Technical University of Delft

Dear Taneha,
About one year ago, we had our first meeting on this graduation project. Now, one year later, the Master is finished. It would not have been such an incredible year without your support and inspiring meetings. Thank you so much and we will work together sometime! I wish you good luck finishing your PhD. Um abraço!

Dear Nico,
Bridging the gap between the TU Delft and the municipality made this year much more easy. Thank you for participating in all meetings with this big mentor team and translating my sometimes too theoretical and philosophical ideas into understandable stories.

Dear Ulf,
At the beginning of the graduation year you have been introduced to me as 'the food guy from the TU Delft'. The project would have looked completely different without your clear, and sometimes critical, remarks. Especially concerning the design you have been of great support. Thank you for being this critical, because it made me think more in depth before proposing the design.

Municipality of Rotterdam

Dear Pieter,
An internship during the graduation year, many students told me it was a crazy idea. But I have not regret the decision for even one second. Thanks to your enthusiasm and devoted way of working I have learned so much. Not only from a professional point of view, but also personally. Thank you for giving me the opportunity to work together with you during this year.

Deltares

Dear Victor,
You have not been part of the official mentor team. Nevertheless, you have been of great support regarding the ecological side of this thesis. Because of this knowledge, I have been able to link the farming opportunities to the region of Rotterdam. Thank you for finding the time to discuss this graduation project.

SPECIAL THANKS TO:

Remco Andeweg
Bureau Stadsnatuur, Rotterdam

Hans van der Boor
Municipality of Rotterdam, Rotterdam

Han Dijkstra
Fabrications, Amsterdam

Bas Driessen

Rutger de Graaf
Deltasync, Rotterdam

Arjan Harbers

Sander Klaukeers

Ramon Kroester

Arjo Klijnsmit

Jeep van Leeuwen

Gerard Lijten

Kees van Oorschot

Maartje Visser

Luc de Vries

Bas de Wildt

Technical University of Delft

Bureau Stadsnatuur, Rotterdam

Municipality of Rotterdam, Rotterdam

POSGAD spatial strategies, The Hague

Fabrications, Amsterdam

Debatyserc, Rotterdam

PBL, The Hague

STEK, Rotterdam

Municipality of Rotterdam, Rotterdam

WHIM Architecture, Rotterdam

Municipality of Rotterdam, Rotterdam

Municipality of Rotterdam, Rotterdam

Bureau Stroming Wageningen

Municipality of Rotterdam, Rotterdam

Municipality of Rotterdam, Rotterdam

Ministry of Infrastructure and Environment, The Hague

Municipality of Rotterdam, Rotterdam

Alexandre Delijiacov

FAU-USP, Sao Paulo

Helena Aparecida Ayoubi Silva

FAU-USP, Sao Paulo

Vladimir Bartolini

FAU-USP, Sao Paulo

Hannah Arcuschin Machado

Sao Paulo

Bassy Machado

Sao Paulo

Alberto Abreu Machado

Sao Paulo

Carmem Aires

Sao Paulo
‘A vibrant city needs three things: good social interaction, good infrastructure, and nature’

- ADRIAAN GEUZE AND METHEW SKONSBERG
Chapter 1: Relevance and Objectives
Relevant metabolism
an approach to design resilient waterfronts for highly dense cities
Productive riverscapes
as tool for connecting people and nature in the city
Sustainable urban planning
Research question
Research strategy

Chapter 2: Urban Metabolism and Green Infrastructures
The city as an urban ecosystem
The developed versus the present landscape
Green infrastructure planning and design
The adaptive framework

Chapter 3: Methodology: The Rhine-Maas Delta
Understanding the context of the delta

Chapter 4: Riverscape Case Studies: The Rhine-Maas Delta
Introducing food in the Rhine-Maas Delta
Food production and biotopes
Food production and cultures
Farming opportunities
Conclusion

Chapter 5: Riverscape Case Studies: Catalogue of Proposals
The small scale: Food production in the city
Jobs Collective Gardens
Pick and Net Park
The mezo scale: Food production around the city
Fish and Farm Island
Salty Shore
The large scale: Food production in the North Sea
Wind Farm Farm

Chapter 6: Conclusions
Design as research tool
Patterns for productive riverscapes
Recommendations for the Rhine-Maas Delta

Appendix
List of definitions
Interviews
Workshops
Analysis
Design variations
References
MY MOTIVATION This thesis is designed by my own fascination. How to transform the existing urban fabric in highly dense cities with minimal actions into resilient and self-sufficient areas resulting in maximum improvement of people’s daily lives in cities? Therefore, this thesis is combining technical, ecological, social and spatial processes in surface and subsurface of high dense delta cities for the design of productive riverscapes in the city of Rotterdam.
URBAN METABOLISM
an approach to design resilient waterfronts in highly dense cities

PRODUCTIVE RIVERSCAPES
as tool for connecting people and nature in the city

SUSTAINABLE URBAN PLANNING

RESEARCH QUESTION

METHODOLOGY

relevance and objectives
This graduation project is written in a turbulent period. Not only the profession of urbanism is changing, also the object of our profession, the city itself, is changing. Today cities have become complex systems, which require an adaptive approach in urban planning and design. But what is the new role of an urban planner? And how has the object, the city itself, changed?

The International Architecture Biennale Rotterdam of the summer 2014 can be seen as one of the main incentives of the on-going transition period. The objective of this exhibition was to put the topic of urban metabolism on the agenda of urban planning and design. Remarkably, only a limited amount of the proposed metabolic designs for cities has been realised in the practice of urbanism, despite the high amount of exhibited projects in Rotterdam. They have not been transferred into the practice of urbanism and therefore remained on a conceptual level. Hence, it is still necessary to define urban metabolism and to transfer the idea into the urban practice.

Metabolism is founded in the science of biology. It is described as a physical and chemical process occurring in every living organism, whereby it gets energy from one or less elementary building blocks from the outside world and deposits waste materials ("woordenboek," n.d.). Applying the same phenomenon to cities results in the oxymoron of urban metabolism. According to Paulo Ferrao and John E. Fernandez the concept of urban metabolism derives directly from the metaphor of industrial ecology and urban systems (Ferrao & Fernandez, 2013, p. 2). They state:

"Urban systems are open systems characterized by several interlinked subsystems – social, economic, institutional – that interact with the environment by consuming materials and energy they accumulate in the built environment and other stock and by rejecting different solid wastes and emissions to air and water, which are to be absorbed and regenerated by the environment. The city can thus be viewed as an organism with a metabolism that can be studied"  

More importantly, Ferrao and Fernandez compare the system of urban flows with the ecological system, also called nature. Because nature has survived over ages, we observe these robust, resilient and long-live ecological communities in order to redesign the human world from a sustainable perspective. Consequently, nature is not only part of our planet earth; it has become a source for new ideas on researching our cities (Ferrao & Fernandez, 2013). This statement is fundamental to this thesis. The idea, however, is not only accepted within the academic field of urban planning and design. Also the practice of urbanism is starting to incorporate the idea of the city as a natural system. Still, the amount of major natural disasters torturing today’s cities proves the urge to rethink our urban systems even more in relation to ecology.
A productive landscape is not yet officially defined within the field of urban planning and design. Though productive landscapes are not defined yet, it is elaborating on the on-going discussions in both the academic field and urban practice of the city as an urban ecosystem.

In this thesis a productive landscape is referred to as a landscape in which a symbiosis between housing, production, biodiversity and recreation is sought, all within the framework of (sustainable) landscape planning and design (‘archined,’ n.d.).

The focus of designing productive landscapes in this thesis will be on the physical spot, where city and nature confront each other every day: in and around rivers of highly dense cities. In those parts of cities all agents are highly intertwined: the users of the city, the river and the built environment have to face each other every day. How come these parts of cities especially became the battleground of human versus nature?

A specific location has been chosen to understand and grasp the struggle between both. The Rhine-Muse Delta in the Netherlands is used as case study in this thesis. The city of Sao Paulo serves as case study to reflect on the developed theory of this thesis.

According to statistics, a Dutch family consumes about 1350 kilograms of food per year (figure 1). They require about 8800 square meter of land to produce all this food. Applying these numbers to the city of Rotterdam reveals that Rotterdam should be equalled by 8 times in size to provide enough land regarding food production. As we all know, the amount of available land within our Rhine/Muse Delta is limited. Therefore it is important to analyse the production and consumption of food and rethink the system.
Why is it necessary to take a closer look at the waterfronts of highly dense cities? First of all, the effects of climate change and an out-balanced carrying capacity are threatening our daily routine of cities. Second of all, the out-balanced carrying capacity causes degradation of both nature and city. Both will be explained in this paragraph.

Climate change versus carrying capacity:
Cities encounter negative effects of climate change on the urban fabric (Rees, 1992). But what is climate change? Greenhouse gasses cause the atmosphere to retain sun radiation. These gasses are produced by industry, energy production and agriculture. As a consequence the global temperature rises. Compared to the year 1850 the average temperature has risen 1 degree Celsius on average. This is expected to increase in the coming years if the current situation remains. What are the consequences? For example, hundreds of millions of people have to deal with water stress. Crop productivity will change. If the average temperature rises until 4 degrees Celsius, effects will be even worse. Crop productivity will decrease globally, 30% of coastal areas will be lost. Additionally, the risk of flooding will increase. Therefore it is necessary to alter our built environment to deal with the negative effects of climate change in our cities (Ministry of Infrastructure and the Environment, 2014). As mentioned before, the focus of this thesis is on designing the urban fabric adjacent to the river in highly dense cities. Consequently, flood risk management and decreasing crop productivity are affecting the design of productive riverscapes and will be taken into account.

In addition, carrying capacity of today’s cities is out-balanced. The total amount of land necessary to ensure enough urban provision for a region (or the ecological footprint) is larger than the amount of land available in and around cities. The output is more than the input of productive landscapes in cities, which results in energy, food and fresh water shortage (figure 3). To secure the provision of our natural capital and their productive capacity, it is necessary to rethink the relation between the natural and built environment in our cities and take action (Rees, 1992). It is important that urban planners and designers are incorporating urban metabolism in design projects.

Effects on today’s high density city:
Today, both the negative impact of climate change and the out-balanced carrying capacity on the urban fabrics of our cities already cause degradation of both nature and city. The world population will increase even more by two million thousand people in 2050 of which 90% will live in cities. Consequently, CO2 emissions will increase with two billion tons and four hundred twenty million of agricultural fields are needed to feed all people in 2050 (Dassen & Haajer, 2014). Therefore,
INTRODUCTION

Background

It is necessary to analyse the structure and metabolism of our cities as an urban planner and understand the complexity of it for the design of resilient cities (Tillie, Klijn, Borsboom, & Looije, 2014, p. 51). Hence, understanding the relation between city and nature today is necessary to minimise the impact of both. It means that we have to rethink our entire economic system. Though we are using a linear system, it should become a circular economy. It means that we have to close the urban metabolism as much as possible within our cities and change our entire system in one go (figure 4) (UNEP, 2014). Therefore we have to start altering parts of the existing urban fabric on a small scale. We should become capable of integrating ecological and social processes in metabolic design projects. Consequently, this thesis focuses on designing productive landscapes in river parks to open up the discussion of the technical, ecological, social and spatial implications of the circular economy in and around rivers in highly dense cities.

Think global, act local

The relation between both the ecological and cultural processes in the existing urban fabric thus has to be changed to achieve resilient and liveable conditions of cities in the future. As cities act on different scale levels, these processes also occur in different scales. According to the theory of Saskia Sassen it is necessary to research and tackle problems on a small scale in order to change problems on a global scale. This is called ‘think global, act local’ (Sassen, 2004). Therefore, this thesis focuses on the small scale, though in the end results will be evaluated on a large scale.

As mentioned before, the city of Rotterdam, The Netherlands is used as case study to test the developed structure of an adaptive framework for the design of resilient and liveable cities on a local scale. Consequently, this thesis consists of three parts:

1. Developing an adaptive framework to understand the relation between the existing urban ecosystem and food production for the design of productive riverscapes using food as a tool to connect nature and human in the city (research by design).
2. Overall analysis of the Rhine/Muse Delta according to the developed analytical framework.
3. A catalogue of design proposals to alter the existing flow of food in the highly dense city of Rotterdam.

Figure 4

From a linear to a circular economy
Source: image made by author based on image retrieved from www.symbioticcities.net
1.4 RESEARCH QUESTION

How to design productive riverscapes using food as a tool to shape the current riverfronts for stimulating social interaction and improving biodiversity in Rotterdam?

Adaptive framework

• what is the overall framework to analyse the complexity of the existing fabric of the urban ecosystem adjacent to a river?
• what types of food production in river parks could result in maximum resiliency and liveability by minimal actions in the urban ecosystem?
• how to design multifunctional river parks via green infrastructures planning and design in highly dense cities?

Design

• what are the problems and opportunities of the ecological and cultural infrastructures of Rotterdam?
• how could a spatial strategy be used to design productive riverscapes along the waterfront of Rotterdam for the design of resilient and liveable urban fabrics?

1.5 RESEARCH STRATEGY

The overall methodology of this thesis is a research by design project. Thus, the research feeds the design process to achieve maximum efficiency of the final design (Nijhuis & Bobbink, 2012). The case study is used to test the adaptive framework, derived from theory, in the Rhine-Muse Delta and the city of Rotterdam. Additionally, two motives are driving forces behind this thesis. Both will be explained.

Design as catalyst for interdisciplinary research

First of all, the research by design approach applied in this thesis is used to make the role of the new urban planner explicit. According to my own statement, the urban planner of today should be a pro-active communicator. Design should be used as catalyst for interdisciplinary research. Already in 1980 Pieter Tiedeman was convinced of the designing disciplines as mediator between the scientific ‘knowledge’ disciplines (Tiedeman, 1980). According to Tiedeman (1980), design is a tool to stimulate and improve communication among disciplines. Consequently, this thesis is conducted according to the same way of thinking. The design of productive landscapes is established via an extensive amount of interviews, workshops and guidance of several people with completely different backgrounds. Without the expertise of these people, it would not have been possible to achieve the same level of knowledge, which is fundamental regarding the objective of this thesis.

Linking research by design and urban practice

Second of all, this thesis is an attempt to link the scientific approach of the Technical University of Delft and the practical approach of the urban development department of the Municipality of Rotterdam. Though this is not underpinned scientifically, I believe research by design is not only linking research and design. It is also necessary to link the academic field and the practice of urban planning. Though both are sharing the same object, namely the city, they cherish different ambitions. Consequently, it is necessary to develop a project between both worlds for the design of resilient and self-sustaining waterfronts in the city of Rotterdam. Not only the research-by-design approach is it iterative, also the exchange of ideas between the academic field and practice should be the same.

To conclude, the method of this thesis is a research-by-design approach. It is linking knowledge of different disciplines and at the same time bridging the gap between urban practice and the academic field. Figure 5 (next page) shows how the research questions, stated in the previous chapter, are combined by the different disciplines and objectives.
INTRODUCTION

Figure 5

Research strategy

Source: Image made by author

WHAT ARE THE PROBLEMS AND OPPORTUNITIES OF THE ECOLOGICAL SYSTEM OF THE CITY OF ROTTERDAM?

WHAT ARE THE PROBLEMS AND OPPORTUNITIES OF THE CULTURAL SYSTEM OF THE CITY OF ROTTERDAM?

HOW COULD THE ECOLOGICAL AND CULTURAL SYSTEM OF THE CITY OF ROTTERDAM BE CONNECTED?

ANALYSIS

LOCATION

PATTERNS

FOOD

water
sediments

MODEL 1

MODEL 2

MODEL 3

MODEL 4

ANALYSIS

LOCATION

PATTERNS

FOOD

water
sediments

MODEL 1

MODEL 2

MODEL 3

MODEL 4

ANALYSIS

LOCATION

PATTERNS

FOOD

water
sediments

MODEL 1

MODEL 2

MODEL 3

MODEL 4

ANALYSIS

LOCATION

PATTERNS

FOOD

water
sediments

MODEL 1

MODEL 2

MODEL 3

MODEL 4

ANALYSIS

LOCATION

PATTERNS

FOOD

water
sediments

MODEL 1

MODEL 2

MODEL 3

MODEL 4

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?

DESIGN

EVALUATION

how does the design improve biodiversity?

how does the design stimulate social interaction?
THE CITY AS AN URBAN ECOSYSTEM
the developed versus the present landscape

GREEN INFRASTRUCTURE PLANNING AND DESIGN

THE ADAPTIVE FRAMEWORK
As mentioned before, the object of the city is also called the urban ecosystem. What does it imply? How does it function? In this paragraph the complexity of the urban ecosystem is researched for the design of resilient and self-sustaining urban fabrics. It is based on the science of urban ecology. This theory aims to understand the city by studying the relation between ecological and cultural processes in our cities. Though Urban Ecology is founded in the 1970’s as part of biology, recently urban ecologists have been linking the ecological processes to the cultural processes in order to understand the relation between human and nature in the urban ecosystem before altering the city via planning and design (Forman 2014, p.23).

Urban ecosystems evolve over time and space as the outcome of dynamic interactions between socio-economic (before referred to as cultural) and biophysical (before referred to as ecological) processes operating over multiple scales (Alberti & Marzluff, 2004). Both processes are used to explain the problems of the urban ecosystem, caused by both the outbalanced carrying capacity and the negative effects of climate change on today’s cities. Firstly, the biophysical processes in the city are disturbed, resulting in degradation of the ecological condition. Urban development separates and simplifies the natural habitat of species, disturbs the hydrological system and changes the energy flows and nutrient cycles. As a result the ecological processes become vulnerable in their structure (Alberti & Marzluff, 2004, p.1). Therefore it is important to make our living environments more resilient and robust. Secondly, socio-economic processes influence the degradation of the ecological functions in a negative way on different scale levels. Major human driving forces, like demographics, socio-economic organizations, political structures and technology, are disturbing biophysical processes in the natural land cover in cities. In addition, human behaviour directly influences the use of land and the demand for and supply of resources. In urban areas these forces combine, which results in spatial heterogeneity of biophysical processes. This is linked directly to the degradation of ecological functions (Alberti, 2008, p. XIV). Therefore it is important to guide socio-economic processes to improve nature for the design of liveable urban ecosystems. What layers should be studied to understand the relation between ecological and cultural processes of today’s cities? And how could an urban planner learn from the historic processes?

The developed landscape: understanding the backbone of nature

People live for decades, plus buildings last for decades to centuries on the mighty backbone of nature (Forman 2014, p.56). Even the earthly deposits of sand, silt and clay cover valleys and plains for hundreds, thousands, or even millions of years. In addition, it is necessary to reveal the urban backbone, or underlying geomorphological pattern, of a city to understand the foundation of present cities. Why is a city built in this specific location? Though it might seem an obvious question as an urban planner, only Forman stresses the importance of studying the historical conditions of a city in his analytical model. Firstly, mapping long-term microclimate patterns and linking them to natural processes across the landscape leads to an urban backbone mosaic. Secondly, analysing the city from the perspective of the five basic needs of people leads to a framework to investigate the geomorphological conditions of cities. These are defined by: (1) Clean fresh water. It is a daily human necessity. Water is heavy to transport and therefore cities are close to water supplies. Additionally, restoring a water supply is normally the first priority after a disaster. (2) Food, which is required every day. Perishable foods and those with slow or extensive transport may be mainly grown locally in urban agriculture or market-gardening farming. Pastureland for livestock is normally somewhat more distant, since considerable land is required and either the animals or their products can be readily moved to the city. (3) Minerals and wood fibre, which are transported either directly to the city for manufacturing goods, or to factories elsewhere producing light- to heavy goods transported to the city. (4) Transportation. It provides efficient access to resources and other communities depends on plans, valleys, rivers, harbours and the sea. (5) Security or defence against competitors focuses on distinctive arrangements of land and water (Forman 2014, p.35).

To conclude, connecting the natural processes to the existing urban fabric leads to a deep understanding of the landscape patterns figure 1) in relation to the urban backbone. As a result each pattern provides inside information of suitable future land uses, potential disasters and public health problems. This information provides handles and needles in the future planning of resilient and self-sustaining cities (Forman 2014).
The present landscape: layers of the urban ecosystem

Originally, today's cities were built near the most suitable location on the mighty backbone of nature. Still, analysing only the urban backbone to understand the present urban fabric is not sufficient. Over time, people have altered and shaped the natural living environments according to their needs. As a result, former landscapes of the urban ecosystem have been altered in such a manner that it is necessary to analyse the present landscape separate from the developed landscape. An extensive amount of analytical models has been published to analyse the current landscape of cities. They can be categorised according to four themes: (1) early models; (2) donut models; (3) ecological pattern models and (4) urban models (Forman 2014). Since this paper aims to establish an analytical framework for urban planning and design, only the urban models are relevant. Both Forman (2014) and Alberti (2008) have published urban models. Both will be explained shortly. Alberti (2008) is proposing a multifunctional approach to understand the relation between socio-economic and bio-physical processes (Alberti & Marzluff 2004). Notably, this model does not explain how the flows of energy, food, etc. in cities should be integrated in an analytical model in order to study the urban ecosystem.

