New Port–Island Connector

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Designing a landscape infrastructure frame to connect Voorne-Putten Island and the Port of Rotterdam

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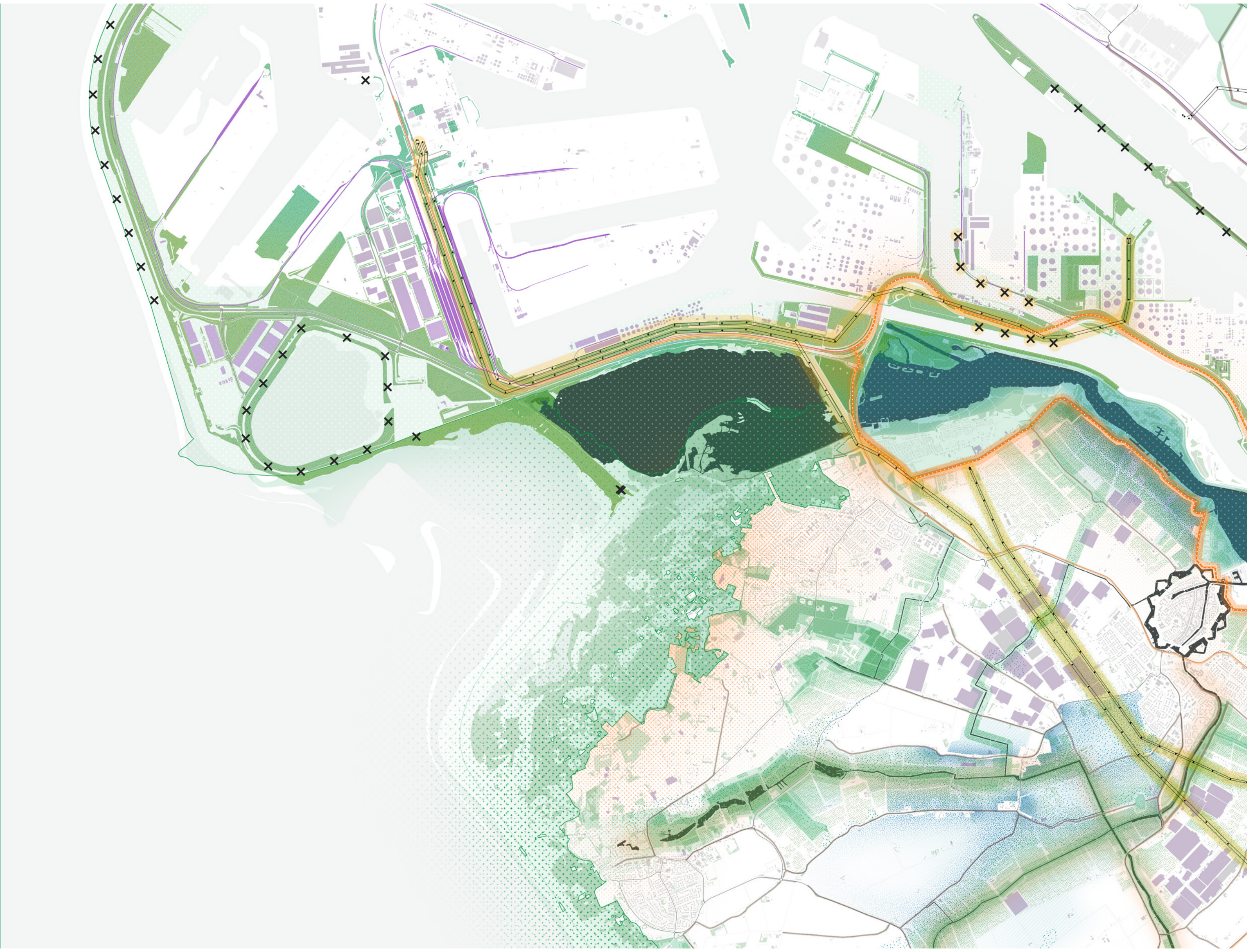

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COLOPHON

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Designing a landscape infrastructure frame to connect Voorne-Putten Island and the Port of Rotterdam

Master Thesis Report
MSc Architecture, Urbanism and the Built Environment
Landscape Architecture Track

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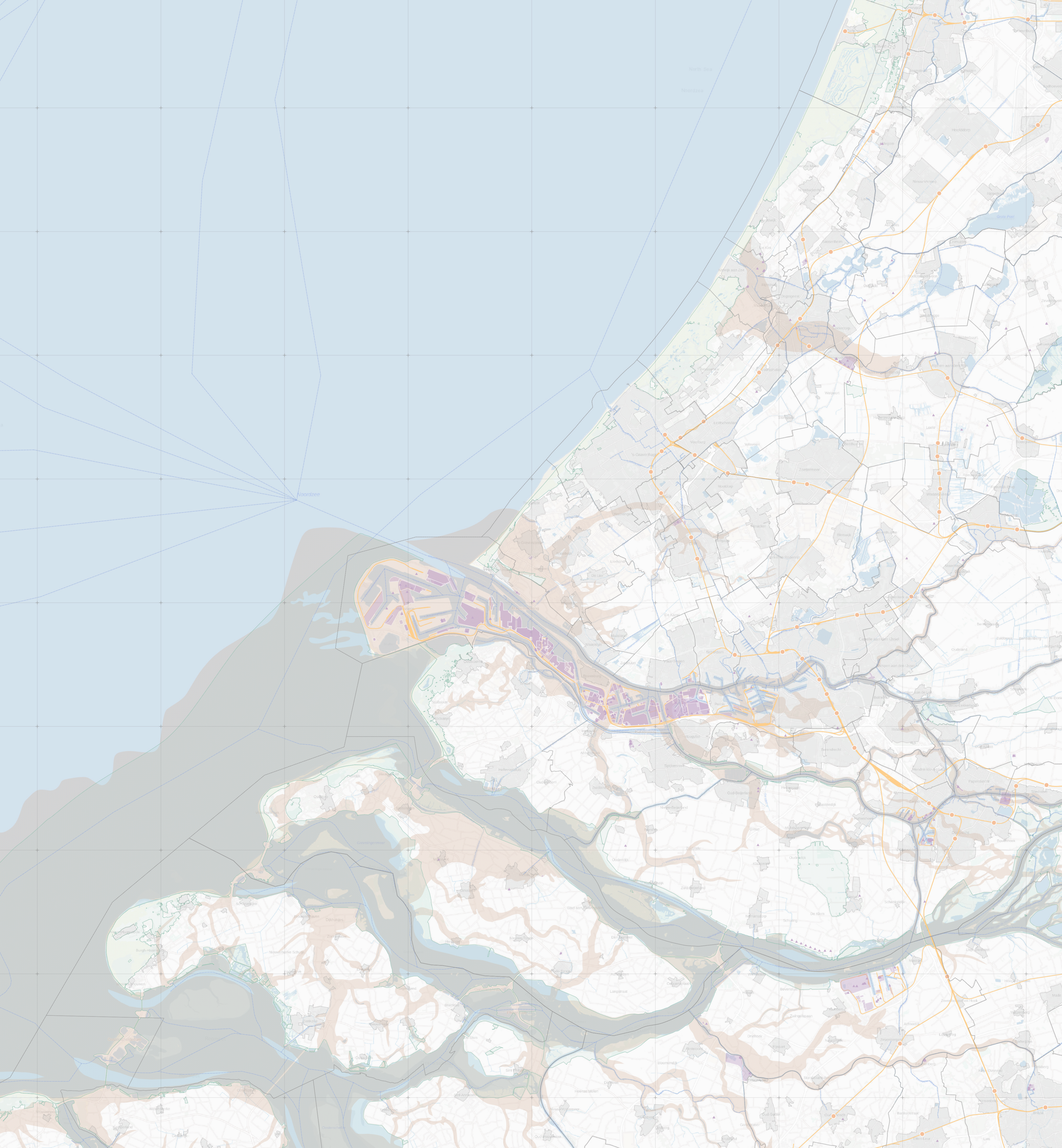


Abstract

This research investigates the transitional landscape between the Port of Rotterdam and Voorne-Putten Island, with the objective of reconfiguring the relationship between natural systems and anthropogenic environments through the lens of landscape infrastructure. Situated at the forefront of the Rhine-Meuse Delta, this region has been substantially altered by land reclamation, industrial development, and urban expansion. These interventions have resulted in compounded spatial and ecological challenges, including freshwater scarcity, landscape fragmentation, land-use conflicts, and heightened vulnerability to climate change. The freshwater lake system—once a vital ecological and productive resource—is now increasingly compromised by saltwater intrusion, intensive agricultural practices, urban runoff, and extreme climatic events.

Informed by the theoretical framework of landscape-based urbanism, this study proposes the reorganization of hydrological-ecological networks, agroecological systems, and industrial-port functions through the implementation of multi-scalar landscape infrastructures. At the regional scale, the research identifies critical spatial tensions within the existing infrastructural landscape and proposes three interrelated strategies: a dynamic, climate-adaptive network; an ecologically inclusive network; and a network that fosters spatial identity and collective experience. The design methodology integrates spatial and temporal dimensions, positioning landscape infrastructure as a catalyst for the sustainable transformation of port-related territories and their surrounding productive landscapes.

By conceptualizing infrastructure as an operative structure, the project transcends conventional functionalist paradigms, embedding ecological, socio-cultural, and aesthetic dimensions into its design. The research demonstrates the potential of landscape to mediate between urban-industrial systems and vulnerable ecological zones, offering both a spatial prototype and a methodological contribution to the discourse on resilient urban development in deltaic territories.

Keywords

Port of Rotterdam
Voorne-Putten
Delta Metropolitan
Landscape
Landscape-based Urbanism
Landscape Infrastructure
Territories in between
Regional Transformation

CONTENT

CHAPTER 01-A DETECHED LANDSCAPE

Introduction

Introduction

- Research Location
- Historical Timeline
- Problem Field
- Problem Statement

FASCINATION

Designing for Different Dynamics: The Search for a New Practice of Planning and Design in the Dutch Delta

by Han Meyer & Steffen Nijhuis

"The Dutch delta is an example of a complex urban landscape, the result of different processes with different time frames." This highlights how Rotterdam's landscape is shaped by the interplay of natural and human-induced processes operating over varying temporal scales.

My studies and life experiences in the Netherlands have deepened my understanding of the unique challenges and opportunities in the coexistence of urban and natural systems in delta regions.
The complex interactions between high-density urban areas and sensitive ecosystems have sparked my strong interest in the landscape mechanisms involved. Through coursework and practical projects, I have particularly focused on integrated approaches to water management, ecological restoration, and spatial design.
As a result, I hope to explore further in my graduation project how the Dutch delta can achieve a harmonious coexistence between urban landscapes and natural systems while addressing climate change.

Hoek van Holland: Rotterdam beach seen from the sky.

© Guido Pijper/Rotterdam Partners

SITE LOCATION

Rivers, coastlines, deltas, and estuaries are dynamic landscapes where the relationship between land and water is constantly shifting. These changes result from natural processes involving water flow, sedimentation, erosion, and climate change. Due to this continuous transformation, these landscapes exhibit <u>diverse water-land interfaces</u> (Meyer 2019). With their strategic economic importance, abundant natural resources, and geographical advantages, the first island at the entrance to the Netherlands and its largest estuary provide an optimal location for a major port.

Beyond economic and functional value, this dynamic land-water interaction also supports rich ecosystems(Costanza et al. 1999). It shapes coastal zones with high ecological and dynamic value, including tidal flats, coastal dunes, and transitional river systems influenced by tidal fluctuations and the salinity gradient from saltwater to freshwater.

Build up Areas
Dalta Geomorphology Trace
Nature 2000 Area
Railways
Railway Stations
Shipping Course
Industrial Area
production installation

Port City and Its Economic and Ecological Relations with Delta Area

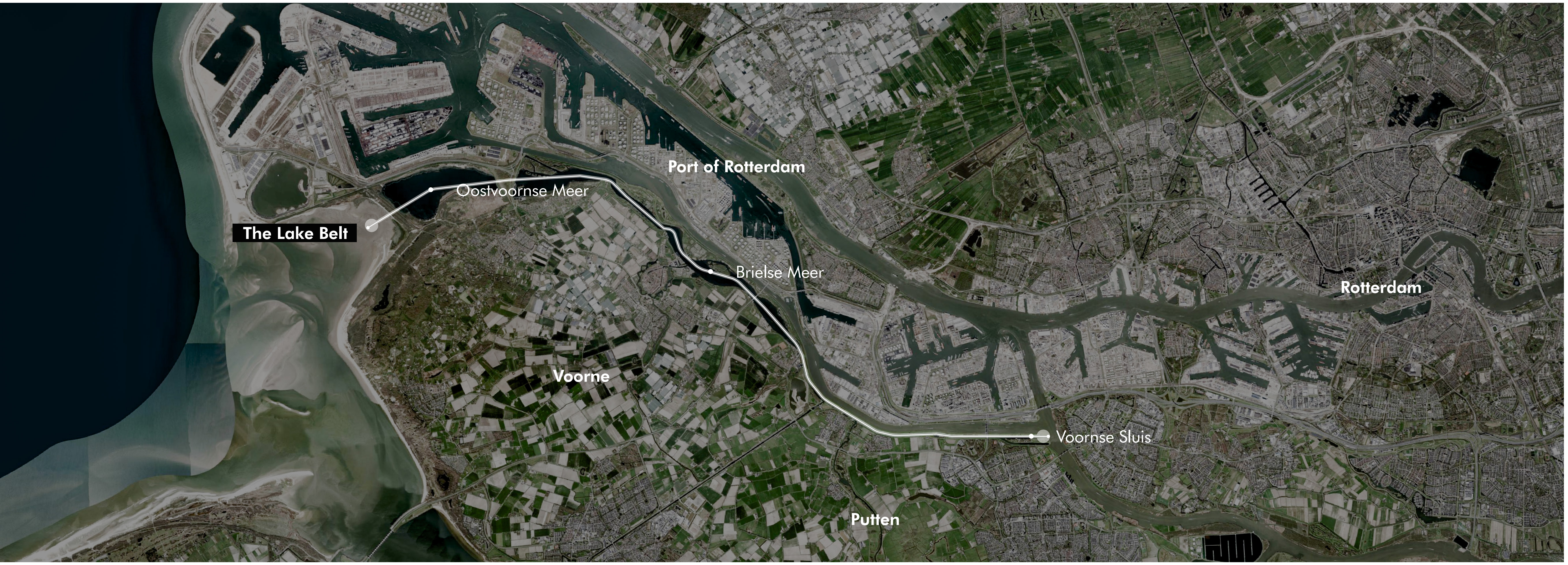
Map by Author/Data from Zuid Holland GIS Portal

Map of the annual average discharge of Rhine and Maas 2000-2011

By Maximilian Dörrbecker (Chumwa)

The Rhine-Meuse-Schlert delta is extremely important economically, as all three rivers are major navigable waterways. The delta is the entrance from the North Sea into the hinterland of Germany and Central Europe. The main ports in the delta are Rotterdam, Antwerp, etc. The Dutch Delta Works protect the land within the delta from flooding.

THE LAKE BELT



The distribution and dynamics of water are pivotal in shaping the urban spaces of deltaic port cities. Focusing on the Port of Rotterdam, my research examines the narrow water bodies situated between the port and the Voorne-Putten region. The Brielse Meer and Oostvoornse Meer lake system significantly contributes to the port's operations, flood defense mechanisms, delta geomorphology, and the development of surrounding landscape ecosystems. They exemplify the interaction between human engineering and natural environments, offering various possibilities for achieving ecological balance within dynamic land-water relationships.

Located southwest of the Port of Rotterdam, these lakes were once bays connected to the North Sea. Through extensive Dutch hydraulic engineering projects, particularly the Delta Works, they were transformed into inland lakes. This transformation enhanced the port's flood protection capabilities, provided additional spaces for water-based recreation and ecological habitats, and served as environmental buffers for the port's expansion and operations.

Historically, these areas experienced marine transgressions and fluvial sedimentation, resulting in complex interlaced land-water formations. In the mid-20th century, with the construction of the Delta Works, these water bodies were isolated and converted into freshwater lakes. This anthropogenic intervention altered the original sedimentation and erosion dynamics, stabilized shorelines, and facilitated the establishment of new ecosystems.

The transformation of the lake system has had profound impacts on the surrounding landscape ecology. Transitioning from saline to freshwater environments, Brielse Meer and Oostvoornse Meer have become habitats for diverse flora and fauna. Wetlands, grasslands, and forest ecosystems around the lakes have been restored and developed, enhancing regional biodiversity. Additionally, these lakes offer local residents and visitors a variety of recreational activities, such as swimming, sailing, and fishing, promoting harmonious coexistence between humans and nature.

In summary, the Brielse Meer and Oostvoornse Meer lake system plays a crucial role in the Port of Rotterdam's functionality, flood defense, deltaic geological evolution, and the formation and development of surrounding landscape ecosystems. They illustrate the interplay between human engineering and the natural environment, highlighting the potential for achieving ecological balance within dynamic land-water relationships.

Satellite imagery reveals that the Brielse Meer and Oostvoornse Meer lake system is situated within a complex and fragmented landscape matrix. This system functions as a structural spine, supporting the spatial relationship between the Port of Rotterdam and the Voorne-Putten island.

Data from Zuid Holland GIS Portal

From an aerial perspective, the lake system appears intermittently visible within the fragmented landscape. Amidst the island's reclaimed polders, large industrial facilities and wind farms are discernible.

Photo from Google Map

How did this landscape forms.....

The historic town of Brielle's defensive waterline and the port's canal network intricately subdivide this disconnected landscape

Photo from Google Map

The northern edge of Voorne-Putten as part of the Metropolitan Region Rotterdam The Hague (MRDH) and the Southwestern Delta

Map by Author/Data from Zuid Holland GIS Portal

The northern region of Voorne-Putten is a unique transitional zone, positioned between the global port of Rotterdam and the open green spaces of the southwestern delta. It is naturally bordered by the Hartelkanaal to the north and the Groene Kruisweg to the south.

This landscape is highly complex and diverse. From a provincial perspective, it appears as a gap within the otherwise continuous delta landscape of South Holland. However, this gap is also the most active hub for trade and production within the Dutch delta region.

In Voorne-Putten, the interdependence between the urban environment and the delta is evident in daily life. Most working residents are connected to the city and the port, while the northern landscape is dominated by large-scale port infrastructure, intricate waterways, and reclaimed land, forming both visual landmarks and spatial barriers. This extensive land reclamation has shaped a distinct landscape typology.

Conversely, Voorne-Putten also serves as a recreational destination for people from the metropolitan region. To the south, beyond the canal, lies a quiet expanse of marine clay polders, featuring a rich agricultural structure and village patterns. This open rural landscape contrasts sharply with the distant presence of wind turbines along the port skyline.

Despite the need for a comprehensive and collaborative planning approach for such a complex region, the strongest interdependencies remain along the north-south axis. Given its strategic location and the influence of the port-industrial complex, the northern area holds significant development potential. The challenge lies in facilitating these developments while preventing further spatial disorder or fragmentation. A forward-looking strategy is essential to establish a guiding framework for high-quality spatial interventions.

TRANSITIONAL ZONE BETWEEN LANDSCAPE

Two islands with a long history of land reclamation define the region, which is divided into dunes, old land, and new land. The area features both ring villages and linear villages. Voorne-Putten primarily orients itself toward Rotterdam. With the construction of the Delta Works, transportation in the region has significantly improved (Benschop, B. 2014).

In archaeological landscape maps, the area is classified into the Zeeland-South Holland clay district, the young marine intrusion zone, and dune and beach ridge formations. Within this classification, salt marshes, creek gullies, creek ridges, beach plains, beach ridges, and low dunes are identified as distinct landscape zones.

Landscape type map of Zuid Holland showing the white gap bewteen marine polders (dark green) and peat polder/ cities (light green)

Map by Author/Data from Zuid Holland GIS Portal

"The landscape that once was part of a large estuary, is now the scenery for container ships, refineries and oil drums. A landscape of trade and transport, occupied by almost alien machines and otherworldly constructions."

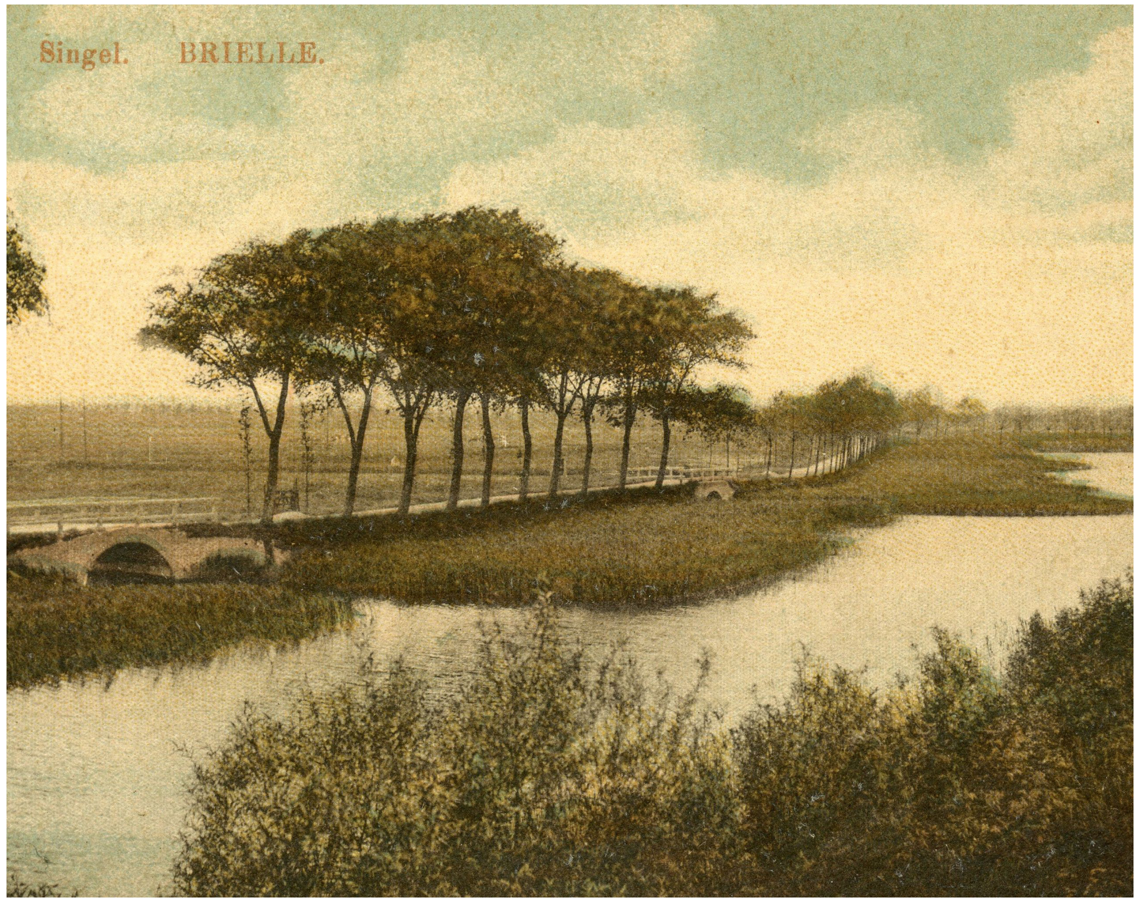
In contrast, Voorne-Putten offers a serene environment. As noted by Two Tickets To, "This quiet, sleepy region is a pleasant mixture of rolling green fields, waterways, vast beaches and quaint towns. Windmills dot the landscape, and cycle lanes are everywhere."

