NEW PERSPECTIVE ON THE [FOOD] LANDSCAPES IN MRA 2050



Developing a new perspective & design for resilient & attractive agricultural landscapes in the metropolitan region of Amsterdam in 2050

Anne-wil Min I Master Urbanism TU Delft I Graduation thesis

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Auteur:	Anne-Wil Min (4285603)
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Faculty:	Architecture and the Built Environment, Urbanism
Educational institution:	Delft University of Technology
Mentors:	Kristel Aalbers (TU Delft) Nico Tillie (TU Delft) Sacha Maarschall (Province of Noord-Holland) Jurjen Tjarks (Province of Noord-Holland)

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TU Delft

Provincie Noord-Holland


NEW PERSPECTIVE ON THE [FOOD] LANDSCAPES IN 2050

''De agrarische sector maakt een transitie door. Bedrijven ontwikkelen zich in heel verschillende richtingen. Dat geeft kans om een betere balans te zoeken met de lokale omgeving, volgens het principe 'doe meer met minder'. Meer maatschappelijk en economisch rendement op minder grond, met minder belasting voor de leefomgeving en de gezondheid. De trend van bulkproductie voor de wereldmarkt moet worden omgebogen in de richting van kwaliteitsproducten met hogere toegevoegde waarde. Plaatselijk kan een grotere waarde ontstaan voor andere maatschappelijke behoeften, zoals natuur, recreatie en hernieuwbare energie. Elders kan de landbouw zich verder ontplooien als innovatieve sector, cruciaal in de omslag naar een circulaire en biobased economie. Nederland moet zich ontwikkelen als internationaal kennislab dat, in combinatie met de sterke maakindustrie, agro- en foodtechnologie exporteert.''

Inspirational text for the transition of the [food] landscapes in the metropolitan region (Jonge, 2018)

PREFACE

This graduation report is inspired by the recently published National Environmental Vision (NOVI) and the Environmental Vision of the Province of Noord-Holland (NH2050). These reports give predictions for the future development of the Netherlands on specific relevant topics. In this graduation report the focus will be on the integration of the topics of climate resilience, sustainable agriculture, landscape and urbanisation, with a focus on the metropolitan region of Amsterdam where these problems are concentrated. It will give an overview and solutions of the most urgent problems in the [food] landscapes of the metropolitan region of Amsterdam. In that way it is an elaborational research & design on the theme's in the published reports of the NOVI and NH2050.

The topics of research will arise as problems in the metropolitan region of Amsterdam towards 2050. The graduation report is thus giving solutions based on predicted problems in the future. However, it is important to already start doing research and planning for these solutions because it takes a lot of new knowledge and time to realise these in practise before 2050. Next to this, the Netherlands could serve as an inspiration for other metropolitan regions in the world that are coping with the same type of problems towards the future, by doing so. Furthermore, the research & design in this report is one of the first examples of the new integrative thinking that is introduced with the NOVI and NH2050. It could in that way be an inspiration for new projects, because there is a lot of potential in integrating different sectors as water, food, recreation and energy.

This graduation report is focussed on the adaptation of the agricultural landscapes to the new climate change conditions, pollution of freshwater by the agricultural sector and urbanisation trend in the region. The reason for this is that mitigation of these problems is not always enough or even possible. The effects of climate change on the [food] landscapes are already visible, and pollution of the freshwater in the landscapes is still going on, as well as the urbanisation in the region. Adaptation of the landscapes to these problems is thus, next to mitigation equally important.

In this graduation report the focus is on three different theme's and finding the synergy between the solutions of these theme's. The basic colors that are used throughout the report correspond to these theme's and are used to give a clear overview. The following colors are used:

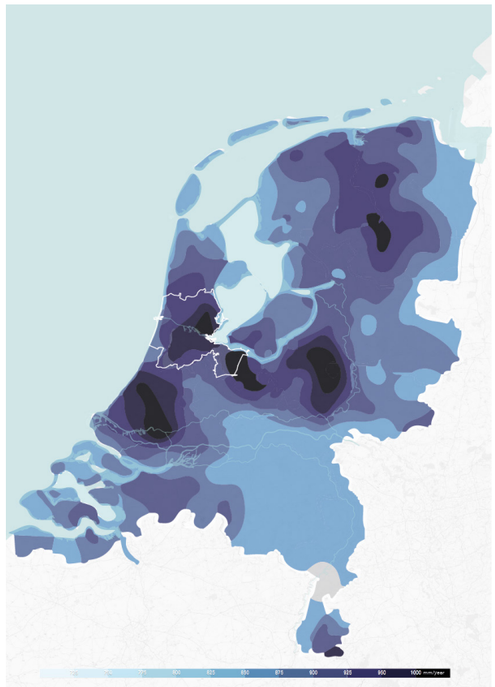
- Climate change resilient [food] landscapes
- Purifying agricultural [food] landscapes
- Recreational [food] landscapes



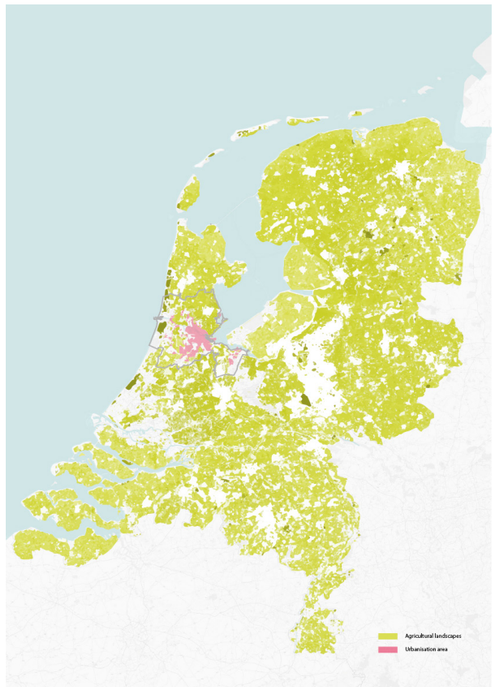
01. The route towards a resilient & attractive metropolitan [food] landscape of Amsterdam in 2050

ABSTRACT

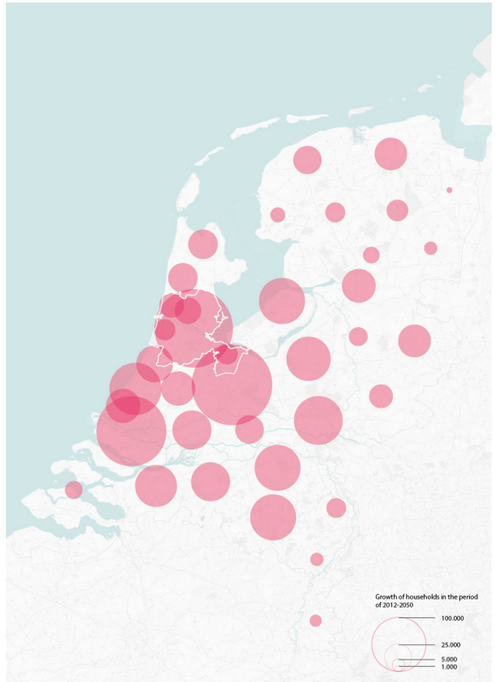
The purpose of this graduation report is to give an overview and inspiration on the route towards a resilient & attractive metropolitan [food] landscape of Amsterdam in 2050. The topic of research is the impact of climate change, unsustainable agriculture and urbanisation towards 2050, on the agricultural landscapes in the metropolitan region of Amsterdam, in the Netherlands. With the challenges and the problems that arise from these, it becomes inevitable to design a transition of the [food] landscapes in the region. Therefore the following research question is defined:
''How to design a new perspective on the food landscapes in the metropolitan region of Amsterdam towards 2050 for a landscape that is resilient to the effects of climate change, to restore the ecosystem (in the freshwater) of the landscape and create opportunities for new activities to start that will strenghten the connection between cities and landscapes, for a resilient & attractive region?'' A new method is used to find solutions for the three challenges in an integrative way, as there is a lot of potential in the synergy of the solutions. The maximization method provides an overview of individual solutions for the problems in the region, which can be used if the challenges change over time. Subsequently, in the optimization phase, the solutions with the most potential to be combined are given (waterstorage, new food types, circular watersystem, purifying nature & greenhouses). In the final integration phase, the solutions are integrated into the landscapes of the region. An innovative element in this research is the addition of scenarios for the future transition of agricultural landscapes to the maximization method: climate resilient, purifying agriculture or recreational [food] landscapes. This, together with interviews, results in a new perspective on the [food] landscapes in the region, that is a design for the landscapes created by the synergy between the solutions for the challenges (with a focus on the purifying & climate resilient scenarios). With a new perspective, pilot projects are designed to give an example of the new perspective solutions through the scales and by using the unique characteristics of the agricultural landscapes in the region (Waterland, Haarlemmermeer, Zaanstreek & the Beemster). In the conclusion, the new perspective with pilot projects will create solutions for the challenges in the metropolitan region of Amsterdam towards 2050.



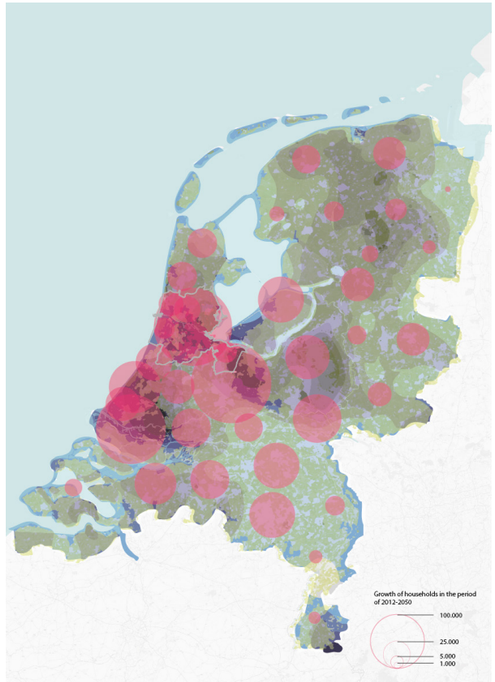
Climate change (precipitation) 2050



Sustainable transition in agriculture



Urbanisation 2050



Concentration of the challenges in MRA

Maps created by author.
Based on Zeegers (2018) & GIS

BESTUURSSAMENVATTING

Uitdagingen & problemen in 2050

Nederland staat in de toekomst voor grote uitdagingen als klimaatverandering, een vervuilend landbouw systeem, en de verstedelijkings opgave naar 2050.
In de Nationale Omgevingsvisie (NOVI) en de Omgevingsvisie NH2050, worden deze uitdagingen beschreven en richtlijnen gegeven op landelijk en provinciaal niveau. Dit afstudeerrapport gaat verder in op het regionale schaalniveau, waar de uitdagingen zich vooral concentreren in de voedsel landschappen van de metropoolregio van Amsterdam (zie kaarten hiernaast). Meer dan 60% van de landschappen in deze regio is gericht op de voedselproductie, waardoor de uitdagingen niet alleen een grote impact zullen hebben op de voedselproductie in Nederland, maar ook op de ruimtelijke kwaliteit van de landschappen in de metropoolregio in 2050.

De verschillende trends geven op regionaal niveau grote problemen en kunnen op deze schaal in samenhang opgelost worden. Klimaatverandering heeft tot gevolg dat er nieuwe condities ontstaan in het agrarische landschap (droger, natter en zilter). Bovendien blijft bodemdaling een urgent probleem in de veenweide landschappen in de regio, dat bijdraagt aan de uitstoot van CO2 en op die manier de klimaatverandering versterkt. De vervuilende landbouw gebruikt veel meststoffen en pesticides voor de voedselproductie. Deze nutrienten spoelen in het watersysteem van de landschappen, en creeren daarmee een disbalans in het (water) ecosysteem. Bovendien, geeft de verstedelijking in de metropoolregio van Amsterdam een grotere recreatievraag (35%) waardoor een tekort in recreatielandschappen naar 2050 ontstaat. Door een transitie van de agrarische landschappen in de regio, kunnen de problemen worden opgelost en ontstaan nieuwe kansen in de synergie tussen oplossingen vanuit andere thema's/sectoren. Dit is de vraag die in het afstudeerrapport onderzocht is. Op de volgende pagina zullen de belangrijkste conclusies van het onderzoek zichtbaar worden gemaakt.

Oplossingen

In het afstudeerrapport is een nieuwe methode gebruikt om op een integrale manier te ontwerpen (zie overzicht hiernaast). Met de maximalisatie methode zijn de verschillende thema's en oplossingen eerst los van elkaar bekeken. Vervolgens in de optimalisatie fase, is er gekeken naar welke oplossingen de meeste potentie hebben om gecombineerd te worden. Op die manier wordt er door de verschillende sectoren heen gewerkt. Bovendien wordt voor stakeholders duidelijk waar de meeste potentie is voor samenwerking tussen sectoren en waar er een meerwaarde (economisch of in ruimtelijke kwaliteit) ontstaat door combinaties van oplossingen. De oplossingen met de meeste potentie zijn gebruikt als basis in de scenario's voor de transitie van de landschappen naar 2050. Door het introduceren van scenario's voor de transitie, wordt er rekening gehouden met de onzekerheid in de trends naar de toekomst. In interviews met de verschillende sectoren bij de Provincie Noord-Holland, is het purifying agriculture scenario gekozen (in combinatie met oplossingen van het climate resilient scenario).

Dit scenario vormt de basis van het nieuwe toekomst perspectief voor de voedsellandschappen in de metropoolregio van Amsterdam (zie volgende pagina). Oplossingen als waterberging & duurzame energie, nieuwe water peilen in het veenweide gebied & natte teelt en purifying nature met recreatie worden in het toekomstbeeld gecombineerd. Verder zijn pilot projects uitgewerkt, op plekken waar de problemen in de regio samenkomen of er veel potentie is voor een synergie in oplossingen (in Waterland, Haarlemmermeer, Zaanstreek en de Beemster). De pilot projects zijn voorbeeld uitwerkingen voor ontwerpers op regionaal en lokaal schaalniveau, van de oplossingen in het nieuwe toekomstperspectief. Het nieuwe toekomst perspectief en de pilot projects laten de synergie in verschillende oplossingen zien voor de uitdagingen in 2050.

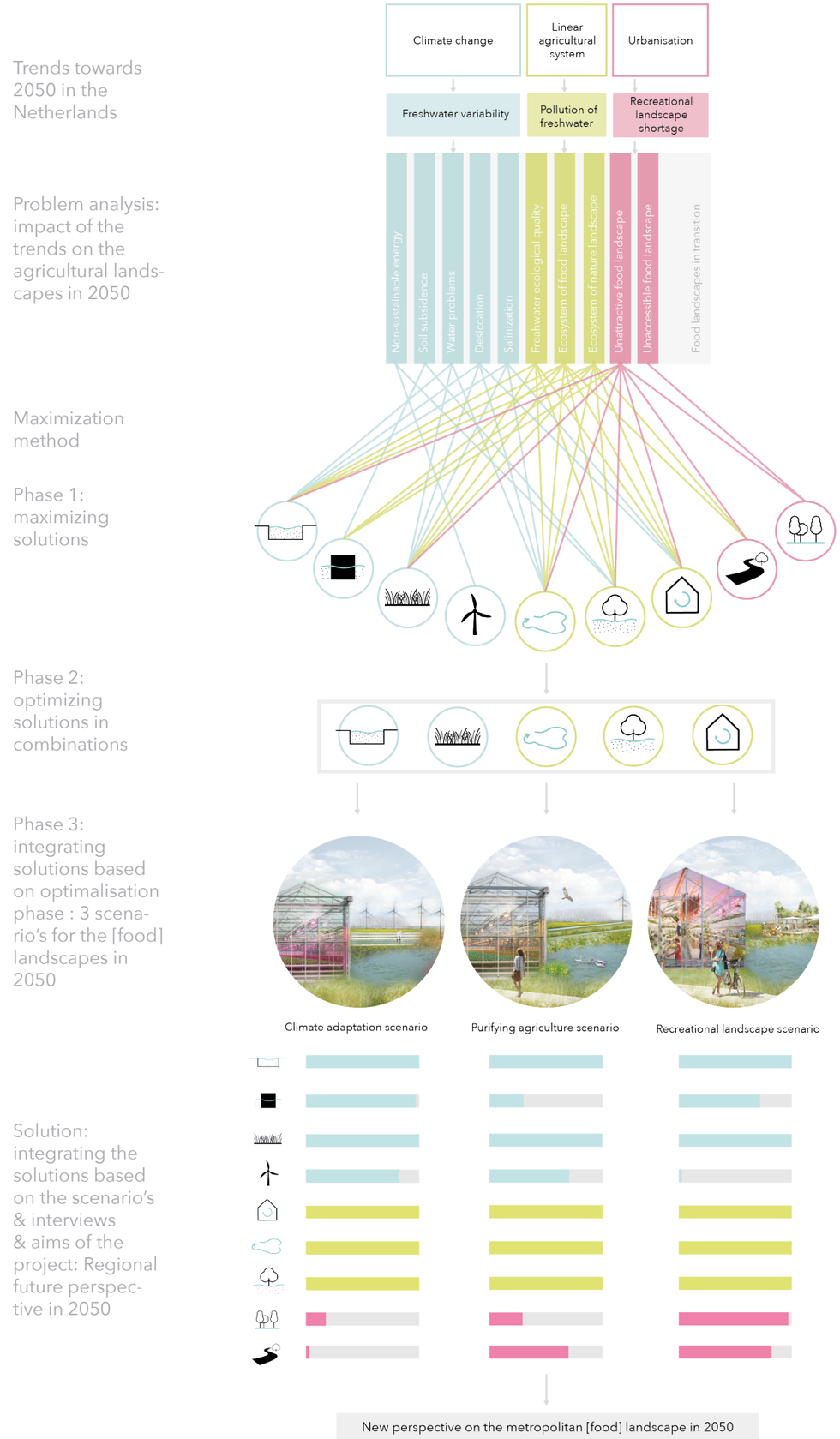
Aanbevelingen

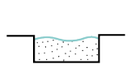
De regionale schaal is van belang om oplossingen te vinden voor de uitdagingen en problemen in de toekomst. Op deze schaal kunnen oplossingen geintroduceerd worden die gericht zijn op de unieke lokale kwaliteiten van het landschap en tegelijkertijd onderdeel vormen van een groot regionaal systeem. Voorbeelden zijn waterberging (en de impact op het regionale watersysteem), ecologische structuren, duurzame energie, nieuwe teelten productie en een recreatief netwerk.

Verder is een integrale aanpak nodig in toekomstige projecten, vanwege de vraag naar ruimte in de landschappen die groeit door de toekomstige uitdagingen (duurzame energie, voedselproductie, waterberging, recreatie). Daardoor zullen we meer moeten doen met minder ruimte, en integrale oplossingen vinden. Bovendien wordt er een meerwaarde gecreerd door verschillende oplossingen te combineren (bijv. een nieuw waterpeil & natte teelten). Om hiermee te kunnen ontwerpen is een design tool in het rapport opgenomen voor de optimale combinaties van oplossingen (p. 298).

Door scenario's voor de toekomstige ontwikkeling van landschappen te creeren, blijven de oplossingen geschikt in een tijd van onzekerheden in de toekomstige uitdagingen. En wordt het voor beleidsadviseurs makkelijker om te communiceren over de gewenste ontwikkelingen.

Tot slot is het van belang om verschillende sectoren te laten samenwerken wanneer dit mogelijk is of interviews te geven bij de betrokken partijen voor de gewenste ontwikkelingen. Op die manier ontstaat een draagvlak in verschillende sectoren om op een integrale manier te werken.





Water storage



New water level



New food types



Sustainable energy



Circular water system



Circular water greenhouse



Purifying nature



Attractive food landscape



Accessible food landscape



ZAANSTREEK LANDSCAPE

BEEMSTER LANDSCAPE

WATERLAND LANDSCAPE

HAARLEMMERMEER LANDSCAPE

NEW PERSPECTIVE ON THE [FOOD] LANDSCAPES IN 2050

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INTRODUCTION

INTRODUCTION

Towards the year 2050, there are large challenges predicted for the Netherlands. According to the research for the National Environmental Vision, the most important challenges are the sustainable energy transition, climate change, the up-scaling and transition of agriculture, recreation and urbanisation (Ministry of infrastructure and environment, 2017). The effects of these challenges will have a large impact on the landscapes in the Netherlands.

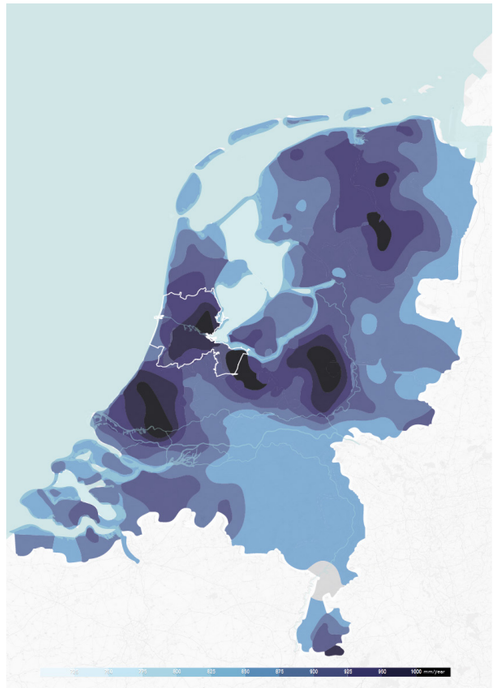
Most of the predicted challenges cluster in the metropolitan region in the south of Noord-Holland (the metropolitan region of Amsterdam) where the pressure on the landscapes (cities, agricultural and water) is already high. Climate change for example is having the most impact in the delta landscapes of the Netherlands (Scientas, 2018) and this delta landscape is simultaneously the most densified (and with the trend of urbanisation towards 2050 even further) part of the Netherlands. It is therefore imaginable that problems in the metropolitan region of Noord-Holland will arise towards 2050. Also the Province of Noord-Holland predicated this in the Environmental Vision NH2050 (2018) and references to climate change, soil, water & air quality, biodiversity, the economical transition, the energy transition, urbanisation, mobility and landscapes as the main challenges towards 2050.



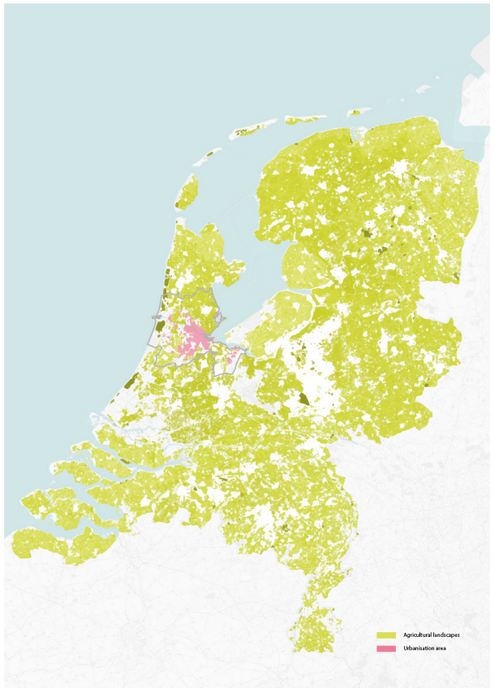
Scale levels in the Netherlands that have an impact on eachother & the scale this research is focussed on.

The development of these challenges, requires a new research on the effects of the challenges on the landscapes of the metropolitan region in NH2050, and the possible solutions that could be created (with an integrative approach) to resolve the problems and to give quality to the landscapes of the future. Furthermore, new landscape types and innovative functions in the landscapes could arise with these challenges for 2050. Therefore an innovative and creative vision is needed for the development of the landscapes towards the future. Not only on the national scale (the National Environmental Vision, 2019) and the provincial scale (the Environmental Vision NH2050, 2018). But especially on the regional scale, where the challenges may differ from the larger scales, and a customized approach is needed to solve the problems with respect to the landscapes in the region and the connetion to the cities (PBL, 2009). In the Environmental Vision NH2050, the metropolitan region is described as part of the future vision and guidelines are given for the socio-economic and landscape aspects in the region. However, the regional vision (a new perspective on the [food] landscapes in 2050) in this graduation report makes the guidelines for the landscape more defined (with a focus on water, food & recreation). Next to this, it gives an overview of solutions for the challenges in the region to guide the design of the new landscapes on the smaller scale. In this way, it is an inspiration for the sustainable transition of the landscapes towards 2050.

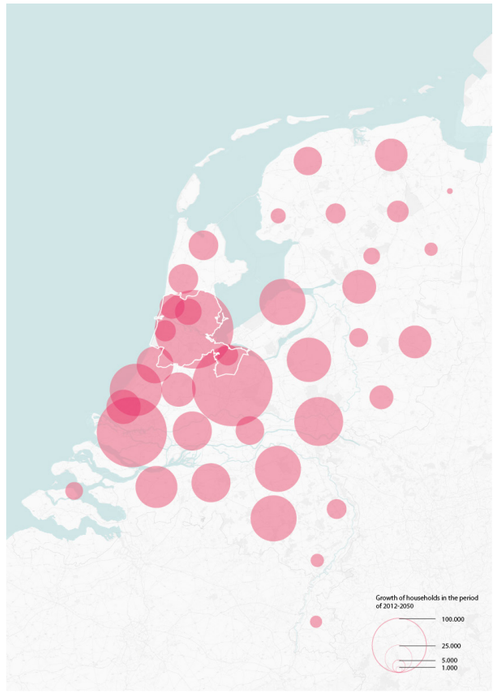
In this report the focus of the research will be on the challenges of climate change, the agricultural transition and urbanisation and the impact of this on the metropolitan landscape of NH2050 (on the theme's of water, food & recreation).



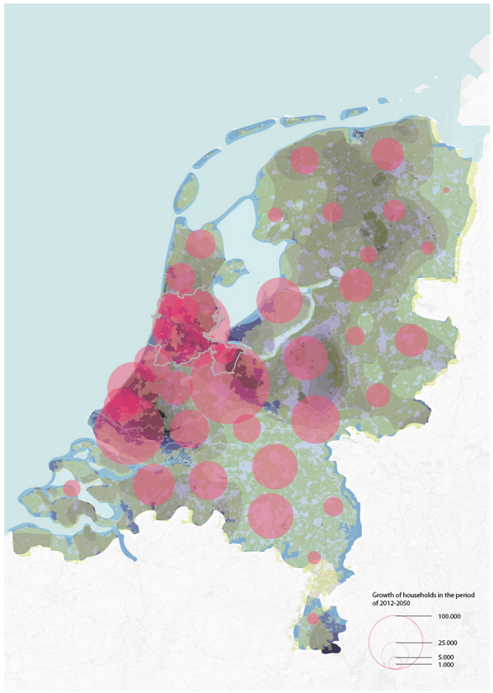
Climate change (precipitation) 2050



Sustainable transition in agriculture



Urbanisation 2050



Concentration of the challenges in MRA

Maps with the concentration of the challenges in the MRA in the Netherlands. Extreme precipitation & the urbanisation trend towards 2050 are concentrated in the MRA. The transition of the agricultural landscapes, is important because it is closely located to the cities in the metropolitan region and creates the metropolitan landscape and therefore has an impact on the living quality & international competitiveness of the region. Overlaying the maps gives the mra region as the location with the most problems towards 2050.

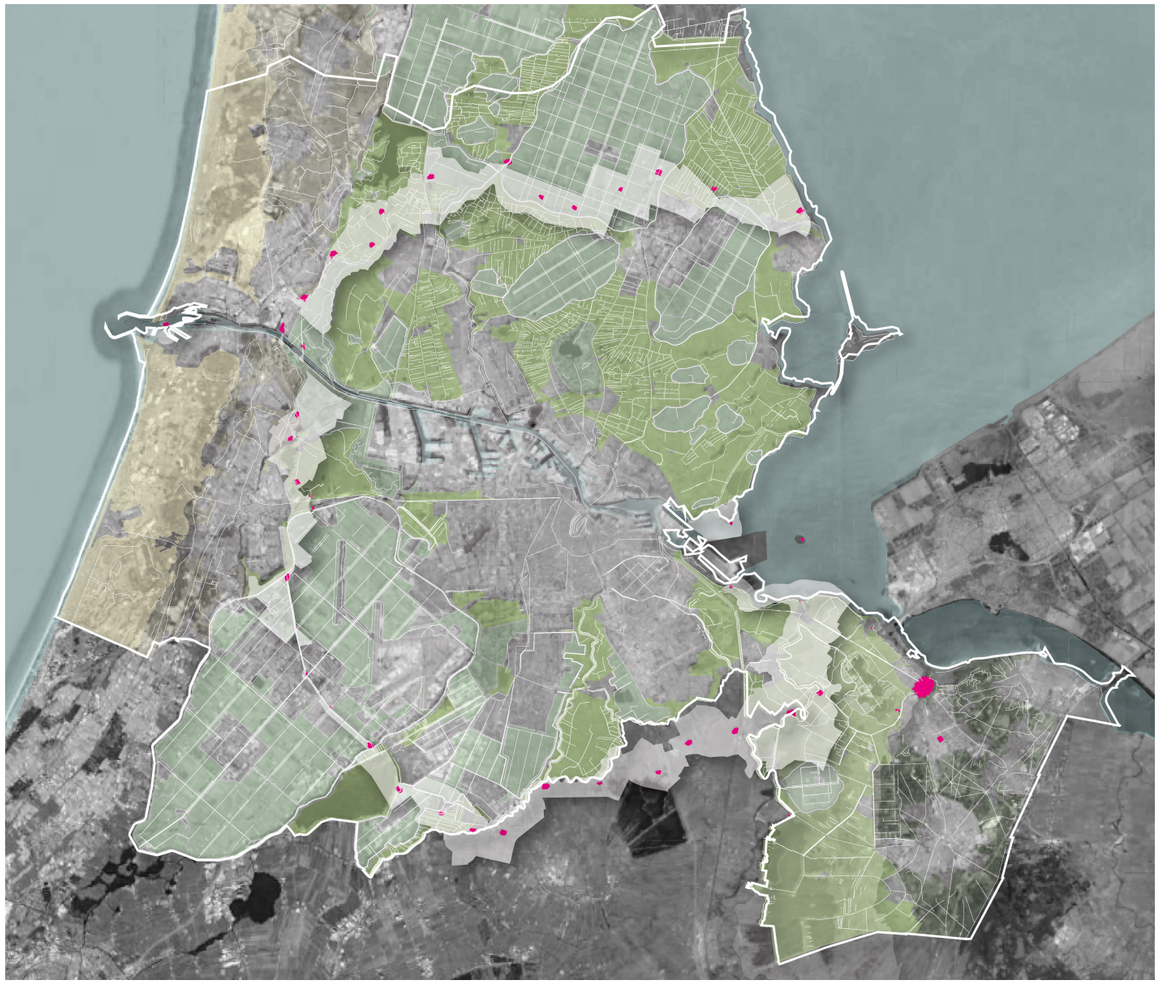
Source: images created by author.
Based on Zeegers (2018) & GIS

THE LOCATION

The location is the metropolitan region of Amsterdam, located in the Province of Noord-Holland in the Netherlands. This metropolitan region is one of the few metropolitan areas in Europe that is surrounded by a variety of landscapes with different qualities (Rijnbout, 2018). For example the agricultural landscapes as an unique characteristic of the Dutch landscape, the nearby beaches, the IJsselmeer lake and several historical landscape sites (as Monnickendam & Marken) that are located at short distance from eachother. These landscapes are important for the international competitiveness of the metropolitan region. Because the landscape is an incentive for the settlement of the knowledge based economy in the region (Vereniging Deltametrool, 2017). Next to the international competitiveness, the landscapes furthermore are an important factor in the food production and liveability of the region.

As described in the introduction chapter, most of the challenges towards 2050 in the Netherlands are concentrated in this metropolitan region of Noord-Holland. Therefore it is an interesting location for research on the effects of the challenges on the landscapes in the region and to propose a solution for the problems towards the future. The challenges of climate change, the transition in agriculture and urbanisation will have an impact on the landscapes and with that on the international position of the region, the food production and liveability.

With finding a solution for the challenges in the landscapes of the region in 2050, a new relation between the urban and agricultural landscapes could be established. Because the challenges can only be resolved by integrative solutions with different sectors and thus with a connection between the landscapes (Vereniging Deltametrool, 2017). The research in the report could be an inspiration for other metropolitan regions around the world, and especially in Europe on how to cope with the challenges of the future and create a better connection between the metropolitan cities and its surrounding landscapes.



METROPOLITAN LANDSCAPES CONCEPT

''The typical 'Dutch landscape' of the Amsterdam metropolitan area is one of its strongest assets. The diversity of landscapes, the interlinkage of land and water, countryside and cities and cultural heritage with ecological values are of great importance. Landscape is seen as a key factor that determines the quality of living in the metropolitan area and therefore is important for international competeveness.'' (the Netherlands Landscape Triennial, 2017)

- Jonge duinen landschap
- Strandwallen landschap
- Veenweide landschap (peat landscapes)
- Droogmakerij landschap (polder landscapes)
- Stuwwallen landschap
- Stelling van Amsterdam (fortification structure)
- Fortifications

Scale 1: 1:400000
Map created by author & based on Provincie Noord-Holland (2010)



Zandvoort Beach landscape (2018)



Agricultural landscape in the region (2018)



Village of Marken (2018)



IJsselmeer lake (2018)

DEFINITION OF THE LANDSCAPES

In the metropolitan region of Amterdam three types of landscapes could be defined that will be used for the research in this report.

Water landscapes

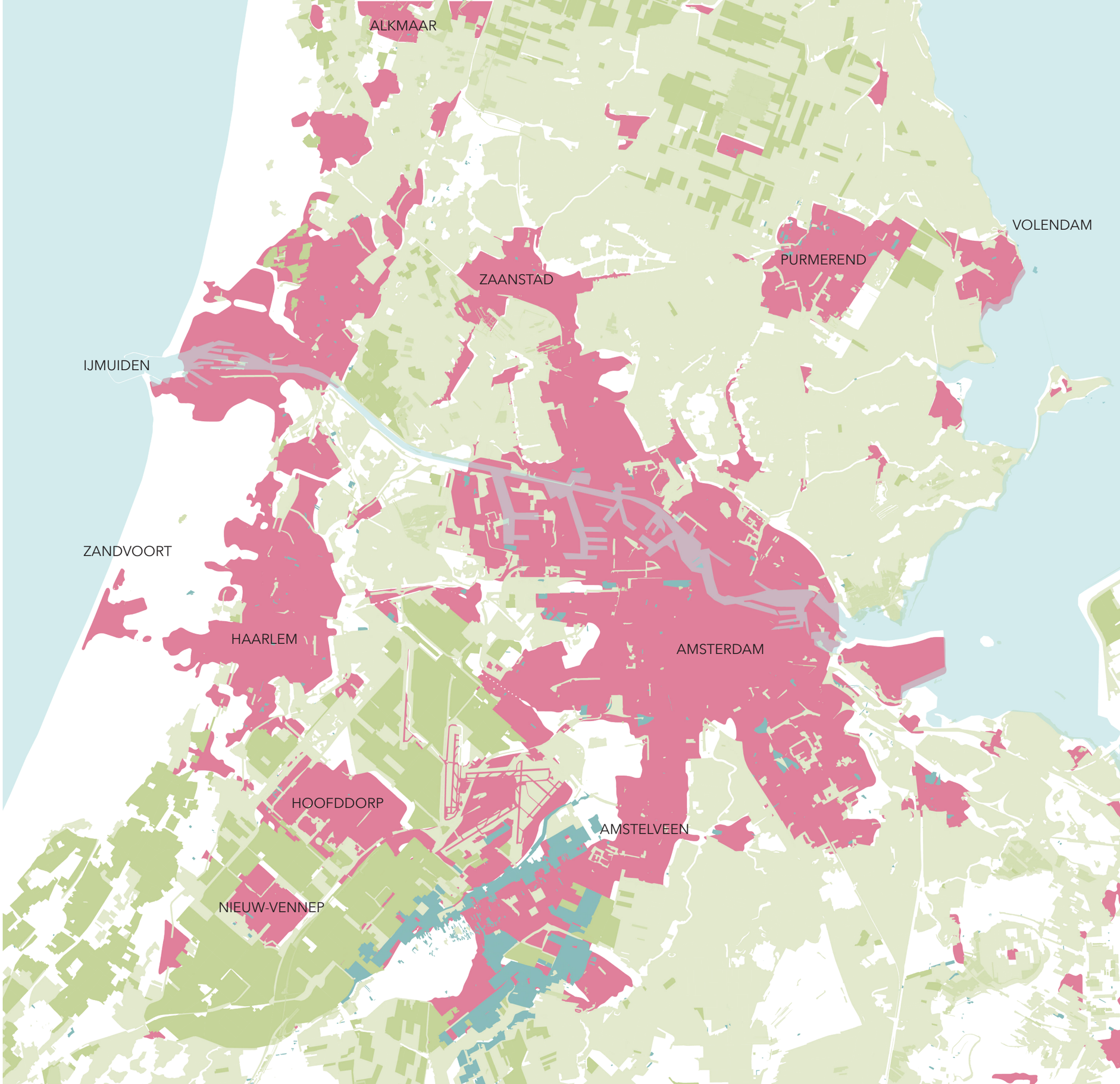
The waterlandscapes in the region are the water flows through the region that create connections between the different landscapes (e.g. rivers, ditches in the agricultural landscapes) and water landscapes in the shape of large waterbodies as the Northsea in the west of the region and the IJsselmeer lake in the east.

Agricultural landscapes

In the metropolitan region of Amsterdam 60 percent of the landscape consists of the agricultural landscape type (LTO Noord, 2018). This has a large impact on the image and quality of the metropolitan landscape now and towards 2050. Therefore the focus of this research is mainly on the agricultural landscapes and the future transition of these landscapes. Together with the connections of the water and urban landscapes to these agricultural landscapes.

Urban landscapes

The urban landscapes consists of the urban enviroments (cities) in the region. This could vary from the metropolitan city of Amsterdam to the historical villages of Volendam & Marken. The focus in this research is on the relation of the urban landscapes (especially the metropolitan city of Amsterdam) with the agricultural landscape transition towards 2050.



Water landscapes
Agricultural landscapes
Grassland
Agriculture
Horticulture
Urban landscapes

1:150000. Source: GIS maps



Problem field (trends) and problem statement overview

THE PROBLEM STATEMENT

In the next image the problem statement that is used in the graduation report is visible. The framework builds up from the problem field (the challenges as described in the introduction) to the problems in the region and the problem statement.

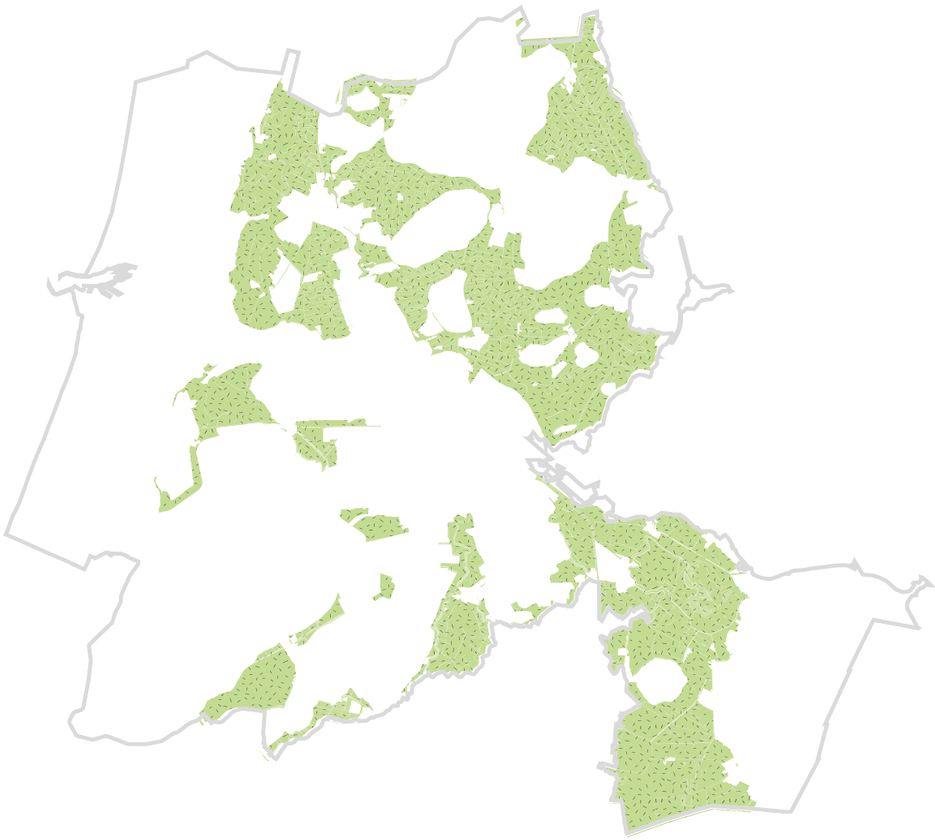
The trend of climate change towards 2050 has an impact on the water landscapes in the region, and with that on the freshwater supply for the food production in the agricultural landscapes. This creates an uncertainty in the food production towards 2050 with the variability of freshwater in the agricultural landscapes (problem 1). Next to this the unsustainable way of agriculture is creating a lot of polluted water (with fertilizers and pesticides) in the landscapes which results in the declining of the ecosystem of these landscapes (2). Furthermore, the urbanisation and trend towards 2050 in the region is giving a high pressure on the liveability in the cities and therefore creating a demand for attractive and accessible landscapes in the region (3).

The trends of climate change and urbanisation are challenges that can't be easily transformed. The unsustainable trend of agriculture however, is something we can change. The main goal of this graduation report is to research & design the transition of these agricultural landscapes in the region to create resilient & attractive [food] landscaps that are able to resolve the three problems that will arise towards 2050. Since the peat landscapes & polder landscapes are foremost the largest food landscapes in the metropolitan region of Amsterdam, the focus of the research in this graduation report will be on these two types of agricultural landscapes.

''Uncertainty in the food production caused by the impact of climate change on freshwater, the depletion of the ecosystem (of freshwater) in the agricultural landscapes by the current way of working, and the demand for a connection between the cities and landscapes by the urbanisation trend, are asking for a transition in the agricultural landscapes of the region towards 2050 that can reserve these problems and create atttractive & resilient regional landscapes for the future.''

PEAT LANDSCAPES (VEENWEIDE LANDSCHAPPEN)

Eilandspolder landscape (VVV, 2018).



A ‘peat landscape’ is a Dutch type of landscape consisting of meadows on peat soil. This landscape is seen as characteristic of the lower parts of the Noord-Holland. Until the 10th to the 13th century, there were large peat landscapes in these areas. In contrast to the current situation, the ground level was often a few meters higher than the water level, so that there were ‘peat cushions’ separated by small water streams. By creating drainage ditches, the wet peat land was dewatered to create a suitable landscape for farming. Due to the dewatering, the peat soil settled in as a result of drying out and oxidation processes. After a few centuries the ground level was almost at the same level as the groundwater and the landscape had become too wet conditions for agriculture. Since then, it has been used as pasture grounds for animals and especially for dairy farming. Farmers switched from producing arable crops to producing milk, butter and cheese. Due to the ongoing subsidence, the land had to be protected by quays and is later arranged as a polder system to keep the water level low by drainage. (Grondrr, 2019).



Picture of the peat landscapes (veenweidelandschap) in the metropolitan region of Amsterdam (Meelker, 2018)

POLDER LANDSCAPES (DROOGMAKERIJEN LANDSCHAPPEN)

Beemster landscape (Van de Biezen, 2018).

A ‘polder landscape’ is a drained landscape (with the polder system of dikes, pumping stations and water ditches) that was originally a water landscape (lake, open water or wetland). Since the polder landscape is designed by humans, it is the ultimate form of an anthropogenic cultural landscape and often consists of long, straight lines as characteristics of the landscape structures. Most polder landscapes have a clay soil type that became exposed when the old peat was gone. Deep land reclamation can be distinguished from (shallow) peat polders, which generally have a sandy or peat bottom. In the metropolitan region of Amsterdam there is a variety of deep land reclamation polders, such as the Haarlemmermeer and the UNESCO protected landscape of the Beemster polder (Bentwoud, 2019).



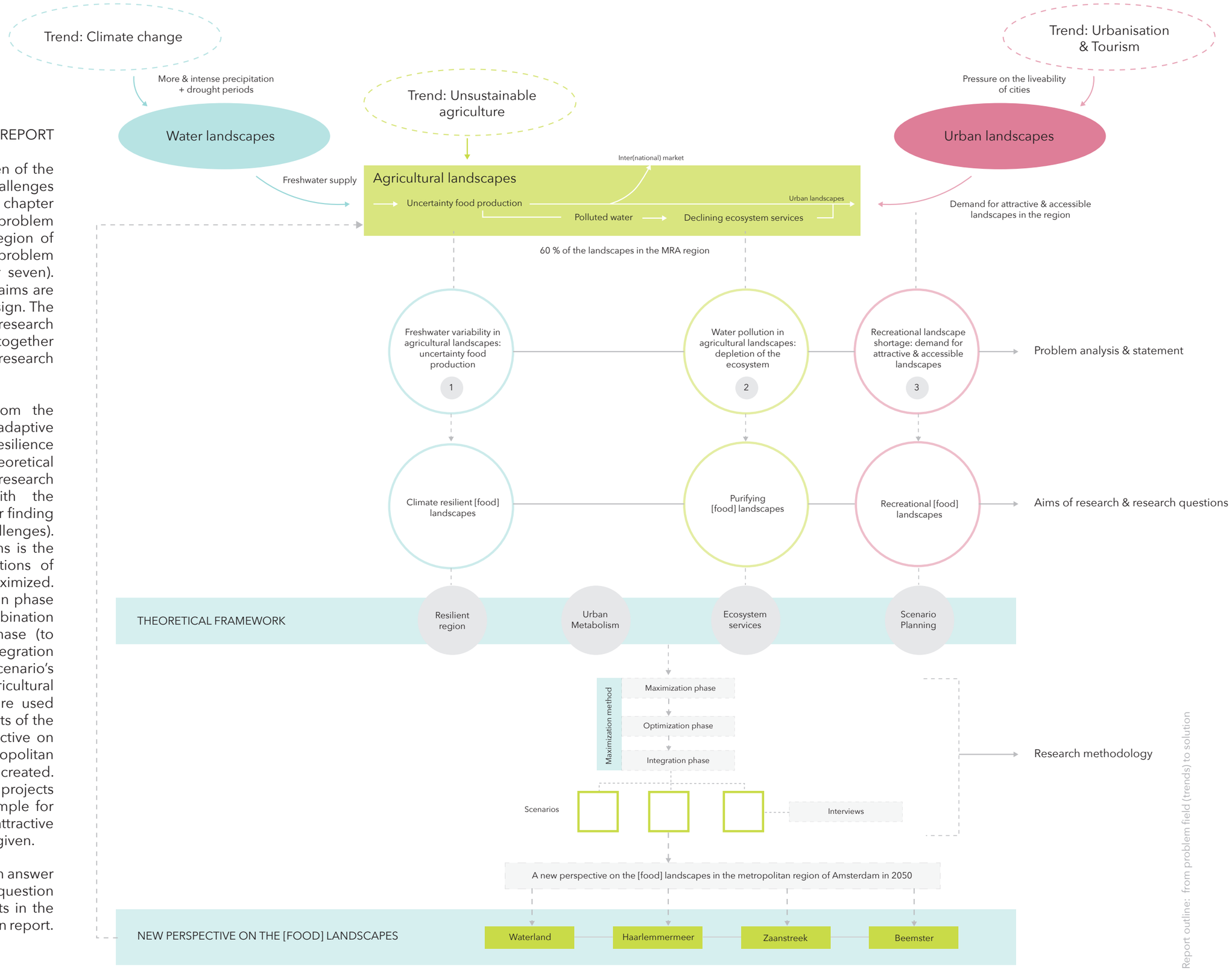
Picture of the polder landscapes (droogmakerijen landschap) in the metropolitan region of Amsterdam (Sikich, 2018)

OVERVIEW OF THE GRADUATION REPORT

In this scheme an overview is given of the structure for this report. First the challenges or trends will be described in the chapter of the problem field. Then the problem statement for the metropolitan region of Amsterdam is given (based on the problem analysis of the region in chapter seven). From this problem statement the aims are determined for the research & design. The aims are corresponding to the sub-research questions in the research, that together will give an answer to the main research question in the report.

The research is approached from the direction of urban metabolism, adaptive planning, ecosystem services and resilience theories that together form the theoretical framework. With this approach the research methodology is designed (with the maximization method as a basis for finding integrative solutions on the challenges). The first phase in finding solutions is the maximization phase, where solutions of different problem theme's are maximized. The next steps are the optimization phase (to find the most optimal combination of solutions) and integration phase (to create the final solutions). This integration phase is combined with different scenario's for the transition of the agricultural landscapes towards 2050, that are used to create interviews. With the results of the interviews a new regional perspective on the [food] landscapes in the metropolitan region of Amsterdam in 2050 is created. Together with the design of pilot projects in the region, in this way an example for the transition towards resilient & attractive [food] landscapes in the region is given.

Finally, in the conclusion chapter an answer will be given to the main research question and a reflection on the end results in the research & design of this graduation report.



Report outline: from problem field (trends) to solution

THE PROBLEM FIELD

CLIMATE CHANGE IN THE NETHERLANDS

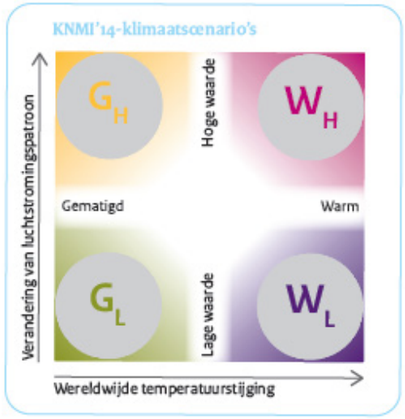
The KNMI (Royal Dutch Meteological Institute) climate scenario's (2014), translate the results of the research on global climate change towards the future from the IPCC (2013) to the Netherlands. The four scenario's represent the vertices, where climate change in the Netherlands is most propably going to be within according to the latest insights (KNMI, 2014). The scenario's illustrate the climate change effects towards 2050 and 2085, in relation to the climate in the past time period of 1981-2010.

The variables that determine the four scenario's are the global temperature rise (moderate or warm) and the possible change in air flows (low or high) (see image 2). Because climate change is already on-going (and the first effects of climate change are starting to become visible) adaptation to this trend in the future is inevitable to create a resilient region for the future. Water systems are particulary sensitive to changes in the climate system (Suraje Dessai, D Groves, R Lempert, 2009) and furthermore the effects of climate change are larger in delta regions (Scientas, 2018). This makes it interesting to look at the variability of the waterflows in the metropolitan region of Amsterdam towards the future.

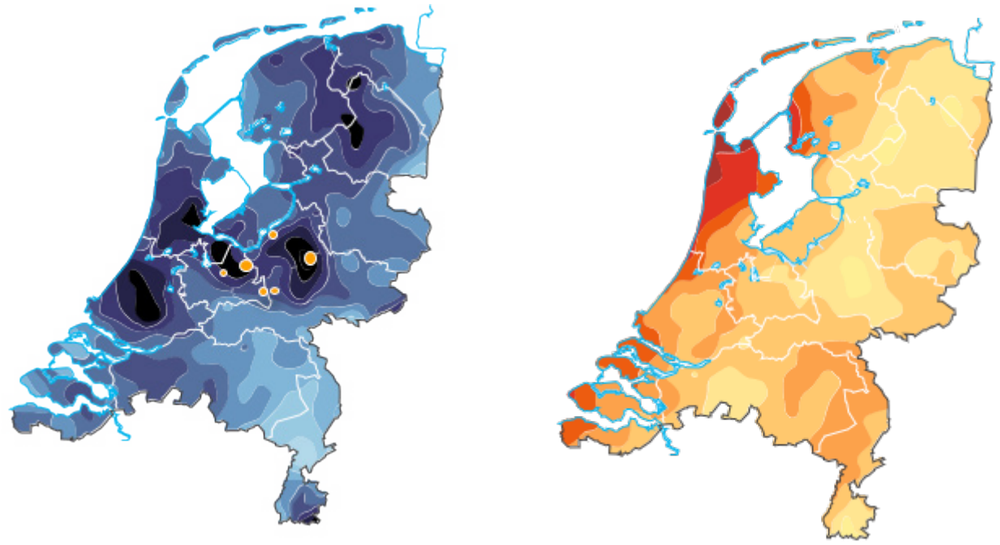
In the next graphic the average quantity of precipitation (mm) in one year in the Netherlands is visible for the winter and summer periods (see image 3). The four climate scenario's are used to develop a prediction on the precipitation of the future in 2050 and 2100. Next to the precipitation (or drought) also the sealevel rise is part of the climate change effects in the Netherlands. In this research the focus is on the relation between the freshwater flows and food production landscapes. Therefore the sealevel rise will not be further researched. However, it does have an impact on the water level in the agricultural landscapes. Because with a rising sea level and more water in the rivers to the sea during rainy periods, it will be difficult to pump the high water levels into the regional watersystem to create good conditions for the food production landscapes.

Another effect of climate change in the Netherlands is the higher average temperature, especially during summer periods. This will create more difficulties in periods of drought, however at the same time also gives opportunities for the food production (crops) landscapes if there is enough freshwater available.

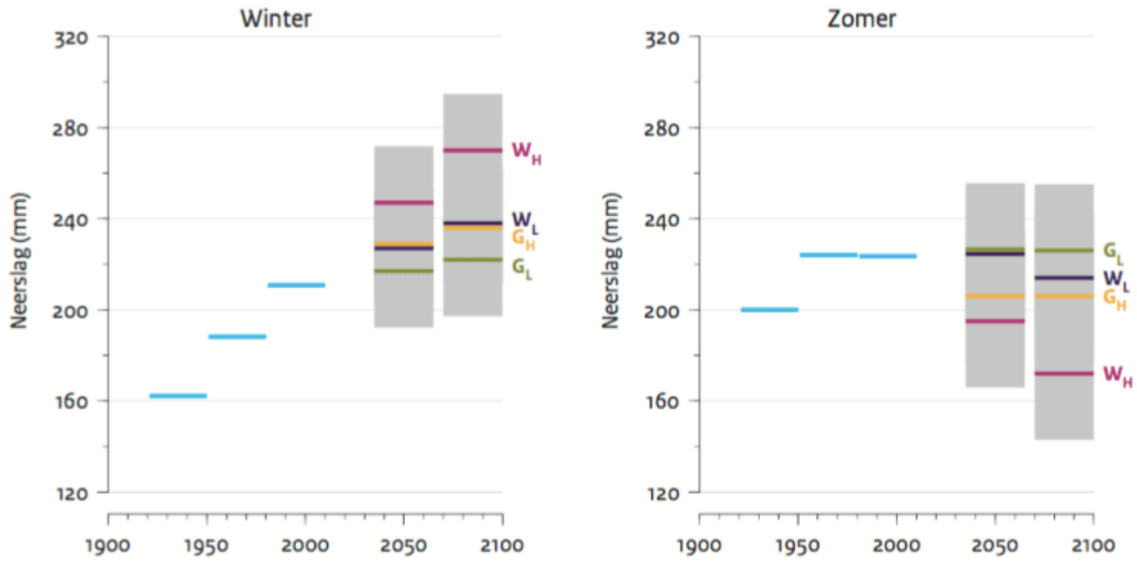
The climate scenario that will be used for the research in this report is the Wh-scenario. Since this climate scenario is the most extreme in the predictions for the precipitation and periods of drought towards the future. As a result this will give a regional strategy that solves the problems of freshwater variability in food production landscapes even for the most extreme scenario. Furthermore according to the IPCC (2013) the climate change effects that are already going on today, were predicted before in the most extreme scenario's. The timeframe that is chosen for the research in this report is towards 2050. The climate change predictions in 2050, created by the KNMI, are more accurate than the predictions for the long-term perspective of 2100 because the uncertainty of the predictions increases with time (KNMI, 2014). Additionally for a regional strategy the solutions created for a timeframe towards 2050 are more feasible then on the longer timescale.



Climate scenario's KNMI for the Netherlands (KNMI, 2014)



Visible is that the climate change effect on the precipitation and drought has the largest impact in the metropolitan region of Amsterdam (Zeegers, 2018)



Precipitation during winter and summer periods in the Netherlands (Scientas,2018)

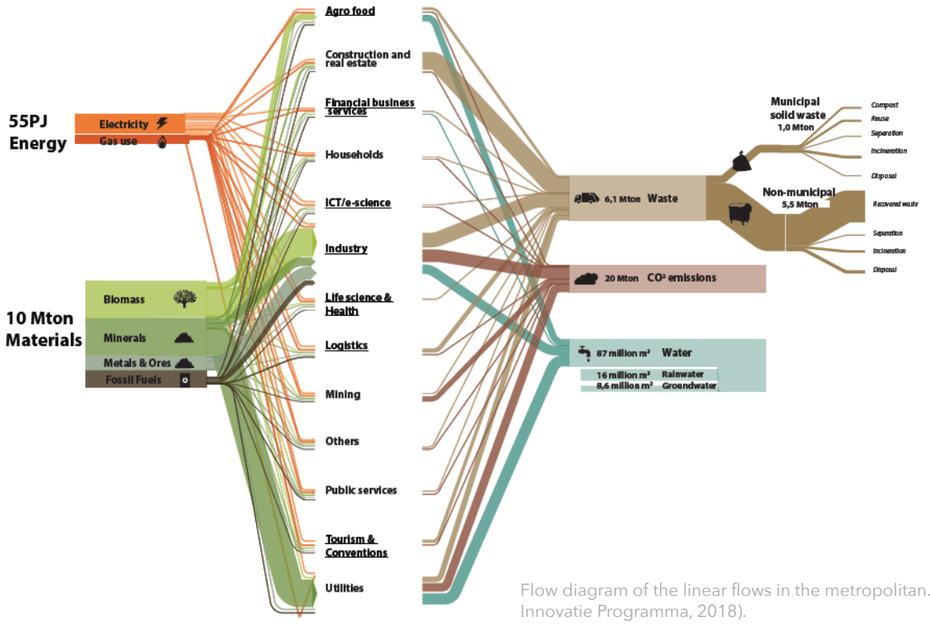
2. UNSUSTAINABLE WAY OF AGRICULTURE: A LINEAR FOOD PRODUCTION SYSTEM

The current trend in the agricultural landscapes of the Netherlands is a linear food production system, that requires a lot of input of resources and creates a lot of output of (waste) flows. This process is visible in the flow diagram of the metropolitan region of Amsterdam.

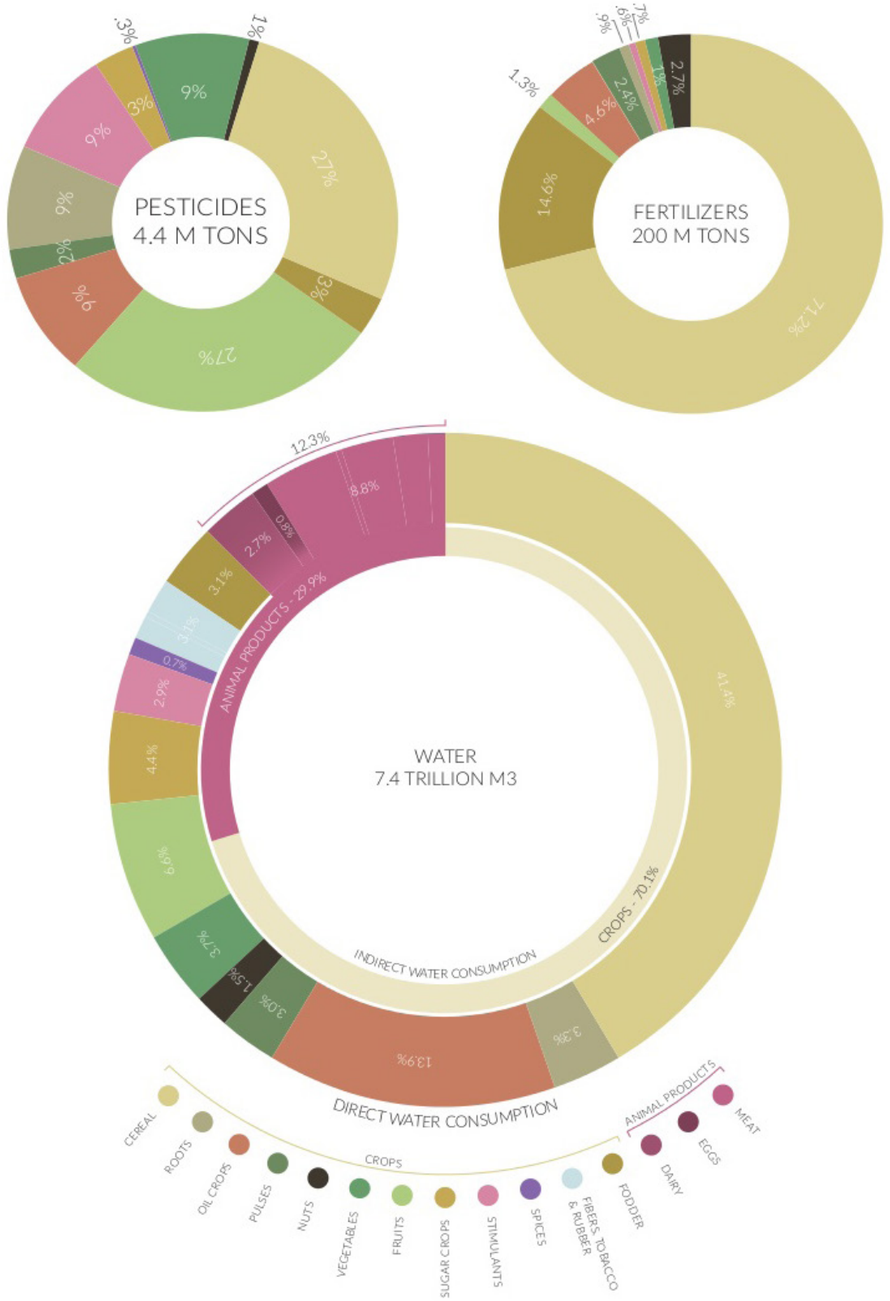
One of the largest flows that is part of the input as well as the output of this food system is water. Freshwater is needed for the food production system and in the food production landscapes of the region a lot of waste water is created. In one year 16 million m3 of rainwater and 8,6 million m3 of groundwater is used in the metropolitan region. (see flow diagram). The large quantity of water use if not surprising if we look at how much water is needed for the food production of crops and animal products. (cirkel diagram).

This will become a problem in the future with the trend of climate change, because the freshwater supply for the food production landscapes will become more variable, this means that sometimes there is not enough freshwater available.

Furthermore another problem is the use of pesticides and fertilizers in the agricultural landscapes that are polluting the large amount of water that is used for the crops and animal food production. This is resulting in a depletion of the ecosystem of the landscapes, and is especially in the Netherlands a problem because a lot of pesticides and fertilizers for agricultural landscapes are imported and this high amount of artificial substances are declining the natural balance of the soil and water in the landscapes (Golternman, 1976).



Flow diagram of the linear flows in the metropolitan. (Circulair Innovatie Programma, 2018).



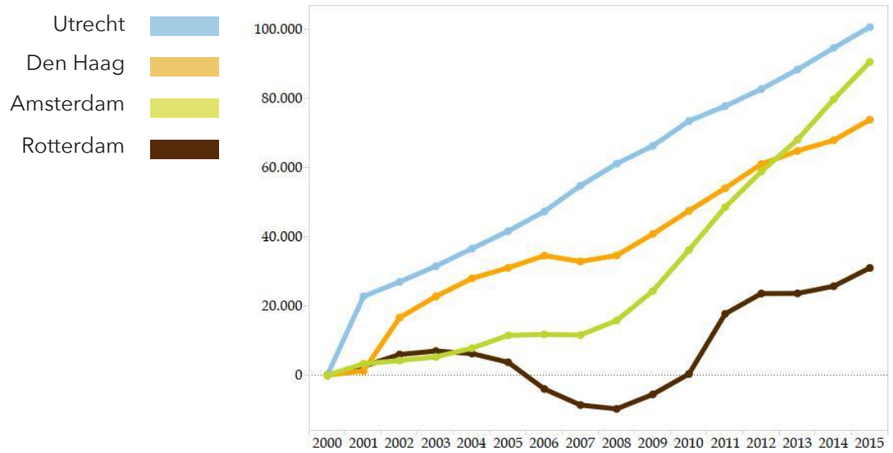
Water quantity used for the food production per type & pesticides + fertilizers use. (Metabolic, 2016)

3. URBANISATION TREND

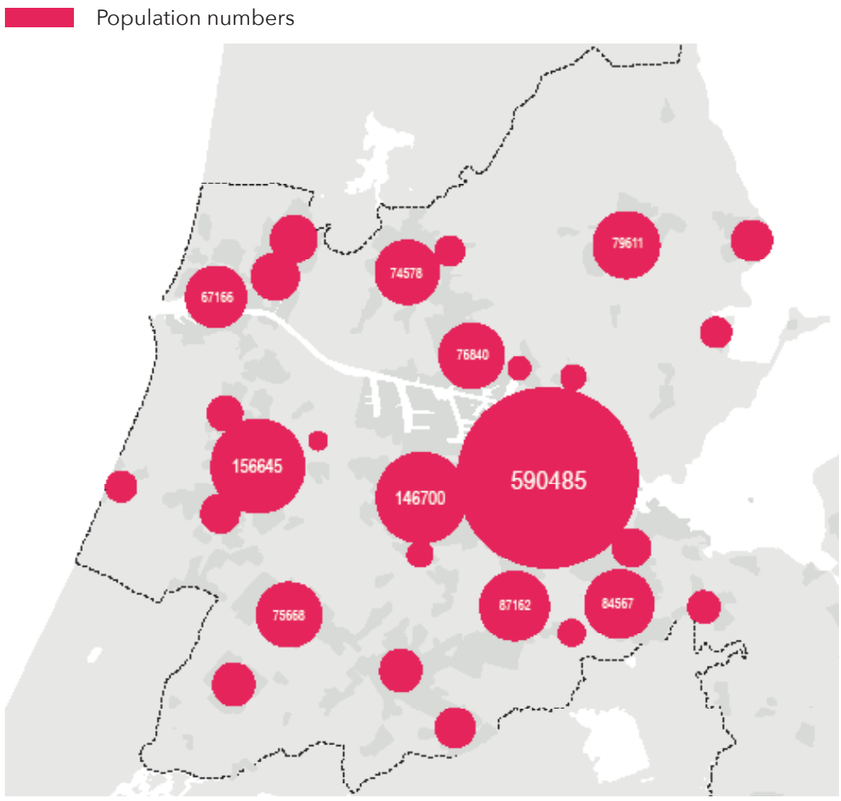
The urbanisation trend in the metropolitan region of Amsterdam is an impulse and challenge at the same time. The increasing concentration of people and companies in the region creates opportunities for investments and innovation. However, at the same time a large quantity of new houses needs to be realised within an already densified urban landscape (since the Dutch Nota Ruimte with a policy focus on building within the contours of the cities ('inbreiding') instead of expansion in the landscapes (2006)) and a demand for new houses that is the highest in the largest cities of the region (e.g. Amsterdam) (Vereniging Deltametrool, 2017).

This results in cities with a higher density towards 2050 in the metropolitan region of Amsterdam. The most recent research on the demographic growth shows that the pressure on the housing stock in the metropolitan region of Amsterdam in the Netherlands is higher than ever before. The predictions for the popultation growth in the cities of the metropolitan region are visible in the maps below. In the period of 2010-2040 the demand for new houses in the region will be 300.000 (without taking into account the replacement of old houses (MRA denktank, 2013). In the existing 'Ontwikkelingsbeeld 2040' for the region this demand for houses towards the future is not even calculated.

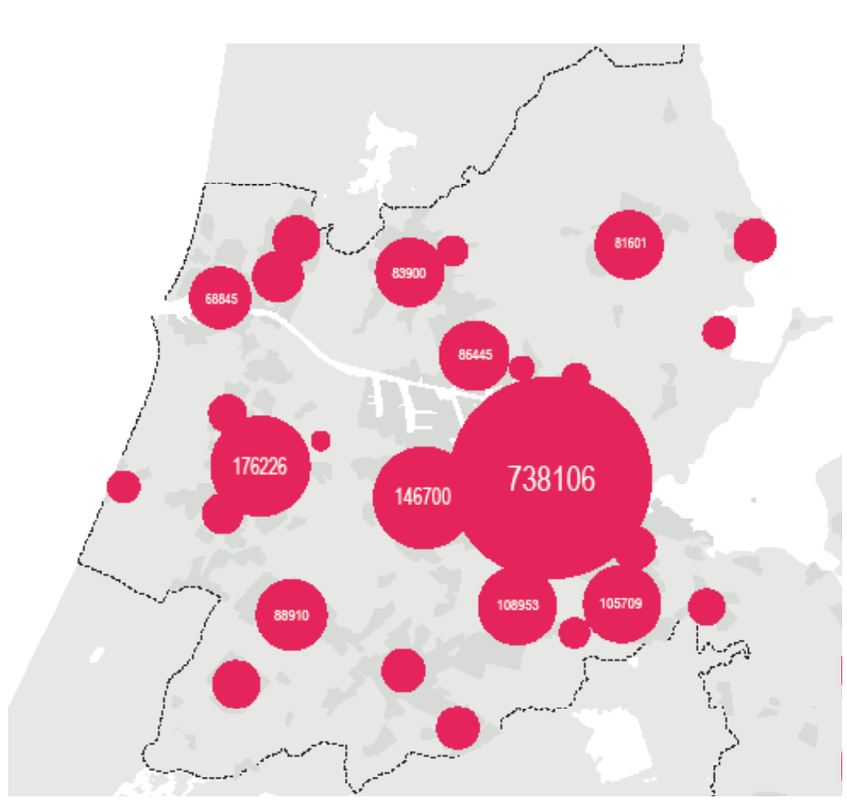
The challenge is to create a high-quality liveability for the growing number of people living in the urban landscapes of the metropolitan region towards 2050. In order to maintain and strenghten the international competitive position of the region for companies, residents and visitors.



Absolute population growth in the city of Amsterdam (Rekenkamer Amsterdam, 2016)



Popultation of the metropolitan region of Amsterdam in 2016.
Source: images by author. Based on rekenkamer Amsterdam (2016)



Popultation of the metropolitan region of Amsterdam in 2040.
Source: images by author. Based on rekenkamer Amsterdam (2016)



Problem field (trends) and problem statement overview

''Uncertainty in the food production caused by the impact of climate change on freshwater, the depletion of the ecosystem (of freshwater) in the agricultural landscapes by the current way of working, and the demand for a connection between the cities and landscapes because of the urbanisation trend, are asking for a transition in the agricultural landscapes of the region towards 2050 that can reserve these problems and create atttractive & resilient regional landscapes for the future.''

THE OBJECTIVES

AIMS

Based on the problem statement on the previous page, the following aims for the graduation project are defined:

Climate resilient [food] landscapes

The agricultural landscapes in the region need to become resilient to the variability in freshwater flows caused by climate change towards 2050. This could be done, by creating a more circular water system with the possibility for waterstorage as a buffer or by introducing new (salt) food types.

Purifying [food] landscapes

The agricultural landscapes need to recyle the polluted water to obtain more freshwater for the food production where possible. Furthermore nature could be introduced in the landscapes to purify the polluted water. In that way the ecosystem of the landscapes will improve and the resilience of the landscapes towards 2050 will increase.

Recreational [food] landscapes

- Attractive [food] landscapes

By improving the resilience and ecosystem of the landscapes, new opportunities for other types of activities could arise (as recreation, sustainable energy). These new opportunities could be integrated with the agricultural landscapes of the future in an attractive way.

- Accessible [food] landscapes

New agricultural landscapes will be created towards 2050 by improving the resilience & ecosystem and creating new activities in the landscapes (recreation, sustainable energy innovation). The cities are connected to these attractive landscapes at short distances by a sustainable network in the region.

The goal of these aims is to resolve the problems that are mentioned in the problem statement and create an attractive & resilient metropolitan landscape in the region of Amsterdam in 2050.

RESEARCH QUESTION & DEFINITIONS

From the problem statement and research & design aims the following research question is created:

"How to design a new perspective on the food landscapes in the metropolitan region of Amsterdam towards 2050 for a landscape that is resilient to the effects of climate change, to restore the ecosystem (in the freshwater) of the landscape and create opportunities for new activities to start that will strenghten the connection between cities and landscapes, for a resilient & attractive region?"

This research question does not only include the process of developing of a new perspective for the metropolitan region of Amsterdam in 2050, but also the actual new perspective as an end-product.

The hypothesis:

"What if we transform the agricultural landscapes in the metropolitan region of Amsterdam into a circular perspective on freshwater & polluted water flows, to deal with the shortage of freshwater and recycle the nutrients out of the water. At the same time new food types are introduced in the wet, dry or salt conditions and nature is created in landscapes that are not suitable for food production anymore. This will increase the ecosystem by creating more biodiversity and non-depleting or polluting the environment. By restoring the ecosystem of the landscapes, the resilience towards 2050 will increase. And by merging other functions (recreational, sustainable energy) into the food production landscapes also the social and economical resilience will improve. The landscapes become more attractive for people living or visiting the cities in the region and the liveability in the region & connections between the cities and the [food] landscapes will advance.

SUB-QUESTIONS

The research question in the previous paragraph is divided into five sub-questions that can be answered with the research. Together the sub-questions give an answer to the main research question and resolve the problems as mentioned in the problem statement. Furthermore the sub-questions are corresponding to the aims of the graduation project.

SQ1: How to create a food production landscape that is resilient to the variable freshwater flows caused by climate change towards 2050?

SQ2: How can the ecosystem of the agricultural landscapes be improved, by re-cycling and purifying the polluted water in the landscapes?

SQ3: How can attractive agricultural landscapes be created by combing the landscapes with new opportunities for activities?

SQ4: How can the cities be connected to these new attractive & resilient landscapes in the future?

SQ5: How can the results be combined in a new perspective on the [food] landscapes in the metropolitan region of Amsterdam in 2050?

THE THEORETICAL FRAMEWORK

The research and design in this graduation report are grounded in the following theories: urban metabolism (urban ecology), adaptive planning , ecosystem services and resilience thinking. The image below shows the most important literature about these theories that is reviewed to get a clear understanding of each theory.

The conceptual framework on p. 48 is linked to this theoretical framework. The climate change & urbanisation trends with the corresponding scenario's that are predicted for 2050, are an important part of the adaptive planning theory.

The theory of Urban Metabolism is represented by the flows of freshwater and polluted water in the agricultural landscapes of the region and the solution of a circular watersystem. Furthermore the theory of ecosystem services is used for the aim of improving the ecosystem of the landscapes and creating attractive landscapes for the cities.

Finally, resilience thinking is represented in the aim of creating a resilient food landscape and the main goal of the graduation project: creating a resilient & attractive metropolitan [food] landscape of Amsterdam in 2050.

A framework for resilience in agricultural landscapes is created in the theory paper (see appendix).

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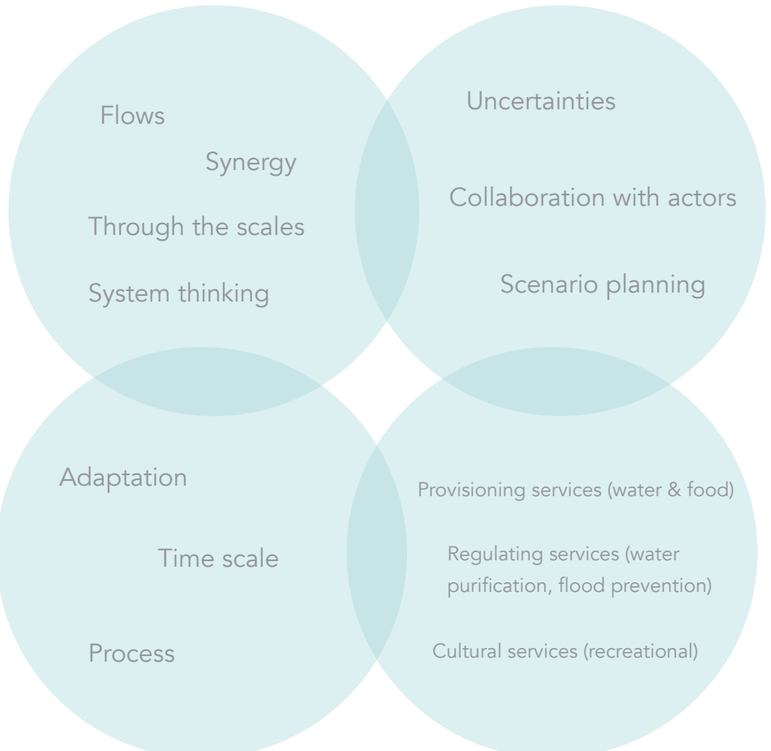
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GUNDERSON, L. H., HOLLING, C. S. (Eds). 2002. Panarchy: understanding transformations in human and natural systems. Washington, D.C.: Island Press.

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URBAN METABOLISM (URBAN ECOLOGY)



ADAPTIVE PLANNING

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There is a lot of uncertainty in planning with climate change towards the future. Therefore a new organisational/ governmental model is needed to create a more collaborative and adaptive spatial planning system in the Netherlands. In this way the problems that will arise because of climate change in the future can be more efficient and effectively tackled. At the same time while bringing together the different levels of govenance, a new planning model will be created that is capable of responding quickly to climate change problems and is working together in the long run on climate change adaptation solutions towards 2050 & 2100.

