AR3U100 Transitional Territories

Msc Urbanism

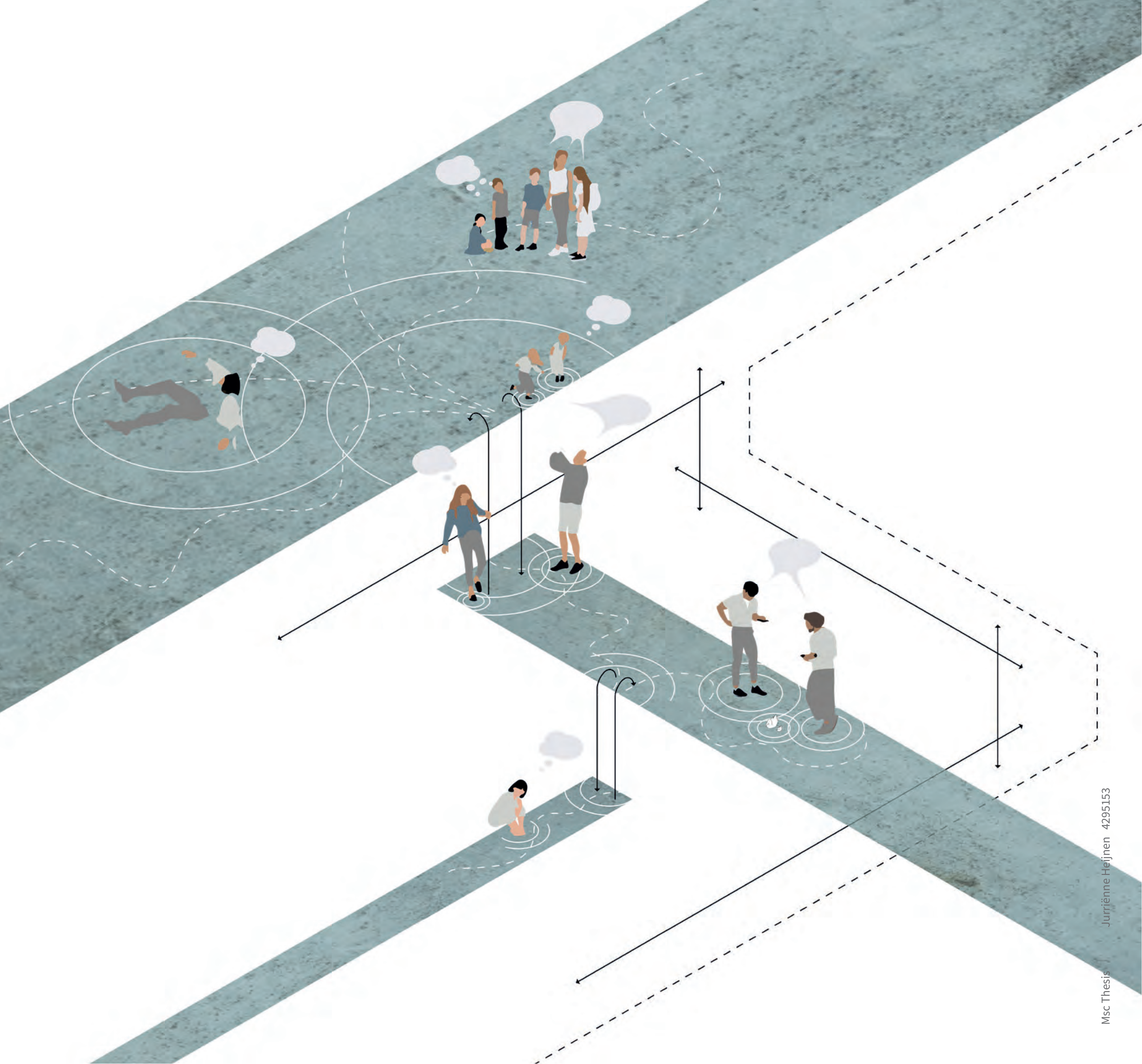
Faculty of Architecture and the Built Environment,
Delft University of Technology

P5 Report

An exploration of Landscape Identity related to Flood Safety...

... a delta dilemma?

On the reconciliation of the antropogenic and natural flux
in the peat pasture delta landscape through Building with Nature



Msc Thesis Jurriënne Heijnen 4295153

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Colophon

An exploration of Landscape Identity related to Flood Safety, reconciling the Dutch technocratic understanding of flood safety with hydrologic dynamics of the landscape through Building with Nature. A DELTA DILEMMA?

MSc. Thesis project - P5 report

MSc. Architecture, Urbanism and Building Sciences
Track of Urbanism

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Faculty of Architecture and the Built Environment
Delft University of Technology

Delft, The Netherlands, July 2021

scale 1: x 000

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INTRODUCTION

Dilemma

A usually undesirable or unpleasant choice or a situation involving such a choice.

A problem involving a difficult choice, a difficult or persistent problem, an argument presenting two or more equally conclusive alternatives against an opponent.

Abstract

A sectoral flood safety approach has been the critical condition for Delta Urbanization in the Netherlands until now. But does this have to be the case for future urbanization as well? In the Dutch approach to flood safety, a dilemma appears to exist between (sectoral) flood safety on the one hand and biodiversity and flood resilience on the other. Where the pursuit of flood safety, especially in a context of extreme climate scenario's, might continue to go at the cost of biodiversity and resilience.

The thesis is on the reconciliation of the human understanding of flood safety and the natural dynamic system of water, soil and air within the Dutch Delta, specifically the Alblasserwaard. It explores the spatial manifestation of the relationship between people and nature and proposes re-positioning of this relationship between through a different understanding of flood safety and the application of Building with Nature.

The concept and understanding of landscape identity is an expression of the people- nature relationship. In the case of the Dutch delta, landscape and flood safety are inevitably intertwined, and a certain relationship of people mastering nature becomes apparent of this intertwining. The Dutch delta landscape, before human settlement, was shaped through forces of water, soil and air and had a dynamic nature. Urbanization was accompanied with damaging floods and over time, flood risk adaptation shifted from retreat to prevention. Ultimately resulting in the contemporary understanding of flood safety, which is a sectoral one: preventing flooding at all cost and a applying a one size fits all approach to achieve this criterion.

The contemporary delta landscapes represent severe anthropogenic intervening, enclosing and contol of the dynamics of hydrology, geology and climate. And with this, the sectoral approach to flood safety apprears to be a prerequisite for delta urbanization, the only way for people to live with the pressures and dynamics of the water. In this thesis, a more embracive approach to flood safety is explored. It is an explorative research by design, aimed at not only understanding the spatial implications of a transition from human mastery over nature.It is above all about grasping the relationship between people and nature.

Landscape Identity is the mutual relationship between people and landscape, shaped by and shaping physical landscape characteristics and individual and collective identity attached to landscape.

A method for understanding this relationship through its spatial manifestation is proposed. Subsequently, altering this relationship is proposed and tested in the case of the Alblasserwaard dike ring. based on the following hypothesis: Shifting the sectoral understanding of flood safety to align with the dynamics of hydrology, geology, air and climate, which are both fundamentally shaping the landscape, allows the transition towards a biodiverse and flood resilient delta. Rethinking the relationship between people and nature, through landscape, is therefore essential. The concept of Building with Nature is tested as an approach to align the understanding of flood safety with the dynamics of air, water and soil. Proposing this re-alignment as the new critical condition for delta urbanization in transition towards a biodiverse and resilient delta. Ultimately, proving this apparent dilemma between flood safety on the one hand and biodiversity and resilience on the other, to be void.

Levee enforcements in Kinderdijk Schoonhovenseveer

Photograph showing the Dutch 'bathtub'

Source: Deltaprogramma 2021, 2020


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RESEARCH PROPOSAL

Methodology

The methodology chapter lays out the framework for the graduation thesis. Elaborating step by step on the research structure, establishing the relationship between problem statement, knowledge gap, research objectives, research questions, theoretical framework, hypothesis, methods and outcomes of the research. The definition of these elements together position the thesis within the field of delta urbanism.

Problem Statement

Problem statement

The urbanized areas within the Dutch delta are under increasing stress of climate change and urbanization as future extremes of the rising sea level, drought and precipitation are more and more becoming a part of the everyday reality (Bars et al., 2020; KNMI, 2020). Meanwhile, there is a housing shortage of 3,8 % in the Netherlands. This means that annually, an average addition of 75 000 dwellings is required to solve this housing shortage. As mapped on the right page, national densification strategies are focused on the Randstad, the highest urbanized area of the Netherlands that almost completely lies below the sea level (Manshanden & Koops, 2019; Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020).

Dealing with the pressures of urbanization and climate change within the Dutch Delta, increasing resilience, adapting and mitigating flood risk remain of the utmost importance (Nijhuis et al., 2020). Current adaptation and mitigation strategies of the Netherlands have been shaped by the Dutch faith in technology and quantitative flood risk assessment (Pols et al., 2007). This becomes apparent when looking at the current flood safety policy and planning, which is focused on strengthening existing levee systems on the term of one hundred years, assuming a moderate sea level rise of 0,25 to 0,80 meter by the year of 2085 (Ministerie van Infrastructure en Milieu & Ministerie van Economische Zaken, 2015).

The Dutch flood risk assessment model is based on the product of probability and consequences of flooding (Jonkman et al., 2008). In reaction to this risk assessment, the flood safety system in place, focuses on reducing the probability of flooding to almost zero (Vergouwe, 2014). Due to climate change, the flood probability is increasing and some events of flooding have occurred. High water levels along the Rhine, Waal, Lek and IJssel in 1993 and 1995 required the large scale evacuations of people and cattle. Ultimately, the flooding resulted in large in damages in urban and agricultural area (Bleichrodt & Ensinck, 1993).

These events have resulted in a partial shift of focus in flood safety development. From measures reducing flood probability towards reducing flood consequences, ultimately resulting in the national Room for the River programme that incorporated nature based solutions in flood safety development. This programme consisted of 34 projects that were completed in 2015 (Bars et al., 2020). At this point, the notion of resilience came into the discourse, which is the capacity of a society to react to flooding (Koers & Duijn, 2019).

Current flood safety development, planned until 2050, is focused on strengthening the current levee system and as mentioned before, assumes a moderate sea level rise of 0,80 meter (Koninklijk Nederlands Meteorologisch Instituut, 2015). For the coming decades, nearly 300 kilometres of Dike will be reinforced to reach the levee standards (Programmabureau Hoogwaterbeschermingsprogramma, 2020). The Room for the River approach that was taken the three decades after 1995, will not be continued. The question rises on what approach is right to take for flood safety development, taking into account scenarios of high end sea level rise. Which is predicted to possibly be as high as 1.00 meter around 2085 (IPCC, 2013). Can the current approach be continued, should we revert back to the Room for the River approach, or is another approach necessary?

Developing in flood risk areas

Source: Nationaal Georegister, 2020
Source: NOVI, 2020
Source: PBL, 2020

North sea

River

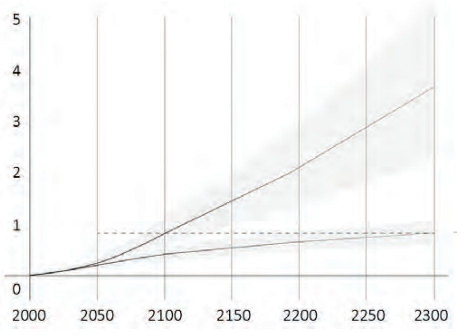
Below NAP area

Planned urban development area

Urban region

Predicted urban shrinkage area

0 km | 25 km



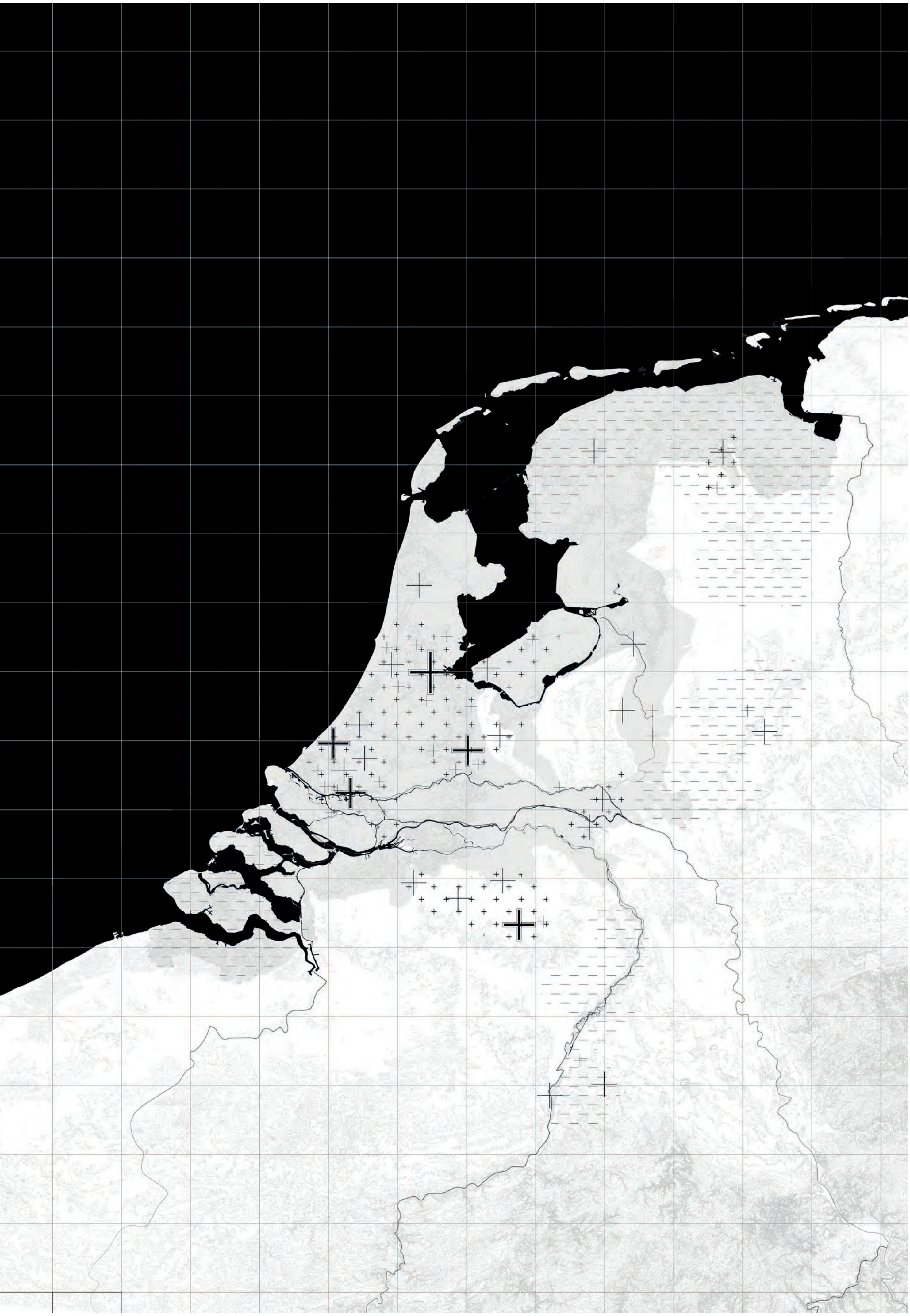
Sea level resulting from high emissions

Sea level resulting from low emissions

Levee protection in 2050

Predicted Sea Level Rise: Compared to the average level of 1986- 2005

Source: IPCC, 2019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scale 1: 1 300 000

Knowledge Gap

There are many diverse visions, on the national scale, on what approach to take in adapting to high end sea level rise. These approaches can all be regarded on a spectrum of moving seaward towards moving inland. As described by the Deltares Institute, they can be divided in four approaches. They are, moving seaward, remaining a closed system, embracing the water and retreating inland from the flood risk areas (Haasnoot et al., 2019). All significant visions on delta development fit on this spectrum. Some recent well-known proposals for development are Plan B NL2200 by Lola, NL 2120 by the WUR, New Netherlands by van der Meulen or the Northern European Enclosure Dam by Groeskamp and Kjellson, they alle fit on this spectrum, as presented in the schematic section (Baptist et al., 2019; Groeskamp & Kjellsson, 2020; Lola Landschape Architects, 2018; Van Der Meulen, 2020).

Most of these proposals are very far away from the upcoming flood safety development approach that is planned until 2050. What becomes evident in the proposals is the need for an increase in flood resilience and biodiversity. Within the scientific and design field, a certain consensus or awareness on the need for ecologic restoration seems apparent. The upcoming flood safety development interventions however, are along the lines of the 'remain' approach. The planned interventions, as presented in the so called Hoogwaterbeschermingsprogramma, are solely focused on increasing the ability of the current levee system to prevent flooding impact of moderate sea level rise. This sectoral approach does not steer towards an increase in resilience and biodiversity as proposed in the earlier mentioned visions for dealing with high end sea level rise. It becomes apparent that flood safety development needs to be steered towards a more nature based approach as an alternative to extreme river pumping, river embankment to protect the polders and elevation of the urbanised delta (Haasnoot et al., 2017). In addition, different proposals that mitigate more extreme scenarios are lacking (Pols et al., 2007).

In conclusion: there is a missing link between the current and planned sectoral flood safety approach and a possibly required transformative approach towards a resilient, biodiverse and flood safe delta. This thesis is an exploration of what lies at the base of this gap between the current sectoral flood safety approach and a more embracive, resilient and biodiverse approach. It is not only about broadening the scope of flood safety development and adding to the body of knowledge on the embracive approach. It is also about understanding the ideas of flood safety connected to the landscape, and the relationship between people and nature that is fundamental to this. Furthermore, it is an exploration of a method to intervene in the people – nature relationship, through spatial interventions.

Flood safety development approaches

Different flood risk development approaches according to the Deltares

Delta Development proposals

Planned levee strengthening until 2050

The 'natural' state of the Dutch Delta

Source: Joop van den Houdt, unknown

http://defotograaf.eu/blog/de-kwade-hoek-goeree/

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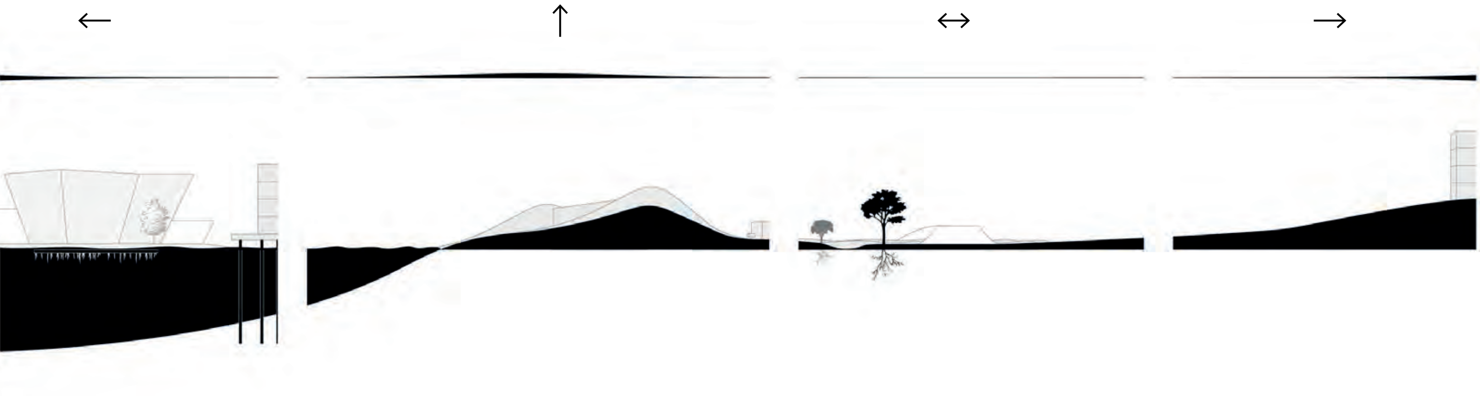
Seaward

Remain

Embrace [advance]

Retreat

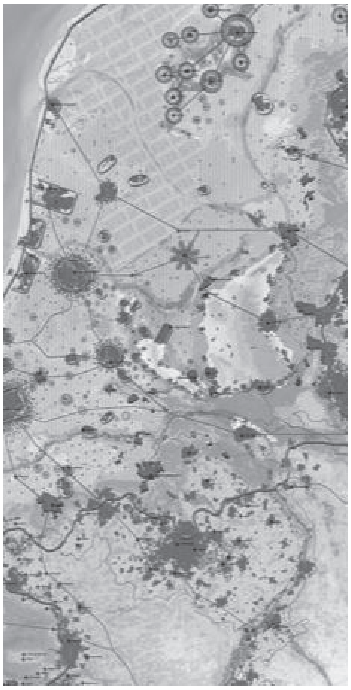


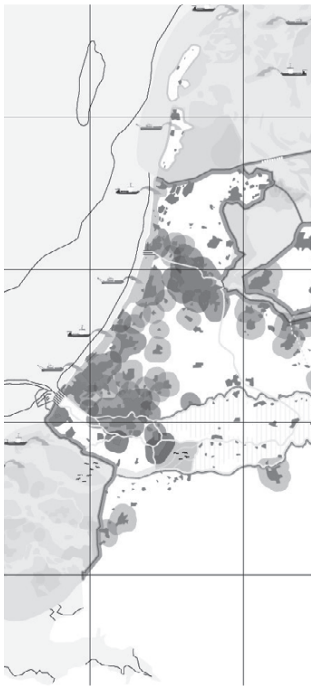
OCEANIX CITY
Bjarke Ingels Group
concept for floating villages that can withstand hurricanes
Source: Dezeen, 2019

NORTHERN EUROPEAN ENCLOSURE DAM
Groeskamp and Kjellson
x
Source: Groeskamp and Kjellson, 2020

PLAN B
LOLA
x
Source: LOLA, 2018

NEW NETHERLANDS
Van der Meulen
x
Source: Geert van der Meulen, 2019





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Relevance, Objectives and Approach

Relevance

With the growing pressures on the Dutch urbanized delta, living with extreme conditions will be the new reality. This thesis explores the spatial implications of an embracive approach for mitigating climate change extremes and adapting to future flood risk scenarios. Therefor, the thesis adds to the spectrum of possible approaches to adaptive and mitigative development of the [Dutch] urbanising delta. Moreover, through an exploration of the people – nature relationship manifested in the landscape, the thesis can aid in understanding the obstacles and synergies of agency in the transition of the sectoral flood safety approach. Subsequently this aids in steering decision making and participation in the transition towards a more resilient and biodiverse delta. Understanding the conceptualization of landscape through how it is manifested in the landscape, reveals a certain self-positioning of people relative to nature. Through spatially adressing the conceptualization of people as part of nature, not mastering it, the thesis is relevant in countering the issues of climate change. As this contemporary climate challenge is not only a challenge of urban design, but is strongly intertwined with social, technological and governmental processes, the thesis is a connects to a broader scope of different disciplines and reveals the need for an interdisciplinary approach. The thesis builds further upon existing long-term transformative development approaches, by testing already proposed interventions on their impact on the people – nature relationship.

Research objectives

As previously mentioned, there is a knowledge gap between the current and planned sectoral flood safety approach and a possibly required transformative approach towards a resilient, biodiverse and flood safe delta. In order to contribute to bridging this gap, the thesis aims to explore how an understanding of people- nature relationships, through Landscape Identity, can contribute to a less sectoral approach to flood safety. Ultimately to achieve a flood safe and biodiverse urbanized delta.

Firstly, through the method of research by design, the aim is to explore the transition from the current sectoral flood safety understanding into a systemic of flood safety where the human and natural systems are reconciled. Meaning that people and the urban and rural fabric can be considered as part of the natural system of water, soil and air, rather then a mastery over them. Subsequently, this leads to the objective is to understand the people- nature relationship and propose and test a method for understanding and restoring the people – nature relationship in relation to flood safety. Furthermore, the concept of Building with Nature is explored as a potential fitting approach to break away from the sectoral flood safety approach and reconcile the human and natural domains of flood safety, re-positioning people as part of nature rather than mastering over nature.

Research approach

This thesis is approached from a constructivist worldview. It focusses on perception instead of the perceived. Therefore, theories discussed in this thesis are used to be tested and challenged in order to build an in depth understanding of the context and participants of Flood Safety through Landscape Identity. Corresponding to this worldview, mixed methods of reasoning are used, deductive for the problem field analysis and mainly inductive reasoning for the research by design (Creswell & Plano Clark, 2011).

Conclusions are drawn from data and literature and specific spatial observations are used to understand the general patterns of landscape identity and the people – nature relationship Drawbacks from this approach are that the findings from this research are more easily challenged than the outcomes of quantitative research. In order to express the conclusions and assumptions made in this thesis on the understanding of Landscape Identity and the people-nature relationship, The visualization methods of Van den Born [2008] are used.

This relationship is presented as people in partnership with nature, people in mastery over nature or people participating in nature.

The conceptualization of a landscape Identity is decompositioned through the landscape character model and from the inter-domian relationships, the human – nature relationship becomes apparent.

This research approach of mostly spatial, qualitative inductive research is fitting to understand the relationship of people and nature which goes beyond quantitative data. Through a mixed methods approach, the thesis aims to understand spatial and behavioural patterns of the people– nature relationship in regards to Flood Safety, under the pressures of climate change and urbanization.

Theoretical Framework

The three main theoretical concepts that are researched in this thesis are Landscape Identity, Flood Safety and Building with Nature. As previously mentioned, Landscape Identity is employed to understand the people - nature relationship manifested in the Dutch landscape in regards to Flood Safety.

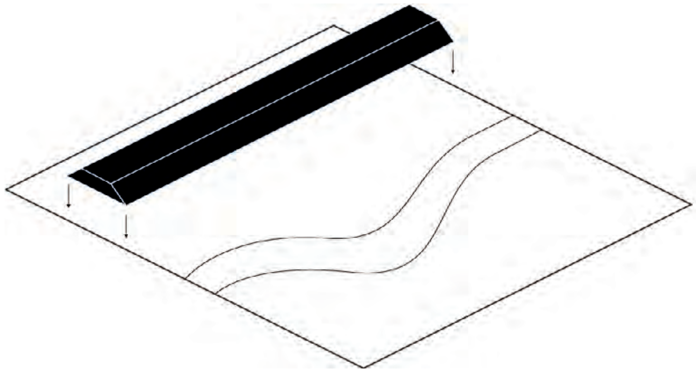
Subsequently, through this understanding, the applicability of Building with Nature for a transition of the flood safety approach is explored. Furthermore, through this understanding of Landscape Identity, the conceptualization of Building with Nature and Flood safety are reflected upon.

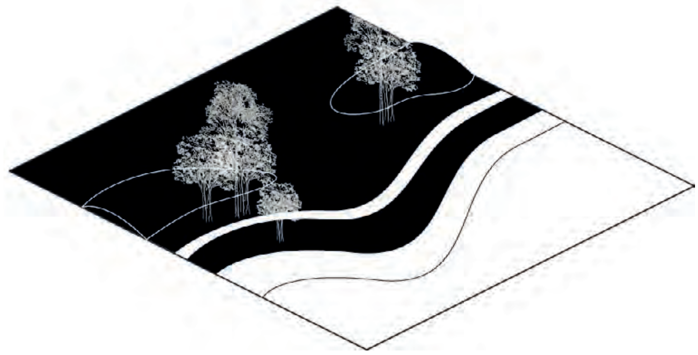
Additionally, the Landscape Character Assessment Model is used for the operationalisation of the

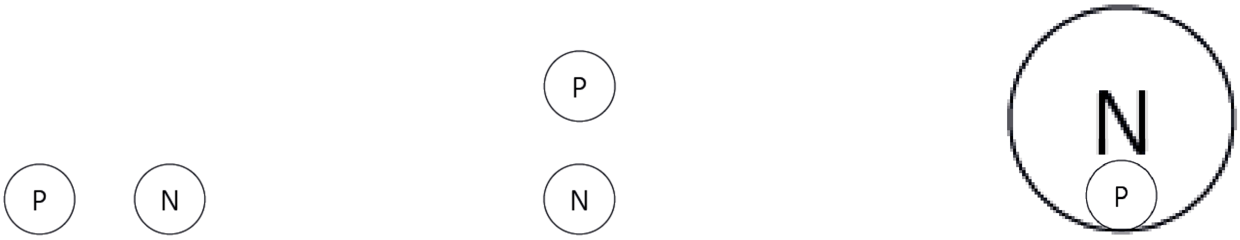
Knowledge Gap
Achieving flood safety, not from a system imposed upon the landscape but from the landscape

Posititioning of the relationship between people and nature
Resilience framework and
Source: Van den Born, 2008
Image: Heijnen, 2021

Theoretical Framework
Achieving flood safety, not from a system imposed upon the landscape but from the landscape







In partnership with nature

Mastery over nature

Participant in nature

Landscape Identity

[Landscape Character Assesment Model]

Flood Safety ↔ **Building with Nature**

scale 1: x 000

Conceptual Framework

Problem Field

Starting from the problem field, as expleained in the problem statement, the concepts of Flood Safety, Landscape Identity and Building with Nature are researched within the context of delta urbanization and the problems it faces with climate change pressures.

Concepts and Domains

The three concepts can be deconstructed in several domains for research as represented in the figure on the right. Landscape Identity defines people and landscape as driving factors in shaping the landscape, furthermore, the action and perception spheres are identified to adress the physical and societal components of Landscape Identity. The domains of Flood Safety that are researched are the assessment model of 'Risk = Probability x Consequences' and the flood safety approach of 'Embrace' is explored. For the Building with Nature concept, the design approach and intervention concepts can be defined. This deconstruction of the concepts is further explained in the Theoretical Underpinning chapter.

Conceptual Framework

The conceptual framework represent the presumed relationships between the different domains that are researched. The dotted lines represent the lines of research for this thesis.

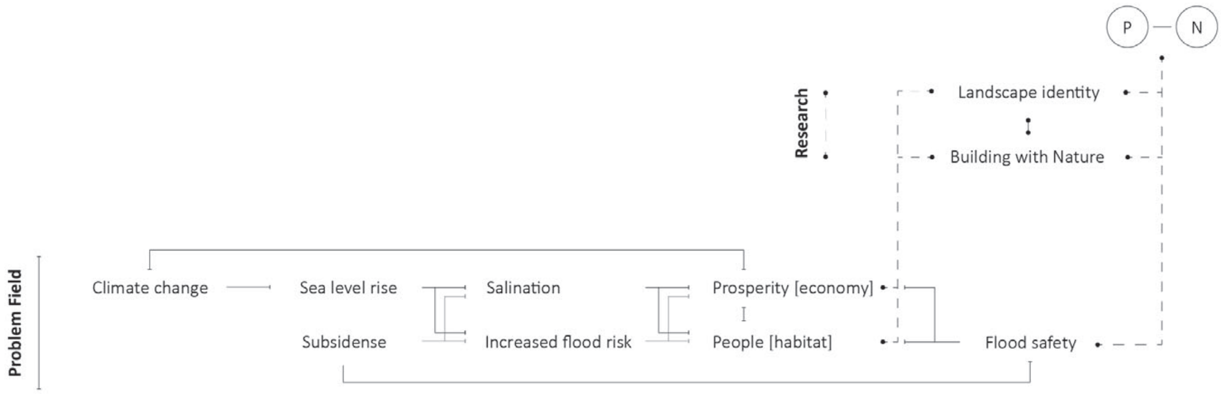
Firstly, the spatial manifestation of the sectoral flood safety approach, probability reduction measured by R = P x C is analysed. Furthermore it is considered what people- nature relationship becomes apparent of this spatial manifestation.

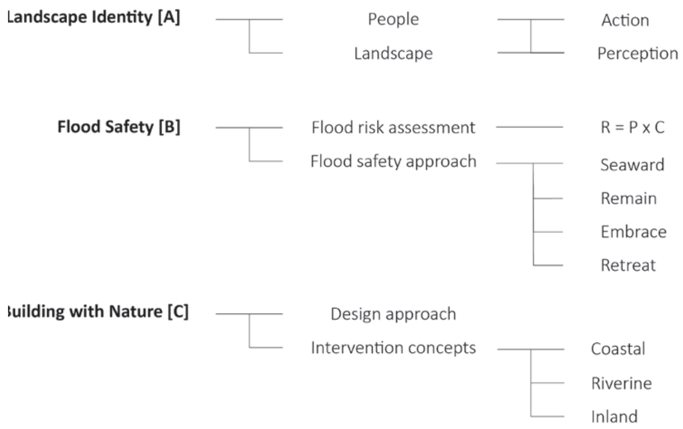
Secondly, with the understanding of this relationship and the aim to reconcile the anthropogenic and natural systems to re-position people as part of nature instead of mastering over it, the approach and interventions of Building with Nature are tested and reflected upon through research by design.

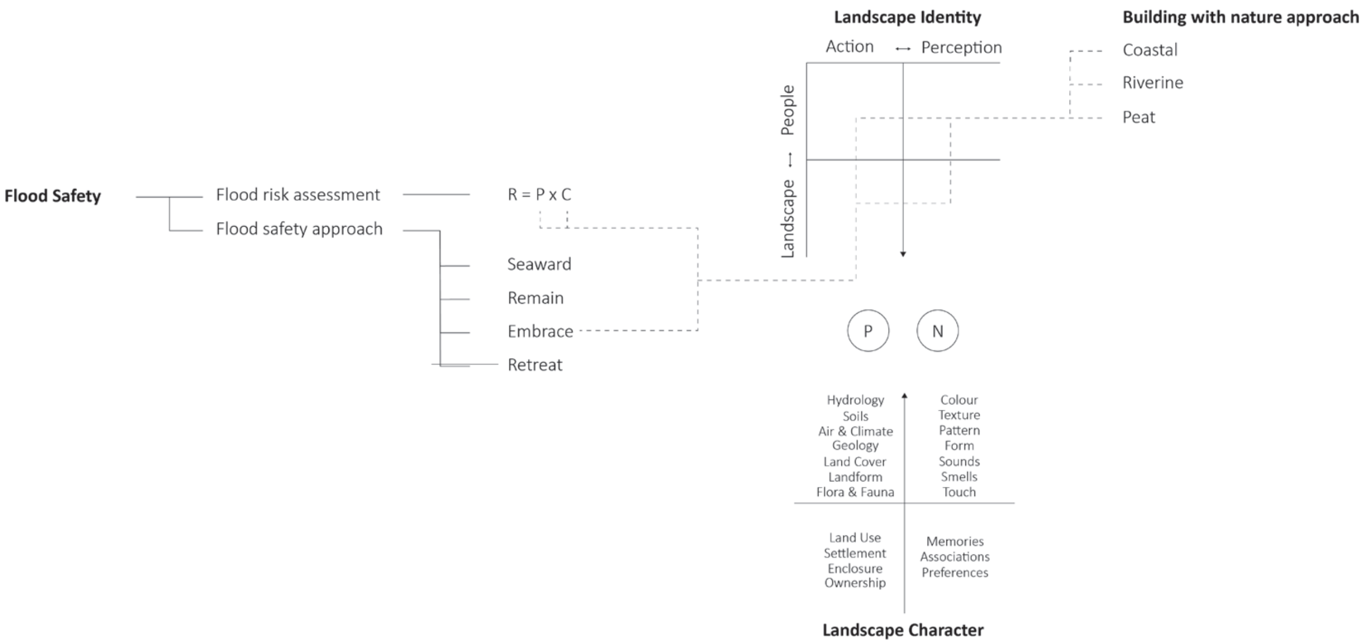
Research connected to the problem Field
From problem field to research framework

Concepts and Domains
The three main concepts and the researched domains in which they are subdivided

Conceptual Framework
The alignment of the different concepts en their domains


P
N
Research
Landscape identity
Building with Nature
Problem Field
Climate change
Sea level rise
Subsidense
Salination
Increased flood risk
Prosperity [economy]
People [habitat]
Flood safety


Landscape Identity [A]
People
Landscape
Action
Perception
Flood Safety [B]
Flood risk assessment
Flood safety approach
R = P x C
Seaward
Remain
Embrace
Retreat
Building with Nature [C]
Design approach
Intervention concepts
Coastal
Riverine
Inland


Landscape Identity
Action ↔ Perception
People ↔ Landscape
Building with nature approach
Coastal
Riverine
Peat
Flood Safety
Flood risk assessment
Flood safety approach
R = P x C
Seaward
Remain
Embrace
Retreat
P
N
Hydrology
Soils
Air & Climate
Geology
Land Cover
Landform
Flora & Fauna
Colour
Texture
Pattern
Form
Sounds
Smells
Touch
Land Use
Settlement
Enclosure
Ownership
Memories
Associations
Preferences
Landscape Character

Research questions

Main Questions

Derived from the problem statement, knowledge gap and research aim, the main research question of the thesis is:

'How can an understanding of Landscape Identity promote a biodiverse and flood resilient urbanized delta?'

- Exploring a building with nature approach to Flood Safety in the Albasserwaard -

Concept domains

The three concepts of landscape identity [A], Flood Safety [B] and building with nature [C] are operationalized in different domains and variables. Subsequently these domains and variables are assimilated in to frame the lines for research. These lines of research explore the relationships between the three concepts. They explore the relations of A+B, B+C as well as A+C.

[A] Landscape identities + flood safety [B]

[B] Flood safety + Building with Nature [C]

[A] Landscape identities + Building with Nature [C

Sub Questions

This composes the follow three sub questions:

AB: [How] are flood safety and landscape identity related?

The answering of this question is an analysis of the Dutch flood safety approach that is strongly embedded in the landscape.

BC: How does the understanding of Landscape Identity inform the application of Building with Nature solutions to acheive flood safety?

Building further on the identified domains that shape the landscape and the people- nature relationship, answering this question provided insight in the suitability of Building with Nature solutions in the Alblasserwaard. Adressing flood resilience and biodiversity, as well as the

AC: How can BwN solutions be applied to alter the human-nature relationship?

Through the application of Building with Nature solutions aimed at altering the damaging land use and settlement processes, meanwhile adressing the flawed people- nature relationship, this question is answered..

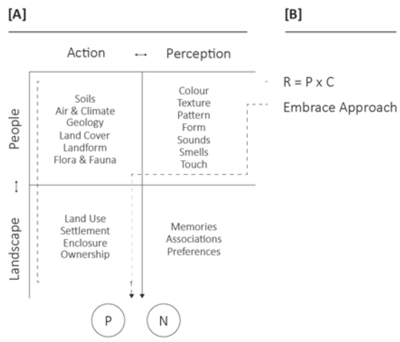
Research Framework

Operationalization and setting the outline for researching the relationships between the different concepts and domains.

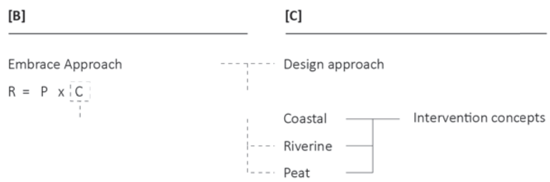
'How can an understanding of Landscape Identity promote a biodiverse and flood resilient urbanized delta?'

- Exploring a building with nature approach to Flood Safety in the Albasserwaard -

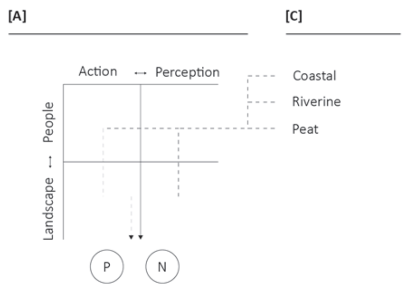
[AB] Landscape Identity and Flood safety



[BC] Flood safety and building with nature



[AC] Landscape Identity and Building with Nature



Hypothesis and Expected output

Hypothesis

The research is started from the following hypothesis:

In the case of the Dutch delta, flood safety and landscape are inevitably intertwined and a certain relationship of people mastering nature becomes apparent of this intertwining. This relationship, has gone hand in had with a sectoral pursuit of flood safety, that has gone at the cost of biodiversity and flood resilience.

Building with Nature can provide the tailor made solutions towards a more embracive and less sectoral flood safety approach, as these solutions take natural conditions of water, soil and air into account. The notion of people mastering nature can be an obstacle in transitioning towards a biodiverse and flood resilient delta, more embracive of hydrologic dynamics. As the pursuit of flood safety, especially with the perspective of extreme climate scenario's, might continue to go at the cost of biodiversity and resilience. Therefore, the building with Nature solutions aimed to transition the flood safety approach, need to address and alter the human – nature relationship as well.

Insight in the Dutch landscape identity exposes the dichotomic relation between people and nature.

Expected research output

Considering people as the agents of transition, the thesis proposes a systemic transition of the flood safety approach. Regarding the Alblasserwaard / Vijfheerenlanden dike ring as on the national and regional scale of the Rhine Meuse Scheldt delta. Supported by research by design interventions focused on mitigating polluting activities and flood risk adaptation through the scope of flood risk perception. Flood risk perception is analysed on the three scales of the national, local and individual. Taking a stance on the direction that water management in the Dutch delta should take, the proposed interventions and emphasized attitudes brought forth by the thesis, promote a transformative pathway towards a flood resilient Dutch Delta.

On the one hand, the design is an application on a regional scale of the building with nature and nature-based solutions that connect to the natural [physical] landscape identity and call for the amphibious [social] landscape identity]. With the aim of achieving a balance between the cultural and natural landscape in which ecology and economy [human habitat] are equivalent. And to take this goal as a condition for developing flood risk management. In some places this means a shift [from the natural physical landscape identity] to reducing the consequences of flooding instead of prevention, which requires a different social landscape identity.

The relationship between much building with nature and NBS and the social / physical landscape identity can therefore be measured on the one hand by:

- The goals that are pursued in the BwN or NBS intervention and how these correspond to the relationship between people and nature that fit with a social landscape identity.

