# HABITAT EMBROIDERY

## An Interwoven Landscape Framework for Delta Urbanism

"In considering the study of physical phenomena, not merely in its bearings on the material wants of life, but in its general influence on the intellectual advancement of mankind, we find its noblest and most important result to be a knowledge of the chain of connection, by which all natural forces are linked together, and made mutually dependent upon each other; and it is the perception of these relations that exalts our views and ennobles our enjoyments."

— Alexander Humboldt, COSMOS: A Sketch of the Physical Description of the Universe, Vol. 1

# HABITAT EMBROIDERY

An Interwoven Landscape Framework
for Delta Urbanism


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



An Interwoven Landscape Framework
for Delta Urbanism



Supervisors

**Han Meyer**
**Steffen Nijhuis**
**Giambattista Zaccariotto**

Student

**Lin Wei Yun**



June 2017

CONTENTS


**1 Location of the study area** (False-colour image)

Source: European space agency (ESA)


## ABSTRACT

The thesis aims to discuss the possibility of introducing a interwoven spatial relationship between urban landscape, agricultural landscape and natural landscape, with natural landscape as an infrastructure that could be used as a framework in the development of delta environment. 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 was selected as the study area. Its unique location and history of development have led to the complex situation today, which reflects on the overall issues in the delta areas. The design of the territory contains 2 parts, the formation of ecological backbone, and the structure and typology of multifunctionality.

Through designing a robust ecological backbone that supports the growth of natural dynamics, ecosystem services such as water storage and environmental purification in the landscape were highly enhanced. Based on the ecological structure, multifunctionality was introduced to the territory. Urban and agricultural functions, depending on the location, were designed with different typology that on one hand support the cultural demand, on the other hand minimize the impact on the environment while sustain the potential fluctuation in the natural dynamics.

**2 Knardijk construction**

Source: Netherlands fotomuseum

## 1 Motivation

As a foreigner, the Netherlands in my eyes is coloured with green and grey. Green from the trees on the sidewalks, the canals, the well-organized parks, while grey from all the little details that enables the urban functions on this low, wet land.

As the saying goes, "God created the earth, but Dutch created the Netherlands." What could be experienced today in this territory is resulted from an enormous effort of fighting against the power of nature. This effort was therefore embedded and appreciated in the history, in the culture, and in the national spirit. From the outsider's point of view, everything is advanced and functioning perfectly here, but if I may say so, it seems a little bit too perfect.

"What if the beginning of this perfection - the water drainage - would be stopped, what would happen then?" This question opened up my imagination, and finally led me to the topic of this research. As I investigated further, I realized that the "perfection" is not as perfect as it seems. In fact, the price behind this image is unable to value. The original landscape has been completely altered for the development of cultural environment, and the power of nature has also been dinimished so dramatically to a point where survival is almost impossible without the power of man. And therefore the vicious cycle continues, and it may bring an undesirable consequence to the future.

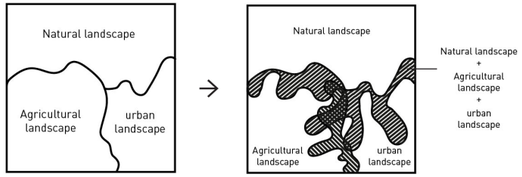
What matters today is to change the way of living. Is there still a possibility for people to live with nature? Not just literally, but a harmonious relationship from the root, on this land where perfection is not perfect, where nature is not natural anymore? And what would "nature" mean in the end for this land? I hope to find out some possible answers to these questions.

**3 Oostwaardersplassen aerial photo**

Author: Siebe Swart

## 2 Hypothesis

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.




**4 Conceptual drawing of the hypothesis**

Source: Made by author

## 3 Terminology

The division of image of land was firstly introduced by Alexander von Humboldt, a German naturalist in 19th century, he suggested that nature has a distinct feature from the human living environment. While the "landscape" terms were developed by Otto Schlülter in the early 20th century, who divided the landscapes into two, the orginal landscape (*Urlandschaft*) and cultural landscape (*Kulturlandschaft*).

* Natural landscape

Since human have drastically transformed the physical space, the original "nature" almost no longer exists. Therefore natural landscape could only be seen as degrees of naturalness within a landscape. (EEA, 1995)

* Cultural landscape

A landscape designed and created intentionally by man, (UNESCO, 2012) which is combination of natural material and the force of human culture, a "man's record upon the landscape". (Sauer, 1925)

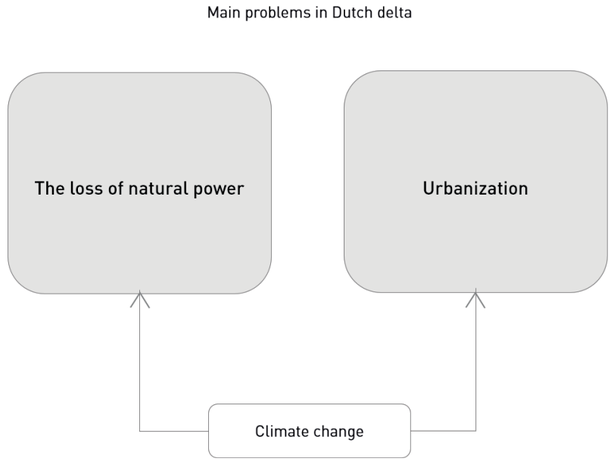
Reflection

Even though the original nature had been transformed, the term "natural landscape" is still used in the thesis to represent the area that is not used as the space for mainly economic activities, in order to make a differentiation with the cultural landscape (which include urban and agricultural landscape).

# 4 Problem field

Two inter-connected main problemes were identified in the delta areas in the Netherlands, including the loss of natural power and the challenge of metropolitan development, both have created significant spatial influences on the land. In addition, climate change has brought the power to intensify the potential influences.

In order to analyze the problems and understand their spatial influences, the thesis focuses on the territory of Flevopolders as a study area.



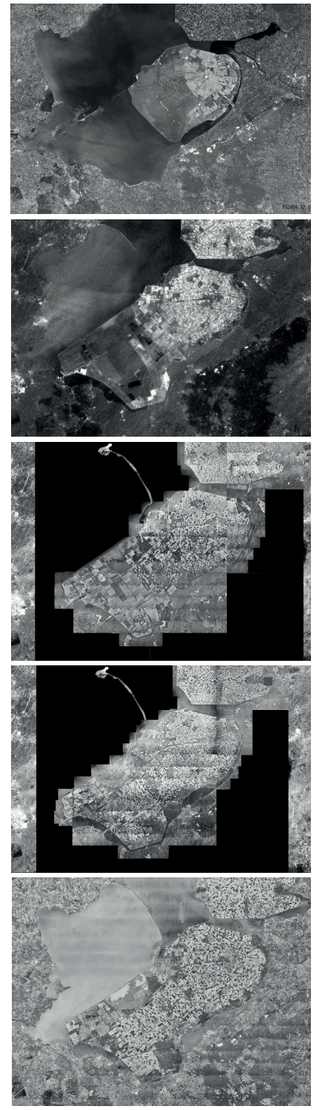

**5 Diagram showing the main problems**

Source: Made by author

## 4.1 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. (Hooimeijer & Meyer & Nienhuis, 2009) 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. 6) 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 Flevopolders 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, while the environment has become vulnerable because natural system is no longer able to grow and develop on its own.

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)



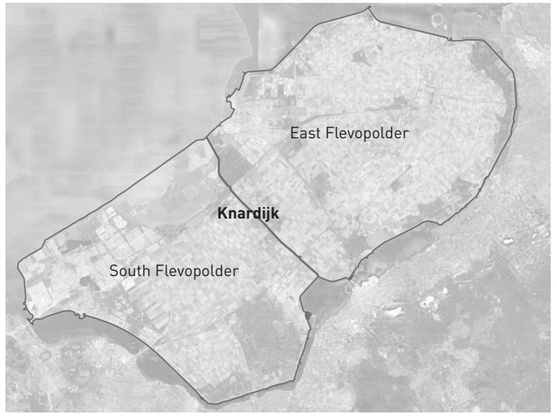

**6 Historical satellite images of Flevopolders**

Source: Provincie Flevoland

In the case of Flevopolders, land was reclaimed through the process of building dykes and pumping the water out. Two polders were formed, East Flevopolder and South Flevopolder, with Knardijk in the middle as a separation. (Fig. 7) The process resulted in the fact that the land of Flevopolders is actually the former sea bed of the IJsselmeer, therefore the water outside the dykes is higher than the ground itself inside. (Fig. 8) As a result, the negative elevation of the land by default made it extra vulnerable when it comes to flooding. Hence the reinforcement of dykes and constant water drainage became essential.

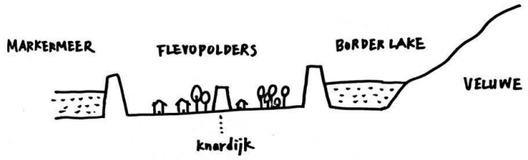
The initial state of the polders contains a saturated wet ground with nothing growing on top. (Fig. 9) As the process of natural evaporation started to take place, pioneer plants had covered several parts of the polders. (Fig. 10) At the same time, ditches were dug for draining the water, and to prepare the land for agriculture and housing. Soil type was analyzed for designing the function of the land, large amount of fertile sea clay soil 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, which was also the main goal to develop Flevopolders.

Despite the suitability for cultivating crops, agriculture and the urbanization have brought soil subsidence to the land through groundwater extraction. For the land that is already low with water constantly seeping through, soil subsidence and more drainage no doubt intensified the damage. Since the lower the land, the more vulnerable it is to withstand flooding, in recent years the province of Flevoland made a more ubsidence anticipation until the year 2030. (Fig. 11&12) It is clear that there is a stress on the two main cities, Almere and Lelystad, while the south Flevopolder has in general a higher risk than the east Flevopolder. In addition, climate change may drastically increase the rainfall in certain period in certain location, which would worsen the situation. From the Flevopolders point of view, diminishing land subsidence is considered as a priority, along with the aim to conserve groundwater resources. (Provincie Flevoland, 2017)




**7 Division of Flevopolders**

Source: Google Earth




**8 Diagram of the relationship between Flevopolders and surroundings**

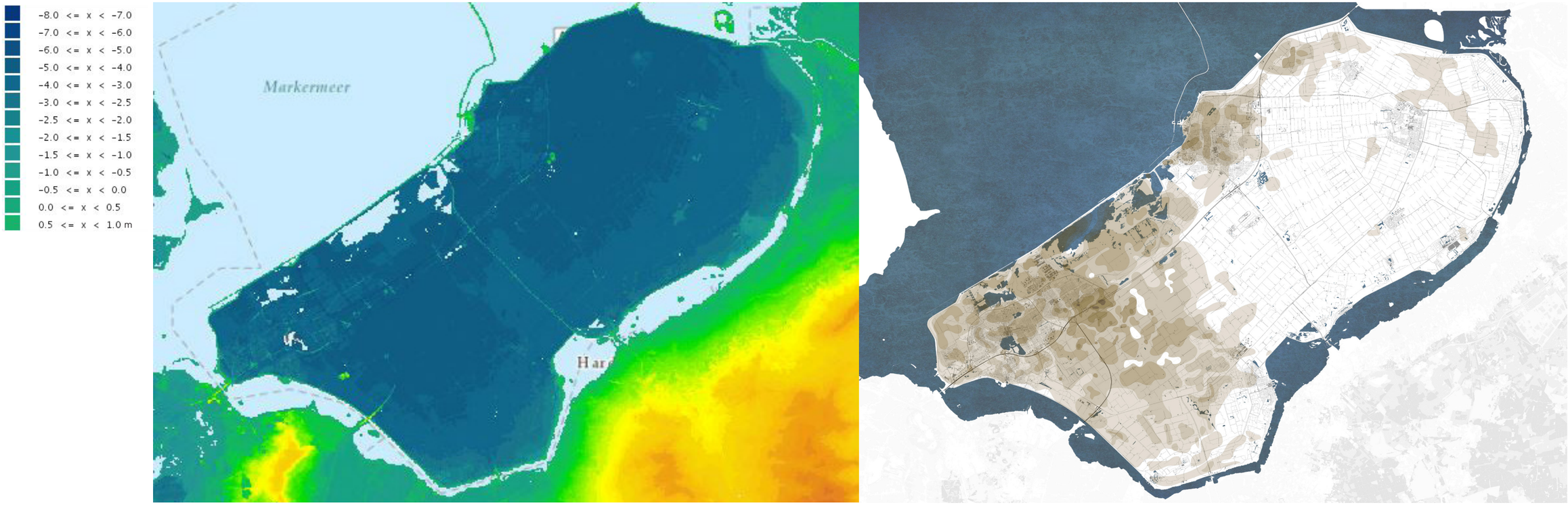
Source: Google Earth

**9 Initial landscape of Flevopolder**

Source: LandschapsbeheerFlevoland

**10 Pioneer plants in the Flevopolders**

Source: LandschapsbeheerFlevoland




**11 Current elevation**

Source: Provincie Flevoland

**12 Soil subsidence until 2030**

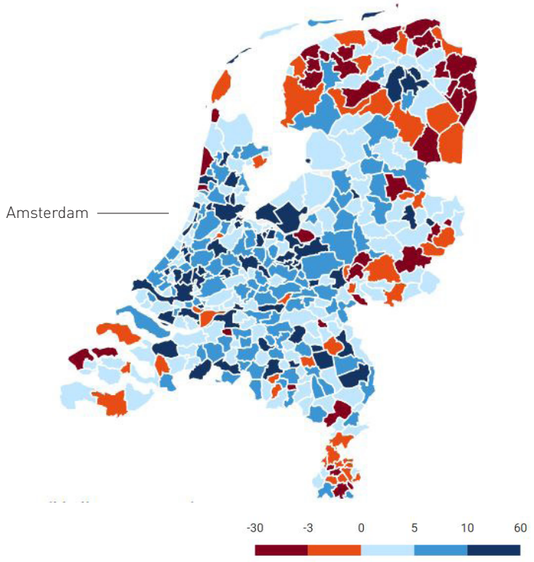
Source: Made by author

Data source: Provincie Flevoland

**4.2 Metropolitan challenge**

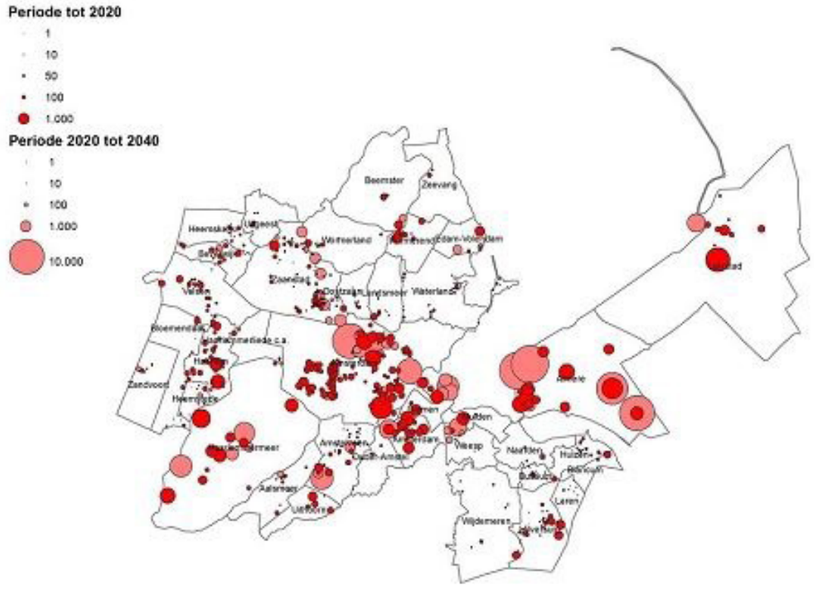
Within the territory of the Netherlands, the most well-known and attratctive city is no doubt the captial Amsterdam. The city itself together with the 31 municipalities around has formed an informal metropolitan grouping, which today accommodates more than 2 millions of inhabitants. (CBS, 2016) Today, the fast growing Amsterdam metropolitan area (*Dutch: Metropoolregio Amsterdam, MRA*) has dropped pressure on the territory of Flevopolders. Since 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/km$^2$, Almere 1,528 inh/km$^2$)(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. 14) Almere itself is planning to build 60,000 housing in both existing urban area and the planned urban expension, which would possibly pressure the surrounding landscape by occupying more space, building more infrastructure and gaining more need for recreation areas. For Flevopolders, 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 competitivemess 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. 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.