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RESILIENCE

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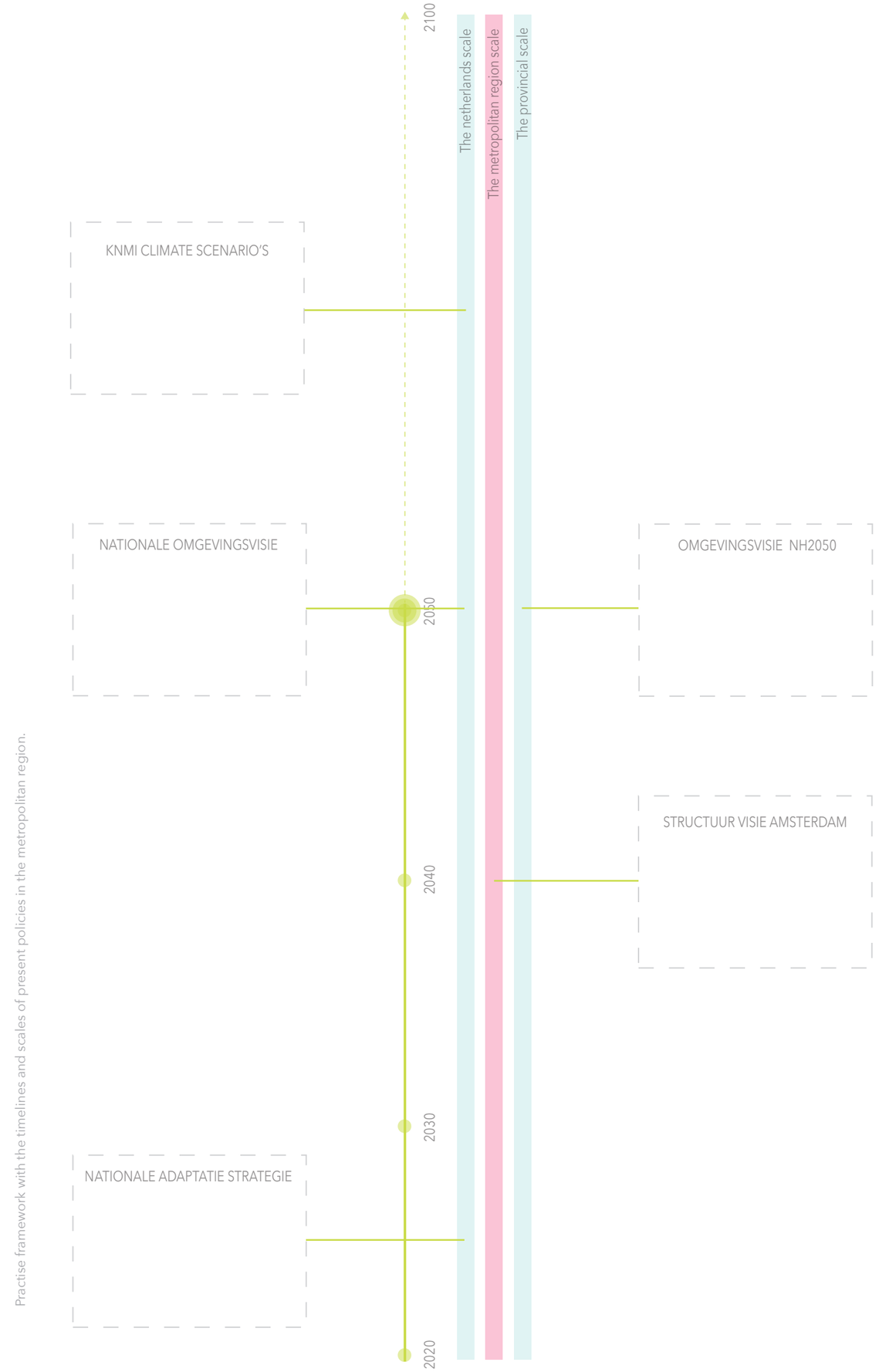
HOLLING, C. S. 2001. Understanding the complexity of economic, ecological, and social systems, Ecosystems, 4, 390-405.

THE PRACTICE FRAMEWORK

EXISTING POLICIES IN THE METROPOLITAN REGION OF AMSTERDAM: SETTING OUT THE CONTEXT

Before starting with the research & design in this graduation report, it is not only important to have an clear overview of the theoretical framework but also of a practise framework in the region. In the following image the existing policies that are important as a context to work with in the Netherlands and metropolitan region of Amsterdam are given.

Since 2018 the policies of different sectors in the Netherlands and the region are combined into one document: the National and NH2050 environmental visions. This makes it easier to have an overview of all the specific theme's in one place. Furthermore, the Structuurvisie Amsterdam is important for the context of the metropolitan landscape of Amsterdam. Since there are more detailled guidelines given in this document and the focus is especially on the landscape of the region.



RESEARCH METHODOLOGY

SUMMARY OF THE PROBLEM STATEMENT & RESEARCH QUESTION

For the research methodology chapter in this report, it is important to have a clear definition of the problem statement & research question. In order to allign the problem statement and research question with the research methodology.



THE PROBLEM STATEMENT

"Uncertainty in the food production caused by the impact of climate change on freshwater, the depletion of the ecosystem (of freshwater) in the agricultural landscapes by the current way of working, and the demand for a connection between the cities and landscapes because of the urbanisation, are asking for a transition in the agricultural landscapes of the region towards 2050 that can reserve these problems and create atttractive & resilient regional landscapes for the future."

THE RESEARCH QUESTION

"How to design a new perspective on the food landscapes in the metropolitan region of Amsterdam towards 2050 for a landscape that is resilient to the effects of climate change, to restore the ecosystem (in the freshwater) of the landscape and create opportunities for new activities to start that will strenghten the connection between cities and landscapes, for a resilient & attractive region?"

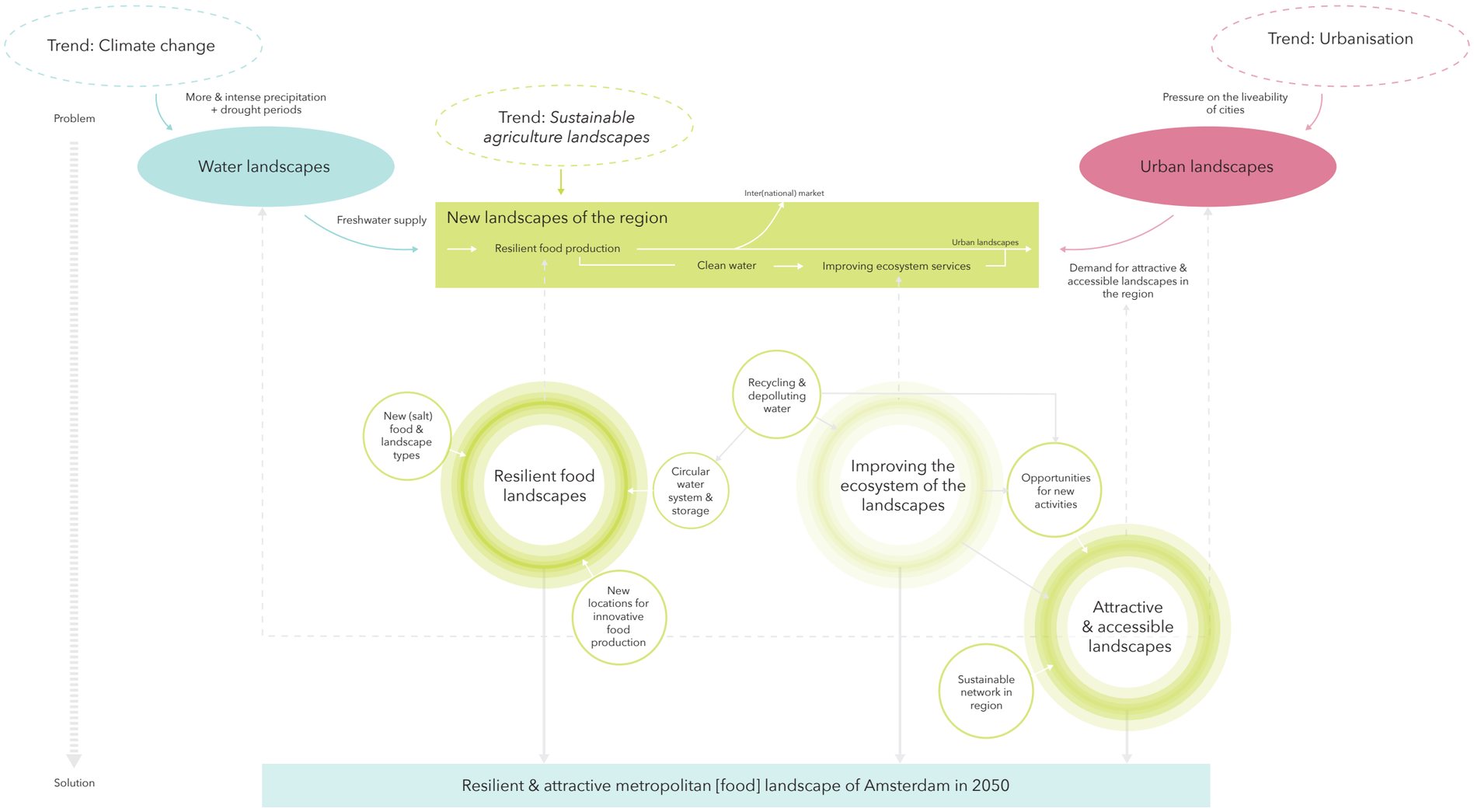
THE CONCEPTUAL FRAMEWORK

In the next image the conceptual framework that is used in this graduation report is visible. The framework builds up from the problem field (trends) to the solutions for the problem statement in the report.

The trends of climate change and urbanisation in the metropolitan region of Amsterdam are difficult to change. However, by changing the trend of a non-sustainable way of agriculture in the region into a sustainable way, a resilient food landscape to these trends can be created. This resilient landscape is achieved by implementing a circular water system in the agricultural landscapes, creating new types of food production and landscapes and searching for innovative locations of food production.

The circular watersystem is also having a positive impact on the ecosystem of the landscapes by recyling of the polluted water. This recycling process of the water and improved ecosystem in the landscapes gives opportunities for new activites in the landscapes of the region (as sustainable energy production, recreation). And therefore contributes to an attractive landscape. This landscape of the region is made accessible by a sustainable transportation network between the cities and landscapes and thus giving a solution for the growing demand for attractive & accessible landscapes.

The largest circles represent the aims of the research and design, together they are working towards the main aim of the graduation project "A resilient & attractive metropolitan [food] landscape of Amsterdam in 2050".



THE SCALES OF RESEARCH & DESIGN

The research and design in this graduation project will be done on multilple scales. The reasons for choosing these specific scales will be given in this paragraph. The focus in the graduation project is on the scale of the metropolitan region of Amsterdam.

XL

To position the project in a broader context, the scale of Europe is included. In the final chapter of the graduation project, a reflection on the vision and new perspective on the metropolitan landscape of Amsterdam towards 2050 is given. This is done by looking at the solutions in the new perspective that could be translated to other metropolitan regions in Europe, by up-scaling the concept for the metropolitan region of Amsterdam.

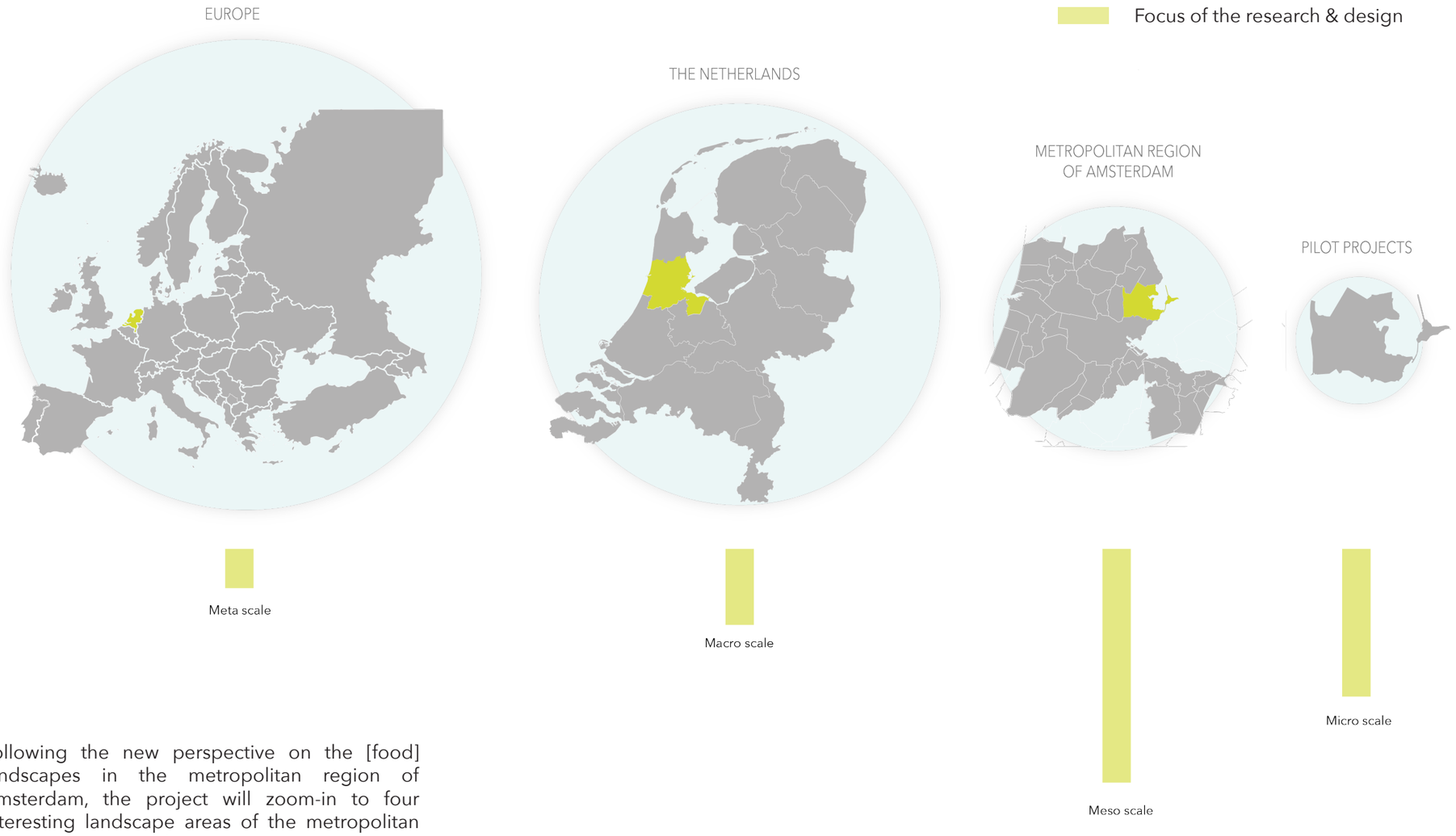
L

On the scale of the Netherlands, the main challenges towards 2050 (climate change, agricultural transition and urbanisation) are researched. Furthermore, the climate scenario's of the KNMI that are used as a basis for the research are created for the Netherlands. The water system and freshwater flows on this scale are studied to get a better understanding of how the watersystem works, then when only looking at the regional scale.

And the National Enviromental Law (2016) is studied as an important document that is part of the context of the project.

M

The main part of the research and design is focussed on the regional scale of the metropolitan region of Amsterdam. The problem analysis and the research for finding solutions are mostly linked to this scale. The new perspective that will be made in this project is created for the scale of the metropolitan region.



S

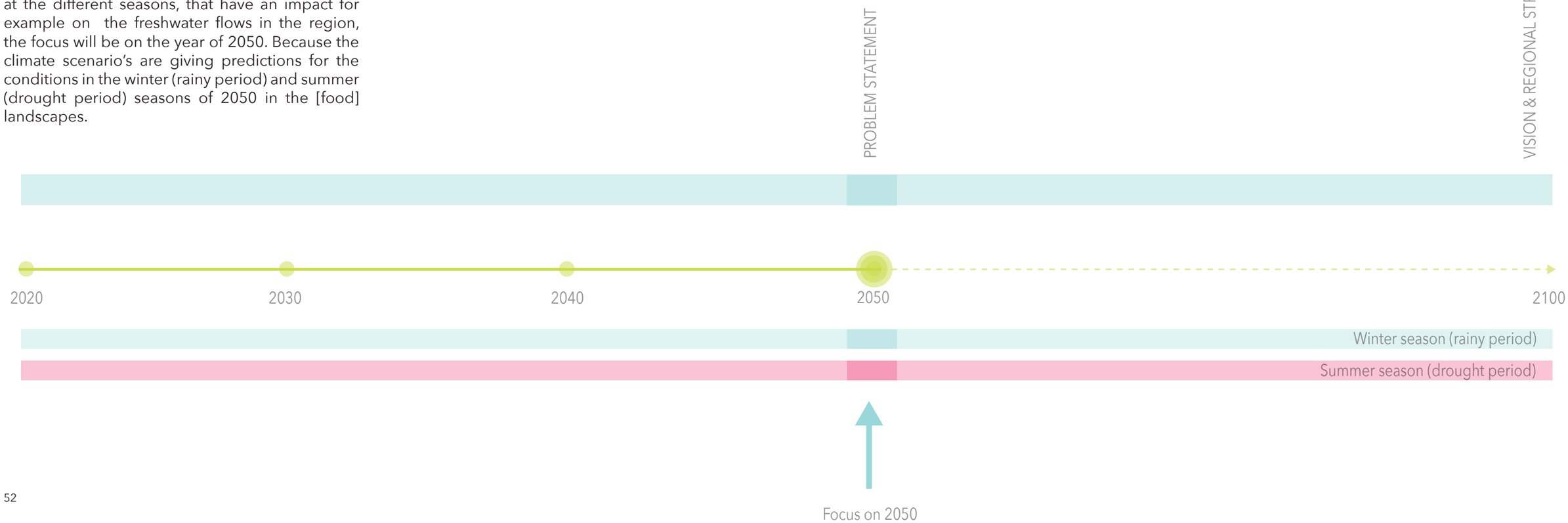
Following the new perspective on the [food] landscapes in the metropolitan region of Amsterdam, the project will zoom-in to four interesting landscape areas of the metropolitan region to show the solutions in the new perspective in the landscapes of 2050.

THE TIMEFRAMES AND SEASONS IN THE RESEARCH & DESIGN

The timeframes that are used for the research & design in this graduation report are starting from 2020 to 2100. For the problem statement and problem analysis the timeframe consists of 2050, because most of the predictions for the problems in the metropolitan region of Amsterdam are made towards 2050. With the data of these predictions the research on the problems will be done.

With designing the new perspective for the location the timeframes consists of 2020 to 2050. The reason for this is that, for the implementation of the solutions in the new perspective a longer time period is needed with different steps towards the transition of the landscapes in the future. Furthermore, the vision on the landscapes of the region will hopefully have an impact on the development of the region after 2050, towards 2100.

Overall the focus in the research & design of the project is on the timeframe of 2050. Also by looking at the different seasons, that have an impact for example on the freshwater flows in the region, the focus will be on the year of 2050. Because the climate scenario's are giving predictions for the conditions in the winter (rainy period) and summer (drought period) seasons of 2050 in the [food] landscapes.



LEGENDA OF THE RESEARCH FRAMEWORK

Phase of the research

Water landscapes

Agricultural landscapes

Urban landscapes

Methods for research

Connections in research

SQ1 Sub-question

Aims

THE PROBLEM STATEMENT

''Uncertainty in the food production caused by the impact of climate change on freshwater, the depletion of the ecosystem (of freshwater) in the agricultural landscapes by the current way of working, and the demand for a connection between the cities and landscapes because of the urbanisation, are asking for a transition in the agricultural landscapes of the region towards 2050 that can reserve these problems and create atttractive & resilient regional landscapes for the future.''

THE RESEARCH QUESTION

''How to design a new perspective on the food landscapes in the metropolitan region of Amsterdam towards 2050 for a landscape that is resilient to the effects of climate change, to restore the ecosystem (in the freshwater) of the landscape and create opportunities for new activities to start that will strenghten the connection between cities and landscapes, for a resilient & attractive region?''

INTRODUCTION TO THE RESEARCH FRAMEWORK

The research framework is the body of the graduation project, that will serve as a guideline for the research and design.

In the research framework three layers of research are visible. These layers are corresponding to the main problems in the metropolitan region of Amsterdam: climate change & freshwater variability in the food landscapes, unsustainable agriculture & ecosystem depletion in the landscapes and the urbanisation trend & a demand for attractive and accessible landscapes in the region. The colors of the research layers are corresponding to the landscapes that the problems are related to (see p. 18).

It is interesting to do research on these three problems in the region, because there is a lot of potential in the integration of solutions for these problems. For example: freshwater storage could be combined with a recreational landscape for the cities in the region. In that way an integrative regional strategy and design could be created, that is resolving multiple problems at the same time and therefore creating more value.

The three research layers are connected to eachother by the transition of the agricultural landscapes that is needed towards 2050 to create an attractive and resilient metropolitan [food] landscape. The first (blue) and second problem (green) are interconnected by taking the flows of freshwater and polluted water (and the impact on the agricultural landscapes) as the topic of focus in the research. An example of an integrated solution of these problems could be the recycling of polluted water to improve the ecosystem in the landscapes and create more freshwater (with a purification process) for the food production.

These two problems create a necessary transition of the landscapes towards 2050, to create a resilient [food] landscape for climate change and the ecosystem. The transition of these landscapes can be done in such a way that it creates furthermore attractive and accessible landscapes for the cities in the region. This is how the third problem (pink) is connected to the other research layers.

THE RESEARCH FRAMEWORK

The research framework consists of seven phases. The first phase is the problem definition, starting with the research on three trends in the region (and the Netherlands) that have an influence on the problems in the region. The trends are climate change, the unsustainable way of agriculture (up-scaling & pollution) and urbanisation that will increase towards 2050.

The trend of climate change towards 2050 will have an impact on the freshwater flows in the region for the agricultural landscapes and with that create an uncertainty in the food production of the region towards the future. The subquestion that needs to be answered to solve this problem is: *How to create a food production landscape that is resilient to the variable freshwater flows caused by climate change towards 2050? (SQ1).* The trend of an unsustainable way of agriculture will have an impact on the freshwater & polluted water (by pesticides and fertilizers) flows in the landscapes of the region. And especially with the polluted water flows this will have an effect on the ecosystem of the landscapes. Therefore the following sub questions need to be answered: *How can the ecosystem of the agricultural landscapes be improved, by re-cycling and purifying the polluted water in the landscapes? (SQ2)* Furthermore the urbanisation trend towards the future will create a demand for attractive and accessible landscapes in the metropolitan region of Amsterdam. The agricultural landscapes in the region are not attractive today because of the monotonous landscapes and depleting ecosystem. The subquestion that needs to be answered therefore is: *How can attractive agricultural landscapes be created by combining the landscapes with new opportunities for activities? (SQ3).* Furthermore there is a missing network between the cities in the region and these landscapes. The sub-question therefore is: *How can the cities be connected to these new attractive & resilient landscapes in the future? (SQ4).*

The definition of the subquestions for the research is part of the phase 'defining the project scope & context'. Together the sub-research questions will give an answer to the main research question in the report: *How can the results be combined in a new perspective for the metropolitan region of Amsterdam in 2050? (SQ5).*



Per sub-question different types of research methods to find solutions

FINDING SOLUTIONS

Maximization phase

Mapping the potential locations

Mapping & graphics

Inspirational case studies with new food types & landscapes

Inspirational studies with innovative sustainable energy

Resilient food landscapes

4. Non-resilient landscapes for food production → 5. Creating waterstorage in landscapes → 6. New water levels for soil subsidence → 7. New food types (dry, wet & salt) → 8. Sustainable energy in combination with food

Improvement flows of polluted water in food landscapes

Literature review on the possibilities to use nature for purification of polluted water

Principle sections with water flows

4. Circular water system → 5. Introducing nature to purify the polluted water in the landscapes → 6. Circular & purifying greenhouses watersystems

Improving the ecosystem of the landscapes

Overview of new activities that could be combined with the food landscapes

Mapping & graphics

4. New opportunities for activities in landscapes that create a better connection with the cities (sustainable energy, recreation) → 5. Sustainable network in region between landscapes

Attractive & accessible landscapes

The third phase of the research framework is ‘finding solutions’. In this phase an answer will be given to the sub-questions of the previous phase of research.

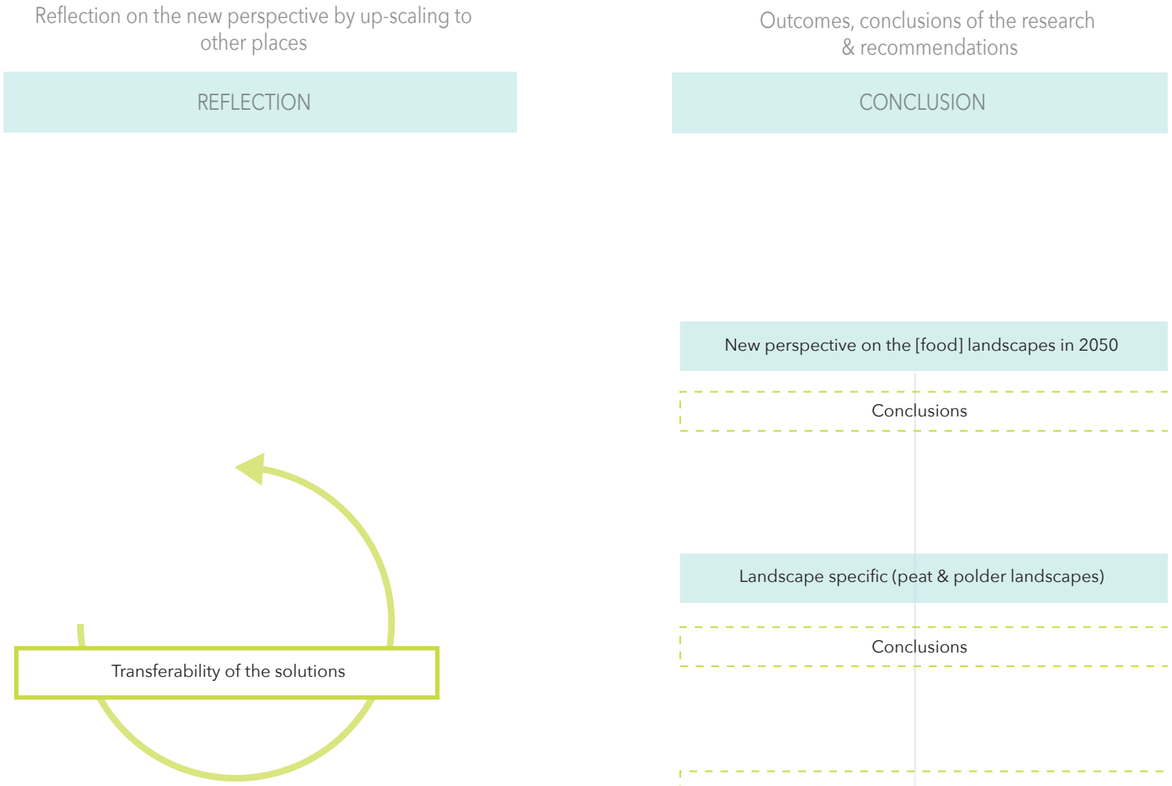
From the analysis on the impact of freshwater variability in the agricultural landscapes, two different locations could be defined: resilient & non-resilient. In the resilient landscapes the food production process towards 2050 will continue, if there is enough freshwater available. Therefore research on a circular water system and storage in the landscape will be done. For the landscapes that are non-resilient an inspirational study will be done on new food types and landscapes for the future.

The problem of the impact on polluted water on the ecosystem of the landscapes will be solved by the circular water system in the landscapes. Furthermore research will be done on possibilities to purify the polluted water in the food landscapes.

By improving the ecosystem of the landscapes, new opportunities for activities in the agricultural landscapes arise. These new activities in the landscapes could be designed in such a way that it creates a better connection between the cities and lansdscapes of the region. This is supported by a research for the possibility of a sustainable network that is connecting the different landscapes and cities of the region.

In this way, by doing research for solutions and answering the sub-questions a new vision for the region will be created (see image 3).





In the fourth phase of the research different scenario's will be created with the theme's in the maximization method. Subsequently these scenario's of the future region (with a selected focus theme) will be given to different actors in the region and results will be gained by interviews with the actors. The results will be reflected upon with the aims of the graduation project, and translated into a new perspective on the [food] landscapes in the metropolitan region in 2050.

Furthermore this new perspective is further developed in the most interesting locations, where problems are concentrated or there is a lot of potential in the combinations of solutions. There will be zoomed-in to the locations of waterland, haarlemmermeer, zaanstreek and the beemster to show how it will be possible to design for the future [food] landscapes with this perspective. And to give an impression of how the landscapes will look like in 2050.

In the reflection phase, the new perspective will be tested by looking at the possibility for up-scaling the results to other metropolitan regions in Europe. This could be seen as a inductive research approach, as the specific problems in the metropolitan region of Amsterdam are first analysed to develop solutions. And more general lessons from this research could be found to be implemented in other metropolitan regions too.

The outcomes of the research and design will lead to a conclusion in the report that is giving an answer to the main research question and reflects on the solutions for the problem statement. Furthermore recommendations are given for future steps in the research.

For a more detailled overview of the research method that are used in this graduation report, the scales and end products see in the appendix.

RESEARCH METHODS IN THE RESEARCH FRAMEWORK

In the research framework several research methods are mentioned. In this paragraph these methods will be explained and reasons for the use of the methods in the research will be given.

To give an answer to the first research question in the framework: *How to create a food production landscape that is resilient to the variable freshwater flows caused by climate change towards 2050? (SQ1)* the following research methods are used.

1. Climate change scenario planning

Scenario planning is often used to predict challenges in the future. Because there is a lot of uncertainty in these challenges different scenario's are given for possibilities in the future. The KNMI (Royal Dutch Meteological Institute) has translated the most up-to-date climate scenario's of the IPCC (for the world), to the Netherlands (KNMI, 2014). In the graduation project, the most extreme Wh-scenario for climate change towards 2050 in the Netherlands will be used for research, to create a regional strategy and design of the landscapes that are resilient to even the most extreme scenario. Furthermore the timeframe of 2050 is chosen, because the climate scenario's that give predictions for 2100 have more uncertainty.

2. Flows analysis of freshwater

The climate scenario (Wh 2050), will be an input for research on the freshwater flows in the food production landscapes. These freshwater flows will be analyses on the national scale to understand the larger freshwater system, and then later on in the metropolitan region of Amsterdam for the existing situation and the climate change in 2050 scenario (in the winter as well as summer). With the analysis of the changing freshwater flows in the region, the impact on the agricultural landscapes could be predicted.

3. Analysis on the impact of freshwater variability in agricultural landscapes in the region

With the analysis of the freshwater flows in 2050 in the agricultural landscapes of the region for the winter (wet situation) and summer (dry situation), the new conditions of the landscapes could be mapped. These new conditions give opportunities as well as threats to the food production in the landscapes of 2050. This is made visible in a conclusion map of the problems in the landscapes in 2050. This conclusion map is will be the final part of the problem analysis and the start of finding solutions for these landscapes.

4. Improvement flows of freshwater

In the landscapes that are resilient to the new conditions in 2050 (see conclusion map), it is important to have enough freshwater available during the summer (dry) periods. Therefore an analysis of the freshwater flows will be done to create a circular water system where possible. Furthermore water storage in the landscapes will be introduced where needed and a new water level is introduced in landscapes with soil subsidence.

5. Inspirational case studies (with new food types)

In the food landscapes that are not resilient to the new conditions in 2050 (see conclusion map), new food types could be introduced. Therefore an inspirational case study will be done, to see other projects where new food types are introduced that are resilient to the new conditions of the landscapes. These examples are used for the vision on these landscapes.

6. Innovative projects for food production landscapes

From the SWOT analysis in the conclusion map, new potential locations for food production become visible towards 2050. In landscapes that are no longer suitable for food production, nature or other landscapes could be introduced.

To give an answer to the second research question in the framework: *How can the ecosystem of the agricultural landscapes be improved, by re-cycling and purifying the polluted water in the landscapes? (SQ2)* the following research methods are used.

1. Definition types of agricultural landscapes in the region

Before this sub-question can be answered it is important to have a clear definition of the different types of agricultural landscapes in the region. The different types of agricultural landscapes can have a different way of the process of polluted water (greenhouses and grassland for example). In this way the definition of the types of landscapes will be an input for the flows analysis of polluted water in the landscapes.

2. Flows analysis of freshwater & polluted water in the food production process

For the ecosystem in the landscapes it is important to analyse how much freshwater will be used in the process (for SQ1) and how much polluted water will be produced from this in the landscapes. This can be done with a flows analysis of the freshwater and polluted water.

3. (GIS) mapping & graphics (of the ecosystem)

The impact of the polluted water on the ecosystem in the landscapes of the region can be mapped by looking at the water quality in these landscapes. And especially at the amount of fertilizers and pesticides in this surface water of the landscapes. This map will be the conclusion map of the problem analysis on the ecosystem of the landscapes effected by polluted water of the unsustainable agriculture.

4. Improvement flows of polluted water

To improve the ecosystem of the agricultural landscapes in the region, the polluted water can be recycled to prevent it from going into the landscapes. Therefore with the previous flows analysis of freshwater and polluted water in the agricultural landscapes, opportunities for re-cycling this polluted water will be researched. This is for example possible in the greenhouses, by creating a circulair water system.

5. Literature review (on the possibilities to use nature for purification of polluted water)

In the landscapes where re-cyling of the polluted water is not an option, the ecosystem in the landscapes can be improved by introducing nature that will purify the polluted water. This nature could be used for sustainable energy or recreational landscapes to create activities in the food landscapes that make them more attractive and accessible for cities.

6. (GIS) mapping & graphics (of the ecosystem)

The final step is to create a new map of the ecosystem in the agricultural landscapes towards 2050, when re-cycling the polluted water and introducing purifying nature in the landscapes is realised.

To give an answer to the third and fourth research questions in the framework: *How can attractive agricultural landscapes be created by combing the landscapes with new opportunities for activities? (SQ4)* and *How can the cities be connected to these new attractive & resilient landscapes in the future? (SQ5)* the following research methods are used.

1. Predictive analysis of trends
The trend of urbanisation towards 2050 is predicted by the metropolitan region of Amsterdam. Based on this predictive trend and the problems that are already there in the cities of the region because of the urbanisation trend in the previous years, a map can be created with the impact of this trend towards 2050 on the recreational landscape shortage in the region.

2. Literature review
With a literature review, the elements of an attractive and accessible landscape can be defined. These elements can later on be compared with the new characteristics of the food landscapes towards 2050 to see if specific agricultural landscapes are attractive to the cities and if new activities in these landscapes can be added to strenghten the link between the cities and [food] landscapes.

3. (GIS) mapping & graphics (of the network)
With a map of the infrastructural networks in the region, it becomes clear that there is a missing network between the cities and the agricultural landscapes in the metropolitan region. And especially the type of network is important (sustainable transportation network of cycling walking and sailing routes).

4. Opportunities list
With the literature review on the elements that make an attractive and accessible landscape for cities, an opportunities list can be created with activities that can be introduced in the new agricultural landscapes to strengthen the connection with the cities.

5. (GIS) mapping & graphics (of the sustainable network)
With the new activities in the agricultural landscapes these landscapes become more attractive for the cities in the region. By creating a new sustainable network between the cities and the new [food] landscapes, they are also accessible towards 2050. This network will be mapped in the region, and is a connecting element in the new perspective for the metropolitan region of Amsterdam.

Furthermore the following research methods are used in the research framework to create a new perspective for the metropolitan region of Amsterdam in 2050:

1. Maximization method for developing the new perspective in 2050
The maximization method is a method that consist of three steps. The maximization phase is the step in which all the solutions of the problem theme's in the region will be seen apart from eachother, and being maximalized.

The second step is the optimalisation phase. In this phase, the different solutions (maximalized) will be combined to see if they can work together of exclude eachother.

The final step of this method is the integration phase, where the solutions of the scenario that is chosen will be integrated into a new perspective for the region in 2050.

2. Scenario's for the transition of the [food] landscapes in 2050
In order to find out what the most important solution theme's in the region are (for the integration phase) three scenario's will be made for the region in 2050 based on the main problems of research in the graduation project. These scenario studies can be used in the interviews with the actors in the region, to have a clear overview of the focus theme's in each scenario and give an idea of what the landscapes with each scenario would look like in 2050.

3. Interviews
Interviews with the actors of different sectors at the Province of Noord-Holland will be done to see which of the scenario's is most appreciated, based on the three scenario's. The results will be compared with the aims of the project and result in the new perspective.

THE SCOPE AND LIMITATIONS OF THE RESEARCH DESIGN

In the following image a diagram of the scope and limitations of the graduation project is visible. In the graduation project the main aim is to create an attractive & resilient metropolitan landscape of Amsterdam towards 2050. In the research and design that will be done to achieve this goal, the focus is more on some aspects than on others (see diagram).

The regional and metropolitan scale in the metropolitan region of Amsterdam will have the focus. In the research and finding solutions for the problems, all of the elements in blue will be studied. However, the emphasis is most on the food production landscapes and creating attractiveness in these agricultural landscapes. For the challenges towards 2050, the linear agricultural system with the flows of freshwater and polluted water will have the attention. And the most important outcome of the research and design in the graduation report is a vision and regional strategy that promotes an attractive and resilient metropolitan [food] landscape towards 2050.



Diagram of the research boundaries.

Scales
Research & design theme's
Landscapes types
Challenges
Expected outcomes

TYPES OF LANDSCAPES IN THE METROPOLITAN REGION OF AMSTERDAM

For the research & design on the impact of climate change, unsustainable agriculture and urbanisation trends in the agricultural landscapes of the metropolitan region, there are different layers of landscapes of importance. These four layers are visible in the following maps.

The soil types & structures (identities) of the landscapes are for example important for the water conditions for the food production with climate change towards 2050. The historical identity layer of the landscapes is furtermore important for the attractiveness of the landscapes for the cities in the region.

The types of food production landscapes are more important for the pollution of the water in the region and the impact on the ecosystem of the landscapes. As well as the possibilities to find solutions for this polluted freshwater created by the food production in the region.

The food types in the landscapes of the region are an interesting layer, to see what the impact of the trends (e.g. climate change) in the region is on the food that could be produced towards 2050. In this way it becomes clear where problems in the food production will arise and alternative types of food should be introduced.

1. Types of food produced in the metropolitan region of Amsterdam in 2018

Grass	43000 ha
Wheat	3000 ha
Sugarbeet	2000 ha
Potatoes	1500 ha
Maize	2000 ha
Vegetables	7000 ha
Barley	1700 ha

2. Types of food production landscapes in the metropolitan region of Amsterdam

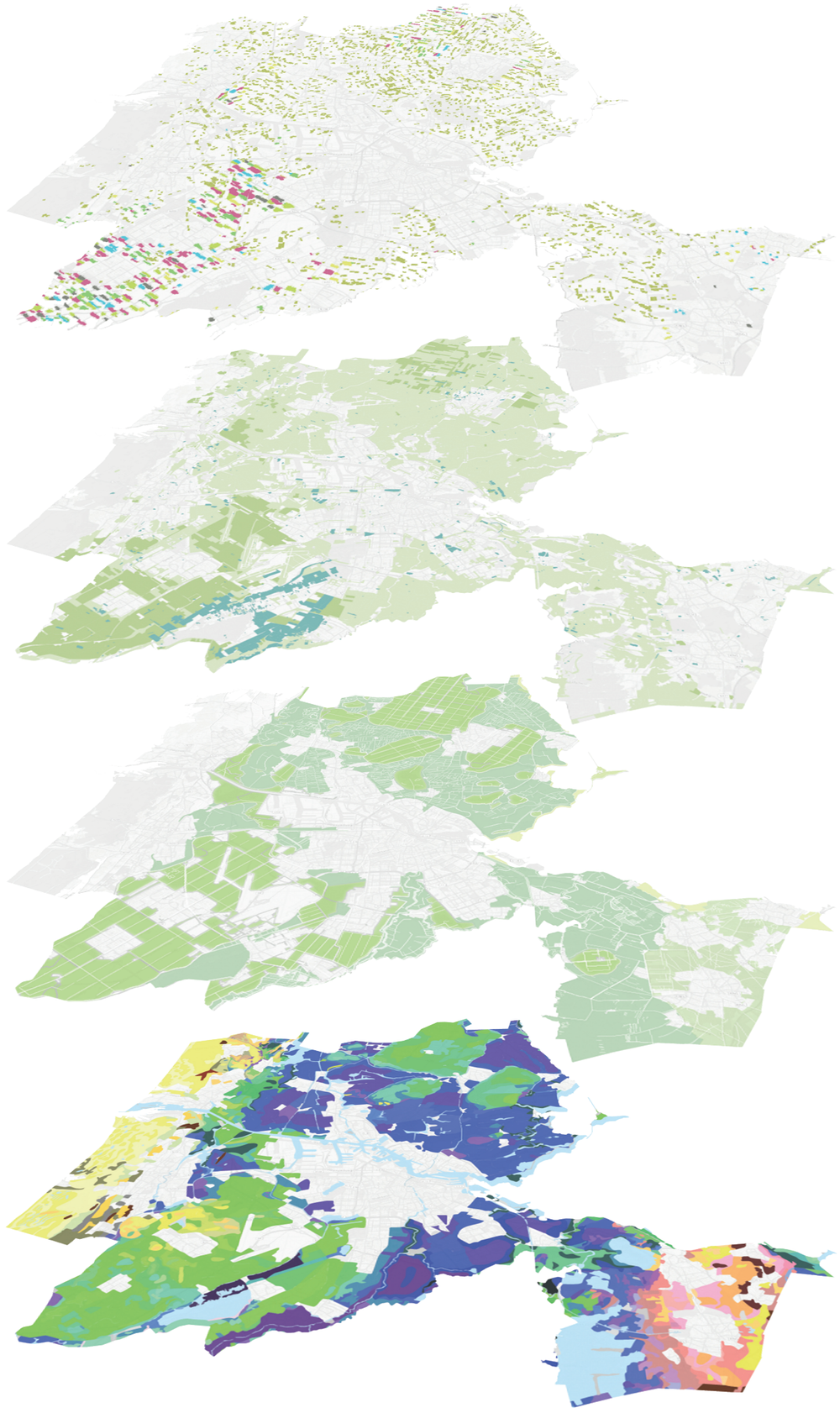
- Grassland (grasland)
- Agriculture (akkerbouw)
- Horticulture (glastuinbouw)

3. Types of landscapes with a historical identity in the metropolitan region of Amsterdam

- Polder landscapes (droogmakerij landschap)
- Peat landscapes (veenweide landschap)

4. Soil types of the agricultural landscapes in the metropolitan region of Amsterdam

- Sand
- Clay
- Sea clay
- Peat
- Sand



Schaal 1:1500000

Maps created by author & based on GIS, One Soil (2019).

THE PROBLEM ANALYSIS

1. FRESHWATER VARIABILITY & AGRICULTURAL LANDSCAPES: UNCERTAIN FOOD PRODUCTION

According to the Nationale Adaptatie Strategie for the Netherlands (2016), one of the most urgent climate change effects that needs to be resolved is the more frequent harvest damage in the agriculture and horticulture landscapes of the Netherlands caused by a variability of freshwater.

The harvest damage in the landscapes consists of reduced crop profits and loss of quality of the products due to more precipitation and water-satured soils. And through long-term periods of drought in places with insufficient freshwater supply.

The effect of climate change that will become more urgent towards the future is the salinization of the agricultural landscapes in the west of the Netherlands (Noord-Holland) due to the sea level rise and in combination with soil subsidence in the food landscapes.

In the images next to this, recent newspaper articles show the urgency of this waterproblem in the agricultural landscapes of the Netherlands during periods of drought and rainfall.



Drought period in the agricultural landscape (Droogte, 2018)



Heavy rainfall in the agricultural landscape (Natte grond, 2018)

‘Hele percelen zijn al opgegeven’

Boeren tijdens droogte

Verdord gras, maïs zonder kolven, kleine aardappels: boeren in deze droogte is moeilijk. LTO spreekt van een crisis en pleit voor maatregelen.

Geertje Tuenter 2 augustus 2018



News paper: agricultural land & drought (NRC, 2018)

Landbouw lijdt schade door hoogwater en regen: 'de bodem is verzadigd'

DRIEL - Het aanhoudende hoge water en natte weer brengt boeren in de problemen. Met name akkerbouwers en fruittelers hebben er last van. Hoe hoog de schade uitvalt is nog niet te zeggen.

Menno Pols 02-02-18, 07:00 **Laatste update:** 07:14

,,Het is al vanaf september nat”, zegt woordvoerder Maarten Leseman van boerenorganisatie LTO Nederland. ,,Het heeft de laatste maanden erg veel geregend. Daarbij is de waterstand in de rivieren ook al lange tijd erg hoog.”

Verzadigd

De schade is het grootst in laaggelegen gebieden met een kleibodem, zoals de Betuwe en het Land van Maas en Waal. Veel velden in die streken staan al vanaf half december, met een korte tussenpoos, blank. ,,De bodem is helemaal verzadigd”, zegt Leseman.

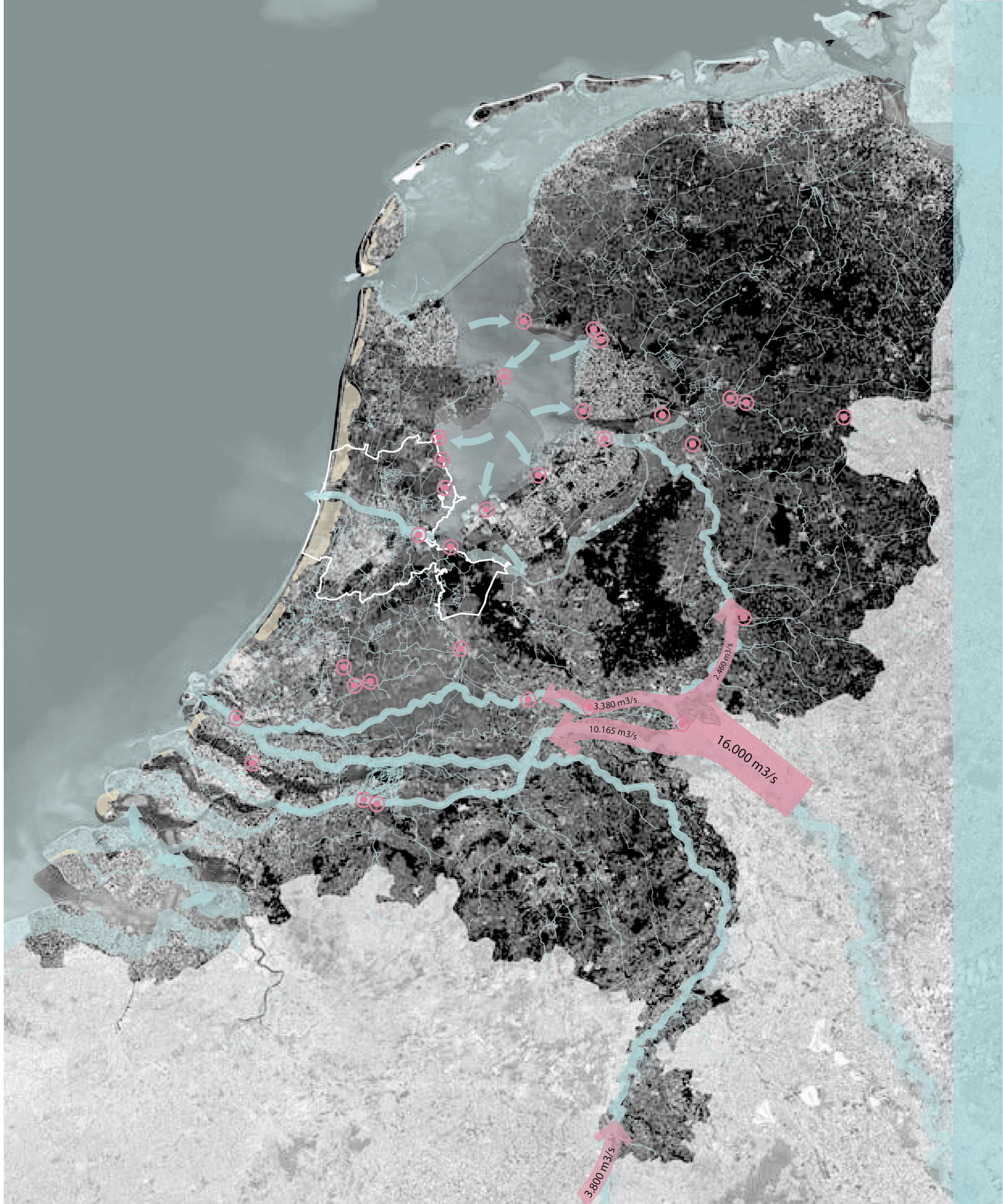
News paper: agricultural land & rainfall (De gelderlander, 2018)

FRESHWATER FLOWS FOR FOOD LANDSCAPES ON THE NATIONAL SCALE: EXISTING WINTER PERIOD

For the problem analysis of the impact of climate change (freshwater variability) on the agricultural landscapes in the metropolitan region of Amsterdam, it is important to understand the freshwater system on the larger scale of the Netherlands. The freshwater system is shown in the following map for the existing winter period and in the map on page 78 for the existing summer period. The most important freshwater flows are visible, together with the quantity of freshwater (m3/s) that is being transported to the Northsea or IJsselmeer lake during the winter and summer.

In the map are the freshwater supply points of the region given, as the main switches of the freshwater system. These supply points can regulate the freshwater flows in the Netherlands during extreme periods of rainfall or drought and with that give the future possibilities to change the freshwater system. (Ministerie van Infrastructuur & Milieu, 2012).

In the following maps the effects of climate change towards 2050 on the freshwater system in the Netherlands, are visible and the metropolitan region of Amsterdam is highlighted in each of the large scale maps.



North sea (salt water)

IJsselmeer (freshwater)

Freshwater flows

Quantity of freshwater m3/s

Freshwater supply from the IJsselmeer lake

Freshwater supply points to regional waters > 5 m3/s

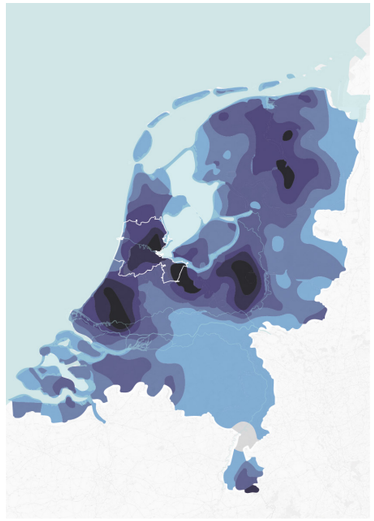
Secondairy freshwater supply points

Schaal 1:1500000

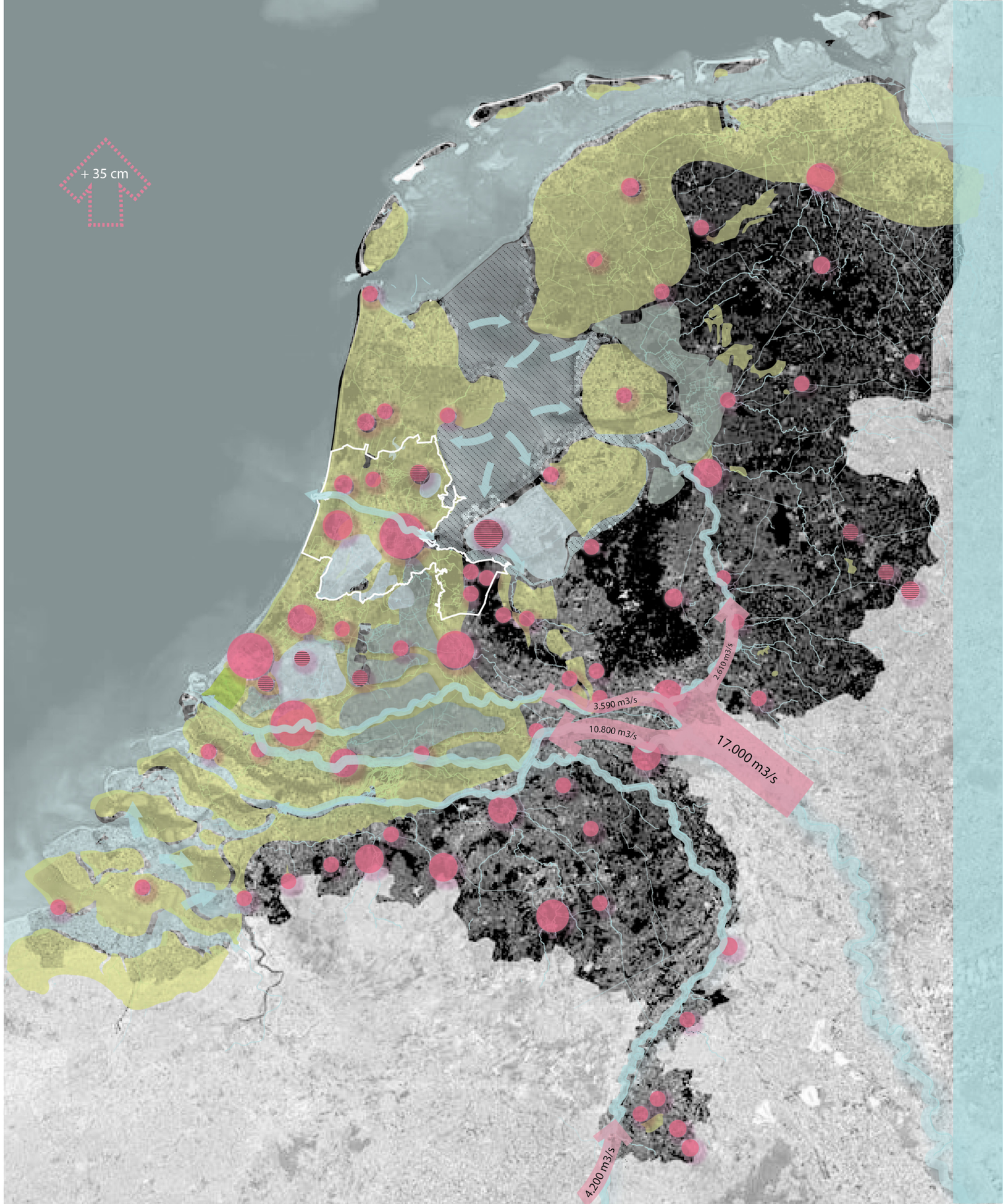
Map created by author & based on GIS,
Ministerie van Infrastructuur en Milieu (2012: 35 & 53)
H+N+S Landschapsarchitecten. (2012: 36)

FRESHWATER FLOWS FOR FOOD LANDSCAPES ON THE NATIONAL SCALE: WH+ SCENARIO 2050 IN WINTER PERIOD

Towards 2050 the sealevel in the Netherlands will rise with 35 centimeter and in 2100 even higher with 85 centimeter (H+N+S Landschapsarchitecten, 2012). This creates difficulties in the freshwater system to discharge the large amount of freshwater during winter periods to the Northsea. Additionally more and extreme precipitation is predicted towards 2050 (image) and the largest impact of this trend is in the metropolitan region of Amsterdam (KNMI 2014). Therefore more water problems in the agricultural landscapes of the region will arise towards the future. Especially, because the waterstorage capacity of the polders and rivers in the Netherlands is limited and these landscapes have the lowest depth (below sealevel) in the metropolitan region of Amsterdam (AHN, 2018). Furthermore, a lot of water problems will arise in the cities of the region too, as the water storage capacity of these landscapes is very low.



Climate change (precipitation) 2050



North sea (salt water)
IJsselmeer (freshwater)
Freshwater flows
Quantity of freshwater m3/s
Sealevel rise
Freshwater supply from the IJsselmeer lake
Waterstorage capacity of polders & boezems limited
Deep, highly urbanised droogmakerijen
Watery veenweidegebied
Limited waterstorage capacity of glastuinbouwgebied
Afwatering onder vrij verval op termijn niet mogelijk met huidig peilbeheer
Limited waterstorage capacity of cities and villages
Cities with (undesired) high groundwater levels

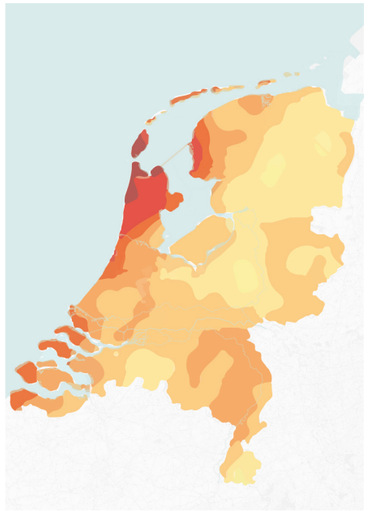
Schaal 1:1500000

Map created by author & based on GIS,
Ministerie van Infrastructuur en Milieu (2012: 35 & 53)
H+N+S Landschapsarchitecten. (2012: 36)
Ministerie van Verkeer en Waterstaat (2010: 31,39,55)

FRESHWATER FLOWS FOR FOOD LANDSCAPES ON THE NATIONAL SCALE : EXISTING SUMMER PERIOD

In this map the freshwater system in the Netherlands during the summer period is visible. The freshwater flows discharge is less than during a winter period (m3/s) and with this lower pressure of freshwater flows to the sea, salt water from the North Sea is coming into the agricultural landscapes by salinization (kwel). Furthermore during long periods of drought in the summer, freshwater shortage could appear in the agricultural landscapes (e.g. summer of 2018). Towards 2050, this drought is especially concentrated in the Province of Noord-Holland (image 2).

In the case of a long period of drought in the Netherlands, the 'verdelingsreeks' is used to decide how the freshwater flows will be devided over the freshwater system and landscapes (Ministerie van Infrastructuur & Milieu, 2011). As it becomes clear from this image, the irrigation of agricultural landscapes is not prioritised during periods of drought. Therefore a lot of damage on the harvest in these landscapes during summer periods could become reality.



Climate change (drought) 2050

Water wordt bij tekorten verdeeld volgens de verdringingsreeks

1 Veiligheid en voorkomen van onomkeerbare schade
- stabiliteit van waterkering
- klink en zetting (veen en hoogveen)
- natuur (gebonden aan bodemgesteldheid)

gaat voor

2 Nutsvoorzieningen
- drinkwatervoorziening
- energievoorziening

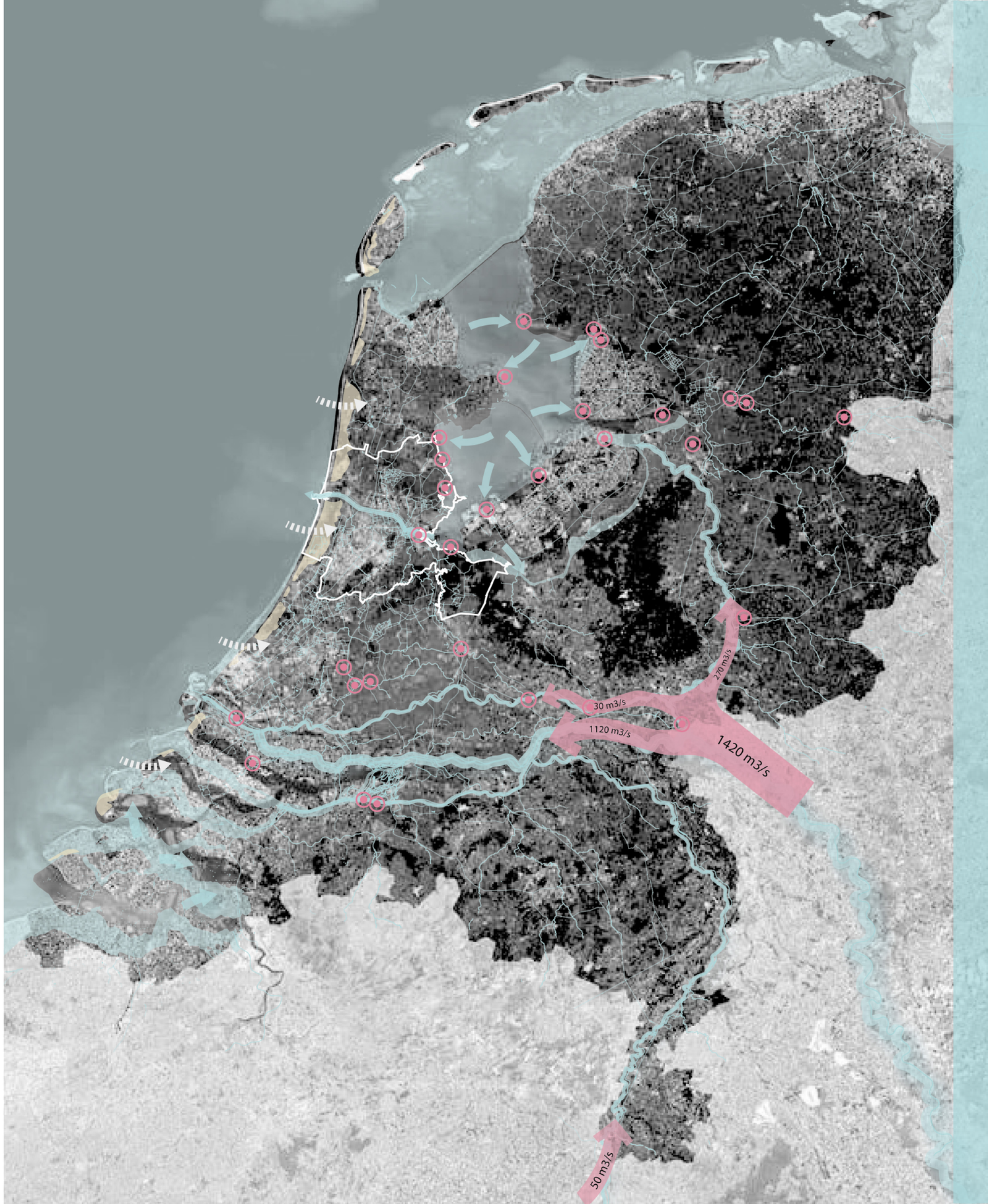
gaat voor

3 Kleinschalig hoogwaardig gebruik
- tijdelijke beregening intensieve gewassen
- proceswater

gaat voor

4 Overige belangen (economische afweging, ook voor natuur)
- scheepvaart
- landbouw
- natuur (zolang geen onomkeerbare schade optreedt)
- industrie
- waterrecreatie
- binnenvisserij

Verdelingsreeks in the Netherlands (Ministerie van Infrastructuur en Milieu, 2011).



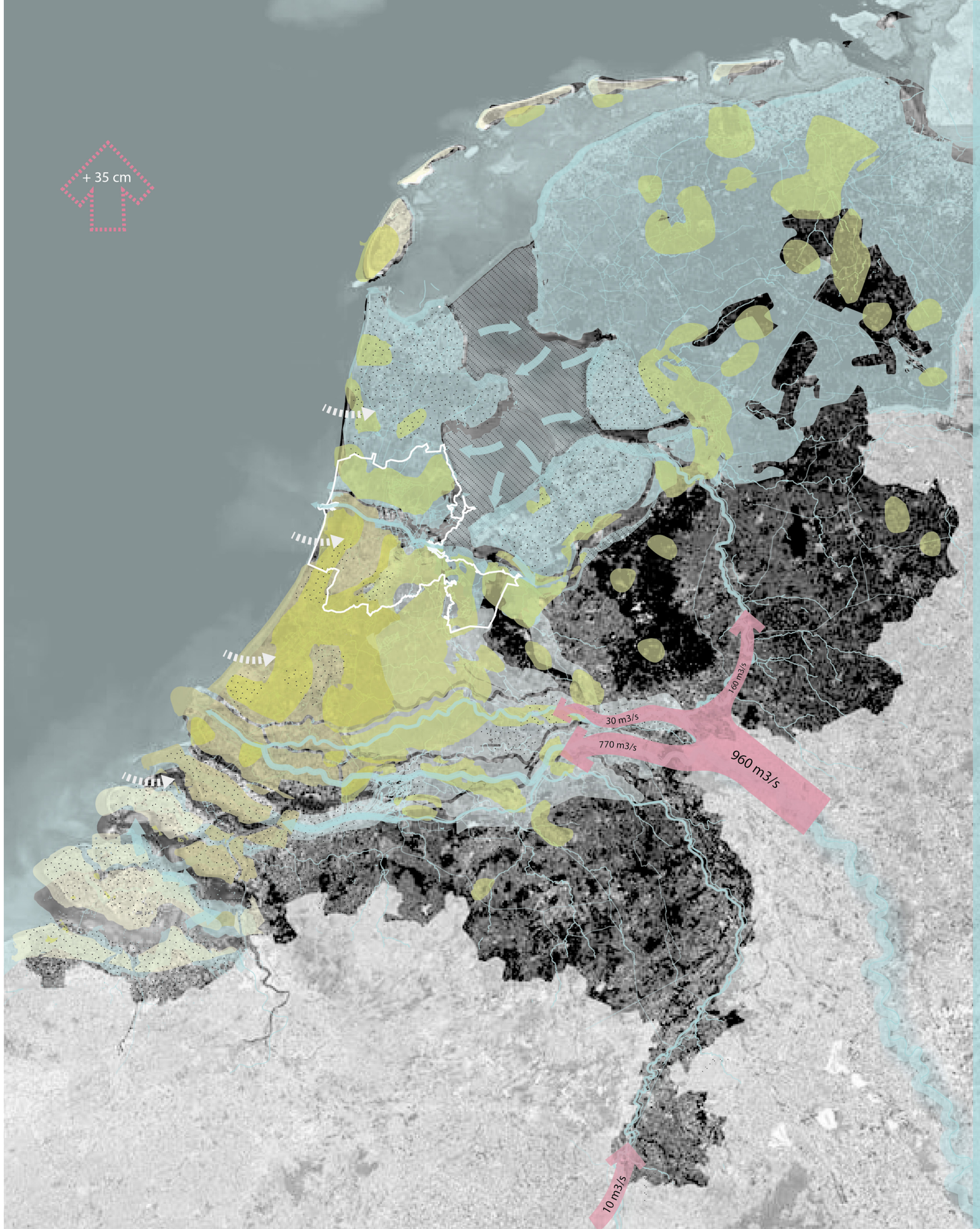
Schaal 1:1500000

Map created by author & based on GIS, Ministerie van Infrastructuur en Milieu (2012: 35 & 53)

FRESHWATER FLOWS FOR FOOD LANDSCAPES ON THE NATIONAL SCALE: WH+ SCENARIO 2050 IN SUMMER PERIOD (DROUGHT)

Towards 2050 the quantity of freshwater coming from the mountains during summer periods (m3/s) will become less than it is already at this moment. In combination with more extreme and longer periods of drought that are predicted by the KNMI in the metropolitan region of Amsterdam (Province of Noord-Holland), this results in a lot of drought problems in the agricultural landscapes of the region (Ludwig, 2017).

The waterbuffer of the IJsselmeer lake and the rivers & canals that transport freshwater to the agricultural landscapes in the metropolitan region will be overcharged and therefore can no longer provide enough freshwater for these landscapes. This is especially a problem in the areas of the region with special or intensive cultivation that requires a high quantity of freshwater at all times. As groundwater flows with freshwater will move to the lowest areas of the region (droogmakerijen) during periods of drought, also nature landscapes in the higher parts of the region will be desiccated and therefore decrease in ecological quality (Ministerie van Verkeer en Waterstaat, 2010). Finally, the higher temperatures that are combined with the climate change effects of drought towards 2050, will result in a pressure on the quality of the freshwater (e.g in the IJsselmeer lake).



North sea (salt water)

IJsselmeer (freshwater)

Freshwater flows

Quantity of freshwater m3/s

Sealevel rise

Salinisation (kwel)

Freshwater supply from the IJsselmeer lake

Waterbuffer Ijsselmeer overcharged

Nature quality decreases in a normal year with Wh + scenario

Inlaatpunten raken verzilt (o.a. Gouda & Bernisse)

No freshwater supply possible and salinization

Insufficient water quantity available in rivers and canals

Quality of fresh water (large lakes) under pressure

Special / intensive cultivation, critical water users

Inlaatpunt water onder druk

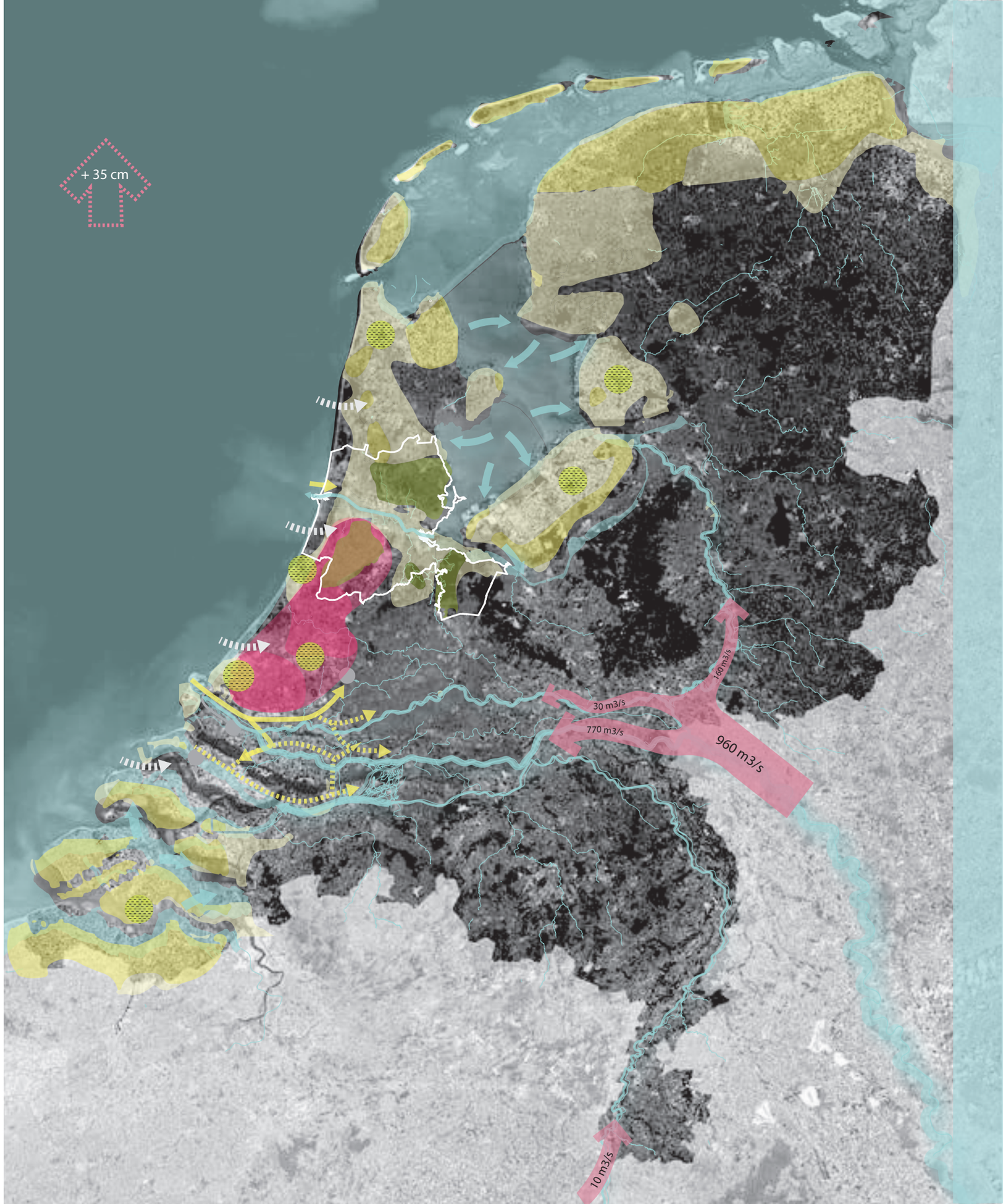
Schaal 1:1500000

Map created by author & based on GIS,
Ministerie van Infrastructuur en Milieu (2012: 35 & 53)
H+N+S Landschapsarchitecten (2012: 36)
Ministerie van Verkeer en Waterstaat (2010: 31,39,55)

FRESHWATER FLOWS FOR FOOD LANDSCAPES ON THE NATIONAL SCALE: WH+ SCENARIO 2050 IN SUMMER PERIOD (SALINIZATION)

Another problem during the summer periods of 2050 is salinization, especially in the west of the Netherlands (Ministerie van Verkeer en Waterstaat, 2010). Salt water is coming into the agricultural landscapes because the pressure in the freshwater system during the summer in 2050 is very low. This high quantity of salt in the water and soil of the landscapes is having an impact on the food production possibilities in the future and the ecological quality of nature in the landscapes (Ministerie van Verkeer en Waterstaat, 2010). The salinization process is intensified by the sealevel rise (+ 35 cm) that is giving a high pressure of salt water into the landscapes.

This process is especially in the landscapes with salinity sensitive cultivation a problem towards 2050. And most of these cultivation landscapes are located in areas where salinization takes place (in the west of the Netherlands). At this moment the landscapes conditions are preserved by the process of 'doorspoeling' of the water system in the landscapes with freshwater (around 50% of the freshwater use in the West of the Netherlands during summer). In 2050 however, there is not enough freshwater available during the summer period to continue this process with ongoing salinization of the landscapes (Deltares & Alterra, 2018).



North sea (salt water)

IJsselmeer (freshwater)

Freshwater flows

Quantity of freshwater m3/s

Sealevel rise

Freshwater supply from the IJsselmeer lake

Salinisation (kwel)

Gebied met interne verzilting door zoute kwel (gebied met oppervlaktewater > 600 mg/l

Gebied met interne verzilting door zoute kwel (grondwater/oppervlaktewater > 200 mg/l)

Freshwater supply under pressure 2018-2050

Freshwater supply under pressure 2050-2100

Salinity increasing problem for nature and urban green

Zoutwaterindringing 2018-2050 (+35 cm Wh+) inname punten langdurig onbruikbaar

Zoutwaterindringing 2050-2100 (+85 cm Wh+) inname punten langdurig onbruikbaar

Salinization sensitive cultivation (glastuinbouw, bollenteelt, boomteelt, fruitteelt in verziltingsgebied)

Schaal 1:1500000

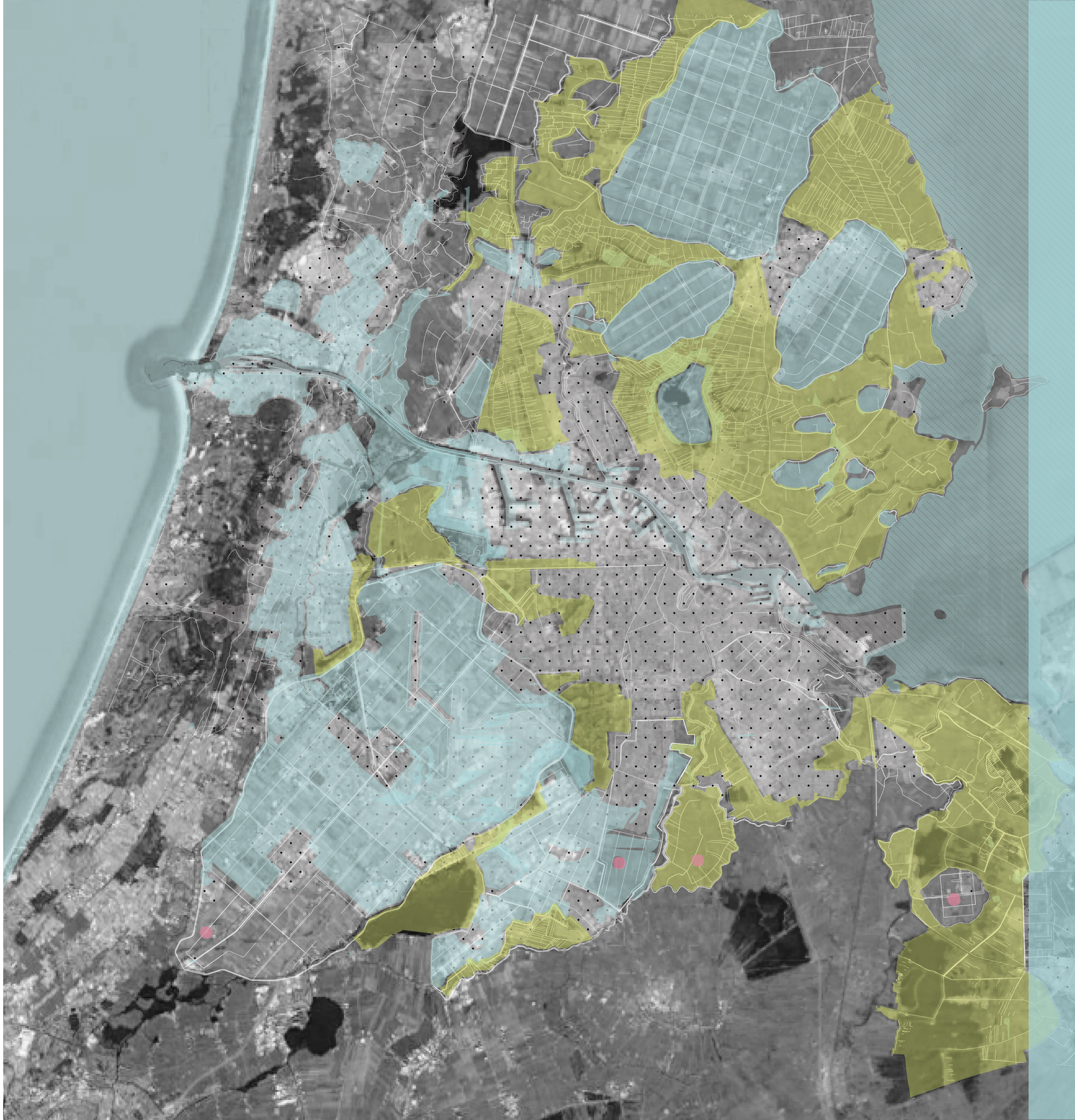
Map created by author & based on GIS,
Ministerie van Infrastructuur en Milieu (2012: 35 & 53)
Ministerie van Verkeer en Waterstaat (2010: 31,39,55)

IMPACT ON THE LANDSCAPES OF THE REGION: WH+ SCENARIO 2050 IN WINTER PERIOD

In the previous maps, the freshwater system in the Netherlands is explained and the effects of climate change towards 2050 on the freshwater flows, together with the impact of this on the landscapes during winter and summer periods. In the following maps these effects on the landscapes in the region are visible in more detail.

During the winter periods towards 2050, the sea level will rise and a higher quantity of freshwater flows result in water problems in the region. Especially in the lower areas as the polders (Haarlemmermeer, Beemster & Schermer) of the region (and cities), where the waterstorage capacity is not enough, problems will arise towards the future.

Furthermore the soil subsidence in mostly the peat landscapes (veenweidegebieden) of the metropolitan region will create lower areas and CO2 emissions in the process of oxidation of the peat. This is contributing to the climate change effects that are causing the water problems in the region.