This juxtaposition highlights the region's unique blend of bustling industrial activity and tranquil natural beauty.

What happens next.....

This historic photograph shows a scenic view of the Langesingel, a former city moat or canal in the Dutch town of Brielle.

Photo: Kijkje op de Langesingel met bruggen, ca 1913



People are enjoying the water in various small boats during summer. In the background, large oil storage tanks signal the proximity of industrial infrastructure, probably associated with the port or petrochemical facilities in the Rotterdam region.

Photo: Recreanten met allerlei soorten bootjes varen op de Brielse Maas; olie-opslagtanks op de achtergrond

FRAGMENTATION-
LOSING THE CONNECTION WITH NATURE...

The Green Beach with glasswort growing, and in the background the fragmented dunes

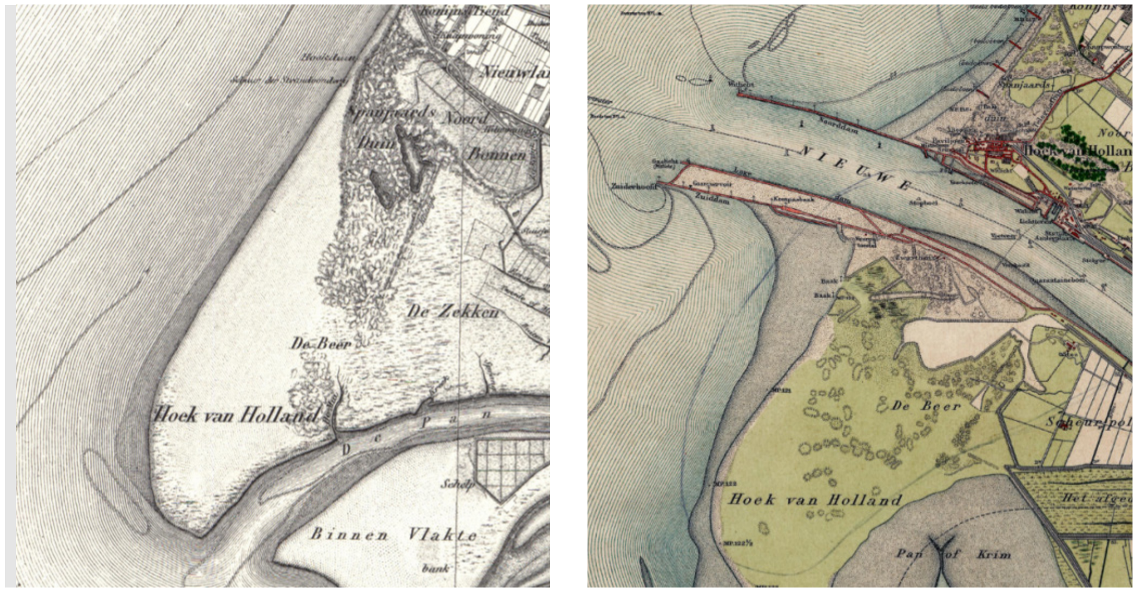
1930. Photo by Jan P. Strijbos.

The expansion of the Port of Rotterdam and surrounding agricultural and industrial zones has led to significant ecological degradation and fragmentation in the region. A striking example is De Beer, a former island and nature reserve located near the mouth of the Brielse Maas. Once a vital stopover site for migratory birds and home to rare dune and wetland ecosystems, De Beer was destroyed in the 1960s to make way for the industrial port expansion at Europoort. This marked a turning point in the relationship between urban development and ecological preservation in the region.

The loss of De Beer reflects a broader pattern. The continuous enlargement of the port, particularly through land reclamation and the construction of Maasvlakte I and II, has replaced natural estuarine habitats with container terminals, petrochemical storage, and logistics zones. These transformations have severely disrupted the ecological connectivity between coastal dunes, inland wetlands, and river systems, reducing biodiversity and damaging the resilience of natural systems.

In addition to industrial growth, intensive agriculture in the surrounding polders has contributed to the ecological decline. Farmland drainage, monoculture practices, and nutrient runoff have degraded soil and water quality while eliminating natural buffer zones. The resulting landscape is highly fragmented, with few continuous ecological corridors left for wildlife.

The construction of the new waterway was initially a major attack on De beer. But amazingly, it has accelerated growth along the coast.



A small piece remains of De Beer. It lies against the northeast side of the Brielse Maasdam, along the Brielse Meer. You can see it from the bike path on the east side of the dam, don't bar in.

Despite efforts to restore nature — such as the development of the Voornes Duin nature reserve and the implementation of the Ecological Main Structure (EHS) — the pressures from infrastructure, energy facilities, and global trade remain dominant. As seen in the case of De Beer, the prioritization of economic expansion over ecological values has long-lasting consequences. Rebuilding ecological networks in this region will require not only spatial interventions but also a shift in land-use priorities and stronger integration of ecological functions into regional planning.

FRAGMENTATION-
PEOPLE'S LIVES DETECHED FROM LANDSCAPE...

Many respondents associate Voorne-Putten with both positive terms like "beach" and "sea," and negative or vague terms like "nothing" or "none," indicating a lack of clear identity for the island.

BUREAU VOOR RUIMTE & VRIJE TIJD

The presence of industrial infrastructure, particularly the nearby port, significantly influences the recreational and landscape image of Voorne-Putten. According to survey results, many respondents spontaneously associate the island with terms like "industry," "nothing," and "not attractive," in addition to more neutral or positive terms like "beach," "sea," and "nature." The word cloud (BUREAU VOOR RUIMTE & VRIJE TIJD) highlights a divided perception of the island, where industrial presence competes with natural and recreational elements. Many people—especially those unfamiliar with Voorne-Putten—fail to form a clear or positive image of the island, with words like "none" and "nothing" frequently appearing. This suggests a lack of strong identity and poor recognition, especially compared to neighboring islands, where Voorne-Putten scores lowest in awareness and visitation among national respondents.

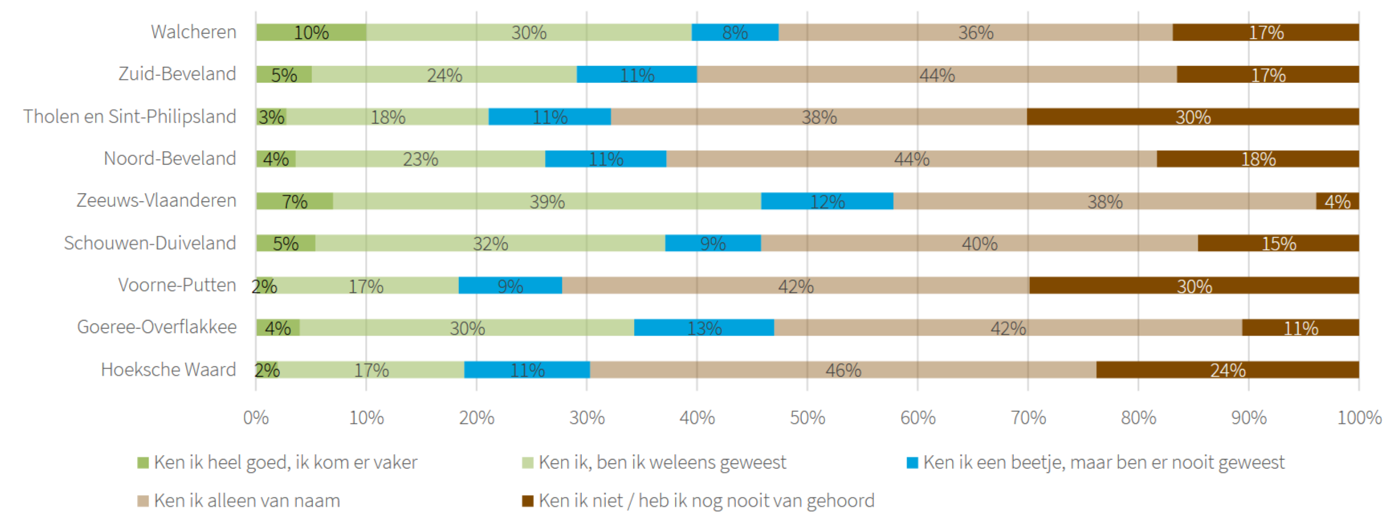
Furthermore, the port's proximity to Rotterdam and the associated industrial activity appear to diminish the island's appeal as a leisure destination. Respondents cite limited experiences, weak connectivity, and a general lack of vibrancy or atmosphere. This is reinforced by responses to improvement suggestions, where people frequently mentioned the need for "more" — more hospitality services, more shops, more events, and better public transportation. The word "nothing" was again prominent, reflecting a perception of emptiness or absence of inviting element

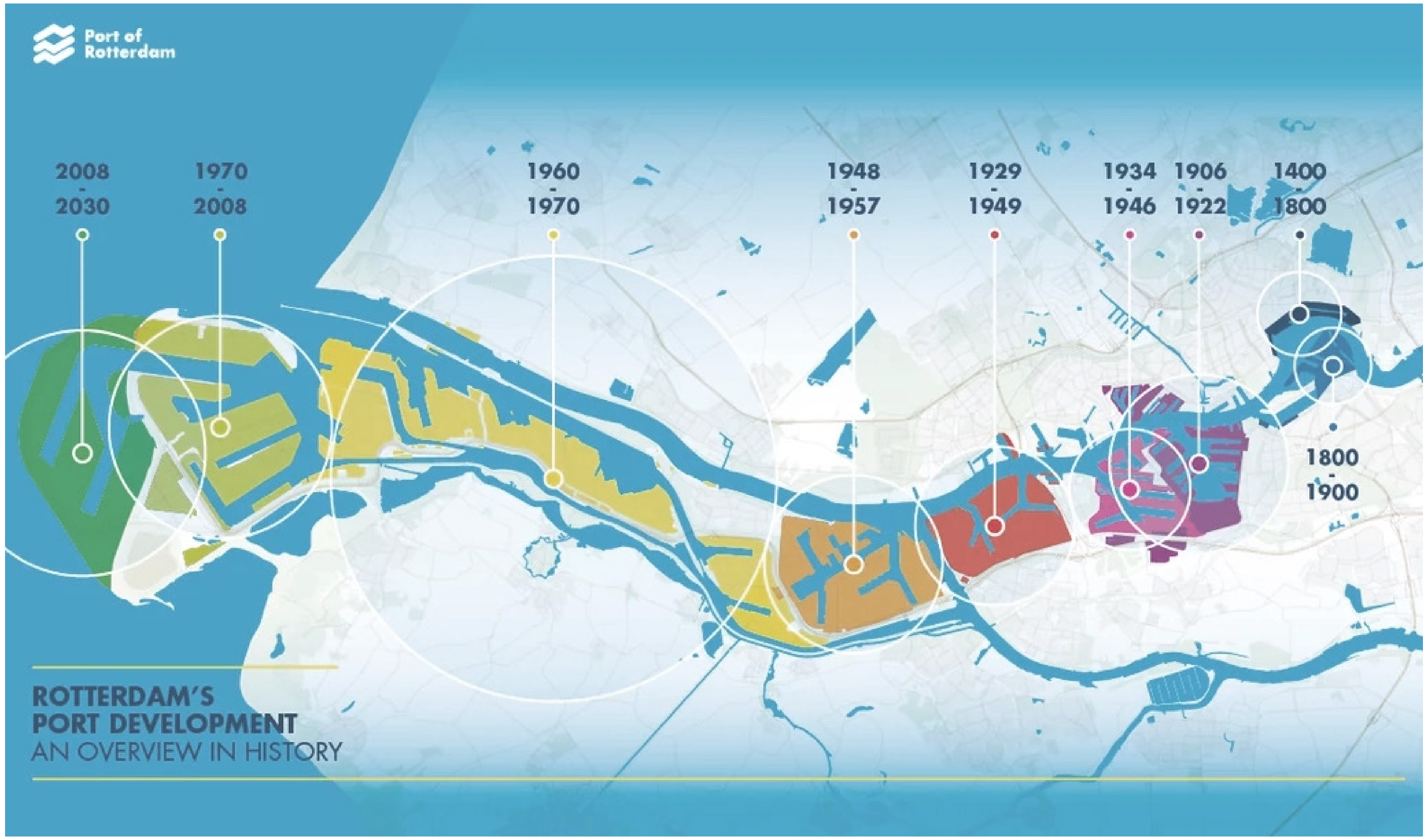
The infrastructure in far skyline really have a strong effect on the visible landscape in recreational area

Google Photo: Vakantie Park De Zeehoeve

Although some respondents acknowledged the island's natural beauty and tranquility—especially near areas like Rockanje or Brielle—these qualities are often overshadowed by the visual and spatial impact of industrial development. As such, the current landscape quality suffers from a fragmented identity, where the coastal and green potential is not fully realized or communicated due to the dominance of industrial imagery and poor recreational infrastructure. If Voorne-Putten is to become a more appealing destination, improving the interface between industrial zones and public landscapes, as well as investing in accessible, diverse recreational amenities, will be essential.

Figuur 2.3 Landelijke response: welke van deze eilanden kent u? (N=1.681)





URBAN EXPANSION-RECLAMATION

Following the catastrophic North Sea flood of 1953, the Netherlands started up the Delta Works—a series of engineering projects aimed at safeguarding the delta region. This initiative significantly altered natural estuarine dynamics, impacting tidal flows and sedimentation patterns .

In the 1960s, to accommodate the booming maritime industry, Rotterdam initiated the Maasvlakte land reclamation, extending the port into the North Sea. This expansion continued with Maasvlakte 2 between 2008 and 2013, adding approximately 2,000 hectares of land, half of which is designed for port-related activities .

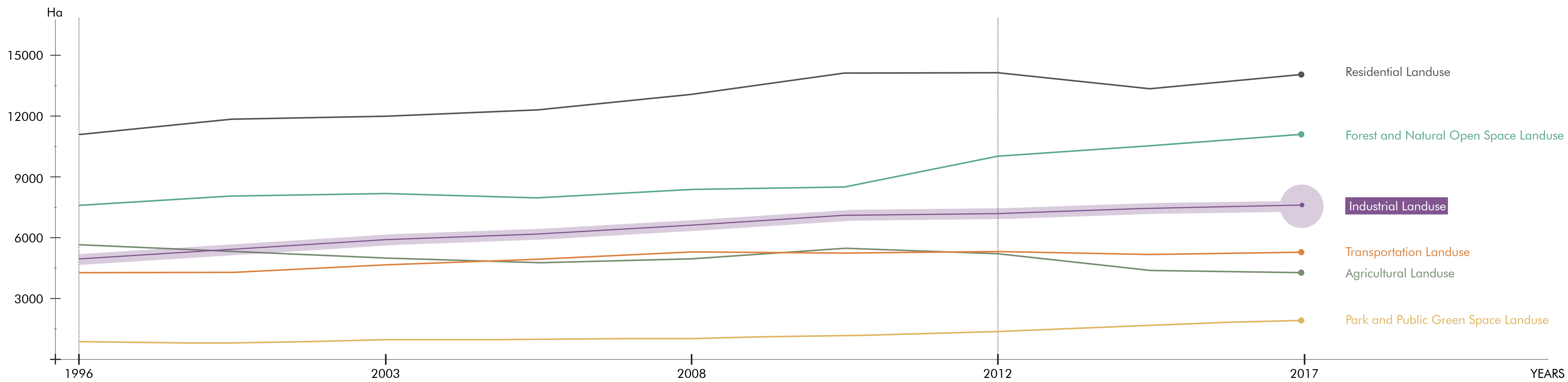
These developments have stimulated urbanization on adjacent islands, transforming them into industrial and logistical hubs.

However, the extensive land reclamation and infrastructural projects have disrupted natural habitats, altered coastal morphologies, and interfered with sediment transport processes. Environmental compensation measures, such as the creation of new dune areas and seabed protection zones, have been implemented to mitigate these impacts .

From a landscape architecture perspective, the Maasvlakte expansions exemplify the complex interplay between large-scale infrastructural development and the preservation of natural systems within delta environments.

The development of the port of Rotterdam

Diagram from Port of Rotterdam



The landuse data in areas of Rhine Urban Region shows the most changes are in industrial use, agriculture showing in decrease and forest and open green space increased

Graphic by Author/Data from CBS: Centraal Bureau voor de Statistiek

WITH INTENSIVE AND UNSUSTAINABLE MANAGEMENT ...

ports and port cities are taking proactive measures to maximize economic benefits while mitigating negative impacts

Photo: Jite Eriabie

The Port of Rotterdam, Europe's largest seaport, significantly impacts the surrounding environment, particularly soil and water quality. Industrial activities such as oil refining, chemical processing, and heavy cargo handling have led to extensive contamination of soil and groundwater. Studies indicate the presence of heavy metals like arsenic, cadmium, copper, mercury, lead, and zinc, along with organic pollutants such as chlorinated hydrocarbons, affecting groundwater systems on a regional scale .

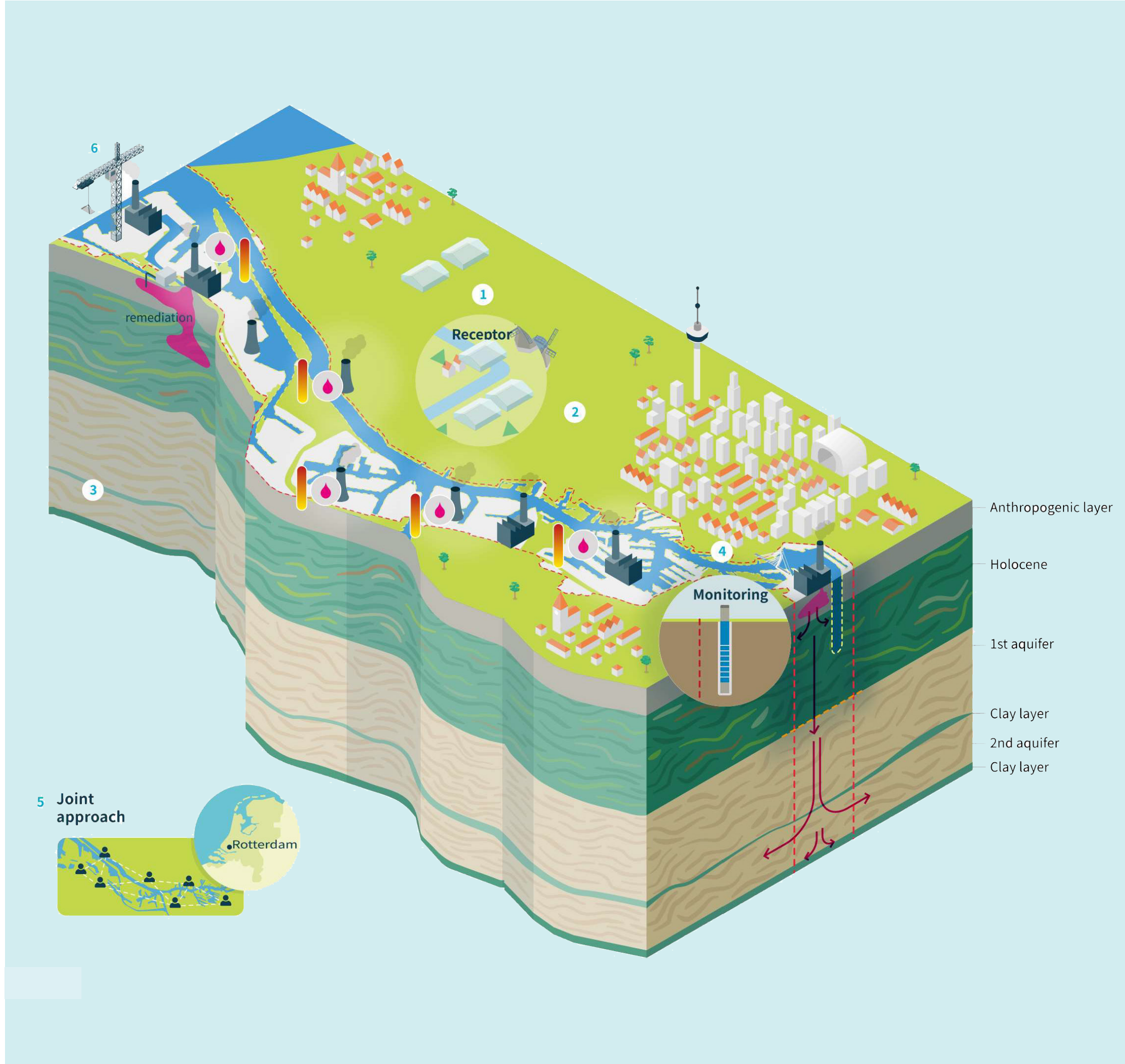
The port's operations also contribute to water pollution. Emissions from port activities and upstream river transport have degraded ecological water quality, posing risks to biodiversity and public health . Additionally, maintenance dredging activities can resuspend contaminated sediments, further impacting water quality .

Adjacent agricultural regions, such as the Westland area, are affected by these environmental issues. The intrusion of saltwater due to sea-level rise and industrial water usage has led to soil salinization, adversely impacting agricultural productivity . Moreover, the use of fertilizers and pesticides in agriculture contributes to nutrient runoff, leading to eutrophication in nearby water bodies .

In response, the Port of Rotterdam Authority has implemented measures to mitigate environmental impacts, including the development of environmental criteria for port activities and collaboration with environmental organizations . Despite these efforts, the cumulative effects of industrial and agricultural activities continue to pose significant environmental challenges in the region.

The infographic illustrates a strategic and layered approach to managing soil and groundwater pollution in the Rotterdam Harbour area, highlighting monitoring, remediation, and prioritization efforts supported by a subsurface groundwater model.