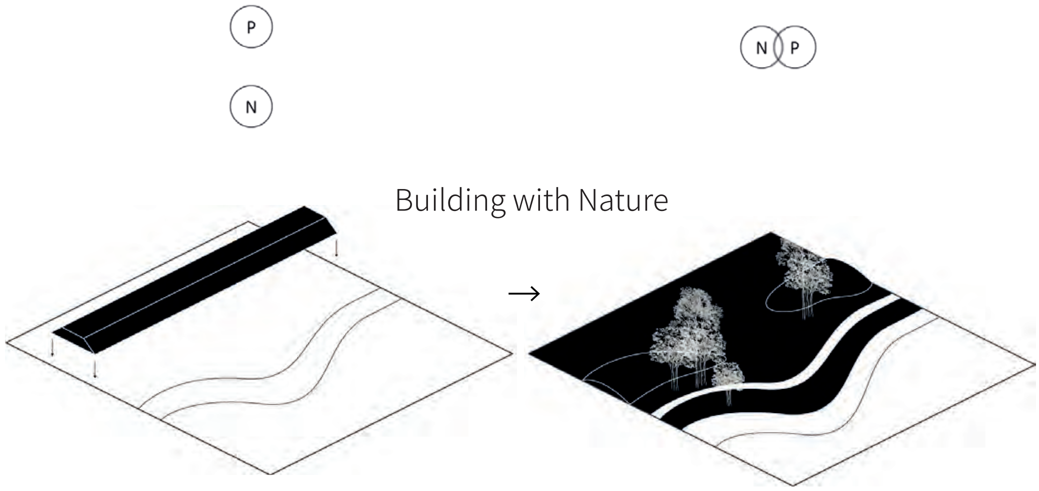
- The degree of connection to or restoration of the natural dynamics in the landscape [physical identity] by means of a BwN or NBS intervention.

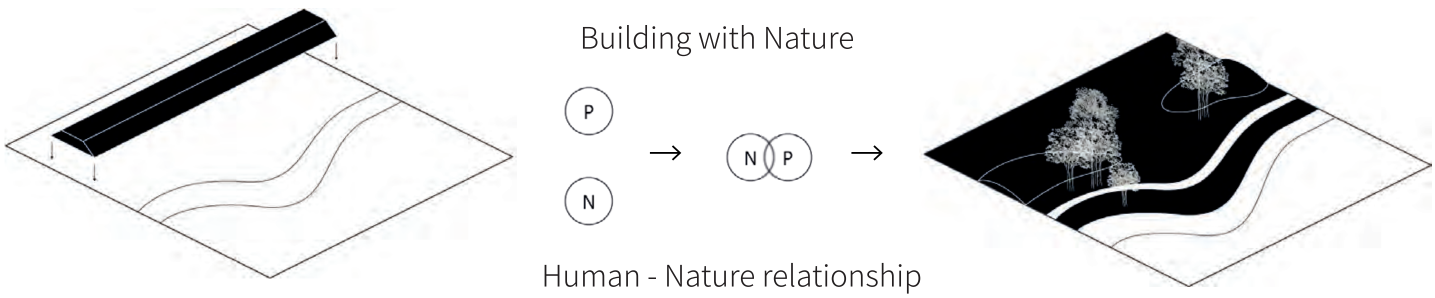
Reflection

Certain aspects of landscape identity can only be grasped in a certain time depth. A site, scent and sense of a place may only last a moment.

Hypothesis

Developing flood safety using the landscape qualities of water, air and soil


P
N
N P
Building with Nature


Building with Nature
P
N
N P
Human - Nature relationship

scale 1: x 000

Methods

Methods

The different methods that are used to answer the sub questions and ultimately the main question are represented in the scheme on the right page. The main methods that are used are firstly the literature review for the elaboration and decomposition of the three different concepts. Secondly, spatial [GIS] analysis is conducted together with critical mapping, in order to grasp the elements and spatial manifestation of the concepts.

The mixed methods research consists of qualitative analysis of flood risk perception and the perception of the Dutch landscape identity trough literature review and interviews. Per sub question different methods of representation and methods of research are used. Each focused on different scales, from the individual to the regional to the [inter]national.

The analysis section of the thesis consist of firstly, quantitative GIS analysis of the [future] flood risk in the Dutch context of the Rhine Meuse Scheldt delta. This is presented in mappings followed by the mapping of quantitative spatial and qualitative analysis of flood risk perception. The mapping of flood risk perception is supported by a literature review on flood risk assessment in the Netherlands.

This analysis will lead to an understanding of the water system, landscape transformations and human behaviour concerning this water system. Fragilities of flood risk perception and flood risk management development exposed through analysis. Subsequently, possible synergies of flood risk perception and flood risk management are researched by design. Proposed interventions and a development strategy, supported by a manifesto emphasizing attitudes, both focus on mitigating polluting activities and adapting to flood risk through the scope of flood risk perception.

The Transitional Territories studio brings forth a method of five lines of inquiry, matter, topos, habitat, geopolitics and project. The studio focuses on the notion of territory as a constructed project across scales, subjects and media. In particular, the studio focuses on the agency of design in territories at risk between land and water (maritime, riverine, delta landscapes), and the dialectical (or inseparable) relation between nature and culture.

This is achieved through firstly, visualizing the spatial outcome of transitions in land use practices and settlement patterns that are the result of an alternative approach to flood safety. Secondly, as a result of these spatial outcomes, shifts in the relationship between human and nature are presented as well.

Firstly, a method is proposed, based on a literature review on Landscape Identity, for grasping the people – nature relationship. in the Dutch case through the concept of Landscape Identity, operationalized though the concept of Landscape Character. Secondly, the Building with Nature concept and approach is explored and tested on its applicability for achieving flood safety and simultaneously promoting a reconciliation of the natural and human systems, balancing the people – nature relationship.

This understanding of the human – nature relationship is subsequently translated into research by design, through exploring the Building with Nature concept. By reflecting on the past development of cohabitation with the water and taking future scenario's in account, a different relationship between human and nature, through landscaping is proposed.

The research by design will reveal insights on what kind of Building with Nature interventions are effective for achieving resilience. Fitting in the third option, that is more focused on Nature Based Solutions and a systemic approach to cope with the issues of sea level rise, extreme precipitation, drought and fluctuating groundwater levels.

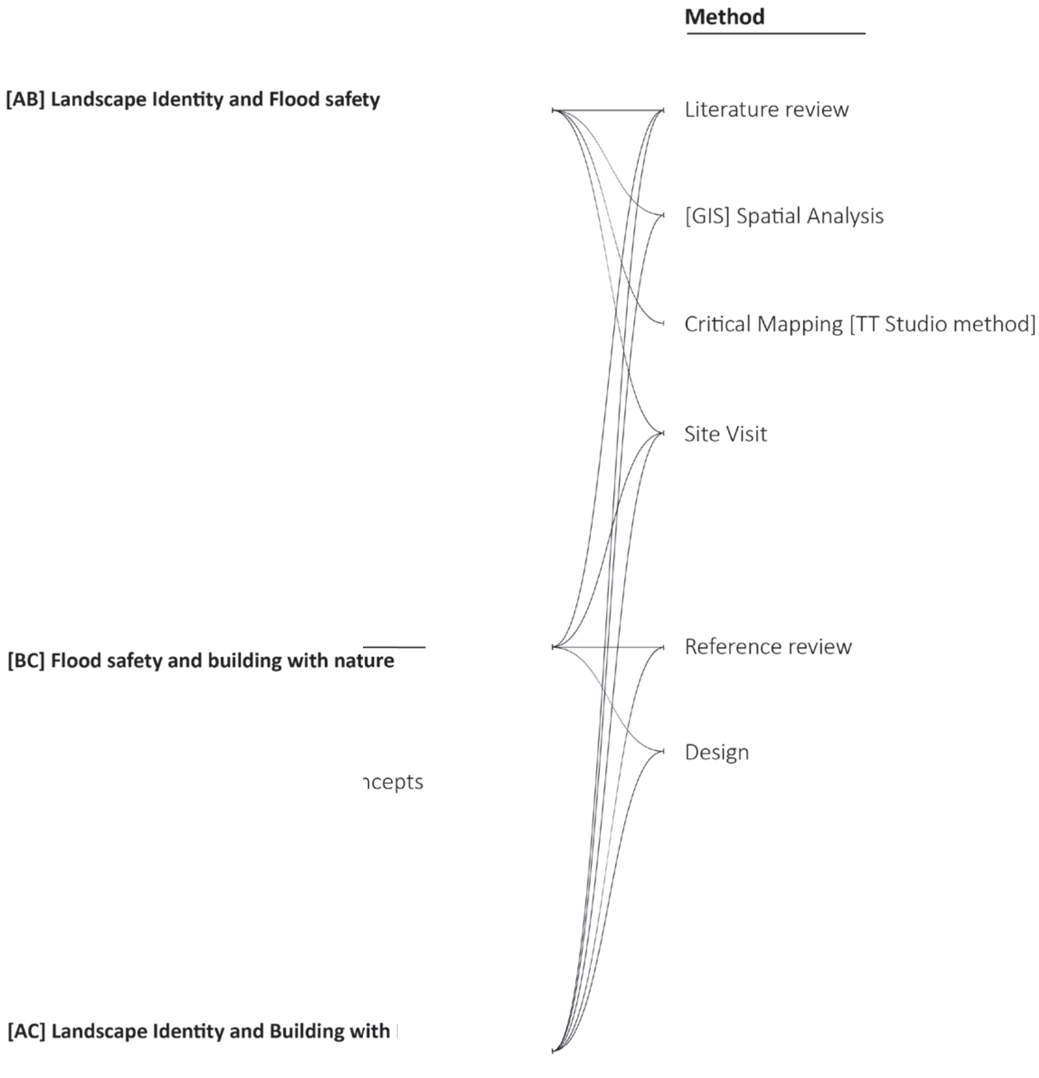
This relationship is operationalised through the concept of landscape identity. As current development strategies are for a large part still based on a faith in technology. Trough exploring the different landscape identities and how flood safety can be implemented within them, in the Rhine Meuse delta, the research will provide additional (long term) development scenario's to cope with issues of flood risk in the Rhine Meuse delta within the Dutch border.

Make assumptions about the positioning of the relationship between People and Nature based on the landscape identity framework.

The mutual relationship between people and landscape revealed through the shaping forces of the landscape. How do they represent the relationship between people and nature?

Specify and elaborate on the building with nature solutions fitting within the landscape character. Assessed on their ability to mitigate and adapt to climate change.

Test for implementation ability and temporal framework. Subsequently, contemplate and compare the proposed interventions to the current assumed landscape identity, in order to predict obstacles and opportunities in agency.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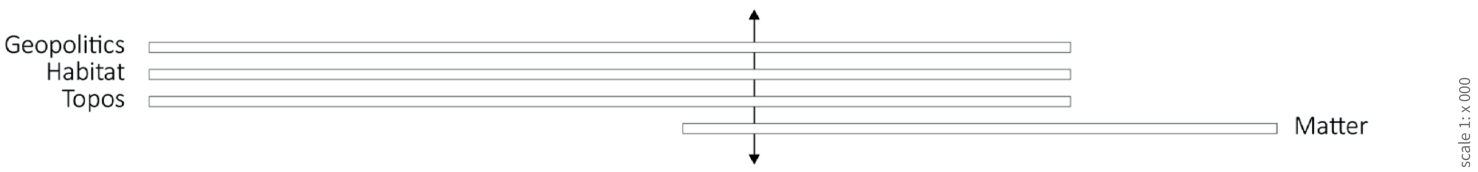
[AB] Landscape Identity and Flood safety
Literature review
[GIS] Spatial Analysis
Critical Mapping [TT Studio method]
Site Visit
[BC] Flood safety and building with nature
Reference review
Design
ıcepts
[AC] Landscape Identity and Building with


Geopolitics
Habitat
Topos
Matter
scale 1: x 000

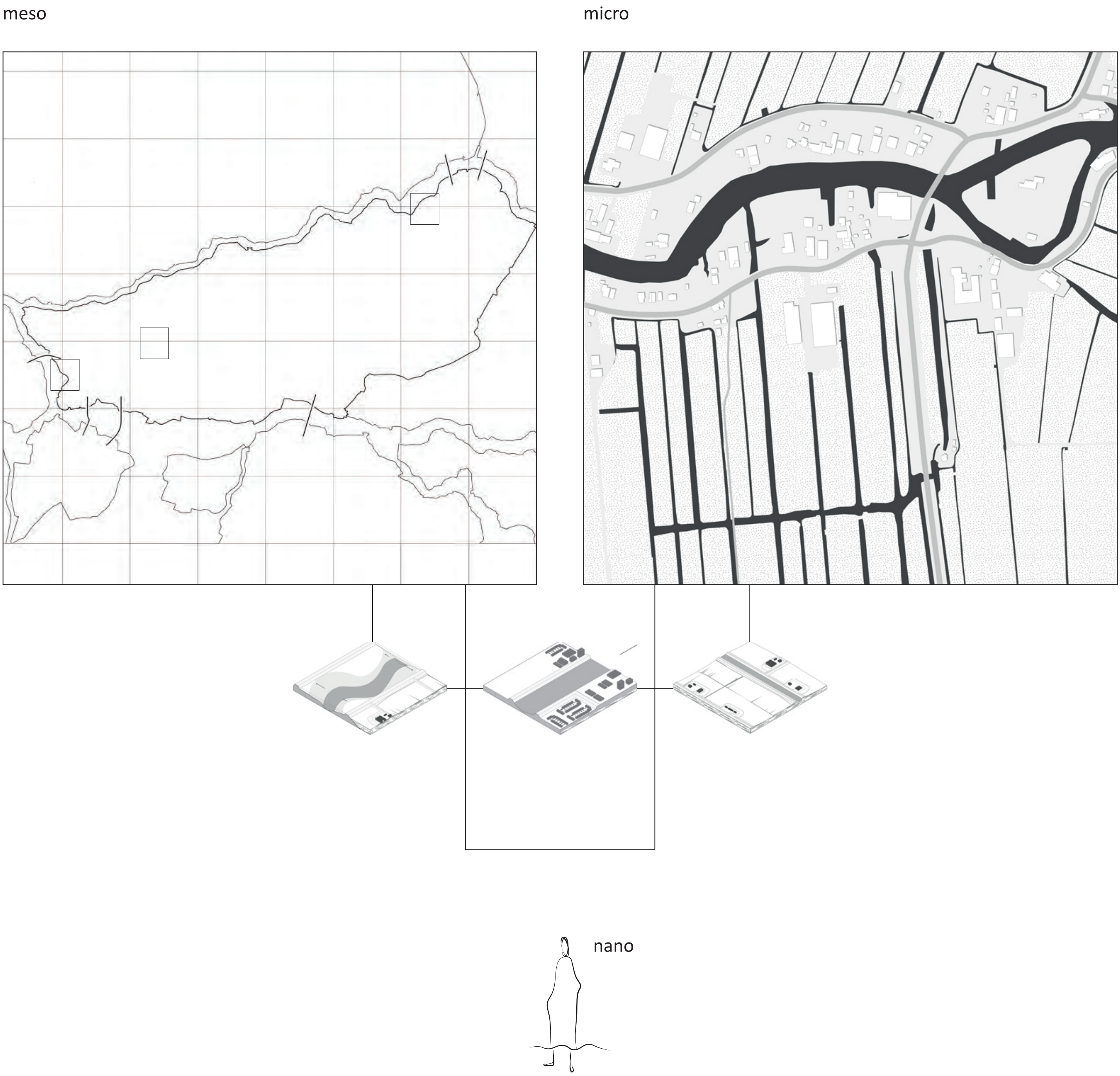
Scales

The scales that are considered are, firstly the macro, national scale of the Netherlands, for the problem field analysis, addressing the flood safety system and flood safety paradigms. Subsequently, for the research by design, the meso, micro and nano scale are considered.

The meso scale of the Alblasserwaard dike ring, as one of the compartments within the larger national flood safety system and conceptualized as a Veenweide polder landscape is regarded to addressing the systemic transition. Thereafter, the micro scale, distinguished by the three different landscape characters within the dike ring and Veenweide landscape, is regarded to address the local implications of this systemic transition. Lastly, the nano scale of the individual is addressed to speculate on the human – nature relationship and how this affects agency in the transition towards a biodiverse and flood resilient urbanized delta.

macro

Problem Field analysis



Research by Design

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Project argumentation

The thesis is on the reconciliation of human and natural systems. A reconciliation of the relationship between human and nature. The concept and understanding of landscape identity is an expression of this relationship.

In the case of the Dutch delta, landscape and flood safety are inevitably intertwined. A certain relationship of human dominating over nature becomes apparent of this intertwining.

Developing flood safety from the landscape qualities, rethinking this relationship and aiming to reshape this inevitable intertwining of flood safety and the Dutch landscape, making people and nature more equal/balanced.

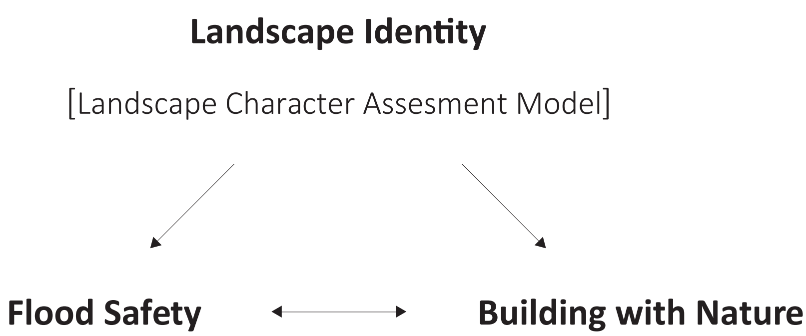
There often seems to be a dilemma in urbanized delta's. A choice between two evils: between a functioning human system, [of economy and safety] or a functioning ecological system of no humans [no safety or economy].

However, it is not a dilemma, but a relationship out of balance and cadence.

The thesis aims to understand this relationship, through the concept of Landscape Identity and operationalized through the model of Landscape Character. It is explored if a Building with Nature approach is suitable to improve this relationship and prove this dilemma to be void.

3

THEORETICAL UNDERPINNING



Theoretical framework

This chapter is a further elaboration of the three concepts of Flood Safety, Landscape Identity and Building with Nature.

The theoretical framework is the structure that guides research by relying on a formal theory, constructed by using an established, coherent explanation of certain phenomena and relationships (Eisenhart, 1991). It guides the research by providing a structure, by connecting to other research and assuring reproducibility. In this thesis, the theoretical framework explains the relationships of the phenomena presented in the conceptual framework and research framework. As defined by Ravitch and Riggan (2017), the formal theories support the relationships embedded in the conceptual framework.

The theoretical framework emerged from the problem statement and research framework. The theories on adaptation pathways argue the aim of the study because they state the need for alternative mitigative and adaptive flood risk development approaches. Secondly, they state the urgency of preparing for future extreme scenario's and therefore emphasize the importance of the research. Subsequently the theories on flood risk assessment offer insights in these alternative development approaches. Finally, theory on landscape identity and risk perception can give understanding in the processes that constrain or catalyse the actors involved.

- Landscape Identity definition and method of grasping it through Landscape Character Assessment model
- Dutch flood risk assessment methodology [R=P x C] and alternatives explained in essay
- Building with Nature concept and strategy for implementation. Do nature based solutions perform better than grey infrastructures [on biodiversity]?

Flood Safety: a probability reduction approach

Introduction

Flood risk management policy and decision-making is underpinned by flood risk analysis and assessment. Accurate flood risk assessment can provide consistent information to support the development of flood management policy, allocation of resources and monitoring the performance of flood mitigation activities. In the Dutch context, the flood risk assessment model regards flood risk as the product of probability and consequences of flooding. Within this approach, reducing the flood risk can be done by development focused on reducing either the probability or the consequences of flooding. Due to climate change, the probability of flooding is increasing. Globally, the interest of flood risk measures has been shifting more and more towards reducing flood consequences as well as reducing flood probability (Bars et al., 2020). This is however not reflected in the planned Dutch flood risk development. The risk assessment approach is technocratic and sectoral, focused on separate levee systems, economic damage and probability of death. Alternative flood risk assessment approaches are more qualitative trough incorporating additional consequential values or regard flood risk within river system behavior dynamics that influence flood probability. This literature review reflects on the Dutch flood risk assessment approach. Through comparison with a multi criteria approach and a systemic approach, neglected potentials of the Dutch approach are revealed. Subsequently, a broadening of this approach is proposed as the underpinning of flood risk management policy and development towards a Dutch delta able to sustain extreme and uncertain future scenario's.

Climate change

Flood risk assessment sets the framework for flood risk management policy as it provides information necessary for decision making on development of flood defences, allocation of resources and monitoring the performance of flood mitigation activities.(Gouldby et al., 2009; Jorissen et al., 2016). In the Dutch case this means that the way in which flood risk is evaluated and calculated strongly influences the development of more than half of the Dutch landscape that is dependent on the flood defence infrastructures. Current flood risk management policy and planned development of flood defences in the Netherlands are focused on the period until 2050 and are based upon the expectation of a moderate sea level rise of 0,25 to 0,80 meter by 2085 (Vergouwe, 2014).

The current Dutch flood risk assessment approach is rooted in the safety standards that reacted to the disastrous flooding of 1953. These safety standards developed into an assessment approach over time bringing forth more up to date safety standards. These standards are guiding in current flood risk management and eventually shape the landscape transformations that follow from it.

The Dutch flood risk assessment approach

Historically, the response after a flood in the Netherlands was to reduce flood risk by elevating the levees, with the highest observed water level as reference point. After the flooding of 1953, different safety standards were implemented for the flood defenses. The flood prone area of the Netherlands was divided into different dike rings consisting of primary flood defense elements such as dikes, dunes, dams, sluices or high grounds that together protect the area within from flooding.

Each dike ring had a specific safety standard corresponding to the economic value of the area and the exceedance frequency of either coastal- or river flooding, as shown in figure one. For high risk coastal areas, these standards were 1 in 10,000 years and 1 in 4000 years for low risk areas. For river areas this was 1 in 2000 years and 1 in 250 years, revealing a higher flood probability in river areas (Jonkman et al., 2008).

This approach to flood risk assessment is referred to as the exceedance probability approach and the safety standards following from this approach were laid down in the Water Act of 2009. This act shapes the flood defence development of the primary flood defences until 2050, as all levee systems must meet the safety standards of the water act by 2050 (Jonkman et al., 2008; Vergouwe, 2014). These standards, originally derived in the 1960s, were revised around 2000. This revision brought forth the conclusion that levees were more likely to breach because they were too narrow instead of too low to deal with extreme water loads. Therefore, the revised flood risk assessment approach, which was the product of the Flood Risk and Safety in the Netherlands (FLORIS/VNK) project in 2003, incorporates failure mechanisms of flood defences. It proposes flood risk not just as the exceedance probability but as the product of multiple variables. The latest VNK report was published in 2014, presenting new flood risk values for the flood defence system, based on this new flood risk assessment approach. These values also no longer applied to the dike rings but to each levee system separately (Vergouwe, 2014). In 2017, new safety standards derived from the risk values were included in the water act, they are the safety standards that currently shape flood risk management in the Netherlands.

The current flood risk assessment approach calculates risk as the product of flood probability and flood consequences, defining economical, individual and societal risk (Jonkman et al., 2008; Vergouwe, 2014). In 2014, 58 of the 95 levee systems were assessed on their probability of flooding. This was done by calculating the probability of a breach, which occurs when the pressure of the water is greater than the strength of the flood defence structure. Each levee system consist of one or more flood defence structure such as dunes, dikes or dams or sluices. The probability of a breach can be increased by several different failure mechanisms that are influenced by climate conditions such as high or fluctuating water levels (Vergouwe, 2014). The breach in 2003 of a regional dike in Wilnis, as shown in figure two, was an example of such a failure mechanism caused by drought.

Furthermore, the consequences of a breach are calculated for the inner areas of the levee systems in economic loss and fatalities. This is done by determining the direct and indirect economic damages to capital goods such infrastructure, homes, and loss of businesses. In addition, the fatality consequences are calculated through the number of inhabitants combined with evacuation measures and flood characteristics such as rise rate and velocity of the water. Together, probability and consequences of flooding determine the flood risk, as shown in figure 3.

Flood risk management policy

Based on the safety standards brought forth by the flood risk assessment of the Dutch levee systems, a development program (HWBP) was created to strengthen the levees and bring them up to the standards added to the water act in 2017. In the planned development of 2021 until 2026 gives insight in the developments until 2050. Almost all interventions are focused on strengthening levees and reducing probability of flooding (Programmabureau Hoogwaterbeschermingsprogramma, 2020).

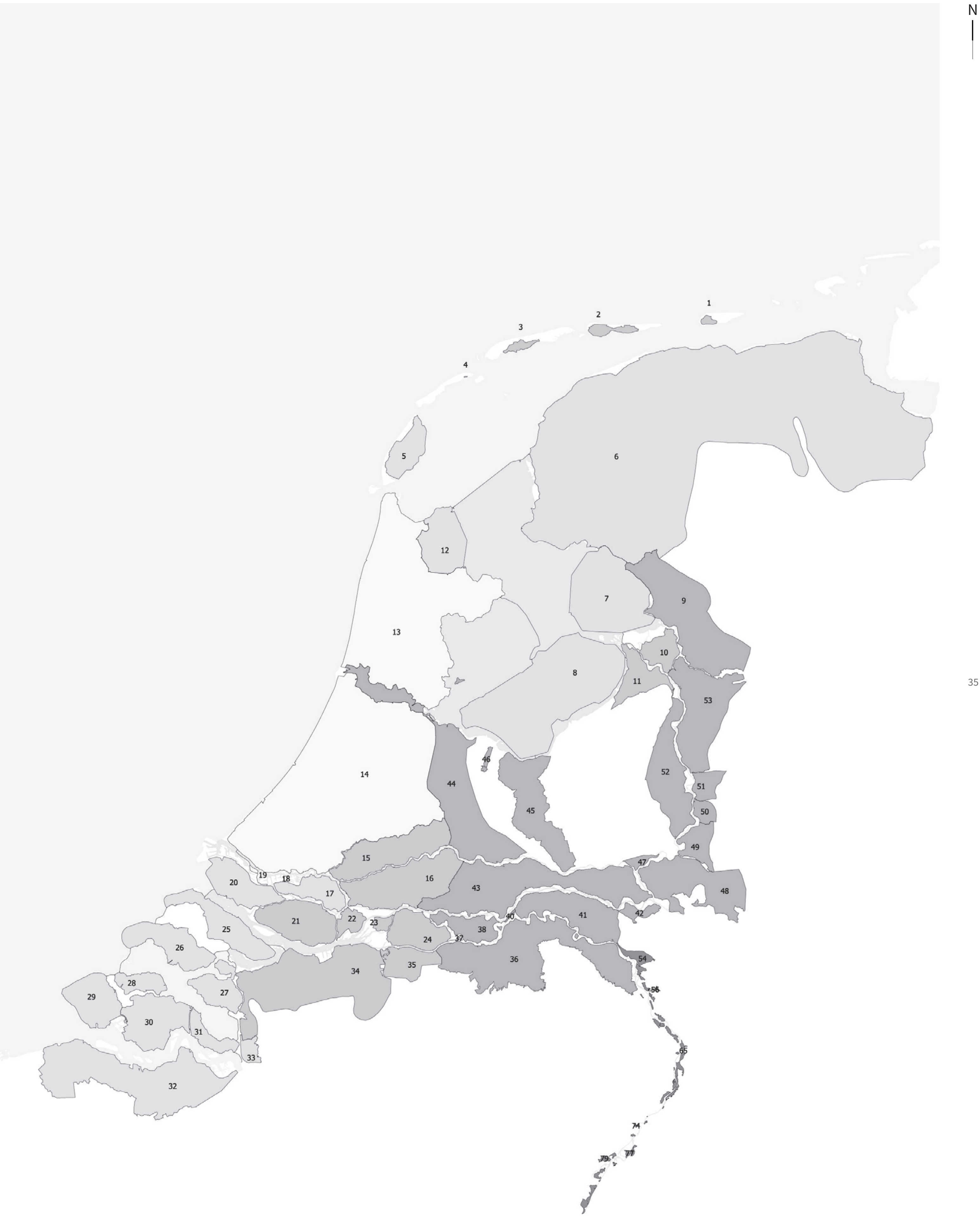
In a reflective report on the planned flood defense developments, the collective of governmental advisors (CRa) were critical on the development approach. Claiming that the scope of the developments is too narrow and the focus too sectoral, resulting in projects merely aimed at flood protection, not utilizing spatial quality opportunities (Alkemade et al., 2020).

The limits of the Dutch system

The so called levee effect, describes the effect of intensive development in floodplains after the placement of flood protective levee structures. When flooding occurs, this development then results in increased damage (White, 1942). The Dutch flood risk protection system is the ultimate example of the levee effect. With sea level rising faster and higher than expected, eventually this current flood protection system might not be sufficient and sustainable in the long term. As soon as 2100, sand nourishment demands will be twenty times as high, storm surge barriers will have to close at a high frequency and fresh water will be less available due to saltwater intrusion (Haasnoot et al., 2020). Globally, decision makers are increasingly interested in sea level rise events with a small probability but with very high consequences. With this, the focus of flood risk measures has been shifting more and more from reducing flood probability towards reducing flood consequences as well (Bars et al., 2020).

Figure 1
The flood exceedance probability of the Dike ring levee systems.

Source: Heijnen, 2020
Data Source: Rijkswaterstaat, 2010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scale 1: x 000

Flood Safety: Alternative approaches

Alternative approaches

The technocratic Dutch approach of flood risk assessment per separate levee structure does not take into account the systemic mechanisms or that influence flood risk once a breach occurs. Therefore it is interesting to explore different models of flood risk assessment.

In the Dutch delta, the estuary of the Rhine and Meuse river meets the North sea. The Rhine basin reaches from Switzerland, Austria and Liechtenstein, through France and Germany before it enters the Netherlands. For accurate flood risk assessment of river systems, every relevant failure mechanism as well as uncertainties and planned safety improvement measures are to be mutually regarded (Mierlo et al., 2007). As flooding from rivers poses the highest flooding threat in the Netherlands. Looking beyond the national border at the entire river basin is therefore essential. Regarding the occurrence of breach of each separate levee system in the Netherlands within this larger system affects the flood risk. Shown by a computational example where upstream levee breaches reduced downstream flood risk when system behavior was accounted for as shown in figure 3. Van Mierlo et al (2017) argue that this conceptual flood risk assessment model that incorporates river system behaviors serves as a tool for flood risk managers and policy makers on the regional scale.

A study on flood risk assessment in Leipzig of the Mulde river basin brought forth a multi criteria assessment model. Similar to the Dutch approach, flood risk was defined as the product of probability and consequences of flooding. In addition, the so called urban approach defines economic, social and ecological flood risk criteria specified to deal with urban issues. Subsequently, these criteria incorporate urban issues in the flood risk assessment such as vulnerable groups, areas of social and ecological health care, differentiated residential land use classes and ecological value of urban green spaces. Addition of these different weighted criteria to the assessment model, as seen in table 1, influenced the flood risk and the spatial distribution of flood risk in the case area. It was concluded that a better understanding of the spatial distribution of vulnerable social, economic and ecological elements provides a more specific insight in risk situations that goes beyond the technocratic approach (Kubal et al., 2009). Taking into account that the context of Leipzig differs from the Dutch delta territory in many ways, this alternative approach gives an insight in different validation methods of the consequences of flooding. Incorporating multiple elements in addition to the economic value and losses of life might provide a better understanding of the exact spatial distribution of flood risk.

The room for the river project, completed in 2015 was an example of flood risk management policy that resulted in flood defense development which (unknowingly) incorporated some of the aspects of the earlier described river system thinking and multicriteria approach. This project can be seen as the predecessor for the HWBP. Besides strengthening levees, levees were pushed back, creating larger floodplains. This nationally carried project incorporated ecological and spatial quality values as well as flood risk reducing measures (Keessen et al., 2018).

Conclusion

In the Netherlands, historically, flood risk management and flood protection development responded to flooding events. Currently, flood risk management decision-making is underpinned by flood risk analysis and assessment. Accurate flood-risk analysis and assessment is therefore critical in order to assure flood-resilient development. This becomes apparent considering the planned flood risk development for the Netherlands until 2026. The planned development and interventions are aimed at strengthening the levees to meet the safety standards that were brought forth from flood risk analysis and assessment by 2050. These standards are based on a moderate sea level rise. However, recent studies show that sea levels might rise at a faster rate than predicted before. This increase in sea levels will put an enormous pressure on the Dutch flood-protection system. If sea levels rise even higher than predicted, the Dutch levee system will not suffice to protect all of the below sea level areas of the Netherlands.

In order to be prepared for this uncertainty in sea level rise it is therefore necessary to look beyond the current flood risk management approach of strengthening the levee systems. As this approach is largely based on flood risk assessment, a broadening or redefinition of the flood risk assessment model can be an important step in adapting to scenarios of increasing sea levels in order to achieve flood resilience in the long term.

In the Dutch flood risk assessment approach, flood risk is regarded as the product of the probability of flooding and the consequences of flooding. The probability calculations do not incorporate systemic behaviours that influence flood risk. The calculations of consequences have a limited scope of economic damage and fatalities, ecologic values are not incorporated.

With the room for the river project, the scope of flood risk management and flood defence development was broadened and incorporated these ecological and spatial quality values. With planned interventions of strengthening levees until 2050, based on the current flood risk management policy and flood risk assessment model, it appears that steps are taken back and the scope is narrowed again.

Therefore the current Dutch flood risk assessment approach can be regarded as too technocratic and sectoral, resulting in missed potentialities of ecologic and spatial quality in the development of the Dutch delta on the national scale.

The Dutch flood risk development seems to be stuck in a downwards spiral, as the perfect example of the levee effect. Redefining the approach to flood risk assessment trough incorporating systemic behaviour and values of spatial quality and ecology might be a first step in breaking this cycle and allow for more transformative development towards long term resilience.

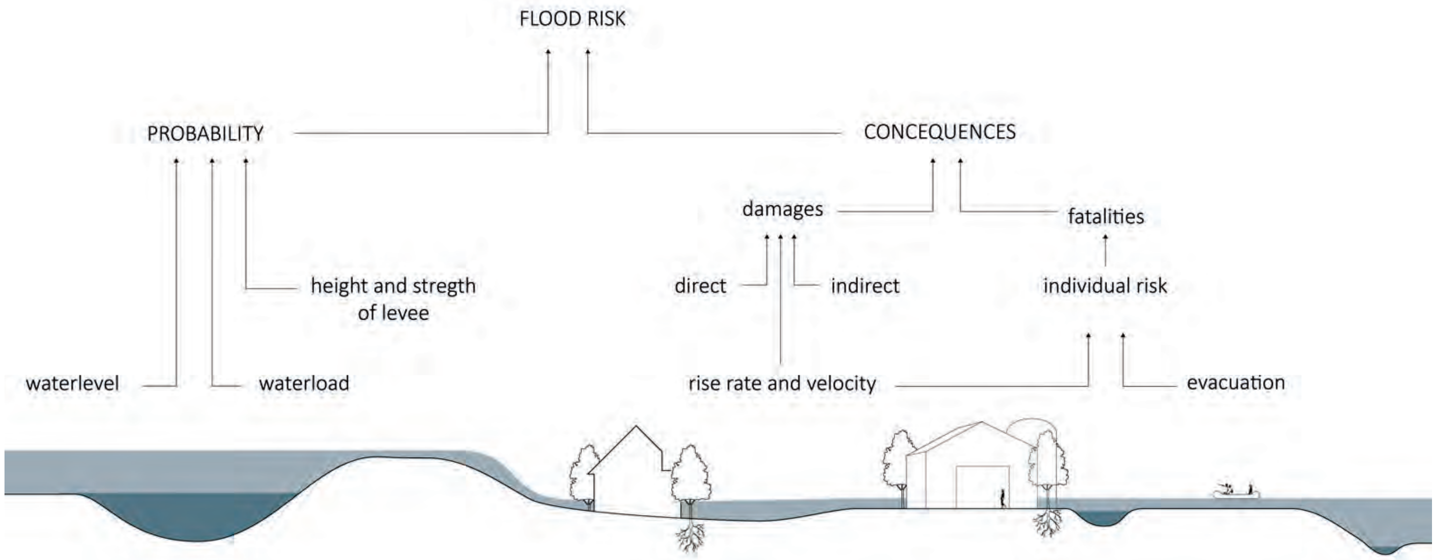
Figure 3

Schematic representation of flood risk assessment.

Source: Heijnen, 2020

Data Source: Deltares, 2012; Vergouwe, 2014

$$R = P \times C$$



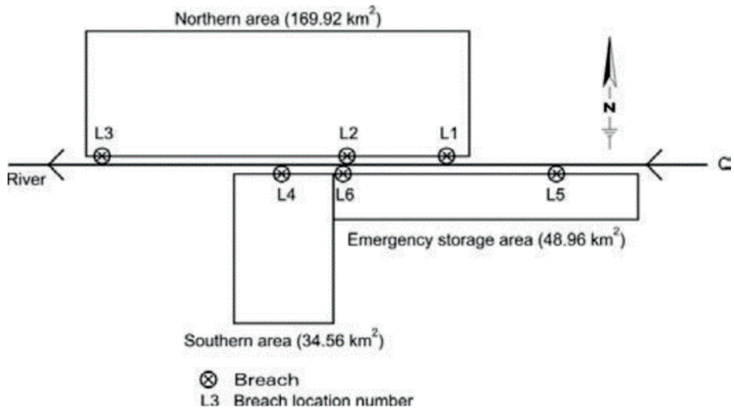


Figure 4

Reduced flood risk in the Southern area when taking river system behavior in account: levee breach of the Northern area.

Source: van Mierlo et. al., 2017

Landscape Identity

Conceptualization
Landscape identity can be defined as the mutual relationship between people and landscape. It is formed through the mutual interaction of people and landscape at two distinct levels in space and time, namely on the action sphere and the perception sphere.

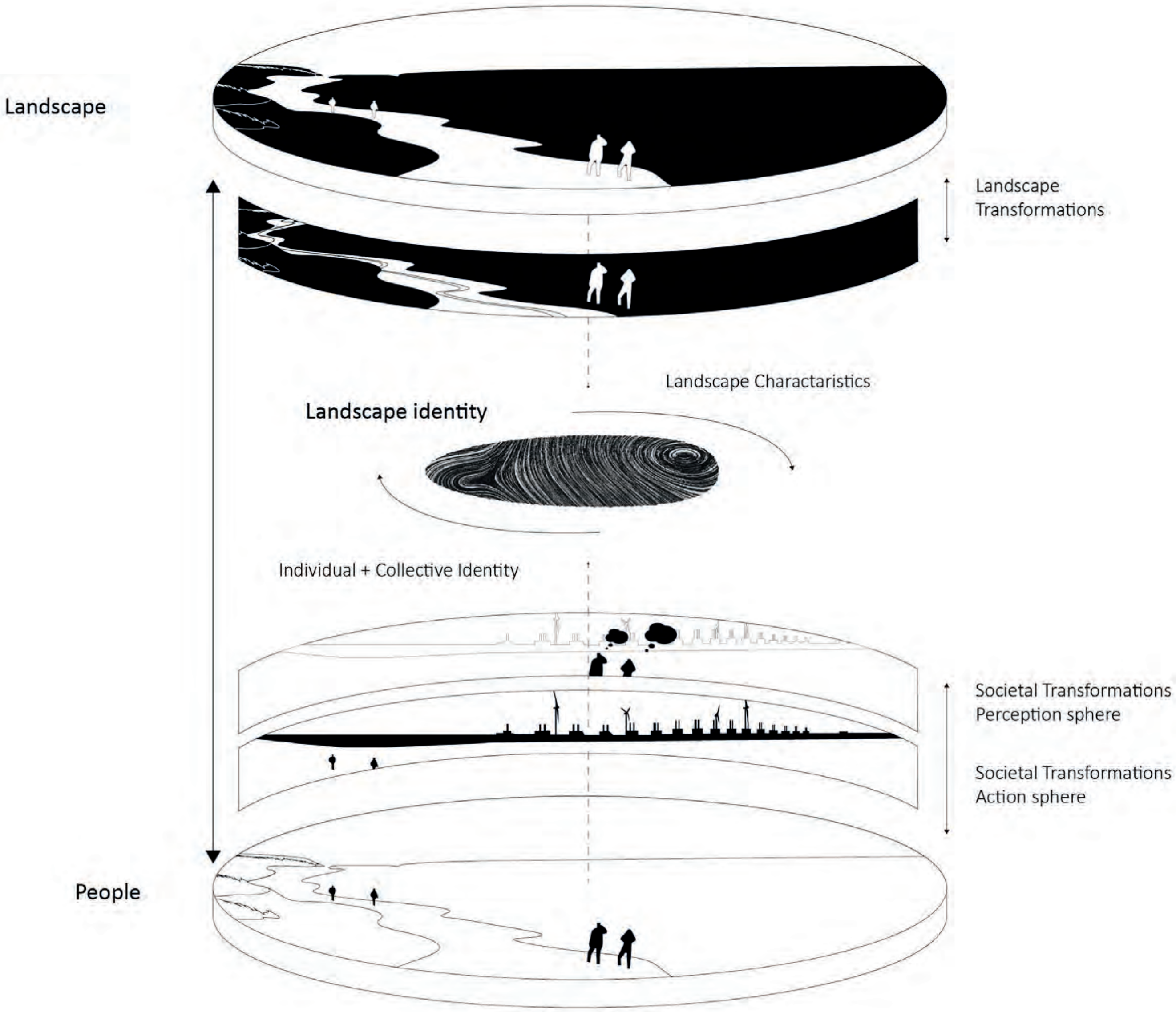
Landscape identity, as described differently in literature and appears to be difficult to grasp. Stobbelaar and Pedroli (2011, p. 322), defined landscape identity as the "perceived uniqueness of a place". Egoz (2013) described "landscape and identity" as the "relation between landscape and the identity of humans engaged with the landscape, it represents the formative role of landscape in building identity, both collective and individual, in response to the basic human need to belong" (Egoz, 2013, p. 272).