North sea (salt water)

IJsselmeer (freshwater)

Afwatering onder vrij verval op termijn niet mogelijk met huidig peilbeheer

Soil subsidence

Water problems/limited waterstorage capacity of polders

Limited waterstorage capacity of cities and villages

Large-scale waterstorage or emergency storage planned

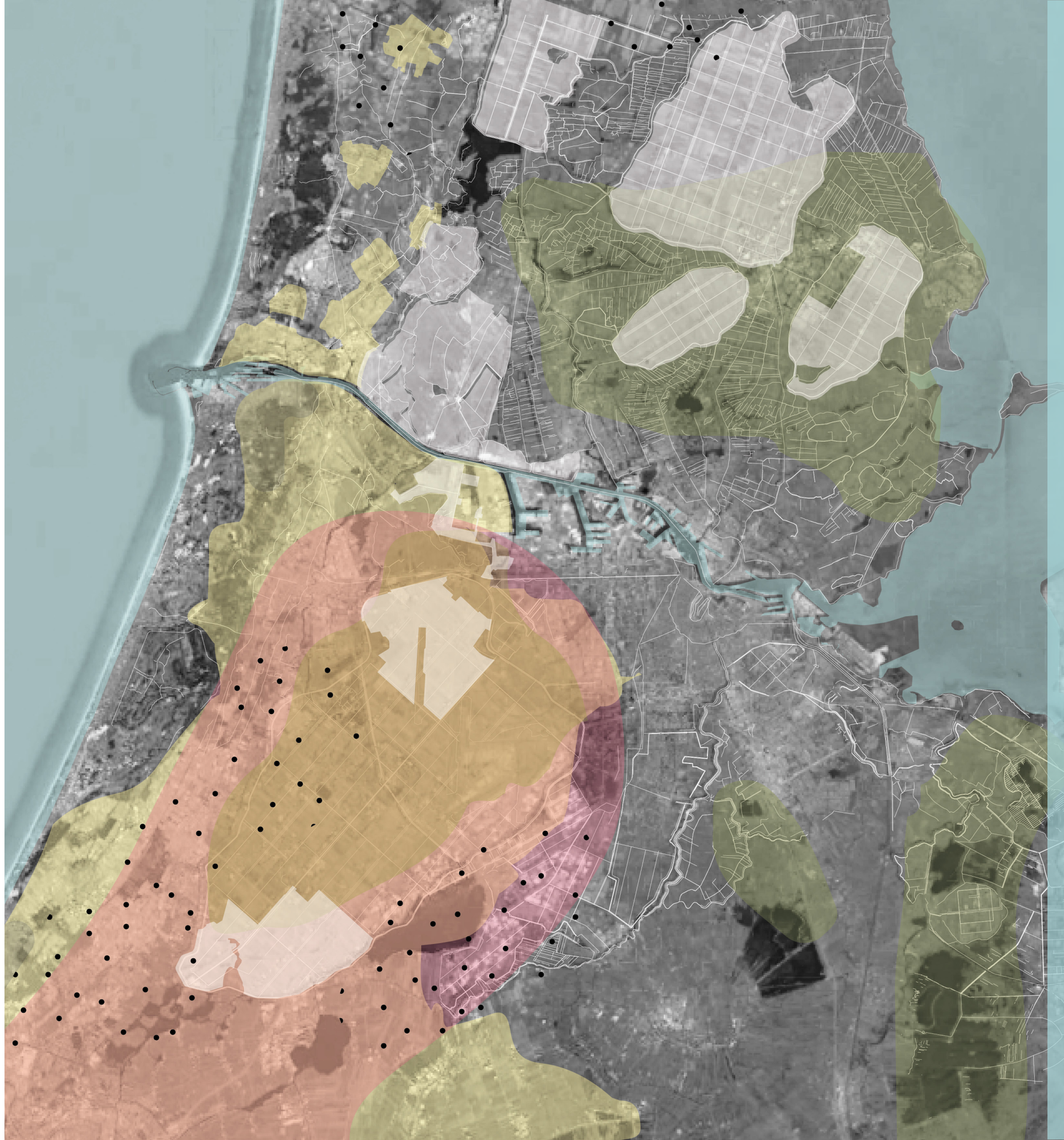
Schaal 1: 1:400000

Map created by author & based on GIS,
Van Paridon & de Groot landschapsarchitecten (2017: 59)
Provincie Noord-Holland (2014: 56)
BOOM landscape (2018)

IMPACT ON THE LANDSCAPES OF THE REGION: WH+ SCENARIO 2050 IN SUMMER PERIOD

During the summer periods towards 2050, drought problems in the agricultural landscapes are becoming more extreme. Most of the drought problems are concentrated in the polders, where at the same time during the winter period water problems arise.

Furthermore, in the west of the metropolitan region a process of salinization of the agricultural landscapes takes place, and especially in and around the polder of the Haarlemmermeer. This is one of the most urgent locations in the region to solve the climate change problems towards 2050, because the freshwater supply will become under pressure in this landscape too and the salinity of the landscape is resulting in problems for nature in this area. On top of that, this agricultural polder is really important for the food production in the region, and consists of large areas with intensive (a lot of freshwater use) and salinization sensitive cultivation.



Schaal 1: 1:400000

Map created by author & based on GIS,
Van Paridon & de Groot landschapsarchitecten (2017: 59)

IMPACTS ON THE FOOD LANDSCAPES IN THE METROPOLITAN REGION

In the following principle section are the problems in the metropolitan region of Amsterdam visible, that will appear in 2050. In this section the problems during the summer and winter period in the region are combined to give a complete overview. The colors in the section are corresponding to the problems in the maps of the region as shown in the previous maps.

Towards 2050 the predicted sealevel rise of the North Sea will be 35 cm, and towards 2100 even higher with 85 cm. This sealevel rise will give a pressure of salt water in the soils of the region (seepage flows), and therefore results in salinization of the landscapes along the coastline.

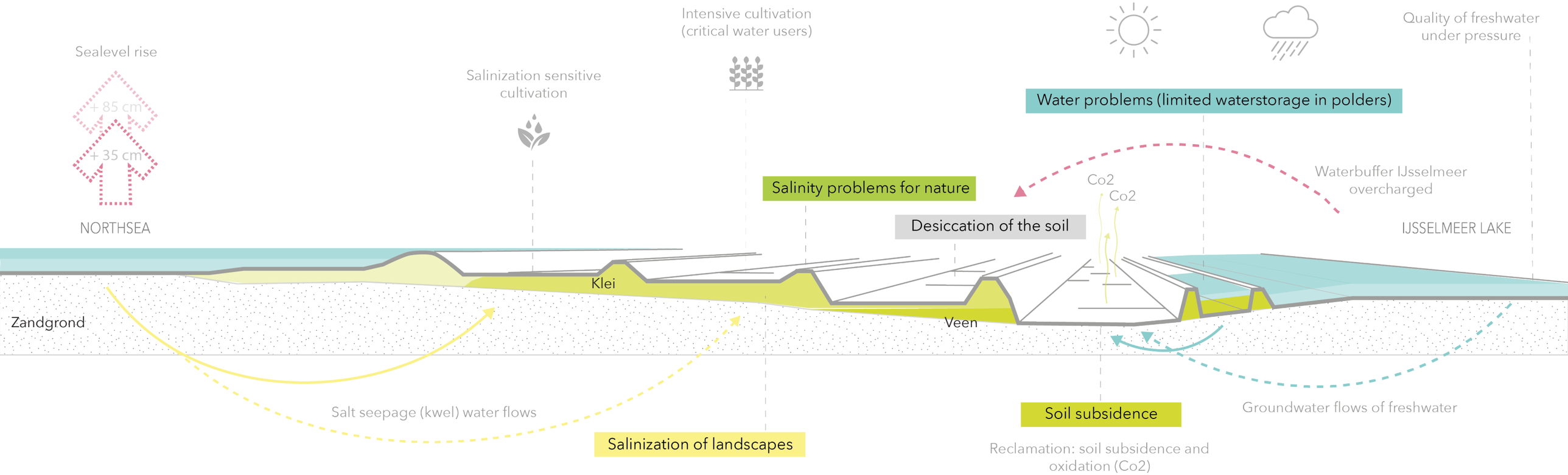
Especially in the metropolitan region of Amsterdam, there is a high amount of cultivation (glastuinbouw, bollenteelt, boomteelt & fruitteelt) that is sensitive to this salinization of the soil. Furthermore the sealevel rise results in deeper salt water flows that will even impact the agricultural and nature landscapes at a greater distance from the coast.

The salinization of the landscapes in the region especially takes place during the summer periods when there is not enough freshwater available to prevent the salt water of the North Sea from coming into the freshwatersystem.

During the summer period the waterbuffer of the IJsselmeer lake can be overcharged after a long period of drought in 2050 (caused by the climate change Wh+ scenario), as well as the freshwater for the food landscapes in the region coming from the rivers and canals. This results in desiccation of the food landscapes and with that in a damage of the harvest of the summer period. Furthermore, if there is enough freshwater available the quality of the water will be lower (because of higher temperatures in 2050 during summer). During winter periods however, water problems can arise in the lower parts of the region, e.g. the polders. Groundwater flows with freshwater will move to the lower areas of the region and because there is not enough waterstorage capacity in these polders, this results in flooding problems.

The problems will even get higher with the predicted periods of extreme rainfall in the region in 2050. Furthermore this movement of freshwater flows will create desiccation in the higher laying (nature) areas during summer.

At last there is the problem of soil subsidence in the region. Because of the on-going reclamation of the peat landscapes for agriculture, soil subsidence and oxidation (resulting in Co2 emission) are already present problems in the region. With this process the peat landscape in the region is changing (degrading) towards 2050, together with the 'sponse' function of this landscape and thus resulting in even more water problems towards the future.





Impression of the water problems during the winter of 2050 in the Beemster polder.



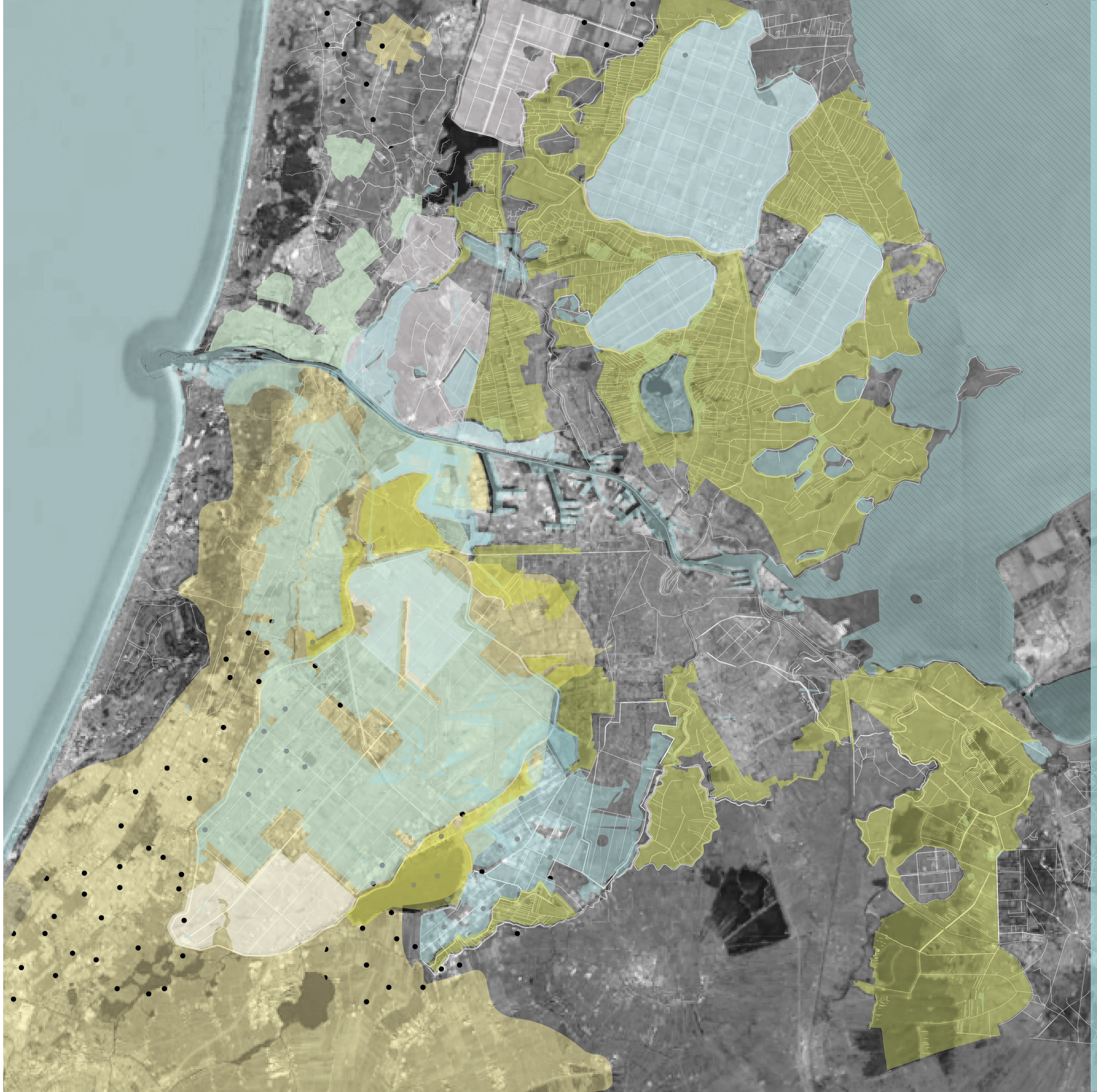
Impression of the drought & salinization problems during the summer of 2050 in the Beemster polder.

CONCLUSION MAP OF THE IMPACT OF FRESHWATER FLOWS (2050) IN THE FOOD LANDSCAPES OF THE REGION

In general the conditions of the agricultural landscapes become wetter during the winter periods and more dry (together with salinization) in the summer periods. In the western part of the region, salinization of the agricultural landscapes takes place, while soil subsidence (especially in the peat landscapes) is a major problem in the east of the region. Drought and water problems are mainly the problem in the lower parts of the region: the droogmakerijen.

Most of the problems are coming together in the droogmakerijen as becomes visible from this map. These are precisely the landscapes where there is intensive food production in the region, as a result of which many problems will arise in these areas during the winter and summer period. The water-dependent agricultural sector now supplies our largest export product, with a very high contribution to the BNP, a lot of employment and the highest yield per hectare. In the future, however, this could change if no solutions are found for the problems (Adviesgroep Borm & Huijgens, 2014).

This conclusion map of the impact of climate change (freshwater variability) on the agricultural landscapes in the region, is an input for the next research phase to find solutions. Moreover, an unexpected outcome of this problem analysis is that not only the agricultural landscapes are affected by climate change, but that salinisation is also increasingly a problem for nature in the region towards 2050.



Schaal 1:400000, GIS maps

2. AGRICULTURAL LANDSCAPES & WATER POLLUTION: DEPLETION OF THE ECOSYSTEM

The Netherlands is facing great challenges in the agricultural watermanagement towards 2050, especially in the context of Europese regulations, climate change and national nature ambitions (Wageningen University & Research, 2016). The agricultural sector plays a crucial role in this, because many agricultural parcels are having an polluting impact on the adjacent waterways and are managed by the farmers. At this moment, the Netherlands is lagging behind to achieve the water quality goals. Less than 40 percent of the water bodies have the desired ecological quality (Van Wezel, 2018).

The cause of this pollution of freshwater lies with two types of sources in the landscapes (Van Wezel, 2018). The point sources are for example glasshouses (glastuinbouw) in the landscapes. Since 1 januari 2018 there is a new regulation for these glasshouses in the Netherlands to improve the waterquality of the landscapes. The farmer must demonstrate that purification technology has been installed, which removes more than 95 percent of the pesticides used, before the wastewater reaches the rivers. Another important source of pollution of the freshwater in the landscapes are diffuse sources. These are the pesticides and fertilizers used in agricultural landscapes.

During spraying, part of these can already get into the water, which is why special spray equipment is often prescribed to limit this as much as possible. After use, the pesticides and fertilizers can rinse to groundwater and surface water. This results in a high content of fertilizers and pesticides coming from the agricultural landscapes into the freshwater and with that having an impact on the ecological quality of the water in the landscapes. This quality of freshwater is the responsibility of Rijkswaterstaat for large waterways and the Waterschappen for regional waterways. Especially the fertilizers that are used on these landscapes will have a large impact on the ecological quality of the water in the region (Trouw, 2012).

In the images next to this, recent newspaper articles and pictures show the urgency of this freshwater quality problem in the agricultural landscapes of the Netherlands.



Pesticides and fertilizers in the agricultural landscapes (Topsimages, 2018)



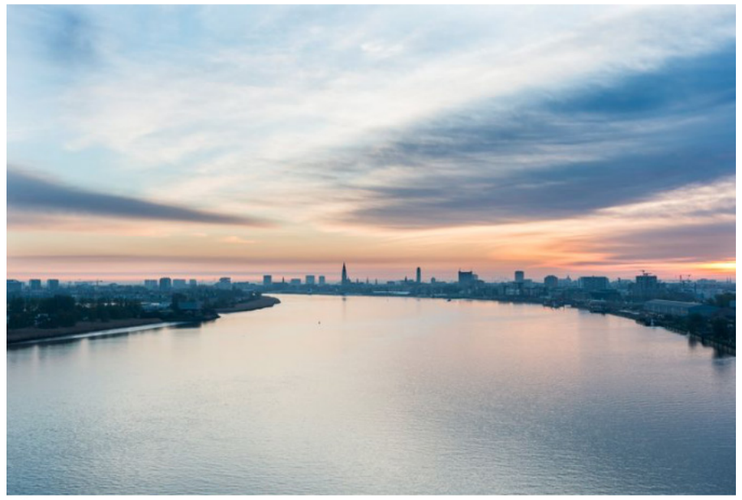
Pollution of the freshwater by pesticides and fertilizers (Wikipedia, 2018)



Veel speciale soorten overleven niet door kwaliteit wateren

Arjen Schreuder 24 december 2012

News paper: ecosystem species will not survive because of freshwater quality (NRC, 2018).



Waterkwaliteit in ons land is zorgwekkend

HA | 03 juli 2018 | 16u18 | Bron: IPS

DEEL 25 32 REACTIES

© Photonews - Om het tij te keren, moet onder andere vervuiling door landbouw, industrie en huishoudens aangepakt worden.

News paper: Freshwater quality in the Netherlands is too low (IPS, 2018)

RULES FOR THE FRESHWATER QUALITY IN AGRICULTURAL LANDSCAPES OF THE REGION

To prevent the pollution of freshwater in the landscapes of the Netherlands, there are already rules and regulations set up. In the following list the existing rules and regulations are visible that are established through time. As a result of these the nutrients concentrations in the freshwater (nitrogen and phosphate in the agricultural landscapes that are used as fertilizers as an important component) have decreased in the past years. However, the concentrations are still above the target value for nutrient concentrations to create a high quality ecological environment and the improvement process of the quality of freshwater has stagnated in the last few years. Therefore, next to these rules and regulations new solutions for the improvement of the freshwater quality need to be found.

The target value for the most polluting nutrients in the freshwater of the agricultural landscapes (nitrogen and phosphate) is given by the 'Kaderrichtlijn Water' (KRW). It is expressed in the Good Ecological Potential (GEP) for the canals and ditches in the landscapes and needs to be respectively 2,4 - 2,8 N/l and 0,15 - 0,22 P/l (CBS, PBL, RIVM & WUR, 2016). The effects of high concentrations of nitrogen and phosphate in the freshwater of the region result in algea bloom (caused by eutrophication). Furthermore duckweed (kroos) is a large problem in the freshwater ways of the region, since the water underneath this has no oxygen anymore. And on a larger scale, these nutrients will flow with the freshwater to the Northsea, where problems in the ecosystem could arise (CBS, PBL, RIVM & WUR, 2016).

Waterwetten

Na de Tweede Wereldoorlog was Nederland vooral bezig met de wederopbouw en niet met de kwaliteit van het milieu en het oppervlaktewater. Tussen 1960 en 1970 bereikte de waterkwaliteit een dieptepunt; de rivier de Rijn stond bekend als 'het riool van Europa'. Pas na de invoering van de WVO kwam hier verandering in.

1970 Wet Verontreiniging Oppervlaktewateren (WVO)

De wet heeft als doel de kwaliteit van oppervlaktewateren te beschermen door lozingen aan regels te binden. Het lozen zonder vergunning van afval- en schadelijke stoffen in oppervlaktewater in het gehele Nederlandse grondgebied is verboden.

1971 Oprichting Stichting Toegepast Onderzoek Waterbeheer (STOWA)

Het kenniscentrum van regionale waterbeheerders in Nederland voor afvalwaterzuivering, klimaatbestendig waterbeheer, ecologische waterkwaliteit, veilige regionale waterkeringen.

1991 Richtlijn stedelijk afvalwater

De richtlijn legt normen op voor concentraties van BZV (biochemische zuurstofverbruik: de hoeveelheid zuurstof die nodig is voor de afbraak van biologisch afbreekbare organische stoffen in water door micro-organismen), ammonium, nitraat, fosfaat en zwevende stoffen.

1993 Het BOOM-besluit

Het besluit kwaliteit en gebruik overige organische meststoffen verbiedt het gebruik van zuiveringsslib van rwzi-installaties in de landbouw vanwege het gehalte aan zware metalen. Ook storten is verboden waardoor het slib op grotere schaal wordt verbrand.

1993 Wet milieubeheer

Elke Nederlandse gemeente moet het binnen haar grenzen vrijkomende afvalwater via de riolering inzamelen en aanbieden aan de rioolwaterzuivering.

2000 Europese Kaderrichtlijn Water (KRW)

De richtlijn heeft als doel de kwaliteit van oppervlakte- en grondwater in Europa te waarborgen. Voor Nederland gaat het om het stroomgebied van respectievelijk Schelde, Maas, Rijn en Eems. In 2015 moet de kwaliteit op orde zijn, zowel de chemische als ecologische toestand. Dit houdt onder andere in dat men een goede rioolwaterzuiveringsinfrastructuur heeft.

Waterbeheerders moeten aan nog vele andere Europese richtlijnen voldoen: de Drinkwaterrichtlijn, de Grondwaterrichtlijn, de Hoogwaterrichtlijn, de Kaderrichtlijn mariene strategie, de Nitraatrichtlijn, de Richtlijn prioritaire stoffen, de Richtlijn stedelijk afvalwater, de Richtlijn aquatisch milieu, de Viswater- en Schelpdierwaterrichtlijn en de Zwemwaterrichtlijn.

2005 Besluit lozing huishoudelijk afvalwater

Huishoudens die geen riolering hebben, moeten het afvalwater eerst met een eigen zuiveringssysteem reinigen voordat het in de bodem of op het oppervlaktewater kunnen lozen. In 2008 waren er in Nederland nog 65.000 personen niet aangesloten op een riool dat naar een rioolwaterzuiveringsinstallatie leidt.

2009 De Waterwet

De Waterwet vervangt de WVO en nog zeven wetten om de handhaving te vereenvoudigen. De Waterwet is van toepassing op lozingen die direct in het oppervlaktewater plaatsvinden en lozingen rechtstreeks op de rwzi. Alle overige lozingen vallen onder de Wet milieubeheer. Verder geeft de Waterwet, invulling aan de Europese kaderrichtlijn water. Zo zijn de waterbeheerders verplicht te voldoen aan de chemische en ecologische kwaliteitsnormen voor oppervlaktewater en grondwater.

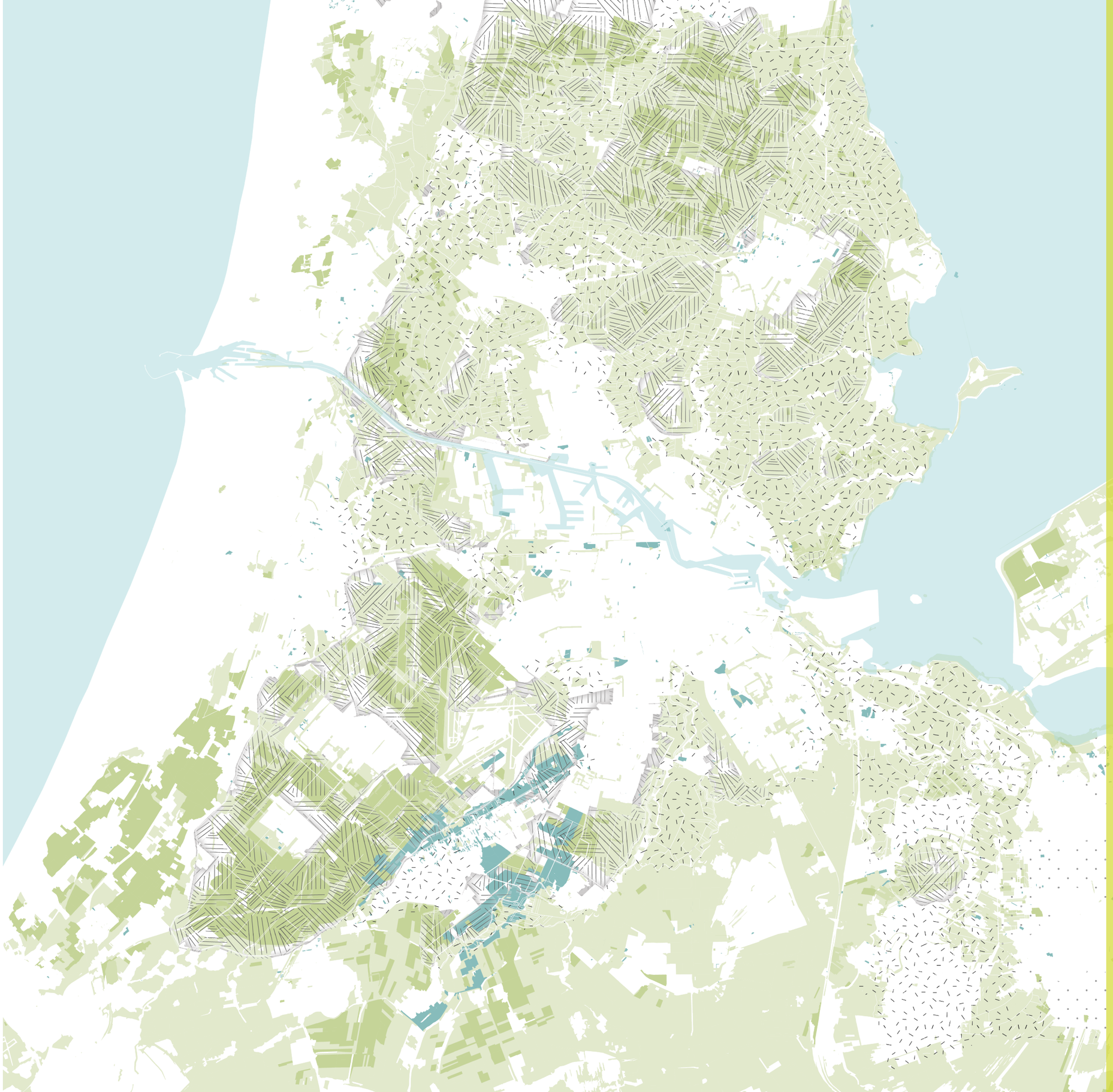
2018 Zuiveringsplicht glastuinbouw

Een glastuinder moet aantonen dat er zuiveringstechnologie is geïnstalleerd, die meer dan 95% van de gebruikte bestrijdingsmiddelen verwijdert voordat het afvalwater wordt geloosd.

Water rules & regulations in the Netherlands through time (Wezel, 2018)

DEFINITION OF THE AGRICULTURAL LANDSCAPES IN THE REGION THAT HAVE AN IMPACT ON THE POLLUTION OF FRESHWATER

In this map the agricultural landscapes in the region that will have an impact on the pollutions of the freshwater by nutrients are visible: grassland, agriculture and horticulture. In the other layers are the types of structures in the landscapes given (droogmakerijen & veenweidegebieden). These will have an impact on the freshwater system in the landscapes and thus on the possibilities for solutions on the freshwater pollution in the region.



Grassland
Agriculture
Horticulture
Veenweide (peat landscapes)
Droogmakerijen (polder landscapes)
Water landscapes

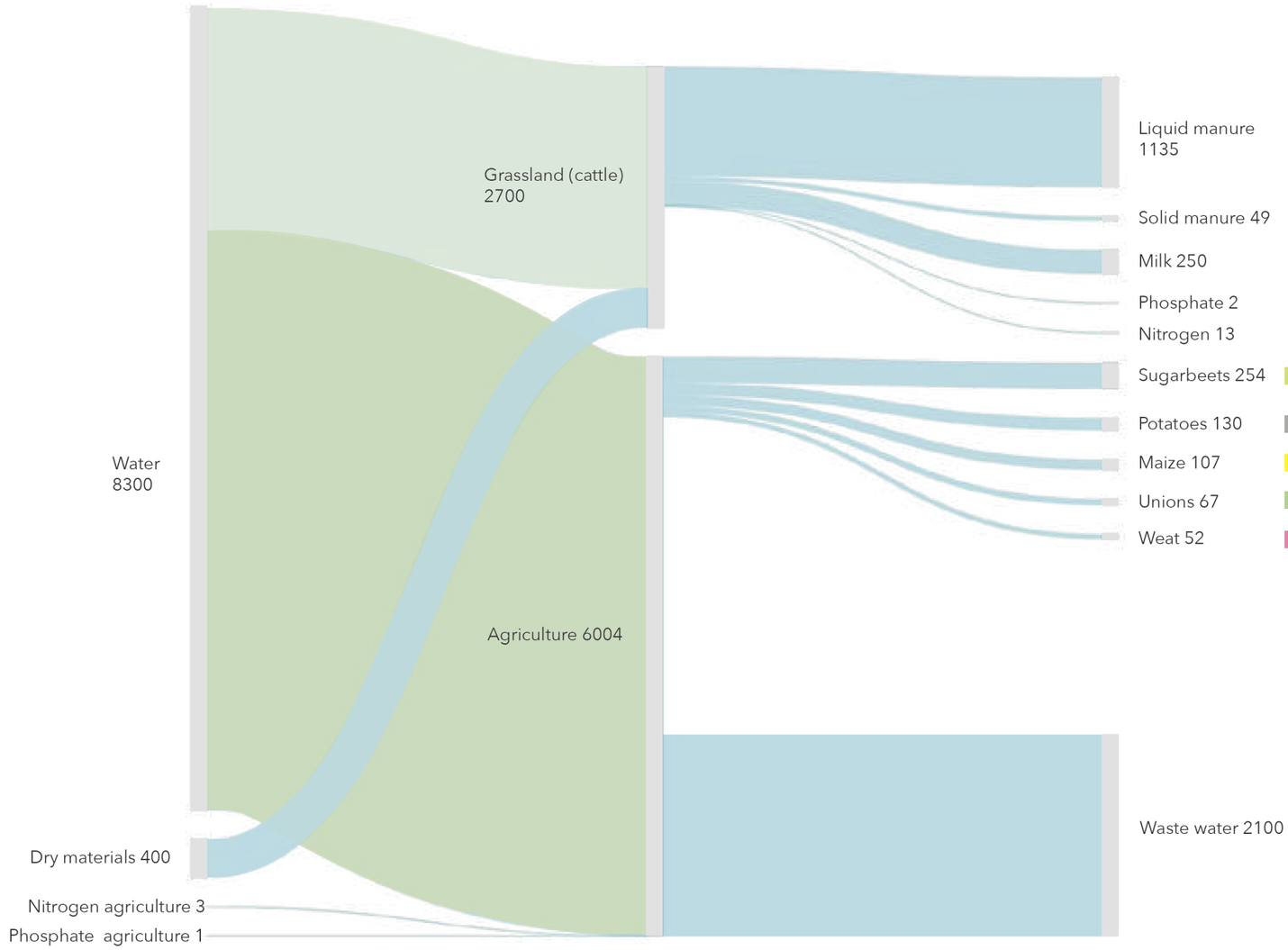
1:150000. Source: GIS maps

FRESHWATER & POLLUTED WATER (BY FERTILIZERS) FLOW ANALYSIS IN THE FOOD LANDSCAPES

Because the largest impact on the pollution of freshwater by agricultural landscapes, is the use of fertilizers in the agricultural landscapes of the region (Trouw, 2012), the flows of freshwater in the landscapes and the substances of nitrogen and phosphate as the main nutrients of the fertilizers used in the agricultural landscapes will be analysed in a flow diagram for the metropolitan region of Amsterdam. Nitrogen and phosphate in the water of the landscapes result a high concentration of nutrients in the water and thus a low biodiversity of the freshwater. In this way the artificial nutrients are having an impact on the natural ecosystem of water and the landscapes.

In this flow diagram of the metropolitan region of Amsterdam, only the flows of freshwater and produced products in the landscape types of grassland (veeteelt) and agriculture (akkerbouw) are given. Because the landscapes of horticulture (kassen) have (with the new regulations) a negligible impact on the ecosystem of the freshwater in the landscapes.

In the following maps the concentrations of the nitrogen and phosphate in the freshwater of the region are compared to the target values as described before, and expressed in a score of the concentration of nutrients in the water. Together the maps for nitrogen and phosphate in the freshwater of the landscapes in the region, are having an impact on the ecological quality of the water and the landscapes.



Grassland
Agriculture
Horticulture

Flow diagram created by author, based on Metropoolregio Amsterdam (2018).

NUTRIENTS (NITROGEN & PHOSPHATE) OF THE AGRICULTURAL LANDSCAPES IN THE FRESHWATER



Nitrogen concentrations in the freshwater of the region



Phosphate concentrations in the freshwater of the region

North sea (salt water)

IJsselmeer (freshwater)

Bad score

Inadequate score

Moderate score

Good score

Schaal 1: 1:400000

Map created by author & based on GIS,

IMPACT OF THE POLLUTED WATER ON THE ECOSYSTEM IN THE LANDSCAPES

In this map the impact of the pollution of the freshwater in the region (largely influenced by the concentrations of nitrogen and phosphate) is given. The ecological water quality has a large impact on the biodiversity of the landscapes and the natural resistance to diseases and plagues. Furthermore, it determines the possibility to use the freshwater for irrigation of the landscapes and thus is having an impact on the possibilities for the food production (Gemeente Haarlemmermeer, 2016).

As becomes clear from this map, the lowest ecological freshwater quality concentrates around the Haarlemmermeer polder and the agricultural landscape near Zaandam. This low quality of the water is mostly the cause of the high concentrations of phosphate in the water as is visible in the previous map.



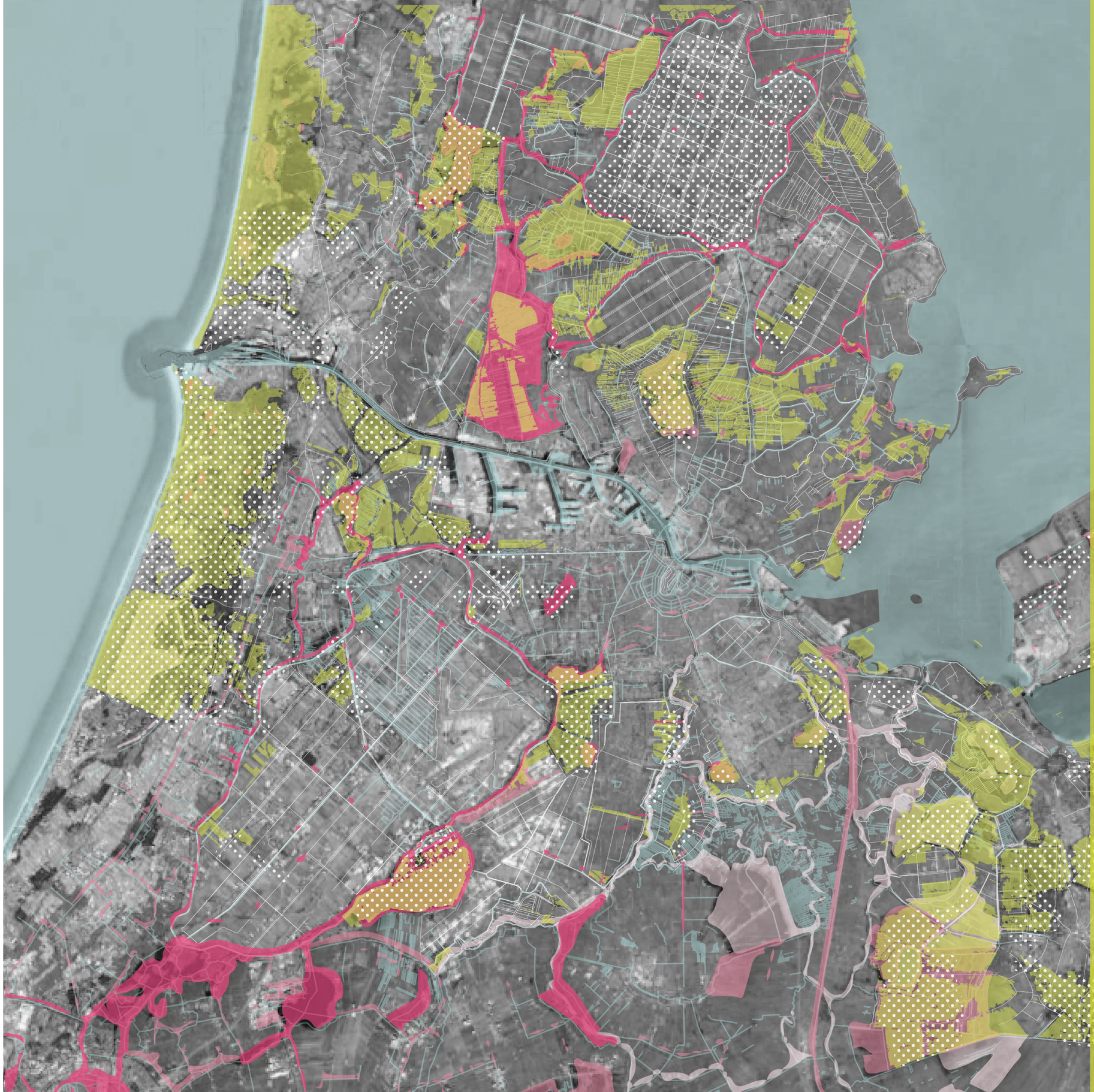
Schaal 1: 1:400000

Map created by author & based on GIS,

POLLUTED WATER IN THE REGION IS CLOSELY LOCATED TO NATURE & RECREATIONAL AREAS

An interesting aspect of the polluted freshwater in the region (with a low ecological quality) is that it is often connected to or closely located to nature and recreational areas. In this way the low quality of the water is having a negative impact on the biodiversity in these landscapes and the recreational possibilities (e.g. swimming in the water during summer periods).

On the other hand, a high quality ecological structure could positively contribute to the water quality in the landscapes and in this way purify the polluted water (Gemeente Haarlemmermeer, 2016). It is however better to purify the polluted freshwater in the agricultural landscapes where most of the water is created, instead of transporting the freshwater to other landscapes that already have a high ecological or recreational value.



Schaal 1: 1:400000

Map created by author & based on GIS,



Impression of the freshwater in the landscapes if the pollution will be solved towards 2050

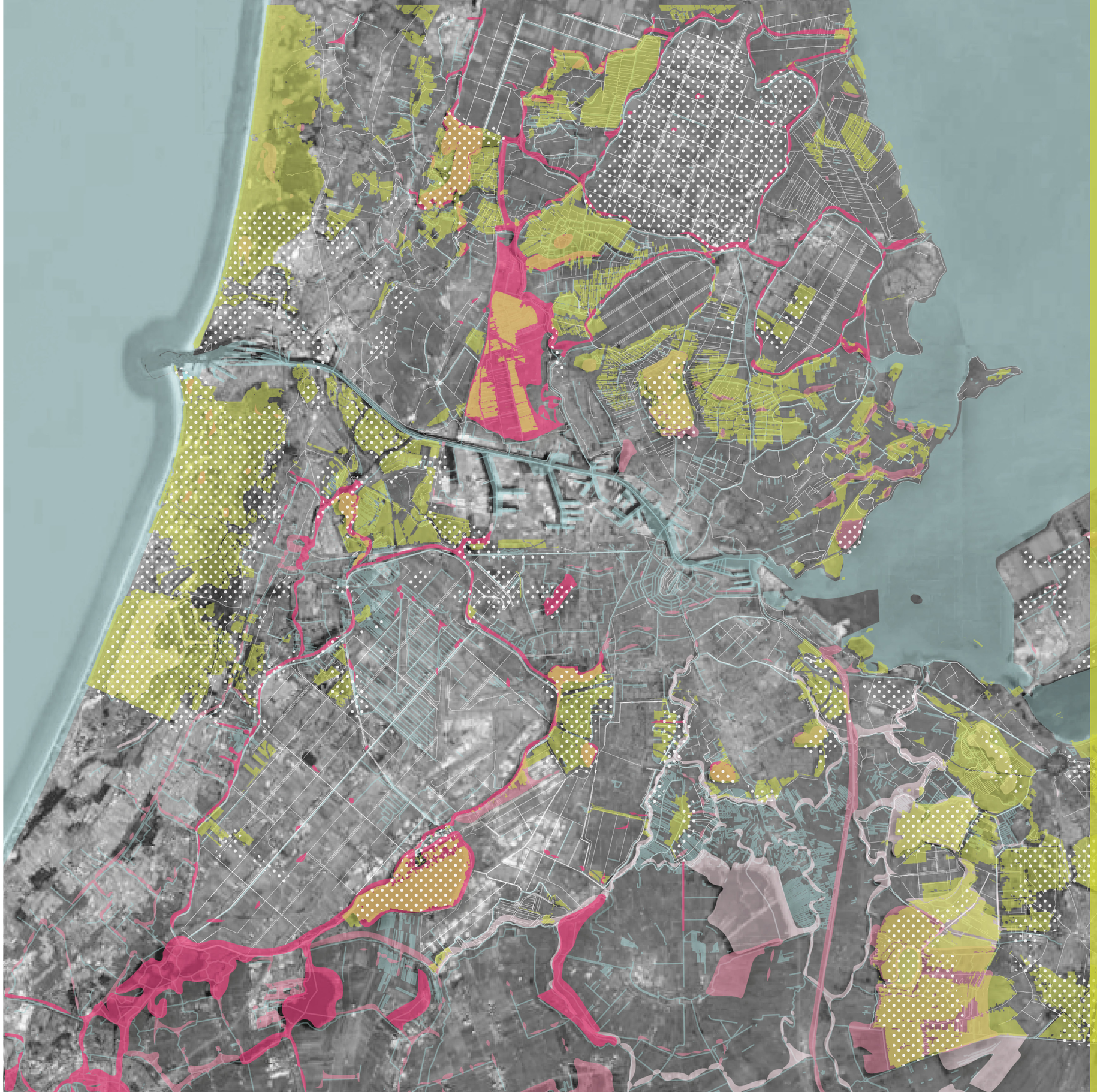


Impression of the freshwater in the landscapes if the pollution continues towards 2050

CONCLUSION MAP : IMPACT OF FERTILIZERS ON THE ECOLOGICAL QUALIY OF FRESHWATER IN THE FOOD LANDSCAPES OF THE REGION

In this conclusion map the areas with large problems because of the pollution of freshwater by the agricultural landscapes in the region are visible. In these areas the ecological quality of the freshwater is very low and often combined with a nature landscape and recreational area for the cities in the region. In this way, the pollution caused by the fertilizers (nitrogen and phospate) that are used in the agricultural landscapes, is having a negative impact on the ecological and recreational value of these landscapes too as well as in the agricultural landscapes itself. Therefore solutions need to be found for the pollution of freshwater in the agricultural landscapes towards 2050.

The problems are the most urgent in the areas of the Beemster polder, the agricultural landscape near Zaandam and around the Haarlemmermeer polder landscape.



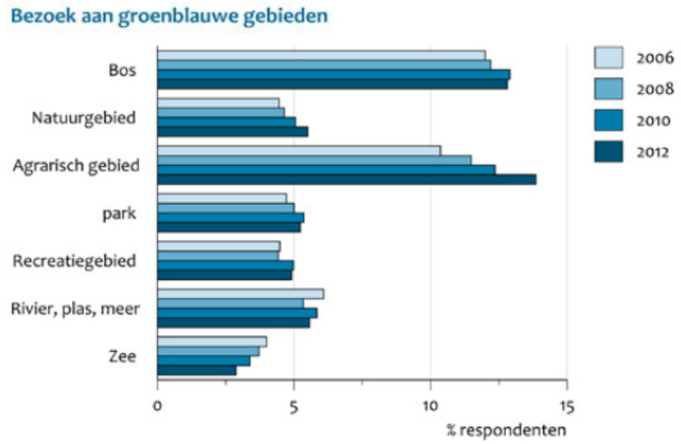
North sea (salt water)
IJsselmeer (freshwater)
Bad ecological quality
Inadequate ecological quality
Moderate ecological quality
Nature landscapes
Recreational landscapes

Schaal 1: 1:400000

Map created by author & based on GIS,

3. URBANISATION & AGRICULTURAL LANDSCAPES: NEW DEMAND FOR ATTRACTIVE & ACCESSIBLE LANDSCAPES

The liveability of the cities in the metropolitan region of Amsterdam is quite high according to the Leefbarometer (2018). One of the reasons for this high liveability score is that the cities are surrounded by an accessible and diverse landscape. And for the case of Amsterdam, the high liveability score is partly due to the green wedges of the surrounding landscape that are coming into the city and create in that way a high densified, but liveable city. However, with the urbanisation trend towards 2050, a shortage in recreational landscapes will arise that are attractive and accessible from these cities in the region (with a growth of 35% in the demand for recreational landscapes (Kennis & innovatiecentrum Recreatie, 2008). At the same time the development at this moment is that the amount of recreational landscapes in the region is declining (due to new housing, companies etc.) There is thus an increasing shortage in recreational landscapes in the region towards the future. Especially the connection of the cities to and the quality of the surrounding landscapes becomes important towards the future, to resolve this recreational landscape shortage. With the transition of the agricultural landscapes in the region, new opportunities could arise to create an attractive & accessible recreational [food] landscape. As becomes visible from the diagram, the agricultural landscapes are already more visited than they were before as a recreational landscape.



Changing demand for recreational landscapes in time (Alterra, 2014)

1.2 AMSTERDAMMERS RECREËREN ANDERS DAN DE UIT DE OMGEVING.

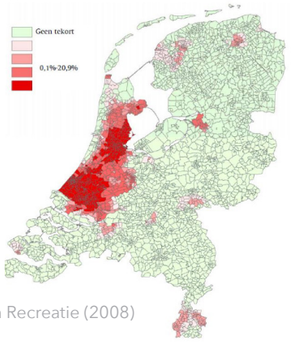
Kleinere steden hebben minder parken en zijn daarom meer aangewezen op regionale recreatiegebieden. Verder liggen ze dichter bij de regionale recreatiegebieden en is het autobezit en daarmee de regionale mobiliteit hoger. Daarom is het de verwachting dat ze meer gebruik maken van regionaal groen.



Recreational use of regional landscapes (Kennis & Innovatiecentrum Recreatie, 2008)

POPULATION GROWTH & SHORTAGE IN RECREATIONAL LANDSCAPES IN THE REGION

With the growth of the population in the largest cities of the metropolitan region of Amsterdam towards 2040, the demand for recreational landscapes in the region will increase with 35% (Kennis & innovatiecentrum Recreatie, 2008). The existing recreational landscapes in the region are therefore not enough. To resolve this recreational landscape shortage, for example 40.000 ha additional attractive landscapes are needed (in the regions of Noord & Zuid-Holland (Kennis & innovatiecentrum Recreatie, 2008). In this map the growing population density in the cities of the region is visible, together with the recreational landscape shortage that arises with this challenge. In the image this recreational landscape shortage is visible on the larger scale of the Netherlands, where the problems are concentrated in the Randstad.



Kennis & innovatiecentrum Recreatie (2008)

Population density (urbanisation) towards 2040

Recreational landscape shortage per year in 2025
(percentage non-accredited demand)

- < 1 %
- 1 - 10 %
- 10 - 15 %
- 15 - 20 %
- 20 - 50 %
- > 50 %

Schaal 1: 1:400000

Map created by author & based on GIS,
Kennis & Innovatiecentrum Recreatie (2008)

ATTRACTIVENESS OF THE AGRICULTURAL LANDSCAPES IN THE REGION

In general, the experience rate of the landscapes in the metropolitan region of Amsterdam, is rather low in the edges of the cities and in the agricultural landscapes with a large scale food production.

The cities with a lower living quality in the region are often surrounded by landscapes that have a lower score for the attractiveness (Amsterdam, Purmerend) and furthermore are often not well connected (with a recreational network) to the attractive landscapes in the region. The attractiveness of these nearby landscapes can be improved by applying the elements of nature & recreation in the surrounding landscapes. This will be further researched in the solutions for an attractive [food] landscape.



Experience of the landscape by visitors (grade 1-10)

> 8

7.5 - 8

7 - 7.5

6.5 - 7

6 - 6.5

< 6

Schaal 1: 1:400000

Map created by author & based on GIS,

ACCESSIBILITY OF THE AGRICULTURAL LANDSCAPES IN THE REGION

As becomes visible from this map, is that the landscapes with the highest recreational landscape shortage often have a less dense recreational network. A new recreational network could be introduced in the region to connect the cities better with these landscapes and at the same time use the transition of the agricultural landscapes to create more attractive [food] landscapes.



Railway
High intensity station
Low intensity station
Cycling network
Walking network
Main recreation boat nodes
Route for boats with standing masts
Recreational routes for boats
Polder structure for small recreation boats

Schaal 1: 1:400000

Map created by author & based on GIS,
Kennis & Innovatiecentrum Recreatie (2008)
PARK (2014)



Impression of the recreation in the landscapes if more recreational landscapes will be created towards 2050



Impression of the recreation in the landscapes if the amount of recreational landscapes continous towards 2050

CONCLUSION MAP: RECREATIONAL LANDSCAPE SHORTAGE & AGRICULTURAL LANDSCAPES

In this conclusion map the growth of the cities in the region towards 2040 is visible. With this growth also a shortage in recreational landscapes will arise. Most of the landscapes in this area, are the agricultural landscapes in the region that at this moment are often experienced as unattractive and unaccessible for visitors in the region. Therefore if the transition of these food landscapes in 2050 is combined with making the landscapes more attractive & accessible, the problem of the shortage in recreational landscapes in the metropolitan region can be solved.



Urbanisation towards 2040

Landscapes with a low experience grade (< 7)

Cycling network

Walking network

Recreational routes for boats

Recreational landscape shortage

Schaal 1:400000, GIS maps &
Kennis & Innovatiecentrum Recreatie (2008)

COMBINING THE PROBLEM MAPS IN THE REGION

In this final map of the problem analysis in the metropolitan region of Amsterdam, the areas with the most urgent challenges towards 2050 in the context of climate change, freshwater pollution and recreational landscapes are visible. This map will be used as an input to find solutions for these problems in the following chapter.

Soil subsidence
Water problems/limited waterstorage
Desiccation
Salinization
Special / intensive cultivation,
Salinization sensitive cultivation
Bad ecological quality
Nature landscapes
Recreational landscapes
Population growth towards 2040

Scale 1:400000, GIS maps

DROOGMAKERIJ LANDSCAPES

VEENWEIDE LANDSCAPES



Impression of the problems in the food landscape of the region in 2050



Impression of the problems in the food landscape of the region in 2050

OVERVIEW OF THE MAXIMIZATION METHOD IN THE REPORT

In this graduation report is the maximization method used to solve the problems in the agricultural landscapes, by creating a synergy between the solutions of the different problem theme's. This method is also used in the outline of the report to give an clear overview of the steps towards a new perspective on the [food] landscapes in the metropolitan region of Amsterdam in 2050.

The first phase in this method is the maximization phase. In this phase each solution for one of the problem theme's is maximized within the region. The next step is to see if these solutions can be combined to create an optimal synergy in the solutions. This will be done in the optimization phase of this maximization method. The final step is the integration phase, where the most optimal combinations of solutions will be integrated to give a solution to the problems in the region. Because there is a lot of uncertainty in the trends that will develop towards the future, the maximization method is complemented with different scenario's for the transition of the food landscapes in the region towards 2050. One of these scenario's will be chosen as a basis to create a new perspective on the [food] landscapes in the region. However, if the trends will change towards 2050, another scenario for the agricultural landscapes can be chosen. With the maximization method, the solutions and the most optimal combination of solutions (integrated in the scenario's for the region) will still be usefull.

Trends towards 2050 in the Netherlands

Problem analysis: impact of the trends on the agricultural lands-capes in 2050

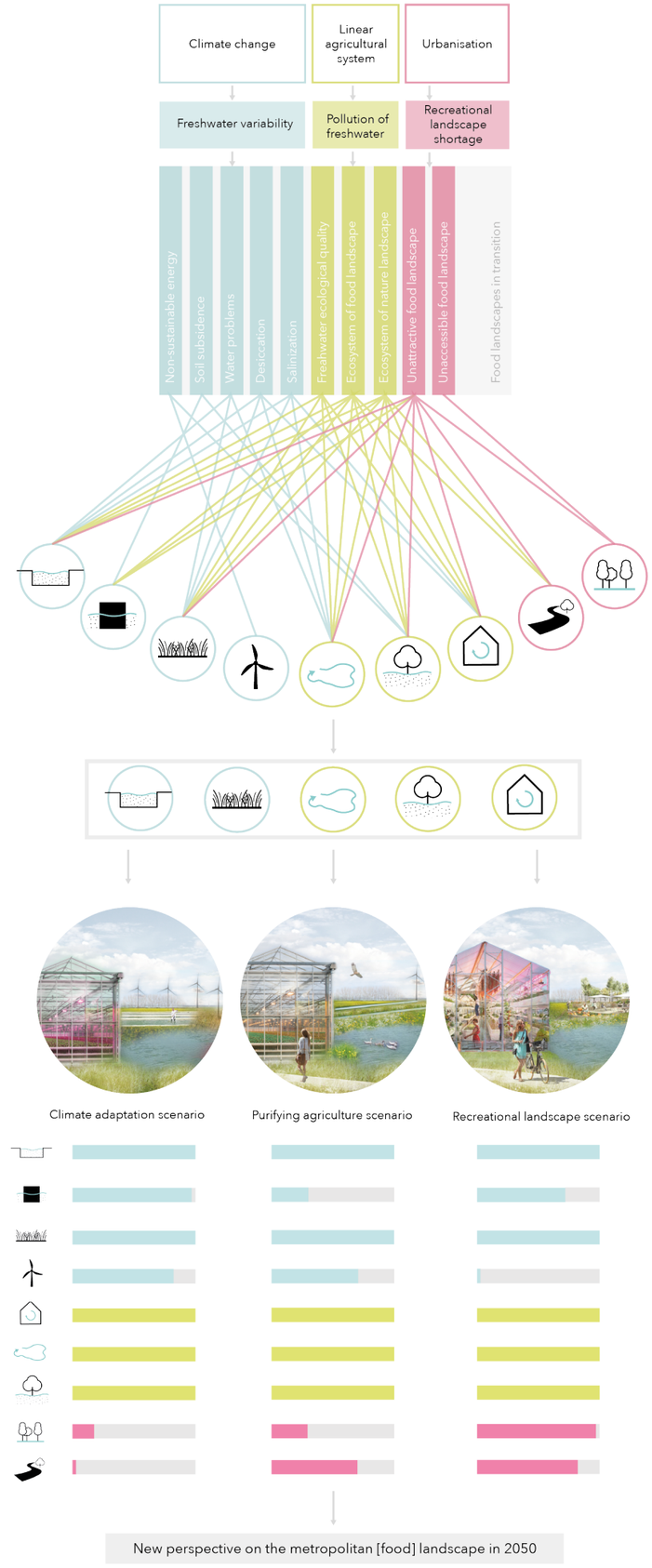
Maximization method

Phase 1: maximizing solutions

Phase 2: optimizing solutions in combinations

Phase 3: integrating solutions based on optimalisation phase : 3 scena-rio's for the [food] landscapes in 2050

Solution: integrating the solutions based on the scenario's & interviews & aims of the project: Regional future perspec-tive in 2050



RESILIENT [FOOD] LANDSCAPES



Water storage

New water level

New food types

Sustainable energy



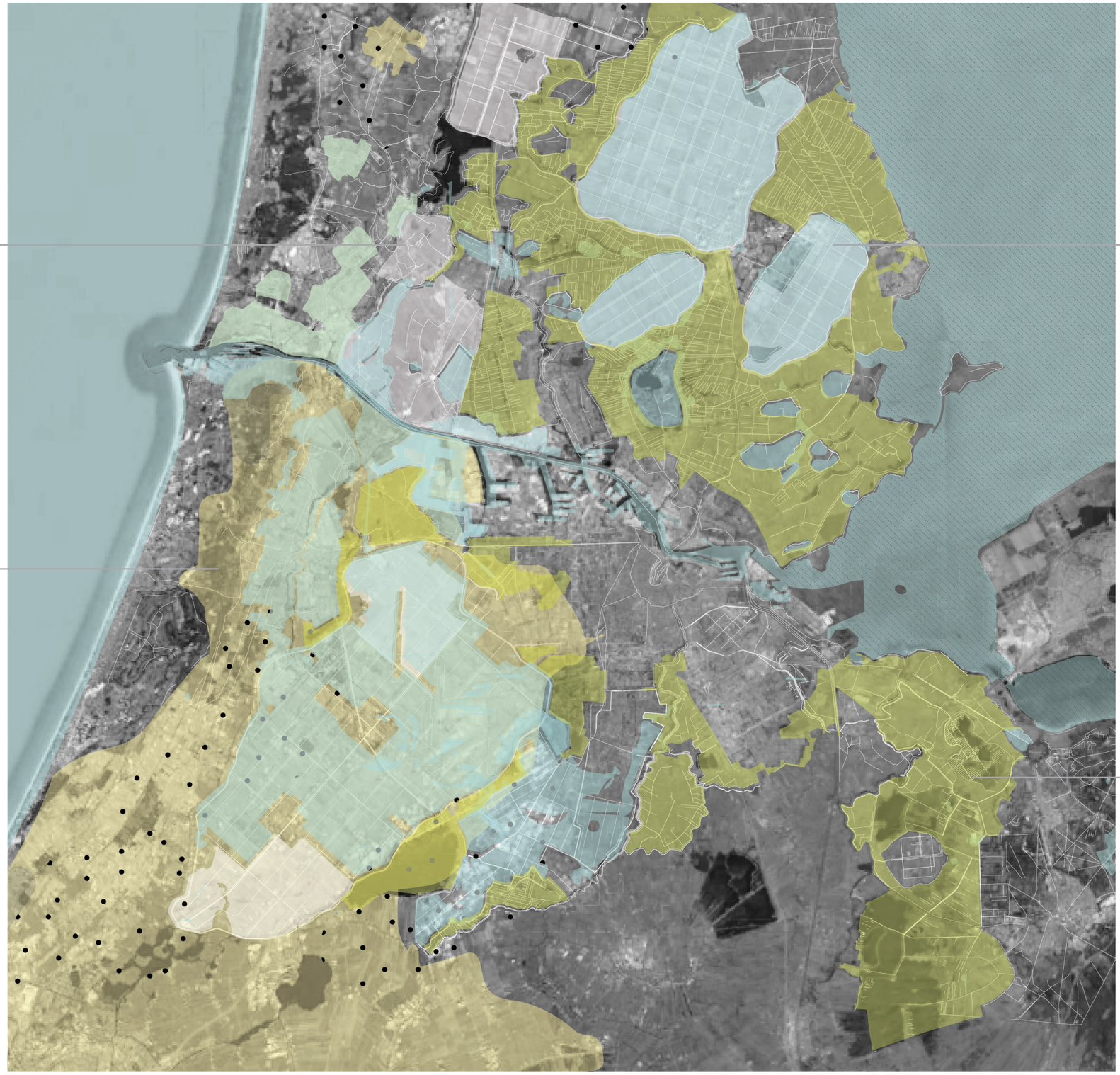
Resilient [food] landscape (Trouw, 2018)

Drought problems

Together with water problems, also longer periods of drought (as a result of climate change) create problems with the harvest in the agricultural landscapes.

Salinization problems

With the longer periods of drought and less freshwater available, salinization problems occur in the agricultural landscapes near the coast in the region.



Waterproblems

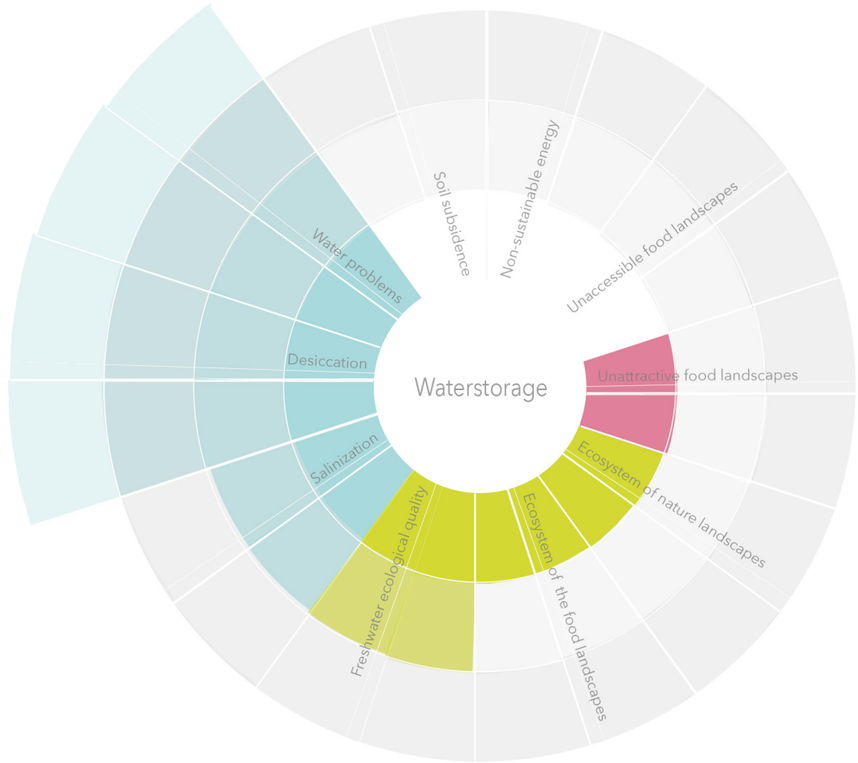
In the droogmakerijen landscapes (the lower polders in the region) water problems arise as a consequence of climate change towards 2050.

Soil subsidence

In the veenweide landscapes (with peat as the main soil type) a large problem towards 2050 is soil subsidence of the agricultural landscapes.

Conclusion map: the impact of the variability in freshwater flows on the agricultural landscapes in the region

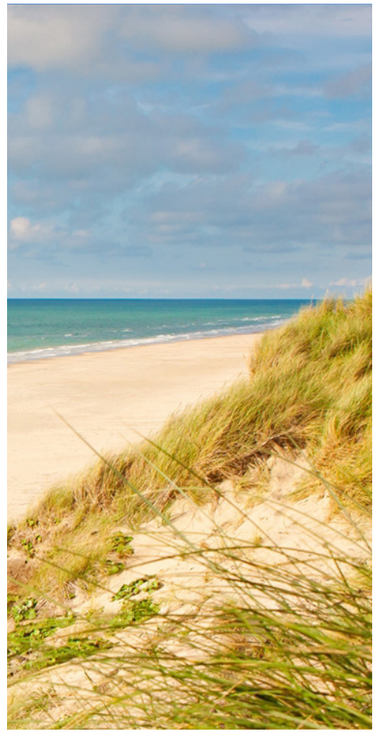
CLIMATE RESILIENT SOLUTION IN THE LANDSCAPES: WATERSTORAGE



REGIONAL SCALE SOLUTION (Droogmakerijen)

PRINCIPLE SECTION OF THE WATERSYSTEM IN THE REGION: low waterbuffer capacity in polder landscapes

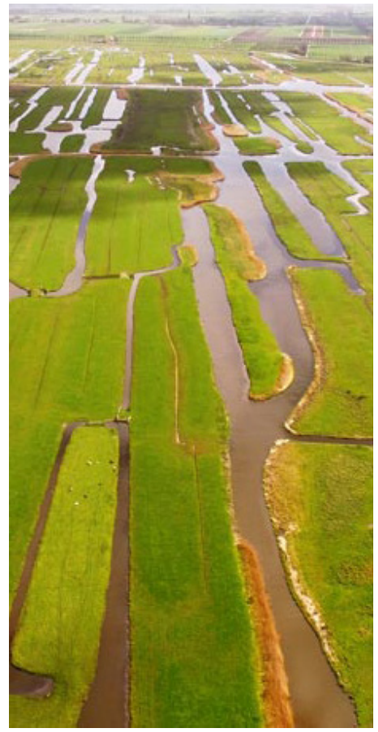
The groundwater level and the amount of surface water in the landscapes determine the water buffer capacity. In the peat landscapes there is enough surface water that is used as a buffer (see image) for wet and dry periods. Therefore, there are no water and drought problems occuring in these type of landscapes with the climate change trend towards 2050. However, in the polder landscapes there are large water and drought problems predicted for 2050 and these problems already start to become visible. The groundwaterlevel relative to the ground level is almost equal to the peat landscapes. The largest problem is however, that there is not enough surface water in the polder landscapes (see image) to create the water buffer capacity that is needed towards 2050. Because of the low water buffer capacity in the landscape, during winter large amounts of freshwater are pumped out of the polder in the boezem and discharged to the Northsea. During summer, a lot of freshwater is needed again for the food production and water from outside the polder landscapes is pumped into this polder. This freshwater has often a lower quality and therefore has a negative impact on the (water) ecosystem in the agricultural landscapes of the polder.



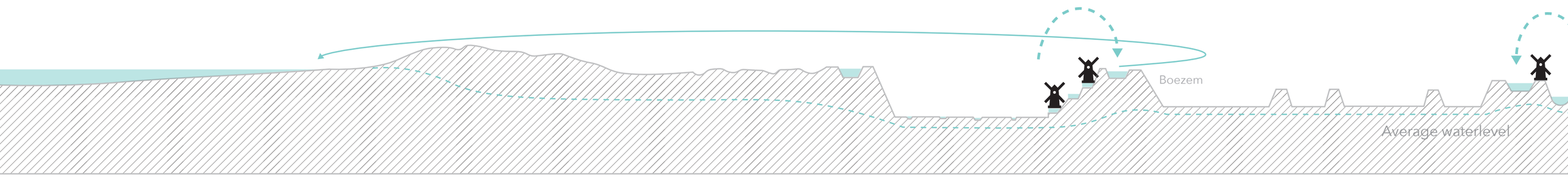
Dunes landscape (Natuurmonumenten, 2018)



Polder landscape (Meelker, 2018)



Peat landscape (VVE, 2018)



Northsea + dunes landscape

Polder landscape (droogmakerij)

Peat landscape (veenweidegebied)

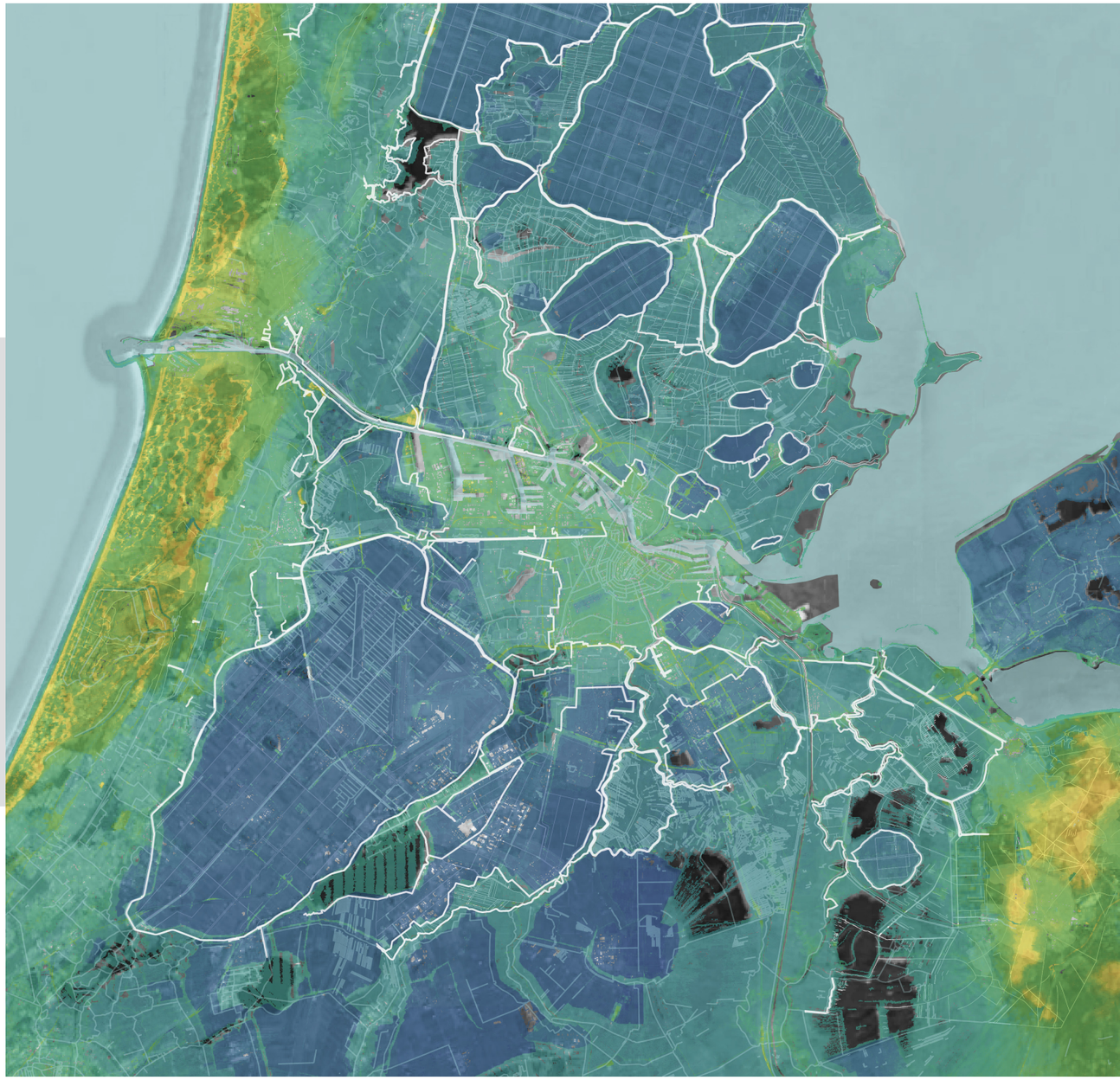
WATER & DROUGHT PROBLEMS IN THE POLDER LANDSCAPES

The polder landscapes have the lowest depth in the metropolitan region of Amsterdam (even 8 meters below the NAP (Nieuw Amsterdams Peil). Become of this low depth of the landscapes, freshwater is continuously pumped out of the polder landscape. And during summer pumped into the polder for the agricultural landscapes. This results in water & drought problems towards the future, because of the increasing variability in freswater towards 2050. A solution could be to create more water buffer capacity in the landscapes of the polder. In this way, there is not only more certainty in the availability of freshwater for the food production, but also the freshwater quality will improve (by reducing the amount of water coming into the polder with a low quality).

For creating more waterstorage capacity in the polder landscapes 'peilvakken' are of great importantance. These are parcels in the landscapes of the polder with a specific water level. And with this water level also determine the possibility for waterstorage in the landscapes. In the following pages the 'peilvakken' in the lowest polder landscapes in the region are visible.

Schaal 1:400000, GIS maps & AHN (2018)

In this map the depth of the landscapes in the metropolitan region of Amsterdam is visible, relative to the N.A.P (Nieuw Amsterdams Peil). Most of the regional dikes/boezems are closely located to the deepest polders in the region and the cities. In this way these polders could serve as waterstorage landscapes for the cities and surrounding landscapes. This water storage landscapes can be combined with 'natte teelt' for food production in the landscapes, as well as recreational landscapes.



SOLUTIONS FOR CREATING WATERSTORAGE IN THE POLDER LANDSCAPES

In the ‘peilvakken’ with the largest drainage (drooglegging) and that are located close to the boezem, a flexible water level is realised. In this way, more waterstorage in the polder landscapes is created. During summer the freshwater is retained in the landscapes by this waterbuffer. And during winter, more freshwater can be stored in the polder landscapes by pumping out the water before extreme rainfall. Because of this new waterstorage capacity in the polder landscape, the pressure on the regional waterstructure (with boezems) is decreased. Therefore, on a larger scale less waterproblems will arise in other locations towards the future. (Provincie Noord-Holland, 2016).

In other locations in the polder landscape with water & drought problems and ‘peilvakken’ with less drainage (drooglegging), waterways will be broadened. This gives the opportunity to combine these waterways with nature friendly banks to improve not only the waterstorage capacity but also the freshwater quality.

Furthermore, by creating waterstorage in the polder landscapes, more water pressure is created and results in less seepage flows into the landscape. This prevents salinization of the agricultural landscapes in the region. (Ministerie van Ecocomische Zaken, Landbouw & Innovatie (2011).

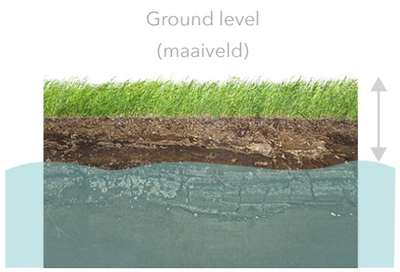


Surface water

Large drainage in peilvak:
large water buffer capacity



Creating a higher water level in the peilvakken with large drainage & located next to the boezem (flexibel water level)



Surface water

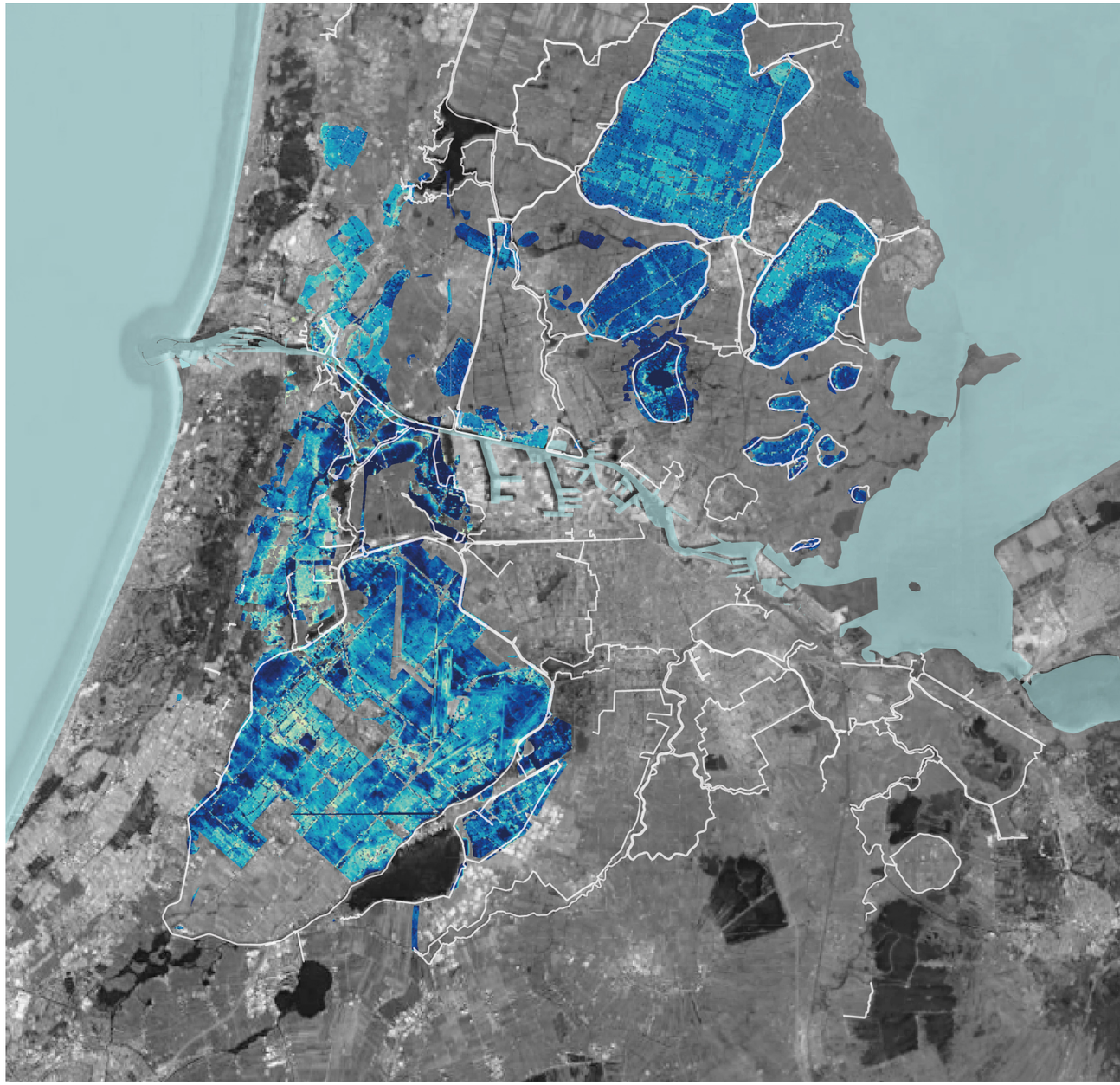
Small drainage in peilvak:
small water buffer capacity



Creating wider waterways & nature friendly banks in peilvakken with less drainage

Disclaimer: no data could be found on the peilvakken in the water authority of Amstel, Gooi & Vecht. Therefore, the peilvakken are not included in this map. For the solution of creating water storage in the polder landscapes this has not a large impact, because especially the peilvakken in the locations with water & drought problems are important (there are not a lot of problems in the location of Amstel, Gooi & Vecht).

