Productive Landscapes in the Dutch Delta

Integrating climate-adaptive strategies for vulnerable landscapes

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Delta Futures Lab

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Integrating climate-adaptive strategies for vulnerable landscapes

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Abstract

This research explores the spatial implications of climate change and sea level rise on the Dutch Delta's productive landscapes, focusing on integrating spatial design and water management within a risk framework. The transition from adaptive planning to planned adaptation is highlighted as crucial for addressing the unpredictability of climate change impacts, advocating for a shift in strategy from a reactive to a proactive approach in delta management.

Design experiments play a central role in this research, employing critical cartography and sectional drawings as tools to analyse and synthesise localised adaptation strategies to the vulnerabilities posed by sea level rise. These design tools facilitate the exploration of innovative spatial responses that accommodate climatic uncertainties, contributing to the resilience and sustainability of the landscapes.

Designing with uncertainties underpins the research methodology, embracing the unpredictability of future climate conditions as a foundation for developing adaptive spatial strategies. This approach entails a paradigm shift towards accommodation and planned adaptation, emphasising the need for flexible, integrated planning that can evolve over time. The research underscores the potential of nature-based solutions to synergise productive and protective systems, enhancing ecological, social, and economic resilience in the face of climate change and sea level rise.

Through a combination of theoretical frameworks and design experiments, the research presents a forward-thinking vision for the Dutch Delta. It proposes a methodological approach to landscape and urban planning that navigates the complexities of climate adaptation, demonstrating how productive landscapes can be reimagined to thrive in an uncertain future.

Project Context

The pressing issue of climate change and sea level has resulted in the coastal regions and low-lying countries transitioning into a state of vulnerability, further compounded by the phenomena of land subsidence, coastal flooding and saltwater intrusion. This research primarily focuses on the productive landscapes within the Dutch deltaic system, where agriculture and energy are produced in a vulnerable environment and questions how these can adapt to climate change by integrating spatial design and water management within the framework of the risk approach (risk=probability*consequences).

This research project involves collaboration between four Honours Programme Master (HPM) students from the Faculty of Architecture and Built Environment, and it is run in the realm of the Delta Futures Lab, Delta Urbanism research group, Delft Deltas, Infrastructures & Mobility Initiative and the Climate Action Program.

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This research will explore the spatial implications of climate change and sea level rise on vulnerable productive landscapes by methods of critical cartography for analysis and synthesis. Sectional drawings are used as design tools to experiment localised adaptation strategies to the vulnerabilities of sea level rise and the resulting productive landscapes.

Contents

Windmill at Wijk bij Duurstede, Jacob van Ruisdael. (1670).

Preface

Interpreting its Artistic, Architectural, Media, and AI Dimensions

An artistic and architectural interpretation of a delta encompasses a diverse range of possibilities. Artists can portray deltas through paintings, sculptures, and installations, capturing the dynamic interplay between water, sediment, and natural elements. For example, the landscape paintings of Jacob van Ruisdael, a renowned Dutch artist of the 17th century, often depicted breathtaking natural scenes that included rivers, estuaries, and deltas. His works, such as "Windmill at Wijk bij Duurstede" showcased his ability to convey deltaic landscapes' beauty and atmospheric qualities. Furthermore, artists might create immersive installations that simulate the sensory experience of being in a delta, incorporating flowing water, textured surfaces, and deltaic sounds.

Architects, on the other hand, can draw inspiration from deltas when designing structures, incorporating their forms, patterns, or materials. They may also explore sustainable and resilient design solutions for delta regions, considering the challenges posed by rising sea levels and changing environmental conditions. Both artists and architects can delve into the cultural symbolism of deltas, examining their historical and social significance. The installation structure 'Terp fan de Takomst' in the Netherlands by Observatorium Collective is a powerful example of art and architecture which invites you to experience the impressive and unique landscape of the Wadden Sea outside the dike. Such works can raise awareness about the ecological importance of deltas, addressing issues such as climate change and land degradation. Through their creative endeavours, artists and architects bring forth an appreciation for the aesthetic, cultural, and environmental aspects of these unique landforms.

Media coverage of delta regions have increasingly focused on the environmental challenges and risks they face. Topics such as sea-level rise, land subsidence, coastal erosion, and the impact of climate change on deltas have gained significant attention. The media often highlights the vulnerability of deltaic communities to natural disasters like floods, hurricanes, and storm surges. For instance, media outlets often emphasise in the coastal areas of Togo and Benin in West Africa alarming erosion rate, exceeding two metresmeters per year, to underscore the rapid loss of land and its impact on the affected communities. They frequently use visual imagery, such as photographs or videos showing houses being engulfed by the ocean, to depict the severity of the problem visually. Additionally, the media, in this case, focuses on the socioeconomic implications, shedding light on the challenges faced by the local population who heavily rely on fishing and farming, as their livelihoods are jeopardised. By presenting this ongoing erosion, the media aims to raise awareness about the plight of these coastal communities and the urgent need for action to address the impacts of rising sea levels.

Discussions on the need for sustainable development, ecosystem preservation, and adaptation strategies in delta regions have also been prominent. Media outlets may emphasise the economic significance of delta regions. They might cover topics such as agriculture, fisheries, energy production, and transportation infrastructure, showcasing deltas' economic activities and opportunities. Media's projection of delta regions in recent years has been characterised by an increased focus on their environmental challenges, climate change impacts, and the need for sustainable development and adaptation. However, it's important to note that specific media coverage can vary depending on the region, the nature of the delta, and the prevailing news agenda.

AI plays a crucial role in projecting the future of delta regions through data analysis, modelling, and simulation techniques. By analysing large datasets, AI can identify trends and patterns in factors like sea-level rise, sediment deposition, and climate patterns. It can develop climate models that simulate the potential impacts of these factors on delta regions. AI algorithms can also assess the vulnerability of deltas to risks such as flooding and salinisation by analysing diverse data sources. AI-powered predictive analytics can estimate the likelihood and impacts of these risks in the future.

Furthermore, AI supports scenario planning exercises by simulating different future scenarios based on varying factors like climate change and land use. AI, including innovative platforms like DALL·E, contributes significantly to projecting the future of delta regions.

By leveraging the capabilities of DALL·E, researchers and scientists can simulate and generate visual representations of potential future scenarios for delta regions. Such decision support systems powered by AI provide insights and recommendations for sustainable development and adaptation strategies.

Combining creativity, information dissemination, and advanced technologies, we can enhance our understanding and appreciation of deltas in both their influences and physical forms. Creative expressions, such as artistic interpretations and architectural designs, can capture the dynamic nature of deltas and evoke a deeper connection with these unique landforms.
Furthermore, information dissemination through various media channels allows for the sharing of knowledge about deltas, their environmental challenges, and the importance of sustainable development in these regions. Advanced technologies, including data analysis and modelling techniques, enable us to study deltas in greater detail, understand their complex dynamics, and predict future changes. By combining these creative, informative, and technological approaches, we can expand our knowledge and foster a deeper appreciation for the beauty, significance, and ecological importance of deltas worldwide.

How will the Dutch delta look like if water becomes the new surface to build cities upon?, [author using Dall.E] (2023)

Future Dutch Deltas, [author using Dall.E] (2023)

Terp fan de Takomst, Observatorium Projects (2022)

1. Basis

"Clearly, the problem of man and nature is not one of providing a decorative background for the human play, or even ameliorating the grim city: it is the necessity of sustaining nature as source of life, milieu, teacher, sanctum, challenge and, most of all, of rediscovering nature's corollary of the unknown in the self, the source of meaning."

(McHarg, 1971)

Introduction

The rate of climate change and its impact on sea level rise are both accelerating, and anthropogenic activities are becoming the primary factors. The sea level rise rate increased from 1.9 millimetres per year on average between 1971 and 2006 to 3.7 millimetres per year on average between 2006 and 2020 (IPCC, 2021). The vulnerability of deltaic settlements to sea-level rise is amplified by a number of factors, including but not limited to non-climatic anthropogenic drivers such as historical and recent demographic and settlement trends. The land is becoming more susceptible to frequent storm surges while SLR continues at its current rate, with land submergence changing coastlines and affecting the availability of fresh water and sediment. The Rhine River delta in Europe, amongst all, are highly vulnerable to flood danger as a result of anthropogenic activity (Renaud et al., 2013; Day et al., 2016). Subsidence is one of the primary factors that contribute to the likelihood of future changes in the relative sea level (RSL). There are increased cases of shifts in the coast's ecosystems, ecosystem services, infrastructure, and habitability (IPCC, 2021). In this context, the Deltaprogramme of the Netherlands shifted the notion of climate change from a slow process that will accelerate after 2050 to a non-gradual process that is occurring now because of the uncertainty of the events. This was necessary because of the multiscalar impact of the sea level rise events (van Alphen et al., 2022). From assuming that climate change events were predictable and that the water system would react predictably to them, the problem's view shifted to assuming that both were unpredictable. The strategy required a change from adaptive planning to planned adaptation in the deltas.

Although, as of 2022, one-third of the urban agglomerations are located in the deltaic regions, the occupation of the land in the deltaic regions historically is attributed to the productivity of landscapes. We can define productivity as the ability of the landscapes to be appropriated for different activities to support the functioning of the cities. Agricultural landscapes and energy landscapes are the most prominent among these productive landscapes, which form the majority of the hinterlands of the urban centres. The development of the cities has a large spatial implication on these hinterlands, on its land use and infrastructural configuration. The primary production is based on extra-human geographies like the quality of the soil, availability of water etc. Due to the supply chain, it is mostly the case that the construction of landscapes and the activities in one place is related to the transformation of a landscape elsewhere, forming reciprocal landscapes (Hutton, 2019). Infrastructure is to be considered both the site and the system where it is designed, constructed and continuously reconstructed (Bélanger,2013).

With more than 3000 people per square km, the Netherlands is a small country with a dense population. It lacks most of the essential natural resources for large-scale agriculture, yet it is the second largest food exporter in the world, only behind the United States, which has 270 times its landmass. Utilising the world's most efficient agricultural technologies has made this possible. More than fifty per cent of the land in the Netherlands is devoted to agriculture and horticulture, with 175 acres of land being occupied by greenhouse complexes. These climate-controlled farms contribute to the Netherlands' global leadership in the sectors of food and flower production throughout the year (Viviano, 2017).

The Dutch ports play a crucial role in food exports globally, and incidentally, these are also the hubs for energy production in the Netherlands with the availability of oil, petrochemical products, renewable energy potentials and logistical infrastructure (Hein & van de Laar, 2020). However, SLR pushes them into a state of vulnerability as these landscapes of economic productivity are rendered susceptible to land submergence, groundwater and soil salinisation, damage to biodiversity and land loss due to permanent coastal erosion (IPCC, 2021).

Aside from the Wadden Sea, the Dutch delta is no longer natural: rivers have been embanked, and most floodplains have been turned into polder systems (cutting off natural sediment supply), the coastline is artificially maintained with beach nourishments, the inlets and estuaries have been closed with dams or protected by storm surge barriers, and former lakes have been drained and turned into polders, with ground surface levels up to 6 m below the mean sea level. The impact of sea-level rise on the Dutch delta is determined based on three essential aspects of delta management: maintenance of the littoral, flood protection, and supply of fresh water (van Alphen et al., 2022).

To respond to the problem of sea level rise, IPCC (2014) identified four ideological approaches

1. **Protection** reduces the impact of the events by blocking the land
2. **Retreat** reduces the exposure to events through displacement
3. **Advance** creates new lands by reclamation
4. **Accommodate** adapts for the change by reducing the vulnerability of the environment.

Building upon these approaches, Deltares and the Delta Commissioner developed four approaches for the Dutch context.

1. **Protect - closed** (Beschermen gesloten)
2. **Protect - open** (Beschermen open)
3. **Advance** (Zeewaarts)
4. **Accomodate** (Meebewegen)

In this context, where there was a long-standing tradition of constantly engineering water and land to accommodate human activities and the built environment, the retreat is not considered an approach. Here, protection is subdivided into protect-closed, in which the land and river systems are protected from the sea, and protect-open, in which the river opens to the sea and land is protected by dikes along all river borders. (Deltacommissaris, 2014).

While protection is the most prevalent response to SLR, reducing flood risk through hard protection increases infrastructure capital and maintenance expenditures. In addition, these large-scale infrastructure projects like the Dutch Deltaworks are time-consuming for their design and construction, this approach is counterproductive for extreme sea level rise because these systems offer less design flexibility to account for uncertainties. In contrast, accommodation employs principles to reduce vulnerability by adapting to the change, as opposed to protecting against the problem. Historically, this approach's measures are not directly due to sea level rise but rather a response to coastal hazards such as flooding, salinisation, and cyclones. Nevertheless, these measures have increased the landscape's resilience without retreating by adapting to the changes through biophysical measures such as transitioning to salt-tolerant crops and marine parks, and institutional measures such as integrated coastal management. (IPCC, 2021)

Current land planning and management is based on the functional segregation of land uses. Here, the potential for an integrated approach to adaptive landscape use is minimal. There is an increased need for a paradigm shift from protection-based planning to planning for adaptation to design for uncertainties. In the case of productive landscapes, this calls for integrating territorial organisation and adapting the critical infrastructure to the uncertainties of sea level rise.

Conceptual and Theoretical Framework

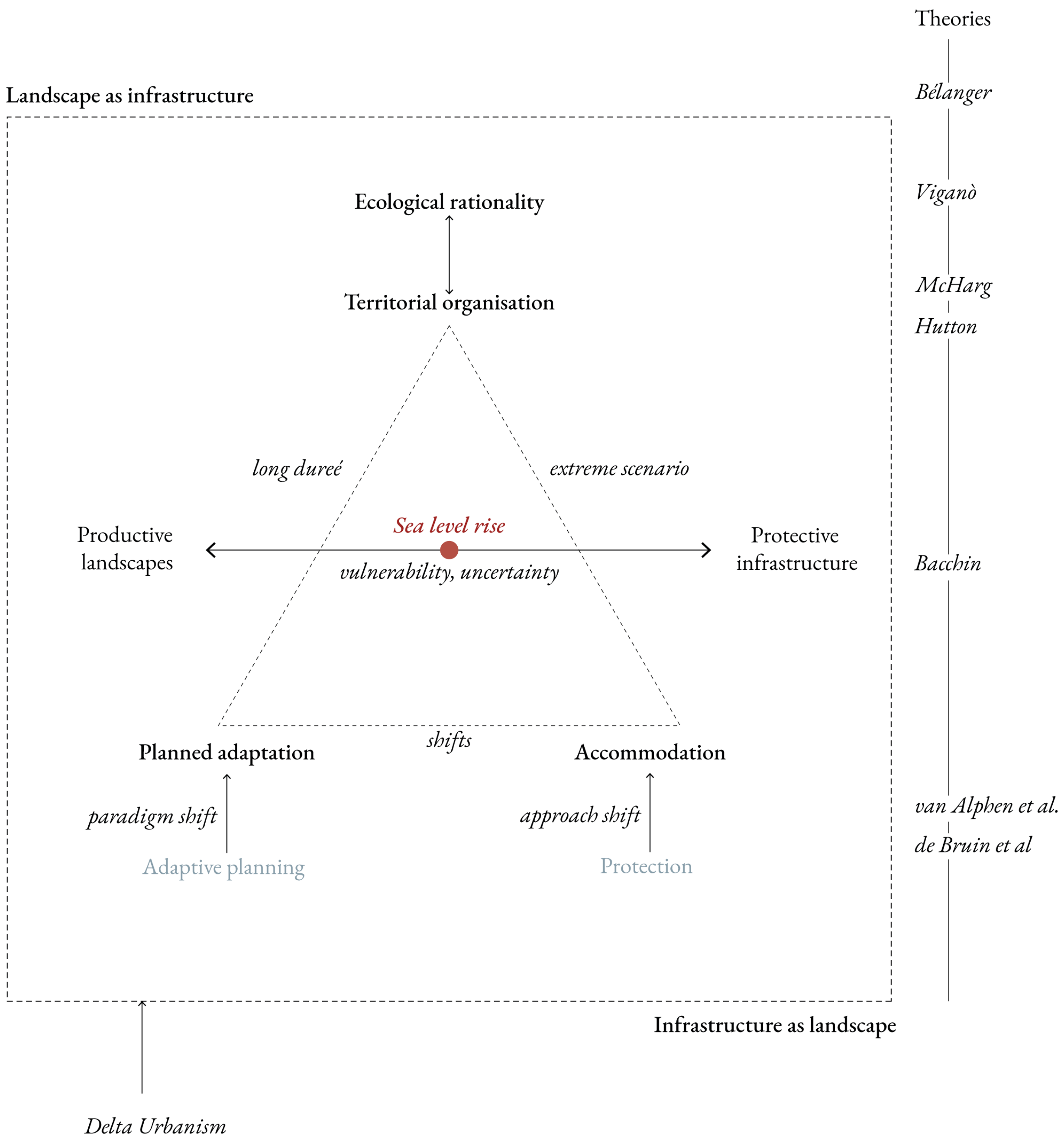
The framework illustrates the main concepts that the research is based on. Productive landscapes and protective landscapes respond to sea level rise. The uncertainty of sea level rise has spatial implications on the landscape, making it vulnerable to salinisation, subsidence, submergence and storm surges. The spatial response to this combines territorial organisation, the approach of accommodation and planned adaptation for extremes.

The territorial organisation refers to the spatial distribution and dynamics of spatial interaction of landscapes and infrastructures. The approach of accommodation is fundamental for extreme adaptation. So the approach for design shifts from protection to accommodation. Parallelly it focuses on the paradigm of planned adaptation instead of adaptive planning.

The main theoretical premise is to find the balance between landscapes as infrastructure and vice versa. When landscapes are seen as infrastructures, design strategies can be launched between short immediate interventions that are gradual and sequenced over a large period with large geopolitical and ecological effects. If infrastructures are landscapes, they can be strategic interventions that span extremely short and immediate intervals across different scales. (Bélanger,2013)

The idea of longue durée termed by Braudel in1958 is adopted to explore the long term impacts and potentials of the solutions. The ability to plan and explore over extended periods of time opens up ways of inquiry that would be impossible under shorter time constraints. Possibilities that can be pursued across longer periods of time are technological opportunities that can be developed and implemented. Thinking in extremes allows pushing the boundaries of design thinking, envisioning an alternate future and shifting pedagogic approaches(Vigano, 2010).

Ecological rationality is the capacity of human and natural systems to handle the ecological and urban problems of : complexity, non-reducibility, variability in time and space, and uncertainty. (Viganò, 2013). Territorial resilience is strengthened by various processes in which the different forms of ecological rationalities are manifested as infrastructures. The territorial organisation is the spatial function of this rationality.


Theories
Landscape as infrastructure
Bélanger
Viganò
Ecological rationality
McHarg
Territorial organisation
Hutton
long dureé
extreme scenario
Productive landscapes
Sea level rise
Protective infrastructure
vulnerability, uncertainty
Bacchin
shifts
Planned adaptation
Accommodation
paradigm shift
approach shift
van Alphen et al.
Adaptive planning
Protection
de Bruin et al
Infrastructure as landscape
Delta Urbanism

Research Questions

"How can the vulnerable productive landscapes in the deltas adapt to sea level rise?"

[*Sub-questions*]

How does sea level rise make the productive landscapes vulnerable in the Dutch delta?

To understand the importance of productive landscapes: agricultural landscapes and energy landscapes within the Dutch delta. The agricultural landscapes are integral to the Dutch economy as the Netherlands generates large amounts of revenue through exports of agricultural products across the globe. A majority of these exports are carried out through the major ports located in the Dutch delta, which are also hubs for energy production, thus becoming critical points of productivity. SLR poses an impending threat to productive landscapes through land submergence, groundwater and soil salinisation, biodiversity loss and permanent coastal erosion.

Why do the Dutch productive landscapes and protective systems need to adapt to sea level rise through the approach of accommodation?

The Dutch have waged a constant battle against the rising sea over the past few centuries by creating an artificial protection system against water which closes off rivers, lakes, floodplains and estuaries. But the advent of climate change and extreme SLR projections in the near future calls for a pedagogic shift from these conventional approaches. Thus the approach of accommodation calls for extreme adaptations within the productive Dutch landscapes.

Why is there a need to use nature-based solutions (NbS) to synergise productive and protective systems for extreme adaptation?

The advent of climate change has increased the environmental, social and economic challenges that threaten the resilience of the urban settlements and the surrounding productive landscapes. Nature-based solutions(NbS), a term coined by the International Union for Conservation of Nature (IUCN) in 2016, have emerged as a concept for integrating ecosystem-based approaches and increasing urban resilience (Bush & Doyon, 2019). Nature-based solutions are approaches that use nature and its processes to address societal and environmental challenges like SLR using nature-based interventions such as coastal protection through beach nourishment, dune restoration and so on. Urbanism and spatial design can play a decisive role in implementing multifunctional nature-based solutions across temporal and spatial scales and managing the synergies and trade-offs between the productive and protective systems for extreme adaptation. This also reflects on Viganò's (2013) concept of ecological rationality.

[*What-if question*]

"What if productive systems and protection systems are integrated for extreme climatic adaptation in the longue durée?"

This scenario explores the integration of the productive and protection landscapes, which are currently monofunctional and fragmented systems, in order to adapt to extreme climatic changes in the longue durée. This extreme scenario is defined for the year 2100 considering a possibility of 3m SLR and RCP 8.5 (IPCC 2019) and projections by Dutch National Water and Floods Information System (LIWO), which presents an opportunity to think and design for future uncertainties through 'extreme scenario'.

Methodology

To investigate the research questions abductive method is used primarily as the research type. This integrates the explorative and evidence-based methods of inductive research and deductive research. The what-if approach is used as an experiment to create an extreme scenario and detail for extreme adaptation of productive and protective systems for sea level rise. Here methods structures interview, field observations and research by design through sections are used to generate integrated concepts that provide conclusions through design solutions.

Method Descriptions

1. Literature Review

The objective of the literature is to understand the critical landscapes, planning paradigms and approaches to the sea level rise. This is used as a method to identify the problem statement, which is the basis of the research question. The chapter on sea level rise in the Intergovernmental Plan for Climate Change assessment report (IPCC, 2021) was reviewed to understand the drivers, effects and projections that make the landscapes vulnerable to the impacts and the general approaches to SLR. The general and contextual approaches by IPCC and Deltares (van Alphen et al., 2022) towards sea level rise were studied to identify the approach for extreme adaptation to living with water. Extreme conditions from these scenarios are used as the conditions for design problems. The concepts of Landscape Infrastructure (Bélanger, 2013) and Reciprocal Landscapes (Hutton, 2019) were studied to understand the spatial implication of the infrastructures and production landscapes. Literature from Vivano (2017) and Hein & van de Laar (2020) was used to identify the potential of productive landscapes in the Netherlands. These were used as tools to diagnose the problem and identify the need for paradigm shifts and approaches. Based on the concepts of longue durée and extreme scenario, to design for uncertainties, a scenario is defined based on the projections by IPCC (2019) and Haasnoot (2019). Considering the extreme greenhouse gas emission of RCP 8.5 and the high acceleration of the rate at which the Antarctic, Greenland and glacial sheets are melting, the maximum sea level is projected to rise to 3m in 2100. This extreme condition is used as the scenario to test the design of the integrated productive and protective systems.

2. Critical Cartography

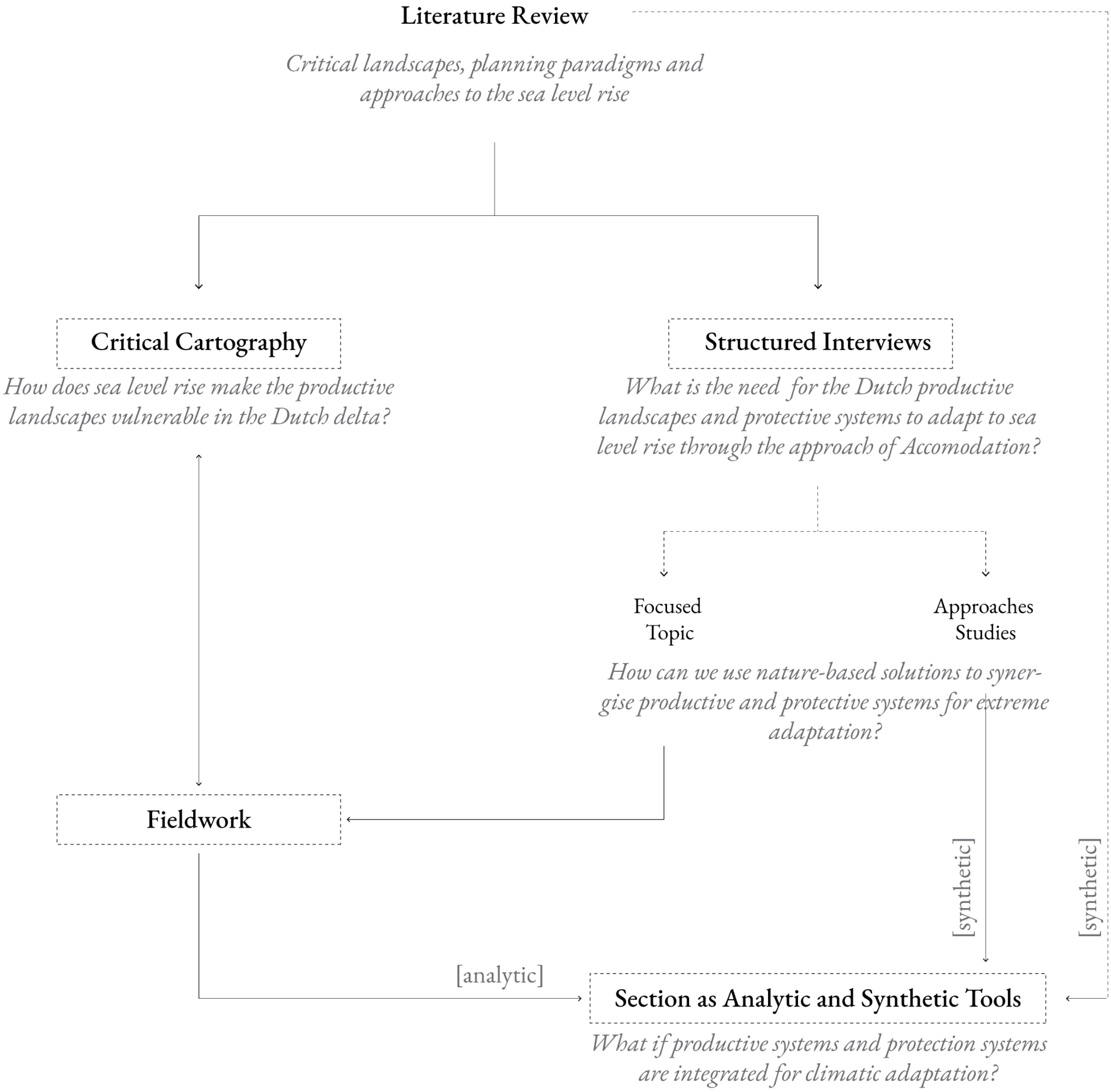
In addition to the literature review, critical cartography is used as a method to study the question — *How does sea level rise make the productive landscapes vulnerable in the Dutch delta?*

At the planetary scale, mapping productive landscapes is done first to understand the global agricultural climatic zones. Secondly, the major global ports with energy landscapes are mapped, highlighting their trade connections to the Netherlands. Satellite imagery is used to understand the spatial patterns of these landscapes.
At the scale of the Netherlands, cartography is used as an analytical tool by drawing exaggerated transects across the country to understand the relation between the location of the productive landscapes and the elevations. This method is also used to create synthetic maps to understand the effect of the sea level rise by mapping the submergence to projected levels by Deltares and also the network of protection infrastructure.

3. Structured interviews to experts

The objectives of the expert interviews are to understand the critical need for the extreme adaptation. The subquestion — *What is the need for the Dutch productive landscapes and protective systems to adapt to sea level rise through the approach of Accomodation?* and *How can we use nature-based solutions to synergise productive and protective systems for extreme adaptation?* These consists of four concepts - productive landscapes, protective systems, extreme adaptation and accommodation. Experts in research, academics and practice are interviewed to understand the urgency of the whole question. The interview has two parts. The first part consists of the same questions which are asked to the interviewees. The answers are compared to analyse the approaches qualitatively. The second part consists of questions focused to each interviewees based on their expertise to understand the state-of-art approaches to the problem of sea-level rise and the use of accommodation approach in the Dutch Deltas.

Interviewees:
Practice - *Defacto Urbanism, Flux Landscape Architecture*
Academics/Research - *Fransje Hooimeijer, Steffen Nijhuis*



Methodological Framework

4. Fieldwork

To test the design strategies, a paradigmatic area is selected in the Netherlands. It is a mode to stimulate design thinking to explore an integrated approach with the learning from the external case workshop. But to apply the learnings, a smaller context: field is selected within the Netherlands with the following criteria

- High vulnerability to sea level rise - susceptibility to storm surges, groundwater salinisation, land submergence and subsidence.
- Presence of critical productive landscapes - energy and agriculture
- Presence of critical protection infrastructure - large dikes and barriers for adaptation
- Presence of natural protection structures like dunes for learning and integrating nature-based solutions.

The selected site is studied and visited to analyse the spatial characteristics of the landscapes and design is used as a method to project the performance and adaptive capacity of the protection structures. The outcome of the field visit includes photographic documentation, a sectional profile of the site.

5. Section as an analytic and synthetic tool

Sections are usd to experiment with the what-if approach - *What if productive systems and protection systems are integrated for climatic adaptation?*

The extreme conditions and time scale defined are used to synthesise a design solution based on ecological rationale. The detail of this design responds to and contains the spatial structure, planned adaptation strategy and the system detail. Since it is a paradigmatic area, the principle working method is to use sections. A path is selected in the site of experimentation and unique sections are cut across this path. The boundary conditions - sea level rise, salinity, subsidence are projected on these sections. Design of these sections are used to experiment with the strategies to integrate productive and protective systems.

Disciplines

Urbanism

Urbanism plays a pivotal role in the territorial reorganisation and strategic development of the vulnerable deltaic region in the context of climate change and sea level rise. Our project is based upon the key concepts of Delta Urbanism which is a specialised field within Urbanism that facilitates an interdisciplinary approach integrating flood protection strategies, water management with spatial design while planning for extremities and shifts in the longue durée . Delta Urbanism aims at re-envisioning spatial structures and forms through developing innovative, strategic solutions that combine the concepts of adaptive planning , protection and ecological rationality and creating synergies between the productive landscapes and the protective infrastructural systems. The programmatic transformation of the landscape systems and infrastructures are integral to the design research and contributes to the critical understanding of the natural and anthropolological systems and processes.

Landscape Architecture

In addressing the challenges of climate change and sea-level rise in vulnerable deltaic regions, landscape architecture combines various strategies and approaches to promote resilience, sustainability, adaptability, and community inclusivity. This research seeks to incorporate those design disciplines that landscape architecture has developed specifically for vulnerable deltaic regions and find a harmonious balance between landscapes and infrastructure, recognizing their reciprocal relationship. Through its multidisciplinary approach, landscape architecture facilitates a continuous and meaningful dialogue between productive landscapes and protective infrastructural systems. By fostering this interaction, landscape architecture enhances the effectiveness of design strategies, which encompass a range of interventions, from short-term immediate actions to gradual and sequenced measures implemented over an extended period. This holistic approach results in significant geopolitical and ecological impacts, ensuring the resilience, sustainability, and well-being of vulnerable deltaic regions.

2. Context

Mapping the vulnerability of productive landscapes to Sea-level rise

The Dutch landscape is known for its high agricultural productivity which has enabled the Netherlands to become one of the global leaders in agricultural exports. This is further facilitated by the presence of major ports, such as the Port of Rotterdam, within the Dutch Delta which ship these agricultural products to numerous ports located within varying agro-climatic zones across the world. However, the pressing issue of sea level rise due to climate change poses a serious threat to these productive landscapes which are primarily located within the Dutch lowlands.

In the following chapter, the method of Critical Cartography is used as an analytical tool to understand and map the significance of the Netherlands in global food production and trade. Thereafter, the productive landscapes and the protective dike infrastructures are analysed and mapped to understand their spatial correlations and the vulnerable regions as a result of sea level rise in 2100.

The cartographic process is followed by a series of structured interviews to experts from both Academics and Practice, belonging to the field of Delta Urbanism in order to understand the critical needs for extreme adaptation in the longue durée.

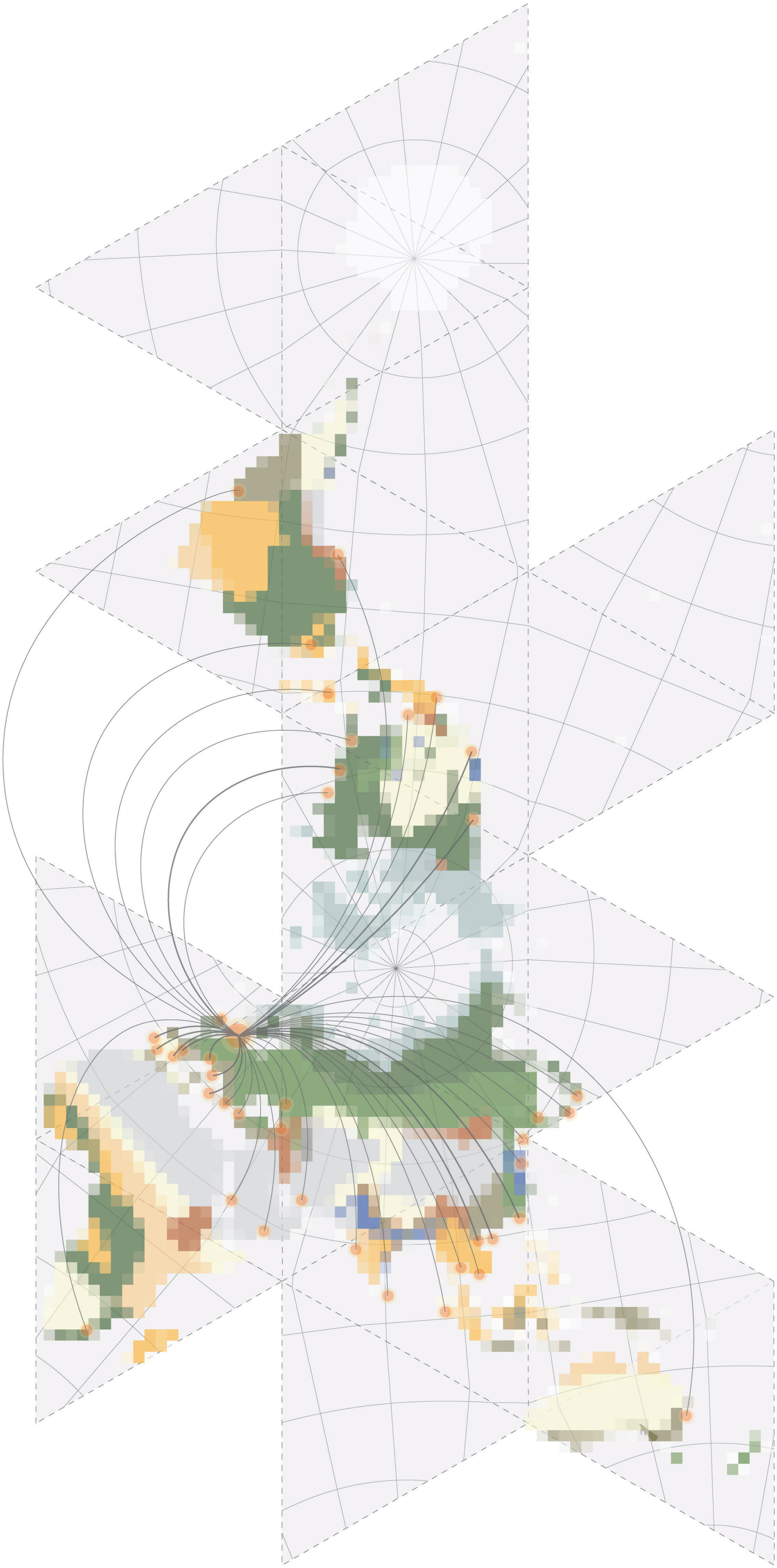
Composition of agroclimatic zones and location of ports with major connections to the Netherlands

The map figure illustrates the agricultural and the port landscapes around the world as well as the significance of the Netherlands in the global context.