According to Ramos et al. (2016) landscape identity can be understood as the mutual relationship between landscape and people. They claim, literature either refers to it as the physical aspects of the a landscape that render the differences or as the manner in which people use the landscape and though it, construct their individual or collective identity (Ramos et al., 2016). They describe process of the latter as a circular process: people are influenced by the landscape; they change or interact with the landscape; which again creates conditions for new relations and thereby influencing people's perceptions of it.

This process, shaping Landscape identity, acknowledges a dynamic relationship between people and the landscape, considering it as interdependent aspects. In this model, landscape identity is formed through the mutual interaction of people and the landscape at two distinct levels – a sphere of perceptions and a sphere of action. The first sphere builds on the assumption that landscape identity is not only based on the perceived landscape character but also on the character of the landscape as a constructed entity (Altman and Rogoff, 1987; Werner et al., 2002). The second sphere relates to the way people and landscape interact on a physical level by taking action on the landscape (e.g. policies, planning, management), driving the change of the landscape and altering its character, and on how the resulting landscape shapes the relationships between people and place (Antrop, 2005; Selman, 2012). Furthermore, these two spheres are considered as dynamic and interdependent, based on the understanding that perception and action are two sides of the same coin that cannot be dissociated when approaching landscape identity in an integrated way. Figure X represents this process of people and landscape shaping landscape identity through space and time, on the action and perception spheres. It is a visual de-assemblage of the interdependent domains of people and landscape interacting through the spheres of action and perception, and through this interaction, shaping landscape identity.

Furthermore, Landscape identity, although difficult to grasp, is often framed as a social construct, of fluid, elusive ideas, built on peoples' perspective rather than tangible a physical concept. However, as argued by Ramos (2016), as part of the circular process through which landscape identity is shaped, in return, it greatly influences landscape transformations through people's perceptions of landscape. Therefore, it is argued that an improved understanding of the processes shaping landscape identity may provide insights on the acceptable threshold of landscape change and thereby support developments that strongly benefit from a territorial approach (Wylie, 2007, p. 191). While the perception sphere of landscape identity appears to be the more important construct, it can be said that through the action sphere, physical elements of landscape identity can also be deployed to support change. In this thesis the possible physical landscape transformations that result transformations of the individual or collective identity connected to the landscape, are explored in relation to the concept of flood safety. As they might give insight in the ways that design can promote agency in climate adaptation an mitigation processes.

Grasping Landscape Identity
How the interaction between People and Landscap shapes Landscape identity
Source: Nationaal Georegister, 2020
Dinoloket, 2020


Landscape
Landscape
Transformations
Landscape Charactaristics
Landscape identity
Individual + Collective Identity
Societal Transformations
Perception sphere
Societal Transformations
Action sphere
People

Operationalizing Landscape Identity

Landscape Character

The landscape Character Assessment Model, framing landscape as a material construct as well as a mental construct, is used to operationalize the concept of landscape identity. In order to be able to analyse and understand the physical and societal domains of the mutual relationship between people and landscape that is landscape identity.

Based on the understanding of landscape as both a material as well as a complex mental construct, Fairclough, Sarlöv, Herlin and Swanwick developed a model for assessing the character of landscape as a method of operationalizing complex ideas of landscape (Howard et al., 2018). The model recognizes that landscape is perceived through all the senses and that it is dependent on cognition, knowledge and memory and is often socially and politically constructed. Attempting to grasp the complex whole that is landscape, the model is proposed to support and inform the protection, management or planning and design of landscapes, as well as contributing broadly to environmental management and to other means for sustainability.

Recognizing the spheres of 'place' and 'people', and subdividing those in natural, societal, perceptual and aesthetic, 21 domains of landscape character are defined.

Landscape identity is understood as the mutual relationship between people and landscape, which is formed through the mutual interaction of people and landscape in space and time, on the action sphere and the perception sphere. The 21 domains, separating Land Cover and Flora & Fauna, and interpreting time depth as a condition of each of the domains, can be projected on this understanding of four spheres of people, landscape, action and perception.

Through this operationalisation, the different domains that shape the character of a landscape, can be used to grasp the landscape identity of a certain place. Subsequently, assumptions can be made on the most dominantly domains in shaping the relationship between human and nature, that is spatially manifested in a place. These assumptions are made through identifying a hierarchy in relationships between different domains. For example if the domain of land use defines the settlement, enclosure, colour and vegetation of a landscape. These assumptions then support research by design as they reveal the domains of landscape that are most impactful in shaping landscape identity. Namely, in designing the transition a flood safety landscape towards a reconciled state of the human and natural system, interventions are aimed not only at a transition toward a climate adaptative and mitigative landscape itself, but most importantly to promote the agency in this transition.

As the boundaries of the four spheres may not be as rigid as presented in the scheme, the domains are very much related, for example, a certain land use practice will result in a specific landform, texture, smell and colour, influencing

Landscape Character Assessment model
Domains of Landscape character ordered in the spheres of People and Place, subdevided in the natural, social, perceptual and aesthetical spheres.
Source: Swanwick, 2017.
Altered by Heijnen, 2020

Operationalizing Landscape Identity
Projecting the domains of Landscape Character on the spheres of Landscape Identity in order to understand the interaction between People and Landscape, that shape Landscape Identity of a place.
Source: Heijnen, 2021

	ACTION sphere	PERCEPTION sphere
[place] **Landscape** sphere	Hydrology Soils Air and Climate Landform Geology Land cover Flora and Fauna [natural]	Colour Texture Pattern Form Sounds Smells Touch [aestetic]
People sphere	[social] Land Use Settlement Enclosure Land Ownership	[perceptual] Memories Associations Preferences

Building with Nature

Conceptualization

The building with Nature approach and concepts offer opportunities and a handhold for flood safety development from a landscape perspective, as it takes the natural layer as the starting point for hydraulic infrastructure design. However, the approach is in line with a design-for-solution-solving paradigm. Utilizing the forces of nature to achieve the goal of flood safety. The approach can be taken as a handhold for flood safety design, however, it should not be used as a framework for problem-solving-design, but for design- for reflection. In this manner, the design of this thesis, from a landscape / urban design perspective may offer a transition towards a design-for-reflection paradigm. Taking landscape character as the starting point for designing flood safety, the Building with Nature approach can be used to incorporate the human-nature relationships, recognized as landscape identity???

The Building with Nature approach, is a proactive approach to developing coastal and river works, making use of the dynamics of the natural environment. And additionally, providing opportunities for natural processes (de Vriend et al., 2014). This approach is recently more accepted in the Dutch context and attempts to trigger stakeholders such as project developers, experts and professionals, to think, act and interact differently. Namely, to create opportunities for nature development and ecosystem services whilst developing hydraulic engineering structures (van Eekelen & Bouw, 2020). Therefore, more broadly, the Building with Nature approach attempt to minimize damage to natural environments and increase ecological value near hydraulic infrastructures (van der Velde et al., 2021). Specifically, they address the UN sustainable development goals of 'Clean water and sanitation' (6), 'Sustainable cities and communities' (11) and 'Climate action' (13) (van Eekelen & Bouw, 2020).

Van Eekelen and Bouw (2020) propose Building with Nature as a design approach, in which the natural layer is taken as the starting point. They developed a strategy for Building with Nature design, consisting of five steps.

"1 Understand the system (physical, ecological, societal).
2 Identify alternatives that use or provide value for nature and humans.
3 Evaluate each alternative to select an integral solution.
4 Refine the selected solution.
5 Prepare the solution for implementation." (van Eekelen & Bouw, 2020, p. 15)

With this approach, several solution concepts and their applicability in different contexts are presented. These different contexts are Sandy Coasts, Muddy Coasts, Lowland Lakes, Rivers and Estuaries, Cities and Ports. For the case of the Alblasserwaard, because of the diversity present in soils, besides the Sandy Coasts, all these context are explored. The applicable solutions are visible in the table on the right page.

N

Building with Nature concepts
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Source: Ecoshape, 2020
Image: Heijnen, 2021

Applicability
Growing system feature
Coastal
Riverine
Rural

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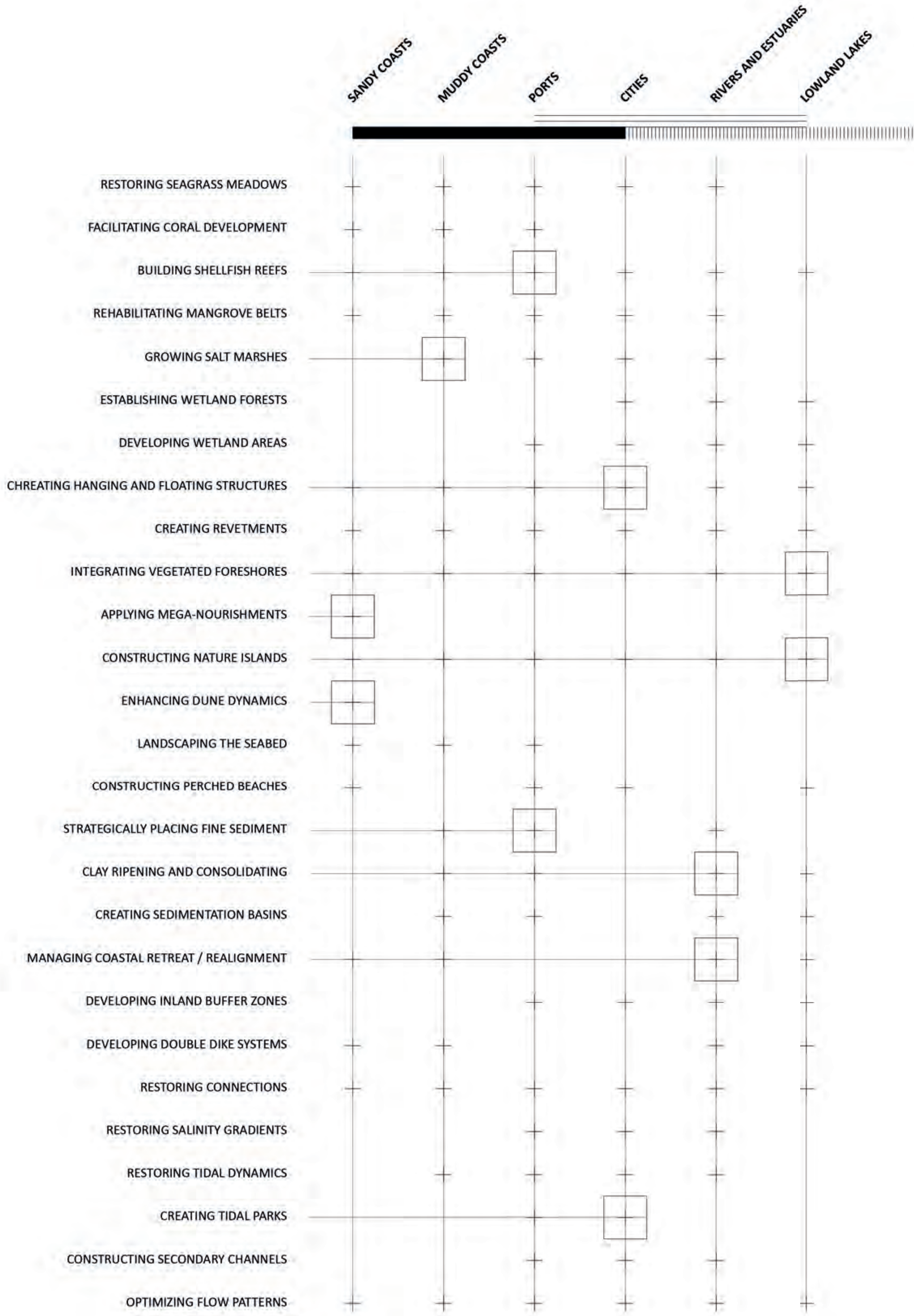
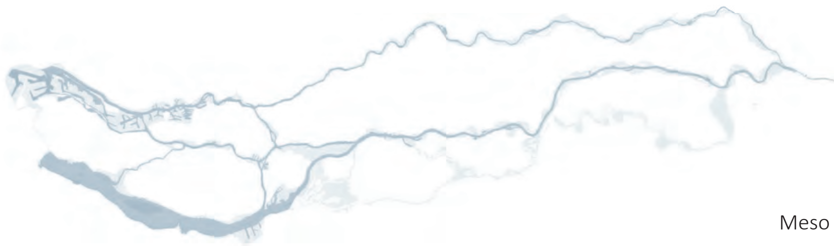

SANDY COASTS
MUDDY COASTS
PORTS
CITIES
RIVERS AND ESTUARIES
LOWLAND LAKES
RESTORING SEAGRASS MEADOWS
FACILITATING CORAL DEVELOPMENT
BUILDING SHELLFISH REEFS
REHABILITATING MANGROVE BELTS
GROWING SALT MARSHES
ESTABLISHING WETLAND FORESTS
DEVELOPING WETLAND AREAS
CHREATING HANGING AND FLOATING STRUCTURES
CREATING REVETMENTS
INTEGRATING VEGETATED FORESHORES
APPLYING MEGA-NOURISHMENTS
CONSTRUCTING NATURE ISLANDS
ENHANCING DUNE DYNAMICS
LANDSCAPING THE SEABED
CONSTRUCTING PERCHED BEACHES
STRATEGICALLY PLACING FINE SEDIMENT
CLAY RIPENING AND CONSOLIDATING
CREATING SEDIMENTATION BASINS
MANAGING COASTAL RETREAT / REALIGNMENT
DEVELOPING INLAND BUFFER ZONES
DEVELOPING DOUBLE DIKE SYSTEMS
RESTORING CONNECTIONS
RESTORING SALINITY GRADIENTS
RESTORING TIDAL DYNAMICS
CREATING TIDAL PARKS
CONSTRUCTING SECONDARY CHANNELS
OPTIMIZING FLOW PATTERNS

4

PROBLEM FIELD ANALYSIS

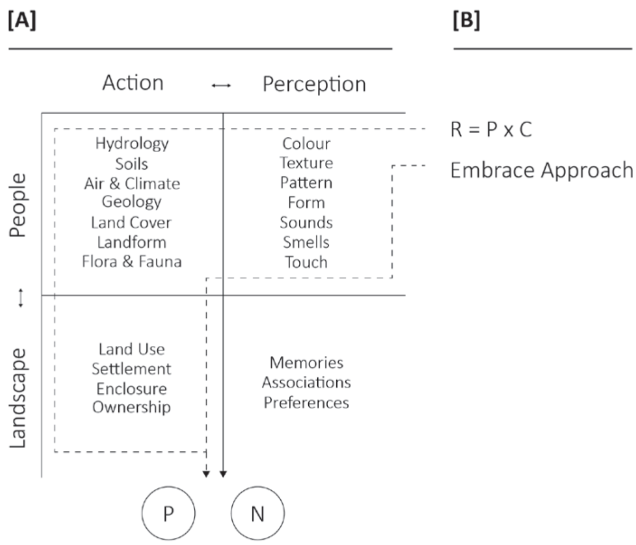
Macro



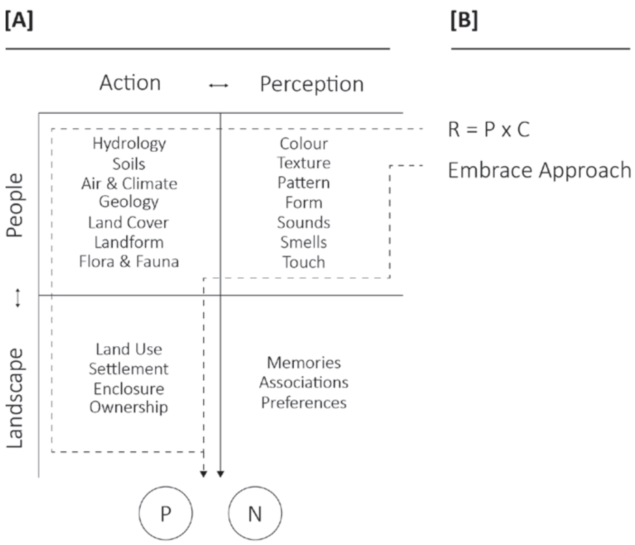
Meso

Introduction

This chapter is the initial exploration of the problem field and design context, regarding the concepts of Flood Safety and Landscape Identity. The macro and meso scales of the Netherlands, the Rhine Meuse delta and the Alblasserwaard are looked at.



State of matter - Water, Soil and Air



The ‘Evil Corner’, Goeree Overflakke

The ‘natural’ state of the Dutch Delta

Source: Joop van den Houdt, unknown

http://defotograaf.eu/blog/de-kwade-hoek-goeree/

N

scale 1: x 000

Natural state of matter - Coastal and riverine dynamics

— 'Matter'
What is the natural state of the Dutch Delta landscape, how is it altered through the flood safety system and what are the limits of this system regarding climate change on a national scale?

Earth
Water
Air

What are the natural shaping domains of the landscape?

Looking at the macro scales of the Netherlands and the Rhine riverine basin.

Composition
9000 years BC the delta was in constant movement. A dynamic of sedimentation and erosion shaped the water and land bodies. A reproduction of the Dutch pleistocene coastline reveals the pre antropocenic dynamics of land and sea. Coastal landscapes must have looked similar to the 'Evil Corner', an area of the Dutch coast where the landscape is mostly shaped by the forces of the Northsea.

Through the elevation contours, the current shape of the Netherlands can be recognized. It becomes apparent that the coastline has moved seawards and has been shortened by straightening of the coastline throug flood defence elements such as the afsluitdijk and the Easterscheldt barrier.

The red line indicates the areas that lie below sea level and are at risk of flooding this area covers more than sixty percent of the Netherlands. This area would be flooded if there were no flood defence system in place.

Influence of human settlement
The 'natural' pleistocene state of the Dutch Delta at the beginning of human inhabitation
Source: Nationaal Georegister, 2020
Dinoloket, 2020

Below NAP boundary
Source: Nationaal Georegister, 2020

Pleistocene land compositions
Source: Dinoloket, 2020

Land surface contour 5m
Source: OpenDEM, 2020

Below NAP boundary
Source: Nationaal Georegister, 2020

Dike Ring
Source: Nationaal Georegister, 2020

0 km 25 km

N

scale 1 : 2 000 000

Movement of matter

Alteration

The section shows a height and soil profile of the Dutch river basin of the Rhine, Meuse and Scheldt rivers.

Geology slope

As can be seen in the morphology of the soil layers, a steadily slope appears from the inland east with more sandy grounds, towards the coastal clay and peat grounds in the west.
This slope is the result of geologic forces of downwards moving Northsea part of the Eurasian plate, this movement caused the Netherlands to become a main endpoint of European riverine flux. In some areas, the slope is altered, this is visible in the section at the coastline, and where the river is intersected. Peaks in the section represent the dunes and dikes that form the coastal and riverine flood defence system.

The image of the Rhine and Meuse basin reveals the large area of hydrodynamics that ultimately have their influence on the Dutch delta. Besides hydrology, the natu

Sea level rise as a result of climate change and subsidense as a result of lowering ground water levels appear to be flooding or tipping over the Netherlands. As can be seen in the section.

It becomes apparent that the riverbed is elevated above the surrounding surfaces. The areas protected by levees are significantly lower, especially in the western part, towards the coastline.

If current sea levels are projected as if flood defence systems were not in place, it becomes apparent that the morphology of the surface does not allow water to flow away easily.

Rhine Meuse Scheldt delta

Elevation of the river and soil profiles

Source: Nationaal Georegister, 2020

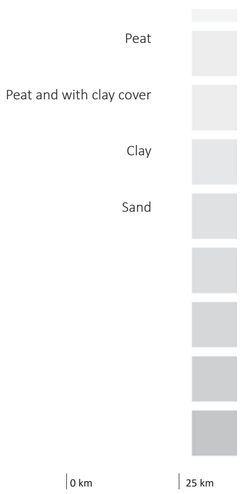
Dinoloket, 2020

The Rhine and Meuse basin

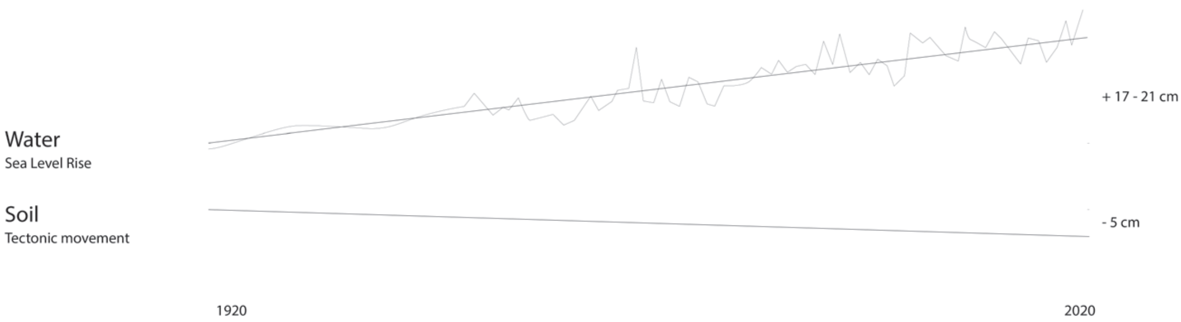
The area of hydrodynamics that influence the Dutch Delta

Source: Joop van den Houdt, unknown

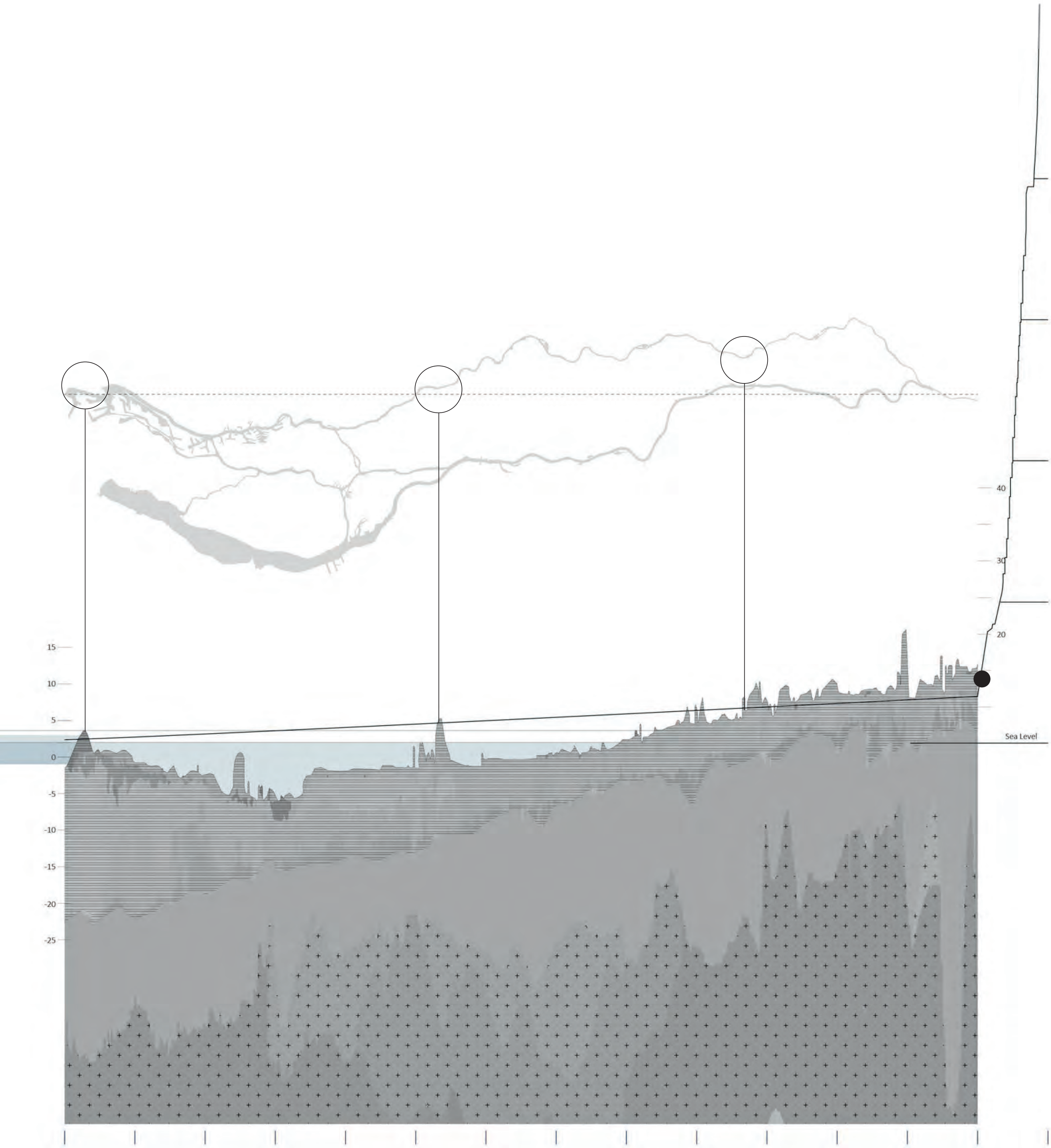
http://defotograaf.eu/blog/de-kwade-hoek-goeree/



N



Water
Sea Level Rise
Soil
Tectonic movement
+ 17 - 21 cm
- 5 cm
1920
2020



15
10
5
0
-5
-10
-15
-20
-25
40
30
20
Sea Level

Climate change pressure on water levels

Limitation

The Rhine Meuse scheld delta experiences threaths of flood risk from both sea, river and pluvial flooding.

Influences of climate change cause sea level rise, extremes in river run off and precipitation. This results in peaks of exess water and drought.

Temporality is essential in the consideration of flood risk. Risk of flooding is the highest at a so called 'maatgevende' situation of a storm surge together with peak river run off. The structures that are in place, protect agains this peak in water pressure. Not only do they experience pressure from high water shock events, long term stress of drought also increase the possibility of failure. This temporal dynamic of water pressure and heat stress is represented in the scheme.

As mentioned before, climate change is causing an increase in pressure from both the stress and shock events. The section reveals that the flood defence structure protects agains current storm surge water levels. It is however not able to resist the water pressure when sea levels rise over 0,85 m. And as shown in the graph in the previous chapter, when steps are taken sea level rise should be prevented. If not, the image shows a flooded coastline with a 1 meter in sea level rise.

Extreme Conditions

The 'natural' pleistocene state of the Dutch Delta at the beginning of human inhabitation

Source: Nationaal Georegister, 2020

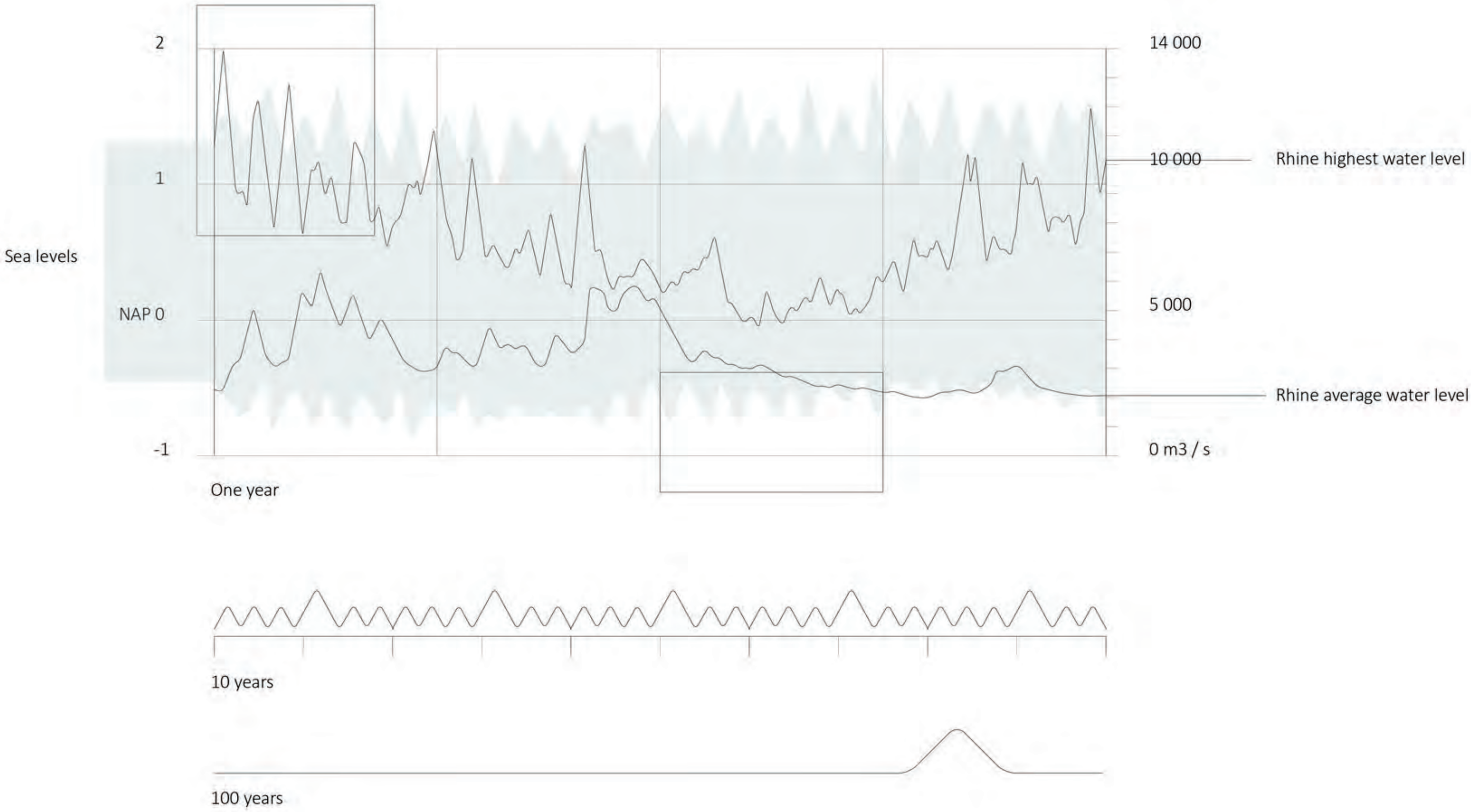
Dinoloket, 2020

+1 m sea level rise

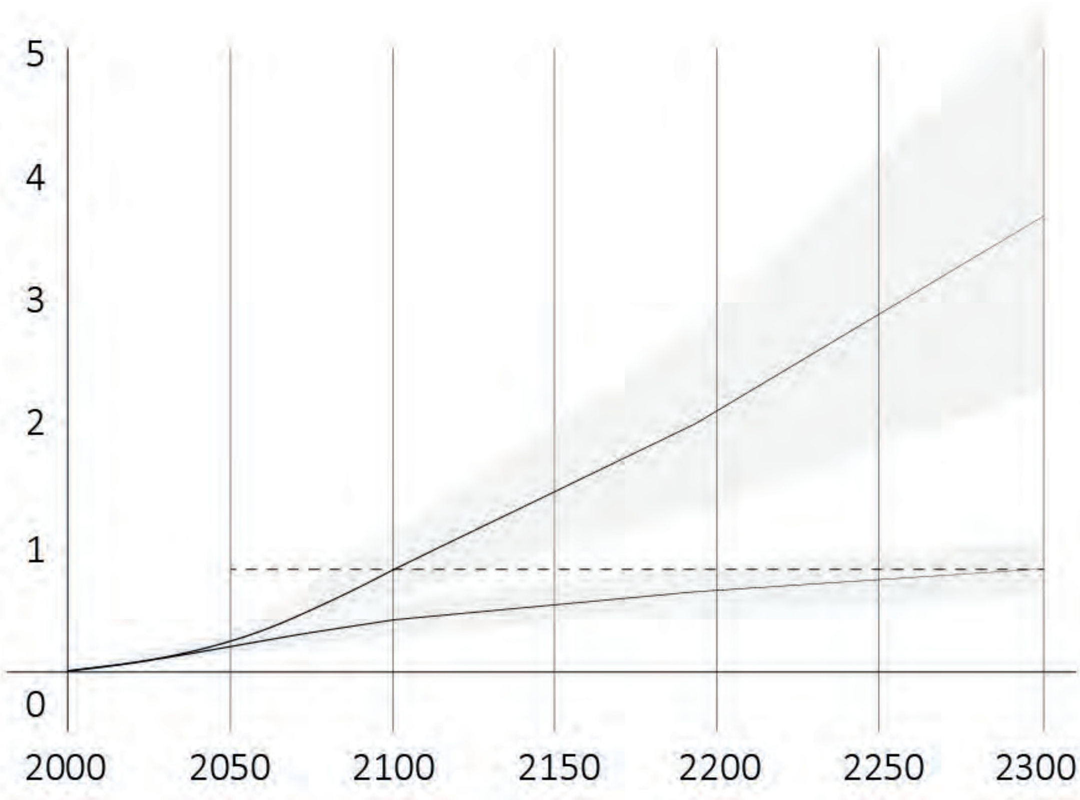
The 'natural' state of the Dutch Delta

Source: Joop van den Houdt, unknown

http://defotograaf.eu/blog/de-kwade-hoek-goeree/



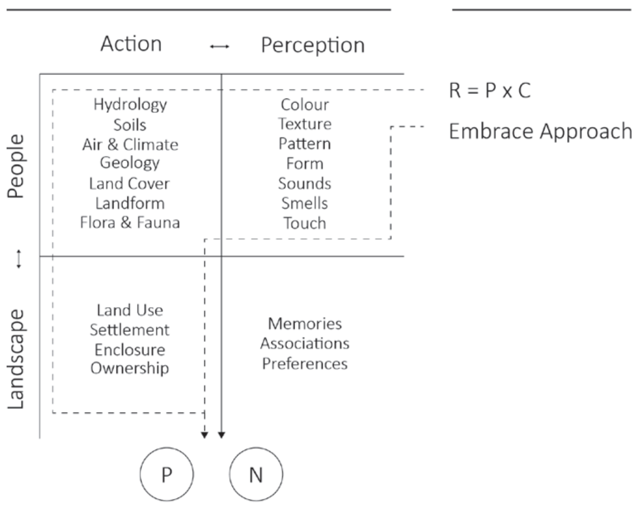
2
1
Sea levels
NAP 0
-1
One year
14 000
10 000
Rhine highest water level
5 000
Rhine average water level
0 m3 / s
10 years
100 years



5
4
3
2
1
0
2000
2050
2100
2150
2200
2250
2300

Delta Habitat

[A] [B]



Sint Elizabets Flooding

De Sint-Elisabethsvloed, Meester van de Heilige Elisabeth-Panelen, ca. 1490- ca. 1495

Source: Joop van den Houdt, unknown

http://defotograaf.eu/blog/de-kwade-hoek-goeree/

scale 1: 1 300 000

Enclosure

Hydraulic control

Water dynamics are controlled through a system of edges and nodes. This system profides flood safety from coastal, fluvial and pluvial flooding.

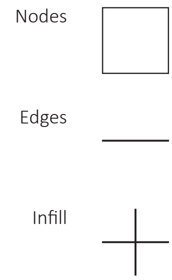
This system operates on three scales and prevents water from entering the 'infill' areas or facilitates the draining of water from the infill area. The three scales are the primary coastal and riverine territory, followed by the regional boezem structure and finally the polder.

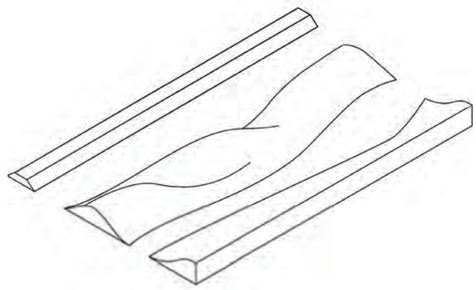
The edges and the nodes define and connect these three tiers of the water system. The edges are made up of dunes, dikes and higher grounds that prevent water from entering the inland area. The nodes are placed within them and consist of moduleable infrastructes or pumps that mainly move the water from inland to the coast. A schematic representation of the hydrologic system as well as an overview of the artifacts that are the nodes in the system can be seen on the right page.