On the contrary, Forman (2014) stresses the distinction between the static land mosaic and the flows of urban ecosystems. According to his analytical model the structure, or static layer of the land mosaic, should be analysed first. Secondly, it is necessary to understand the dynamic interactions of the urban ecosystem. Thirdly, the functioning of the entire ecosystem should be understood before the existing urban fabric could be altered via urban planning and design (figure 6). The next paragraphs clarify both the static land mosaic and dynamic flows.

Land mosaic: patches and corridors

The land mosaic exists of patterns and corridors. Together they define the characteristics of each unique land-mosaic. Though it remains on a theoretical level, Forman gives an overview of different patterns and corridors, which together compose the land-mosaic (figure 6). Analysing the patterns and corridors leads to a basic understanding of the static layer of the city.

Generally speaking it is necessary to first define the patterns before determining the corridors. Patterns can be categorised in several ways. They can be defined by (1) organizing force; (2) focus on the set of basic needs; (3) identifying major barriers. Methodologies to analyse both patterns and corridors are (1) mapping; (2) geographic information system images (GIS); (3) mental mapping; (4) other computer modelling software (Forman 2014). Additionally, both Forman and Alberti distinguish the type of methodology and patterns should be selected depending on the main objective of a research. In this thesis, organizing forces will define the patches. They have been filtered out via mapping and GIS analysis (see chapter 3).

The research City Sink by Denise Brandt Hofmann (2014) is one of the pioneers that integrates research by design and the analysis regarding the topic of urban metabolism as described above. In her research New York City is analysed via GIS analysis and mapping. Hofmann calculates and visualises the cycle of carbon. Firstly, data of the patches of carbon are analysed via GIS on both the global and regional scale. Consequently, mapping the corridors of green, blue and grey infrastructures revealed critical spots where ecological and cultural processes are not functioning well regarding carbon emission. Thirdly, the land mosaic is analysed on micro scale and translated into a catalogue of proposals for the design of low carbon corridors and patches. Brandt Hofmann proposes black box models as analytical tools. A certain amount of flows (Y) is going in the black box (X), which results in an outcome (Z). Though a lot of black box models on flows have been published, none of them are combining flows. For example models to grasp the flow of energy and analytical tools to analyse the cycle of nutrients (Broersma et al. 2013; Craul 1992; Smith 1996). Those models remain very theoretical and do not bridge the gap between the academic field and urban practice. Additionally, neither Forman nor Alberti proposes an analytical model, which links all flows to the land mosaic. On the contrary, Hoffman (2014) focuses on the cycle of carbon emissions via urban planning and design. Though her research does not focus on the production of food, she aims to visualise the flow of carbon and reduce emissions via green infrastructure planning and design. Notably, other flows are not addressed in City Sink proposals. Still, Forman implies that linking the input-output ecological flows to the spatial patterns within the metro area seems an especially important next step (Forman 2014, p.85). As mentioned before, the flow of food is the main flow addressed in the design of productive riverscapes. Nevertheless, other flows affecting the design of waterfronts in cities are included. All are explained shortly. Notably, Hofmann’s research aims at visualising the carbon cycle and reduce emissions via green infrastructure planning and design. In his analytical model these leads to an understanding of the dynamic layer of the urban ecosystem. Forman (2014) distinguishes three perspectives to analyse flows: (1) flow and movement patterns; (2) animal and plant movement; (3) system and ecosystem flows. Since the focus of this thesis is on urban metabolism, an oxymoron of the system and ecosystem flows, only this perspective is made explicit.

To analyse the urban system and the ecosystem flows Forman (2014) proposes black box models as analytical tools. A certain amount of flows (Y) is going in the black box (X), which results in an outcome (Z). Though a lot of black box models on flows have been published, none of them are combining flows. For example models to grasp the flow of energy and analytical tools to analyse the cycle of nutrients (Broersma et al. 2013; Craul 1992; Smith 1996). Those models remain very theoretical and do not bridge the gap between the academic field and urban practice. Additionally, neither Forman nor Alberti proposes an analytical model, which links all flows to the land mosaic. On the contrary, Hoffman (2014) focuses on the cycle of carbon emissions via urban planning and design. Though her research does not focus on the production of food, she aims to visualise the flow of carbon and reduce emissions via green infrastructure planning and design. Notably, other flows are not addressed in City Sink proposals. Still, Forman implies that linking the input-output ecological flows to the spatial patterns within the metro area seems an especially important next step (Forman 2014, p.85). As mentioned before, the flow of food is the main flow addressed in the design of productive riverscapes. Nevertheless, other flows affecting the design of storefronts in cities are included. All are explained shortly.

Food

The flow of food is underestimated in urban landscape planning and design. Since urban planners need to reach out to and build alliances with like-minded people in the city, food could be an important tool to build these alliances. Nowadays a lot of urban farming and social initiatives related to food (production) are popping up in and around the city (Miazzo & Minján, 2013). But not only could it be a tool to create a link between city and nature. Recent studies have proven that the population of cities will increase by two million thousand people by fifty years of which 90 per cent will live in cities (Dassen & Haajer, 2014). All these people are in need of food to survive. It requires a certain amount of space (close to the city). Since space is limited, other solutions need to be found to produce enough food in the near future. It should be made explicit that the aim of this thesis is not to design large scale food industries in the middle of highly dense cities, it is aiming to make people aware of this problem. The aim is to educate people, make them aware of the outbalanced carrying capacity of our cities today and get them involved in the climate related issues themselves.

Biota

Since this thesis is focussing on food production in river parks, analysing the ecological process, or the river itself, is one of the main objectives. The river is a habitat for many species living in and around the water. Both animals and plants are occupying these areas. What species are living in the
Natural processes across the landscape

Ground water flow
Water in eroding stream
Water in meandering river
Wind erosion
Wind-dispersed seeds, dust
Fire movement
Seasonal migration
Animal dispersal
Animal foraging for food
Pollinator pollinating flowers

Landscape patterns produced by:

Natural processes
Planning and design
Unplanned development
Long-term trial and error

urban nature? Why are they living in these places and how can urban planning and design improve their habitats? Is it possible to link these natural habitats to food production? Or maybe energy production is possible using these habitats? Although biota might seem part of the field of biology, it is important to research the ecological system in order to understand the relation between human and nature in cities (Alberti & Marzluff, 2004).

People
Though the flow of people is the only non-spatial flow, it is affecting the design of waterfronts. It is therefore necessary to analyse the cultural processes in relation to food production. What is the current diet of people? How is it related to the different cultures living in Rotterdam?

Water
The flow of water, or the blue networks, is defined as the planned network of the natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services, of complex interrelations and dynamics of the hydrological system.

In this thesis the infrastructure of blue networks refers to the management of both fluvial and pluvial water in river parks to turn the existing urban fabric adjacent to the river Muse into resilient waterfronts in the future. Addressing water management of fluvial and pluvial water is relevant, because cities are threatened by flooding and drought caused by climate change. These dangers are highly present in the city of Rotterdam.

Sediments
This thesis is aiming to design productive landscapes in and around the river. Since the river is a natural source of sand and clay, the flow of these sediments should be included. Rivers transport a certain amount of sediments which will eventually alter the entire form of the river. Nowadays, rivers are dredged to clear the way for aquatic mobility and protect cities (Leeuwen, 2014). Consequently, sludge is displaced miles away from the city, which causes not only environmental damage, but also an inefficient way of moving solid ground costing a lot of money. Although this type of flow is not theoretically underpinned in Urban Ecology, it is a given that sand and clay will affect the design objective.
2.2 GREEN INFRASTRUCTURE PLANNING AND DESIGN

Today, a lot of pressure is put on nature in our cities. Since the early days urban planners and designers like Jacobs and Howard have addressed the various means of incorporating nature into the city and preserving it. Landscape architects like Frederik Law Olmsted not only investigated the appearance of nature in our cities, but also researched how to improve health and provide areas for recreation for the highly dense city (McPhearson, Hamstead, & Kremer, 2014). This is highly intertwined with the objectives of a productive riverscape. This is also expressed in the role of ecology in the design of resilient and self-sustaining cities via urban planning and design. Urban nature becomes a tool to design spaces for recreation, at the same time it improves the human health and well-being. Consequently, types of land define the land mosaic: the natural land cover (nature) and built cover (city). These types are linked via the infrastructures of green networks. These networks are defined as strategically planned networks of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. According to Hansen and Pauleit (2014) assessing ecosystem services in a multifunctional approach could improve resiliency and liveability of the urban fabric. Therefore an extensive amount of ecosystem services has been listed over the last years. These can be seen as a melting pot of innovative planning approaches in the field of nature conservation and green space planning (Hansen & Pauleit, 2014).

In this thesis the ecological services contribute to both the ecological and cultural layer of the design of productive riverscapes in Rotterdam. They are used to improve resiliency in neighbourhoods along the river in Rotterdam. Hence, ecosystem services are able to contribute to the design of waterfronts. Because this thesis is aiming to link the academic field to the practice of urbanism, the objectives of the municipality of Rotterdam are categorised according to a scientific scheme (Groot, Alkemade, Braat, Hein, & Willemsen, 2015, p. 2). According to this scientific scheme they are listed in figure 7 (next page).

Consequently, evaluating the analysis of the urban ecosystem according to the services of provisioning, supporting, regulating and cultural aspects of ecosystem services might lead to an adaptive framework for the design of productive riverscapes.

Figure 7  Green infrastructure planning and design
Source: image made by author using image retrieved from p.7, Barcelone Green infrastructure plan 2020
2.3 THE ADAPTIVE FRAMEWORK
understanding the relation between city and nature

In this final paragraph an adaptive framework to understand the relation between city and nature is proposed. It derived from both the theory and the study by Hoffman (2012), as explained previously. The adaptive framework is explained by both the developed and the present landscape.

> The developed landscape: how and in what form did an urban ecosystem evolve over time? And what can an urban planner learn from the historic processes?

Analysing landscape patterns via the former natural processes of the urban backbone could clarify current climate related issues. This information provides handles and needles in the future planning of resilient cities. Only the study of Forman (2014) proposes an analytical tool to review both the historical and present conditions of the urban ecosystem. According to his study revealing the urban backbone is necessary to understand natural processes in the city, which are linked to the negative effects of climate change and out balanced carrying capacity. Through it might be useful to analyse the historical natural processes, these can be altered in such a manner that current climate related issues cannot be clarified by former natural conditions (Dassen & Haajer 2014). Additionally, the research of Hoffman shows that analysing and visualising a certain flow for the design of resilient cities is possible without taking historical conditions into account. Still, it is wise to introduce the current land mosaic accompanied by a short historical analysis.

The research of Hofmann shows that analysing and visualising a certain flow for the design of resilient cities is possible without taking historical conditions into account. Still, it is wise to introduce the current land mosaic accompanied by a short historical analysis.

The models of Alberti (2008) and Forman (2014) can be compared, though the model of Alberti (2008) is only addressing the static layers of the land mosaic. Furthermore, Forman (2014) makes how to link the static and dynamic layers using his analytical model explicit. Additionally, the research of Hoffman is a practical implication of how these models are suitable for research by design.

Figure 3 (next page) shows the final framework as derived from the scientific models of Forman (2014) and Alberti (2008) related to the research by design study of Hoffman (2012). Finally, the complexity of the urban ecosystem can be simplified by making a distinction between static and dynamic layers. Firstly it is important to analyse the static layers. The patterns and corridors of the urban ecosystem define these. Categorising the different land uses and mapping them reveals the underlying structure of the patterns of the land mosaic. The corridors are defined as the infrastructures of green, blue and grey networks. Finally, the dynamic layer, or the metabolic flows, can be visualised using the geographical information system (GIS). The research of Hoffman shows the complexity of analysing one specific flow. Therefore, focussing only on the flow of food for the design of productive river- scapes is wiser than trying to understand all flows. Data can be made spatial via GIS City Sinks shows how the cycle of carbon can be analysed, visualised and redesigned using this methodology. Finally, maps are the results of static layers, while infographics are retrieved from the dynamic layers.

To conclude it remains difficult to simplify the complex layers of the urban ecosystem for the design of productive river- scopes. Chapter three will elaborate on the case study of the Rhine-Muse Delta and the city of Rotterdam. This area is analysed using the adaptive framework form where a catalogue of proposals is derived (chapter 4). The final chapter (chapter 5) is a reflection on both the method of this research by design project and the adaptive framework.
METHODOLOGY
The Rhine-Maas Delta

UNDERSTANDING THE CONTEXT OF THE DELTA
The objective of this thesis is to analyse and understand the metabolic system of food of both people and nature in the city. Consequently, is it necessary to analyse the Rhine-Maas Delta from the perspective of food, city and water. Nevertheless, the outcome will be a design of productive riverscapes. A landscape in which a symbiosis between housing, production, biodiversity and recreation is sought. Consequently, it is necessary to understand the context of the city not only from a metabolic point of view. One should gain a basic understanding of the all layers of the city before altering it via (sustainable) urban landscape planning and design.

Several workshops have been organised to gain a quick understanding of the Rhine-Maas Delta. Those have been in collaboration with the municipality of Rotterdam. Pieter de Greef, who is responsible to start a new urban project to improve the spatial and ecological quality of the river Muse and New Waterway, has defined the topics. Nevertheless, they have been chosen with ‘food’ in mind. The following workshops are:

- The natural river
  12th of February 2015
- The characteristic river
  16th of February 2015
- The robust river
  19th of February 2015
- The efficient river
  19th of February 2015
- The edible river
  4th of March 2015 (part of project Kennisvalorisatie Building with Nature in de stad, ECOSHAPE 2014 - 2015)
- The connecting river
  5th of March 2015
- The attractive river
  5th of March 2015
- The lively river
  5th of March 2015

Eight maps illustrate the results of the workshops. They are organised according to different layers of the city as follows:

- The natural river
  What are opportunities and constraints of the biophysical layer of the Rhine-Maas Delta?
- The robust river
  What are opportunities and constraints from the perspective of water management?
- The efficient river
  What are opportunities and constraints regarding other metabolic flows like sludge and energy?
- The edible river
  What are opportunities and constraints regarding the production of food?
- The connecting river
  What are opportunities and constraints regarding the topic of infrastructure?
- The attractive river
  How are users of the city experiencing the river?
- The lively river
  Where are activities located along the river?
- The characteristics of the river
  What are the characteristics of the three rivers?

All maps are shown on the next pages accompanied by small conclusions. The appendix contains the written reports. The results are used as input regarding the design of productive riverscapes in the delta.
The natural river: there are lots of opportunities within the biophysical layer regarding food production.

The robust river: the river Muse is still threatening the inner city of Rotterdam.

The efficient river: sludge is available and could be reused in the design of productive riverscapes.

The edible river: the river Muse produces edible species.

Figure 10
The natural river
Source: image made by author

Figure 11
The robust river
Source: image made by author and Wilfried Stolte

Figure 12
The efficient river
Source: image made by author and Wilfried Stolte

Figure 13
The edible river
Source: image made by author
The connective river: the world expo cherishes an improved connection along the river Muse

The attractive river: people experience a lack of green in the innercity close to the river

The lively river: several festivals and concerts are held in the inner city along the river Muse

The characteristics of the river: the river Muse is seen as an international and industrial river
INTRODUCING FOOD IN THE RHINE-MAAS DELTA

FOOD PRODUCTION
- food and biotopes
- food and cultures

FARMING OPPORTUNITIES

CONCLUSION
- regional system to produce food along the river of Rotterdam
3.1 INTRODUCTING FOOD PRODUCTION IN THE DELTA

The adaptive framework as derived from theory is used to analyse the ecological and cultural processes of the flow of food in the Rhine-Maas Delta. First of all, an introduction on the physical context is given. Second, the developed landscape is shortly explained. In the third paragraph the present landscape of the urban ecosystem is analysed from two perspectives: food production based on both the biotopes and the cultures of the city of Rotterdam. Finally, this chapter concludes with a regional system of food production in the Rhine-Maas delta.

The city of Rotterdam is located downstream of an urbanised delta near the mouth of the river Rhine and the river Muse. The wells of these rivers are in the Alps of Switzerland and France. Water of the mountains is collected in the Rhine and the Muse and is transported respectively 1233 and 950 kilometres towards the city of Rotterdam. Finally the amount of water is distributed among several rivers in the lowland of Rotterdam (Berger & Mugie, 1994).

Originally, Rotterdam has not been a city, which was easily connected to the sea via a big harbour. The map on the right shows how many islands have excluded the city from the open water around 1750. The meandering rivers transformed the landscape from time to time. Nevertheless, Rotterdam cherished to become one of the main ports of the Netherlands. Consequently, the New Waterway has been constructed in the 19th century as main connection between city and sea. From that moment on the Rhine/Maas Delta became one of the main civil constructions of the Dutch. The rivers no longer had their natural flow. From time to time, they are torturing the city, because they still are ‘natural’ rivers. They are in search of their own riverbanks through the lowland. Therefore, the city of Rotterdam has to deal with flooding caused by both the amount of water of the hinterland and the rising sea level of today. To conclude, productive riverscapes in the Rhine/Maas Delta are not only seeking to produce food. It is also used to design resilient waterfronts along river Muse.

Figure 18 Rotterdam around 1750
Source: municipal archive of Rotterdam
In the early days of civilization the production and consumption of food has been the opposite of today. People had to chase animals and collect herbs and spices. Consequently, cities have been built according to the most optimal location to survive. In the case of Rotterdam this has been in the Delta of the Rhine and Muse. Deltas have been providing fertile land, building materials and good transportation because of their locations. Therefore people have been occupying these areas over ages and transformed them to their own needs. Figure 19 is an example of how food has been incorporated in the daily life of Rotterdam. It is a painting of the famous Salmon house near ‘de Esch’, an area in the East of Rotterdam. This house served as a market, where daily caught salmon was sold. Apparently the Muse was once full of salmon, which was consumed by the inhabitants of Rotterdam. Nowadays salmon is not longer caught in the Rhine-Maas Delta. This could be explained by the way we have taken care of our natural environment since the early days of the industrial Revolution (de Greef, 2015). Technology and innovation have been prior to the preservation of nature.

This example stresses how the production and consumption of food has changed in the city of Rotterdam. Consequently, the Delta has been constructed and changed in such a manner that we are no longer able to consume food provided by the ecological system in and around the city of Rotterdam. Additionally, the diet of people has changed. The population of Rotterdam no longer includes only Dutch cultures; it has become a mix of more than 20 different nationalities. Therefore the demand of food typology has changed in relation to the different cultures living in Rotterdam.

This paragraph elaborates on current conditions of both the ecological and cultural system of food. How has the ecological system in Rotterdam changed over the years? Is it still possible to eat out of our natural environment? And what could we, urban planners, do to improve the edible biodiversity in the city of Rotterdam? Furthermore, food related to the different cultures in Rotterdam is investigated. What types of cultures inhabit the city? What is their daily diet? What types of food could be produced in and around the city of Rotterdam?

Figure 19
Salmon house in Rotterdam
Source: municipal archive of Rotterdam

3.2 FOOD PRODUCTION
production in the urban ecosystem of Rotterdam
At the beginning of every conversation regarding food production, the first question asked is: how is it possible to produce food in the highly dense city of Rotterdam? Is it not dangerous and poisonous?

Yes, several years ago it would not have been possible to produce food in biotopes in the city of Rotterdam. This analysis shows how the ecological conditions have changed over the last years and that its current state is suitable regarding food production.

**Physical conditions have changed**

Figure 20 gives an overview of the most important changes of the natural conditions in Rotterdam.

The ecological system has improved over the last years. Several species have been visiting the city. For example, seals are spotted in the harbour; they are even seen in the city centre! Also, a rare type of fish, the sturgeon, has been found in the harbour of Rotterdam.

This could be explained by the fact that the ecological system is affected less by human behaviour than it was before. We have clearly lowered the use of phosphates. Consequently, the quality of the water is improving and biodiversity is able to start restoring itself (de Greef, 2015).

But at the same time there are still constraints regarding food production based on the ecological system of Rotterdam. The water temperature is rising caused by the industrial wastewater. This contaminated water is still dumped into the main rivers and causes degradation. Also, the civil system of sluices and pumps is affecting the flow of water so much that aquatic animals are ‘lost’ in their own habitat of the rivers. Hence, migratory species like salmon and shad have disappeared.

Last but not least, contaminated sludge is thrown into the Muse. Though the velocity of the water does not move the contamination itself, some types of aquatic food should not be eaten (bron). Especially species that search for food in the soil of our riverbeds should be avoided. These types are encountered in the analysis (like carp and eel), but special measurements should be taken in the design of a productive riverscape.

**Types of biotopes and food production**

Figure 21 shows all types of food that could be harvested from the current biotopes in and around the city of Rotterdam.

A distinction is made between aquatic food and food produced on land. The map proves that the ecological system of Rotterdam already contains a lot of edible fish (shown as green types of fish). Talking to local fishermen along the New Waterway revealed new insights why these fish are not eaten yet. First of all, we are not used to catch our own fish anymore. Consequently, we have no idea what types of fish are inhabiting the city. Although we buy these types of fish in supermarkets every day, we have no idea where and how these species live.

Second of all, these fishermen prove that it is not dangerous to eat these species out of the water. Some have been eating out of the river their entire lives (about 70 years old). During my visits I have seen a lot of fish being caught over the last year.

Regarding the change of the ecological conditions several aquatic species could be produced in the near future (shown as orange types of fish). So why are we not catching fish and eating out of the river? It contains a diversity of species, which we already buy at the supermarket every day.