- Rainfed agriculture: Humid tropics
- Rainfed agriculture: Dry tropics
- Rainfed agriculture: Subtropic
- Rainfed agriculture: Temperate
- Rainfed agriculture: Highlands
- Rangelands: Subtropics
- Rangelands: Boreal
- Irrigate crops: paddy rice
- Forest
- Desert

- Major global ports

Cartographic references
Agricultural Systems, Food and Agriculture Organisation, 2011
UN Comtrade Database, 2022
Dymaxion Map Transformations , Kitrick, Christopher & Jolla, La., 2018.



Rainfed agriculture: Humid tropics

Rainfed agriculture: Dry tropics

Rainfed agriculture: Dry tropics

Rainfed agriculture: Temperate

Rainfed agriculture: Highlands

Rangelands: Subtropics

Rangelands: Boreal

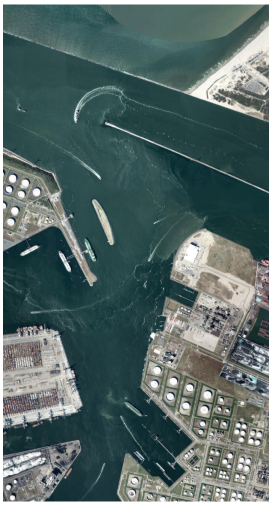
Irrigate crops: paddy rice

Forest

Desert

Satellite images of the agriculture and major ports , from ESRI

Rotterdam,
Netherlands



Hamburg,
Germany

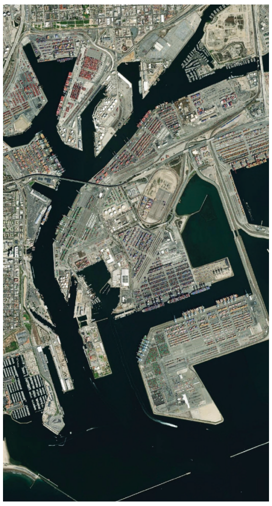
Antwerp,
Belgium

Le Havre,
France

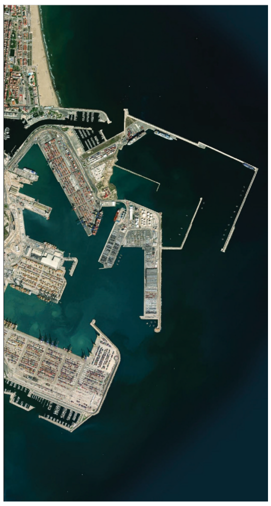
London,
United Kingdom

Trieste,
Italy

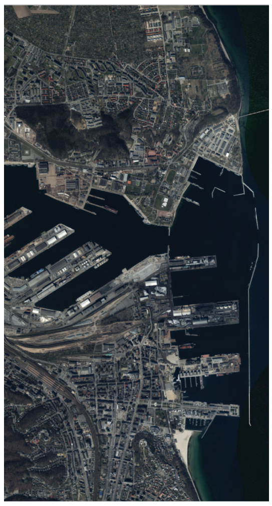
Schenzen,
China



Los Angeles,
USA



Valencia,
Spain



Gydinia,
Poland

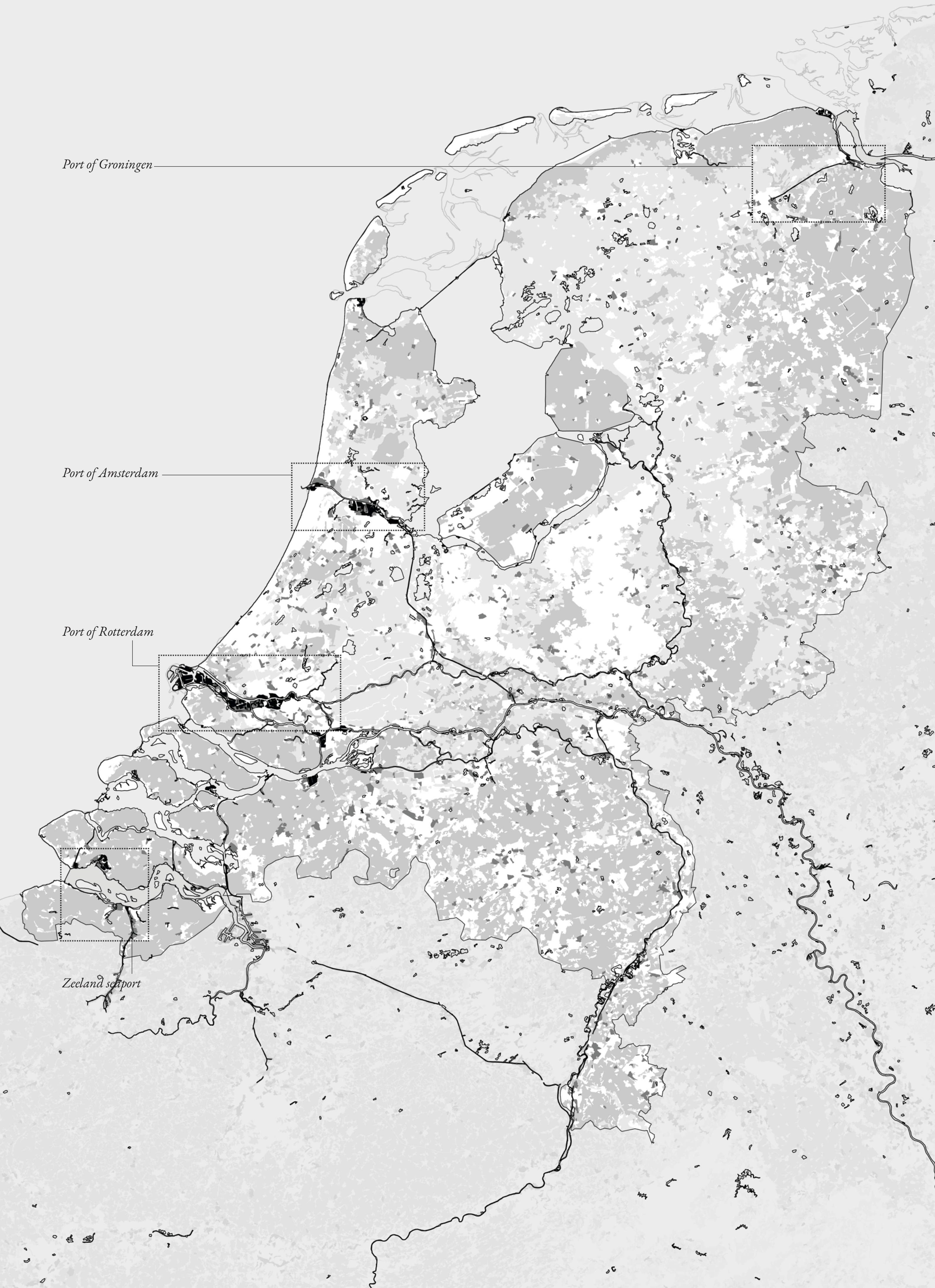
Frame 1

Map of the Netherlands with agricultural and port landscapes.

Ports
Industrial
Cropland
Pastures

25 50km N

Cartographic References
Corine land cover change, Copernicus Programme, European Environmental Agency (2018)


Port of Groningen
Port of Amsterdam
Port of Rotterdam
Zeeland seaport

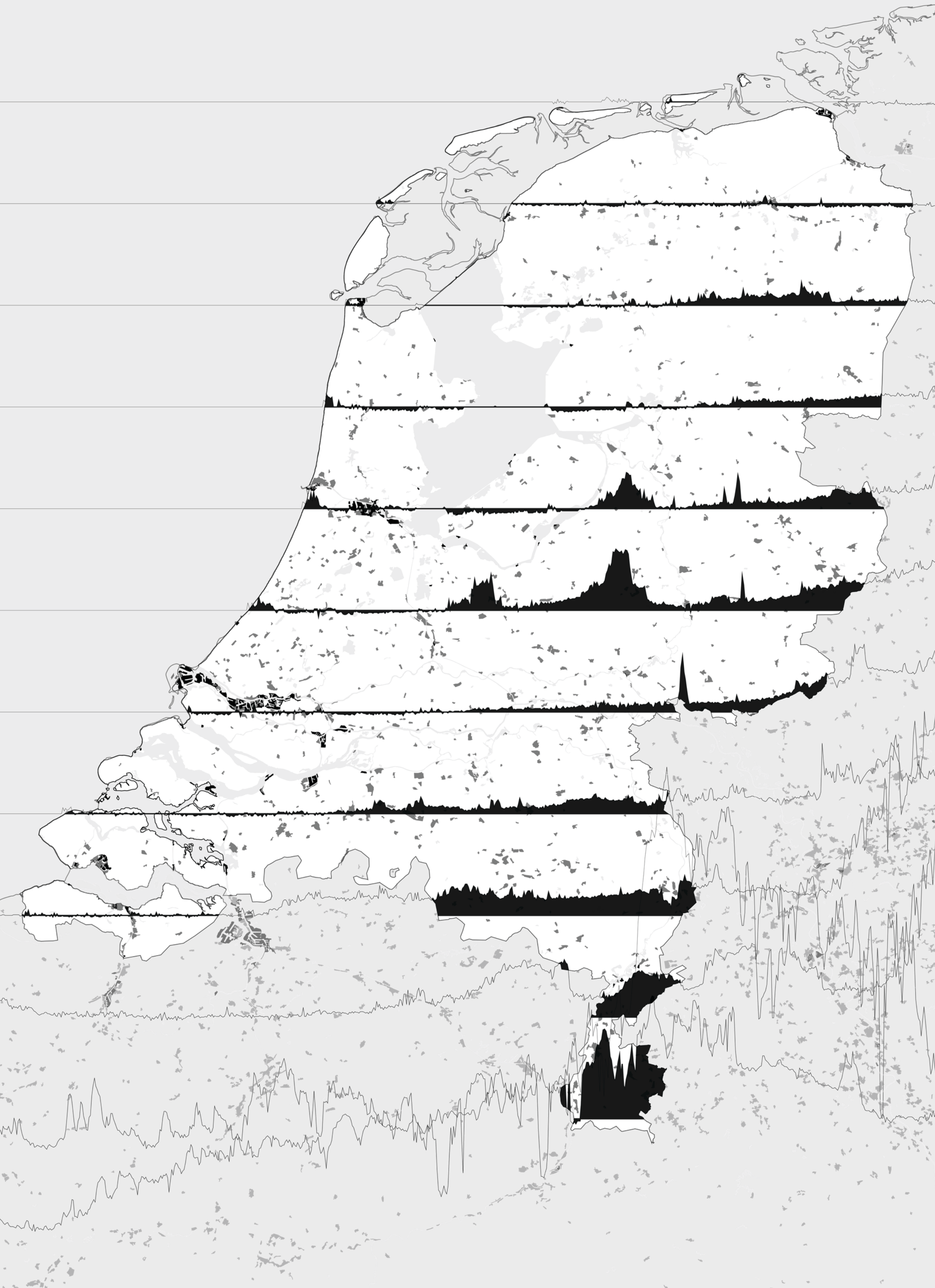
Frame 2

Map of the Netherlands with sectional transects the election exaggerated by 20 times.

■ Terrain Profile from MSL

| 25 | 50km N

Cartographic References
Corine land cover change, Copernicus Programme, European Environmental Agency (2018)
Profiling from Shuttle Radar Topography Mission (NASA server)



Frame 3

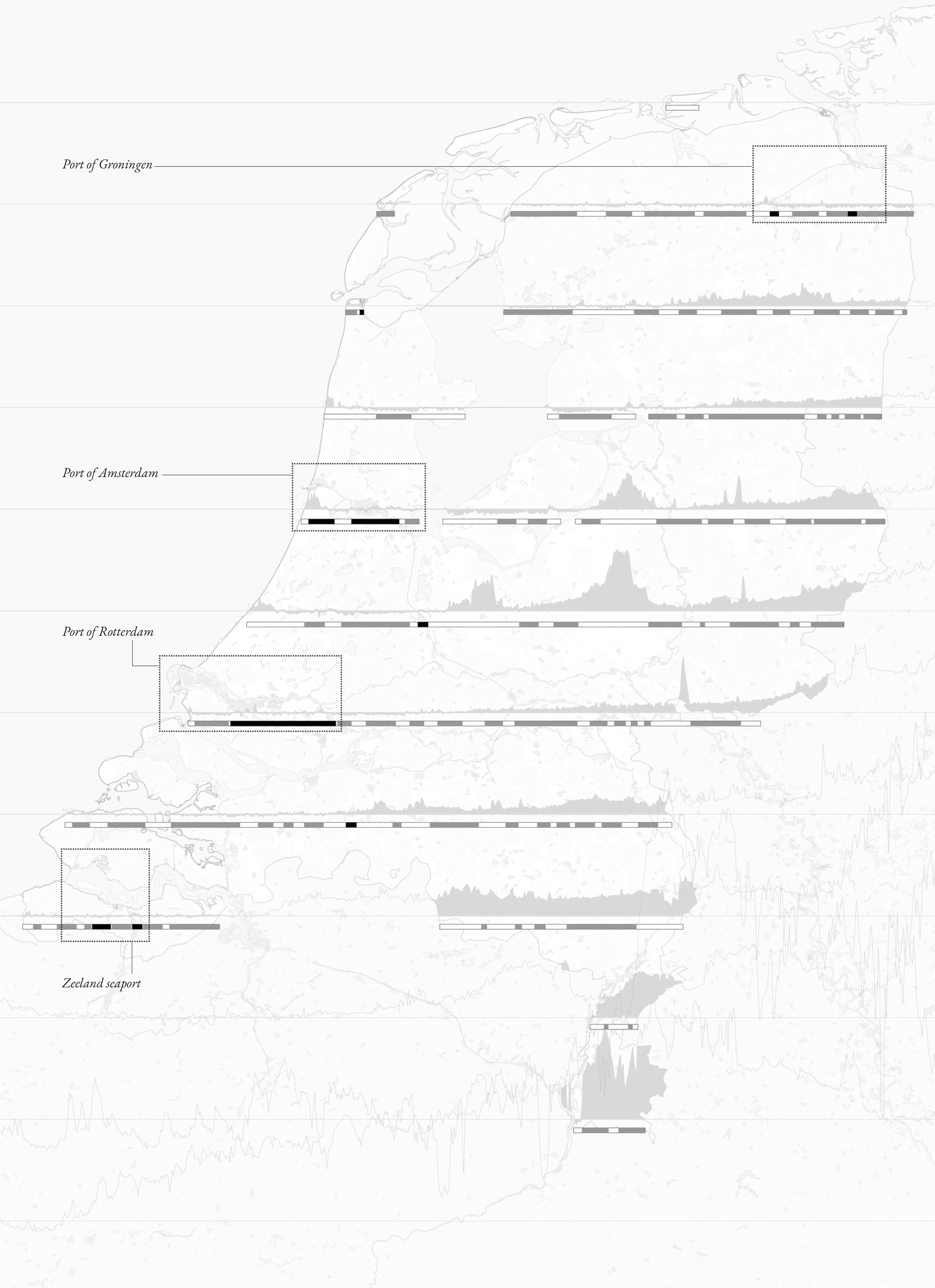
Map of the Netherlands highlighting the productional parts of the sectional transects and the location of the major Dutch ports

Ports

Agriculture

| 25 | 50km | N

Cartographic References
Corine land cover change, Copernicus Programme, European Environmental Agency (2018)
Profiling from Shuttle Radar Topography Mission (NASA server)


Port of Groningen
Port of Amsterdam
Port of Rotterdam
Zeeland seaport

Frame 4

Map of the Netherlands highlighting the productive landscapes vulnerable to extreme case sea level rise of 3m by 2100

Deeper Productive landscapes wrt MSL

Shallower productive landscapes wrt MSL

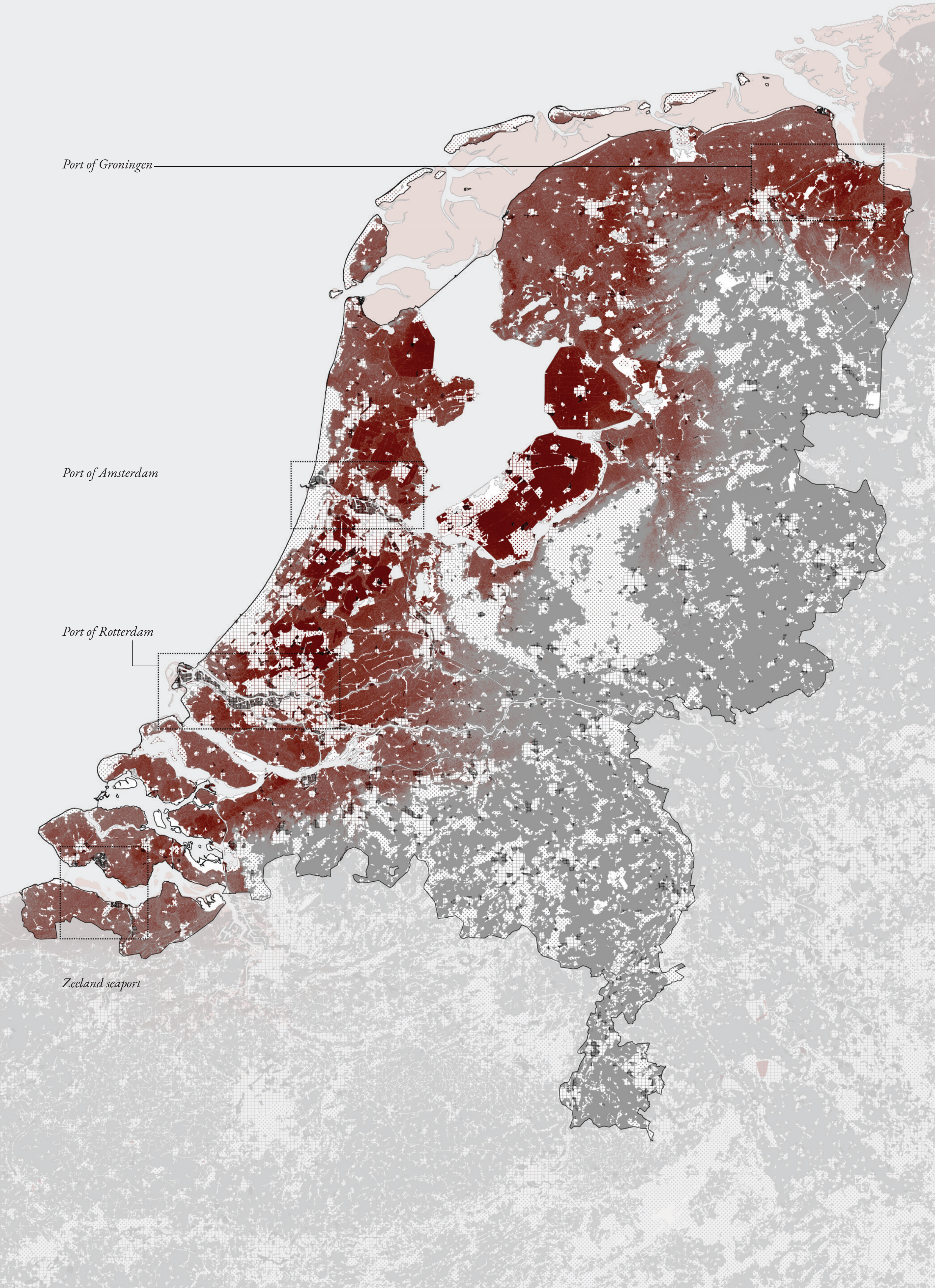
25 50km N

Cartographic References

Corine land cover change, Copernicus Programme, European Environmental Agency (2018)

Profiling from Shuttle Radar Topography Mission (NASA server)

van Alphen, J.; Haasnoot, M.; Diermanse, F. Uncertain, Accelerated Sea-Level Rise, Potential Consequences, and Adaptive Strategies in The Netherlands. Water, 2022, 14, 1527.


Port of Groningen
Port of Amsterdam
Port of Rotterdam
Zeeland seaport

Frame 5

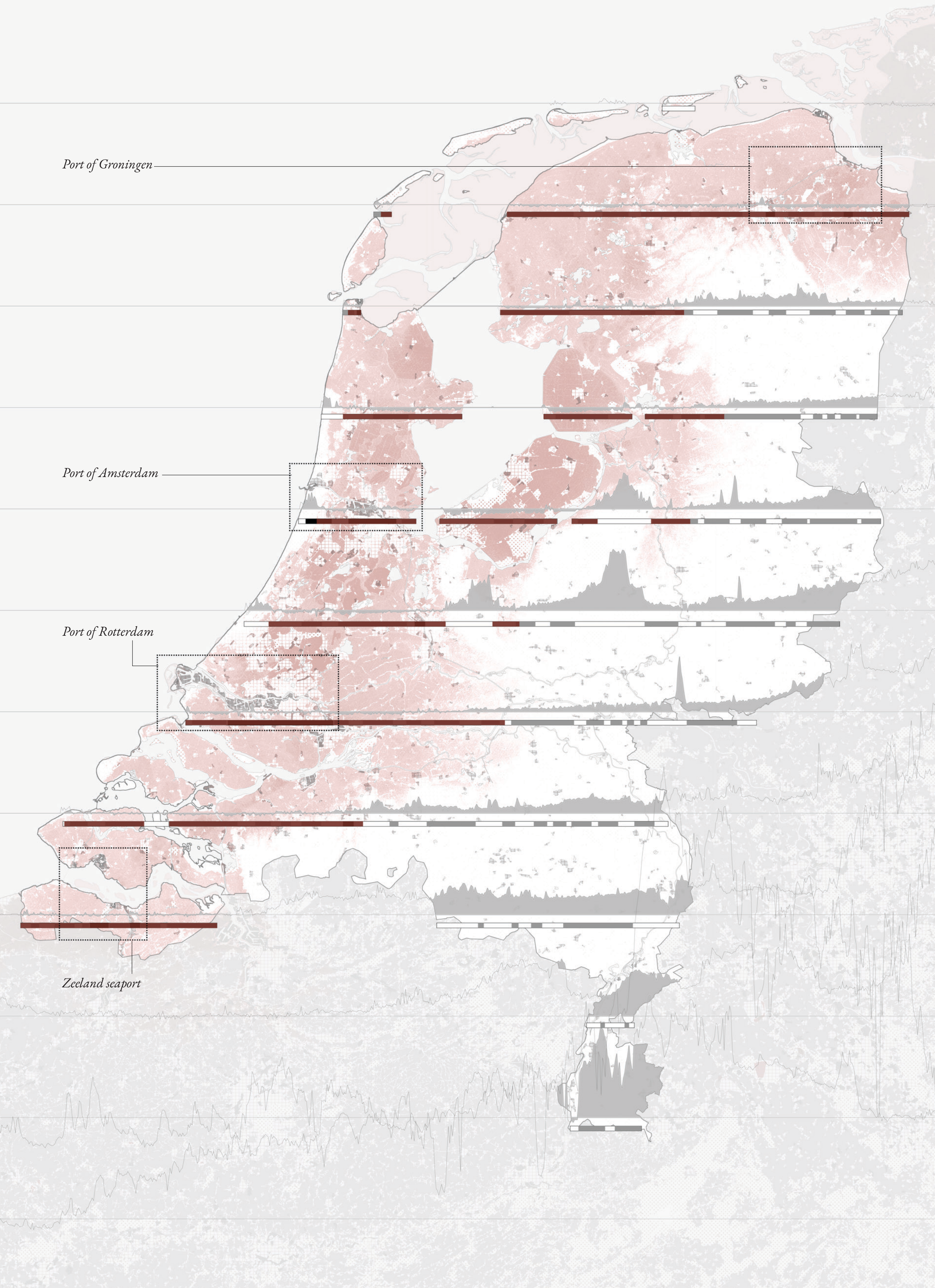
Map of the Netherlands highlighting the productive landscapes vulnerable to extreme case sea level rise of 3m by 2100 on the transects

Affected productive landscapes without consideration of the dykes

25 50km N

Cartographic References

Corine land cover change, Copernicus Programme, European Environmental Agency (2018)
Profiling from Shuttle Radar Topography Mission (NASA server)
van Alphen, J.; Haasnoot, M.; Diermanse, F. Uncertain, Accelerated Sea-Level Rise, Potential Consequences, and Adaptive, Strategies in The Netherlands. Water, 2022, 14, 1527.


Port of Groningen
Port of Amsterdam
Port of Rotterdam
Zeeland seaport

Synthetic map

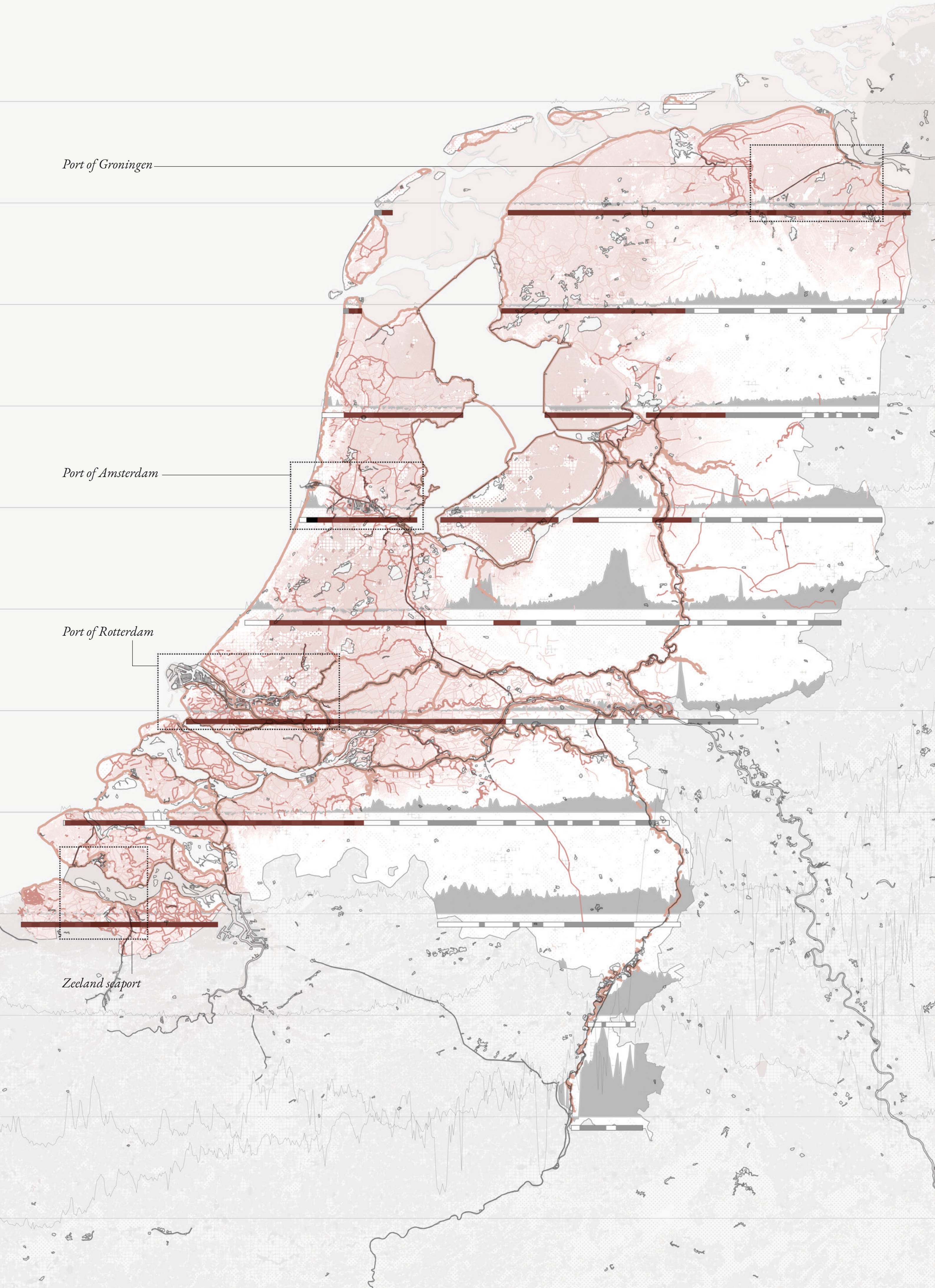
Map of the Netherlands highlighting the productive landscapes vulnerable to extreme case sea level rise of 3m by 2100 on the transects and the dyke system

Existing dyke system

Affected productive landscapes without consideration of the dykes

| 25 | 50km N

Cartographic References
Corine land cover change, Copernicus Programme, European Environmental Agency (2018)
Profiling from Shuttle Radar Topography Mission (NASA server)
RCE dijkenkaart, Rijksdienst voor het Cultureel Erfgoed, 2021



Port of Groningen
Port of Amsterdam
Port of Rotterdam
Zeeland seaport

Structured interviews with experts from Academics and Practice

The objective of the expert interviews was to understand the critical need for the extreme adaptation.

What is the need for the Dutch productive landscapes and protective systems to adapt to sea level rise through the approach of Accomodation?

Why is there a need to use nature-based solutions (NbS) to synergise productive and protective systems for extreme adaptation?

The interviews were structured in two parts. The first part consisted of common questions which were asked to the interviewees. The answers were compared to analyze the approaches qualitatively. The second part consisted of questions focused to each interviewees based on their expertise to understand the state-of-art approaches to the problem of sea-level rise and the use of accommodation approach in the Dutch Deltas.

Fransje Hooimeijer [Associate Professor, Environmental Technology and Design, *TU Delft A+BE*]

F. Hooimeijer talks on how the Netherlands' rising sea level affects the integration of productive and defensive systems. She highlights the significance of the accommodation technique, which goes beyond merely using precautions and entails living with water. Fransje emphasises how important it is to investigate localities for possible transitions and safeguards that would benefit both natural and human systems. She also discusses design-oriented methodology that builds flexible solutions by including design research and long-term potentials.

Steffen Nijhuis [Associate Professor, Landscape Architecture, *TU Delft A+BE*]

S. Nijhuis concentrates on the idea of accommodation from the standpoint of academic research, highlighting the landscape's flexibility and capacity to alter depending on the circumstance and setting. He cites the Room for the River initiative as an effective illustration of lodging. Steffen argues in favour of combining ideas from a variety of disciplines, including governance, landscape ecology, and geology, to create sturdy, multifunctional buildings that may change over time. In addition, he talks about the transition from adaptive planning to planned adaptation, emphasising the significance of approaching crises from a long-term viewpoint.

Mona Zum Felde [Urban Designer, *Defacto Urbanism*]

Mona discusses the need for a paradigm shift towards accommodation techniques that incorporate living with water, offering insights from the practice perspective. She emphasises the significance of a comprehensive, integrated strategy that incorporates all relevant parties and modifies urban and rural design to account for water. Political, financial, and geographical factors are only a few of the chances and problems that Zum Felde highlights in the process of bringing about this change. She highlights that long-term accomodation techniques are viable, even with the difficult choices and adjustments they require.

Bram Willemse [Urban Designer, *Flux Landscape Architecture*]

Bram discusses the integration of natural systems and dynamics of accommodation in landscape architecture. He promotes designs that can be modified throughout time by providing examples of creative initiatives that combine protective measures with useful landscapes. He emphasises how crucial it is to incorporate living things into designs, work with nature, and take climate change-related environmental changes into account. According to him, accommodation entails creating designs that are durable and fruitful in the face of uncertainty, as well as thriving beside what nature has to offer.

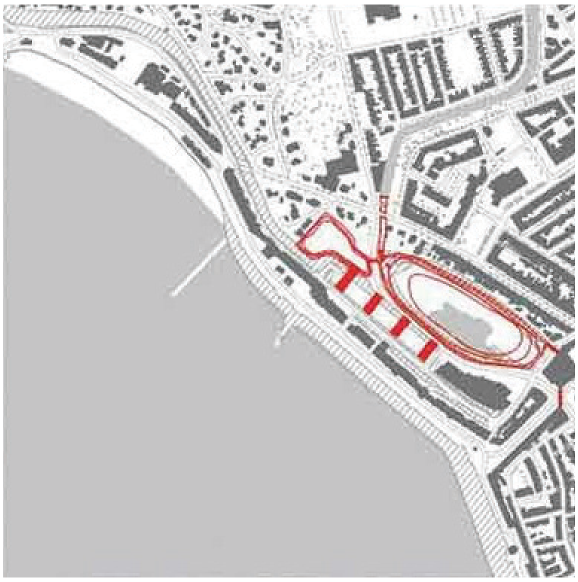
Views on approach of Accommodation

Fransje Hooimeijer and Steffen Nijhuis offer more academic perspectives, emphasising theoretical underpinnings and the importance of multifunctional, adaptable structures.

Fransje Hooimeijer highlights the academic perspective, emphasising the importance of flexibility in understanding and investigating the potential for paradigm shifts in flood defence. She contends that accommodation does not imply the end of protection, but rather the need to study localities in order to find reasons for protection or transition, viewing it as synonymous with investigating potentials and reasons for specific actions in given areas. She highlights this with the Vlissingen project. Here the approach allowed water to overflow the dike during severe storms, blending the protective system into the natural landscape. This project exemplifies accommodation by managing flood risk using natural processes rather than traditional protective measures such as dikes. Steffen Nijhuis focuses on the integration of protective and productive systems, advocating for robust structures that can adapt over time. He emphasises the importance of multifunctionality in these structures to ensure long-term usability, as well as the need for a regional perspective in defining their functions, advocating for working with principles rather than fixed solutions to adapt to changing environmental conditions .

Mona Zum Felde and Bram Willemse, on the other hand, discuss the practical challenges and mindset shifts that stakeholders and the larger community must make in order to effectively implement accommodation strategies. Mona discusses the practical perspective, arguing that accommodation necessitates a paradigm shift away from current practices that focus solely on protection. She acknowledges the difficulties in implementing accommodation strategies, particularly in the absence of clear political statements or contradictory investments, and emphasises the long-term viability of accommodation despite the need for immediate, sometimes difficult, decisions. Bram observes that, from a practical standpoint, accommodation is becoming more realistic for clients, influenced by recent climatic extremes that have highlighted the limitations of relying solely on traditional flood defences. He proposes that these extremes, beyond sea level rise, are making stakeholders more open to accommodation strategies.