**13 Municipality population development in every 1000 people**

Source: CBS, 2016

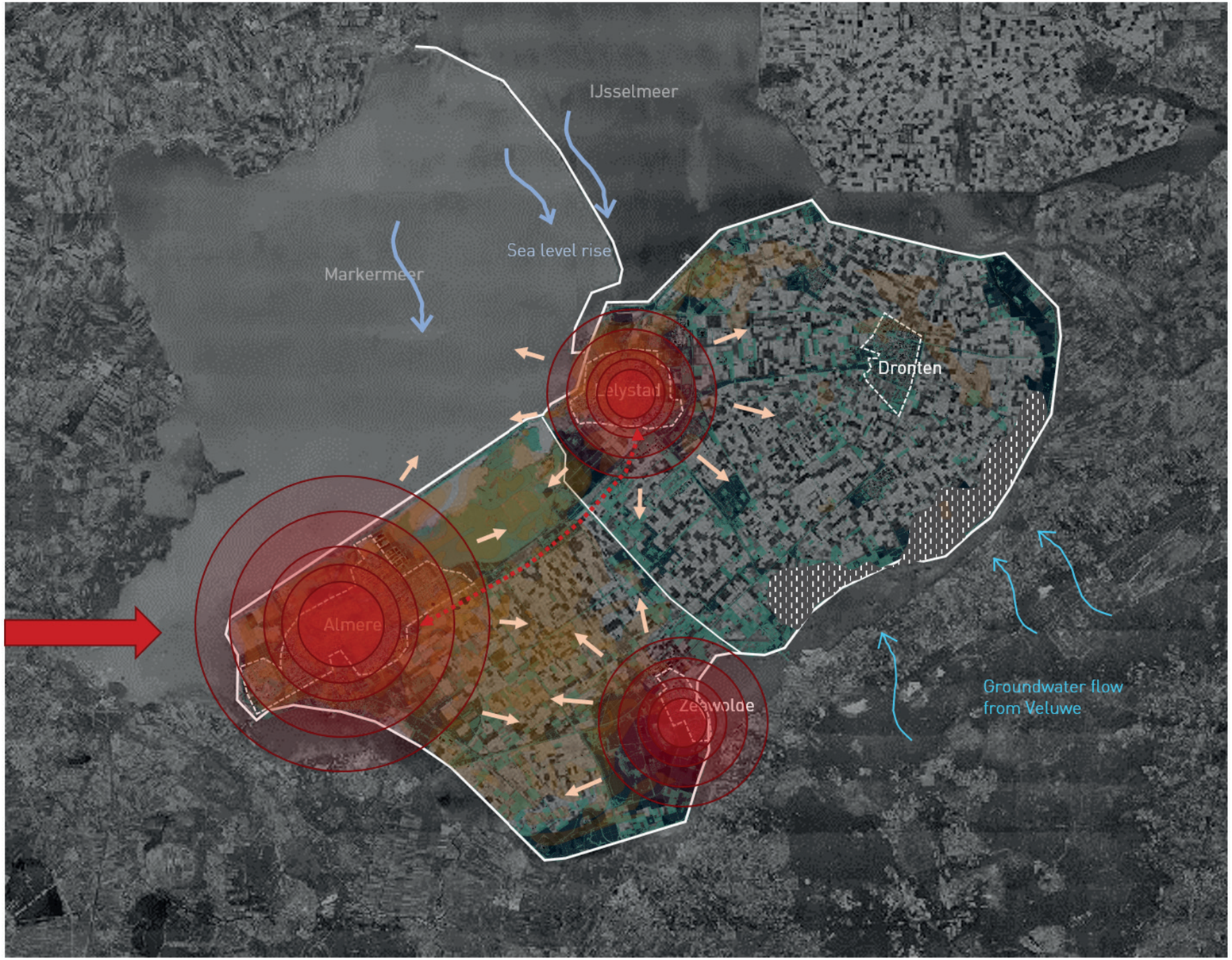



**14 Housing plan in MRA until 2040**

Source: Metropoolregio Amsterdam

**15 Conclusion diagram of main problems**

Souce: Made by author



## 5 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".



## 6 Research questions and methods

### 6.1 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.

### 6.2 Sub questions:

*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?*

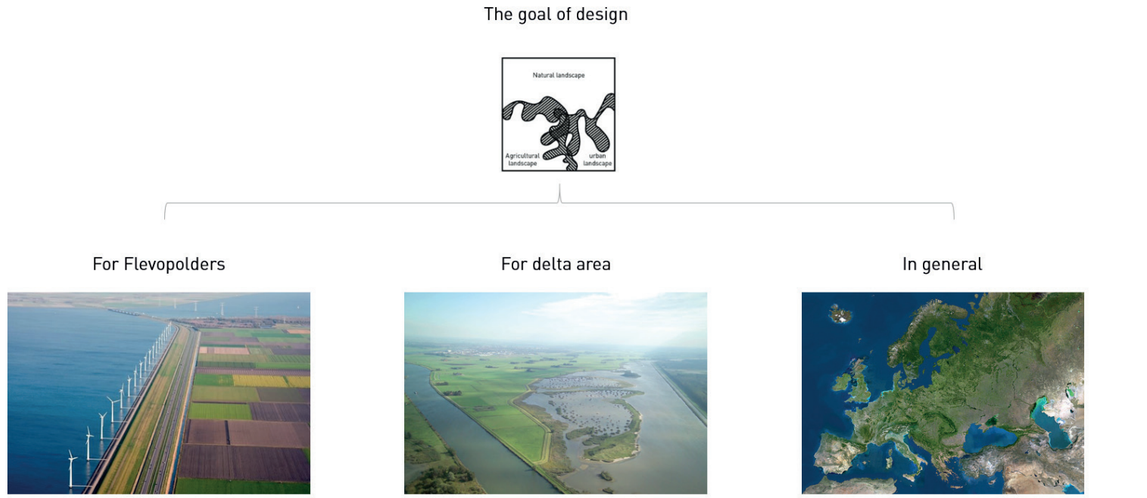
Method: Case study
Case studies could provide an insight of successful implementation in the reality, hence could play the role of offering reference, being showcase, or help with the enhancement of feasibility in the design process.

*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.

## 7 The goal of design

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.




**16 The goal of design in 3 scales**

Souce: Made by author



## 8 Theoretical framework

### 8.1 Landscape in urbanism

**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.

### 8.2 Design with nature

**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.

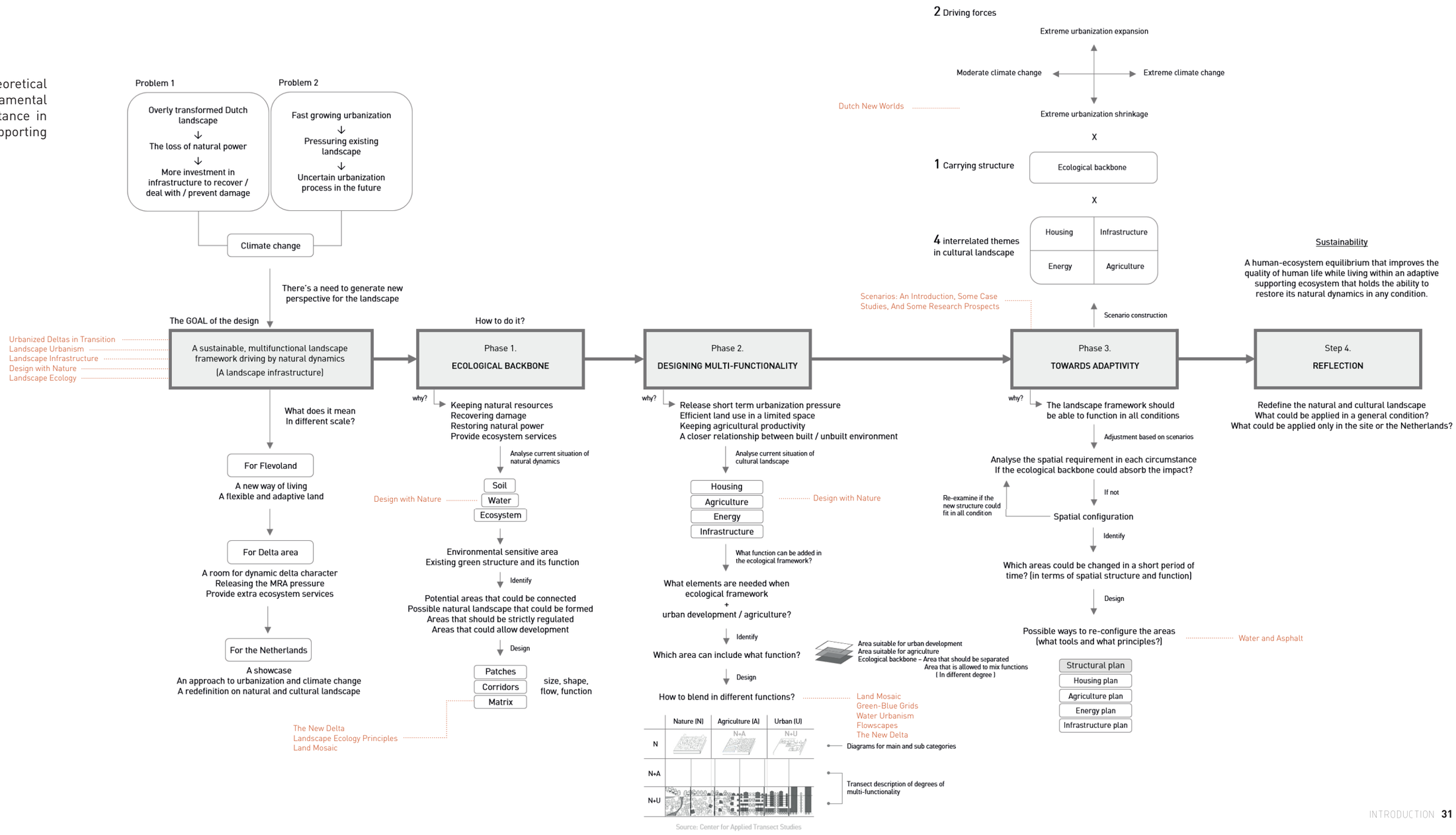
**Landscape ecology**

*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.

## 8.3 Design structure

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.



## 8.4 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.

| Theory \ Theme | Fundamental concept | Analysis | Design principle | Reflection |
|---|---|---|---|---|
| Design with nature<br>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<br>Salewski, 2010 | | Provides scenario construction on Flevoland during the reclamation of the polder. | | |
| Flowscapes<br>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<br>Pötz, 2016 | | | Provides tools to integrate natural processes into urban areas | Depending on the theme, tools could vary in terms of scales |
| Landscape urbanism<br>Waldheim, 2006 | Design landscape continuity could enhance both natural and cultural performance. | | | |
| Landscape infrastructure<br>Belanger, 2013<br>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<br>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<br>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<br>de Vlieger, 2017 | | | Provides project examples in Dutch delta area that focus on natural processes and multi-functionality | |
| Urbanized deltas in transition<br>Meyer & Nijhuis, 2014 | The vulnerable deltas require a perspective to design towards sustainability. | Indicate important themes for analysing delta dynamics. | | |
| Water and asphalt<br>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. |

# 9 Scientific and societal relevance

## 9.1 Scientific 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.

## 9.2 Societal 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.18), 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.

## 9.3 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.


**18 News relate to the plan of Oostvaardersplassen**

Source: https://www.omroepflevoland.nl

**19 Agricultural landscape in Flevopolders**

Source: Alchetron.com

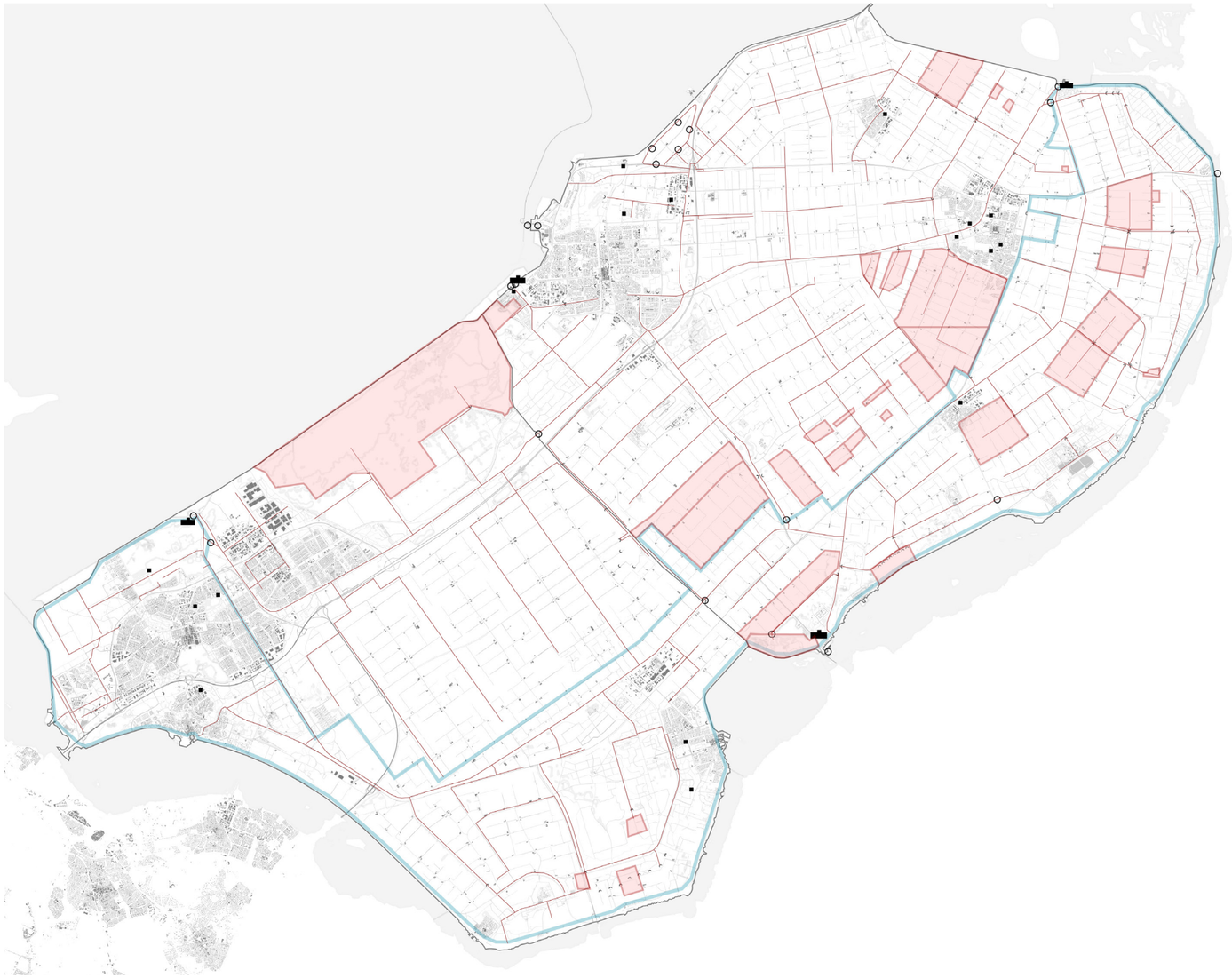
In this section, main resources that provide the foundation of landscape infrastructure are introduced, including water, soil and existing green spaces.

## 10.1 Water

In the delta areas, water has always been a double-sided sword for human being. On one hand it enables the diversity of species and habitats that could offer abundant resources, on the other hand the flooding in winter brings damage to the cultural landscape. Nevertheless, under the guidance of the "design with nature" concept, the negative influence of water is reconsidered as an advantage to regain nature dynamics, which could be further leveraged as a resource.

In Flevopolders, the water system is managed by several main infrastructures. Firstly, dykes not only separates the land from water, but also separates the two polders into individual water drainage units. Secondly, Each units has its own topography, but with the similar inclination from southern east part towards the Markermeer and IJsselmeer, which influences the water flow foundamentally. Thirdly, ditches were dug to guide the water to flow towards pumping station along the edge of polders. In between locks and weirs facilitate the direction and volumn of water flow. (Fig. 20) Finally the water is pumped out into the lakes outside the dykes.

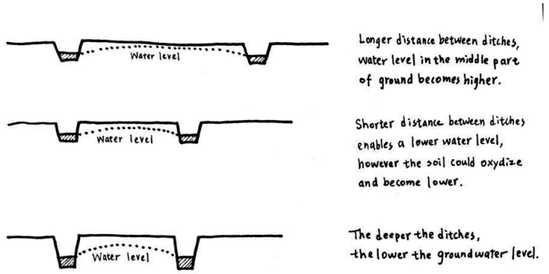
In order to ensure the various functions assigned to the land, such as housing and crop cultivation, could work properly, water level was mainatained in different height according to the local condition of the land (desired water level / *Dutch: gewenst peil* ). However, since the intense groundwater extraction has lowered the ground level itself, especially in agricultural land, water level became relatively high, and therefore more drainage was required to lower the water level again. As a conclusion, a new water management should be proposed to stop the vicious cycle.




**20 Water management in Flevopolders**

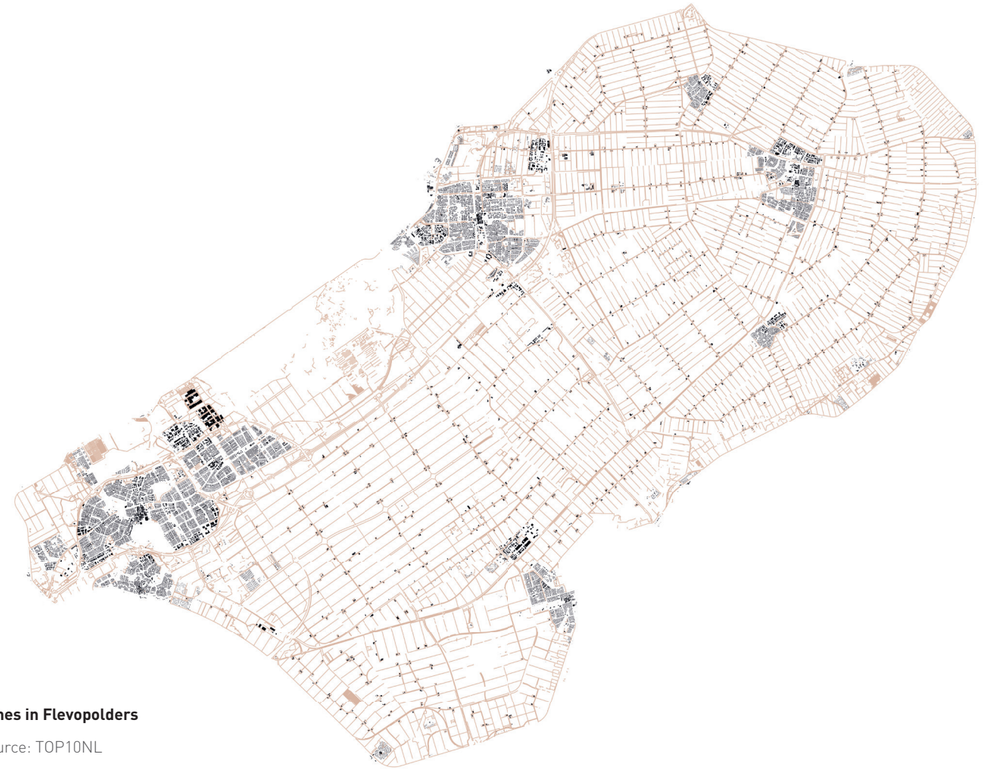
Data source: Waterstraatkaart

Within the main structure of water drainage, the land was covered by even more sophisticated water systems. (Fig. 21) Small ditches were placed in the field with measured depth and distance to maintain the water level in the parcel. (Fig. 22) Therefore, ditches could become a tool to make a parcel of land wetter or dryer depending on the purpose. A wetter ground limits the fundtion and types of crops that could be developed on the land, while a dryer ground has to take precautions for the possible subsidence due to oxydization.