Also the biotopes on land produce several edible species. It should be mentioned that these types of food might not be seen as edible yet. Nevertheless, they could be a link between city and nature by incorporating these species in the design of a productive landscape.
Figure 21
Food production and biotopes in Rotterdam
Source: image made by author
Productive Riverscapes are not only about producing food based on the ecological system. It is aiming to link the ecological and cultural layers of the urban ecosystem via food. Therefore, also the diet of people has been analysed to gain insight in the actual demand of food typologies in the city of Rotterdam.

The ‘Rotterdam Cookbook’ (2013) serves as main reference to analyse the diet of people in Rotterdam. This book is a journalistic report of the different cultures living in Rotterdam and how they have their own food cultures. Notably, it remains difficult to get a grip on the actual types of food people consume.

The image on the next page (figure 23) is the result of this analysis. It shows the thirteen biggest cultures of Rotterdam.

- Dutch culture
- Chinese culture
- Indian culture
- Hindoestanic culture
- Creolean culture
- Antillean culture
- Cape Verdean culture
- Eritrean culture
- Iranian culture
- Turkish culture
- Moroccan culture
- Italian culture
- Jewish culture

The recipes of the different cultures are compared to each other and the types of products are listed according to different categories of food. Additionally, each category is ranked from the type of food most consumed (first in line) to the type of food least consumed (last in line).

One could conclude that though the cultures are different, people have a comparable diet. For example almost all cultures consume onions and garlic. Also cod is a common fish that could be eaten. Surprisingly, this type of fish is present in the ecological system of Rotterdam. So why not catch and eat out of our own front yard? Catching this type of fish could even increase social interaction between different cultures in Rotterdam.

The most important conclusion of the analysis of food cultures is that most types of food could be produced in and around the city of Rotterdam. Naturally some species are too exotic and our climate is not suitable to produce these types. Nevertheless, our moderate climate is suitable to produce most of these types of food.

To conclude, many typologies related to cultures could be produced locally. At the same time figure 22 gives an overview of the urban farming initiatives, allotment gardens and the local markets, where these products are traded. So why not extend the range of products in productive riverscapes based on the different cultures in Rotterdam? What types of food could be produced in Rotterdam?

Figure 22
Urban farming, allotment gardens and local markets in Rotterdam
Source: Image made by author
### Figure 23

Food and cultures in Rotterdam

Source: Image made by author
As shown in the analysis of both the current ecological and cultural system of Rotterdam, food could be produced linking both people and nature in the city. Consequently, the typologies of food are translated into farming opportunities. They are fundamental to the regional food system for the Rhine-Maas Delta and the catalogue of proposals. This paragraph shortly explains each farming opportunity.

The types of food are categorised according to the family they belong to:

- fish
- shellfish
- aquatic herbs
- herbs and spices
- vegetables
- meat

Every pattern is explained by the physical conditions that are necessary to produce this type of food. Consequently, the affected cultures are linked to the farming opportunity. Each coloured dot represents the culture as stated in figure 23.

The appendix contains an overview of all types of food, which could be produced in and around the city of Rotterdam. The image on the right (figure 24) only shows an impression of what the patterns look like.

Figure 24
Farming opportunities and types of food
Source: image made by author
A regional system to produce food along the river of Rotterdam is the result of the analysis of the ecological and cultural system of Rotterdam. Figure 27 (next spread) is an overview of the regional system of food. It consists of both patches and corridors. Each of them is suitable to produce certain types of food according to their physical conditions.

**Patches**

Different locations (= patterns) to produce food in and around the city of Rotterdam have been defined based on the ecological and cultural system. Each location has been analysed according to their physical conditions. What type of water is present in the patch? What type of soil is defining the characteristics of types of food? Which cultures are inhabiting the area? The outcome of this analysis is shown in the appendix (see Appendix: analysis). Figure 17 shows the final locations, which serve as input regarding the Catalogue of design proposals (chapter 4).

**Corridors**

This thesis is using the theory of Green Infrastructure Planning and Design. Not only patterns are important. Especially the corridors, connecting the different patches and enabling interaction between them, are highly valuable. Consequently, a network analysis (see Appendix: analysis) defined the different corridors. In the end, the blue infrastructure (the waterways in and around the city of Rotterdam) is mainly used as corridor between patches.

As mentioned before, the matter of scale is very important to produce food in a regional system. Different patches are defined on three different scale levels: the small scale, the meso scale and the large scale (see Appendix: spacematrix).

The large scale (1) is situated on the North Sea. Large fields of floating agriculture between windmills are densifying the surface of water. Nowadays, these areas are empty and ‘underused’, but they are highly suitable for large scale production in the Rhine-Maas Delta.

Locations on the meso scale (2, 3 and 5) are located around the city of Rotterdam. A certain amount of space is available, though large production is still impossible. These patches stimulate mainly interaction between people and nature in the city via recreational food production.

The small scale (3 and 4) is situated in the city of Rotterdam. A limited amount of space is available and therefore the objective is not producing food. Since people are living in and around these patches, these projects are aiming to stimulate social interaction among people via food. At the same time food production in and along the river could contribute to improving biodiversity on a small scale.

The next chapter elaborates on the different designs of these patches.

---

**Figure 25**

Different scales in the regional system of food production

Source: image made by author
Figure 26
Conclusion analysis. 1. inhabitants of Rotterdam experience lack of green along the waterfront of the city. 2. urban farming is mainly located in green areas of the city. 3. the quality of the water is improving. 4. habitat is separated from the river by the city itself.

Source: Image made by author.
Figure 27
Regional system of food production
Source: Image made by author
THE SMALL SCALE
Food production in the city

Jobscollective gardens
Pick and Net park

THE MEZO SCALE
Food production around the city

Fish and Farm island
Salty Shore

THE LARGE SCALE
Food production in the sea

Wind park farm
JOBS COLLECTIVE GARDENS
Schiehaven and Jobshaven, Rotterdam

Community farming as catalyst for social interaction
The Jobshaven and Schiehaven are situated in the city centre of Rotterdam. Large-scale production is impossible regarding the amount of available space. Therefore recreation and the stimulation of social interaction are the focal points of this design. The area is known for its character. It is an outer-dike area, where several former industry buildings are in contrast with the new modern built apartment blocks. Though the Schiehaven is not an active harbour anymore, the Jobshaven still serves as one of the main transport hubs of the aqua liner in Rotterdam.

**Figures and facts**

In the outer-dike housing blocks of Jobshaven are occupied by mainly Dutch people. The inner dike area of Delfshaven is mainly occupied by several cultures like Surinamese, Antillean and Moroccan families. The physical conditions of the area are comparable to those of the mouth of the Rhine-Maas Delta. The water is still salty (\(100,000 \pm\) ), though it is sometime mixed with brackish to fresh water (\(10,300 >\) ). This highly influences the type of food production in Jobs Collective gardens. Freshwater species do not want to be flooded by salt water from time to time (de Greef, 2015). Furthermore both harbours contain constructed quays of steel and very deep waters. Regarding the design of a productive riverscape it is necessary to change these typologies in order to produce food, improve biodiversity and stimulate social interaction.

**Objectives**

A workshop among inhabitants, stakeholders and the urban development department has been organised by the municipality of Rotterdam itself. During the workshop it became clear that the inhabitants are cherishing a different character between both harbours. The Jobshaven should still be used as an industrial and active harbour. Regarding food production the area could be changed via the implementation of a floating platform (related to urban farming). The Schiehaven should have a natural character than it has now. Greener, recreation and building with nature are the objectives of this specific harbour (see Appendix: workshops).

**Conditions**

Several measurements have to be taken in order to turn these ambitions into reality. Regarding food production the area should be changed according to the following:

- Creating a sloping shore
- Decrease the velocity of the water
- Create shallow water
- Clean the soil
- Avoid sediments to flow into the main river

Next to these physical conditions to enable food production and increase biodiversity, measurements have to be taken to include people in the design.

- Provide access to aquatic/tidal production
- Create more visible green in the harbour

**Variations**

With these objectives and conditions in mind, several conceptual variations have been produced (see Appendix: variations). From a moderate impact concept (1) to a highly conceptual design proposal regarding building with nature and food production (3) are the results. After discussions with experts and quantifying the scenarios, the variation that combines both (variation 2) is seen as the most realistic scenario in terms of recreation, food production, improving biodiversity and stimulating social interaction.
JOBS AND SCHIEHAVE

TOTAL M2
48.4 ha
land: 287,000 m2
water: 205,000 m2

TYPE OF ECOTOPE
extreme to moderate/low dynamic tidal stream

VELOCITY
<0, 0.42> m/s

WATER DEPTH
<3 < 10 m

SOIL TYPE
clay and moderately coarse sand

GSI
[0.2, 0.4]

FSI
[0.4, 22 <

UNEMPLOYMENT
43%

NUMBER OF HOUSEHOLDS
3,050
38% dutch
12% suinamese
9% antillean
8% moroccan

Figure 29
Food typology Jobs and Schiehaven
Source: image made by author
This proposal is a low-impact design for the Jobs and Schiehaven. The Jobshaven will be altered via a floating structure at the end of the harbour. The element could serve multiple purposes like recreation and urban farming.

The Schiehaven also contains new islands at the East side of the harbour. These could serve as floating urban farming platforms. The green patches on both the North and South side of the harbour are small parks based on the building with nature principle. By demolishing part of the structure of the quay, sand will relocate itself via the velocity of the water.

The design has limited space to produce food, but is serving as research pilot in the city of Rotterdam. It is touching upon all criteria of a productive riverscape: housing, production, biodiversity and recreation. Nevertheless, recreation is most effected in this proposal.
The design is a moderate-impact proposal. Again, floating structures are introduced in the Jobshaven. Four bigger elements are proposed in contrast with the previous variation.

The proposal of the Schiehaven contains a bigger park, which is again based on the principle of building with nature. Almost all structures of the Northern quay is demolished. Consequently, a large gradient could be constructed by ‘nature’. Eventually, it would not only be a park, but it would be used to produce food based on the biotopes. Seaweed, samphire and lamsoor are products that could be produced in the area.

To conclude, the productive landscape is mainly composed by production and biodiversity in combination with recreation and a bit of housing.

The last proposal is a high-impact design based on the building with nature principle. All quays will be demolished, expect for those that are protecting the current housing areas. As a result the area would become a large park in which both local inhabitants and users of the city could recreate along a natural part of the river. Not only would they be able to reach the shoreline, they would also be educated on local food products based on the biotopes.
Eventually a combination between the first and second variation is proposed. After talking and evaluating the design with several employees of the municipality, demolishing the structure of the quays would not be feasible. One should think of re-using sludge to create a gradient along the existing quay in order to build a gradient in this area.

Additionally, the inhabitants of this area have been involved in the process of transforming the area. They would like floating structures and an industrial character in the Jobshaven. A natural character based on the building with nature principle could be a possibility in the Schiehaven. Nevertheless, the Northern part of the quay should still be accessible for bigger boats. A large gradient would only be possible on the South and East side of the Schiehaven. One could produce food based on the biotopes by adding a large area of sloping shoreline along those quays. Both inhabitants and other users of the city would be able to recreate and reach the shoreline of the river Muse. By making platforms the height difference between the existing quay and the height of the water could be minimized. At the same time one could experience the tidal difference from another perspective.

Regarding food production it is wise to implement land farming on the Schiehaven. The existing urban farm on the Jobshaven side will be demolished in the near future. By adding both a farming island in the Jobshaven and an urban farm on the Schiehaven one could produce a high amount of land-based products. It should be mentioned that all stakeholders (municipality, inhabitants and private investors) should be included in the design process regarding maintenance of the production area.
Avoid sediment from moving

Forest of willow trees and floating structures

The combination of both avoids the sediment from moving and also creates visible greening and habitat.

Accessibility

Sloping shoreline and floating structures

People are able to access and harvest the food via these spatial elements.

Remediation

Mussel banks and aquatic vegetation

They are filtering and cleaning the water inside the Maasharbour.

Shallowing water

Re-use sludge

Shallow water could be made by re-using sludge of the area. It creates optimal habitat for aquatic food.

Visible greening

Vegetated slope & forest of willow trees

The gradient of food and forest of willow trees create visible greening in contrast with the current quays.

Gradient

Soft covered shoreline

At this moment the shoreline of the area is a quay. By making soft covered dikes an extensive amount of food could be produced on the new gradient.

Lower velocity

Forest of willow trees and floating structures

The velocity of the water could be lowered by these structures to protect both food production and the hinterland.
ROOFTOP FARMING & FOOD
- onions, potatoes, quinoa, garlic, paprika, tomatoes, carrots

TIDAL HABITAT & HERBS
- samphire, lamsoor, watermint

AQUATIC FOOD
- cod, herring, salmon, bream, shad, pike-perch, sturgeon, eel, flounder
- mitten crab, cray fish
- sea cauliflower, japanese seaweed, seaweed

FLOODPLAIN HABITAT & HERBS
- celery, parsley, sage, lettuce of willow

LAND HABITAT & SPICES
- thyme, bay leaf, coriander, clove

LAND FARMING & FOOD
- onions, potatoes, quinoa, garlic, paprika, tomatoes, carrots

ROOFTOP FARMING & FOOD
- onions, potatoes, quinoa, garlic, paprika, tomatoes, carrots

JOBS COLLECTIVE GARDENS
- community farming as catalyst for social interaction

Source: image made by author
PICK AND NET PARK
Maashaven, Rotterdam

Productive public park for mixed neighbourhood
Also situated in the city centre of Rotterdam is the Maashaven. Large-scale production could be possible regarding the amount of available space. Nevertheless, this would not contribute much to the objectives of social interaction and greening the harbour. Therefore also recreation and the stimulation of social interaction are the focal points of this design. The area is located in the South of Rotterdam. Compared to other harbours in the city centre, this harbour contains a large amount of available space. In the area around the harbour, new building blocks (on the North side) and empty industrial buildings (on the South side) define the character of this location.

Figures and facts

The area is occupied by many different cultures. Although several ethnicities live in the South of Rotterdam, this harbour is of special interest because it is located close to the daily food market of the Maashaven. Inhabitants from all nationalities are buying local food in this market every day. Turkish people inhabit the area for 34%. Other cultures living around the Maashaven are Dutch, Moroccan and Surinamese families. Though the area is located almost on the opposite site of the Jobs and Schiehaven, the physical conditions are different. Most of the time, the water is brackish to fresh. Depending on the season and year, the water is completely fresh. It should be mentioned that according to present studies, the water could become completely salt in the future. When the New Waterway will be excavated (de Greef, 2015). This will affect the typology of food. Nevertheless, the current situation is a focal point of this design. Additionally, the harbour contains constructed quays of steel and very deep waters. Regarding food production it is necessary to change these typologies in order to produce food, improve biodiversity and stimulate social interaction.

Objectives

Different designs have been made by design offices to test several scenarios. A few variations have been defined by studying the scenarios. First of all, the harbour is still in use for industry and shipping. This should be taken into account when (some parts of) the harbour is changed into a productive riverscape. Second of all, the area around the harbour is marked as an area with a lot of potential to be developed. Consequently, the design of a productive riverscape could be used as a catalyst for this social interaction and greening of the area.

Conditions

Several measurements have to be taken in order to turn these ambitions into reality. Regarding food production the area should be changed according to the following:
- create a sloping shore
- decrease the velocity of the water
- create shallow water
- clean the soil
- avoid sediments to flow into the main river

Next to these physical conditions to enable food production and increase biodiversity, measurements have to be taken to include people in the design.
- provide access to aquatic/tidal production
- create more visible green in the harbour.

Variations

With these objectives and conditions in mind, also several conceptual variations have been made. From a moderate impact concept (1) to a highly conceptual design proposal regarding building with nature and food production (3) are the results. After scoring and discussions with several stakeholders, the variation that combines both (variation 2) is seen as the most realistic scenario.

![Diagram](http://www.rijkswaterstaat.nl/water/feiten_en_cijfers/vaarwegenoverzicht/nieuwe_waterweg/;
Total M2: 51.4 ha
- Land: 304,000 m²
- Water: -

Type of Ecotope: Extreme to moderate/low dynamic tidal stream

Velocity: <0, 0.42> m/s

Salinity: [300, 1000] mg/l Cl
[0, 300] mg/l Cl

Water Depth: <10 m>

Type of Shore: Quay

Soil Type: Clay and moderately coarse sand

GSI: 0.21

FSI: 0.8

Unemployment: 43%

Number of Households: 3,520
- 34% Turkish
- 16% Dutch
- 13% Moroccan
- 13% Surinamese

Figure 32: Food typology Maashaven
Source: Image made by author
### VARIATION 1

Again, the first proposal is a low-impact design. Nowadays, the Maas haven is an active harbour. Therefore, the design should always include the functioning of an active harbour.

The Maas haven is split into two parts. Industries and their big boats use the Western part. The Eastern part of the harbour is transformed into a park based on the building with nature principle. The two parts are divided by a large floating structure. The structure could serve as an urban farming area with unique views. A natural-like park with edible plants on the one side and an industrial view on shipping boats on the other side. Regarding the design of productive riverscapes this proposal highly integrates the two faces of Rotterdam: the natural character of the river combined with the industrial harbour.
VARIATION 2

The second proposal is a combination where a symbiosis between floating elements, building with nature and harbour activities is sought. Industrial activities are located at the mouth of the Maashaven and separated from the ecological park by the production of mussels. Since these grow on wooden poles, the elements could be used for both decreasing the velocity of the water and cleaning the water from industrial waste. Consequently, it is questionable if these mussels should be eaten or not. But since they are cleaning the water that goes in to the ecological park, food production in this area would be less affected by the industrial wastewaters. The ecological park is providing food based on the biotopes. Urban farming could be located on the floating structures as well could recreational functions like restaurants and events be.

VARIATION 3

The third variation has eliminated the boats almost entirely. A connection is made between the North and South side of the Maashaven in order to improve mobility in the area. Also smaller floating structures are introduced, which serve as recreational purposes. For example restaurants, which want to produce their food locally would have an opportunity to introduce a new concept of recreation in the Southern part of Rotterdam. Regarding food production this proposal would be optimal, because of the large amount of space of food production that is created. Nevertheless, it would be difficult to implement this design, because of the current use of the harbour.
Eventually a combination between the first and second variation has been chosen to implement in the regional system of food production in the Rhine-Maas Delta. The first variation has a limited amount of space available regarding the ecological park. A larger patch could be achieved by relocating the floating structures more to the West side of the Maashaven.

Consequently, the astonishing view of the ecological park on the East side and the industrial harbour on the West side could be maintained. At the same time food could be produced in combination with recreational and educational function.

This specific location is not adding that much value to the regional system of food production. This is because of the lack of green patches in the Southern part of Rotterdam. Nevertheless, it is even more important to implement these small ecological patches on the Southern side of the river Muse. By creating several green infrastructural locations along the Southern side the ecological network on a regional scale could be improved.

Additionally, the area of Rotterdam South is in need for improvement from a social point of view. Since green spaces are adding value to the way people perceive their living environment, the implementation of productive riverscapes could be a to do so.

At the same time, urban farming is a way of educating people. Participants start learning about the production and consumption of food. Consequently, they are able to make choices regarding food based on knowledge they gained in practice.

To conclude, food production itself is not the main objective of this location. The design is mainly contributing to improvement of the area via education and recreation.
MAAS HAVEN

**Figure 34**
Section Pick and Net Park
Source: image made by author

**MAAS HAVEN**

---

**MAAS HAVEN**

---

**MAAS HAVEN**

---

**MAAS HAVEN**

---

**AVOID SEDIMENT FROM MOVING**
Forest of willow trees and floating structures
The combination of both avoids the sediment from moving and also creates visible greening and habitat.

**ACCESSIBILITY**
Slipping shoreline and floating structures
People are able to access and harvest the food via these spatial elements.

**REMEDATION**
Mussel banks and aquatic vegetation
They are filtering and cleaning the water inside the Maasharbour.

**LOWER VELOCITY**
Forest of willow trees and floating structures
The velocity of the water could be lowered by these structures to protect both food production and the hinterland.

**VISIBEL GREENING**
Vegetated slope & forest of willow trees
Vegetation slope & forest of willow trees create visible greening in contrast with the current quays.

**SHALLOWING WATER**
Re-use sludge
Shallow water could be made by re-using sludge of the area. It creates optimal habitat for aquatic food.

**GRADIENT**
Soft covered shoreline
At this moment the shore of the area is a quay. By making soft covered dike an extensive amount of food could be produced on the new gradient.

**RECREATIONAL PARK**
Collecting food in urban nature: fishing, swimming.

**BLUE CONNECTION**
Barrier between food and park: lowering visibility of the water; breeding area for biodiversity.

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---

**MARKET**

---
FISH AND FARM ISLAND
Eiland van Blienenoord, Rotterdam

Recreational farm and allotment gardens in the city

Eiland van Brienenoord is a small island located on the East side of the city centre of Rotterdam. Most inhabitants do not even know this island. Because of the size of the plot, it is possible to produce a vast amount of food on the island. Nevertheless, the area is characterised by an old forest. It serves as a hotspot regarding biodiversity in the city. The area contains no buildings and is mainly used for recreation. The green forest is a calm and relaxed area to escape from the highly dense city centre. Next to the recreational function, a large amount of allotment gardens are located on the island.