Schaal 1:400000, GIS maps & Hoogheemraadschap Hollands Noorderkwartier & Rijnland (2018)



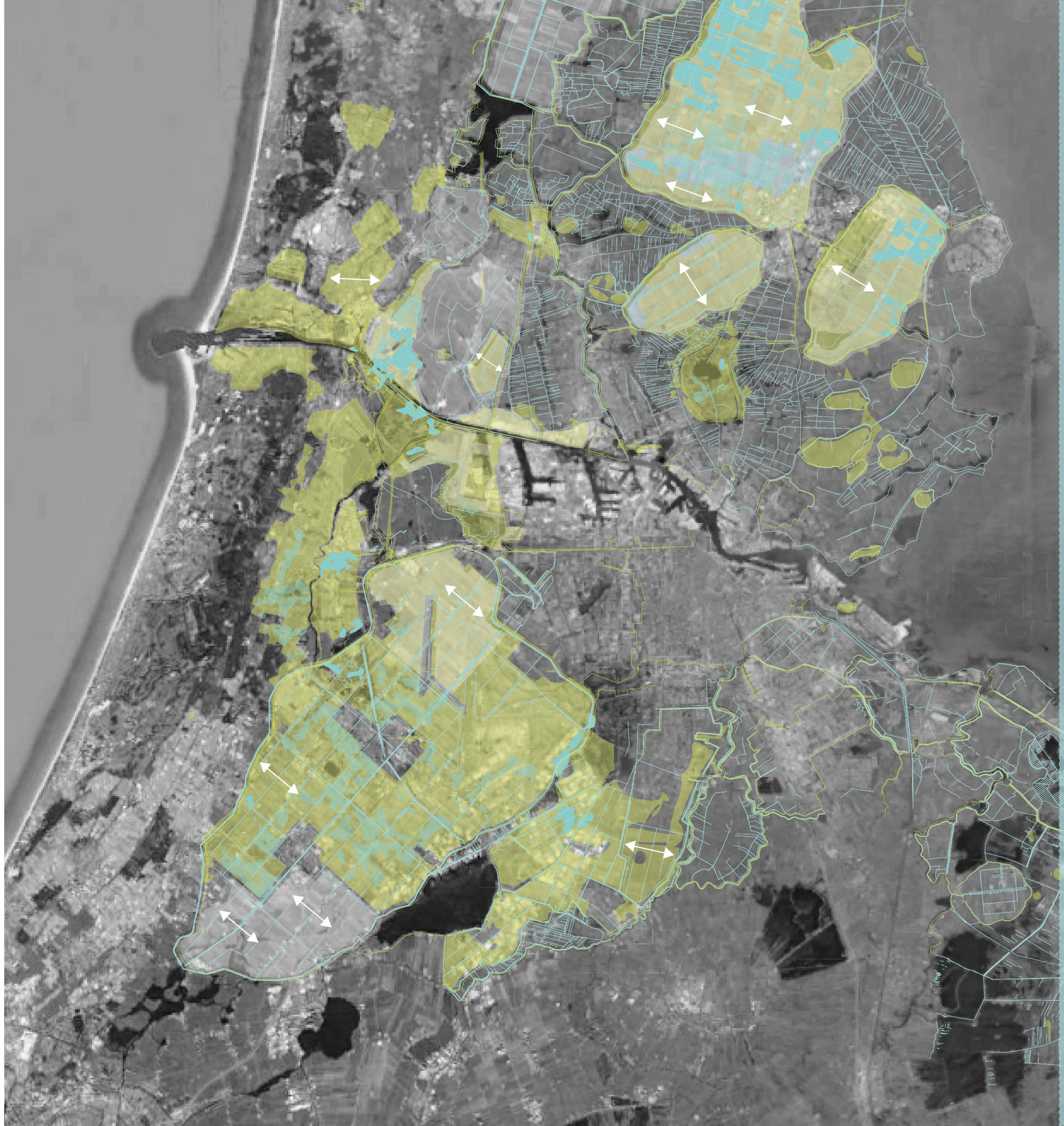


Drainage/drooglegging = hight difference between the ground level and surface water level.

NEW MAP WITH WATERSTORAGE SOLUTIONS IN THE POLDER LANDSCAPE

The solution for creating more waterstorage capacity in the polder landscapes, and with that preventing water & drought problems towards 2050, is to create a higher (flexibel) waterlevel in the peilvakken with a large drainage. For the new flexibel water level, only the agricultural landscapes in the region are taken into account. In the urban landscapes it is not possible to create a flexible and higher waterlevel. A low water level need to maintained for the houses.

In the peilvakken with less drainage, wider waterways with nature friendly banks are created to create more waterstorage in the surface water. These nature friendly waterways improve the ecological quality of the freshwater and structures in the landscape. See for more information on this topic the solution of purifying nature.



Waterproblems in the food landscapes towards 2050

Drought problems in the food landscapes towards 2050

Peilvak with a large drainage located near the boezem: possible waterstorage location for a flexibel waterlevel

Peilvak with a large drainage: possible waterstorage location

Waterstucture in the food landscapes

Solution to create more surfacewater by wider water ways & possibility for nature friendly banks (natuurvriendelijke oevers)

Schaal 1: 1:400000

Map created by author & based on ArcGIS,

IMPRESSIONS OF THE WATERSTORAGE IN THE LANDSCAPES

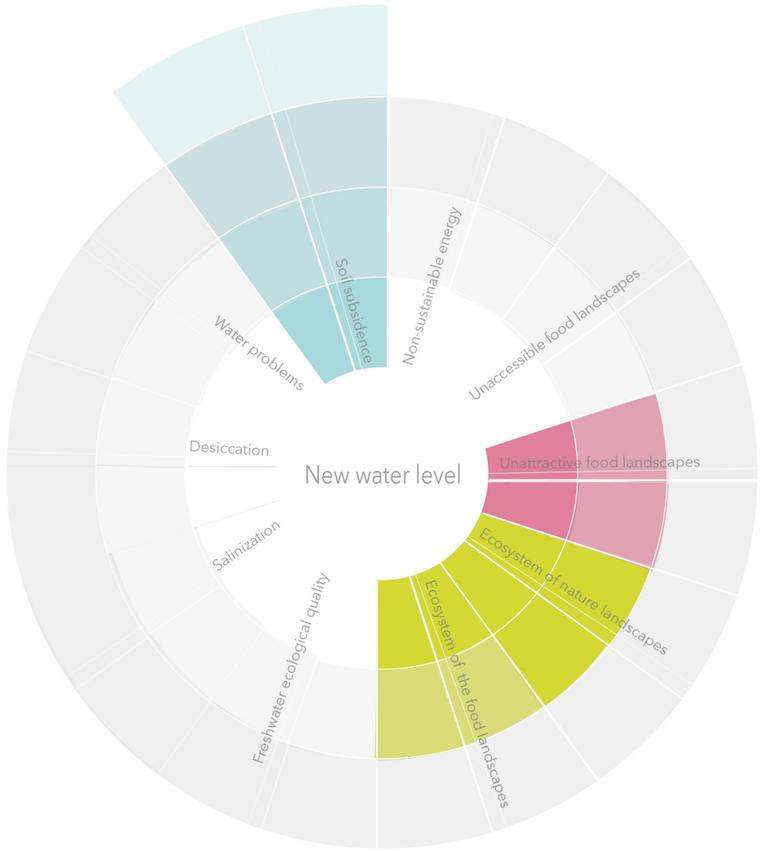






Images created by author

CLIMATE RESILIENT SOLUTION IN THE LANDSCAPES: NEW WATER LEVEL



SOIL SUBSIDENCE IN THE AGRICULTURAL LANDSCAPES TOWARDS 2050



cm

3-10 10-20 20-40 40-60 > 60

Soil subsidence with the existing water level management & climate conditions
2016 - 2050



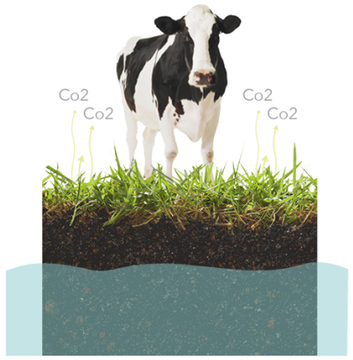
cm

0-5 5-10 10-15 > 15

Soil subsidence with the existing water level management & climate conditions in 2050
Wh-scenario (lower groundwater levels)
2016 - 2050

Schaal 1: 1:400000

Map created by author & based on GIS.

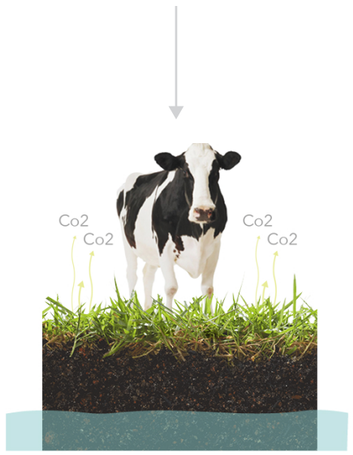


SOIL SUBSIDENCE PROCESS IN THE LANDSCAPES TOWARDS 2050

Desiccation of the peat landscape with lower water levels that are necessary for the current way of farming.



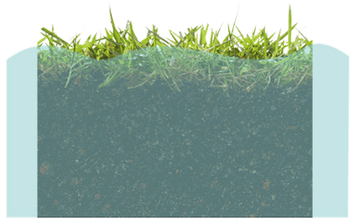
Soil subsidence as a result of the desiccation process of peat ('inklinking').



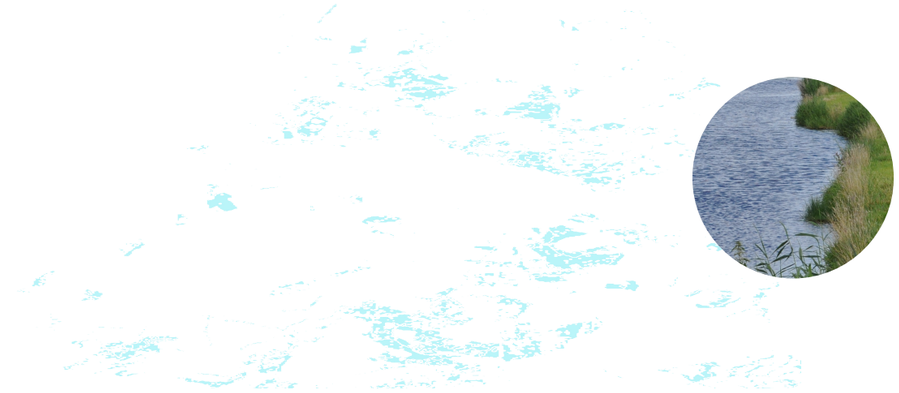
Once again creating a lower waterlevel to maintain the current way of farming.

SOLUTIONS FOR THE SOIL SUBSIDENCE IN THE PEAT LANDSCAPES

Wet food types in these landscapes (with a layer of water above the ground level)

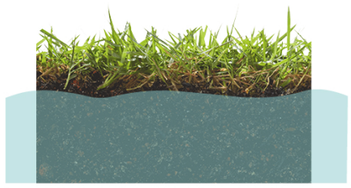


New high water level to stop the soil subsidence process in these landscapes.



Soil subsidence is extremely high in these landscapes. Therefore the water level will be raised above the ground level to stop the oxidation processs of the peat completely.

Regular cultivation with this type of water level. The soil is still dry, however not stable enough for heavier cows.



New higher water level to brake the soil subsidence process in these landscapes.



Traditional dairy farming landscape with cows



Existing water level to continue the current way of farming in these landscapes.

Soil subsidence is higher in these landscapes and therefore the water level will be raised to brake the oxidation process of the peat in these areas.



Soil subsidence is the lowest in these landscapes. Therefore the existing water level will be maintained to continue with the use of the landscapes as grassland and be able to let the cattle walk in these food landscapes.

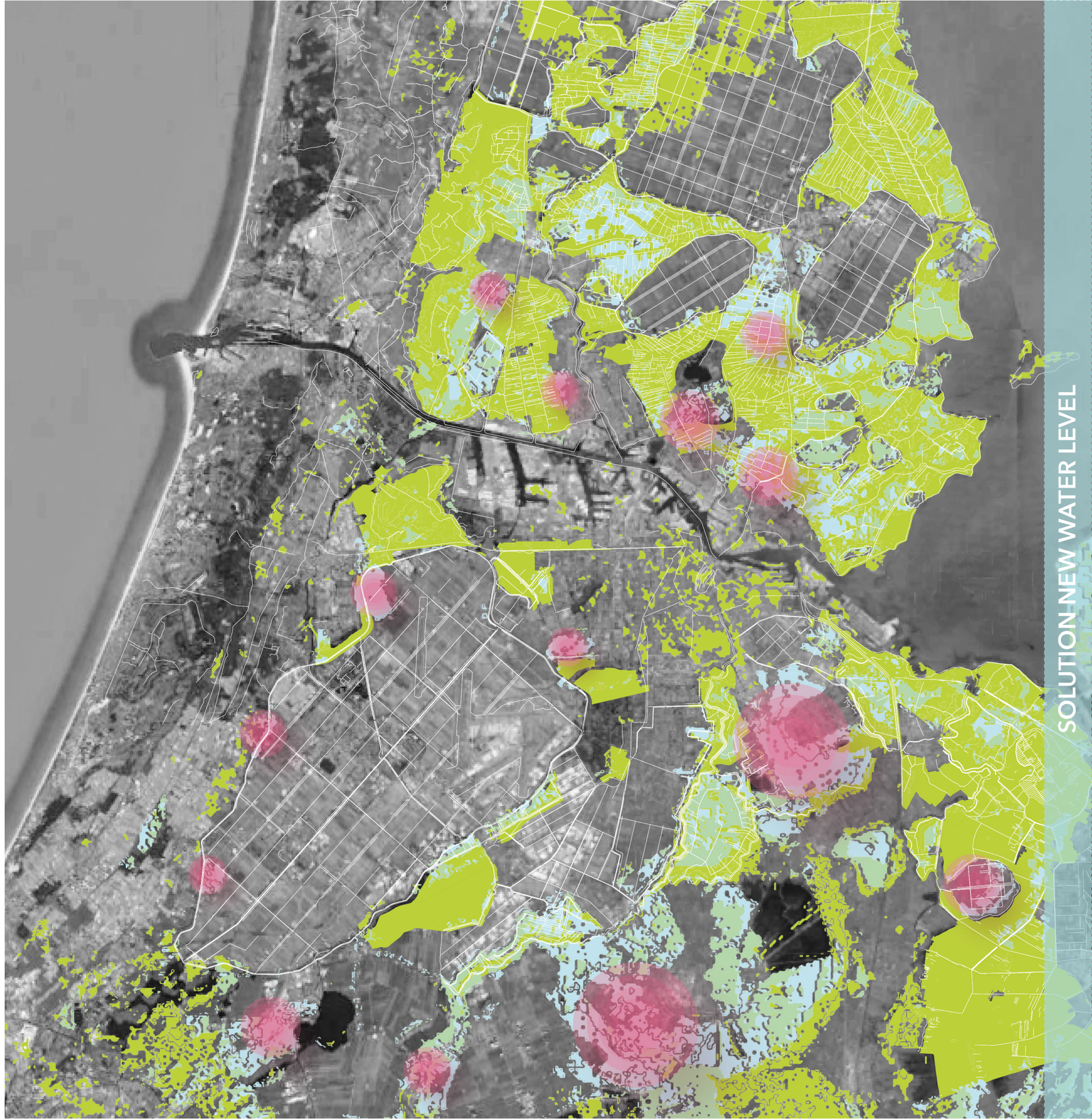
Note: most of the subsidence areas with the existing climate conditions overlay with the areas of the additional soil subsidence by climate change towards 2050. Therefore in the solution layers, these two categories are combined.

SOIL SUBSIDENCE SOLUTIONS WITH ADJUSTMENT OF THE WATER LEVEL IN THE LANDSCAPES

The solutions for the urgent soil subsidence problem in the peat landscapes of the region are three types of water levels. In the locations where the soil subsidence is more than 60 cm, the new water level will be created above the ground level. In this way the soil subsidence process stops, and a new innovative [food] landscape arises. This new landscape could be well combined with new food types, sustainable energy and recreational activities (see the next solutions). Furthermore, this new landscape prevents the release of CO_2 emissions that are created in the oxidation process of the peat and contribute to climate change. In some of these landscapes, there will be the opportunity to grow peat by introducing nature landscapes (in the pink areas).

In the landscapes with a higher water level, new food types could be introduced. And in the landscape where the existing waterlevel is maintained, the traditional peat landscape with meadows and cows is still there (in most landscapes of the region).

An interesting conclusion of the previous maps is that the additional soil subsidence is concentrated in the landscapes where there is already a high soil subsidence predicted. Therefore, the urgency to create solutions in these landscapes is the highest.



Most urgent soil subsidence landscapes with climate change towards 2050 (+15 cm)

Peat landscapes

Landscapes with a low waterlevel: dry grassland

Landscapes with a higher waterlevel: wet grassland

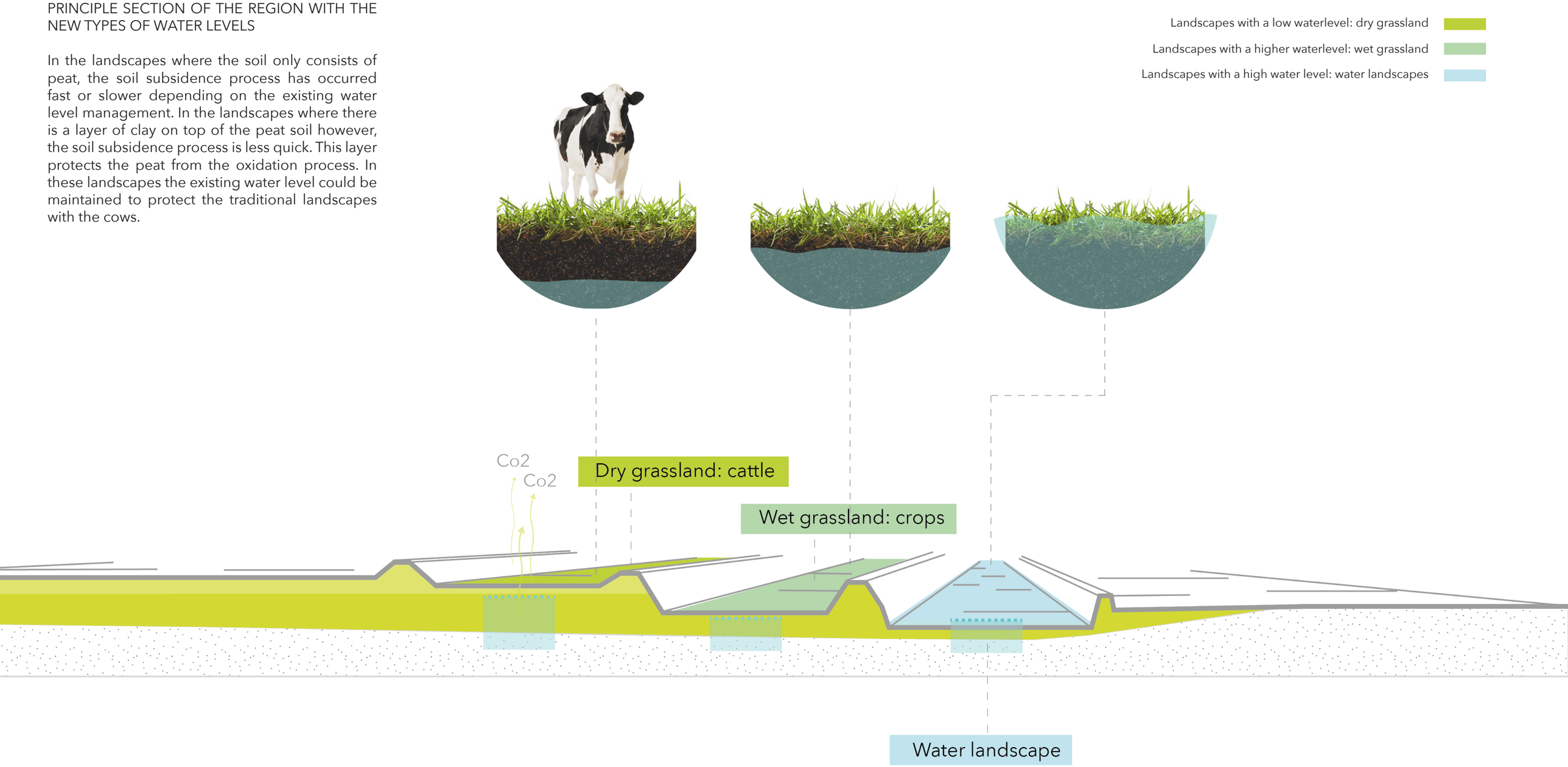
Landscapes with a high water level: water landscapes

Schaal 1: 1:400000

Map created by author & based on GIS,

PRINCIPLE SECTION OF THE REGION WITH THE NEW TYPES OF WATER LEVELS

In the landscapes where the soil only consists of peat, the soil subsidence process has occurred fast or slower depending on the existing water level management. In the landscapes where there is a layer of clay on top of the peat soil however, the soil subsidence process is less quick. This layer protects the peat from the oxidation process. In these landscapes the existing water level could be maintained to protect the traditional landscapes with the cows.



IMPRESSIONS OF THE NEW WATER LEVELS IN THE LANDSCAPES

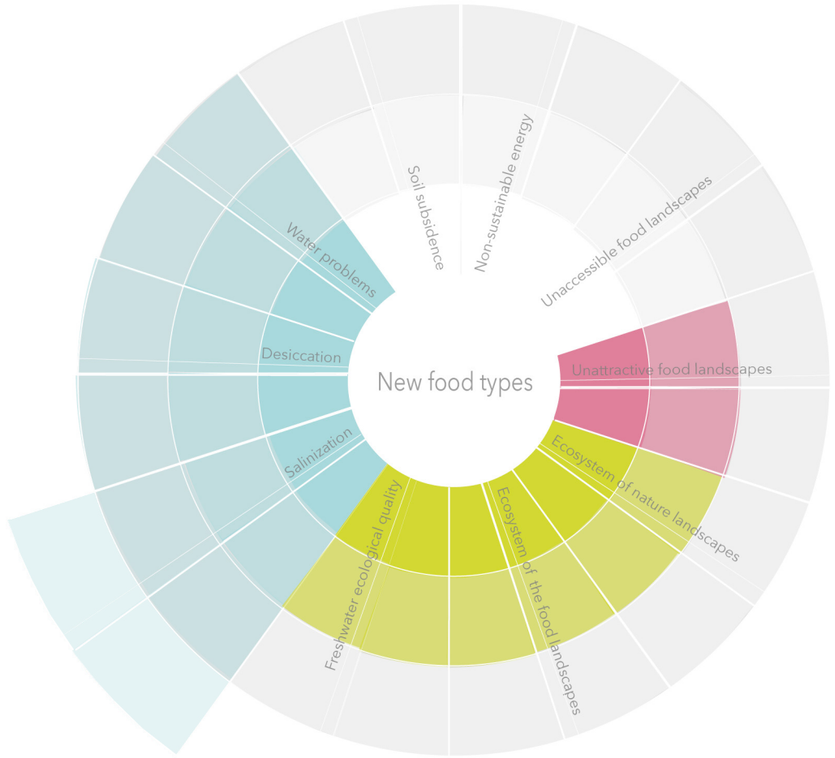






Images created by author

CLIMATE RESILIENT SOLUTION IN THE LANDSCAPES: NEW FOOD TYPES



LANDSCAPE SCALE SOLUTION

FOOD TYPES IN THE LANDSCAPES OF THE REGION

With the previous maps, the effects of climate change on the [food] landscapes in the metropolitan region of Amsterdam towards 2050 become clear. As is visible from this map, the most diverse food production takes place in the lower polders (droogmakerijen) and especially in Haarlemmermeer. The climate change effects will have a large impact on these landscapes, and thus on the food production in the Netherlands towards 2050.

Disclaimer: this map represents a moment in time of the food production landscapes in the metropolitan region of Amsterdam. As the food types are rotating during the year, the current situation could differ from this map.

- Grass & cattle
- Wheat
- Sugarbeet
- Potatoes
- Maize
- Vegetables
- Barley
- Greenhouses: vegetables

Schaal 1: 1:400000

Map created by author & based on GIS, One Soil (2019)

Characteristics of grass

Growing period: march - september
Indicative yield:

- Price: 0,22 euro/kVEM
- Amount: 2,500 euro/ha
- Grass: 11.000 kVEM/ha



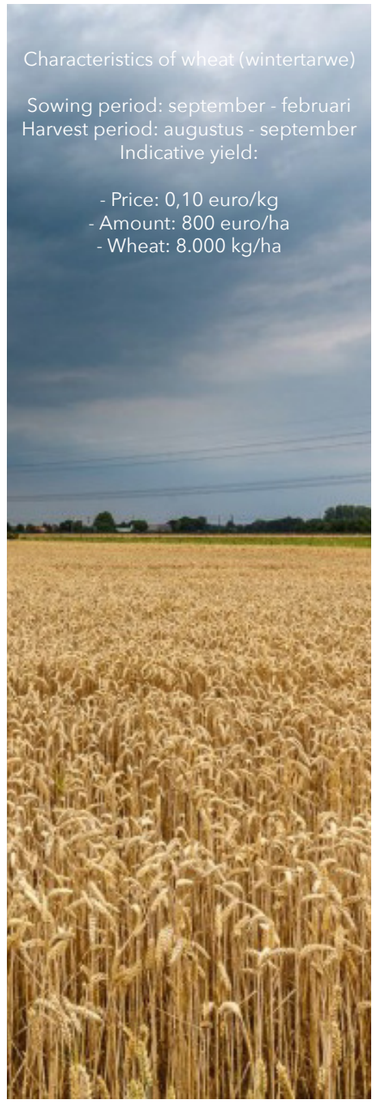
Grass

43000 ha in region

Characteristics of wheat (wintertarwe)

Sowing period: september - februari
Harvest period: augustus - september
Indicative yield:

- Price: 0,10 euro/kg
- Amount: 800 euro/ha
- Wheat: 8.000 kg/ha



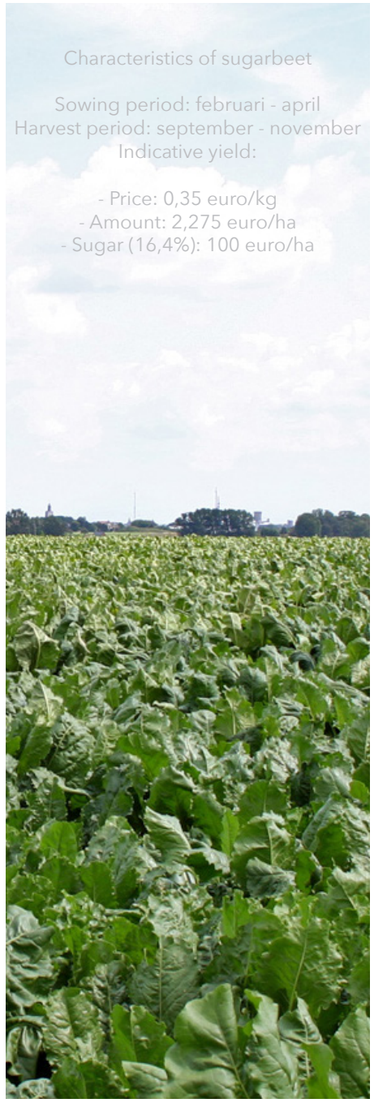
Wheat

3000 ha

Characteristics of sugarbeet

Sowing period: februari - april
Harvest period: september - november
Indicative yield:

- Price: 0,35 euro/kg
- Amount: 2,275 euro/ha
- Sugar (16,4%): 100 euro/ha



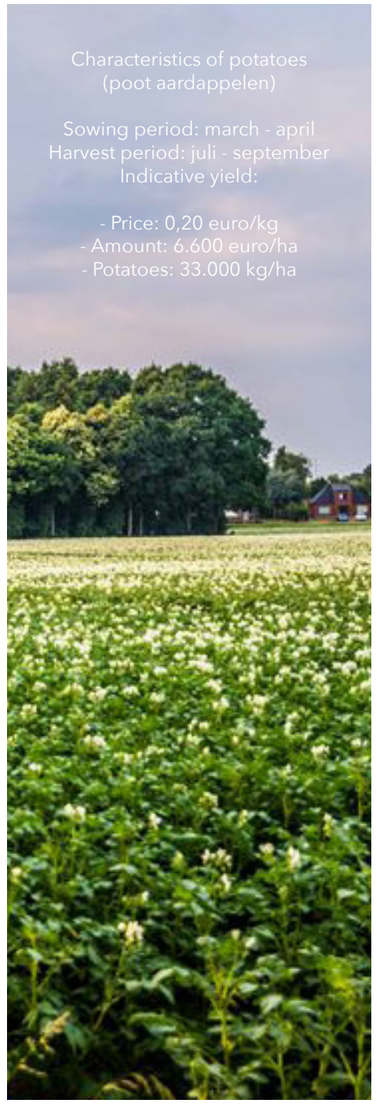
Sugarbeet

2000 ha

Characteristics of potatoes
(poot aardappelen)

Sowing period: march - april
Harvest period: juli - september
Indicative yield:

- Price: 0,20 euro/kg
- Amount: 6.600 euro/ha
- Potatoes: 33.000 kg/ha



Potatoes

1500 ha

Characteristics of maize

No specific data was found on
this food type



Maize

2000 ha

Characteristics of vegetables in
agriculture (example of unions)

Sowing period: februari - april
Harvest period: augustus - september
Indicative yield:

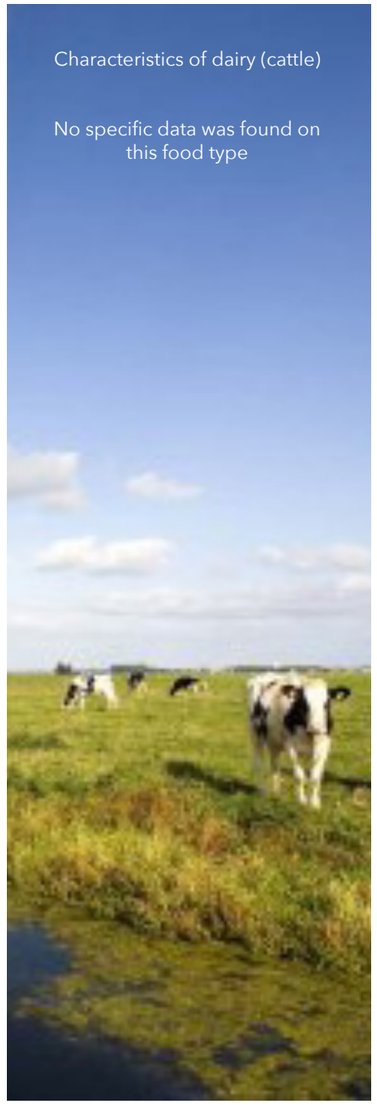
- Price: 0,10 euro/kg
- Amount: 6.600 euro/ha
- Vegetables (unions): 66.000 kg/ha



Vegetables (unions)

7000 ha





Vegetables (in greenhouses)

1700 ha

Dairy & cattle

43000 ha in region

7000 ha

3000 ha

2000 ha

2000 ha

1700 ha

1500 ha

EXISTING FOOD TYPES IN THE LANDSCAPES OF THE REGION

In these pages the existing food types in the agricultural landscapes of the metropolitan region of Amsterdam are given with the average surface for the production of these food types in the region. Grass (in combination with cattle) is the largest food production landscapes in the region, together with vegetables and wheat. The smallest landscape are the vegetables in the greenhouses and potatoes.

The surface for the production of these food types is important to take into account, because it determines the damage that is caused by the climate change effects on the food production in the region. For example, if there are water problems in the agricultural landscapes where vegetables are produced this will have a large impact on the harvest and economical loss in the region in 2050. However, if in these locations potatoes are produced this damage will be significant less.

Source:
Images created by author & based on
Grondmij (2009) & One Soil (2019)

SUITABILITY OF LANDSCAPES FOR FOOD PRODUCTION (based on growing conditions)

This map gives the suitability of the parcels in the agricultural landscapes for the production of the existing food types in the region. The map shows on a relative scale of 1% (location unsuitable for arable crops) to 100% (maximum growth of arable crops) how much production is achieved at a location. In this way, it gives a background for the overview scheme on the next pages, where the impact of climate change on the harvest loss of the existing food types becomes visible. In locations where the conditions for food production are not optimal, there is a change of large harvest loss with the climate change effects.

Grassland
- 1 - 20%
- 40 - 60%
- 60 - 80%
- 80 - 100%

Agriculture
- 20 - 40%
- 60 - 80%
- 80 - 100%

Schaal 1: 1:400000

Map created by author & based on GIS.

ECONOMIC VALUES OF THE FOOD PRODUCTION LANDSCAPES

This map gives the economical value of the food production in the landscapes of the region. With this map the economical loss by the effects of climate change could be determined (as is done in the overview scheme on the next pages). Horticulture and agriculture food types have the most economical value in the region.

Grassland
- < 100 €/ha

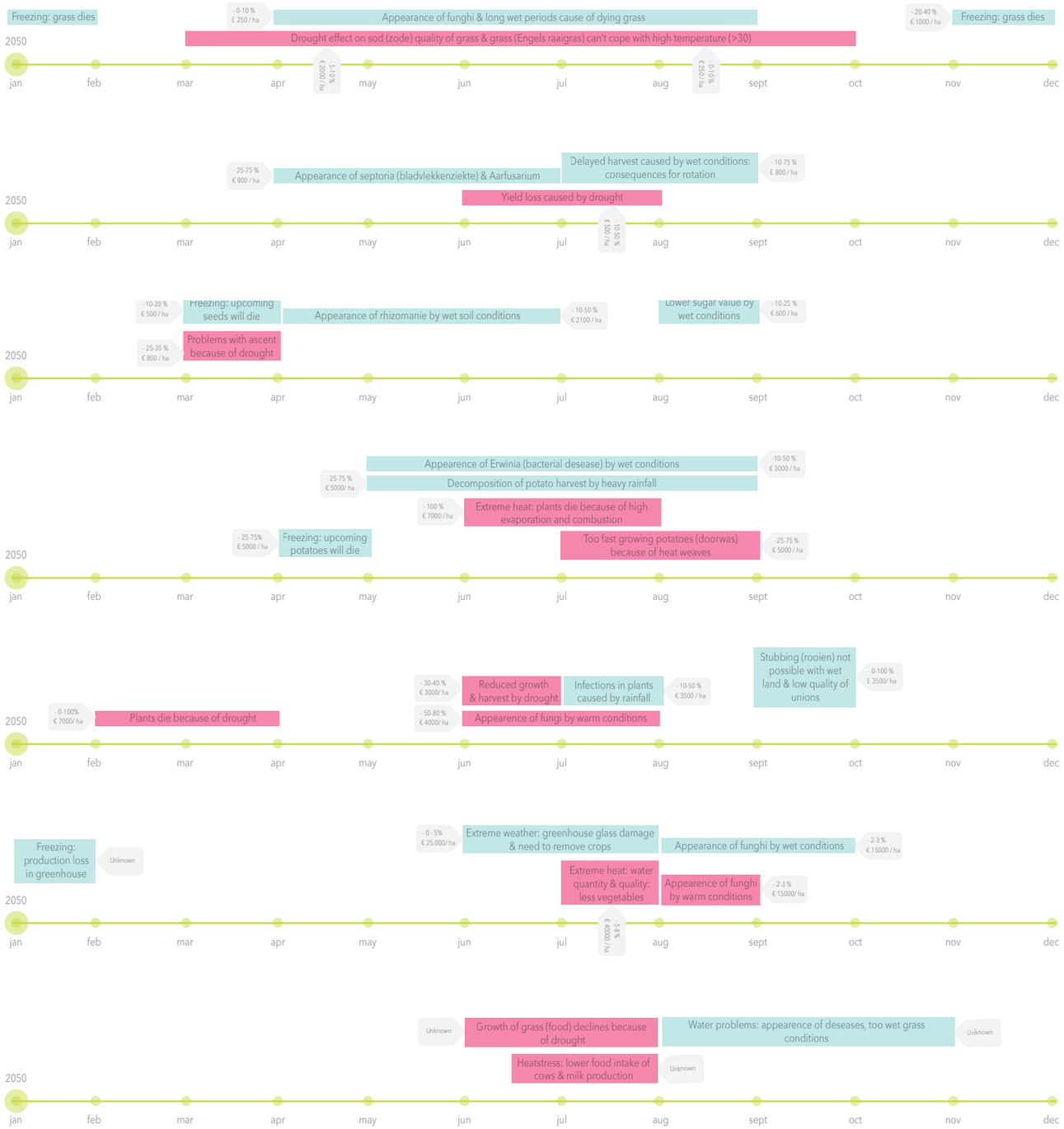
Agriculture
- 100 - 200 €/ha
- 200 - 500 €/ha
- 500 - 1000 €/ha
- > 1000 €/ha

Horticulture
- 500 - 1000 €/ha

Schaal 1: 1:400000

Map created by author & based on GIS,

HARVEST & ECONOMIC LOSS OF THE FOOD TYPES WITH CLIMATE CHANGE TOWARDS 2050





This scheme gives the impact of climate change towards 2050 on the existing food types in the region (in harvest & economical loss) as based on the previous maps and research of Grontmij on climate change effects and food (2009). Harvest loss arises because of the new warm & dry, wet and salt conditions of the landscapes with climate change towards 2050. The economical loss of the food production is based on the economical value of the different crops and the impact of climate change on the damage to the harvest of the crops.

In the graphic the harvest and the ecomical loss is visible per crop type. From this graphic on the following page the resilience of the existing crops could be defined and therefore the adaptation of the crops in the landscapes that is needed towards 2050 in the region.

Disclaimer: large economical loss with the greenhouses, however the chance of occurrance of an event is really small (0 - 5%).

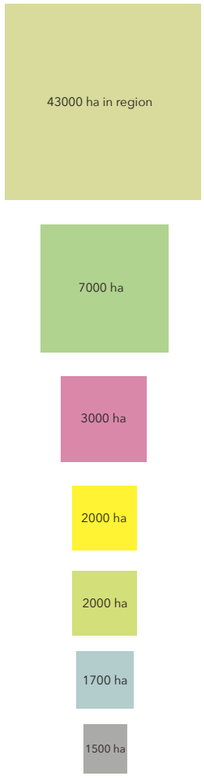
Source:
Images created by author & based on Grondmij (2009) & One Soil (2019)

RESILIENCE OF THE FOOD TYPES IN THE REGION TOWARDS 2050

Based on the harvest & economical loss of each food type in the landscapes of the region, the resilience of the food types for the new conditions created by climate change towards 2050, is given.

In the green icons the food types that are resilient to the new conditions in the region are visible.

It is interesting to relate the resilience of each food type to the amount of hectare that is used in the region to produce this type of food, to see the impact of climate change on the existing food production.

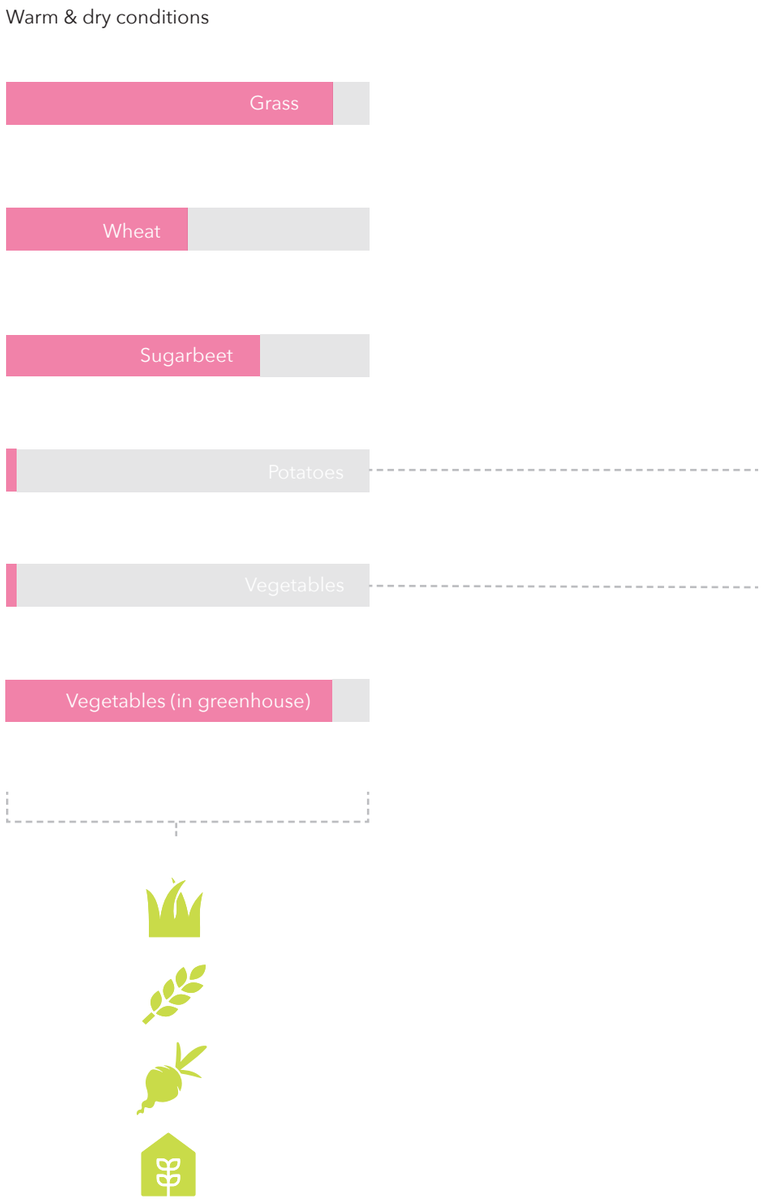




Source:
Images created by author & based on Grondmij (2009) & One Soil (2019)

NEW FOOD TYPES WITH WARM & DRY CONDITIONS IN THE LANDSCAPES

In this scheme the resilient food types to warm & dry conditions in the landscapes are given & new food types that could be introduced in the landscape to become resilient are given. Sometimes not only new food types are a solution to create resilience, but also other products in the landscape are possible (as sunflowers).



WARM & DRY PRODUCTION OF FOOD

Sunflower oil



Rapeseed (koolzaad)



Artichokes and grapes





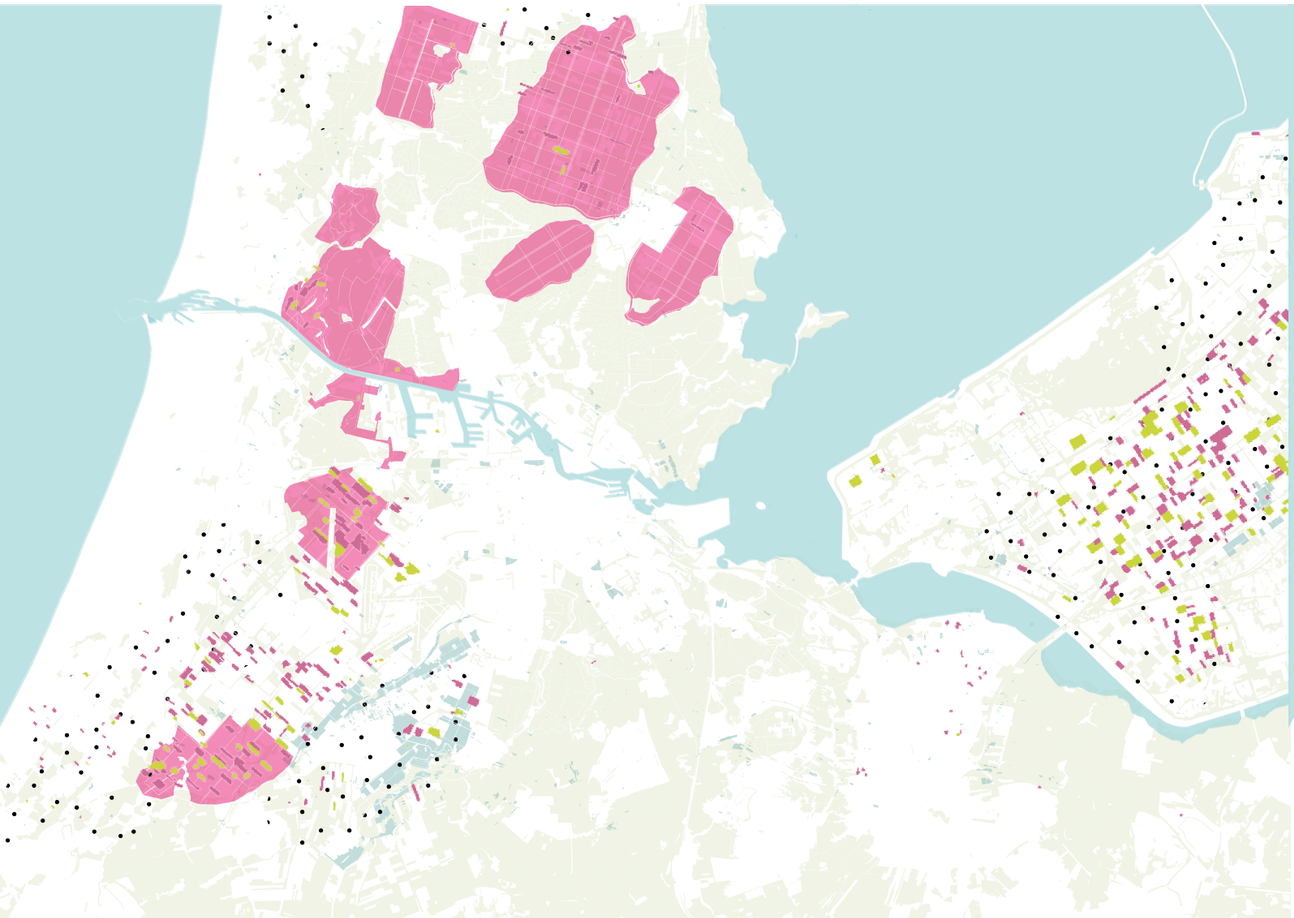
Source:
Images created by author & based on Buiter (2015)

RESILIENT & NON-RESILIENT FOOD TYPES: WARM & DRY CONDITIONS

The food types of grass, wheat, sugarbeet and vegetables in the greenhouses are resilient towards 2050 to the warm and dry conditions of the landscapes. Especially in the pink areas drought will be a large problem towards 2050 according to the previous maps. In these places a solution need to be introduced that prevents drought problems in these areas of the region (like water storage locations in the landscapes), to have an optimal production of these food types. Because they are resilient to the warm & dry conditions, but grow better if the conditions are optimal. This is especially the case for wheat and sugarbeet (which are sensitive to the new conditions).

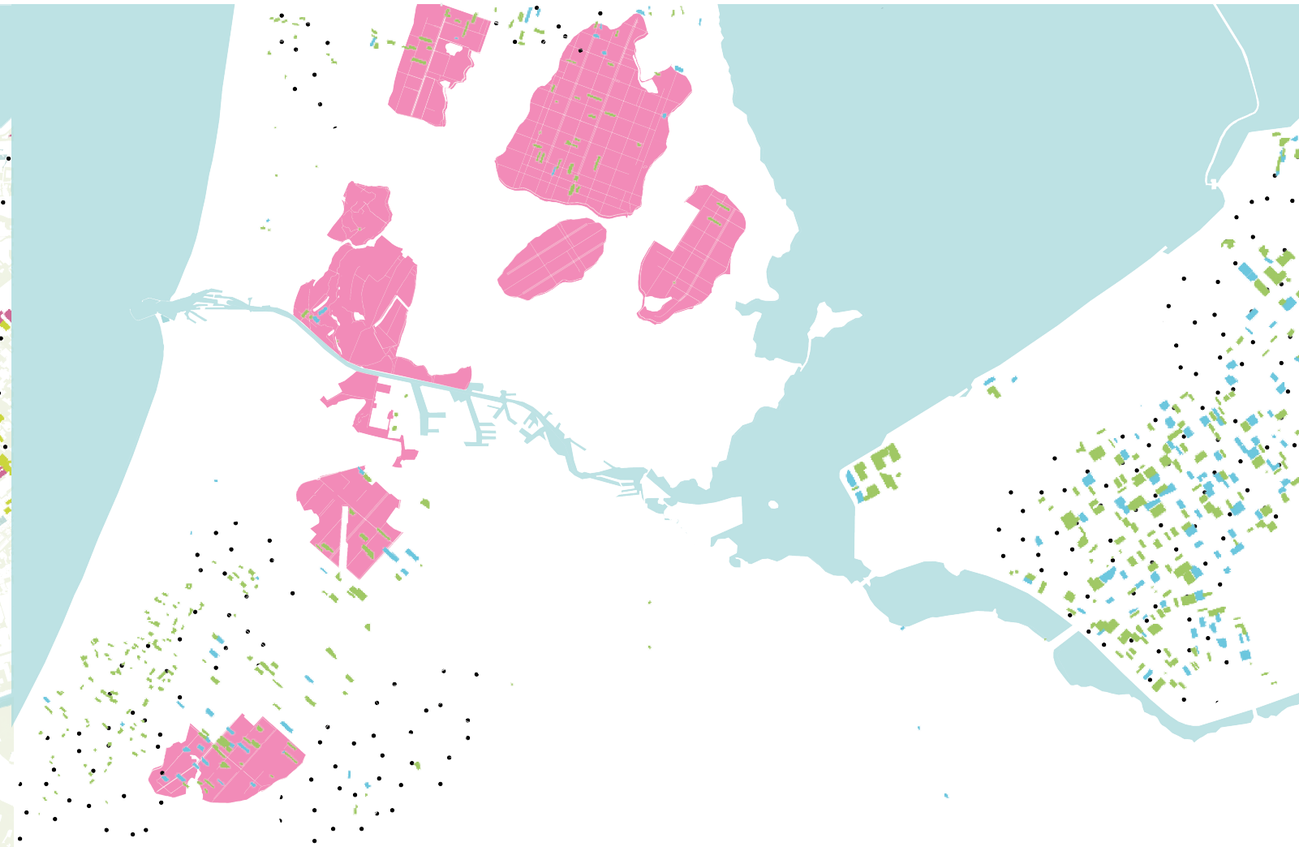
The food types of potatoes and vegetables in the region are not resilient towards 2050 to the warm and dry conditions of the landscapes. Especially in the pink areas, drought will be a large problem towards 2050 according to the previous maps.

In these places new food types need to be introduced to become more resilient to climate change with the food production and have an economical benefit. Or a solution need to be introduced that prevents drought problems in these areas of the region (like water storage locations in the landscapes).



Resilient food types towards 2050 in the region

- Grass
- Wheat
- Sugarbeet
- Greenhouses: vegetables
- Drought problems in the landscapes
- Critical water-demanding food types



Non-resilient food types towards 2050 in the region

- Potatoes
- Vegetables
- Drought problems in the landscapes
- Critical water-demanding food types

Schaal 1: 1:400000
Map created by author & based on GIS,

NEW FOOD TYPES WITH WET CONDITIONS IN THE LANDSCAPES

In this scheme the resilient food types to wet conditions in the landscapes are given & new food types that could be introduced in the landscape to become resilient are given. Sometimes not only new food types are a solution to create resilience, but also several other products in the landscape are possible (as cattails and reed). These other products could be well combined with the purifying nature solution.



WET PRODUCTION OF FOOD



Wild rice (zizania)



Duck-potato (pijlkruid)

Mooseberry (veenbes) & Cranberry





WET PRODUCTION OF OTHER PRODUCTS

Cattail (Lisdodde)

Duckweed (Kroosvaren)

Peat moss (Veenmos)

Elephant grass (Olifantsgras)

Willow (Wilg)

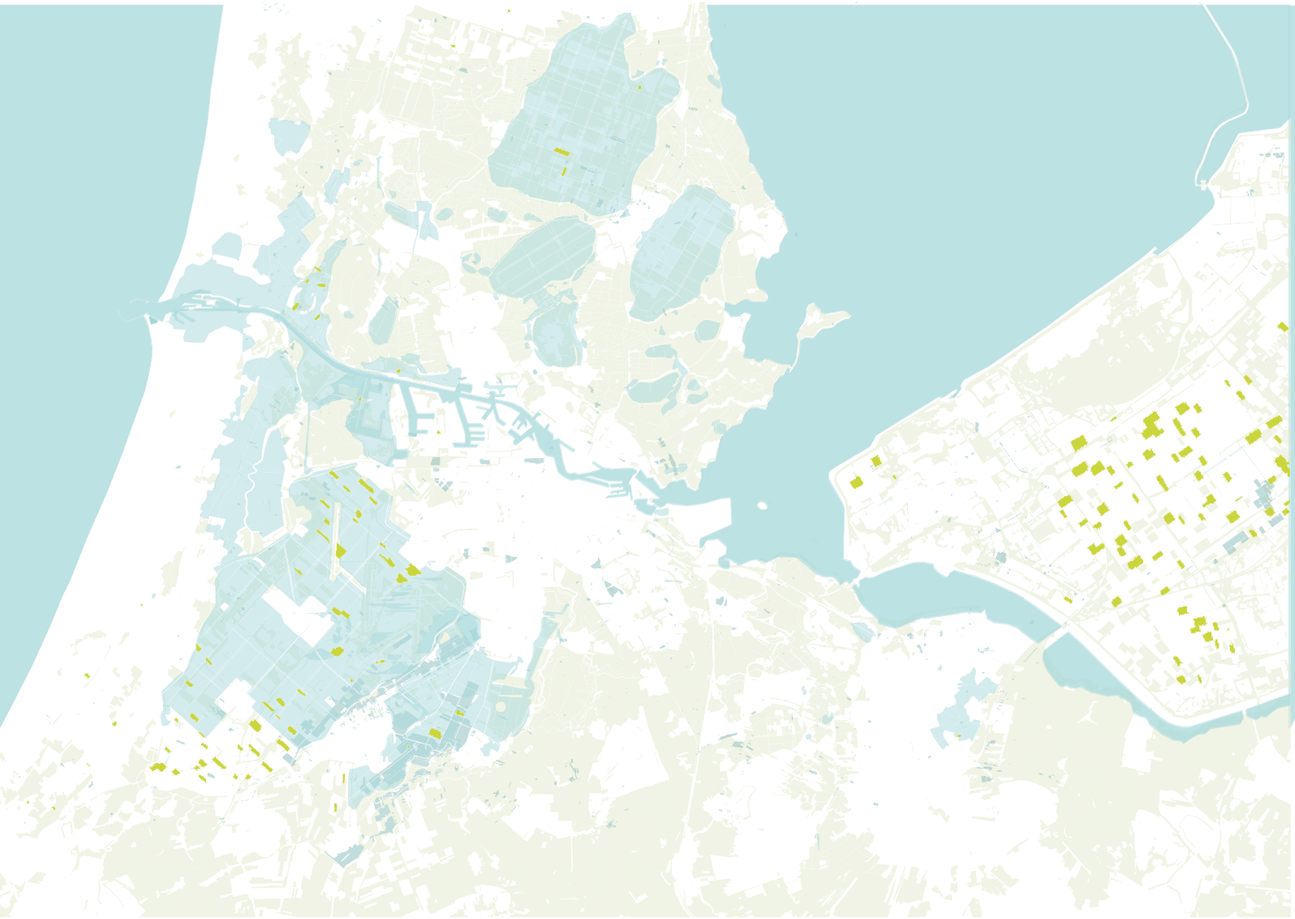
Reed (Riet)

Source:
Images created by author & based on
Praasterink & Keet (2017).
Stowa (2016)
Proeftuinkrimperwaard (2018)

RESILIENT & NON-RESILIENT FOOD TYPES: WET CONDITIONS

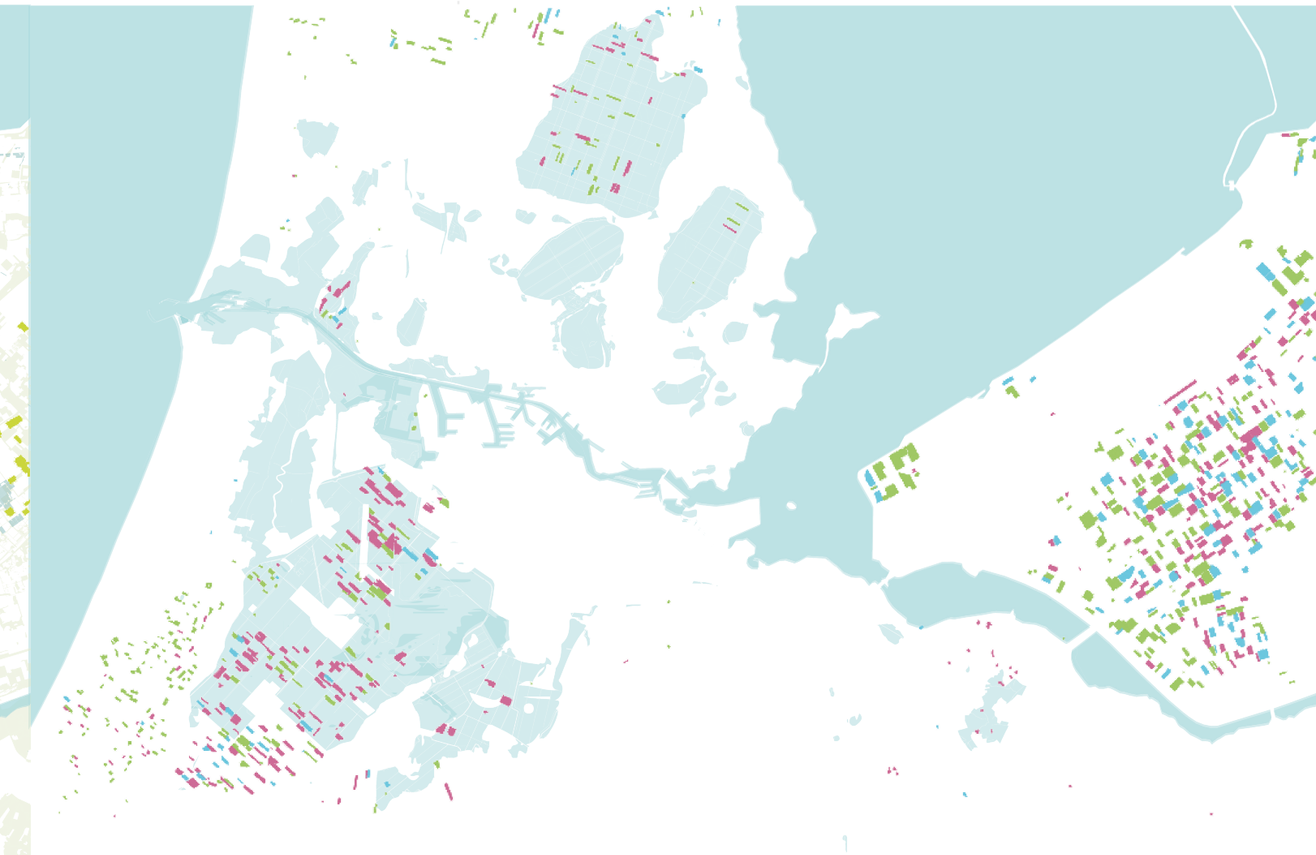
The food types of wheat, potatoes and vegetables in the region are not resilient towards 2050 to the wet conditions of the landscapes. Especially in the blue areas, water problems will be a large problem towards 2050.

Preventing water problems by creating more water storage in the landscapes in combination with wet food types that are more resilient to the wet conditions is a solution. Furthermore, the wet food types could be well combined with the new water levels in the peat landscapes.



Resilient food types towards 2050 in the region

- Grass
- Sugarbeet
- Greenhouses: vegetables
- Water problems in the landscapes



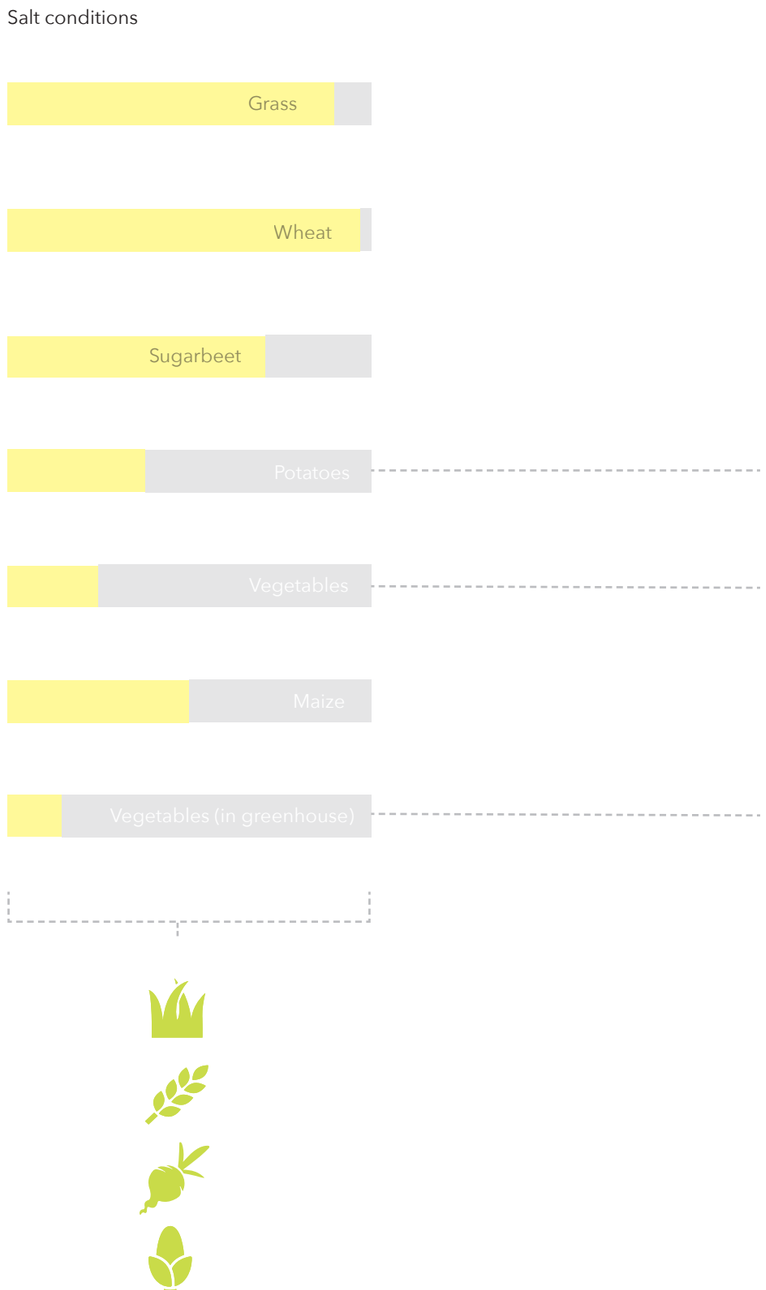
Non-resilient food types towards 2050 in the region

- Wheat
- Potatoes
- Vegetables
- Water problems in the landscapes

Schaal 1: 1:400000
Map created by author & based on GIS,

NEW FOOD TYPES WITH SALT CONDITIONS OF THE LANDSCAPES

In this scheme the resilient food types to salt conditions of the landscapes are given & new food types that could be introduced in the landscape to become resilient. Sometimes not only new food types are a solution to create resilience, but also several other products in the landscape are possible (as purifying nature).



Disclaimer: the solution is not found in new crops in the greenhouses, but in fresh irrigation water due to sufficient water storage for dry periods.

Salt potatoes
Barley (gerst)
Rapeseed (koolzaad)

Artichoke
Samphire (zeekraal)
Sea lavender (lamsoor)

(Tomatoes & Grapes)

SALT PRODUCTION OF FOOD



SALT PRODUCTION OF OTHER PRODUCTS

Reed (Riet)

Sunflower (Zonnebloem)

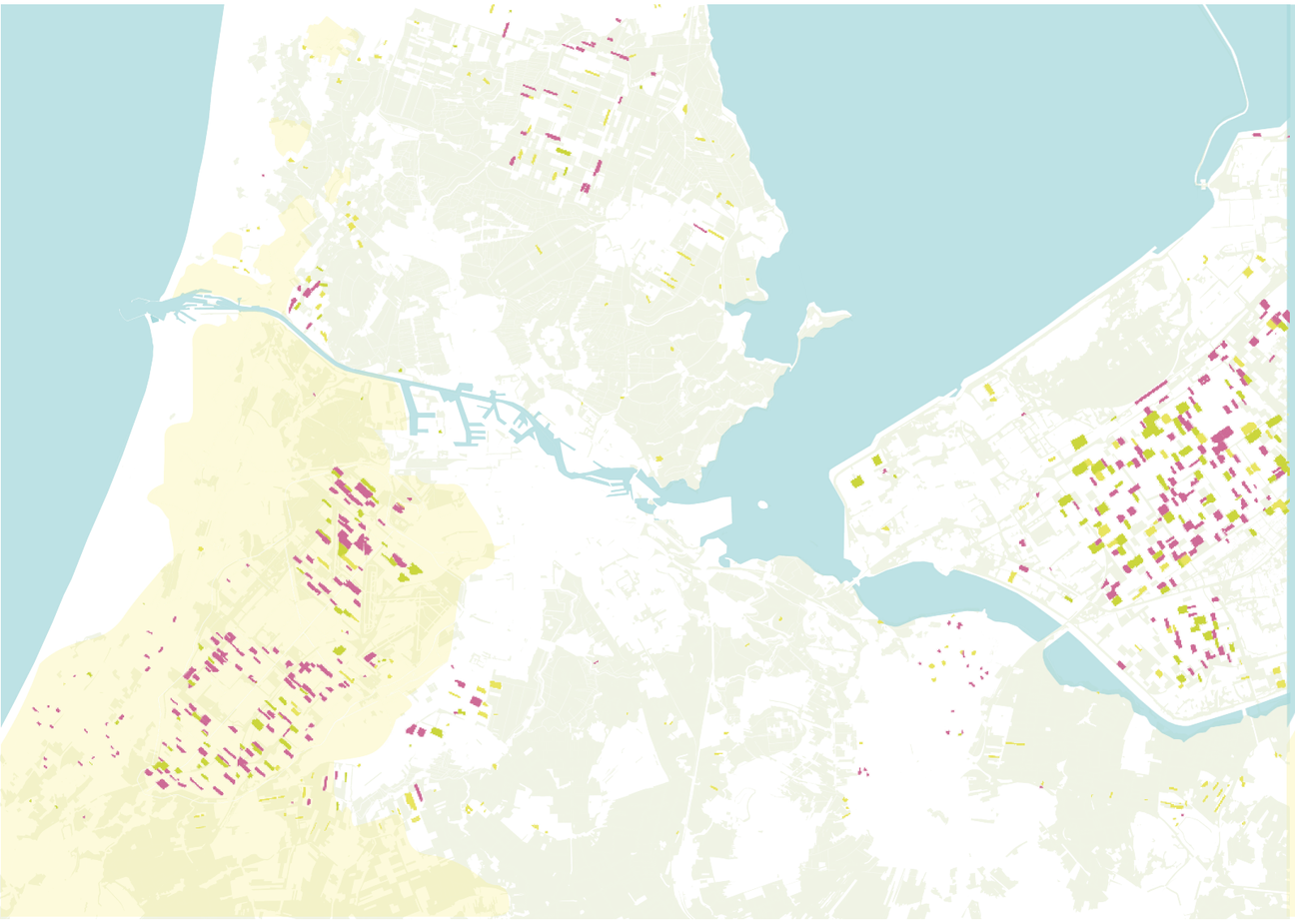
Lily (Lelie)

Source:
Images created by author & bases on
Grondmij (2009)
Deltares & Alterra (2018b)

RESILIENT & NON-RESILIENT FOOD TYPES: SALT CONDITIONS

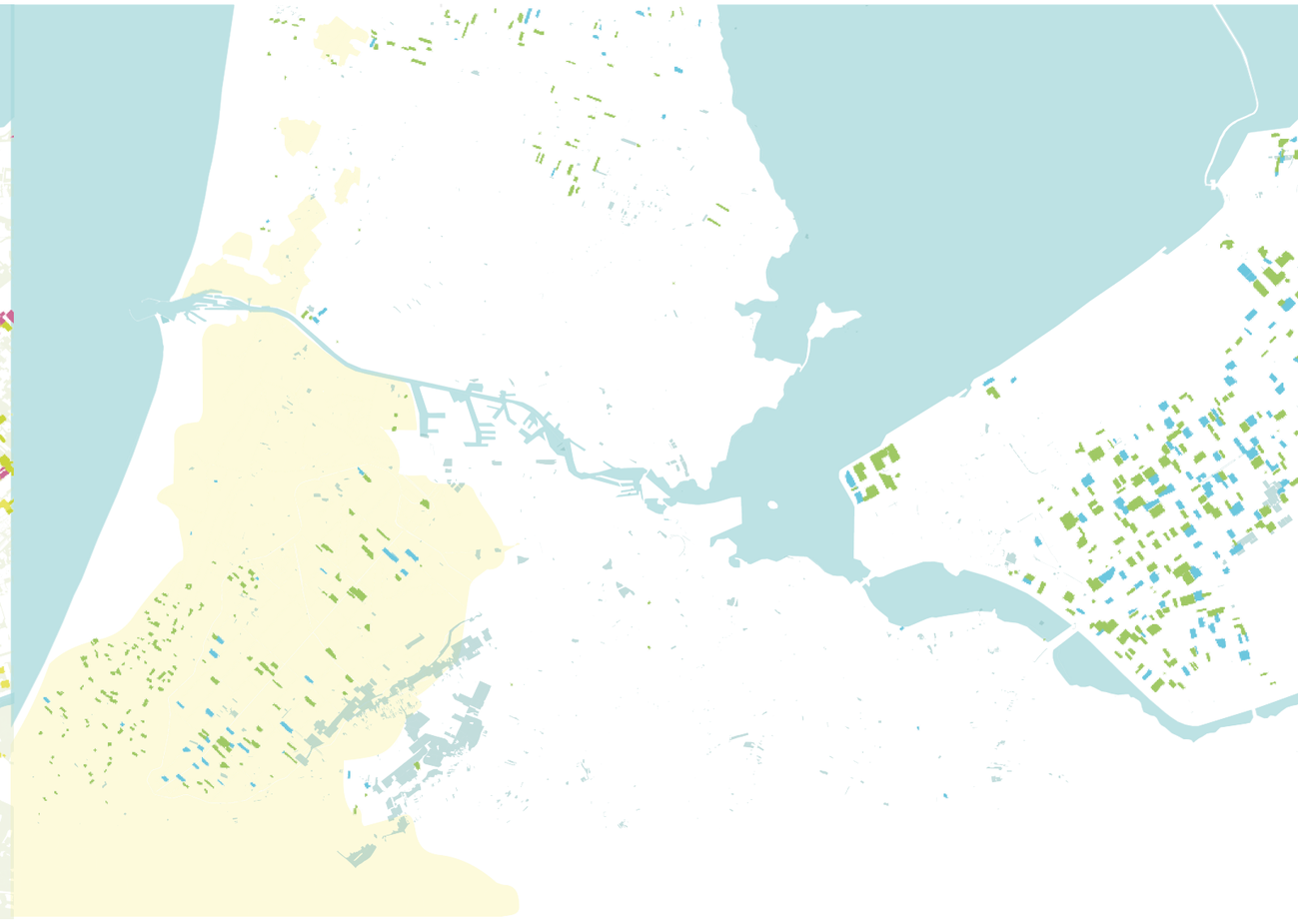
The food types of potatoes and vegetables in the region are not resilient towards 2050 to the salt conditions of the landscapes. Especially in the yellow areas, salinization will be a large problem towards 2050.

In these places new salt food types need to be introduced to become more resilient to climate change with the food production and have an economical benefit. Or the on-going process of 'doorspoeling' needs to be continued towards the future to maintain the existing conditions, however this will require a lot of freshwater (while shortage is appearing) and costs a large amount of money and energy for pumping (Ministerie van IenM, EZ & BZK, 2018)



Resilient food types towards 2050 in the region

- Grass
- Wheat
- Sugarbeet
- Maize
- Salinization problems in the landscapes



Non-resilient food types towards 2050 in the region

Disclaimer: salt sensitivity depends on the type of vegetables. In this graduation project unions are taken as an example of the vegetables in the region (because they are largely produced in this region). However there are vegetables that are more or less sensitive to the salt concentrations of the freshwater towards 2050. More sensitive: komkommer, paprika, radijs, sla. Less sensitive: prei, wortel, spinazie, spruiten & rode bieten (Deltares & Alterra, 2018b).

Greenhouses are part of the non-resilient food landscapes with new salt conditions because of shortage in freshwater for irrigation. However this problem will be solved with the waterstorage and water purification solutions in the other chapters. Therefore this type of landscape will not have the focus in this solution chapter.

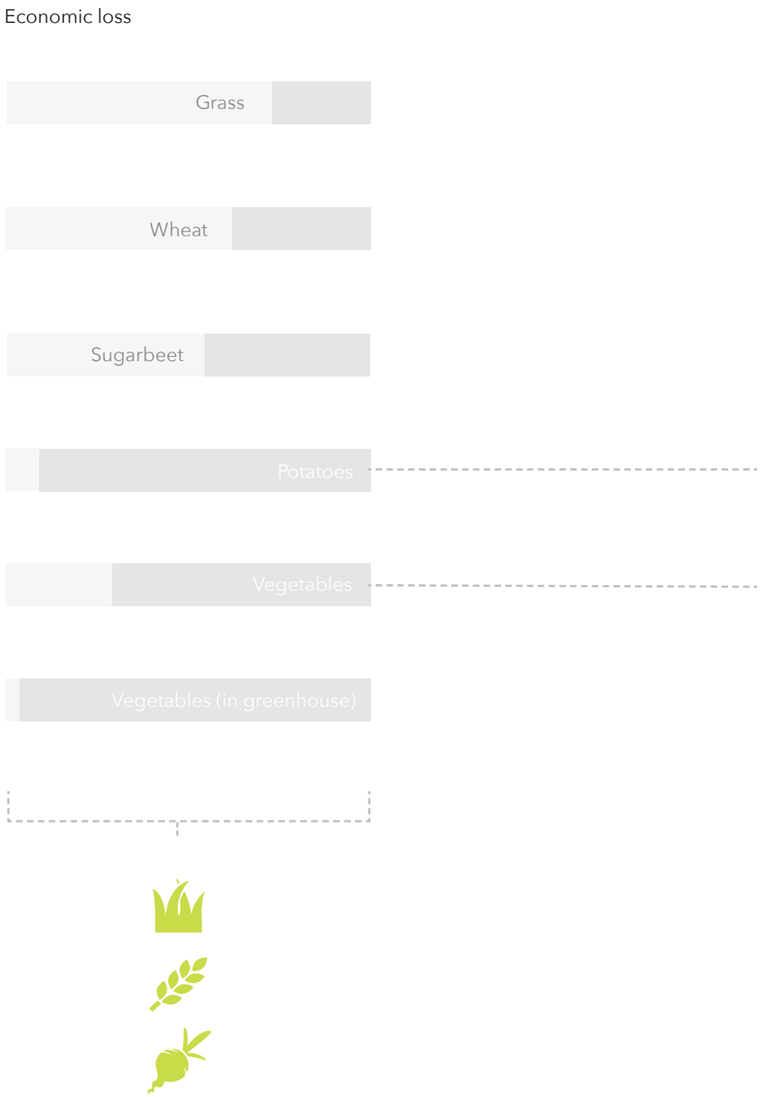
- Potatoes
- Vegetables
- Greenhouses: vegetables
- Salinization problems in the landscapes

Schaal 1: 1:400000
Map created by author & based on GIS,

NEW ACTIVITIES IN THE FOOD LANDSCAPES WITH A LARGE ECONOMIC LOSS

Most of the largest areas for agriculture are landscapes with food types that are resilient to the new climate conditions towards 2050. The largest problems arise in the landscapes with crops that are not resilient and have a large surface for food production in the region, the vegetables. And potatoes are furthermore not resilient.

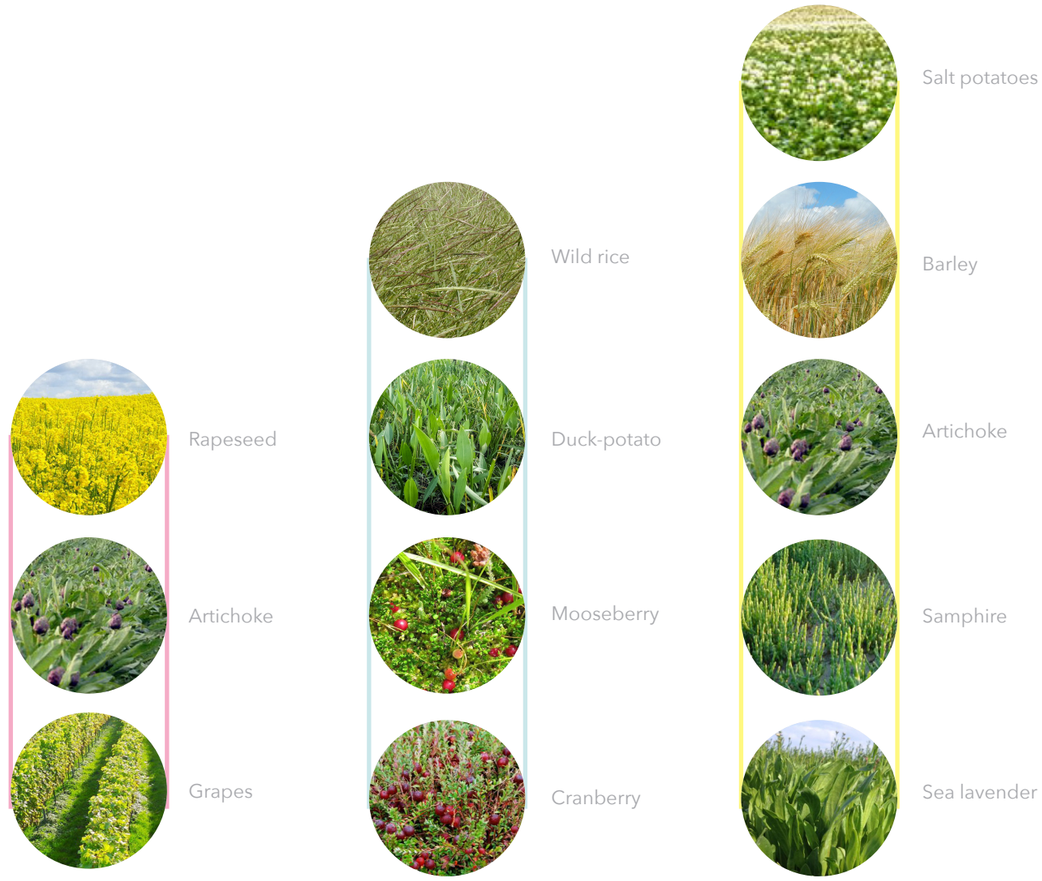
Therefore in the landscapes where the economical value of vegetables and potatoes is low and there is a large economical loss towards the future, new food types should be introduced that are resilient. Or the landscapes could be combined with new activities for economical profit (as sustainable energy, recreation and nature).