**22 Principles of placing ditches**

Source: Made by author

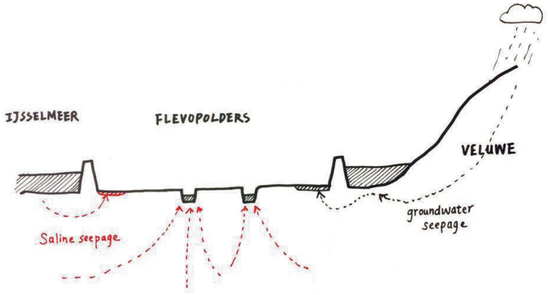


**21 Ditches in Flevopolders**

Data source: TOP10NL

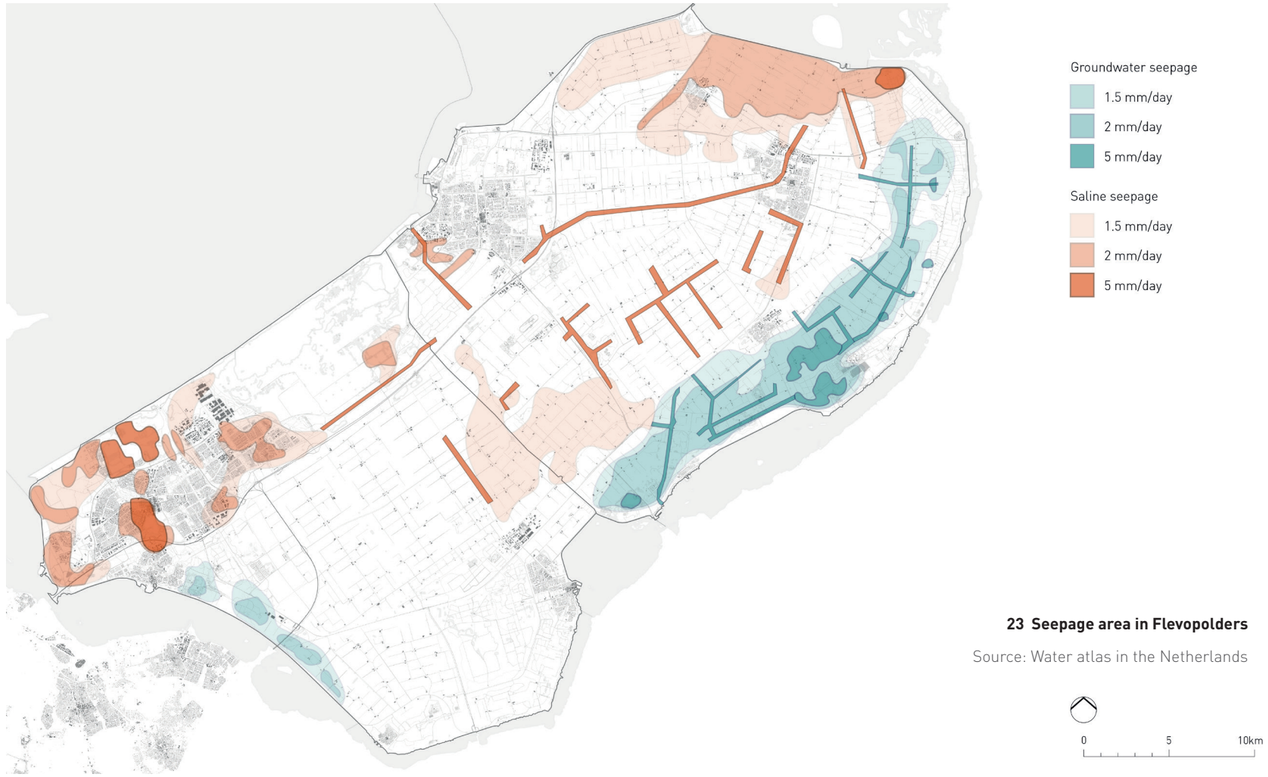


Seepage, on the other hand, has been considered as another troublesome issue in Flevopolders. Two types of seepage could be discovered here, (Fig. 22 & 23) one came from the salt water underneath the polders, which is often drew by the ditches and made the surface water brackish. (TNO, 2008) Therefore freshwater flush has been used as a strategy to deal with the problem. The other type of seepage came from the higher ground in Veluwe forest, the rain water infiltrated into the ground, after hundereds of years of gravity influence, finally reached the other side of the dyke, into Flevopolders. The groundwater seepage contains special nutrient poor quality, which is unique for developing certain types of natural landscape. (Noordhoff, 2012)




**22 Principles of placing ditches**

Source: Made by author




**23 Seepage area in Flevopolders**

Source: Water atlas in the Netherlands

## 10.2 Soil

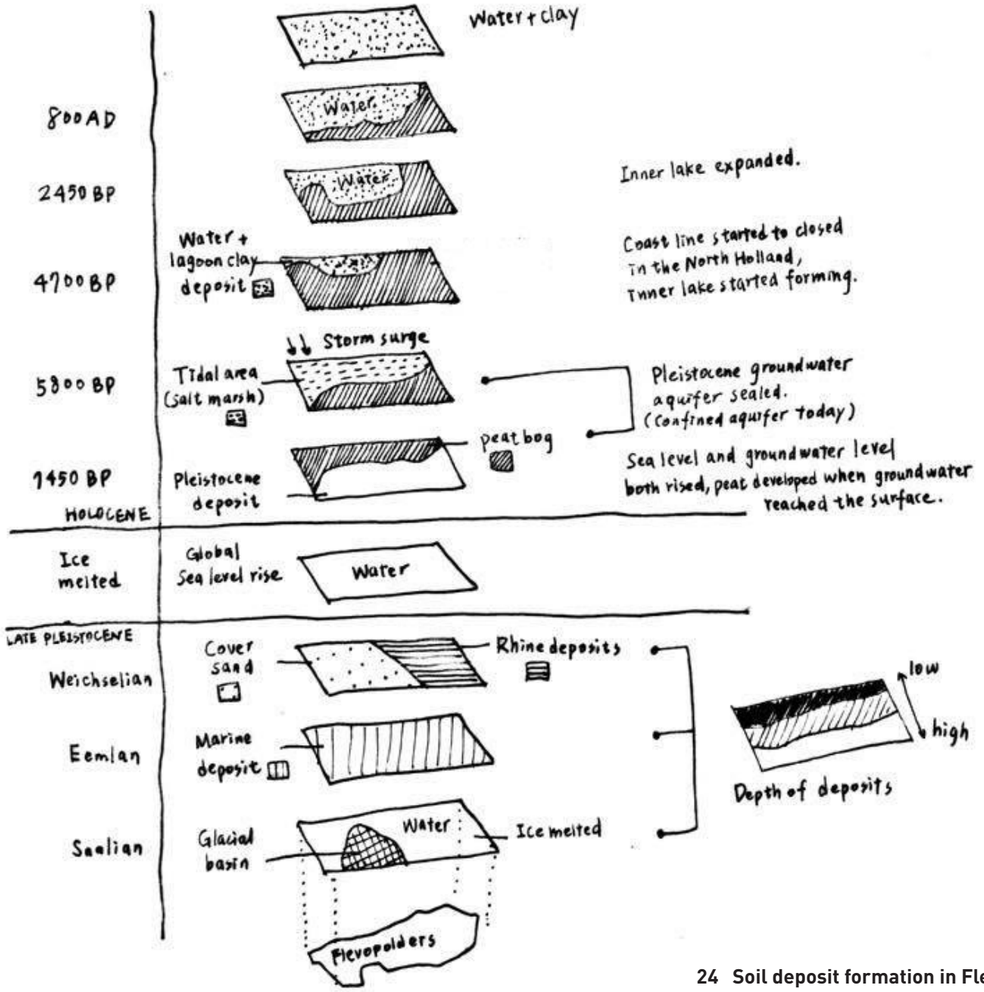
Soil formation in the Flevopolders had been though a long and complicated development throughout history. (Fig. 24) Influenced by the big environment in IJsselmeer, (Originally as Zuiderzee) salt water, freshwater and various deposits have interwoven together and layered the soil today. The surface nowadays is covered by sea clay, while the edge around the polders contains a variety of soils. (Fig. 23) Based on the soil type, the function that could be applied on top and the vegetation spieces that could grow differ foundamentally.

In areas with sandy soil, since agriculture could not benefit from the strong infiltration, woodlands were developed instead; while in the sea clay soil area, agriculture and urban function flourish. Even so, knowing the characteristics of soil enables minor adjustment to be proposed to break through some limitations of functions. For instance, in sea clay areas that are not suitable for trees to grow, elevation was applied to provide trees enough air in the root zone.


**23 Soil type**

Source: Made by author

Data source: Provincie Flevoland




**24 Soil deposit formation in Flevopolders**

Source: Made by author

Data source: Sediment characteristics and late Holocene evolution of the IJsseldelta

## 10.3 Existing green structure

As described in the previous section, woodlands were planted in areas not suitable for agriculture, which forms the basic ecosystem structure in the Flevopolders. 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) Located on the opposite direction of Oostvaardersplassen is the largest deciduous forest in Europe, Horsterwold. These two big nature reserve assured the unique ecological status of Flevopolders, along with several proposals to connect the two for deer migration.

Other woodland patches could be found on the edge of polders or near the cities, all these green spaces serve not only as ecological habitats but also important recreational areas. (Fig. 25 & 26) A tendency of fragmentation could be observed from the patterns of green patches. Even though the amount of green spaces seems large, the connection in between is often only formed by open green corridor, which does not provide as efficient ecological purpose as a closed green corridor. (Forman, 1996) Or, the possible linkage is interupted by recreational spaces such as theme parks and golf courses. Nevertheless, if a landscape infrastructure would be proposed, the existing green spaces provided potential areas for creating spatial connections.


**25 Existing Green structure**
Source: Made by author
Data source: Provincie Flevoland

## Wetland

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




Swamp ragwort

Cane

Marsh cudweed

Marshelder

## Deciduous forest

Regulate water
Regulate temparature
Habitat for mammals
Recreation
Wood cultivation




Beech

poplar

Fern

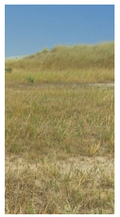
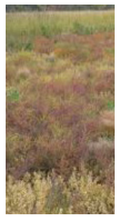
Moss

## Natural grassland

Regulate water
Habitat for birds
Soil purification



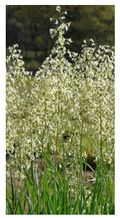




Pioneer plants

## 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

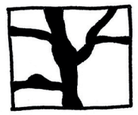
Windshield
Habitat for bird and
small mammal


**26 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.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

# 11 Design phase I: Ecological backbone



The first phase of constructing the landscape infrastructure is to form a robust ecological backbone that based on the soil type, water condition and existing green structure. By managing water level in different location, the ground condition could be prepared for developing various types of landscape, which could further contribute to different ecological benifit. Overall, the ecological backbone serves the purpose of regaining nature dynamics.

The backbone consists of two parts, the main structure which should remain relatively segragated to the cultural landscape, with spatial transitions on the edges to ensure the quality of core natural habitat; while the secondary structure is interwoven with the cultural landscape, supporting and guiding the spatial transformation within.

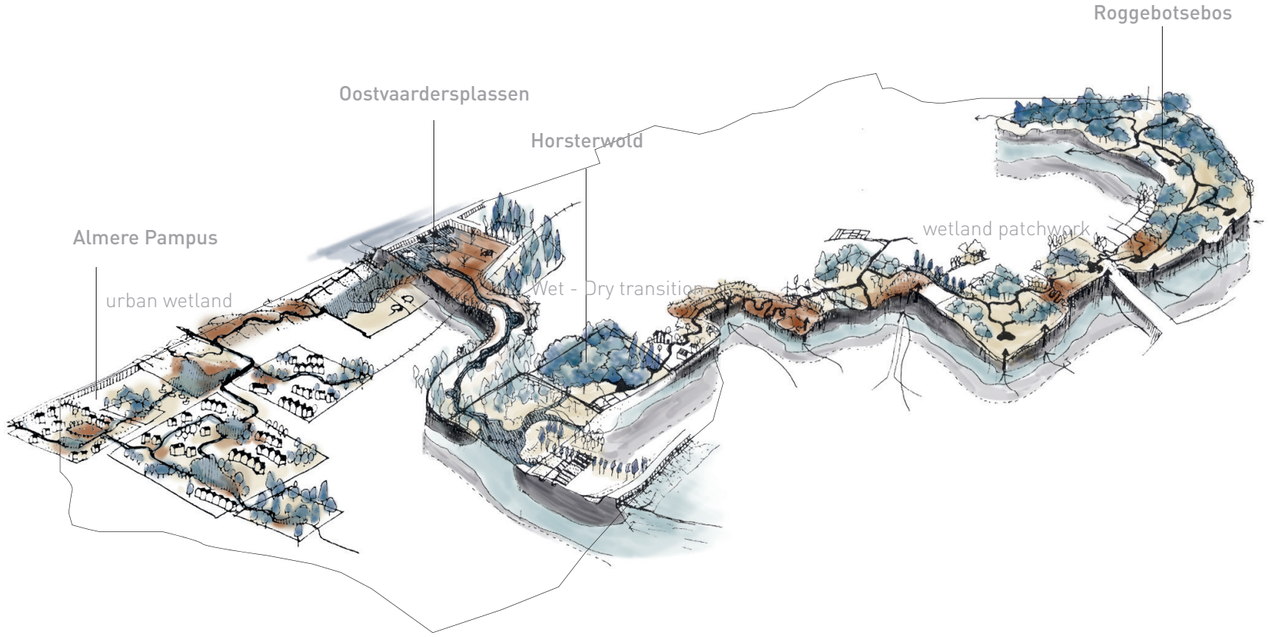
## 11.1 Main structure

Three connections were proposed to form the main structure of ecological backbone:

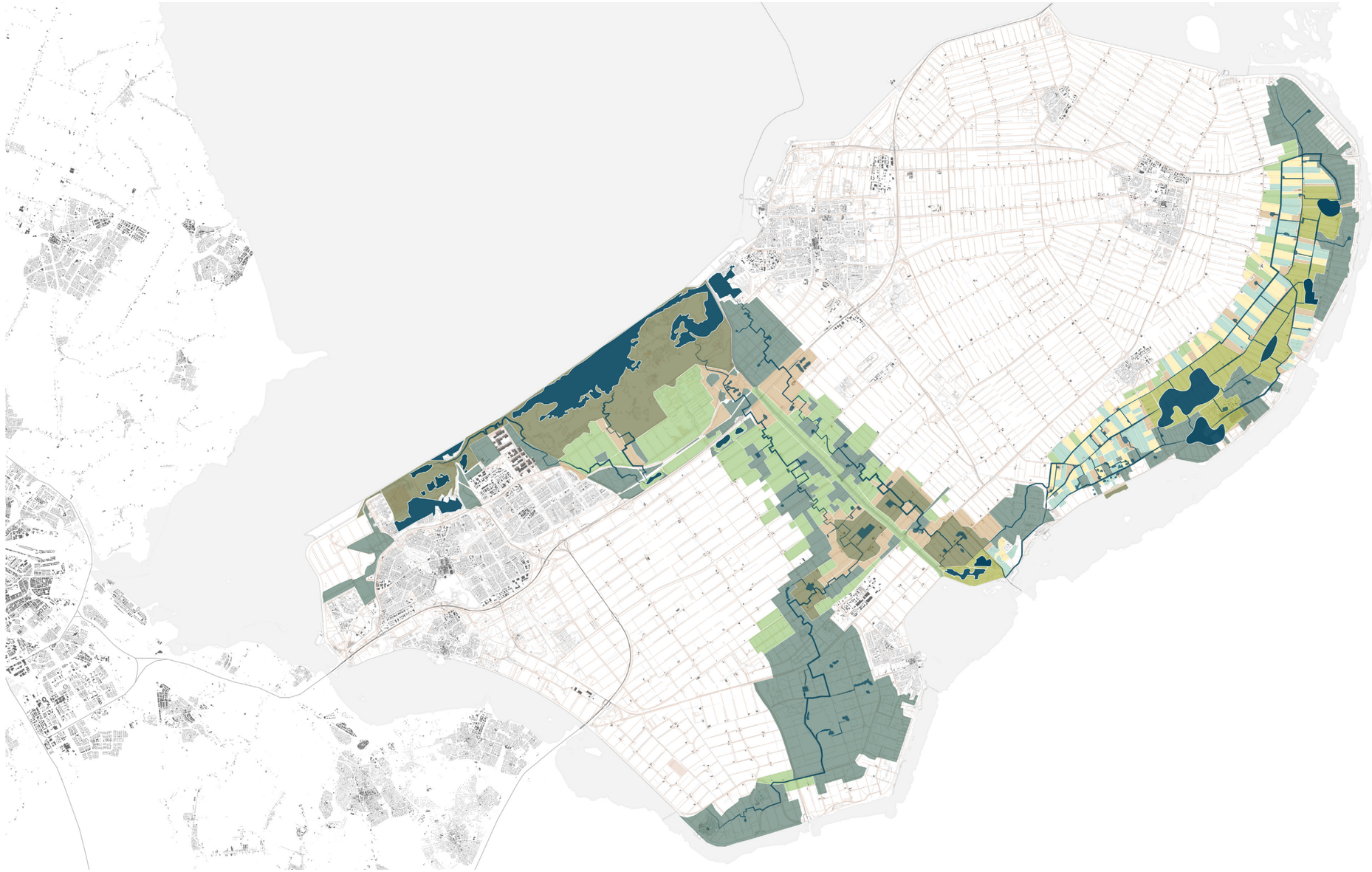
1. From Oostvaardersplassen to Horsterwold
A transition from wetland to forest is formed passing through the existing woodland patches in the middle, the connection provide a migration route for red deer living in the nature reserves.