**Figures and facts**

Though people do not occupy the area, the allotment gardens are used by several ethnicities living in the South of Rotterdam. The neighbourhood close to the iseland van Brienenoord is enclosed in this patch, because it could be used for daily food production regarding these building blocks. Again, mainly Dutch people inhabit these areas. Next to this majority, several Surinamese, Antillean and Moroccan families are living close to the island.

Since the island is located on the East of Rotterdam, the physical conditions are very different from the others. The velocity of the water has decreased a lot. Also the salinity is classified as fresh water. No salt water, even brackish water is not in question. Additional influences to this type of food production (1) to a highly conceptual design proposal regarding building with nature and food production (3) are the results.

**Objectives**

Also regarding this location, several design offices have done research. Nevertheless, the overall objective has been the same. It is important to preserve the ecological function of the island in order to improve biodiversity. Next to this main point of interest, recreation and education of people are addressed. This should also be incorporated in the final design of this case. But how could one increase biodiversity via food production?

**Conditions**

Several measurements have to be taken in order to improve the ecological system of Rotterdam. Regarding food production the area should be changed according to the following:
- create a sloping shore
- create shallow water
- clean the soil
- avoid sediments to flow into the main river

Next to these physical conditions to enable food production and increase biodiversity, measurements have to be taken to include people in the design:
- provide access to aquatic/tidal production
- create more visible green in the harbour.

**Variations**

With these objectives and conditions in mind, also several conceptual variations have been made. From a moderate impact concept (1) to a highly conceptual design proposal regarding building with nature and food production (3) are the results.

After scoring and discussions with several stakeholders, the most extreme concept of building with nature could be interesting regarding the entire regional system of food. On one hand biodiversity could be improved as much as possible. On the other hand recreational routes concerning the production of food, combined with educational points, could improve the relation between people and nature in the city.
**TOTAL M2**
- 19.2 ha
  - land: 182,000 m²
  - water: 100,000 m²

**TYPE OF ECOTOPE**
- low dynamic tidal stream

**VOLUME**
- <0, 0.42 m/s

**SALINITY**
- [0, 300 mg/l Cl⁻]

**WATER DEPTH**
- [3 < 14 m]

**TYPE OF SHORE**
- vegetated slope

**SOIL TYPE**
- clay and peat

**GSI**
- 0.03

**FSI**
- 0.05

**UNEMPLOYMENT**
- 24%

**NUMBER OF HOUSEHOLDS**
- 13,500
  - 66% Dutch
  - 7% Surinamese
  - 5% Antillean
  - 3% Moroccan

---

**EILAND VAN BRIESEN-NOORD**

**CATALOGUE OF DESIGN PROPOSALS | FISH AND FARM ISLAND**

**Figure 35**

Food typology Eiland van Brienenoord

Source: image made by author

- **Lunch**
- **Bream**
- **Eel**
- **Grey goose**
- **Cray fish**
- **Pike perch**
- **Sturgeon**
- **Mitten crab**
- **Cauliflower**
- **Lettuce of willow**
- **Water mint**
- **Parsley**
- **Potato**
- **Chicken**
- **Quinoa**
- **Crake**
- **Paprika**
- **Garlic**
- **Carrot**
- **Thyme**
- **Coriander**
- **Onion**
- **Ginger root**
- **Tomato**

---
EILAND VAN BRIENEN-NOORD

**EILAND VAN BRIENEN-NOORD**

**Figure 36**
Evaluation of variations
Source: Image made by author

**PRODUCTIVITY**

<table>
<thead>
<tr>
<th>Biophysical</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil type</td>
<td>2.9</td>
</tr>
<tr>
<td>Contamination</td>
<td>3.3</td>
</tr>
<tr>
<td>Groundwater table</td>
<td>3.3</td>
</tr>
<tr>
<td>Water quality</td>
<td>3.3</td>
</tr>
<tr>
<td>Velocity</td>
<td>3.3</td>
</tr>
</tbody>
</table>

**INVOlVEMENT**

<table>
<thead>
<tr>
<th>Ecosystem services</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits</td>
<td></td>
</tr>
<tr>
<td>Small scale food production</td>
<td>4.3</td>
</tr>
<tr>
<td>Increase biodiversity</td>
<td>5.5</td>
</tr>
<tr>
<td>Re-use sludge</td>
<td>3.3</td>
</tr>
<tr>
<td>Reduce cost of maintenance</td>
<td>4.3</td>
</tr>
<tr>
<td>Symbolic value</td>
<td>3.9</td>
</tr>
<tr>
<td>Increase value of property</td>
<td>3.3</td>
</tr>
<tr>
<td>Catalysed urban development</td>
<td>3.3</td>
</tr>
</tbody>
</table>

**CONSTRAINTS**

<table>
<thead>
<tr>
<th>Productivity</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigable depth &amp; width</td>
<td>1.1</td>
</tr>
<tr>
<td>Active harbour activities</td>
<td>3.3</td>
</tr>
<tr>
<td>Harbour city sentiment</td>
<td>3.3</td>
</tr>
</tbody>
</table>

**ECOSYSTEM SERVICES**

<table>
<thead>
<tr>
<th>Benefits</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase biodiversity</td>
<td>5.5</td>
</tr>
<tr>
<td>Re-use sludge</td>
<td>3.3</td>
</tr>
<tr>
<td>Reduce cost of maintenance</td>
<td>4.3</td>
</tr>
<tr>
<td>Symbolic value</td>
<td>3.9</td>
</tr>
<tr>
<td>Increase value of property</td>
<td>3.3</td>
</tr>
<tr>
<td>Catalysed urban development</td>
<td>3.3</td>
</tr>
</tbody>
</table>

**VARIATION 1**

The first variation is a low impact design for the Eiland van Brienen-Noord. Both the existing allotment gardens and forest will be retained. The West side of the island will be transformed into a park, where people are able to recreate. Either by fishing, walking along the shoreline or taking a boat to explore the island from a water point of view. Till now, most locations have a small food gradient with aquatic food production till production on land along the shoreline. This design differs from the others, because of the locations of the types of food production. The gradient is not along the shoreline; it is along the entire island. Consequently, the recreational purpose of the design has another character than all other three locations. Nevertheless, the area of an ecological park based on the building with nature principle is limited.
The second variation is a moderate-impact design. It is comparable to the first proposal. The only difference is the Western part of the island. By opening up parts of the shoreline, an ecological park could be constructed using the natural forces of the river. Patches of mussel production and willow trees are protecting the shoreline from too much erosion.

Consequently, the design would still have the characteristics of a large gradient from the Western to the Eastern part of the island. Nevertheless, the ecological park would be bigger. The result would be a bigger amount of food production based on the existing biotopes of the Island van Brienenoord. Constraints of this extension are the loss of recreational space of the island.

The last variation is again a high impact design. Both the Western and Eastern side of the island are given back to the nature. The velocity of the water will constantly change the shoreline on the South. Only the old forest will be remained, since it is adding a both ecological and recreational value to the design. In addition, food could be produced in the so-called ‘food-forest’.

The main challenge regarding this design is avoiding that the sediment is moving into the river Muse. Since the island is located near a transportation routing of the industrial ships, sedimentation is allowed till a certain level. Consequently, a large amount of mussel poles and willow trees are located on the Western side of the island. These constructions will avoid the sediment from moving into the main part of the river.

To conclude, this location would contribute to the production of food based on biotopes. Also it would add value to biodiversity and recreation.
Evaluating the different variations with the municipality of Rotterdam revealed a suitable design for the Eiland van Brienenoord. Since the island is exclusive by its natural character, it is mainly used for recreation by both local inhabitants and users of the city. Therefore, a symbiosis between recreation and food production should be the main objective of the design. The final design is a combination between the first and second variation.

The large gradient spread out over the entire island is the main characteristic of the design. Aquatic food production based on the existing biotopes is located in the ecological park on the West side of the island. The middle part is defined by the old forest, which could be transformed into a food forest. The East side of the island will still be used by the allotment gardens of local inhabitants. Consequently, a gradient from aquatic food production in the West to land production in the East defines the new fish and farm island.

To conclude, this design of a productive landscape is mainly focussing on the production of food in combination with improving biodiversity and recreation. Visitors of the island are able to catch their own food and immediately prepare it in the park areas on the island. Additionally, an educational route could teach users of the island on nature and food production based on both the biotopes and cultures of Rotterdam. To implement the project, it is less important to involve the inhabitants near the island compared to the Jobs/Schiehaven and Maashaven. One is not using the island on a daily basis and therefore it is not affecting the living environment of people. Nevertheless, private stakeholders should be involved in an early stage to create a widely accepted design.
**ACCESSIBILITY**

Slipping shoreline and floating structures. People are able to access and harvest the food via these spatial elements.

**VISIBLE GREENING**

Vegetated slope creates visible greening in contrast with the rocky shoreline.

**AVOID SEDIMENT FROM MOVING**

Riverpark located in the inner curve of the river & forrest of willow trees. The combination of both avoids the sediment from moving and also creates visible greening and habitat.

**LOWER VELOCITY**

Riverpark located in the inner curve of the river. In this part of the river, the velocity of the water is lower than in an outer curve.

**SHALLOWING WATER**

Re-use sludge. Shallow water could be made by re-using sludge of the area. It creates optimal habitat for aquatic food.

**ON-GOING CORRIDORS**

Stairs for fishes. Connecting the main river to the existing pool on the island creates a new ‘highway’ for aquatic species. Nowadays, there is no connection at all.

**GRADIENT**

Soft covered shoreline. At this moment, the shore of the area is a steep vegetated slope. By making soft covered dikes, an extensive amount of food could be produced on the new gradient.

**LOWER VELOCITY**

Riverpark located in the inner curve of the river. In this part of the river, the velocity of the water is lower than in an outer curve.

**SHALLOWING WATER**

Re-use sludge. Shallow water could be made by re-using sludge of the area. It creates optimal habitat for aquatic food.

**ON-GOING CORRIDORS**

Stairs for fishes. Connecting the main river to the existing pool on the island creates a new ‘highway’ for aquatic species. Nowadays, there is no connection at all.

**GRADIENT**

Soft covered shoreline. At this moment, the shore of the area is a steep vegetated slope. By making soft covered dikes, an extensive amount of food could be produced on the new gradient.

---

**RECREATIONAL POND**

Wading, swimming, wading.

**VEGETATED SLOPE**

Stairs for dikes. An existing dune for irrigation.

**HELOPHYES**

Greening velocity of water. Filtering the water for irrigation.

**BLUE CONNECTION**

Inter-service, reeds, lake, dikes.
SALTY SHORE
Oranjebuitenpolder, Maassluis
Recreational riverscape along the Muse
Oranjetuinenpolder is not part of the municipality of Rotterdam. Nevertheless, it is part of the regional program of ‘the river as a tidal park’. Because of the high amount of available space, the area is of big importance regarding the production of food itself. The remote location (about 20 kilometres away from the city centre of Rotterdam) will make it difficult to address participatory design to improve the link between people and nature. Consequently, this location is characterised by the production of food and improving biodiversity along a recreational route.

Figures and facts

Nowadays, the area behind the dike (inner-dike) is mainly used as farming land. The road in front of the dike (outer-dike) is used a recreational route between the city of Rotterdam and the beach, near Hoek van Holland. Consequently, only a limited amount of people is living in the area and they are almost all Dutch farmers.

The Oranjetuinenpolder is located near the mouth of the Rhine-Maas Delta. Therefore, the physical conditions of the area can be compared to those of the North Sea. The water is very deep, the velocity of the water is high, as is the salinity of the water. It is always salty (>3000 ppm). Regarding food production the area behind the dike is mainly dominated by clay, which is affected by the salty ground water. Consequently, the type of food production is completely different (maybe even the opposite) of the production at the Eiland van Brienenoord.

Objectives

This area is defined by its location regarding the regional system of food. On the one hand it contains an enormous amount of space. On the other hand, it is located along both the Muse River and one of the main canals of the hinterland. Therefore the objective of the location is to design a patch on the connection point of two important (blue) corridors. But what should be done to transform this area into a connection point of two corridors via food production?

Conditions

Several measurements have to be taken in order to improve the ecological system of Rotterdam. Regarding food production the area should be changed as follows:
- create vegetated slopes
- create shallow water
- decrease the velocity of the water
- avoid sediments to flow into the main river

Next to these physical conditions to enable food production and increase biodiversity, measurements have to be taken to include people in the design.
- provide access to aquatic/tidal production

Variations

With these objectives and conditions in mind several conceptual variations have been made. From a moderate impact concept (1) to a highly conceptual design proposal regarding building with nature and food production (3) are the results. After scoring the different variations, the main focus point is on creating a recreational route along the shore of the Muse river. The Salty Shore. The hinterland is used for silt agriculture to produce exclusive types of silt vegetables. Since this type of production is new in the Rotterdam region, it could serve as an educational hotspot along the recreational route.
ORANJE BUITENPOLDER

TOTAL M2
325 ha
land: 3,220,000 m²
water: 3.5 km along shoreline

TYPE OF ECOTOPE
highly dynamic tidal river

VELOCITY
<0.5, < m/s

SALINITY
[3000, < mg/l Cl

WATER DEPTH
[0.5 < 14 m]

TYPE OF SHORE
rocky slope

SOIL TYPE
sand (hinterland: clay)

GSI
0.007

FSI
0.007

UNEMPLOYMENT
24 %

NUMBER OF HOUSEHOLDS
15
99% dutch

Figure 38
Food typology Oranjebuitenpolder
Source: image made by author
## Current Situation

*Figure 39: Evaluation of variations*  
*Source: Image made by author*

<table>
<thead>
<tr>
<th><strong>Productivity</strong></th>
<th><strong>Involvement</strong></th>
<th><strong>Ecosystem Services</strong></th>
<th><strong>Constraints</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil type</td>
<td>Point in ecological network</td>
<td>Small scale food production</td>
<td>Navigable depth &amp; width</td>
</tr>
<tr>
<td>Contamination</td>
<td>Point in recreational network</td>
<td>Small scale energy production</td>
<td>Active harbour activities</td>
</tr>
<tr>
<td>Groundwater table</td>
<td>Participation</td>
<td>Increase biodiversity</td>
<td>Harbour - city sentiment</td>
</tr>
<tr>
<td>Water quality</td>
<td>Educational value</td>
<td>Greening land</td>
<td>-</td>
</tr>
<tr>
<td>Velocity</td>
<td>Linking city and nature</td>
<td>Improve water safety</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Research pilot</td>
<td>Re-use sludge</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce cost of maintenance</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multiplier effect</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Symbolic value</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase value of property</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Catalyst urban development</td>
<td>-</td>
</tr>
</tbody>
</table>

### Current Situation

"ORANJE BUITENPOL-DER"

"CATALOGUE OF DESIGN PROPOSALS | SHALTY SHORE"
The first variation has a moderate impact on the current functioning of the area. A vegetated shoreline is created along the river Muse. It does not only function as an ecological corridor, but also serves as recreational route between the city of Rotterdam and the city of Hoek van Holland. Nowadays, people are walking, cycling and fishing along the shoreline. Talking to current users of this space revealed that they would like to have more recreational functions along the river. Turning the rocky shoreline into a vegetated park, where people could sit, fish, relax and harvest some food out of the habitats could improve the regional recreation in and around the city of Rotterdam.

The second variation is elaborating on the first one (left page). The idea of a recreational shoreline is transferred into this proposal. Nevertheless, the hinterland will also be altered. A new wetland is created in these polder areas by connecting the main river Muse to the polder behind the dike. Consequently, the tide of the water is effecting the current agriculture fields of the Oranjebuitenpolder. One of the conclusions of the workshops regarding this area has been the struggle of fresh water supply in the near future. Instead of looking for opportunities of fresh water supply, the area could be turned into a salty wetland. Farmers are able to produce exclusive products like seaweed, samphire or even crayfish and lobster. Additionally, the new wetland will improve the biophysical layer of the region by creating a large patch of habitat.
To conclude, the second variation would be adding to the objective of the regional food system of Rotterdam. Not only new habitat would be created by the new wetland. Also, exclusive products could be produced, which benefit the entire region. It could become a benchmark of the Delta region.

It should be mentioned that it is necessary to work together with all stakeholders to implement this high impact transformation. Farmers should be willing to change the types of products, which they produce at the moment. The waterboard should be willing to contribute to the entire process. Also the province of South-Holland should be willing to cooperate in the process. Additionally, not only public organisations and inhabitants are necessary to involve. Also private stakeholders play an important role in transforming the Oranjebuitenpolder. They are the ones who might be able to both invest and guide the process of spatial transformation.

All in all, it is not only necessary to think about the design of the area. Creating support within the Oranjebuitenpolder is needed to implement a new type of an edible wetland in the region of Rotterdam.
Figure 40
Section Salty Shore
Source: image made by author

**ACCESSIBILITY**
Stones and floating structures
People are able to access and harvest the food via these spatial elements.

**VISIBLE GREENING**
Vegetated slope
Vegetated slope creates visible greening in contrast with the rocky shoreline.

**AVOID SEDIMENT FROM MOVING**
NOG TOEVOEGEN
These elements not only lower the velocity of the water, they also avoid the sediment from moving.

**LOWER VELOCITY**
NOG TOEVOEGEN NAAR!
The velocity of the water is reduced by these elements to protect the food, which is produced on the soft covered shoreline.

**ON-GOING CORRIDORS**
Stairs for fishes
Connecting the main river to the hinterland creates a new highway for aquatic species. Nowadays, there is no connection at all.

**SHALLOWING WATER**
Re-use sludge
Shallow water could be made by re-using sludge of the area. It creates optimal habitat for aquatic food.

**GRADIENT**
Soft covered dike
At this moment the shore of the area contains rocks. By making soft covered dikes an extensive amount of food could be produced on the new gradient.

**LOWER VELOCITY**
NOG TOEVOEGEN NAAR!
The velocity of the water is reduced by these elements to protect the food, which is produced on the soft covered shoreline.

**ON-GOING CORRIDORS**
Stairs for fishes
Connecting the main river to the hinterland creates a new highway for aquatic species. Nowadays, there is no connection at all.

**SHALLOWING WATER**
Re-use sludge
Shallow water could be made by re-using sludge of the area. It creates optimal habitat for aquatic food.
AQUATIC FOOD
cod, herring, flint, salmon, bream, shad, pike-perch, sturgeon, eel, flounder, anchovy, mackerel, french oyster, japanese oyster, squid, octopus

TIDAL HABITAT & HERBS
samphire, lamsoor, watermint

FLOODPLAIN HABITAT & HERBS
celery, parsley, sage, lettuce of willow

SALTY SHORE
recreational riverscape along the river Muse

Source: image made by author
WIND PARK FARM
along the shore of the North Sea

Floating agriculture for the Rhine-Maas Delta
The final case study is located in the North Sea. The objective of this thesis is to design resilient waterfronts using food as a tool to link people and nature. Nevertheless, a regional food system for the Rhine-Maas Delta is not complete without a location to actually produce a large amount of food. Since both the Rhine-Maas-Delta and the city of Rotterdam are highly dense, the ‘underused’ space of the North Sea is still available for the production of food. It is characterised by the empty open sea and the objectives of the Dutch inhabitants to transform these areas into resilient areas by making big parks of windmills.

Figures and facts
The area is not inhabited at all. From time to time ships are passing by. The physical conditions of the area are very extreme regarding the production of food. It consists of highly dynamic water. Both the velocity and salinity of the water are very high. This has a high impact on the type of food production.

Objectives
It might seem impossible to produce food on the North Sea, but the creation of windmill parks is actually an opportunity to produce food. There are no ships allowed in between the windmills. Consequently, the velocity of the water is decreasing in the area of a windmill park. This creates optimal conditions to produce food. On the one hand the area is not disturbed by human action. On the other hand the extreme conditions of the open sea are altered via the placement of windmills. To conclude, it is known that fish inhabit the areas in between windmills, because of these conditions. Combining it with floating agriculture could result in a wide range of food production, from fish to vegetables.

Conditions
It is not necessary to alter the current conditions of windmill parks. Creating floating elements between windmills will even provide a habitat for macrofauna. This results in an improvement of the local biodiversity.

Next to these physical conditions to enable food production and increase biodiversity, measurements have to be taken to make sure the food can be harvested.

Variations
It is difficult to make different (extreme) variations related to improving biodiversity, because both objectives and conditions only imply the application of floating elements. Nevertheless, two variations have been made. One variation contains the reuse of sediments of the New Waterway. By doing so, a new coastal defence system could be developed in front of the North Sea. As a consequence, dikes and dunes do not have to be heightened that much in the Rotterdam region. The second variation is without this coastal defence system.