Schematic section of hierarchy

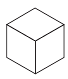
From primary to regional to individual flood defence elements

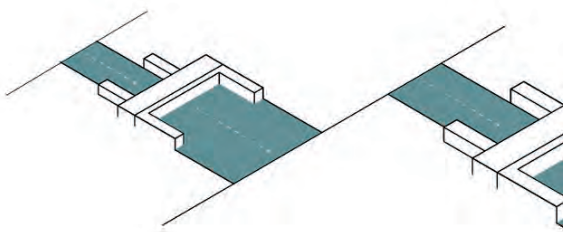
Source: Author





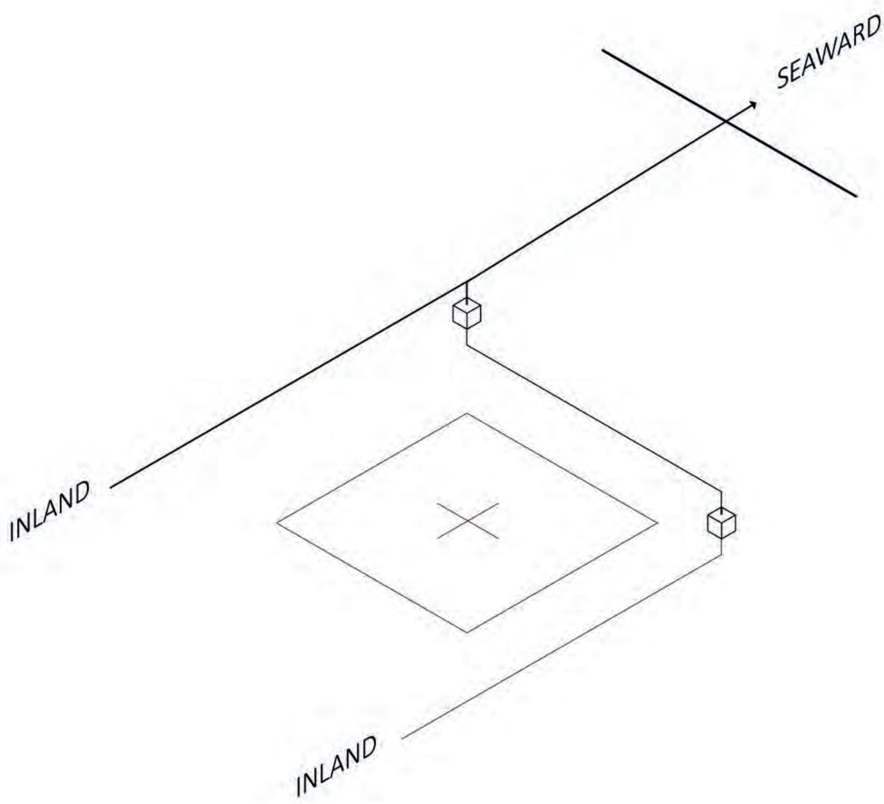
Edges

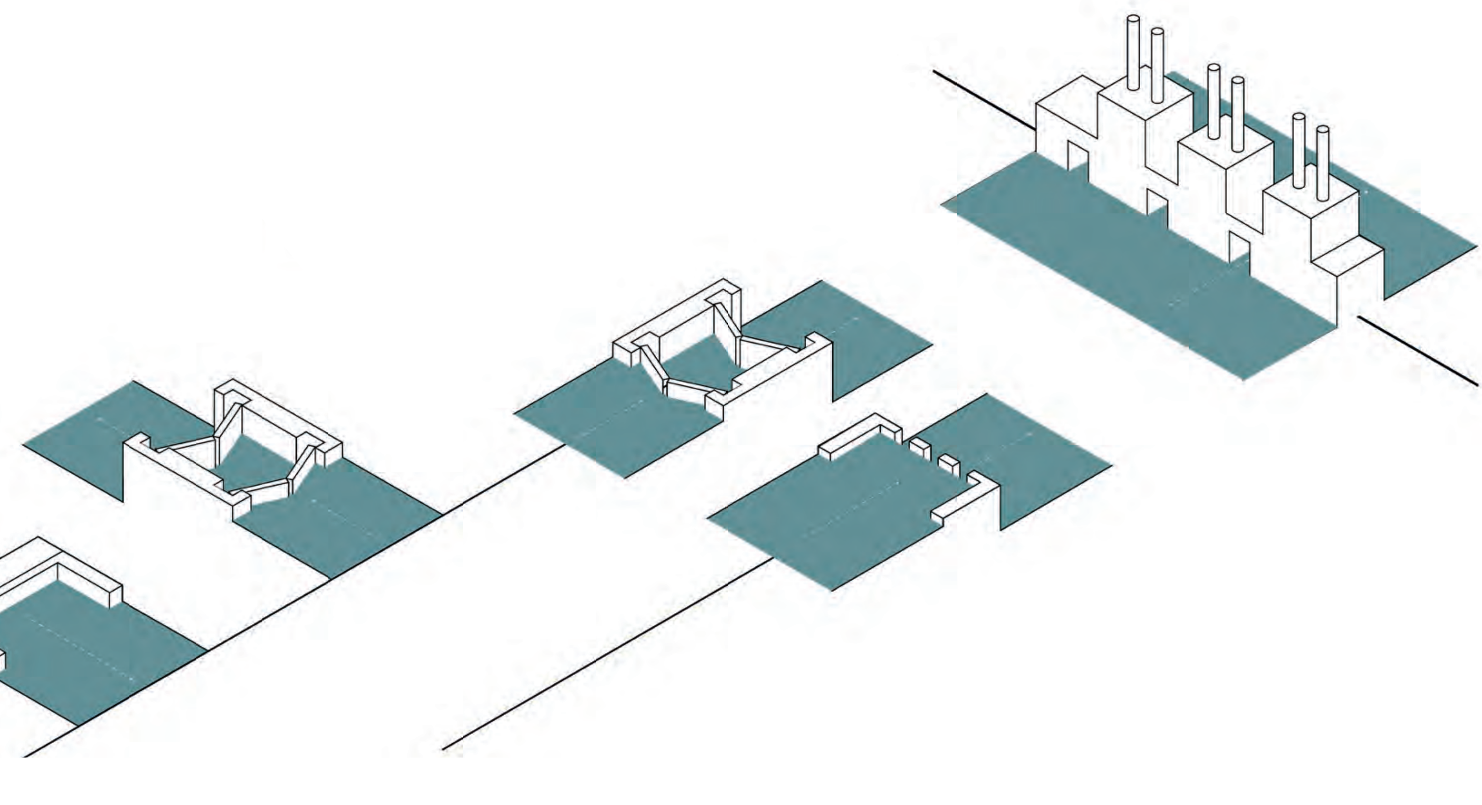




Nodes

N





Vulnerability society to a society of risk

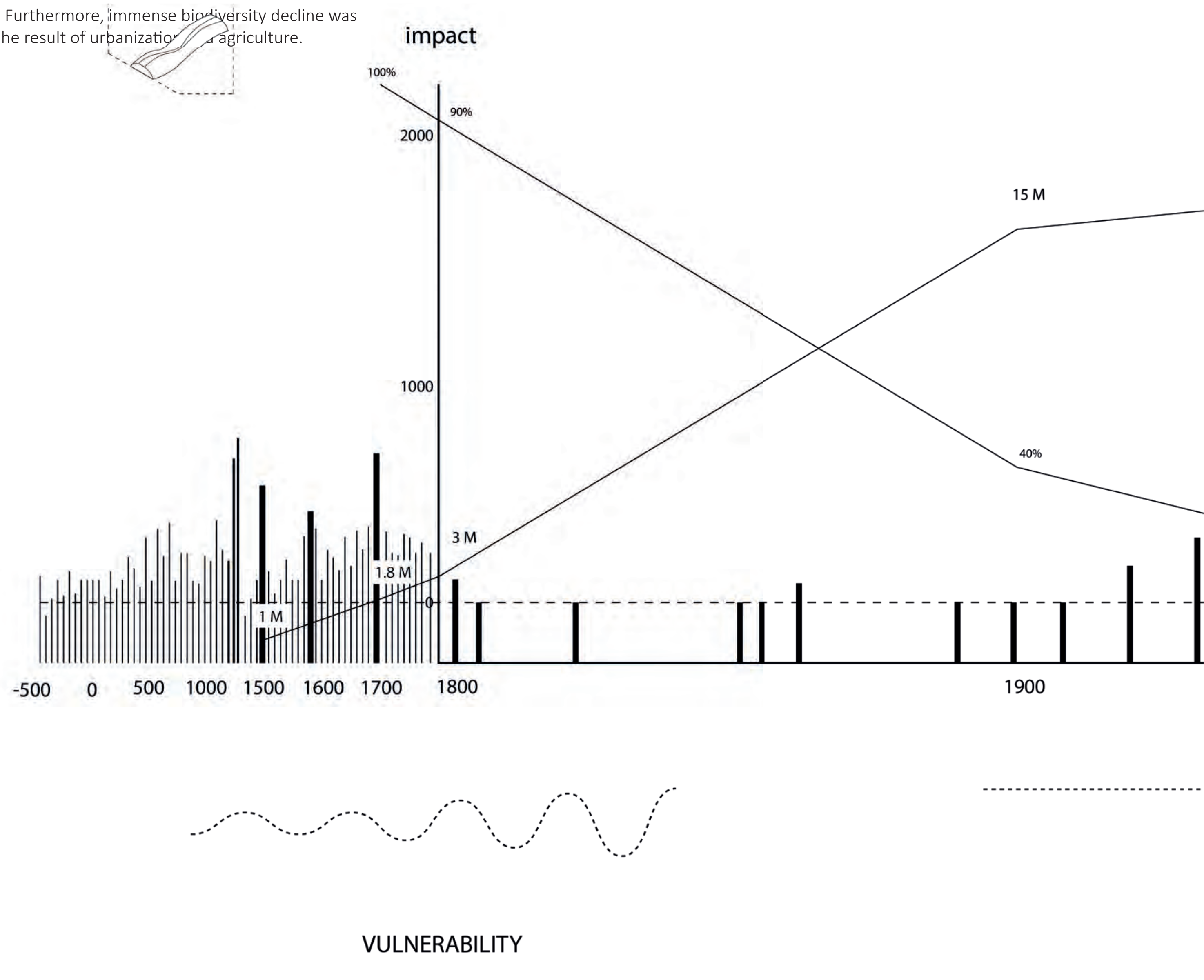
Alteration

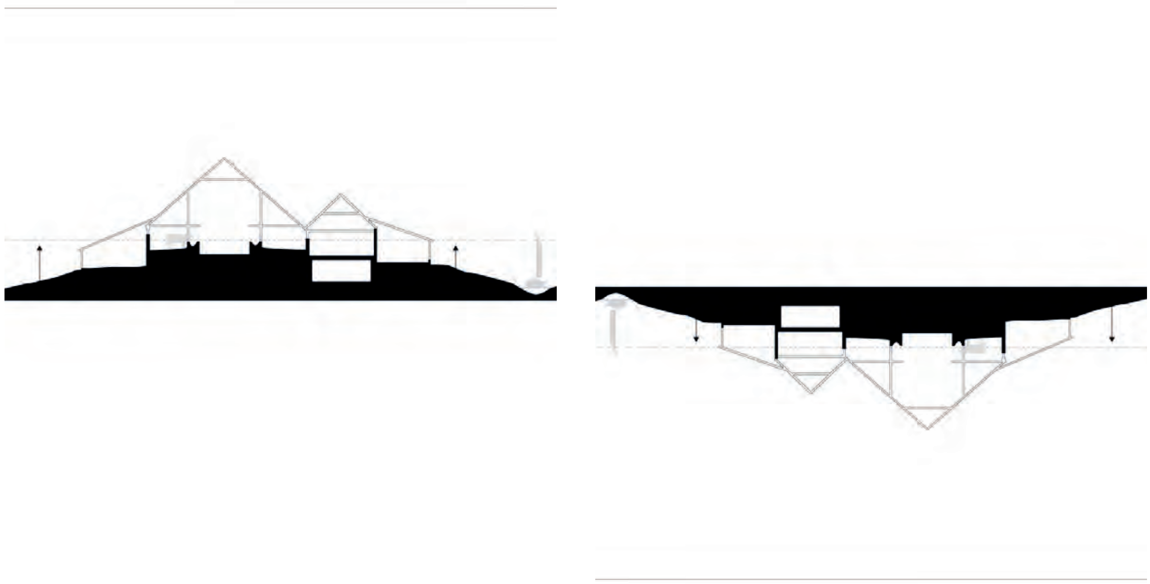
The Dutch approach to flood safety is to minimize the probability of flooding. This is achieved through the implementation of Hydraulic engineering infrastructures of dams, dikes, sluices, channels and pumps in the landscape. This approach has developed over time, starting from a reduction of consequences approach to a reduction of probability.

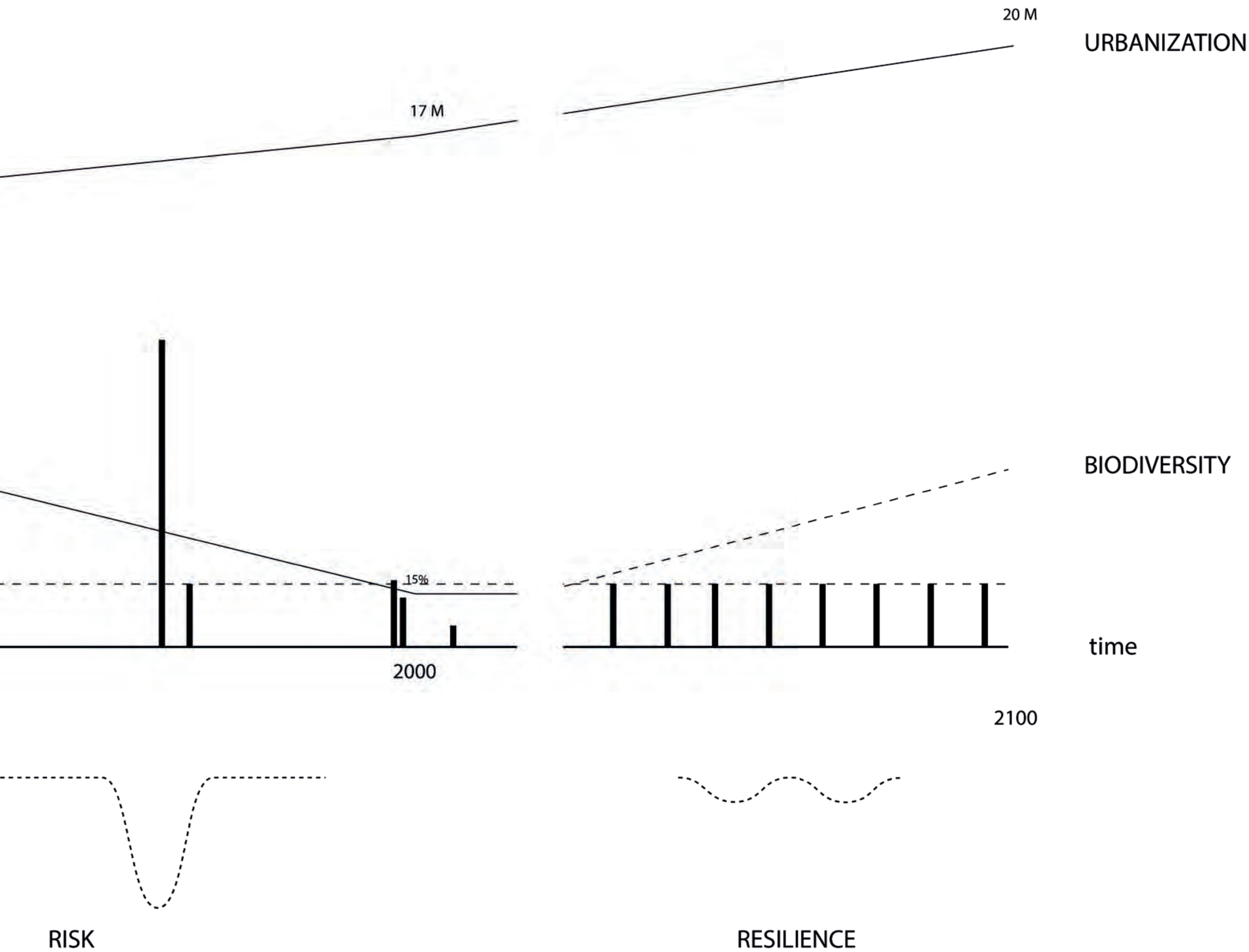
First settlement in the Dutch delta was on mounds and higher grounds. But, with urbanization and higher claims on the land, infrastructures of hydrologic control were implemented for land reclamation and flood safety.

This resulted in:
- A shift from a society of vulnerability to a society of risk. This means that flooding frequency was reduced, but if a flooding occurred, this had a higher impact as people were no longer prepared and adjusted to flooding.

- Furthermore, immense biodiversity decline was the result of urbanization and agriculture.






20 M
URBANIZATION
17 M
BIODIVERSITY
15%
time
2000
2100
RISK
RESILIENCE

Definition of the Rhine riverine landscapes

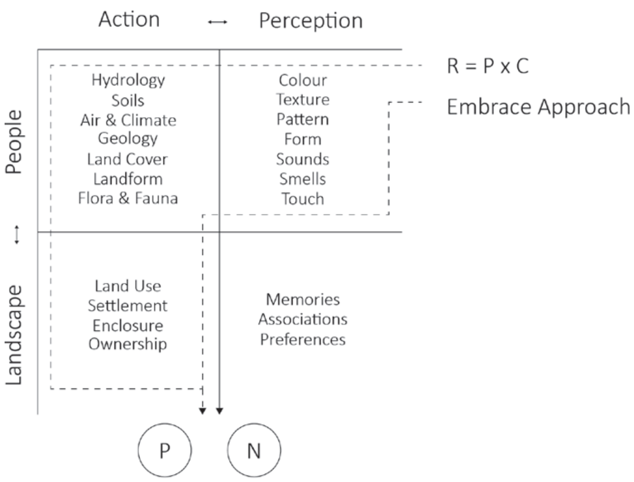
Hoge Zandgronden [High Sand]

River Landscape

Sattelite Images of the different Rhine riverine landscapes

Source: Google Earth, 2020

[A] [B]



Veenweide

Droogmakerij

Seaclay Landscape

scale 1: x 000

N

scale 1: x 000

Defined by soil and enclosure

Composition

Topos, the definition of place. Looking seaward, the gradient from high to low, dry to wet grounds can be recognized. Also the line of urbanization becomes apparent. Spatially manifesting the attractive settlement environment of the coast. On top of these different landscape, the same flood safety solution is implemented, difference in landscapes, does not have any implications on the overall flood safety system implemented.

Looking at the definition of landscape, in the Rhine Meuse delta, the landscape is largely known as the 'Polder'. There are Sea Polders, River Polders and Peat polders, their outline follows the Rhine riverine basin and marks the

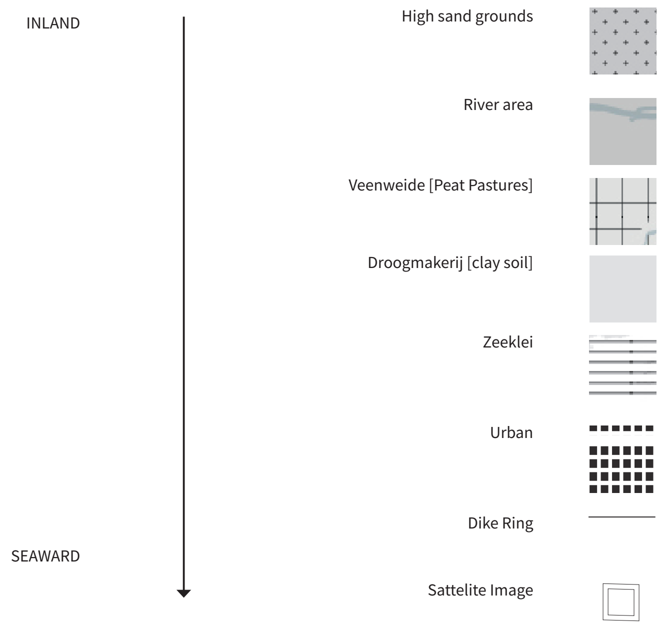
Within the polder landscapes, flow In the Rhine Meuse Scheldt delta, four landscape types within the overall 'Polderlandscape' can be defined. They are, in order from sea, inland: Zeeklei, Droogmakerij, Veenweidie, River area and Hoge Zandgronden. These landscape types are defined by the domains of through soil types and land use.

Different nationally defined landscapes along the Rhine

The 'natural' pleistocene state of the Dutch Delta at the beginning of human inhabitation

Source: Nationaal Georegister, 2020

Dinoloket, 2020



scale 1: x 0000

Landscape of enclosure

Veenweide Landscape

Within the Alblasserwaard the Veenweide landscape is the predominantly defined landscape. However, from reading the different landscape character layers, underneath the apparent heterogenic landscape lie remnants of a landscape once characterized by coastal and riverine dynamics.

As a result of land reclamation and peat extraction, then trough subsidense and cattle farming, over the last 200 years, the landscape of the alblasserwaard has been transformed in the grid of peat pastures as we know it today.

Taking a deeper look at the Polder landscapes of one dike ring, at the convergence of river and sea, it becomes apparent that different landscapes can be found within such one dike ring. These different landscapes are not only shaped by natural forces of air, water and soil but also through the human reaction to these forces. The Alblasserwaard, the area with the highest risk of flooding in the Netherlands, has known a long history of flooding.

However, grounds used for peat extraction and livestock, were too valuable to return to the water. The levee system kept being built back up and over the last 200 years, this area has grown to be one of the most productive dairy and meat farming areas of the country. This convergence of natural and human forces have shaped the landscape as we see it today. Referring to the model of

But there are underlying evidence of other landscape characters. Compartment landscape

Through land reclamation practices and rebuilding dikes after floodings, the landscape has been compartmentalized. Former dikes, transportation- and hydrological infrastructures form the boundaries of these compartments. On the outer edge, the national, primary levee structure encloses the inner dike area and separates it from the riverine hydrology.

What becomes evident is that land use practices, firstly of peat extraction and later on of cattle farming, have been the core drivers of landscape transformations on the regional scale. In order to safeguard thes land use practices, a complete control of the hydrologic system was necessary. Subsequently, settlement patterns followed the hydrologic / transport structure and also completely rely on the performance of these flood safety and hydrologic systems.

This compartmentalization is the spatial outcome of an trhopological control of the riverine dynamics. It shows the outcome of a societal transition from a place of vulnerabiltiy to a society of risk. Building dikes to protect against the water and reduce floodings to 0.

From the characteristic, physical landscape elements on the regional scale, the following assumption is made on the landscape identity of the Alblasserwaard. and the relationhsip between human an nature that is derived from it. It is of tof the dike ring, the boezems and polders. polder regional landscape of the alblasserwaard.

It is a relationship of anthropolocial control over the biophysical environment. The physical elements of landscape, the riverbed, dike ring, boezem and polder, all represent a human control of the hydrologic system, which subsequently determines the Flora & Fauna, Land Form and Land Cover. Consequently this control and order can be perceived through the straight lines in the landscape.

The landscape identity of the human, identity that comes forth from the connection to landscape, is that of the ability to provide safety through manipulation of the landscape. Trust in technology.

Besides the compartmentalizations, three different landscape characters can be defined. The riverine, The Urban riverine and the Rural [peat pasture].

Water dynamics are controlled through the flood defence system that operates on three scales.

Kaarten van landschap en artefacten samenvoegen

N

This system contains fixed structures and adaptable structures that regulate waterflow within the Dutch border.

Veenweide landschap

Sattelite image of the aestetic of most of the land of the Alblasserwaard.

Source: Google maps

http://xxxxx

Natural landscape characters underneath the cultural Veenweide Landscape

The 'natural' pleistocene state of the Dutch Delta at the beginning of human inhabitation

Source: Nationaal Georegister, 2020

Dinoloket, 2020

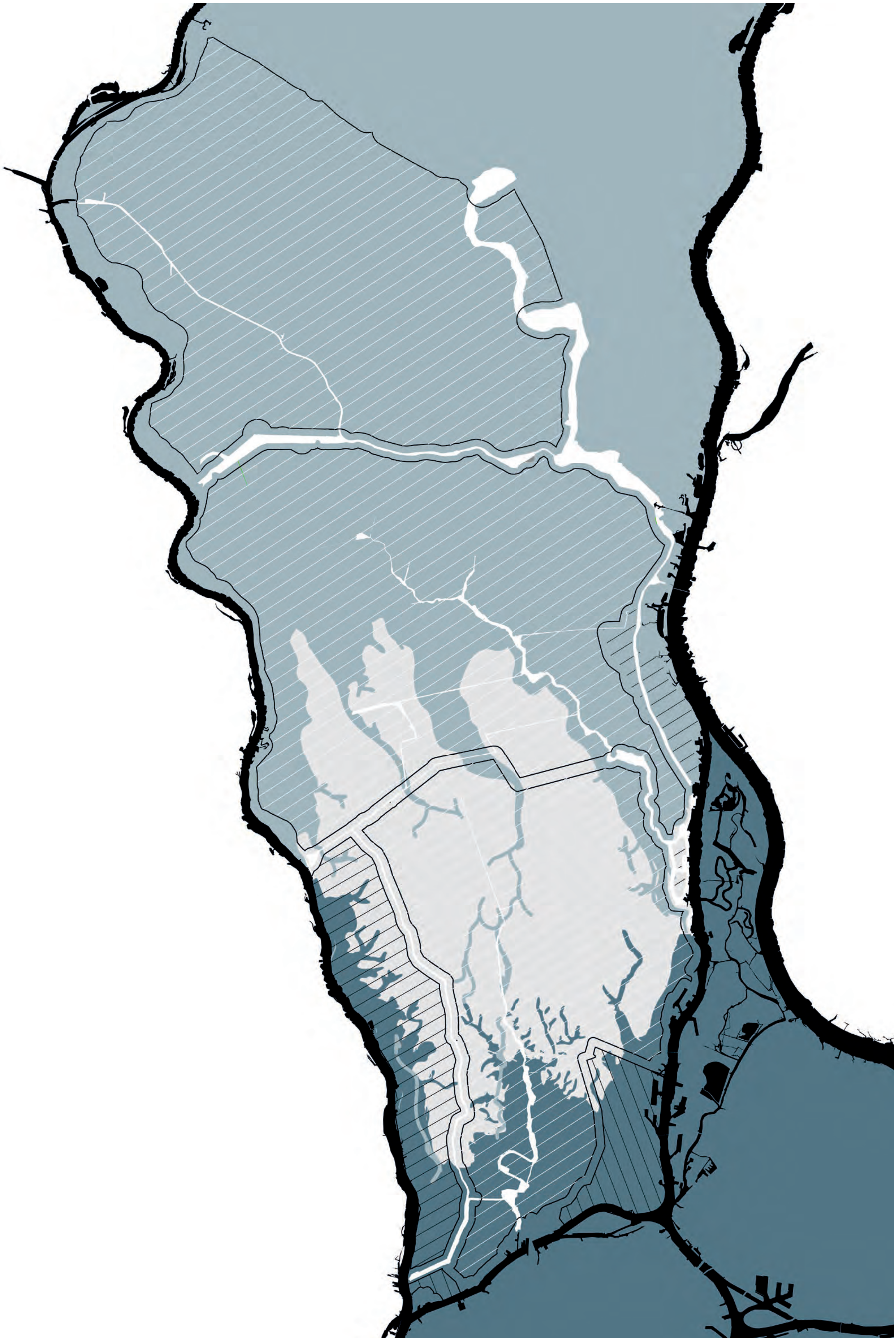
Below NAP boundary
Source: Nationaal Georegister, 2020

Pleistocene land compositions
Source: Dinoloket, 2020

Land surface contour 5m
Source: OpenDEM, 2020

Below NAP boundary
Source: Nationaal Georegister, 2020

0 km 5 km



scale 1: x 000

Low Probability, High Vulnerability and Externalities

Probability

Pluvial, fluvial and coastal flooding form a threat to the Alblasserwaard. The probability of flooding is related to the topography, air/climate and hydrology domains of the landscape. The probability of a levee breach, according to the Dutch assessment model, is determined by the strength of a levee in combination with the pressure of the waterbody it needs to resist.

Flood dynamics and safety system
Referring back to the climate model in the previous chapter, in the three month period of december until februari peak river discharge occurs. Around two times per year, high sea levels are measured. The current levee system, taking into account the alterations planned until 2050, is able to resist a potentially catastrophic storm surge that occurs once every 100 years.

In the case of a breach, the flow pattern of the water is determined by compartments in the landscape that are enclosed by the boezem hydrological infrastructure and the transportation infrastructures of roads, highways and train tracks. In most cases of breaches of the dike ring, the water will fill the adjacent compartments within 3 hours. A breach to the next adjacent compartments might occur within 2 days. Eventually, the whole lowest lying part of the Alblasserwaard, will be inundated, as can be seen on image X. Because of the 'bathtub' topography, it takes at least three months to fully restore water levels after innundation. Furthermore, fluvial and pluvial peaks can be predicted many days or weeks in advance. Coastal peaks however can only be predicted two to zero days in advance.

Vulnerability

Vulnerability is defined through the [in]ability to respond to an occuring of a flooding. This is also known as resilience. Besides socio-economic circumstances, there are spatial circumstances that determine the vulnerability to fatalities and damages of a flooding. The main indicators of vulnerability according to the Dutch assessment model are, firstly the ability to respond and evacuate during or before a flooding and secondly the damages that result from a flooding.

Evacuation

As mentioned in the previous paragraph on probability. A flooding can be predicted 2-0 days in advance. In the scenario of a fluvial peak coinciding with an unpredicted coastal storm surge. Immediate evacuation of the vulnerable low lying urban areas together with people and cattle of the rural low lying areas is necessary. The current infrastructure is not prepared for such a scenario as many water crossings are tunnels and ferries and the carrying capacity of the infrastructure is too low.

Damages

Besides the vulnerability to fatalities in the urban area, flooding and long term innundation, lead do immense economic damages. As it takes a minimum of three months to pump out the water to restore the low groundwater levels in the polder that are required to continue the cattle farming.

Besides the economic damages that are considered in the Dutch flood risk assessment model, heritage sites and ecologic areas will be severely damages as well. Within the Alblasserwaard, there are several Natura 2000 protected areas and other bird nesting areas that require protection. Furtermore, there is the protected heritage site of Kinderdijk, this area is one of the oldest, intact polderlandscapes and mills that are examplary of the development of the hydrological system in the Netherlands

Heritage

The official heritage sites in the Alblasserwaard em

The domains of enclosure, Settlement and Land Use. The concequences of a flooding occuring in the Alblasserwaard are immense. This is however tolerated because the probability is reduced to almost zero.

Both the urban and rural systems are, spatially not resilient to flooding.

Externalities
Hydrolic system in case of breach of primary levee system due to pressures of river or sea flooding.
Image: Heijnen, 2021

Long term innundation

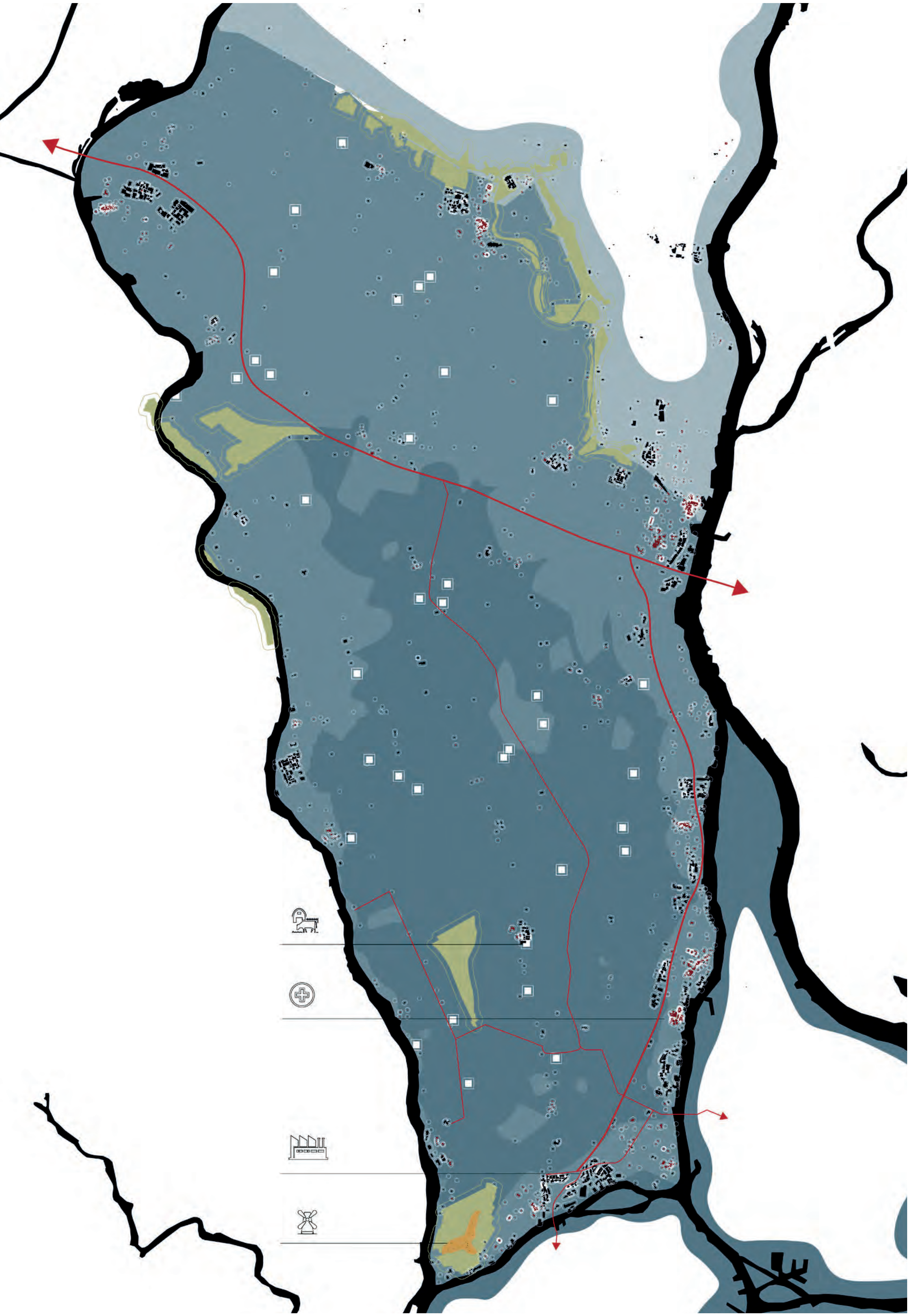
Immediate flood risk

Natura 2000

Heritage

Evacuation route

0 km 5 km



Externalites of the flood safety system

Waterquality and lack of biodiversity

The quality of water in the boezems is very low as a result of urban polluted water. Subsequently, biodiversity is very low around the green blue network.

Subsidence

The drainaige of surfacewater results in subsidence of the soil. The CO2 that is captured in the peat soil is released as a result of this.

Polution

Besides the CO2 release in the air due to the artificially sustained low surface and groundwater levels, the livestock land use is a big polluter as well. Nitrogen in cow menuar is released in the air and is penetrates the soil and groundwater. Furthermore,

Externalities

Subsidence and pollution

Salination of ground water

Waterbuffering capacity degradation

Externalities

Hydrolic system in case of breach of primary levee system due to pressures of river or sea flooding.

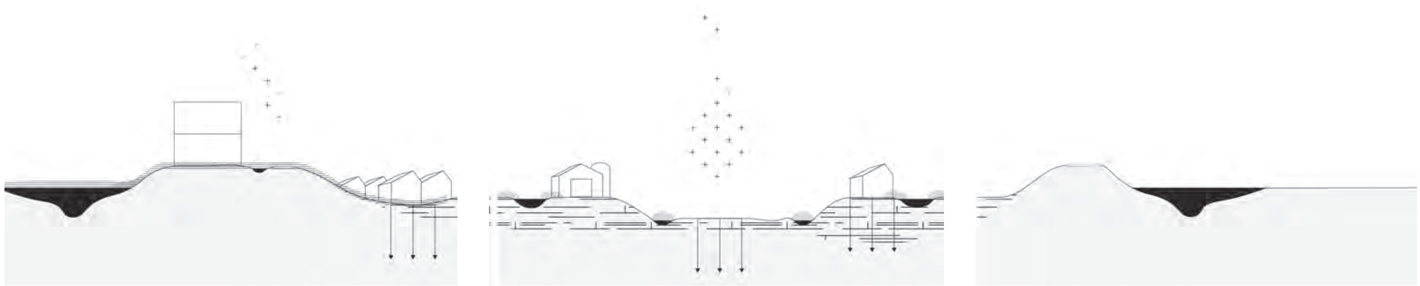
Image: Heijnen, 2021

CO2 + Nitrogen release in air

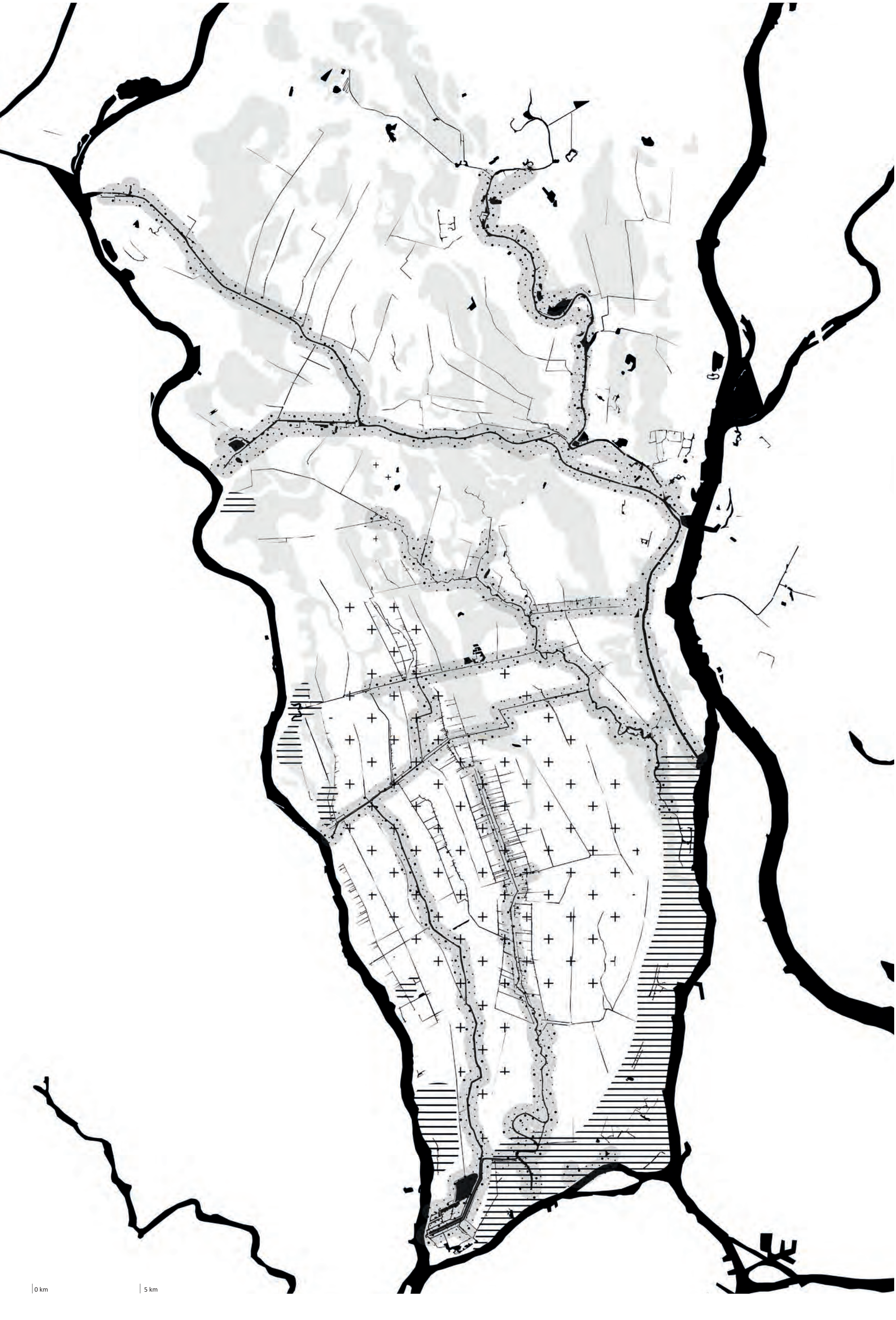
Polluted urban water

Lack of ecology

Subsidence



scale 1 : 150 000

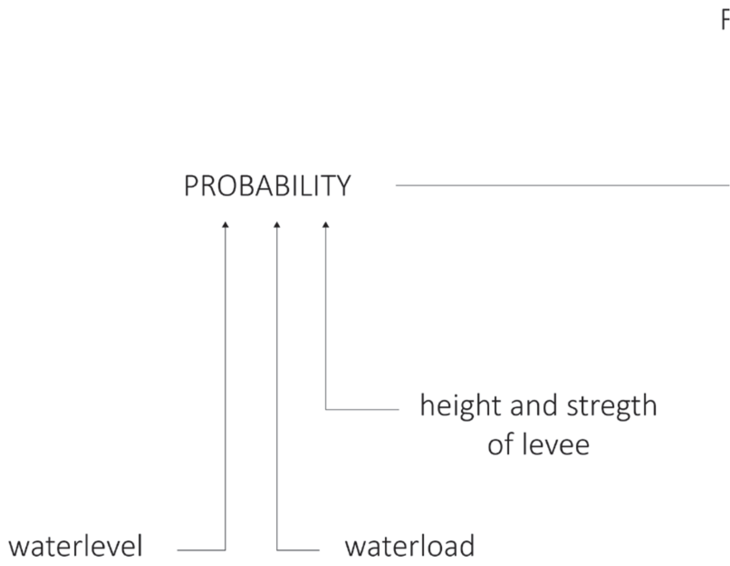

0 km
5 km

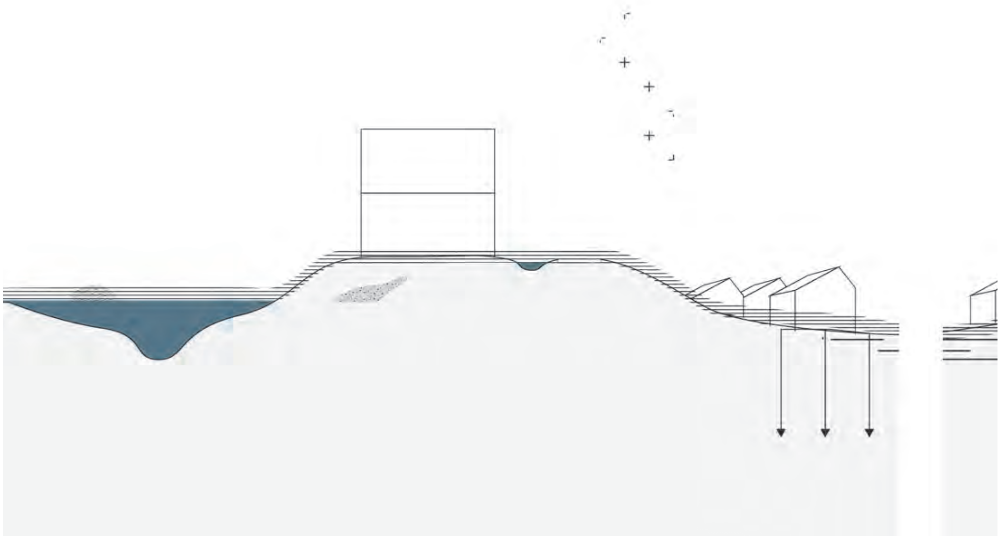
Limits of pollution

Limits

It can be said that to a certain point, the limits of the polder landscape have been reached. Processes for retaining the polder landscape and as a result, the form, colour, vegetation and smell, are erasing the ecology within them. The land use practices are draining and polluting the environment.

The so called levee effect, describes the effect of intensive development in floodplains after the placement of flood protective levee structures. When flooding occurs, this development then results in increased damage (White, 1942). The Dutch flood risk protection system is the ultimate example of the levee effect. With sea level rising faster and higher than expected, eventually this current flood protection system might not be sufficient and sustainable in the long term. As soon as 2100, sand nourishment demands will be twenty times as high, storm surge barriers will have to close at a high frequency and fresh water will be less available due to saltwater intrusion (Haasnoot et al., 2020). Globally, decision makers are increasingly interested in sea level rise events with a small probability but with very high consequences. With this, the focus of flood risk measures has been shifting more and more from reducing flood probability towards reducing flood consequences as well (Bars et al., 2020).