2. From Horsterwold to Roggebotsebos
Along the southern east edge of Flevopolders, a large area of ecological patchwork is established. Taking the advantage of the unique quality of freshwater seepage, the patchwork consists of several large area of fenland, which has the potential to recover the peat landscape in the future. In between and around the fenlands is the mosaic of wet grassland, flowery meadow, reed land, forests and ordinary grassland, which could possibly regain some rare vegetation species.

3. From Oostvaardersplassen to Almere Pampus
The wetland is extended into the west corner of Flevopolders. Since Almere Pampus is surrounded by forest and wetlands, and owns the strategic location to develop connection towards Almere center in the south and IJburg in the west, the extended ecological connection could be expected as the guiding structure for future development.




**27 Concept of main ecological structure**
Source: Made by author




**28 Landscape design of main ecological structure**

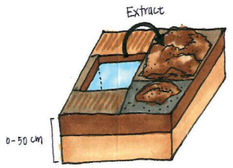
Source: Made by author

**29 Water structure**

Source: Made by author

Existing ditches are used to form meandering open streams on both sides of Knardijk, with small open water parcels along.

Freshwater seepage zone

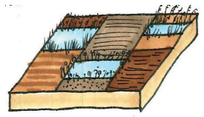



Topsoil and subsoil are extracted to remove the nutrient in the soil in seepage zone. Places with strong seepage could form freshwater seepage reservoirs.

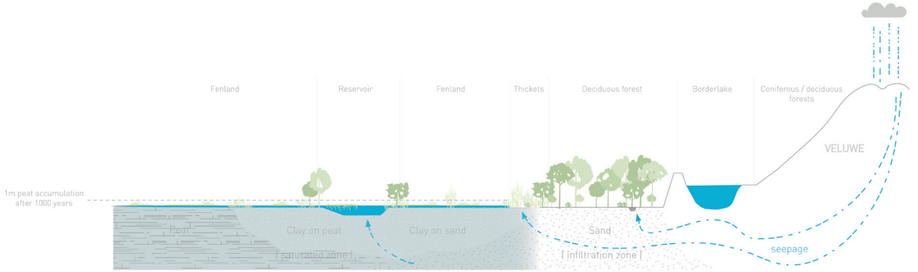
**30 Large wetland patches**

Source: Made by author

Marsh
Fenland
Reeds



Water level in the designated wetland patches is raised to rewet the plot.




**31 Fenland area section**

Source: Made by author

**32 grassland patches**

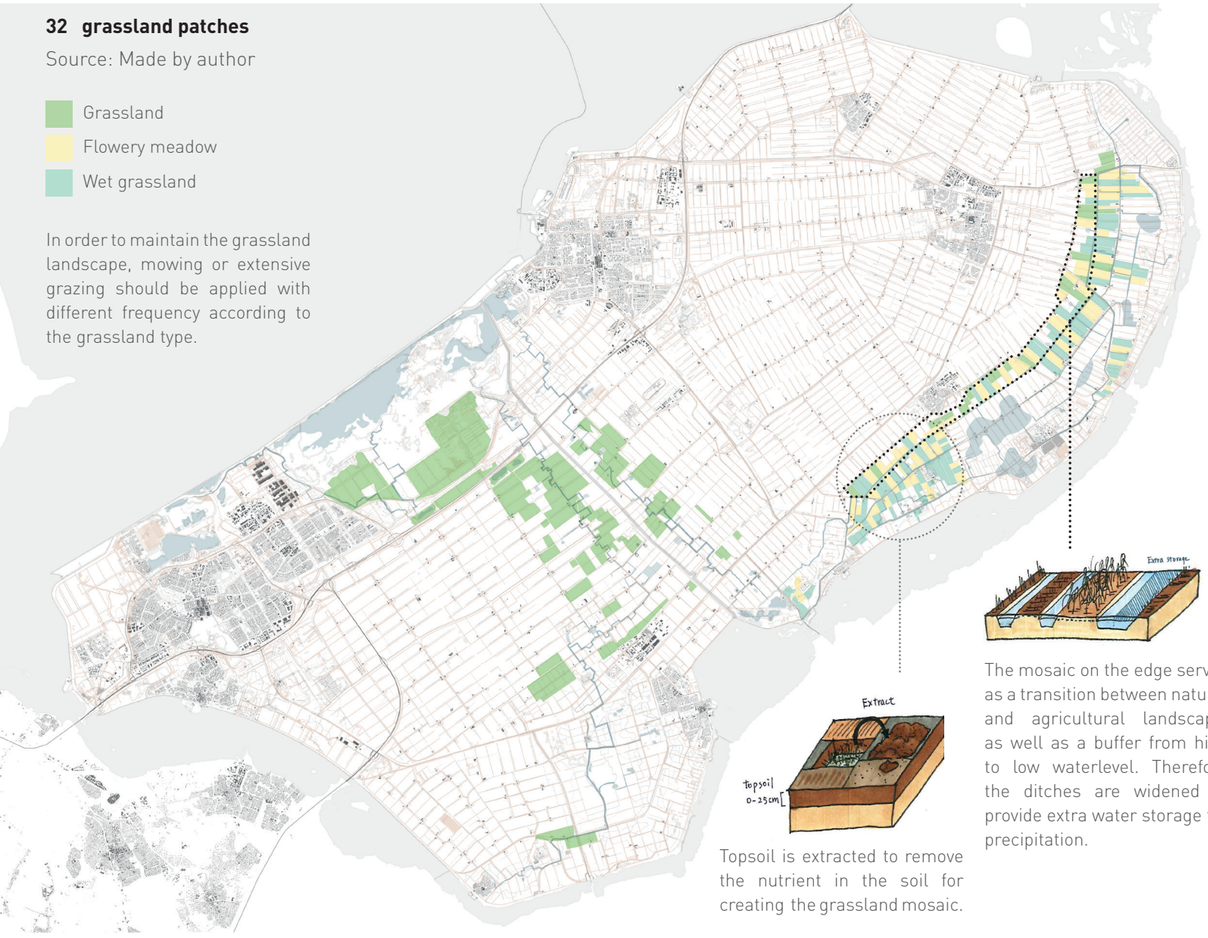
Source: Made by author

Grassland

Flowery meadow

Wet grassland

In order to maintain the grassland landscape, mowing or extensive grazing should be applied with different frequency according to the grassland type.





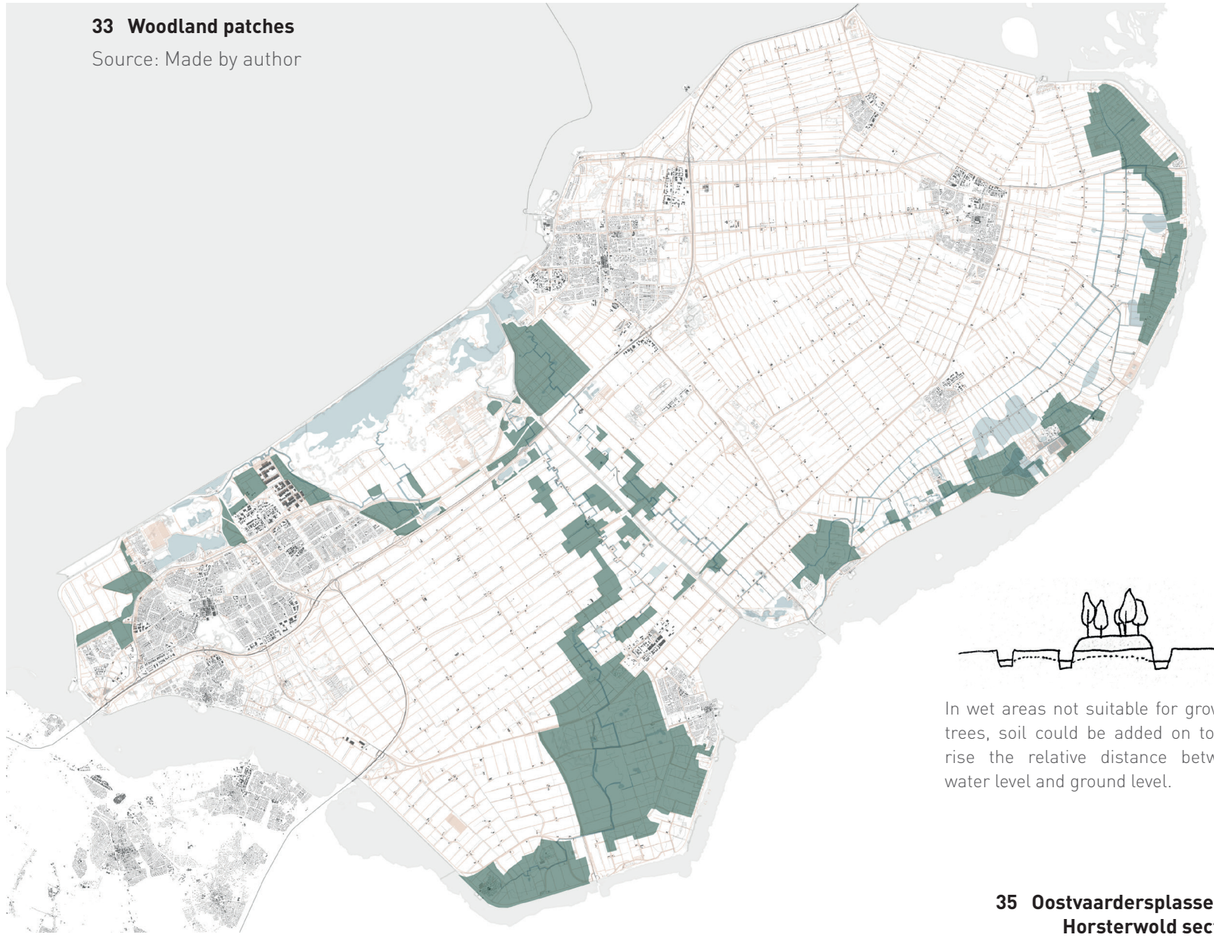

Topsoil is extracted to remove the nutrient in the soil for creating the grassland mosaic.




The mosaic on the edge serves as a transition between natural and agricultural landscape, as well as a buffer from high to low waterlevel. Therefore the ditches are widened to provide extra water storage for precipitation.

**33 Woodland patches**

Source: Made by author





In wet areas not suitable for growing trees, soil could be added on top to rise the relative distance between water level and ground level.

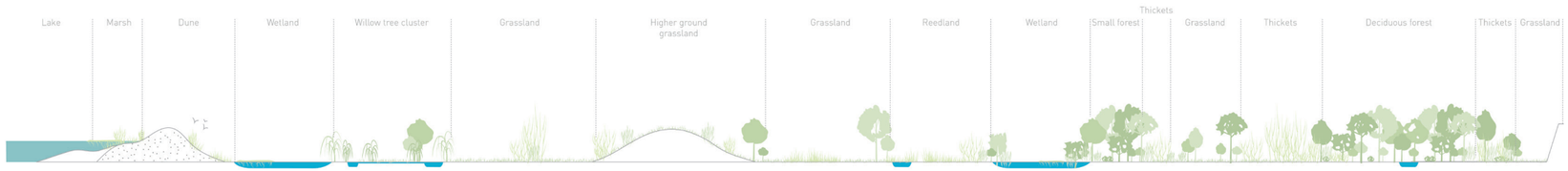
Wet grassland (*nat schraalgrasland* ) has been considered as a rare landscape in the Netherlands with certain speices that is called as "blue grass". The seepage from Veluwe provides adequate water quality for developing this landscape.

**34 Image of wet grassland**

Source: www.vallei-veluwe.nl

**35 Oostvaardersplassen to Horsterwold section**

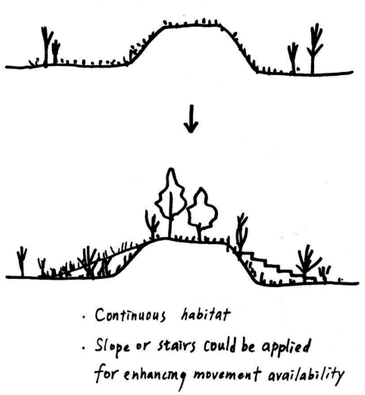
Source: Made by author



## 11.2 Secondary structure

Branching from the main ecological structure are the green corridors and smaller patches that supports the ecological flows (Fig. 36) and foundamental ecosystem services in the cultural landscape, such as wind-breaking, air and water purification, recreational activities, etc. The structure is also used as a guidance for future urban development.

Even though the water courses are separated by the Knardijk in the middle, the ecological function could continue across the dyke through the corridors. (Fig. 37)




**37 Dyke as habitat**

Source: Made by author


**36 Secondary ecological structure**

Source: Made by author

# 12 Design phase II: Multifunctionality

The ecological backbone provides the basic structure to follow for future cultural development. In the limited space of Flevopolders, multifunctional landuse is necessary to enhance the efficiency and variety of living environment.

The territory is divided into several main sections depending on the location, relationship with the ecological structure and future function, each section has its own spatial characteristics.

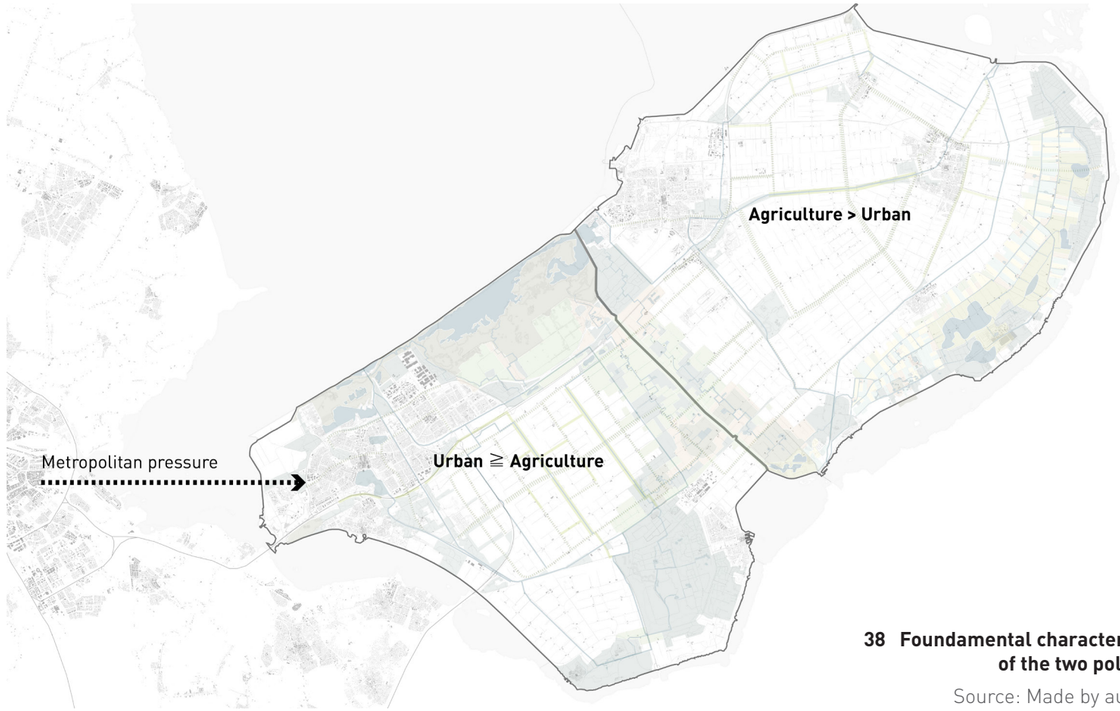
## 12.1 Schemes

This section explains several basic concepts for developing multifunctionality based on ecological backbone in the Flevopolders.

The underlying concept is the division of the two polders. Spatially they are already divided by the Knardijk. However considering the formation of ecological backbone and the metropolitan pressure coming from the west, two polders are assigned with different roles.

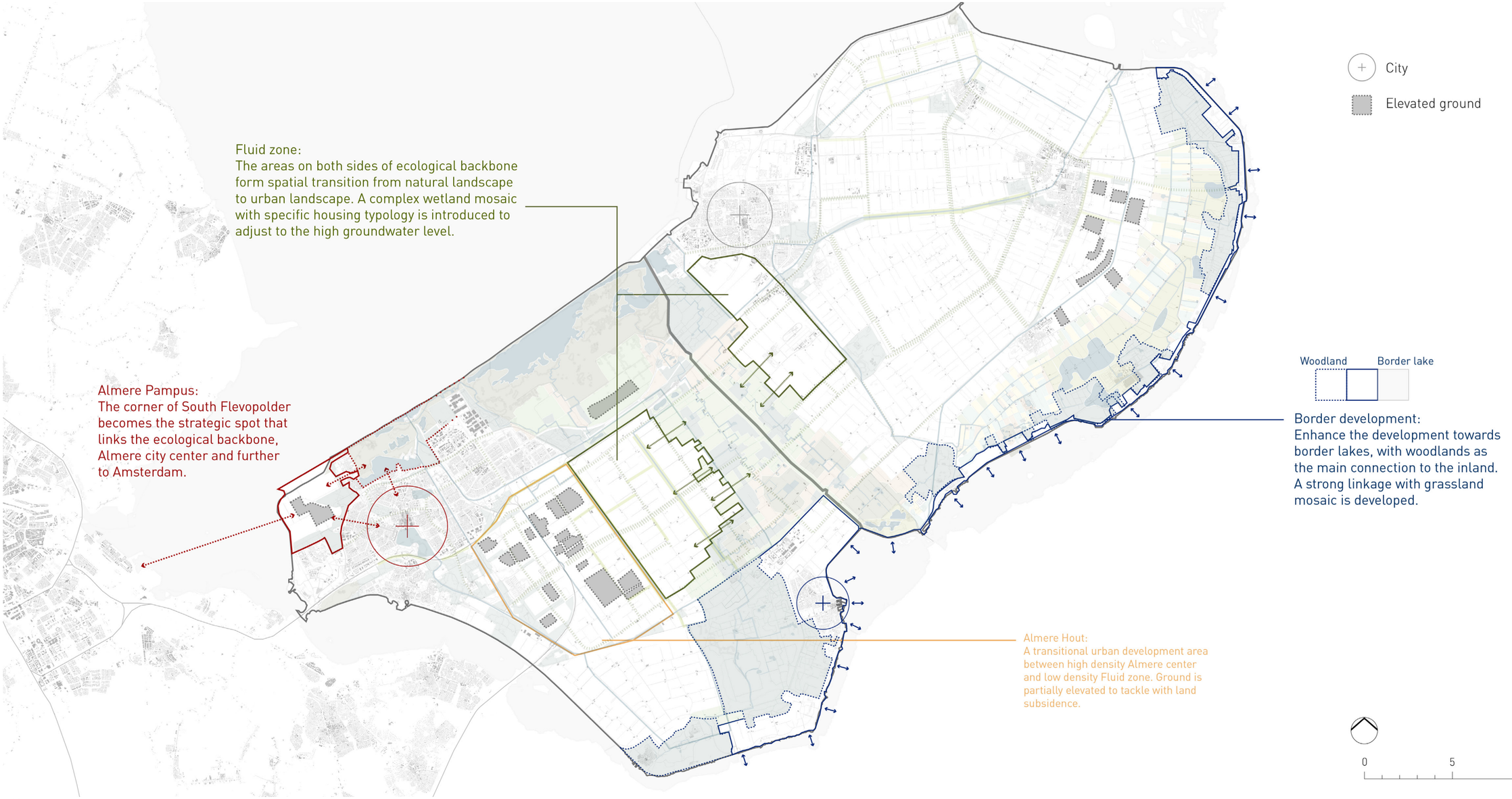
South Flevopolder: The population growth in Amsterdam Metropolitan Area has been pressuring the spaces around Almere. To accommodate the urgent development, the polder is allowed for a relatively intense urbanization comparing to the East Flevopolder. Nevertheless, the original agriculture feature should still remain and be integrated into the new urbanization with the ecological structure.