Eventually, the scenario of the coastal defence system has been chosen. Since the amount of sediments will be available, it could be possible to re-use the sludge in combination with food production.
19.2 ha
land: -
water: 100,000 m²

TYPE OF ECOTOPE
highly dynamic

VELOCITY
<0.5 m/s

SALINITY
[3000, < mg/L Cl

WATER DEPTH
[30 m, <

TYPE OF SHORE
coastal line

SOIL TYPE
clay

GSI
-

FSI
-

UNEMPLOYMENT
-

NUMBER OF HOUSEHOLDS
-

66% dutch

Figure 41
Food typology North Sea
Source: image made by author
### Productivity
- Soil type
- Contamination
- Groundwater table
- Water quality
- Velocity

### Involvement
- Point in ecological network
- Point in recreational network
- Participation
- Educational value
- Linking city and nature
- Research pilot

### Ecosystem Services
- Small scale food production
- Small scale energy production
- Increase biodiversity
- Greening land
- Improve water safety
- Re-use sludge
- Reduce cost of maintenance
- Multiplier effect
- Symbolic value
- Increase value of property
- Catalyst urban development

### Constraints
- Navigable depth & width
- Active harbour activities
- Harbour - city sentiment

---

**Figure 42**
Evaluation of variations
Source: Image made by author

---

**Current situation**
Current windmill parks are only used for energy production. Big transportation boats are not allowed to go in between the windmills. Consequently, the space in between those technical giants could be considered as underused space. The structure of poles is altering both the velocity and flow direction of the water. This impact creates new opportunities for creating habitat, because it might be effecting the aquatic population in a positive manner. Adding floating agriculture in between the windmills adds value to the ‘existing’ habitat. As a consequence, food could be produced both on top of the floating elements and underneath the agriculture.

As was clear from the workshops, the New Waterway will be excavated in the near future. Sludge will be dumped in specific location at the bottom of the North Sea. Since the amount of sludge is immense, the design proposes to re-use the sludge by making a new island in front of the Rhine-Maas Delta. It will not only protect the hinterland by reducing the impact of waves on our current coastline. It will also create new habitat for species like birds and fishes.
In the end the second variation is included in the regional system of food of the Rhine-Maas Delta. Though windmill parks will be build more often in the near future, one almost never considers creating added value to the design. Nevertheless, a new defence system of the lowlands could be created by combining the both the making of windmill parks and the deepening of the New Waterway. Why not use this opportunity and combine energy production, food production and creating habitat at the same time?

To conclude, a critical note should be stated regarding this case study. Windmill parks are relatively a new development. Research is going on on the topic, but monitoring has not been the case yet. This design could be a research pilot, but is not based on existing findings of windmill parks. Hence, the objective of this case study is to add the topic of food production combined with energy production to the discussion on future windmill parks.
ACCESSIBILITY
Platform floating islands are accessible to harvest food

AVOID SEDIMENT FROM MOVING
Windmill park forest of turbines and dikes keep sediment in place

LOWER VELOCITY
Windmill park forest of turbines lowers the velocity of the sea

SHALLOWING WATER
Marshes create new habitat for species

GRADIENT
Soft covered dike used as an additional water defence system

CATALOGUE OF DESIGN PROPOSALS | WIND PARK FARM

Figure 43
Section Wind Park Farm
Source: image made by author
WINDPARK FARM
floating agriculture for the Rhine-Maas Delta

AQUATIC FOOD
- cod, herring, trout, salmon, smelt, eel, pike-perch, sturgeon, bream, shad, anchovy, mackerel, squid, octopus, french oyster, japanese oyster, squid, octopus

LAND FARMING & FOOD
- potatoes, Japanese seaweed, sea grass

Source: image made by author
5.1 DESIGN AS RESEARCH TOOL

Chapter two elaborated on the theoretical input to the adaptive framework. It derived from the science of Forman (2014), Alberti (2004) and Hoffman (2012). The framework served as starting point to analyse the ecological and cultural processes of the Rhine-Maas Delta. This paragraph evaluates the role of design in testing the adaptive framework.

Firstly, the collaboration between the academic education at Technical University of Delft and the internship at the municipality of Rotterdam has been of great importance to this thesis. Talking and discussing with both the mentors of the university, the municipality and others like Ecoshape, emphasize the difference between the academic field and the practice of urbanism. The framework would not link both worlds without the collaboration. The academic field is searching for evidence behind the adaptive framework and methodology. The practice of urbanism is mainly interested in the catalogue of proposals: the result of the framework. Hence, the amount of workshops and interviews are important to link theory and practice.

Secondly, Forman (2014), Alberti (2004) and Hoffman (2012) all stress the distinction between the land use, patterns and flows. Figure 44 is stating the adaptive framework as shown in chapter 2. Nevertheless, practice of urbanism is not analysing the city according to these different layers. In practice the differentiation between patches and corridors is not commonly used. Nevertheless, regarding food production it is necessary to make a distinction between patches and corridors. Food is produced on a certain location, or patch. Corridors are used to link the different locations among each other. Together they establish a regional system of food. The catalogue of design proposals stresses the differentiation of the patches and corridors in the Rhine-Maas Delta. Hence, the final adaptive framework is incorporating the difference between patches, corridors and flows. Hence, it is not making the differentiation explicit, the different layers are aiming to connect the patches and corridors regarding the flow of food. In the end the adaptive framework might be feasible for urban practice to design productive riverscapes and use food as a tool to link people and nature in the city.

Thirdly, design has not only been important to research the adaptive framework. The process of the design is maybe even of greater importance. According to the model of Tiedeman (1980), the designer should function as communicator among different disciplines. The interviews and workshops during this graduation year have proven the urge to use design as a method of communication. Collaborating with different experts revealed an enormous amount of information regarding the technical, ecological and socio-economic processes of the city of Rotterdam. For example the collaboration with Victor Beumer (Deltares, 2015) resulted in the spatial operations of the patterns to produce food. To conclude, design as catalyst among different disciplines is the new role of today's urban planner.

Figure 44
Source: image made by author
The adaptive framework is a tool that should be used to analyse the ecological and cultural layer of highly dense cities. It is especially aiming to analyse the flow of food and water of cities, which are experiencing water-related problems. This paragraph explains the tool. First, the overall adaptive framework is explained. Second, three steps will be made explicit on the next pages.

First of all, the main conclusion derived from the riverscape case studies is the importance of scale for the design of a regional food system. Consequently, the tool is designed by scale. Firstly, soil type, physical characteristics of the water and types of biotopes should be analysed on the macro scale. In this case, the macro scale is defined as the entire region of Rotterdam, which is part of the Rhine-Maas Delta. The outcome will be critical spots, where food production might be possible. These locations should be further analysed by taking a closer look at the diet of people, density of the area and economical factors of the locations. In the end, a regional food network could be developed using patches of food production and corridors to interlink the locations. The outcome, or critical locations for riverparks, should be altered on the small scale in order to optimise the functioning of the city.

Second of all, designing productive riverscapes using food as a tool to connect people and nature in highly dense cities might only be feasible on certain spots. Again, productive riverscapes are landscapes in which a symbiosis between housing, production, biodiversity and recreation is sought. Consequently, several steps have been developed from the small to the large scale to achieve this.

The steps, as stated in Figure 45, are each based on the same principles. These principles, referred to as patterns, are the conclusion of this research-by-design project. On one hand, the input of the experts during workshops and interviews has been of great importance to these conclusions. On the other hand, testing the input via different design proposals has been necessary to test and evaluate the technical, spatial and socio-economic impact on the regional food system for the Rhine-Maas Delta. The next pages elaborate on the different steps. First, the typologies of food, referred to as farming opportunities, are shown. The complete overview of farming opportunities for the Rhine-Maas Delta, including the evaluation via ecosystem services, can be found in the Appendix. Second, the patterns are explained. These are rules and regulations to adjust the current riverfronts into suitable locations regarding food production. Each pattern is explained by a spatial index. At the same time, the riverscape design studies are used as an example to show possible solutions in the city of Rotterdam. Third, the evaluation matrix of the ecosystem services is used to evaluate the contribution of each case study and reflect on the regional system of food. The riverscape design proposals are used to demonstrate the use of the adaptive framework.

Figure 45 CONCLUSION: the adaptive framework
Source: image made by author
One of the objectives of the project ‘River as a Tidal park’ is to create more visible green in the city. Nevertheless, not all types of food production and building with nature are contributing to this objective.

- Forest of willows
- Marshes
- Vegetated slope/dike
- Swamp area
- Floating structures

Creating river parks along the river Muse should not affect the harbour activities. A large amount of big ships are passing by the river parks every day. To eventually realise river parks in the city of Rotterdam, one should avoid sediment of the parks from moving into the main transportation zone of the harbour.

River parks located in the inner curve of the river; velocity is less than in the outer curve.

- River parks located in the inner curve of the river: velocity is less than in the outer curve.
- Create shallow water: sediment in slowly flowing water will not move.
- Same principal: by using this principal both the flow of water and movement of sediment can be diminished.
- Forest of willow trees: by existing these types of forests the sediment will not move.
- Forest of poles: same principle as the forest of willow trees.
- Floating structures: construction avoids sediment from moving.

Avoid sediment from moving

Creating river parks along the river Muse should not affect the harbour activities. A large amount of big ships are passing by the river parks every day. To eventually realise river parks in the city of Rotterdam, one should avoid sediment of the parks from moving into the main transportation zone of the harbour.

- Re-use of sludge: used for heightening the ground level in order to create optimal habitat.
- Dead wood: creates a new habitat for macrofauna (short-term measurement).
- Stones: creates a new habitat for macrofauna (long-term measurement).

- Mosses: able to reach the ground of the riverbed if shallow water is created. It both affects the quality of the water and the population of aquatic food positively.

Shallowing water

An optimal habitat for aquatic food production could be achieved by creating less deep waters in the current harbours. At this moment there is not enough light in the deep water, which has a negative effect on the quality of the water (growth of algae). More daylight is able to reach the bottom of the riverbed when shallow water is created.

- Dead wood: habitat for macrofauna (long-term measurement).
- Floating structures: useful for macrofauna (short-term measurement).
- Stones: create a new habitat for macrofauna (long-term measurement).
- Forest of poles: useful for heightening the ground level in order to create optimal

Lower velocity

Lowering the velocity of the water aims three different goals. Firstly, plants are able to attach to substrate. Secondly, fish are able to find optimal habitat, regarding both migration and breeding season. Thirdly, the flux of sediment is decreased.

- Tidal area
- Seaweed area
- Forest of poles (hoela’s)
- Oyster reefs
- Mussel banks
- Dead wood
- Aquatic vegetation
- Forest of willow trees
- Floating structures
- Ramesing structures
- Stones
- Eco concrete
Patterns

SPATIAL OPERATION

- Soft covered dikes/shores: certain types of crops could be produced based on the type of water/cultures of people. It results in both production of food and habitat for other species.
- Marshes: could be designed as an alternative shore
- Eco-concrete: creates habitat for macrofauna, which improves the ecological system
- Backfill: creates habitat for macrofauna, which improves the ecological system

Land:
Ecological connection under/along big infrastructure. For example tidal corridors, marshes, small patches of willow trees. By creating small ecological corridors along major infrastructural routes, animals are able to cross these barriers.

Water:
- Stairs for fish: they are able to take the stairs
- Slides that are fish-friendly, technical measurement to enable fish to cross those civil constructions.

Gradient
Create a gradient (aquatic, tide, country) as large as possible. On one hand, a greater surface for food production is achieved. On the other hand, a longer sloping shore (low inclination) protects the hinterland better than a short sloping shore (high inclination).

On-going corridors
By creating on-going routing (corridors), animals are able to move from A to B. This is necessary to improve biodiversity (patches) along the river.

Remediation
Both the type of soil and the quality of the water should be suitable for food production. Certain types of food could be used to clean the soil and water. Notably, the quality of the food itself should be taken into account.

- Mussel banks: in low tide are filtering water
- Forest of poles/hoela's: marshes, improving the aquatic habitat
- Aquatic vegetation: contaminated soil can be kept in place by adding vegetation
- Phytoremediation: certain types of plants are able to clean the soil and water

Accessibility
The added value of food production in urban river parks is stimulating social interaction among people and nature. Still, the type of food production and building with nature should be accessible by both people and biodiversity.

- Forest of willow trees: harvesting is only possible during low tide
- Marshes: harvesting is only possible during low tide
- Vegetated slopes/dikes: harvesting is depending on the angle of the dike
- Swimming: harvesting is only possible via floating elements
- Floating structures: harvesting is possible at all times
- Stones: harvesting is depending on the placement of stones regarding the height of the tide
- Eco-concrete: harvesting is depending on the placement of concrete regarding the height of the tide

Figure 47
Patterns
Source: image made by author. Spatial operations retrieved from report Eco-engineering in the Netherlands RWS& Deltares, 2013
Figure 48: Evaluation ecosystem services and Riverscape Case studies
Source: image made by author
5.3 RECOMMENDATIONS FOR THE RHINE-MAAS DELTA

This paragraph concludes this thesis by giving recommendations for a regional food system in the Rhine-Maas Delta. At the same time, this final paragraph reflects on the project of productive riverscapes.

The adaptive framework

Firstly, the objective of this thesis is to analyse and understand the metabolic system of food of both people and nature in the city. Consequently, the design should affect all agents: the users of the city, the river and the built environment. This seems important to understand the struggle between people and nature in highly dense cities.

The adaptive framework is the conclusion of this thesis to analyse and understand the flow of food and water in highly dense cities. First, the framework derived from the theory of Forman (2014), Alberti (2004) and Hofmann (2012). Evaluating the framework via workshops and interviews quickly showed the non-transferability of the theory into the practice of urbanism. In the end, the final adaptive framework seems like an easy way of analysing the city. Nevertheless, it is questionable if urban practice will use the method. It takes a lot of time to analyse all layers of food and water. From the experience of the working at the municipality it might seem feasible to gain knowledge on these topics via workshops and interviews. The way of working is quick and does not consume too much time. After knowing the critical locations to produce food, it is quit simple to use the three-step approach. Even if the objective is not to design food in a certain location in first place, it might seem wise to take a closer look at the farming opportunities. They could contribute to creating other values like improving biodiversity and stimulating social interaction in both public and private space in the area of Rotterdam.

Though the project is not going too much into detail on strategies to implement food production in on-going projects, some conclusions could be drawn from the catalogue of design proposals. Especially regarding the small scale, local inhabitants do have an important role in maintaining production sites. Therefore, they should be included in the process. Consequently, private stakeholders are also important to include. They could contribute by creating support in the local area. At the same time, they are able to invest in local food production and use the investment to profile themselves as sustainable companies.

reflection: Sao Paulo

Notably, the types of food that could be produced in the Rhine-Maas Delta are not transferable. Though the method in itself is applicable in other highly dense cities, the outcome will differ. Even the type of food produced in the Rhine-Maas Delta could be different in a couple of years. Deepening the New Waterway will affect the velocity and salinity of the water that it even might change the proposed catalogue of designs in this thesis. The city of Sao Paulo would serve as a case study on which the adaptive framework would be reflected. Hence, researching the different layers of the city in combination with local farming opportunities is not feasible after all. Analysing the city of Rotterdam and designing the catalogue of design proposals has taken too much time in this project. Hence, possibilities have been explored during a series of workshops in Sao Paulo in November 2014.

The city of Sao Paulo is build in between several hills. As a consequence, the city is covered by hundreds of small rivers. Today they are almost all covered up and serve as some sort of sewerage system. All waste water is disposed into the main rivers: Tiete river and Pinheiros river. The idea is to collect the waste water of the smaller canals before flowing into the main rivers. These treatment stations should be designed with a metabolic way of thinking. Nutrients could be filtered out of the water, before the water itself will be cleaned by helophytes. Those nutrients are a source of compost regarding food production. Second, this thesis aims to design productive riverscapes for the Rhine-Maas Delta. It is defined as a landscape in which a symbiosis between housing, production, biodiversity and recreation is sought. The focus is on the waterfront of the highly dense city of Rotterdam, because all agents are intertwined in these specific locations. Additionally, all flows should be included in the riverscape design studies.

The catalogue of design proposals shows both the locations and design variations. The different designs are evaluated by using both the ecosystem services and discussing the possibilities with experts of different disciplines. Especially the mix of both the academic world and the practice of urbanism lead to interesting discussions about the design proposals. For example, it might seem feasible from a theoretical point of view to transform the island van Brienenkoord into an island, which is formed by the building with nature-principles. Nevertheless, discussions with the municipality of Rotterdam revealed that the city itself adheres a lot of value on the historical character of the island. Consequently, only a limited amount of change is allowed using building with nature-like thinking. In the end, all flows of food, water, sediments, biota and people are evaluated in the design proposals. Each flow is more or less affected in the design depending on the objective of each location.
To conclude, the matter of scale is important in the design of productive riverscapes in the Rhine-Maas Delta. The evaluation of each location via ecosystem services (figure 48) shows the different objectives on the small, mezo and large scale.

The small scale is mainly suitable for production that is linked to stimulating social interaction. Production in itself, including the improvement of biodiversity, is not possible because of a limited amount of available space. The meso scale mainly serves as a case to improve biodiversity. Some production is possible in combination with stimulating social interaction. Since people are not living close to these locations, it is difficult to include them in the design. Only the large scale is used as production site. Since there is a vast amount of space available in between windmills, floating agriculture could be a possibility to sustain local food production in the near future. Nevertheless, it is a relatively new way of thinking and therefore it should be investigated how and where these floating agriculture might be feasible in the delta-region.

Reflection

Thirdly, this project was initiated because of a limited amount of proposed projects in the practice of urbanism. Though hundreds of projects have been exhibited during the International Architectural Biennale of Rotterdam (2014), only a limited amount of projects have been realised. This thesis could be added to the list of proposed projects on urban metabolism. Hence, the design proposals might seem on a conceptual level, they could be transferred into real designs for the city of Rotterdam using the farming opportunities. They could not only be used in the catalogue of design proposals, also on-going design projects of the municipality itself could include the production of food by taking a closer look at farming opportunities.

But still, after one year working on the project, I am sceptical about food production in the city itself. It is possible to integrate the production of food in on-going projects, but the objective should not be producing food within the city. Stimulating social interaction, improving health conditions and biodiversity might be feasible. Hence, if one adheres creating local food, a regional system on different scale levels is the answer. As stated before each location will have another objective depending on the physical and socio-economic context.

Future of food

This thesis not only shows conclusions on producing food. After all the main objective is to open up the discussion on food production in and around cities. The project itself is already selected by two different conferences. The first is the GREY TO GREEN conference in Toronto (June, 2015). The second is the Young Urban Planner-program of the ISOCARP conference, which will be held in the Netherlands (October, 2015).

Presenting the project in Toronto has raised several interesting discussions on the topic of regional food systems for resilient cities in the near future. Urban farming is seen as the solution to feed the world metropolises according to most participants. Hence, relating food production to biotpes and cultures of specific regions was not mentioned at all. Stating one of the participants of the conference during a discussion on this graduation project:

‘The project is a new way of approaching food production in the city and pushes the current discussion into another direction than urban farming.’
List of definitions

- **Adaptive framework**
  An adaptive approach is everything that is needed to make the urban ecosystem less vulnerable to the consequences of cloudbursts. It is a multidisciplinary approach that brings technical, social, political and economic professions together (Washburn 2014).

- **Biophysical processes**
  These processes consist of the dynamics of energy, water, nutrients, materials and air in the urban ecosystem (Alberti, 2008, p. 12).

- **Ecological design**
  Aims to improve ecological functioning, preserve and generate resources for human use, and foster a more resilient approach to the design and management of our built environments. As an interactive approach and process, ecological design includes human as well as non-human communities and systems, applying best available scientific theory and evidence to create resilient, sustained environment quality (Rottle & Yocom 2010, p.13).

- **Ecological services**
  Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on earth.

- **Ecosystem services**
  Ecosystem services provide a collection of services to study and redesign the human and ecological functions and their processes in the natural and built land cover in urban ecosystems.

- **Liveable**
  A liveable city is a place suitable for living, guaranteeing the quality of urban life and resiliency to its users at the same time.

- **Productive landscape**
  Productive landscapes are defined as the sum total of circular flows of energy, food and water that occur on the macro, meso and micro scale of cities.

- **Resilient**
  Something produced in reality is resilient if it makes the urban ecosystem stronger instead of demolishing the existing qualities (Washburn 2014).

- **Socio-economic processes**
  These processes describe the city as an economic, social and political system with economic, social and political dynamics (Alberti, 2008, p. 15).

- **Spatial strategy**
  It gives geographical expression to the economic, social, cultural and ecological policies of society. It is at the same time a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards a balanced regional development and the physical organisation of space according to an overall strategy (Karasek, 1983, p. 13).

- **River park**
  A river park is about the development between the ecology in the city directly connected to the river. From the perspective of the river the tidal park establishes a strong relation between both water and land, but also between nature and the city (de Boer, 2014).

- **Urban ecosystems**
  Urban ecosystems evolve over time and space as the outcome of dynamic interactions between socio-economic and biophysical processes operating over multiple scales (Alberti & Marzluff, 2004, p. 1).

- **Urban ecology**
  Urban ecology studies the ecological functions and their biophysical processes in the natural and built land cover in urban ecosystems.

- **Urban metabolism**
  Urban metabolism is the sum of the surface and the subsurface including the technical and spatial infrastructures of productive landscapes combined with the socioeconomic processes occurring in cities resulting in resilient and liveable cities.
Remco Andeweg
Stadsbiooog

Wednesday 19th of November,
Bureau Stadsnatuur, Natuurhistorisch museum

Confirmed: 11th of December 2014

At the end of the 19th century the New Waterway was build. Since this new canal was finished, the city of Rotterdam expanded from a remote village towards one of the main port of Europe.