Across the responses, there's an underlying consensus on the necessity of integrating accommodation with protection efforts, highlighting the complexity of adapting to climate change and sea-level rise through innovative, flexible, and integrated approaches.



Vlissings and Spuikum model , Hooimeijer et. al. (2022).

The thoughts on the transition from adaptive planning to planned adaptation show that everyone agrees on the significance of including long-term considerations into spatial design. While both approaches are recognised as necessary, the emphasis on planned adaptation reflects a larger movement towards sustainability and resilience in the face of climate change and environmental uncertainty.

Fransje and Bram's discussions highlight the importance of design and research in bridging the gap between short-term solutions and long-term strategies, implying a combination of technical and creative problem-solving methods. Bram offers a nuanced perspective, defining adaptive planning as dealing with uncertainty as it arises and planned adaptation as anticipating uncertainty over time. He proposes that planned adaptation entails creating systems that fit both the current ecosystem and anticipate future changes. Bram's viewpoint emphasises the significance of incorporating time and change into the design process, advocating for solutions that are both adaptable to current conditions and capable of evolving over time. Fransje discusses the importance of both planned adaptation and adaptive planning, arguing that the shift is more about incorporating long-term perspectives than a fundamental change in approach. She contends that while the methodology remains the same, the outlook now includes long-term considerations in addition to the importance of design research or research by design. This inclusion represents a cultural shift towards incorporating design into strategic planning, reintroducing vision-driven development in the Netherlands.

Steffen's views emphasise the importance of altering mindsets in order to meet future difficulties more effectively, while Mona highlights the practical and regulatory challenges of executing such a transformation. Steffen emphasises the value of long-term thinking over rapid problem solving. He distinguishes between adaptive planning, which entails anticipating and responding to unforeseen obstacles, and planned adaptation, a more flexible approach that adapts plans and activities in response to changes, uncertainties, and unexpected events. Nijhuis references the Room for the River project as an example that embodies the principles of planned adaptation. This project, which involves creating more space for rivers to manage floodwaters more effectively, is indicative of a long-term, anticipatory approach to water management. This characteristic indicates a more proactive and forward-thinking approach to tackling environmental issues. Mona discusses the practical implications of the shift, including the distinction between being reactive and proactive. She emphasises the importance of major governmental action to change legislation and perceptions in order to assist this transition. Mona suggests that present procedures may fail to properly incorporate the long-term considerations required for planned adaptation, showing a disconnect between current methods and the need for a more forward-thinking strategy.

Collectively, these findings indicate that the transition to planned adaptation necessitates a multidisciplinary approach that integrates scientific research, design thinking, and policy reforms to produce resilient responses to uncertainties.

Room for the River, H+N+S Landscape Architects (2013). [image by Johan Roerink]

The interviewees' responses highlight the critical need to rethink and redesign our approach to managing environmental challenges. While Hooimeijer focuses on the theoretical foundations and broad applicability of integrated systems, Nijhuis delves into the practical aspects of designing multifunctional, adaptable structures.

Fransje Hooimeijer underscores the academic and practical importance of integrating protective systems with productive systems, such as agriculture and energy landscapes. She emphasises that accommodation strategies that involve living with water are critical for developing sustainable and efficient adaptations to sea-level rise. Hooimeijer contends that this integrated approach is not only more realistic, but also improves the efficiency and resilience of both human and natural systems, resulting in a paradigm shift in flood defence and environmental management. Mona Zum Felde also discusses the importance of shifting the paradigm away from purely protectionist approaches and towards accommodating water. She emphasises that integrating systems necessitates significant changes not only from a governmental and regulatory perspective, but also from the residents themselves. This approach necessitates a broader understanding and acceptance of integrated water management strategies, emphasising the challenges and potential resistance to changing long-standing practices.

Steffen Nijhuis advocates for multifunctional structures that can adapt their functions over time, emphasising the importance of taking a regional perspective when defining these structures' roles. Nijhuis' views reflect an acknowledgment of the long-term viability of integrated systems, as long as they are informed by principles of governance, landscape ecology, geology, and other fields, rather than relying on fixed solutions.

Bram Willemse provides a practical perspective on the opportunities and challenges of designing systems that are both immediately functional and capable of evolving over time. e emphasises the short-term productivity limitations of traditional, heavily engineered solutions while arguing for the long-term benefits of resilience and sustainability provided by integrated systems. He advocates for designs that not only fit the current ecosystem, but also adapt and evolve with it over time, implying a combination of immediate functional integration and long-term ecological planning.

Bram Willemse emphasises how an integrated approach improves resilience to environmental extremes like droughts and floods. By adapting to natural processes and anticipating changes over time, these systems can ensure long-term sustainability and health for both ecosystems and human populations. According to Steffen Nijhuis, integrating protective and productive systems enables the creation of multifunctional structures capable of adapting their functions over time. This adaptability is critical for long-term use and overcoming unexpected challenges, ensuring that these structures remain effective and relevant.

Mona Zum Felde discusses the challenges of implementing integrated systems, citing the need for a paradigm shift in both policy and practice. This approach necessitates significant changes in regulation, investment, and public acceptance, which can be difficult to implement. Bram points out that integrated systems may not be as immediately productive as traditional, heavily engineered solutions. The emphasis on long-term resilience and adaptability may come at the expense of short-term efficiency and output, which may be problematic for stakeholders seeking immediate gains. Integrating systems necessitates a delicate balance to avoid oversimplifying complex ecological and social dynamics. There is a risk that attempts to integrate functions will not fully capture the complexities of natural processes and human needs, resulting in solutions that are less effective than intended.

3. Field Trip

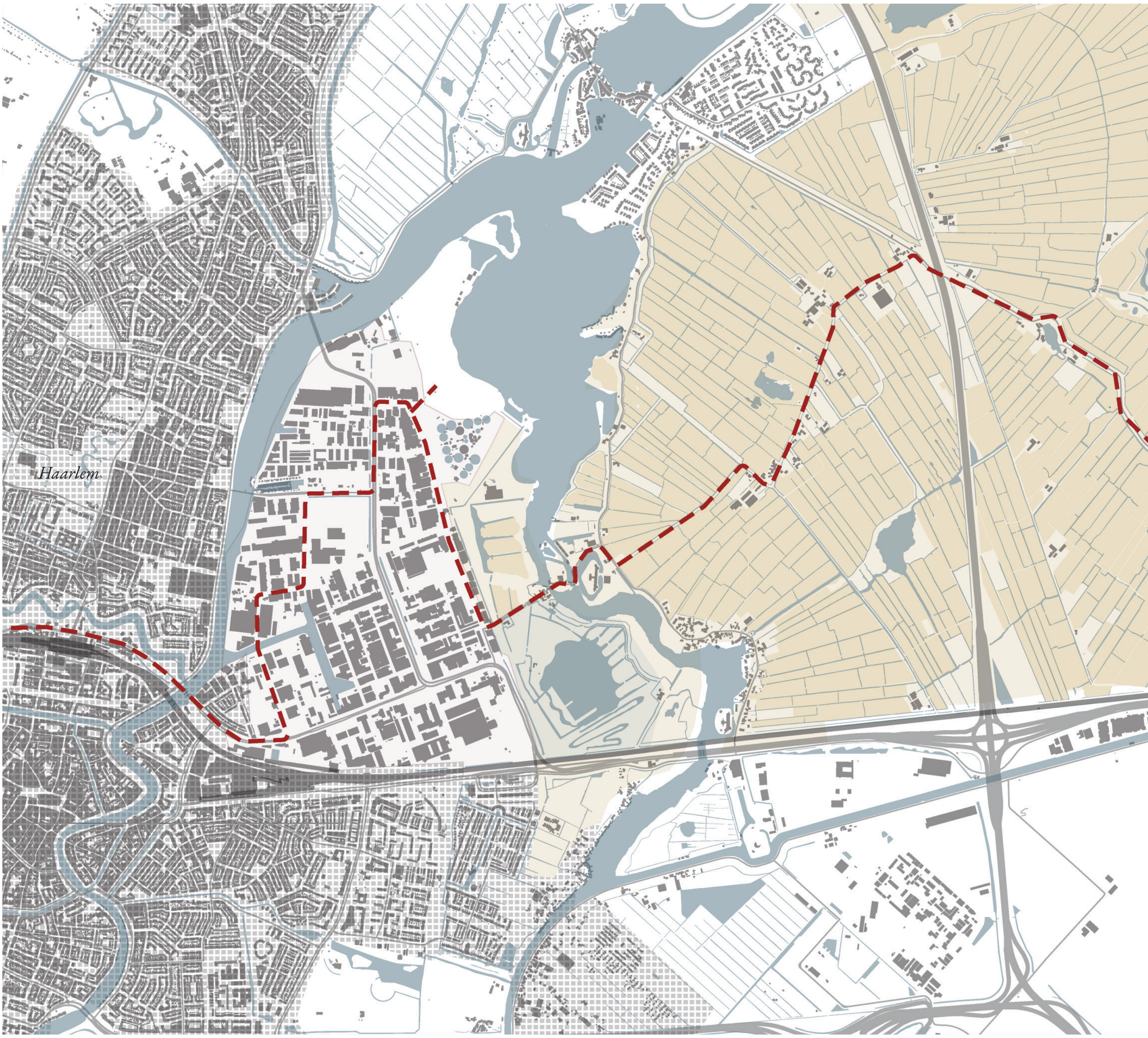
Criteria

As a case, a paradigmatic area was selected with the following criteriaa to analyse and experiment with design conditions

- High vulnerability to sea level rise - susceptibility to storm surges, groundwater salinisation, land submergence and subsidence.
- Presence of critical productive landscapes - energy and agriculture
- Presence of critical protection infrastructure - large dikes and barriers for adaptation
- Presence of natural protection structures like dunes for learning and integrating nature-based solutions.

Based on this criteria, a transect between Amsterdam Westpoort and Haarlem Station was selected. The transect is located in the province of North Holland in the Amsterdam Metropolitan region. Transect locus moves from the city of Haarlem in the west to Amsterdam Westpoort in the east through the Harlememeerpolder. The intersecting land covers predominantly include productive patches such as ports, industries and agriculture; natural zones such as parks and inland marshes; and urban areas.

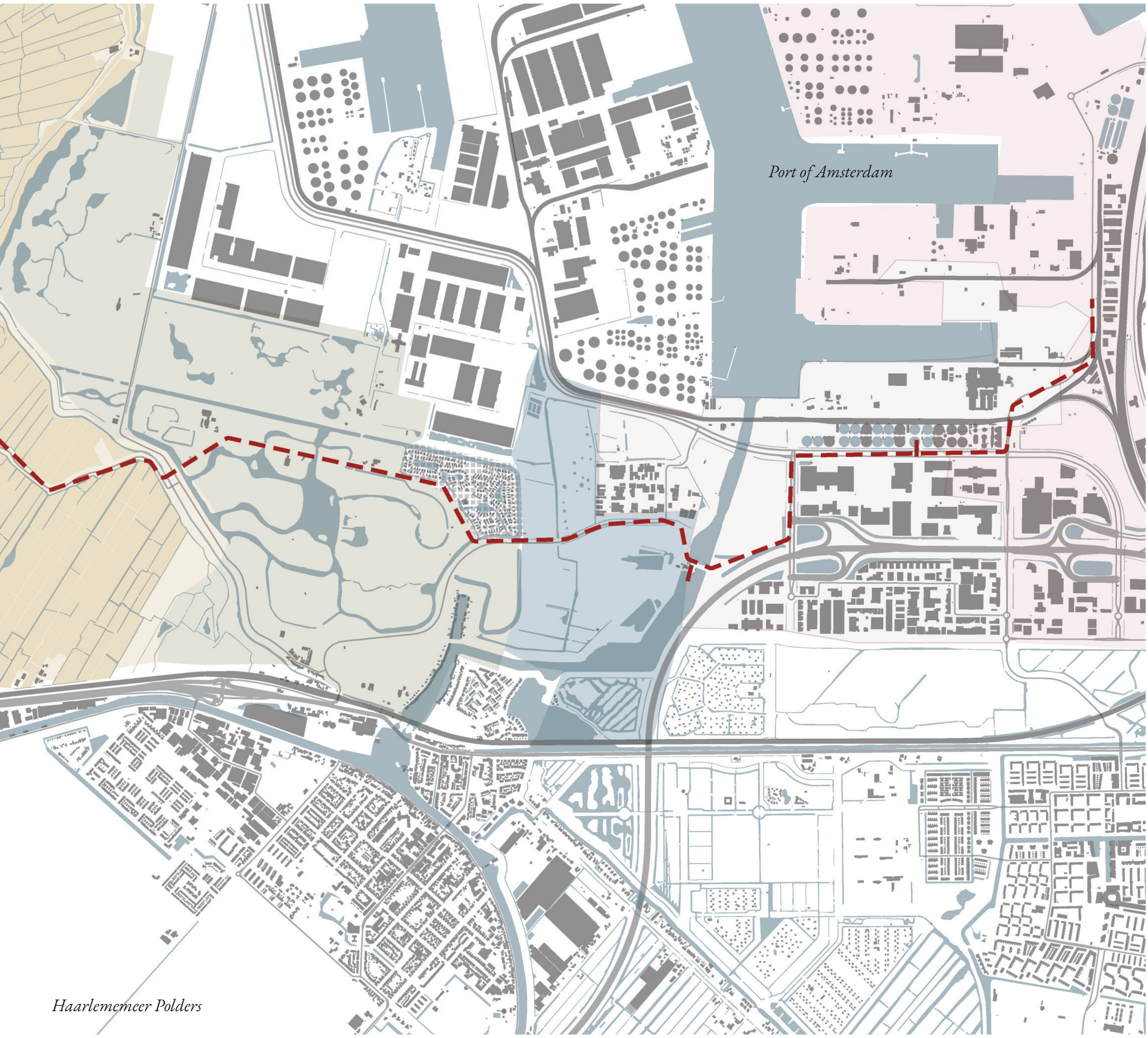
Key Plan illustrating the location of the field trip transect in the Netherlands



Map highlighthing the landcovers and the characteristics of water

- Urban
- Port
- Wetland
- Forest
- Pastures
- Field trip trail

0.5 1 km N



Observations

The transect showcased in the province of North Holland within the Amsterdam Metropolitan region displays various landscape typologies. This presentation allows the research to explore and experiment with areas vulnerable to sea-level rise, productive landscapes, and protective infrastructures. Traversing from east to west along the transect, a diverse array of landscapes and urban environments unfolds. Beginning in Haarlem, a city with a rich history situated along the banks of the Spaarne River. Traverse through Waarder- en Veerpolder, an industrial area and port crucial for facilitating regional trade and transportation networks. Transitioning to Schoteroog, with its recreational spaces, offering a retreat from urban activity. Then Penningsveer unfolds, boasting a charming neighbourhood and a small fishermen's marina, emblematic of the region's connection to maritime traditions. Deeper into the transect, the pastoral landscapes of Spaarnwoude, characterised by scenic views. The landscape transforms once more upon reaching Spaarnwoude Park, juxtaposed with new residential units reflecting the evolving urban fabric. The significance of infrastructural elements becomes apparent with the presence of Boezemgemaal Halfweg, a vital pumping station integral to managing water levels within the region. Finally, Westpoort, the bustling main harbour and industrial heart of Amsterdam.


P


70

Boundary Conditions

Fluvial flooding - Overstroming

Overstroming pertains to the fluvial flooding that is caused due the overflow and inundation caused by river and coastal waters. The measures employed to address waterlogging resulting from sea level rise and water inflow can also be effectively utilised to mitigate shallow floods generated by rivers, the sea, and other surface waters. This is mostly observed in the natural and the agricultural areas, historical polders. The map represents flooding depth - 2020-2100 through overstroming.v

2.0 - 5.0
1.5 - 2
1.0 - 1.5
0.5 - 1.0
<0.5 metres

Pluvial Flooding - Waterlogging

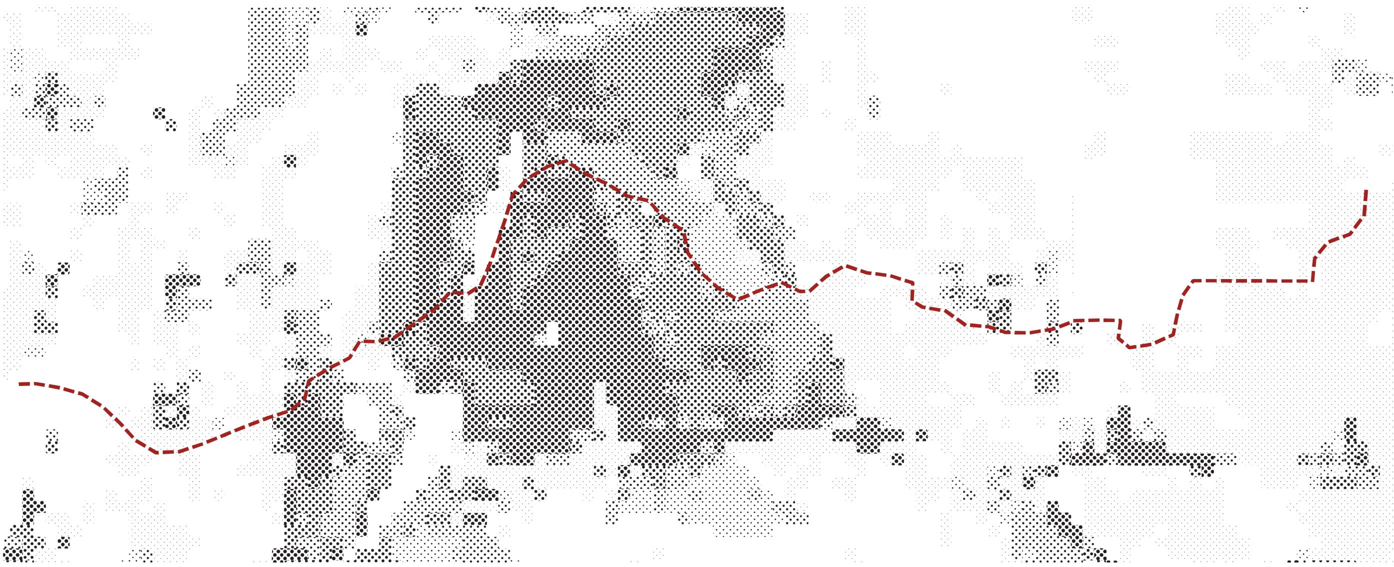
This condition indicates the depth of waterlogging in the area from heavy precipitation. It is observed relatively higher in the urban, industries and port zones. The condition dthus requires adaptation to heavy precipitation in these areas. The map illustrates flooding Depth - 2hrs 70cm through pluvial flooding

>30
20 - 30
15 - 20
10 - 15
<10 mm

Subsidence

The Netherlands has been implementing water level indexation as a strategy to counteract land subsidence. This involves reducing the water level in ditches and drainage canals to prevent excessive water saturation in the soil. Nevertheless, the process of water level indexation also promotes ongoing soil sinking. The indexation of water levels is crucial in peat locations, as the soil continues to sink due to the decomposition of peat. Moreover, global warming will accelerate the degradation of peat by increasing soil temperatures, which promotes the more rapid conversion of organic matter. The map represents subsidence from 2020 - 2100

>60
40 - 60
20 - 40
10 - 20
<10 cm



4. Experiments

Inferences

Sea level rise poses a major threat to the low-lying productive landscapes of the Netherlands, which are protected by an extensive system of critical infrastructures such as dike rings, canals and pumping stations. Sea level rise makes the productive landscape vulnerable primarily through the processes of fluvial flooding, pluvial flooding , land subsidence and saltwater intrusion which have an adverse impact on infrastructure, biodiversity as well as the economic productivity of the land.

The approach of accommodation in the context of sea level rise refers to the idea of embracing and adapting to the impacts of rising sea levels rather than just trying to prevent or mitigate them. Accommodation strategies must aim at integrating productive and protective infrastructures as they focus on sustaining ecology and are economically cost-effective in the long run. Moreover, they offer a degree of flexibility and resilience by integrating multiple functions and programs, thus facilitating the preservation of socio-cultural values.

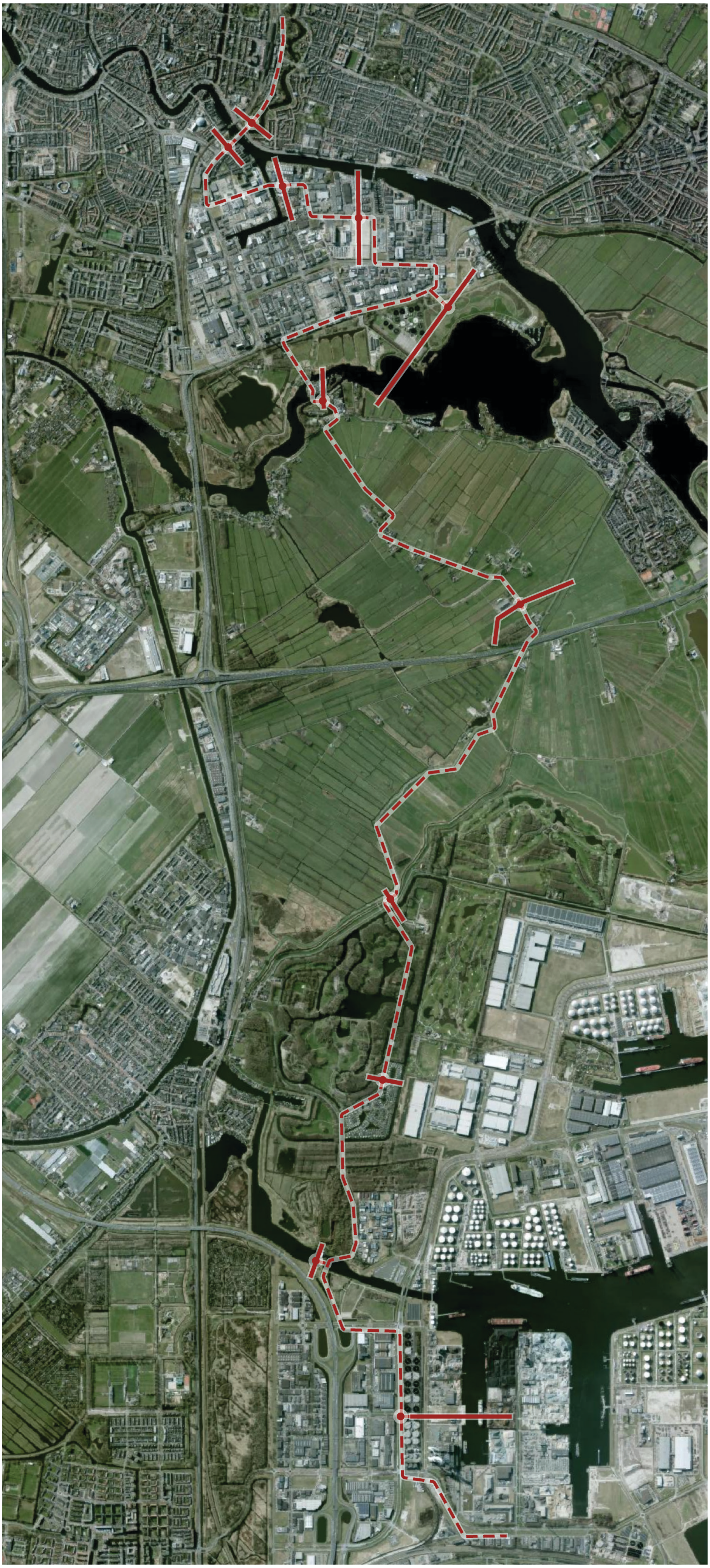
For extreme adaptation in the context of sea level rise, nature-based solutions (NbS) are proving out to be the way forward within the approach of accommodation for synergising productive and protective systems. Nature-based solutions harness the potential of natural ecosystems to induce a degree of resilience against rising sea levels, which can be seen in the case of the Zandmotor. Moreover, they have the ability to provide a degree of protection along with productive values such as agriculture & energy generation, ecological regeneration as well as recreational opportunities, which is economically more viable in the longue durée.

Sections were used as first the analytic method to project the previously listed boundary conditions on to the different parts of the landscapes to analyse the SLR vulnerability in each section. Then adaptation strategies are used to react to the projection. This also allows for ideating programmatic transformations to experiment different ways the spaces are productive.

By this method we tend to use sections as a synthetic method to reflect on the design question
"What if productive systems and protection systems are integrated for extreme climatic adaptation in the long dureé?"

Transformations

Existing dyke system
Critical Infrastructure
Fluvial Flooding
Anthropogenic Soil
Clay
Peat
Gravel
Sandy Soil
Modified ground profile
Ground line
Porosity
Water



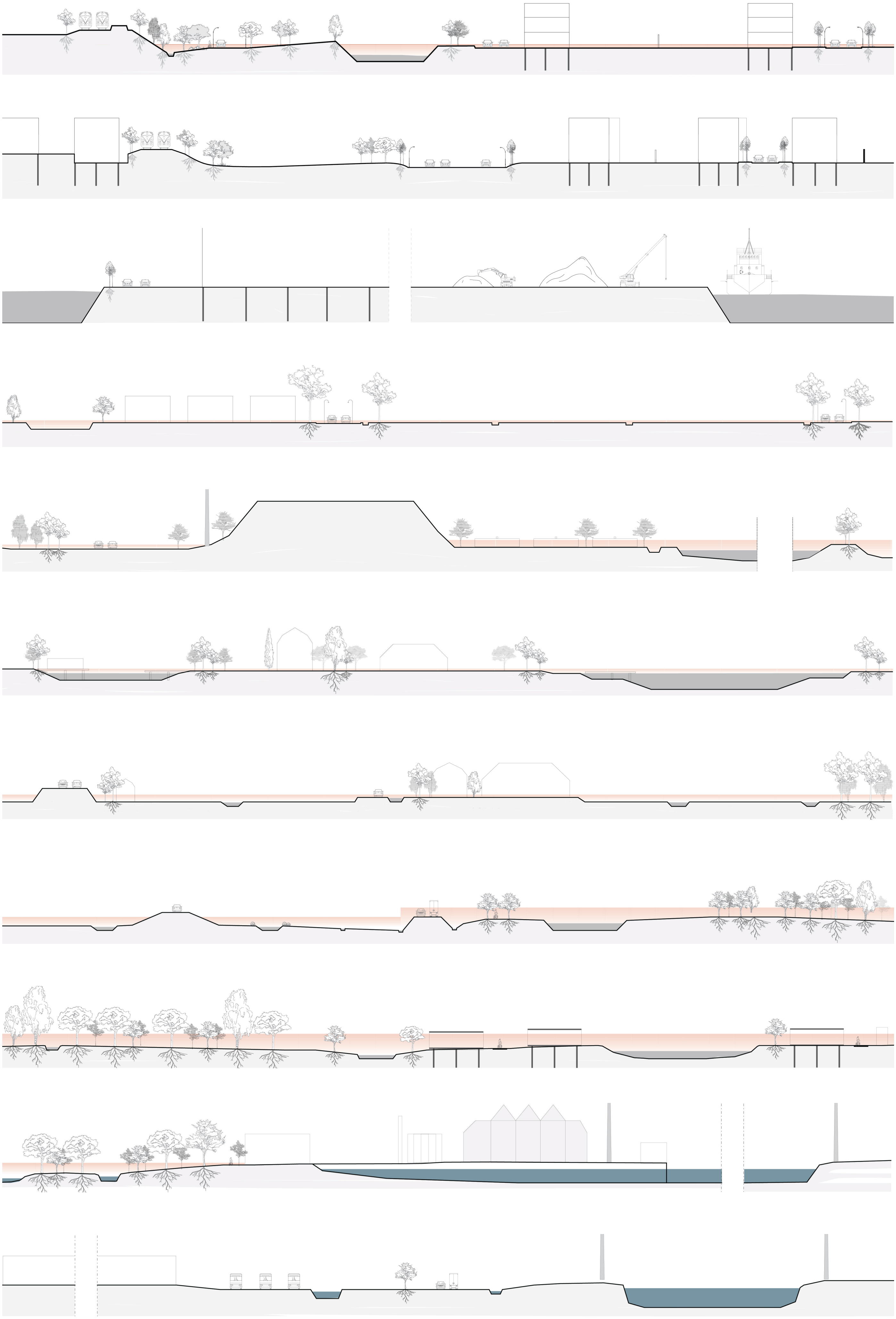
Existing profiles

Projecting the boundary conditions on the existing sectional profile to understand the physical impacts

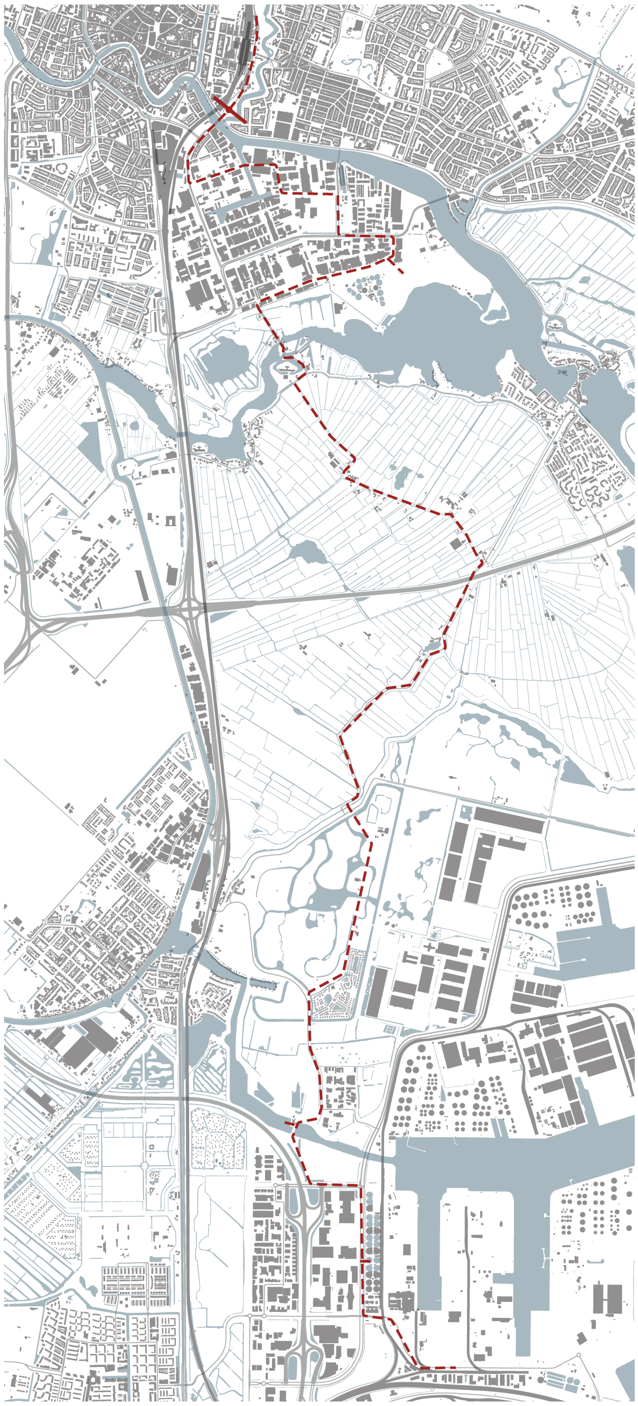
1 km

N

Satellite image from ESRI

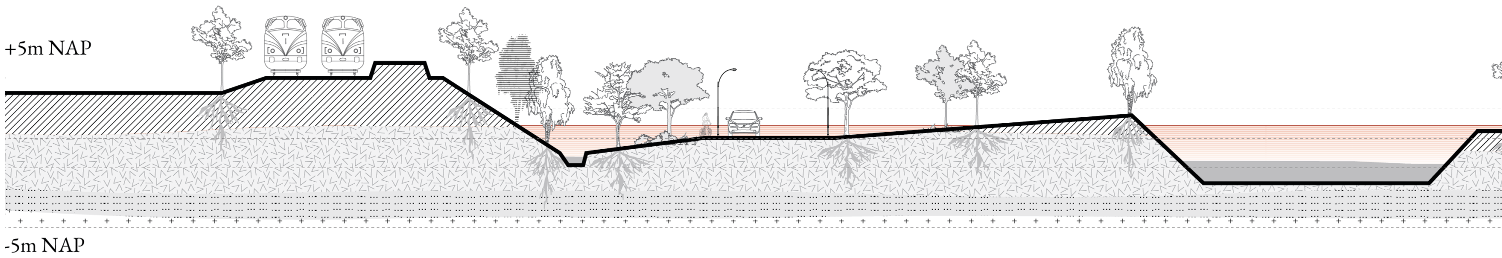


1. Kloppersingel

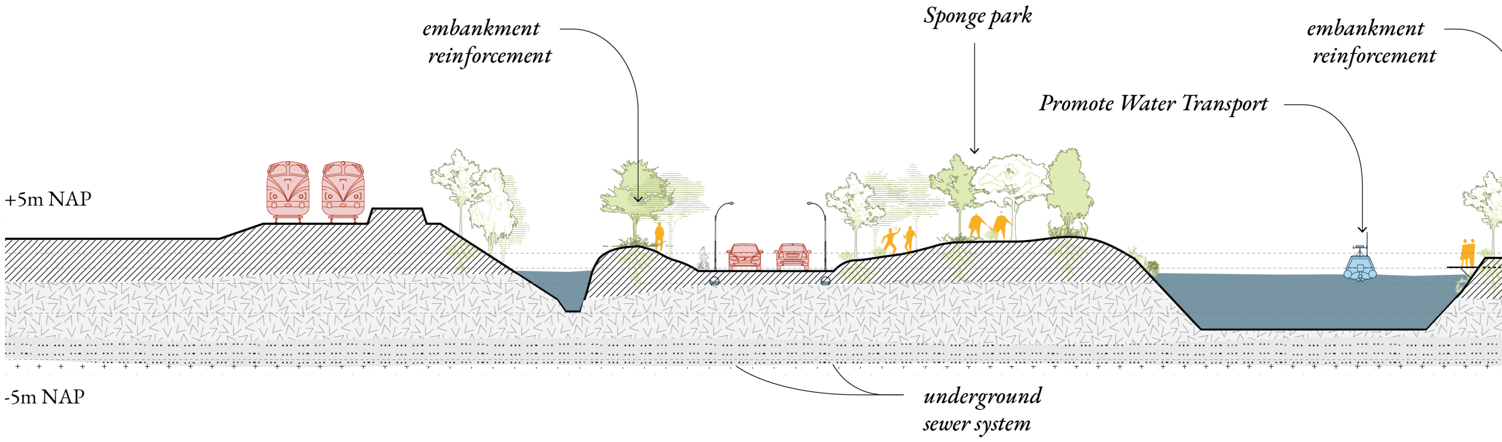


A transect is drawn perpendicular to Kloppersingel which cuts through critical infrastructures such as railway tracks and primary road, a green buffer space and residential quarters. Since the area is vulnerable to fluvial flooding, the critical infrastructures are protected by accommodating the excess water through deepening the canals, modifying the slope profile and landscape processes which act as a sponge and provide resilience.