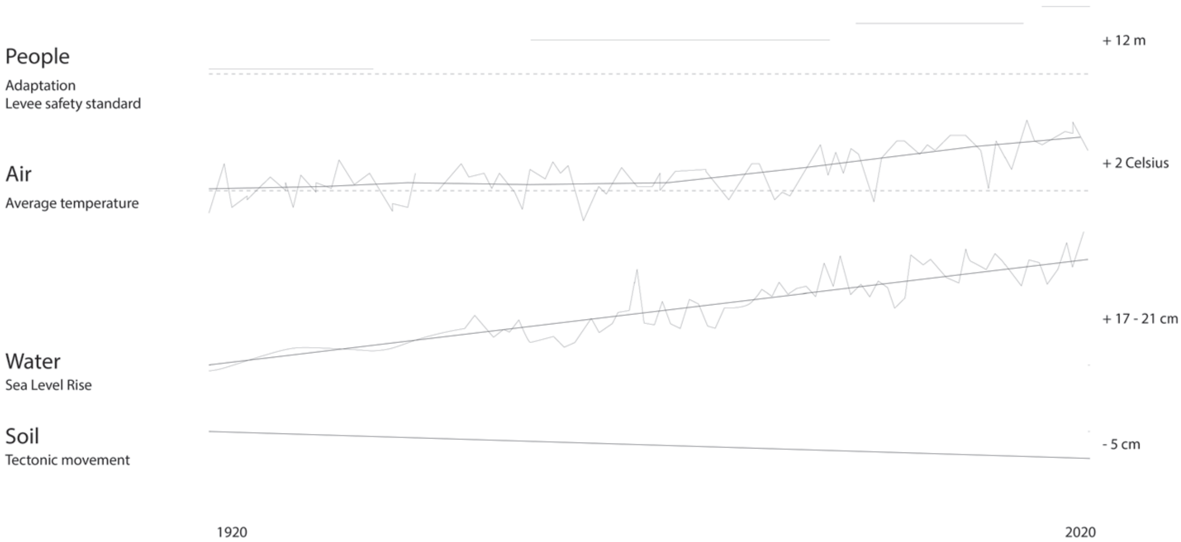
Section of different landscapes

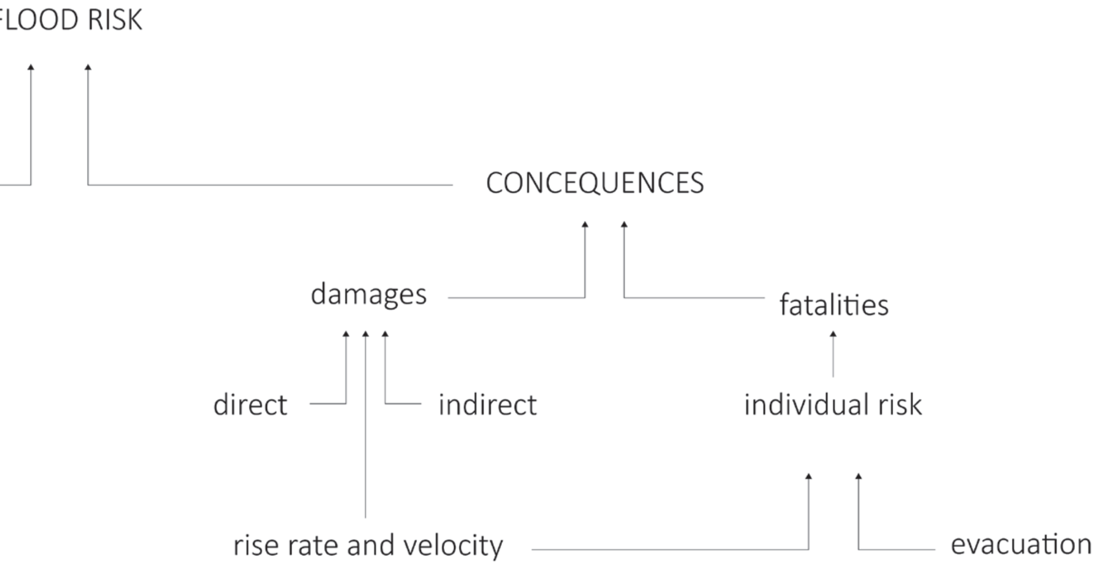
The 'natural' pleistocene state of the Dutch Delta at the beginning of human inhabitation

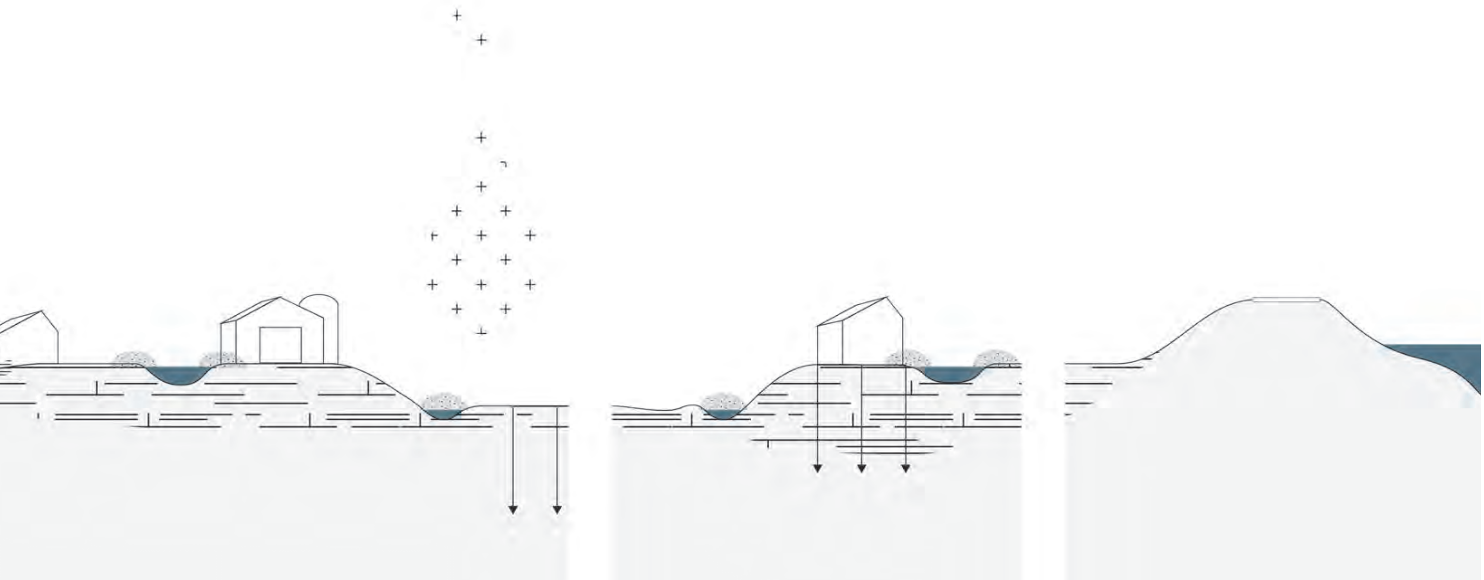
Source: Nationaal Georegister, 2020

Dinoloket, 2020

0 km 2,5 km


People
Adaptation
Levee safety standard
Air
Average temperature
Water
Sea Level Rise
Soil
Tectonic movement
+ 12 m
+ 2 Celsius
+ 17 - 21 cm
- 5 cm
1920
2020


FLOOD RISK
CONCEQUENCES
damages
fatalities
direct
indirect
individual risk
rise rate and velocity
evacuation



Operators of the Dutch flood risk management system

Actors and agency

In the Netherlands, flood safety is a national responsability and Flood safety standards of the primary levee system are nationally determined. The levee system is however maintained by the water authorities. These are cross province institutions that maintain not only the levee system but they control the pumps and inlets of surface and groundwater as well.

Furhtermore, municipalities are responsable for urban watermanagement. Subsequently, each property owner is responsable for the groundwater levels on their property. As the watersystem is not bound by administrative bounderies, this can lead to conflicts of responsability and interest.

Agents of the watermanagement system

The different governal bodies surrounding and within the water authority

Source: Nationaal Georegister, 2020

Dinoloket, 2020

Province

Water Authority

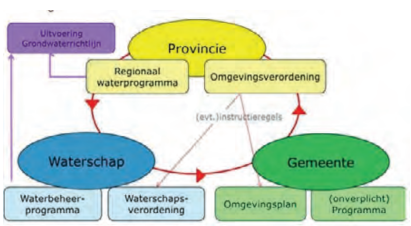
Pump

Municipality

Urban Area

Plot owner

N



Actor positioning concerning water management

The 'natural' state of the Dutch Delta

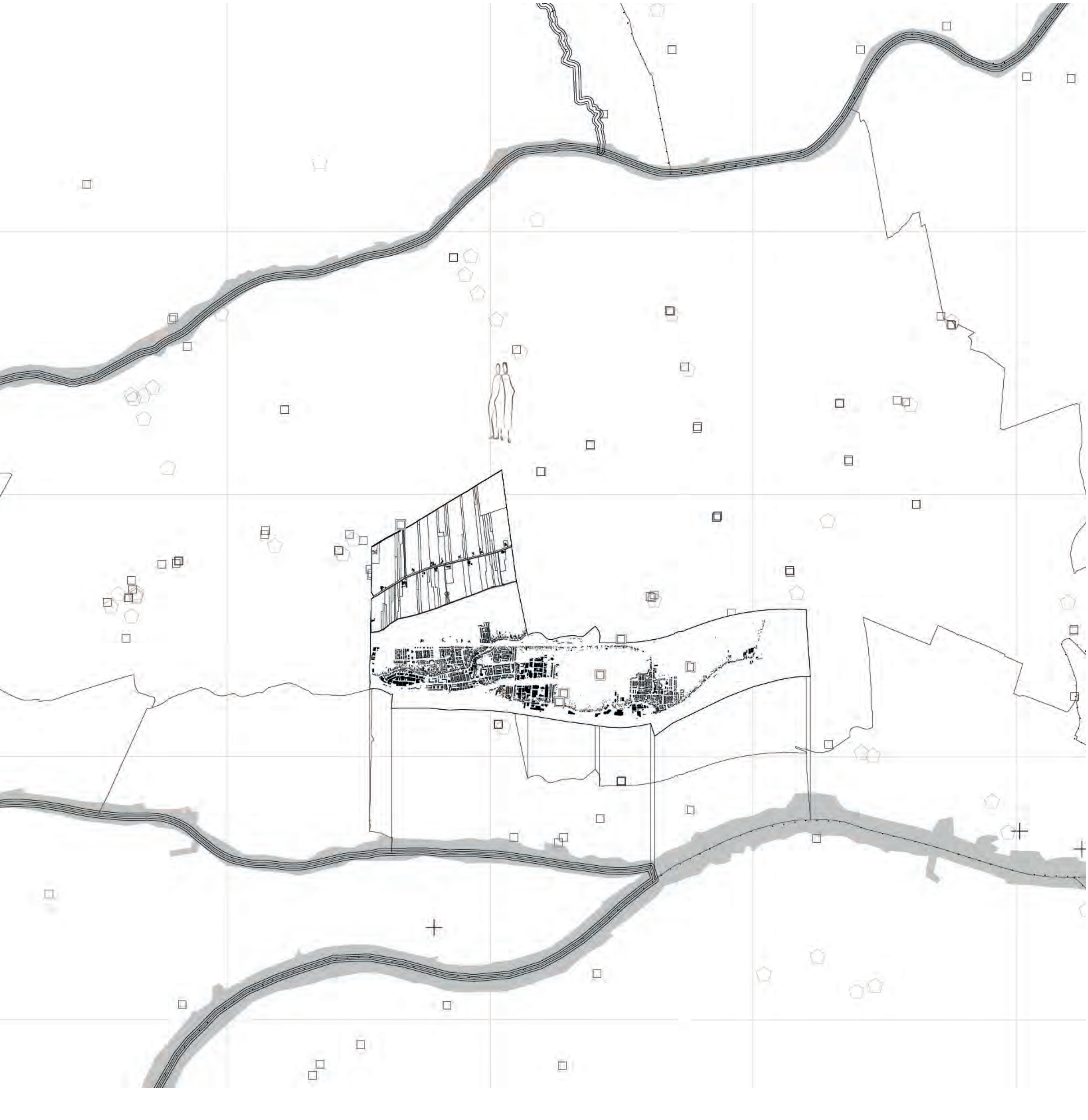
Source: Joop van den Houdt, unknown

http://defotograaf.eu/blog/de-kwade-hoek-goeree/

0 km

5 km

N



Conclusions

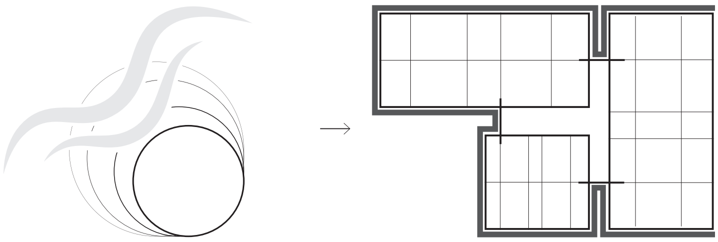
ON MATTER
Land reclamation and flood safety development have transformed the Dutch landscapes from dynamic landscapes to rigid enclosed environments

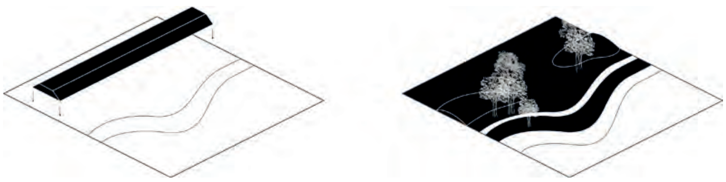
ON TOPOS
Place and landscape are defined and shaped based on values of economy and safety [settlement] imposed upon the landscape

ON HABITAT
Anthropogenic dominance over the biophysical states of water, and soil have overtaken and sometimes eliminated other species, resulting in a lack of ecology and an unbalanced relationship between human and nature

ON GEOPOLITICS
Flood safety is a national responsibility, water management however, has agents on all scales until the individual. A technocratic attitude has shaped flood safety development in a reactive manner.

N





scale 1: x 000

Manifesto

Delta settlement has always been a high risk, high profit trade-off in employing the fruitful zone where land meets river and sea. Historically, the Dutch embodied an epic of controlling the menace of the sea, the evolution of a nation of disaster to a nation of risk. This evolution has manifested spatially. An elaborate system of infrastructures imposed on the natural states of matter has stabilized and contained natural dynamics regarded as unsafe or unprofitable. Reducing probability of flooding to a minimum and hydraulic control to a maximum. Resulting in the overthrowing and commodification of the 'original landscapes', the natural states and tensions of matter [water and land].

Climate change predictions of extremes in water, wind and temperatures challenge the ability of this flood system to adapt to new thresholds. Its limits becoming more apparent with increasing frequency of flooding, salt intrusion and soil subsidence. An uncertain juncture of a system under pressure of extreme forces of water, wind and temperature becomes inevitable. Therefore, an approach directed at reducing the probability of flooding is no longer sufficient.

Since a few decades, flood safety solutions counterintuitive to the Dutch epic of control have entered the playing field. Incorporating natural forces and systems, they partly answer to the shifting thresholds of sea level rise and to the need of ecological redemption. How do these contemporary and possible future approaches align with this traditional epic embedded in the landscape? And must the logic of imposed infrastructures shaping and becoming the landscape be released, if it were even possible? What clues does the landscape give us for a balanced [co] existing? What does it say about what we are and what we want?

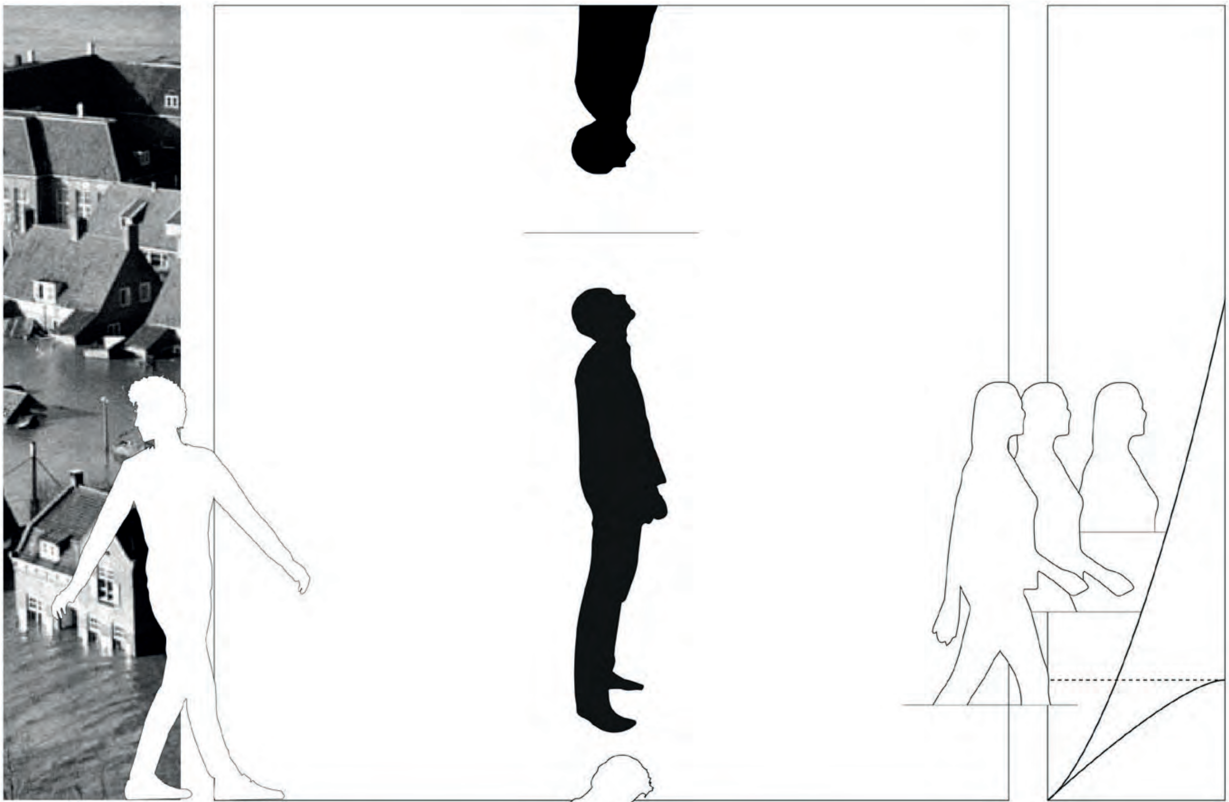
Landscape identity, the physical attributes that construct a landscape and render the intermediate differences.

Landscape identity, the human use of landscape to construct their collective or individual identity.

- We call the river 'sea' when it's wide. A sea is only a sea for the person who names it.-
[ARCHIPEL by Félix Dufour-Laperrière movie stills 0:64:12- 00:66:08]

Regarding landscape identity as a common ground for traversing the anthropogenic forces of topos, habitat and geopolitics and the natural forces of matter, a shift in perspectives on flood safety can be made. Manifesting patterns of attributing values of safety, economy, ecology and aestetics to the landscape that reflect a synchronizing habitat instead of a competing one. Focusing on reduction of flood consequences, increasing resilience and exploring amphibious settlement and land-use. Spatially exercising a different division of territory of human and water apropos of 'outside the dikes' – 'on the dikes' – 'inside the dikes'.

N



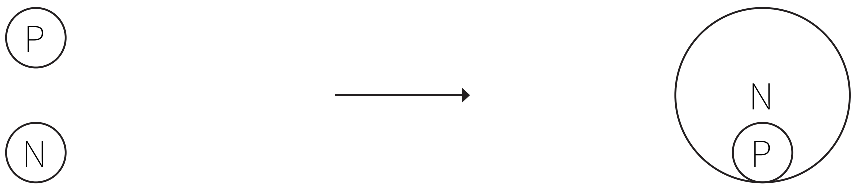
Manifesting the landscape identity of the amphibious Dutch. After looking back, looking down and looking ahead, steps can be taken towards a new ‘self’ in the Dutch delta territory.

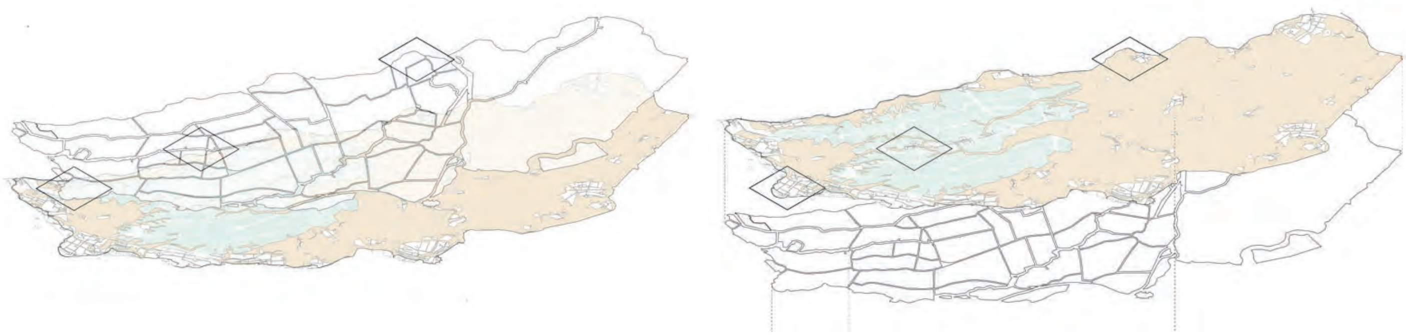
A territory historically and inherently transitioning under natural [climatic] and human [urbanization] pressures. Currently evolving from rigid enclosure

scale 1: x 000

5

RESEARCH BY DESIGN





Introduction

This chapter is an application of the method aimed at reconciliation of the human and natural systems in regards to flood safety through the concepts of Building with Nature and Landscape Identity. The method is applied on the Alblasserwaard and Vijfheerenlanden region, also known as dike ring number 16, an area within the Rhine Meuse Estuary, with the highest flood risk in the Netherlands.

Through research by design, the method is tested and opportunities of reconciliation of the human and natural system, in regards to flood safety are revealed. Through an iterative process, implications of the regional systemic transition on the local and individual, and vice versa become apparent.

The land use practices of the Alblasserwaard, mainly livestock farming, are currently shaping the landscape character of the Alblasserwaard. They represent a large part of the economic value but they also largely result in polluted soil, air and water. The fully controlled hydrologic system is also strongly determining the landscape character.

The assumed landscape identity connected to this landscape character reveals an imbalanced relation between people and nature. For economic gain and safety of settlement, the landscape has been altered drastically, resulting in a weakening and often stand still of natural dynamics, and subsequently, a degradation of environments and biodiversity.

In the case of the Alblasserwaard, two main Building with Nature concepts seem suitable for achieving flood safety while remediating polluted environments [grounds / water / air] and increasing biodiversity. They are the restoration of peat grounds and optimization of the coastal and riverine sediment flows. These flood safety solutions are less focused on probability reduction but focused on reducing the consequences of a flooding when and if it occurs. Simply put, the solutions are about elevating subsided grounds and adopting circular, seasonal and dynamic patterns of production and settlement. A long term, phased, transition is proposed to shift from a probability reduction approach to the consequences reduction approach to flood safety.

Defining scales and domains of intervention

Compartment landscape

Through land reclamation practices and rebuilding dikes after floodings, the landscape has been compartmentalized. Former dikes, transportation- and hydrological infrastructures form the boundaries of these compartments. On the outer edge, the national, primary levee structure encloses the inner dike area and separates it from the riverine hydrology.

What becomes evident is that land use practices, firstly of peat extraction and later on of cattle farming, have been the core drivers of landscape transformations on the regional scale. In order to safeguard thes land use practices, a complete control of the hydrologic system was necessary. Subsequently, settlement patterns followed the hydrologic / transport structure and also completely rely on the performance of these flood safety and hydrologic systems.

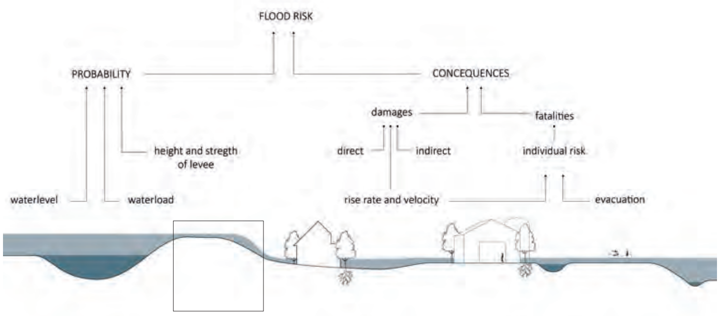
This compartmentalization is the spatial outcome of an trhopological control of the riverine dynamics. It shows the outcome of a societal transition from a place of vulnerabiltiy to a society of risk. Building dikes to protect against the water and reduce floodings to 0.

From the characteristic, physical landscape elements on the regional scale, the following assumption is made on the landscape identity of the Alblasserwaard. and the relationhsip between human an nature that is derived from it. It is of tof the dike ring, the boezems and polders. polder regional landscape of the alblasserwaard.

It is a relationship of anthropolocial control over the biophysical environment. The physical elements of landscape, the riverbed, dike ring, boezem and polder, all represent a human control of the hydrologic system, which subsequently determines the Flora & Fauna, Land Form and Land Cover. Consequently this control and order can be perceived through the straight lines in the landscape.

The landscape identity of the human, identity that comes forth from the connection to landscape, is that of the ability to provide safety through manipulation of the landscape. Trust in technology.

Besides the compartmentalizations, three different landscape characters can be defined. The riverine, The Urban riverine and the Rural [peat pasture].



National Flood Safety system of Dike Rings

Alblasserwaard

Figure X: Outset of the research by design scales

From rigid to dynamic

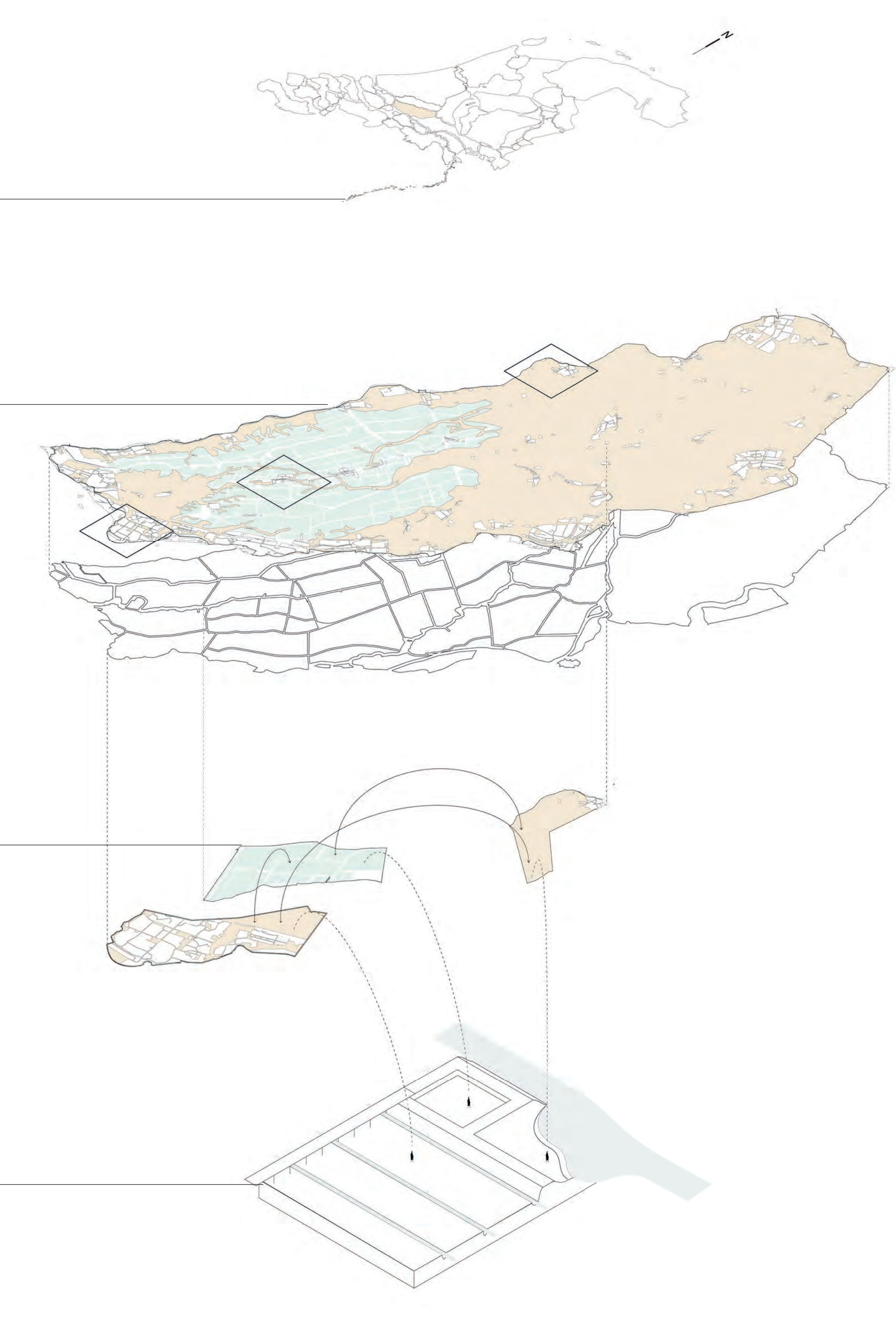
Image: Heijnen, 2021

Landscape Character

Compartiment [Edges]

0 km

5 km



Dominant domains of water, air, soil and people

Riverine

Three Landscape Characters

Three landscape characters can be defined in the Alblasserwaard based on the Landscape Character assessment model.

The domains of soils, air and climate, geology, land cover, hydrology, land use, settlement and enclosure, are the domains that have strongly shaped this area.

Proximity to river, land form, land use and settlement are the main shaping domains in the peat pasture landscape and define three different landscape characters within this landscape. They are the Urban Riverine, Riverine and Rural.

Rural Peat

Riverine

- Clay soil [soil]
- Low density [settlement]
- Primary system edges and nodes [hydrology]
- Cattle Farming [Land Use]

Urban Riverine

- Clay soil
- High density
- Primary system edges and nodes
- Maritime and Transshipment industry [Land Use]

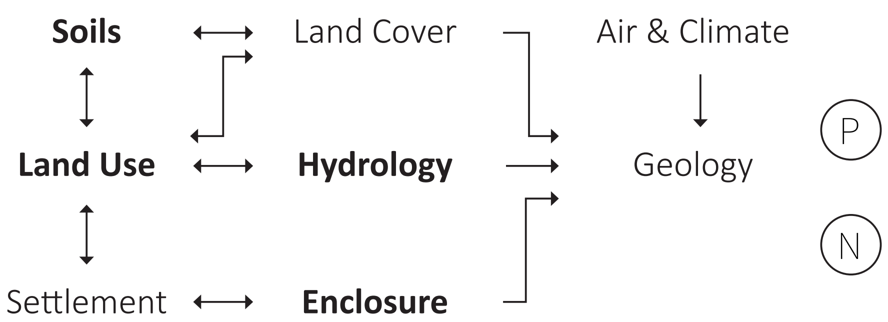
Rural

- Peat soil
- Low density
- Secundary edges and nodes
- Cattle Farming [Land Use]

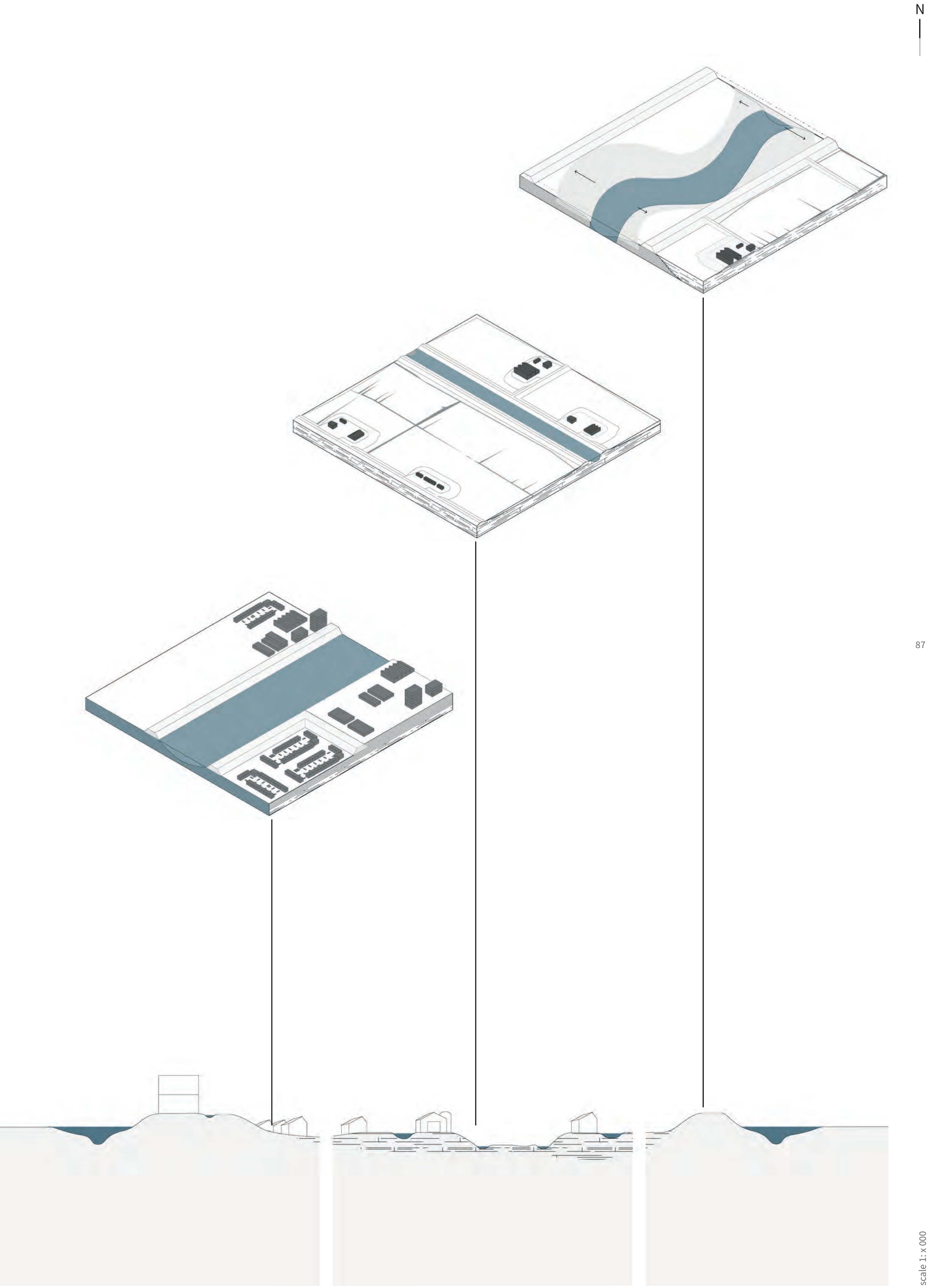
Rural Peat

Landscape Identity

The relationship between people and landscape, that is described in the previoius chapter, of human mastering nature, becomes apparent on the local scale as well. The pursuit of flood safety, preventing flooding at all cost, has manifested in the landscape. The enclosure of the urban and rural territory is defined by the hydrology, the flow of the river. However, this river flux is highly controlled and subdivided by man-made infrastructures and the 'infill' the cattle farming and urban area are highly dependend on the performance of these infrastructures.



The different characters of the Peat pasture landscape
Image: Heijnen, 2021



scale 1: x 000

Domains of action and perception

Domain relations
Land use domain is most dominant.

Rural
Rural peat pasture landscape

Landscape Identity
The relationship between people and landscape of dominance.

Boezem

Cattle farming

Road

Elevated grounds

0 m 20 m

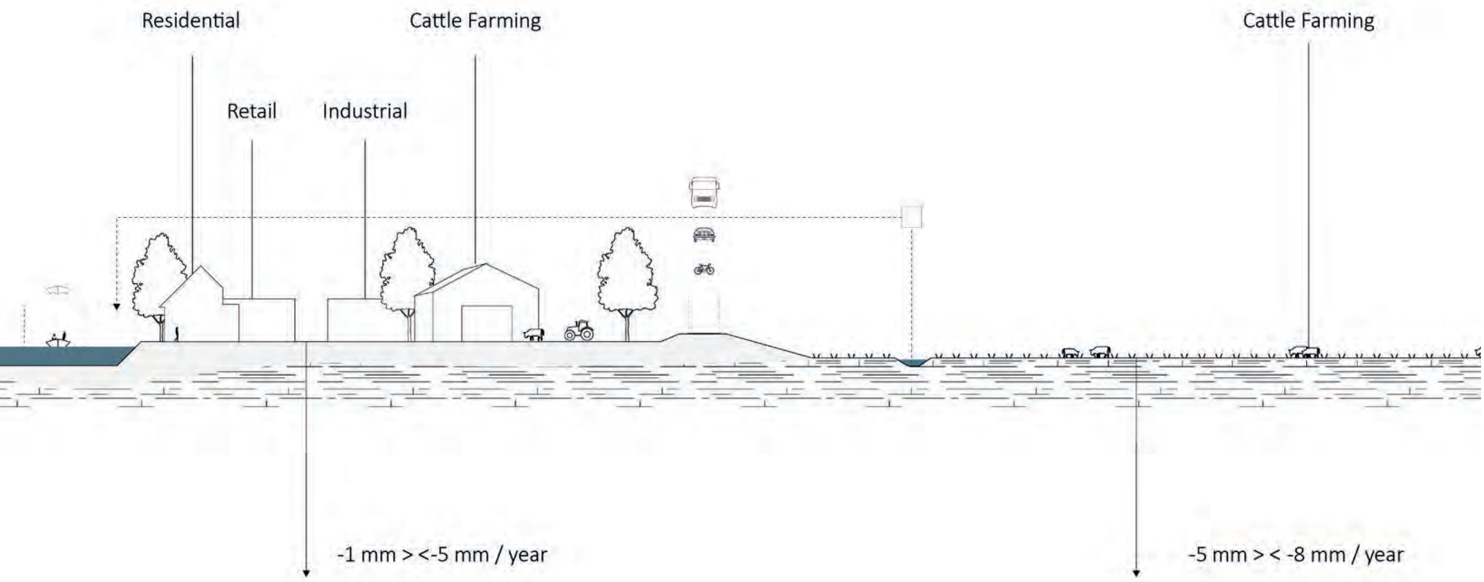
0 m 10 m

Cattel Farming

Peat soil

Urban river edge
Hydrolic system in case of breach of primary levee system due to pressures of river or sea flooding.
Source: Heijnen, 2021


N


Residential
Cattle Farming
Retail
Industrial
Cattle Farming
-1 mm > <-5 mm / year
-5 mm > < -8 mm / year

scale 1: x 000

Domains of action and perception

Domain relations
Land use domain is most dominant.

Landscape Identity
The relationship between people and landscape of dominance however with a larger dependence on the domains of air and climate because they determine water levels.

Urban river edge
Hydrolic system in case of breach of primary levee system due to pressures of river or sea flooding.
Source: Heijnen, 2021

Boezem

Cattle farming

Road

Elevated grounds

0 m 20 m

0 m 10 m

Urban river edge
Hydrolic system in case of breach of primary levee system due to pressures of river or sea flooding.
Source: Heijnen, 2021

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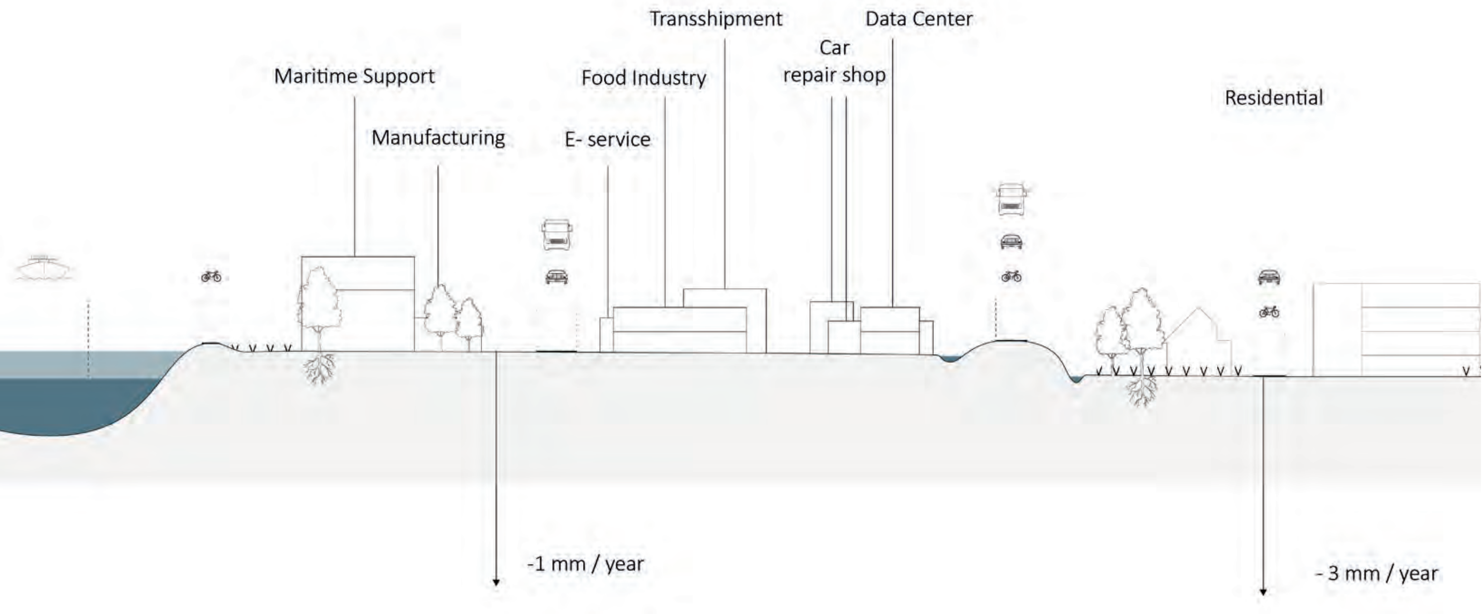

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Habitat [in] dependent on water

[In]dependency
On the dike system, the systems provides safety for land use and settlement making them independend from hydrologic or air dynamics. With this independency from the sea comes a dependency on the levee and pumping system.

Fragmentation
Fragmentation and segregation of water, ecologic networks.

Different temporal scales
Alteration of domains

Invisible system
Some elements of this system are regarded as Heritage and some are hidden in the landscape. Artefacts of mastery over nature are hidden in the landscape. They must be revealed to alter the relationship between people and nature.