• As a result of all the industrial activities around the rivers of Rotterdam, the relation between city and river has been lost.
• Today, the relation between city and river is shifting again. The river used to be a dirty canal used only for economy and transportation. Nowadays the river is seen as part of the city again, it is the so-called ‘living with water’ approach.
• Some examples of the original ecology are still present today:
  o Little beach at Heijplaat
  o Hoarseley at Rozenburg
  o Hartelkanaal (this is not the original type of vegetation, though it is grown natural)
  o Old Muse close to Hoogvliet
• To create nature-friendly banks it is not necessary to create sloping and vegetated shores, though these are preferred to restore aquatic ecology. The material of the shores does not matter. It could be stony or grassy, as long as the new edges are sloped.
• The most interesting type of biotopes is the nature of a tidal area. Most of the times the water is present. Going a bit more into the water, aquatic ecology is found. Going up to the land, the flora of the city will be found. Both have to deal with uniform conditions, though tidal nature should be harsher to survive.
• Biodiversity could be used as food production. For example the small rivers at the Brienenoord Island. Every time the tide covers the shores with a tiny layer of silt. This could be an optimal condition to grow species like watercress. This type of sediments remains on the watercress, which makes it unsuitable for consumption. Though this type of nature could be an opportunity for food production if it would be designed in another way.

Joep van Leeuwen
Ingenieursbureau Rotterdam

Monday 24th of November,
Gemeente Rotterdam, Rotterdam

Confirmed: 15th of December 2014

The city of Rotterdam has to deal with two types of sediments. The first type is a residue from urban development for which the municipalities are responsible for. For example the ground, which is left over after building underground parking spaces. The second type of sediments is sludge, which results from the dredging of the harbours. The harbours and Rijkswaterstaat are in charge of this sludge. This type of sediments is transported towards the North Sea.

• Joep van Leeuwen mainly works with a company, specialised in recycling soil and residues of Rotterdam (grond en reststoffenbank). The philosophy of this company is based on the concept of a circular economy. In practice this means supply and demand of soil are brought together, so new (spatial) opportunities are created.
• An example of such a project is ‘The Green Port’. In this project soil, residue and other types of waste are transported towards the harbour. After creating sloping shores of these materials, different plant species can grow naturally.
• Left over soil can also be used to create shallow harbours. By doing so, recycling soil is used to create optimal habitats for aquatic ecology in harbours.
The municipality of Rotterdam, PBL, TNO and the firm of FABRIC have produced the maps of the city of Rotterdam. These were exhibited at the IABR 2014. On the occasion of this event Sander Klaassen has been interviewed about designing with urban metabolism.

- The types of flows, which are selected to design with, are depending on the type of design project. Therefore a few questions are leading in the project of ‘River as a tidal park’.
  - What is defined as ‘the river’? And what is meant by ‘productive’?
  - The spatial strategy of the project could be making nature more visible in the city. To achieve this in reality productive landscapes can be used as method to earn money (= based on circular economy).
  - The river is one of the major types of landscapes in the region of Rotterdam. It used to be a productive landscape, providing food, transportation, etc.
  - Just selecting different flows, which lead to an assignment is not the best way to start. You always have to take in mind the spatial and physical conditions of the flows to design a productive landscape along the river.
- Several examples to design productive landscapes are:
  - Energy: filling harbours up with water and releasing it again / thermal storage
  - Windmills located in the sea can be used as a major productive landscape. Nobody is allowed to enter these areas, which means nature can develop without people involved.

Over the last years the quality of water in the River The Muese has been improved. This has resulted in a growth of biodiversity in and around the river.

- The estuary of Rotterdam has a high diversity of aquatic species. In the future this could lead to a domino effect. This means other species are attracted towards the river resulting in an overcrowded river. A productive landscape would mean the surplus of this growing biodiversity would be harvested.
- Productive landscape is defined by the surplus of biodiversity in and around the river.
- Nowadays, siltation is a major threat to the landscape in and around the city of Rotterdam. In the near future this could result in a lack of freshwater. Agriculture and horticulture are depending on the flow of freshwater. Therefore attention should be paid to these threats.
- Several remarks about designing productive landscapes in and around rivers:
  - Turn quays into sloped shores.
  - Restore the tide in some areas. For example this could be done by technical interventions in a dike.
  - Making shallow harbours could lead to an improved aquatic ecology in those areas.
  - If you want to design interventions, which improve biodiversity, it is important to study and design on a small scale.
Luc de Vries
Ministry of Infrastructure and Environment

Wednesday 3th of December,
Gemeente Rotterdam, Rotterdam

Confirmed: 9th of December 2014

Ministry works for Infrastructure, space and mobility according to a MIRT-approach. First it is investigated if the country experiences a certain problem, which is explored in a first research. Secondly the favourable results could be explored further and lead to an actual project. Finally Rijkswaterstaat executes the project. The most important aspect in these processes is the involvement of different stakeholders in an early phase of the research. So how does such a process evolve?

• First of all it is advised to investigate if the project could be linked to a certain vibe, which controls people nowadays. It is necessary to think about the role of the ministry from the first moment.

• In the second stage it is wise to invite people, who could be involved in the project. There are different ways to involve people in the process. In this interview the possibility of having a workshop is mentioned to explore what could be possible (spatial) outcomes of the process. Several tips for these workshops:
  o Reasoning of the different interests should be explored. In this process it is important not to think for other people. They should talk themselves, which could lead to surprising results.
  o It takes time to create one shared ambition. Make sure everyone has the same interests before executing the workshop.
  o Put yourself forward as a researcher, who doesn’t know anything. Do not steer the discussions into a certain direction.
  o A good chairman is someone who is either drive by ambition, either someone who knows a lot about the subject or someone who is able to create enthusiasm in a group.

• The most favourable result is that one of the stakeholders is so enthusiastic about the project that he is taking the lead. By the collaboration all together the project could be executed.

• Several remarks about designing productive landscapes in and around rivers;
  o District heating is a popular subject of many companies today. It is not wise to focus the flow of energy on this type of renewable production. Try to link the design with other small (experimental) initiatives:
    • Smartpolder: thermal heat storage is linked to a technical part of the water system, which functions by the power of water.
    • IAC-Merwede: turbines are placed in the water, which produce energy using the tide of the water.
    • Energy from plants.

Rutger de Graaf
Deltasync

Thursday 4th of December,
Gemeente Rotterdam, Rotterdam

Confirmed: 9th of December 2014

The carrying capacity of today’s cities needs to be redesigned. Cities need to grow up and clean their own mess.

• An example of the flow of food: animals in the province of Brabant are being feed by food, which is produced in South-America. The manure of these animals is distributed over the agriculture land, from which it is transported towards the fluvial system by the flow of groundwater. As a result we are exhausting the fertile ground of South-America and at the same time wasting a big amount of nutrients by both our fluvial and pluvial water system;
  • A solution could be bio based industries, which is based on (phosphate&nitrate) nutrients;
  • Rutger de Graaf developed the idea of the blue revolution. This means floating (urban) development could be a next step in densifying our cities. Underneath these floating elements a richness of biodiversity is present. So in the end it is not only about developing the immense amount of water surface, at the same time it could create opportunities to improve aquatic biodiversity.

Several remarks about designing productive landscapes in and around rivers;
  • Investigate our water system as a source of resources;
  • River as a tidal park could function as a breakwater. If this is the case, a weak dike of the hinterland could be restored in a later stage;
  • The link between city, river and harbour should not be planned. It should be a process.
Factors, who influence the quality of water in the river:

Outer dike areas:
• Discharge from overflow drainage
• Discharge from surface drainage
• Discharge from industrial water and waste heat
• Discharge from wastewater-treatment plants

Inner dike areas:
• Inflow of water of the main river through measurements of water management
• Leaves of trees produce too much food in the water
• Discharge of pollution like dog poo
• Emissions of sewer overflows

Because of these factors the water is becoming too much eutrophic, which enables duckweed to grow in the water. In case of sewer overflows the water does not contain enough oxygen, which could lead to less fish in the water.

River basin management: European Framework of water (KRW). The Netherlands has to meet certain criteria of the European Union in terms of water quality. Consequently, a certain action program is established to reach the criteria in 2027. For example measures are cleaning the polluted water and creating natural banks. These objectives are part of the current water management programs of the municipality of Rotterdam. The amount of fishes in the water is an important indicator to evaluate the program. Therefore, the migration of fish is an important measurement of the KRW, which results in creating optimal habitats to improve the amount of migratory fish. To promote these habitats, the following physical implications are important:
• Green quays
• Resting places for fishes. Eventually it will lead to more fish.

NOTE: the physical conditions to create these biotopes are shown on p. 109 of the RAS.

Conclusion: if you are able to connect different objectives in one (physical) project, the more likely it will succeed.

During the Biennale of 2014 PBL has researched big data on both the national (the Netherlands) and the global scale. Conclusions have been drawn according to the 10 different flows, which have been formulated by Dirk Sijmons. Harbers stresses the fact that the flow of demography has not been shown during the exhibition. Nevertheless, this flow has been researched and published in the book of PBL named ‘Smart Cities’. In this book each flow is explained using five infographics:
1. Use per person/family of the Netherlands
2. Sanky-model on the national scale-level (A Sanky-model is produced via software, which transforms data of Excel-sheets into flow schemes)
3. Map on national scale-level
4. Map on global scale-level
5. Free choice of editor to visualise data of the specific flow.

NB. Arjan Harbers himself is responsible for three chapters of which the chapter about water is one of them. He explained the infographics addressing this flow.

As an urban planner or designer it is important to investigate the impact of each flow before integrating the urban metabolism in a design assignment. The difficulty is to find harmony between the self-sufficient city and the high density of cities.
• How is food production changing the landscape in and around the city?
• What kind of street patterns could be designed?

One of the first examples concerning this mind-set is the Broadacre City of the architect Frank Loyd Wright (1932)

Collecting data to (re-) design the urban metabolism can be executed in several ways. Notably, the objective of the design should serve as starting point. To establish a network of food in and around the river in could be possible to find certain patterns. Comparing the local and national conclusions could lead to handles and needles for a design. Also comparing neighbourhoods within Rotterdam could be a strategy.
• Information can be sought in different ways:
• Google (always check if the source is scientifically underpinned)
• Statistical websites
• The website ‘compendium’ of PBL

The aim of urban planning and design has been building housing areas (for inhabitants). Nowadays, the content of urbanism has changed to an economic assignment. The central question is what the design/project contributes to the city/country.
Ramon Knoester
WHIM Architecture

Thursday 29th of January 2015,
Zomerhofstraat 71, Rotterdam

Confirmed: 30th of January 2015

Ramon Knoester has its own company (WHIM Architecture). He investigates how plastic of the New Muse and New Waterway could be recycled and could be used for building floating elements. The overall aim is to catch all plastic at the end of the delta-river of the Rhine, before it is released in the North Sea. The objective is not only to build floating islands, but also creating new types of nature. This is achieved by adding natural elements of plants. Examples are helophytes, which filter the water to improve the quality of the water.

- Nowadays, a certain amount of plastic is caught by WHIM Architecture. The university of Wageningen investigates how this plastic could be moulded into strong building materials.
- Two types of floating elements are developed:
  - Elements along paved quays: the elements are anchored to the soil, which enables the elements to move according to the tidal.
  - Elements for floating parks: the elements are anchored to the soil, but eventually are also able to move horizontally.
- Ramon Knoester works together with a landscape architect (Tieme Haddeman – Urban Green), who is developing three prototypes at the RDM Campus. Finally, they are researching the building materials on one hand, and on the other hand planting schemes specified to the type of water and water quality.

Bas Driessen
FABRIC, Amsterdam

Friday 6th of February 2015,
Tussen de Bogen 22, Amsterdam

Confirmed: 8th of February 2015

Bas Driessen works at the design office called Fabric. This agency has made the analysis of the metabolic system of Rotterdam for the IABR 2014. The interview is divided into three parts. The first part deals with the analysis and design process during the IABR. The second part is about the lessons that can be learned from the entire process. The third part reveals some tips and tricks to analyze the metabolic system (about food).

The analysis process of the IABR 2014:
- The assignment from Dirk Sijmons was to show both the infrastructure (eg cables, pipes, etc of each stream as well as the performance. Bas defines performance as both the points of inflow and outflow as well as points where it is leaking.
- In relation to the flow of food: many farmers produce food on a local scale. Ultimately, this food is bought by 5 mega companies (such as Jumbo and Albert Heijn), which sell the products in their supermarket at “competitive” prices. Bas notes that the Netherlands has many cheap supermarkets in comparison with the surrounding countries.

Lessons learned from the IABR. Afterwards Fabric has developed a method, which schematically shows how the information from a metabolic city should be categorized. This method is the so-called DOCA-method:
- Data: all data is collected in this category. This can be through its own research on the internet or for example by involving professionals through workshops. The data is closely related to the collection of anecdotes.
- Opportunities: what opportunities does the city face? How can they be incorporated? From this perspective, opportunities are closely related to policy framework that contributes to the design problem.
- Challenges: what are the challenges for the city? And how can these be linked to the design? Also this framework is related to the policy of the city.
- Anecdotes: stories often addressing (aspects) of the metabolic system pop up during the process. These offer clues and starting points to collect data. According to Bas, this is why it is the most important category of all four. This category tells stories and can organize the vast amount of data.

Tips to analyse the metabolic system:
- Information can be obtained in several ways:
  - NL Agency
  - CBS
  - Euro City
Professor Bartalini is investigating the hidden canals of Sao Paulo and how the relation between people and nature could be improved. Why is this important?  
• Almost everyone owns a car in the city. It is seen as a symbol of ‘the American dream’. As a result there is no space for slow traffic in the city. Nobody enjoys the small pleasures nature is giving you for free: every day.  
• Nevertheless, users of Sao Paulo are starting to change. Nowadays, 88 % approved to transform car parking into cycling lanes. Consequently, private investors are even investing in these sustainable transportation modes. For example the bikes by Itau (private bank). How did this happen?  
  o Originally, Sao Paulo has been founded around plantations to produce coffee. Via the political system, lead by governors, the society individualised. Since cities offered jobs and a good life, many people moved to the city. Nevertheless, the individual society is still present. Therefore it is necessary to change not only the existing urban fabric, but the system of society. From an individual mindset to a collective nation.  
• Remarks regarding the research:  
  o People worry about large things, for example climate change, but are not consciousness about our own actions. This could be solved via a systems approach:   
    • start with a small action. Eventually, it will lead to change in the bigger system.  
  o Our work is like a archeologist’s work: he finds a piece in the field and does not know to what part it belongs. Years later another piece is found and it starts to become a body. This could be a symbolic value: will not be the full body, but the idea should be clear. Eventually it will become an process of the urban system.  
  o Art is another way to see things. An artist can show things in another way. It opens up and changes views.

Helena Aparecida Ayoub Silva  
Professor FAU USP, Sao Paulo  
Wednesday 12th of November,  
FAU-USP  

• Regarding mobility: change the profiles to be able to design accessible riverparks.  
• Try to link open space and informal housing via productive landscapes.  
• There are environmental protected areas in the North and South of the Pinheiros river.  
• Use small plots as example to catalyze the system. From a historical point of view Brazilians wanted to own small plots to produce. For example food. Additionally, involvement of people will be present for sure.
Workshops

- Building with Nature
- The natural river
- The robust river
- The edible river
- The efficient river
- The lively river
- The attractive river
- The characteristic river
- The connected river

WORKSHOP: the natural river
Municipality of Rotterdam, Rotterdam
12th of February, 2015

Participants:
Victor Beumer (Deltares/Eco shrimp)
Pieter de Greef
Peter Philipsen (Nature at work)
Lena Niel
Gis van Sonneveld (WNF-ARK)
Gerard Litjens (Bureau Stroming)
Arjo Klijnsmit

WORKSHOP: the characteristic river
Municipality of Rotterdam, Rotterdam
17th of February, 2015

Participants:
Annemiek Fontein,
Lena Niel
Sander Klaassen
Emiel Arends
Joke Klumper
Arjo Klijnsmit
Maartje Visser
Mieke van Leeuwen
Michiel Couperus

WORKSHOP: the efficient river
Municipality of Rotterdam, Rotterdam
19th of February, 2015

Participants:
Laurence Peels
Pieter de Greef
Lena Niel
Arjo Klijnsmit
Joop Zwiep
Dirk Enslin
Leonard van der Velde
Joep van Leeuwen
Sander Klaassen

WORKSHOP: the robust river
Municipality of Rotterdam, Rotterdam
23rd of February, 2015

Participants:
Nick van Barneveld
Marit Meijer
Pieter de Greef
Peter van Veen
Wilfried Stolte
Maartje Visser
Arjo Klijnsmit
Lena Niel
Sander Klaassen

WORKSHOP: building with nature
Deltares, Utrecht
4th of March, 2015

Participants:
Victor Beumer (Deltares/Eco shrimp)
Jelle (...)
Sofie (...)(Deltares)

WORKSHOP: the connected river
Municipality of Rotterdam, Rotterdam
5th of March, 2015

Participants:
Lena Niel
Michiel Couperus
Martin Guz
Arjo Klijnsmit
Pieter de Greef
Building with Nature: possible locations along the river
Source: workshop ecoshape, 2015
Building with Nature: handles and needles to build nature in the city
Source: workshop ecoshape, 2015
The natural river: there are a lots of opportunities regarding food production (yellow colors)
Impressie Werksessie Programma Rivieroevers:
Natuurlijke rivier, donderdag 12 februari 2015

aanwezig:
Gijs van Zonneveld (WNF-ARK)
Gerard Liljens (Bureau Stroming)
Peter Philipse (Nature@work)
Victor Beumer (Deltares/Ecoshape)
Pieter de Greet (gemeente Rotterdam)
Arjo Klijnsmit (gemeente Rotterdam)
Lena Niël (afstudeerstagiair gemeente Rotterdam)

Een van de prioriteiten van Rotterdam voor de komende jaren is het verbeteren van de verblijfskwaliteit en de ecologische kwaliteit langs de rivieren. Het gaat daarbij om de Nieuwe Maas, Rotte en (Delfse) Schie. De wethouder heeft de opdracht gegeven om een programma Rivieroevers op te stellen waarbij ook gevraagd wordt om concrete uitvoeringsprojecten die vanaf 2016 een bijdrage kunnen gaan leveren aan de gestelde doelen. Naast het Rotterdamse programma is er ook het (stadsregionale) programma De Rivier als getijde npark. Dit is gericht op het regionaal bestrijken van de rivieren in de provincie Zuid-Holland.

Verziling wordt een steeds groter probleem. Door het diepverdiepen van de Nieuwe Waterweg trekt de zoutgradient steeds verder in de richting van de stad. Daardoor nemen de inspanningen toe om te voorkomen dat het zoutgehalte bij zoetwaterinlaat-punten zal toenemen. Zoetwaterinlaat punten zijn nodig voor drinkwater, proces en koelwater. Een voorbeeld van de inspanningen is de rivier Het Spui. Deze rivier heeft sinds de Deltawerken een omgekeerde stroomrichting. Het water van het Haringvliet stroomt niet langer direct naar zee, maar stroomt via het Spui richting de Oude Maas, om uiteindelijk via de Nieuwe Waterweg de zee te bereiken. Daar door wordt de verziling van de Nieuwe Waterweg tegengegaan. Aangezien het Spui vrij smal is, maar een hoog waterdebit heeft, heerst er een sterke stroming en brokken de dijken af. De komende jaren wordt er voor vele miljoenen euro’s inspanningen geleverd om dit te herstellen. WNF stelt voor om de zoetwaterinlaat niet meer in dit gebied te laten plaatsvinden maar in de Lek.

WNF wil graag op het eiland Goeree (bij Dirksland) een binnendijks Deltanatuur gebied aanleggen. Dit kan door het weghalen van het gemaal bij het Zuiderdiep. Vissen die niet tegen de sterke stroming van het Haringvliet willen inzwemmen kunnen via een omweg toch in de Delta komen.

De Steur is het vlaggenschip voor een schone delta. Een Jonge steur blijft in het estuarium tot het op volwassen leeftijd verder de rivier in trekt. Er bestaat een wens om vanuit WNF een bezoekerscentrum op te zetten voor de steur. Daarvoor zou bijvoorbeeld de Slijkplaat gebruik kunnen worden. De slijkplaat is een natuurlijk eiland in het Haringvliet. Voor de kust kan de natuurlijk diversiteit worden verbeterd door de aanleg van schelpenbanken. Schelpenbanken zijn plekken met natuurlijk materiaal waarbij het broed van de schelpen tot ontwikkeling komt. Schelpensoorten die interessant zijn betreffen de mossel en de platelooster. Mosselen groeien vrijwel niet in de delta. Hoewel de mossel een enigszins zoët tolerant is groeien ze niet in het Haringvliet of komen ze niet verder landinwaarts dan ter hoogte van de Landtong Rozenburg. Schelpen zijn nodzakelijk voor de ontwikkeling van een volwaardig ecosysteem. Er wordt teveel gevist in de Noordzee volgens WNF.

Schelpdiere die in brakwater groeien is de zogenoemde brakwaterkokkel. Dit dier is uitermate geschikt voor voedsel. Ook de kabeljouw, zeebaars, paling en snoekbaars zijn gewaardeerde consumpties.