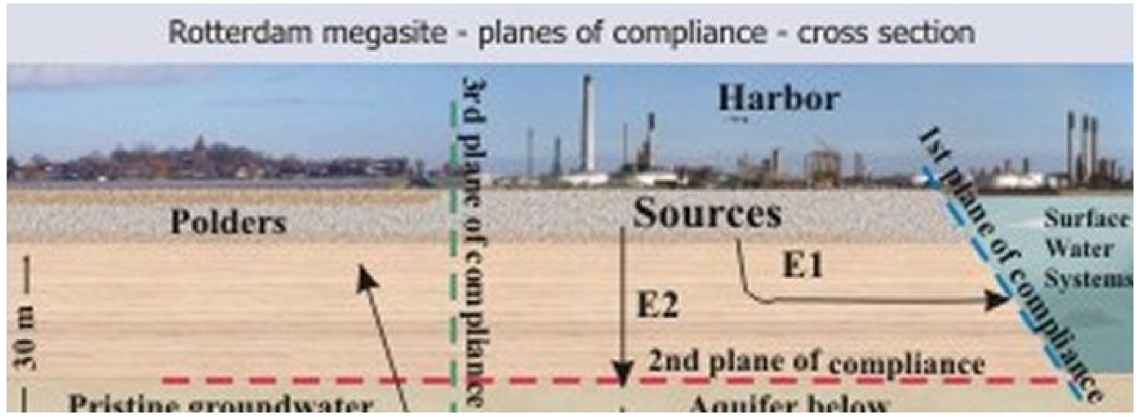
by Deltares



For a visual representation of the contaminant distribution in the Port of Rotterdam area, refer to the following figure:

Conceptual model for the Rotterdam megasite, including contaminant sources, path-ways and receptors, as well as the planes of compliance

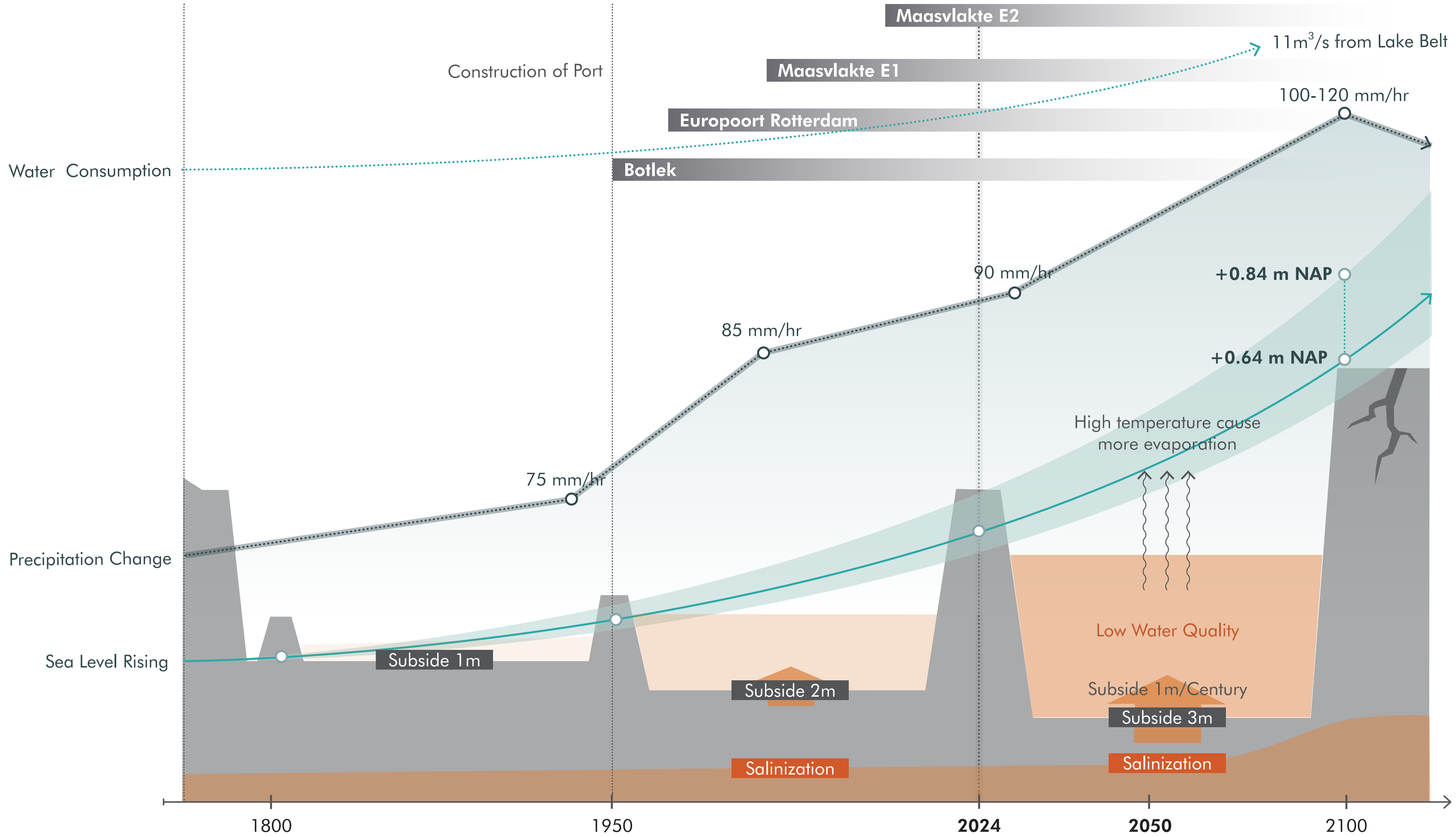
Fachhochschule Osnabrück, Diskussionsforum Bodenwissenschaften 2007 „Grundwasser und Boden" Contaminant sources, pathways and receptors at the Rotterdam Port Area – a non-site-specific approach-Jeroen Ter Meer



This figure illustrates the spatial distribution of various contaminants in the port area, highlighting the extent of environmental pollution resulting from industrial activities.

UNSTOPPABLE CLIMATE CRISES....

"The great economic significance and the presence of vital and vulnerable functions in parts of the port area mean that a timely response to the consequences of this is desirable".



This chart is mean to show the presure been put on port area and surronding urban area. the government have tried to highten the dike and protect the area from flooded, but the area is still sufering from other issues like soil subcidense and salt intrusion

Graphic by Author/Data from KNMI

The Port of Rotterdam and its surrounding urban areas are facing multiple climate-related risks.

Firstly, sea level rise has significantly increased the risk of flooding. According to the Royal Netherlands Meteorological Institute (KNMI), sea levels could rise by 35 to 110 centimeters by 2100. Much of the port area lies outside the primary flood protection system, making it particularly vulnerable to storm surges and extreme weather events.

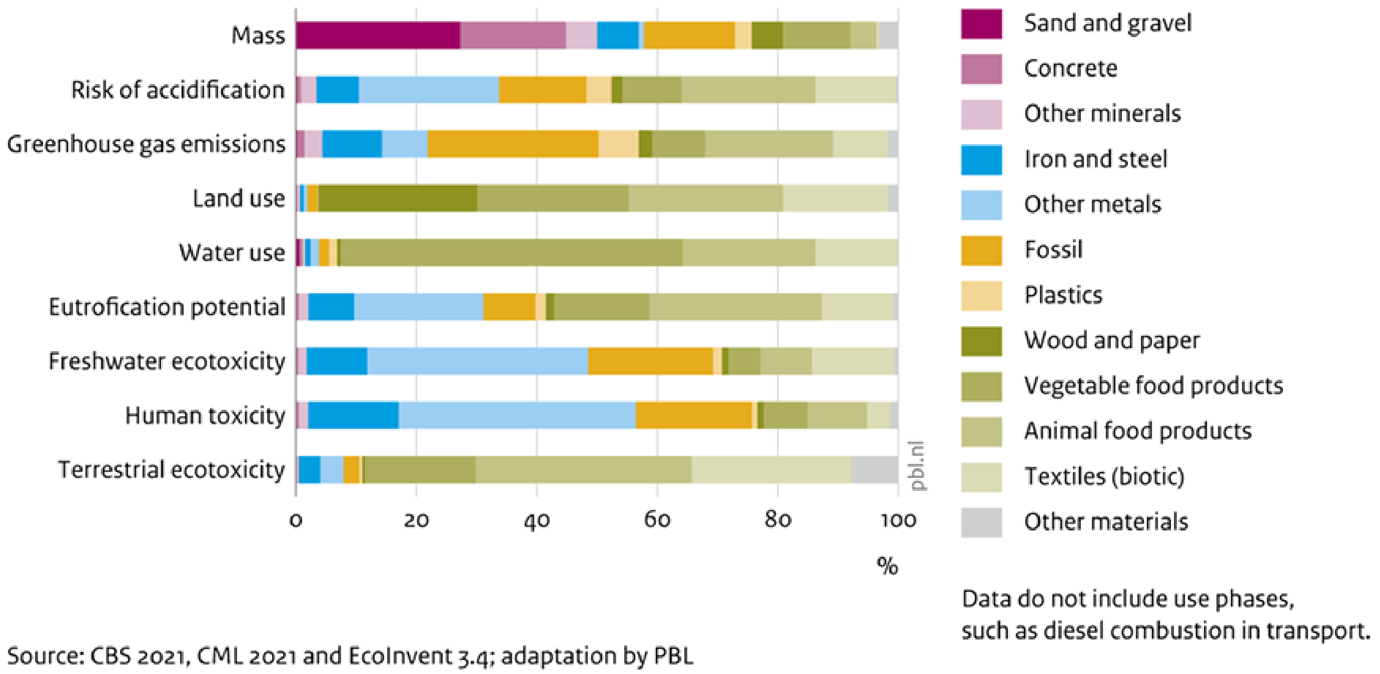
Secondly, shifting precipitation patterns and long-time droughts are intensifying saltwater intrusion. During the drought in the summer of 2022, saltwater encroached as far as 42 kilometers inland, severely impacting the availability of freshwater resources such as the Brielse Meer.

Additionally, the increasing frequency and intensity of extreme rainfall events may overwhelm urban drainage systems, raising the risk of pluvial flooding in low-lying urban areas.

THE "DUTCH DISEASE" , NATURAL RESOURCES IS EXHAUSTING...

Figure 6.

Relevance of various resources and materials for environmental impacts from a Dutch consumption perspective, 2018



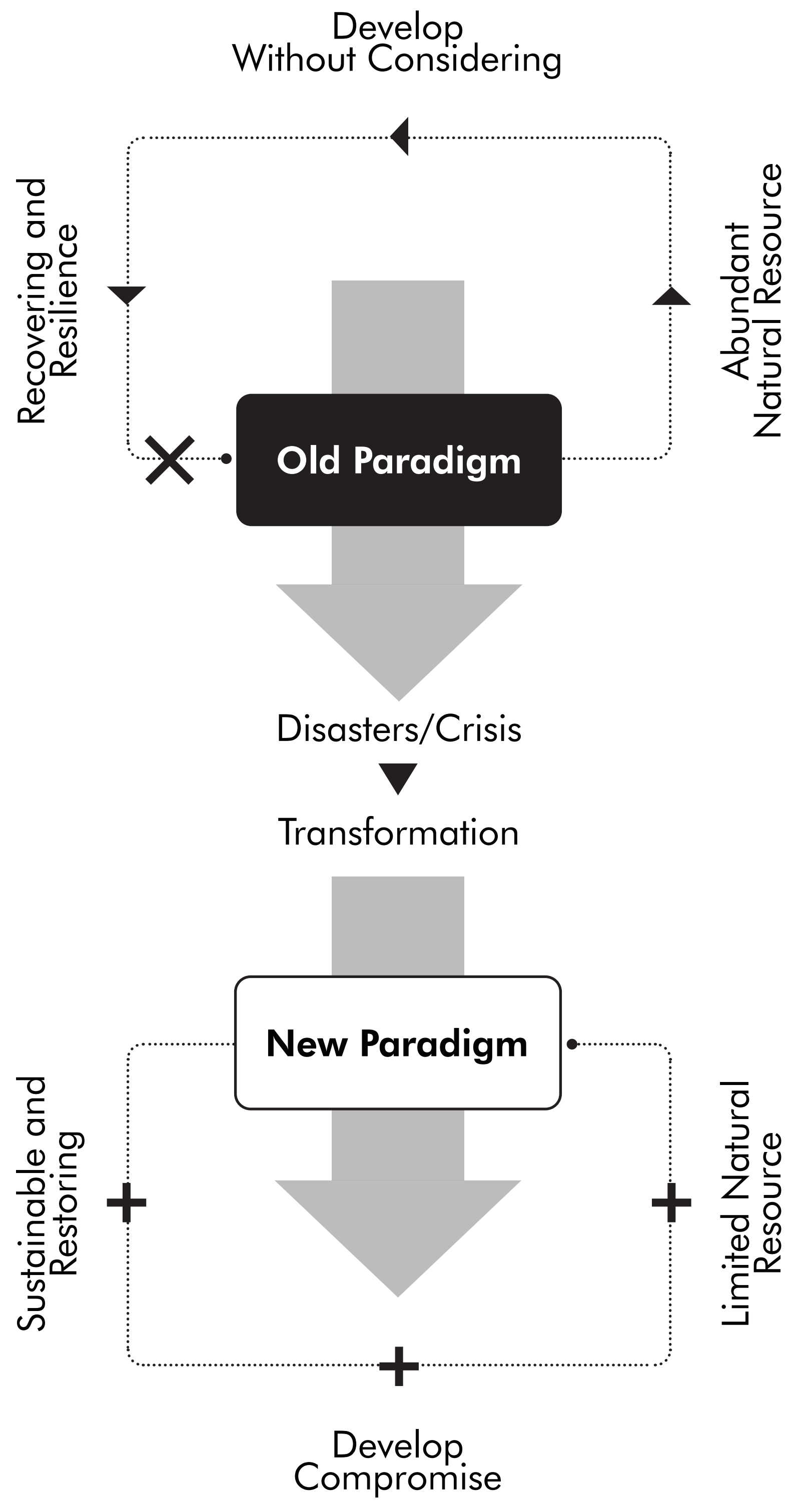
Source: CBS 2021, CML 2021 and EcoInvent 3.4; adaptation by PBL

The relevance of raw materials and resources to the environmental impacts of Dutch consumption in 2018

Dutch industry and agricultural production are struggling with a shortage of natural resources. First, energy and raw material supply risks have risen significantly: since 2020, the Russian-Ukrainian conflict has led to disruptions in oil and gas supplies, and soaring energy prices in Europe have exposed Dutch companies to high production costs and supply uncertainty, revealing that the linear production model of relying on cheap, disposable resources is no longer viable. Second, the tight supply of "key" raw materials such as minerals and metals (e.g., nickel, cobalt, rare earths), and the difficulty of rapidly expanding production due to long extraction cycles and high levels of concentration, are impeding the deployment of new technologies needed for the manufacturing and energy transitions. In agriculture, the global supply of fertilizer feedstocks (nitrogen, phosphorus, potassium) is also constrained, with greenhouse gas (GHG) emissions from the Dutch agricultural sector remaining at 18.0 Mt COe in 2022, only 29% lower than in 1990, partly due to inefficient use of resources as a result of persistently high rates of fertilizer application to ensure yields. This old paradigm of "resource-product-waste" closed loop is grossly inadequate, not only exacerbating environmental pollution and ecological degradation (one-time resource extraction and processing accounts for nearly half of the Netherlands' greenhouse gas emissions), but also making it difficult to meet the increasingly urgent demand for resource security and sustainable development. It is also difficult to meet the increasingly urgent needs for resource security and sustainable development, forcing industry and agriculture to accelerate the transition to a new model of circular economy, energy conservation, emission reduction and resource reuse.

Between the Port of Rotterdam and the surrounding islands and towns, an industrial-agricultural transition zone is formed: on one side, energy-intensive industries such as oil refining, chemicals and logistics; on the other side, intensive agriculture such as greenhouses and farmland. Energy shortages have led to an unstable supply of natural gas, which has increased the cost of refining in the port area by 20%; and a tight supply of fertilizer raw materials (nitrogen and phosphorus) has caused farmers to purchase them at a premium, with the price of urea soaring by 30%. Meanwhile, high-intensity pumping for industrial cooling and agricultural irrigation has brought surface and groundwater resources close to critical levels, with seasonal drying and salinization. Monitoring showed that the annual average PM2.5 concentration in the transition zone reached 14 $\mu g/m^3$, and soil organic matter declined by 0.15% over five years. The old linear model of "one-time input-high output" has boosted production in the short term, but exacerbated resource depletion and pollution accumulation, and a systematic transformation through circular economy, regional energy network and agro-ecological engineering is urgently needed to build a more resilient and sustainable regional development pattern.

PROBLEM STATEMENT



In one of Europe's most complex and heavily engineered delta regions—the Rotterdam Delta—development has long been guided by the old paradigm of "nature as an inexhaustible resource." This mindset has driven the continuous expansion of port, urban, and agricultural land. The Maasvlakte I and II land reclamation projects, for example, added approximately 2,000 hectares of new land, significantly boosting Rotterdam's global port status. However, these expansions have come at a high ecological cost, causing severe fragmentation and loss of coastal wetlands, intertidal zones, and ecological corridors. As a result, the region's ecosystem connectivity and landscape continuity have been drastically reduced.

Meanwhile, surrounding islands such as Voorne and Putten are experiencing increasing environmental pressure from intensive agriculture. Issues such as soil and water pollution, excessive nitrate concentrations in groundwater, and eutrophication of surface water are threatening local biodiversity and ecological health.

Climate change is further compounding these systemic challenges. The frequency of extreme heat and drought is rising, while upstream glacier melt—once a key source of freshwater—is diminishing due to global warming, contributing to more volatile hydrological and climatic conditions.

At the root of these problems lies our continued obsession to an outdated development model based on the limitless exploitation of nature to serve human needs. A systematic shift toward a new paradigm is urgently needed—one that prioritizes ecological balance, resource restraint, and systemic resilience. With natural resources and ecological space becoming increasingly scarce, maintaining the status quo will only accelerate system collapse.
It is imperative to re-establish a balanced relationship between development and ecology by adopting more sustainable and adaptive landscape structures and management strategies.

CHAPTER 02-LANDSCAPE BASED

Research Method

Research Approach

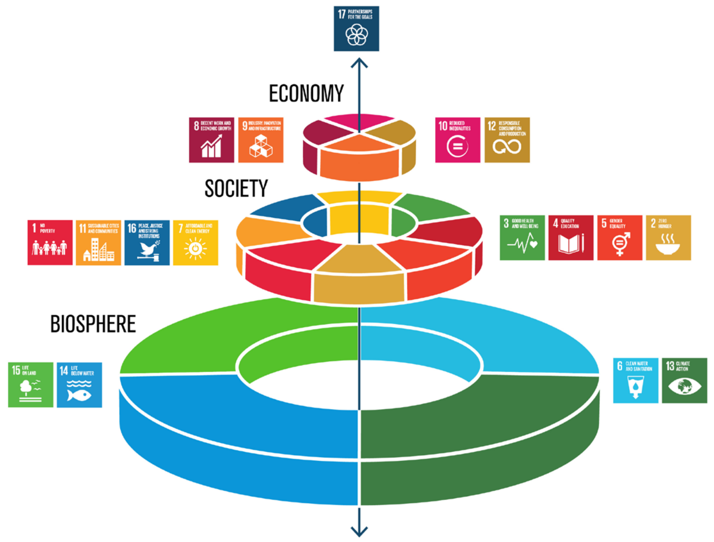
- Theoretical background
- Research Object/Question
- Research Framework
- Scope/Relevance
- Reading Itinerary

POSE THE QUEESTION?

The transformation of paradigms is not possible through instantaneous mandatory requirements;
such a shift is a continuous process over time in different time-spaces and scales. Involving interdisciplinary content and fields of knowledge as well as the demands of different interests, where exactly are the potentials and challenges that these fields of knowledge and interests demonstrate in the perspective of landscape and spatial planning?

"......taking the physical landscape structure, and associated natural processes as a foundation to generate favourable conditions for future development and to guide and shape spatial transformation."-Steffen Nijhuis

How can this complex and diverse landscape mosaic serve as a coherent and powerful basis to guide urban and regional development in the face of future changes?



Landscape as the basis for social and economic development.

Image: © Stockholm Resilience Centre

THEORETICAL BACKGROUND-LBU

SUSTAINABLE URBANIZATION

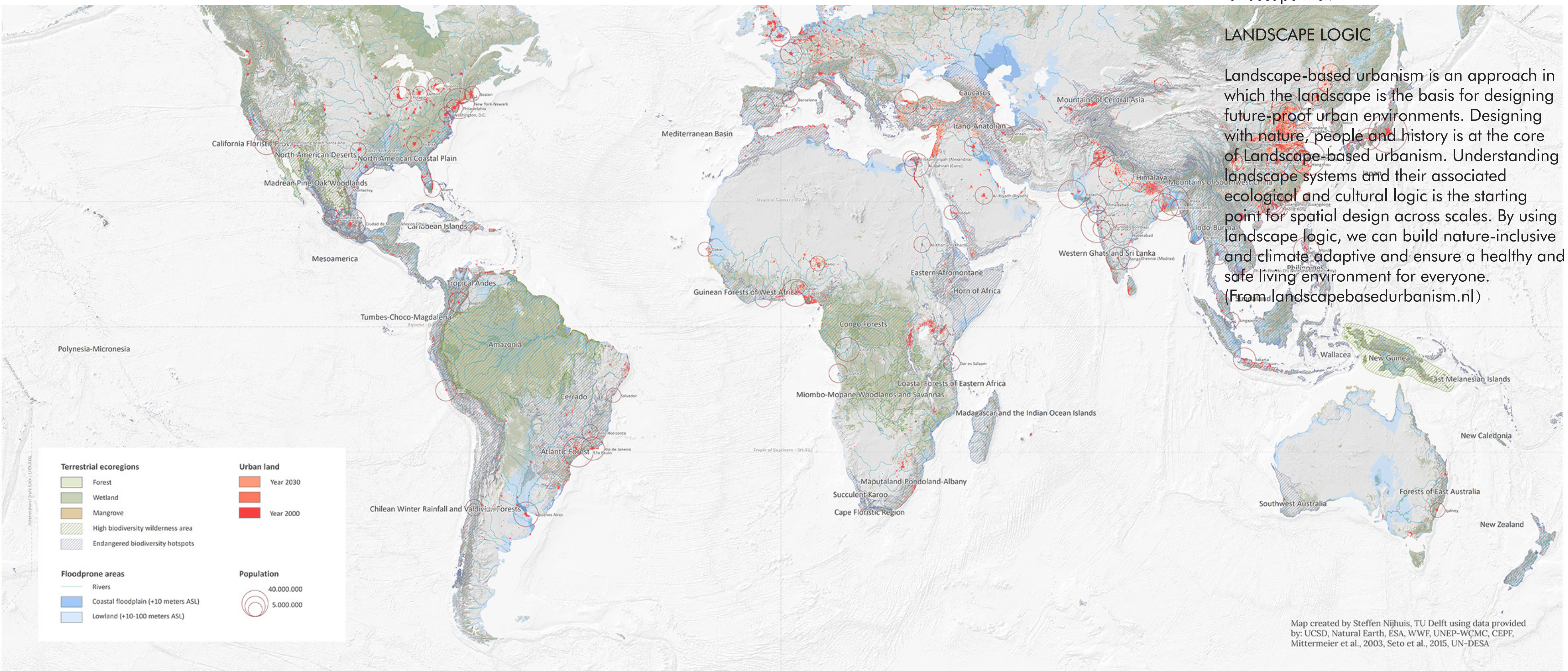
Urbanization is one of the biggest challenges of this century, alongside biodiversity loss and climate change. Urbanization comes at the expense of fragile ecosystems that protect and provide us with food and water, not to mention the associated increasing vulnerability to flooding, drought and social inequality. For sustainable urbanization we need a landscape-based approach to urbanism that considers the biosphere as the context for social and economic development and takes the landscape first.

LANDSCAPE LOGIC

Landscape-based urbanism is an approach in which the landscape is the basis for designing future-proof urban environments. Designing with nature, people and history is at the core of Landscape-based urbanism. Understanding landscape systems and their associated ecological and cultural logic is the starting point for spatial design across scales. By using landscape logic, we can build nature-inclusive and climate adaptive and ensure a healthy and safe living environment for everyone. (From landscapebasedurbanism.nl)

In the Rotterdam Delta, long-term urban expansion and port development have led to ecosystem fragmentation and disruption of natural processes. The traditional "old paradigm" of development has failed to adequately consider the carrying capacity of natural systems, resulting in resource depletion and ecological degradation. In contrast, "landscape-based urbanism" offers a new "paradigm," emphasizing a balance and compromise with natural systems during development. By understanding and utilizing natural processes of the landscape, such as the hydrological cycle, topographical changes, and ecological succession, ecological restoration and systemic integration can be achieved in spatial planning.

The core of this theory lies in multi-scale spatial design and interdisciplinary integration. It focuses not only on macro-level regional development strategies but also on micro-level specific interventions. By creating resilient landscape structures, it guides spatial choices, functional arrangements, and scale relationships in urban development, fostering ecological, social, and economic synergies. Additionally, the theory advocates the use of digital design technologies combined with local ecological and cultural knowledge to create adaptive and resilient spatial frameworks.



Biodiversity and urbanization.