Disclaimer: large economical loss with the greenhouses, however the chance of occurrance of an event is really small (0 - 5%). Furthermore the damage is caused by the greenhouses itself (glass falling into the crops ect.) Therefore not an alternative solution will be created in this project for new food types in the greenhouses.

Source:
Images created by author.

ECONOMIC PRODUCTION OF FOOD



ECONOMICAL PRODUCTION OF OTHER PRODUCTS

Solar energy: solar panels in landscape or water, solar glass

Wind energy: windmills, wind energy elements

Algae energy: outside or in greenhouses

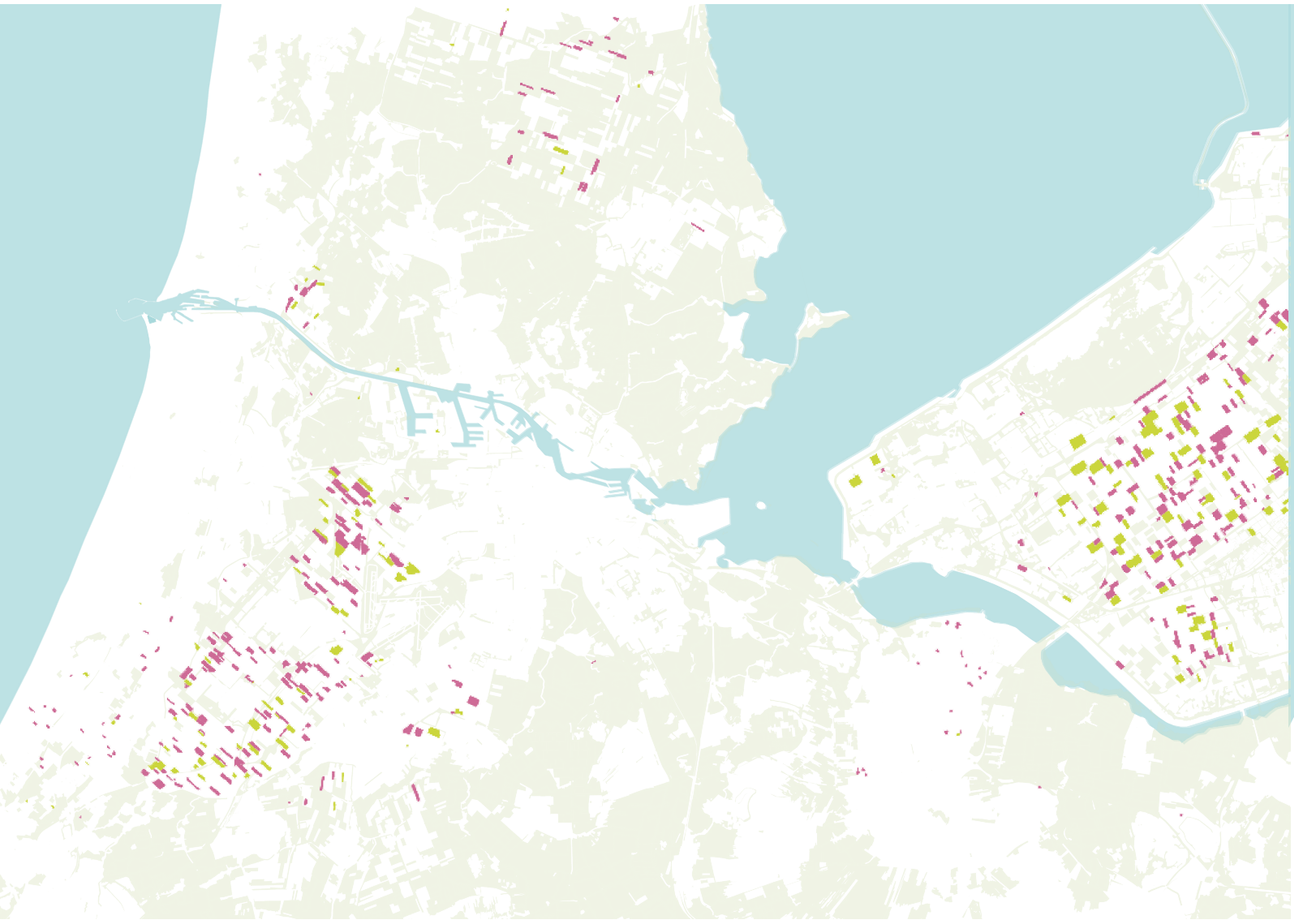
Recreational activities: care farms, pick up your food at the farm

Nature landscapes: to increase the biodiversity (less use of fertilizers & pesticides)

RESILIENT & NON-RESILIENT FOOD TYPES: ECONOMIC LOSS

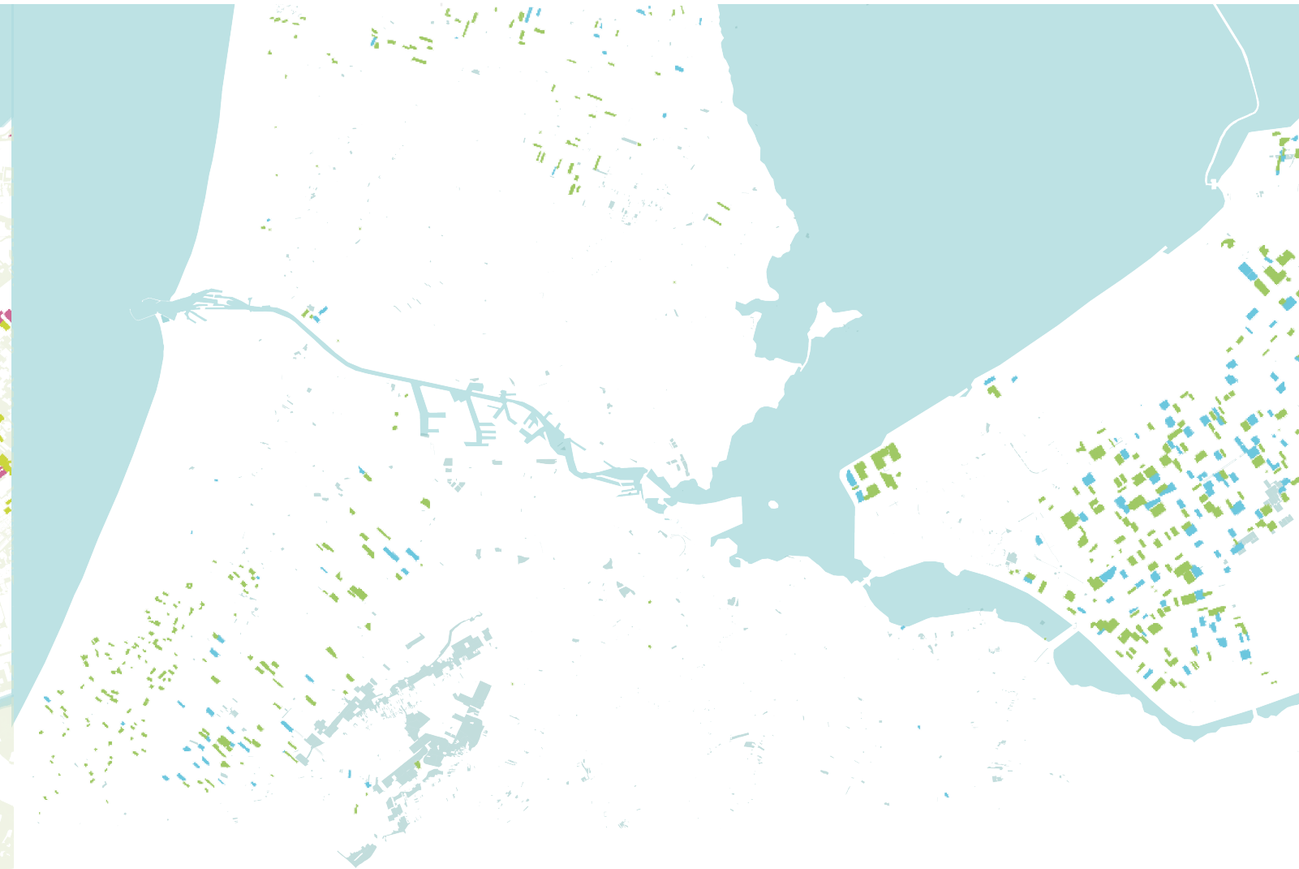
The food types of potatoes and vegetables in the region are not resilient towards 2050 in economical value.

In these places new food types need to be introduced to become more resilient to climate change with the food production and have an economical benefit. Or new activities that could be combined with the agricultural landscapes could be introduced for additional economical profit (as sustainable energy and recreation).



Resilient food types towards 2050 in the region

- Grass
- Wheat
- Sugarbeet



Non-resilient food types towards 2050 in the region

- Potatoes
- Vegetables
- Greenhouses: vegetables

Schaal 1: 1:400000
Map created by author & based on GIS,

NEW FOOD TYPES SOLUTIONS IN THE REGION

The new resilient food types that are selected in the landscapes of the region towards 2050 will be visible in the new perspective map, as they depend on the scenario's that are choses for the region based on the interviews (climate adaptation, purifying agriculture or recreational landscapes).

In places with more than one extreme condition during the year, the crops need to be rotated according to the resilience to the new conditions of the landscapes during the year. For example: during summer a crop type is chosen that is resilient to the salt conditions in the landscape and during winter one that is resilient to the wet conditions in the landscapes.



Peat landscapes (veenweide)

Polder landscapes (droogmakerij)

Resilient to dry conditions needed

Resilient to wet conditions needed

Resilient to salt conditions needed

Resilient to dry & wet conditions needed

Resilient to wet & salt conditions needed

Resilient to dry & salt conditions needed

Resilient to dry, wet and salt conditions needed

Schaal 1: 1:400000

Map created by author & based on GIS,

IMPRESSIONS OF THE NEW FOOD TYPES
IN THE LANDSCAPES

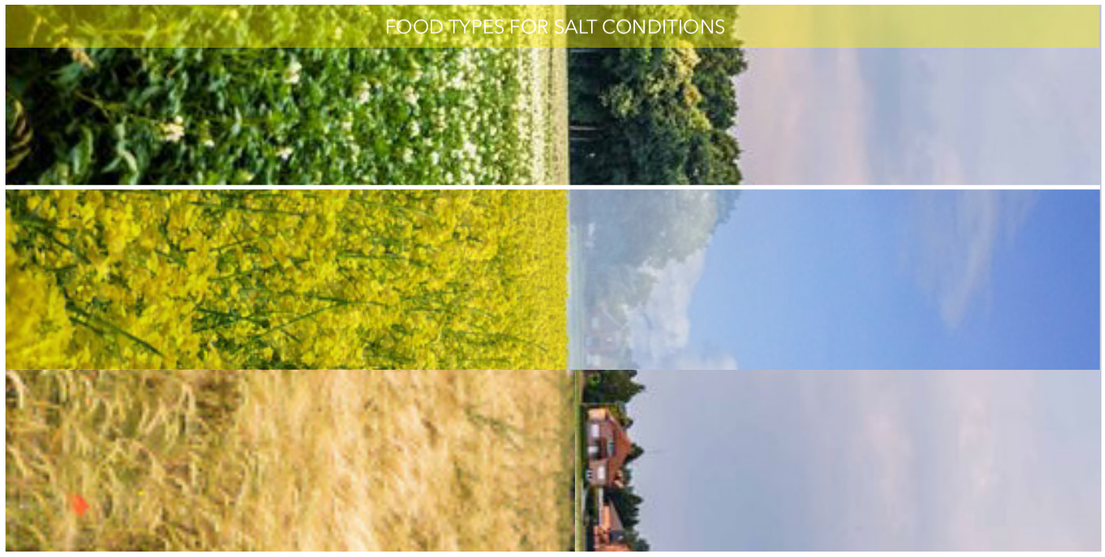


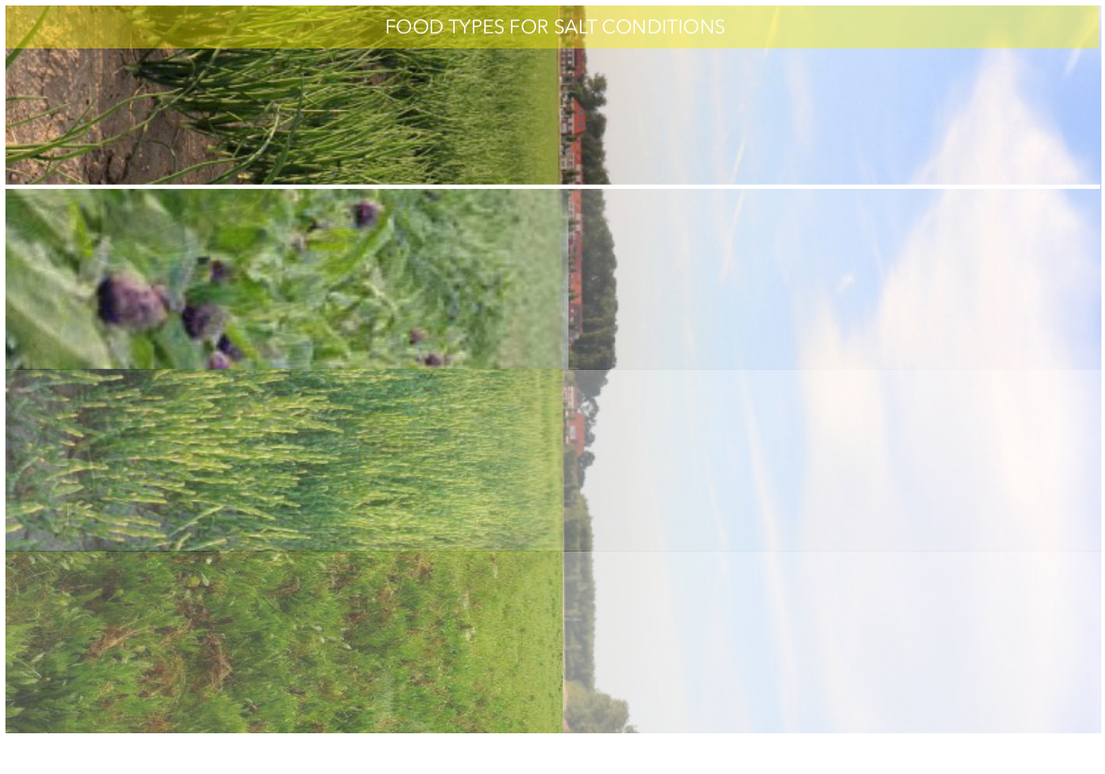




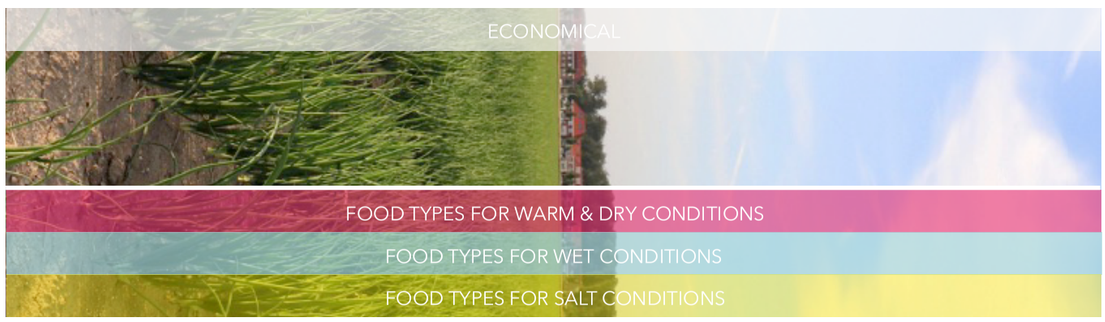






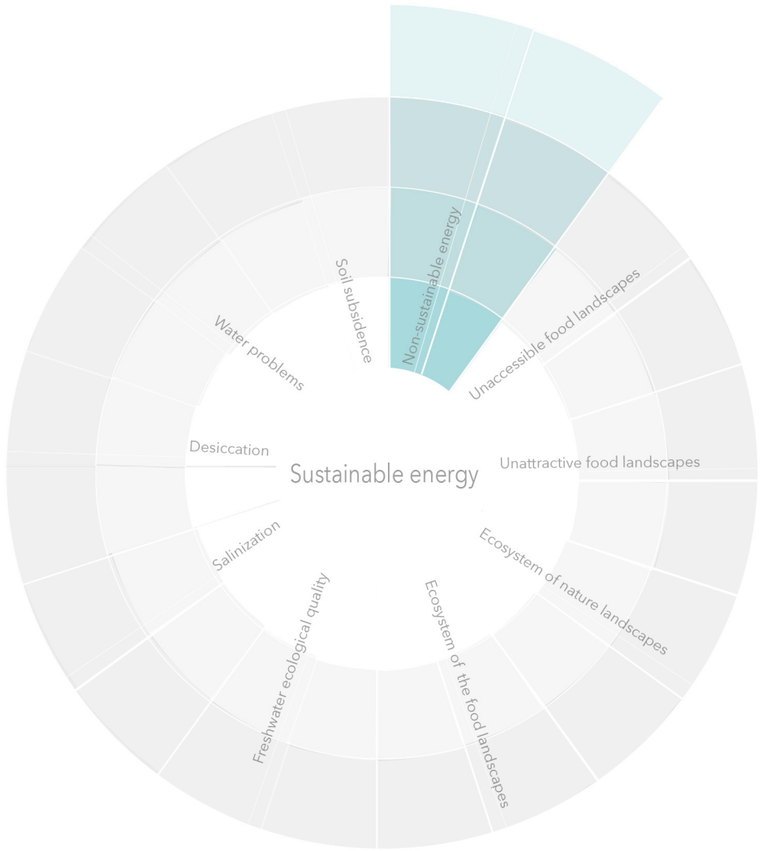






Images created by author

CLIMATE RESILIENT SOLUTION IN THE LANDSCAPES: SUSTAINABLE ENERGY



LANDSCAPE SCALE SOLUTION

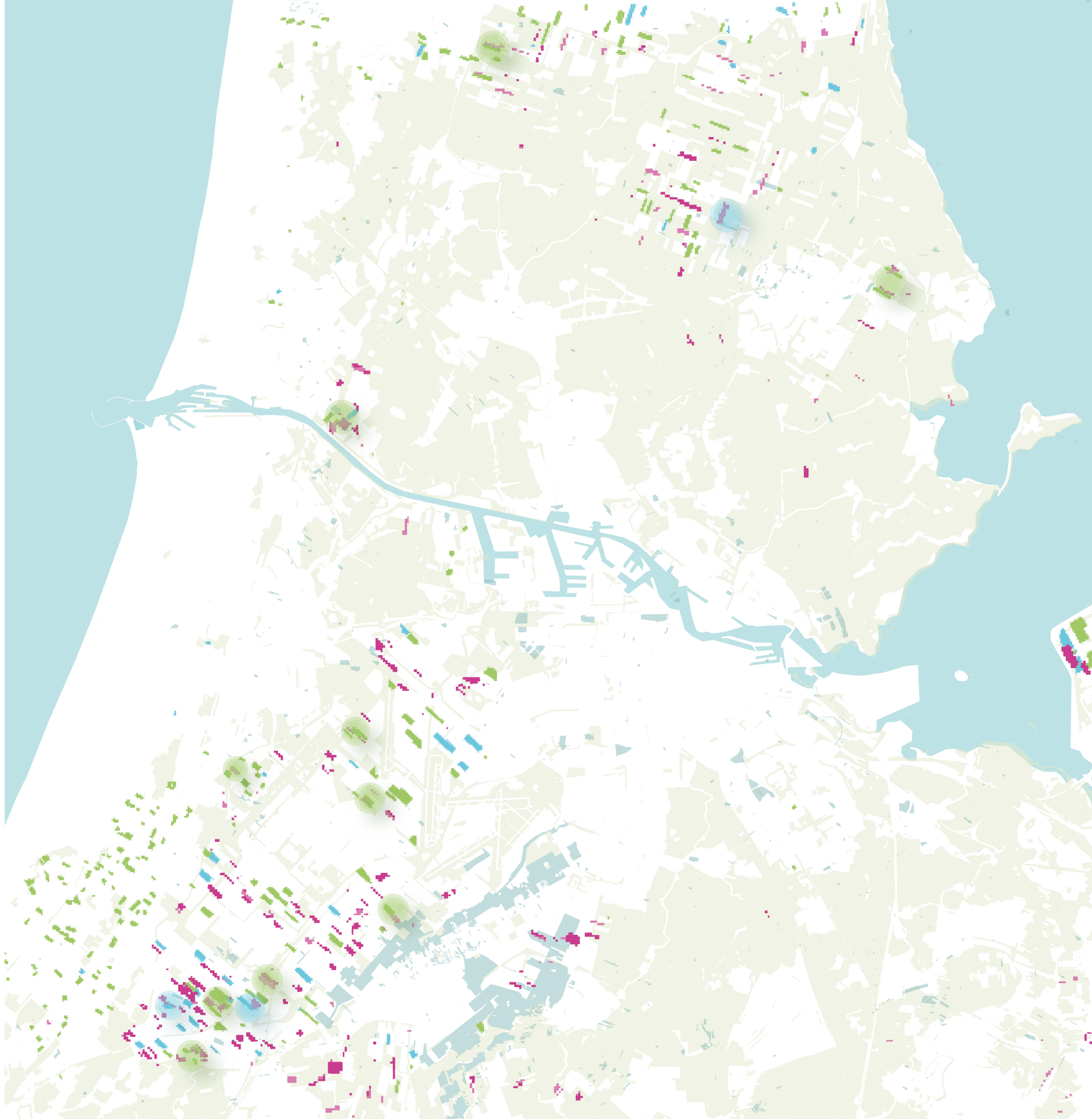
NEW ACTIVITIES IN THE FOOD LANDSCAPES WITH A LARGE ECONOMICAL LOSS

In landscapes that are no longer economical resilient, new activities in combination with the food production could be introduced. These new activities generate extra income for the farmers in the agricultural landscapes and economical stability.

Possibilities are:

- Sustainable energy
- Nature landscapes
- Recreational activities

In this map the landscapes that produce food types with a low economical value and types that are no longer resilient towards 2050 (vegetables & potatoes), are visible. These are the locations where there is a lot of potential for a combination with other activities (in the cirkels).



Grass: < 100 €/ha
Agriculture: 100 - 200 €/ha
Agriculture: 200 - 500 €/ha
Potatoes
Vegetables
Greenhouses: vegetables

Schaal 1: 1:400000
Map created by author & based on GIS,

SUSTAINABLE ENERGY AS A NEW FOOD TYPE IN THE LANDSCAPES OF THE REGION

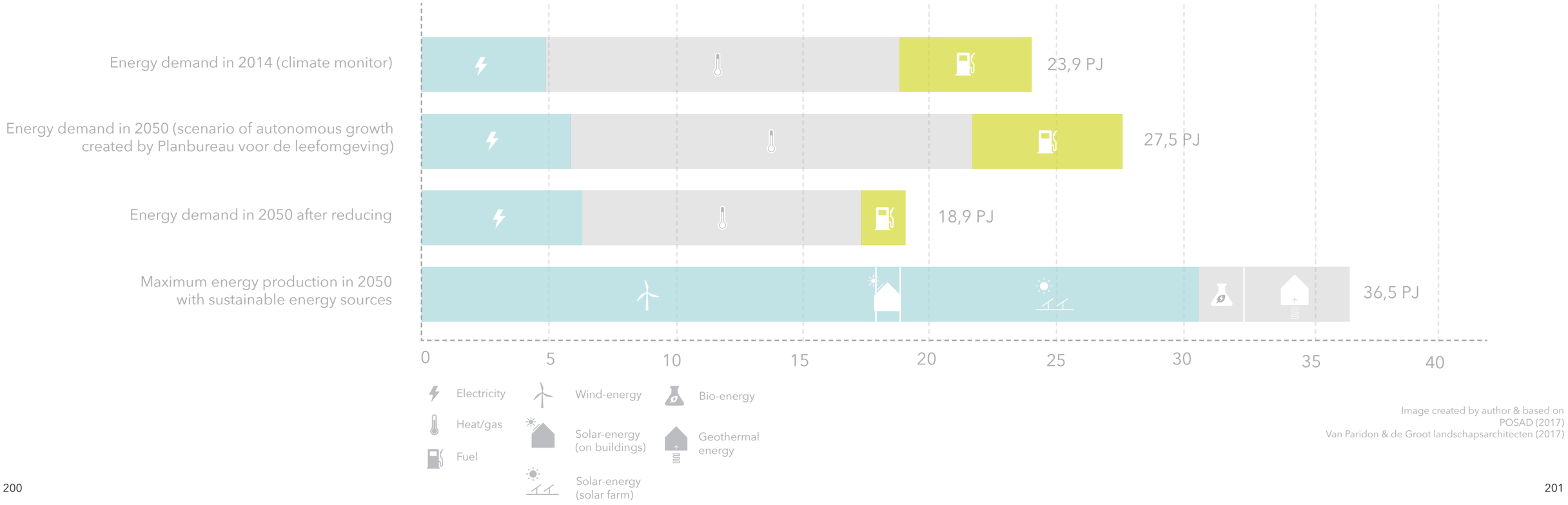
Sustainable energy solutions could be combined with the agricultural landscapes that are no longer economical resilient towards 2050 with the effects of climate change. In this way, additional economical profit comes from these solutions and creates a secure income for the farmers. In some cases, the benefits of renewable energy on the farm can be used directly for food production in the landscape.

Wind and solar energy are two important energy sources to provide for the future. These sustainable energy solutions have a major impact on the landscape (as they use a lot of space, see image) and will therefore have to be designed in the landscapes for an attractive food landscape in the future. Therefore, the sustainable energy solutions in the landscapes of the region are included in the design in this graduation report. Another sustainable energy solution that has a lot of potential is algae energy. This could be well combined with the surface water in the landscapes and greenhouses in the region.

Disclaimer: there are also other sustainable energy forms that can be applied towards 2050 (such as nuclear energy). These will not be addressed in this graduation project, because only the sustainable energy solutions that have a major impact on the landscapes or that can go together with the food production will be considered. In this way, a synergy between the energy transition and the transition of the food landscapes will be designed.



Source: bureau de helling (2018)



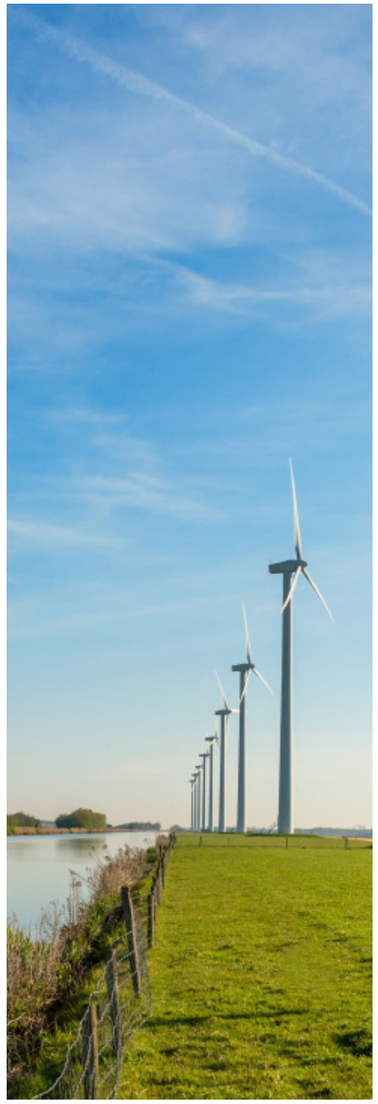
Zonne-energie als nieuw ‘gewas’ voor worstelende boer



Geen opvolger kunnen vinden, de trend van schaalvergroting die zorgt voor steeds zwaardere concurrentie, milieu-eisen die steeds strenger worden; veel boeren worstelen om hun hoofd boven water te houden. In de Achterhoek proberen ze het tij te keren. Een groep boeren maakt daar de (gedeeltelijke) transitie van voedselproducent naar energieproducent.

Image created by author & based on
POSAD (2017)
Van Paridon & de Groot landschapsarchitecten (2017)

INSPIRATIONAL SUSTAINABLE ENERGY SOLUTIONS



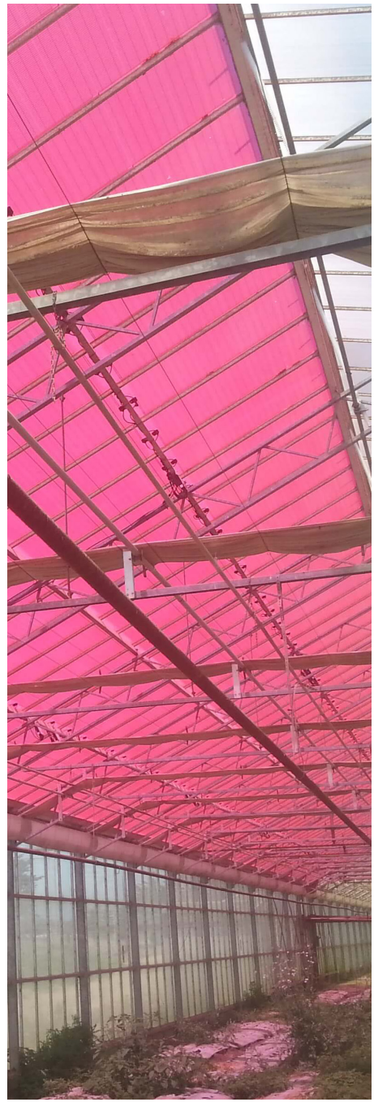
Wind-energy in combination with the food landscapes



Floating solar panels on waterstorage areas or larger waterbodies



Algea energy in waterstorage areas or larger waterbodies.



Translucent solar panels on greenhouse. The pink light stimulates the growth of the crops in the greenhouse.

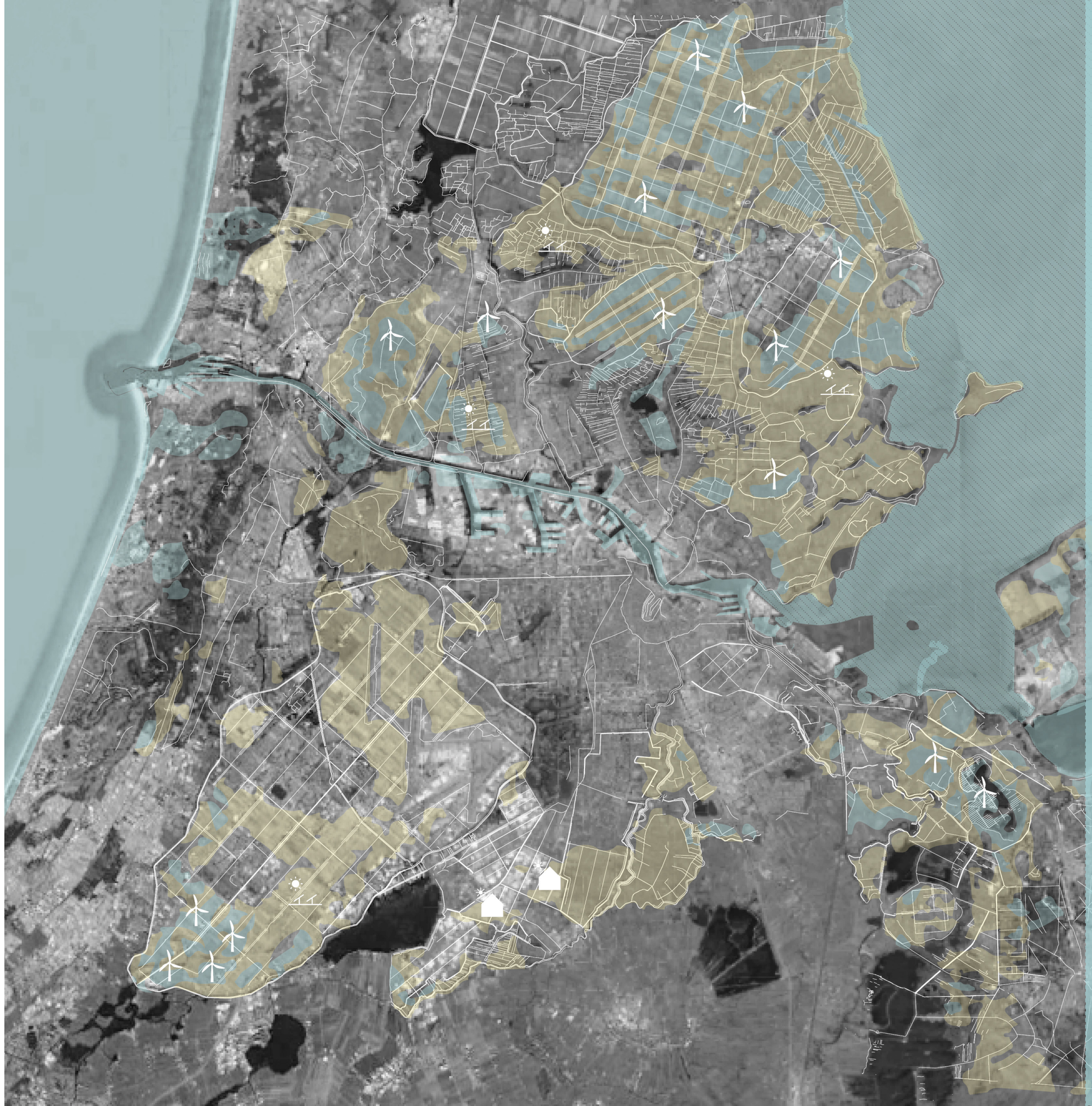


Algea energy production in greenhouses.

In these images sustainable energy solutions that could be well combined with the food landscapes in the region are visible.

POSSIBLE LOCATIONS FOR SUSTAINABLE ENERGY IN THE REGION

This map gives the locations where it is possible to introduce a combination of sustainable energy solutions (wind & solar energy) and agricultural landscapes towards 2050.



Potential locations for wind energy

Potential locations for solar energy

Potential locations for wind energy on IJsselmeer lake

Wind-energy in food landscape or waterlandscape

Solar energy in waterlandscape

Solar energy glass in greenhouses

Schaal 1: 1:400000
Map created by author & based on GIS, Vereniging Deltametropool (2018)

DROOGMAKERIJ LANDSCAPES

VEENWEIDE LANDSCAPES



Impression of the combination of solutions for a climate resilient food landscape in 2050



Impression of the combination of solutions for a climate resilient food landscape in 2050

PURIFYING [FOOD] LANDSCAPES

Circular water system

Purifying nature

Circular water greenhouse



Purifying [food] landscape (Meelker, 2018)

Bad ecological quality

In these landscapes the ecological quality of the freshwater is very low. This is especially a problem in the Zaanstreek, Beemster and Haarlemmermeer polder landscapes.

Recreational & nature areas

The landscapes with a low ecological water quality are often located close to recreational & nature areas for the cities in the region. This results in problems with the activities in these landscapes and biodiversity.



Inadequate ecological quality

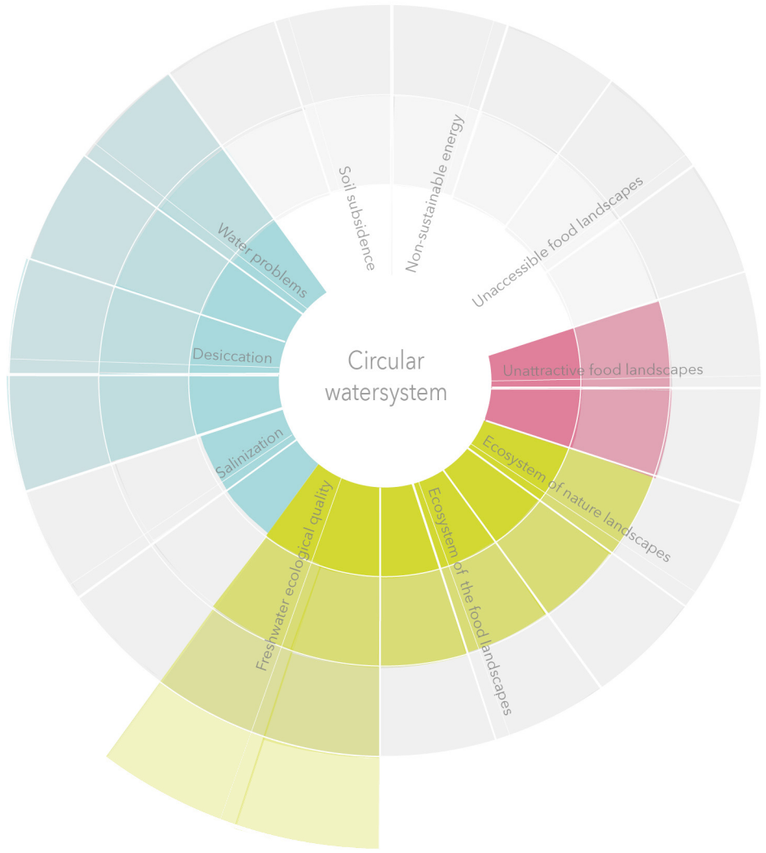
In these waterways the ecological quality is lower. than it should be. The waterways are connected to the landscapes in the region and give problems in these landscapes.

Moderate ecological quality

In these landscapes the waterquality is moderate (still lower than the guidelines that are set for the ecological freshwater quality).

Conclusion map: the impact of fertilizers on the ecological quality of freshwater in the landscapes of the region

PURIFYING AGRICULTURAL SOLUTIONS IN THE LANDSCAPES: CIRCULAR WATERSYSTEM



OPEN FIELD AGRICULTURE & POLLUTION OF THE FRESHWATER IN THE REGION BY HIGH CONCENTRATIONS OF NITROGEN & PHOSPHATE

With the open field agriculture in the region, a lot of nutrients (from fertilizers as nitrogen and phosphate) rinse into the freshwater in the landscapes, after rainfall. This results in a disbalance of the ecosystem in water of these landscapes. As becomes clear from this map, especially the water quality in the boezems of the polder landscapes is very low. To create a solution for this low freshwater quality, a circular watersystem in the region could be introduced. On the following pages, the different steps towards a circular watersystem are visible and based on the circulation model of Tjallingi (2011).



Bad ecological freshwater quality

Inadequate ecological freshwater quality

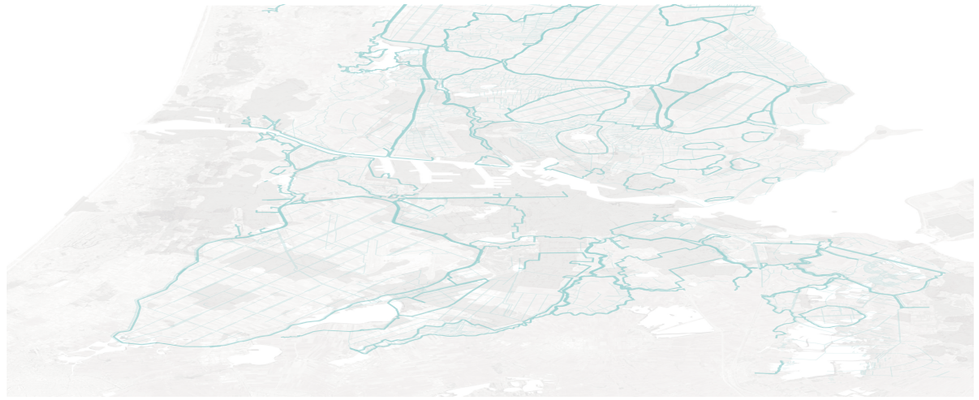
Moderate ecological freshwater quality

Open field agricultural landscapes

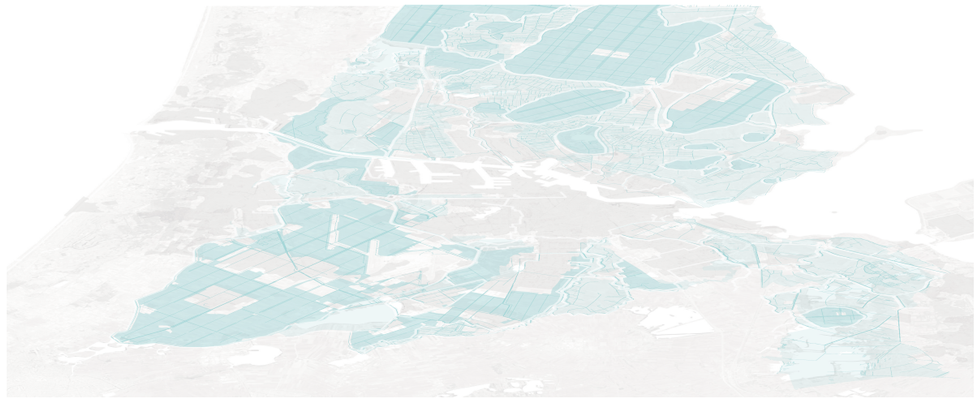
Schaal 1: 1:400000

Map created by author & based on GIS,

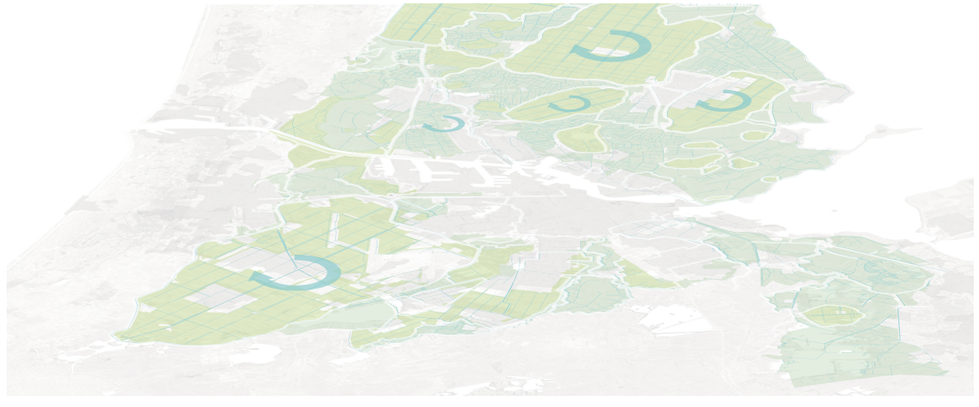
SOLUTION STEPS TOWARDS A CIRCULAR & PURIFYING WATERSYSTEM



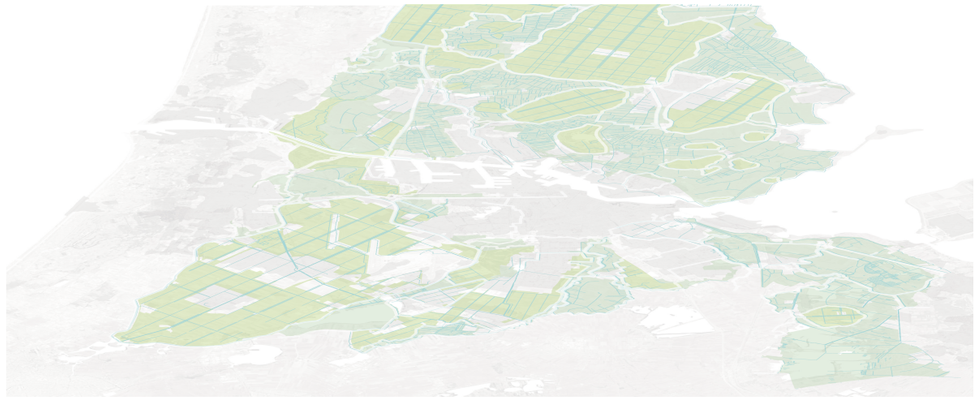
1. Disconnecting the regional watersystem (boezems) and water in the polders



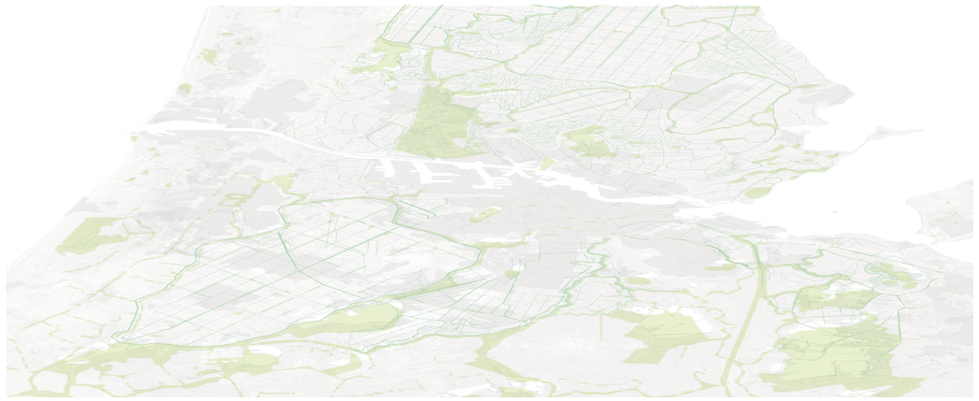
2. Polder landscapes of the droogmakerijen & veenweide with a seperate watersystem



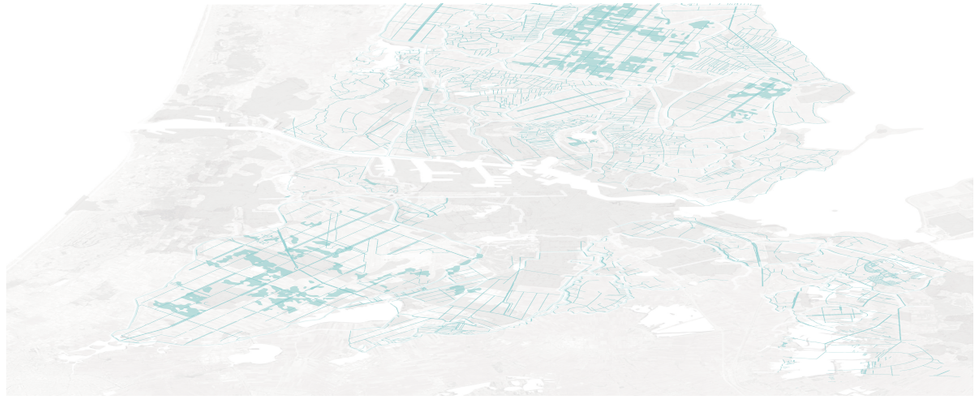
3. Creating a circular watersystem in the polders



4. Creating more surface water for circulation & purification by connecting existing waterways in the landscape and creating new ones



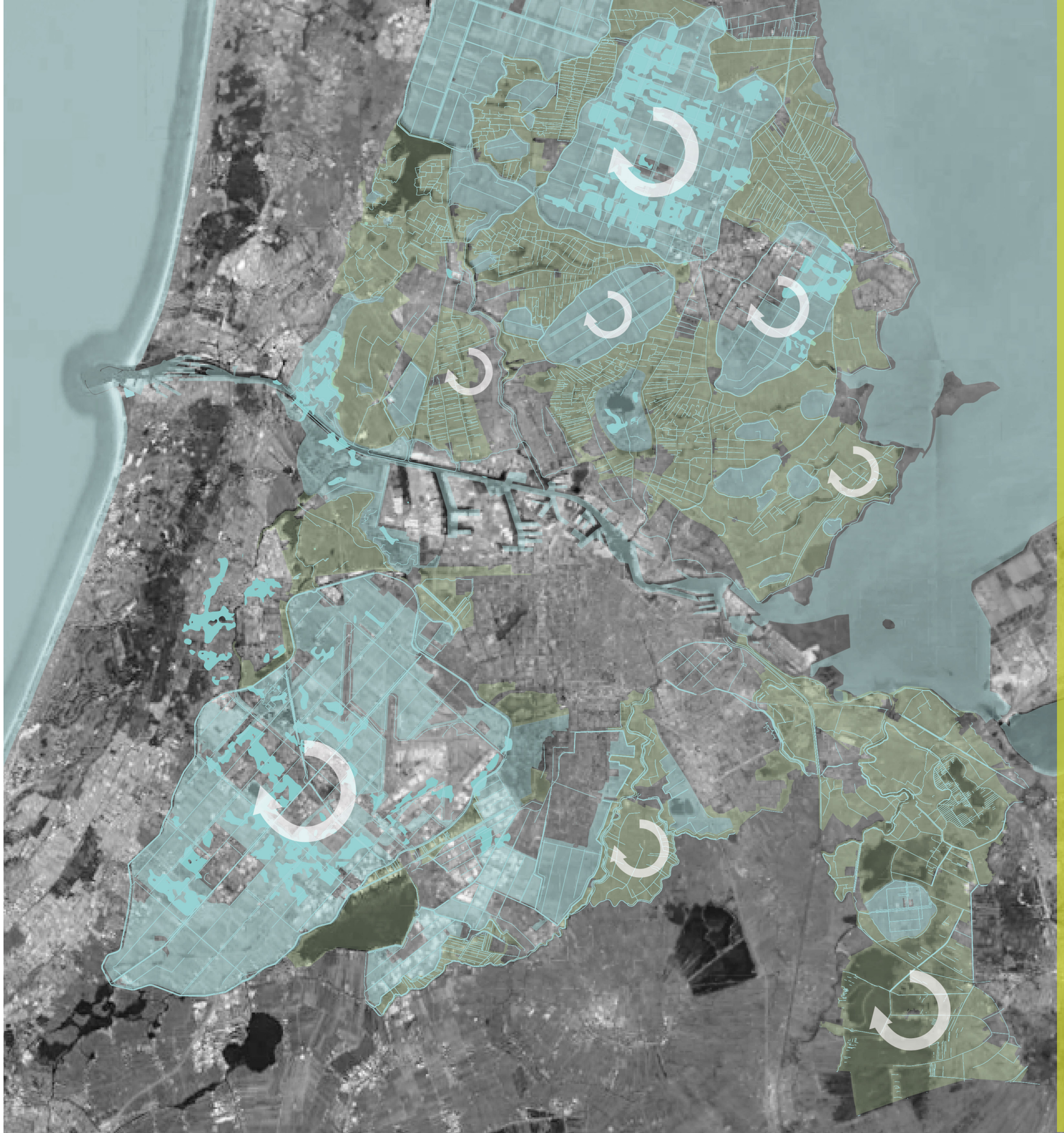
5. Improving the circular watersystem with purifiying nature (see next solution)



6. Creating waterstorage in the landscapes for buffering during seasons

CIRCULAR WATERSYSTEM IN THE REGION TOWARDS 2050

As a solution to the low ecological freshwater quality in the agricultural landscapes of the region, a circular watersystem could be created. To improve the water quality, this system in the landscapes will be seperated from the boezems. Furthermore, new water ways are introduced and connected for a better circulation of the water and waterstorage is needed as a buffer in the system. This solution could be well combined with the next solutions of purifying nature and greenhouses. In this way, a purifying water system arises in the region towards 2050.



Watersystem in the droogmakerijen landscapes

Watersystem in the veenweide landscapes

Circular watersystem by connecting the waterways in the landscape

Purifying watersystem by creating new waterways in the landscape

Waterstucture in the food landscapes

New waterstorage in the landscape because of disconnection with the boezem

Schaal 1: 1:400000

Map created by author & based on GIS,

IMPRESSION OF THE CIRCULAR WATERSYSTEM
IN THE LANDSCAPES

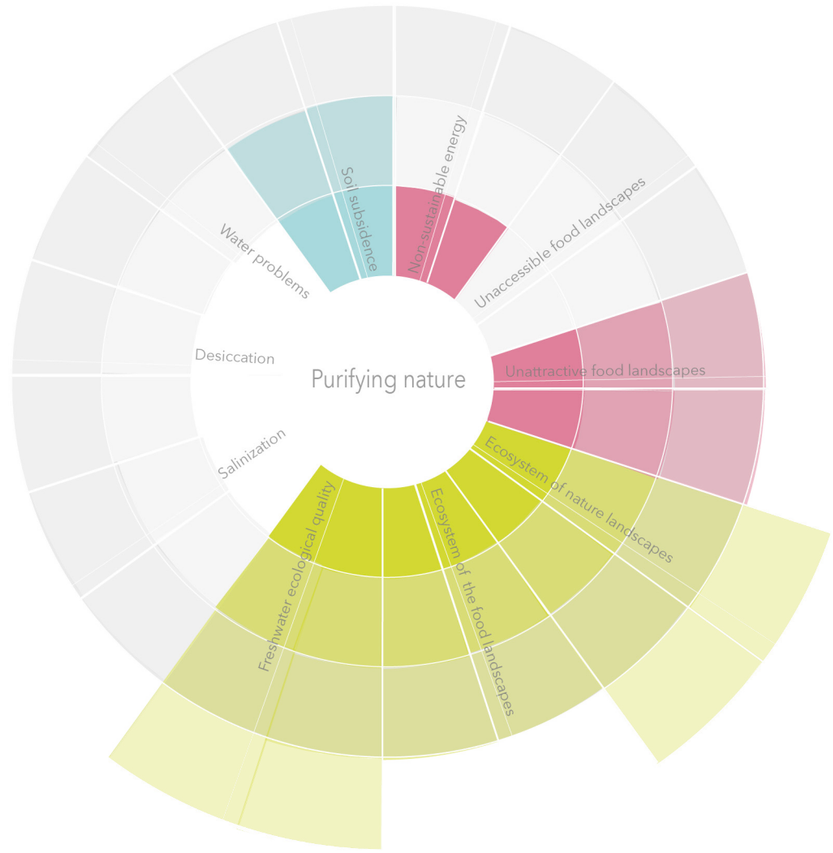






Images created by author

PURIFYING AGRICULTURAL SOLUTIONS IN THE LANDSCAPES: PURIFYING NATURE



INTRODUCING PLANTS IN THE WATERSYSTEM OF THE FOOD LANDSCAPES FOR PURIFYING THE POLLUTED WATER

The polluted water in the landscapes is caused by nitrogen and phosphate substances that flow into the water and create high concentrations of nutrients. These overflow of nutrients results in a disbalance of the ecosystem in the water. A solution for this could be to introduce purifying plants in the watersystem of the landscapes. These plants absorb the nutrients in the freshwater to restore the balance in the ecosystem. Furthermore, a higher biodiversity in the landscapes is created with the introduction of a variety of plants. The plants in the purifying watersystem, could be divided into several categories that are depending on the location of the plants in the waterway. The plants that could be selected for each location, are visible in this image.

Purifying plants: absorb nitrogen & phosphate (fertilizers) and adding oxygen into the water.

Bank plants (oeverplanten)


Riet


Gele lis


Lisdodde


Kalmoes

Marsh plants varying in depth from 0 to 15 cm under water.


Mattenbies/Waterbies


Waternavel


Beekpunge


Crassula helmsii

Aquatic plants varying in depth from 0 to 40 cm under water.


Naaldwaterbies


Lidsteng


Zegge

Water lilies and oxygen plants varying in depth from 40 to 120 cm under water.


Waterpest


Sterrenkroos


Fonteinkruid

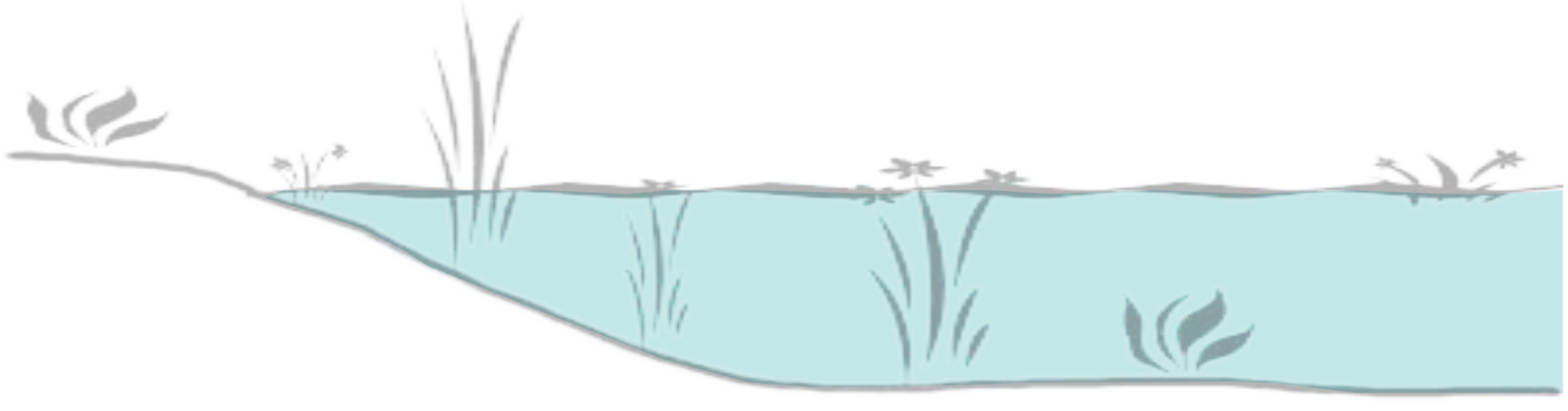

Waterviolier

Floating plants floating on the water surface


Kikkerbeet


Watersla


Waternoot



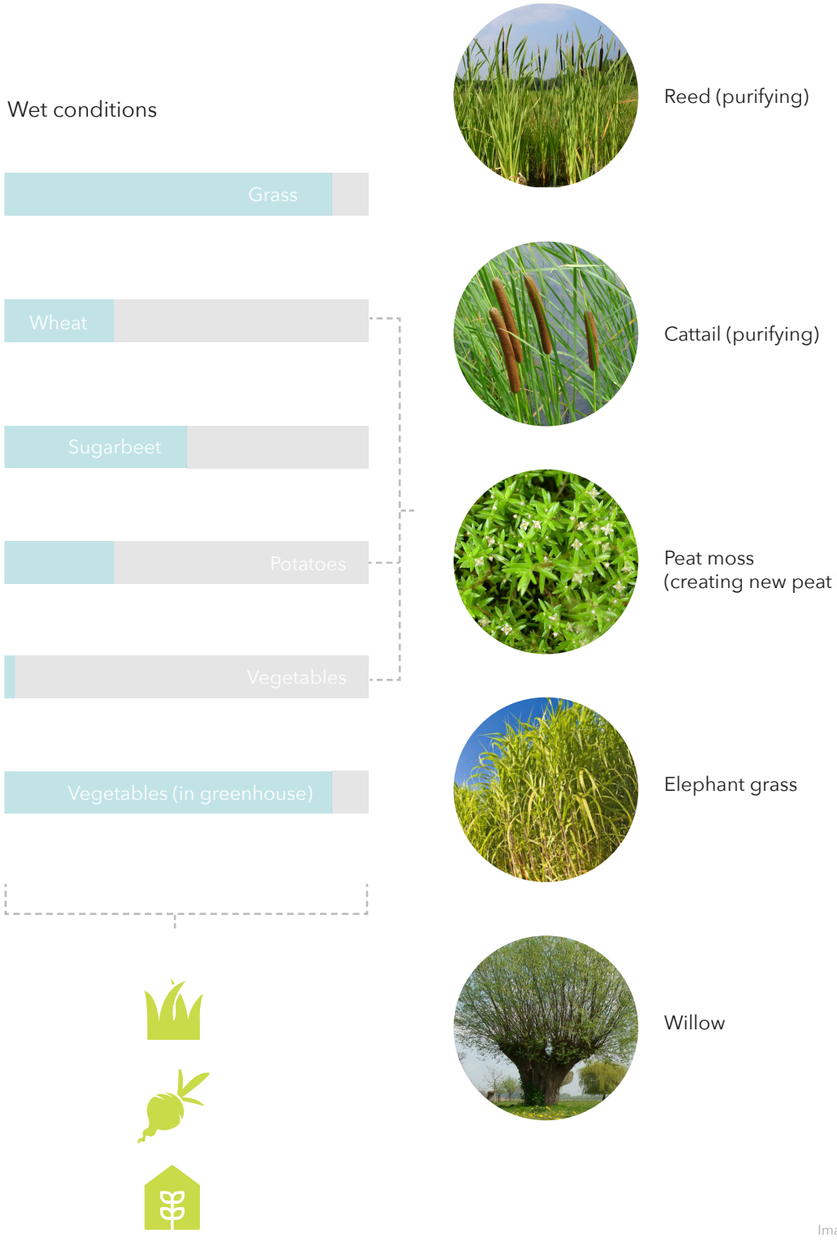
Source:
Images created by author & based on
Vijver (2018)
Aquatica (2018)
Schone vijver (2018)

INTRODUCING NATURE IN THE FOOD LANDSCAPES

In agricultural landscapes with new conditions towards 2050 and food types that are not resilient to these conditions, purifying nature could be introduced (next to new resilient food types). These nature solutions are visible in the image.

Another possibility is to introduce nature in the peat landscapes with soil subsidence. In the most urgent soil subsidence landscapes, peat moss could be placed to grow new peat in this landscape (with a new high water level).





Source:
Images created by author.
Aquatica (2018)

NEW PURIFYING WATERSYSTEM & NATURE IN THE LANDSCAPES

A new purifying watersystem in the landscapes of the region could be created by introducing specific plants in the waterways. These plants will absorb the overflows of nutrients that create a disbalance in the ecosystem of the freshwater. In this way, the ecosystem will improve and the biodiversity will increase. Furthermore, nature could be combined with the agricultural landscapes in locations where the food types are not resilient. And in the peat landscapes, new peat could be created by introducing peat moss in the landscapes with a higher water level. In time, this will result in new peat landscapes (veenaangroei gebieden).

This solution could be well combined with the circular watersystem and purifying greenhouses.



Purifying nature in the watersystem

Nature friendly banks

Nature in the agricultural landscapes

New peat landscapes (peat moss)

Schaal 1: 1:400000

Map created by author & based on GIS,

IMPRESSIONS OF THE PURIFYING NATURE SOLUTION IN THE LANDSCAPE

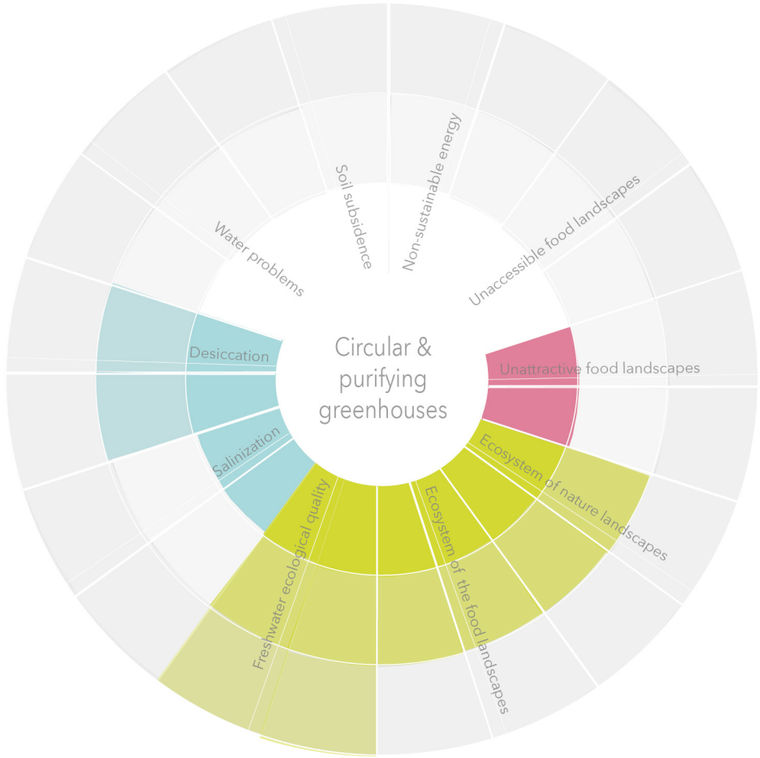






Images created by author

PURIFYING AGRICULTURAL SOLUTIONS IN THE LANDSCAPES: CIRCULAR & PURIFYING GREENHOUSES



GREENHOUSES & POLLUTION OF FRESHWATER BY HIGH CONCENTRATIONS OF NITROGEN & PHOSPHATE IN THE REGION

The greenhouses in the landscapes of the region have less impact on the ecological freshwater quality than the open field agriculture, as described in the solution of purifying nature. However, with the wastewater of the greenhouses there is a negative impact on the freshwater quality. Especially, in the landscapes where the greenhouses are concentrated (for example, near the Haarlemmermeer polder). In these landscapes the ecological waterquality is very low. Therefore a solution need to be found to purify this wastewater.



Bad ecological freshwater quality

Inadequate ecological freshwater quality

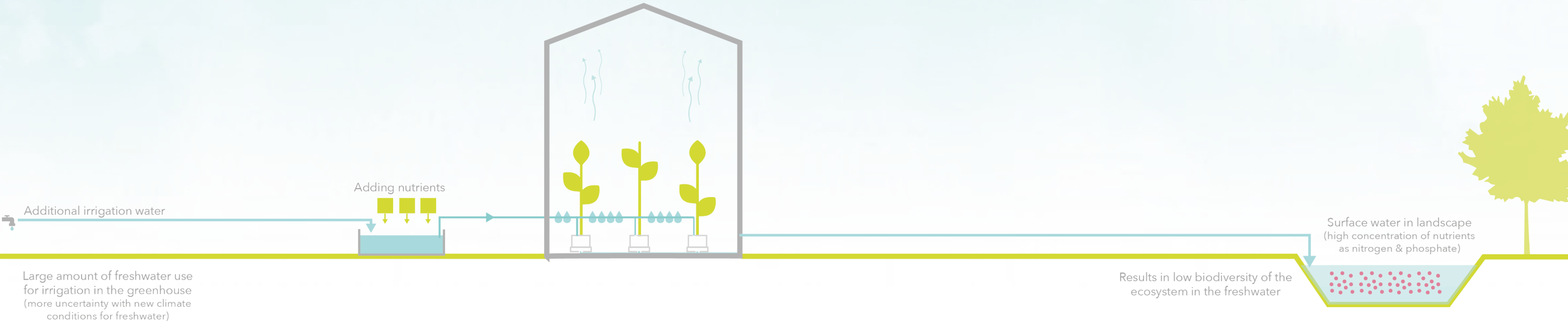
Moderate ecological freshwater quality

Greenhouses in the landscapes of the region

Schaal 1: 1:400000

Map created by author & based on GIS,

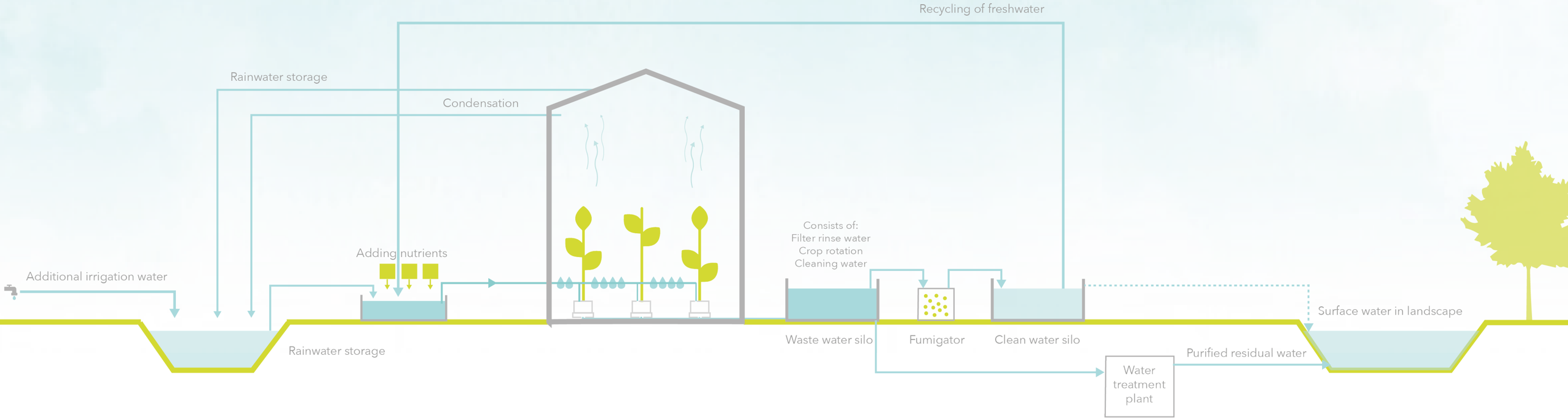
EXISTING GREENHOUSE WATERSYSTEM: NUTRIENTS IN THE SURFACE WATER OF THE LANDSCAPES



Source:
Images created by author & based on
Wageningen Environmental Research (2018).
LTO Noord (2017)
Van Paridon & de Groot landschapsarchitecten (2017)

GREENHOUSE WATERSYSTEM: RECYLING WASTEWATER

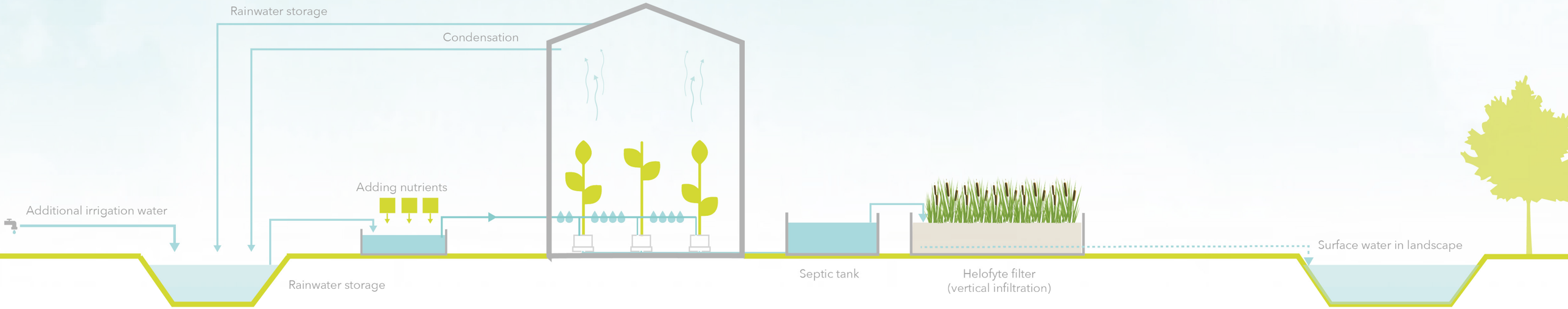
The circular greenhouse concept (recycling of wastewater) could be applied in the landscapes where there are large water & drought problems towards 2050. This is particularly in the droogmakerijen landscapes in the region. By using this watersystem in the greenhouses, a more resilient system to climate change is created. And less nutrients will flow into the freshwater of the landscapes.



Source:
Images created by author & based on
Wageningen Environmental Research (2018).
LTO Noord (2017)
Van Paridon & de Groot landschapsarchitecten (2017)

GREENHOUSE WATERSYSTEM: PURIFYING WASTEWATER

The purifying greenhouse concept could be introduced in the landscapes with a very low ecological quality in freshwater. With the helofytes filter the waste water of the greenhouses is purified (by using the nitrogen & phosphate in plants). This results in freshwater with a lower concentration of nutrients that flows to the surface water in the landscapes. In this way, the purification process is locally & naturally (without energy consumption) and improves the ecosystem in the landscapes.



Source:
Images created by author & based on
Wageningen Environmental Research (2018).
LTO Noord (2017)
Van Paridon & de Groot landschapsarchitecten (2017)

NEW SOLUTION OF CIRCULAR & PURIFYING GREENHOUSES IN THE REGION

In this map the new concepts for the greenhouses in the landscapes are visible. In the landscapes that will have drought problems towards 2050, the circular greenhouses will be realised (to recycle the water). In the landscapes that have a very low ecological freshwater quality, the purifying greenhouses are introduced.

In combination with the previous solutions of a circular watersystem and purifying nature, the purifying greenhouses could be connected to this system (and an individual helofytesfilter is no longer needed).

Furthermore, these new solutions are focussed on the existing greenhouses in the region. If new greenhouses are created these could be introduced close to the purifying watersystem in the region. Or the purifying system (of helofytes) could be placed within the greenhouses to create a living machine. The purification process of waste water works better in this way, because of the higer temperatures.

Drought problems in the landscape towards 2050

Low ecological freshwater quality in the watersystem

Greenhouses: recycling the water

Greenhouses: purifying the water with helofytes plants in the landscape

Schaal 1: 1:400000

Map created by author & based on GIS,



SOLUTION CIRCULAR & PURIFYING GREENHOUSES

IMPRESSIONS OF THE CIRCULAR & PURIFYING GREENHOUSES IN THE LANDSCAPE







Images created by author

DROOGMAKERIJ LANDSCAPES



Impression of the combination of solutions for a purifying food landscape in 2050

VEENWEIDE LANDSCAPES



Impression of the combination of solutions for a purifying food landscape in 2050

ATTRACTIVE & RECREATIONAL [FOOD] LANDSCAPES

Attractive food landscape

Accessible food landscape



Recreational [food] landscape (MOSS Amsterdam, 2018)

Growth of cities in the region

Towards 2040 the largest cities in the metropolitan region of Amsterdam will have a higher population density caused by the urbanisation trend in the Netherlands.

Unattractive food landscapes

The agricultural landscapes are graded with a low experience (< 7) by visitors. The transition of the agricultural landscapes could be used to create more attractive agricultural landscapes in the region and an opportunity for recreational [food] landscapes.



Conclusion map: the impact of the urbanisation trend on the recreational landscape shortage in the region

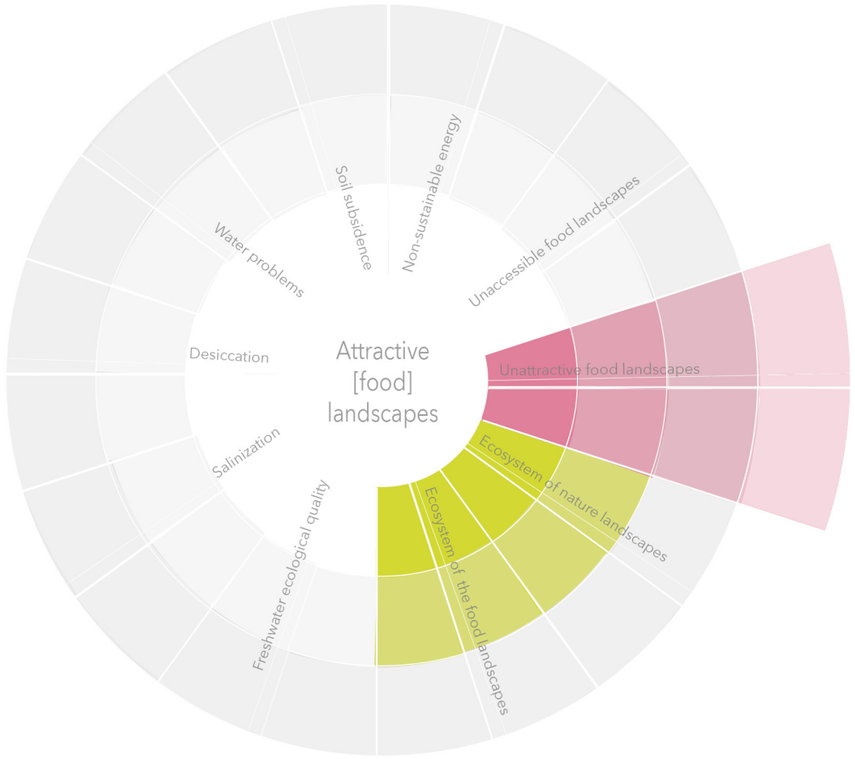
Recreational landscape shortage

The urbanisation trend results in a higher demand for attractive & accessible recreational landscapes. In the region this results in a recreational landscape shortage towards 2050.

Unaccessible food landscapes

The agricultural landscapes are often not accessible or connected to the cities in the region by a recreational network.

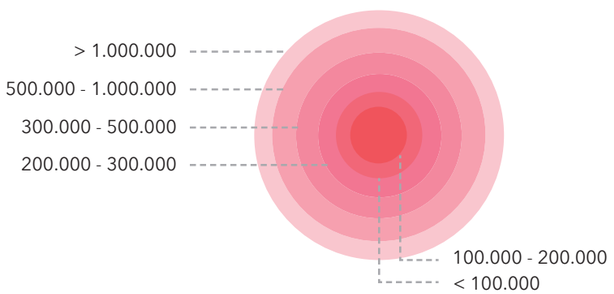
RECREATIONAL SOLUTIONS IN THE LANDSCAPES:
ATTRACTIVE [FOOD]LANDSCAPES



ATTRACTIVENESS OF THE EXISTING RECREATIONAL LANDSCAPES IN THE REGION

Most of the recreational & nature landscapes in the region that are frequently visited in 2018 by Dutch visitors are the beaches & dunes and the parks around Amsterdam (Vereniging Deltametropool, 2018). In this map is the amount of visitors (from the Netherlands) in the recreational and nature landscapes is visible, and overlayed with the food landscapes in the region in green (droogmakerijen & veenweide landscapes). As becomes visible from this map is that most of the visitors per year attend the recreational landscapes outsite of the food landscapes. However, in the food landscapes several recreational or nature landscapes are visited more frequently in the last years (Alterra, 2014). For example, 't Twiske, the Haarlemmermeer forest and the Amstel polders. In order to create more attractive recreational food landscapes in the region towards 2050, the elements that make these landscapes attractive and thus often visited will be analysed in the next pages. With this overview of elements to create an attractive food landscape (seperated into research on the characteristics of the landscapes and the activities in the landscapes), it becomes possible to develop the food landscapes with the most potential (that already have a few of those elements) into attractive recreational landscapes. These landscapes could be connected to the cities in the region with a sustainable recreational network towards 2050.

Amount of visitors (from the Netherlands) in the recreational and nature landscapes of the region



Schaal 1: 1:400000

Map created by author & based on GIS, Vereniging Deltametropool (2018)



ELEMENTS OF ATTRACTIVE RECREATIONAL [FOOD] LANDSCAPES: VEENWEIDE LANDSCAPE STRUCTURES

According to the Dutch visitors of the food landscapes (SCP, 2008) the most important elements that create attractive food landscapes are the characteristics of the landscape itself (85,7%) and the activities that could be practised in the landscape (23,9%). Especially for people in the cities of the Netherlands, that are visiting these landscapes the first aspect is highly important (up to 89,5 %). The elements of social & cultural value (21,7%) and tranquility (15,6%) are assessed as less important elements for an attractive food landscape. Therefore in this research & design only the elements of the characteristics and activities in the food landscapes will be taken into account.