P

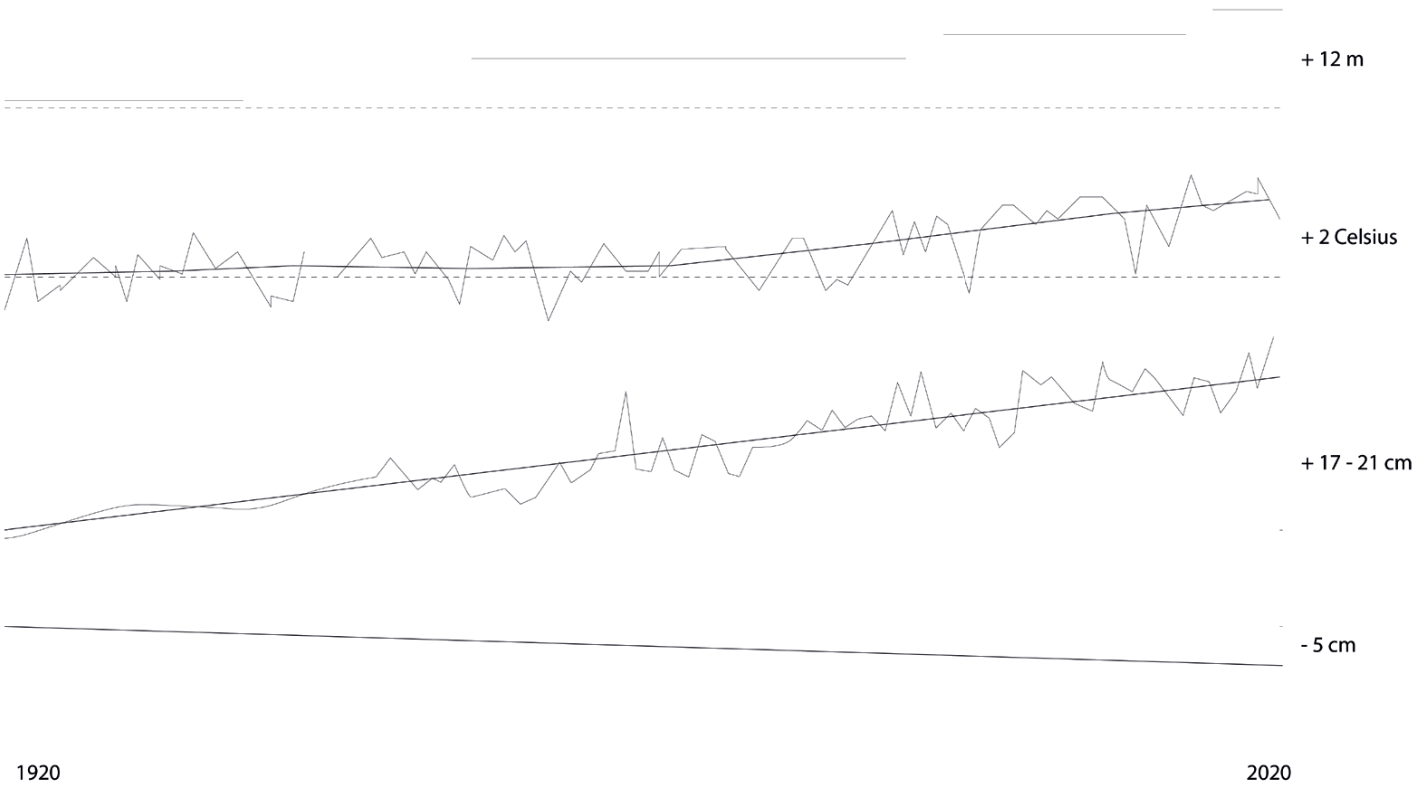
N

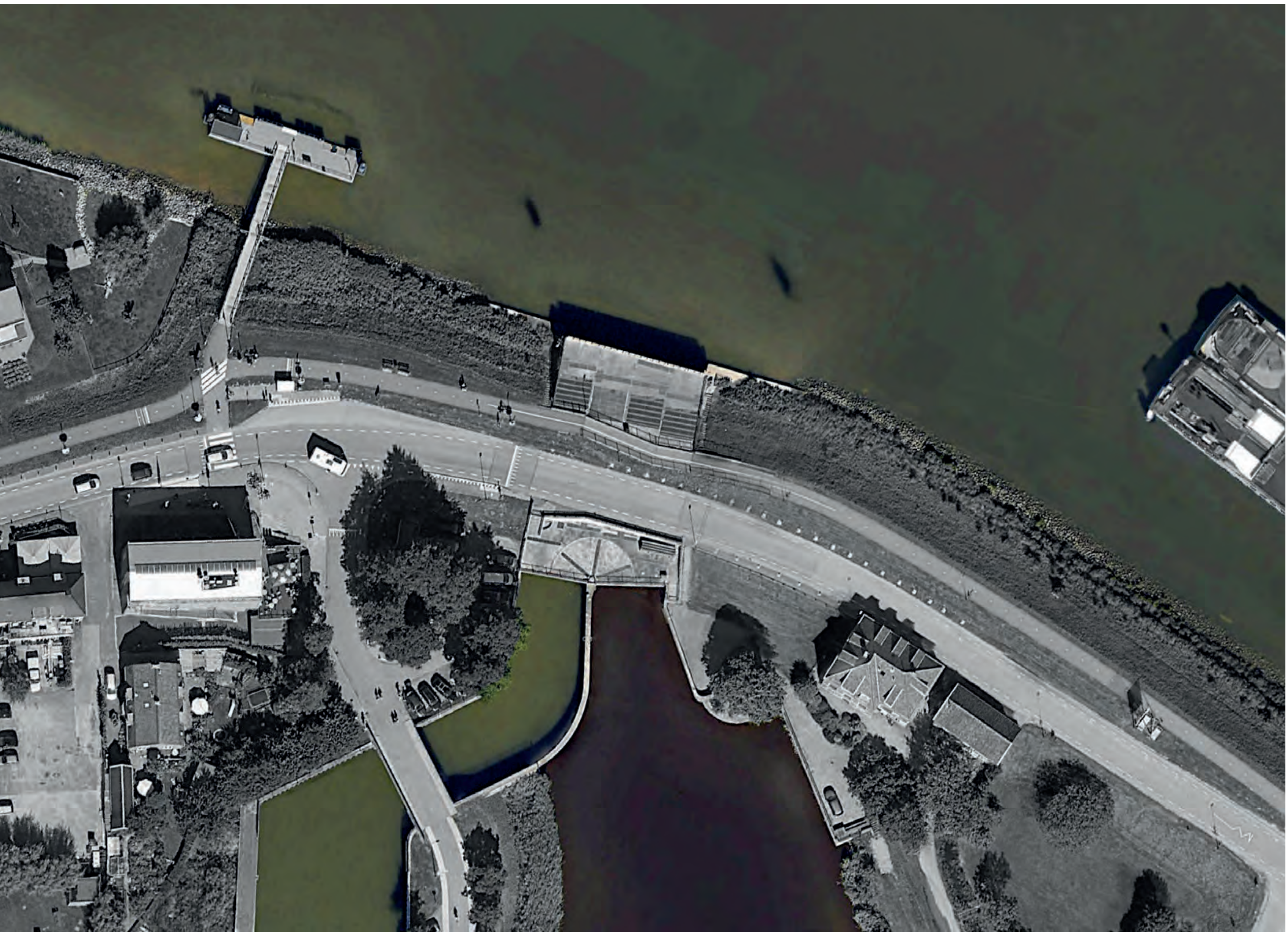
People
Adaptation
Levee safety standard

Air
Average temperature

Water
Sea Level Rise

Soil
Tectonic movement


+ 12 m
+ 2 Celsius
+ 17 - 21 cm
- 5 cm
1920
2020



BUILDING WITH NATURE

INTRODUCTION

Introduction

This chapter is a research by design application of the concepts and approach of Building with Nature.

The research by design aims at answering the research subquestion

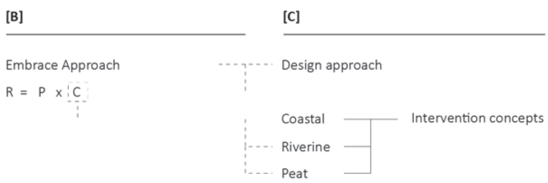
- What are the potentials and restrictions in the application of a Building with Nature approach to the landscape identities that exist in the Alblasserwaard?

- What are the [spatial] implications of applying a Building with nature approach to the development of flood safety in the Alblasserwaard?

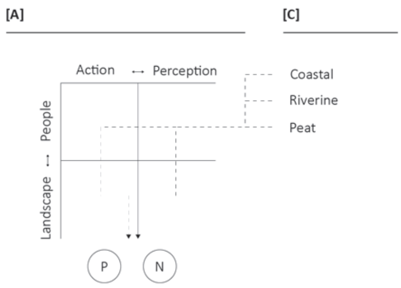
First the suitable Building with Nature concepts that are applicable in the Alblasserwaard are explained. Subsequently their applicability and effect is tested through desinging throughout different scales.

N

[BC] Flood safety and building with nature



[AC] Landscape Identity and Building with Nature



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Building with Nature
for flood safety and the reconciliation of the anthropogenic and natural systems

Systemic transition

The building with nature solutions, when applied in a systemic manner, are able to transition the landscape characters of the Alblasserwaard. This transition will result in more equal relationships between the domains where there are no one predominantly shaping domains. The adress the perceived dilemma between flood safety and resilience and biodiversity.

A long term, phased, transition is proposed to shift from a probability reduction approach to the consequences reduction approach to flood safety. This systemic transition is presented in three phases.

The first phase is about remediating damaged ecosystems and laying the framework and base for building with nature solutions to flood safety, settlement and land use practices. The second phase is about establishing and strengthening the new system components and learning of actors and agents to adjust to and exist in a dynamic system. The third phase is about living with nature and assessing and defining the reconciliation of the human as part of the natural system. The three phases are represented in figure X.

The three phases can be seen as a circular loop of resilience. After the third phase, a systemic assessment through the method can be applied and reveal new intervention opportunities.

Schem relteren n gp en probleemstelling, verdichten beneden eeniveu moet op een meer ecologiche en resilient mnier, dit is een uitwerking vn de embrce pproch

Method

- Define spatial and systemic scales / territories

In this thesis the scales are: the Rhine river basin, the Dutch Flood safety system, The Alblasserwaard / Vijfheerenlanden Dike Ring #16, the three landscape characters , the systemic components, and the individual.

- Mapping Landscape character elements in relation to flood safety
    - Flood Risk Mapping
    - Flood Vulnerability Mapping
    - Flood safety system externalities Mapping
    - Flood safety potentialities Mapping [Building with Nature]

As it were, a spatial SWOT analysis of the landscape character in relation to flood safety.

- Make assumptions about the positioning of the relationship between People and Nature based on the landscape identity framework.

The mutual relationship between people and landscape revealed through the shaping forces of the landscape. How do they represent the relationship between people and nature?

- Specify and elaborate on the building with nature solutions fitting within the landscape character. Assessed on their ability to mitigate and adapt to climate change.

- Test for implementation ability and temporal framework. Subsequently, contemplate and compare the proposed interventions to the current assumed landscape identity, in order to predict obstacles and opportunities in agency.

Scales

The dike ring of the Alblasserwaard is one of the components of the Dutch flood safety system and at the highest risk of flooding [1 in 100 years], and is at risk of coastal, pluvial and fluvial flooding.

It is taken as a testing location for the proposed flood safety transition. Firstly, it serves as the location for application of the identifying pplication of the landscape identity method

The following scales are regarded during the research:

- The dike ring scale
- The Landscape character scale
- The local compartiments scale
- The Landscape Identity scale

Furthermore, the temporal scale is very important.

Compartmentalization

The compartments shaped by the hydrological and mobility infrastructures shape the framework for development of the area. The infrastructures form natural barriers against flooding and allow a certain amount of 'micro' climate control, that allow the start of the building with nature processes.

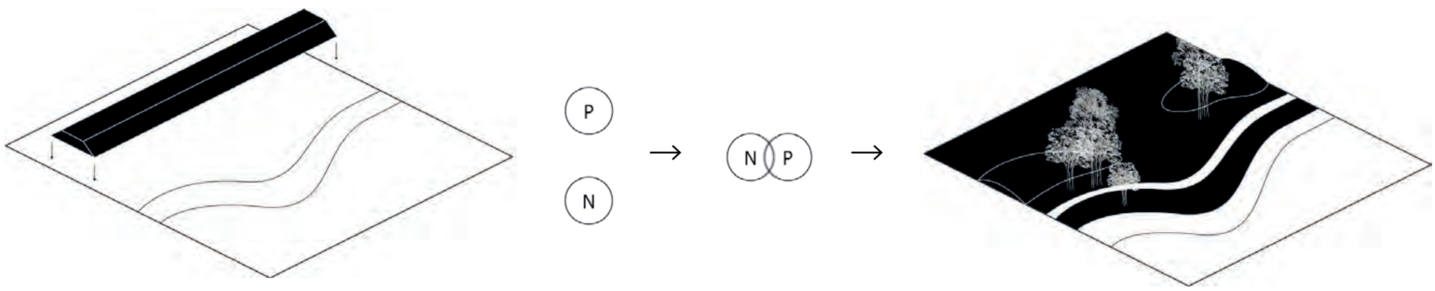
Afwatering...

This compartimentalization can be taken as the framework for reconciling the societal and biophysical systems related to flood safety.

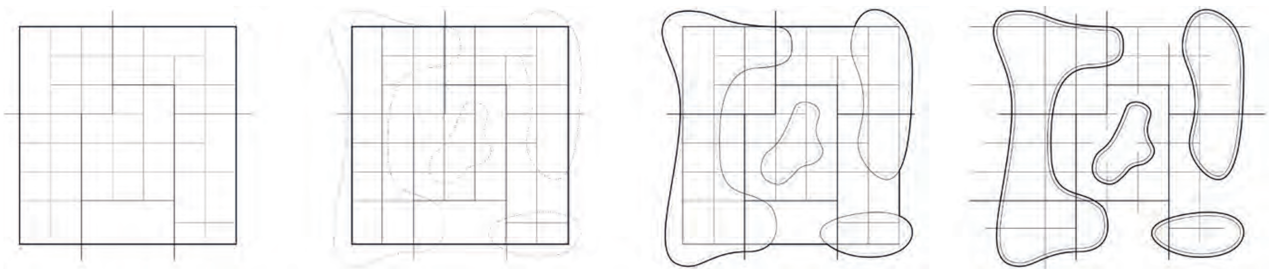
Taylor made [Building with Nature] solutions
From a one size fits all to taylor made solutions fitting the landscape
Image: Heijnen, 2021

Systemic Transition of the Dike ring system
From rigid probability reduction to dynamic flood resilienc and biodiversity
Image: Heijnen, 2021

Building with Nature



Human - Nature relationship

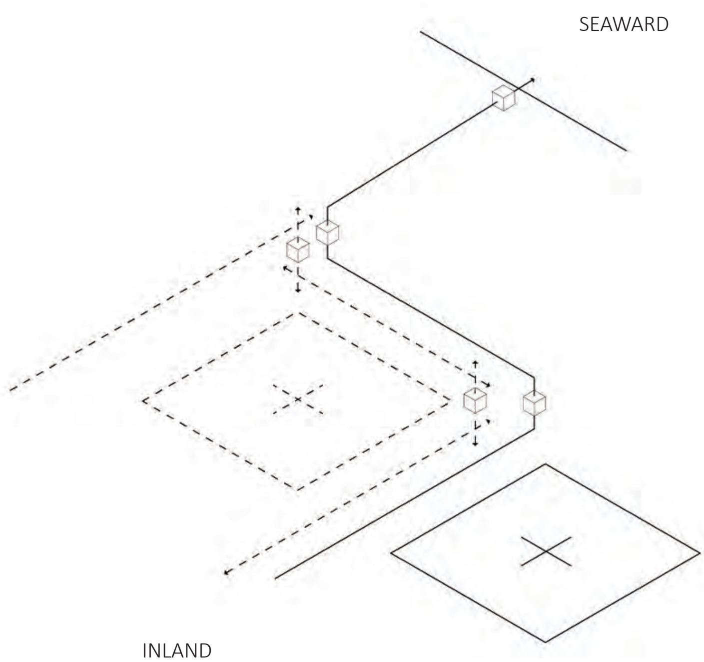


Intervening on Nodes, Edges and Infill

Systemic transition
Intervening on the nodes, edges and infill of the watersystem shaped by the flood safety approach.

This chapter eplores the applicability of BwN for towards a flood resilient and biodiverse Alblasserwaard.

Reshaping water, soil, air and people
Reshaping the most impactful domains of the landscape, adressing the action and perception spheres of landscape identity. Through networks and nodes for transitioning flood safety.



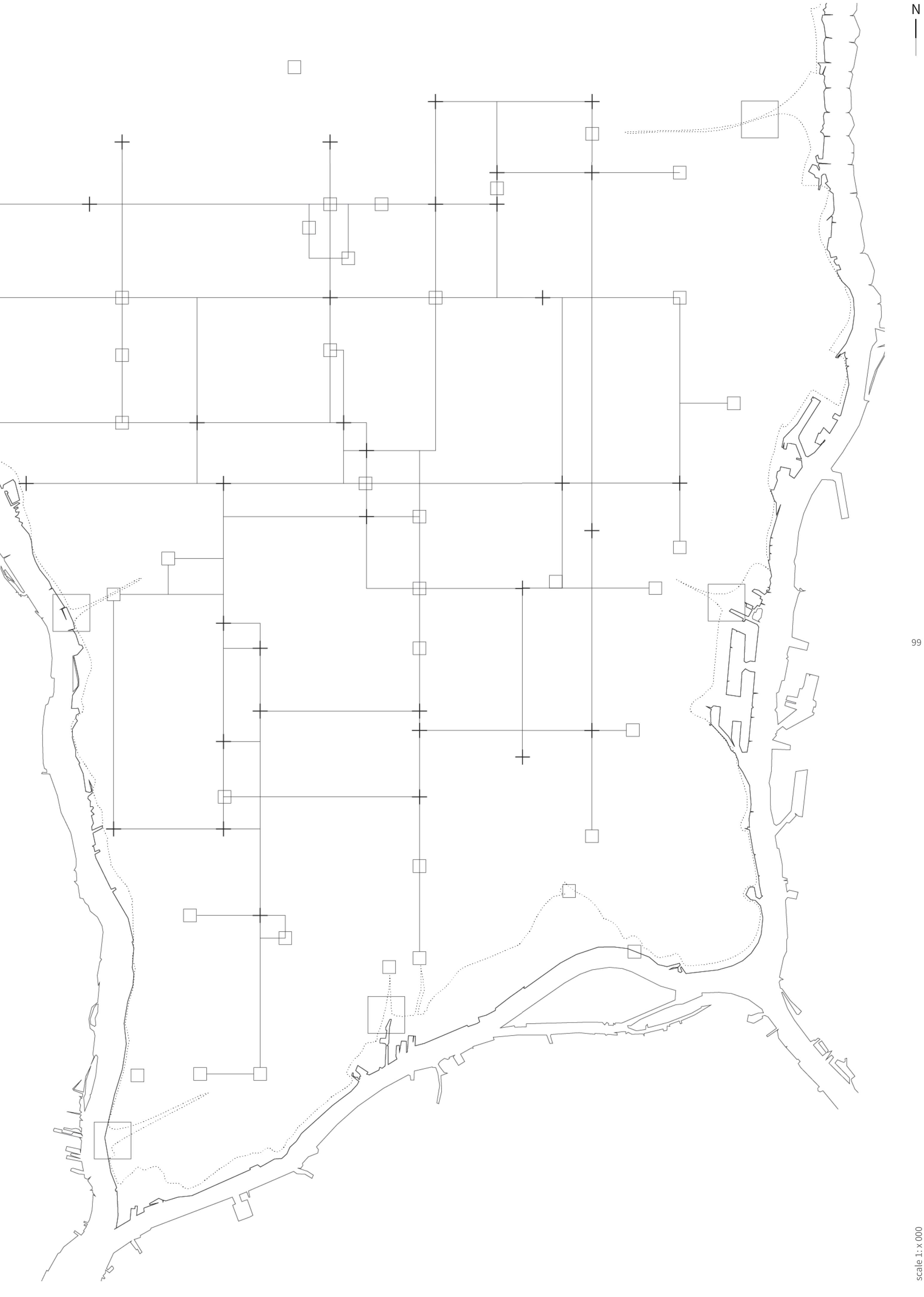
Edge

Node

Infill

0 km

15 km



scale 1: x 000

Flood safety through building with nature

Domain relations

TOgether, in a systemic manner the buidlign with nature solutions can provide flood safety less focused on eliminating the probability of flooding but focusing on resilience to the consequences of flooding.

Phasing / sequencing

Edges and Infill

The BwN solutions focus on the edges and infill of the water system, not on the nodes. This is where design can play a role.

Building with Nature concepts

This is an verview of all Building with Nature concepts applicable in the landscape characters of the Alblasserwaard.

Double Dikes

ALteration of aquaculture, paludiculture and sediment extraction. Buffers drought and wet periods and utilizes this riverine / coastal dynamic.

Bypass

pressure relief in high fluvial peaks

Tidal Park

Buffer capacity increase of riverine edges

Phytoremediation

Increase in biodiversity and quality of water and soil.

Paludiculture

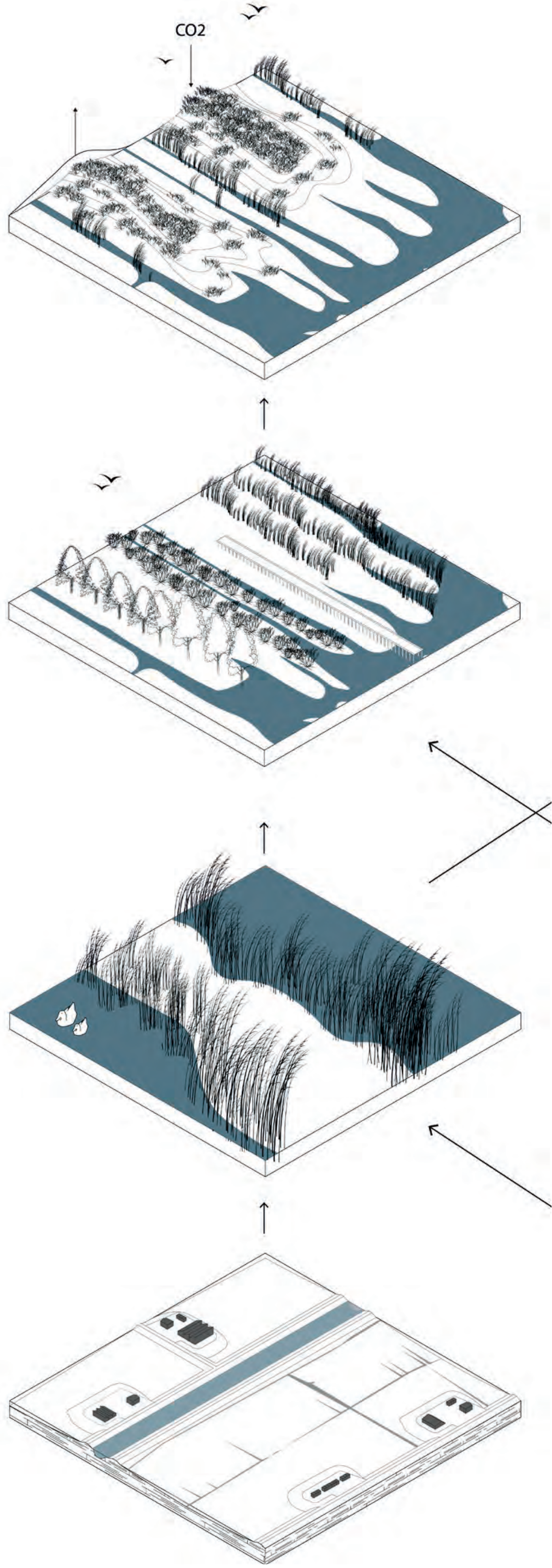
Wet agriculture of crops and building material that can sustain high and fluctuating ground and surface water levels.

Aquaculture

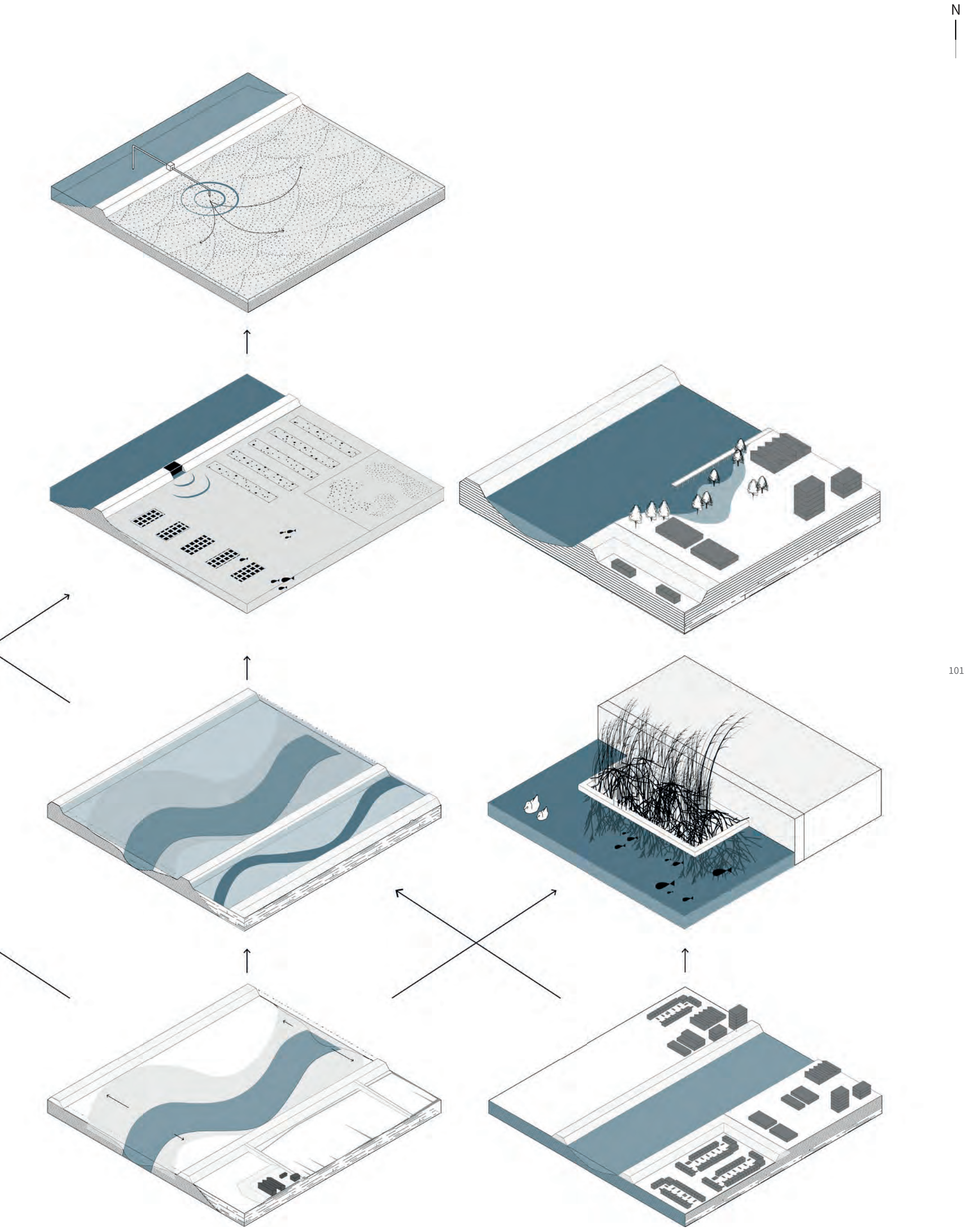
A double dike with floodable area inbetween where aquaculture and fishing can take place.

Peat Bog

Planting sphagnum to promote peat bog formation. Able to absorb large amounts of rain water and CO2, increasing soil levels with 1-2 mm per year.



Rural [Peat]



Riverine [clay]

Urban riverine [clay]

scale 1: x 000

Flood safety through building with nature

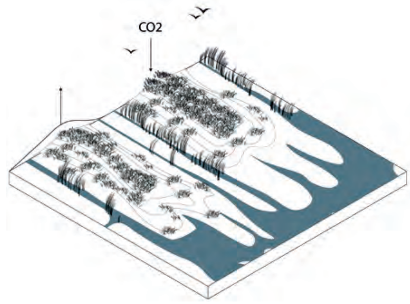
Peat Bog Formation

The motivation for implementing a peat growing system at the center, the lowest point of the Alblasserwaard, is threefold. Firstly, sphagnum vegetation can capture 3 to 4 tons of CO_2 per hectare per year. Through transforming former livestock pastures to peat growing compartments, air pollution is reversed compared to the emission of 25 tons of CO_2 per hectare per year as a result of the former land use. Secondly, on the long term, it reverses the process of subsidence. From ground levels going down 5 to 8 mm per year, laagveen can grow 1-2 mm per year (van de Riet et al., 2018). And thirdly, a functioning peat growing system has a large water buffering capacity. Because it provides a wet environment in periods of drought, it increases biodiversity (Bijlsma et al., 2011). Especially when replacing livestock pasture grounds, biodiversity increases a lot.

Peat growing

Design / Conditions: In order for the low peat layer to grow, it is required for groundwater levels to be up to ground level. Water quality of the ground water needs to be up to standard, surface water does not suffice for supplying water. The waterquality of the Alblasserwaard is below standard and remediation through vegetation to remove Nitrogen and Phosphate necessary (Waterschap Rivierenland, 2010). This can be done with the growing of Lisdodde and Riet, they bring down the nutrient value in the water and soil (Reuler, 2009). Peat growing depends on rainwater, therefor buffer basins need to be realized. Furthermore, a so called Lagg or buffer zone.

Implementation Potential: Rainwater catchment from the surrounding urban areas. A peat growing system builds and maintains its own soil and hydrological system (VBNE, 2017). A self sustaining peat growing system requires to exist within a meso scale peat landscape that allows for a different types of peat bogs to grow within a peat system of low peat (Wheeler et al., 1995). The scale of the Alblasserwaard dike ring is a very suitable environment for this.

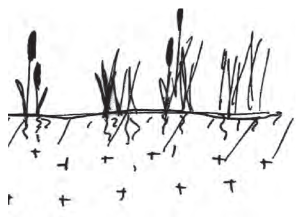


Peat Bog [Sphagnum] formation [Veenmo

Remediaton 3 - 5 years

- 30 cm water level increase / fluctuation

- Reeds and Cattail for insulation and cattle fe



Peat Growing 5 - 10 years

- 1 month innundation resilient

- reversing subsidence 1 - 2 mm per year

Sphagnum
Peat bog
Peat soil

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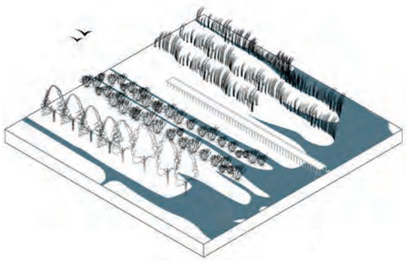


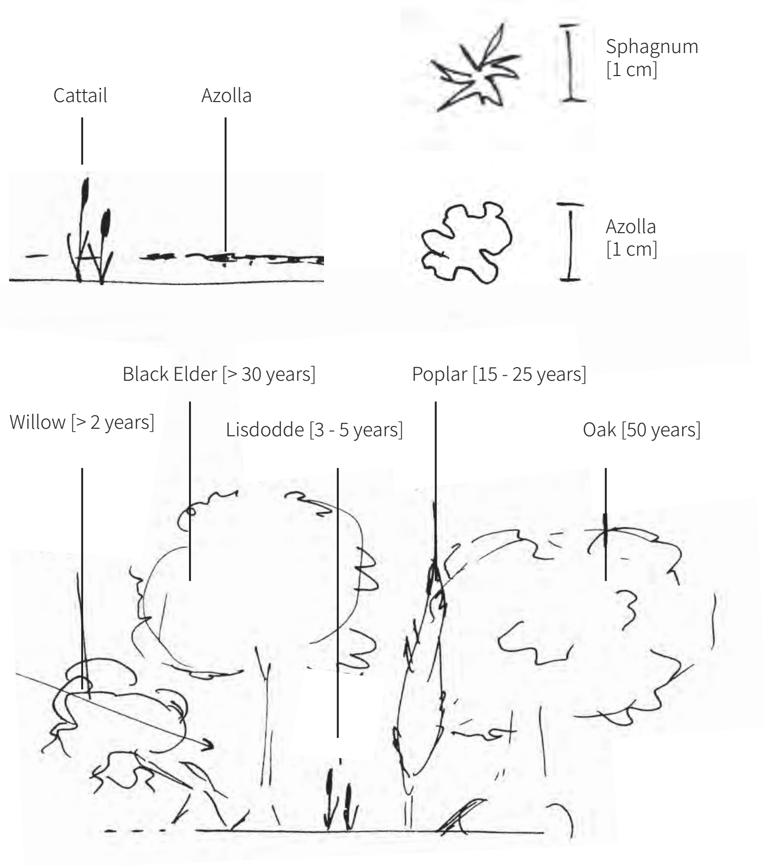
s]

Paludiculture

Crops

ed

- Cattail [insulation / cattle feed]
- Azolla [Meat substitute / cattle feed]
- Sphagnum

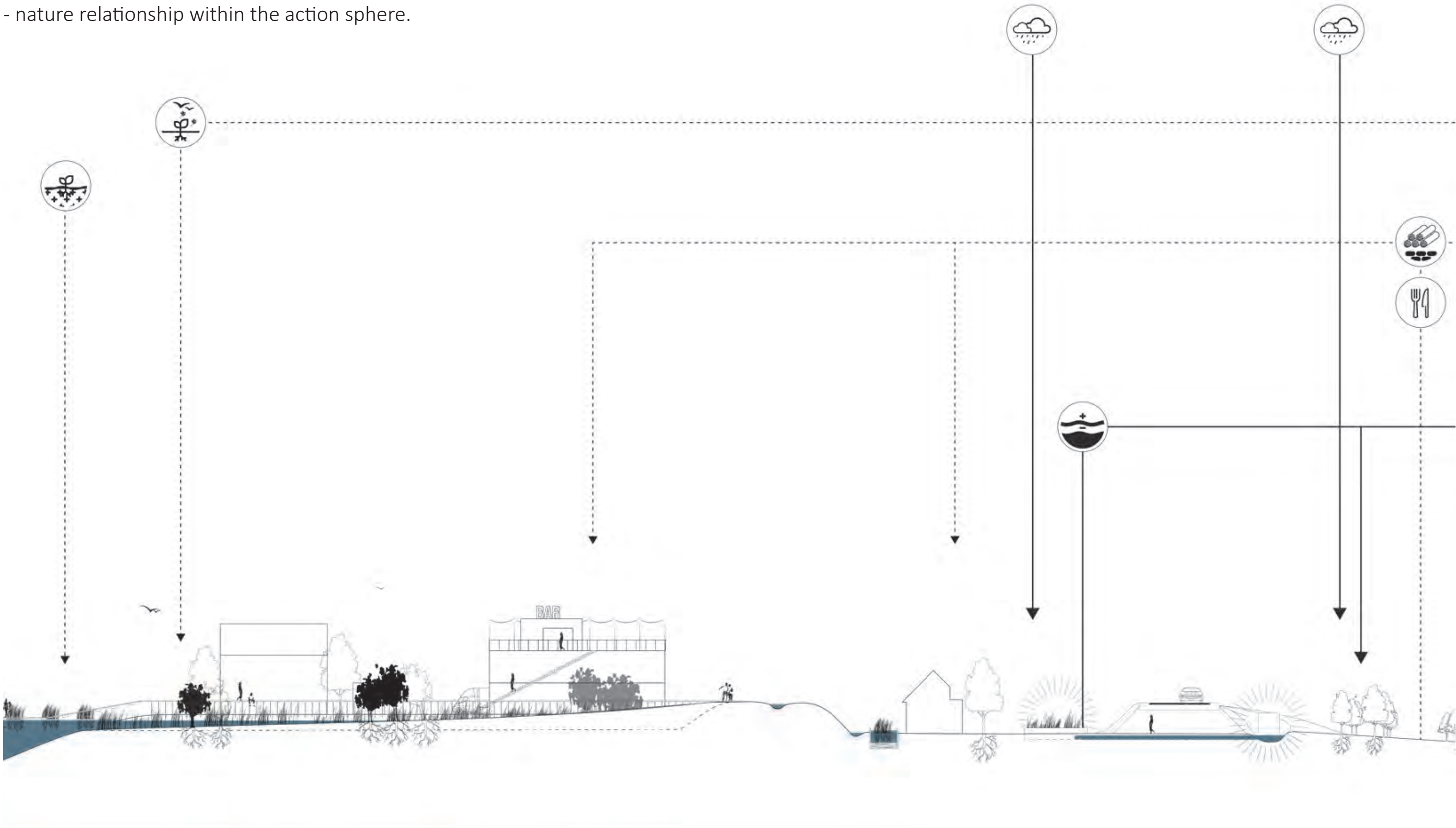


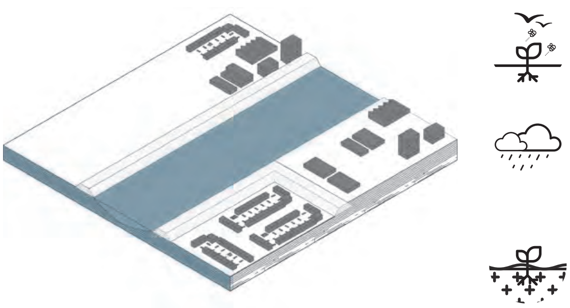
Building Material 2 - 5 years

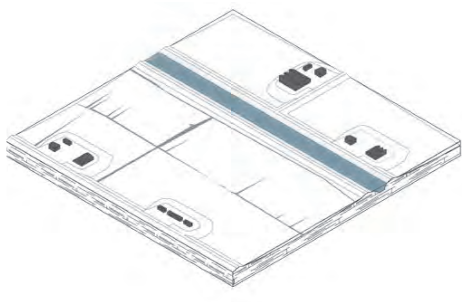
Systemic of solutions

Biodiversity and Flood resilience

Building with Nature solutions to alter the people - nature relationship within the action sphere.





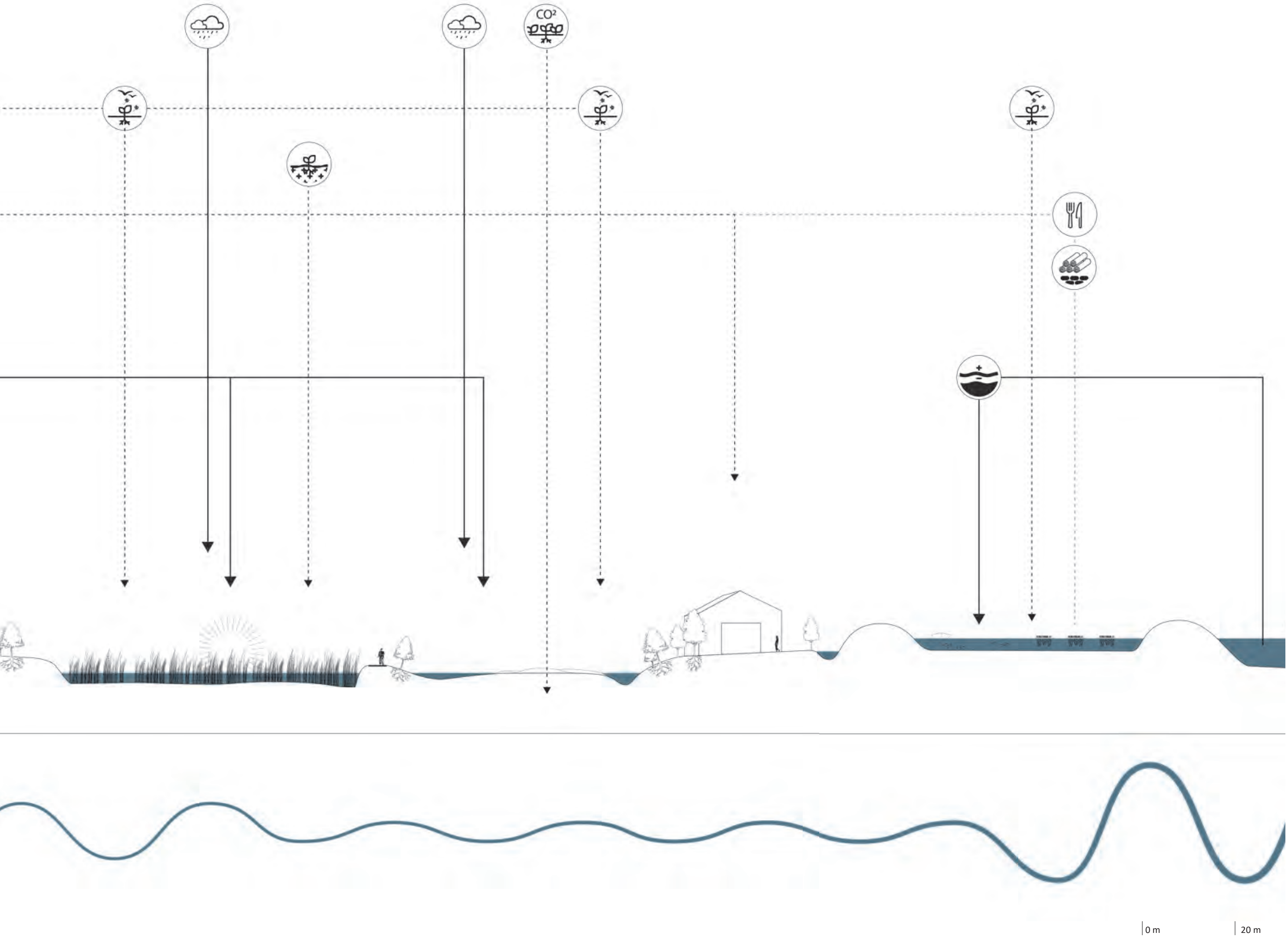


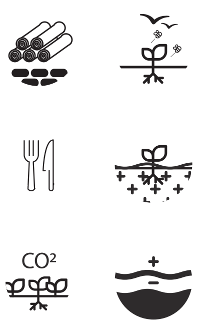
Urban riverine

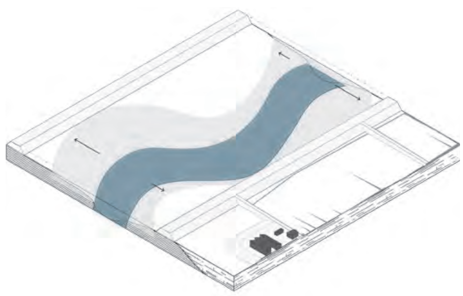
Building with Nature solutions to alter the people - nature relationship within the action sphere.

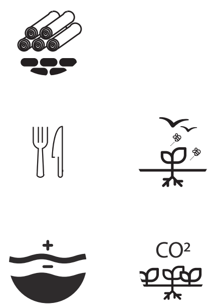
Urban riverine

Building with Nature solutions to alter the people - nature relationship within the action sphere.