Om de bereikbaarheid van de haven te garanderen wordt de Nieuwe Waterweg onnatuurlijk diep gehouden. Per jaar wordt er 14,5 miljoen m3 bagger weggehaald. Dit wordt verkocht. De zandfractie wordt in slibputten voor de kust gestort en afgedekt met zand. De silbfraction wordt in slibputten voor de kust gestort en afgedekt met zand. WNF zou graag een vogeleiland willen vormen door het bagger in zijn geheel te gaan storten voor de kust. Daarbij zouden er ook schelpenbanken aangetegd moeten worden.

Bureau Stroming is op de hoogte van de wens om de Aqualiner naar Stellendam door te trekken. Het hartje van Rotterdam zou op deze manier verbonden kunnen worden met Spijkenisse, Hellevoetsluis en Stellendam. Bezoekers van Rotterdam kunnen op deze manier eenvoudig naar het buitengebied. Er is nog geen businesscase opgesteld.

Het openstellen van deze sluis zou de KRW doelstellingen voor de aanleg van een groot schepenbief af. De komende jaren wordt er voor vele miljoenen euro’s inspanningen geleverd om dit te herstellen. WNF stelt voor om de zoetwaterinlaat niet meer in dit gebied te laten plaatsvinden maar in de Lek.

WNF wil graag op het eiland Goeree (bij Dirksland) een binnendijks Deltanatuur gebied aanleggen. Dit kan door het weghalen van het gemaal bij het Zuiderdiep. Vissen die niet tegen de sterke stroming van het Haringvliet willen inzwemmen kunnen via een omweg toch in de Delta komen.

De Steur is het vlaggenschip voor een schone delta. Een Jonge steur blijft in het estuarium tot het op volwassen leeftijd verder de rivier in trekt. Er bestaat een wens om vanuit WNF een bezoekerscentrum op te zetten voor de steur. Daarvoor zou bijvoorbeeld de Slijkplaat gebruik kunnen worden. De slijkplaat is een natuurlijk eiland in het Haringvliet. Voor de kust kan de natuurlijk diversiteit worden verbeterd door de aanleg van schelpenbanken. Schelpenbanken zijn plekken met natuurlijk materiaal waarbij het broed van de schelpen tot ontwikkeling komt. Schelpensoorten die interessant zijn betreffen de mossel en de platelooster. Mosselen groeien vrijwel niet in de delta. Hoewel de mossel een enigszins zoët tolerant is groeien ze niet in het Haringvliet of komen ze niet verder landinwaarts dan ter hoogte van de Landtong Rozenburg. Schelpen zijn nodzakelijk voor de ontwikkeling van een volwaardig ecosysteem. Er wordt teveel gevist in de Noordzee volgens WNF.

Schelpdiere die in brakwater groeien is de zogenoemde brakwaterkokkel. Dit dier is uitermate geschikt voor voedsel. Ook de kabeljouw, zeebaars, paling en snoekbaars zijn gewaardeerde consumpties.

Om de bereikbaarheid van de haven te garanderen wordt de Nieuwe Waterweg onnatuurlijk diep gehouden. Per jaar wordt er 14,5 miljoen m3 bagger weggehaald. Dit wordt verkocht. De zandfractie wordt in slibputten voor de kust gestort en afgedekt met zand. De silbfraction wordt in slibputten voor de kust gestort en afgedekt met zand. WNF zou graag een vogeleiland willen vormen door het bagger in zijn geheel te gaan storten voor de kust. Daarbij zouden er ook schelpenbanken aangetegd moeten worden.

Bureau Stroming is op de hoogte van de wens om de Aqualiner naar Stellendam door te trekken. Het hartje van Rotterdam zou op deze manier verbonden kunnen worden met Spijkenisse, Hellevoetsluis en Stellendam. Bezoekers van Rotterdam kunnen op deze manier eenvoudig naar het buitengebied. Er is nog geen businesscase opgesteld.

Er is een breed palet aan mogelijkheden en projecten. Vaak zijn dit kleine projecten die gezamenlijk een bijdrage leveren aan het ontwikkelen van natuur. Je kunt spreken van ‘a bite, a snack of a meal’

Er is een breed palet aan mogelijkheden en projecten. Vaak zijn dit kleine projecten die gezamenlijk een bijdrage leveren aan het ontwikkelen van natuur. Je kunt spreken van ‘a bite, a snack of a meal’

De waterkwaliteit is in de Nieuwe Maas fors verbeterd. Dit is te danken aan het terugdringen van fosfaat in de wasmiddelen en het instellen van een mestboekhouding. In de zijrivieren zoals Schie en Rotte ligt dit nog anders. Deze rivieren hebben een hoger fosfaat en nitraat gehalte door bemesting van de polders en het gebruik van bestrijdingsmiddelen. De waterbodems in de haven zijn vervuild met dioxines. Daarom is er een beroepsverbod ingesteld voor palingvissers. Veel waterbodems worden afgedekt. Zolang deze laag niet wordt omgewoeld is het geen probleem voor het ecosysteem.

De chemische kwaliteit van het water is zó goed dat de bever, lepelaar, zilverreiger, kroeskoppelikaan, zeearend, haai en dolfijn terug zouden kunnen komen. Tekenend is stijging van de zeehondenpopulatie. Chemische kwaliteit is goed maar de fysieke kwaliteit blijft gruwelijk achter.

In het algemeen kun je stellen dat het ecosysteem in verwarring is door de hogere watertemperatuur. Door de losing van koelwater is de temperatuur met 3 graden gestegen. Daarnaast draagt ook de verbinding tussen het Donau-systeem en Rijn-systeem er aan bij dat het aantal invasive exoten stijgt en de bestaande populatie onder druk zet.

Er zouden inlaten worden aangelegd voor trekvissen naar de rivieren Rotte en Schie. Tijdens de werksessie was het niet helemaal duidelijk waar die inlaten zouden worden aangelegd en hoe de aanleg is gevorderd.

Nabranders:
- zalmvangen en eten bij het zalmhuis
- snoekbaars eten en in de wildernis klaarmaken op een kampvuurtje draagt bij aan de wildbeleving
- Zeekraal en zeebloemkool zijn gewilde groenten voor zeeboederijen. Willem Brandenburg van de Wageningen Universiteit kan hier meer over vermelden.
- Het verankeren van klinkhout op de bodem is een goede manier om nieuwe macrofauna aan te trekken.

Verziltingsproblematiek: Evides, Deltalinqs, Hoogheemraadsschappen

Stand van zaken waterkwaliteit: zijrivieren staan onder de invloed van de polders. (Niels Breveer, sportvisserij Nederland)
The robust river: the river Muse is still threatening the inner city of Rotterdam
Impressie Werksessie Programma Rivieroevers: Robuuste rivier, maandag 23 februari 2015

Aanwezig:
Nick van Barneveld
Marit Meijer
Pieter de Greff
Peter van Veelen
Wilfried Stolte
Maartje Visser
Arjo Klijnsmit
Lena Niel
Sander Klaassen

Marit Meijer (Hooghoomtraadschap Schieland) geeft aan dat er verschillende kwaliteitsdoelstellingen zijn vanuit de Kader Richtlijn Water KRW. In 2027 moet een goed ecologische potentieel worden gehaald. Om dit te behalen zijn voldoende oevers voor paaiende vissen nodig, en mag er geen algenbloei meer voorkomen.


Het is een wens van het waterschap en ook van RWS om bij de Leuvehaven een spuileding en vistrap aan te leggen. Bijkomend voordeel is het inlaten van schoon rivierwater in de binnenrotte. Het project zou in zijn eenvoudige variant 550.000 euro kosten. Het project staat ingepland na 2021. Het naar voren halen van dit project in de tijd, zo mogelijk een meer luxere variant zijn bespreekbaar.

Ook het gemaal aan de Oostplein wordt aangepast om vissen door te laten. Dit kan door met een lager debiet te gaan pompen. Het visualiseren van de vispassage bij het Oostplein of een educatieve component zou dit gemaal beter kunnen promoten.

Erwordt op de binnenwateren gevis. Er is landelijk beleid voor het vissen. Hengelaars moeten gevangen vissen weer terugplaatsen. Bas de Wildt van Waterschap Schieland is bekend met het landelijke en regionale beleid ten aanzien van hengelaars. Streetfishing is een populair fenomeen.

Voor de Bergsluis in het Noorderkanaal wordt onderzoek gedaan naar een vispassage.

Door klimaatverandering neemt zoutindringing toe. Dit betekent een paar % chloride in extra ten opzichte van de huidige concentratie chloride. Vooralsnog is het volgens Schieland geen groot probleem voor het water of vissen. Het is een keuze van het waterschap om de zoutindringing tegen te gaan door het openen of sluiten van gemalen. Jeroen Willenman kan meer over dit feit vertellen.

Voor de vergroening van de rivier is het belangrijk om de doorstroming te verbeteren. In ieder geval mag in dit kunstmatige binnenwater geen stil water komen. De gemalen moeten blijven draaien om de stroming te garanderen. Het waterschap heeft 500.000 euro in een periode van 2016 - 2021 uitgetrokken voor de aanleg van 3 - 5 kilometer natuurvriendelijke oevers in de Rotte. Het gaat om het deel vanaf de Gordelweg richting het noorden. Er zijn harde kades. In sommige gevallen is er een harde kade vanwege de functie van waterkering. (Christa Groshart, technische inpassing van Natuurvriendelijke oevers Schieland)

Dijkdoorbraak in de Schie en of Rotte leidt tot bijna 1,6 miljard euro schade. Directe schade 340 miljoen euro bij berekening door Stadsbeheer. De dijken van de Rotte en Schie zijn dus enorm belangrijk. Belangrijk om crisisbeheersing toe te passen en niet blind maatregelen te gaan bedenken. Dus zandzakken bij de hand!

Klimaatverandering is een bedreiging door pieken in neerslagwater en in een droge periode voor het uitdrogen van de dijken.

Opgave voor Rotte en Schie volgens stadsbeheer:

Wateropgave is gigantisch: Effectief is een grote berging van bijvoorbeeld de Eendragtpolder niet. Binnen 2 -3 dagen is dat watervoorraad bij droog weer op. Er zou beter getekenen kunnen worden naar opslag in de grond: moerassige gebieden. Ook omdat de Rotte en Schie geen bergingscapaciteit hebben. Het verhogen van het waterpeil vraagt om aanpassing van de kaden en dijken. Bergen van het water in de achterliggende polders zijn effectiever en goedkoper wanneer gewerkt wordt met een robuuste natuur die zowel tegen moerassige als droge grond kan.

Peter van Veelen geeft aan dat er een voor het bouwen buitendijks een uitgiftepeil wordt gegeven van 3.60 meter NAP. De overstroomingsrisico is daarbij 1:10.000. Kwetsbare projecten moeten hoger worden gebouwd nl 3.90 NAP.

Het structureel ophogen met grond is alleen mogelijk in "lege" gebieden zoals bijvoorbeeld in Merwe Vierhavens.
The edible river: the river Muse produces edible species
The efficient river: sludge is available and could be reused in the design of productive riverscapes
Impressie Werksessie Programma Rivieroevers:
Hergebruik kade en materialen, donderdag 19 februari 2015

Aanwezig:
Laurence Peels
Pieter de Greef
Lena Niël
Ayo Klijnsmit
Joop Zwiep
Dirk Enslin
Leonard van der Velde
Joep van Leeuwen
Sander Klaassen

Een van de prioriteiten van Rotterdam voor de komende jaren is het verbeteren van de verblijfskwaliteit en de ecologische kwaliteit langs de rivieren. Het gaat daarbij om de Nieuwe Maas, Rotte en (Delfse) Schie. De wethouder heeft de opdracht gegeven om een programma Rivieroevers op te stellen waarbij ook gevraagd wordt om concrete uitvoeringsprojecten die vanaf 2016 een bijdrage kunnen gaan leveren aan de gestelde doelen. Deze moeten ingebracht worden bij de college-onderhandelingen tijdens de Voorjaarsretraite. Het gaat daarbij om een beschikbare geldsom van circa 4 miljoen euro. Daarvoor is het nodig om eind maart een lijst met projecten te hebben die onderdeel kunnen uitmaken van het programma. Naast het Rotterdamse programma is er ook een programma De Rivier als getijdepark. Dit is gericht op het regio-verband en richt zich voornamelijk op de aanleg van getijdenatuur. Voor het Rotterdamse programma is Pieter programmamanager voor de Nieuwe Maas, Waterweg en Scheur. Maartje Visser voor Rotte en Schie. Voor het opstellen van een programma worden er enkele verkennende werksessies gehouden. Doel van deze werksessie is het in kaart brengen van allerlei feiten die samenhangen met de rivier. Deze werksessie moet gaan over efficiënt omgaan met beheer en kademuren en hergebruik van grondstoffen.


The lively river: several festivals and concerts are held in the innercity along the river Muse
The attractive river: people experience a lack of green in the innercity close to the river
The characteristic river: the river Muse is seen as an international and industrial river
Rondje verschillen

Focus voor vandaag: versterken karakter van rivieren, zoeken naar Rotterdamse

Michiel Couperus
Mieke van Leeuwen
Maartje Visser
Arjo Klijnsmit
Joke Klumper
Sander Klaassen
Annemiek Fontein
Emiel Arends
Lena Niel
Verslag Workshop 17 februari 2015
3 rivieren – 1 programma

Verschillen 3 rivieren – samenhang 3 rivieren – aanzet opgaven en focus/perspectief Rivieren

Verslag Arjo
Aanwezig:
Annemie Fontein
Lena Niel
Sander Klaassen
Emiel Arends
Joke Klumper
Arjo Klijnsmit
Maartje Visser
Mieke van Leeuwen
Michiel Couperus

Aanwezig:

Verslag Mieke van Leeuwen

Aftrap Annemieke

• Zoeken naar identiteit van de rivieren: rotte en Schie hebben wel eigen karakteristiek.
  o Rotte pittoresk rivier veenlandschap, plezier en recreatie
  Combinatie recreatie en zakelijk
  Maas kenmerkt zich door afwisseling en verschillende schaalniveaus: botlek, strandje
  heiplaats. Wel de grootste opgave, kansen en opgaven. Hoe zorgen we voor
  samenhang en continuïteit langs de rivier en uitbuiten constrasten. Vernieuwing met
  name in havengebied.
  Hoe lang blijven de raffinaderijen actueel? Welke kansen biedt dat? A la Ruhrgebied?
  Grote kanshebbers om havengebied om te vormen tot stedelijk landschap.
  Waalhaven als eerste voor waterrecreatie
  Korte termijn ingrepen zien in een perspectief van die horizon
  Opgave voor korte termijn om iets te doen met landtong Rozenburg, extremer inzetten
  op getijdenatuur. Daarnaast eiland van brienen oord
  Grote kanshebbers om havengebied om te vormen tot stedelijk landschap.
  Waalhaven als eerste voor waterrecreatie
  Korte termijn ingrepen zien in een perspectief van die horizon
  Opgave voor korte termijn om iets te doen met landtong Rozenburg, extremer inzetten
  op getijdenatuur. Daarnaast eiland van brienen oord
  Grote kanshebbers om havengebied om te vormen tot stedelijk landschap.
  Waalhaven als eerste voor waterrecreatie
  Korte termijn ingrepen zien in een perspectief van die horizon
  Opgave voor korte termijn om iets te doen met landtong Rozenburg, extremer inzetten
  op getijdenatuur. Daarnaast eiland van brienen oord

Focus voor vandaag: versterken karakter van rivieren, zoeken naar Rotterdamse

Ronde verschillen

• Route langs Schie is makkelijk te maken, maar niet logisch
• Route langs rotte is in het centrum vrij wel niet te maken, omdat hij daar niet te vinden is
• Rotte is veel meer functioneel, minder recreatief. Kan nauwelijks overgestoken worden. Snijdt door het landschap, is er geen onderdeel van.
• Schie mist een verbinding met rest van het landschap, is wel duidelijk onderdeel van zijn eigen landschap
• Rotte en Schie horen tot standaard Hollandse landschap
• Schie vrij stenige, grote blokken, is niet leuk. Wel adressen aan het water. Eindeloze exercitie, berekent op snelheden boven 5 km/H. Met name in de stad is dat een gemiste kans (Coolhaven, aelbrechtskade, gevangenis, van nelle). Relatie met woonmilieus
• Uniek bij Schie is juist de bedrijvigheid
• Route door overschie is alternatief voor langs het kanaal.

• Maas is unieke ruimte, ook in NL, panorama dat steeds verandert. Maas is Rotterdamse decor! Stroomt. Opgave om beleenbaar en tastbaar te maken.
• Eigenlijk geen programma en adressen langs het water. Alles zit in de havenbekkens.
• Er is niets te doen langs het water. Restaurants/cafés
• Verbinding met rivier zelf is slecht.
• Getijdencafe is ongezond.
• Activiteit, beweging op het water.
• Menselijke schaal wordt nietig bij Maas.
• Vervoer over water: dagelijks personenvervoer in combinatie met vracht. Kansen om gebieden te verbinden.
• OV komt nauwelijks bij het water.
• Nauwelijks privaat gebruikt op het water, strenge regels. Wel verborgen strandjes, die goed gebruikt worden. Veiligheid wel een item.
• Rolte: idyllisch, verbonden met stad
• Schie: open, industriëel
• Maas: oorspronkelijke levensader van de stad, ligging in de delta, is in de stad veel minder zichtbaar.
• Kansen voor voedselproductie: Maas biedt Letterlijk ruimte richting haven voor voedselproductie. Bij rotte en Schie geen ruimte voor voedselproductie, knooppunten waar rotte en Schie aan landen in de stad zijn wel de koppelpunten waar het achterland verbonden wordt met stad.
• Toegankelijk makten van de rivierovens biedt kansen voor visproducten of zelfvoorzienendheid voor mensen.

Rivieren als oorsprong van natuur, leven: instinctieve aantrekkingskracht. Dynamiek van de delta essentieel element voor branding van Rotterdam.

Verslag Maartje

DE 3 RIVIEREN

Annemieke

.Rotte pittoresk, veen riviertje
.Schie, veel industrieler, vaart en zakelijker, hoofdvloerweg + recreatie
.Maas, grote tegenstellingen, lege complexen in havengebied, terug naar eco, getijdenwerking en ook invulling modern in haven, kans in waalhaven, landtong rozenburg nog meer getijden, eiland van brienenoord

VERSCHILLEN PER RIVIER

Maas
.is einde van de delta
.voedsel/productie, grootschalige productie
.industriële rivier, getijden, verbinding grote landschappen
.stroom, dynamiek
.veranderend Rotterdamse decor door slingerende rivier, dit beleefbaar en tastbaar te maken
.run van ruimte
.programma raakt de maas niet, zit allemaal in de havenbekken, gekoppeld aan de woonomgeving
.Een versteld landschap
.recreatief fascineren, niet alleen leefomgeving

.Rotte is heel divers
..je voelt je nietig
.binnenvaart is weggewoon, kan die niet zichtbaar, wonen op het water
.verbindingen over water, dagelijks vervoer

..verbluffend uitzicht standaard landschap opzij

Rotte
.idyllisch
.mens
..komt niet uit in maas
..fietstroute bij de rotte in centrum niet vindbaar

.Voordeuren aan het water
..veerboot komt uit in een droogmakerij
..jaagparden en auto's aan huiskant.

.Rotte niet alleen leefomgeving, maar voor grotere groepen mensen
.is onderdeel van het landschap, verbind rottenmeren
.boeren verbinding van oudsher
..rotte is soms minder zichtbaar
..in de stad geen beleving, geen herkenbare rotte
..verbruiken water op water, voor dagelijks vervoer, wel voor recreatie
..dead end rivertje
.recreatief ver ontwikkeld
..weinig medegebruik

Schie
.industriële, maakbare landschap
.mond uit in de maas
..fietstroute is makkelijker, opstakels bij de schie
..schie is een rechte vaart
..duurt lang voordat je eruit bent,
..aan het begin zijn voor de vaart in rotterdam, inlever en menselijker mag
..geen programma erlangs, gevangen, wordt beleefd terwijl ook euromast, van nelle, colthaven, aalbregtshkade

..vooral een fietstroute, fijne snelheid, aantrekkelijke route
..industriële oudwetse karakter, met van nelle, spaanse polder
..programma bij de zweth
..landgoederen aan de schie
..schie, landschap ontstaan is zichtbaar
..goed te orienteren
..water taxi bij van nelle

..snij door het landschap, minder onderdeel van de, verbind noordas/mdelfland
..medegebruik en geld verdienen
..delfshaven ligt zijdeltjes van de schie terwijl het was de oorsprong, is afgedamd

BINDENDE THEMA'S HET PROGRAMMA
..De rivier als verbinding, stad en land en elkaar
..rivier als decor
..rivier als verblijfskwaliteit
..rivier als economisch verdienmodel
..cultuur historisch ontstaansgeschiedenis, landschappelijk en gebruik, maar ook vuur/ water/ oer
..dynamiek van de delta, incl medegebruik en economie
..rivier als balkon, voortuin, park en landschap
..verdienmodellen
..klimaat en keolte systeem
..waterveiligheid, primair en secundair

PER RIVIER EN FOCUS GEBIEDEN

Maas
..oost west verbinding, feest, wandel, jog, ov, vanuit binnenstad
..haven en rivierbeleving vanuit wijken op zuid, n-z orientatie
Aftrap door Annemieke Fontein

kunnen we het karakter van de rivieren vergroten. Doel van deze bijeenkomst is om de typeringen van de verschillende rivieren te beschrijven. Hoe moet je een rivier als experiment, bijvoorbeeld de Rotterdamse Maas, kunstmatig en loopt niet op de plek waar hij oorspronkelijk heeft gelegen. Maas, het maakt onderdeel uit van een verstild landschap. De enorme bedrijvigheid langs de raffinaderijen tot een klein strandje, de Schie, een zakelijke rivier met nauwelijks medegebruik.