Map created by Steffen Nijhuis, TU Delft using data provided by: UCSD, Natural Earth, ESA, WWF, UNEP-WCMC, CEPF, Mittermeier et al., 2003, Seto et al., 2015, UN-DESA

THEORETICAL BACKGROUND- LANDSCAPE AS LIVING SYSTEM

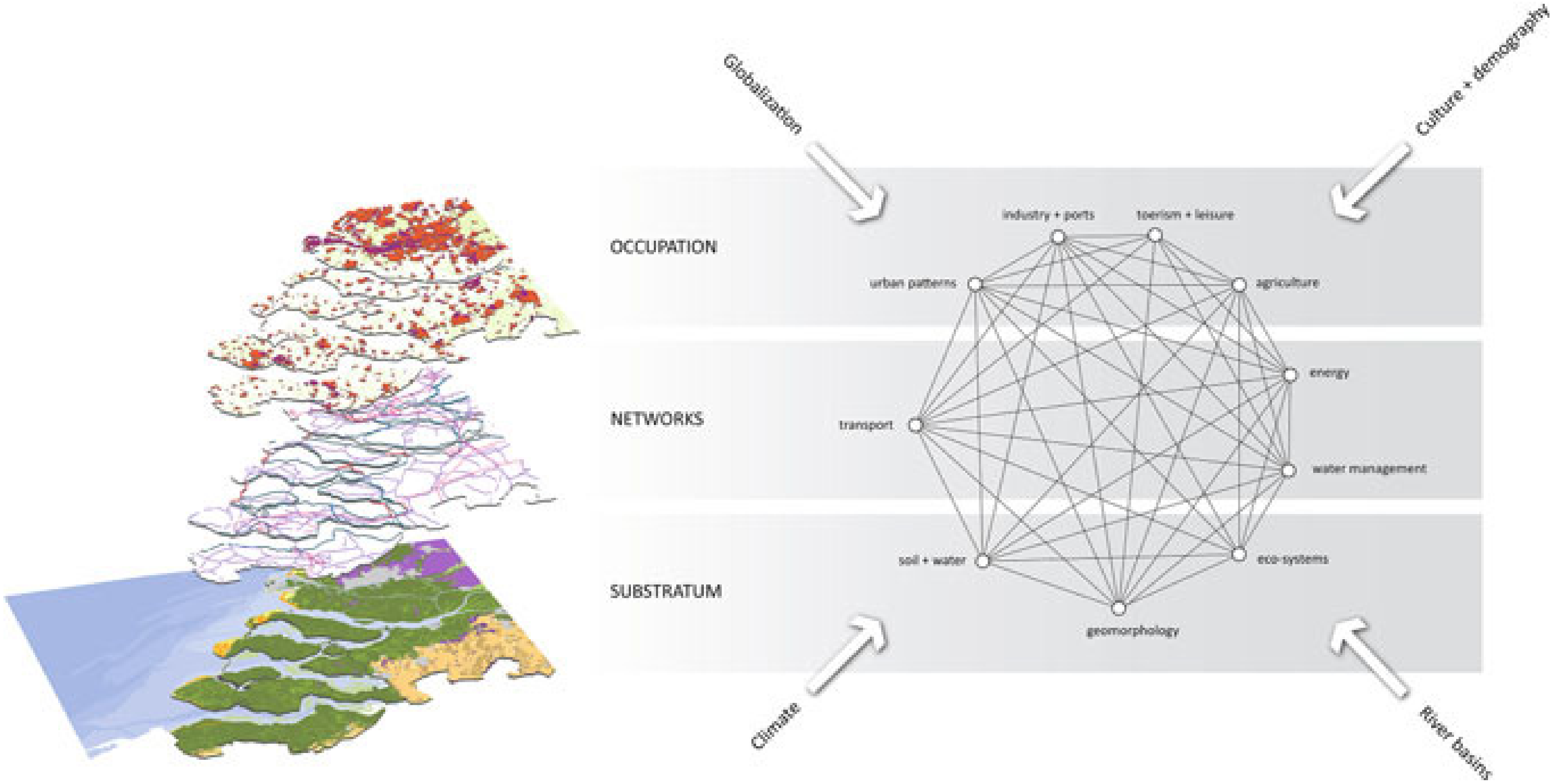
The urban landscape can be understood as a complex system composed of subsystems, each with their own dynamics and speed of change. As a system the urban landscape is a material space that is structured as a constellation of networks and locations with multiple levels of organisation at different spatial and temporal dimensions. Here the concept of the longue durée is essential: understanding the urban landscape as a long-term structure that is changing slowly. The first level of dynamics is related to the natural environment and is characterized by a slow, almost imperceptible, process of change, repetition and natural cycles. The second level of dynamics is related to the long-term social, economic and cultural history. The third level of dynamics is that of short-term events, related to people and politics. In short, the urban landscape is an ongoing development resulting from action and interaction of both natural and human structures, patterns and processes that depend on ecological, socio-cultural, economic and political factors.
(From steffennijhuis.nl)

In my graduation project, I adopt the theory of landscape as a living system as one of the core methodological approaches. The Rotterdam Delta has long been shaped by port expansion, urban development, and agricultural intensification—pressures that, when combined with the increasing uncertainty brought by climate change, have significantly heightened the region's vulnerability.

Viewing the landscape as a living system allows for a holistic and systemic understanding of these complex challenges. This perspective enables me to identify and analyze the interactions and dynamic shifts among various subsystems—such as hydrology, ecology, agriculture, and urban development—while also considering their evolution over different temporal scales.

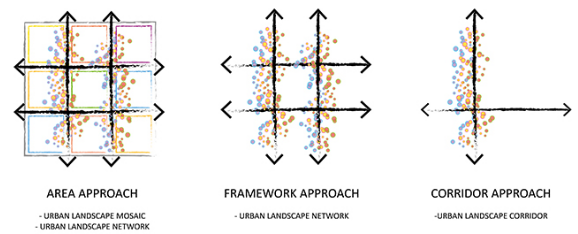
This approach not only emphasizes the ecological functioning of the landscape but also recognizes its socio-cultural value and spatial experience. It advocates for the integration of natural processes and human needs in design, aiming to achieve more sustainable and inclusive spatial development.

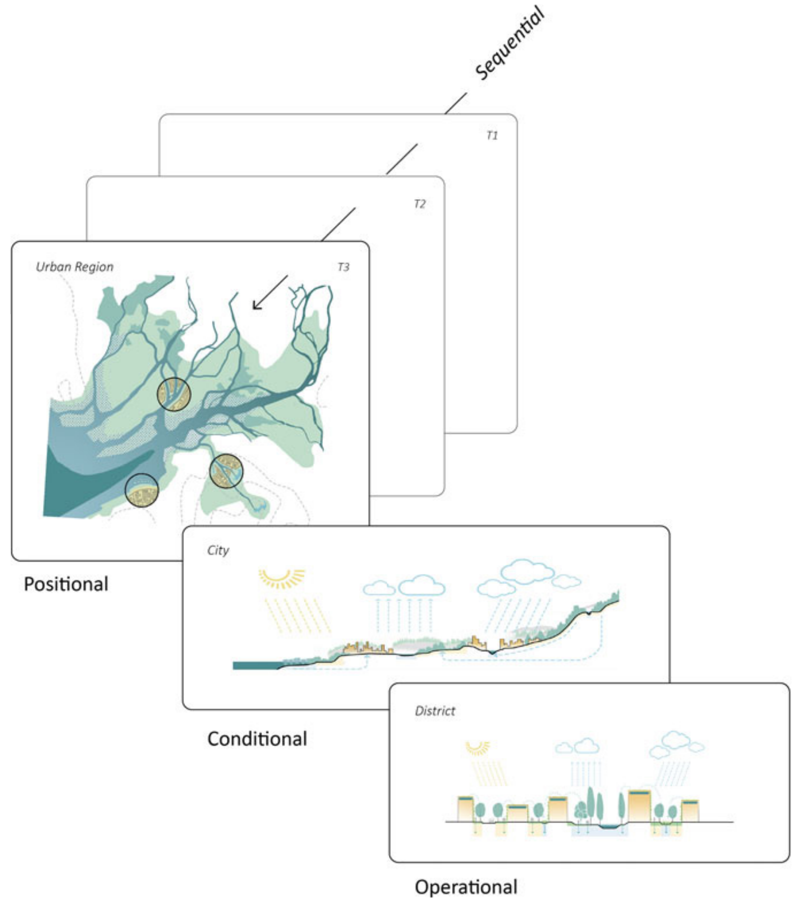
Furthermore, the theory underlines the importance of adaptability and resilience in design—qualities that are essential to cope with future uncertainties and environmental change. In my research, this translates into developing a landscape framework that meets current functional demands while remaining flexible enough to respond to future shifts. By integrating strategies such as ecological restoration, green infrastructure, and community engagement, the design aims to enhance ecological connectivity, social cohesion, and overall environmental quality and livability.



Understanding the urban landscape as a layered and complex system

Image by S. Nijhuis, TU Delft





Landscape-based design approaches

Exploring urban systems at different scale levels and their positional, conditional and operational relationships. Sequential relationships are also important to understand the development through time

Image by Steffen Nijhuis

THEORETICAL BACKGROUND-
LANDSCAPE INFRASTRUCTURE

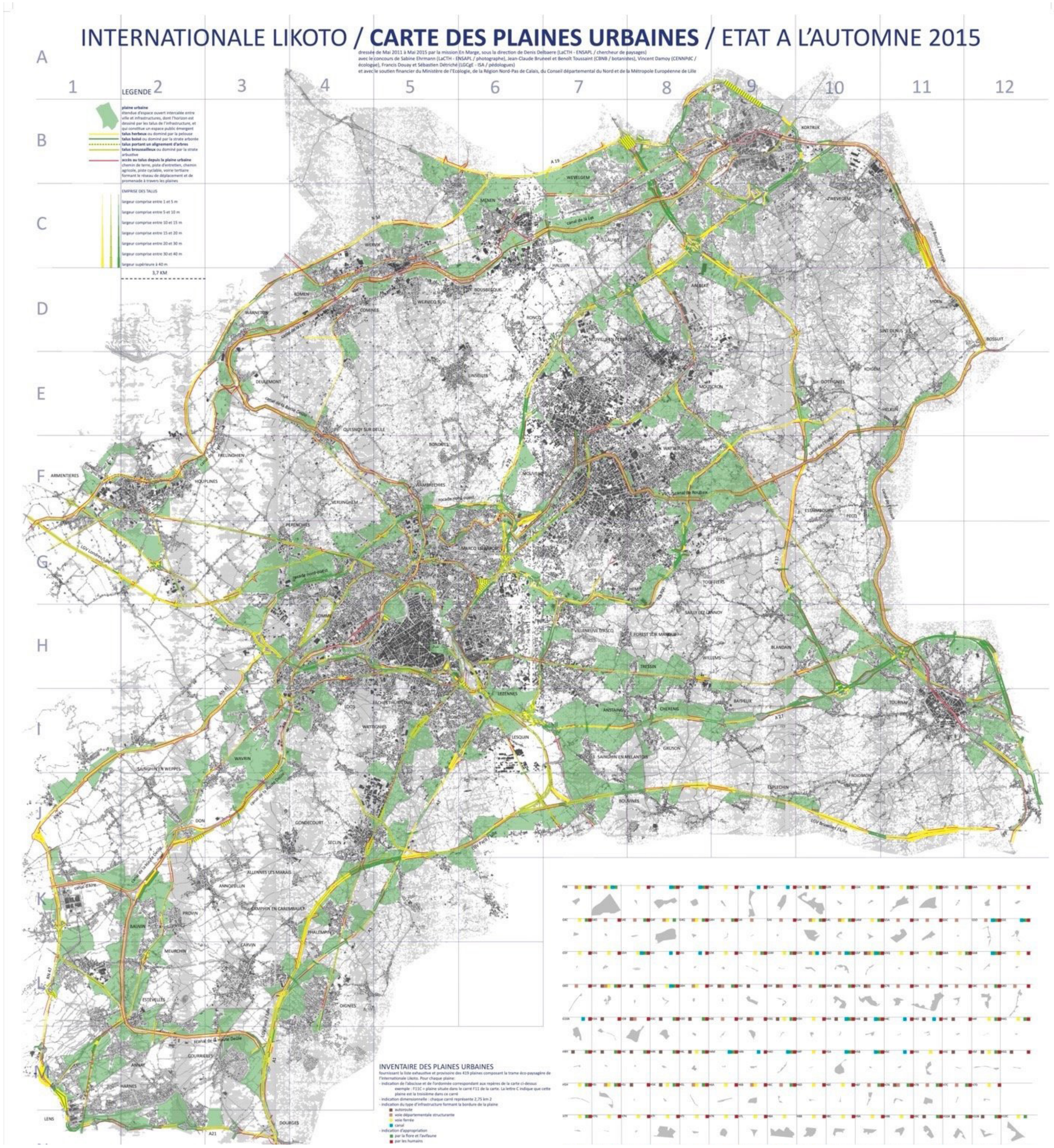
In the paper Urban Landscape Infrastructures: Designing Operative Landscape Structures for the Built Environment, Steffen Nijhuis and Daniel Jauslin propose the concept of landscape infrastructure, which redefines the traditional notion of infrastructure. Rather than viewing infrastructure as merely a collection of technical systems for transport or water management, the authors emphasize a new perspective—seeing infrastructure as landscape and landscape as infrastructure. This integrated approach moves beyond utilitarian design and embraces the idea that infrastructure should support ecological, social, and cultural functions through deliberate design. Landscape infrastructure is not only a spatial form but also a dynamic, operational system encompassing three core domains: transport, green systems, and water infrastructure. In this framework, designers play a critical role in coordinating functional, ecological, and social dimensions to build resilient and meaningful urban structures.

In my graduation project, this theory provides a valuable conceptual and methodological framework. My research focuses on the lake area between Voorne-Putten and the Port of Rotterdam—a transitional zone facing multiple environmental and social pressures, such as water scarcity, ecological fragmentation, and a loss of spatial identity. Conventional single-purpose infrastructure is no longer adequate to address these complex challenges. The theory of landscape infrastructure, with its emphasis on multifunctionality and systems thinking, enables me to integrate hydrological networks, green corridors, and mobility systems into multifunctional landscape structures that serve ecological restoration, community engagement, and cultural expression.

This perspective encourages me to adopt a holistic approach, analyzing the interdependencies between various systems and using landscape design as a mediator that unites them. By treating the water system as an ecological foundation, green corridors as biodiversity support structures, and integrating public and cultural spaces, landscape infrastructure not only delivers environmental services but also strengthens social identity and collective memory. Therefore, the theory of landscape infrastructure is not only a tool for integrated thinking in my project but also a forward-looking approach that allows me to develop spatial strategies capable of responding to contemporary environmental and social complexities.

The concept of landscape is closely tied to infrastructure because, in many cases, we need infrastructure to perceive landscapes on a large scale.

Photo by Denis Delbaere



"We can observe the emergence of spread-cities along infrastructure networks. An example is LIKOTO (Lille-Kortrijk-Tournai), a cross-border Eurometropolis that doesn't follow the classical model of a city with a defined center. It is polycentric, where centres are equally developed. But most people live in an in-between environment—close to the city, yet neither fully rural nor suburban, it's somewhat a mix of those aspects. This pattern is common across northwestern Europe. In these areas, the functions of spontaneous green networks are not coupled with social spaces or agricultural lands, both of which require restructuring."

-LIKOTO Eurometropolis Mapping the Spontaneous Green Web

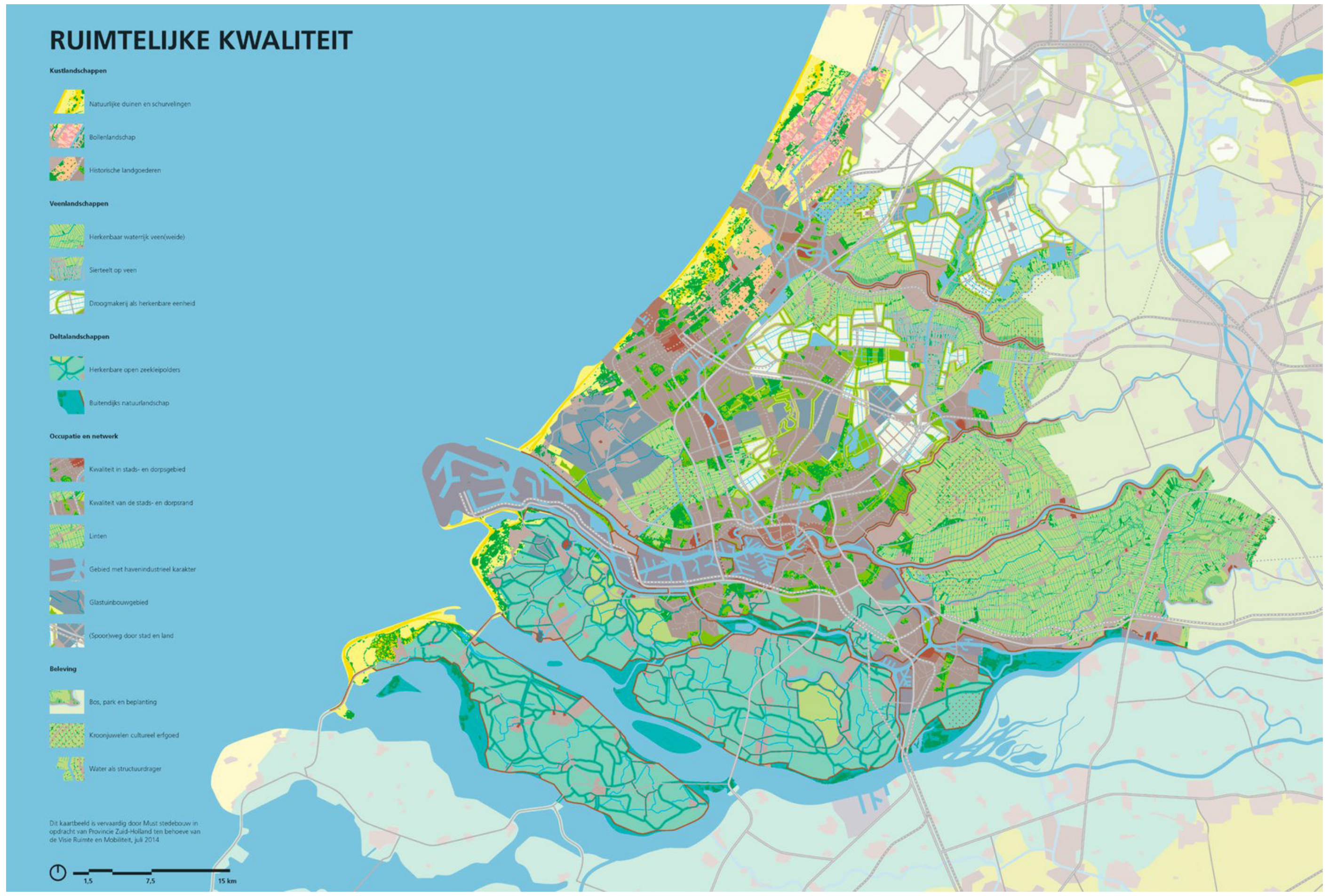
THEORETICAL BACKGROUND- SPATICAL QUALITY

In the Werkboek Ruimtelijke Kwaliteit published by the Province of Zuid-Holland, the concept of spatial quality (ruimtelijke kwaliteit) is defined as a combination of future value, use value, and experience value. This framework emphasizes that spatial environments should not only fulfill functional demands but also be sustainable, attractive, and meaningful. Spatial quality encompasses more than just the existing physical and cultural characteristics of a place—it also considers its potential for future development. Key principles include uniqueness, identity, recognizability, livability, usability, and continuity. This approach highlights the importance of designing spaces that are resilient, socially engaging, and environmentally responsible.

In my graduation project, this theory offers a comprehensive lens through which I analyze and design the transitional landscape between Voorne-Putten and the Port of Rotterdam. This area faces a range of environmental and spatial challenges, including ecological fragmentation, hydrological pressures, and the erosion of local identity. The spatial quality framework helps me to move beyond purely technical or functional solutions and instead focus on creating layered spatial strategies that support ecological performance, social inclusion, and cultural resonance.

Applying this concept allows me to assess the long-term spatial transformation of the region by integrating ecological systems, water management, and socio-cultural dimensions into a cohesive design vision. It encourages me to ask: How can we build environments that are not only efficient, but also offer a sense of belonging and continuity? How can the spatial identity of a fragmented water landscape be strengthened and made legible through design?

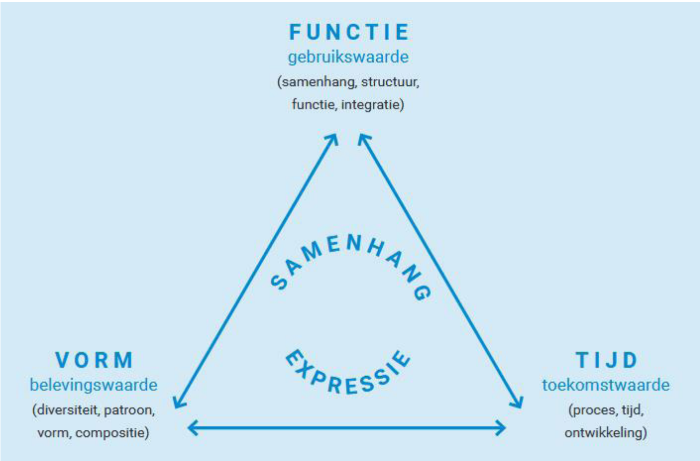
By aligning my design with the principles of spatial quality, I aim to enhance the recognizability and coherence of the region's landscape structure while reinforcing ecological resilience and spatial usability. The theory also supports an iterative, context-sensitive design process, guiding decisions at both the regional and local scale. In this way, ruimtelijke kwaliteit becomes not just a goal, but a critical analytical and design tool—enabling me to envision spatial transformations that are meaningful, resilient, and rooted in place.



Spatial quality map of Zuid Holland

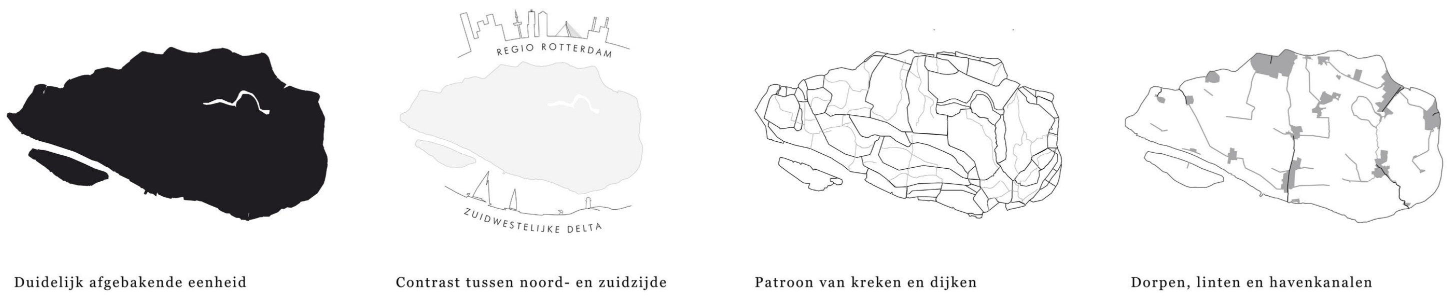
Diagram by H+N+S Landscape

As a guideline for municipalities in drawing up structural visions, zoning plans and image quality plans, the area profiles have been drawn up for this purpose. They form a regional elaboration of the provincial quality map from the Spatial and Mobility Vision.The area profiles describe and illustrate the landscape values that must be taken into account in new spatial interventions. They answer the questions: 'what is there', 'what is going on', 'what is valuable' and 'what do we want to do with it'. They contain a wealth of information and are easily accessible digitally for everyone.