East Flevopolder: Since the urbanization would be concentrated in the South Flevopolder, the space would be remained for mainly agircultural and natural landscape. The polder could be also considered as a reserved urbanization area in case of extreme need for urban development in the future.




**38 Foundamental characteristic of the two polders**

Source: Made by author




**39 Development scheme**

Source: Made by author

**40 Sections representing the elevated ground and wet area**

Source: Made by author

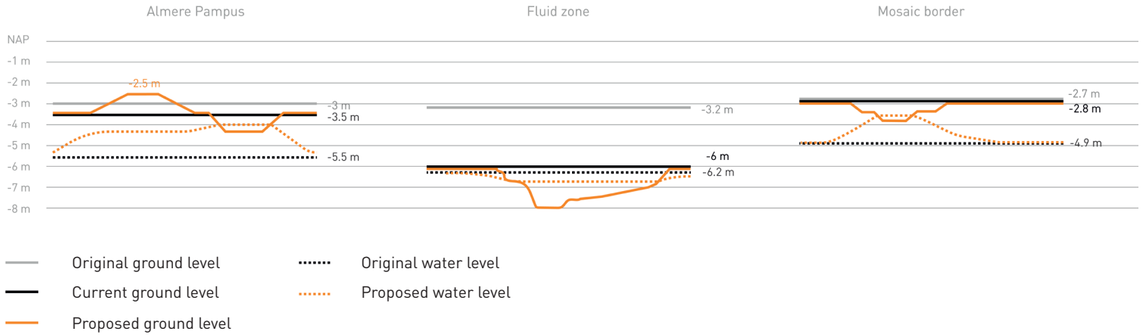
As described in the strategy to construct ecological border, part of soil would be removed from creating mosaic grassland habitat in the east Flevopolder. The soil would be transported and reused for ground elevation in several areas. (Represented in black) On the other hand, some part of the territory would be applied with ground-rewetting operation to create more water storage. (Represent in blue)

0 5 10km

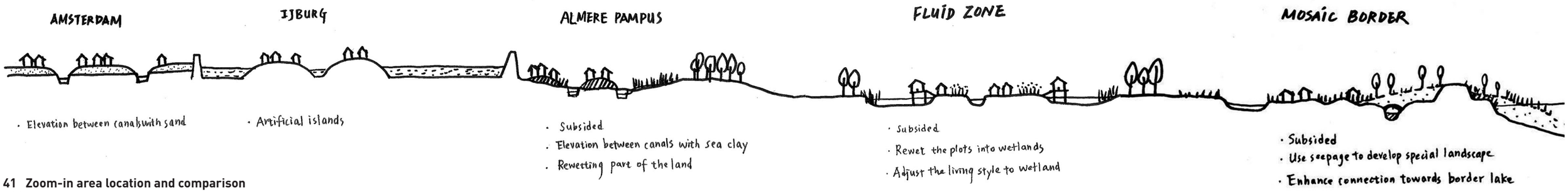
## 12.2 Zoom-in areas

Three areas were selected for detail zoom-in design, including Almere Pampus, a part of Fluid zone, and a small section of the border development. In figure 40 the main design principle between these zoom-in areas are compared along with Amsterdam and IJburg.

The foundamental way of treating the ground and water level has significant influence on the future development of the land. Both Amsterdam and IJburg were designed with an elevation of ground level that allows a more stable urbanization comparing to the Flevopolders, which are suffering from more and more serious of land subsidence due to intensive pumping. In these potential or already subsided areas such as Almere Pampus and Fluid zone, ground elevation or ground rewetting is proposed to either provide a safer living environment or to create extra water storage with natural landscape development. While in area that is relatively safe, like the border in east Flevopolder, certain spots could also be developed with higher water level and higher biodiversity.








**41 Zoom-in area location and comparison of foundamental design principle**

Source: Made by author

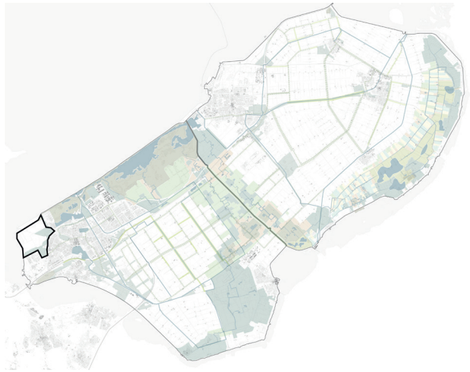
Data source: Waterstraatkaart / AHN

### 12.2.1 Almere Pampus

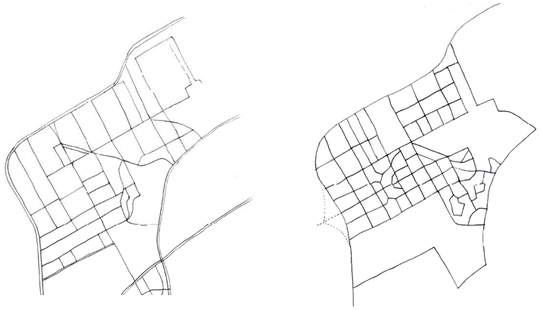
Almere Pampus is located in the northern west corner of the south Flevopolder. It is surrounded by lakes, Almere city center and forests, with a small connection to the wetland in the east.

Three main concepts were proposed for the development of this district:

1. The ground should be rearranged through replotting, redirecting ditches and elevating the ground partially.
2. The district is divided into several zones with different orientation.
3. The connection towards IJburg in the west is considered.

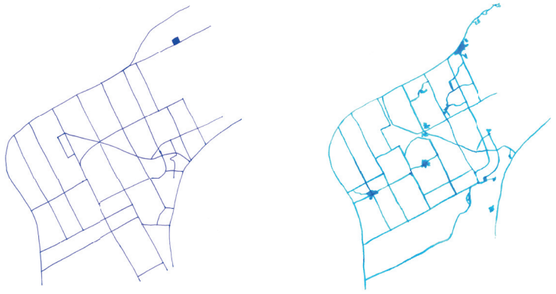


**42 Satellite image of Almere Pampus**
Source: Google map



Original plots

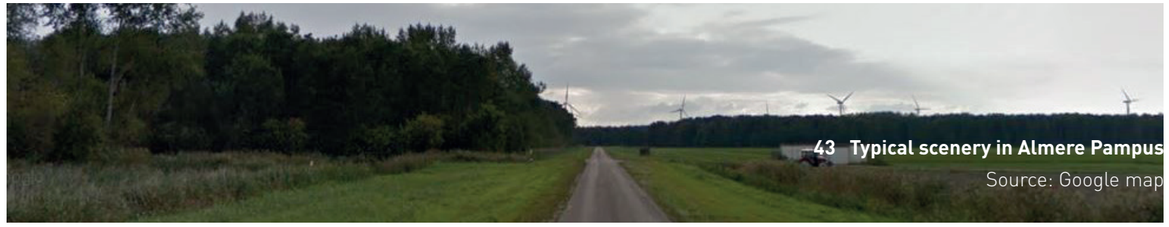
Replotted:
Smaller parcel for urban development



Original water system

New water system:
Integrate small wetlands

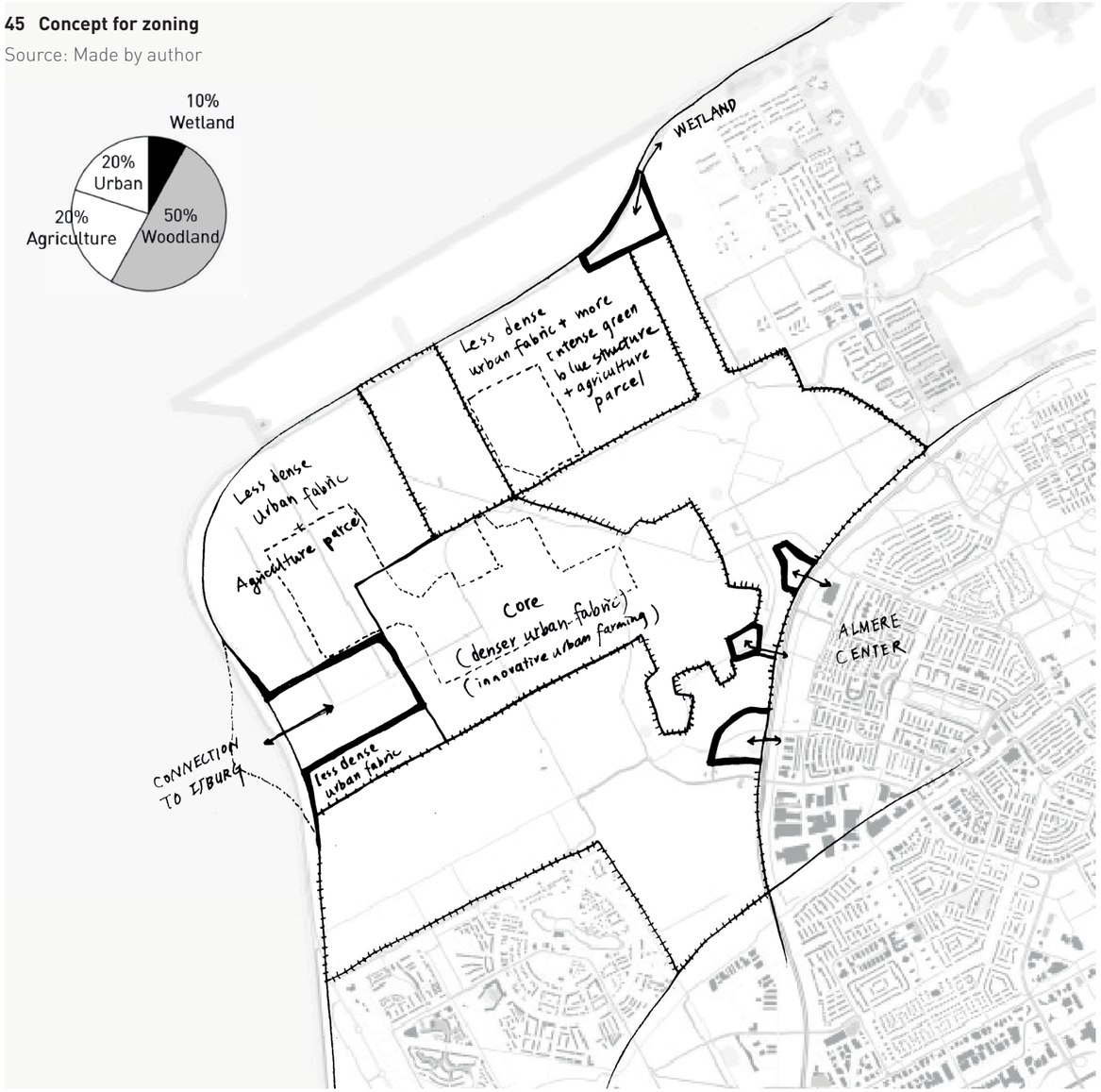
**44 Ground preparation**
Source: Made by author



**43 Typical scenery in Almere Pampus**
Source: Google map

**45 Concept for zoning**

Source: Made by author




**46 Conceptual drawing**

Source: Made by author

## 47 Implemented principles

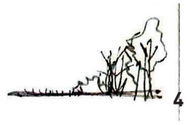
Spatial characteristics are designed in different zones according to the spatial features, function and surroundings. According to this, various principles are implemented.

**General principles:**

1. Housing should be developed mostly on elevated ground.
2. Rain water runoff should be collected by housing and community wetlands.
3. Organic agriculture should be promoted to decrease the usage of fertilizer.
4. Thick edges should be constructed along forest areas.

1; 2

3



4

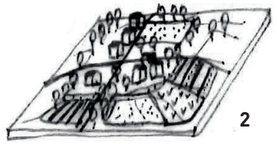
**Spatial openings:**

1. Wetland-based, low density development
2. Recreational / educational function should be included in the wetland area.

**Agro-based areas:**

1. Non-elevated area: allow bigger agricultural plots
2. Elevated area: develop slope agriculture

1



2

**Core:**

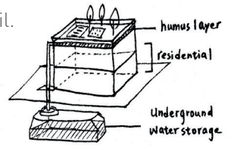
1. Non-elevated area:
   Allow taller buildings and denser road network.
   Concentrate around 70% of housing in the whole district.
   Green corridors should be formed along water courses.

2. Elevated area:
   Central wetland should be proposed to collect runoff.
   Slope could be used for agricultural function with trees to support the soil.

3. Urban agriculture could be experimented in this area.

1

2




3

**Woodland-based area:**

1. Non-elevated area:
   Emphasize the connection to adjacent woodland.
   Low density development.
   Enhace the linkage to Markermeer.

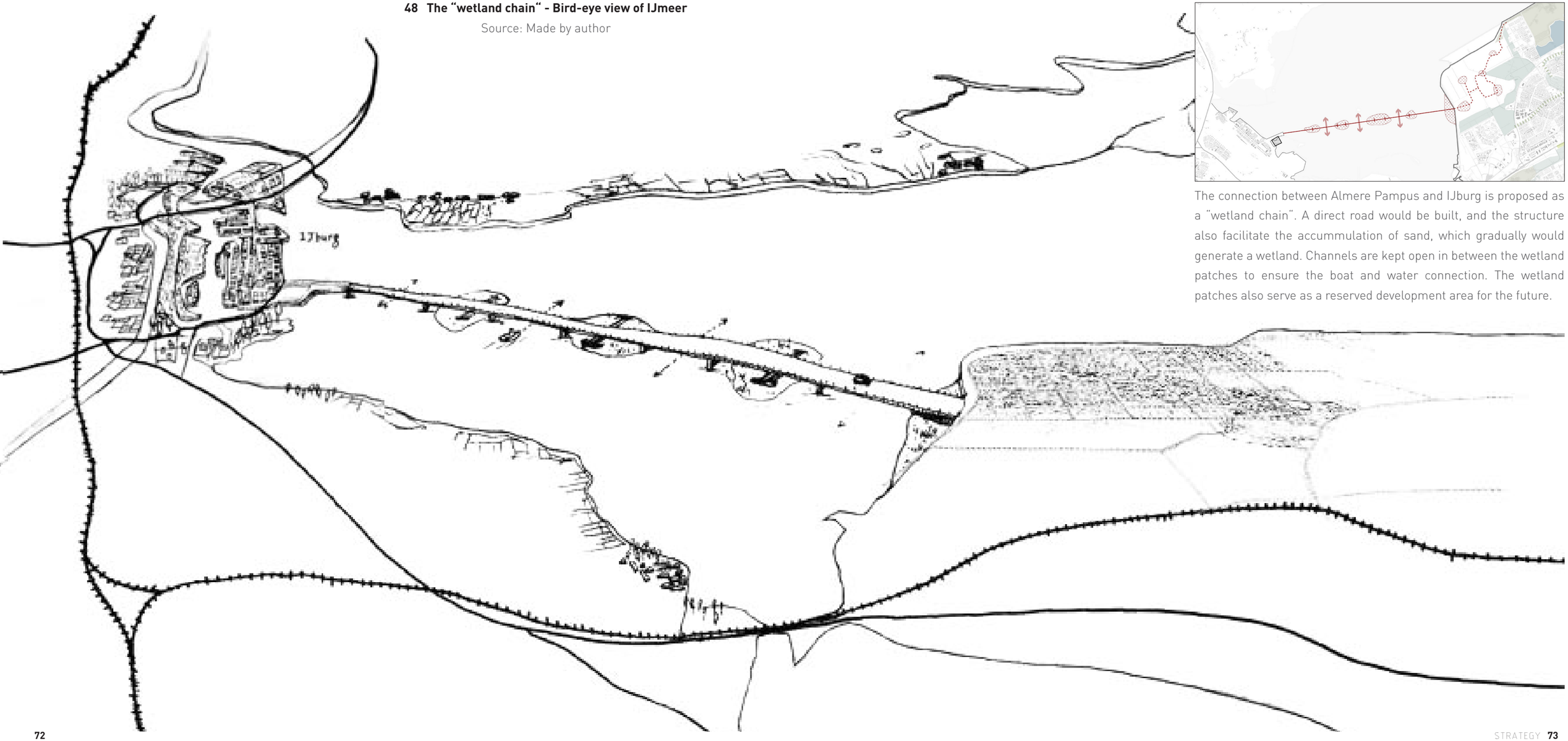
1

2. Elevated area:
   The shape of elevated ground could be used to form passage for small mammals.

2

**48 The “wetland chain“ - Bird-eye view of IJmeer**

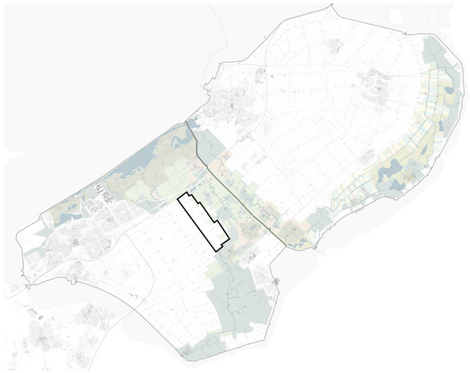
Source: Made by author






The connection between Almere Pampus and IJburg is proposed as a “wetland chain“. A direct road would be built, and the structure also facilitate the accummulation of sand, which gradually would generate a wetland. Channels are kept open in between the wetland patches to ensure the boat and water connection. The wetland patches also serve as a reserved development area for the future.