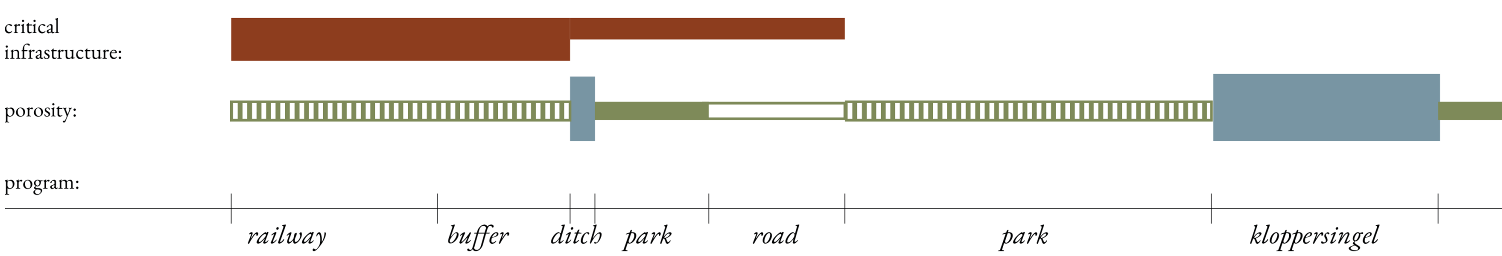
Fluvial flooding	0.5 m
Pluvial flooding	NA
Subsidence	10 cm



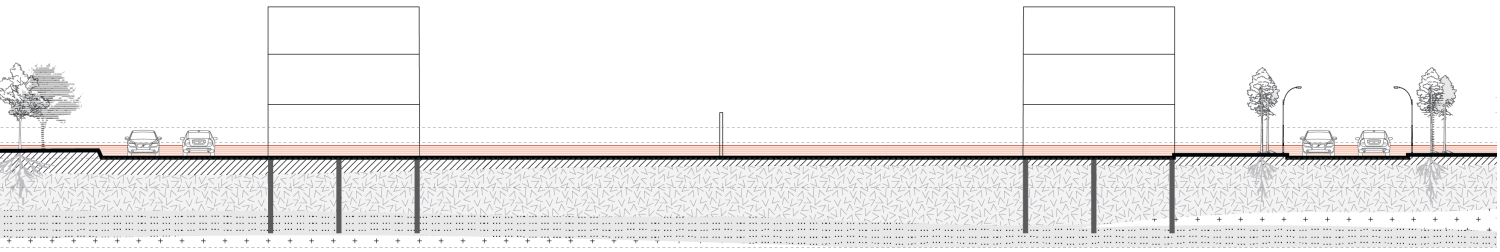
+5m NAP
-5m NAP

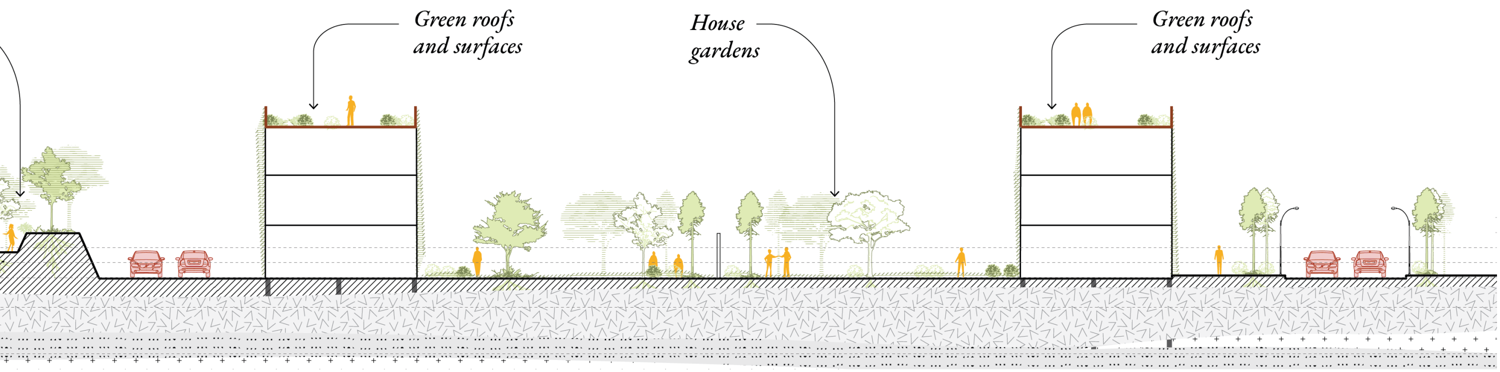


embankment reinforcement
Sponge park
embankment reinforcement
Promote Water Transport
+5m NAP
-5m NAP
underground sewer system



critical infrastructure:
porosity:
program:
railway
buffer
ditch
park
road
park
kloppersingel





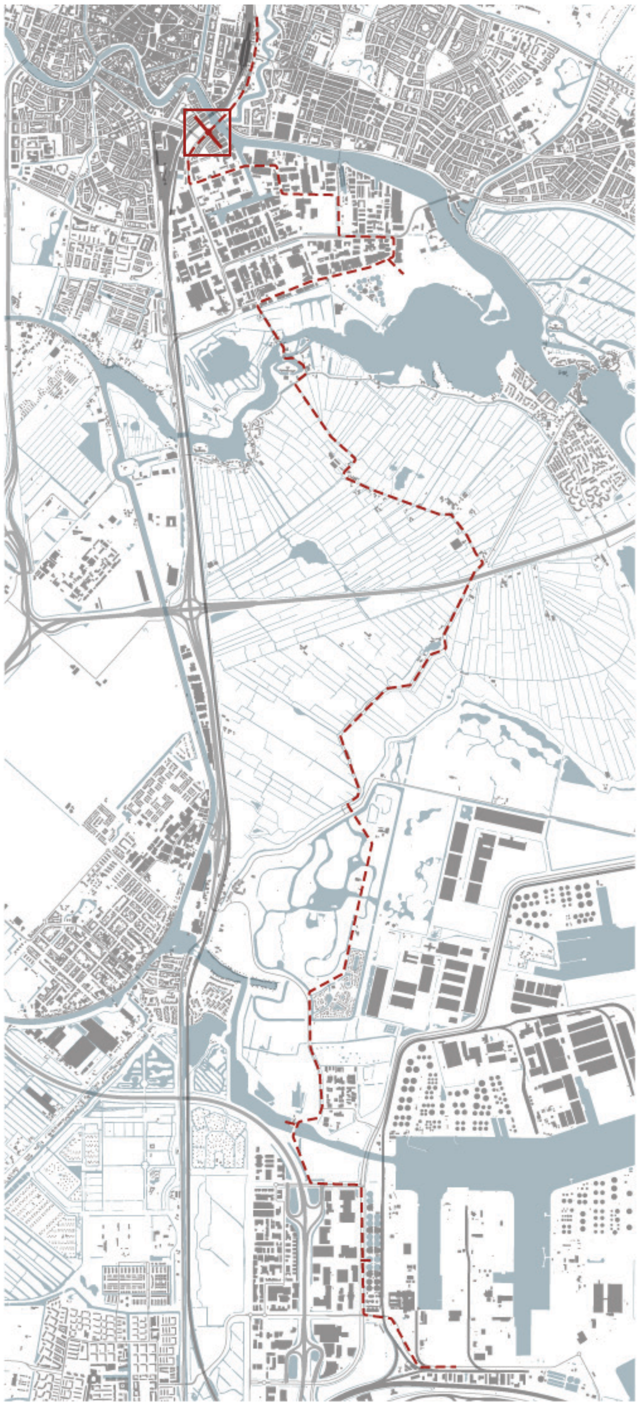
Green roofs
and surfaces
House
gardens
Green roofs
and surfaces

road
residential
area
residential gardens
residential
area
road

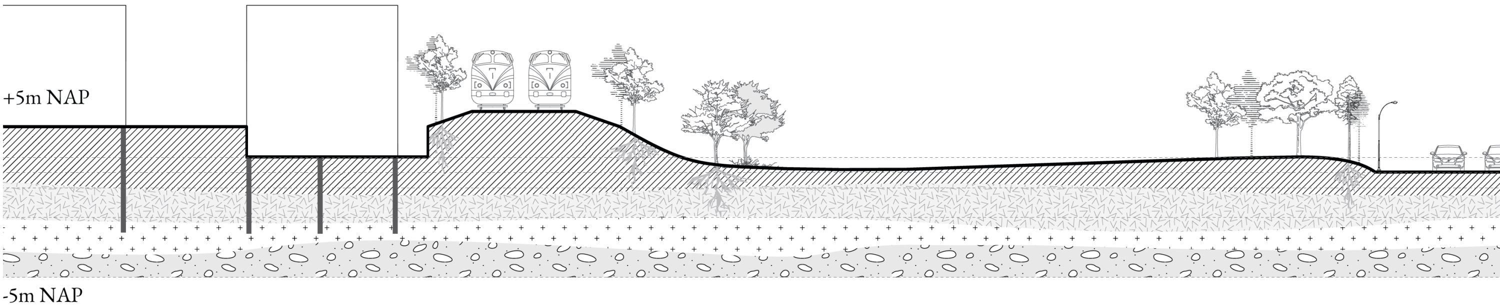
2. Neighbourhood

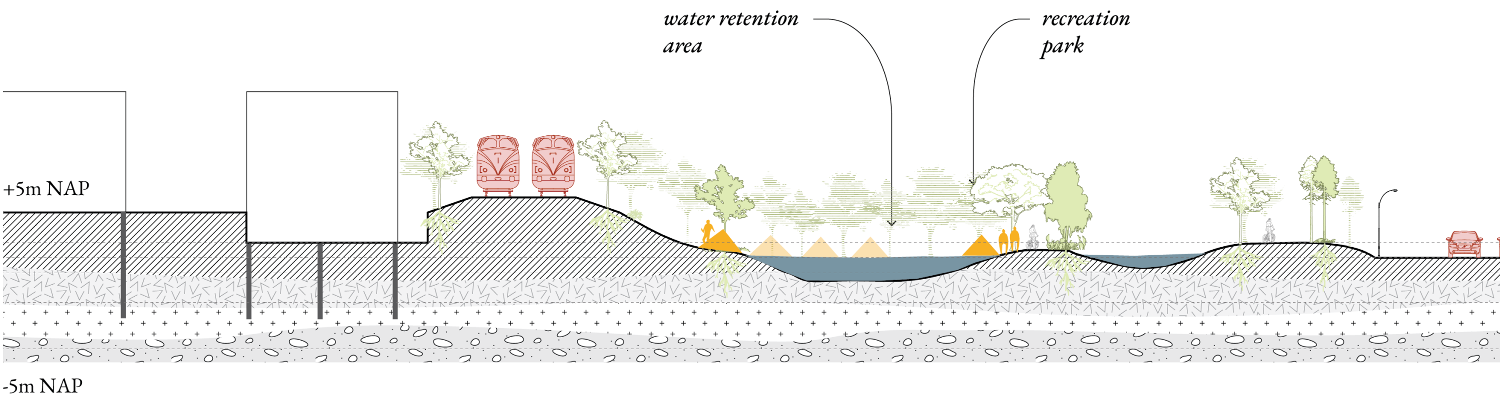
This transect cuts through critical infrastructures, a large paved buffer zone and a series of housing blocks which follow the form of a flood defence wall. Since this area is susceptible to pluvial flooding, the buffer zone is de-paved and transformed into a water retention zone which supports recreational activities like camping. The terraces of the buildings are integrated with solar panels for in situ energy production.

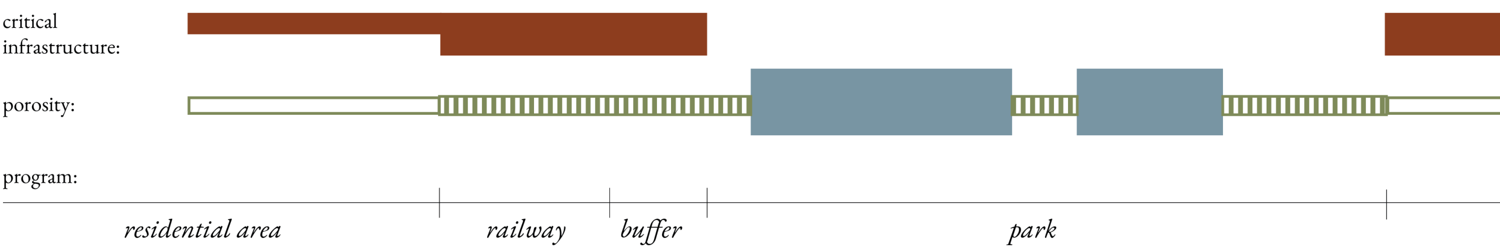
Fluvial flooding	□□□□□	NA
Pluvial flooding	■■□□□	20 cm
Subsidence	■■□□□	20 cm

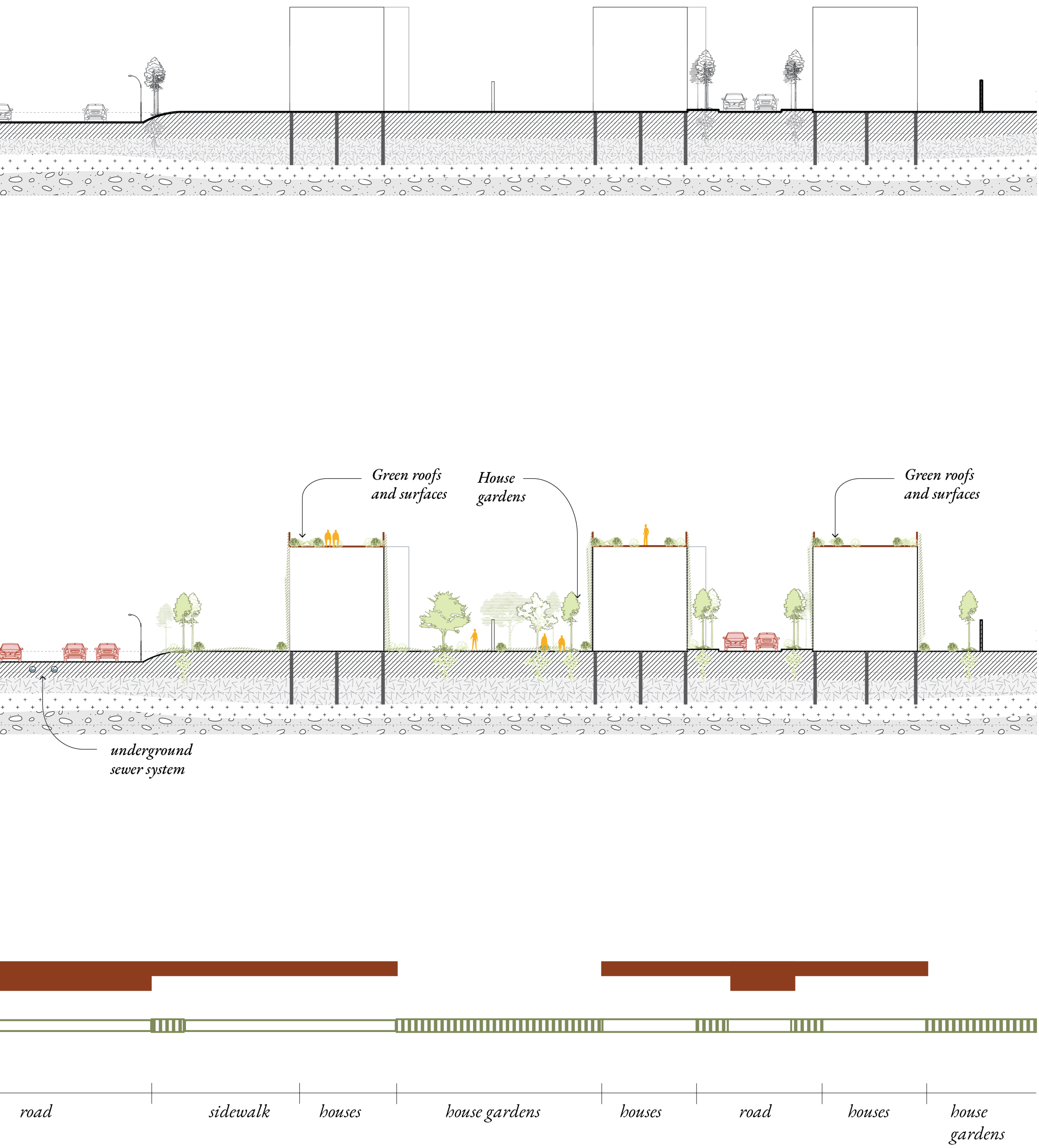



N200
P-route Centrum
Bloemendaal
Zandvoort
P-route Centrum


+5m NAP
-5m NAP


water retention area
recreation park
+5m NAP
-5m NAP


critical infrastructure:
porosity:
program:
residential area
railway
buffer
park

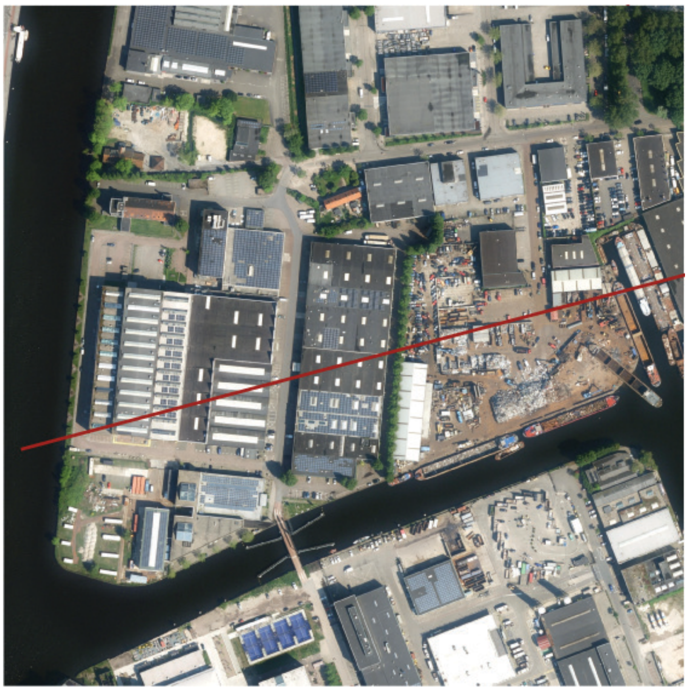


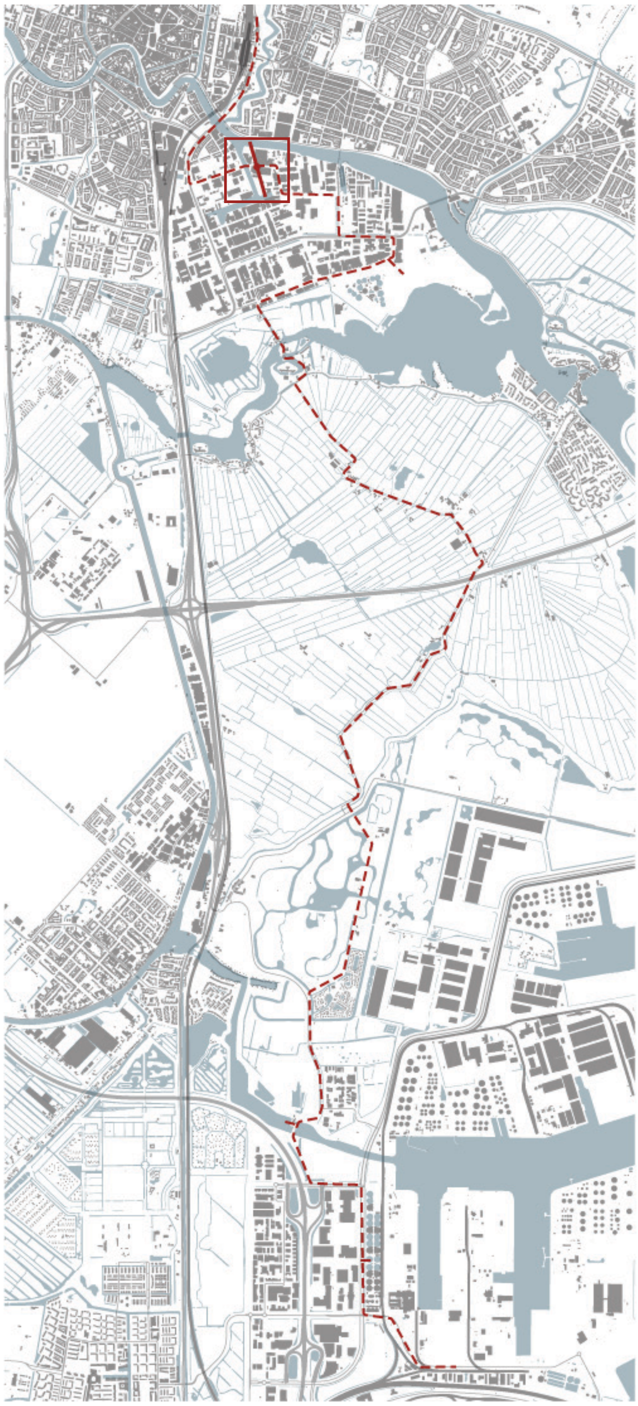
Green roofs
and surfaces
House
gardens
Green roofs
and surfaces
underground
sewer system
road
sidewalk
houses
house gardens
houses
road
houses
house
gardens

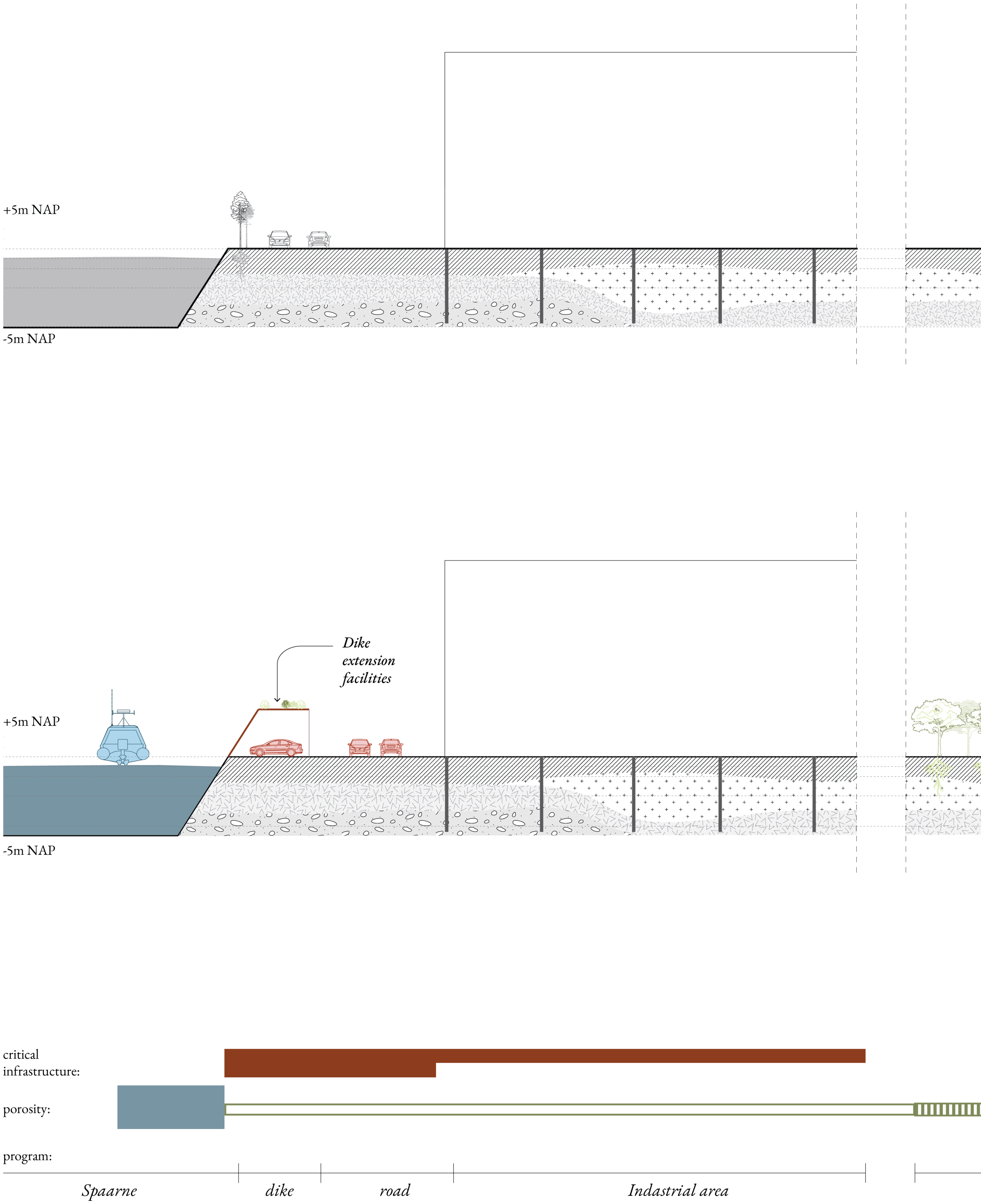
3. Dump

This section passes through the industrial area, port as well as a dumping yard which holds a huge pile of industrial waste. Since this region is vulnerable to fluvial flooding, a dike ring is developed along the water-industry boundary for flood defence and water related functions To tackle pluvial flooding, the dumping yard is transformed into a sponge park which accommodates recreational activities.

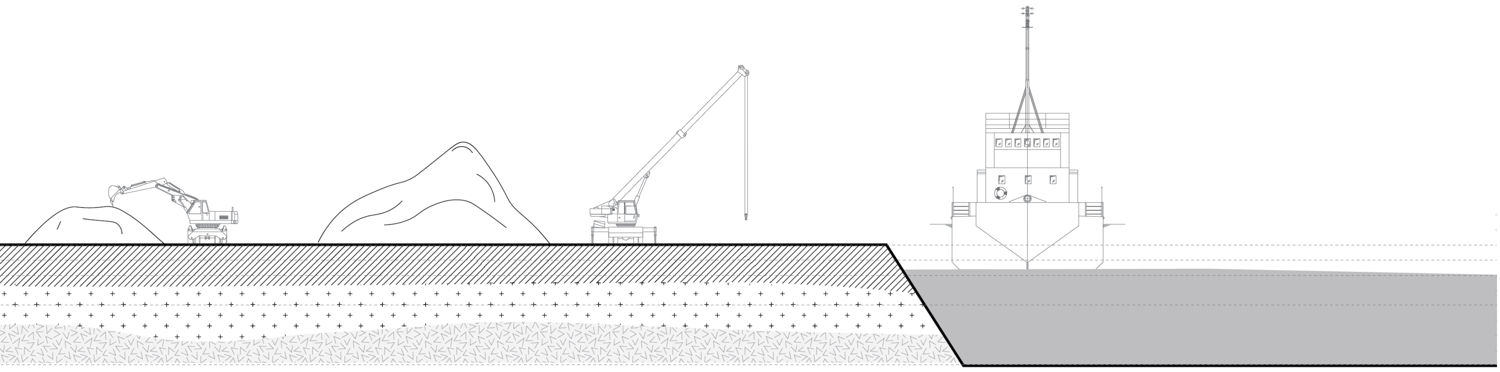
Fluvial flooding	□□□□□	NA
Pluvial flooding	■■■□□	30 cm
Subsidence	■■□□□	20 cm

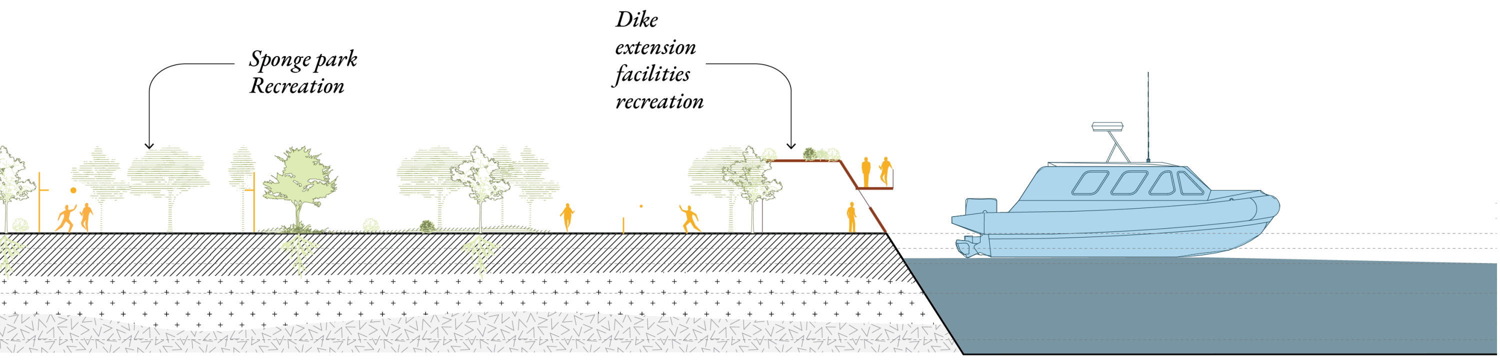


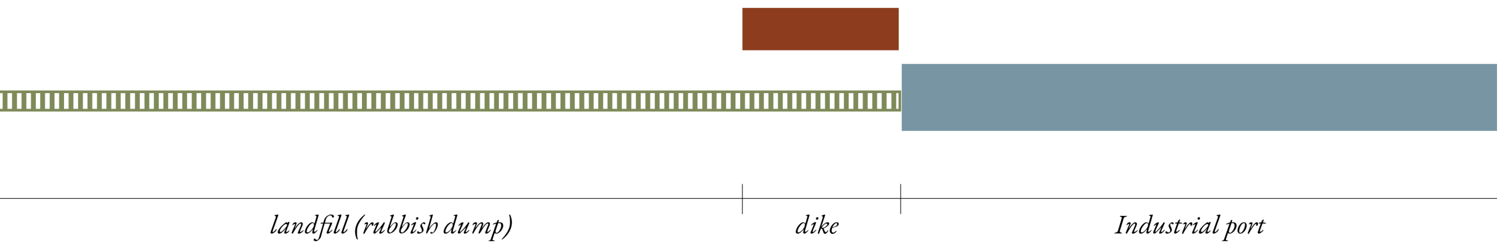




+5m NAP
-5m NAP
Dike extension facilities
+5m NAP
-5m NAP
critical infrastructure:
porosity:
program:
Spaarne
dike
road
Indastrial area



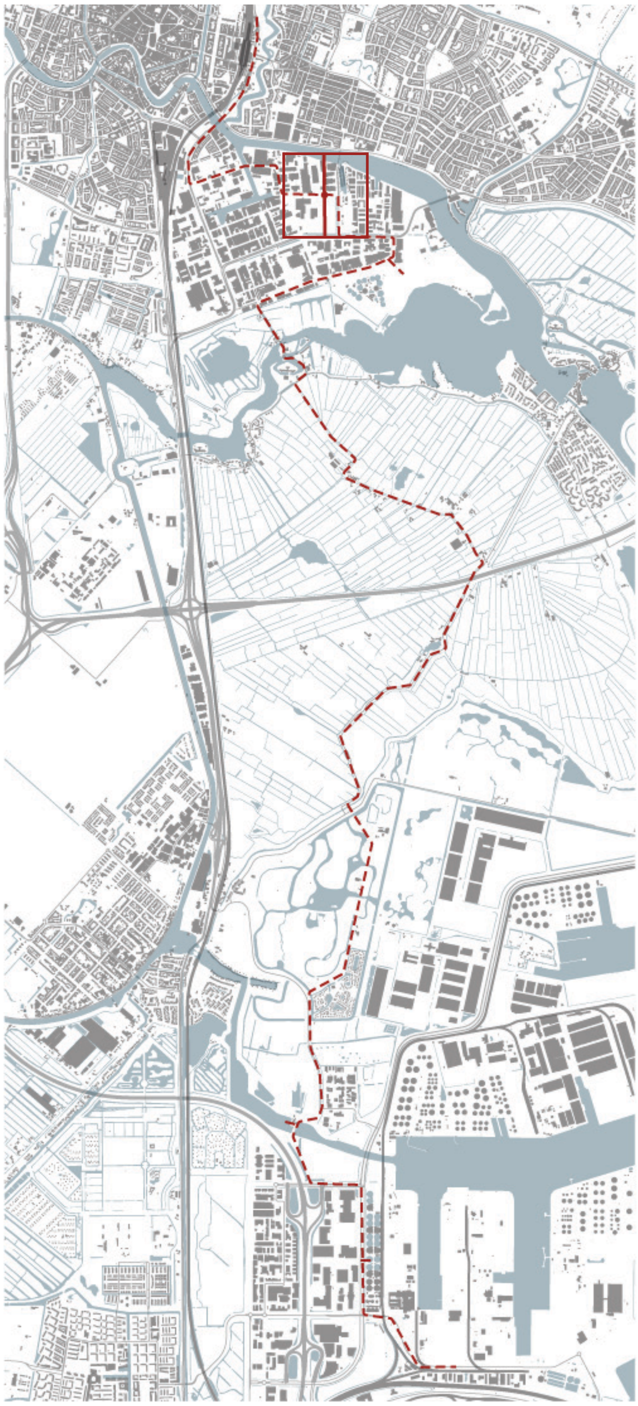

Sponge park
Recreation
Dike
extension
facilities
recreation

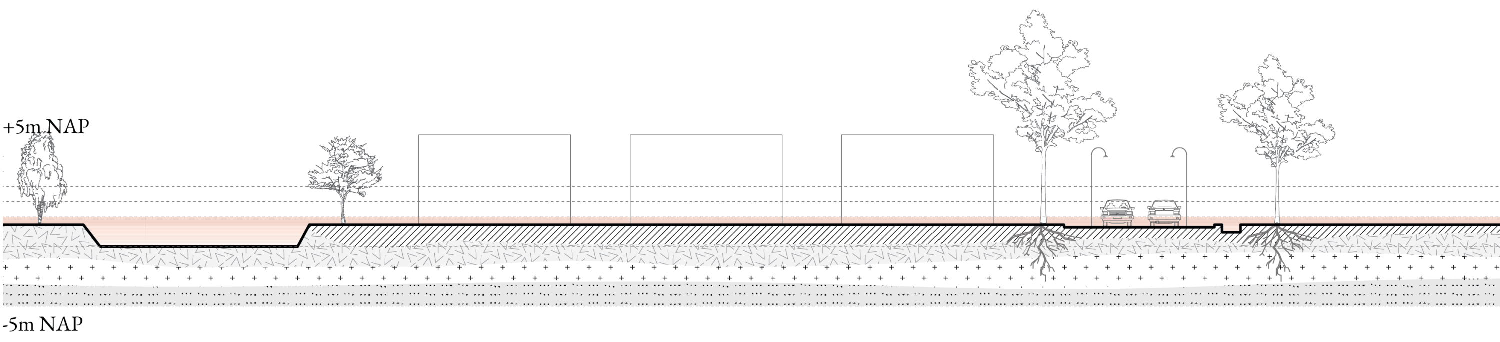

landfill (rubbish dump)
dike
Industrial port

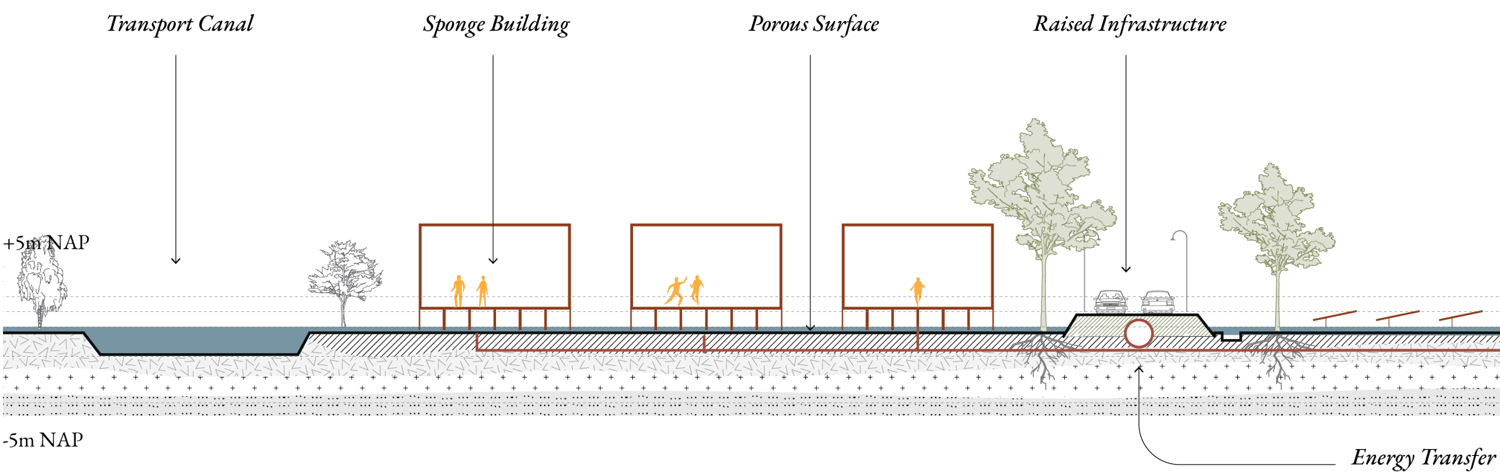
4. Solar Field

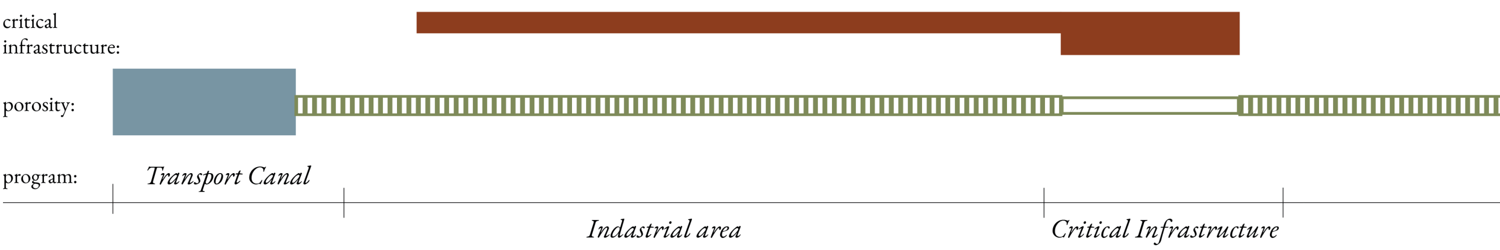
This section demonstrates how an industrial area and an energy landscape consisting of solar panels adapt to vulnerabilities arising due to rising sea levels. To tackle pluvial and fluvial flooding, the hard flooring is de-paved to increase porosity and thereafter the industrial buildings are transformed into floating structures or on-stilts. The critical infrastructures such as roads are raised which also function as energy networks.