The balance and coherence between form, function, and time can provide spatial quality

Diagram by H+N+S Landscape



Area profile Hoeksche Waard

Diagram by H+N+S Landscape

RESEARCH QUESTION & OBJECT

Inspired by the theory of Landscape-Based Urbanism (LBU) and based on preliminary site research and analysis, it becomes clear that this freshwater lake belt plays a crucial role in connecting the island and the port. Beyond serving as a source of vital natural resources, it also functions as a key spatial corridor that links surrounding areas.

This raises the idea: can this freshwater zone be reimagined as the backbone of a new landscape framework—one that stimulates and supports the region's sustainable transition?

This line of inquiry leads directly to my research question.

General Research Question

How to design for a landscape infrastructure framework that connects Voorne-Putten and the Port of Rotterdam and regenerates a robust nature, water and productive network ?

"In this era known as the Antropocene – a human-dominated geological epoch – urbanisation, ecological crisis and climate change are several of the societal challenges. These are demanding a fundamental review of the planning and design of its landscapes and infrastructures, in particular in relation to environmental issues and sustainability."

by Steffen Nijhuis

Aerial photo distripark Maasvlakte West

© Danny Cornelissen

FROM THEORIES TO RESEARCH METHODS

In the theoretical framework, various theories backgrounds servce like concentric layers of an onion—each layer helping me to navigate across different scales and uncover key issues and focuses at each level.

In my final project, I have taken the three theoretical systems of Landscape-based Urbanism, Landscape Infrastructure and Ruimtelijke Kwaliteit and constructed a multi-scale, interdisciplinary strategic framework in a logical sequence from macro to micro, from research to design, in order to address the ecological, social and spatial challenges facing the transition area between Voorne-Putten and the Port of Rotterdam.

1. Landscape-based Urbanism: A Macroscale Research Perspective

Landscape-based Urbanism emphasizes landscape as a dominant force in urban organization, beyond the traditional architecture-centered urban planning paradigm. In my research, this theory has helped me to analyze the ecosystems, infrastructure networks and social structures between Voorne-Putten and the Port of Rotterdam on a regional scale, identifying key issues such as ecological fragmentation, resource scarcity and lack of social identity. Through this macro perspective, I am able to understand the complexity of regional development and provide a basis for subsequent strategy development.

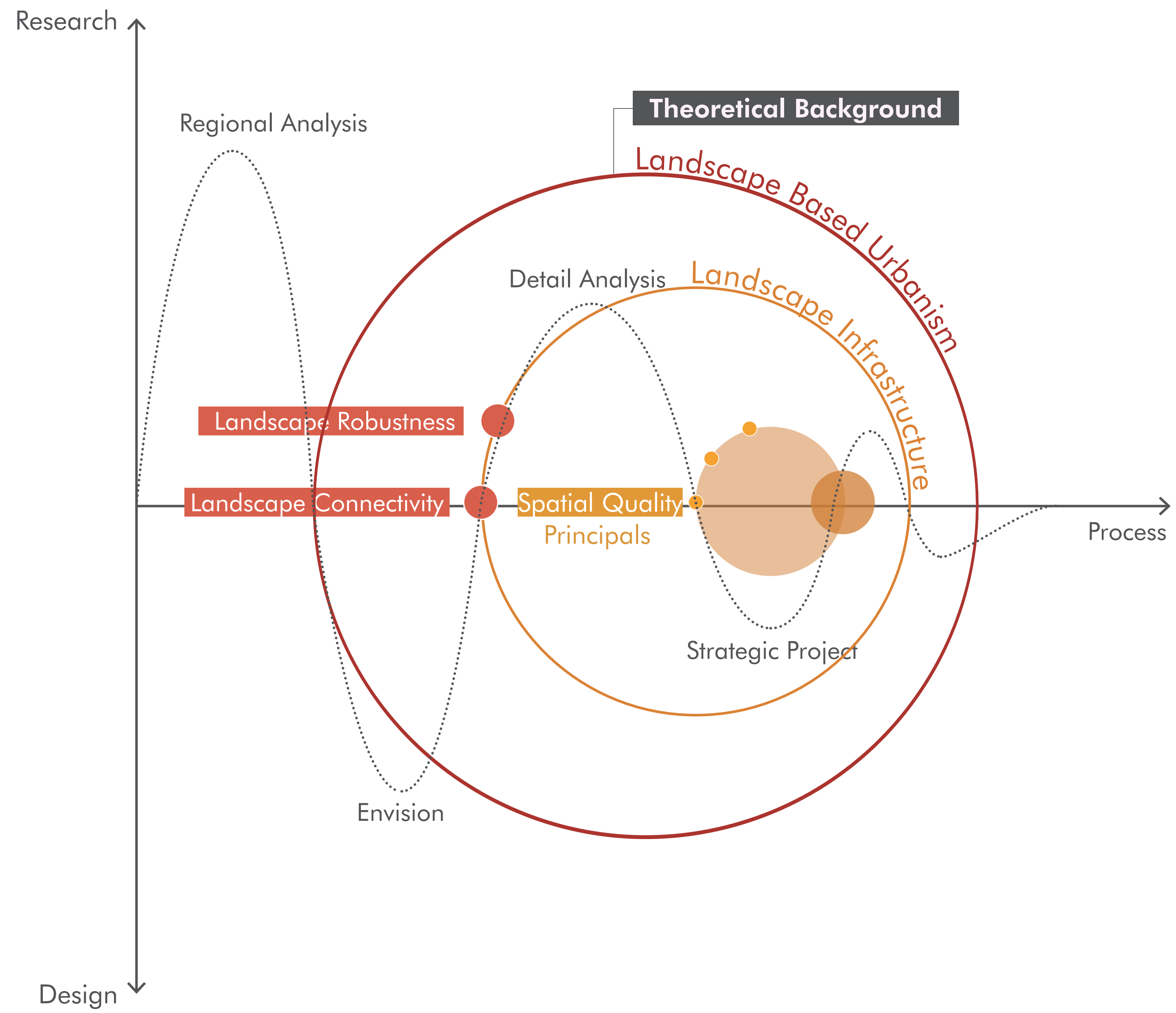
2. Landscape Infrastructure: A Mesoscale Strategy Framework

After identifying regional problems, landscape infrastructure theory provides a mesoscale strategy framework that integrates ecological, hydrological, and social functions. The theory emphasizes that infrastructure is not only a technical system, but also a landscape structure that carries ecological and social functions.
In my design, I transformed the water system, green network and transportation structure into a composite landscape infrastructure with ecological restoration, community participation and cultural expression functions. This not only enhances the ecological resilience and water security of the region, but also establishes an emotional connection and sense of belonging to the site for local residents.

3. Spatial quality: micro-scale design guidance

The theory of spatial quality provides micro-scale design guidance during the design implementation phase. The theory emphasizes the use value, perceived value and future value of space, and focuses on the uniqueness, recognizability and livability of a place. In my design, I enhance spatial quality and strengthen residents' sense of belonging and identity by creating public spaces with local characteristics, improving spatial accessibility and continuity, and reinforcing community participation.

By moving from macro Landscape-based Urbanism, to meso Landscape Infrastructure, to micro spatial quality, I have constructed a multi-scale strategy framework from research to design. This framework not only helps me to systematically analyze and understand regional issues, but also guides me to integrate ecological, social, and spatial factors in my design, and to propose design strategies that are sustainable and local. This logical relationship from theory to practice makes my graduation design more systematic and operational in addressing complex regional challenges.



RESEARCH FRAMEWORK

To address this complex research question, I will approach it through multiple scales and a set of sub-questions that help break down the problem and guide both understanding, analysis and design.

In the theoretical framework, various theories backgrounds servce like concentric layers of an onion—each layer helping me to navigate across different scales and uncover key issues and focuses at each level. for example in regional level I apply the LBU to locate robustness and connectivity as the two main focus.

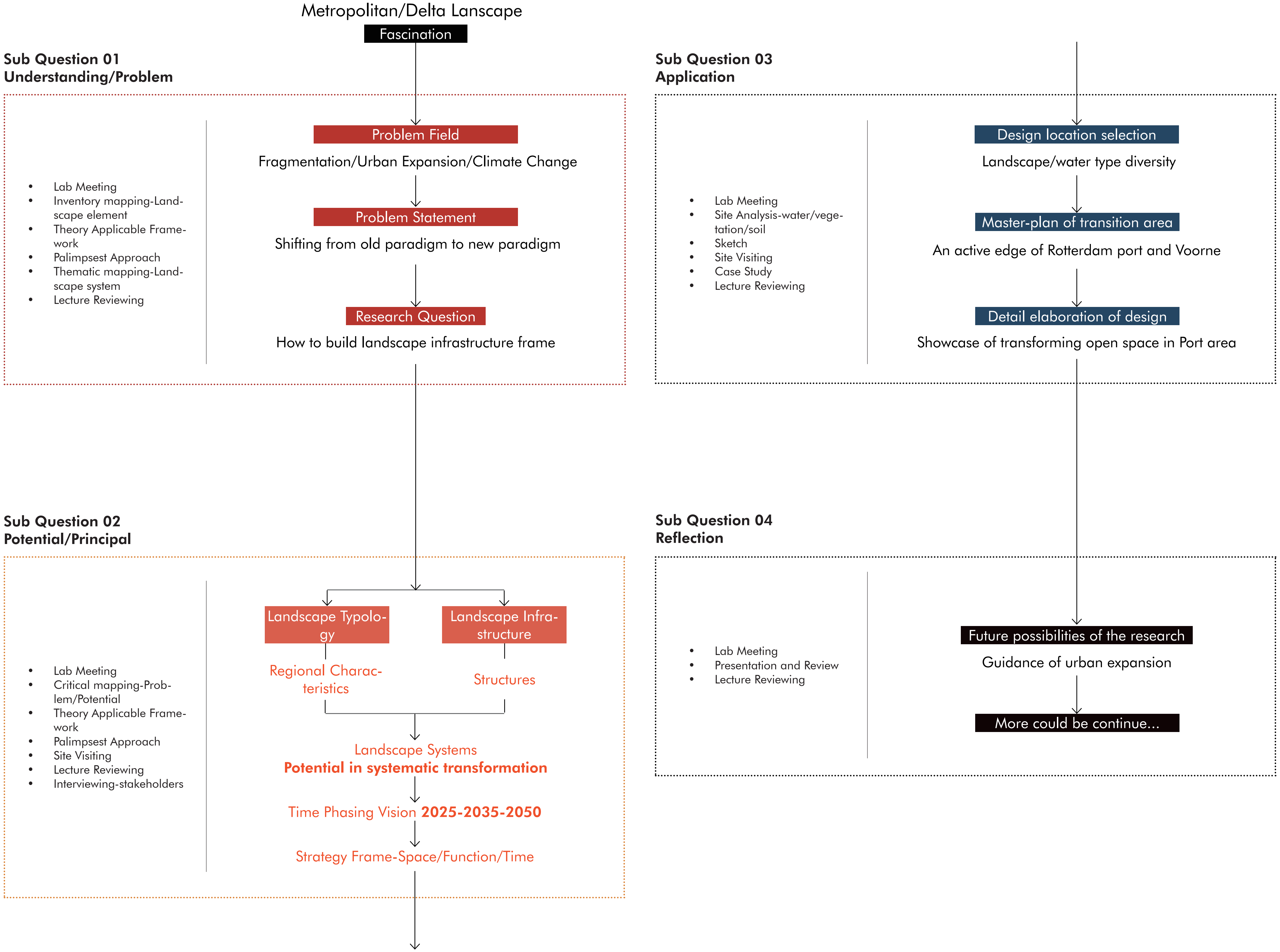
The sub-questions serve as stepping stones, supporting a gradual translation from research to design, ensuring that analytical insights inform spatial strategies and interventions in a structured and coherent way.

Sub Question 01
Understanding/Problem/Potential
-What are the key spatial, ecological and functional characteristics of the regional landscape system, as well as the challenges and opportunities for designing a connecting green-blue infrastructure ?

Sub Question 02
Strategy/Principal
-What landscape-based design strategies and principles can be employed to create a well connected, coherent and robust landscape infrastructure network?

Sub Question 03
Application
-How to apply design strategies and principles across scales and what's the connection between landscape infrastructure design in regional and detail scale ?

Sub Question 04
Reflection, what is the "take away" and space to improve?



SCOPE/RELEVANCE

In my graduation project, I explore the transformation of the freshwater landscape on the Dutch delta island of Voorne-Putten, an area historically shaped by hydraulic engineering, intensive agriculture, and urban expansion. The project takes a systems-based approach, using the framework of landscape architecture to critically examine how water management, ecological connectivity, and agricultural practices can be restructured to meet the challenges of climate change, freshwater scarcity, and biodiversity loss. The design scope extends from the regional scale—addressing the reorganization of the island's main freshwater infrastructure and ecological corridors—to the local scale, where spatial strategies are developed for multifunctional dikes, adaptive agricultural plots, and hybrid zones that negotiate between land and water.

This project is situated within the academic and professional discourse of landscape infrastructure, positioning landscape not as a static or decorative element, but as an active system capable of organizing flows—of water, species, materials, and people—across space and time. By integrating knowledge from hydrology, ecology, agronomy, and spatial planning, the project employs landscape design as a method of inquiry, synthesizing complex data and stakeholder interests into legible, implementable design proposals. It explores how water can be treated not only as a resource to be controlled but as a landscape-forming agent that can shape more resilient, biodiverse, and socially inclusive environments.

The relevance of this research extends beyond the site itself. It contributes to academic debates on adaptive landscape strategies in delta regions, and offers applicable models for freshwater governance, rural transformation, and climate-responsive spatial planning. By reframing water landscapes as multifunctional and regenerative systems, the project proposes a future-oriented design approach with potential applications in other vulnerable lowland regions around the world.

READING ITINERARY

This master thesis is structured into four main parts, comprising a total of eight chapters. The first part introduces the research scope and research questions, while the remaining three parts attempt to address the 01 and 02 Sub research questions through analysis, strategy, and design. The overall structure moves from contextual understanding to strategic design exploration, gradually deepening the discourse on landscape transformation in the transitional areas of the Rotterdam port region.

Part I – Chapters 01/02: What has shaped the current landscape?
This introductory section outlines the background and research focus. Chapter 01 presents a general introduction to the Voorne-Port region, identifies key spatial and environmental challenges, and formulates the research objectives and questions. Chapter 02 then establishes the research framework and theoretical background, introducing key theories such as landscape infrastructure and LBU. It also explains the methodological approach necessary to address the questions posed in Chapter 02.

Part II – Chapters 03/04: Landscape Systems
This part investigates the transitional zone between the Rotterdam port and the surrounding deltaic landscape. Chapter 03 delves into the historical evolution of the region's water and land systems, analyzing how infrastructural developments and human interventions have shaped its transformation. Chapter 04 builds on this analysis to examine current spatial systems through the lens of landscape infrastructure, identifying key challenges and potentials. System diagrams and multi-scalar spatial mappings are used to interpret the landscape and set the foundation for design development.

Part III – Chapters 05/06: Regional Vision and Time Phasing Strategies
This section introduces a framework of spatial strategies and guiding principles aimed at transforming the landscape over time. Chapter 05 explains how future scenarios are constructed across different scales and temporal phases. Chapter 06 elaborates on how transformation can be guided through interventions that are adaptive, phased, and responsive to ecological and social change, building a strategic roadmap for implementation.

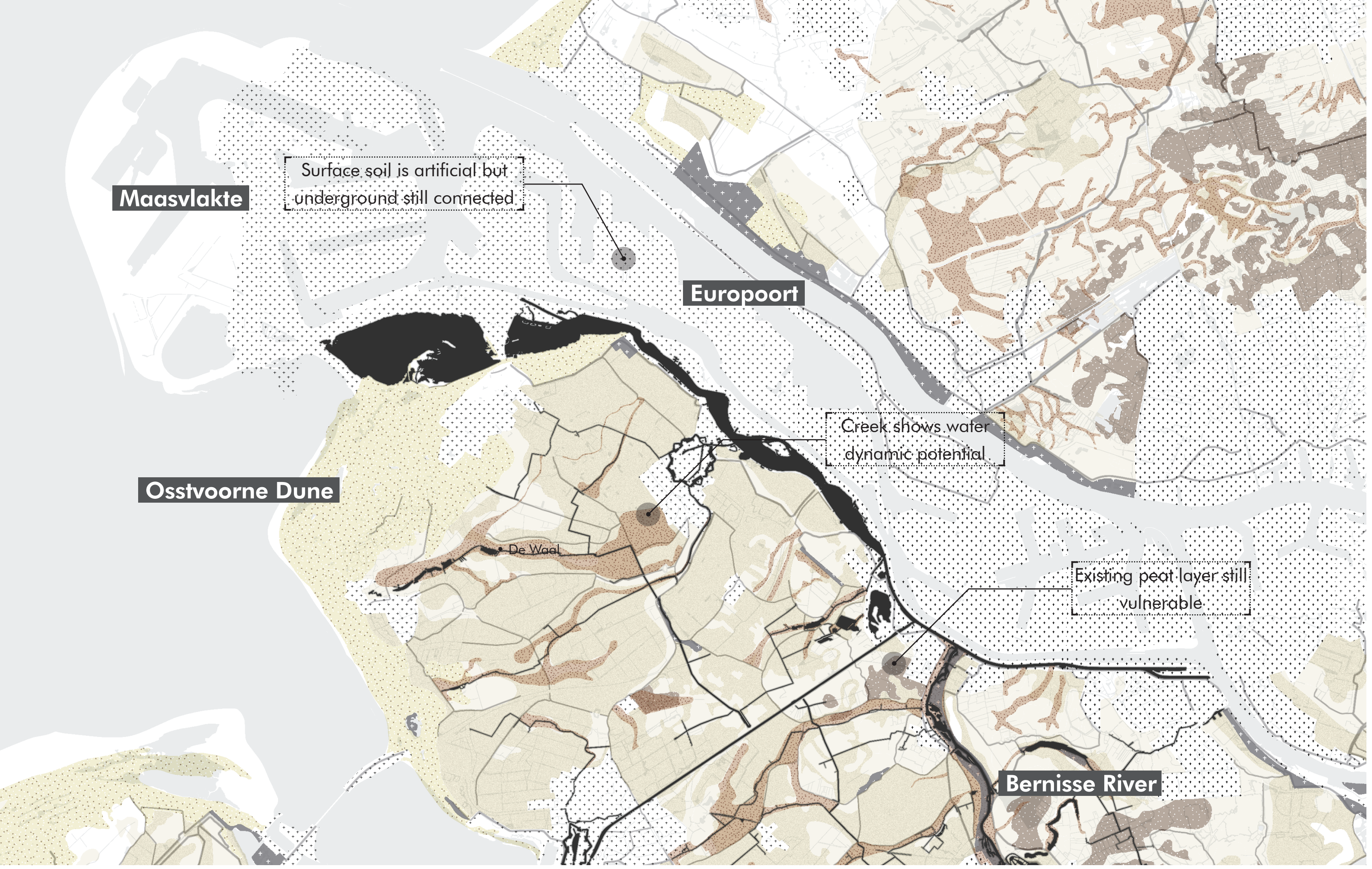
Part IV – Chapters 07/08: Designing the Transformative Flowscape
In this final part, the strategic framework developed in Part III is translated into spatial design proposals. Chapter 07 focuses on the application of strategies to specific sites within the transitional area, exploring spatial design interventions that respond to water dynamics, infrastructural structures, and ecological corridors. Chapter 08 then scales up these design explorations to form an reflection of regional and detail design, demonstrating how small-scale interventions can initiate broader landscape transformation. This concluding section also reflects on the research findings and discusses the potential academic and practical contributions of the project.

CHAPTER 03-LANDSCAPE BACKGROUND

Analysis and Understanding

Analysis and Understanding

- What is the potential connection between islands and port?
- What contribute to the diverse landscape typologies?
- What are the qualities of thoes typologies?



This geologica map shows most areas in this transitional zones is over clay(grey yellow hatch) and sandy soil. and also have a lot water connection

Map by Author/Data from Zuid Holland GIS Portal

The geological and hydrological characteristics of the Port of Rotterdam and its surroundings exhibit significant differences and potential connections between the natural and urban environments. The area is situated in the Rhine-Maas delta and the geological structure consists mainly of Holocene sediments up to 15 to 20 meters thick, including peat, tidal and fluvial sediments, overlying deeper Pleistocene sand layers. This geology results in differences in soil types and stability in different areas.

In urban areas, especially urban centers, many areas are built on peat and clay layers below sea level. As a result of long periods of drainage and land reclamation, these areas have experienced significant ground subsidence, and what was once a higher riverbed is now a relatively elevated terrain in the city. In order to support the construction of the city, large amounts of artificial soil have been filled in over these soft soils, further compressing the underlying peat layer.

In contrast, the Rotterdam Harbor area, especially the Maasvlakte, which was created through land reclamation, has a much higher topography and a much higher carrying capacity with soils consisting mainly of sandy material. Most of these sandy soils come from the North Sea and share similar hydrological characteristics with the neighboring dune areas, while the abundance of natural dunes along the coast brings natural and hydrological diversity.

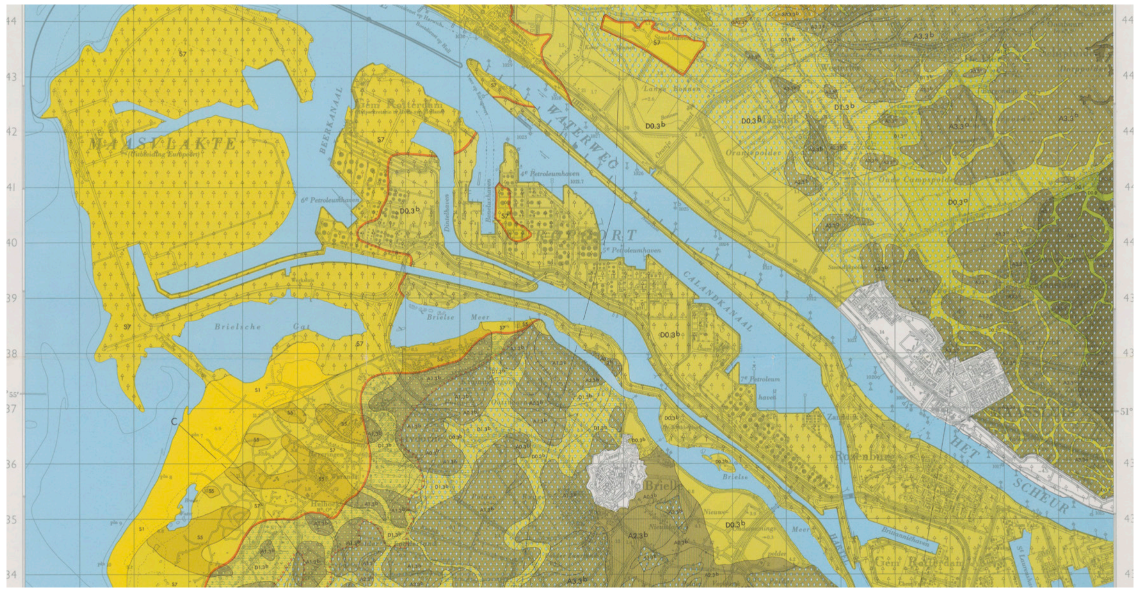
Despite these differences, there are potential links between natural and urban areas. For example, redistributing sediments in harbor areas can restore the natural sedimentary balance and increase coastal erosion resistance, or restore geological structures such as streams that are abundant in these islands and provide habitat for ecosystems. These measures not only help to improve the climate resilience of the region, but also promote the integration of the natural and urban environments.