In the following image the characteristics of the veenweide landscapes in the region that make these landscapes attractive are visible. These consists of landscape structures as well as unique elements in the landscapes as decribed in the Leidraad Landschap & Cultuurhistorie (2018).









Source:
Images created by author.
Location: Windmill in Eilandspolder, the Netherlandsn

Map created by author & based on Google Maps.

Map created by author & based on GIS.

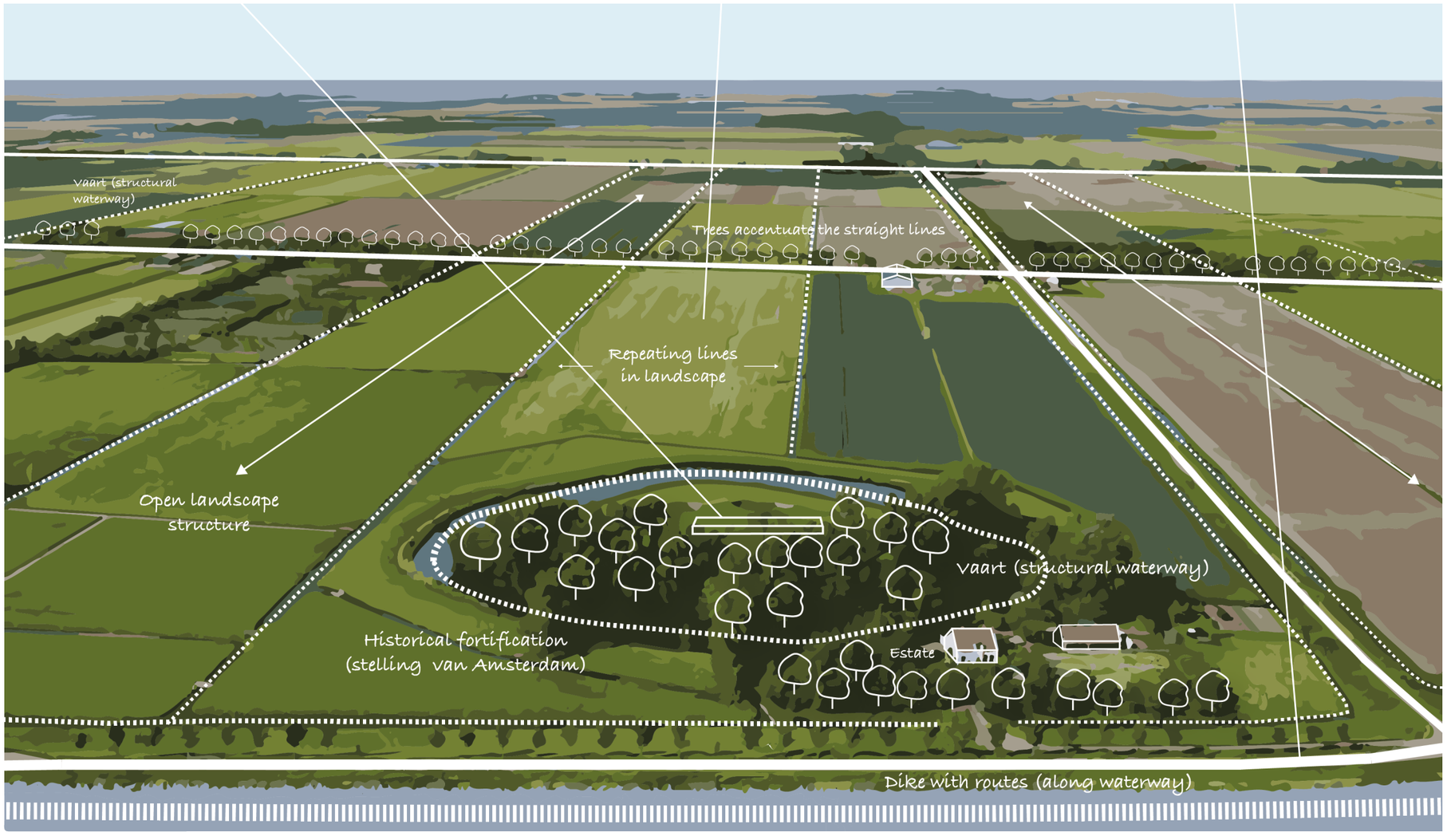






DROOGMAKERIJ LANDSCAPE STRUCTURES

In the following image the characteristics of the droogmakerijen landscapes in the region that make these landscapes attractive are visible. These consists of landscape structures as well as unique elements in the landscapes (Leidraad Landschap & Cultuurhistorie, 2018).



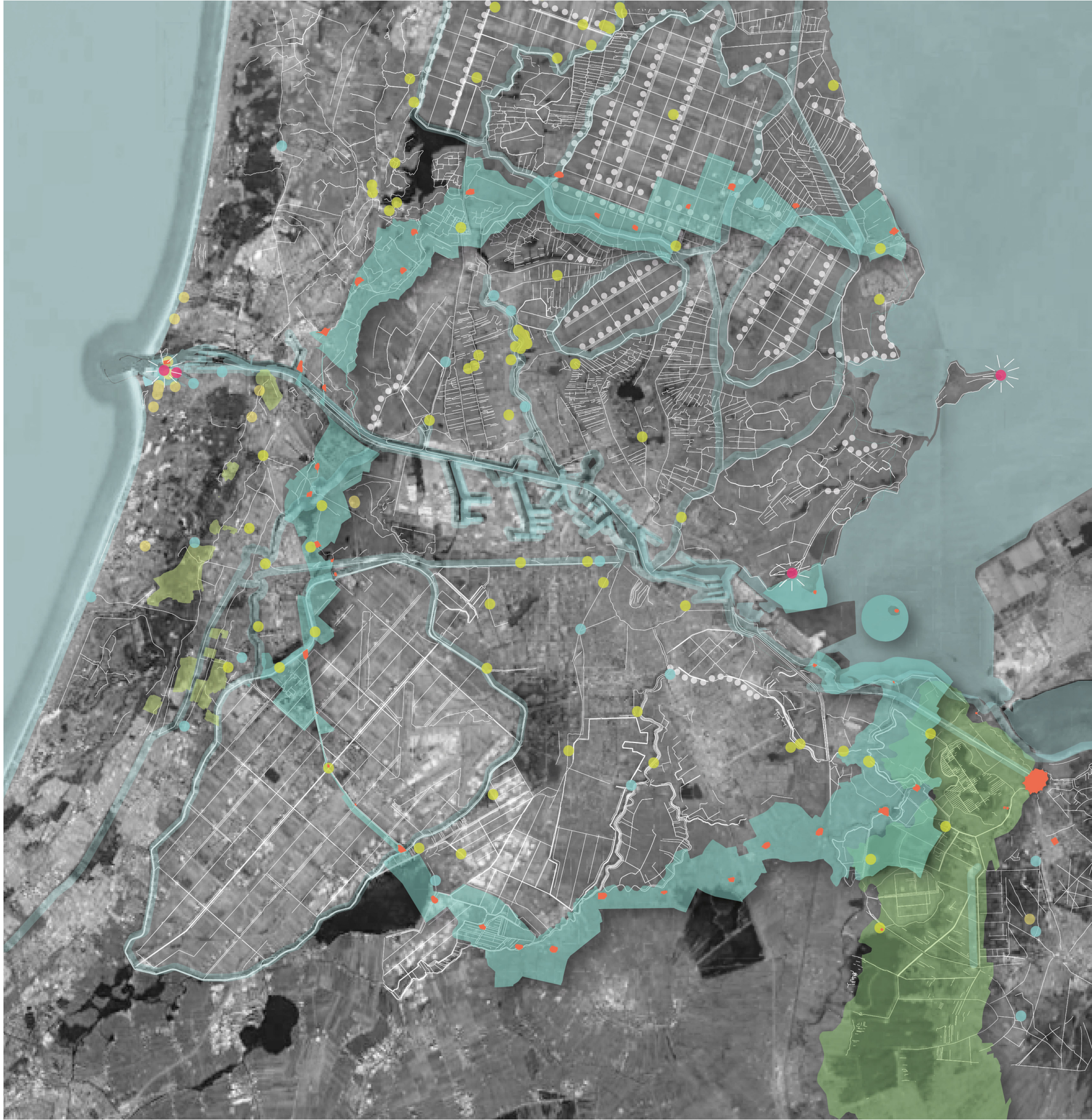
Source:
Images created by author.
Location: Fort Resort Beemster, the Netherlands

Map created by author & based on Google Maps.

CHARACTERISTICS OF THE EXISTING AGRICULTURAL LANDSCAPES

The landscape structures and unique elements in the agricultural landscape of the region are visible in this map. These structures consist of historical fortification lines (Stelling van Amsterdam and Nieuw Hollandse Waterlinie). Or existing waterstructures that are characteristic for the landscapes. Special elements in the landscapes of the region are traditional windmills, bunkers, and stolpen.

Especially in locations in the agricultural landscapes where the structures and elements are coming together, there is a lot of potential to use the transition of the food landscapes to create an attractive recreational landscape.



Fortification structures of Amsterdam

Nieuw Hollandse Waterlinie

Structural waterways in the region (vaarten & kanalen)

Fortifications

Estates

Water towers

Lighthouses

Bunkers

Traditional windmills

Stolpen (farms) structure

Schaal 1: 1:400000

Map created by author & based on GIS, Provincie Noord-Holland (2018)

ATTRACTIVE FOOD LANDSCAPES: RECREATIONAL ACTIVITIES IN THE LANDSCAPE

In the following images of the food landscapes the interest rate of the Dutch visitors in activities in these landscapes is visible (SCP, 2008). From these images the most popular activities that could be realised in the design of the new food landscapes are defined. These activities include walking, cycling, nature watching, picking up your food at a farm and care farms in the food landscapes.

Source:
Images created by author.
SCP (2008)



Recreational nature landscape



Dining in the food landscape



Care farm



Pick up food at the farm



Sleeping at the farm

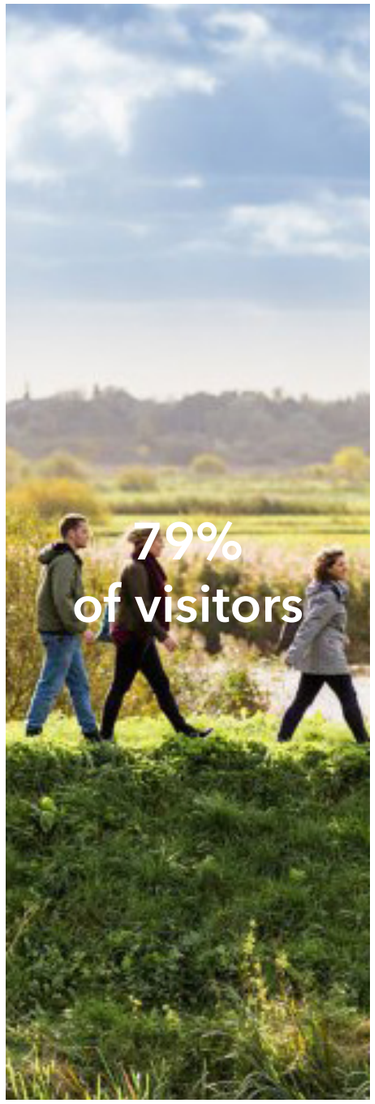
ATTRACTIVE FOOD LANDSCAPES: RECREATIONAL ACTIVITIES IN THE LANDSCAPE

Some of these activities are also part of the solution of a sustainable recreational network in the region (as walking, cycling, running & sailing). See therefore the next solution. They are integrated into this solution as well to give a complete overview of the activities in an attractive food landscape.

Source:
Images created by author.
SCP (2008)



Sailing



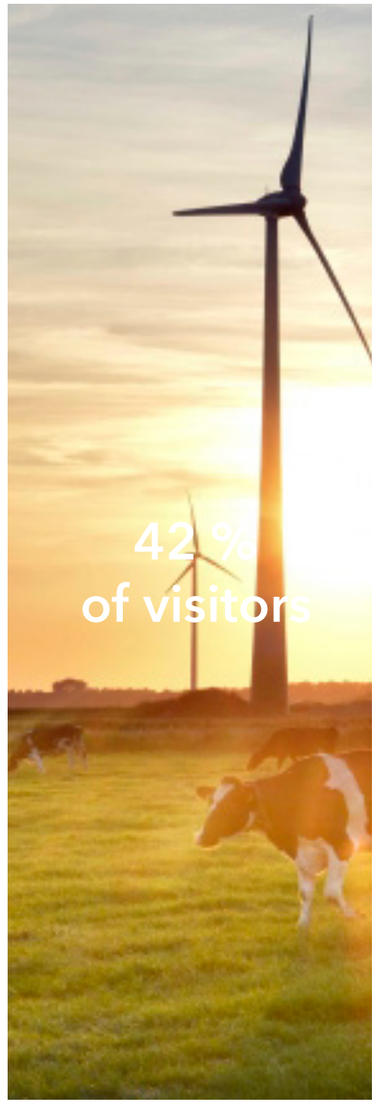
Walking



Cycling



Running



Sustainable energy

ACTIVITIES IN THE EXISTING AGRICULTURAL LANDSCAPES

In this map the activities that result in an attractive food landscape for visitors in the region are visible. In locations where there is a variety in activities that are combined with the food landscapes (clusters) and the recreational network, there is a lot of potential to use these landscapes as new recreational areas.

Disclaimer: no specific data was found on the location of farms with renewable energy in the region. Therefore this activity in the food landscapes that could make the landscape more attractive as a recreational landscape (if the sustainable energy solutions are innovative and realised on the small farm scale) is not visible in this map of existing activities in the landscapes.

Recreational nature landscape

Dining in the food landscape

Care farm

Pick up your food at the farm

Sleeping at the farm

Sailing network

Walking & running network

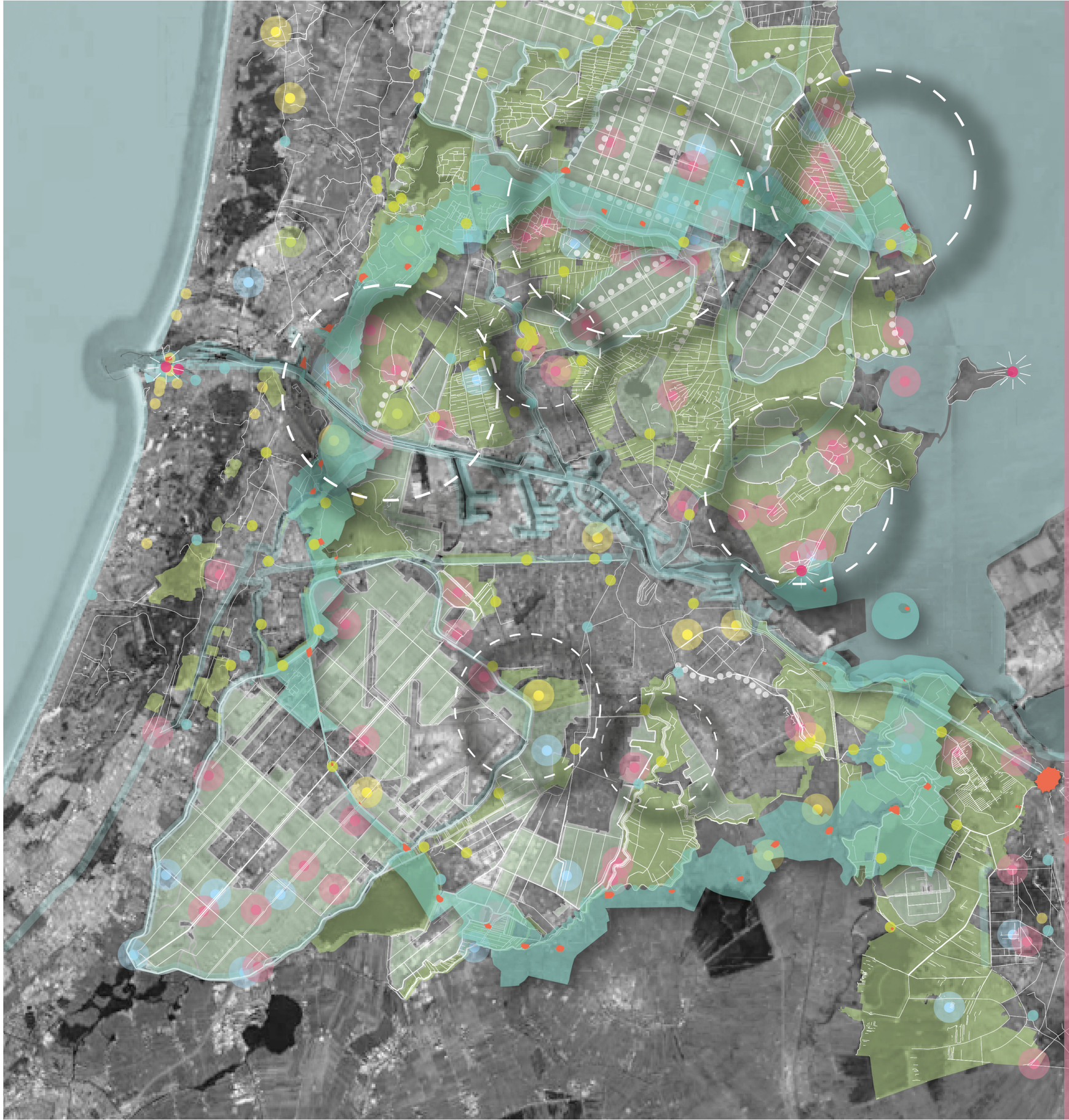
Cycling network

Schaal 1: 1:400000

Map created by author & based on GIS, Metropoolregio Amsterdam (2018)

SOLUTION MAP ATTRACTIVE LANDSCAPES

The potential locations to create a recreational [food] landscape result from the presence of attractive elements (characteristic landscape structures and activities) in the food landscapes ,overlayed with the locations where there is a shortage of recreational landscapes (a demand for transition food landscapes for recreation). This will be compared with the solutions of the other theme's to create an attractive & resilient landscape towards 2050. In this way the location for the recreational [food] landscapes in the region will be determined in the new perspective. An attractive and accessible landscape can not be created seperately from the other theme's, since these solutions create new conditions in the landscapes for the future. The existing landscape could not be taken as a starting point for the recreational solutions, if we want to resolve the problems in the future.



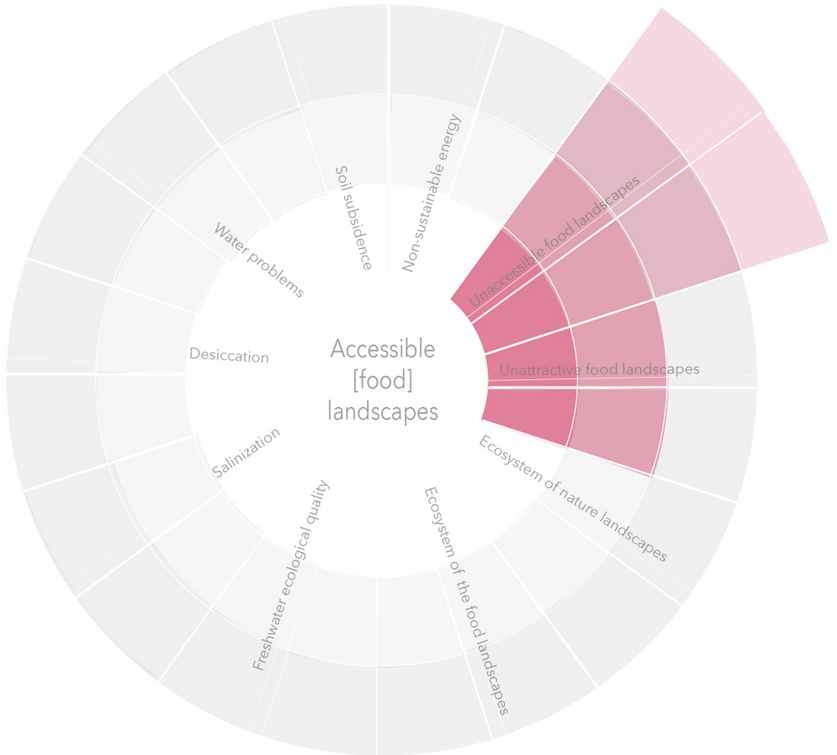
- Dining in the food landscape
- Care farm
- Pick up your food at the farm
- Sleeping at the farm
- Fortification structures of Amsterdam
- Nieuw Hollandse Waterlinie
- Structural waterways in the region (vaarten & kanalen)
- Fortifications
- Estates
- Water towers
- Lighthouses
- Bunkers
- Traditional windmills
- Stolpen (farms) structure

Schaal 1: 1:400000

Map created by author & based on GIS,
Provincie Noord-Holland (2018) & Metropoolregio Amsterdam (2018)

RECREATIONAL SOLUTIONS IN THE LANDSCAPES: ACCESSIBLE [FOOD]LANDSCAPES

The recreational network in the region depends on the combination of solutions in the landscapes. This will chosen in the scenario's for the transition of the agricultural landscapes (with a focus on climate adaptation, purifying agriculture or recreation) and interviews. Therefore the recreational network, will be further designed in the new perspective in 2050.



The recreational [food] landscape in the region can not be created seperately from the new solutions in the agricultural landscapes. These solutions will change the basic conditions of the landscapes and therefore create opportunities for a new recreational landscapes.

DROOGMAKERIJ LANDSCAPES



Impression of the combination of solutions for a recreational food landscape in 2050

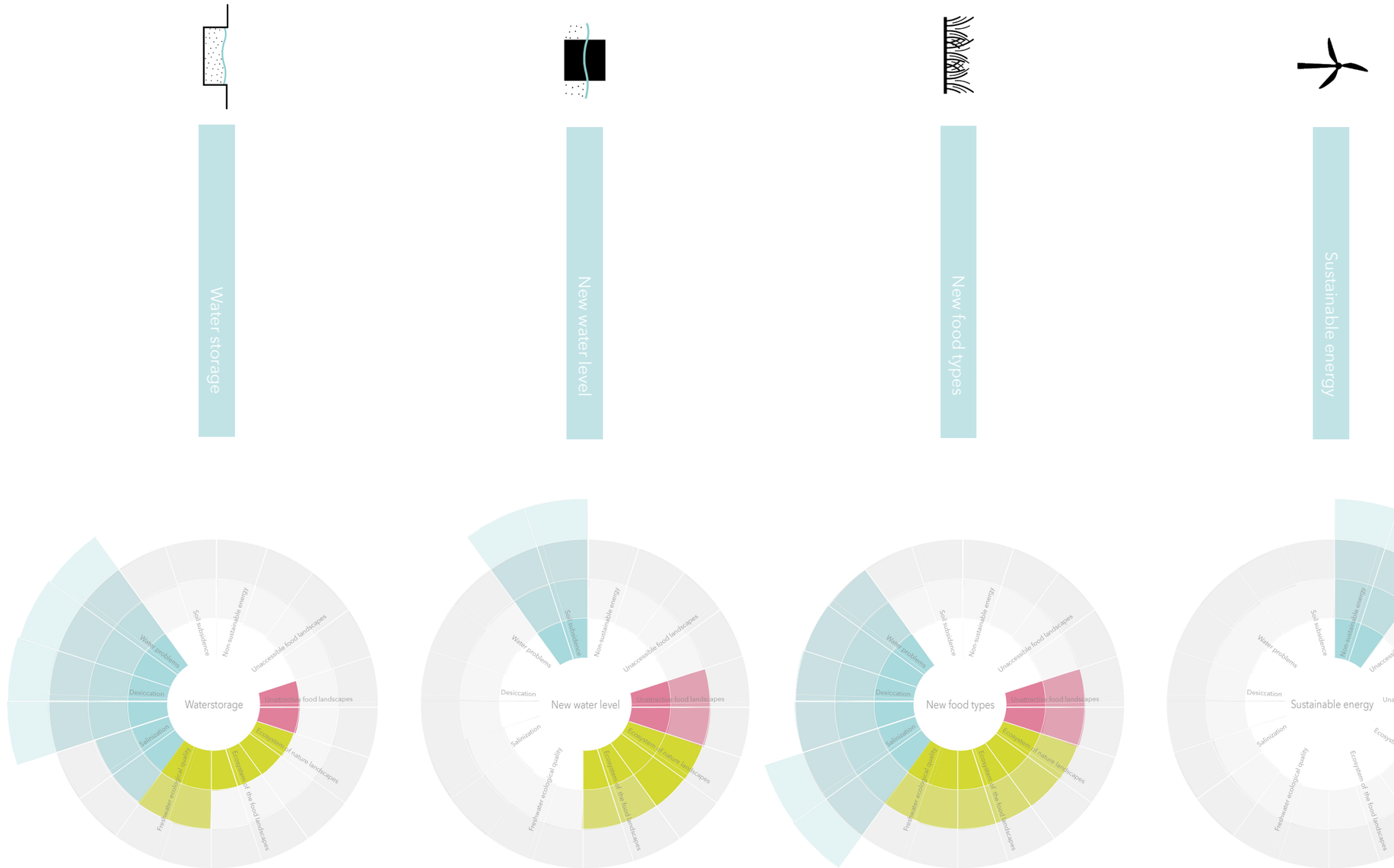
VEENWEIDE LANDSCAPES



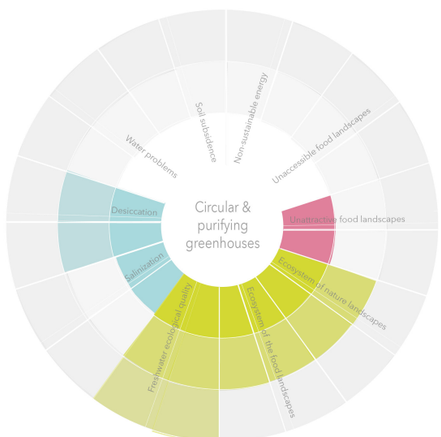
Impression of the combination of solutions for a recreational food landscape in 2050

CREATING A RESILIENT & ATTRACTIVE [FOOD] LANDSCAPES IN THE REGION

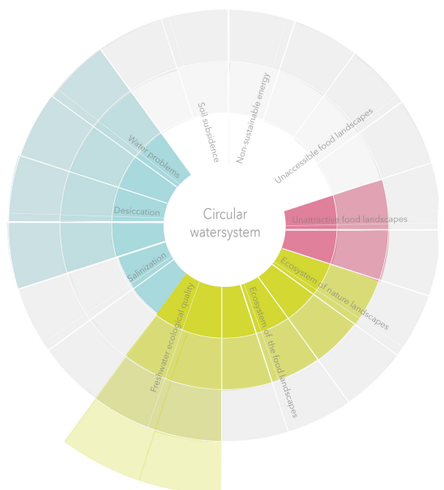
MAXIMIZATION PHASE OF THE MAXIMIZATION METHOD



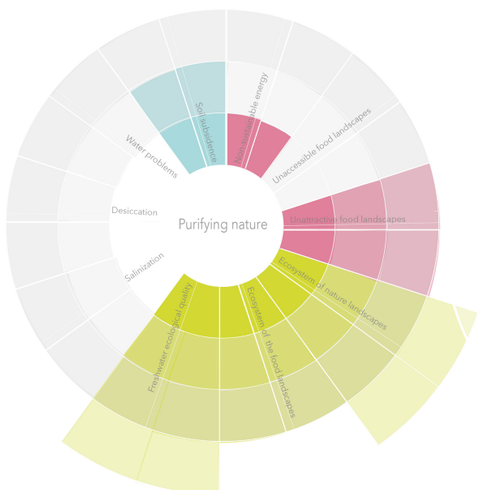
Circular water greenhouse



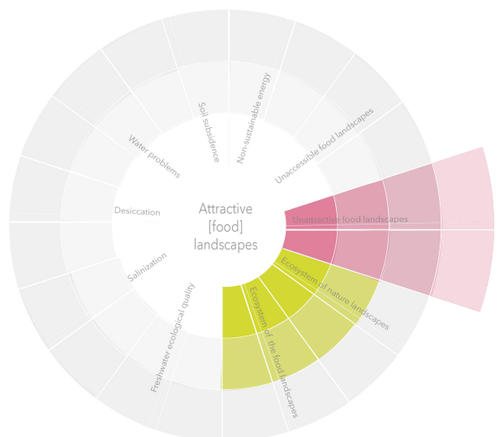
Circular water system



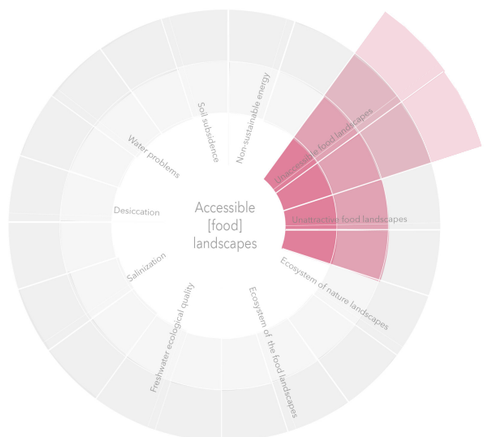
Purifying nature



Attractive food landscape



Accessible food landscape

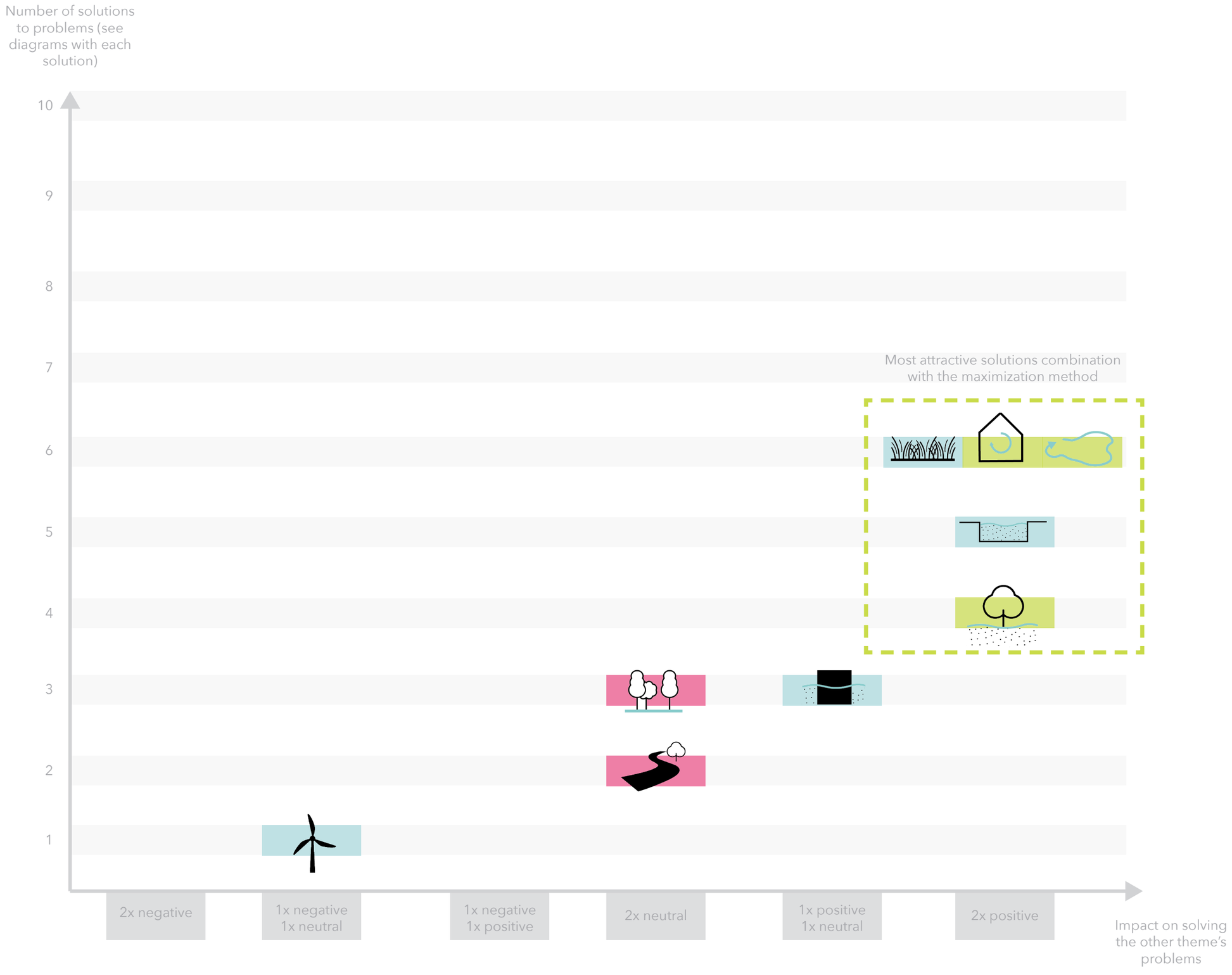


OPTIMALISATION PHASE OF THE MAXIMIZATION METHOD

With the previous pages, that give an overview of the solutions for the problems of climate change, agricultural pollution and recreational landscapes the following maximization scheme is created. The left axis is based on the cirkel diagrams that are given with each solution in the report. In each diagram the problems that will be solved in the region by the solution are visible. In the axis the total amount of problems that will be solved with one solution is given. The more problems that one solution can solve at the same time, the higher the score in the maximixation scheme.

Furthermore, the right axis is based on the impact of the solutions within one theme of the problem statement on the other theme's. For example, one solution for climate change problems in the region (waterstorage), could have also a positive impact on the problems of polluting agriculture & recreational landscapes. By creating more surface water in the landscape for purification and an attractive recreational landscape. In this way the impact of this solution is 2x positive, and thus it has a high score in the maximization scheme. This method (based on the previous pages) is used for all the solutions that are given in the report.

In the upper right of the scheme, the solutions for the problems in the metropolitan region of Amsterdam towards 2050, that have the most potential are visible. These will solve multiple problems at the same time, and have a positive impact on the other theme's. This also results in economical efficient solutions & bringing the actors of different sectors together more easily.



Water storage

New water level

New food types

Sustainable energy

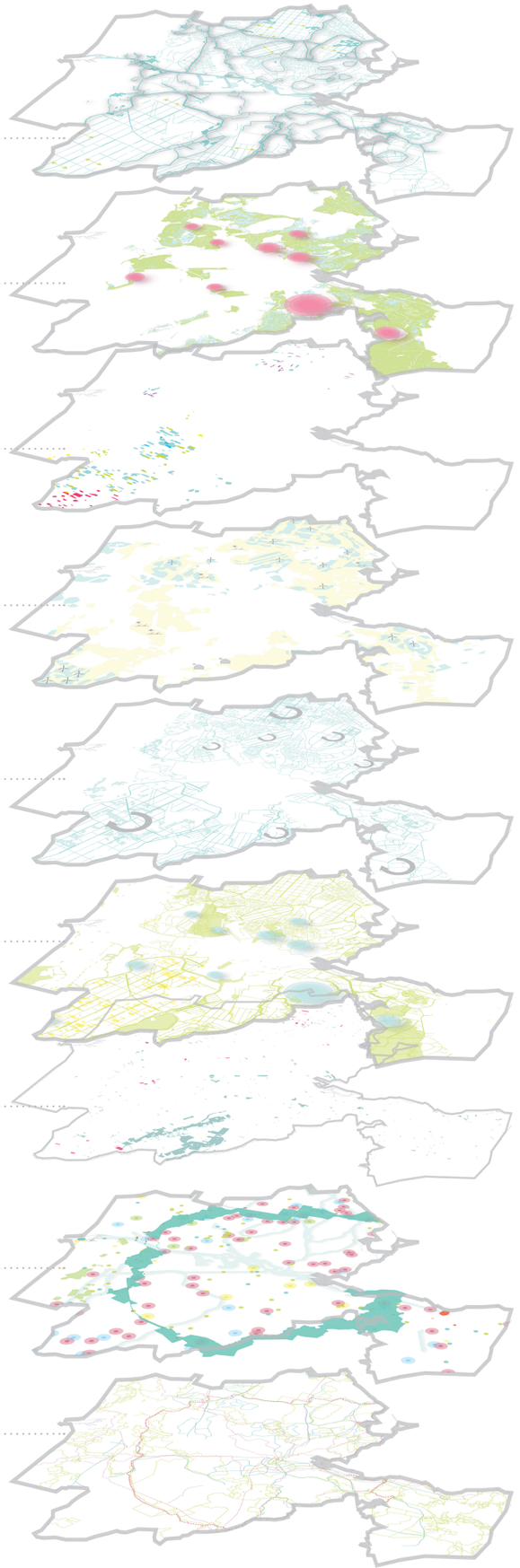
Circular water system

Purifying nature

Circular water greenhouse

Attractive food landscape

Accessible food landscape

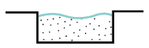


A STEP BY STEP GUIDE TROUGH THE OPTIMIZATION PROCESS OF THE SOLUTIONS IN THE REGION

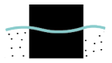
The solution of waterstorage is only adequate in the droogmakerijen landscapes, as the solution of a new waterlevel to prevent further soil subsidence is in the veenweide landscapes. Therefore these solutions will not directly impact each other. Furthermore the solutions will give the basis conditions for the [food] landscapes in 2050, and are therefore used as the underlay in this process.

With the higher waterlevel in de veenweide landscapes, a side effect is that there is more waterstorage created in the landscape. On a larger scale in the region this could prevent the water problems in the droogmakerijen landscapes, and therefore less waterstorage could be needed in these landscapes.

Furthermore the nature friendly waterways as part of the waterstorage solution, could also be created in the veenweide landscapes. In this case not to increase the waterstorage, but to improve the ecosystem of the landscapes.



Water storage



New water level



New food types



Sustainable energy



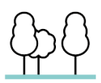
Circular water system



Circular water greenhouse



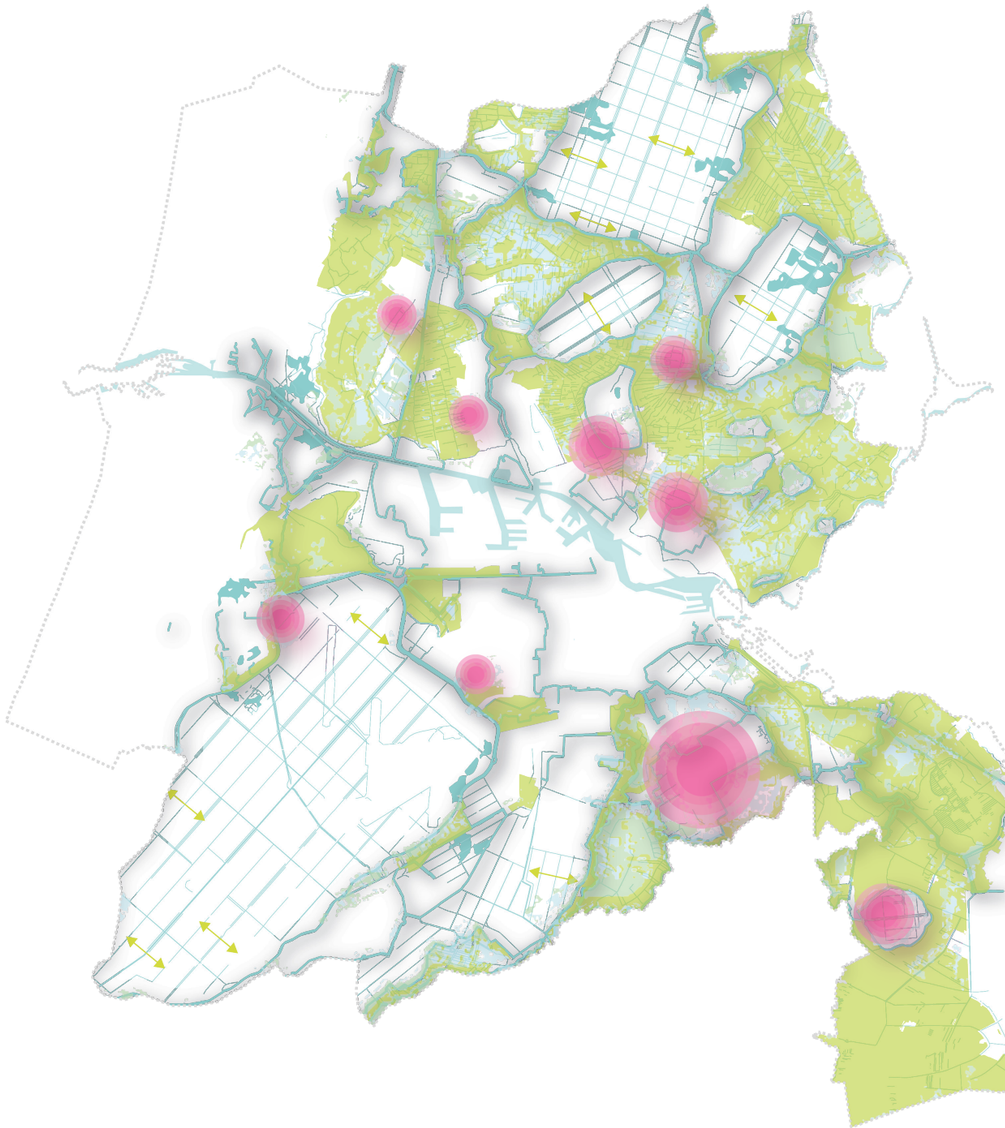
Purifying nature



Attractive food landscape

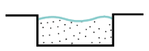


Accessible food landscape

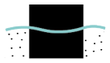


The solution of new food types in the landscapes of the region is especially concentrated in the droogmakerijen landscapes. As the problems in these landscapes with new freshwater conditions are significant. The new food types could be combined with the waterstorage solution, since these solutions are not planned in the same location. The nature friendly waterways will create a slightly reduced landscape for the harvest of new food types, however at the same time improve the natural ecosystem of these landscapes.

The new water levels in the veenweidelandscapes, give opportunities to introduce the wet food types in these landscapes. Salt and dry food types are not needed in these landscape conditions.



Water storage



New water level



New food types



Sustainable energy



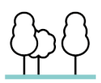
Circular water system



Circular water greenhouse



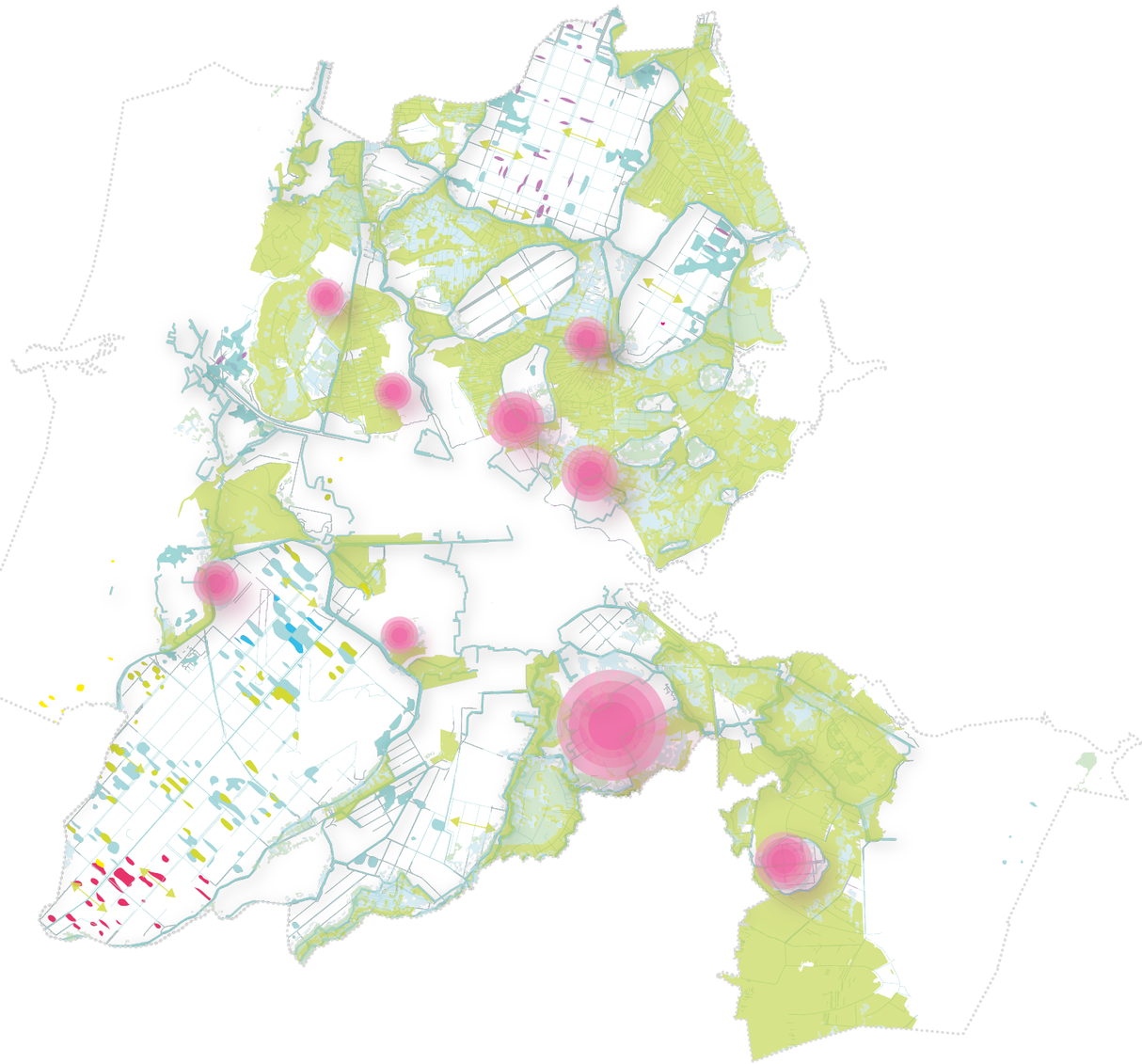
Purifying nature



Attractive food landscape

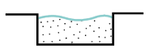


Accessible food landscape

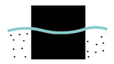


The solution of sustainable energy forms an effective combination with the other solutions for the climate adaptation in the landscapes. The pumps for the process of waterstorage in the droogmakerijen landscapes and the new water levels in the veenweide landscapes, could operate on this renewable energy. And the waterstorage locations could be well combined with windmills or floating solar panels.

Furthermore the sustainable energy could provide a secure income for the farmers in the first phase of the transition towards harvesting new food types in the landscapes of the region. Windmills in the landscape or solar panels in the greenhouses are the most suitable to be combined with the new food types, since they do not compete with the landscape for food production (as solar panels in the landscape).



Water storage



New water level



New food types



Sustainable energy



Circular water system



Circular water greenhouse



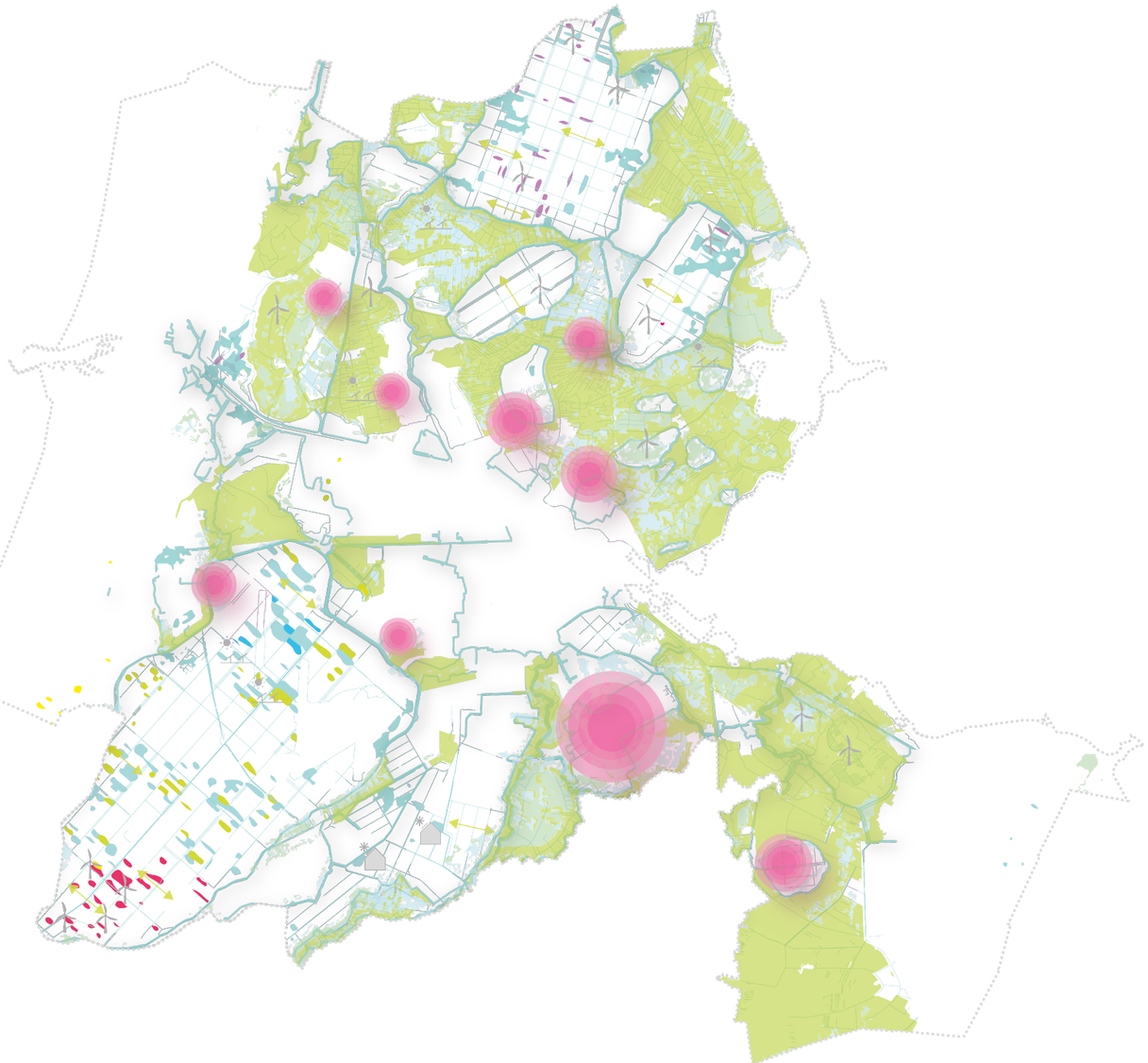
Purifying nature



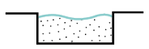
Attractive food landscape



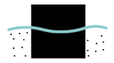
Accessible food landscape



The solution of a circular watersystem, as part of creating a purifying agricultural landscape in the region, has a lot of potential to be combined with the previous solutions for a climate adaptive landscape. A circular watersystem in the landscape could be well combined with the nature friendly water ways. As well as with the (new) food types in the landscapes, since it will improve the freshwater waterquality for the food production landscapes. With a circular watersystem in the polders, more waterstorage in the landscapes is needed as the system is disconnected from the boezem to improve the waterquality. This waterstorage overlays in some locations with the new food types. Therefore the other locations for waterstorage are preferred. A circular watersystem could be combined with the sustainable energy solutions.



Water storage



New water level



New food types



Sustainable energy



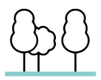
Circular water system



Circular water greenhouse



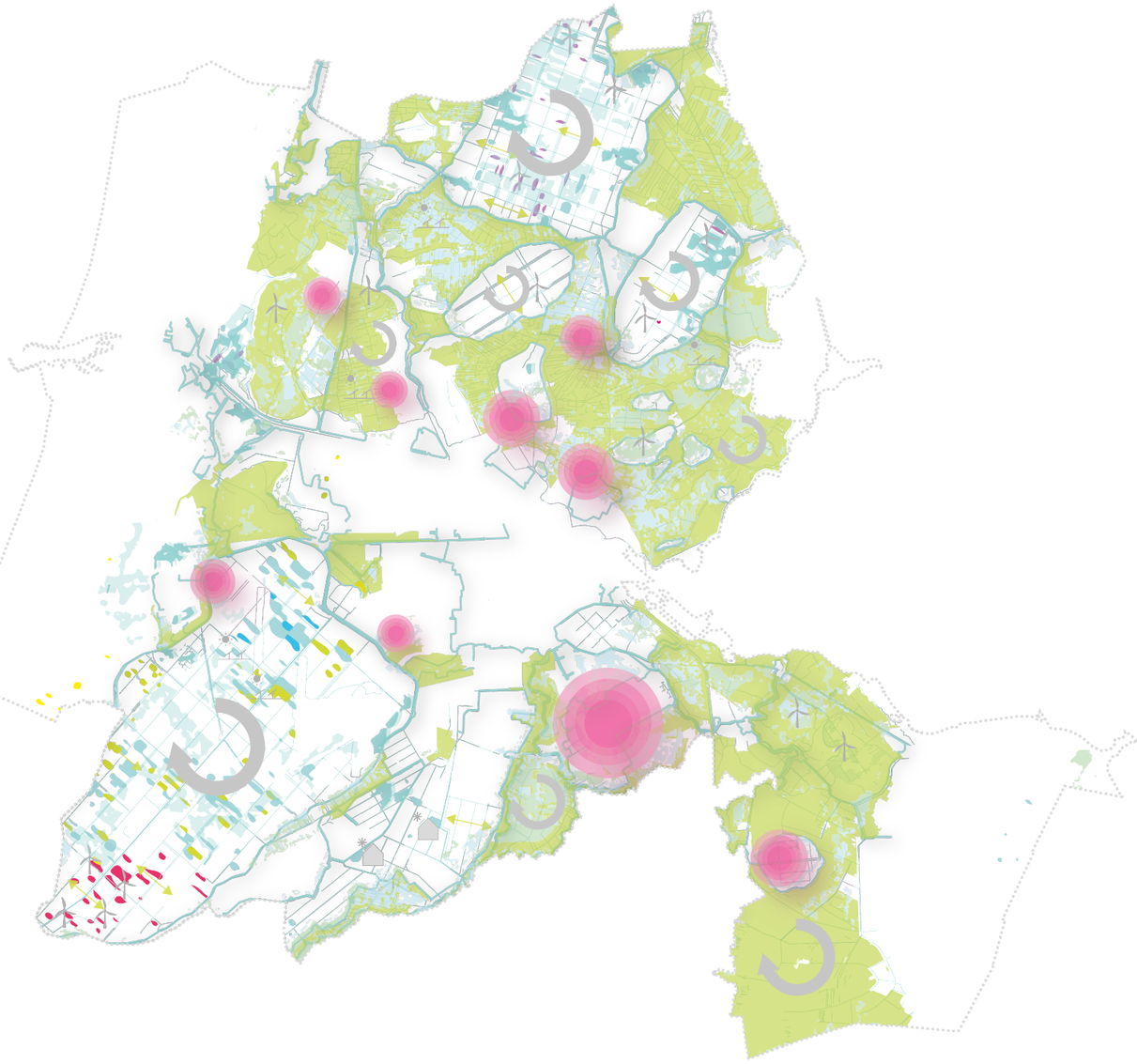
Purifying nature



Attractive food landscape



Accessible food landscape

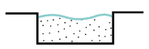


Together with the solution of a circular watersystem, the solution of purifying nature creates a purifying watersystem in the region and a high quality ecosystem in the landscapes.

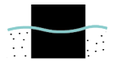
The nature friendly waterways of the solution of waterstorage are also included in this purifying system. And at specific locations in the veenweide landscapes where the process of soil subsidence is evolving at a high rate, nature is introduced in the higher water level to create new peat in the landscapes and maintain the unique ecosystem in these landscapes.

With the solution of the new food types in the landscapes, it is also possible to introduce purifying nature at these locations in the region to improve the ecosystem of the [food] landscapes. A combination between both could be possible, when enough landscape for the food production is maintained.

Sustainable energy in the landscapes and the purifying nature solution are a less good combination. Windmills are having a negative impact on the ecosystem and biodiversity of the landscapes. And solar panels on the water are decreasing the ecosystem in the water, because they prevent sunlight.



Water storage



New water level



New food types



Sustainable energy



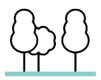
Circular water system



Circular water greenhouse



Purifying nature



Attractive food landscape

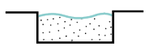


Accessible food landscape

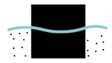


The solution of the circular and purifying greenhouses in the region, is a perfect addition to the purifying watersystem (see previous solution). With this solution the pollution of freshwater in the region is prevented at the greenhouse itself. Pesticides and fertilizers are no longer floating into the freshwater system. With the circular greenhouse the waste water is recycled and re-used in the greenhouse. With the purifying greenhouse the water is purified in a helofytes filter. This could be a good combination with the purifying watersystem to connect to on a larger scale.

The greenhouses also could be combined with the sustainable energy solution of solar panels. These are integrated in the glass of the greenhouses, and therefore a good example of a synergy between different solutions.



Water storage



New water level



New food types



Sustainable energy



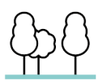
Circular water system



Circular water greenhouse



Purifying nature



Attractive food landscape



Accessible food landscape

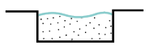


The solution of attractive recreational [food] landscapes has a lot of potential to be combined with most of the previous solutions
to create climate adaptive and purifying agricultural landscapes.

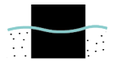
The solution of waterstorage and nature friendly waterways in the droogmakerijen landscapes could create new structures in these landscapes for recreation. As well as the new water levels in the veenweide landscapes result in a new and more diverse [food] landscape. The new food types that are introduced in the region towards 2050, improve this variety of the landscapes even more. Together with a purifying watersystem and by introducing nature in the landscapes, the ecosystem in the landscapes will enhance and the biodiversity will increase. This results in a new perspective on the [food] landscapes in the region, and will become more attractive to visitors.

Especially, in the locations were attractive structures or elements in the landscapes are coming together with activities in these food landscapes, there is a lot of potential to combine the previous solutions in the landscapes with recreational activities. For example, to use waterstorage as a swimming location, the new peat landscapes as a nature area and in locations with new food types create a tasting event for visitors.

The solution of sustainable energy however, is not so well combined with the attractive recreational [food] landscapes. Windmills and solar panels are often seen as unattractive elements in recreational landscapes. The solution of solar panels in the greenhouses is still possible, as it is an innovative and integrative solution for an existing structure in the landscape. In the future, the other solutions for sustainable energy could be combined with the recreational landscape if they are innovatively and well designed in the [food] landscapes and realised as small scale solutions.



Water storage



New water level



New food types



Sustainable energy



Circular water system



Circular water greenhouse



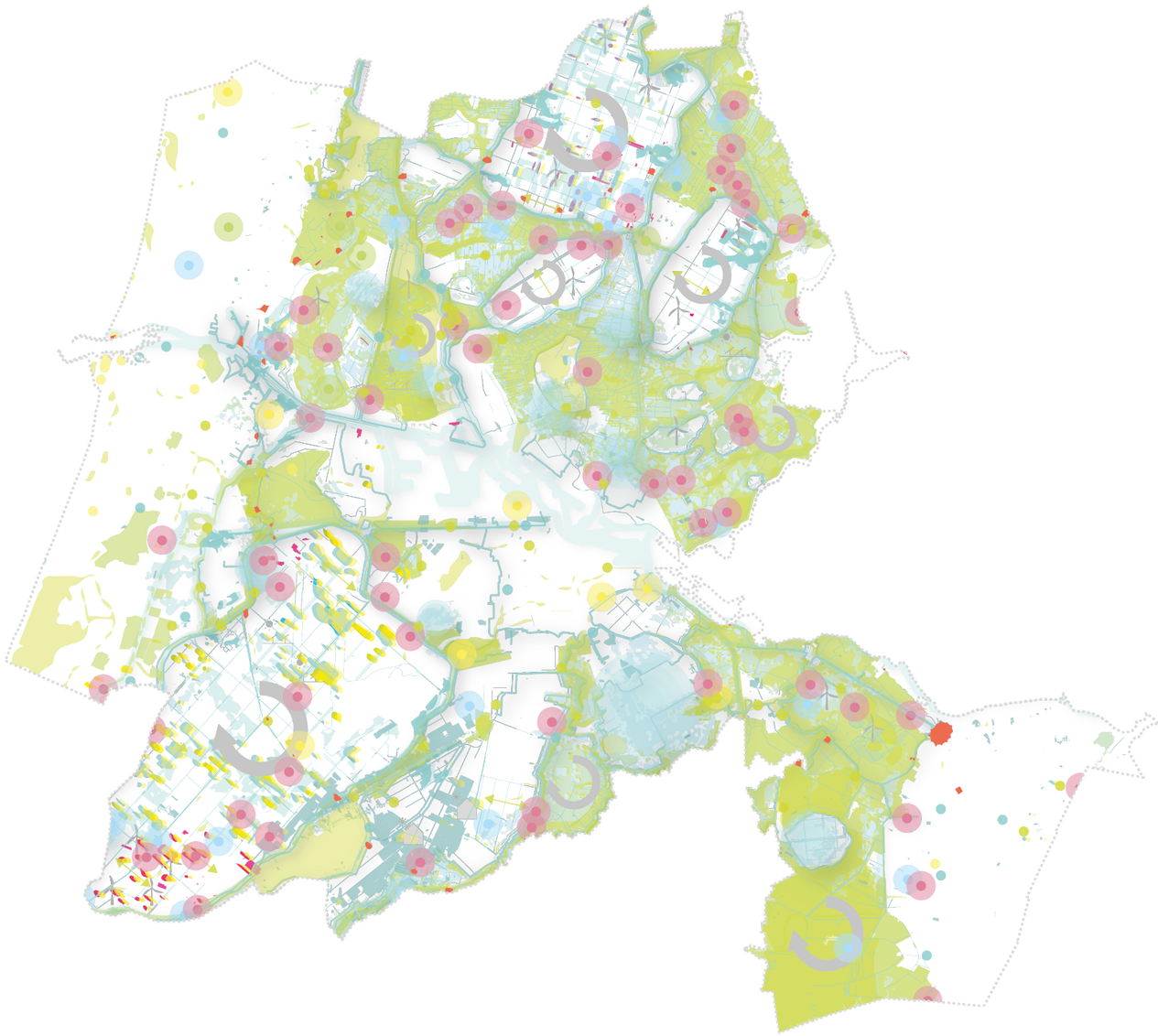
Purifying nature



Attractive food landscape



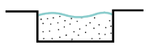
Accessible food landscape



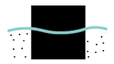
The solution for creating accessible [food] landscapes, is created based on the scenario of the combination of solutions that will be chosen in the next pages. And the final scenario that will be used in the future perspective of the region in 2050. This sustainable recreational network (consisting of waterroutes, walking & cycling routes and public transport) will connect the new solutions in the [food] landscapes of the region towards 2050. And especially create a link between the growing cities in the region and the new attractive recreational [food] landscapes.

This solution is well combined with almost all the previous solutions to create climate adaptive and purifying food landscapes. Most of the solutions create an attractive and more diverse landscape, that results in interesting routes through these new landscapes. However, the new high water level in the veenweide landscapes could make it more difficult to create an accessible [food] landscape. Furthermore, the sustainable energy solutions as windmills and solar panels on the water need to be carefully located to create an attractive and accessible recreational [food] landscape.

For a detailled overview of the combinations of solutions see the appendix.



Water storage



New water level



New food types



Sustainable energy



Circular water system



Circular water greenhouse



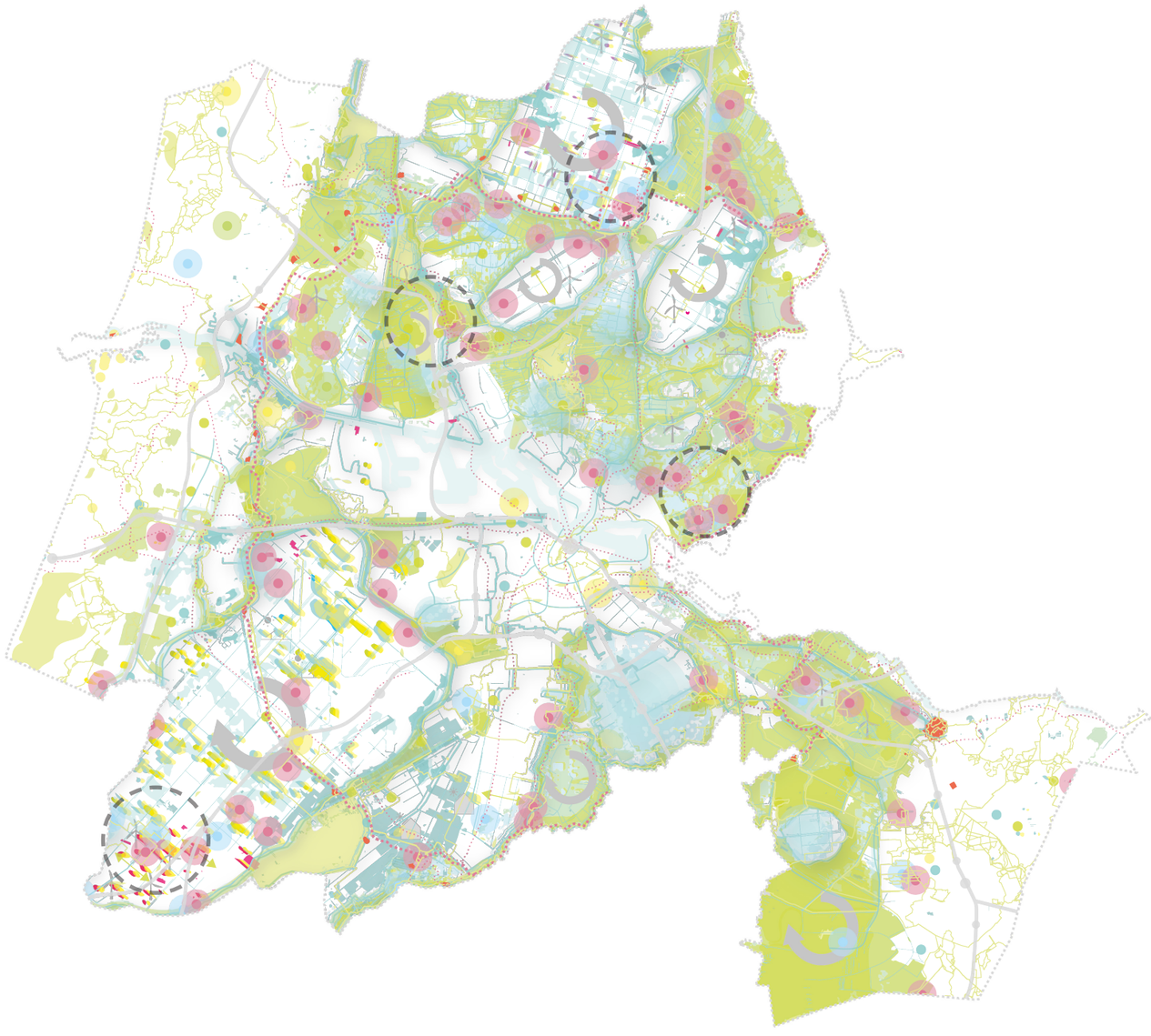
Purifying nature



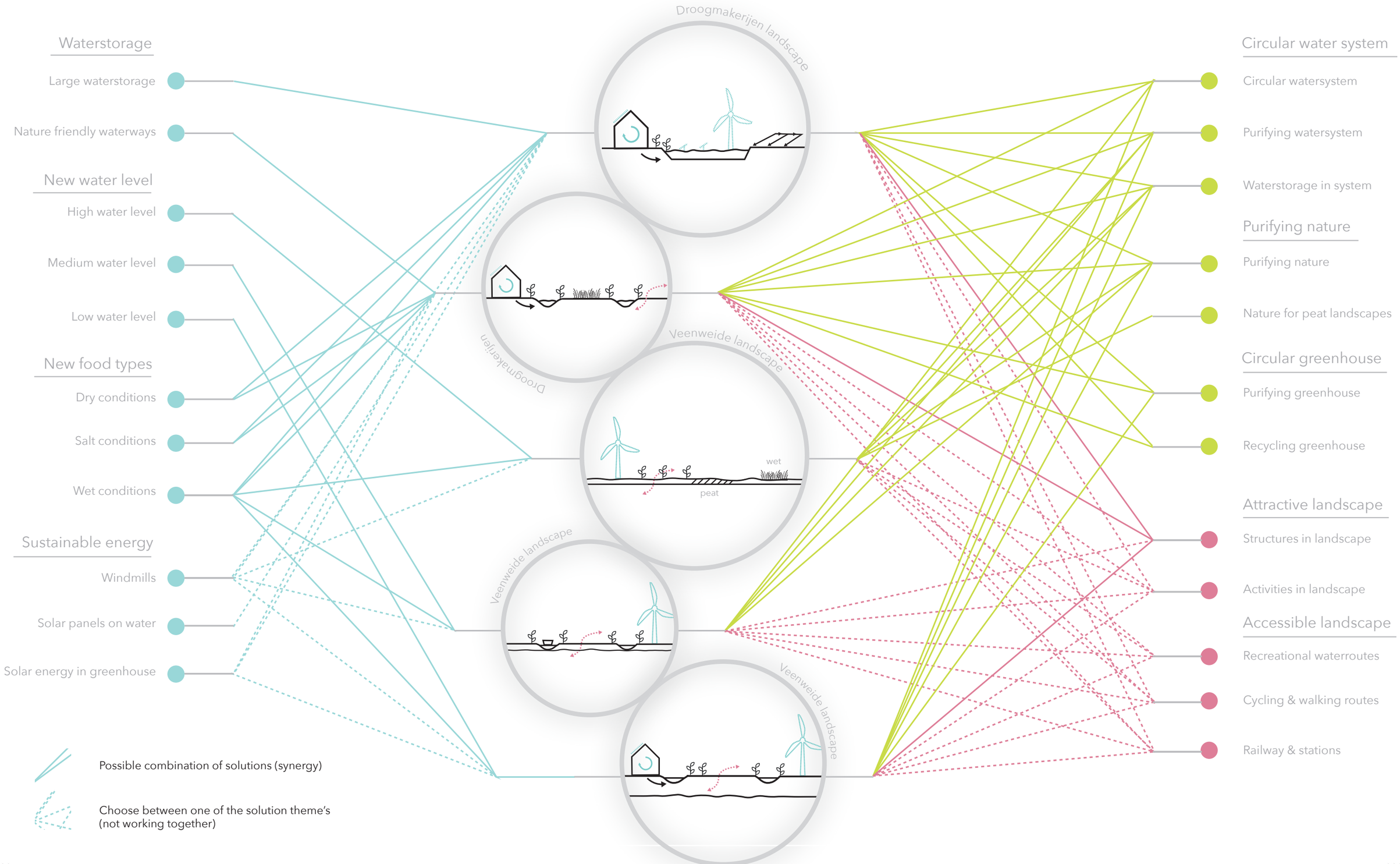
Attractive food landscape



Accessible food landscape



OPTIMIZATION PHASE: DESIGNING NEW [FOOD] LANDSCAPES SCHEME

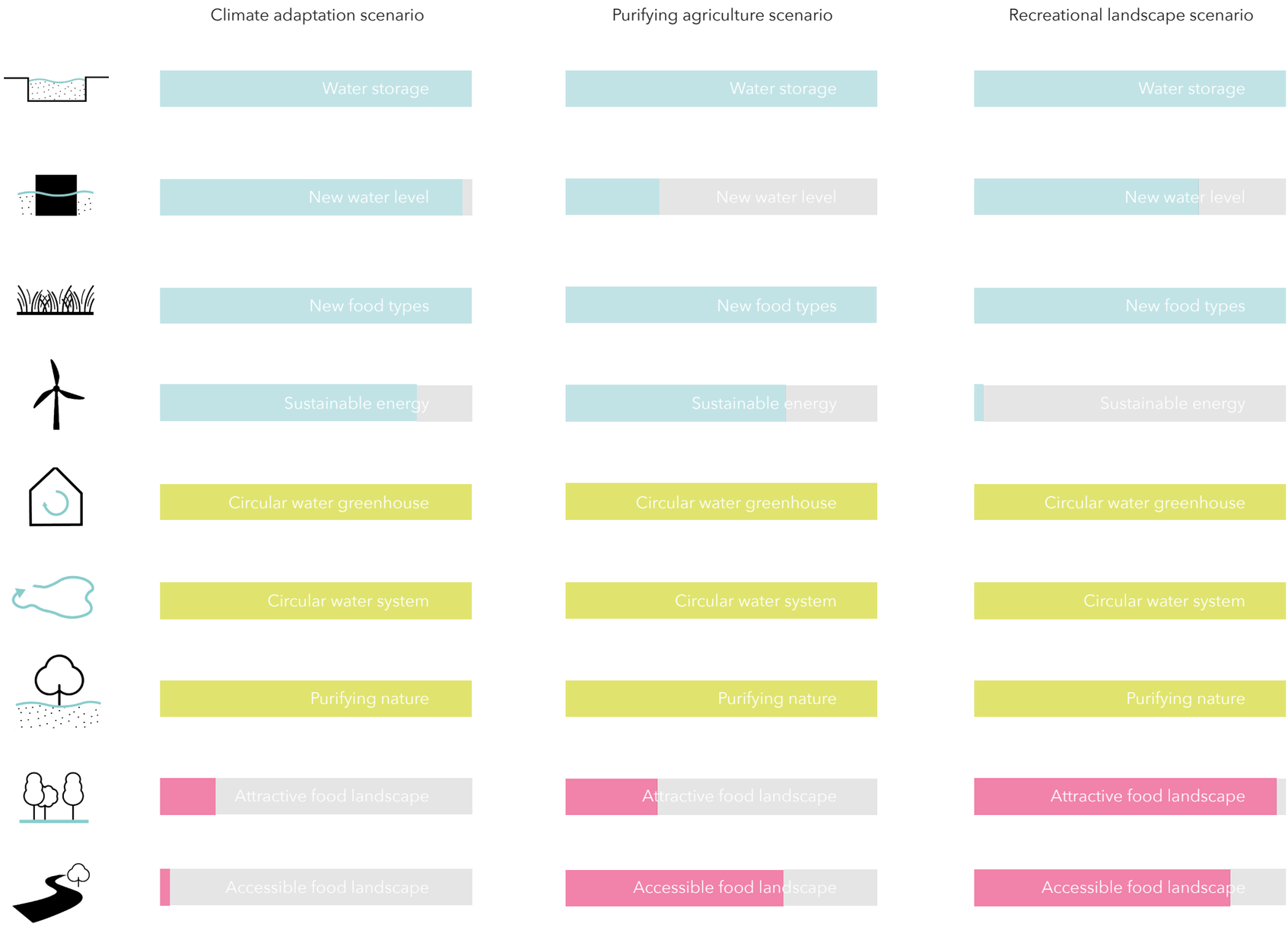


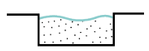
NEW PERSPECTIVES ON THE METROPOLITAN [FOOD} LANDSCAPES IN 2050 IN THE OPTIMALISATION PHASE

In the scenario of a climate resilient [food] landscape in the metropolitan region of Amsterdam towards 2050, the focus is on the solutions that will solve the climate change problems in the landscapes: creating waterstorage in the droogmakerijen, introducing a new (higher) waterlevel in the veenweidelandscapes, together with new food types for dry, salt & wet conditions and combing sustainable energy solutions with the food landscape. In the maximazation scheme it becomes clear that these solutions have a great potential to be combined with the solutions of creating purifying agricultural landscapes (circular watersystem in greenhouses & the landscape and combining this with purifying nature that will strenghten the ecological connections in the landscape). The solutions for climate change can be less well combined with the ones for an attractive & recreational landscape. This maximization method is also used for the purifying & recreational landscapes scenarios.

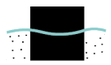
The main difference in the solutions for climate change in the landscapes is the need for waterstorage in the droogmakerijen as a buffer during seasons & the new water level in the veenweidelandscapes that is needed to prevent further soil subsidence. The rest of the solutions are suitable for both types of landscapes in the region.

To give a clear overview of the scenario's for the [food] landscapes of the metropolitan region towards 2050, in the following pages the difference between the droogmakerijen and veenweidelandscape solutions is visible. Impressions of the new landscapes in each scenario are given, as well as a new map of the region and a description of each scenario. In this way interviews can be done with actors of different sectors at the Province of Noord-Holland to get an overview of which of these scenario's is preferred and for what reasons. This will be used as input for creating the regional future perspective map of the region in 2050 and the pilot projects.





Water storage



New water level



New food types



Sustainable energy



Circular water greenhouse



Circular water system



Purifying nature



Attractive food landscape



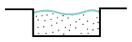
Accessible food landscape

1. CLIMATE ADAPTATION SCENARIO

In the scenario of a climate resilient [food] landscape in the metropolitan region of Amsterdam towards 2050, is the focus is on the solutions that will solve the climate change problems in the landscapes: creating waterstorage in the droogmakerijen, introducing a new (higher) waterlevel in the veenweidelandscapes, together with new food types for dry, salt & wet conditions and combing sustainable energy solutions with the food landscape. In the maximazation scheme it becomes clear that these solutions have a great potential to be combined with the solutions of creating purifying agricultural landscapes (circular watersystem in greenhouses & the landscape and combining this with purifying nature that will strenghten the ecological connections in the landscape). The solutions for climate change can be less well combined with the ones for an attractive & accessible recreational landscape. Since the higher water level in de veenweide landscapes makes it more difficult to create an accessible food landscapes towards 2050. And by introducing sustainable energy solutions in the [food] landscapes, it becomes less attractive as a recreational landscape for the visitors in the region. In the climate resilient scenario of the [food] landscapes it is primarily a productive & resilient landscape that is not focused on the attractiveness of the landscape.