### 12.2.2 Fluid zone



The fluid zone serves as a transition space from ecological backbone to urbanized areas. The original landuse in the areas is mainly agriculture with low density farmhouses located on certain alignment.

To form a transition from natural landscape to agricultural landscape and urban landscape, the original spatial structures (plot, ditch, road, green corridor) and the border of proposed ecological backbone were used as guidelines for development. (Fig. 51)

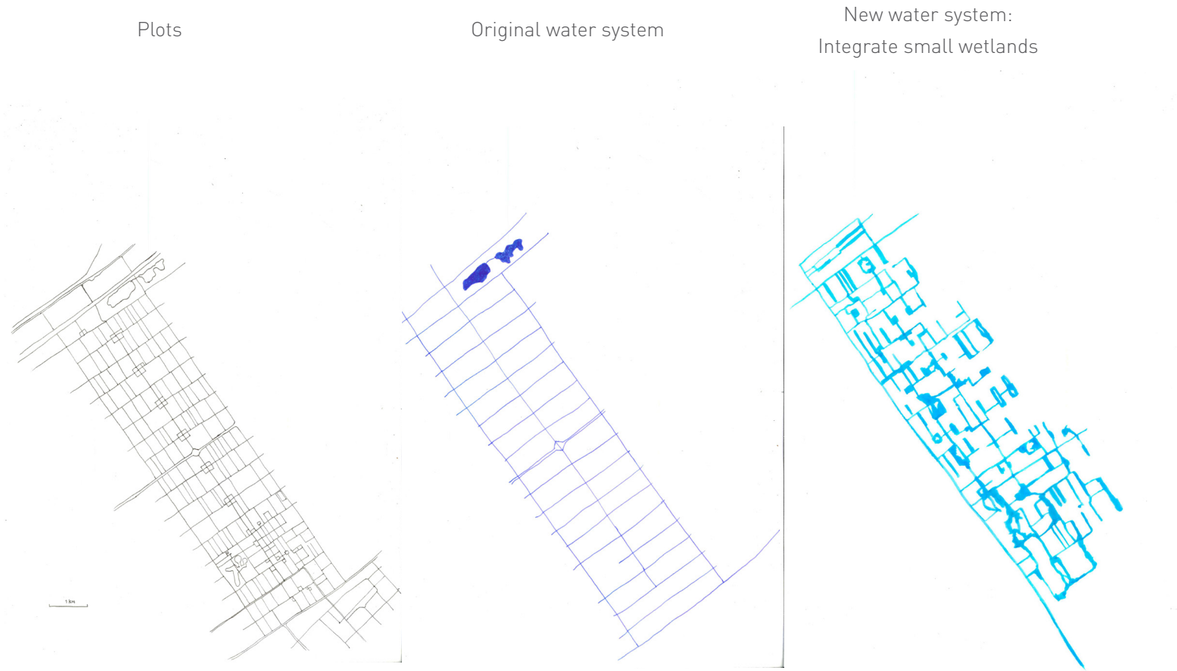
Four design cconcepts were introduced in the fluid zone:

1. A patchwork of wetland, urban and agriculture should be formed in a certain proportion. (25%, 25%, 50%)
2. Plots with farmhouses are assigned as the bases for urbanization.
3. New housing should locate according to the existing structure, either on the base or along the roads and green corridors.
4. An inter-locking model consists of floating houses and floating wetlands could be experimented in certain areas.

**49 Satellite image of Fluid zone**
Source: Google map

The ground preparation of fluid zone focuses on rewetting part of the plot and form an interconnected wetland system that could help with water storage. (Fig. 50) The existing ditches were partially reopened to the surface, linking small parcels of ponds that were formed by removing soil on top and drainage underground. The new overall structure could be seen as an irregular but quite evenly distributed water storage system, as a result the water level of the land within the zone is relatively high but with less risk of future land subsidence.

The high water level limited the chance to integrate ordinary urban function and agricultural function. Therefore specific housing typology and agriculture model that could adjust themselves to the situation should be proposed. The detail design in the next section showed some possibilities. (See page 78)




**50 Ground preparation**
Source: Made by author


**51 Design concept**

Source: Made by author

**52 Conceptual drawing**

Source: Made by author

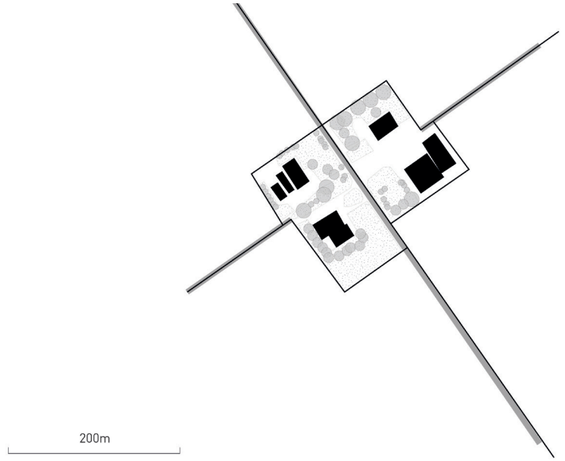
## Detail design: The urbanization base

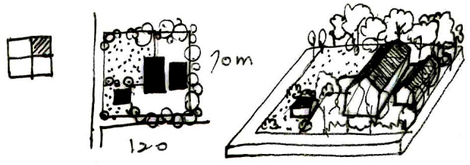
An aggregation of farmhouses that consists of four plots is a typical agricultural scenery in Flevopolders. (Fig. 53) A standard plot (around 70m x 100~120m) usually contains less than 3 large buildings for agro-production usage with the rest of space as grass land. (Fig. 54) However the same size of plot could approximately accommodate 30 typical single residential house plus open space. As a result, for the need of future development, the open spaces would be released for wetland to develop, the farmhouse would be either transformed or reconstructed into new type of housing. (Fig. 56)

The responsibility of developing wetland should be assumed by the community residents. In addition, individual housing rain water storage is also encouraged. (Fig. 57)

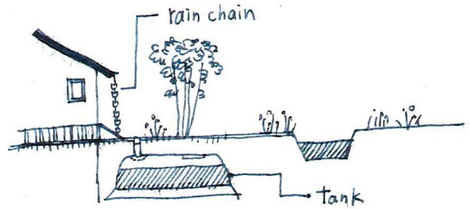
**53 Farmhouse aggregation**
Source: Google map

**55 Original plan of farmhouse aggregation**
Source: Made by author



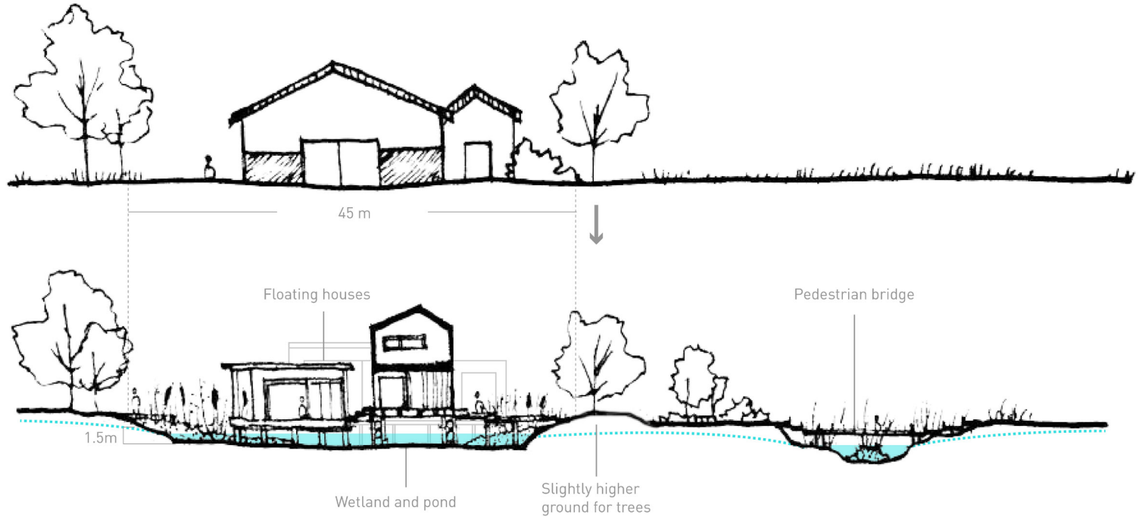




**54 Standard farmhous plot**
Source: Made by author




**57 Concept of individual rainwater storage**
Source: Made by author

**56 Detail Plan of urbanization base**
Source: Made by author

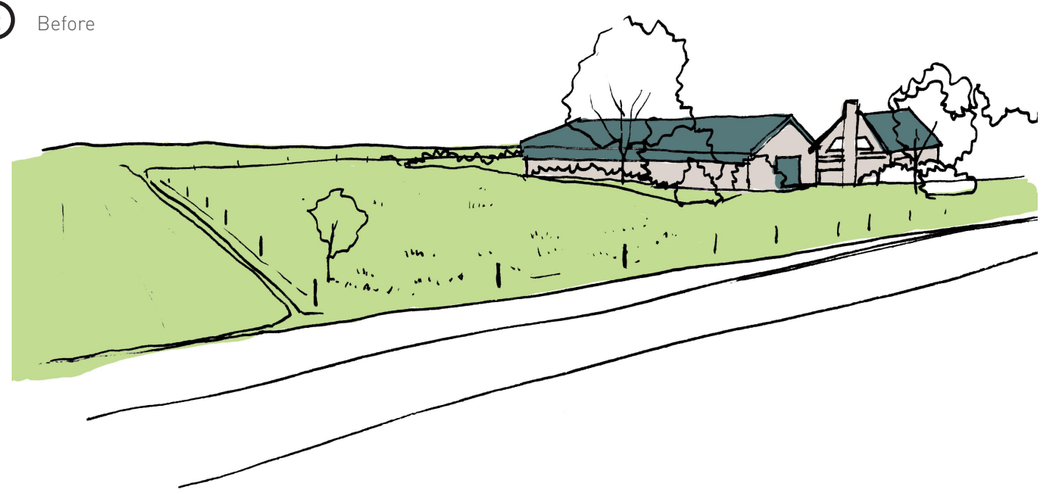
**58 Before and after images showing possible transformation**

Source: Made by author

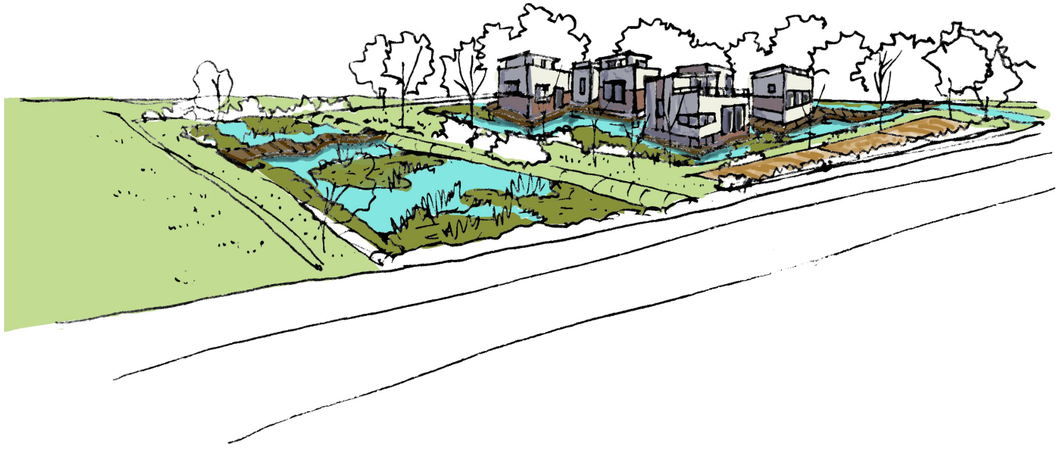
① Before

After: Community wetland

② Before



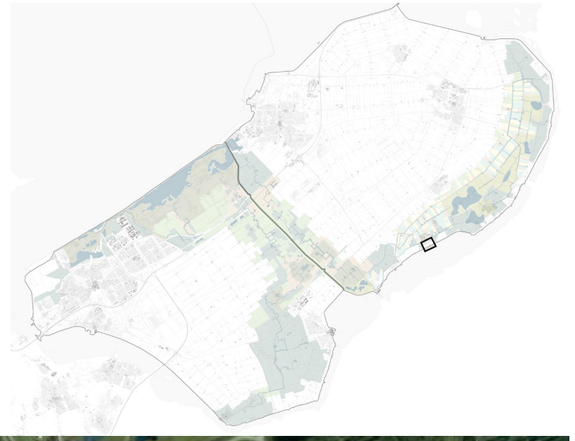
After: Floating house



### 12.2.3 Mosaic border

The freshwater seepage from Veluwe provide special condition for the border of East Flevopolder to develop certain types of landscapes. As a result, a mosaic could be formed with wetland and several types of grassland. The zoom-in area demonstrates how the border of polder could develop recreational function towards ecological backbone and also border lakes.

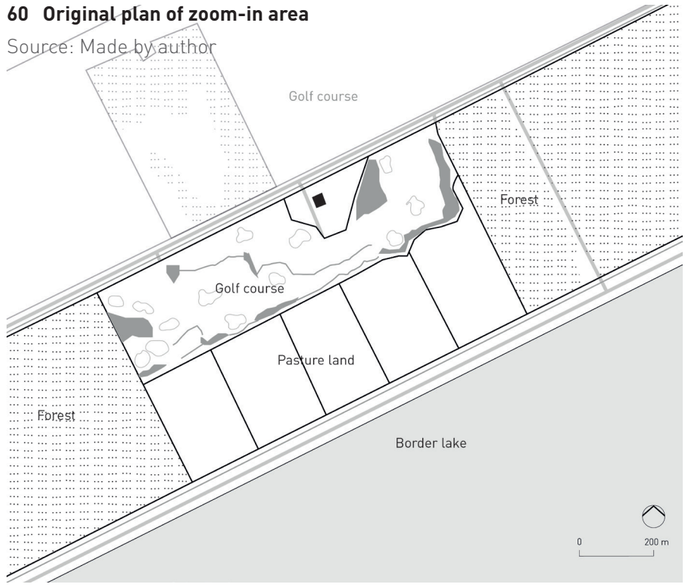
Three design concepts are introduced here:
1. The recovery of rare grassland landscape is integrated in the original landuse.
2. Temporary recreational structures / houses are introduced.
3. A connection towards border lake is developed by creating wetland outside the polder with physical connection to cross the dyke. (Fig. 62)




**59 Satellite image of Mosaic border**
Source: Google map



**60 Original plan of zoom-in area**
Source: Made by author




**61 New plan of zoom-in area**
Source: Made by author


The zoom-in area consists of mainly two types of landuse, golf course and pasture land. (Fig. 60) The design integrates the golf course as part of the wet grassland and flowery meadow landscape recovery space. Since golf course has been considered also an important place to conserve biodiversity, (Gange & Lindsay & Schofield, 2003) the topography and water structure inside has the potential to be managed by the club into a natural conservation space with recreational function. (Fig. 61)

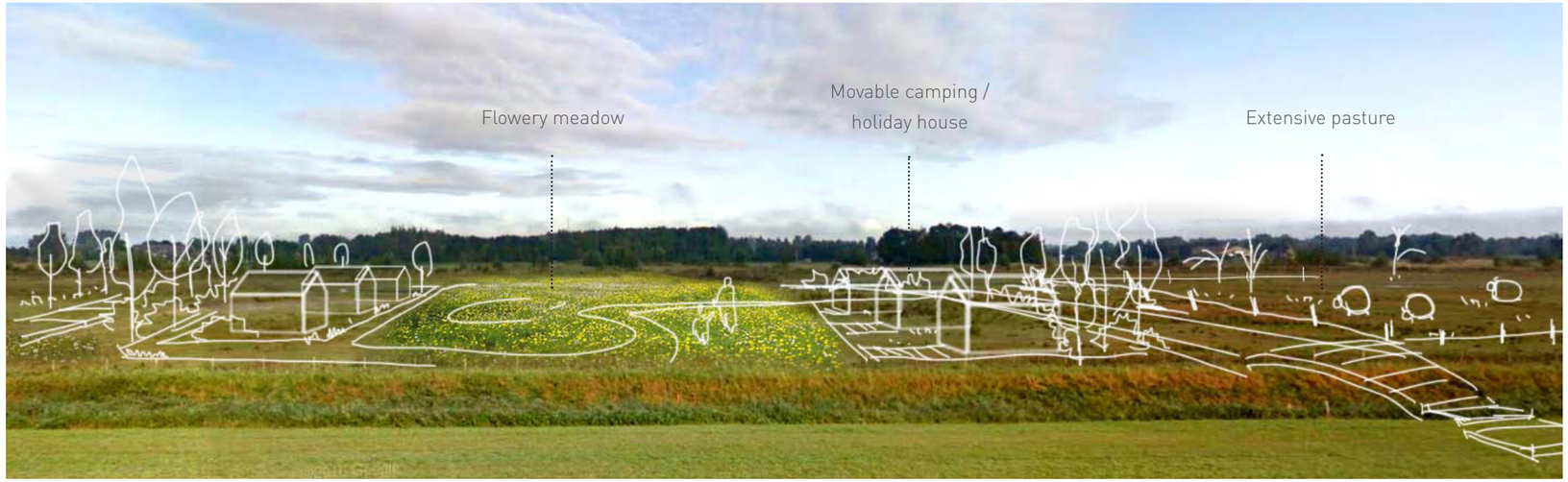
The function of grazing is still kept in an extensive way in order not to fertilize the soil, while the grassland could also accommodate temporary, recyclable facilities for recreational purposes such as camping or small greenhouse farming as habit. The management of grassland lies on the golf club and the farmers.