In summary, the geological and hydrological characteristics of the Port of Rotterdam and its surrounding area create complex interactions between the natural and urban environments. Understanding these differences and linkages is essential for developing effective land use and water management strategies.

LONG GEOLOGICAL PROCESS AS THE BASE...

The green fingers of old clay creeks shows the rich water dynamics used to have in this region also marks out the potential connection in this transitional area

Geologische Kaart van Nederland – ROTTERDAM



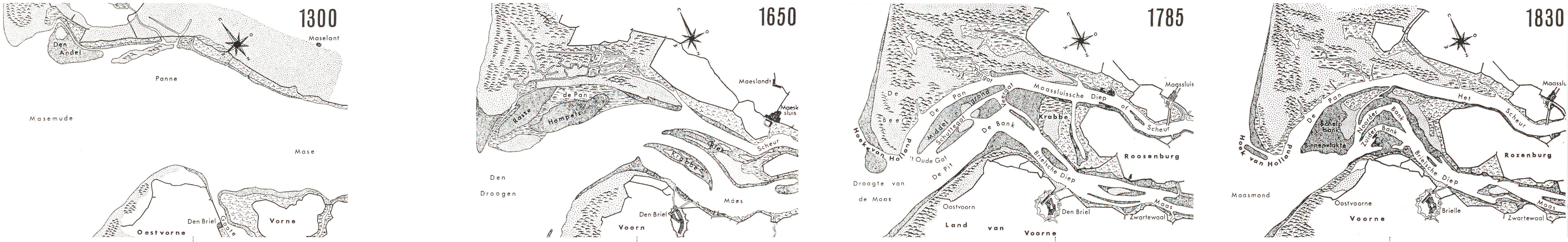
Reconstruction map of Zeeland, the South Holland Islands and the Waarden (Pl.XXIIa) around 1300, edited after JC Ramaer from Geographical History of Holland south of the Lek and Nieuwe Maas in the Middle Ages

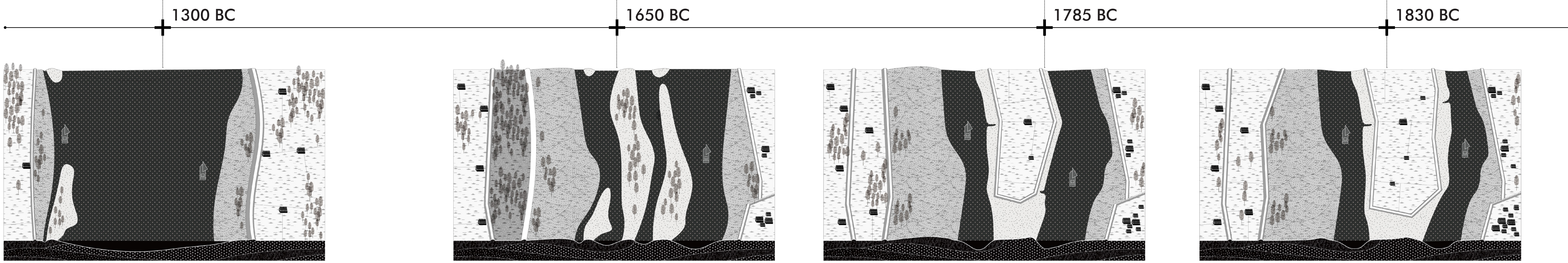
TA REC 001 Reconstruction map Voorne-Putten ±1300

PALIMPSEST OF OLD PARADIGM

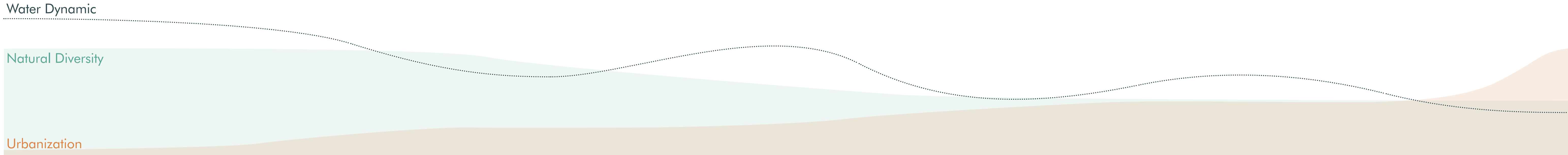
Dynamic Stage (1300-1600 BC)

Before the 13th century, the delta region was widely covered by tidal wetlands, marshes, mudflats, and natural river channels. Tidal influence was significant, shaping diverse sandbanks and islands through sediment deposition and tidal erosion at the river mouths. These landscapes provided rich vegetation and ecological resources. In 1304, Rotterdam remained a small fishing village that relied on coastal shipping and fishing. At the same time, Voorne-Putten is mainly engaged in agriculture and fishing, with limited port trade. Frequent floods pose significant challenges. Starting from the 14th century, people in the delta region began to cultivate land and build dams.





- Subsurface layers consist of sandy and clay-rich sediments, contributing to a high nutrient supply throughout the region (Marjolein, 2024).
- In the 14th century, with effects of subsidence and sea level rise caused the first large-scale construction of dikes.
- Between 1500 and 1800, the Netherlands experienced increasing prosperity and rapid population growth. Large-scale hydraulic projects, including land reclamation, polder construction, and extensive peat extraction, were collectively organized, with stakeholders joining forces for this purpose.

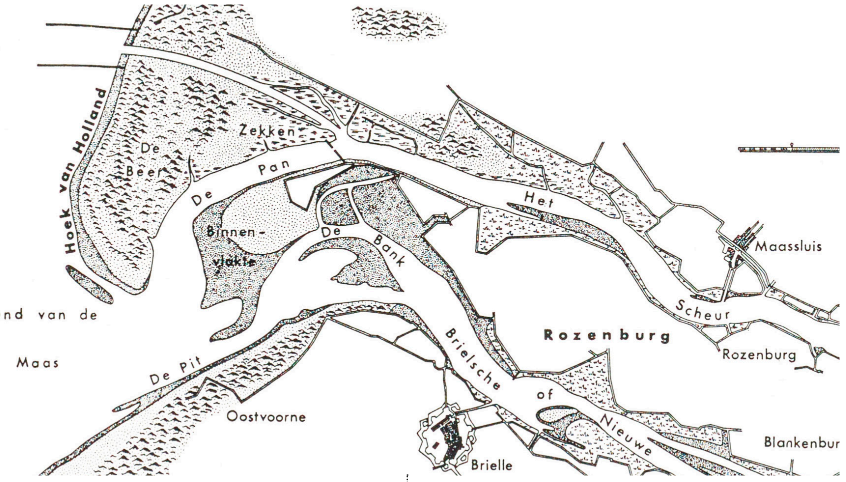


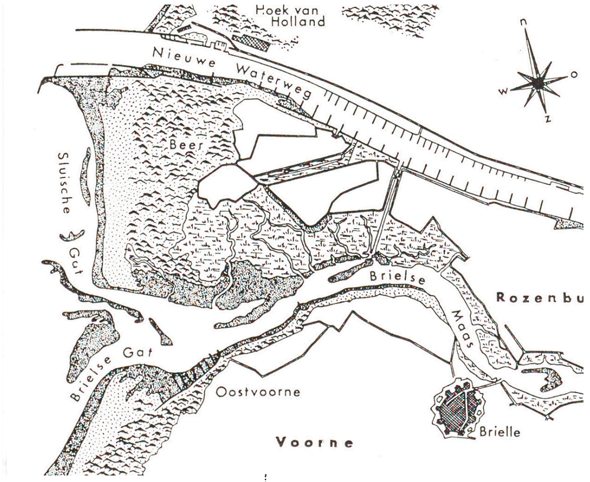
▲ Maps of Delta Works and Port reclamation
Source from Streekarchief Voorne-Putten

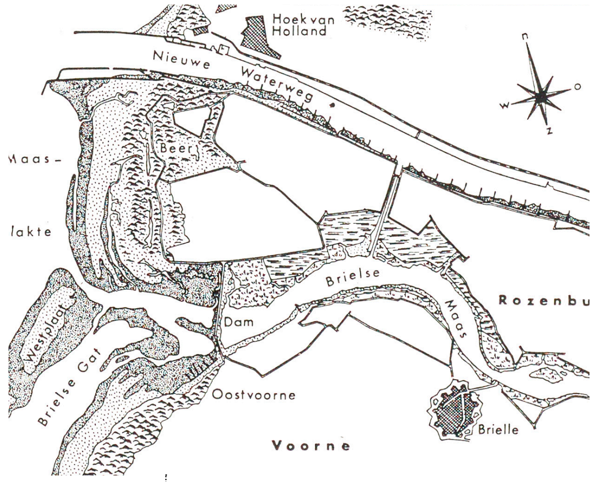
▼ Graphic by author
Data from DINOloket and Cultureelerfgoed.nl

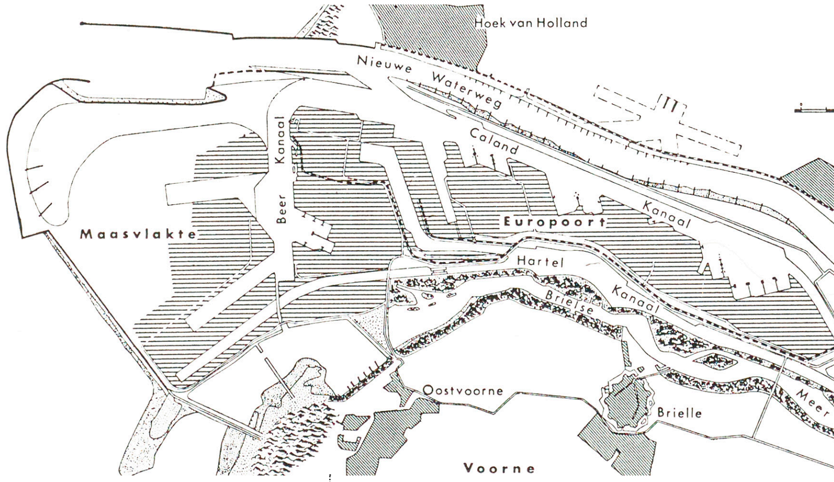
Reclaiming Stage (1601-2010 BC)

This Period reflects a systematic transformation through land reclamation, urbanization, and water management. To address sedimentation issues, the Netherlands constructed the Nieuwe Waterweg, directly linking Rotterdam to the North Sea. This facilitated the westward expansion of the port, creating larger docks, warehouses, and industrial zones, reinforcing its position as a global trade hub. The port's growth accelerated urbanization, extending into Voorne-Putten and integrating it into the port economy. Meanwhile, persistent tidal and flood risks led to the implementation of the Delta Works in the 1950s, featuring storm surge barriers, dikes, and engineered waterways to enhance flood resilience. Through port expansion, urban landscape transformation, and an advanced water management system, the delta evolved from a natural estuary into a highly modernized and climate-adaptive maritime economic hub.

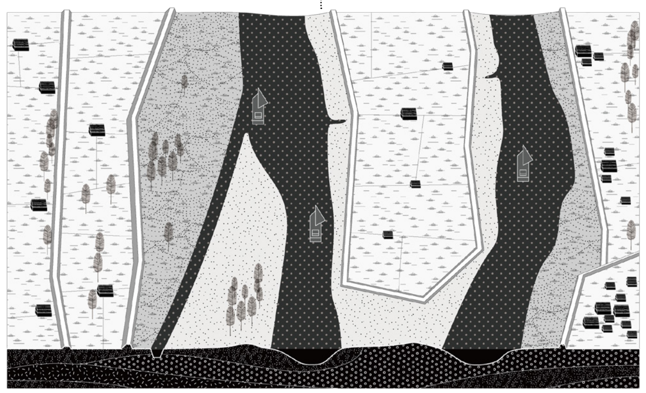


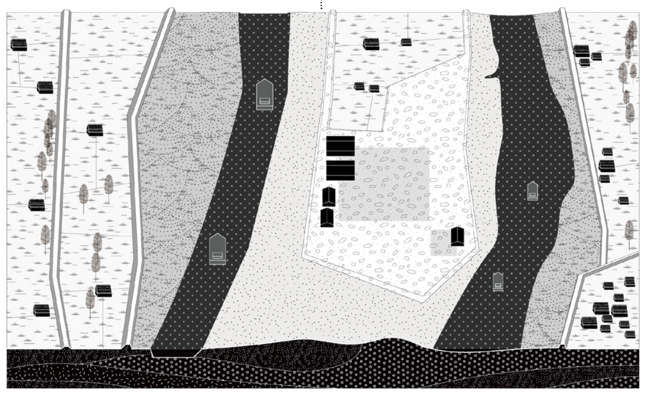


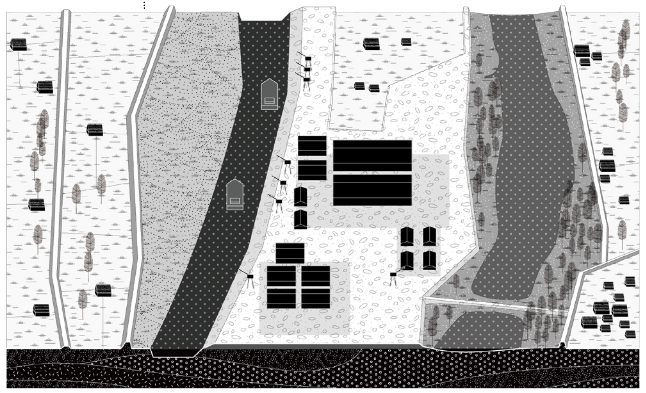


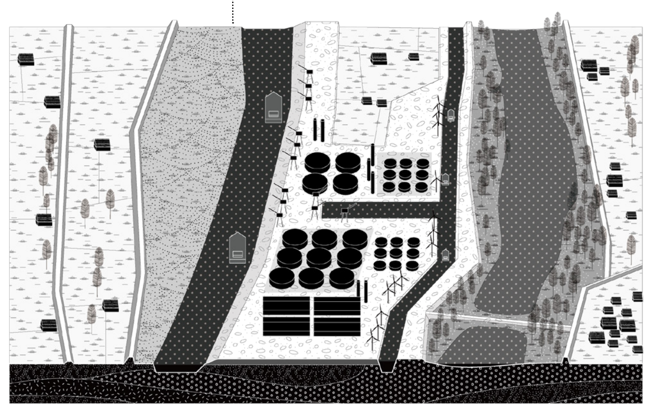


1875 BC | 1930 BC | 1955 BC | 1970 BC









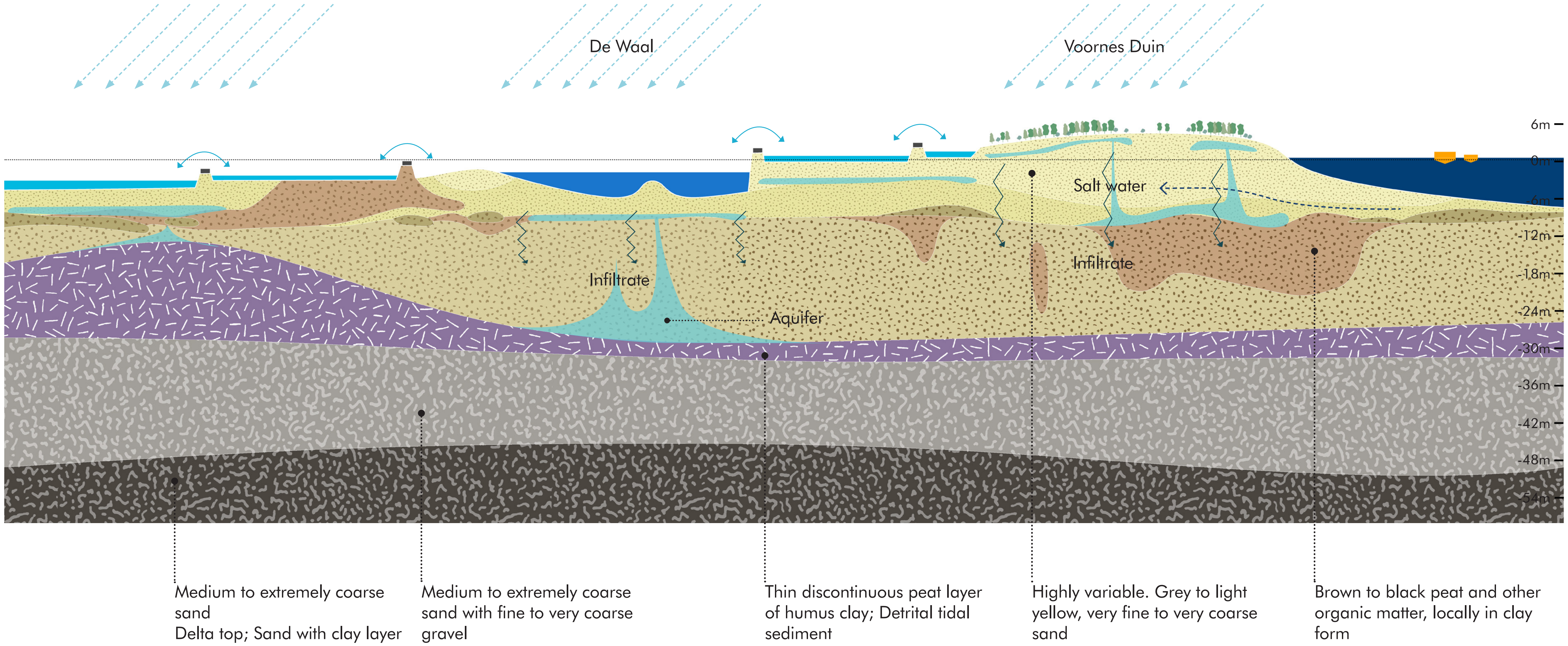
- The Nieuwe Waterweg, opened in 1872 and spanning 20.5 km, was constructed to ensure navigability after the natural tributaries of river became silted up.
- Meanwhile, additional storm barriers and pumping stations were constructed to enhance hydrological safety.
- The devastating 1953 flood accelerated the Delta Works. After World War II, Rotterdam's port and infrastructure were rebuilt. Extensive land reclamation projects and the construction of Botlek strengthened the role of the petrochemical industry in the port economy, generating significant economic benefits. However, this also led to major environmental conflictsts.....

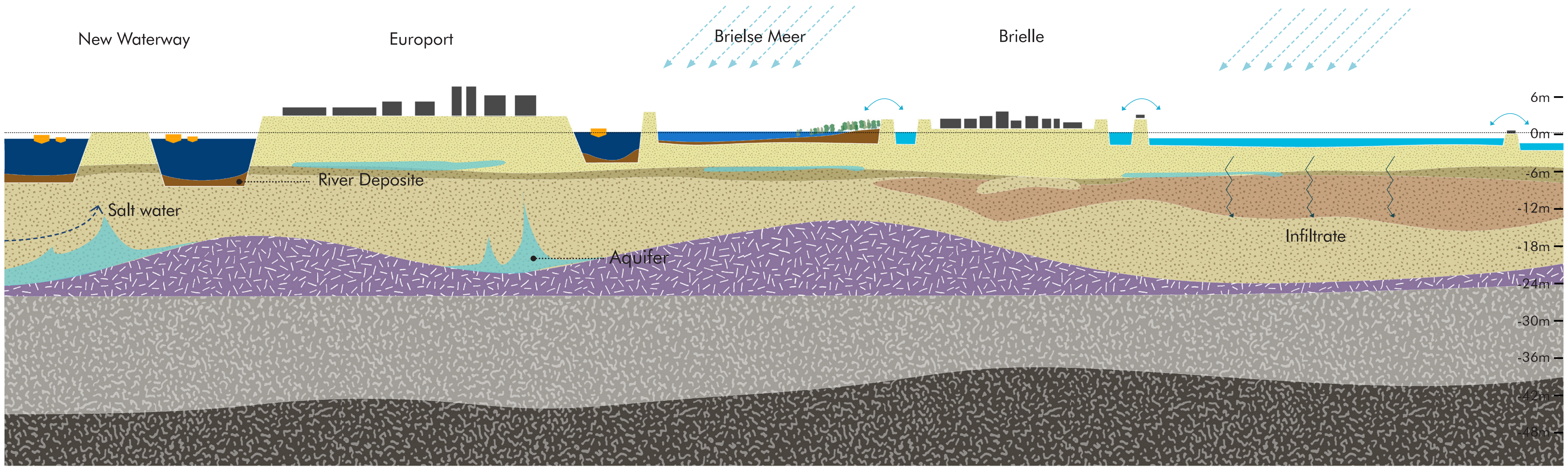
▲ Maps of Delta Works and Port reclamation
Source from Streekarchief Voorne-Putten

▼ Graphic by author
Data from DINOloket and Cultureelerfgoed.nl

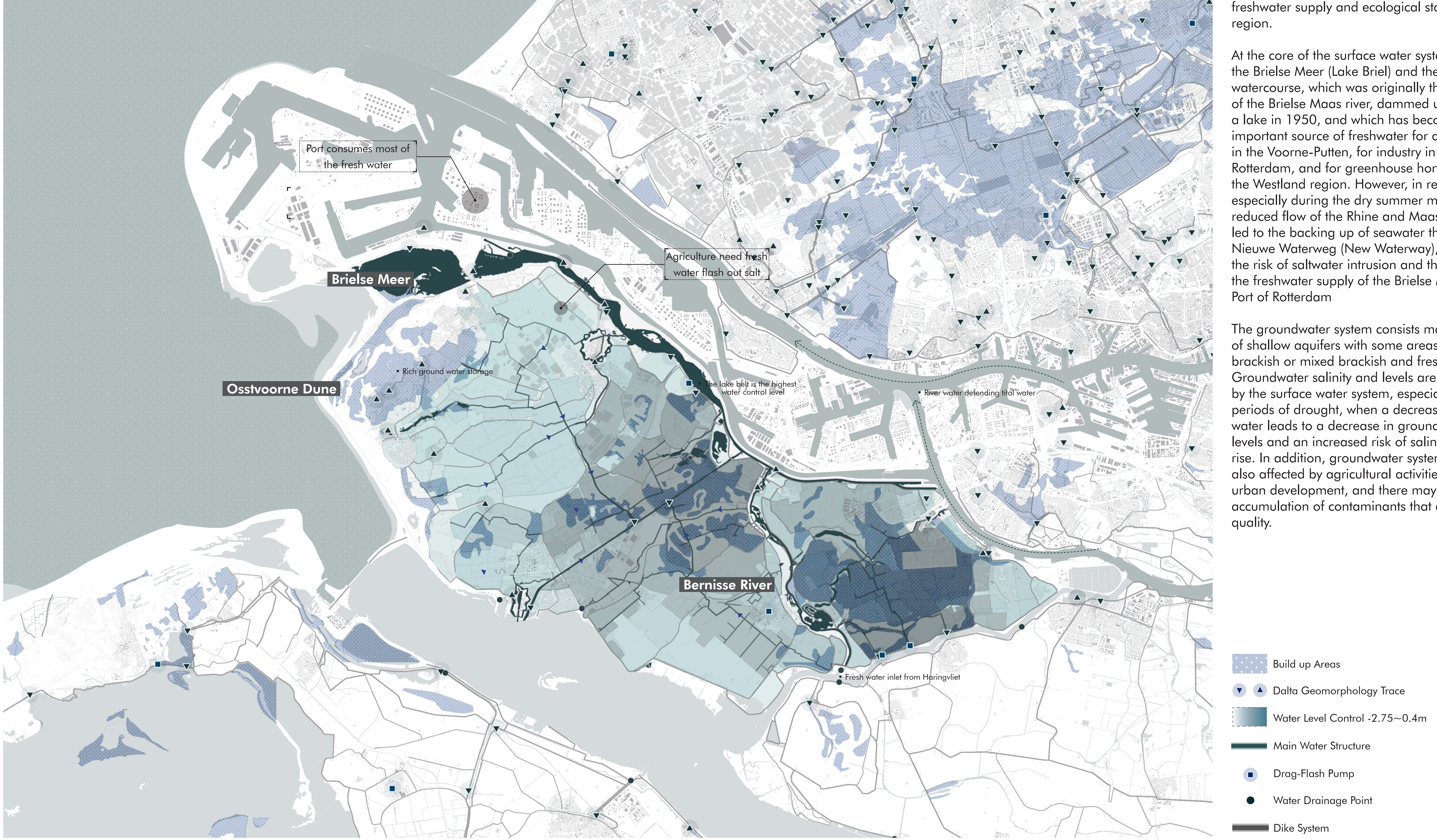
PALIMPSEST UNDERGROUND

the region reveal a dynamic interplay between natural sedimentation processes and long-term human intervention. These stratified soil compositions, shaped by fluvial and marine influences, have been repeatedly modified by diking, poldering, and land reclamation practices. The result is a highly heterogeneous subsurface structure that directly affects surface and subsurface hydrological behavior. Clay layers, with their low permeability, retain water and slow infiltration, while sandy soils allow for quicker drainage and deeper groundwater movement. This contrast leads to significant spatial variations in water retention, seepage, and seasonal fluctuations in groundwater levels. Over time, such hydrological diversity has contributed to the emergence of a wide range of landscape types—from wet meadows and marshlands to elevated dry fields and transitional ecological zones. These variations not only support diverse plant communities and habitat conditions but also offer a complex mosaic of land uses that reflect both ecological processes and historical land management strategies.