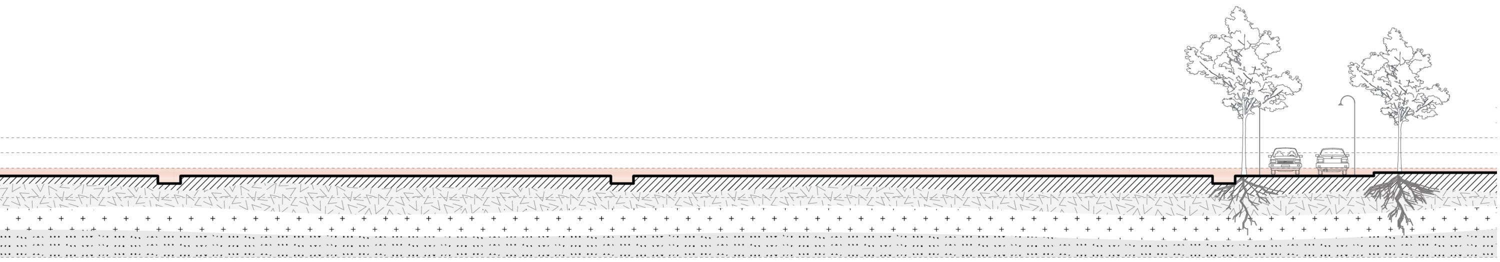
Fluvial flooding	■□□□□	0.5 m
Pluvial flooding	■■■□□	30 cm
Subsidence	■■□□□	20 cm

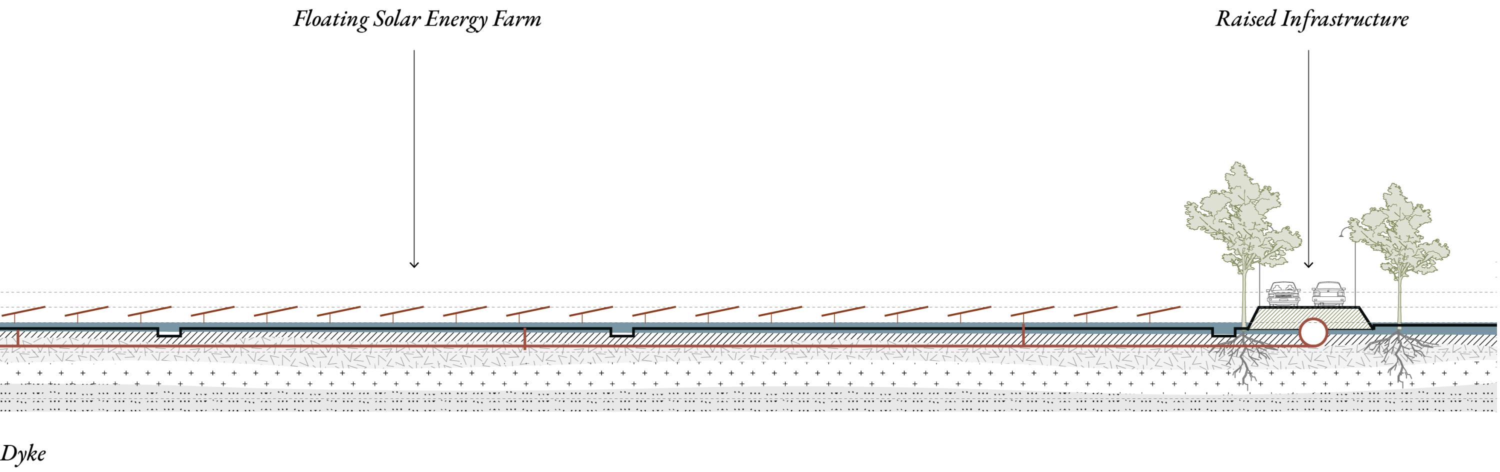


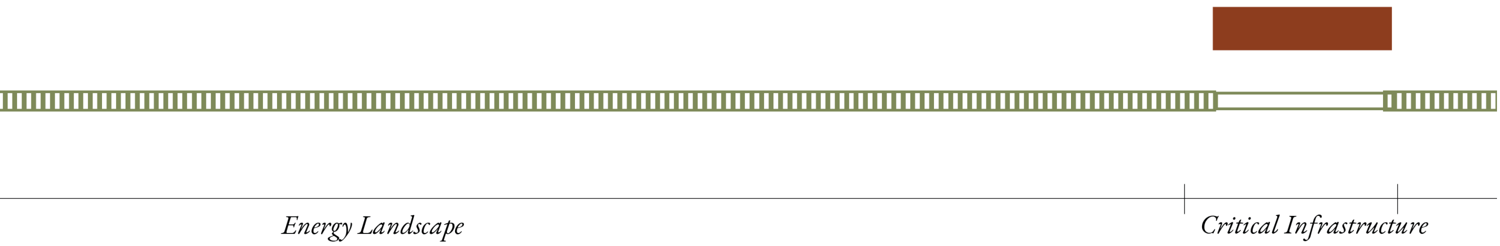

+5m NAP
-5m NAP


Transport Canal
Sponge Building
Porous Surface
Raised Infrastructure
+5m NAP
-5m NAP
Energy Transfer


critical
infrastructure:
porosity:
program:
Transport Canal
Indastrial area
Critical Infrastructure

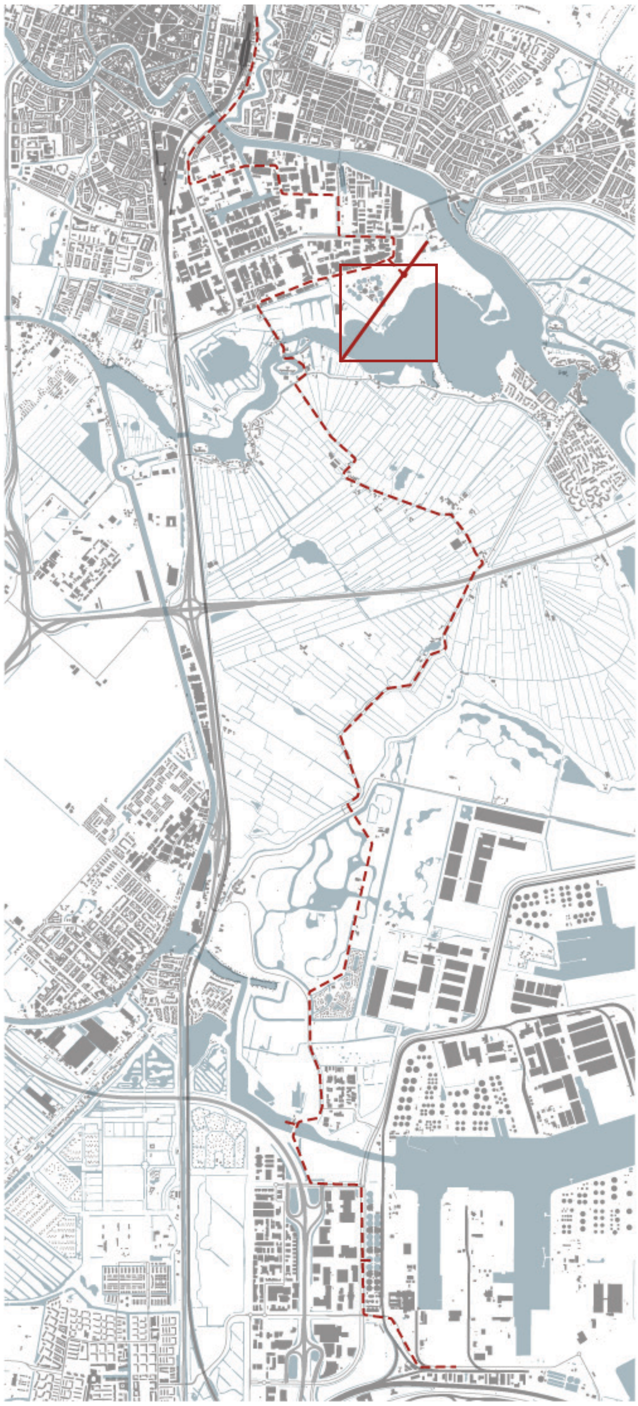



Floating Solar Energy Farm
Raised Infrastructure
Dyke

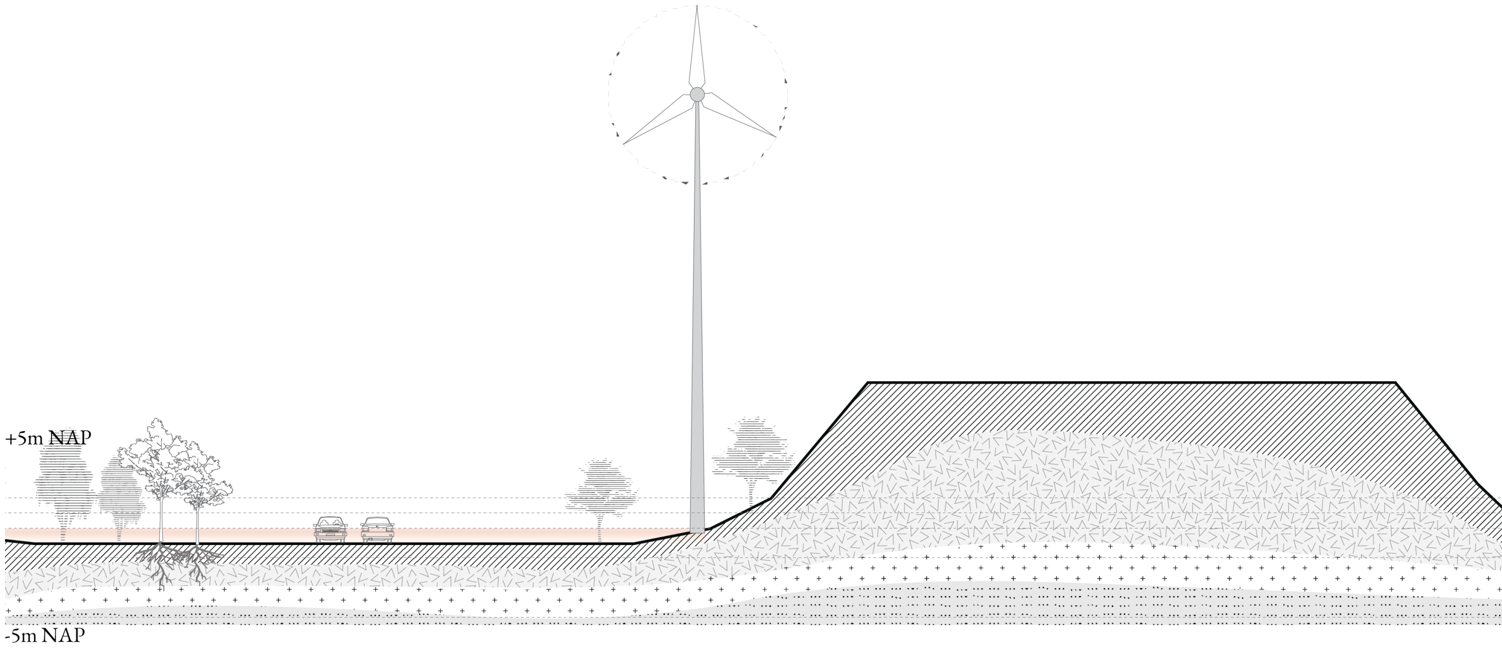

Energy Landscape
Critical Infrastructure

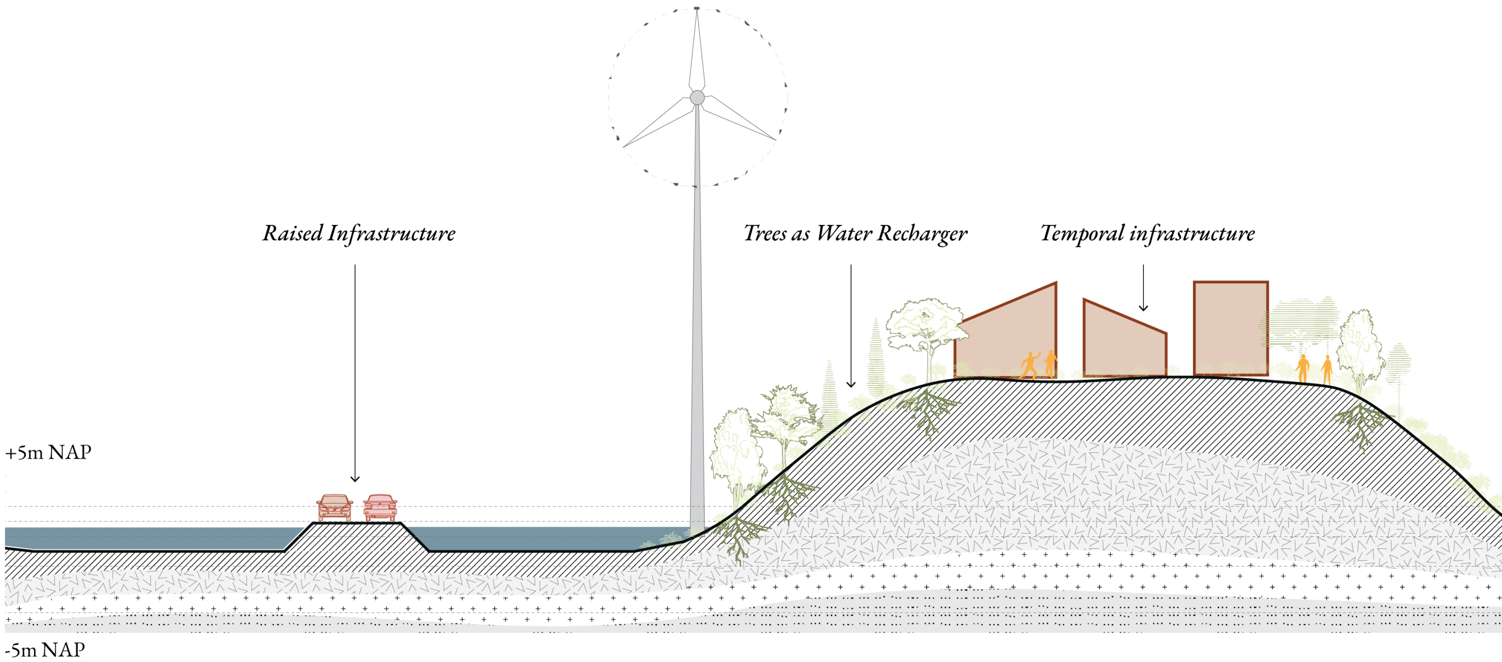
5. Mooie Nel

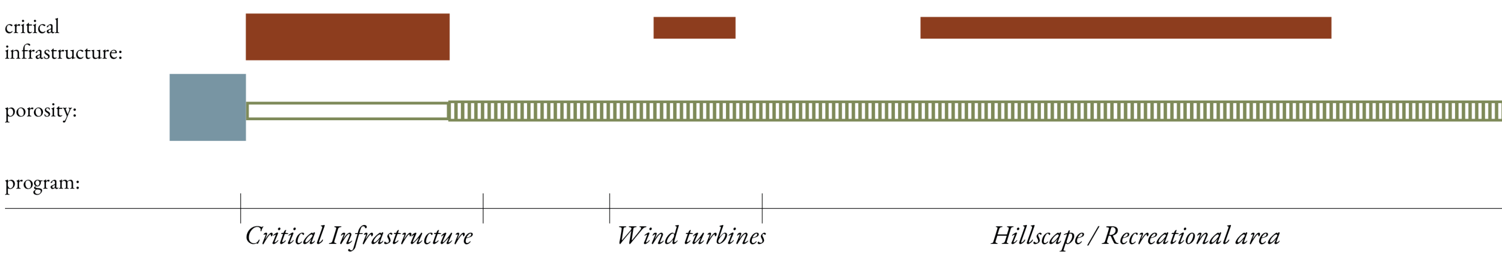
This transects represents the paradigmatic area around the Binnen Liede consisting of a mound which functions as a natural protective buffer against fluvial flooding. The higher levels of the mound are integrated with temporal infrastructures to support the recreational activities around it. Critical infrastructures such as the road networks and the water treatment plant are raised further.

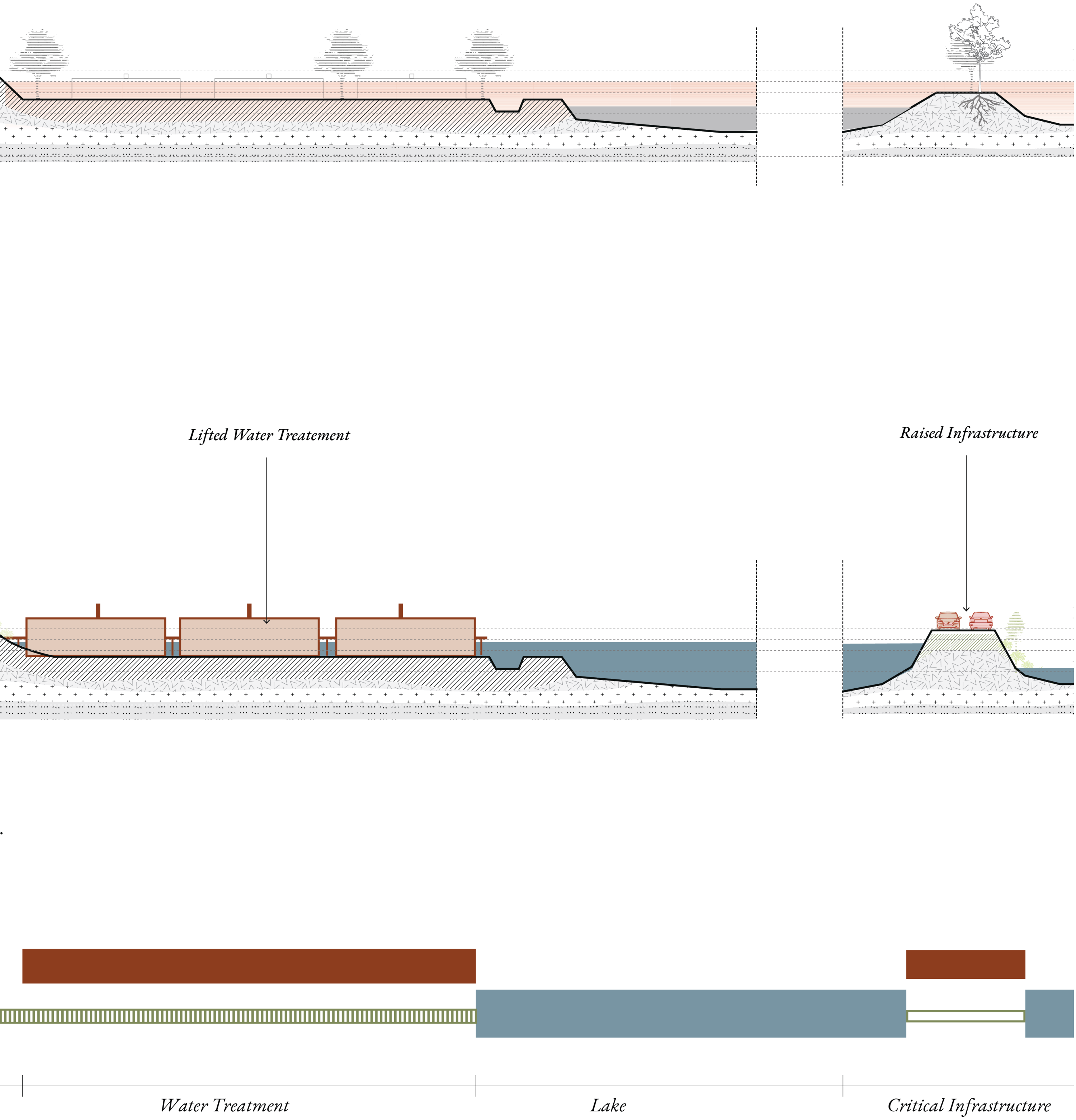


Fluvial flooding	■□□□□	0.5 m
Pluvial flooding	■■■□□	30 cm
Subsidence	■□□□□	10 cm


+5m NAP
-5m NAP


Raised Infrastructure
Trees as Water Recharger
Temporal infrastructure
+5m NAP
-5m NAP

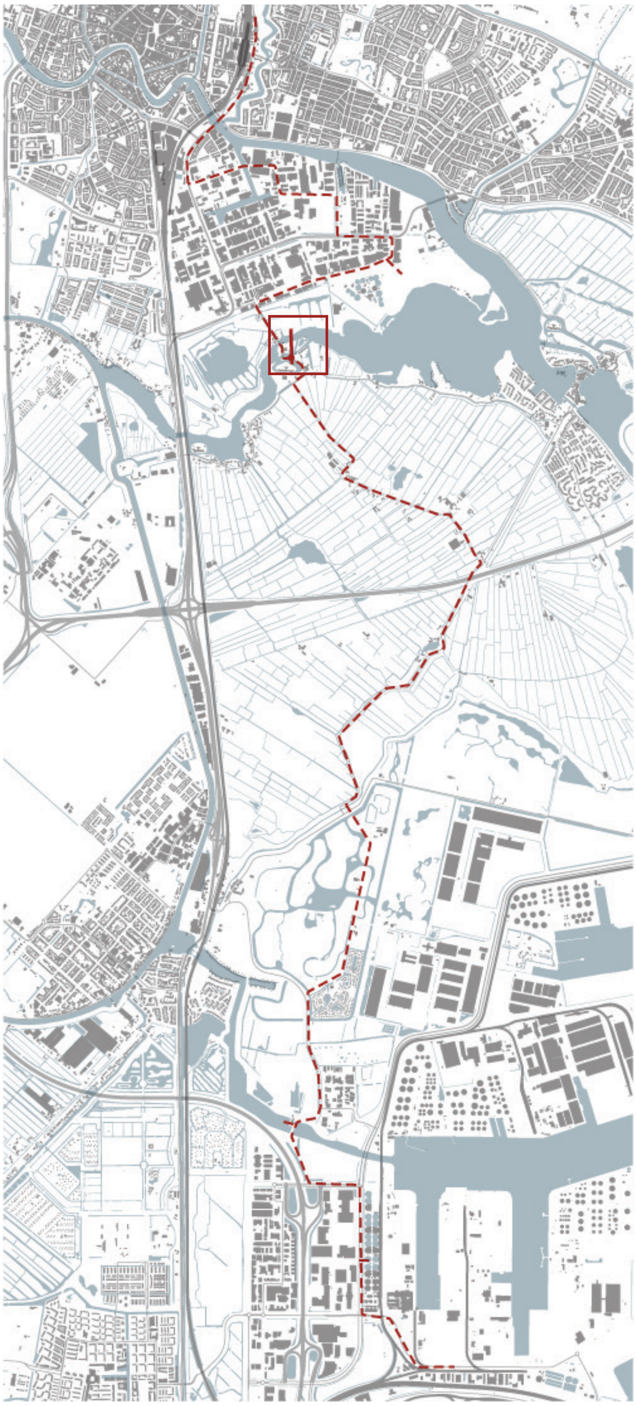

critical infrastructure:
porosity:
program:
Critical Infrastructure
Wind turbines
Hillscape / Recreational area

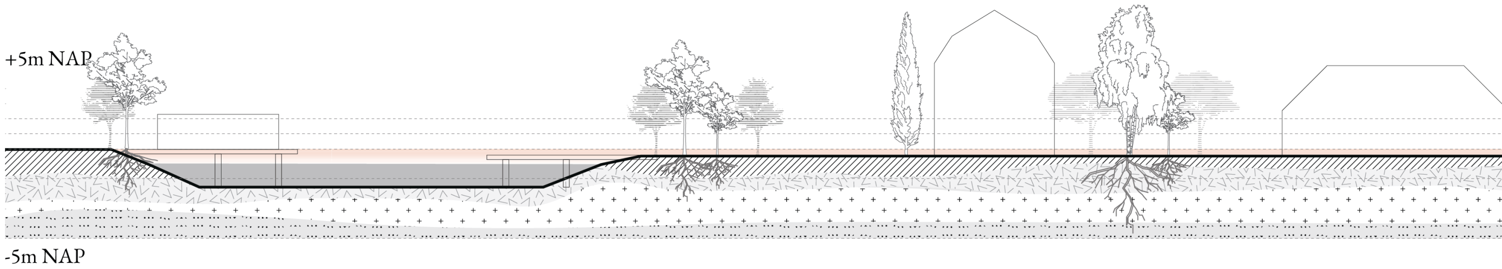

Lifted Water Treatement
Raised Infrastructure
Water Treatment
Lake
Critical Infrastructure

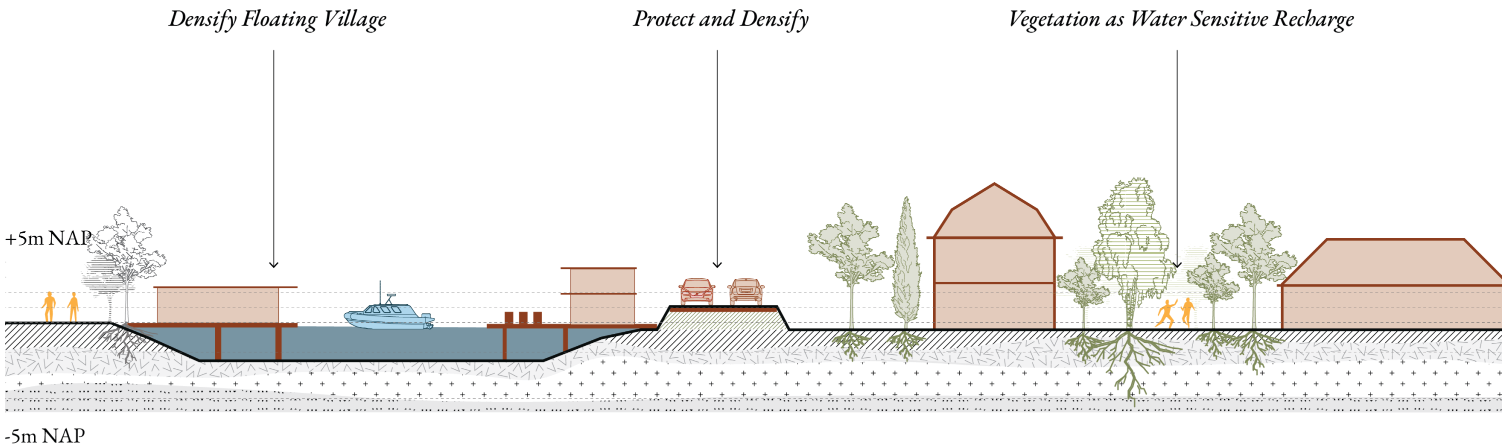
6. Penningveer

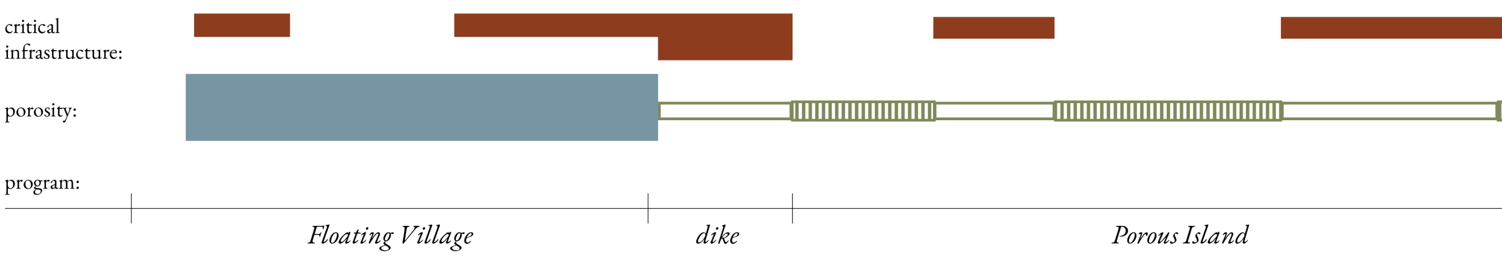
This section represents the transformation of the heritage fishing village of Penningsveer to adapt to rising sea levels. The village is further densified with more floating houses and recreational functions are incorporated along the water edge. Ecological processes are used to recharge and retain fresh groundwater within the interiors of the island.. The critical infrastructures along the edges are raised for flood protection as well as transportation networks.