SCENARIO 1: CLIMATE ADAPTATION IN THE METROPOLITAN LANDSCAPE (DROOGMAKERIJEN)

Climate adaptation scenario


Water storage


New water level


New food types


Sustainable energy


Circular water greenhouse


Circular water system


Purifying nature


Attractive food landscape


Accessible food landscape

Sustainable solar energy in greenhouse

Resilient crops to dry conditions (koolzaad)

Algea energy production in water

Sustainable wind-energy in the food landscape

Resilient crops to salt conditions (salt potatoes)



Purifying watersystem with nature (helofytes) connected to the greenhouse & waterstorage

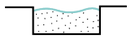
Waterstorage in the landscape as a buffer during seasons & preventing salinization in the landscape (tegendruk)

Resilient crops to wet conditions (cranberry's)

Purifying nature in the waterstorage landscape

SCENARIO 1: CLIMATE ADAPTATION IN THE METROPOLITAN LANDSCAPE (VEENWEIDELANDSCAP)

Climate adaptation scenario


Water storage


New water level


New food types

Sustainable energy


Circular water greenhouse


Circular water system


Purifying nature


Attractive food landscape


Accessible food landscape

Original water level: traditional meadow landscape in the region

New water level: crops instead of cows because of the weight on the soil

Sustainable wind-energy in the food landscape

New water level: 'natte teelt' as wild rice & cranberry's



Sustainable solar energy floating on the surface water in the landscape

Circular & purifying watersystem with nature (helofytes) plants

Nature planting in water landscape for creating new peat in the landscapes with time

Wild rice as a wet crop type in the landscape

Cranberry's as a wet crop type in the landscape

Climate adaptation scenario

Water storage

- Waterstorage (flexibel peilbeheer) in 'grote drooglegging peilvakken' along the boezems
- Waterstorage in wider waterways (natuurvriendelijke oevers)

New water level

- Landscape with a low water level (dry grassland)
- Landscape with a higher water level (wet grassland/crops)
- Landscape with a high water level to prevent soil subsidence (water)

New food types

- Resilient to dry conditions (koolzaad, artisjok & druif)
- Resilient to wet conditions (wild rice, duck-potato, veenbes & cranberry)
- Resilient to salt conditions (salt potatoes, gerst, koolzaad, zeekraal & lamsoor)

Sustainable energy

- Wind-energy in food landscape or waterlandscape
- Solar energy in waterlandscape
- Solar energy glass in greenhouses

Circular water greenhouse

- Greenhouses: purifying the freshwater with helofytes in the landscape
- Greenhouses: recyling the freshwater with cleaning tanks

Circular water system

- Circular watersystem in the landscape by connecting waterways
- Purifying watersystem in the landscape by adding new waterways
- Waterstorage in the landscape as a buffer (polder disconnected from boezem to improve the freshwater quality)

Purifying nature

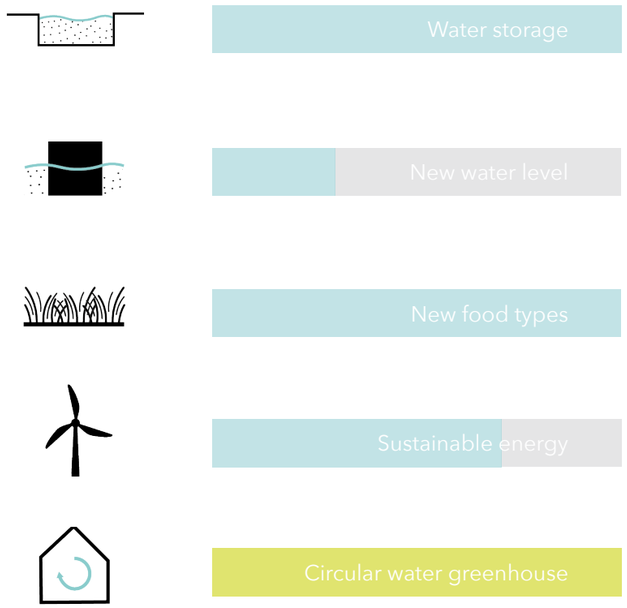
- Purifying nature in the watersystem (see plants in solution chapter)
- Purifying nature in the watersystem: veenaangroei gebieden

Attractive food landscape

- Recreational nature landscape

Accessible food landscape

- Long distance waterroutes for boats
- Recreational waterroutes for boats



2. PURIFYING AGRICULTURE SCENARIO

In the scenario of a purifying [food] landscape in the metropolitan region of Amsterdam towards 2050, is the focus on the solutions that will solve the pollution problems in the freshwater system of the agricultural landscapes and with that the disbalance in the ecosystem of these landscapes. These solutions consist of a circular watersystem in the landscapes that is combined with purifying nature, and greenhouses that are connected to this new purifying watersystem. According to the maximization scheme, these solutions could be combined with the climate adaptation solutions as well as the recreational solutions in the landscapes. There is a lot of potential in the combination with the waterstorage and new food types in the landscapes. Since waterstorage is needed to create a circular watersystem in the region that is purifying the water and therefore no longer connected to the lower water quality in the boezem. And the new food types are benefiting from this new water quality in the landscapes. The other solutions are balanced together (since the climate adaptation and recreational solutions are not well combined together) to create a purifying [food] landscape that is both resilient to the new climate conditions as well as creates an attractive and accessible recreational landscape. However, the focus in this scenario is on the purifying solutions in the food landscapes and less on the other theme's of climate adaptation and recreational [food] landscapes.

SCENARIO 2: PURIFYING AGRICULTURE IN THE METROPOLITAN LANDSCAPE (DROOGMAKERIJEN)

Purifying agriculture scenario

- Water storage
- New water level
- New food types
- Sustainable energy
- Circular water greenhouse
- Circular water system
- Purifying nature
- Attractive food landscape
- Accessible food landscape

Greenhouse with less pesticides & fertilizers

Resilient crops to dry conditions (koolzaad)

Circular watersystem in the landscape to improve the water quality (with natuurvriendelijke oevers)

Sustainable wind-energy in the food landscape

Purifying nature is improving the ecosytem of the landscape (bruine kiekendief & other animals are attracted to the rietmoeras & biezenvelden)



Purifying watersystem with nature (helofytes) connected to the greenhouse & waterstorage

Accessible walking path to the greenhouse & landscape for visitors

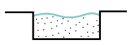
Waterstorage in the landscape as a buffer to improve the freshwater quality (no longer connected to the boezem)

Resilient crops to wet conditions (wild rice) that is also purifying the water

Purifying nature in the waterstorage landscape (lisdodde, riet & gele lis)

SCENARIO 2: PURIFYING AGRICULTURE IN THE METROPOLITAN LANDSCAPE (VEENWEIDELANDSCHAP)

Purifying agriculture scenario


Water storage


New water level


New food types


Sustainable energy


Circular water greenhouse


Circular water system


Purifying nature


Attractive food landscape


Accessible food landscape

Original water level: traditional meadow landscape in the region

Sustainable wind-energy in the food landscape

New water level: 'natte teelt' as wild rice & cranberry's



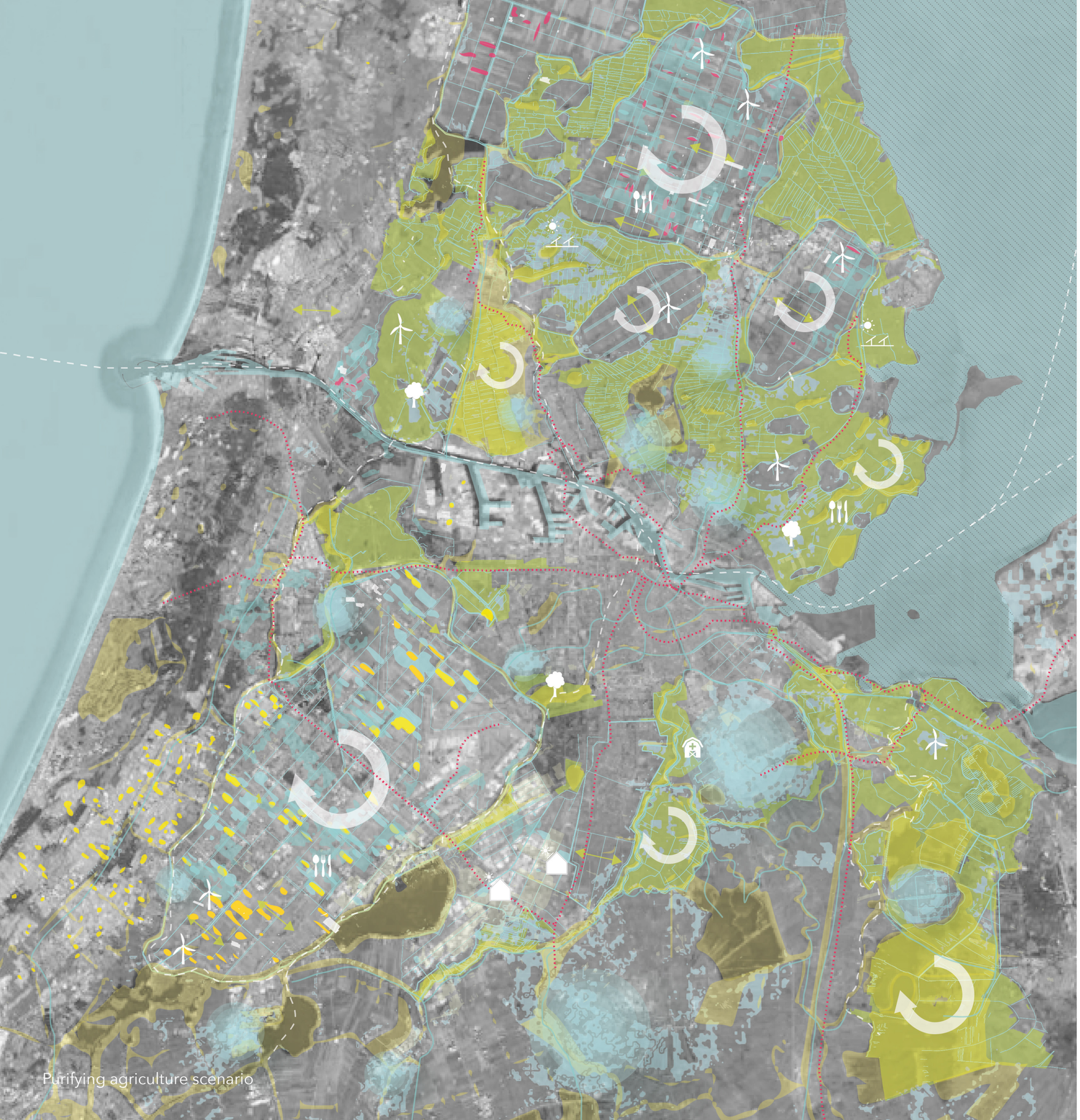
Accessible landscape to enjoy the nature landscape

Circular & purifying watersystem with nature (riet, lisdodde, gele lis, waterviolier & water flowers)

Nature planting in water landscape for creating new peat landscapes during time

New nature is improving the ecological structure in the region

Wild rice & cranberry's as a wet crop type in the landscape



Purifying agriculture scenario

Water storage

- Waterstorage (flexibel peilbeheer) in ‘grote drooglegging peilvakken‘
- Waterstorage in wider waterways (natuurvriendelijke oevers)

New water level

- Landscape with a low water level (dry grassland)
- Landscape with a high water level to prevent soil subsidence (water)

New food types

- Resilient to dry conditions (koolzaad, artisjok & druif)
- Resilient to wet conditions (wild rice, duck-potato, veenbes & cranberry or purifying nature: lisdodde, kroosvaren, veenmos, olifantsgrass, wilg & riet)
- Resilient to salt conditions (salt potatoes, gerst, koolzaad, zeekraal & lamsoor or purifying nature: riet, zonnebloem & lelie)

Sustainable energy

- Wind-energy in food landscape or waterlandscape
- Solar energy in waterlandscape
- Solar energy glass in greenhouses

Circular water greenhouse

- Greenhouses: purifying the freshwater with helofytes in the landscape
- Greenhouses: recyling the freshwater with cleaning tanks

Circular water system

- Circular watersystem in the landscape by connecting waterways
- Purifying watersystem in the landscape by adding new waterways
- Waterstorage in the landscape as a buffer (polder disconnected from boezem to improve the freshwater quality)

Purifying nature

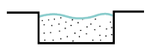
- Purifying nature in the watersystem (see plants in solution chapter)
- Purifying nature in the watersystem: veenaangroei gebieden

Attractive food landscape

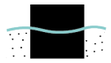
- Recreational nature landscape
- Care farm
- Dining in the food landscape

Accessible food landscape

- Long distance waterroutes for boats
- Recreational waterroutes for boats
- Regional cycling routes



Water storage



New water level



New food types



Sustainable energy



Circular water greenhouse



Circular water system



Purifying nature



Attractive food landscape



Accessible food landscape

3. RECREATIONAL LANDSCAPE SCENARIO

In the scenario of a recreational [food] landscape in the metropolitan region of Amsterdam, the focus is on the solutions that will solve the problem of a shortage in recreational landscapes towards 2050. One of the solutions for this shortage is to use the transition of the agricultural landscapes in the region to create more attractive and accessible [food] landscapes. In this solution the unique landscape structures in the region together with the existing activities for visitors in the food landscapes are combined with new solutions of the other theme's, that are designed in such a way that they are working towards an attractive landscape. Also a sustainable recreational network is created between these attractive [food] landscapes and the cities in the region to make them better accessible. This attractive and accessible [food] landscape can be well combined with the solutions of the purifying agricultural landscape. Since these solutions result in a purifying water system and improved ecosystem in the landscapes. For the combination of these solutions with the climate adaptation solutions, there is a good combination with the waterstorage and the new food types (to create a diverse landscape with new activities). However, the attractive and accessible [food] landscapes is less well combined with the sustainable energy solutions and the new water level. In this scenario the recreational value of the new [food] landscapes is the primary focus. The solutions of the other theme's are combined with the landscapes if they are profiting this recreational landscape.

SCENARIO 3: RECREATIONAL LANDSCAPES IN THE METROPOLITAN REGION (DROOGMAKERIJEN)

Recreational landscape scenario

- Water storage
- New water level
- New food types
- Sustainable energy
- Circular water greenhouse
- Circular water system
- Purifying nature
- Attractive food landscape
- Accessible food landscape

Greenhouse open with recreational activities: pick your own food.

Resilient crops to dry conditions (koolzaad)

Introducing new activities in the landscape: outside dining & picking up your food

Landscape spot for air balloons as recreational activity

Connected to the cycling paths in the region to be easily accessible from the cities in the region



Accessible walking path to the greenhouse & landscape for visitors

Circular watersystem of the greenhouse (recycle), to keep the possibility of swimming water in the landscape

Waterstorage in the landscape as a buffer to improve the freshwater quality (no longer connected to the boezem)

Accessible waterfront in the landscape for recreational activities

Purifying & attractive nature in the waterstorage landscape (riet & flowers)

SCENARIO 3: RECREATIONAL LANDSCAPES IN THE METROPOLITAN REGION (VEENWEIDELANDSCHAP)

Recreational landscape scenario

Water storage

New water level

New food types

Sustainable energy

Circular water greenhouse

Circular water system

Purifying nature

Attractive food landscape

Accessible food landscape

Original water level: traditional meadow landscape in the region

Creating the opportunity of camping at the farm

Attractive view point in the landscape to enjoy nature & spot animals

New water level: 'natte teelt' as wild rice & cranberry's



Accessible landscape by a walking & cycling network or by boat over the recreational waternetwork

Circular & purifying watersystem with nature (riet ,gele lis & water flowers)

Attractive & accessibe landscape by a walking path over the water

New nature is improving the ecological structure in the region

Wild rice & cranberry's as a wet crop type in the landscape

Recreational landscape scenario

Water storage

- Waterstorage (flexibel peilbeheer) in 'grote drooglegging peilvakken'
- Waterstorage in wider waterways (natuurvriendelijke oevers)

New water level

- Landscape with a low water level (dry grassland)
- Landscape with a high water level to prevent soil subsidence (water)

New food types

- Resilient to dry conditions (koolzaad, artisjok & druif)
- Resilient to wet conditions (wild rice, duck-potato, veenbes & cranberry or purifying nature: lisdodde, kroosvaren, veenmos, olifantsgrass, wilg & riet)
- Resilient to salt conditions (salt potatoes, gerst, koolzaad, zeekraal & lamsoor or purifying nature: riet, zonnebloem & lelie)

Sustainable energy

- Wind-energy in food landscape or waterlandscape
- Solar energy in food landscape or in waterlandscape
- Solar energy glass in greenhouses

Circular water greenhouse

- Greenhouses: purifying the freshwater with helofytes in the landscape
- Greenhouses: recyling the freshwater with cleaning tanks

Circular water system

- Circular watersystem in the landscape by connecting waterways
- Purifying watersystem in the landscape by adding new waterways
- Waterstorage in the landscape as a buffer (polder disconnected from boezem to improve the freshwater quality)

Purifying nature

- Purifying nature in the watersystem (see plants in solution chapter)

Attractive food landscape

- Recreational nature landscape
- Dining in the food landscape
- Care farm
- Pick up food at the farm
- Sleeping at the farm
- Sailing

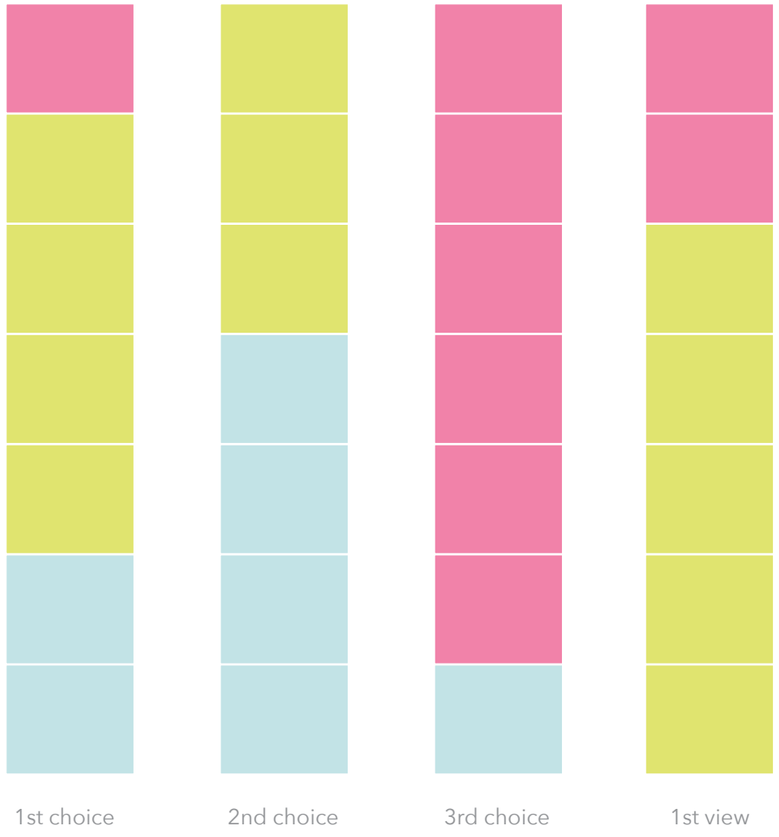
Accessible food landscape

- Long distance waterroutes for boats
- Recreational waterroutes for boats
- Regional cycling routes
- Railway & stations

OVERVIEW OF THE INTERVIEW RESULTS ON THE SCENARIO'S FOR THE [FOOD] LANDSCAPES IN 2050

With the three scenario's (climate adaptation (1), purifying nature (2) & recreational (3)) for the [food] landscapes in the metropolitan region of Amsterdam towards 2050, interviews have been done. Seven different actors within several sectors of the Province of Noord-Holland have been interviewed. The first question in this interview was which of the scenario's they preferred at first view. The second question was which of the scenario's they preferred when all the information about the differences in the scenario's was given to them. The final question was to give an opinition (positive, neutral or negative and the reasons for this) on each of the solutions in the graduation report and thus in the scenario's that was explained to them by the maps of the future regional food landscapes.

From these interviews interesting results on the solutions that were created with the maximization method, were given. One of the main conclusion was that the purifying agriculture scenario was seen as the most important one, because it provides the basic conditions for the food landscapes that need to be improved to create a resilient food & nature landscape. On the second place, the climate adaptation scenario was chosen, as this should be combined with the first scenario when there is a possibility. This is because of the regulations and goals on climate adaptation that need to be archieved in Europe towards 2050 and furthermore this scenario improves the (economic) resilience of the food landscapes. The last place was for the recreational food landscape scenario, as this is not a vital problem at this moment in the region and food landscapes. However when there is a lot of potential at specific locations (e.g. around Amsterdam), where it should be combined with the other two theme's if possible according to the people that are interviewed. For more detailled interview results on the solutions in the scenario's see the appendix.



Overview of the interviews results (2019).

Graphic created by author & based on interviews
with Ad Stavenuiter (waterquality)
Steven Slabbers (landscape quality & transitions)
Andre Smit (nature)
Marijn Bos (metropolitan landscape & recreation)
Ton Bossink (Environmental vision 2050 & landscape of Amsterdam)
Peter Graven (agriculture)
Danielle Lieuwen (nature inclusive agriculture)
of the different sectors at the Province of Noord-Holland (2019)

THE AIMS OF THE GRADUATION PROJECT

At the right of this page the aims at the start of the graduation project are visible. These are based on the problem analysis, problem statement and the research question in this report. In order to choose one of the scenario's as a basis for the future perspective on the [food] landscapes in the metropolitan region of Amsterdam towards 2050, it it essential to compare the interview results with the aims of the graduation project. Each of the aims of the graduation project is reflected in the scenario's for the [food] landscapes in the region. The climate resilient [food] landscapes is mostly represented by the climate resilient scenario. As the aim of purifying [food] landscapes, is more represented in the purifying agriculture scenario. At last the aims to create attractive [food] landscapes and accessible [food] landscapes are the focus of the recreational landscape scenario.

From the results of the interviews it becomes clear that the purifying agriculture scenario is the basis of the new [food] landscapes in the region. And should be combined with the climate resilient and recreational landscapes were possible. In this way all of the aims of the graduation project are represented in this result of the interviews. Therefore this same conclusion will be used to develop the regional future perspective in 2050. The only addition to the interview results will be that the aim to create a climate resilient [food] landscape is more important than mentioned by the actors interviewed. Because the development of the climate change problems in the agricultural landscapes of the region is going fast and creates large problems towards 2050 (see the problem analysis), that will not only harm the farmers, but also the people living in the cities of the region (by resulting in a shortage of certain food types and an unattractive landscape).

Climate resilient [food] landscapes

The agricultural landscapes in the region need to become resilient to the variability in freshwater flows caused by climate change towards 2050. This could be done, by creating a more circular water system with the possibility for waterstorage as a buffer or by introducing new (salt) food types.

Purifying [food] landscapes

The agricultural landscapes need to recyle the polluted water to obtain more freshwater for the food production where possible. Furthermore nature could be introduced in the landscapes to purify the polluted water. In that way the ecosystem of the landscapes will improve and the resilience of the landscapes towards 2050 will increase.

Recreational [food] landscapes

Attractive [food] landscapes

By improving the resilience and ecosystem of the landscapes, new opportunities for other types of activities could arise (as recreation, sustainable energy). These new opportunities could be integrated with the agricultural landscapes of the future in an attractive way.

Accessible [food] landscapes

New agricultural landscapes will be created towards 2050 by improving the resilience & ecosystem and creating new activities in the landscapes (recreation, sustainable energy innovation). The cities are connected to these attractive landscapes at short distances by a sustainable network in the region.

A NEW PERSPECTIVE ON THE [FOOD] LANDSCAPES IN 2050

Together with the aims of the graduation project and the results of the interviews on three different scenario's for the transitition of the agricultural landscapes in the metropolitan region of Amsterdam, a new perspective on the [food] landscapes in 2050 is created. This perspective is based on the scenario for a purifying agricultural landscape in the region. Furthermore, it is complemented with the solutions of the climate resilient and recreational landscapes scenario if possible.

The new perspective on the [food] landscapes consist of the large scale purifying watersystem as the new basis structure in the landscapes of the region. This purifying watersystem is a combination of the circular watersystem and purifying nature solutions. Together with the circular and purifying greenhouses, this new structure in the food landscapes of the region will purify the freshwater in the landscapes and improve the ecosystem and biodiversity in the food landscapes, as well as nature areas. In the droogmakerijen, this purifying watersystem is combined with waterstorage to create a more resilient food landscape for climate change. In the veenweide landscapes, a new water level is introduced besides this purifying watersystem, to prevent further soil subsidence and create new peat landscapes with an unique ecosystem. The [food] landscapes are combined with new food types that are resilient to the salt, wet and dry conditions of the landscapes, that will become more problematic towards 2050. Additionaly, the solution of sustainable energy is introduced in the food landscapes to give the farmers a secure income and make it possible to experiment with new food types towards the future. Together these solutions in the agricultural landscapes of the region, create a new [food] landscape that is resilient to climate change, purifies the freshwater and improves the ecosystem in the landscapes.

This transition of the agricultural landscapes results in an attractive landscape for the future, and with that creates opportunities for new activities to start that will strengthen the connection between the cities and landscapes in the region (e.g. care farms, dining in the food landscapes, pick up your food or sleeping at the farm). These activities are connected by a sustainable recreational network in the region. This network connects the cities and new [food] landscapes with waterroutes, attractive walking & cycling routes and at specific locations, by stations closely located to the landscapes.

In this way, new basic conditions are created in the agricultural landscapes of the region. With these solutions the [food] landscapes become resilient to climate change, purify the freshwater & improve the ecosystem and result in attractive & accessible recreational landscapes. This transition to the new [food] landscapes will prevent the problems that might arise in 2050 by the challenges towards the future.

In the following pages, the new perspective on the [food] landscapes will be explained in more depth by making use of pilot projects. At specific locations in the region, there are a lot of problems coming together towards 2050 (see map on p. 150) or there is a lot of potential in the combination of solutions (see map on p. 330). These locations are selected for the pilot projects, because of the high value of these projects in the transition of the food landscapes in the region. The pilot projects and the solutions that are introduced in these agricultural landscapes are visible on the next page.




ZAANSTREEK LANDSCAPE
BEEMSTER LANDSCAPE
WATERLAND LANDSCAPE
HAARLEMMERMEER LANDSCAPE
NEW PERSPECTIVE ON THE [FOOD] LANDSCAPES IN 2050

DESIGN OF THE NEW LANDSCAPES WITH THE REGIONAL PERSPECTIVE

VEENWEIDE LANDSCAPES (WATERLAND & ZAANSTREEK)

The waterland and zaanstreek landscapes are both veenweide landscapes in the region, and therefore the principles for the solutions in the landscapes are the same. However, the design of the landscapes differs, because of the unique characteristics of the landscapes that are used as an inspiraton for the integration of the solutions in the landscape. In the waterland landscape the focus is on creating an new innovative type of [food] landscape with new (wet) food types in combination with the traditional meadows. This landscape has an important recreational value in the region, especially as a landscape for the city of Amsterdam. Therefore, the landscape is strongly connected to the nearby cities with a recreational network of cycling, walking, sailing routes and new recreational activities. The unique ecosystem of this peat landscape is preserved and combined with solutions to create a resilient [food] landscape (new food types, recreational activities) for 2050.

In the zaanstreek landscape a purifying [food] landscape is designed, because of the low ecological freshwater quality in this landscape of the region. The improvement of the ecosystem by purifying nature and a more diverse landscape, results in an attractive recreational landscape for the surrounding cities. The scale of this recreational landscape however, is smaller than in the waterland landscape. Sustainable energy does not have the focus in this landscape, because is can pervert the natural qualities in the landscape.

A new water level is introduced in both landscapes. Only the highest water level is created in the veenweide landscapes with the most urgent soil subsidence problems. In this way, the unique ecosystem of these peat landscapes is preserved. The higher water level solution is not used in the design of the landscapes, since this will have a negative impact on the freshwater quality in the landscape (by releasing nutrients in the ground). This water quality is one of the most important aspects of the purifying [food] landscape scenario that is chosen.



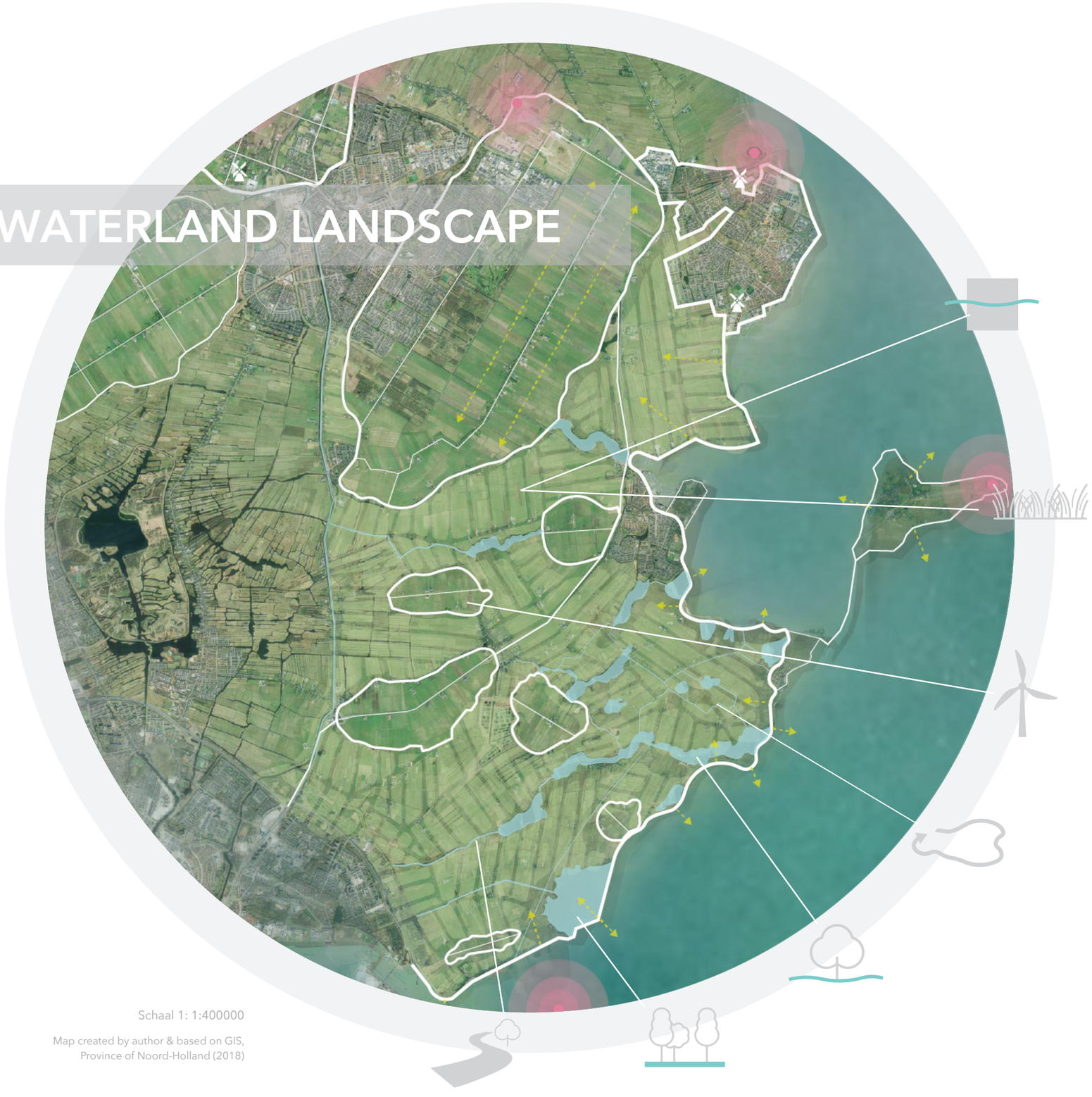
DROOGMAKERIJ LANDSCAPES (HAARLEMMERMEER & BEEMSTER)

The haarlemmermeer and beemster landscapes are both droogmakerij landscapes in the region, and therefore the principles for the solutions in the landscapes are the same. However, again the design of the landscapes differs because of the unique qualities of the landscapes. The beemster landscape is an special landscape, since it is listed on the Unesco World Heritage list. Therefore, the landscape is protected and one of the rules and regulations is that sustainable energy solutions as windmills are not permitted in this landscape. Towards 2050, however a new insight into the introduction of sustainable energy solutions in the beemster landscape could arise in order to accomplish the goals for climate adaptation. However, it is still important to design the sustainable energy solutions in this landscape in such a way that they emphasize the qualities of the unique and historic landscape (for example the long lines in the landscape).

The landscape of the haarlemmermeer is not part of the Unesco World Heritage list, and therefore more design options are possible. The rules and regulations for solutions that could be introduced in the landscapes, are however determined around the airport of Schiphol (for windmills, solar panels and water that could reflect sunlight in the sky). The landscape has a large scale and is focusses on the food production in the Netherlands. Therefore, new innovative food types will be introduced to create a productive [food] landscape that is resilient to the effects of climate change. Because of the large scale, there are a lot of opportunities for sustainable energy solutions in this landscape.



WATERLAND LANDSCAPE



Schaal 1: 1:400000

Map created by author & based on GIS, Province of Noord-Holland (2018)

THE LANDSCAPE CHARACTERISTICS & SOLUTIONS FOR A NEW [FOOD} LANDSCAPE

A new waterlevel is introduced in the waterland (peat) landscape to prevent futher soil subsidence in locations with more than (60) cm/year. This new water level is located, based on the existing small scale allotment in the peat landscapes. Therefore a higher water level is only created in certain parcels. This solution will be combined with new wet food types to create an innovative and diverse food landscape in 2050. In this way, the waterland landscape will still function as a food landscape where the traditional meadows (with cows) will be combined with innovative food production to create an attractive and diverse recreational [food] landscape in the region. This landscape is closely located to the city of Amsterdam, and therefore connected with a sustainable network between the city and the new [food] landscapes. The sustainable energy solutions (windmills) are introduced in the parcels with new food types, to create a new innovative food landscape (and preserve the traditional landscape in other locations). As well as in the large scale droogmakerijen landscapes, where they are located along the sightlines in the landscapes. Furthermore, as a basis structure of the new [food] landscapes, a circular watersystem is created together with purifying plants for improvement of the water quality and ecosystem in the landscapes. In the larger water bodies that are unique for the waterland landscape (dieen), purifying nature is introduced to create nature areas for a higher biodiversity.

Landscape structures

Waterstructures

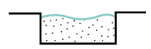
Sightlines in landscapes

Fortifications (Stelling van Amsterdam)

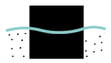
WATERLAND LANDSCAPE



The Waterland [food] landscape is closely located to the metropolitan city of Amsterdam. Therefore the new design is creating a combination of a recreational (new activities & connections) and resilient [food] landscape. The traditional peat meadows are combined with innovative food landscapes to create a diverse and attractive landscape for the surroundings. This landscape is furthermore, resilient to the effects of climate change and improves the ecosystem in the water & [food] landscape by purifying nature.



Water storage



New water level



New food types



Sustainable energy



Circular water greenhouse



Circular water system



Purifying nature



Attractive food landscape

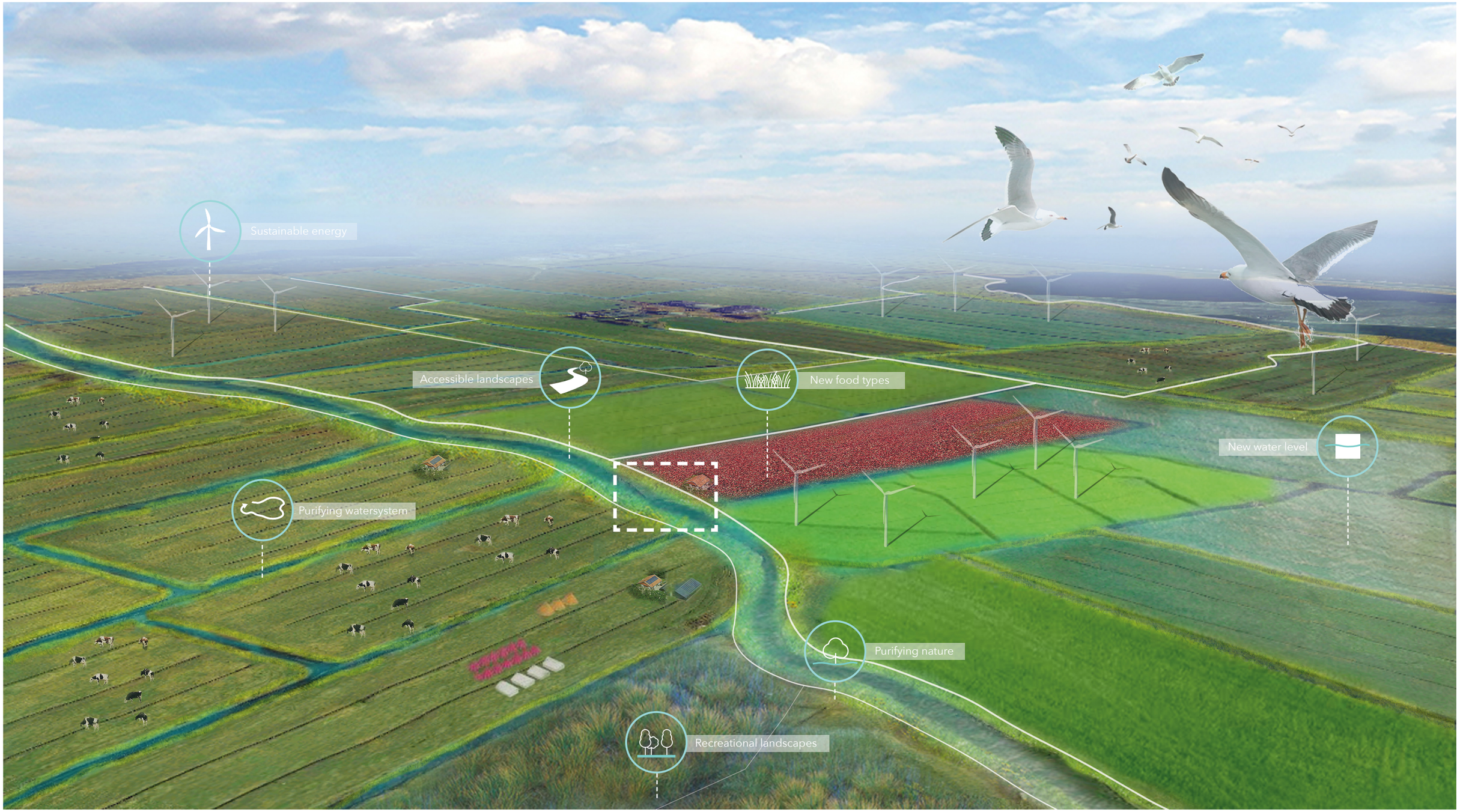


Accessible food landscape

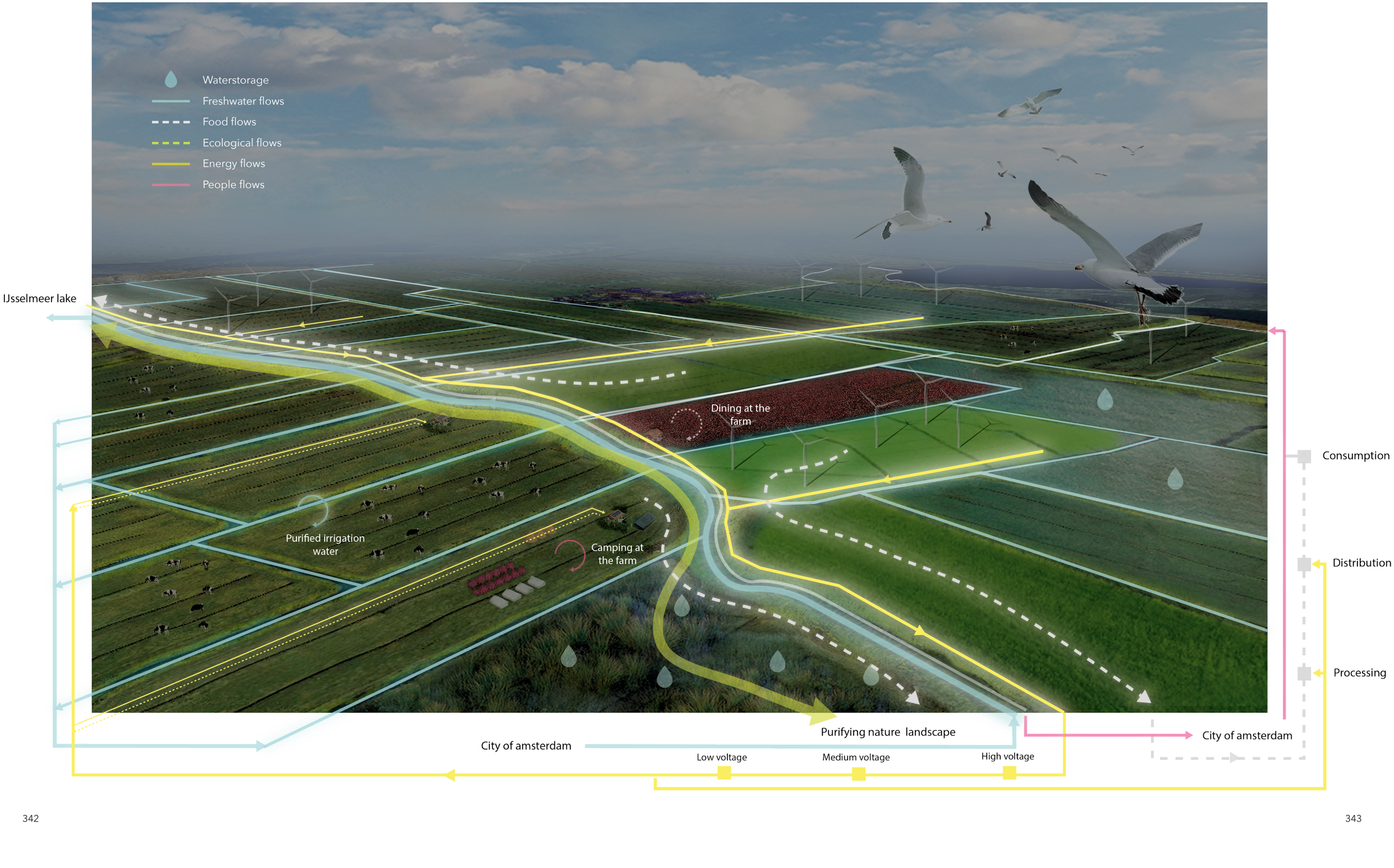
Schaal 1: 1:400000

Map created by author & based on GIS, maximization method in this report

Impression of the integrated solutions in the Waterland landscape



Impression of the synergy in flows in the Waterland landscape



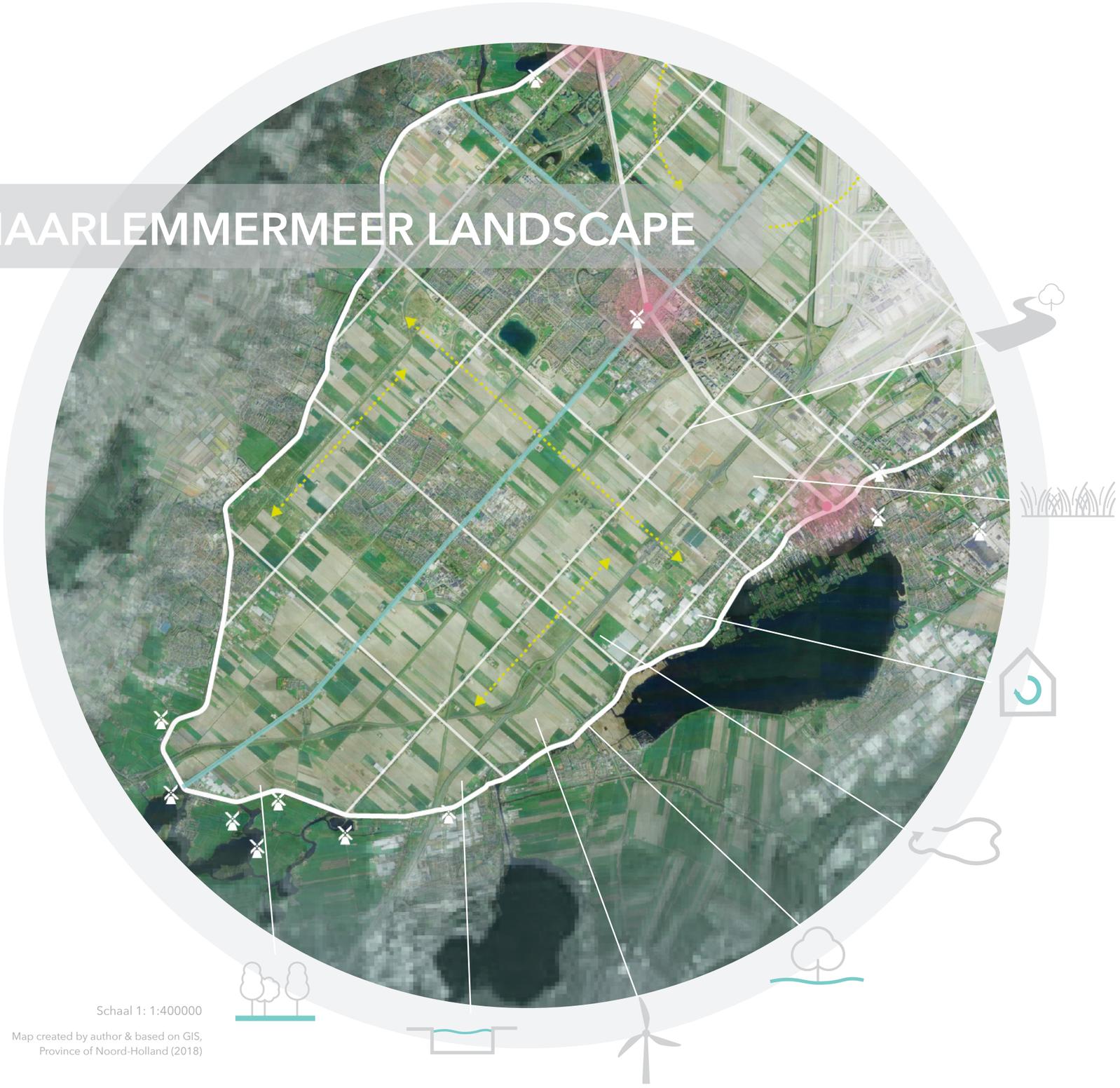
In the Waterland [food] landscape, the new design is creating a combination of a resilient and recreational [food] landscape. This is visible in the new water level that is introduced in the landscape and combined with new food types for these wet conditions as cranberries. At specific locations sustainable energy solutions are introduced in the landscape. This new innovative [food] landscape creates opportunities for recreational activities(e.g. picknick at the farm to taste new food types). The landscape is connected with the cities in the region by a recreational network. And in contrast to this new innovative landscape is the traditional meadows landscape maintained and combined with recreational activities (sleeping at the farm)

WATERLAND

Impression of the integrated solutions in the Waterland landscape



HAARLEMMERMEER LANDSCAPE



Schaal 1: 1:400000

Map created by author & based on GIS, Province of Noord-Holland (2018)

THE LANDSCAPE CHARACTERISTICS & SOLUTIONS FOR A NEW [FOOD} LANDSCAPE

The Haarlemmermeer (polder) landscape is a large scale landscape that is created in the past. Therefore the long lines and large structures in the landscapes are used as a basis in the design of the solutions in 2050. A new purifying waterstructure is introduced in the boezem (with a very low ecological quality) and in the smaller scale waterstructures in the food landscapes. The greenhouses in this landscape are connected to the purifying watersystem. In this way the ecosystem in the freshwater and the landscapes will improve. To create a food landscape that is resilient to the effects of climate change, the solution of waterstorage is realised to create a buffer for the variability in freshwater during the year. Furthermore,new food types are introduced that are resilient to the dry, wet and salt conditions of the agricultural landscapes in 2050 and create a more diverse and attractive landscape in the Haarlemmermeer. This landscape has still the focus on a productive [food] landscape. However, with an improved ecosystem and more diversity. Therefore it becomes more attractive as an recreational landscape (in specific locations), where new activities are introduced and connected to the nearby cities with a recreational network. Because the landscapes consists of large structures and is a productive [food] landscape, there is the opportunity to combine this landscape with sustainable energy solutions. These solutions are introduced along the lines in the landscapes.

Landscape structures

Waterstructures

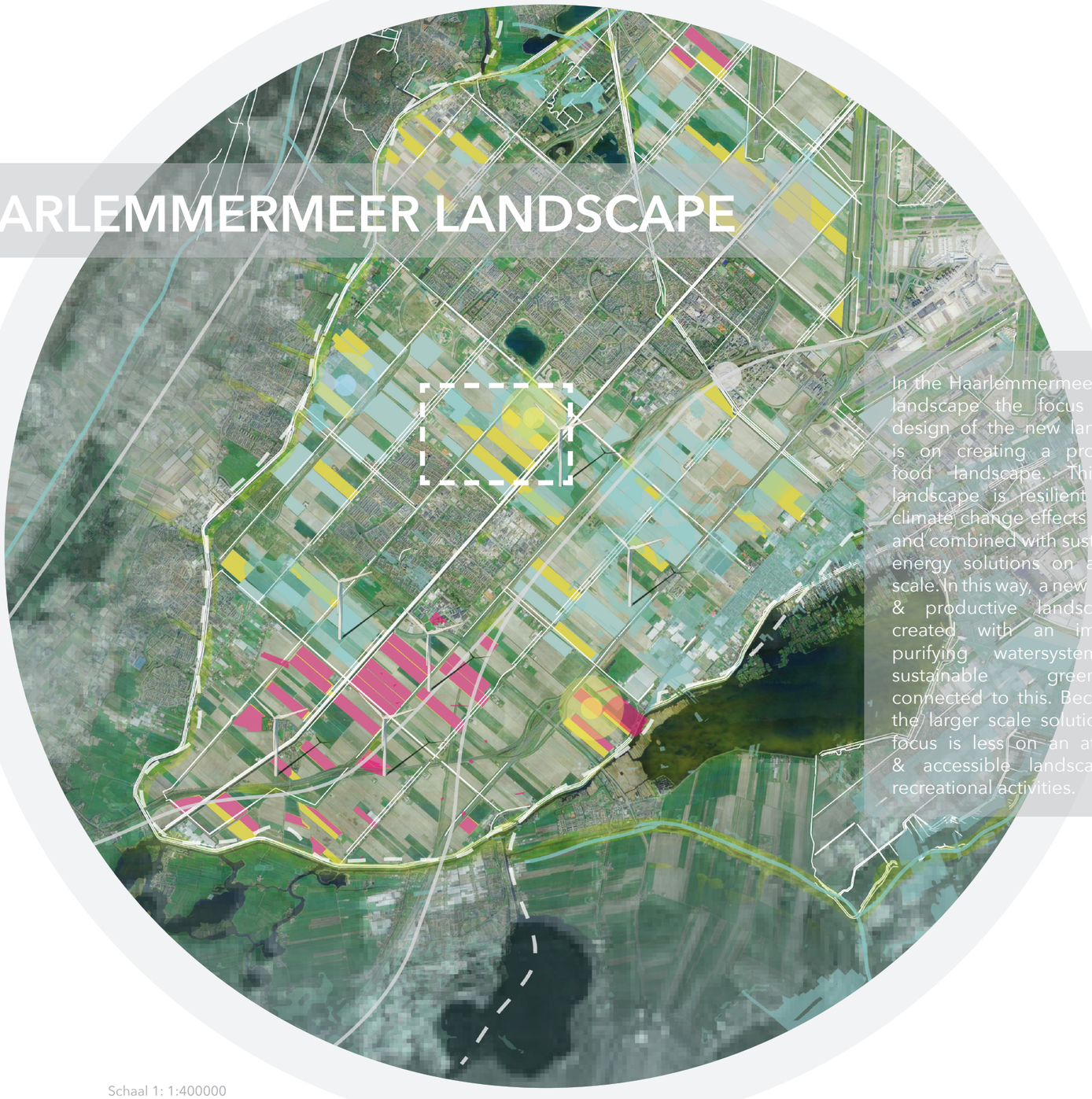
Sightlines in landscapes

Fortifications (Stelling van Amsterdam)

Traditional windmills

Schiphol Airport (landscape with restrictions)

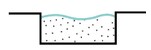
HAARLEMMERMEER LANDSCAPE

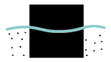


In the Haarlemmermeer [food] landscape the focus in the design of the new landscape is on creating a productive food landscape. This new landscape is resilient to the climate change effects in 2050 and combined with sustainable energy solutions on a larger scale. In this way, a new resilient & productive landscape is created with an improved purifying watersystem and sustainable greenhouses connected to this. Because of the larger scale solutions, the focus is less on an attractive & accessible landscape for recreational activities.

Schaal 1: 1:400000

Map created by author & based on GIS, maximization method in this report


Water storage


New water level

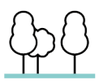

New food types


Sustainable energy


Circular water greenhouse

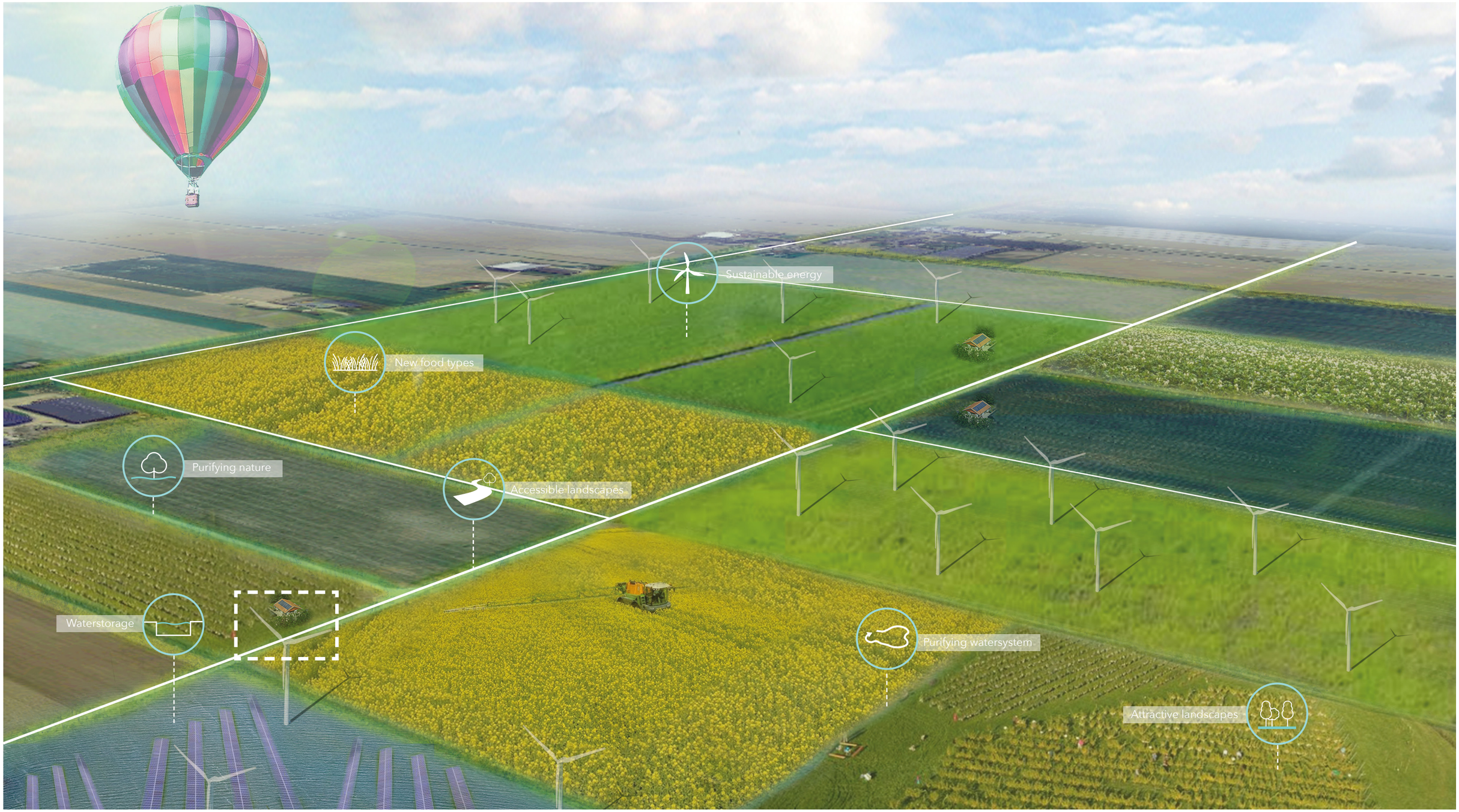

Circular water system


Purifying nature


Attractive food landscape

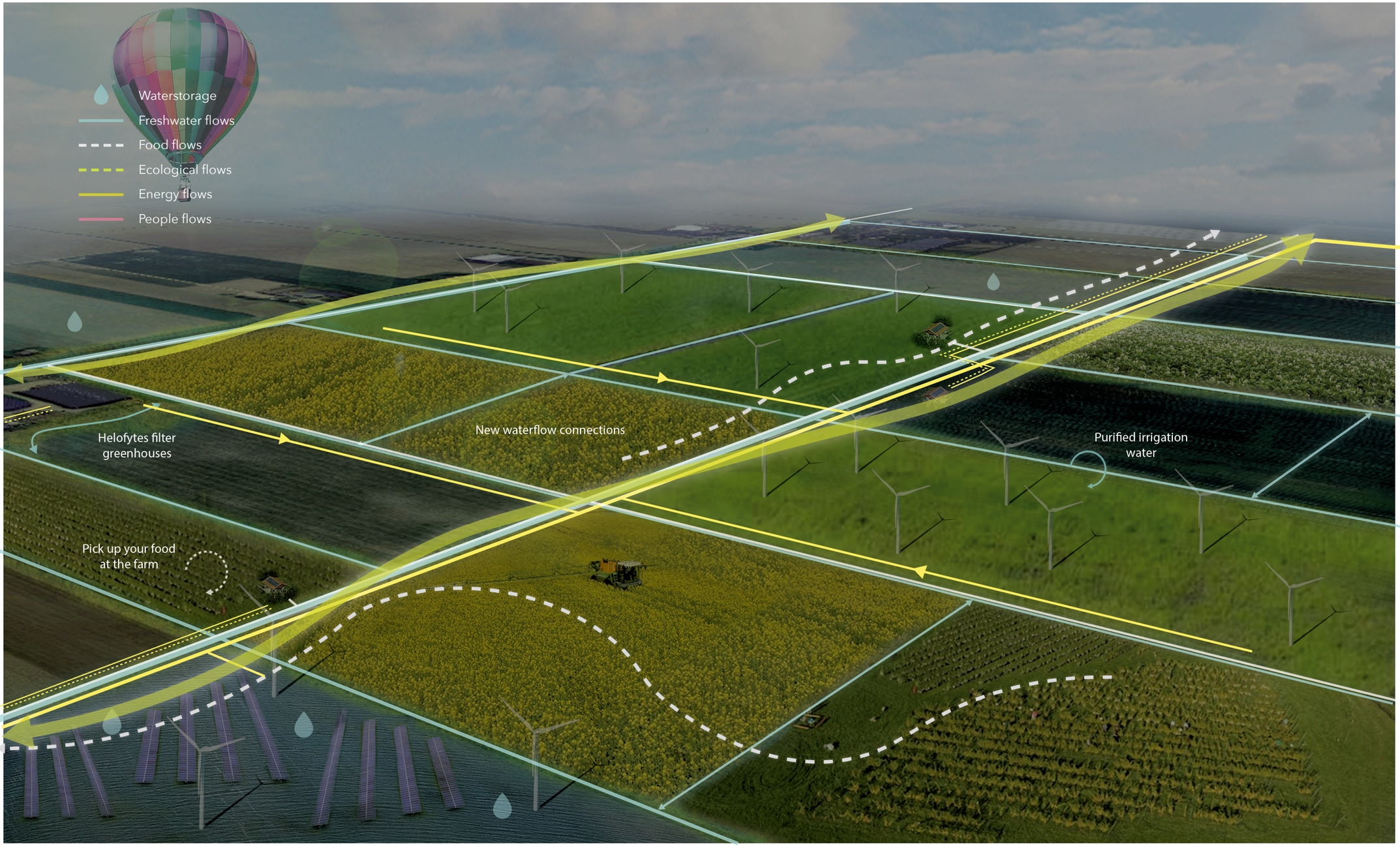

Accessible food landscape

Impression of the integrated solutions in the Haarlemmermeer landscape



Impression of the synergy in flows in the Haarlemmermeer landscape

Purifying nature landscape



In the Haarlemmermeer [food] landscape the focus is on creating a resilient productive food landscape towards 2050. Within the large scale structures in the landscape a purifying watersystem is introduced (where the greenhouses are connected to). To become resilient to the effects of climate change, waterstorage and new food types (as rapeseed & grapes) are realised in the food landscape. The waterstorage location is well combined with sustainable energy solutions to create an innovative & productive food landscape. At speficic locations in the landscape, new activities are combined with the food production (pick up your food at the farm). The landscape is connected to the surrounding cities by a sustainable recreational network.

HAARLEMMERMEER

Impression of the integrated solutions in the Haarlemmermeer landscape



ZAANSTREEK LANDSCAPE



Schaal 1: 1:400000

Map created by author & based on GIS,
Province of Noord-Holland (2018)

THE LANDSCAPE CHARACTERISTICS & SOLUTIONS FOR A NEW [FOOD} LANDSCAPE

The original waterstructure in the Zaantreek is an important basic structure in the landscape and has a very low ecological quality at this moment (because of too much nutrients in the water). Therefore the focus in the design of this landscape is on creating a purifying watersystem. By introducing a circular watersystem and purifying nature, the waterquality and ecosystem in the landscape will improve. The purifying watersystem is complemented with a new water level at specific locations to prevent further soil subsidence. Together, these solutions create new conditions that result in a more diverse and attractive nature & food landscape (in combination with new food types). Furthermore, the new [food] landscape is closely located to the smaller cities in the region (Zaandam, Assendelft etc.), that could be connected to this new food & nature landscape by a small scale sustainable recreational network of walking, cyling and sailing routes. The focus in the landscape of the Zaanstreek is more on a purifying nature landscape, than on a large scale food production landscape (as in the Haarlemmermeer). Therefore, the solutions of sustainable energy are less implemented, because it can disrupt the natural quality and create a less attractive natural & recreational landscape. This however, creates more opportunities for recreational activities to be combined with the nature & food landscape (e.g. sleeping at the farm).

Landscape structures

Waterstructures

Fortifications (Stelling van Amsterdam)

Traditional windmills

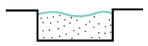
ZAANSTREEK LANDSCAPE

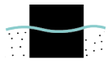


In the Zaanstreek landscape the new basis of the landscape is a purifying waterstructure, in combination with natural areas. With this new structure, the ecosystem in the water & landscapes will be restored (by absorbing the high amount of nutrients). This results in a combination of nature & food landscapes, and creates a more attractive landscape for the cities in the region. With the new sustainable recreational network the cities and the new [food] landscapes will be better connected. Sustainable energy solutions are less introduced, to protect the nature & recreational value.

Schaal 1: 1:400000

Map created by author & based on GIS, maximization method in this report


Water storage


New water level


New food types


Sustainable energy


Circular water greenhouse


Circular water system


Purifying nature


Attractive food landscape


Accessible food landscape

BEEMSTER LANDSCAPE



Schaal 1: 1:400000

Map created by author & based on GIS,
Province of Noord-Holland (2018)

THE LANDSCAPE CHARACTERISTICS & SOLUTIONS FOR A NEW [FOOD} LANDSCAPE

The Beemster landscape is an unique food landscape in the region and part of the UNESCO world heritage list. Therefore, special regulations need to be taken into account in designing these landscapes. The Beemster is surrounded by a boezem, where a purifying watersystem is introduced towards 2050. In the polder landscape, a grid structure is characteristic for this food landscape. This structure is the basis for the smaller scale purifying watersystem. The greenhouses in the landscape are connected to this watersystem and combined with solar energy glass. Furthermore, new food types and waterstorage are introduced in the smaller parcels within the grid landscape structure. This is combined with sustainable energy solutions at specific locations (based on the structures) to create an innovative [food] landscape within the unique polder structure. In this way, the Beemster landscape has still the function of a recreational polder landscape. However, combined with innovative food types an interesting combination of recreation & food is created (e.g. dining at the farm). This makes it possible to introduce new activities in this landscape for a better connection between the cities and agricultural landscape. The recreational network in the landscape corresponds to the grid structure and smaller parcels.

Landscape structures

Waterstructures

Sightlines in landscapes

Fortifications (Stelling van Amsterdam)

Traditional windmills

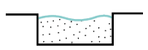
BEEMSTER LANDSCAPE



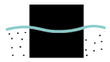
In the Beemster [food] landscape, a new combination of (international) recreation and innovative food production is created. The Beemster is an unique landscape on the unesco world heritage list. In the design of the new landscapes the traditional polder structure is maintained, and combined with new recreational [food] activities. For example, dinner at a farm with new food types that are locally produced. This will strenghten the unique character of the Beemster and create a resilient landscape for the future.

Schaal 1: 1:400000

Map created by author & based on GIS, maximization method in this report



Water storage



New water level



New food types



Sustainable energy



Circular water greenhouse



Circular water system



Purifying nature



Attractive food landscape



Accessible food landscape

ZAANSTREEK LANDSCAPE

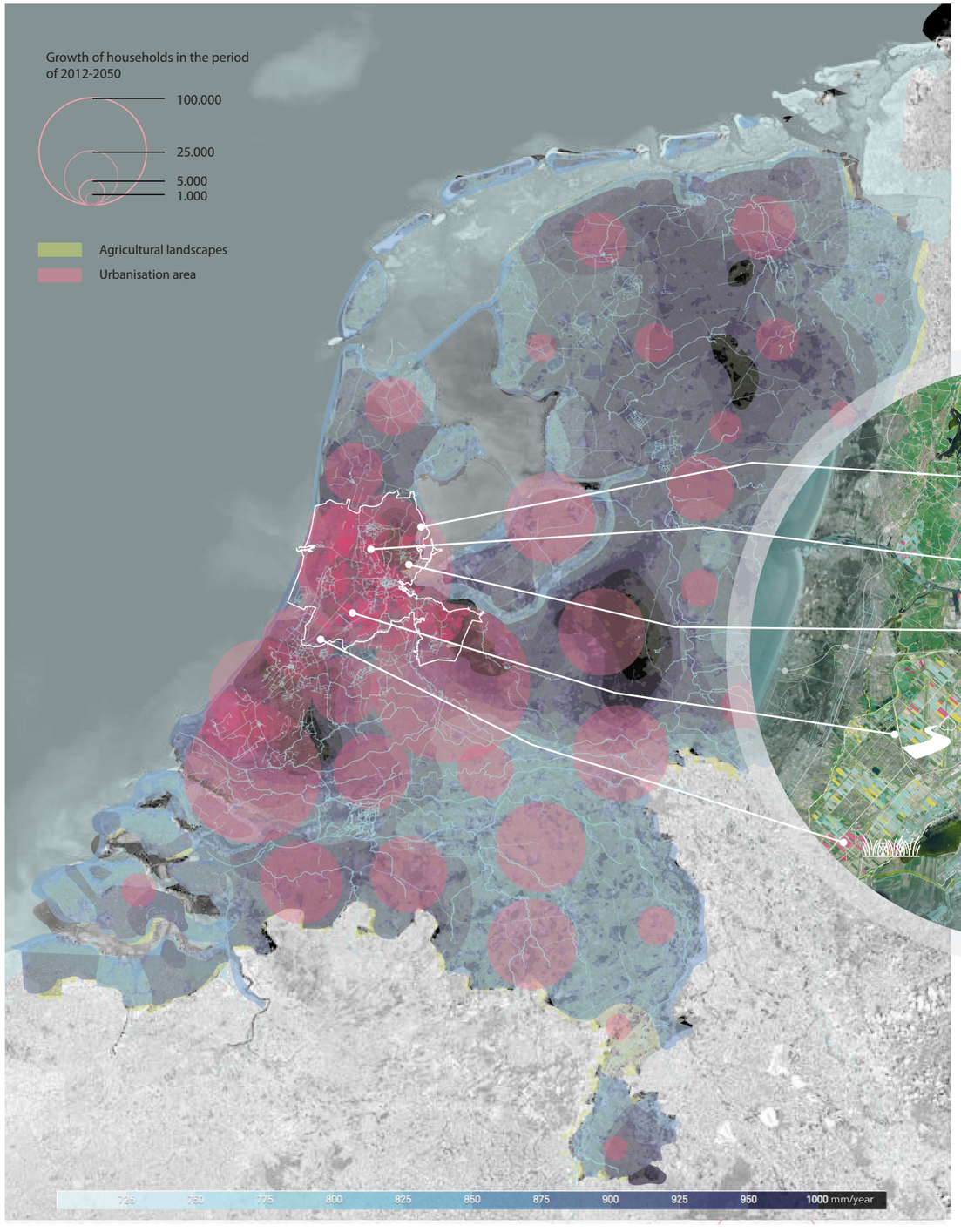
BEEMSTER LANDSCAPE

WATERLAND LANDSCAPE

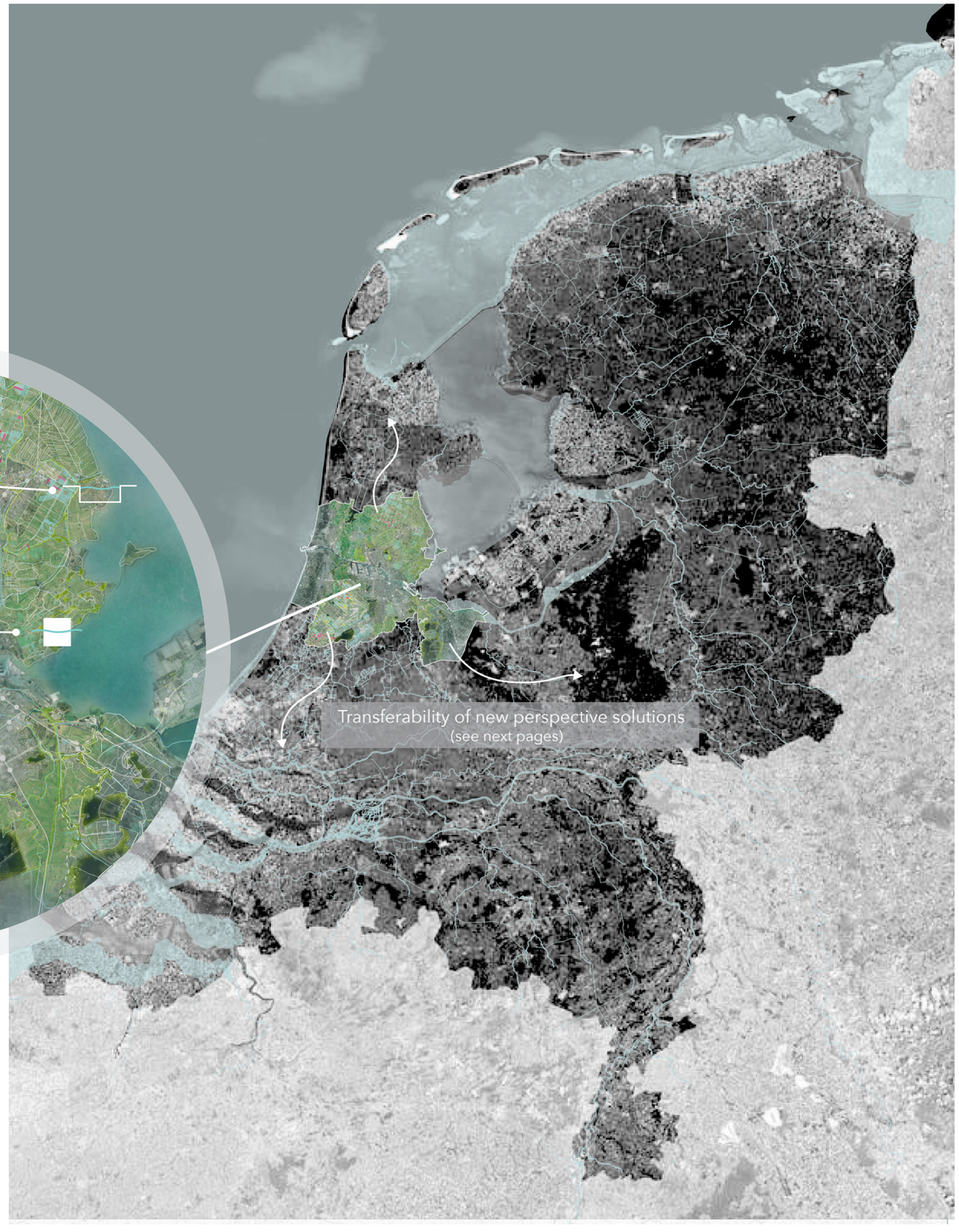
HAARLEMMERMEER LANDSCAPE

NEW PERSPECTIVE ON THE [FOOD] LANDSCAPES IN 2050

NEW PERSPECTIVE ON THE [FOOD] LANDSCAPES & TRENDS IN 2050



Impression of the trends (climate change, agricultural transition & urbanisation) that are concentrated in the metropolitan region of Amsterdam in 2050



Impression of the new perspective on [food] landscapes in the Netherlands to solve the problems in the landscapes of the region that arise from the trends towards 2050.

THE CONCLUSION

GENERAL CONCLUSIONS IN THE GRADUATION REPORT

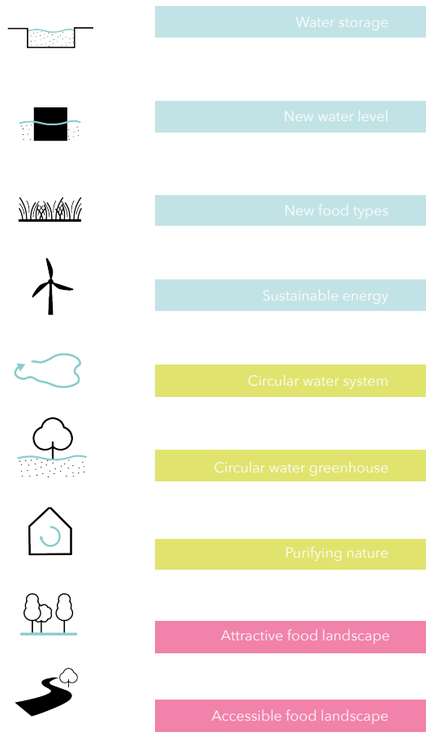
The main purpose of this graduation report is to research & design the transition of the agricultural landscapes in the metropolitan region of Amsterdam, to create resilient & attractive [food] landscapes in 2050. These new [food] landscapes are able to resolve the problems that will arise towards 2050 , as uncertainty in the food production caused by climate change, the depletion of the ecosystem in the landscapes by water pollution and the shortage in recreational landscapes as a result of the ongoing urbanisation trend towards 2050.

To research & design this transition of the agricultural landscapes towards 2050, the following research question was developed: ''How to design a new perspective for the metropolitan region of Amsterdam in 2050, to create a food landscape that is resilient to the variable freshwater flows by climate change, to restore the ecosystem of the landscapes and create opportunities for new activities to start in the landscapes that will strenghten the connection between cities and landscapes, for an attractive & resilient region?''

To give an answer to this research question and create solutions for the problems theme's in synergy, a new method is used in this graduation report. This method continous on the maximization method, by expanding the method with different scenario's for the new perspective on the [food] landscapes in 2050 (see next page). Furthermore, the maximization method is used as a basis for the layout in the graduation report to show the solutions for the problems in the landscapes of the region in connection. It gives a clear overview of the potential in the combinations of solutions (in the optimization phase) and illustrates the added value of the synergy between solutions of different themes/sectors (in the integration phase). In this way, the graduation report has revealed the potential for the transition of the agricultural landscapes in the metropolitan region of Amsterdam towards 2050.

Because the predictions for the challenges in the future come with uncertainties, the maximization method in combination with different scenario's is selected to develop a new perspective on the [food] landscapes in the metropolitan region of Amsterdam in 2050. In this way, the solutions in the report are still usefull if the predictions change, by designing the solutions seperately in the maximization phase. The first part of the graduation report thus gives an overview of solutions, that could still be used if the predictions in the trends change.

The solutions that are created for the landscapes in the region are:



The solutions in blue create a resilient food landscape to the variable freshwater flows by climate change (SQ1). The solutions in green restore the ecosystem in the landscape by purifying the water (SQ2) and the solutions in pink create opportunities for new activities to start in the landscapes that will strenghten the connection between cities and landscapes (SQ3 & 4).

In the next step, the potential combinations of the solutions are researched in the optimization phase. The combinations of solutions that have the most potential are the three solutions for a purifying agriculture landscape (circular watersystem, purifying nature & circular greenhouses) and the waterstorage & new food types solutions from the climate adaptation landscape. The solutions of new new water level, sustainable energy, attractive and accessible landscape are less well combined. With these results the scenario's for the transition of the agricultural landcapes in the region are created (climate adaptation, purifying agriculture & recreational [food] landscapes). The purifying agriculture scenario is chosen in the interviews with differents sectors at the Province of Noord-Holland as the basis for the new perspective on the [food] landscapes in 2050 (SQ6).

In the final part of the graduation report, the solutions are designed in synergy in the region. The new perspective is an example of the integrative solutions in a regional food landscape. The focus in the new perspective is on the solutions for a purifying food landscape as the basis structure in the region. This is combined with solutions for climate adaptation where possible. And at specific locations in the region (with a recreational landscape shortage towards 2050) the new food landscapes are combined with solutions for a recreational [food] landscape. In this way, a new perspective on the [food] landscapes in the metropolitan region of Amsterdam in 2050 is created. Not only in a spatial way with the new map of the agricultural landscapes in the region, but also as a new insight on how to do research & design the transition in these landscapes towards an uncertain future (with the method used in the graduation report).

The pilot projects are an elaboration on the new perspective, as in these projects the difference in solutions of the veenweide & droogmakerijen landscapes in the region becomes clear. See for the conclusions on this topic the next page.

'' In this way, a new perspective on the [food] landscapes in the metropolitan region of Amsterdam in 2050 is created. Not only in a spatial way with the new map of the agricultural landscapes in the region, but also as a new insight on how to do research & design the transition in these landscapes towards an uncertain future ''

LANDSCAPE SPECIFIC CONCLUSIONS IN THE GRADUATION REPORT

The regional future perspective in 2050 gives the solutions in the landscapes of the region. However, the pilot projects give a more detailled overview of the differences in the solutions between these landscapes of the veenweide (peat landscapes) & droogmakerijen (polder landscapes).

One of the most important differences between the solutions in these landscapes, is based on the existing waterstructure in the landscapes and the type of soil. In the droogmakerijen the straight lines of waterways in the polder, that is often 4 - 7 m below N.A.P., are connected to the boezem around the polder. And the water will be pumped in and out of the polder by windmills or pumping stations. In this way the amount of freshwater in the food landscapes of the polder is regulated. The solution for the variability in freshwater by climate change towards 2050, is in these landscapes to create more waterstorage to prevent drought and waterproblems in the landscape. This solution is only possible because of the existing watersystem in these landscapes.