INTELLIGENT AND VULNERABLE WATER SYSTEM



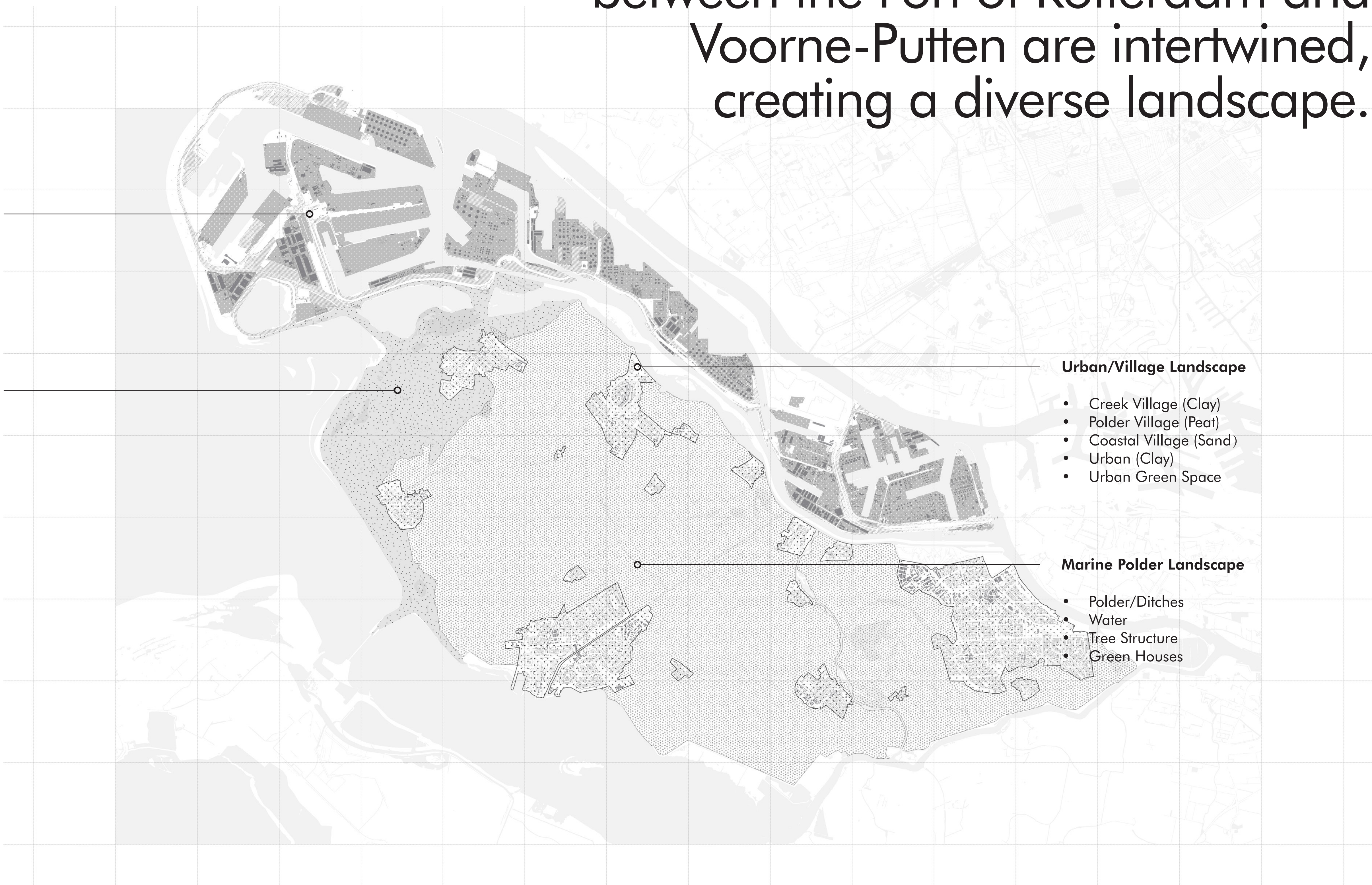
The transition area between the Port of Rotterdam and Voorne-Putten constitutes a complex and critical hydrological system encompassing surface water and groundwater interactions, which directly affects the freshwater supply and ecological stability of the region.

At the core of the surface water system are the Brielse Meer (Lake Briel) and the Bernisse watercourse, which was originally the course of the Brielse Maas river, dammed up to form a lake in 1950, and which has become an important source of freshwater for agriculture in the Voorne-Putten, for industry in the Port of Rotterdam, and for greenhouse horticulture in the Westland region. However, in recent years, especially during the dry summer months, the reduced flow of the Rhine and Maas rivers has led to the backing up of seawater through the Nieuwe Waterweg (New Waterway), increasing the risk of saltwater intrusion and threatening the freshwater supply of the Brielse Meer.
Port of Rotterdam

The groundwater system consists mainly of shallow aquifers with some areas of brackish or mixed brackish and fresh water. Groundwater salinity and levels are influenced by the surface water system, especially during periods of drought, when a decrease in surface water leads to a decrease in groundwater levels and an increased risk of saline water rise. In addition, groundwater systems are also affected by agricultural activities and urban development, and there may be an accumulation of contaminants that affect water quality.

DIVERSE LANDSCAPE TYPOLOIES...

The hydrological and geological systems of the transition area between the Port of Rotterdam and Voorne-Putten are intertwined, creating a diverse landscape.



Industry and Harbor Landscape

- Developed Industrial Area
- Expanding Reclaiming Area

Dune and Forest Landscape

- Sand Dune
- Dune Forest
- Dune Lake
- Estate and Farmhouse

Urban/Village Landscape

- Creek Village (Clay)
- Polder Village (Peat)
- Coastal Village (Sand)
- Urban (Clay)
- Urban Green Space

Marine Polder Landscape

- Polder/Ditches
- Water
- Tree Structure
- Green Houses

Surface water bodies provide freshwater resources for agriculture and industry, while shaping ecosystems such as wetlands, reedbeds and mudflats. The groundwater system consists of shallow aquifers, with water levels and salinity influenced by surface water dynamics, affecting land use and ecological stability. Geologically, there is a diversity of soil types, including peat, clay and sandy soils, which form landscapes such as sand dunes and farmland. Human activities, such as harbor construction and land reclamation, also have a profound impact on landscape structure.

URBAN/VILLAGE LANDSCAPE

The lake belt have a special skyline from the peaceful water to the forest edge between port area but above the canopy you can still see the millls pop up

Photo from GR5 etappe 2 Maassluis – Brielle: Typisch Hollands

The starting point of this hiking route – the water defence line of Brielle – is a living piece of history. The city walls, monumental buildings, harbor, and picturesque streets are the icing on the cake during this walk

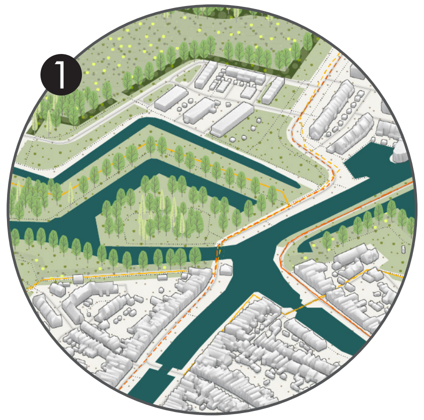
Photo by Watergeuzen en gloeiende kogels

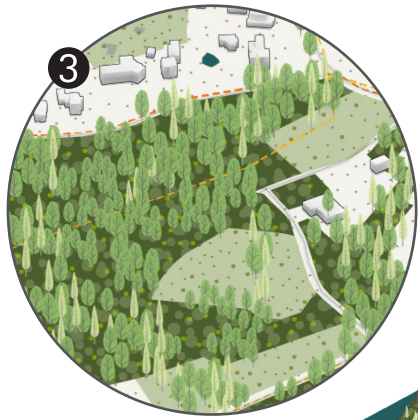
Landgoed Mildenburg (30 hectares) is located in Oostvoorne, close to other nature areas managed by the Zuid-Hollands Landschap, maintaining the lanes as cultural-historical elements, but also because bats use these linear features to navigate their flight paths

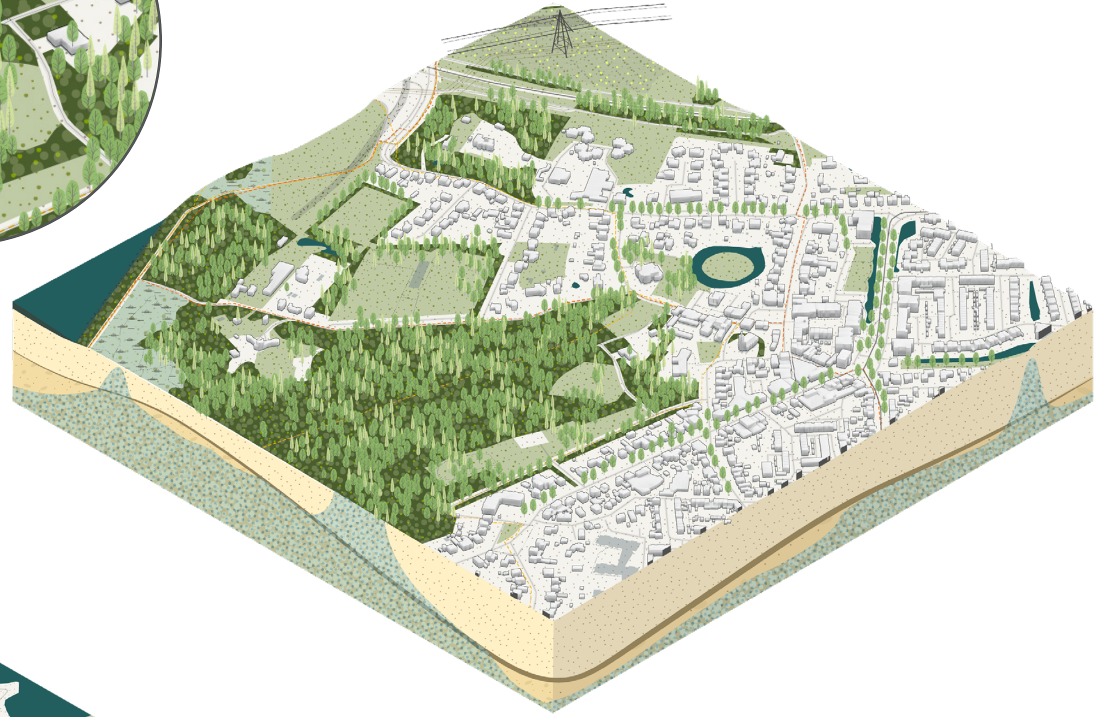
Photo by Zuid-Hollands Landschap

URBAN/VILLAGE LANDSCAPE

In the transition area between the Port of Rotterdam and Voorne-Putten, the Urban/Village Landscape combines point-like urban settlements such as Spijkenisse, Heenvliet and Zwartewaal with smaller settlements combining different geologic and soil properties, linear roads and canals, and tree and water corridors. Corridors including waterways such as the Voorne Canal and Hartelkanaal, as well as a network of roads connecting the settlements, facilitating transportation and water management, and green spaces and parks around the city form a multi-layered spatial structure. Such landscapes not only provide basic service functions such as housing, agricultural production and recreation, but also have the function of carrying cultural identity. Natural resources such as Brielse Meer fresh water and fertile soil are closely related to human activities, and urban water supply and wastewater systems, stormwater management and ecological preservation are intertwined, reflecting the natural spatial evolution of human-dominated factors.

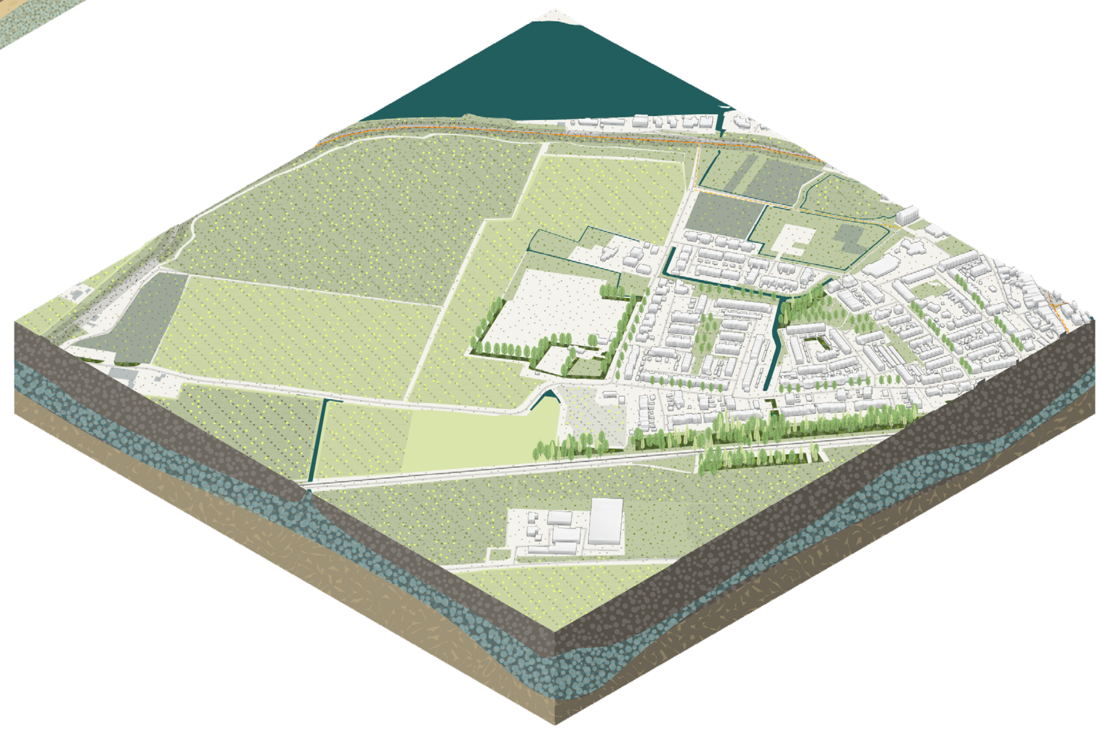






Coastal Village (Sand)(1km*1km)

Urban (Clay)(1.5km*1.5km)



Polder Village (Peat)(1km*1km)

Classify different urban and rural landscapes according to the soil type where the city is located and the vegetation landscape attributes around the city

Graphic by Author
Data from Zuid-Holland GIS Portal

INDUSTRY AND HARBOR LANDSCAPA

Huge wind turbine on the beach of Maasvlakte II, Rotterdam. With road and car park behind the dunes of the recreational beach: Maasvlaktestrand. The North Sea and container terminals with harbour, the sandy space in farm share the same growing quality with dune area.

Photo by Frank T.G. Herben

Huge containers ara one ▸ of the most dominant landscape in port area , BP Raffinaderij Rotterdam (bpRR) is one of the largest refineries in Western Europe, processing 400,000 barrels of crude oil daily (19 million tons annually)

Photo by BP Netherlands

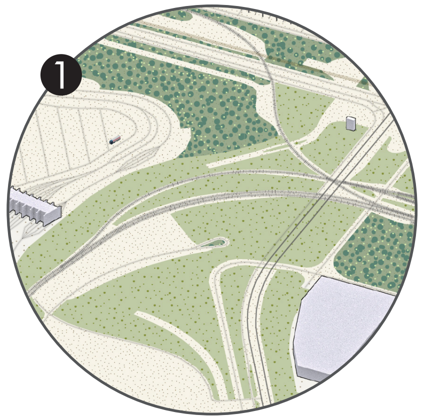
◂ Landtong De Punt is a small stripe of green area between Niew Waterway and Calandkanaal, this forest is very valuable ecological stepping stone

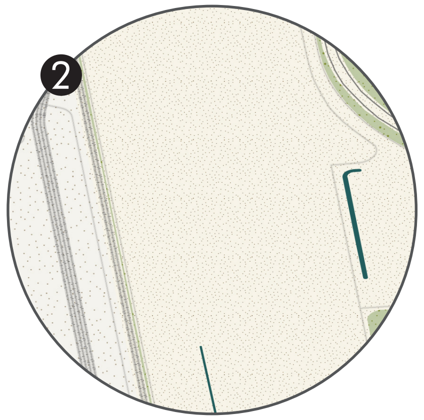
Photo by Piet le Mair

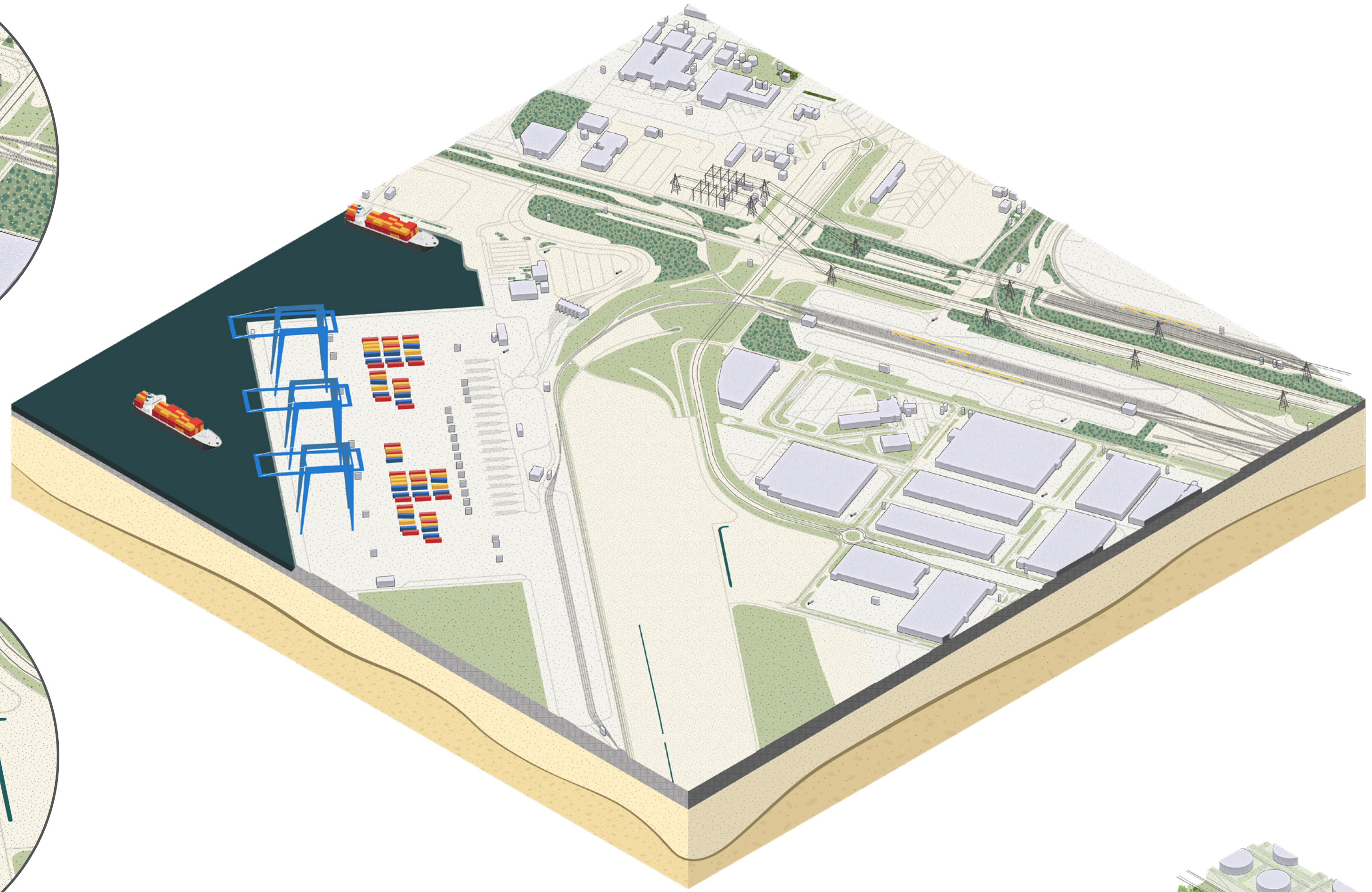
INDUSTRY AND HARBOR LANDSCAPA

In the transition area between the Port of Rotterdam and Voorne-Putten, the Industry and Harbor Landscape constitutes a highly organized and functionally diverse spatial system. The point elements include a wind power station and an automated container terminal, as well as different office buildings and logistics centers. Linear elements include highways, rail freight lines and waterways such as the Hartelkanaal, which connect the inland with the port and support the transportation of goods and energy. Facing elements such as Maasvlakte's yards, tank farms, and a large number of semi-open spaces demonstrate the large-scale functions of industrial production and energy conversion.
The main functions of such landscapes include global logistics transit, energy processing and storage, and the operation of supporting infrastructure.