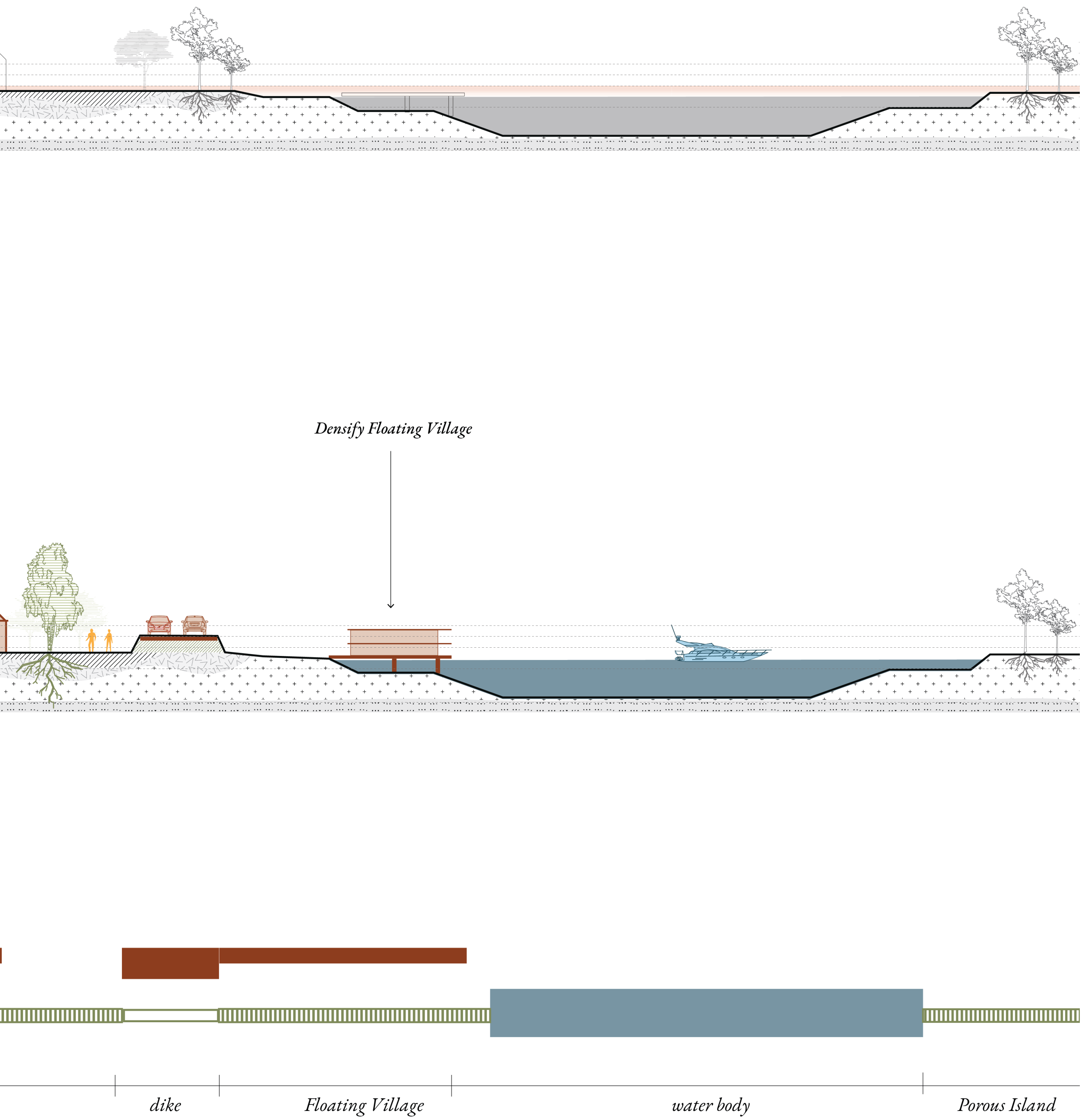
Fluvial flooding	■□□□□	0.5 m
Pluvial flooding	□□□□□	NA
Subsidence	■□□□□	10 cm




+5m NAP
-5m NAP


Densify Floating Village
Protect and Densify
Vegetation as Water Sensitive Recharge
+5m NAP
-5m NAP

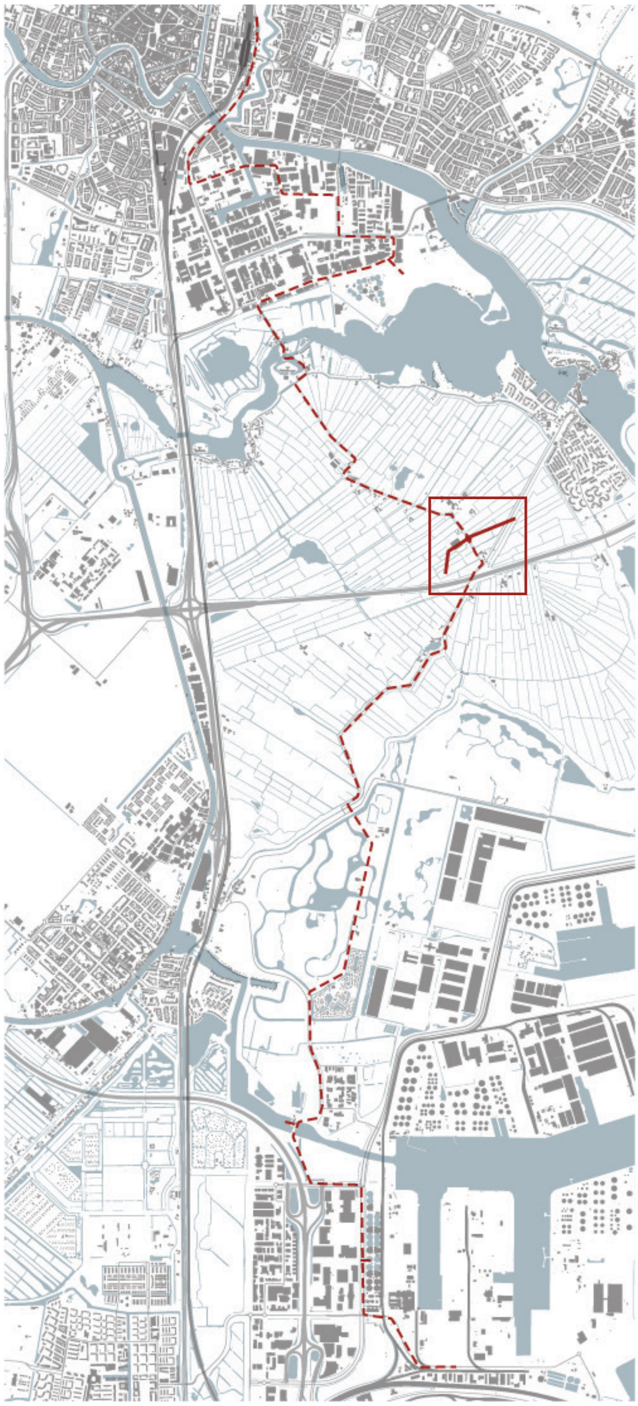

critical infrastructure:
porosity:
program:
Floating Village
dike
Porous Island

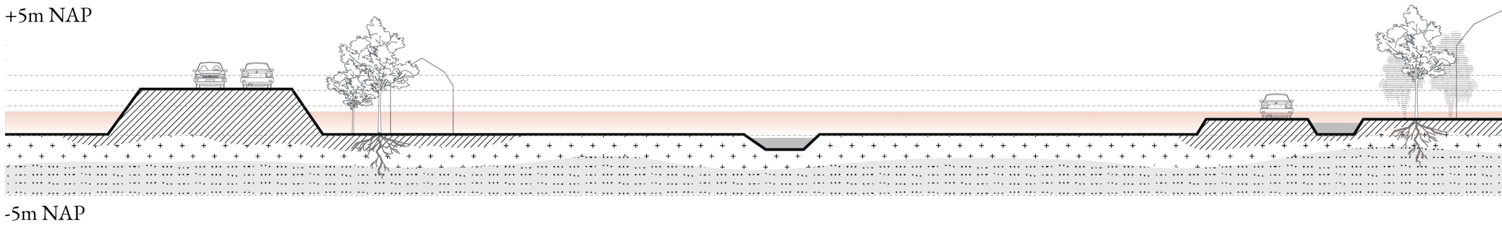

Densify Floating Village
dike
Floating Village
water body
Porous Island

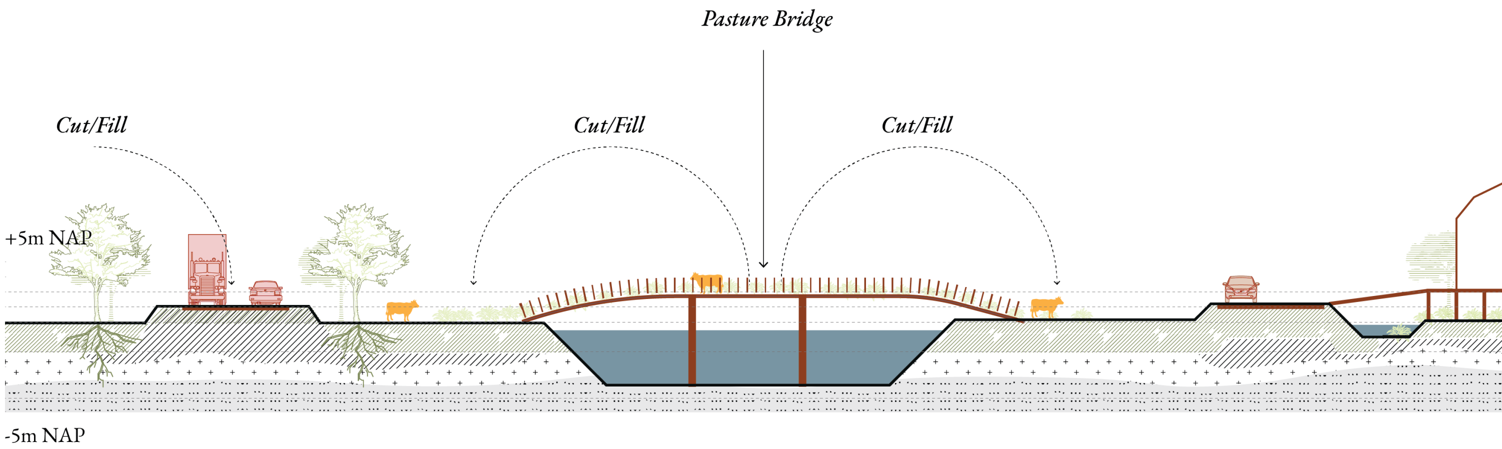
7. Sparndam (Kerkweg)

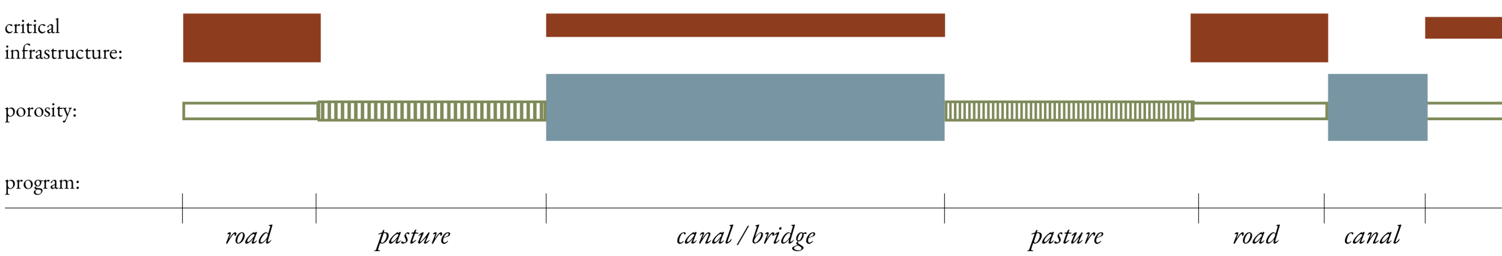
This transect cuts through the vast expanses of pastures on both sides of the existing dyke road. In order to accommodate incoming water from fluvial flooding, the pasture lands are transformed into a series of alternating peaks and troughs by cutting and filling, connected by pasture bridges.The raised peaks house agricultural farms and habitable spaces while the trough structures accommodate more water. Critical infrastructures such as roads are raised further up.

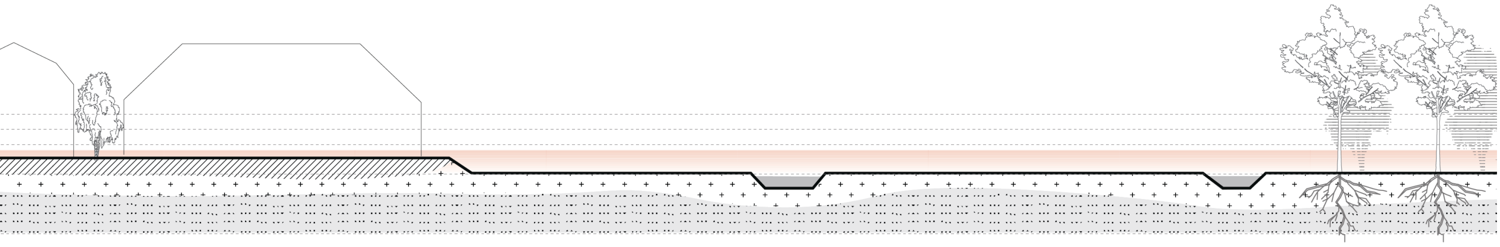
Fluvial flooding	■■■□□	1-1.5 m
Pluvial flooding	■■■□□	30 cm
Subsidence	■□□□□	10 cm

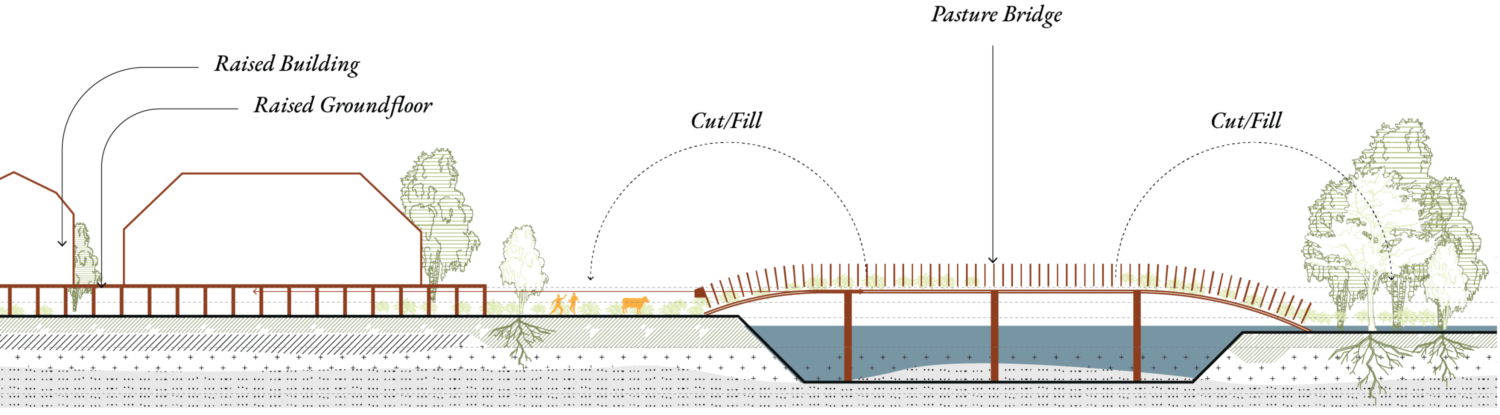



+5m NAP
-5m NAP

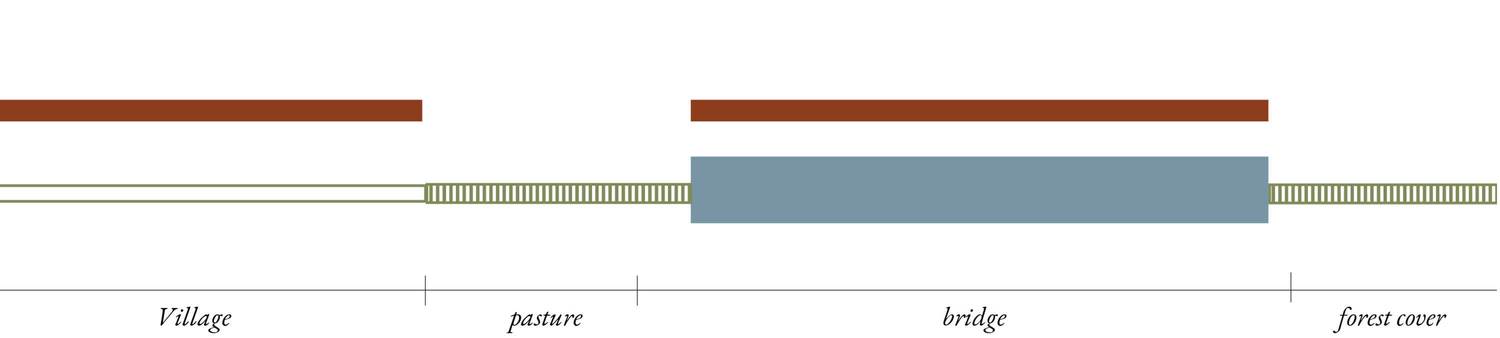

Pasture Bridge
Cut/Fill
Cut/Fill
Cut/Fill
+5m NAP
-5m NAP


critical infrastructure:
porosity:
program:
road
pasture
canal / bridge
pasture
road
canal





Pasture Bridge
Raised Building
Raised Groundfloor
Cut/Fill
Cut/Fill

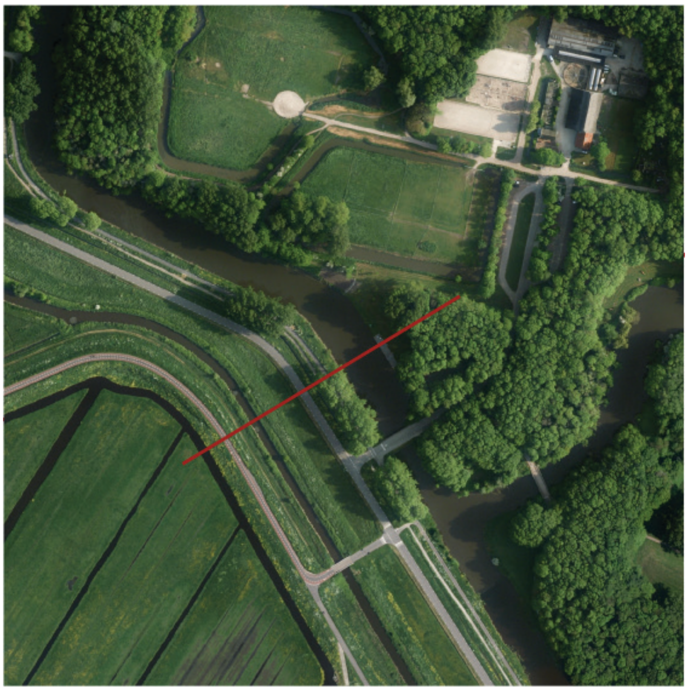


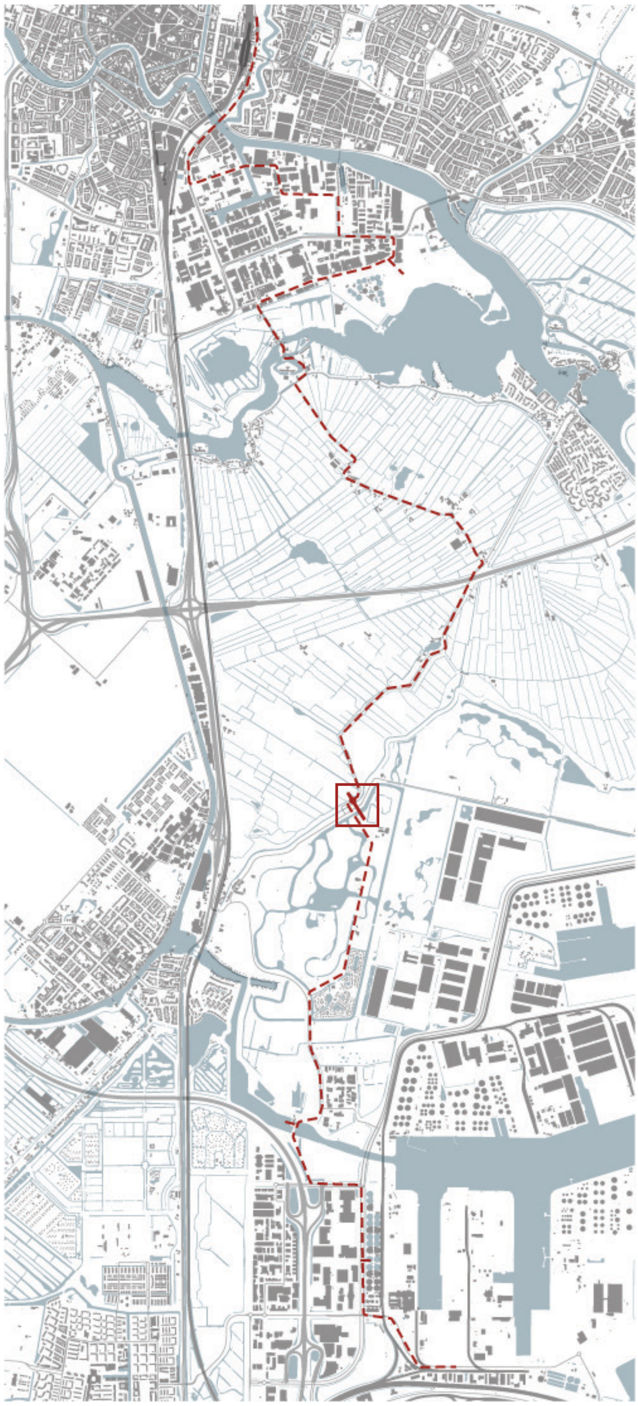
Village
pasture
bridge
forest cover

8. Houtrakkerweg

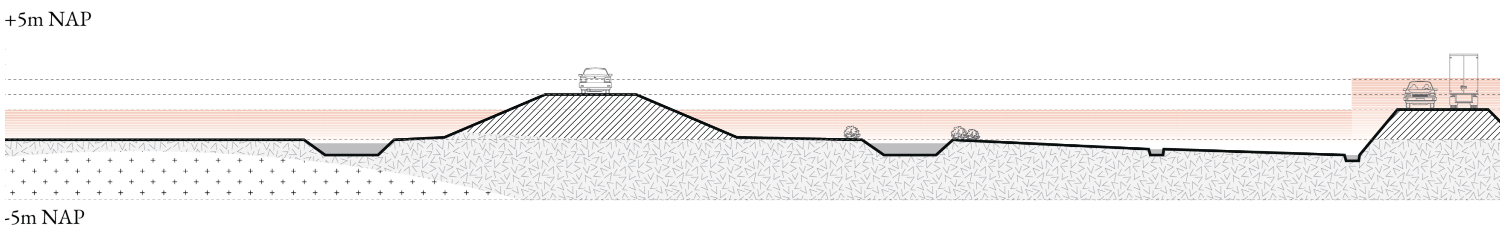
This transect represents the transformation of the agricultural zones and forested areas along the existing dyke network and their response to rising sea levels. The critical infrastructures consisting of the parallel road networks are raised and secured and the transitional buffer between the two networks is programmed to house seasonal infrastructure. Using the cut and fill technique, a freshwater reservoir is created for agricultural purposes. The forested area steadily transforms into a marshland which supports nature based tourism to boost the economy as well as to regenerate regional biodiversity.

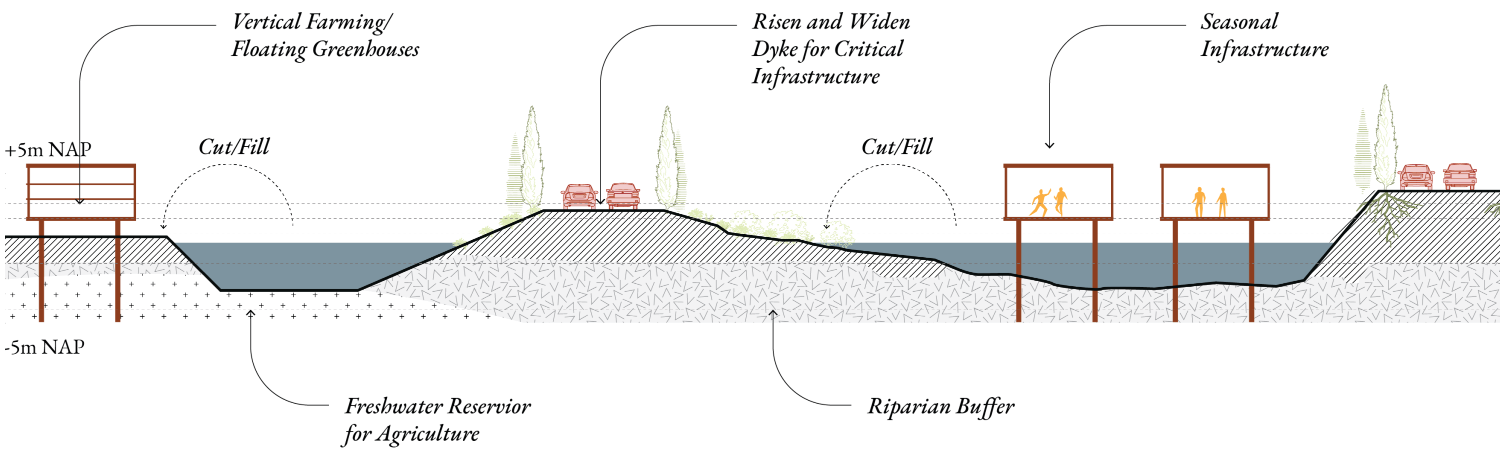
Fluvial flooding	2-5 m
Pluvial flooding	20 cm
Subsidence	10 cm

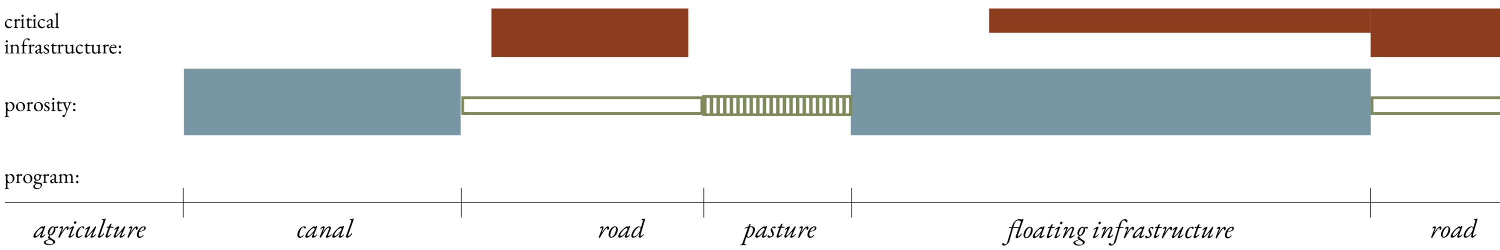


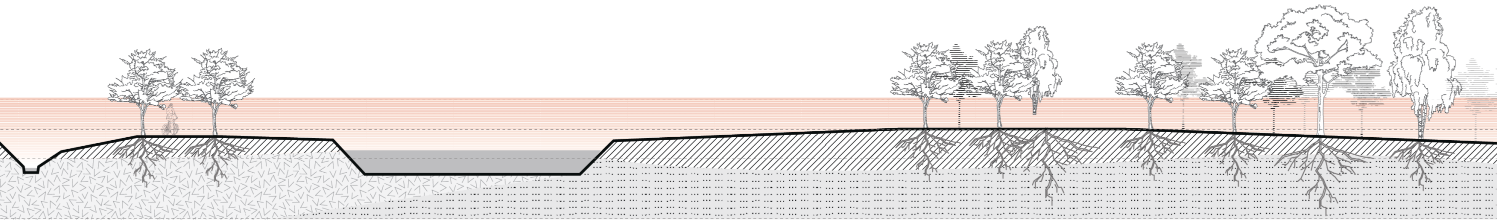


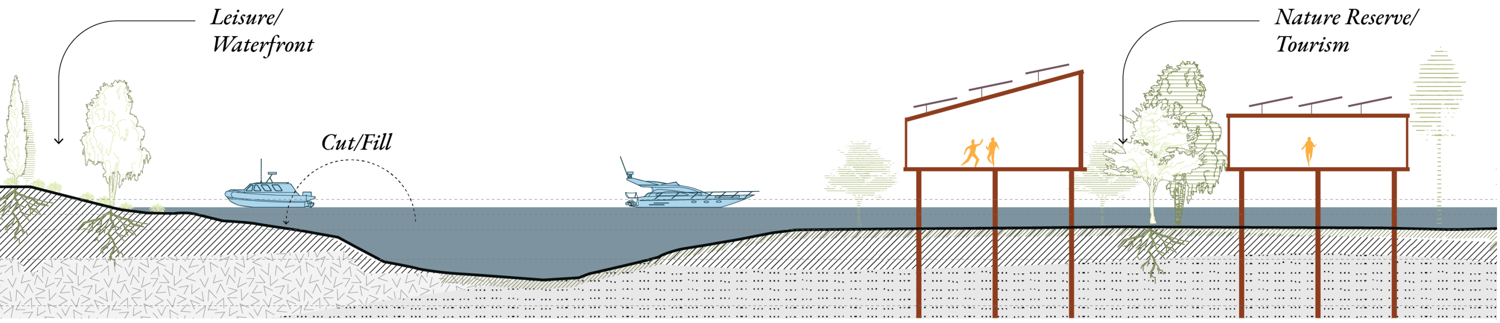

Fietsroute netwerk 'Zuid-Kennemerland'

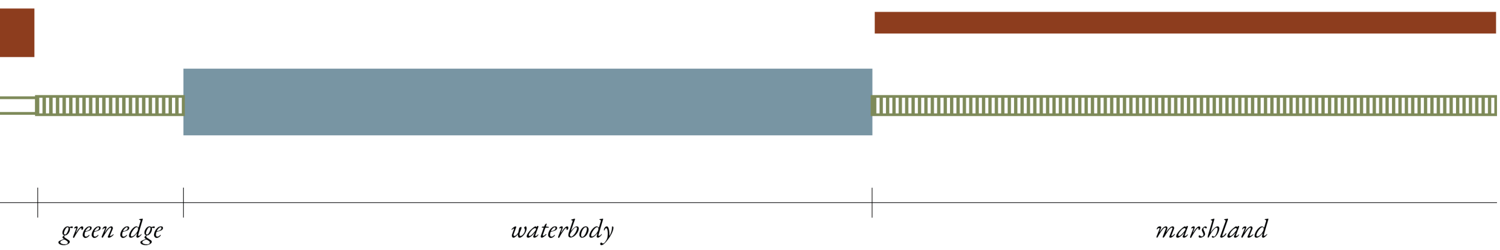

+5m NAP
-5m NAP


Vertical Farming/
Floating Greenhouses
Risen and Widen
Dyke for Critical
Infrastructure
Seasonal
Infrastructure
+5m NAP
Cut/Fill
Cut/Fill
-5m NAP
Freshwater Reservior
for Agriculture
Riparian Buffer


critical
infrastructure:
porosity:
program:
agriculture
canal
road
pasture
floating infrastructure
road



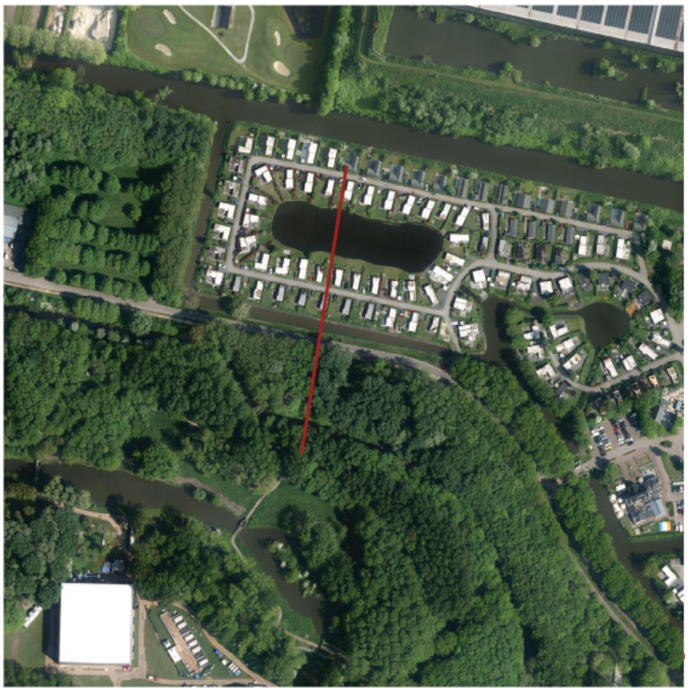

Leisure/
Waterfront
Cut/Fill
Nature Reserve/
Tourism

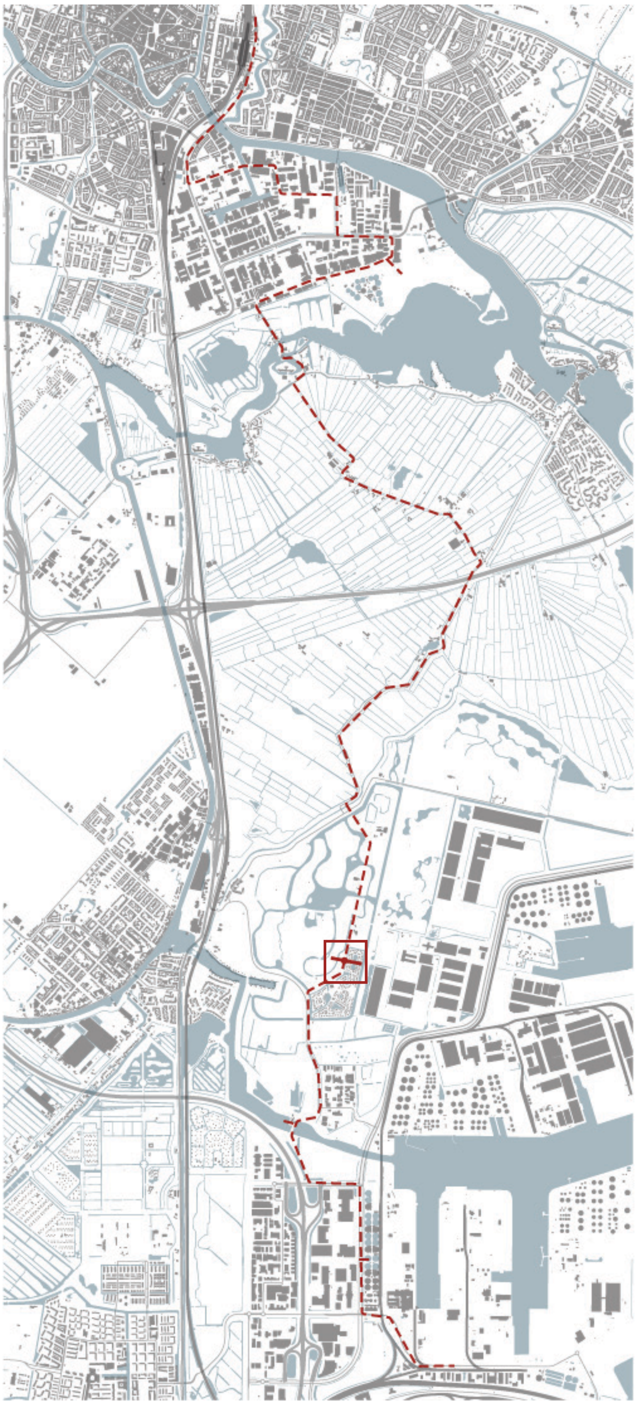

green edge
waterbody
marshland

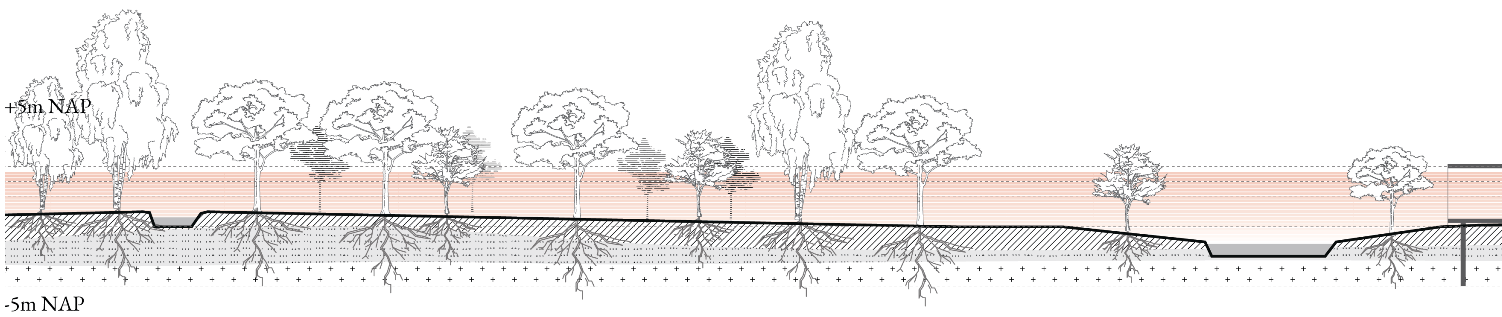
9. Zuiderweg

The following area represents the paradigmatic transformation of forest area with sparse single storey modular housing to tackle rising sea levels. Using the concept of landscape as infrastructure, the forested areas are used for carbon sequestration as well as a salinity buffer. The housing units provide additional protection between saline and fresh water storage and are integrated with solar panels and green infrastructure to enhance productivity.