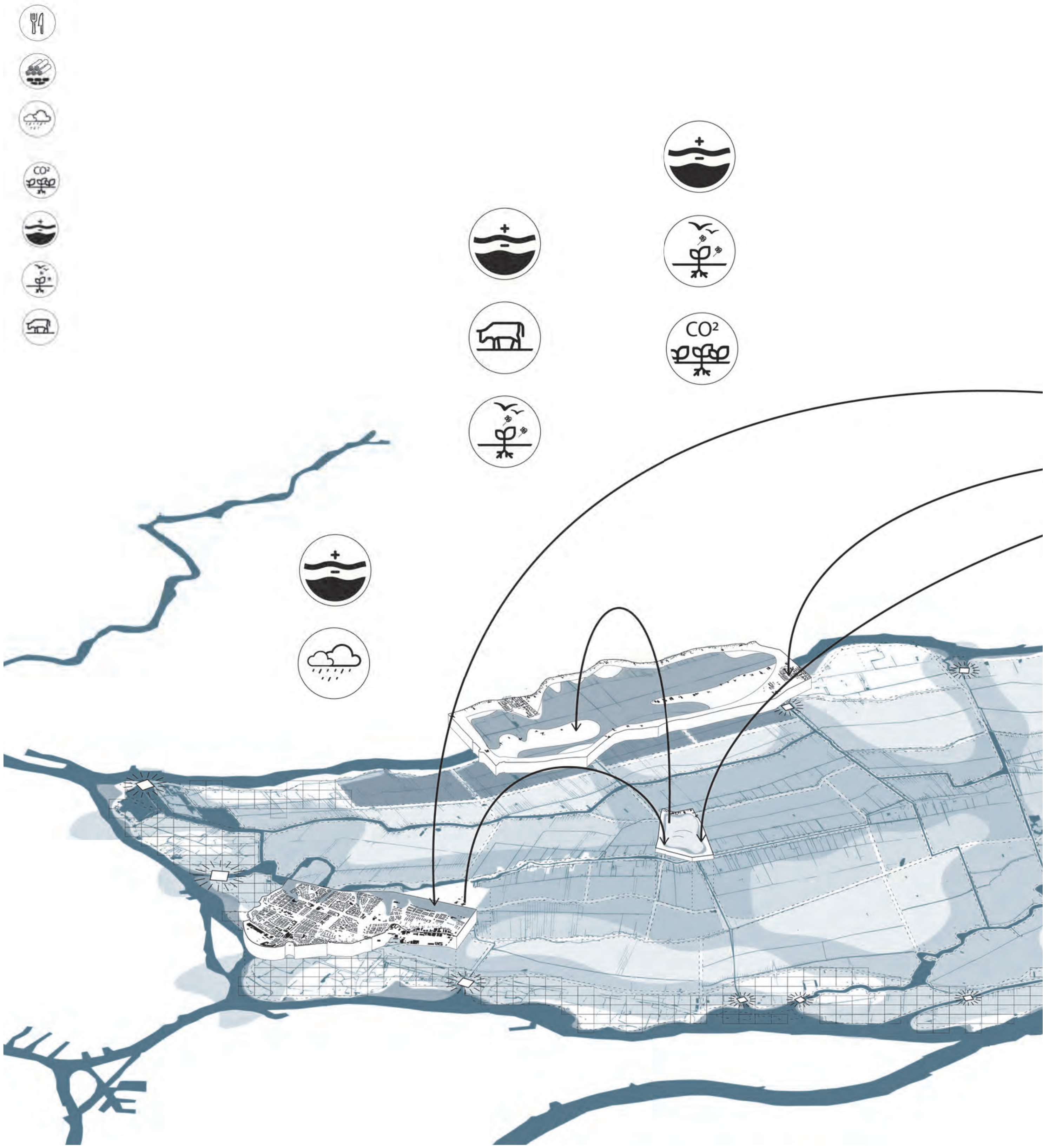
Urban riverine
Building with Nature solutions to alter the people - nature relationship within the action sphere.

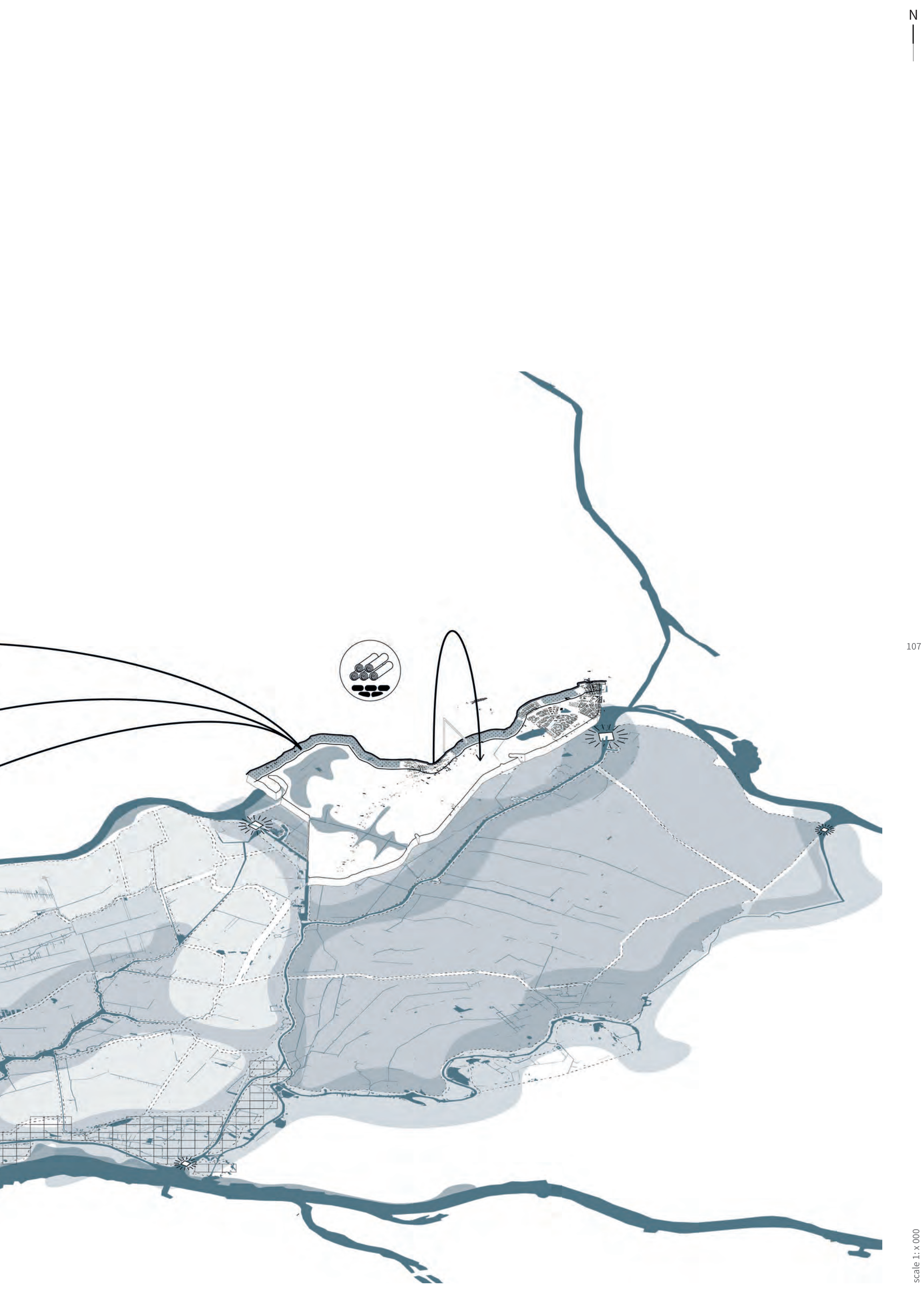
scale 1: x 000

Building with Nature
Systemic reconciliation on the regional scale

Systemic transition in flood safety

Systemic application of buidling with nature resuliting in flood resilience and stable ecological system with hydrologic dynamic system.

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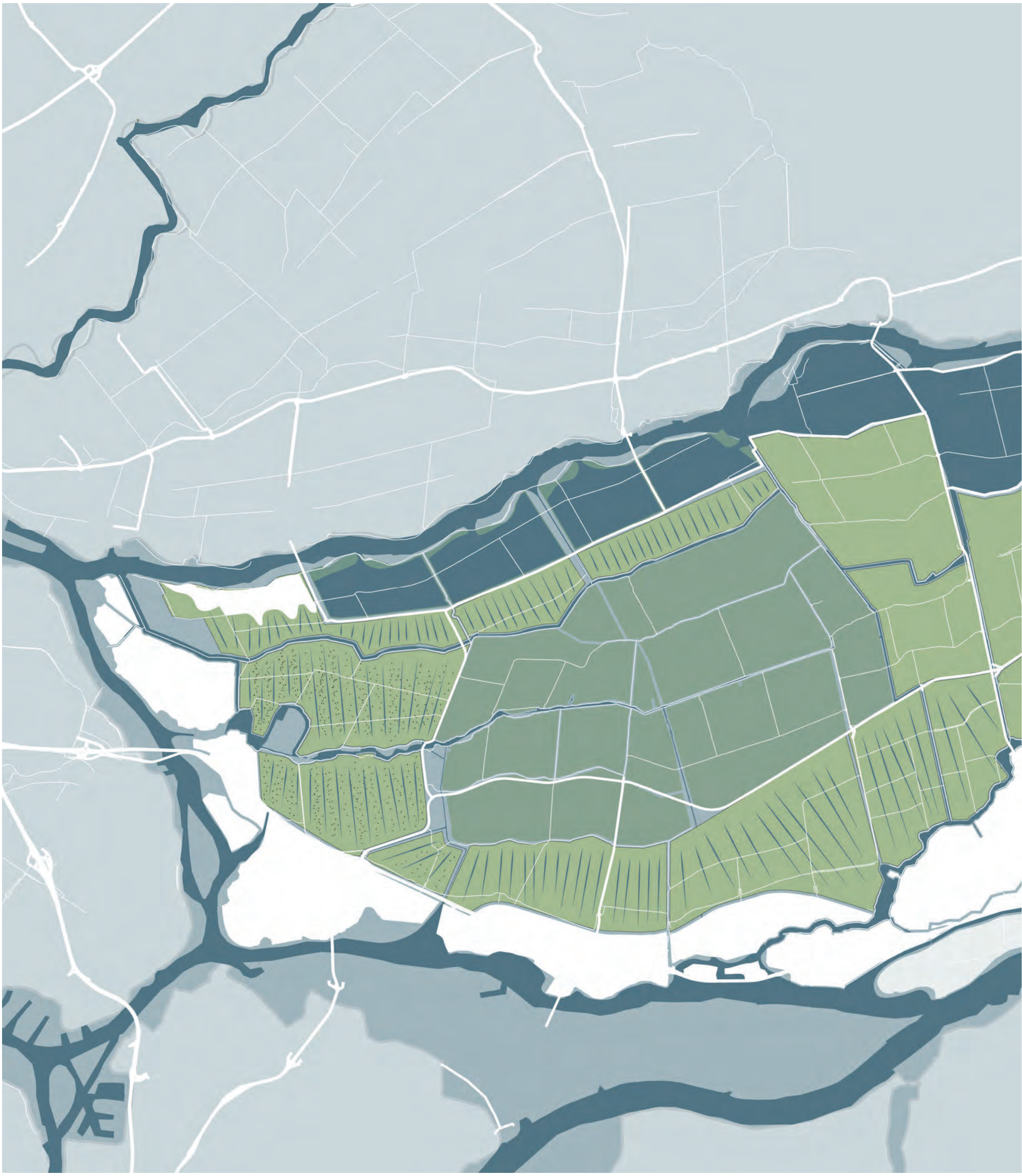
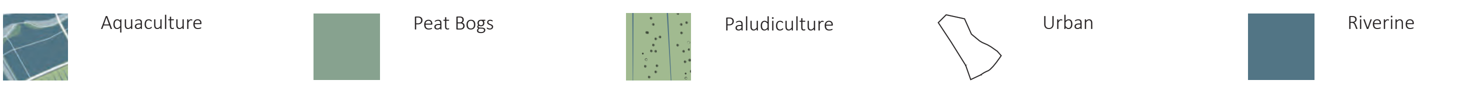
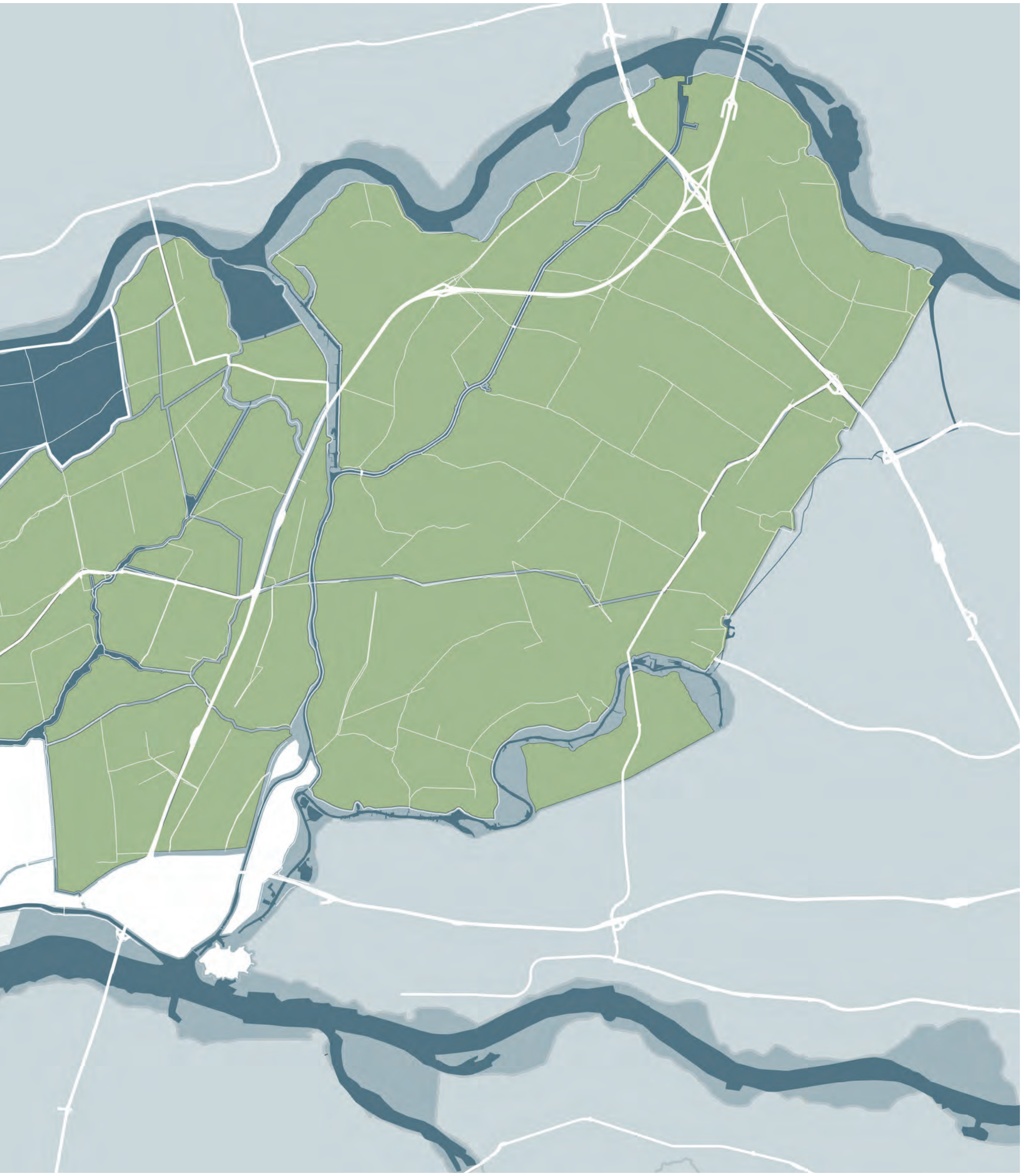
scale 1: x 000

Dynamic Land Use and Hydrology







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Land Use and Settlement patterns

Gradient of dynamics

From the river inland. Dealing with extreme peaks of coastal, fluvial and pluvial flooding.

Temporality

Seasonality: dry and wet periods, extreme peaks

Dealing with sea level rise.

Compartmentalization

The compartments shaped by the hydrological and mobility infrastructures shape the framework for development of the area. The infrastructures form natural barriers against flooding and allow a certain amount of ‘micro’ climate control, that allow the start of the building with nature processes.

Productive Peat - Rising Grounds & Bog formation

Phasing:

Remediation phase: of 4 seasons, drastically increasing water levels;

Establishing low peat: 2 years;

growing sphagnum to create raised peat bogs: rapid increase of soil height 10 years ▯ visually showing the possibility of elevating soil

Conclusion: Comparing the rate of peat growing land accumulation to predicted SLR of 1 meter it is 10 times as slow and it needs to compensate almost 2 meters in addition.

Urbanization pattern

The urbanization pattern follows the patterns of the landscape as enforced through the design framework. Two types of patterns can be distinguished. They are the inner compartment urbanization pattern and the compartment edge urbanization pattern. Both categories differ per context of compartment landscape character and function. Clay

Gradient of dynamics

From the river inland. Dealing with extreme peaks of coastal, fluvial and pluvial flooding.

Temporality

Seasonality: production alteration

Remediating practices- Building with Nature- Production landscape

P1 Remediation and Testing

Patches of experimenting with new, wet agriculture, supporting and supplementing cattle farming and supplying building material. Interventions are connected to current uses and settlement

P2 Systemic implementation

Patches are connected and the first circular connections are manifested and strengthened. Peat bog paludiculture and are now starting to

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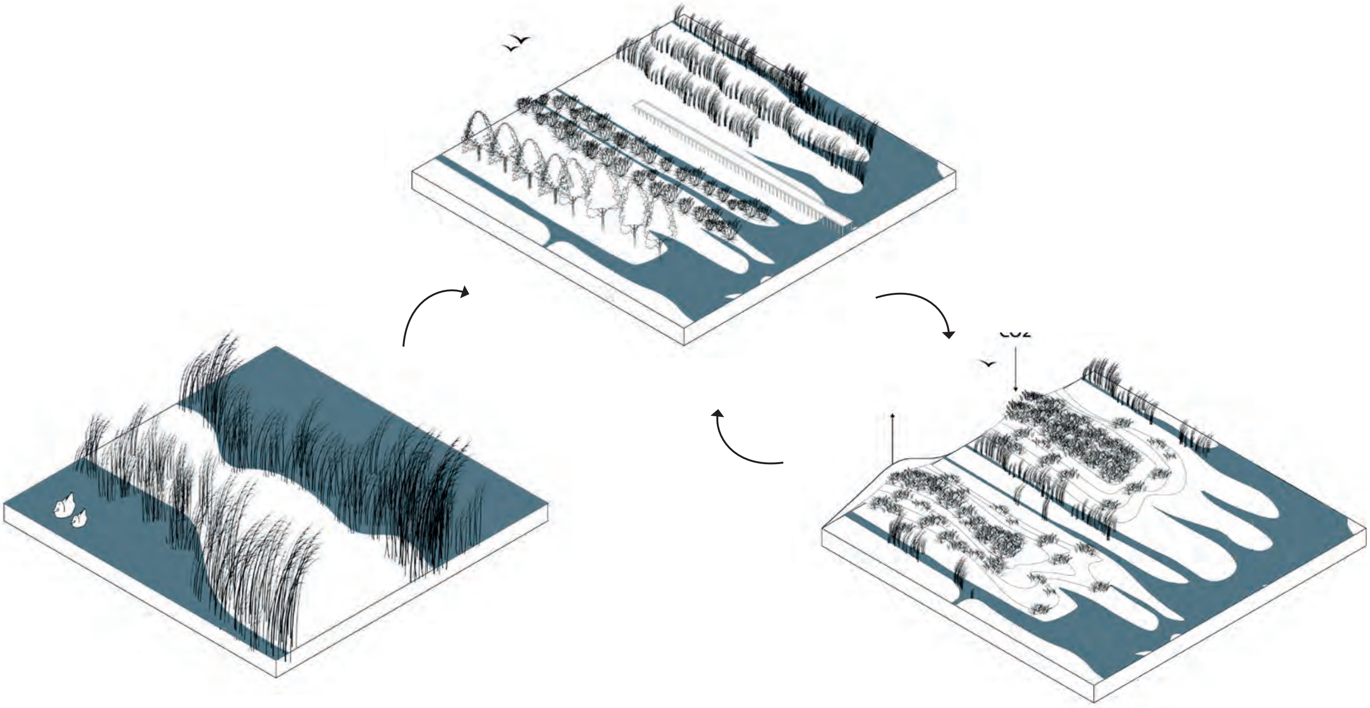

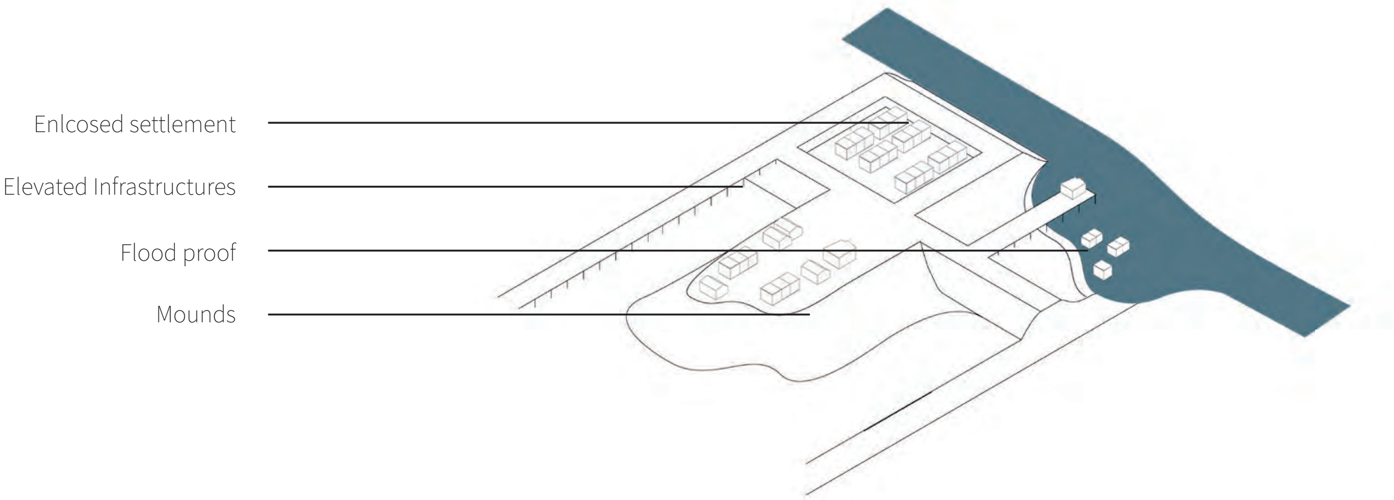
Enlcosed settlement
Elevated Infrastructures
Flood proof
Mounds

NETWORKS AND NODES

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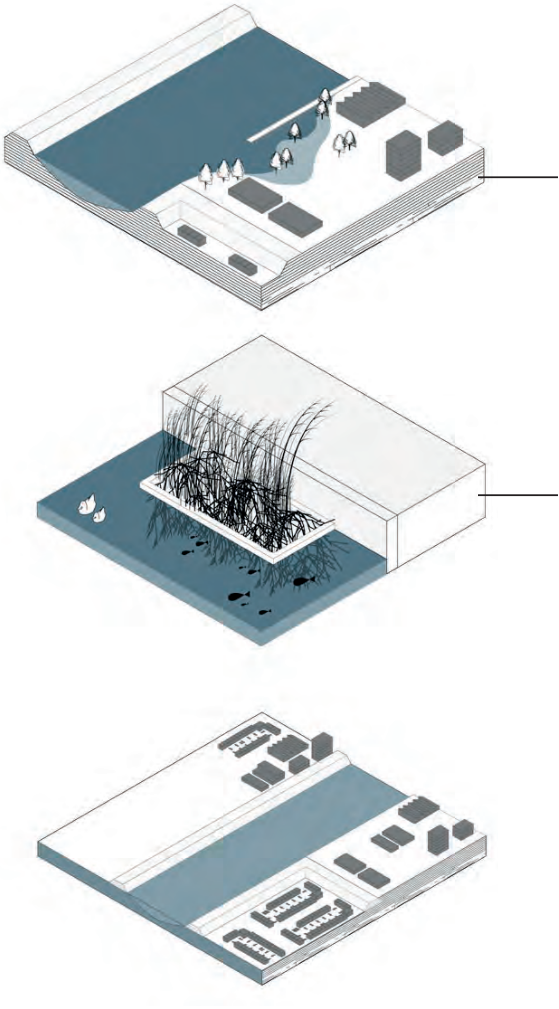
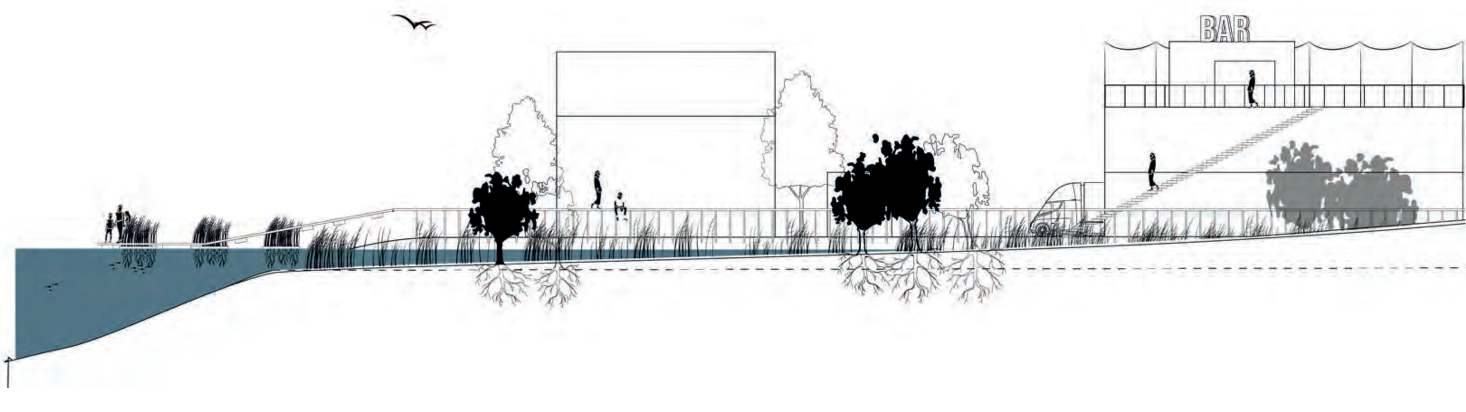
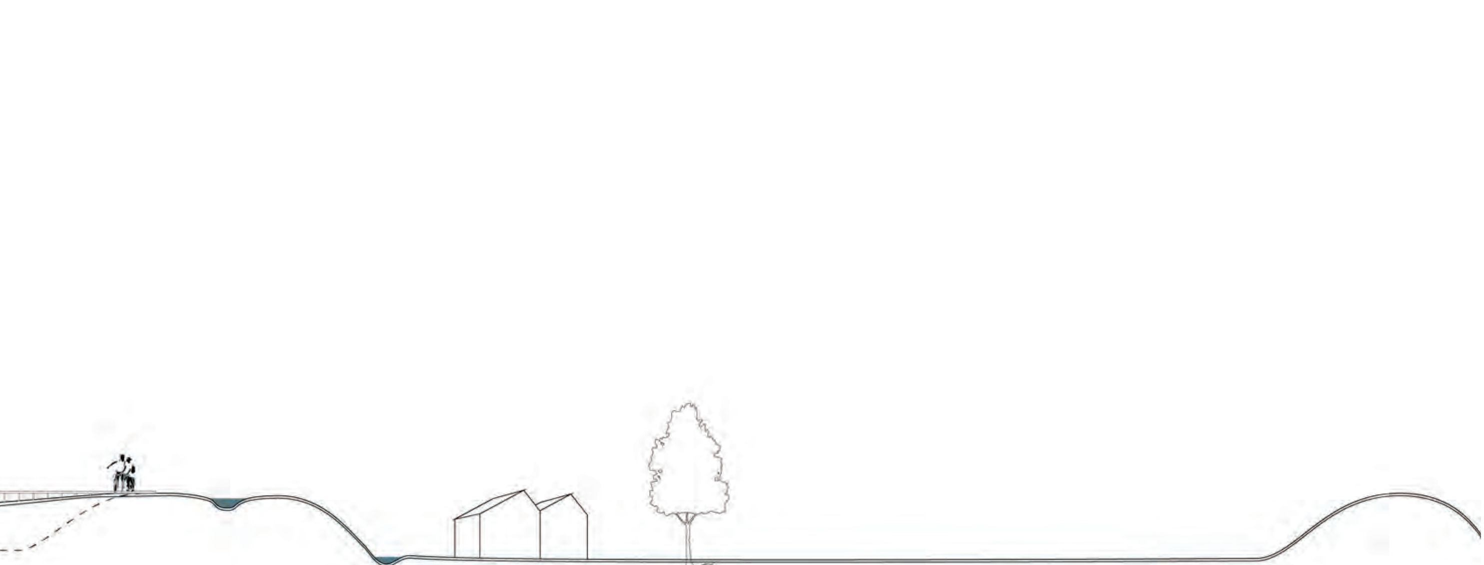
scale 1: x 000

Urban riverine

Current landform, hydrology and land form.
Image: Heijnen, 2021







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Urban riverine

Rural Veenweide design

Rural transformation

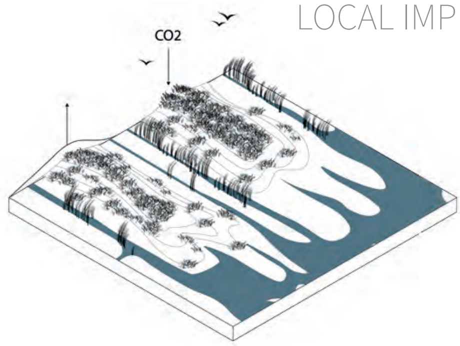
Peat pastures that are currently used for cattle farming can be transformed into soil producing peat bogs. First, phytoremediation throug Lisdodde and Reeds will clean the soil and groundwater of nutrients left of the cattle farming industry. After

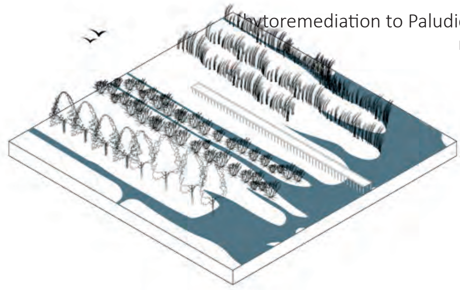
The landscape will transform from the green straight patches into an area of innundated patches that allow bird nesting. After remediation, these compartments can either become productive areas of paludiculture, where trees and crops for building material can be produced together with patches of peat adapted permaculture.

Or, the compartment can transform in a peat growing area where the nurturinig of sphagnum results in peat bog formation. This process can elevat soils with 1 / 2 cm per year.

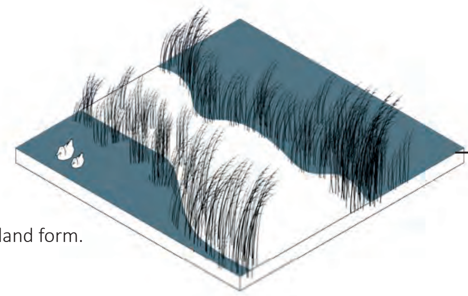
Stakeholders and landscape Identity

How stakeholders are influences and motivated through landscape alterations



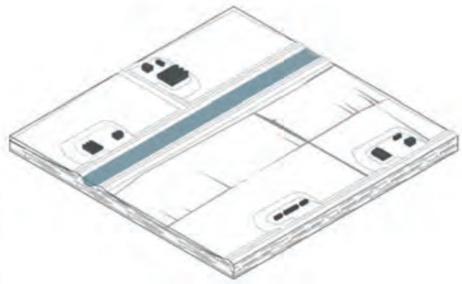


Phytoremediation to Paludiculture to Peat Bog
Rural Building with Nature
Image: Heijnen, 2021

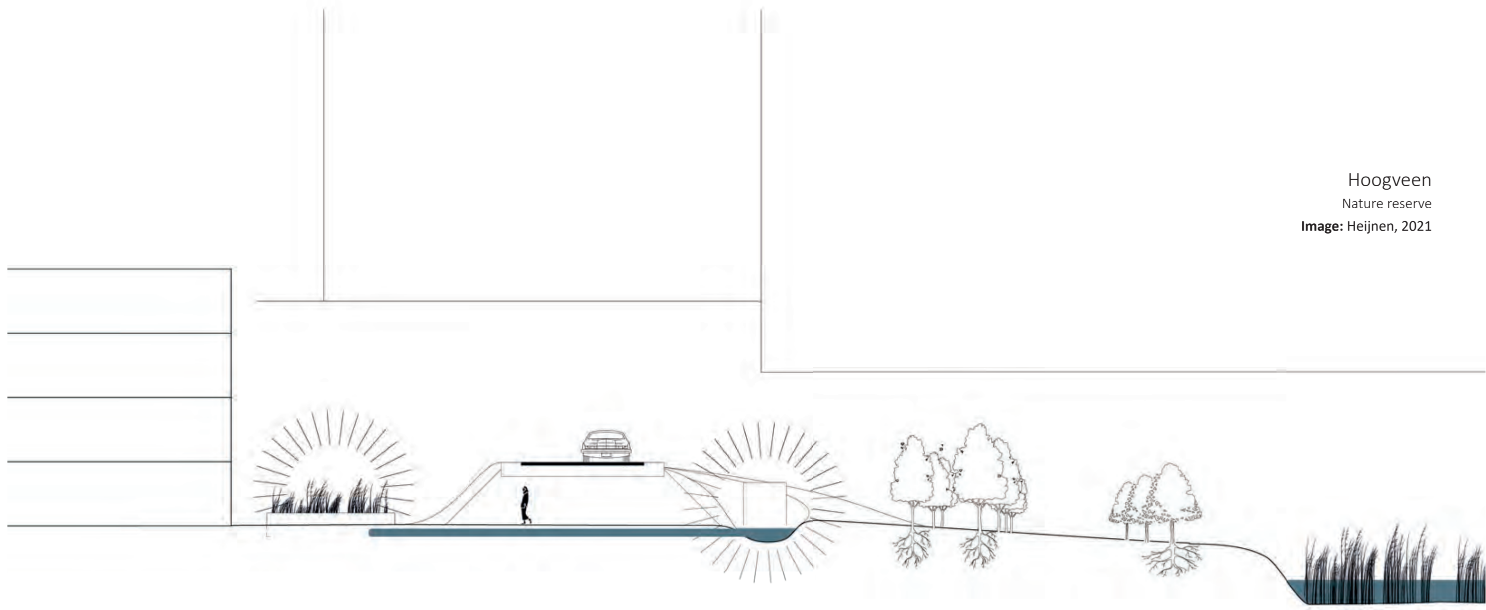


Phytoremediation
Nature reserve
Image: Heijnen, 2021

Transitioned landform, hydrology and land form.
Image: Heijnen, 2021



Hoogveen
Nature reserve
Image: Heijnen, 2021



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Sustem dynamic experience

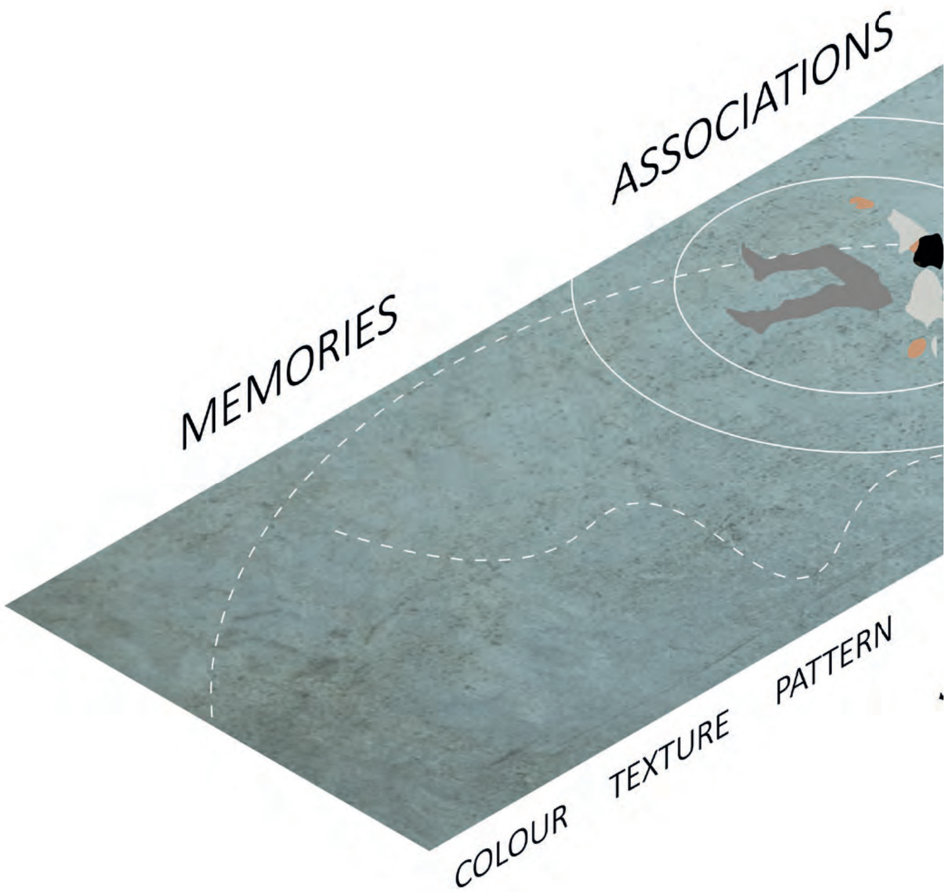
N

scale 1: x 000

Nodes and Network sequence

Rural transformation

The nodes and networks are designed and allow an alteration in action and perception sphere of landscape, attempting to alter the people- nature relationship through reconciling the dynamics of the domains of water, air, soil and people [settlement and land use].



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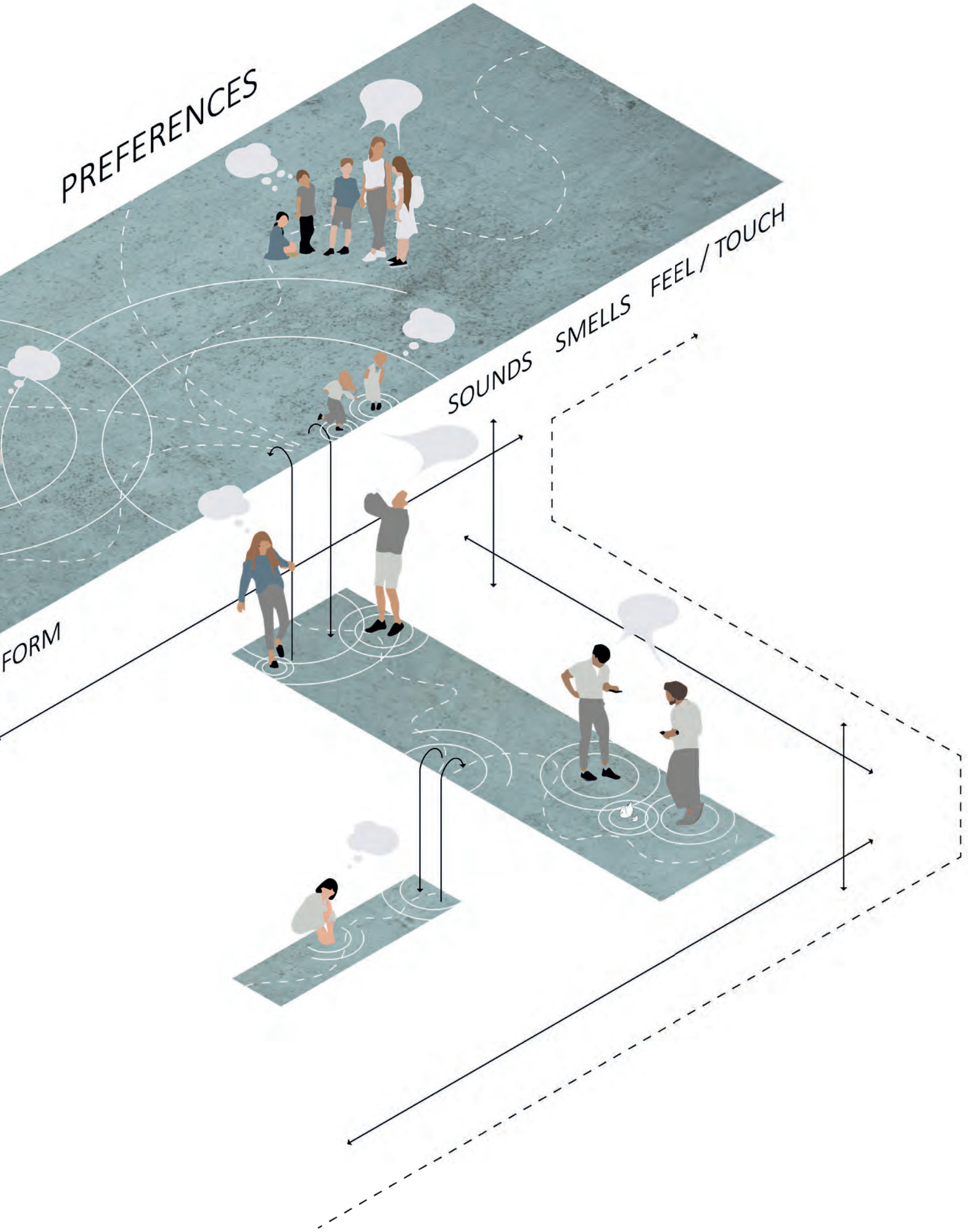

scale 1: x 000

6 CONCLUSIONS

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scale 1: x 000

Conclusions

In this chapter, the research questions are answered.

Dilemma

A sectoral flood safety approach has been a prerequisit for Delta Urbanization in the Netherlands. This, however, has gone at the cost of biodiversity and resilience. As a result, a dilemma appears to exist between sectoral flood safety on the one hand, and biodiversity and flood resilience on the other. The pursuit of flood safety, especially within the perspective of extreme climate scenario's, may continue to go at the cost of biodiversity and resilience. At the heart of this dilemma lies a flawed human- nature relationship: one where people master over nature. The concept of 'landscape identity' - the mutual relationship between people and nature - provides an understanding of this relationship. The current, flawed relationship has become manifest in the Dutch landscape as a result of the sectoral flood safety approach. Likely, it is an obstacle in the transition towards a biodiverse and flood resilient delta; while Building with Nature may provide a solution to this apparent dilemma (flood safety at the cost of biodiversity and resilience) as it takes the natural dynamics into account.

Hypothesis

Therefore, the research was started from the hypothesis that Building with Nature can provide the tailor made flood safety solutions needed to transition towards a more biodiverse and resilient delta. Shifting towards a concequence reduction flood safety approach, embracing the dynamics of water, soil and air as the critical conditions for delta urbanization. The building with Nature solutions aimed to transition the flood safety approach, besides promoting biodiversity and flood resilience, need to address and alter this people – nature relationship as well.