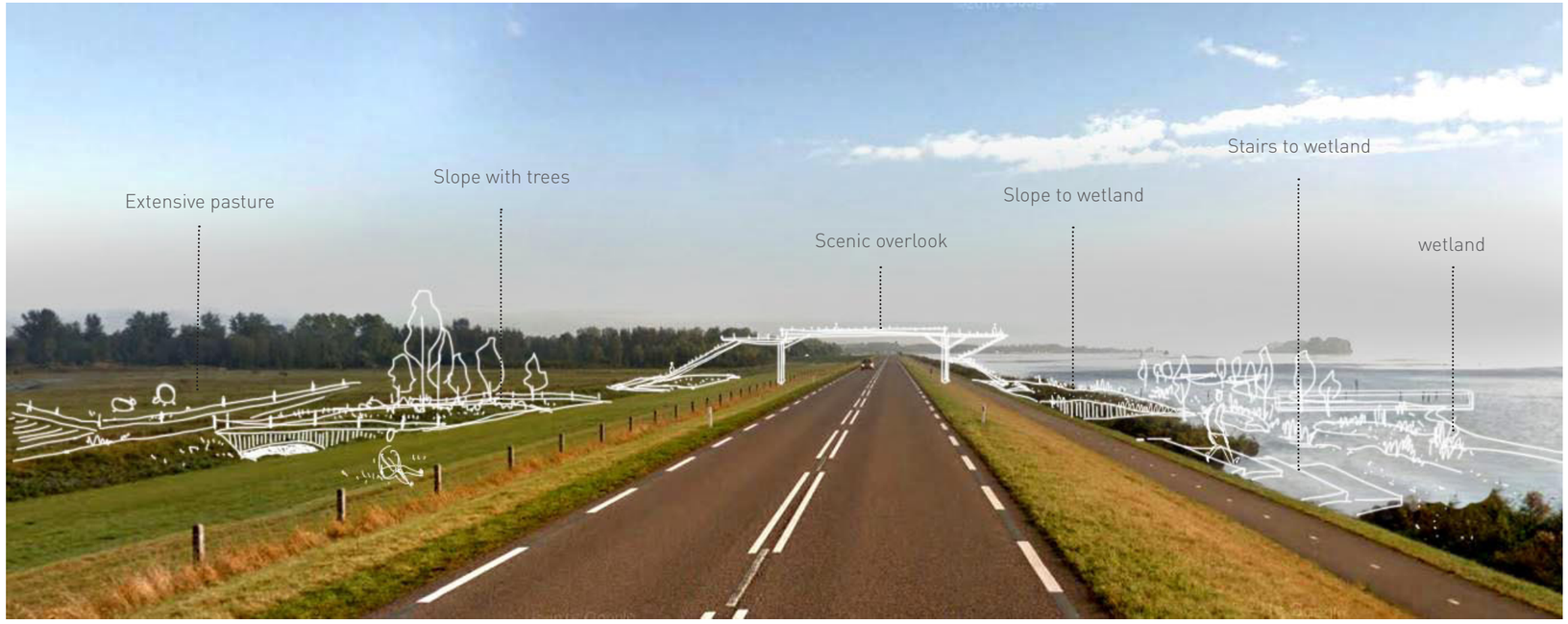
Wetland outside the dyke is formed by constructing structures that accummulate sand on the edge. The same design principle could be seen in many places in Flevopolders.

- Open water
- Wetland
- Wet grassland
- Reeds
- Flowery meadow
- Grassland
- Sand
- Area allowed for extensive grazing
- building
- Main path

**63 Visionary image of possible transformation**

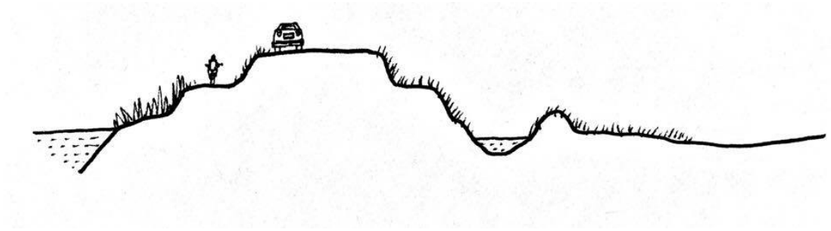
Source: Made by author

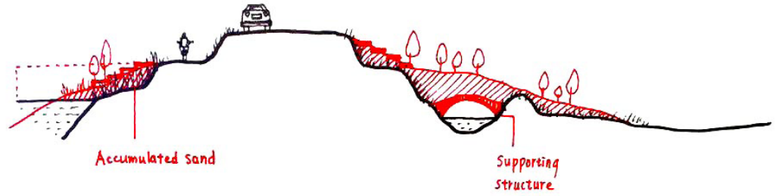


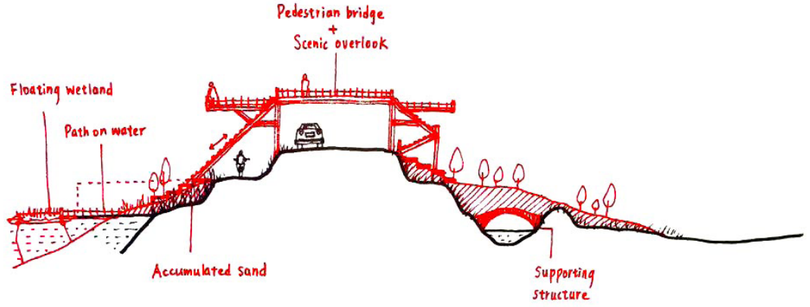



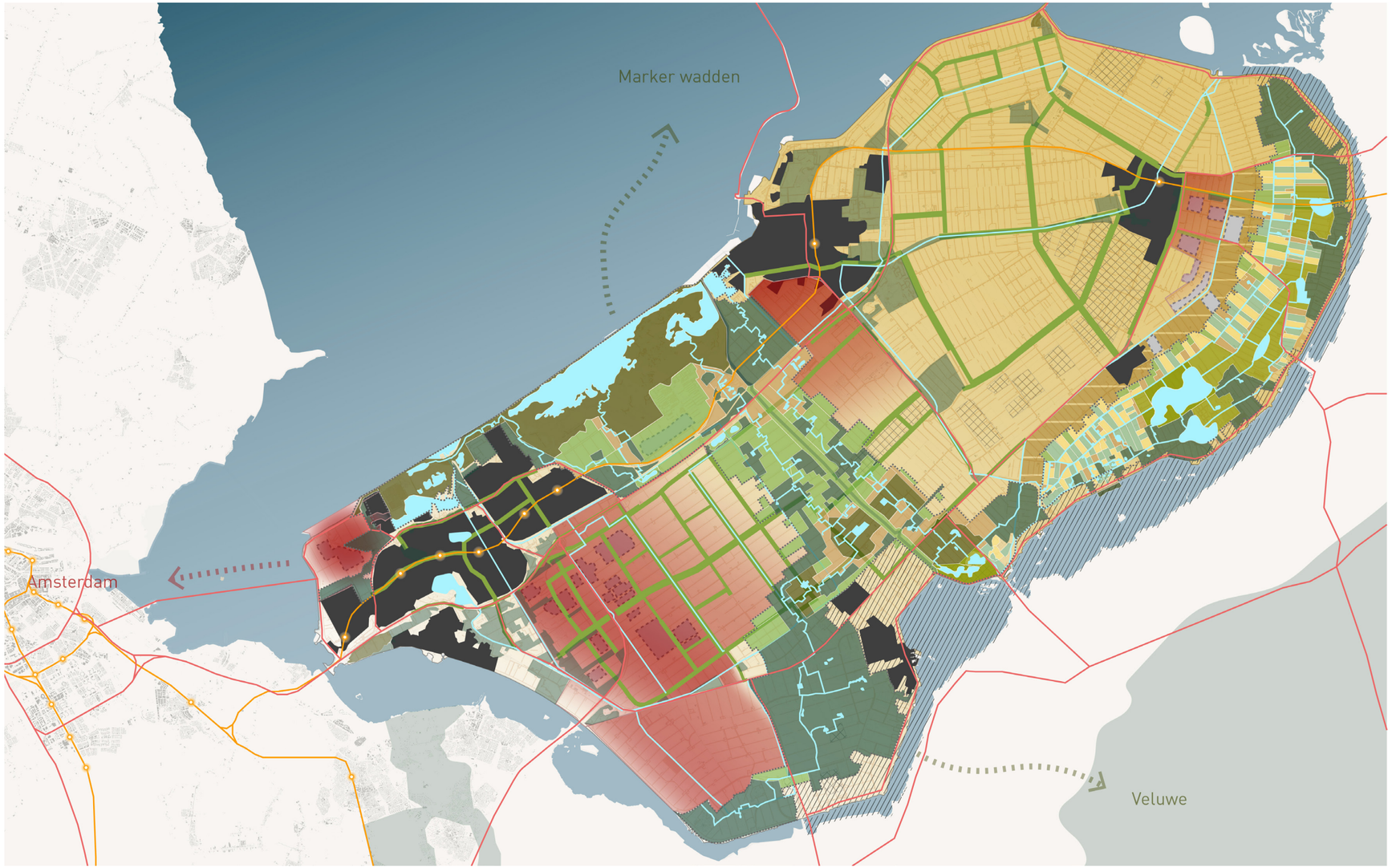

**62 Design concept of dyke transformation in stages**

Source: Made by author








**Ecological backbone**

- Open water
- Marsh
- Fenland
- Wet grassland (Nat schraalgrasland)
- Reed land (Rietland / ruigte)
- Flowery meadow (Bloemgrasland)
- Grassland
- Woodland
- Secondary woodland patch
- Stream
- Secondary green corridor

**Agriculture**

- Ditch-widening area
- Wet agriculture
- Ditch

**Urbanization**

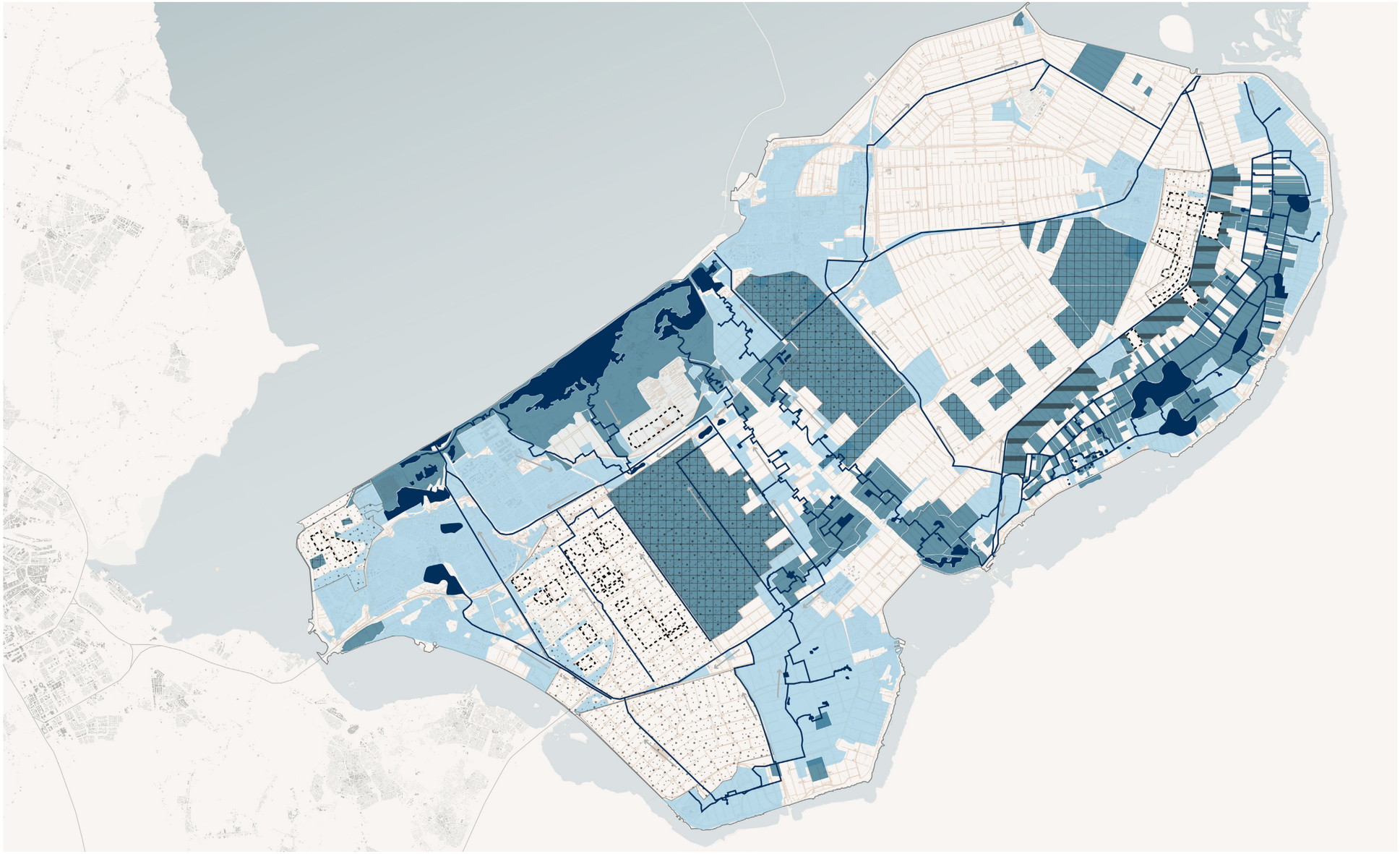
- Existing urban area
- Potential area for urbanization
- Areas develop with border lakes
- Railway
- Main road connection
- Railway station