1. Wat zijn de verschillen tussen de rivieren?


Deze werksessie gaat in de volgende vragen:

1. Wat typeert de Maas, Rotte en de Schie
2. Wat zijn de belangrijkste opgaven
3. Richting en ambitie per rivier

1. Wat zijn de verschillen tussen de rivieren?


De Schie is door het landschap gegraven. Het is een zandriviervoor rivier met een landelijk karakter. De stad Rotterdam is zichtbaar aanwezig maar dringt zichzelf niet op. Het water is als een draad in een parelketting, her en der liggen er langs de Rotte interessante plekken. De Rotte wordt intensief gebruikt voor recreatievaart. In de zomermaanden wordt er tot laat in de avonden geroeid. De Rotte wordt bewoond door bewoners van woningen.

De Schie is door het landschap gegraven. Het is een zandriviervoor rivier met een landelijk karakter. De stad Rotterdam is zichtbaar aanwezig maar dringt zichzelf niet op. Het water is als een draad in een parelketting, her en der liggen er langs de Rotte interessante plekken. De Rotte wordt intensief gebruikt voor recreatievaart. In de zomermaanden wordt er tot laat in de avonden geroeid. De Rotte wordt bewoond door bewoners van woningen.

De Schie is door het landschap gegraven. Het is een zandriviervoor rivier met een landelijk karakter. De stad Rotterdam is zichtbaar aanwezig maar dringt zichzelf niet op. Het water is als een draad in een parelketting, her en der liggen er langs de Rotte interessante plekken. De Rotte wordt intensief gebruikt voor recreatievaart. In de zomermaanden wordt er tot laat in de avonden geroeid. De Rotte wordt bewoond door bewoners van woningen.

Aftrap door Pieter de Greef

College zet in op de rivier. We werken samen met partners om de verblijfskwaliteit en ecologische waarde van de rivier te verbeteren. Doel is het beter benutten van de mogelijkheden van de rivieren. We leveren een perspectief voor de voorjaarstraject 2015, voorstel voor de uitvoeringsprojecten 2015.

1. Wat typeert de Maas, Rotte en de Schie
2. Wat zijn de belangrijkste opgaven
3. Richting en ambitie per rivier

1. Wat zijn de verschillen tussen de rivieren?


De Schie is door het landschap gegraven. Het is een zandriviervoor rivier met een landelijk karakter. De stad Rotterdam is zichtbaar aanwezig maar dringt zichzelf niet op. Het water is als een draad in een parelketting, her en der liggen er langs de Rotte interessante plekken. De Rotte wordt intensief gebruikt voor recreatievaart. In de zomermaanden wordt er tot laat in de avonden geroeid. De Rotte wordt bewoond door bewoners van woningen.

De Schie is door het landschap gegraven. Het is een zandriviervoor rivier met een landelijk karakter. De stad Rotterdam is zichtbaar aanwezig maar dringt zichzelf niet op. Het water is als een draad in een parelketting, her en der liggen er langs de Rotte interessante plekken. De Rotte wordt intensief gebruikt voor recreatievaart. In de zomermaanden wordt er tot laat in de avonden geroeid. De Rotte wordt bewoond door bewoners van woningen.

De Schie is door het landschap gegraven. Het is een zandriviervoor rivier met een landelijk karakter. De stad Rotterdam is zichtbaar aanwezig maar dringt zichzelf niet op. Het water is als een draad in een parelketting, her en der liggen er langs de Rotte interessante plekken. De Rotte wordt intensief gebruikt voor recreatievaart. In de zomermaanden wordt er tot laat in de avonden geroeid. De Rotte wordt bewoond door bewoners van woningen.

De Schie is door het landschap gegraven. Het is een zandriviervoor rivier met een landelijk karakter. De stad Rotterdam is zichtbaar aanwezig maar dringt zichzelf niet op. Het water is als een draad in een parelketting, her en der liggen er langs de Rotte interessante plekken. De Rotte wordt intensief gebruikt voor recreatievaart. In de zomermaanden wordt er tot laat in de avonden geroeid. De Rotte wordt bewoond door bewoners van woningen.

De Schie is door het landschap gegraven. Het is een zandriviervoor rivier met een landelijk karakter. De stad Rotterdam is zichtbaar aanwezig maar dringt zichzelf niet op. Het water is als een draad in een parelketting, her en der liggen er langs de Rotte interessante plekken. De Rotte wordt intensief gebruikt voor recreatievaart. In de zomermaanden wordt er tot laat in de avonden geroeid. De Rotte wordt bewoond door bewoners van woningen.

De Schie is door het landschap gegraven. Het is een zandriviervoor rivier met een landelijk karakter. De stad Rotterdam is zichtbaar aanwezig maar dringt zichzelf niet op. Het water is als een draad in een parelketting, her en der liggen er langs de Rotte interessante plekken. De Rotte wordt intensief gebruikt voor recreatievaart. In de zomermaanden wordt er tot laat in de avonden geroeid. De Rotte wordt bewoond door bewoners van woningen.

De Schie is door het landschap gegraven. Het is een zandriviervoor rivier met een landelijk karakter. De stad Rotterdam is zichtbaar aanwezig maar dringt zichzelf niet op. Het water is als een draad in een parelketting, her en der liggen er langs de Rotte interessante plekken. De Rotte wordt intensief gebruikt voor recreatievaart. In de zomermaanden wordt er tot laat in de avonden geroeid. De Rotte wordt bewoond door bewoners van woningen.
The connective river: the world expo cherishes an improved connection along the river Muse
Impressie Werksessie Programma Rivieroevers Bereikbaarheid en Mobiliteit:

Donderdag 5 maart 2015

Aanwezig:

- Tom Modder, student HvU
- Lena Niel
- Michiel Couperus
- Martin Guit
- Arjo Klijnsmil
- Pieter de Greef

Wethouder Eerdmans heeft in het collegeprogramma aangeven dat één van zijn prioriteiten het verbeteren van de verblijfskwaliteit en de ecologische kwaliteit van de rivieroevers is. Daarom heeft hij opdracht gegeven om een programma Rivieroevers op te stellen. Het doel van het programma is het beter benutten van de mogelijkheden van de rivieren Maas (Nieuwe Waterweg/Nieuwe Maas), de Rotte en de Schie. Hierbij gaat het om het leveren van een bijdrage aan:

- Aantrekkelijker uitstraling en verblijfskwaliteit Rotterdam
- Natuurlijker/vergroten ecologische kwaliteit rivieren
- Levendigere rivieren (programma op en aan rivier)
- Recreatieve en landschappelijke verbindingen van, naar en langs rivier
- Beter benutten van stromen door rivier
- Robuustere of klimaatbestendige rivier
- Karakteristieke rivieren (vergroten Rotterdamse/eigen identiteit)

Er zijn twee manieren om naar de rivier te kijken. 1. de rivier is een barrière voor de mobiliteit en 2. de rivier is een onderdeel van het mobiliteitsnetwerk.

Ad 1. Er is altijd een barrière wat betreft mobiliteit tussen zuid en noord. Voor het fietsverkeer is alleen de Erasmusbrug een centrale ader voor het verkeer van Noord naar Zuid. De Willemsbrug kan bijvoorbeeld niet gebruikt worden voor het OV (tram). Er is veel omrijdtijd nodig om van Noord naar Zuid te komen. Er zijn over de rivier bijna geen cross-overs zoals pontjes of vervoer over water.

Ad 2. De rivier is een enorme ruimte die ook gebruikt zou kunnen worden namelijk erop: verbinding, erover: slechten van een barrière, en erlangs.

Visual report Sao Paulo

Figure 29
Tracing a river during the Biennal in Sao Paulo, november 2014
Source: image made by author

Figure 30
Result drawing conclusions of visit SP together with Alexandrje Delijacov (FAU-USP, Sao Paulol and Taneha Kuzniecow Bacchin (TU Delft)
Source: image made by author, Alexandre Delijacov and Taneha Kuzniecow Bacchin
Analysis urban ecosystem

- sections of design locations
- density analysis of design locations
- urban patterns and corridors
### Section I

#### WATER
- **Stream type**: Sea
- **Catchment area**: North Sea
- **Velocity**: Highly dynamic
- **Salinity**: Salinity
- **River element**: -
- **Depth of water**: 30 meter
- **Influence tidal**: 100%
- **Type of shore**: coastline
- **Angle of shore**: +/- 40 degrees

#### FOOD
- **Type of soil**: clay
- **Habitat**: -
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: [300, <] mg/-1 Cl
- **River element**: -

#### BUILDINGS
- **Type of buildings**: -
- **Habitat**: -
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: [300, <] mg/-1 Cl

### Section II

#### FOOD PRODUCTION
- **Type of soil**: sand in 1st year
- **Habitat**: partly meadow on sea and river clay
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: 1.5 - 3.0 meter
- **Influence tidal**: 20%
- **Type of shore**: vegetated slope
- **Angle of shore**: +/- 40 degrees

#### FOOD
- **Type of soil**: clay
- **Habitat**: -
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: [0.03, < 0.3] mg/-1 Cl

#### BUILDINGS
- **Type of buildings**: industry, housing
- **Habitat**: -
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: [0.05, < 0.7] mg/-1 Cl

### Section III

#### FOOD PRODUCTION
- **Type of soil**: sand in 1st year
- **Habitat**: partly meadow on sea and river clay
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: 1.5 - 3.0 meter
- **Influence tidal**: 20%
- **Type of shore**: vegetated slope
- **Angle of shore**: +/- 40 degrees

#### WATER
- **Stream type**: highly dynamic tidal river
- **Catchment area**: Midden Delfland, Grevelingendam
- **Velocity**: Highly dynamic
- **Salinity**: Salinity
- **River element**: straight line
- **Depth of water**: river: 14.5 - 16.5 meter
- **Influence tidal**: 100%
- **Type of shore**: coastline
- **Angle of shore**: +/- 40 degrees

#### FOOD
- **Type of soil**: sand in 1st year
- **Habitat**: partly meadow on sea and river clay
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: 1.5 - 3.0 meter
- **Influence tidal**: 20%
- **Type of shore**: vegetated slope
- **Angle of shore**: +/- 40 degrees

#### BUILDINGS
- **Type of buildings**: industry, housing
- **Habitat**: -
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: [0.05, < 0.7] mg/-1 Cl

### Section IV

#### FOOD PRODUCTION
- **Type of soil**: sand in 1st year
- **Habitat**: partly meadow on sea and river clay
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: 1.5 - 3.0 meter
- **Influence tidal**: 20%
- **Type of shore**: vegetated slope
- **Angle of shore**: +/- 40 degrees

#### WATER
- **Stream type**: highly dynamic tidal river
- **Catchment area**: Midden Delfland, Grevelingendam
- **Velocity**: Highly dynamic
- **Salinity**: Salinity
- **River element**: straight line
- **Depth of water**: river: 14.5 - 16.5 meter
- **Influence tidal**: 100%
- **Type of shore**: coastline
- **Angle of shore**: +/- 40 degrees

#### FOOD
- **Type of soil**: sand in 1st year
- **Habitat**: partly meadow on sea and river clay
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: 1.5 - 3.0 meter
- **Influence tidal**: 20%
- **Type of shore**: vegetated slope
- **Angle of shore**: +/- 40 degrees

#### BUILDINGS
- **Type of buildings**: industry, housing
- **Habitat**: -
- **Salinity**: -
- **Velocity**: -
- **Depth of water**: [0.05, < 0.7] mg/-1 Cl
“the water system: first and second order”
"about 60% of Rotterdam is built area"
“Unbuilt natural spaces are divided by roads and water”
"food production related to habitats"

- seaweed
  - meadow on sea and river clay
- parsley
  - meadow on sea and river clay
- celery
  - meadow on sea and river clay | estuary
- lettuce of willow
  - meadow on sea and river clay
- sale
  - meadow on sea and river clay
- grey goose
  - estuary | swamp | meadow on sea and river clay
- thyme
  - meadow on sea and river clay
- fowl
  - meadow on peat, sea and river clay
- European grasshopper
  - fenland | swamp | meadow on sea and river clay
Design variations

- the small scale
- the meso scale
- the large scale
JOBSHAVEN AND SCHIEHAVEN

PRODUCTIVITY

Soil type: 2
Contamination: 2
Groundwater table: 2
Water quality: 2
Velocity: 2

IN VOLVEMENT

enable
Point in ecological network: 2
Point in recreational network: 3
Participation: 2
Educational value: 3
Linking city and nature: 2
Research pilot: 2

ECOSYSTEM SERVICES

benefits
Small scale food production: 2
Small scale energy production: 2
Increase biodiversity: 2
Greening land: 2
Improve water safety: 2
Re-use sludge: 2
Reduce cost of maintenance: 2
Multiplier effect: 2
Symbolic value: 2
Increase value of property: 2
Catalyst urban development: 2

CONSTRAINTS

obstruct
Navigable depth & width: 2
Active harbour activities: 2
Harbour - city sentiment: 2

Variation I

Variation II

Variation III

current situation
MAASHAVEN

**PRODUCTIVITY**
- Soil type
- Contamination
- Groundwater table
- Water quality
- Velocity

**IN Volvement**
- Point in ecological network
- Point in recreational network
- Participation
- Educational value
- Linking city and nature
- Research pilot

**ECOSYSTEM SERVICES**
- Small scale food production
- Small scale energy production
- Increase biodiversity
- Greening land
- Improve water supply
- Re-use sludge
- Reduce cost of maintenance
- Diversification
- Symbolic value
- Increase in property value
- Catalyse urban development

**CONSTRAINTS**
- Navigable depth & width
- Active harbour activities
- Harbour - city sentiment

Variation I

Variation II

Variation III
**EILAND VAN BRIENENOORD**

**PRODUCTIVITY**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil type</td>
<td>3.2</td>
</tr>
<tr>
<td>Contamination</td>
<td>3.3</td>
</tr>
<tr>
<td>Groundwater table</td>
<td>3.3</td>
</tr>
<tr>
<td>Water quality</td>
<td>3.5</td>
</tr>
<tr>
<td>Velocity</td>
<td>3.5</td>
</tr>
</tbody>
</table>

**INVOlVEMENT**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enables</td>
<td>3.5</td>
</tr>
<tr>
<td>Point in ecological network</td>
<td>3.5</td>
</tr>
<tr>
<td>Point in recreational network</td>
<td>3.5</td>
</tr>
<tr>
<td>Participation</td>
<td>3.3</td>
</tr>
<tr>
<td>Educational value</td>
<td>3.5</td>
</tr>
<tr>
<td>Linking city and nature</td>
<td>3.5</td>
</tr>
<tr>
<td>Research pilot</td>
<td>3.5</td>
</tr>
</tbody>
</table>

**ECOSYSTEM SERVICES**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits</td>
<td></td>
</tr>
<tr>
<td>Small scale food production</td>
<td>4.2</td>
</tr>
<tr>
<td>Small scale energy production</td>
<td>3.3</td>
</tr>
<tr>
<td>Increase biodiversity</td>
<td>5.5</td>
</tr>
<tr>
<td>Greening land</td>
<td>3.9</td>
</tr>
<tr>
<td>Improve water safety</td>
<td>3.3</td>
</tr>
<tr>
<td>Re-use sludge</td>
<td>3.2</td>
</tr>
<tr>
<td>Reduce cost of maintenance</td>
<td>3.2</td>
</tr>
<tr>
<td>Multiplier effect</td>
<td>3.4</td>
</tr>
<tr>
<td>Symbolic value</td>
<td>3.5</td>
</tr>
<tr>
<td>Increase value of property</td>
<td>3.4</td>
</tr>
<tr>
<td>Catalyst urban development</td>
<td>3.3</td>
</tr>
</tbody>
</table>

**CONSTRAINTS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstructs</td>
<td></td>
</tr>
<tr>
<td>Navigable depth &amp; width</td>
<td>3.5</td>
</tr>
<tr>
<td>Active harbour activities</td>
<td>3.5</td>
</tr>
<tr>
<td>Harbour - city sentiment</td>
<td>3.5</td>
</tr>
</tbody>
</table>

**current situation**

Variation I

Variation II

Variation III
ORANJEBUITENPOLDER

PRODUCTIVITY

Biophysical

Soil type

Contamination

Groundwater table

Water quality

Velocity

INVOIEMENT

Current situation

Involvement enables

Point in ecological network

Point in recreational network

Participation

Educational value

Linking city and nature

Research pilot

ECOSYSTEM SERVICES

Benefits

Small scale food production

Small scale energy production

Increase biodiversity

Greening land

Improve water safety

Re-use sludge

Reduce cost of maintenance

Multiplier effect

Symbolic value

Increase value of property

Catalyst urban development

CONSTRAINTS

Obstructs

Navigable depth & width

Active harbour activities

Harbour - city sentiment

Variation I

Variation II
THE NORTH SEA

PRODUCTIVITY

<table>
<thead>
<tr>
<th>Description</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil type</td>
<td></td>
</tr>
<tr>
<td>Contamination</td>
<td></td>
</tr>
<tr>
<td>Groundwater table</td>
<td></td>
</tr>
<tr>
<td>Water quality</td>
<td></td>
</tr>
<tr>
<td>Velocity</td>
<td></td>
</tr>
</tbody>
</table>

INVOlVEMENT

<table>
<thead>
<tr>
<th>Enable</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point in ecological network</td>
<td></td>
</tr>
<tr>
<td>Point in recreational network</td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td></td>
</tr>
<tr>
<td>Educational value</td>
<td></td>
</tr>
<tr>
<td>Linking city and nature</td>
<td></td>
</tr>
<tr>
<td>Research pilot</td>
<td></td>
</tr>
</tbody>
</table>

ECOSYSTEM SERVICES

<table>
<thead>
<tr>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small scale food production</td>
</tr>
<tr>
<td>Small scale energy production</td>
</tr>
<tr>
<td>Increase biodiversity</td>
</tr>
<tr>
<td>Gazing land</td>
</tr>
<tr>
<td>Improve water safety</td>
</tr>
<tr>
<td>Re-use sludge</td>
</tr>
<tr>
<td>Reduce cost of maintenance</td>
</tr>
<tr>
<td>Multiplex effect</td>
</tr>
<tr>
<td>Symbolic value</td>
</tr>
<tr>
<td>Increase value of property</td>
</tr>
<tr>
<td>Catalyst urban development</td>
</tr>
</tbody>
</table>

CONSTRAINTS

<table>
<thead>
<tr>
<th>Obstruct</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigable depth &amp; width</td>
<td></td>
</tr>
<tr>
<td>Active harbour activities</td>
<td></td>
</tr>
<tr>
<td>Harbour - city sentiment</td>
<td></td>
</tr>
</tbody>
</table>

Variation I

Variation II

current situation
A productive landscape is referred to as a landscape in which the combination of urban and rural areas is sought, as it is the heart of sustainable urban planning and design. How can we design productive landscapes in the city of Rotterdam using food as a tool to shape the current riverfronts for stimulating and improving biodiversity?

How to design productive riverscapes using food as a tool to shape the current riverfronts for stimulating and improving biodiversity?

The negative effects of climate change and the socio-economic systems demand for solutions that can help the city to face major natural disasters efficiently. How can we design productive landscapes in the city of Rotterdam using food as a tool to shape the current riverfronts for stimulating and improving biodiversity?

The adaptive framework and how to design productive riverscapes using food as a tool to shape the current riverfronts for stimulating and improving biodiversity.

The adaptive framework and how to design productive riverscapes using food as a tool to shape the current riverfronts for stimulating and improving biodiversity.

The adaptive framework and how to design productive riverscapes using food as a tool to shape the current riverfronts for stimulating and improving biodiversity.

The adaptive framework and how to design productive riverscapes using food as a tool to shape the current riverfronts for stimulating and improving biodiversity.
WORKSHOP: HOW TO FEED THE WORLD METROPOLISES

JOBS COLLECTIVE GARDENS
community farming for social interaction

This project is a design proposal to produce food based on the existing ecological conditions of an empty harbour in Rotterdam. It creates edible habitats related to the different cultures of the surrounding neighbourhoods. In this way, social interaction is stimulated by community farming, while at the same time biodiversity increases.

ROOFTOP FARMING & FOOD
onions, potatoes, quinoa, garlic, pears, tomatoes, carrots

TIDAL HABITAT & HERBS
various seaweed, kelp

AQUATIC FOOD
oyster, sea urchin, seaweed, fish, prawn, mussels, eel, squid, shrimp, crayfish

FLOODPLAIN HABITAT & HERBS
hydrilla, water chestnut, lotus, arum

LAND HABITAT & SPICES
mango, bay leaf, ginger, lemongrass

LAND FARMING & FOOD
onions, potatoes, quinoa, garlic, pears, tomatoes, carrots

ISOCARP
The Netherlands, October 2015
References