Main Question

The main question of the thesis is :

"How can an understanding of Landscape Identity promote a biodiverse and flood resilient urbanized delta?

- Exploring a building with nature approach to Flood Safety in the Albasserwaard -

The study was started from the hypothesis that Building with Nature provides tailormade flood safety solutions that are suitable to transition towards a more biodiverse and resilient delta. Shifting towards a concequence-reduction flood safety approach; embracing the dynamics of water, soil and air as the critical conditions delta urbanization. To be effective, the building with Nature solutions, besides promoting biodiversity and flood resilience, need to address and alter this people – nature relationship as well. Next to analyzing how the concept of landscape identity can help in promoting a biodiverse and flood resilient urban delta, the study thus explores a building with nature approach to Flood Safety in the Albasserwaard.

In order to answer the main question, three subquestions are posed. They address the relationships between the key concepts of flood safety, landscape identity and Building with Nature.

Sub Questions

1. AB: [How] are flood safety and landscape identity related?

To answer this question, an analysis of the embedding of the (sectoral) Dutch flood safety approach in the landscape was performed.

Over time, through human intervention, the hydrological infrastructures that provide flood safety have shaped the landscape and have become part of the landscape. This 'antropogenic intervention' has caused a 'society of vulnerability' to shift towards a 'society of risk', as people where able to control and minize the threat of the water. Thus, the Dutch epic of conquering the menace of the sea was established. The ability to control the threat of flooding, was critical for urbanization and agricultural land use. Hydrological control and the supported land use have completely altered the delta landscape from its natural state of 'matter' . This caused a severe decline in biodiversity. Looking at landscape change over time, human habitat seems to be dominant in the competition with nature, at the cost of biodiversity. A landscape identity was created based on a unequal relationship between people and nature: one that is flawed and regards delta urbanization as a dilemma between flood safety versus biodiversity and flood resilience.

Landscape identity can be understood as the mutual relationship between people and landscape. Although difficult to grasp, it can be understood by looking at the domains of landscape character . Dominant domains that shape the landscape can be pointed out, they are: hydrology, land use and settlement. Because in the Netherlands, the landscape is inevitably intertwined with flood safety. Human forces have been dominant in shaping the landscape and enclosing and controlling all natural dynamics. An understanding in Landscape Identity is therefore an understanding in the relationship between people and nature. In the case of the Alblasserwaard, the domains of land use and hydrology are dominant in shaping the landscape. They are strongly shaped intrincicly linked to the (sectoral) flood safety approach and depend on the system of hydrological infrastructures that provide this flood safety.

Building with nature solutions can adress the damaging aspects of urbanization and agriculture, as they incorporate and utilize natural dynamics and provide an alternative to the rigid and artificial structures. However, they should also address the flawed people- nature relationship; and steer it from human mastery over nature towards a partnership with nature. Most Building with Nature-solutions are still limited in their ability to increase flood resilience and above all, frame the natural dynamics as fitting in the anthropogenic system rather then people as part of a natural system. Therefore, in their current form, they too express a relationship between people and nature as one where people dominate nature.

2. BC: How does an understanding of landscape identity inform the application of Building with Nature solutions in pursuit of flood safety?

Building on the domains that shape landscape identity and the people-nature relationship, this question provides insight in the applicability of Building with Nature solutions in the case-study of the Alblasserwaard. Building with nature concepts are suitable for implementing flood safety solutions that:

- allow flooding,
- make optimal use of hydrologic dynamics,
- meanwhile improving the ecological environment.

Furthermore, because Building with Nature takes into account natural dynamics and processes, and subsequently models the solution to these circumstances it builds upon the physical action domains of the landscape and its identity.

Building with Nature is therefore a suitable approach for flood safety development, because it promotes a shift from sectoral to multi-dimensional flood safety solutions. However, the solutions are still mostly engineering solutions, and not take the societal synergies that these solutions could offer into account! These synergies address the memories, associations and preferences of people, shaping landscape identity. In addition, when different solutions are applied jointly and regarded as system components, they increase the circularity of the flood safety system. Although not explicitly proposed in the Building with Nature approach, synergies between solutions that are applicable in different landscape characters, increase the performance of the system overall.

On the other hand, Building with Nature solutions, for example as proposed by Ecoshape, are generally limited to the coastal and riverine territories. This becomes clear from spatially outlining and testing these different solutions in regards to flood risk | or flood safety?. In the case of the Alblasserwaard, flood risk occurs not only to the riverine edges, but in the rural hinterland as well. This area is not regarded as coastal or riverine territory (as a system of hydrological infrastructures separates it) and therefore, existing building with nature solutions for this area do not fit. In this thesis, the concept of peat formation is introduced as a Building with Nature solution. With this, not just a broadening of riverine and coastal delineation is proposed, but also the acknowledgement of the intertwinement of the separated landscapes.

This limitation and definition of coastal and riverine territory, is in line with the flood safety approach to limit the probability of flooding, and with this, accepting large damages if a flood does occur. Therefore, as the coastal and riverine territory are limitedly delineated, not including the rural hinterland, and the notion of resilience to flooding is not addressed, the Building with Nature concept is only partly sufficient to achieve flood resilience.

3. AC: How can BwN solutions be applied to alter the human-nature relationship?

This question was answered through research by design and the application of Building with Nature solutions aimed at altering damaging land use and settlement processes, meanwhile adressing the flawed people- nature relationship.

On the regional scale, Building with Nature solutions instigate a systemic transition to multi-dimensional flood safety solutions that restore and support ecology. Therefore, they lay the framework for a transition in landscape identity and a re-positioning of people and nature. Adding the design dimension to these Building with Nature solutions will, first, allow synergies to happen on a systemic level between the different solutions. Second, though designing the implementation of these Building with Nature solutions, they can incorporate resilience. As a result, designing the sceneries and opportunities for interactions between human and nature on the microscale, will alter the relationship between human and nature.

Learning from the Landscape Identity framework, the spheres of action and perception are defined. In the action sphere, damaging processes of agricultural land use and pollution of urbanization can be adressed. Spatially, the highest biodiversity and flood resilience impact is to gain in the rural area by shifting the agricultural function towards paludi- and aquaculture, embracing the water. However on the regional scale of this systemic transition, the scale of Building with Nature flood safety interventions, the people – nature interaction does not take place often . Therefore, complementary interventions on the more urban, smaller scale, where human interaction with the landscape takes place are necessary. They address the perception sphere of landscape identity, which is as important as the action sphere in shifting the human- nature relationship from a mastery over nature towards a partnership with nature. Facilitating the experiences of learning, remediating, monitoring, and nurturing nature in especially the urban Landscape, besides the rural is therefore essential. Properly designing these spaces to facilitate these activities that shape memories, association and preferences of the landscape are critical for reconciling the people-nature relationships.

Main Question

Thus the main question, “How can an understanding of Landscape Identity promote a biodiverse and flood resilient urbanized delta? can be answered.

- Exploring a building with nature approach to Flood Safety in the Albasserwaard -

A people-nature relationship of human mastery over nature becomes apparent from understanding the Dutch Peat meadow landscape through the lens of landscape identity. Deconstructing the different action and perception domains of the landscape, and understanding their interrelations provides not only an understanding in the driving forces of landscape alteration, but also makes the people-nature relationship tangible. And with this, reveals the domains and scales for intervening and reconciling the people- nature relationship.

In the case of Alblasserwaard, where the landscape is inevitably intertwined with flood safety, the pursuit for flood safety has gone at the cost of biodiversity and resilience. Building with Nature is a suitable approach to address flood safety. Taking natural dynamics into account, it promotes a shift from a sectoral approach towards multi-dimensional understanding of flood safety, no longer going at the cost of resilience and biodiversity.

Reccomendations

Recommendations

The main recommendation emerging from this project is firstly to make flood safety solutions compatible to the landscape, meaning that they optimize the movement of water, soil and air conditions specific to a certain conext. With this, a critical reconcideration of the conceptualization of flood safety and Building with Nature is needed to frame spatial interventions as part of a natural system rather then the contrary.

For the conceptualization of flood safety this means encorporating consequence reduction in flood safety developments and considering more systemic and comprehecive assessment models that go beyond the 'Risk = Probability x Consequences' model. With this comes the broadening of the spatial territory of the flood safety infrastructures. To spreak in the systemic terms used in this thesis, flood safety solutions should not only be limited to the edges and notes of the hydrology system but to the infill as well.

A further exploration of Building with Nature solutions that incorporates solutions that go beyond the coastal and riverine territory is recommended. Also referring to the system of edges, nodes and infill, taking the whole at risk area into account of flood safety interventions.

Recognizing and testing the synergies between different Building with Nature solutions in different landscape characters.

Building with Nature concepts

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Source: Ecoshape, 2020

Image: Heijnen, 2021

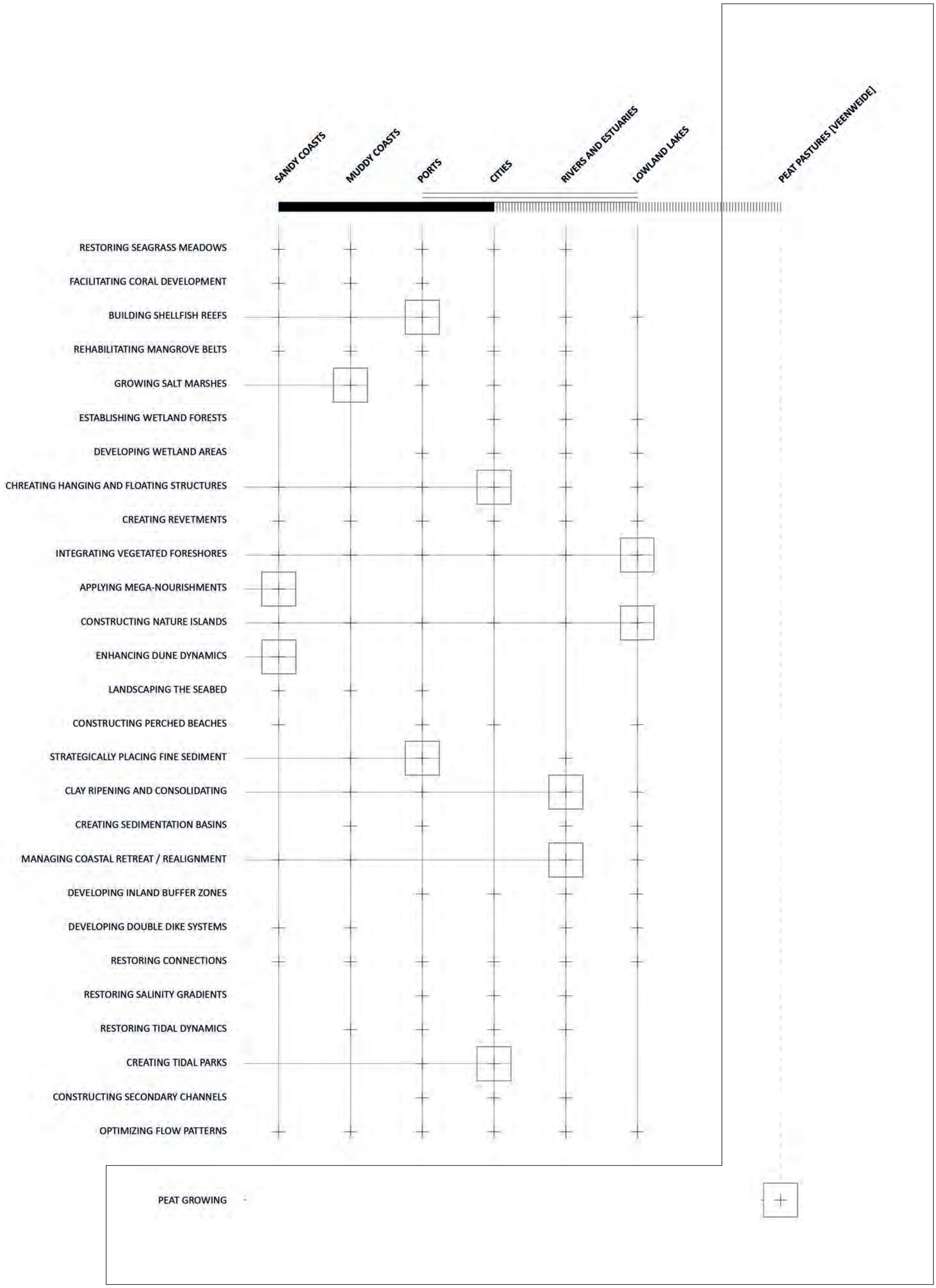
Applicability

Growing system feature

Coastal

Riverine

Rural


SANDY COASTS
MUDDY COASTS
PORTS
CITIES
RIVERS AND ESTUARIES
LOWLAND LAKES
PEAT PASTURES [VEENWEIDE]
RESTORING SEAGRASS MEADOWS
FACILITATING CORAL DEVELOPMENT
BUILDING SHELLFISH REEFS
REHABILITATING MANGROVE BELTS
GROWING SALT MARSHES
ESTABLISHING WETLAND FORESTS
DEVELOPING WETLAND AREAS
CHREATING HANGING AND FLOATING STRUCTURES
CREATING REVETMENTS
INTEGRATING VEGETATED FORESHORES
APPLYING MEGA-NOURISHMENTS
CONSTRUCTING NATURE ISLANDS
ENHANCING DUNE DYNAMICS
LANDSCAPING THE SEABED
CONSTRUCTING PERCHED BEACHES
STRATEGICALLY PLACING FINE SEDIMENT
CLAY RIPENING AND CONSOLIDATING
CREATING SEDIMENTATION BASINS
MANAGING COASTAL RETREAT / REALIGNMENT
DEVELOPING INLAND BUFFER ZONES
DEVELOPING DOUBLE DIKE SYSTEMS
RESTORING CONNECTIONS
RESTORING SALINITY GRADIENTS
RESTORING TIDAL DYNAMICS
CREATING TIDAL PARKS
CONSTRUCTING SECONDARY CHANNELS
OPTIMIZING FLOW PATTERNS
PEAT GROWING

7

REFLECTION

N

AR3U100 Transitional Territories
Msc Urbanism Graduation Thesis

Faculty of Architecture and the Built Environment,
Delft University of Technology

P4 Report - Reflection

Jurriënne Heijnen
4295153

scale 1: x 000

Reflection

Approach

The approach of operationalization and research by design Flood Safety and Building with Nature through Landscape identity has led to a deeper understanding and reflection of the two concepts.

As landscape identity proposes a comprehensive framework of landscape, framing flood safety and the infrastructures that provide it within this framework, enables to grasp their impact on- and compatibility with the landscape. This is also the case for the Building with Nature solutions.

Furthermore, framing flood safety and building with nature in the broader scope of landscape identity, connecting to different domains, also allowed a critical reflection of the solutions and approaches and their connection to the people – nature relationship.

Finally, the concept and framework of landscape identity provide domains for intervention that were used for the research by design.

Scope and further research

Landscape identity presents the human influence on landscape, and the people – nature relationship, as divided in the action and perception sphere. Through research by design, the action sphere was addressed through testing Building with Nature solutions. On the local scale, the perception sphere was addressed through designing spaces that facilitate the creation of memories, associations and preferences that frame people as part of nature, not mastering over it. To motivate the design decisions, assumptions were made on what activities would address the people – nature relationship on the perceptive sphere. However, if, and how the design of these spaces actually addresses the creation of memories, associations and preferences is beyond the scope of this thesis. It is very much an interesting topic for further research.

Limitations

Limitations for implementation of Building with nature on the regional scale. Such a systemic transition requires collaboration of many actors. The interventions as proposed are able to be implemented separately.

A full transition as proposed requires all involved stakeholders to actively participate in the transition which is rather radical. However, a bottom up transition is very much possible using the compartmentation approach. Especially when spaces for co-management are facilitated.

Landscape Identity is difficult to grasp, this thesis project is an attempt to grasp it, pinpoint it in space and use this spatial understanding as a tool to tackle one of the biggest global challenges of this time. Making the urban fabric a functioning element in the dynamic system of water, soil and air, the main natural shapers of the environment.

Father and daughter wade through the so called 'uiterwaarden'

Flooded farmland edging the IJssel river

Source: Teake Zuidema, 2018

N

scale 1: x 000

REFLECTION

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LITERATURE

IMAGES

DATA

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APPENDIX

Project and Method Reflection

Theory Paper

DATA

Method reflection

Advantages and limitations of the studio methodology.

Transitional Territory studio's related methodology entails the model of four lines of inquiry on the domains of Matter, Topos, Habitat and Geopolitics. This methodology is used to understand the coherence and transitional processes, within and across the four domains, in regards to territory of a given context. Similar to the Dutch layers approach that regards the layers of the substratum, networks and occupation, it attempts to understand processes and impacts of change, understanding it in terms of courte, Moyenne and long durée (Braudel, 1949). Compared to the Dutch layers approach, which is broadly used in the last decades of spatial planning in the Dutch context, the four lines of inquiry model allows a more elaborate understanding of the relationships between the societal [human] and biophysical [nature].

This method was used in an explorative manner to grasp the spatio-temporal and societal relationships of Landscape Identity and flood safety in the Netherlands. It provided the first problem field analysis that motivated the location for applying research by design. As mentioned earlier, the thesis was instigated from a concept rather than a location, therefore, the inquiry of the four domains trough critical mapping was an iterative process. Insights of different contexts, sometimes allowed a deeper understanding of a phenomenon.

Relationship between research and design

Overall, the research [by design] process was not a linear process but very much an iterative one, moving in between design, analysis and research. Long moments of diversion and exploration were altered with short moments of synthesizing and decision making.

The research was started from firstly understanding the concept of landscape identity. Conceptualization and operationalization of Landscape Identity, together with a general analysis of the problem field of flood safety in a delta pressured by climate change and urbanization formed the first stages of the research. From this problem field analysis, a location was defined for testing the operationalization of the Landscape Identity concept through research by design. The research by design provided insights the method for grasping and using Landscape Identity. It allowed an iterative process of reflection and sharpening of the method, through the different scale. More specific because interventions on the meso systemic scale were tested on the local scale. Subsequently, the implications on the local scale then informed the performance on the systemic scale.

Conclusion

Building upon the problem field analysis of the four lines of inquiry, the theoretical underpinning sets out the method for research by design. The method that is proposed in this thesis aims to understand Landscape Identity, and through it, understand the relationship between people and nature in a certain scope of space and time. Subsequently, through the application of building with nature, it is tested if Landscape Identity can be altered and if Building with Nature is an appropriate approach and concept for this application. Not only was the research by design phase an exploration of the applicability of Building with Nature, it was above all a process of exploration, reflection and definition of the method for grasping and altering landscape Identity.

Furthermore, the concept of Landscape Identity is only partially spatial, and is to be understood in a qualitative manner. It must be said that the societal domains of perception, preferences and memories of the landscape were not researched in depth. Furthermore, any assumptions made on these domains of landscape, are valid for a certain moment in time. Therefore, results of the method are quantitative and not definite, statements made on the relationship between people and nature are therefore to be regarded as assumptions. However, these assumptions make the implicit relationship between people and landscape, in the Dutch case, people and nature, spatially explicit.

Representation of methods
Four lines of inquiry and the Landscape Identity concept
Source: xx

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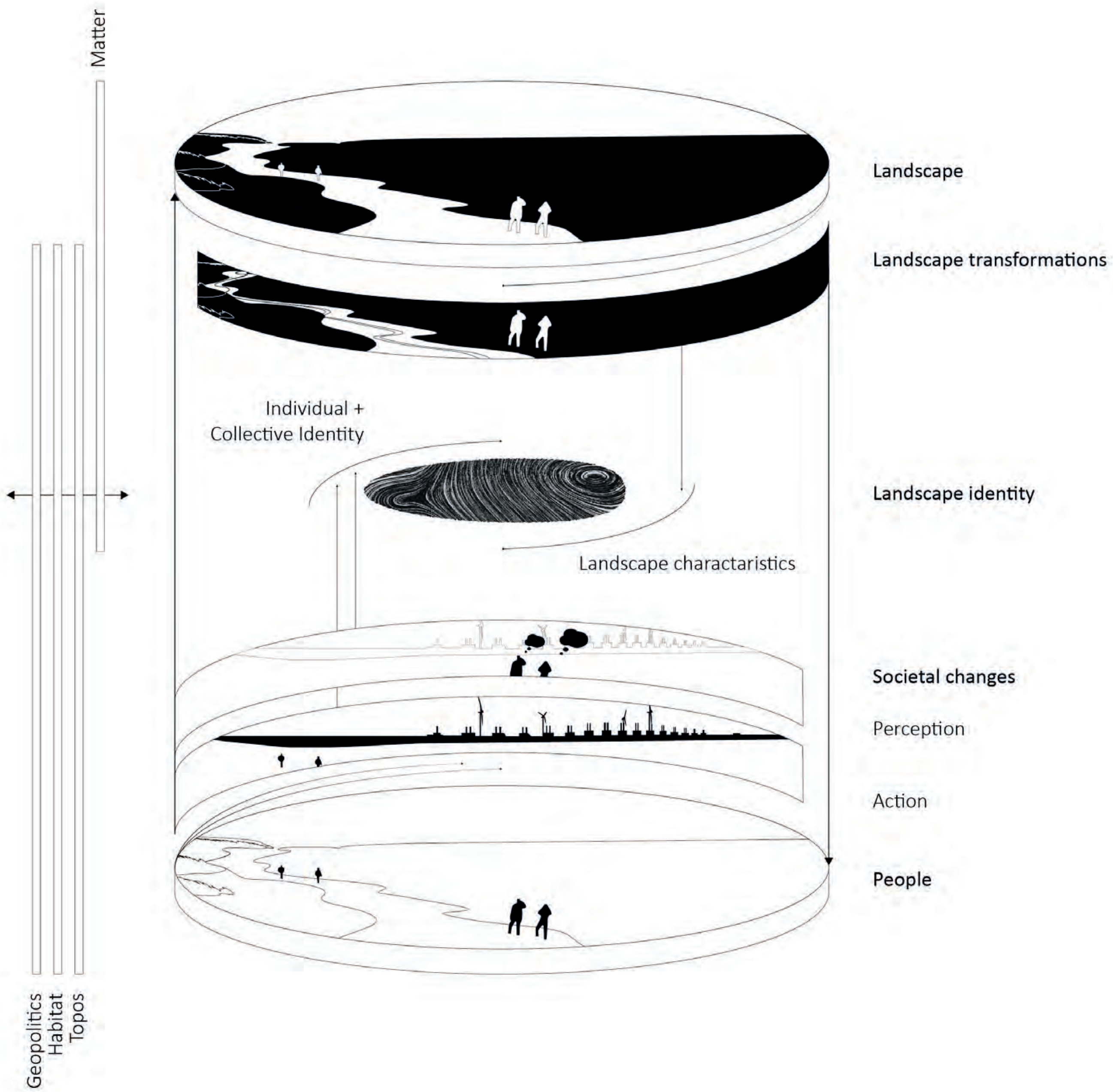

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Project reflection

Relationship between project, studio and track

Delta areas have always been fruitful settling grounds and are currently still at the forefront of human development and economic growth. The economic benefit has mostly been the justification for settling in such flood-prone areas. The Dutch Delta is such a delta where the natural state of land, sea and river formed the foundation for land reclamation and ultimately the current urbanised, economic area. Economic benefit has always justified the creation and maintenance of the system that protects against flood risk and enables habitation.

The Dutch Delta has always been transitioning through this system and urban development has been connected with landscape qualities and driven by economy. Over time, the awareness of future existence came into play and delta development became more and more about flood risk protection of human habitat and nature as well as economic security. With the pressures of climate change challenges and urbanization, the question on how to develop the Dutch delta is still very relevant. In line with the Transitional Territories studio, the thesis considers the position of the urbanised delta within the strongly connected dynamics of socio-spatial and the biophysical domains.

As the thesis partly attempts to answer the question on how to reconcile these two domains through flood safety development and guide this transition within an urbanized delta under pressures of climate and urbanization, it fits within the Transitional Territories studio as part of the Delta Urbanism section. Within the studio topic: 'Inland, seaward', different conditions, approaches, agencies and interventions of territories in transition are considered.

The thesis is a spatial exploration of a method to alter peoples relationship with nature, therefore it mainly addresses spatial and temporal patterns and behaviours of land use and settlement. Through this, on a broader scope, the definition of landscapes and the structuring of space and networks over time are critically reflected upon.

The iterative process of proposing a transformation on the macro systemic scale and subsequently testing the implications on the micro environmental, material and individual scale, is suitable to the design field. This systemic, multi-scalar, socio-spatio-temporal approach is appropriate and within the Urbanism track. Furthermore, as part of the studio's collaborative body of work, the thesis contributes to the scientific body of knowledge, as within the studio different [delta] contexts of transitions are compared.

A description of the societal relevance.

With the growing pressures on the Dutch Delta, living with extreme conditions will be the new reality. The thesis critically reflects on the current approach to flood safety development and proposes and tests a different approach to a high end sea level rise scenario. As it visualizes and frames what interventions are necessary and what agency is required, the thesis can aid in steering decision making and increasing agency towards more a Building with Nature approach in flood safety development. Besides informing the scientific and professional field involved with flood safety in delta contexts, the project can stimulate agency and ecosystem participation through spatially facilitating opportunities for reconciliation of natural dynamics and human behavior of land use and settlement.

Generalization of the results of the research.

The proposed method for spatially understanding human – nature relationships through the concept of Landscape Identity, operationalized with the Landscape Character model is broadly applicable. It is however tested specifically in the Dutch context where the landscape is evidently intertwined with flood safety development and natural dynamics have little influence. Furthermore, the amount of data available on the Dutch delta is immense. Therefore, the method may be more difficult to apply in other contexts.

The outcome of the proposed method, which is the systemic framework and design principles aimed at altering this relationship of dominance over nature, are specific for the dike ring of the Alblasserwaard, as they are depending on context specific environmental conditions of water, soil and air. The proposed solutions might however be applicable for other locations and the design of the meso scale framework serves as an example of the systemic application of the Building with Nature solutions.

Conclusion

Conclusion
In the Netherlands, historically, flood risk management and flood protection development responded to flooding events. Currently, flood risk management decision-making is underpinned by flood risk analysis and assessment.
Accurate flood-risk analysis and assessment is therefore critical in order to assure flood-resilient development. This becomes apparent considering the planned flood risk development for the Netherlands until 2026. The planned development and interventions are aimed at strengthening the levees to meet the safety standards that were brought forth from flood risk analysis and assessment by 2050. These standards are based on a moderate sea level rise. However, recent studies show that sea levels might rise at a faster rate than predicted before. This increase in sea levels will put an enormous pressure on the Dutch flood-protection system. If sea levels rise even higher than predicted, the Dutch levee system will not suffice to protect all of the below sea level areas of the Netherlands.

In order to be prepared for this uncertainty in sea level rise it is therefore necessary to look beyond the current flood risk management approach of strengthening the levee systems. As this approach is largely based on flood risk assessment, a broadening or redefinition of the flood risk assessment model can be an important step in adapting to scenarios of increasing sea levels in order to achieve flood resilience in the long term.

In the Dutch flood risk assessment approach, flood risk is regarded as the product of the probability of flooding and the consequences of flooding. The probability calculations do not incorporate systemic behaviors that influence flood risk. The calculations of consequences have a limited scope of economic damage and fatalities, ecologic values are not incorporated.

With the room for the river project, the scope of flood risk management and flood defense development was broadened and incorporated these ecological and spatial quality values. With planned interventions of strengthening levees until 2050, based on the current flood risk management policy and flood risk assessment model, it appears that steps are taken back and the scope is narrowed again.

Therefore the current Dutch flood risk assessment approach can be regarded as too technocratic and sectoral, resulting in missed potentialities of ecologic and spatial quality in the development of the Dutch delta on the national scale.

The Dutch flood risk development seems to be stuck in a downwards spiral, as the perfect example of the levee effect. Redefining the approach to flood risk assessment trough incorporating systemic behavior and values of spatial quality and ecology might be a first step in breaking this cycle and allow for more transformative development towards long term resilience.

Theory paper on Dutch Flood Risk Assessment
Breaking the downwards spiral: towards a qualitative and systemic ap-

Dutch Flood Risk Assessment

Breaking the downward spiral: towards a qualitative and systemic approach

AR3U023 Theories of Urbanism
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Abstract

Flood risk management policy and decision-making is underpinned by flood risk analysis and assessment. Accurate flood risk assessment can provide consistent information to support the development of flood management policy, allocation of resources and monitoring the performance of flood mitigation activities. In the Dutch context, the flood risk assessment model regards flood risk as the product of probability and consequences of flooding. Within this approach, reducing the flood risk can be done by development focused on reducing either the probability or the consequences of flooding. Due to climate change, the probability of flooding is increasing. Globally, the interest of flood risk measures has been shifting more and more towards reducing flood consequences as well as reducing flood probability (Bars et al., 2020). This is however not reflected in the planned Dutch flood risk development. The risk assessment approach is technocratic and sectoral, focused on separate levee systems, economic damage and probability of death. Alternative flood risk assessment approaches are more qualitative trough incorporating additional consequential values or regard flood risk within river system behavior dynamics that influence flood probability. This literature review reflects on the Dutch flood risk assessment approach. Through comparison with a multi criteria approach and a systemic approach, neglected potentials of the Dutch approach are revealed. Subsequently, a broadening of this approach is proposed as the underpinning of flood risk management policy and development towards a Dutch delta able to sustain extreme and uncertain future scenario's.

Keywords: flood risk assessment, flood risk management policy, flood defense, qualitative multi-criteria assessment, river system behavior dynamics

Introduction

More than 60% of the surface in the Netherlands lies below sea level or below the high water levels of the rivers. A flood defense system protects these low lying areas from coastal flooding, as well as the above sea level areas from river flooding. Without this protective flood defense system of dunes, dikes and hydraulic infrastructures, approximately 60% of the Netherlands would flood regularly (Jorissen et al., 2016). Because of this vulnerable topography, it is important to know the possible risk and consequences of flooding (Jonkman et al., 2008). As a result of climate change, sea level rise is increasing, on an even faster pace and with more uncertainly than predicted. With this growing pressure on the flood defense system and with this uncertainty, the knowledge on flood risk and flood consequences is even more relevant (Bars et al., 2020).

Furthermore, flood risk assessment sets the framework for flood risk management policy as it provides information necessary for decision making on development of flood defenses, allocation of resources and monitoring the performance of flood mitigation activities. (Gouldby et al., 2009; Jorissen et al., 2016). In the Dutch case this means that the way in which flood risk is evaluated and calculated strongly influences the development of more than half of the Dutch landscape that is dependent on the flood defense infrastructures. Current flood risk management policy and planned development of flood defenses in the Netherlands are focused on the period until 2050 and are based upon the expectation of a moderate sea level rise of 0,25 to 0,80 meter by 2085 (Vergouwe, 2014).

The current Dutch flood risk assessment approach is rooted in the safety standards that reacted to the disastrous flooding of 1953. These safety standards developed into an assessment approach over time bringing forth more up to date safety standards. These standards are guiding in current flood risk management and eventually shape the landscape transformations that follow from it.

In this paper, the Dutch flood risk assessment approach is compared to two alternative approaches that on the one hand propose a different assessment of consequences and on the other hand a different approach to assessment of probability. This comparison offers a reflection on neglected potentials of the current Dutch approach to flood risk assessment. Arguing that with the pressures of climate change and increasing probability of flooding, a different approach to flood risk assessment might be more fitting to the extreme and uncertain future scenario's.

Figure 1: The flood exceedance probability of the Dike ring levee systems.
(Source: Author, 2020)
(Data source: Rijkswaterstaat, 2010.)

The Dutch flood risk assessment approach

Historically, the response after a flood in the Netherlands was to reduce flood risk by elevating the levees, with the highest observed water level as reference point. After the flooding of 1953, different safety standards were implemented for the flood defenses. The flood prone area of the Netherlands was divided into different dike rings consisting of primary flood defense elements such as dikes, dunes, dams, sluices or high grounds that together protect the area within from flooding. Each dike ring had a specific safety standard corresponding to the economic value of the area and the exceedance frequency of either coastal- or river flooding, as shown in figure one. For high risk coastal areas, these standards were 1 in 10,000 years and 1 in 4000 years for low risk areas. For river areas this was 1 in 2000 years and 1 in 250 years, revealing a higher flood probability in river areas (Jonkman et al., 2008).

This approach to flood risk assessment is referred to as the exceedance probability approach and the safety standards following from this approach were laid down in the Water Act of 2009. This act shapes the flood defense development of the primary flood defenses until 2050, as all levee systems must meet the safety standards of the water act by 2050 (Jonkman et al., 2008; Vergouwe, 2014). These standards, originally derived in the 1960s, were revised around 2000. This revision brought forth the conclusion that levees were more likely to breach because they were too narrow instead of too low to deal with extreme water loads. Therefore, the revised flood risk assessment approach, which was the product of the Flood Risk and Safety in the Netherlands (FLORIS/VNK) project in 2003, incorporates failure mechanisms of flood defenses. It proposes flood risk not just as the exceedance probability but as the product of multiple variables. The latest VNK report was published in 2014, presenting new flood risk values for the flood defense system, based on this new flood risk assessment approach. These values also no longer applied to the dike rings but to each levee system separately (Vergouwe, 2014). In 2017, new safety standards derived from the risk values were included in the water act, they are the safety standards that currently shape flood risk management in the Netherlands.

Figure 2: Regional levee breach in Wilnis in 2003 caused by drought. (Source: AFP, 2003)

The current flood risk assessment approach calculates risk as the product of flood probability and flood consequences, defining economical, individual and societal risk (Jonkman et al., 2008; Vergouwe, 2014). In 2014, 58 of the 95 levee systems were assessed on their probability of flooding. This was done by calculating the probability of a breach, which occurs when the pressure of the water is greater than the strength of the flood defense structure. Each levee system consist of one or more flood defense structure such as dunes, dikes or dams or sluices. The probability of a breach can be increased by several different failure mechanisms that are influenced by climate conditions such as high or fluctuating water levels (Vergouwe, 2014). The breach in 2003 of a regional dike in Wilnis, as shown in figure two, was an example of such a failure mechanism caused by drought.

Furthermore, the consequences of a breach are calculated for the inner areas of the levee systems in economic loss and fatalities. This is done by determining the direct and indirect economic damages to capital goods such infrastructure, homes, and loss of businesses. In addition, the fatality consequences are calculated through the number of inhabitants combined with evacuation measures and flood characteristics such as rise rate and velocity of the water. Together, probability and consequences of flooding determine the flood risk, as shown in figure 3.

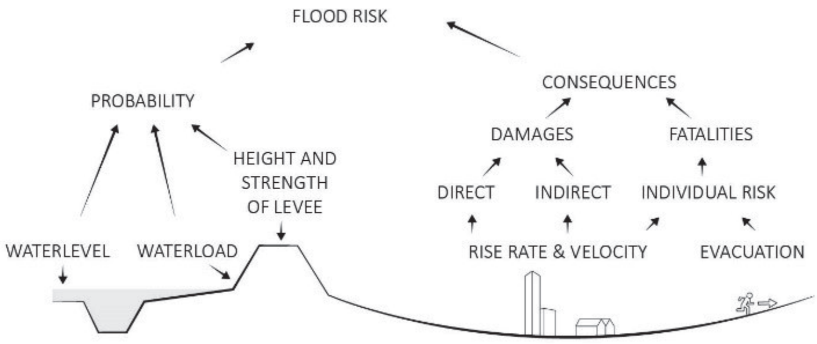

Figure 3: Schematic representation of flood risk assessment.
(Source: Author)
(Data: Deltares, 2012; Vergouwe, 2014)

Flood risk management policy

Based on the safety standards brought forth by the flood risk assessment of the Dutch levee systems, a development program (HWBP) was created to strengthen the levees and bring them up to the standards added to the water act in 2017. In the planned development of 2021 until 2026 gives insight in the developments until 2050. Almost all interventions are focused on strengthening levees and reducing probability of flooding (Programmabureau HWBP, 2020).

In a reflective report on the planned flood defense developments, the collective of governmental advisors (CRa) were critical on the development approach. Claiming that the scope of the developments is too narrow and the focus too sectoral, resulting in projects merely aimed at flood protection, not utilizing spatial quality opportunities (Alkemade et al., 2020).

The limits of the Dutch system

The so called levee effect, describes the effect of intensive development in floodplains after the placement of flood protective levee structures. When flooding occurs, this development then results in increased damage (White, 1942). The Dutch flood risk protection system is the ultimate example of the levee effect. With sea level rising faster and higher than expected, eventually this current flood protection system might not be sufficient and sustainable in the long term. As soon as 2100, sand nourishment demands will be twenty times as high, storm surge barriers will have to close at a high frequency and fresh water will be less available due to saltwater intrusion (Haasnoot et al., 2020). Globally, decision makers are increasingly interested in sea level rise events with a small probability but with very high consequences. With this, the focus of flood risk measures has been shifting more and more from reducing flood probability towards reducing flood consequences as well (Bars et al., 2020).

Alternative approaches

The technocratic Dutch approach of flood risk assessment per separate levee structure does not take into account the systemic mechanisms or that influence flood risk once a breach occurs. Therefore it is interesting to

explore different models of flood risk assessment.
In the Dutch delta, the estuary of the Rhine and Meuse river meets the North sea. The Rhine basin reaches from Switzerland, Austria and Liechtenstein, through France and Germany before it enters the Netherlands. For accurate flood risk assessment of river systems, every relevant failure mechanism as well as uncertainties and planned safety improvement measures are to be mutually regarded (Mierlo et al., 2007). As flooding from rivers poses the highest flooding threat in the Netherlands. Looking beyond the national border at the entire river basin is therefore essential. Regarding the occurrence of breach of each separate levee system in the Netherlands within this larger system affects the flood risk. Shown by a computational example where upstream levee breaches reduced downstream flood risk when system behavior was accounted for as shown in figure 3. Van Mierlo et al (2017) argue that this conceptual flood risk assessment model that incorporates river system behaviors serves as a tool for flood risk managers and policy makers on the regional scale.

A study on flood risk assessment in Leipzig of the Mulde river basin brought forth a multi criteria assessment model. Similar to the Dutch approach, flood risk was defined as the product of probability and consequences of flooding. In addition, the so called urban approach defines economic, social and ecological flood risk criteria specified to deal with urban issues. Subsequently, these criteria incorporate urban issues in the flood risk assessment such as vulnerable groups, areas of social and ecological health care, differentiated residential land use classes and ecological value of urban green spaces. Addition of these different weighted criteria to the assessment model, as seen in table 1, influenced the flood risk and the spatial distribution of flood risk in the case area. It was concluded that a better understanding of the spatial distribution of vulnerable social, economic and ecological elements provides a more specific insight in risk situations that goes beyond the technocratic approach (Kubal et al., 2009). Taking into account that the context of Leipzig differs from the Dutch delta territory in many ways, this alternative approach gives an insight in different validation methods of the consequences of flooding. Incorporating multiple elements in addition to the economic value and losses of life might provide a better understanding of the exact spatial distribution of flood risk.

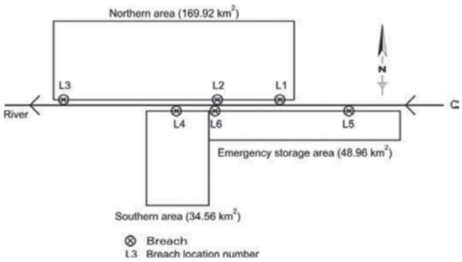

Figure 3: Reduced flood risk in the Southern area when taking river system behavior in account: levee breach of the Northern area. (Source: van Mierlo et. al., 2017)

The room for the river project, completed in 2015 was an example of flood risk management policy that resulted in flood defense development which (unknowingly) incorporated some of the aspects of the earlier described river system thinking and multicriteria approach. This project can be seen as the predecessor for the HWBP. Besides strengthening levees, levees were pushed back, creating larger floodplains. This nationally carried project incorporated ecological and spatial quality values as well as flood risk reducing measures (Keessen et al., 2018).

Conclusion

In the Netherlands, historically, flood risk management and flood protection development responded to flooding events. Currently, flood risk management decision-making is underpinned by flood risk analysis and assessment. Accurate flood-risk analysis and assessment is therefore critical in order to assure flood-resilient development. This becomes apparent considering the planned flood risk development for the Netherlands until 2026. The planned development and interventions are aimed at strengthening the levees to meet the safety standards that were brought forth from flood risk analysis and assessment by 2050. These standards are based on a moderate sea level rise. However, recent studies show that sea levels might rise at a faster rate than predicted before. This increase in sea levels will put an enormous pressure on the Dutch flood-protection system. If sea levels rise even higher than predicted, the Dutch levee system will not suffice to protect all of the below sea level areas of the Netherlands.

In order to be prepared for this uncertainty in sea level rise it is therefore necessary to look beyond the current flood risk management approach of strengthening the levee systems. As this approach is largely based on flood risk assessment, a broadening or redefinition of the flood risk assessment model can be an important step in adapting to scenarios of increasing sea levels in order to achieve flood resilience in the long term.

In the Dutch flood risk assessment approach, flood risk is regarded as the product of the probability of flooding and the consequences of flooding. The probability calculations do not incorporate systemic behaviors that influence flood risk. The calculations of consequences have a limited scope of economic damage and fatalities, ecologic values are not incorporated.

With the room for the river project, the scope of flood risk management and flood defense development was broadened and incorporated these ecological and spatial quality values. With planned interventions of strengthening levees until 2050, based on the current flood risk management policy and flood risk assessment model, it appears that steps are taken back and the scope is narrowed again.

Therefore the current Dutch flood risk assessment approach can be regarded as too technocratic and sectoral, resulting in missed potentialities of ecologic and spatial quality in the development of the Dutch delta on the national scale.

The Dutch flood risk development seems to be stuck in a downwards spiral, as the perfect example of the levee effect. Redefining the approach to flood risk assessment trough incorporating systemic behavior and values of spatial quality and ecology might be a first step in breaking this cycle and allow for more transformative development towards long term resilience.

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