In the veenweide landscapes one of the solutions is to create a higher water level in the food landscapes, to prevent further soil subsidence. In this case, the solution depends on the unique watersystem and soil type in the landscape. The solution of a new water level is therefore, only possible in the veenweide landscapes.

The other solutions of new food types, sustainable energy, circular greenhouses, attractive & accessible landscapes are not depending on the specific landscape types in the region. The solution of a circular & purifying watersystem depends on the existing waterstructure in the landscapes, but is applicable in most of the landscapes in the region and in the Netherlands.

See also the transferability matrix of solutions in the reflection chapter.

Trends towards 2050 in the Netherlands

Problem analysis: impact of the trends on the agricultural lands-capes in 2050

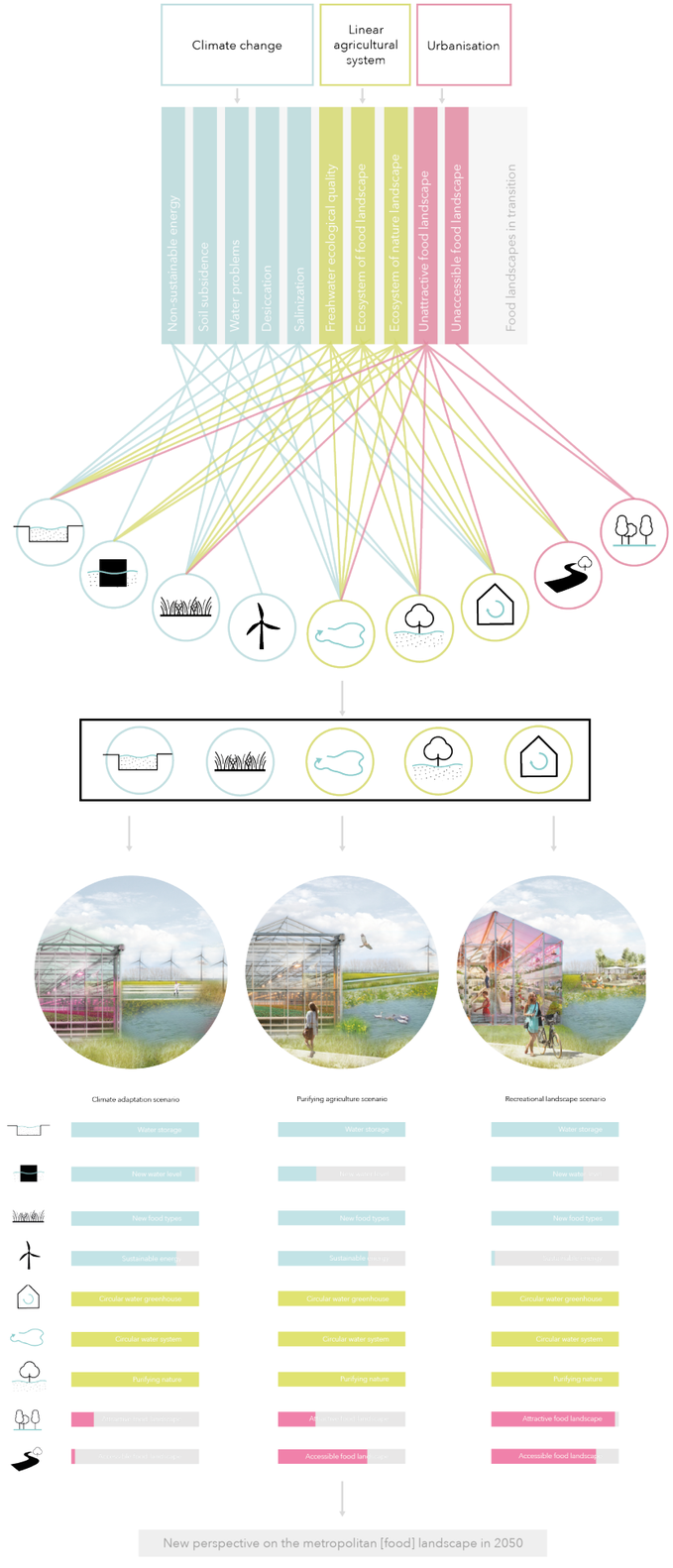
Maximization method

Phase 1: maximizing solutions

Phase 2: optimizing solutions in combinations

Phase 3: integrating solutions based on optimalisation phase : 3 scena-rio's for the [food] landscapes in 2050

Solution: integrating the solutions based on the scenario's & interviews & aims of the project: Regional future perspec-tive in 2050



THE REFLECTION

EVALUATION OF THE RESEARCH & DESIGN

In the research & design of this graduation project three problems are analysed that form the basis of the research. Because the focus of the research is on three problems in the region instead of one, the analysis of these problems and solutions will go less into depth (with the timeframe of the graduation project). However, the combination of research on these problems has created integrative solutions with more value because it resolves multiple problems in one. Furthermore the integrative solutions could result in lower costs and a higher feasibility of the project, because there is a higher interest of actors in the problems. In this way it is contributing to the societal relevance and corresponds to the idea of the Fusie van Belangen of Prof. Anke van Hal (2014).

The research design is based on predictions of the trends and problems towards 2050 in the Netherlands (predictive research). If the reality of the development of these trends turns out differently, then a reflection needs to be given on the regional perspective and design to see which elements of these can still be implemented in the landscapes of the region. Therefore the maximization method is used as an outline in this report and the solutions that are given in the maximization phase, as well as the most potential combinations of solutions in the optimization phase can still be used with new predictions of the trends in the future. A different scenario with focus on one of the three theme's can be chosen and developed into a new regional perspective in 2050. Although there is some uncertainty in the development of the trends towards the future, it is usefull to already start with the research on the problems in the agricultural landscapes towards 2050, to gain more knowledge about this (scientifical relevance) and be able to implement the solutions in time before the problems start to become larger (societal relevance).

The new perspective on the [food] landscapes in the metropolitan region of Amsterdam is created from an urbanism perspective on the topics of water, food and recreational landscapes. This also explains the integrative research design, as it is part of the field of Urbanism.

If this research was done by a researcher from the field of water management or agriculture, there might be very different outcomes. In the process of the research, these different sectors were taken into account where possible, in order to gain the expertise knowledge and opinion in the regional perspective by interviews.

Furthermore the research is mostly designed from a positivistic research philosophy. This is visible in the research on the freshwater & polluted water flows in the food production landscapes that are based on quantitative research. With the research on the attractiveness and accesibility of these landscapes a more phenomenological research approach is adopted that looks at the qualitative characteristics of the landscapes. Most of the data that was needed for the research could be found (after contact with the specific actors or in GIS). The only missing data in the graduation report is about the 'peilvakken' in the water board of Amstel, Gooi and Vecht. This was however, not a large problem because this is precisely the location in the landscapes where there are not large water & drought problems.

CHANGING THE VARIABLES OF THE GRADUATION PROJECT

The graduation project is researched & designed with specific variables. What would happen if these variables would change in the project and what is the impact of this on the results?

- *Wh-climate scenario in 2050*. This is the most extreme scenario that gives predictions for climate change towards 2050. In the case of a climate scenario that is less extreme, the problems in the food landscapes of the region will be less urgent (waterproblems, drought, salinization). Therefore the focus on the climate solutions in the research & scenario's will be reduced. This will result in a new perspective that creates especially a purifying food landscape towards 2050.

- *Time perspective towards 2050*. The time perspective towards 2050 was taken as a starting point in the research & design since most of the predictions are created towards this year. If the time perspective is shorter, the solutions of waterstorage, sustainable energy, circular greenhouses and a recreational network are the most feasible in time. When the time perspective is set to on a longer term, the solutions in the new perspective in 2050 could be even more in the landscapes and transfered to other regions in the Netherlands.

TRANSFERABILITY OF THE SOLUTIONS IN THE GRADUATION PROJECT

In this graduation project, solutions are created for the three problem theme's that are concentrated in the metropolitan region of Amsterdam. According to the transferability matrix on the next page the solution of waterstorage and a new water level are very specific for the landscape types of veenweide & droogmakerijen in the region. The new food types and a purifying circular watersystem however, could be used as solution in the landscapes of the Netherlands. The solutions of sustainable energy and circular greenhouses, are not depending on the landscapes and therefore this solution could be up-scaled to other regions in Europe. The solutions of an attractive & accessible landscape are very reliant on the location of the metropolitan region. Since the high population density and the short distances between the food landscapes and cities in these regions (in the case of the Netherlands), creates the basic conditions for attractive activities that could be realised in the food landscapes and a sustainble recreational network (with high intensity use) between the cities and [food] landscapes.

CONNECTING THE GRADUATION PROJECT TO PRACTISE

The graduation project connects to the National environmental vision & the new environmental vision of the province of Noord-Holland (2018), by taking the aims of these documents, as a starting point for the research & design in the project. These are aims at the larger scale, that are translated to the scale of the metropolitan region by creating a new perspective on the food landscapes & pilot projects. The graduation project at the same time is an example of how to research & design with these aims for the future of the landscapes in the region (by using the maximization method).

By doing interviews with actors at the province of Noord-Holland, the opinions of these actors on the graduation project and its solutions could be tested. The actors were enthusiastic about the spatial translation of the aims of the environmental vision into a design of the food landscapes (with the different scenario's). There is even interest in the sector of agriculture to use the impressions as an example of the transition of the agricultural landscapes. And interest of farmers in the region to test the solutions in the pilot projects.

In the graduation project the sectors of water, food, nature and recreation are combined. This asks for a new collaboration between the sectors in the government and practise. The graduation thesis is an example of how to create integrative solutions, and how to make this process transparent and therefore usefull in any uncertain future situation (with the maximization method). My experience from the internship in practise is however, that the preverence is to find the solutions and not to create a method and translate this into solutions. From an academical perspective however, this has more value because in this way new solutions could be created for the location with the same method and more knowledge on how to design for transitions of landscapes with a lot of uncertainty towards the future is generated.

CONNECTING THE GRADUATION PROJECT TO URBAN METABOLISM

In the project the themes of water, food, energy, biodiversity and people are researched to find a synergy between the solutions of these different themes. This also concerns the flows of the various themes, even though this has not been the focus of research into the graduation project. Particular attention was paid to spatially combining the various solutions. This leads to a multifunctional landscape with different themes of solutions and therefore also to smaller distances of the flows on a larger scale. E.g. Water storage ensures that the water in the landscape is retained and provides an attractive recreational landscape in the neighborhood, which means that people have to travel less for recreation. Short distances mean shorter flows, and therefore also an optimization and synergy between them.

Furthermore, the agricultural landscape is seen as something that consists of systems (of water flows, food production, energy, people etc.) and that can be optimized in the future by looking at the synergy of solutions. This way of thinking corresponds to the concept of Urban Metabolism.

TRANSFERABILITY OF THE SOLUTIONS

	Veenweide landscapes	Droogmakerij landscapes	Regional landscapes	The Netherlands	Europe	Metropolitan region
Water storage						
Waterstorage (flexibel peilbeheer) in 'grote drooglegging peilvakken'		Unique waterstructure				
Waterstorage in wider waterways (natuurvriendelijke oevers)						
New water level						
Landscape with a low water level (dry grassland)	Unique waterstructure & peat landscape					
Landscape with a higher water level (wet grassland/crops)						
Landscape with a high water level to prevent soil subsidence (water)						
New food types						
Resilient to dry conditions (koolzaad, artisjok & druif)				New food types: depending on the climate & freshwater conditions		
Resilient to wet conditions (wild rice, duck-potato, veenbes & cranberry or purifying nature: lisdodde, kroosvaren, veenmos, olifantsgrass, wilg & riet)						
Resilient to salt conditions (salt potatoes, gerst, koolzaad, zeekraal & lamsoor or purifying nature: riet, zonnebloem & lelie)						
Sustainable energy						
Wind-energy in food landscape or waterlandscape					Not depending on the landscape: only in location of these solutions	
Solar energy in waterlandscape						
Solar energy glass in greenhouses						
Circular water greenhouse						
Greenhouses: purifying the freshwater with helofytes in the landscape					Not depending on the landscapes, optimal combination with circular watersystem	
Greenhouses: recyling the freshwater with cleaning tanks						
Circular water system						
Circular watersystem in the landscape by connecting waterways				Unique waterstructure & climate for purifying nature in the watersystem		
Purifying watersystem in the landscape by adding new waterways						
Waterstorage in the landscape as a buffer (polder disconnected from boezem to improve the freshwater quality)						
Purifying nature						
Purifying nature in the watersystem (see plants in solution chapter)				Depending on the climate		
Purifying nature in the watersystem: veenaangroei gebieden	Unique peat landscape					
Attractive food landscape						
Recreational structures/elements in the landscape			Characteristics of the region			
Recreational activities in the landscape				Depending on dutch landscape		Visitors of the food landscape
Accessible food landscape						
Recreational waterroutes for boats						
Regional walking & cycling routes				Short distances between landscapes		High intensity use of the network
Railway & stations						

RECOMMENDATIONS

RELEVANCE (SCIENTIFIC & SOCIETAL)

The relevance of this research & design is important for the scientifical knowlegde and society. This project is a bridge between both, because it increases the general scientifical knowledge about food landscapes with new challenges as climate change, water pollution and urbanisation in the metropolitan region. Furthermore the aim of this graduation project is to inspire actors at the government (the province of Noord-Holland, the municipalities in the metropolitan region and the ministry in the Netherlands) to integrate different problems and solutions towards 2050 and work together with different sectors to esthablish the aims of the new regional perspective. In this way the end result will hopefully have a positive impact on the living environment of the people in the in the metropolitan region of Amsterdam and inspire actors at the govenment to work in a new way to create integrative solutions for problems in the future.

Furthermore more general lessons could be learned from the development of the regional perspective on food landscapes in 2050 (as the new method that is used for the research & design), that could also be applied to other metropolitan landscapes in Europe or even around the world. In this way the project is not only contributing to the scientifical knowledge, but could also is an inspiration to improve the living environment in other metropolitan regions as part of societal relevance.

ETHICAL ISSUES

The graduation project is created for the Netherlands, a country in the world that is already developed. It could be mentioned that the project should better focus on other parts of the world where the problems caused by climate change and urbanisation are larger (e.g. in Bangladesh). Nevertheless, it is important to work towards solutions for the problems in the Netherlands too, because as a pioneer in innovation and resilience the Netherlands could function as an inspiration for other countries in the world. At the same time by doing an internship in the Netherlands at a governmental organisation (the Province of Noord-Holland) and closely working together with the actors that make decisions about the policies for the implementation of solutions, I hope this graduation project could help in practice to work towards a more attractive and resilient metropolitan landscape of Amsterdam in 2050.

Furthermore it is not possible to speak to all of the actors involved in the regional strategy, because of the time limit of the graduation project. Therefore only the most important actors in the project are interviewed: the Province of Noord-Holland, as the target group of the graduation project, they are able to use the new perspective towards 2050 and the farmers in the region (FoodCouncil MRA), because they are the owners of the landscapes and making the transition of these landscapes towards 2050 possible.

RECOMMENDATIONS

In the research & design of the graduation project several lessions are learned that could be given as recommendations for practise or further research.

Recommendations for practise:

It would be interesting to use the new research method for an integrated design that takes into account the uncertainties in the future (the maximixation method with scenarios) in practise. In this way, the design method can be further developed by the experiences in practise during the process of working with it. Furthermore, it becomes possible to compare the design results of the projects in practise that are created before, with the projects that are using this new method.

Another recommendation is to see if it is possible to realise one of the pilot projects in this report in practise. In this way, the synergy between the solutions in the pilot projects could be tested on a farm and new knowledge on the solutions for a resilient & attractive [food] landscape in 2050 is created. It is recommended to start with the small scale solutions in a farm landscape (circular greenhouses, purifying nature etc.). Later on, solutions to improve the systems on a regional scale could be introduced (a circular watersystem).

Recommendations for further research:

In this graduation report an overview is given of the transferability of the solutions in the new perspective in the metropolitan region of Amsterdam. Further research is needed to create more detailled knowledge about the transferability of these solutions, and create resilient & attractive [food] landscapes in other regions too. The solutions could be tested in other locations than the metropolitan region of Amsterdam, starting with the landscapes in other regions of the Netherlands (because of the same climate conditions, scale, and regional systems).

Subsequently, the solutions could be studied in other metropolitan regions in Europe. In this way, the concept for a new perspective on the [food] landscapes could be used in a broader context than the metropolitan region of Amsterdam.

Furthermore, an additional research to this graduation thesis could be to give an overview of the transition of the [food] landscapes towards 2050 in time. By creating a time line and illustrate the transition in the landscapes of the region, it becomes clear when solutions need to be introduced and decisions need to be taken by stakeholders. Because of the scope and timeframe for the graduation, this is not included in the report.

Another option for additional research is to design the landscapes in the pilot projects of the Zaanstreek and the Beemster. The principles for the solutions in these landscapes are described in the report. However, with illustrations and impressions of the solutions in the unique landscapes of the region inspiration for the transition of these landscapes could be given.

GLOSSARY I

Metropolitan region of Amsterdam (MRA) - Metropoolregio van Amsterdam. An administrative partnership between municipalities in the Province of Noord-Holland and spatially the regional food landscape surrounding the city of Amsterdam (definition used in this graduation report)

Climate change - Klimaatverandering. In this graduation report the focus lies on the climate change effects of longer periods of drought and extreme rainfall that have an impact on the freshwater variability in the agricultural landscapes of the region and therefore the uncertainty in food production.

Urbanisation - Verstedelijking. The trend of growing cities (in density) towards 2050 in the region.

Agricultural landscapes - Agrarische landschappen. Landscapes in the region where food is produced (e.g. greenhouses, meadows, agriculture).

Peat landscape - Veenweide landschap. An unique small scale landscape in the region with a soil type that consists of peat and results in more wet conditions in the landscape.

Polder landscape - Droogmakerij landschap. An unique large scale polder landscape in the region with a high depth below sea level and waterlevel that is regulated by pumping water in and out the polder.

Linear food production system - Linear voedselproductie systeem. A non-sustainable food production system where flows are not re-used or recycled and a lot of waste flows are created (e.g. waste water).

Resilient - Veerkrachtig. The ability of a system or landscape to maintain it's balance and function and not be disrupted by the occurence of an event (e.g. climate change, urbanisation etc.)

Ecosystem - Ecosysteem. The natural system of living organisms and the environment. These are linked together through nutrient cycles.

Regional future perspective - Regionaal toekomstbeeld. A new perspective on the [food] landscapes on a regional scale.

Fresh water - Zoetwater. Water in the agricultural landscapes of the Netherlands that is naturally sweet.

Soil subsidence - Bodemdaling. The ongoing process of creating a lower waterlevel in the peat landscapes for food production and the oxidation process (with CO2) of the soil. Resulting in a landscape that becomes even more below sealevel.

Water problems - Wateroverlast. Periods of extreme weather and rainfall as a result of climate change, create wetter conditions in the agricultural landscapes and with that harvest loss.

Desiccation - Verdroging. Periods of drought as a result of climate change, create dry conditions in the agricultural landscapes and with that harvest loss.

Salinization - Verzilting. The process of salt water coming into the agricultural landscapes by seepage flows under the surface. This creates new basis conditions in the landscapes.

Nitrogen - Stikstof. An inorganical chemical that is used as a fertilizer in the agricultural landscapes to increase the food production and creates a disbalance in the ecosystem of the landscape (too much nutrients).

Phosphate - Fosfaat. An inorganic chemical that is used as a fertilizer in the agricultural landscapes to increase the food production and creates a disbalance in the ecosystem of the landscape (too much nutrients).

Maximization method - Maximalisatie methode. A research method used throughout the graduation report, consisting of the maximization, optimization & integration phases for finding a synergy in solutions of different theme's.

Waterstorage - Waterberging. Temporary or permanent storage of freshwater in the agricultural landscapes, to create a buffer for the variability in freshwater as a result of climate change towards 2050.

New water level - Nieuw waterpeil. Different types of new waterlevels are introduced in the peat landscapes to prevent further soil subsidence. This waterlevel is maintained in the landscape and unique in the Netherlands.

Wet food types. Natte teelt. New types of food that are resilient to the wet conditions in the agricultural landscapes.

Dry food types. Droogte teelt. New types of food that are resilient to the dry & warm conditions in the agricultural landscapes.

Salt food types - Zilte teelt. New types of food that are resilient to the salt conditions in the agricultural landscapes.

Economical resilient - Economische veerkrachtigheid. The possibility to maintain a secure income for the farmers in the future, by combing new activities in the landscape (sustainable energy, recreation) with food production.

Sustainable energy - Duurzame energie. Energy production that is not resulting in CO2 emissions (e.g. solar and wind energy).

Circular watersystem - Circulair watersysteem. A watersystem that has connected waterways to enable the freshwater in the landscapes to circulate and improve the waterquality.

Purifying nature - Zuiverende natuur. Types of plants that could be introduced in the watersystem of landscape to purify it, by absorbing the expletive nutrients.

Ecological structure - Ecologische structuur. A large scale structure of nature landscapes that are connected, and therefore enhance the ecosystem & biodiversity in the landscapes.

Greenhouses - Kassen/tuinbouw. Glasshouses that make it possible to produce all sorts of food during the year.

Helofytes filter - Helofytenfilter. A special combination of plants and soil & water, to purify the waste water from (green)houses.

Sustainable recreational network - Duurzaam recreatief netwerk. A combination of walking, cycling and sailing routes together with a public transport network, to connect the new [food] landscapes and cities in the region.

Maximization phase - Maximalisatie fase. The first phase of the maximization method where the solutions of different theme's are researched separately en maximized.

Optimization phase - Optimalisatie fase. The second phase of the maximization method where the solutions of different theme's are overlayed and the most potential combinations of solutions are found.

Integration phase - Integratie fase. The last phase of the maximization method where based on the optimization phase, the most potential combinations of solutions are integrated.

Scenario - Scenario. A potential future for the transition of the agricultural landscapes in the region in 2050.

Climate adaptation scenario - Klimaatadaptatie scenario. The scenario with a focus on the solutions for a climate resilient [food] landscapes in 2050.

Purifying agriculture scenario - Zuiverende landbouw scenario. The scenario with a focus on the solutions for a purifying watersystem and improved ecosystem in the [food] landscapes in 2050.

Recreational landscape scenario - Recreatief landschap scenario. The scenarop with a focus on the solutions for an attractive & accesible recreational [food] landscape in 2050.

New perspective on the [food] landscapes in 2050 - Nieuw toekomst perspectief voor de voedsellandschappen in 2050. The final solution of the transition of the agricultural landscapes in 2050, with the integration of the solutions of different theme's.

Pilot projects - Proef projecten. Example projects of the transition of the [food] landscapes on a smaller scale.

Transferability - Transporteerbaarheid. The possibility to use one of the solutions in this report on other scales or locations (see diagram on p. 400)

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OVERVIEW OF THE RESULTS FROM THE INTERVIEWS

= positive about the solution = neutral about the solution = negative about the solution

Water storage

- Waterstorage (flexibel peilbeheer) in 'grote drooglegging peilvakken'
- Waterstorage in wider waterways (natuurvriendelijke oevers)

New water level

- Landscape with a low water level (dry grassland)
- Landscape with a higher water level (wet grassland/crops)
- Landscape with a high water level to prevent soil subsidence (water)

New food types

- Resilient to dry conditions (koolzaad, artisjok & druif)
- Resilient to wet conditions (wild rice, duck-potato, veenbes & cranberry or purifying nature: lisdodde, kroosvaren, veenmos, olifantsgrass, wilg & riet)
- Resilient to salt conditions (salt potatoes, gerst, koolzaad, zeekraal & lamsoor or purifying nature: riet, zonnebloem & lelie)

Sustainable energy

- Wind-energy in food landscape or waterlandscape
- Solar energy in food landscape or in waterlandscape
- Solar energy glass in greenhouses

Circular water greenhouse

- Greenhouses: purifying the freshwater with helofytes in the landscape
- Greenhouses: recyling the freshwater with cleaning tanks

Circular water system

- Circular watersystem in the landscape by connecting waterways
- Purifying watersystem in the landscape by adding new waterways
- Waterstorage in the landscape as a buffer (polder disconnected from boezem to improve the freshwater quality)

Purifying nature

- Purifying nature in the watersystem (see plants in solution chapter)
- Purifying nature in the watersystem: veenaangroei gebieden

Attractive food landscape

- Recreational nature landscape
- Dining in the food landscape
- Care farm
- Pick up food at the farm
- Picking your own food
- Sleeping at the farm

Accessible food landscape

- Recreational waterroutes for boats
- Regional cycling routes
- Railway & stations

OVERVIEW OF THE DETAILLED OPTIMIZATION SCHEME OF THE SOLUTIONS

v = positive combination x = negative combination

n = neutral combination - = impossible combination

	Water storage		New water level				New food types				Sustainable energy				Circular water greenhouse			Circular water system				Purifying nature			Attractive food landscape			Accessible food landscape			
Water storage																															
Waterstorage (flexibel peilbeheer) in 'grote drooglegging peilvakken'		-																													
Waterstorage in wider waterways (natuurvriendelijke oevers)		v	-																												
New water level																															
Landscape with a low water level (dry grassland)		-	-		-																										
Landscape with a higher water level (wet grassland/crops)		-	-		-	-																									
Landscape with a high water level to prevent soil subsidence (water)		-	-		-	-	-																								
New food types																															
Resilient to dry conditions (koolzaad, artisjok & druif)		n	n		v	-	-	-																							
Resilient to wet conditions (wild rice, duck-potato, veenbes & cranberry or purifying nature: lisdodde, kroosvaren, veenmos, olifantsgrass, wilg & riet)		v	v		-	v	v	-	-																					
Resilient to salt conditions (salt potatoes, gerst, koolzaad, zeekraal & lamsoor or purifying nature: riet, zonnebloem & lelie)		v	v		-	-	-	-	-	-																					
Sustainable energy																															
Wind-energy in food landscape or waterlandscape		v	x		v	v	v	n	n	n		-																			
Solar energy in food landscape or in waterlandscape		v	x		v	x	x	n	n	n		n	-																		
Solar energy glass in greenhouses		v	v		v	v	v	n	n	n		n	v	-																	
Circular water greenhouse																															
Greenhouses: purifying the freshwater with helofytes in the landscape		v	v		v	v	v	v	v	v		n	x	v		-															
Greenhouses: recyling the freshwater with cleaning tanks		v	n		-	-	-	v	v	v		n	x	v		n	-														
Circular water system																															
Circular watersystem in the landscape by connecting waterways		v	v		v	v	n	v	v	v		v	n	n		v	v		-												
Purifying watersystem in the landscape by adding new waterways		v	v		v	v	v	v	v	v		v	x	n		v	v		v	-										
Waterstorage in the landscape as a buffer (polder disconnected from boezem to improve the freshwater quality)		v	v		v	v	v	v	v	v		v	v	n		v	v		v	v	-									
Purifying nature																															
Purifying nature in the watersystem (see plants in solution chapter)		v	v		v	v	v	v	v	v		x	x	n		v	v		v	v	v		-							
Purifying nature in the watersystem: veenaangroei gebieden		-	n		-	-	v	n	n	n		x	x	n		v	v		n	n	x		n	-						
Attractive food landscape																															
Recreational structures/elements in the landscape		v	v		v	v	v	n	n	n		x	x	n		v	n		v	v	v		v	v		-				
Recreational activities in the landscape		v	v		v	v	v	v	v	v		x	x	v		v	v		v	v	v		v	v		-	-			
Accessible food landscape																															
Recreational waterroutes for boats		v	v		v	v	v	v	v	v		x	x	n		v	v		v	v	v		v	x		v	v		-	
Regional walking & cycling routes		v	v		v	v	v	v	v	v		x	x	n		v	n		v	v	v		v	v		v	v		v	-
Railway & stations		n	n		v	x	x	v	v	v		n	x	n		v	n		n	v	n		v	n		v	v		x	v	-

DETAILLED OVERVIEW OF THE RESEARCH METHODS & PRODUCTS

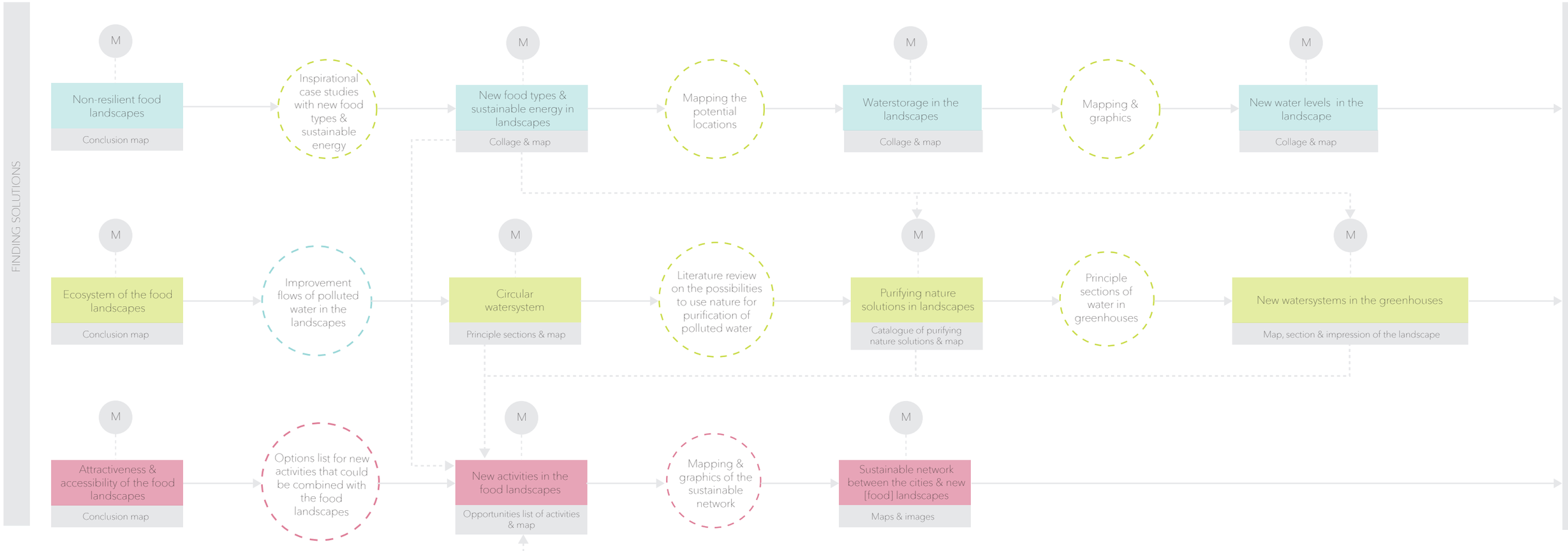
In the following diagram the research methods are visible. For each research method the input and output (products) of the research are given and in this way present the steps in the research of the graduation project. Furthermore, the scale of the research and design is visible for each step and the expected outcome that will show the research results (in grey).

This page shows the first phase of the research: the problem definition with the three main problems in the metropolitan region of Amsterdam towards 2050.

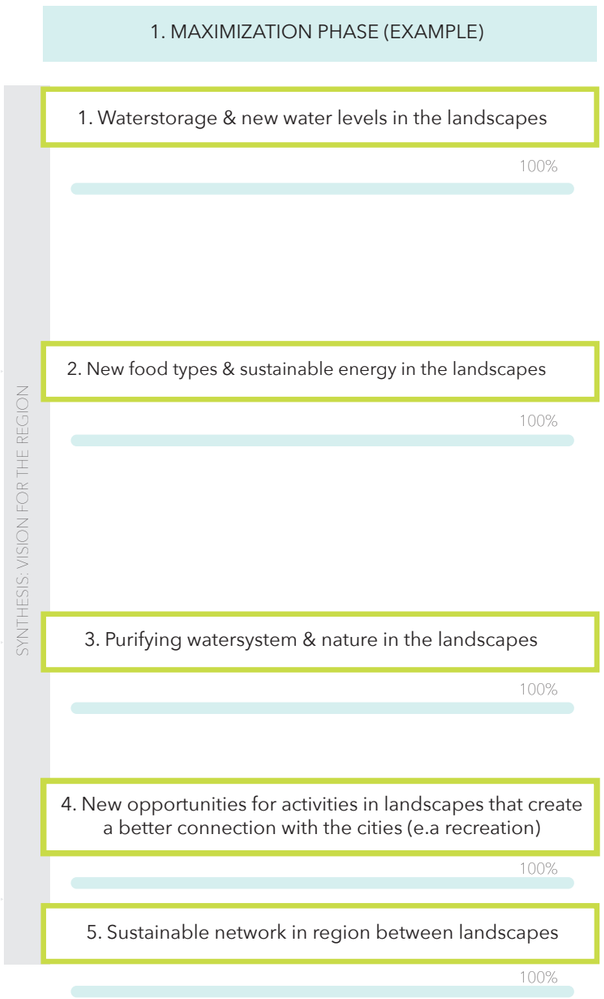
For each of the problems (blue, green & pink), a conclusion map on the scale of the region is created that combines the main problems of these topics. The conclusion maps are the final step of the problem analysis and form an input for the following phase: finding solutions.

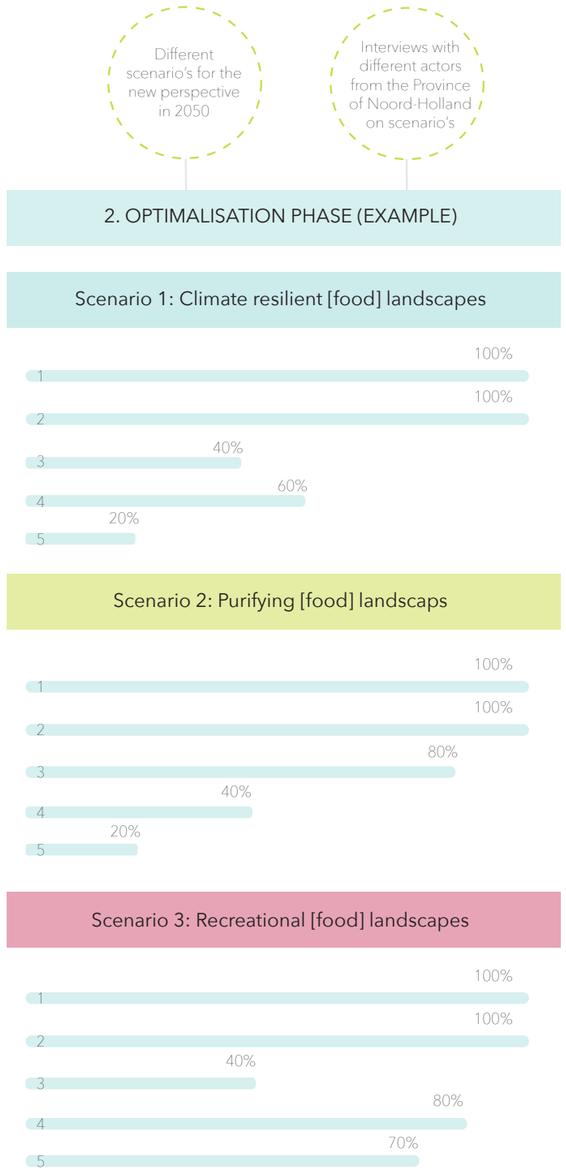


With the conclusion maps of the previous phase, new solutions for the problems in the region can be found through research & design. The steps of research to find solutions for these problems are visible in the following diagram. Each step has an impact on the next steps, and sometimes there are interconnections between the process of finding solutions for the three main problems (dotted grey lines). Together these research steps are working towards a new perspective for the metropolitan region of Amsterdam in 2050.

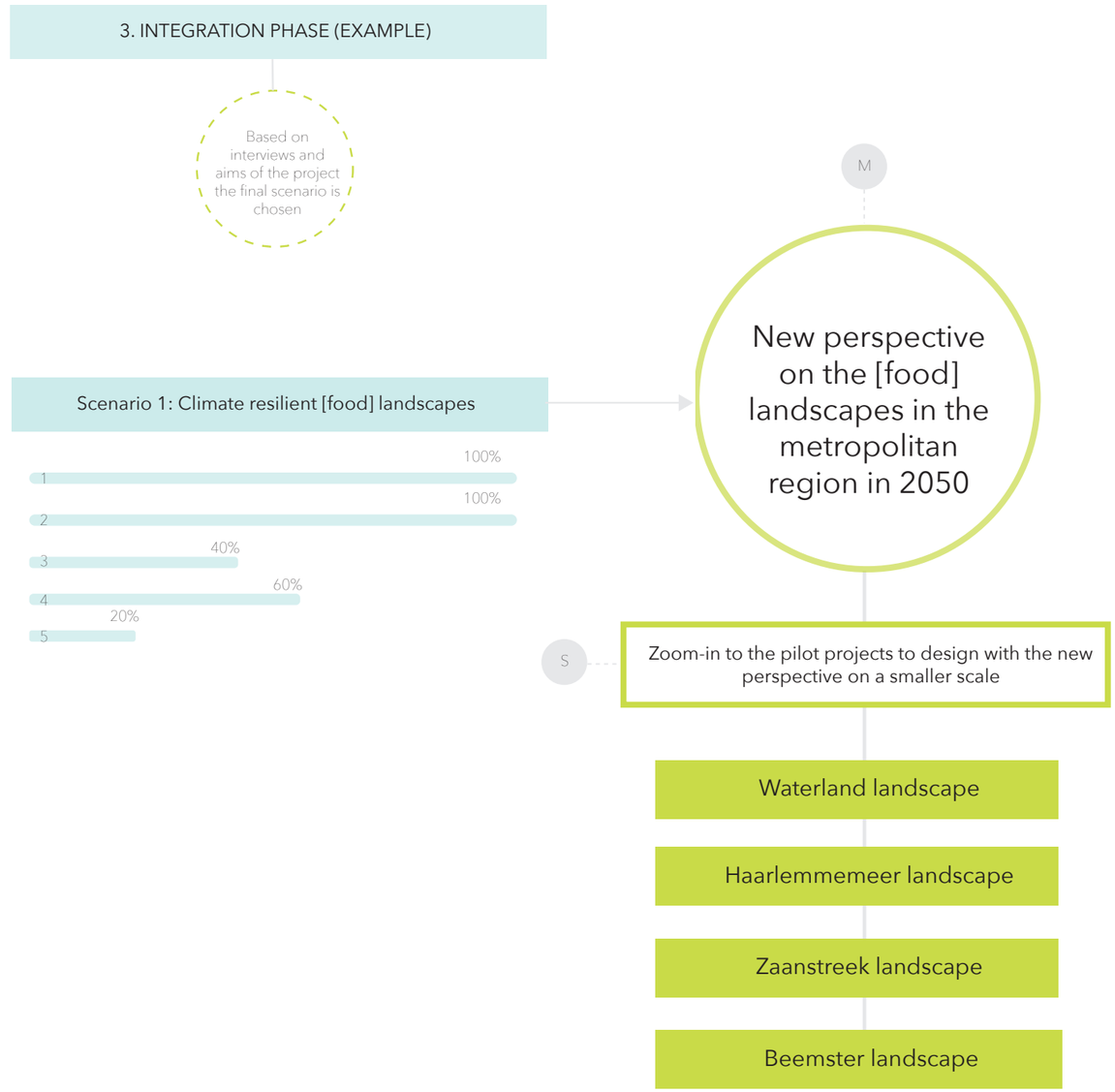


The vision for the region in 2050 is based on the previous steps of finding solutions for the problems in the region and consists of nine solutions within the three theme's. With the maximization method this vision will be translated into a new perspective on the food landscapes. The first phase of this method is the maximization phase, where all the solutions of the theme's will be maximized to 100 percent and seen apart from eachother. The next step is the optimalisation phase. where the different theme's are overlayed and it becomes clear if they can be combined or exclude eachother.





For the theme's that exclude eachother, a choice need to be made on which of these solutions is the most important for the region. Therefore different scenario's will be developed for the [food] landscapes of the region in 2050. The three scenario's of this diagram are based on the main problems in the region, and each give a different focus on the theme's in the graduation report. With these scenario's it becomes possible to do interviews with different actors in the region, to let them choose between these scenario's for the region.

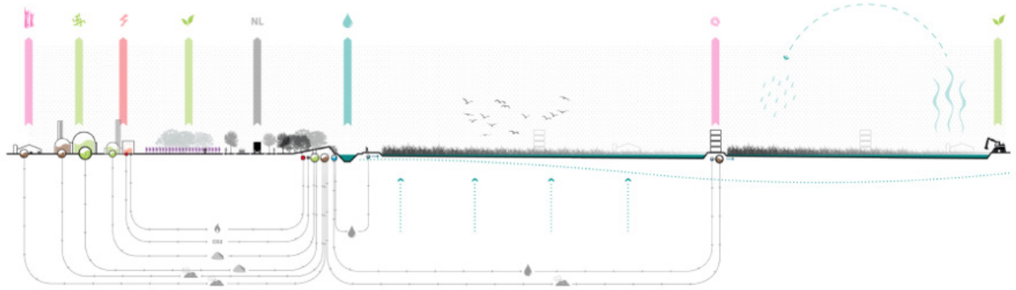


Together with the aims of the graduation project, a choice will be made for one scenario (with elements of other scenario's). This scenario in the integration phase of the maximalization method, will help to develop the new perspective for the region in 2050.

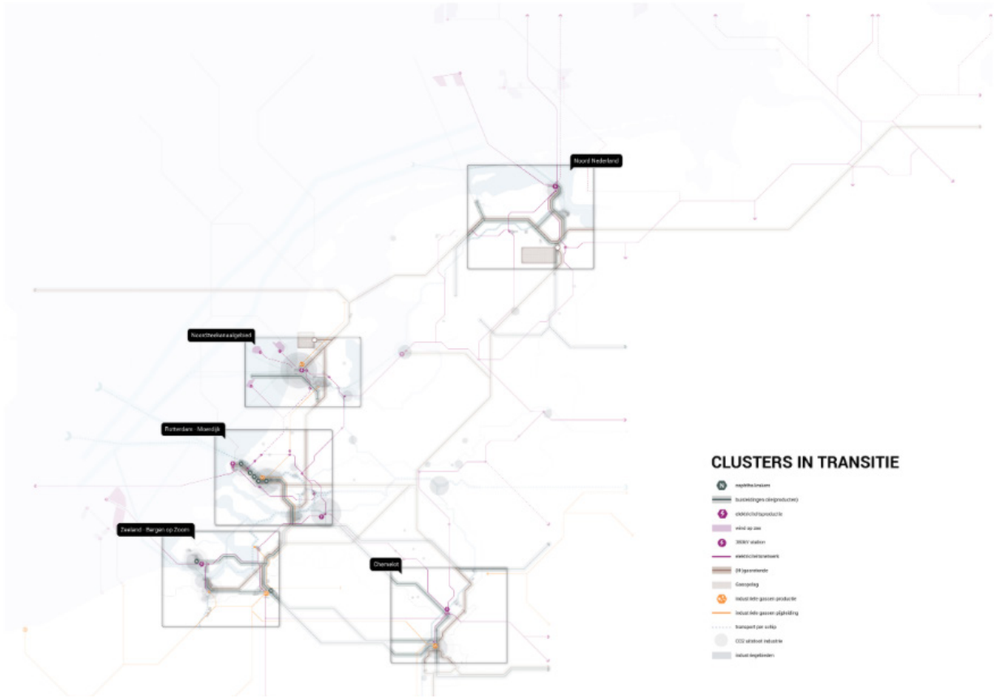
Furthermore this new perspective will be used to create a design for the pilot projects in the metropolitan region of Amsterdam, to show the impact of the new perspective on a smaller scale.

THE EXPECTED OUTCOMES

In the following images examples are given of the expected outcomes of the research and design process in the graduation report.



22. Sustainable & circular flows analysis in the region of water, food, energy & recreation (Studio Macro Vermeulen, 2018)



24. Clusters of transitional landscapes in the region for a more detailled design with the strategy (Studio Marco Vermeulen, 2018)



23. Regional strategy for new landscapes in the future (Karres + Brands, 2018)



25. Impressions of the new landscapes in the region towards the future (Studio Marco Vermeulen, 2018)

Creating [resilient] agricultural landscapes in the future

A framework for research on resilience in agricultural landscapes for environmental challenges in the Netherlands

AR3U023 Theories of Urban planning and Design
MSc Urbanism, Delft University of Technology

Anne-wil Min
4285603

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Ir. Verena Balz

Abstract

With the environmental challenges such as climate change and ecosystem depletion becoming increasingly problematic towards 2050 in the Netherlands, it becomes important to create agricultural landscapes that are resilient to these challenges for food production. However, a clear definition of this 'resilience' is not found in literature. Because of this, it is furthermore not clear how to create resilience in the agricultural landscapes in the Netherlands. The research question in this paper is therefore: "*What is the definition of a environmental resilient agricultural landscape in the Netherlands and how can a framework for research on the resilience of the landscapes be developed?*". To answer this question, the concepts of engineering, ecological and social resilience are compared. A combination of social and ecological resilience in agricultural landscapes gives the definition for a 'resilient agricultural landscape'. Based on this definition, new research approaches within the planning and design field of Urbanism will be compared. This literature study shows that three categories of research approaches can be distinguished: systems thinking, ecosystems and planning approaches. There is great potential in combining water-food-energy nexus (systems thinking) and flexible adaptation pathways (planning) approaches, to establish a research framework for environmental resilient agricultural landscapes in the Netherlands.

Key words: Resilience, agricultural landscapes, environmental challenges in the Netherlands, water-food-energy nexus, flexible adaptation pathways, framework for resilience

Introduction

Environmental challenges towards 2050 in the Netherlands such as climate change (changing conditions for food the production) and ecosystem depletion (risk for diseases and pests in food production) are making the landscape more vulnerable and creating therefore an uncertainty in food production (Ministry of infrastructure and environment, 2017, KNMI, 2014). At the same time, agricultural landscapes become more important, as the demand for food will grow due to further urbanisation and population growth in the Netherlands and the landscapes are an important factor in providing this food (Ministry of infrastructure and environment, 2017). Therefore it is important that the agricultural landscapes in the Netherlands become resilient to the environmental challenges in 2050. In the Sustainable Development Goals this is articulated as follows: "*Because agricultural systems are the primary interface between human and environmental interactions, they are likely to be our single most important source of solutions for addressing both environmental sustainability and food security" (WLE, 2016:3).* At this moment however, there is not a clear definition of the term resilience, because of the variety of definitions given in literature from different fields and therefore it is also not clear how to create this resilience of the agricultural landscapes in the Netherlands (WWF, 2016; Brand & Jax, 2007; Wardekker, 2018).

Therefore the research question in this paper is: *What is the definition of a environmental resilient agricultural landscape in the Netherlands and how can a framework for research on the resilience of the landscapes be developed?*. All of these challenges towards 2050 have an impact on the environment, as well as the economical, technical and social aspects. This paper will only focus on the environmental aspects, as these are the most important for the spatial quality of the agricultural landscapes in the future and thus for the field of Urbanism and design. Additionally, the research in this paper is focused on the agricultural landscapes in the Netherlands, because the Dutch governance system will allow necessary changes to be implemented to create the resilient landscapes of 2050. However, this paper and its findings can also be applied to other European countries, as the challenges they face are almost similar (Vereniging Deltametropool, 2018). This way, the Netherlands can serve as inspiration to other countries.

The first part of answering the research question will consist of finding a definition of the term "resilient agricultural landscapes" by literature review. Using this definition, a framework for research on ways to achieve this resilience in agriculture will be created. In order to do so, new design and research methods in the field of Urbanism will be compared and reviewed on their compatibility with the definition of resilience that has been established. With this review a framework will be developed that could be used to create a resilient landscape in the future. In the conclusion, the main research question will be answered. Finally, the limitations of this research paper and further research possibilities and recommendations will be discussed.

Resilience for environmental challenges towards 2050

To create agricultural landscapes that are resilient to the environmental challenges of the future, it is important to first of all have a clear view on the term of 'resilience'. The word "resilience" finds its origin in the natural sciences , and has later been transformed for the use in other sciences as well, such as engineering, social sciences and psychology (Kim & Lim, 2016; Meerow et al., 2016). Due to these transformations, "resilience" now has many, slightly different, definitions, which makes it a rather vague term to use (WWF, 2016; Brand & Jax, 2007; Wardekker, 2018). Therefore in the following paragraphs, three fundamentally different meanings of resilience will be discussed, to see which of these is most suitable as resilience for environmental challenges in the Netherlands towards 2050.

Engineering resilience

In engineering literature, resilience is defined as the ability of a system to return to its steady-state after a disturbance, or in other words its capacity to bounce-back (Romero-Lankao, Gnatz et al., 2016, Davoudi, Shaw et al., 2012, Holling, 1996**)**. According to Walker and Salt it is also defined as *'the capacity of system to respond to change or disturbance without changing its basic state'* (2006: p 7). An example of this type of resilience is the recovery of an agricultural landscape after a flood.

The emphasis in this approach of resilience lies on returning to the previous steady-state of the system in as short time as possible (*Lamond & Proverbs, 2009).* It is about the efficiency of the system and the predictability of the challenges that could affect the system. As is stated by Ahern.: *"Building resilience capacity through landscape and urban planning requires that planners and designers identify the stochastic processes and disturbances that a particular landscape or city is likely to face, the frequency and intensity of these events, and how landscapes or cities can build the adaptive capacity to respond to these disturbances while remaining in a functional state of resilience"* (2011: p. 3).

The engineering concept of resilience thus covers to the first step of resilient agriculture according to Bennett et al., (2014) and the Stockholm Resilience Centre (2009), which is 'persist '. This means a system continues functioning despite the presence of disturbances and environmental challenges (Holling, 1996). This first step of resilience is shown in figure 1.

The concept of engineering resilience is not entirely suitable for resilience on the environmental challenges in the Netherlands, because there is a lot of uncertainty in these challenges and one equilibrium and returning to this state is therefore not always enough (Romero-Lankao, Gnatz et al. 2016). The conditions will change to the future and that is why it is not always possible to for a (food) system to persist with the increasing environmental challenges. Engineering resilience is thus a short-term resilience solution, and could give problems in the systems on the long-term because they are not adapting or transforming for the changing conditions (Bennet et al., 2014).

Ecological resilience

Contrary to engineering, the field of ecology defines resilience as the capacity of a system to "bounce-forward" (Romero-Lankao, Gnatz et al. 2016). Effectively, Holling used ecological resilience to describe the ability of an ecological system to continue functioning when disturbed or changed, whereby it wouldn't necessarily remain the same, but could also adapt or transform (1973).

In this concept, simply returning to the original steady-state is not enough to be resilient. In order to be resilient, it is also necessary for complex ecosystems or socio-ecological systems to be able to adapt to current challenges and even to transform to stay resilient when new or ever changing challenges (e.g. climate change) arise (Romero-Lankao, Gnatz et al. 2016). Examples of complex systems in this sense are agricultural landscapes, cities and social groups.

"From a socioecological perspective, resilience is conceived of not as a return to equilibrium but rather as the ability of complex socioecological systems to change, adapt, and transform in response to stresses and strains" (Kim & Lim, 2016: p.7). This concept of resilience is in line with the last two steps of agricultural resilience according to Bennett et al., (2014) and the Stockholm Resilience Centre (2009) "adaptation" and "transformation". These two steps enable a (food) system to not only survive the disturbance, but also adapt to it and even strive due to it by transformation (see figure 1).

The ecological resilience concept is therefore a perfect fit for the environmental challenges, as the possibility of the systems to adapt or transform to the new conditions create a long-term resilience perspective (Kim & Lim, 2016). Furthermore with this approach even a more sustainable (food) system towards the future could arise from the adaptation and transformation (Mooij, 2018).

Social resilience

Within the concept of social resilience, resilience is defined as a network's (social group) ability to successfully reorganize, adapt, change and improve after disturbances of the systems (Kim & Lim, 2016). According to some social scientists, however, the concept of resilience can not be applied directly to social aspects, because they are also influenced by other factors as political and cultural processes (National research council, 2013 ; Kim & Lim, 2016).

Nevertheless, social resilience remains an important aspect in combination with ecological resilience, because social groups will have to work together in a different way (adaptation or transformation of governmental planning) in order to get a resilient (socio)-ecological system in the future (Stockholm Resilience Centre, 2009; Kim & Lim, 2016) (see figure 1). An example of this in the agricultural landscapes is the integration of food production with nature, in which different sectors will have to work together in the future (Province of Noord-Holland, 2018) in order to achieve this.

As a conclusion of this review, the socio-ecological resilience is the most suitable to create resilience to the environmental challenges in the Netherlands and will be used for further research in this paper.

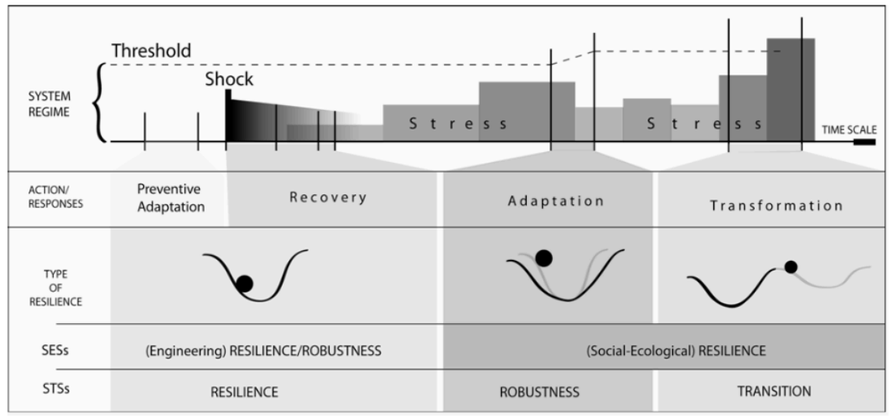


Figure 1: Resilience diagram. This diagrams shows the different steps of 'persist/recovery', adaptation and transformation in time as elements of a resilient system. Source: Olazabal et al., (2012:9)

Definition of 'resilient agricultural landscapes' towards 2050

Since a clear view on the concept of resilience for environmental challenges in the Netherlands has now been defined, it is important to give a definition of this socio-ecological resilience in the agricultural landscapes. With this definition a research framework on the resilience in the landscapes could be created later on.

The fifth assessment report of the Intergovernmental Panel on Climate Change gives a clear socio-ecological definition of resilience for the environmental challenges towards the future. Therefore, this definition has been chosen to be used in this paper. The report states that resilience is *"the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation."*(IPCC, 2014: p 54).

Since the focus of this paper is only on the environmental challenges (with the social aspect as an important tool to achieve change), the economical system will not be included in the definition. Furthermore the scope of this paper is on the agricultural landscapes as the location to create resilience, thus need to be included in the definition as well. According to Bennet et al., *"resilient agricultural landscapes need to be persistent, adaptive and transformative,* each at the appropriate moment in time and at the appropriate place/scale." (2014:p.6 *).* This definition is adding the spatial and time aspects to the definition of socio-ecological resilience.

The final definition of resilient agricultural landscapes in the Netherlands is: *"Resilience is the capacity of social and environmental systems in agricultural landscapes to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation through time and scales"*

This definition includes elements from: (social & environmental) systems thinking, agricultural landscapes, uncertain challenges towards the future, the steps of persist, adaptation and transformation to become resilient and different timeframes and scales to create resilience in the landscapes.

New research & design approaches for resilience in the agricultural landscapes

To find a research approach that is most suitable for resilience in agricultural landscapes, the approach needs to have all the elements of the definition. The most recent approaches have been selected on their compatibility with agricultural landscapes and their ability to create resilience.

1. Urban Metabolism

The Urban Metabolism approach is based on the analogy between cities or landscapes and the metabolism of living creatures (Anguillari & Dimitrijević, 2018). With this approach an analysis of the inputs, outputs, storage of materials, water, energy, nutrients and other flows of urban environments or landscapes is done to find indicators and data for the sustainability and resilience of systems (OVAM, 2016). In this way, it is the perfect example of system thinking and thus doing research through the scales. In the agricultural landscapes where flows of food can be studied, it is often used to optimize the food system.

However, this approach does not take into account the existence of different timeframes and the uncertainty of environmental challenges that can impact the system. It is more a research method to work towards a sustainable system in itself and often used for research on the metabolic system of cities (Broto et al., 2012). Possibilities of the systems to persist, adapt or transform are incorporated in the approach, because the focus lies on the linear system and how to create a new circular or sustainable system for the future, by adaptation and transformation of the system (Ferrão & Fernández, 2013; OVAM, 2016).

2. Urban Ecology

Another approach to Urban Metabolism is Urban Ecology. This approach focusses also on systems thinking and working through the scales. Urban ecology however, is a better research approach for resilience of agricultural landscapes because it is the part of Urban Metabolism that focusses on the natural flows (of water, food, biota etc.). Therefore, it is more closely related to the specific flows that can be found in agricultural landscapes (Nature, n.d.).

This approach has the idea of the landscape as a complex adaptive system within a larger system and analysis the interactions between the subsystems in a region (Broto et al., 2012). The focus of the research approach is not only on the system itself, but also on "how to achieve resilience to changes and shocks that will impact such a dynamic system" (Broto et al., 2012, p. 853). The uncertainty aspect of changes and shocks are thus taken into account. Similar to the urban metabolism approach, it understands the complex systems and with that the steps of persist, adaptation and transformation. However, a perspective on timeframes is still not incorporated into this research approach.

3. Water-food-energy nexus

The water-food-energy nexus approach is mostly focused on integrating these different flows to create a sustainable system for future uncertain challenges (Wakeford, 2016). With this concept the risks and vulnerabilities of the systems are reduced by creating back-up resources and systems and therefore the resilience of the systems is increased (BMZ & BMU, 2014). This approach includes thus also the systems thinking through different scales as the main aspect. The nexus as an approach *"represents an important opportunity to optimize cities, landscapes and metropolitan regions in order to address local, national and global sustainable development objectives, while meeting the challenges of resource scarcity, environmental pollution and degradation of ecosystem services."* (BMZ & BMU, 2014: p.16). Therefore, the nexus approach is even more specific to the agricultural landscapes than the Urban Ecology approach, as it includes the most important flows for future challenges in these landscapes. By integrating the flows of water, food and energy a more adaptive or transformable system could be created (Leck et al., 2015).

However the only aspect of the definition that is not represented in this approach are the timeframes. Therefore, there is a lot of potential in combining this research approach for resilience in agricultural landscapes, with a research approach that includes the timeframes.

4. Flexible Adaptation pathways

This approach is one of the essential elements of the concept of resilience (see figure 1). If a system is not able to persist due to the environmental challenges (the tipping point is reached), then it must either adapt or transform to become resilient (Rosenzweig and Solecki, 2010). In this approach the system thinking and the steps of persist, adaptation and transformation within different timeframes are included. One of the key elements of this approach is the recognition that strategies and designs need to evolve through time in response to changes in the challenges (Federal Ministry for Economic Cooperation and Development, 2014). With this also the uncertainty aspect of the definition is included.

However, it is more a planning research approach, with no specific applicability to agricultural landscapes, but it could be used to provide the water-food-energy nexus approach with the perspective of timeframes. It could therefore be the social resilience addition to the ecological resilience already represented in the nexus theory. In combination, they could successfully be used to create resilient agricultural landscapes in the Netherlands.

5. Ecosystem services

The ecosystem services approach focusses on the benefits that humans can obtain from natural ecosystems (Gardiner & Huser, 2017). Social and environmental system thinking and working through the scales are efficiently used in this approach. Although several conceptual frameworks for ecosystem services can be found, the one created by the Millennium Ecosystem Assessment is most often used (MA, 2005). It divides ecosystem services into four categories; *"provisioning services (the products obtained from the ecosystems as food and fresh water), regulating services (the benefits obtained from the regulation of natural processes, as climate regulation, water purification, disease and pest control in agricultural landscapes), cultural services (the non-materialistic benefits people get from the ecosystem, as recreation, cultural and spiritual reflection) and supporting services (the services that are necessary for the production of all the other ecosystem services, for example soil formation, nutrient and water cycles in agricultural landscapes)"* (Gardiner & Huser, 2017: p. 12). All of these ecosystem services are highly linked to the agricultural landscapes (WLE, 2014).

However, this approach also lacks certain aspects of the definition, such as working with different timeframes and the ability of the ecosystem services to adapt and transform. Transformation of the ecosystem is even sometimes even considered to be something negative (National research council, 2013). Furthermore, this approach does not adequately include the uncertainty of future challenges and ecosystem services are difficult to measure or research in agricultural landscapes (national research council, 2013). Consequently, it may not be the most useful research approach to establish a resilient agricultural landscape.

6. Scenario planning

"Scenario planning *is used to develop long-term plans that are resilient under a variety of potential future conditions or scenarios. Planners consider a range of scenarios, and then select the plan that is most robust across several or all scenarios."* (Land Trust Alliance, 2018: p1.). Thus this approach is also more a part of the planning. In the scenario planning approach, the system thinking as one of the main parts of creating resilience has not the main focus, as well as working on different scales. Furthermore it is not a specific method for agricultural landscapes, because it is a broader concept for planning towards future challenges (Rasmussen et al., 2015).

However, it is a good research approach to take into account the uncertainty of the challenges towards the future and work with different timeframes. Together with the systems approaches of urban metabolism, urban ecology and the nexus, the possibilities of a system to persist, adapt or transform within different scenario's can be researched. In this way it could be an addition to the system research approaches.

Learning from the approaches for environmental resilience in agricultural landscapes

Overall three different categories of approaches become apparent. Those that focus on system thinking (urban metabolism, urban ecology and water-food-energy nexus), on ecosystem and nature (ecosystem services) and those that focus on planning/governance (adaptive pathways and scenario planning). The approaches of system thinking go from more broadly to precise research approaches for the agricultural landscapes with a focus on the flows that are important for the landscapes (water, food and energy) and are well developed to be researched for resilience. The ecosystem approach is difficult to research in spatial terms and therefore not a clear method to do research on resilience, however it is an important framework to understand the ecosystem in agricultural landscapes.

The planning research approaches are more an addition to the systems thinking approaches (spatial), as it takes into account the uncertainties of future environmental challenges and working with different timeframes for adaptation or transformation of the systems towards a more sustainable system. There is thus potential in combining the system thinking research approach with the planning approaches. Because the water-food-energy nexus is most related to the agricultural landscapes, this will be chosen as the basis research framework for creating resilient agricultural landscapes.

A framework for creating resilient agricultural landscapes

According to Hoff (2011) a framework for the water-food-energy nexus could be defined in the following way: (see figure 2). This framework was produced in the paper "Understanding the Nexus' and became highly influential and shaped widely used applications (Hoff, 2011). Therefore it will be taken as a basis framework for research on resilience in this paper. The scope of this paper focusses on the field of the 'environment' and the goal of creating a 'resilient productive environment' in the figure.

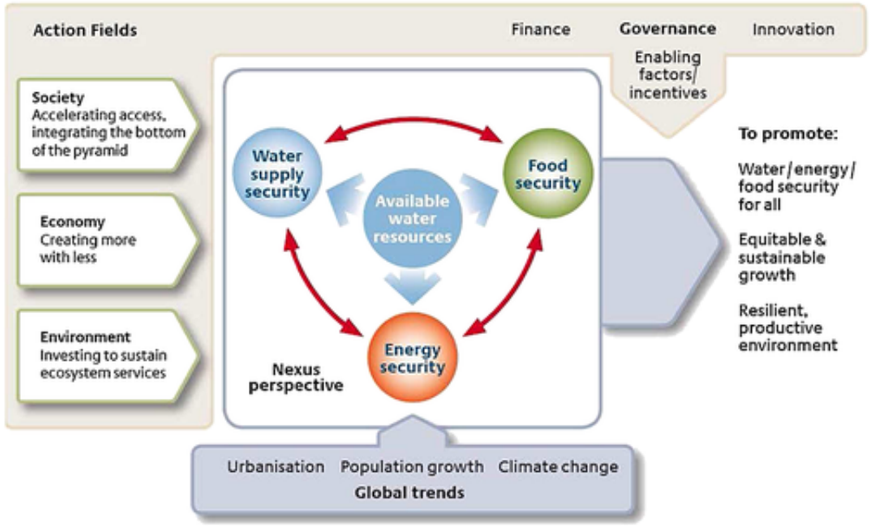


Figure 2: Water-food-energy nexus framework.
Source: Hoff (2011:5)

The water-food-energy nexus is the main element of research in this framework. Furthermore, it includes the ecosystem services as part of understanding the environment and different challenges towards the future (urbanisation, population growth, climate change) (figure 2). This part could be extended with scenario planning to do research on the possible futures of these challenges. Moreover, the factor of governance in the process of research is mentioned (figure 2). The research framework however, does not include the element of adaptive pathways in this governance, while there is a lot of potential in combining this approach with the water-food-energy nexus approach.

In the following framework, this scenario planning and adaptation pathways approach is added and with that a new framework for the research on (socio-ecological) resilience for environmental challenges in the agricultural landscapes of the Netherlands is given.

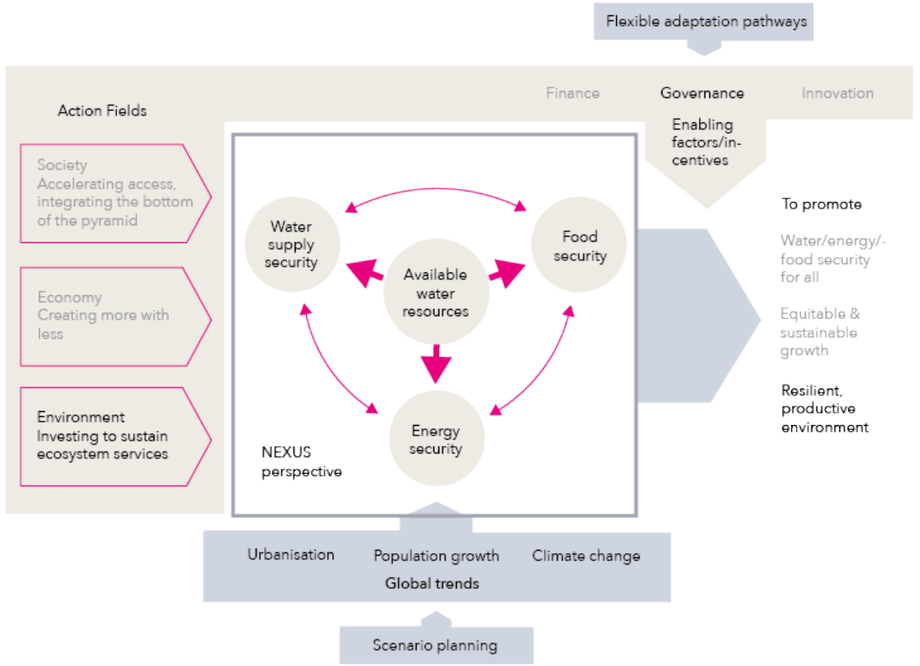


Figure 3: Resilience framework for environmental challenges in agricultural landscapes.
Source: created by author (2018)

Conclusion

The research question in this paper is: *What is the definition of a environmental resilient agricultural landscape in the Netherlands and how can a framework for research on the resilience of the landscapes be developed?*. To answer this question, the concepts of engineering, ecological and social resilience are compared, to see which of these concepts is best for the environmental challenges in the Netherlands towards 2050. The most important conclusion that can be drawn from this review is that the engineering resilience concept is simply too limited and rigid for creating resilience to environmental challenges towards 2050. Since the system will return after disturbance to the same equilibrium that is often unsustainable and not resilient in the long-term with increasing challenges. The ecological resilience approach however, includes all three steps of persistence, adaptation and transformation to create long-term resilience for the increasing environmental challenges and even creates with these steps opportunities for a sustainable system in the future. Furthermore, the addition of social resilience to this definition will create a system in which not only the physical but also the social or planning environment can be resilient to make it possible to realise a resilient (socio)-ecological system.

The definition for socio-ecological resilience is therefore chosen as the basis definition. Furthermore this definition is combined with the spatial aspect of agricultural landscapes in the Netherlands which results in the following definition for this paper: *"Resilience is the capacity of social and environmental systems in agricultural landscapes of the Netherlands to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation through time and scales."*

Based on this definition, we looked at which research approach within the urban planning and design field could be used to create the 'environmental resilient agricultural landscapes in the Netherlands'. Overall with the literature review of the different research approaches, three different categories become visible: system thinking (urban metabolism, urban ecology and the water-food-energy nexus), ecosystems/nature as a basis of research (ecosystem services) and more towards the planning/governance perspective (adaptive pathways and scenario planning). The systems thinking approaches are well developed to do research on resilience, and the water-food-energy nexus approach fits best with the flows in the agricultural landscapes. The ecosystem approach however, is difficult to research in spatial terms and

therefore not a clear method to do research on resilience. Finally, the planning approaches are more an addition to the research approaches of systems thinking (spatial), because it into account the uncertainties of future environmental challenges and working with different timeframes for adaptation or transformation of the systems towards a more sustainable system.

There is thus potential in combining the system thinking research approaches with the planning approaches. Because the water-food-energy nexus is most related to the agricultural landscapes, this is chosen as the basis research framework for creating resilient agricultural landscapes. The scenario planning and flexible adaptation pathways approaches are added to this framework. In this way, a new framework for research on the environmental resilience of agricultural landscapes in the Netherlands is given.

Reflection & recommendations

In this paper a resilience framework for environmental challenges in agricultural landscapes is developed. A suggestion for further research could be to work with this framework in research or design projects in practice. Because it is interesting to see if the use of this framework in the process will give different outcomes, then the usual way of working to resilience (without a clear definition and framework).

Furthermore, the paper focuses on the environmental resilience of agricultural landscapes towards the future, and especially the spatial research approach of systems thinking (water-food-energy nexus). It would be interesting in further research to get more knowledge on the social aspect of this resilience framework (e.g. the governmental processes). As this is an important aspect of the process towards resilience: *"Resilience thinking calls for ways of governing that create space for flexible, innovative collaboration and open institutions that allow for learning and building capacity to cope with change. Such flexible institutional arrangements tend to be much better adapted for long-term survival" (Stockholm Resilience Centre, 2009:5).*

Finally, the research in this paper is focused on the resilience of agricultural landscapes in the Netherlands. There is already a lot written about the concept of 'urban resilience' in literature. It could be interesting to see how these concepts relate to each other and create possibilities for a resilient system in regions.

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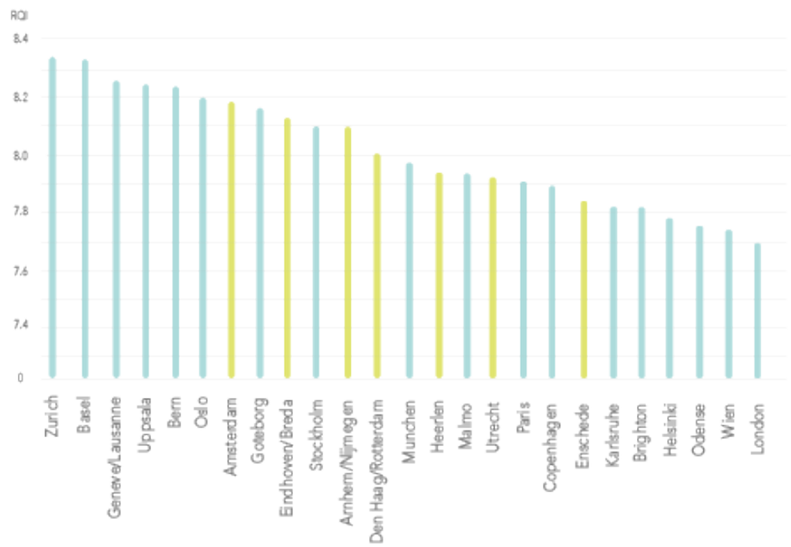
LIVEABILITY OF CITIES IN THE REGION & INDICATORS OF ATTRACTIVE METROPOLITAN LANDSCAPES

Towards 2050 the predicted liveability in the cities of the metropolitan region of Amsterdam will decline, because of the urbanisation trend. The aim is to maintain the high living quality of the metropolitan region towards the future, and therefore the landscape of the metropolitan region becomes important. To define the elements of a metropolitan region with a high living quality, the indicators of the living quality on a regional scale in the research of Lagas, van Dongen, van Rijn & Visser (2015) are used. Because of the combination of this problem with the climate resilience of the agricultural landscapes (see blue colors), in this graduation report only the spatial indicators of the metropolitan *landscape* will be selected. The following indicators of the metropolitan landscape are used:

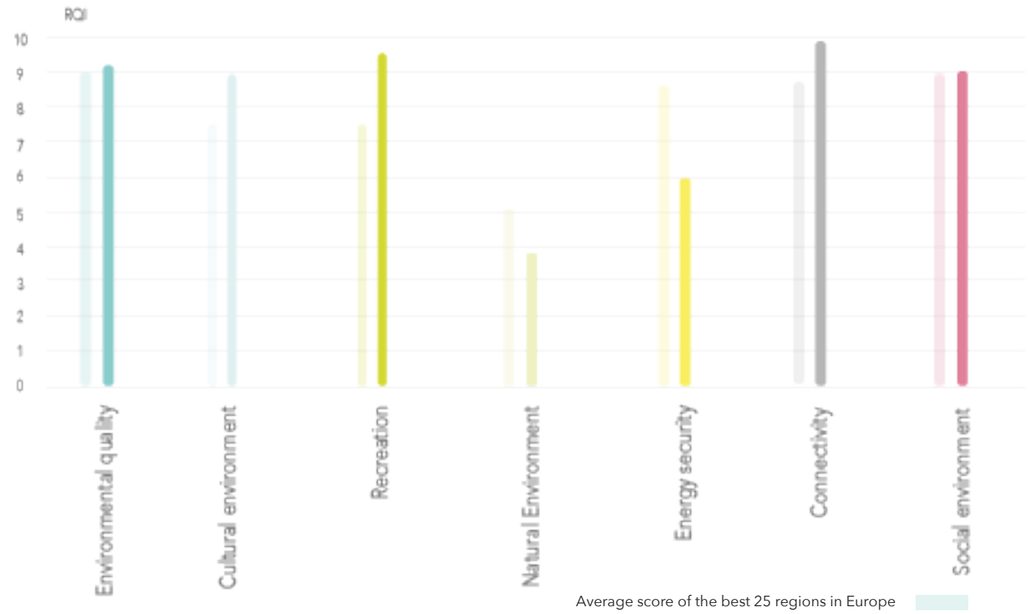
- Environmental quality
- Cultural environment
- Recreation
- Natural environment
- Energy security (sustainable energy)
- Connectivity (high quality infratructure)
- Social environment (not a spatial indicator, however an important indicator that could be realised by spatial solutions)

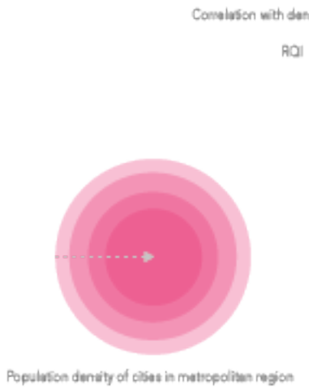
These indicators are corresponding to the spatial criteria for the surrounding landscapes of cities used in the Economist Rankings for the most liveable cities in the world (Economist Intelligence Unit, 2012): natural assets, cultural assets and connectivity.

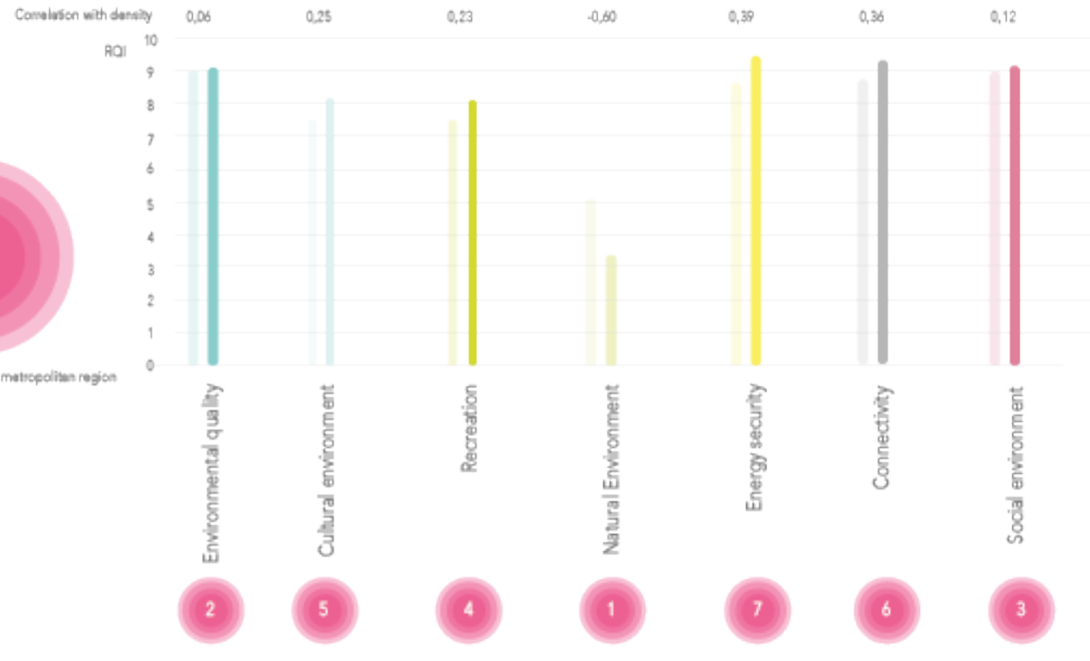
In the following diagrams the regional liveability score on these indicators of the landscape is visible, for the average of the top 25 regions in Europe and the metropolitan region of Amsterdam. Furthermore the correlation of the density of cities with the indicators for a high liveability score is given in the second diagram and from this the most important elements of the metropolitan landscape towards 2050 are distracted.



All indicators have the same weight in the average RQL of the regions in Europe
All the selected regions in Europe have more than 1 milion inhabitants.







Correlation between population density and RQL scores of the indicators in landscapes.
The indicators for the living quality in the region with lower scores, are thus the most important aspects of the landscapes to improve in the metropolitan region with a higher density in 2050.
Note: most of the indicators will improve with more density in the cities because there is a lot of investment in these aspects of the landscapes. The other indicators are in this case overlooked (nature, environmental quality).
The numbers underneath the indicators give the most important aspects of the landscapes to focus on towards 2050.