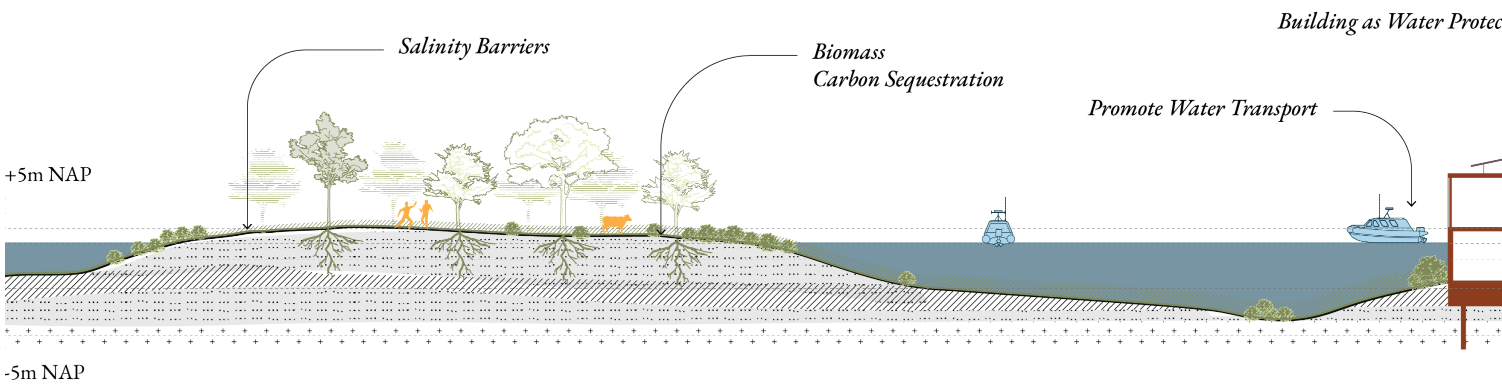
Fluvial flooding	■■■■■	2-5 m
Pluvial flooding	■■■□□	20 cm
Subsidence	■■■■□	40 cm



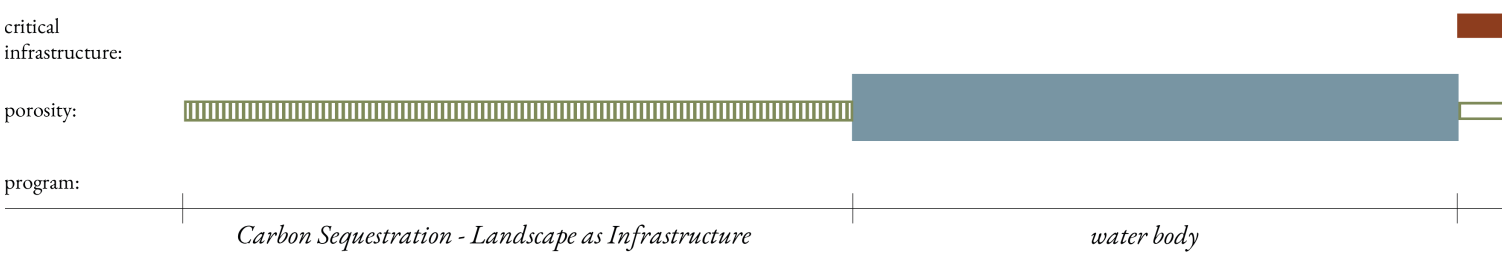




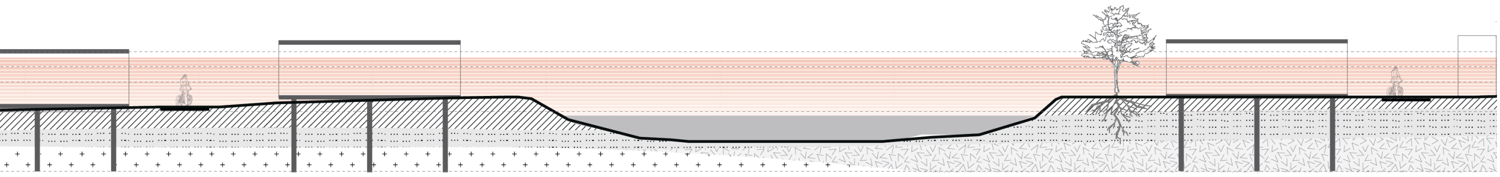
+5m NAP
-5m NAP

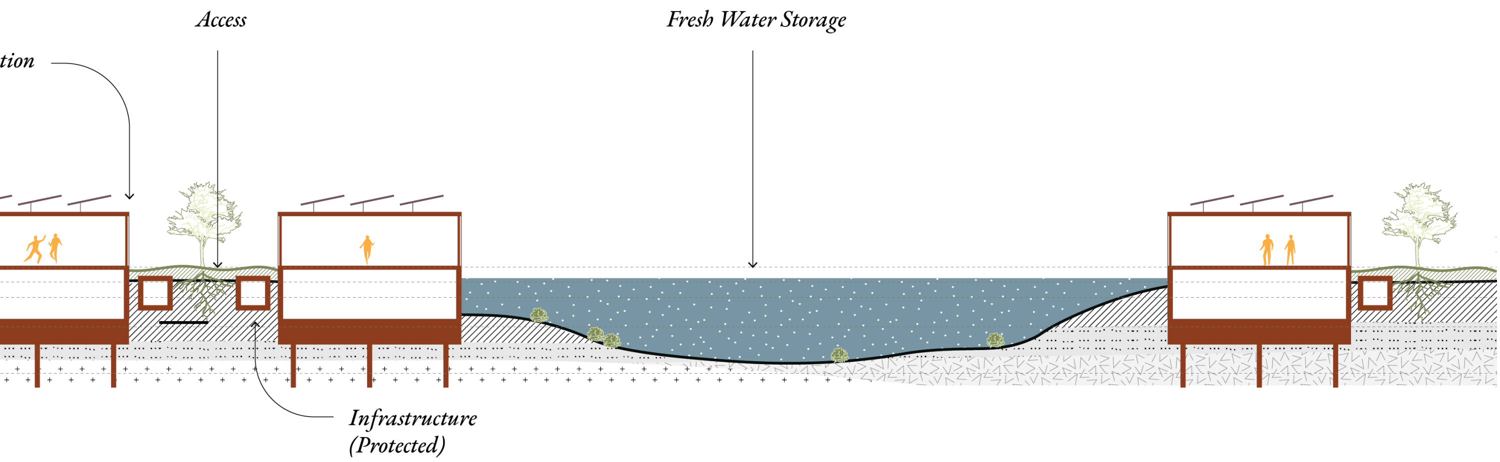


Building as Water Protec
Salinity Barriers
Biomass
Carbon Sequestration
Promote Water Transport
+5m NAP
-5m NAP



critical infrastructure:
porosity:
program:
Carbon Sequestration - Landscape as Infrastructure
water body



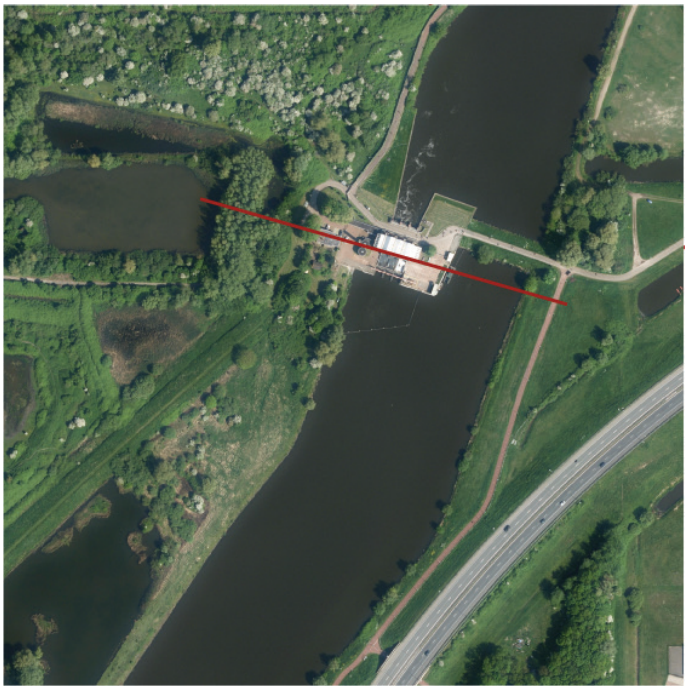

tion
Access
Fresh Water Storage
Infrastructure
(Protected)

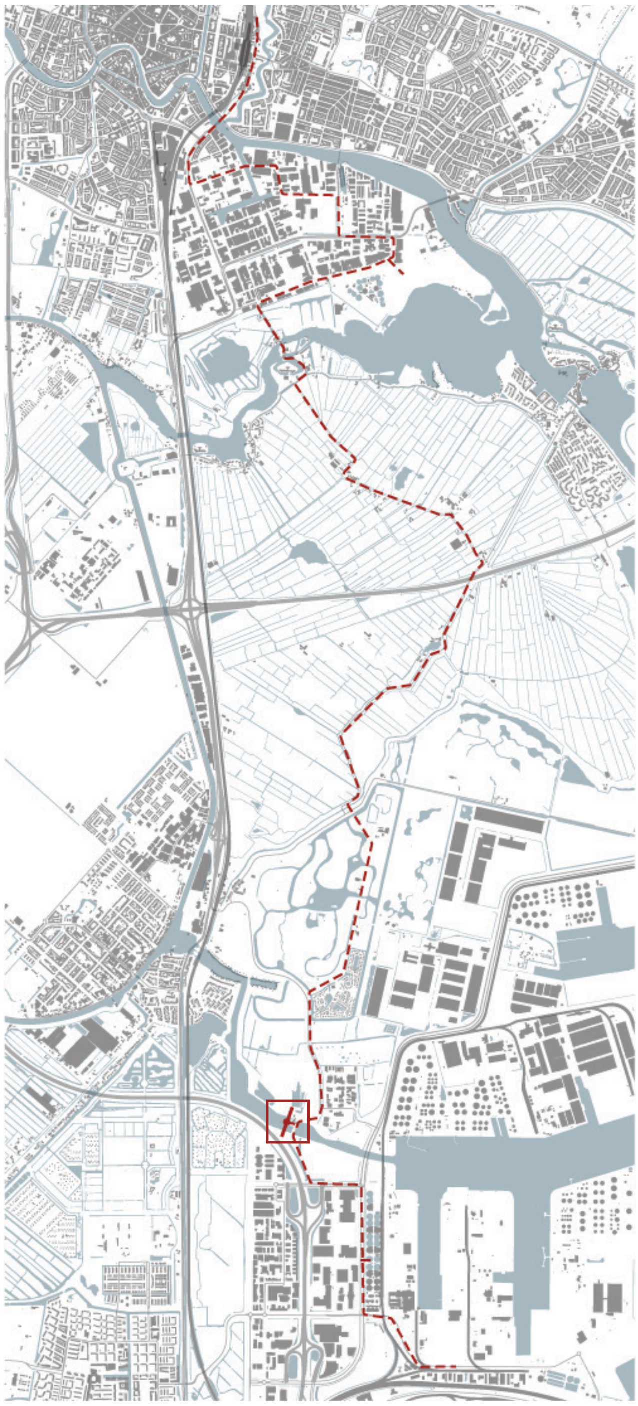

housing
access
housing
freshwater storage
housing
access

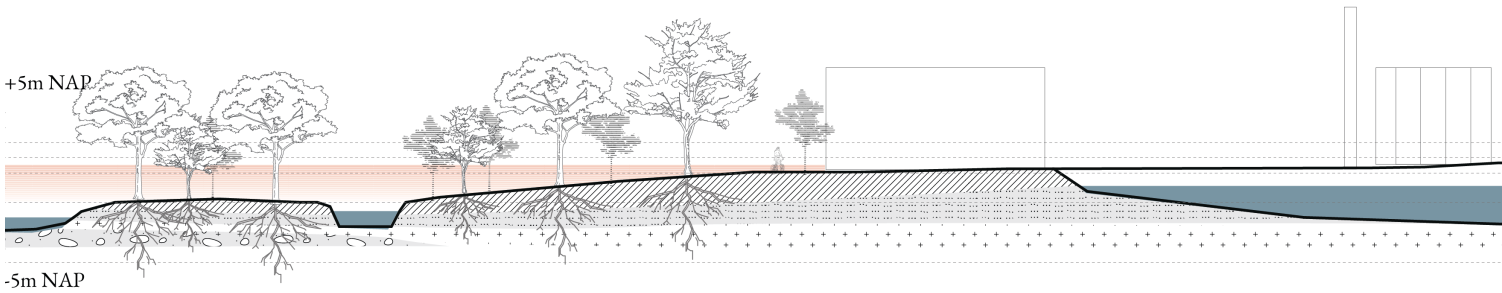
10. N1 Park

This area is transformed using the concept of infrastructure as landscape and facilitating the use of water as a public space. The waterworks structure is converted into a socio-cultural heritage monument to promote eco-tourism and serves as the entry point for tourists into the nature reserve. This region is marked by a dynamic relationship between land and water, flanked by rich biodiversity and regenerative ecology.

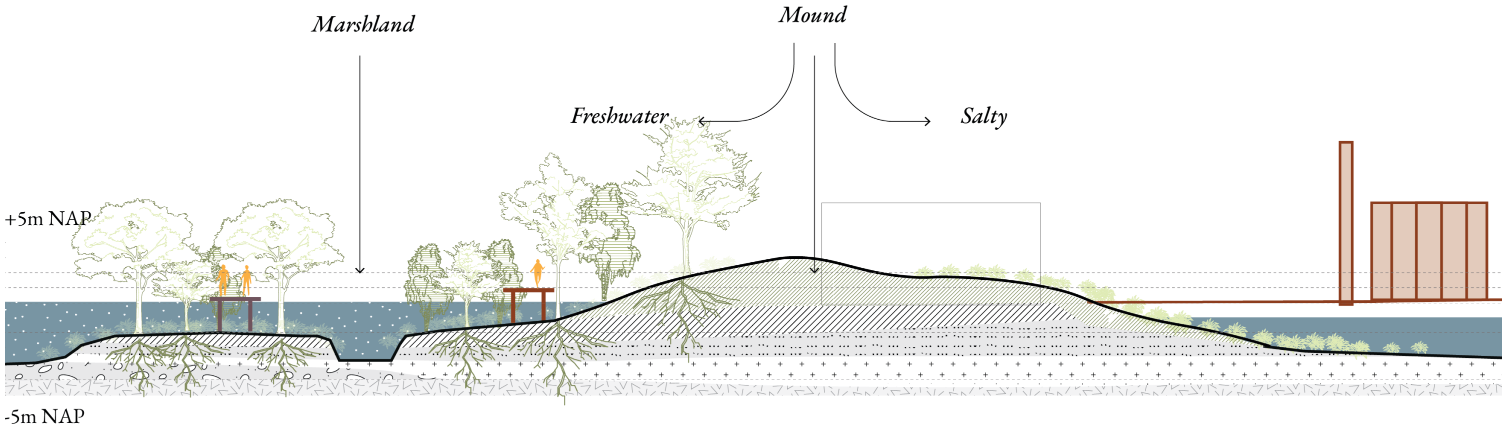
Fluvial flooding	■■■□□	1-1.5 m
Pluvial flooding	■■□□□	20 cm
Subsidence	■□□□□	10 cm





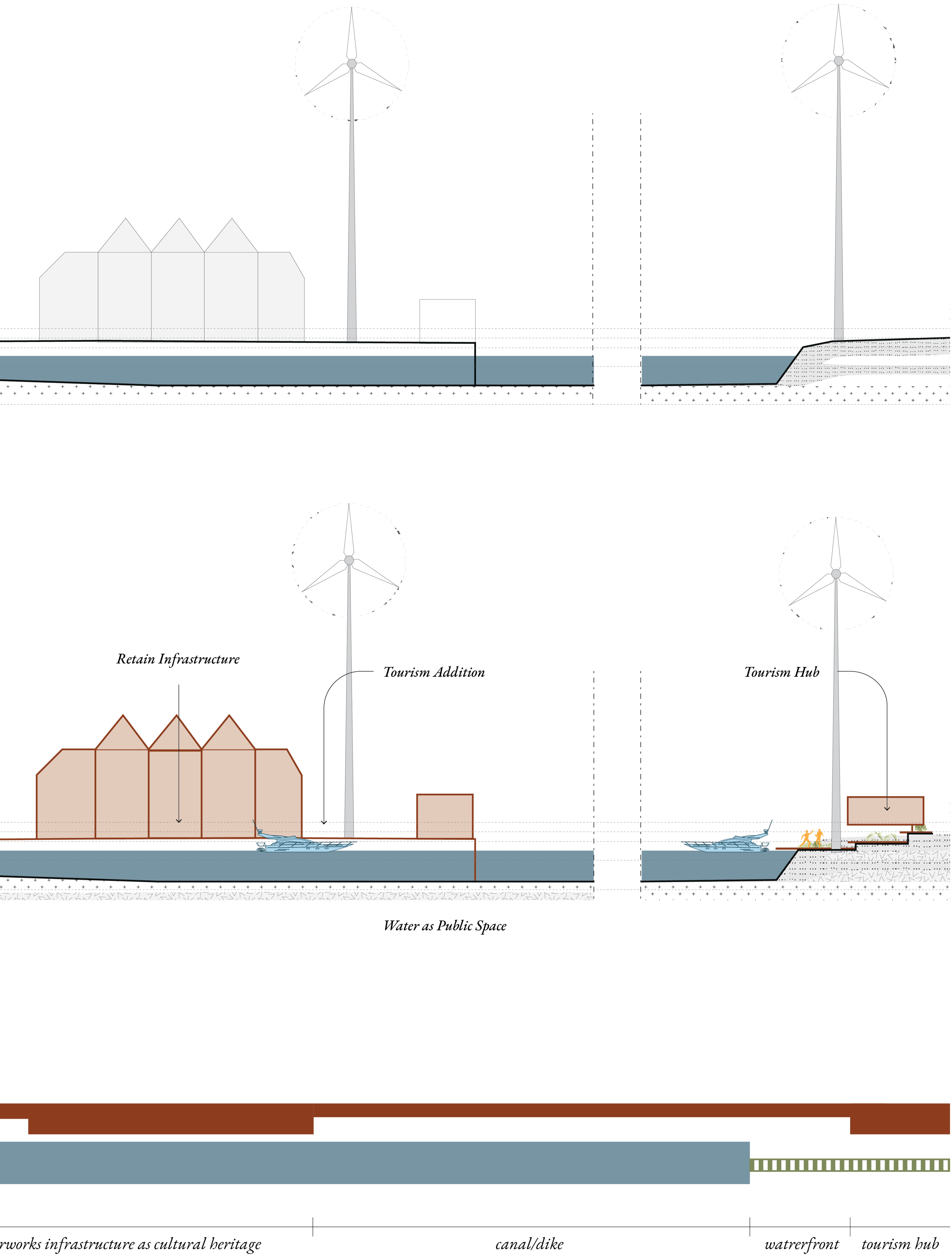


+5m NAP
-5m NAP



Marshland
Mound
Freshwater
Salty
+5m NAP
-5m NAP

critical infrastructure:
porosity:
program:
freshwater storage
marshland
wate

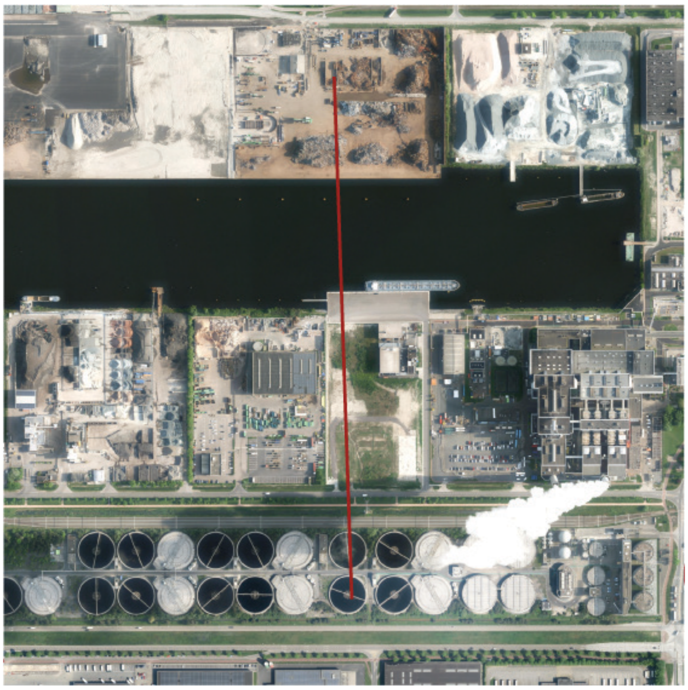


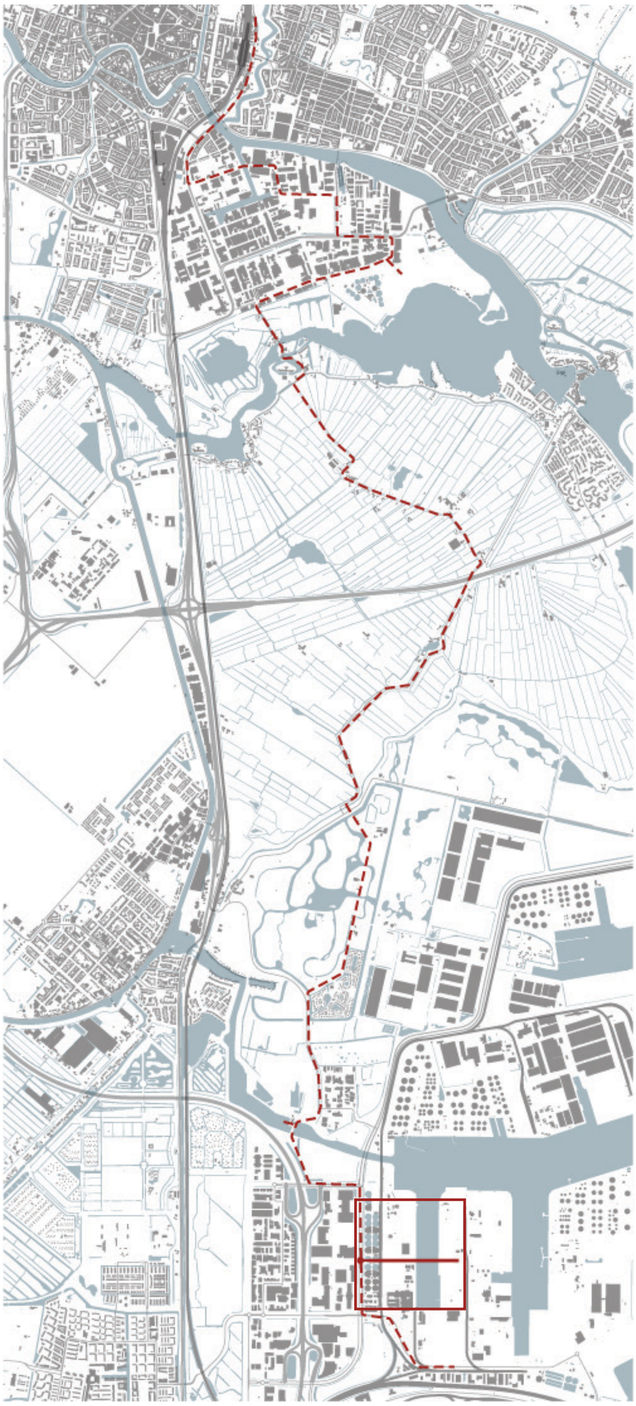
Retain Infrastructure
Tourism Addition
Tourism Hub
Water as Public Space
rworks infrastructure as cultural heritage
canal/dike
watrerfront
tourism hub

11. Portscape

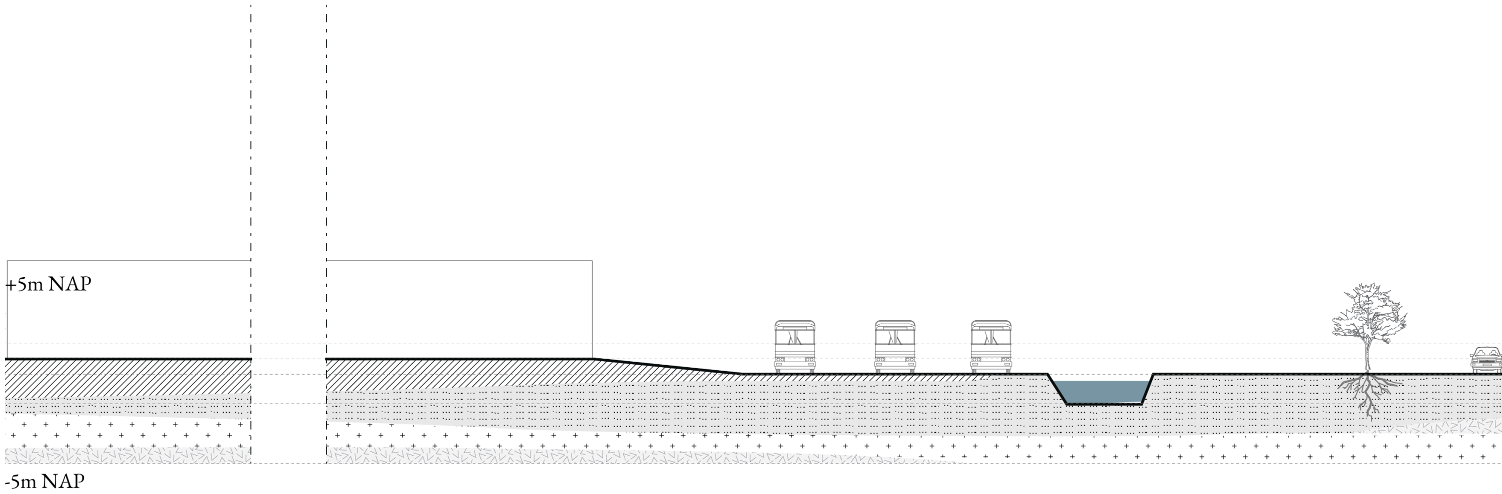
In general, port landscapes provide a sturdy foundation for efficient logistics operations thanks to their durable structures and raised surfaces. However, their lack of permeability can limit their ability to handle heavy rainfall. To address this issue, we suggest enhancing the landscape by introducing greenery and resurfacing the ground. The region is re-densified following a mixed-use development strategy to accommodate a multifunctional-flexible program.

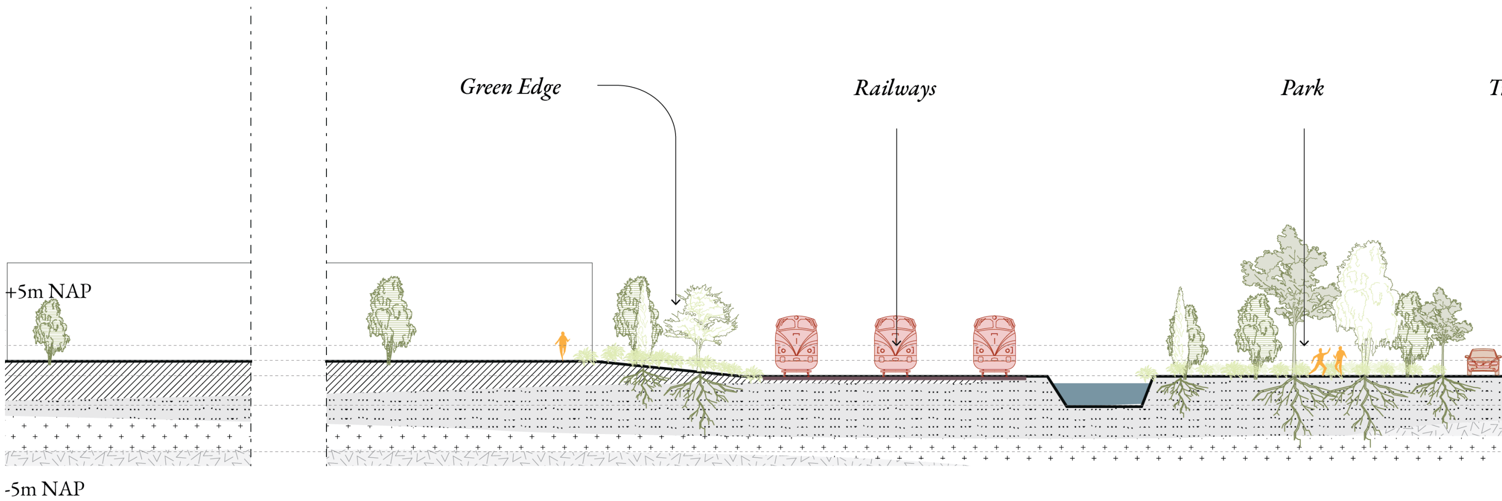
Fluvial flooding	□□□□□	NA
Pluvial flooding	■■■□□	30 cm
Subsidence	■□□□□	10 cm

