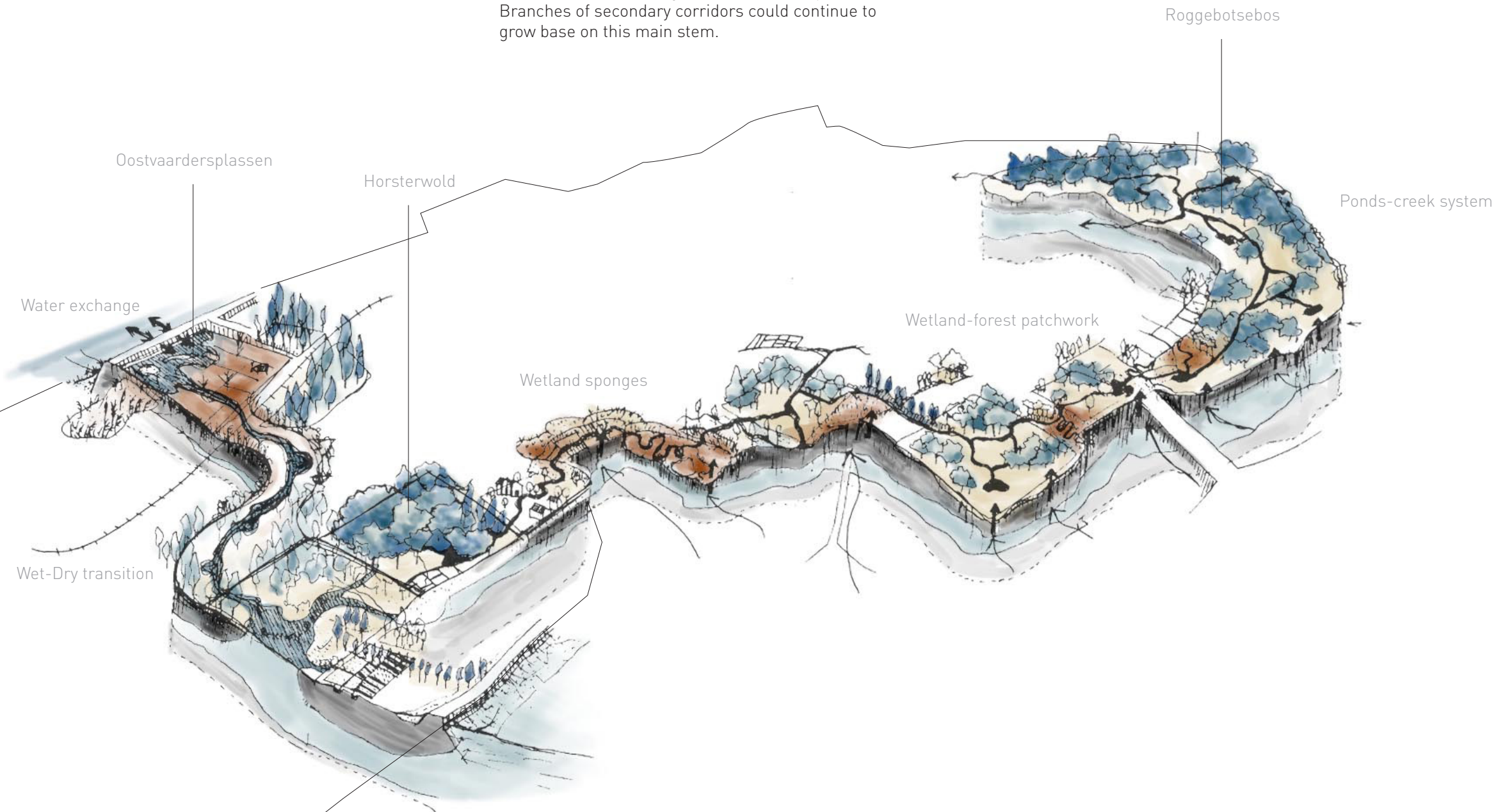
Along the water structure, forests patches are linked with thick hedges to allow movement of species, while part of the wetlands are integrated with crop cultivation and function as organic farms.

Connection 2. Horsterwold - Wilhelminabos / Roggebotsebos



The main ecological axes

Intersecting at Horsterwold, the two corridor form the robust ecological axes in Flevopolders. Branches of secondary corridors could continue to grow base on this main stem.



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