**Others**

- Elevated ground

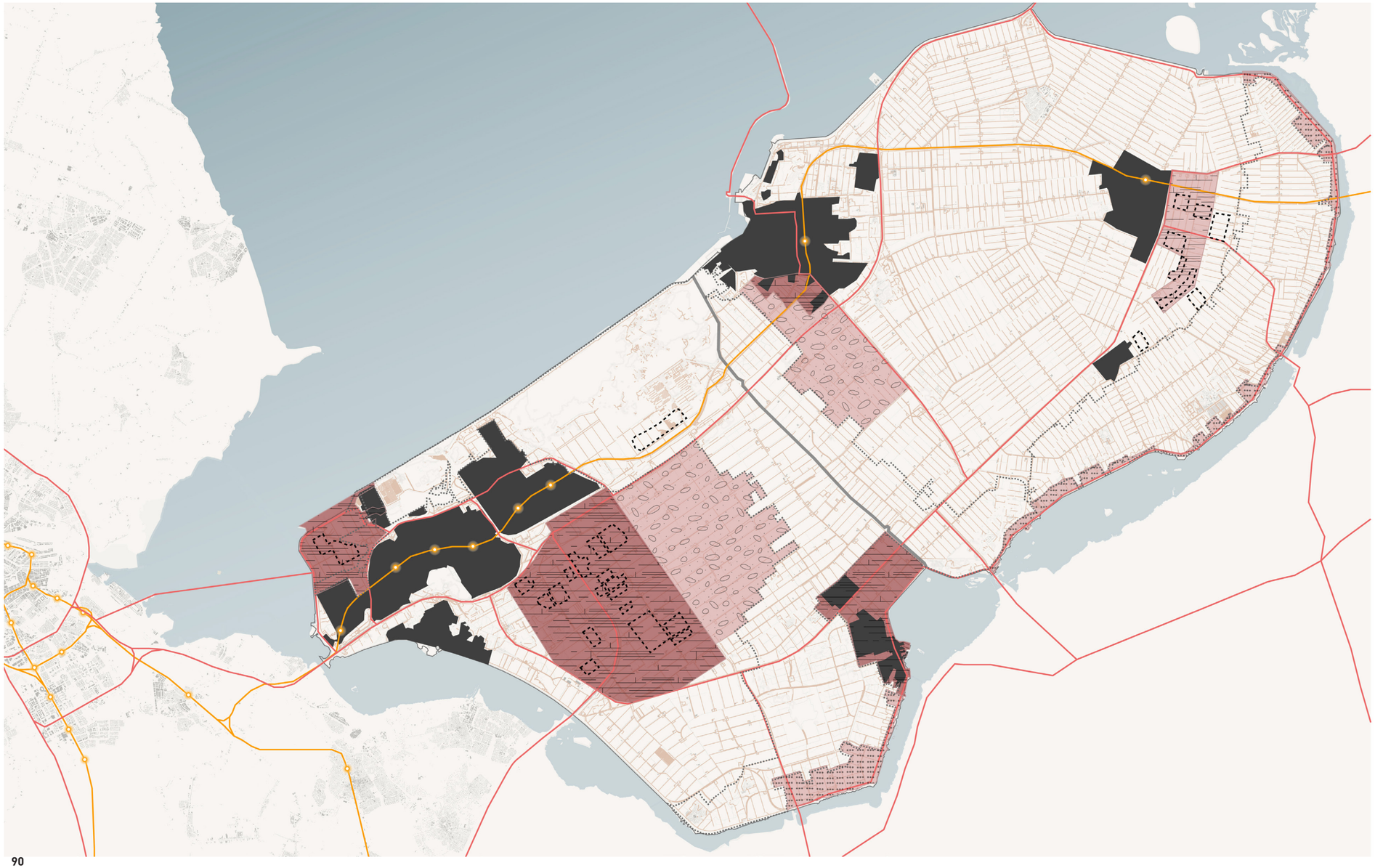
0 5 10km

**64 Overall structural plan**
Source: Made by author




**65 Water management plan**

Source: Made by author




**66 Building density and typology plan**

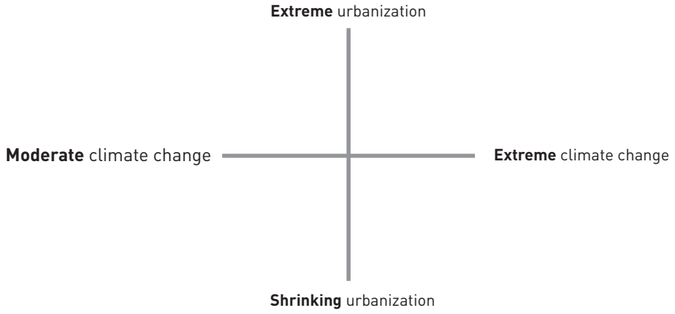
Source: Made by author

**67 Project of Marker Wadden**

Source: www.natuurmonumenten.nl

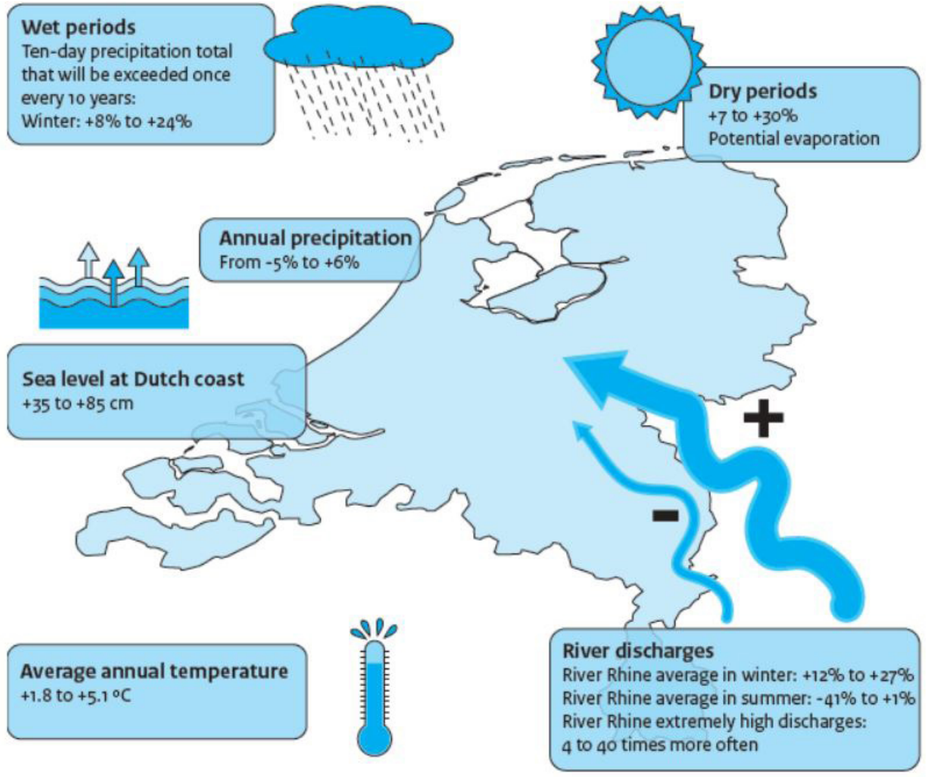
SCENARIO

Reflecting on the two main problems in the delta areas, urbanization and climate change, the landscape framework needs to be able to adjust itself to these uncertainties. Therefore scenario construction is used to explore the extreme situations that may be generated under the two main driving forces, and could further on be used to decide the overall strategy for the near future.







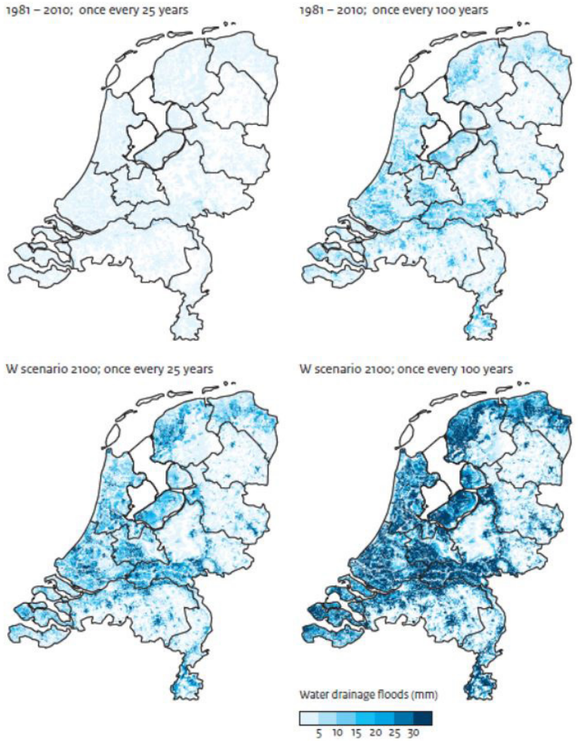




**68 Possible climate change in the Netherlands (1900-2100)**

Source: The effects of climate change in the Netherlands, PBL

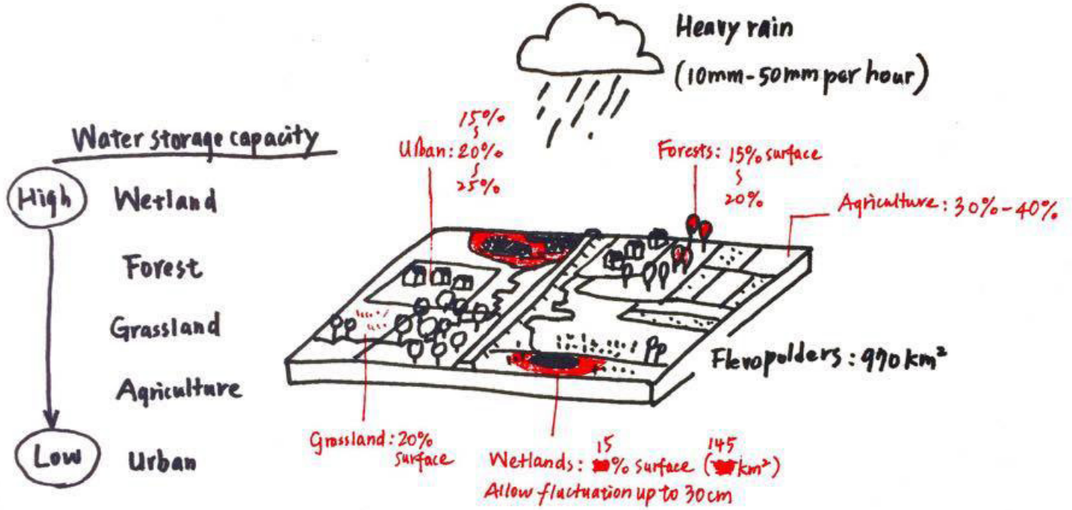
One of the most significant influence brought by climate change is the change of precipitation pattern, which has a tendency to increase in general, with heavy rainfall in a short period of time. (PBL, 2012) The sudden heavy rainfall would cause the runoff to increase, and lead to possible water drainage flooding. (Fig. 69) As a result, there is a need to prepare in advance and develop enough water storage in the space. The water storage not only contribute to the collection of runoff rain water, the water could be reused especially in summer, when the water demand is a lot higher, but the available freshwater does not meet the requirement.

The overall strategy of water storage design here is to enable the whole Flevopolders to collect the precipitation during heavy shower through different types of landscapes, and slowly discharge the water afterwards. (Fig. 70)




**69 Frequency of water drainage floods**

Source: PBL




**70 Concept of using landscape surface and available fluctuation to calculate water storage**

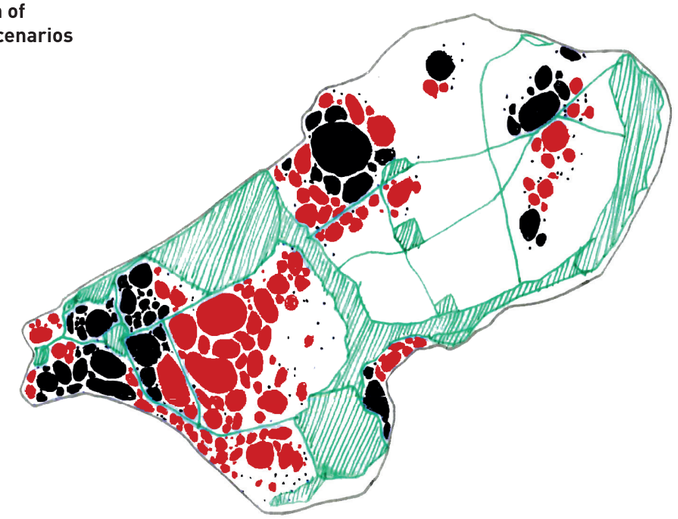
Source: Made by author

**71 Conceptual drawing of how the structure of ecological backbone and the pattern of urbanization may differ according to scenarios**

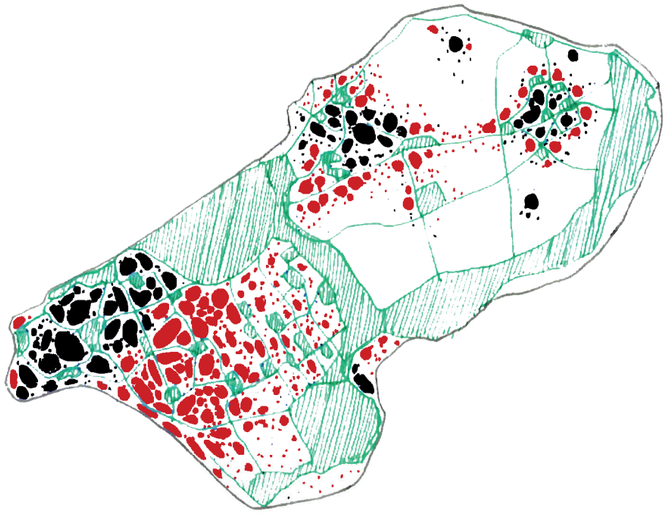
Existing urban area

Expansion of urban area

Ecological backbone

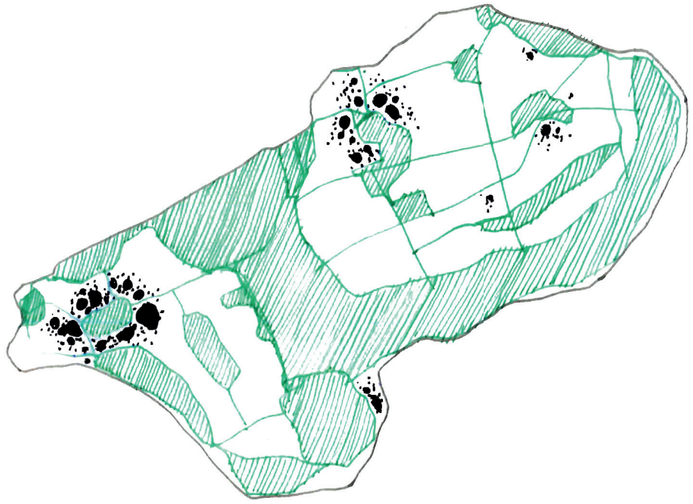


**Extreme** urbanization
**Moderate** climate change

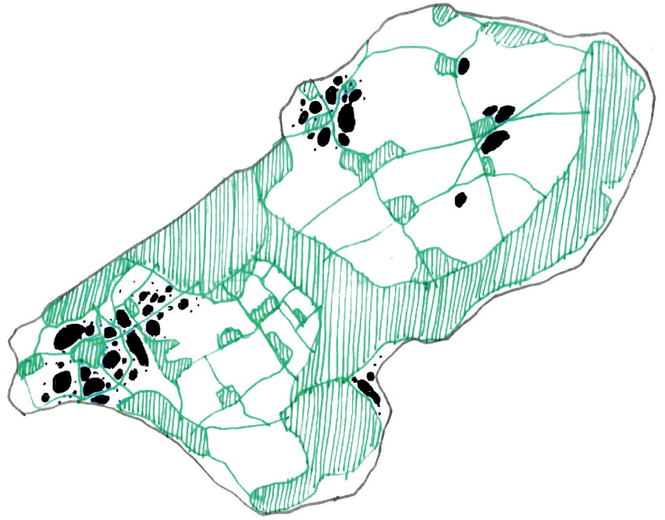


**Extreme** urbanization
**Extreme** climate change

**Shrinking** urbanization
**Moderate** climate change



**Shrinking** urbanization
**Extreme** climate change



# REFERENCE

## Bibliography


Bélanger, P. (2013). Landscape as infrastructure. Abingdon, Oxon: Routledge.

Brand, G., Merkelyn, A., & Doesburg-Maas, D. (1988). Dynamic Flevoland. Hoogezand: Doesburg.

Fabian, L., Viganò, P., & Secchi, B. (2016). Water and asphalt: the Project of Isotropy. Zurich: Park Books.

Forman, R. T. T., & Godron, M. (1986). Landscape ecology. New York: Wiley.

Forman, R. T. T. (2006). Land mosaics : The ecology of landscapes and regions. Cambridge: Cambridge University Press.

Hooimeijer, F., Meyer, H., & Nienhuis, A. (2009). Atlas of Dutch water cities. Amsterdam: SUN.

MacHarg, I. L. (1971). Design with nature. Garden City, N.Y.: Doubleday etc..

Meyer, H., & Nijhuis, S. (2014). Urbanized deltas in transition. Amsterdam: Techne Press.

Nijhuis, S., Jauslin, D., & Hoeven, F. V. (2015). Flowscapes: designing infrastructure as landscape. Delft: TU Delft in cooperation with Delft Infrastructures & Mobility Initiative.

Pötz, H., Wa, A. S., & Forno, G. (2016). Groenblauwe netwerken: handleiding voor veerkrachtige steden = Green-blue grids: manual for resilient cities. Delft: Atelier GROENBLAUW.

Rijksdienst voor de IJsselmeerpolders. (1971). Atlas voor Flevoland 1971. Zwolle: Rijksdienst voor de IJsselmeerpolders.

Salewski, C., & Paine, S. (2012). Dutch new worlds: scenarios in physical planning and design in the Netherlands, 1970-2000. Rotterdam: 010 .

Waldheim, C. (2016). Landscape as urbanism : A general theory. Princeton, New Jersey: Princeton University Press.

Water atlas of The Netherlands. Groningen: Noordhoff, 2012. Print.


## Essay


DuPont, S. T. (2012). Introduction to soil quality.

Hara, Y., & Hooimeijer, F., & Nijhuis, S., & Ryu, M., & van Timmeren, A., (2015). The Impact of Historical Geography and Agricultural Land Development Processes on Wetland Restoration Methods Used to Create Ecological Networks: A Comparison of Japan and the Netherlands

Meire, P. (2017). Ecosystem services, a new understanding for a new delta?. In H. Meyer & J. Schrijnen (Eds.), The new delta (pp. 196-203).

Pellengarg, N. P. (1997). "groundwater management in the netherlands :background and legislation". ilri workshop: groundwater management: sharing responsibility for an open acces resource

Shaker, R.R. (2015). "The spatial distribution of development in Europe and its underlying sustainability correlations". Applied Geography.

Van Gogh, I. (2012). Silt in the Markermeer/IJmeer.




## Journal


Gange, A. C., Lindsay, D. E., & Schofield, J. M. (2003). The ecology of golf courses. Biologist, 50(2), 63-68.

Hough, R. L. (2013). Biodiversity and human health: evidence for causality? Biodiversity and Conservation, 23(2), 267-288.


## Report and publication


Agenda 21, UN agriculture, Agriculture and sustainable development in the Netherlands (Publication). (2008). United Nations.

CAP in your country_Netherlands (Publication). (2016). European commission

Driessen, P., Spit, T., Giezen, M., & De Gier, T. (2013). Grondbeleid en Duurzame Ruimtelijke Ontwikkeling (Publication).

Europe's Environment - The Dobris Assessment (Publication). (1995). European Environmental Agency.

Factsheet on 2014-2020 on Rural Development Programme for the Netherlands (Rep.). (2015). European commission.

IUCN/UNEP/WWF (1991). "Caring for the Earth: A Strategy for Sustainable Living." Gland, Switzerland. Retrieved on: 2009-03-29.

NSW Government (2014). "Managing asbestos in or on soil."

Onotwerp Provinciaal Inpassingsplan – Toelichting project Oostvaarderswold (Publication). (2010). Provinciale Flevoland.

Zoet-zout studie Provincie Flevoland, TNO. (2008)

The Netherlands, Gementee Almere. (2009). Summary, Draft Structural Vision Almere 2.0.


## Website


Artificial island. (2017, March 17). Retrieved from https://en.wikipedia.org/wiki/Artificial_island

CBS. CBS StatLine - Landbouw; gewassen, dieren en grondgebruik naar regio. Retrieved from http://statline.cbs.nl

European commission. (2017, February 22). Agriculture and rural development. Retrieved February 23, 2017, from https://ec.europa.eu/agriculture/envir/landscape_en

European commission. Natura 2000. Retrieved February 23, 2017, from http://ec.europa.eu/environment/nature/natura2000/index_en.htm

European commission. EU Results, Online collection of EU funded projects. Retrieved February 23, 2017, from http://ec.europa.eu/budget/euprojects/search-projects_en

European Commission : CORDIS : News and Events : Commission extends ban on asbestos products in EU. (n.d.). Retrieved March, 2017, from http://cordis.europa.eu/news/rcn/13445_en.html

Kaarten.flevoland.nl. (n.d.). Retrieved March, 2017, from http://geo2.flevoland.nl/

Land subsidence is one of the world's underrated problems. (n.d.). Retrieved from https://www.deltares.nl/en/topdossiers/subsidence/

LandschapsbeheerFlevoland (2011). Kwel maakte landbouw onmogelijk. (n.d.). Retrieved from https://www.flevolandsgeheugen.nl/page/3326/kwel-maakte-landbouw-onmogelijk