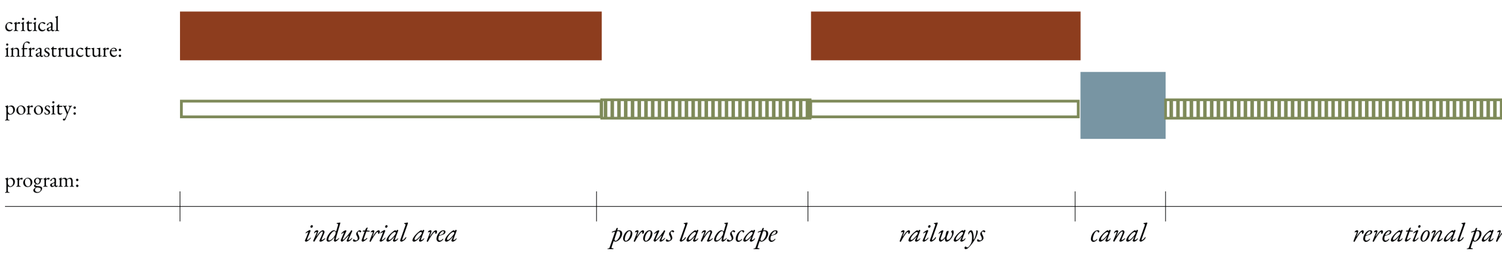


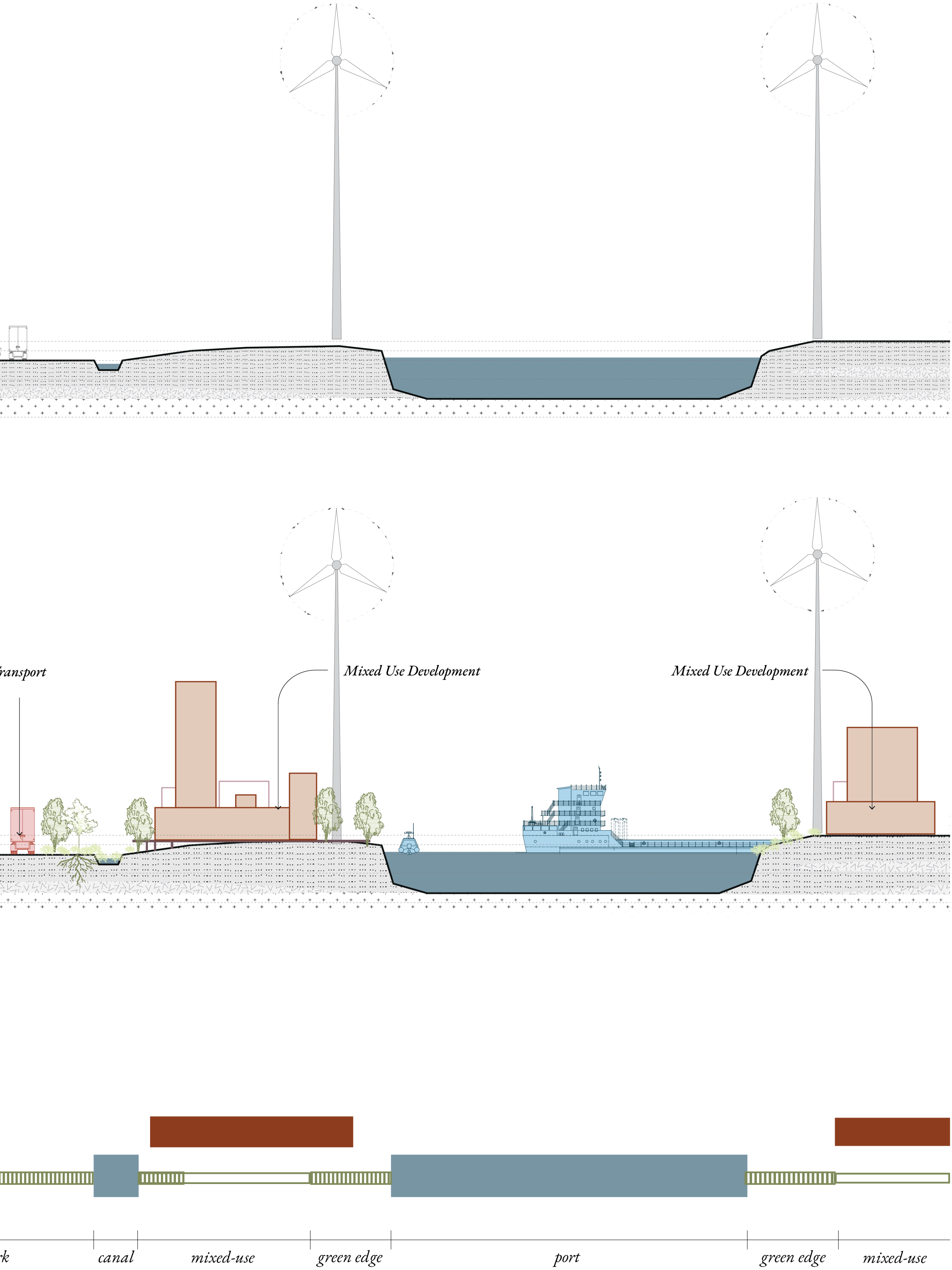


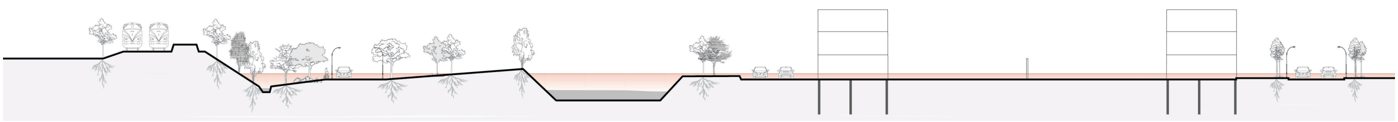
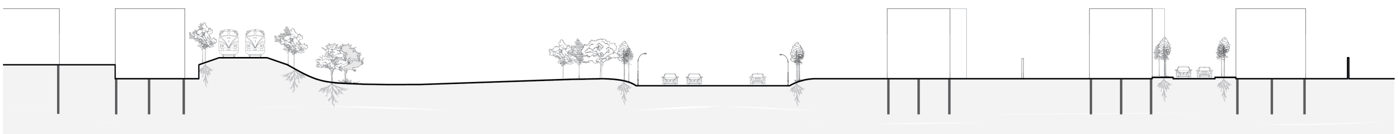
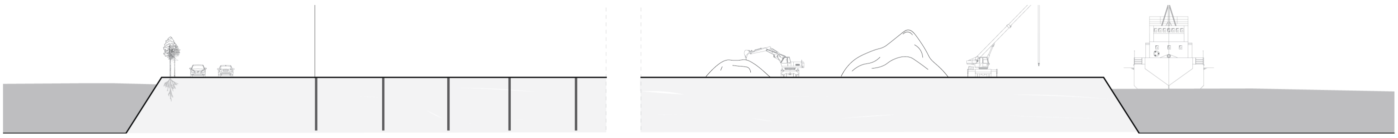
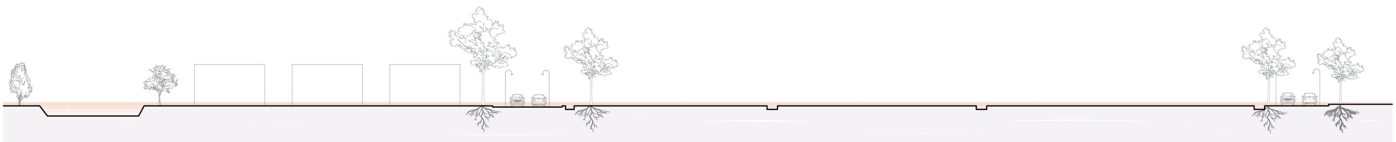
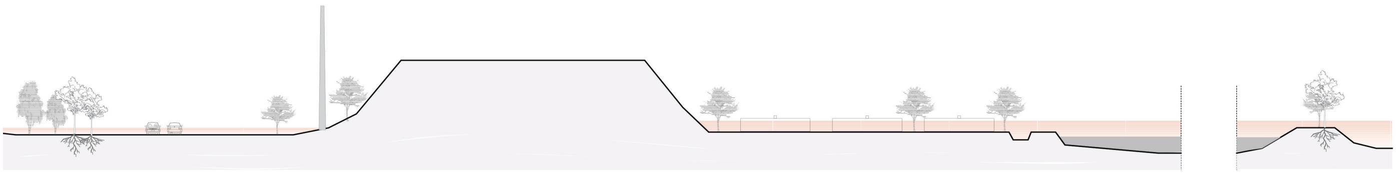
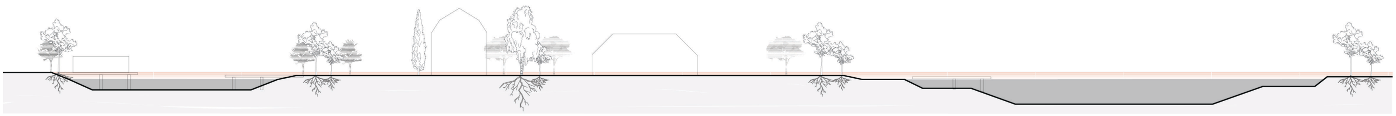
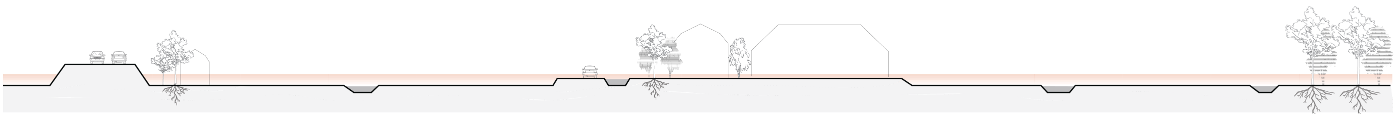
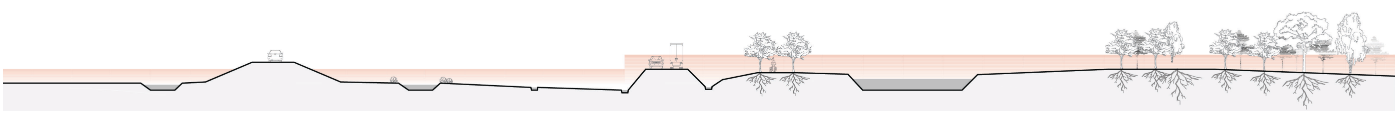
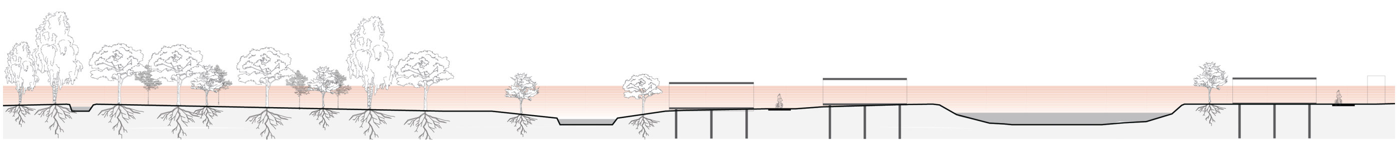
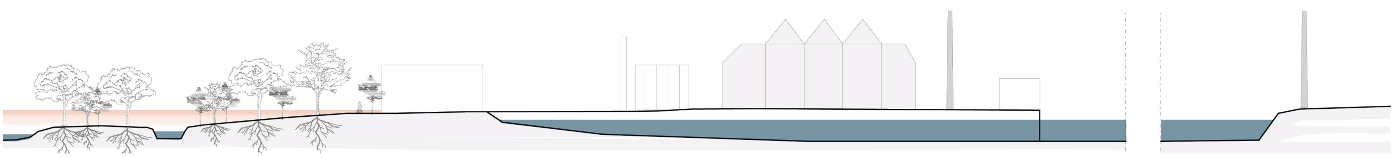
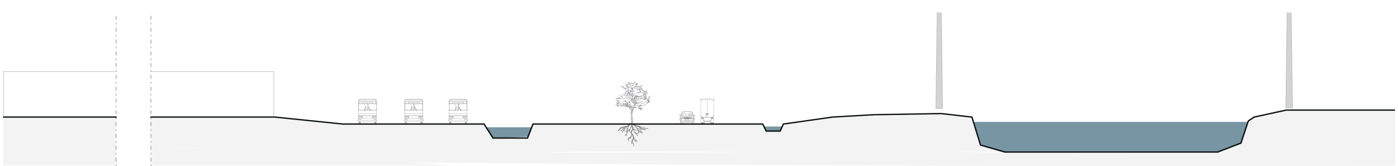

NISSAN

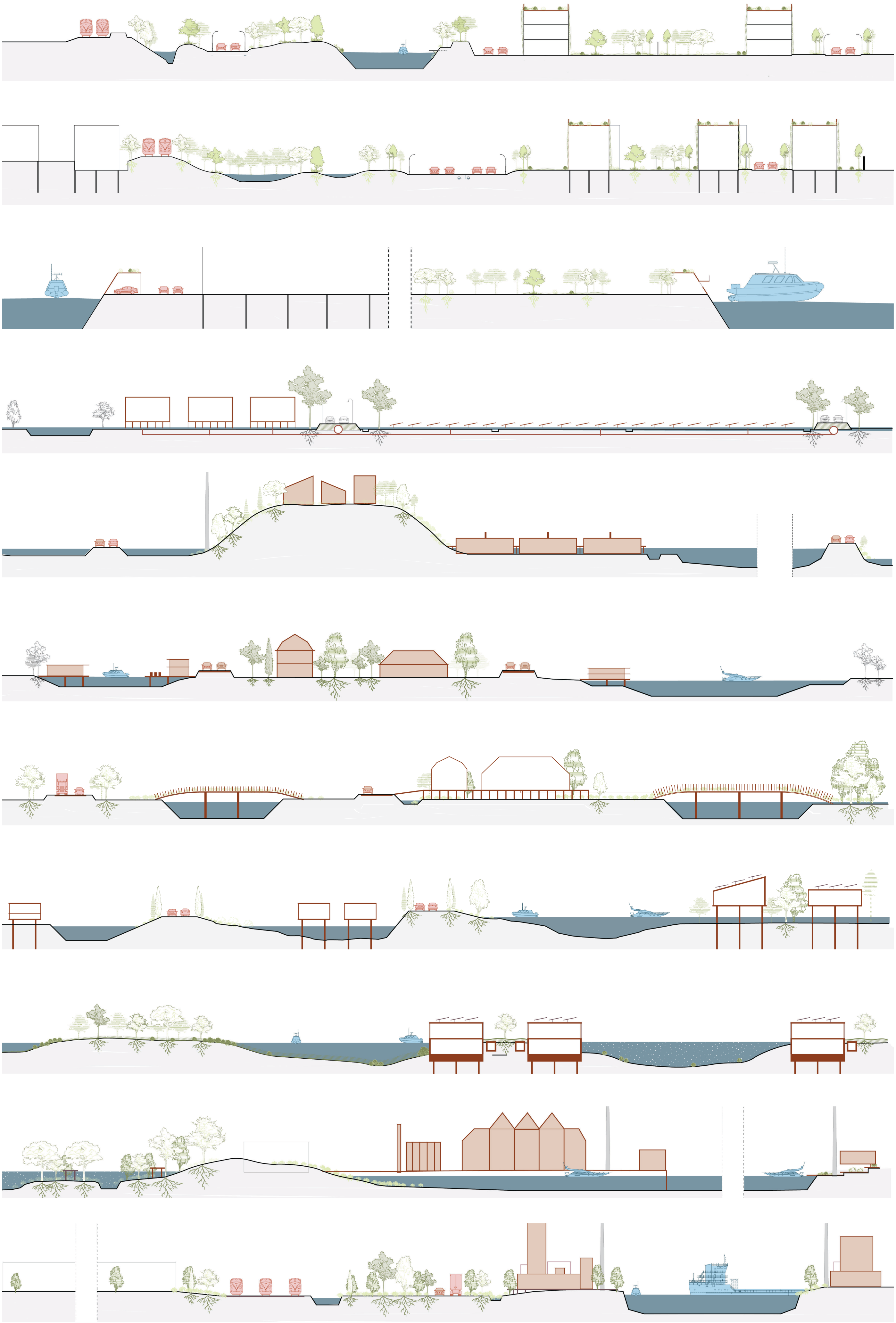

+5m NAP
-5m NAP


Green Edge
Railways
Park
+5m NAP
-5m NAP


critical infrastructure:
porosity:
program:
industrial area
porous landscape
railways
canal
rereational par


ransport
Mixed Use Development
Mixed Use Development
rk
canal
mixed-use
green edge
port
green edge
mixed-use



Synthesis

The drawing illustrates the design action on the plan to project the corelations between the sections to form programmatic areas.


Integrating fresh water storage to the larger infrastrutural framework of neighbourhoods
Wetland buffer
Densification of the port with mixed use program due to availability of fixed infrastructure
Integrating nature tourism hub to the infrastructural corridor
Nature reserves with ecological stepping stones

5. Conclusions

Current land planning and management is typically organized around separating different land uses from one another. However, a more adaptive approach to planning is necessary in deltaic landscapes, where natural forces are constantly shifting, especially regarding critical infrastructure. This involves finding a balance between infrastructure, design strategies, and climate dynamics, which can be achieved through the creation of critical maps and attentive fieldwork. The research process is also informed by insights from structured interviews, which shed light on the importance of adaptable structures and the need to learn from the natural world. Ultimately, long-term planning requires a flexible and integrated approach that avoids creating imbalances.

This study demonstrates the effectiveness of planned adaptation and accommodation in achieving a productive and protective landscape within a territorial configuration. Our findings emphasized the importance of utilizing structured preparation and fieldwork to apprehend the details, which ultimately informed the design process and prevented any misperceptions between plan and reality. Additionally, seeking guidance from experts during the fieldwork facilitated a deeper understanding of the context. By translating the fieldwork into critical maps and analytical and synthetic sections, we were able to gain a deeper understanding of how the protective and productive instruments work together in the deltaic landscape. This enhanced understanding allowed for a more detailed design approach that considers multiple perspectives.

The sections thoughtfully examine the challenges and opportunities of the productive landscape, with a focus on a specific area in the Netherlands. However, further research is needed to fully understand the intricacies of each operation of the landscapes,which in landscape and urbanism perspective, working on this scale was important to understand the relation between the systems and work accordingly. Rather than offering concrete solutions, this research provides valuable tools and theoretical references for designing systems that can effectively address the complexities of sea level rise in deltaic landscapes, as demonstrated through section experimentation.

"Examining the notion of extremes takes one away from a centre point, characterised by its predictability, balance and familiarity, and, instead, moves one towards a condition where unpredictability, disequilibrium and strangeness become the new normal."

(Przybylski & Sheppard, 2016)

Relevance

Scientific Relevance

This study advocates for a restorative approach to tackling the challenges of deltaic landscapes through the lens of fieldwork, diverse viewpoints, and collaborative thinking. It paves the way for interdisciplinary research that delves deeper into potential issues, while urging engineers to consider the quantitative feasibility of their designs. This research, though constructed in a systematic research through design approach, leaves the possibility of further development through engineering and policy research towards mending the transition in regards to climatic challenges.

Ethical Relevance

As an urbanist and landscape designer, we frequently discuss the development of systems that function effectively across various layers. Our conversations have proven fruitful in encouraging interdisciplinary collaboration to refine the built environment, particularly in regards to productive landscapes where changes can impact entire systems, such as the economy and resources. As a result, it is essential to experiment with accommodation scenarios based on the data and research we have gathered to address critical values in more complex consideration challenges.

Societal Relevance

Productive landscape involves multiple stakeholders from industries, logistics, and residents. Therefore, it calls upon the inhabitants who live and operate in the productive landscape to add their values into the research as an agency to address compromises in design and participatory processes. It addresses further challenges to relevance the discussed problems and various stakeholders, making the discourse become common. As we need to survive while caring the environmental dynamics.

Reflection

Anmol Bhargava

As the HPM research project within the Delta Futures Lab nears its conclusion, it is time to reflect on this journey which started more than a year and a half back. My personal motivation to be a part of this program stemmed from my interest in understanding and designing water sensitive environments in the Himalayan Landscape back home in India, a region which is grappling with frequent riverine flooding and accelerated climate change in the recent past. Moreover, getting an opportunity to work in an interdisciplinary team of spatial designers and hydraulic engineers within the Delta Futures Lab further inspired me to be a part of this project.

After intense discussions and brainstorming sessions through literature review, we narrowed down the scope of the research to the deltaic systems within the Dutch delta and how sea level rise and climate change are making it vulnerable, building upon Deltares' approach of 'Living with Water'. This was followed by a constant process of learning and unlearning, since extensive amounts of research has already been within this context. In order to further narrow down on the problem focus, we used the method of critical cartography to understand Netherland's position in the global context. We spatially analysed its dominance, and in turn, heavy dependance on its productive landscapes: agricultural products and the port landscapes that transport them to different parts of the world, and how these are under severe threat from rising sea levels. Thus, the method of critical cartography played a pivotal role in defining the scope of the project and understanding the relevant spatial elements.

Thereafter, we interviewed a group of experts from academics and practice to understand the nuances of integrating productive landscapes and protective infrastructures through the approach of accommodation which yielded in enriching discussions and helped us in expanding our knowledge base and informed us about case studies and ongoing research being done within the domain. This formed the perfect basis for doing fieldwork to test our approach of Research by Design, for which we selected a paradigmatic area between Haarlem and the Port of Amsterdam which we documented through photographs and video montages. Through a series of collaborative workshops we translated our field observations into a series of section profiles which represent the exemplary elements of the existing productive landscapes, protective and supporting infrastructures. Thereafter, we added the vulnerabilities arising from rising sea levels onto these sections and designed strategic operations to adapt them to this future condition of 'living with water'. As a concluding drawing, these transformations were then projected onto a base map to understand and synthesise the spatial implications of these transformative processes.

Thus, this project proposes a pedagogical shift in how we perceive water within our landscapes, the relevance of accommodating it and and aims to come up with creative theoretical concepts and approaches to design future deltaic systems. To conclude, apart from the various methods and skills that I learnt through the course of this research, this project helped me in understanding the importance of being critical of the conventional methods and the need to think out of the box.

Katerina Pavlou

The research presented on the transition from adaptive planning to planned adaptation within the context of integrating nature-based solutions (NbS) within vulnerable deltaic regions, particularly focusing on the Dutch deltaic system, offers valuable insights into the multifaceted challenges posed by climate change and sea-level rise. One key takeaway from this exploration is the recognition of the interdependency between productive and protective systems within these vulnerable regions, underscoring the need for a holistic approach that considers ecological, social, and economic dimensions. By exploiting nature-based solutions, which utilise natural processes and ecosystems, it becomes possible to not only mitigate the impacts of climate change but also enhance the resilience and sustainability of these landscapes.

Through critical cartography and sectional drawings, this research offers a means to visualise and experiment with localised adaptation measures, crucial for informing decision-making and fostering innovation in design. Section is a powerful tool for revealing not only what is happening above the ground but also the intricate dynamics of the undersoil. While the decisions highlighted in this research primarily focus on the productive landscape, their underlying intention is to intervene more substantially in the 'natural' landscape. The proposal includes different 'natural' landscapes such as forests, marshlands, and riparian vegetation on a regional schematic scale, yet there is room to enhance the emphasis on green typologies with native tree species and ecological aspects. Taking it a step further could involve deeper integration of ecological principles, emphasising native species diversity, habitat restoration, and ecosystem functionality within the proposed landscapes. This approach would not only enhance the resilience and adaptability of deltaic regions but also promote the preservation and enhancement of local biodiversity and ecological processes.

Reflecting on these themes, I am deeply aware of the urgency surrounding the need to address climate change and sea-level rise in vulnerable deltaic regions. The obstacles we face are monumental, yet the research presented instils hope by showcasing the effectiveness of nature-based solutions and interdisciplinary cooperation in managing risks and building resilience. Moving forward, it is essential to translate these insights into action, mobilising resources and expertise to safeguard the integrity of both people and ecosystems in the face of the future.

Kirthan Shekar

Firstly, the project allowed me to experiment on design in the landscape and the object scale to understand the implications of sea level rise on the infrastructures and the programming of the landscape. It was necessary to understand the implications of climate change on the land practice. Understanding the possibilities of what the landscape can be when subjected to the problem of the sea-level rise was the central objective of the design project. The project allowed for a better understanding of the concept of adaptive capacity of the landscape. The outcome was apt in trying to understand the difference in adaptive planning and planned adaptation. Here I see the need for the shift from the reactive paradigm to the proactive one of planned adaptation which is more towards transformation. This allows for many radical projects to challenge the engineering tradition of using protective measures in the form of monofunctional dykes. Instead to understand the potential of the change itself. Here it was important to understand the concepts of what to protect - the urban heritage (the urban fabric), landscape heritage (the polder fabric). The project allowed for using the structures for proposals of the program of the landscape.

Secondly, reflecting on the research process and the methodology, the methods of cartography allowed for the better understanding of the landscape using the transects and in turn the topology of the productive landscapes. Projecting the sea-level rise and designing with the extreme scenario allowed for a more critical overview of the landscape and proposed conditions for change. Methods of interviews were used to collect thoughts on the ongoing paradigms and the necessity for a change in the way we work with it. The method of using sections to understand the landscape and propose transformations suits a paradigmatic project like this. But it was difficult to translate it into regional strategies as it was difficult to get the systemic understandings and metabolisms related to infrastructures. But as an experimental process, it was something that fits the project. Synthesising the transformations on a plan from the sectional design method was challenging and this allowed for a tentative operative strategy plan and the degree of resolution we could achieve.

Finally, the project allowed me to reflect on designing with uncertainties the role of experimental methods to propose transformation and the paradigm change from adaptive planning to planned adaptation. In that way, you can respond to the longue dureé - the geographical time instead of the current process reacting to the shorter socio-economic time. The former should dictate the latter and not the other way around. In the discourse of landscape urbanism the project allowed me to understand the role of landscapes as social infrastructures in addition to being just the ecological one. When landscape is perceived as infrastructure itself :and in the project the dutch landscape provides the best example to experiment with it, I realised the significant role of academic projects to propose change.

Satria A Permana

Deltaic systems are complex ecological landscapes that consist of intricate hydrological and geographical features, as well as urban areas. Having spent a year researching these systems, I have come to appreciate the interconnectivity between the human and non-human ecosystems, as well as the delicate balance between surface and subsurface elements. My original motivation for joining this program was to find solutions for the challenges posed by floods, land subsidence, and sea-level rise in Jakarta. However, my research has revealed that these issues are part of multifaceted cycles that require a holistic approach to address.

One of the most inspiring aspects of the research has been the opportunity to engage in discussions and dialogues with other experts on how to navigate these complex systems during times of transition. This learning experience has underscored the need for critical thinking and the ability to consider problems from multiple perspectives.

Conducting fieldwork was a remarkable experience that allowed me to immerse myself in the study site and develop ideas for design. The Netherlands offers diverse landscapes, including protected systems and polder-boezem configurations, which provided valuable insights into how these systems function. Despite not being the primary focus of my research, I was fascinated by the complexities of these systems and their intricate workings.

The experiment through sections was an exceptional opportunity that enabled us to gain a deeper understanding of the systems and to develop analytical configurations based on our research and interviews. We were then able to synthesize this information into our proposal for designs, which sparked lot of ideas.

Working in a dynamic team composed of individuals from diverse backgrounds, including landscape and urbanism perspectives, was an enriching experience. This collaborative environment allowed us to compromise and align our work towards a common goal. I gained valuable knowledge from my colleagues and mentor. However, if I could redo the work, I would like to have strategic environment that values effective communication and collaboration.

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Appendix: Interview Transcripts (concised)

Fransje Hooimeijer
Associate Professor of Environmental Technology and Design
Delft University of Technology

19 December 2023

Interviewer:
Thank you, Fransje, for joining us. Let's dive into the first question. Considering the four approaches to sea level rise—protect, close, protect open seawards, and accommodate—it seems there's a growing preference for the accommodation approach. What are your thoughts on this strategy, especially from the perspective of academic research?

Fransje Hooimeijer:
From an academic standpoint, the four approaches offer a framework to explore potential paradigm shifts in flood defense. It's not merely about choosing one strategy; it's about understanding the outcomes of applying various strategies. For example, the Redesigning Deltas project in Rotterdam utilizes three strategies simultaneously, demonstrating a comprehensive approach to flood defense that moves beyond traditional hydraulic engineering. This methodological variety allows us to assess which strategy might be most beneficial, despite their conceptual simplicity.

Interviewer:
Does the accommodation strategy imply a reduction in protection efforts?

Fransje Hooimeijer:
Not at all. Accommodation involves examining localities to discern potentials for protection or transition. It's synonymous with identifying opportunities for adaptive measures.

Interviewer:
This leads to our next topic on ecological rationality, emphasizing the capacity of human and natural systems to address ecological and urban challenges. With the inevitable complexities and uncertainties, there's been a shift from adaptive planning to planned adaptation in academic research. What's your stance on this transition?

Fransje Hooimeijer:
Planned adaptation doesn't eliminate the need for adaptive planning; rather, it integrates it. The shift you're describing is from a reactive approach to a more future-oriented, research-driven

approach that doesn't exclude adaptability. It signifies not just a change in methods but an expansion in perspective, incorporating long-term planning into our strategies. This shift also underscores the importance of design research in flood defense planning, which is a significant cultural shift for the Netherlands, harking back to our historical approach to urbanization and spatial planning.

Interviewer:
How do integrated systems, like nature-based solutions, fit into this strategic framework?

Fransje Hooimeijer:
Integration is crucial. The Vlissingen project, for instance, showcases how accommodation, protection, and nature-based solutions can be combined in a single strategy, emphasizing the holistic consideration of both human and natural systems.

Interviewer:
With sea level rise, there's a pivot towards aquaculture. How does this align with the accommodation strategy?

Fransje Hooimeijer:
Aquaculture represents a scale of adaptation, from large-scale projects like Floating Cities to localized initiatives that adjust food systems to water system changes. This diversity in approaches highlights the necessity for innovative, comprehensive strategies to manage sea level rise effectively.

Interviewer:
Are there any innovative projects or developments in this area that stand out to you?

Fransje Hooimeijer:
Projects such as Vlissingen and Doppeldijk are at the forefront of innovation, demonstrating how accommodation strategies and nature-based solutions can be effectively implemented. These projects offer a glimpse into the future of flood defense and land use planning, showcasing the potential for a more adaptive and integrated approach.

Steffen Nijhuis
Associate Professor of Landscape Architecture
Delft University of Technology

8 January 2024

Interviewer:
There are four approaches to the sea-level rise: protect-closed protect-open seawards and accommodate. Although most of the interventions' responses to the sea-level rise are combinations of all these four approaches we find the fourth approach of accommodation is where the future is tending towards. What are your views on this approach of accommodation from the perspective of academics-research?

Steffen Nijhuis:
Accommodation means that the structure or the landscape itself is adaptive in nature and has the ability to change as per the situation and the context. The Room for the River project is a quite successful example of accommodation but as you can see there were many estimations which turned out to be different in reality. Now the question is what's the solution. I feel that in these kinds of landscapes we need to build robust structures which have the ability to change over time(.....) There is a reason why the dikes are there. These adaptive structures have to be a collective effort of the principles of governance landscape ecology geology and other fields. This reveals the operative power of these structures because usually these structures are used for centuries. But now the question is how can these structures be used for such a long time? Then we come to our second point which states that these structures should be multifunctional ie they should have the capacity to adapt the function that they are serving over time and only then can they be used as long term structures. This helps in connecting a long term perspective to the short term solutions that these structures might offer. I think what is also very important is that there should be a regional perspective while defining the function of these structures. This also implies in a way that we should work with principles instead of fixed solutions. There should be a deep-rooted understanding of how the structure operates and how its function impacts the larger system.

Interviewer:
Thank you for your detailed insights on the idea of accommodation. As a matter of fact, you have partly answered our next question which revolves around the concept of Ecological Rationality. In this regard, there is a notable shift from the paradigm of adaptive

planning to planned adaptation and looking at the crisis in the longue durée. What are your comments on this shift and the differences between adaptive planning and planned adaptation?

Steffen Nijhuis:
We need to look at changing perspectives in the long term rather than problem-solving in the short term. Planned adaptation means that to prepare and respond to unforeseen challenges in advance whereas adaptive planning is a more flexible approach which has the ability to adjust its strategies and actions with respect to changes, uncertainties, and unexpected events.

Interviewer:
There have been developments in the use of coastal morphodynamics principles (like sand-machine), double-dyke systems, integration of windmills and dykes. What is the need to look at systems of production and protection in an integrated manner?

Steffen Nijhuis:
We need to look at how we define productivity. Is it agriculture, energy, or even parameters like ecological balance can be counted as productive functions? Historically, landscape structures were built in a way that they added a productive value along with their main protective function. However, with the advancement in technology and the development of more specialized and heavily engineered protective systems against SLR, there has been a growing disconnect between protective and productive systems which need to be integrated as per the approach of accommodation.

Interviewer:
With the sea-level rise crises, there is also the rising problem of economic shifts like the need to shift the mode of agriculture to aquaculture, etc. If we integrate the productive and protective systems with the approach of accommodation, what are the benefits and shortcomings of this integration from the perspective of practice/ academics-research/ governance-policy?

Steffen Nijhuis:
We need to experiment and start pilot projects to explore this approach further. We also need to look at our policy space which allows for better governance and more opportunities for collaboration between the various stakeholders and the policymakers.

Interviewer:
Are there any recent projects based on the approach of accommodation that integrate proactive and productive systems?

Steffen Nijhuis:
Yeah, there are some projects in Rotterdam. In the South West Delta, there are some double dyke systems. In Katwijk, there is a parking space which is built in the dunes.

Mona Zum Felde
Urban Designer
Defacto Urbanism, Rotterdam

12 January 2024

Interviewer:
There are four approaches to sea level rise. Although most of the interventions responses to sea level rise are combinations of all these four approaches, we find the fourth approach of accommodation, which is where the future is heading towards. What are your views on this approach of accommodation from the perspective of practice?

Mona Zum Felde:
Well, I think it's the most interesting. The accommodation strategy requires a paradigm shift from current practice, as everything is focused on protection and keeping out the water. Historically, the Netherlands lived with water, and a shift occurred to expel water to become more productive. This shift demands a lot from inhabitants; it's broader than just the Delta program and Rijkswaterstaat fixing all the dikes. It involves everyone adapting, which makes it difficult to realize. The longer the delay in deciding to change course, the more challenging it becomes due to existing investments and diminishing space to accommodate water. Although accommodation is the most viable in the long term, it requires making tough decisions sooner.

Interviewer:
Do you feel there's a difference between research and practice when it comes to this outlook on accommodation?

Mona Zum Felde:
It varies with the type of clients. We work mostly with governments on long-term strategies, while offices more focused on implementation and working for developers face different questions and pressures. Developers, for example, have a different agenda, focused on short-term gains without concern for future flooding. This perspective varies based on the client's goals and the project's scale.

Interviewer:
Reflecting on that, the client will have his or her own needs for the project, but also offices have their own set of principles they want to work with. For example, even if they have to look at a smaller element or system, it has its role in the larger system.

Mona Zum Felde:
Indeed, but to address those principles, one must consider the larger scale and the system approach. If the assignment is to redesign a street with good intentions for climate adaptation, it might not address the larger challenge if it's in a flood risk area. The challenge lies in balancing long-term considerations with immediate actions and determining the usefulness of current efforts against future changes.

Interviewer:
That is really difficult. It actually touches upon the concept of ecological rationality. What are your comments on the shift from adaptive planning to planned adaptation?

Mona Zum Felde:
The difference lies in being reactive versus proactive. We've discussed at the office, somewhat seriously, the potential benefits of experiencing a significant flood to prompt systemic changes. Such a disaster can catalyze change, but avoiding disaster while still implementing significant changes requires substantial effort from governments. This includes altering regulations and cost-benefit analyses to consider long-term public space maintenance costs, which are often overlooked in development projects.

Interviewer:
What's the interaction like with engineers on planned adaptation versus adaptive planning? Do they still want to raise the dikes more? What's the say of spatial planners in these decisions?

Mona Zum Felde:
It varies significantly depending on the person's role and organization. Strategic personnel at water boards align with the need for change, recognizing that the water and soil system should guide development rather than accommodate it. However, individuals focused on local management and maintenance might resist change due to practical concerns with existing infrastructure. Regional experiences also influence perspectives, with areas like Zeeland and Central Holland having different views based on their specific challenges and history with water management.

Interviewer:
The Dutch tradition of engineering and re-engineering, given that much of the land is engineered, plays into this discussion. What's your take on the concept of "making nature"?

Mona Zum Felde:
The notion of "making nature" struck me as peculiar when I first arrived in the Netherlands. The idea that you can create nature, which by definition should occur naturally, embodies the Dutch approach to manipulation and control of the environment, including water management.

Interviewer:
Developments in coastal morphodynamics, like the double dike systems and integration of windmills and dikes, highlight the need to look at production and protection systems in an integrated manner. Is DeFacto working on such projects?

Mona Zum Felde:
Integration is crucial given the limited space and the multitude of functions the land needs to serve. In Zeeland, we worked on a double dike system project exploring different functions and business models to ensure that agricultural land, integrated into the flood risk management system, could still be viable. Other pilots in Groningen are implementing double dike systems, but the challenge with developing on dikes concerns the permanence and adaptability of such structures.

Interviewer:
With sea level rise and economic shifts, such as moving from agriculture to aquaculture, what are the benefits and shortcomings of integrating productive and protective systems?

Mona Zum Felde:
The agricultural sector, facing service area reduction and various challenges, must innovate, as it has historically. Transitioning to different business models and functions can be an opportunity, with the sector already playing a significant role in nature management. Finding new ways to generate revenue and adapt to changing conditions is essential, especially in coastal areas affected by sea level rise and salinity changes.

Interviewer:
The availability of fresh water, impacted by sea level rise and climate change, might become a more urgent challenge than flood risk management, given the Netherlands' robust dike system. How should we address this issue?

Mona Zum Felde:
Fresh water availability, exacerbated by climate change, underscores the need for a holistic approach to water management, beyond just flood risk. The Netherlands' infrastructure, designed to drain water as quickly as possible, might struggle with future droughts and water shortages, highlighting the importance of considering water storage and the broader impacts of climate change on water management.

Bram Willemse
Urban Designer
Flux Landscape Architecture, Utrecht

22 February 2024

Interviewer:
So as we knew in the Deltares report there are four objectives towards sea level rise: protect closed, protect open seawards, and accommodate. Although most intervention responses to sea level rise combine all these approaches, we find the fourth approach, accommodation, is where the leader is heading. What are your views on this approach of accommodation from the perspective of practice?

Bram Willemse:
Accommodation is becoming more realistic for many clients. When I started 10 years ago, it was considered too abstract or extreme. However, recent weather extremes, like the drought in 2018 and fluctuating summers, have made people more open to accommodation. These events have shown that it's not just about flood defence but also about dealing with salination and varying water conditions. The Dutch are adept at managing sea level rise, but recent weather extremes are pushing a shift towards more open accommodation. One example work is the project Drought in the Delta which was exhibited in the IABR 2020. Following the 2018 drought, we were asked to look into sweet water availability, especially the lack of water in summer. The challenge was to use water availability measures as leverage for better agriculture, nature, and water protection, emphasising a system-wide perspective. The Netherlands' delta-type underground, with its sand and clay layers, is conducive to long-term water storage. Our research showed the importance of understanding both the surface and subsurface to develop effective water storage strategies that also enhance agricultural productivity and biodiversity.

Interviewer:
It's challenging to understand the separation between defence and non-defense systems and to see the integration of these systems.

Bram Willemse:
Indeed, accommodation implies multifunctional landscapes. Unlike the more one-dimensional technical solutions of the seawards approach, accommodation embraces more complex, multifunctional landscapes. This complexity can make values and functions more blurred, requiring a broad perspective on

landscape productivity and ecosystem services.

Interviewer:
This touches on the concept of ecological rationality and the shift from adaptive planning to planned adaptation. What are your comments on this?

Bram Willemse:
Adaptive planning deals with uncertainty as it arises, focusing on fitting designs into the current ecosystem. Planned adaptation, however, anticipates changes, allowing designs to evolve over time. This approach benefits from natural processes and systems, which inherently change and grow, making them more resilient to future challenges.

Interviewer:
How do we ensure designs are resilient, able to absorb shocks and thrive amidst uncertainty?

Bram Willemse:
Using natural elements and systems, which can adapt and evolve, is key. While adaptive planning is necessary to fit into the current ecosystem, planning for adaptation allows designs to grow and adjust to future conditions. This approach requires flexibility and a long-term perspective, acknowledging that ecosystems and their needs will change over time.

Interviewer:
The integration of productive and protective systems seems vital, especially in the context of sea level rise and economic shifts. What are the benefits and shortcomings of this integration?

Bram Willemse:
The integration of productive and protective systems enhances resilience by adapting to what nature provides. However, this approach might not be as immediately productive as traditional methods, which are more efficient but environmentally depleting. The challenge lies in developing flexible production chains that can adapt to future conditions, ensuring sustainability and resilience.

Interviewer:
Are there any recent projects based on the accommodation approach that integrate protective and productive systems?

Bram Willemse:
Several projects illustrate this approach, including Urbanista's tidal park, a student's super dike project, and innovative concepts for dynamic energy landscapes and floating cities. These projects demonstrate different scales and aspects of accommodation, from urban nature integration to adaptive energy production.

Interviewer:
Looking at the larger system, how do recent innovations address the integration of protective and productive systems in landscape architecture?

Bram Willemse:
Recent projects, such as the National Delta Programme 2023, showcase a variety of design approaches that address climate adaptation from different perspectives. These include using natural systems as a basis for design, integrating productive landscapes with protective functions, and exploring novel ecosystems to anticipate future changes. The shift towards accommodation and integrated landscape management is evident in these innovative practices.

Delta Futures Lab

TU Delft