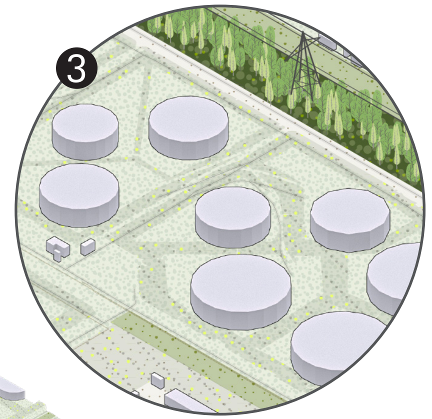
Natural resources and human activities are closely intertwined here. The expansion of ports depends on the reclamation of the coastline, altering the original hydrology and ecosystems. These highly intensive and artificial landscapes are partly in a stable high development phase and partly in an active expansion phase that maintains and enriches the natural dynamics. Rich natural potential

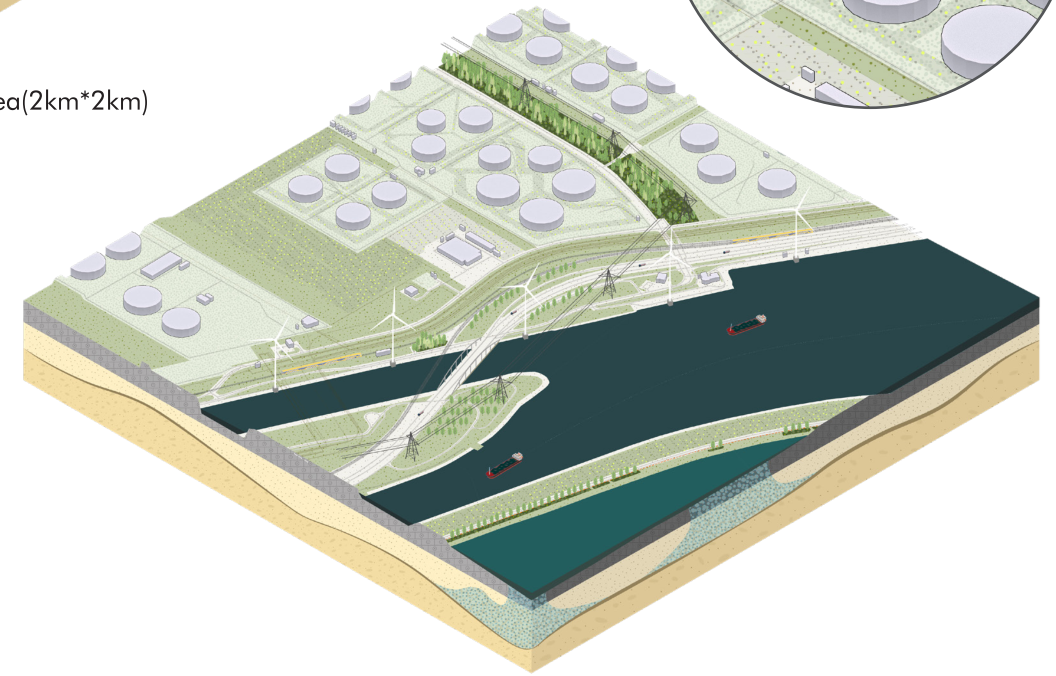






Expanding Reclaiming Area(2km*2km)





Developed Industrial Area(1.5km*1.5km)

The types of industrial landscape can be classified based on the density of facilities and the order of development into expanding areas (characterized by more open space) and developing ports (characterized by less available space and a denser infrastructure framework).

Graphic by Author
Data from Zuid-Holland GIS Portal

MARINE POLDER LANDSCAPE

The clay polders in Maassluis Stellingmolen, vegetation alone the water ditch is intensively managed and the view is very open wide

Photo by GR5 etappe 2 Maassluis – Brielle: Typisch Hollands

◀ The Derryvliet nature reserve (3 hectares) is located along the creek of the same name near Zwartewaal, one of the oldest remaining creek systems on Voorne. This area once had an open connection between the Maasmond and the Haringvliet

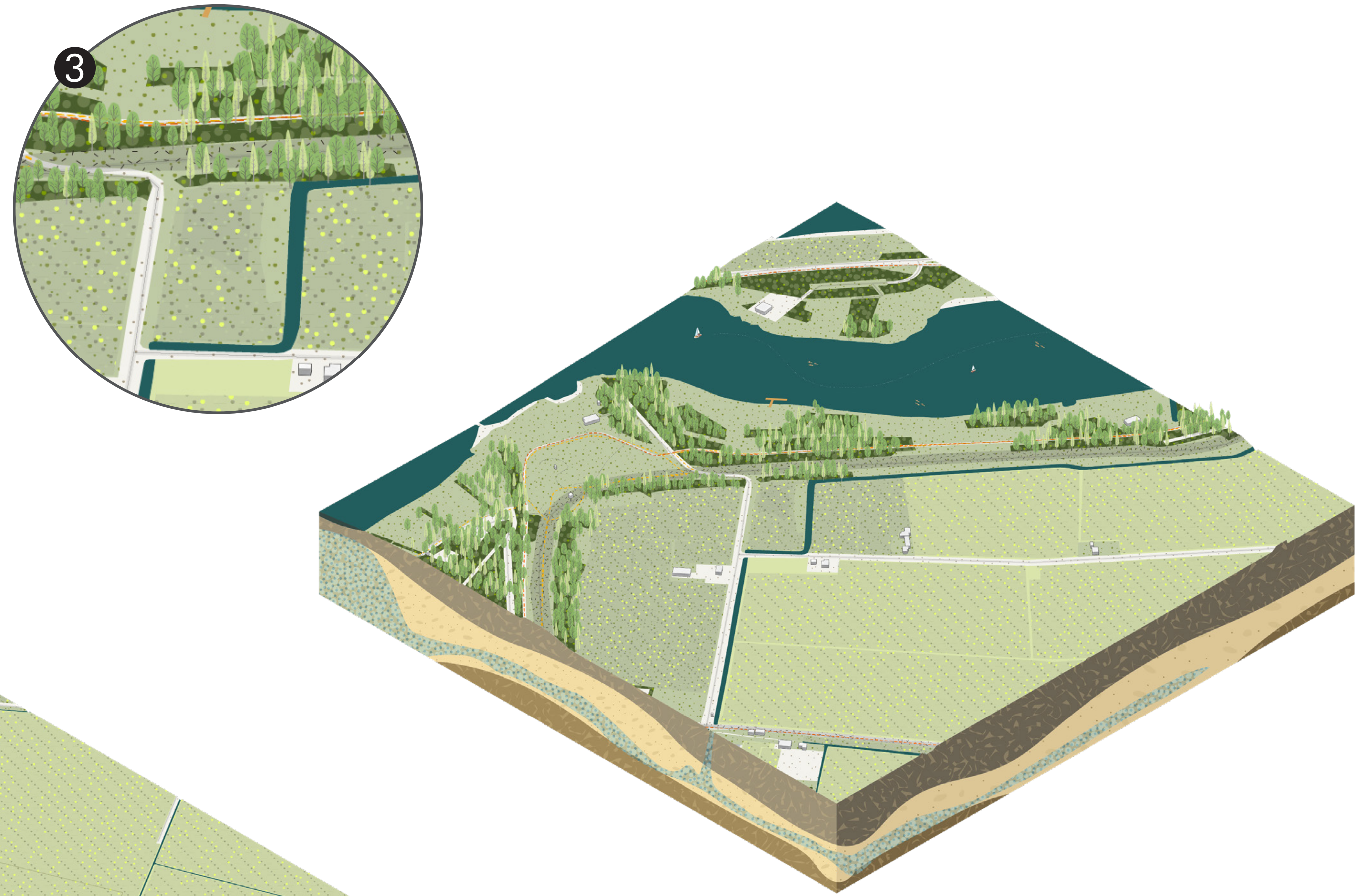
Photo by Zuid-Hollands Landschap

The Ommeloop nature reserve, located northwest of Brielle, used to lie by the sea. Even today, brackish groundwater still seeps to the surface, many of which are rare and dependent on the saline seepage, such as sea milkwort, marsh samphire, and lesser sea-spurrey ▶

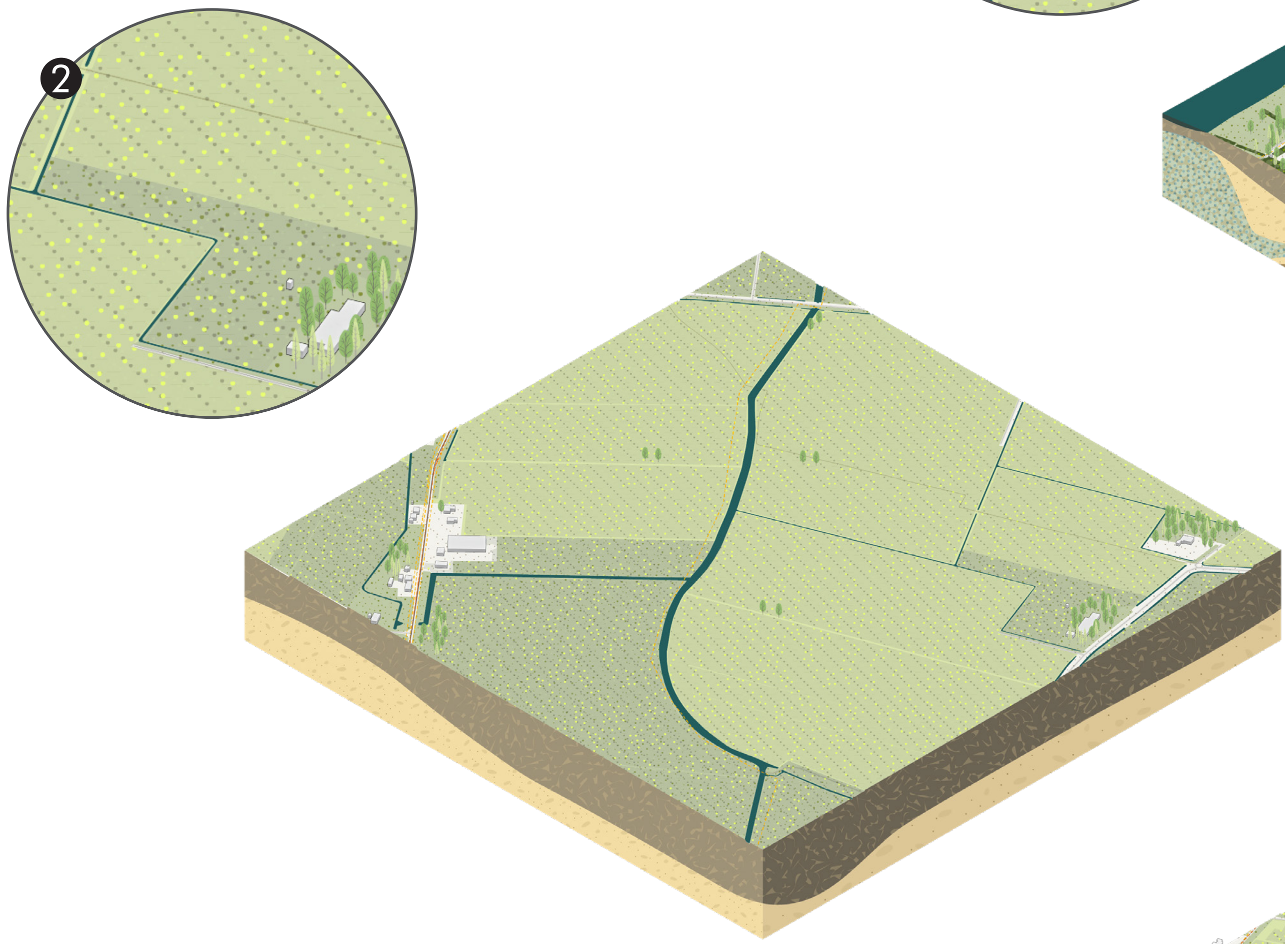
Photo by Zuid-Hollands Landschap

MARINE POLDER LANDSCAPE

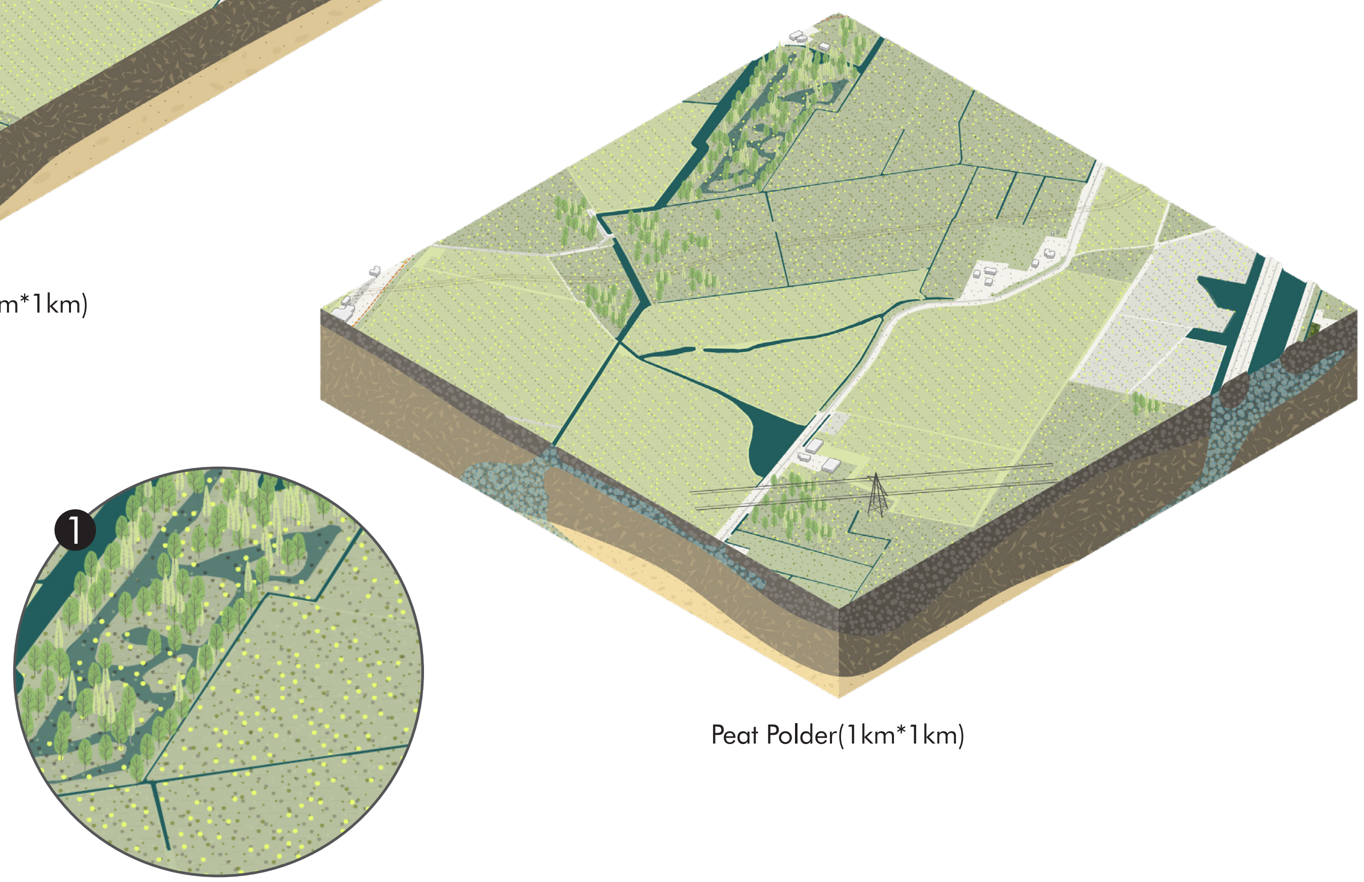
In the transition area between the Port of Rotterdam and Voorne-Putten, the Marine Polder Landscape shows a variety of soil types and corresponding agricultural utilization. The area consists of three main soil types: marine clay, sand and peat.
Marine clay areas, such as those located around Brielse Meer, are fertile and suitable for growing crops such as wheat, sugar beet and potatoes. These zones often employ fine drainage systems and modern agricultural machinery to increase productivity.
Sandy soil areas, such as the inland uplands near Voorne, have well-drained soils suitable for crops such as onions, carrots and flowers. As sandy soils are vulnerable to wind and water erosion, measures such as windbreaks and cover crops are often used in these areas to protect the soil.
Peat areas, such as those along the Bernisse and Spui Rivers, have soils with high organic matter content but poor drainage, and are commonly used for pasture cultivation and animal husbandry. Measures such as water table management and restrictions on drainage are implemented in these areas to prevent ground subsidence and greenhouse gas emissions.
These diverse soil types and corresponding agricultural utilization patterns reflect the close relationship between human activities and natural resources. Through rational land use and water management strategies.



Old Clay Polder(1km*1km)



Young Clay Polder(1km*1km)



Peat Polder(1km*1km)

Classify different marine polder landscapes according to the soil type where the field is located and the ground water level also spatial patterns

Graphic by Author
Data from Zuid-Holland GIS Portal

DUNE AND FOREST LANDSCAPE

Around the Tenellaplas, all the characteristic biotopes of the Voorne dunes have been brought together in a small area: a dune lake, marshy shores, meadows, dry sandy slopes, shrubland, and mature forest

Photo by Zuid-Hollands Landschap

◄ A highly diverse nature reserve in Rockanje features forests, moist dune valleys, shrubland, and dry sandy slopes, the dunes on Voorne are relatively young. The oldest dunes here are about 800 years old, but even today, new dunes continue to form along the beach

Photo by OP Voorne Putten

The dune is like a natural barrier between the port area and islands behind, the wind power farms form unique skyline ►

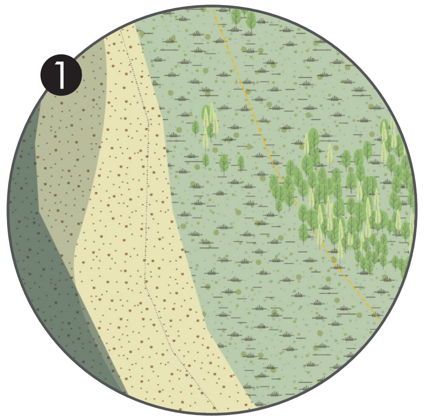
Photo from Google Map

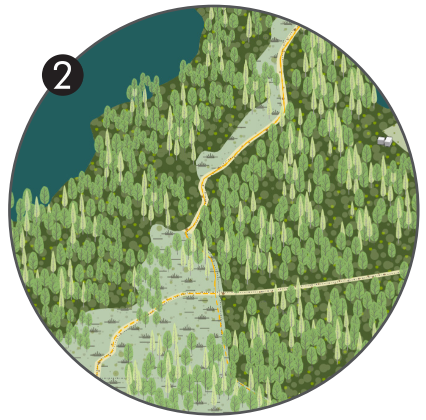
DUNE AND FOREST LANDSCAPE

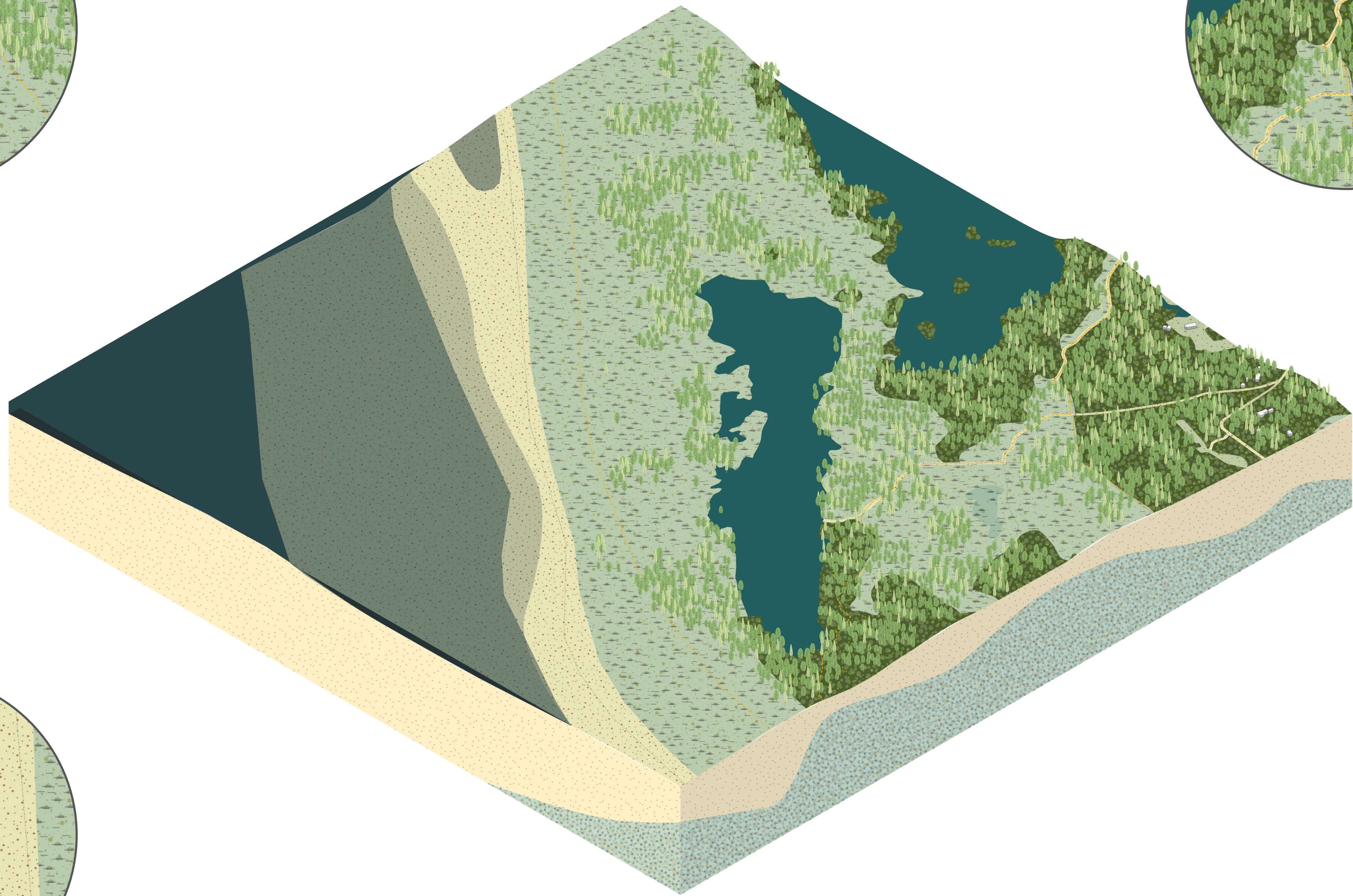
In the transition area between the Port of Rotterdam and Voorne-Putten, the Dune and Forest Landscape constitutes an ecologically diverse natural system. Represented by the Voornes Duin Nature Reserve, this area combines dynamic sand dunes, oak forests, wetlands and freshwater lakes (e.g. Quackjeswater and Breede Water).

The main functions of such landscapes include ecological conservation, recreation and freshwater resource management. Dynamic dune systems are constantly moving through wind action, creating diverse microtopographies that provide habitat for rare plants and animals. Forested areas, on the other hand, provide rich biodiversity and carbon sinks. In addition, the groundwater reservoirs beneath the dune system are an important source of fresh water, supplying the surrounding area with drinking water and irrigation for agriculture.

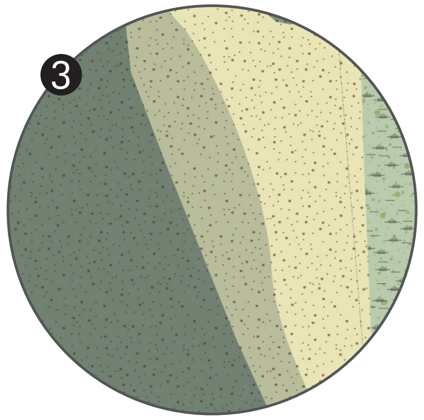
Human activities and natural resources interact here. In order to cope with the problem of declining water table and ecological degradation, the natural dynamics of the dunes are restored and the adaptive capacity of the ecosystem is enhanced by opening up dune gaps to introduce new sand. At the same time, trails and bird-watching spots have been constructed to promote ecotourism and environmental education. The dune and forest landscape in this transition area mainly reflects the multiple functions of ecological protection, recreation and water resource management







Dune and Forest Landscape(1.5km*1.5km)



The Voorne Dune is the area with most biodiversity in the whole netherlands and the topograohy and water type changes provide here excellent condition fot plants and animals

Graphic by Author
Data from Zuid-Holland GIS Portal

CHAPTER 04-LANDSCAPE INFRASTRUCTURE

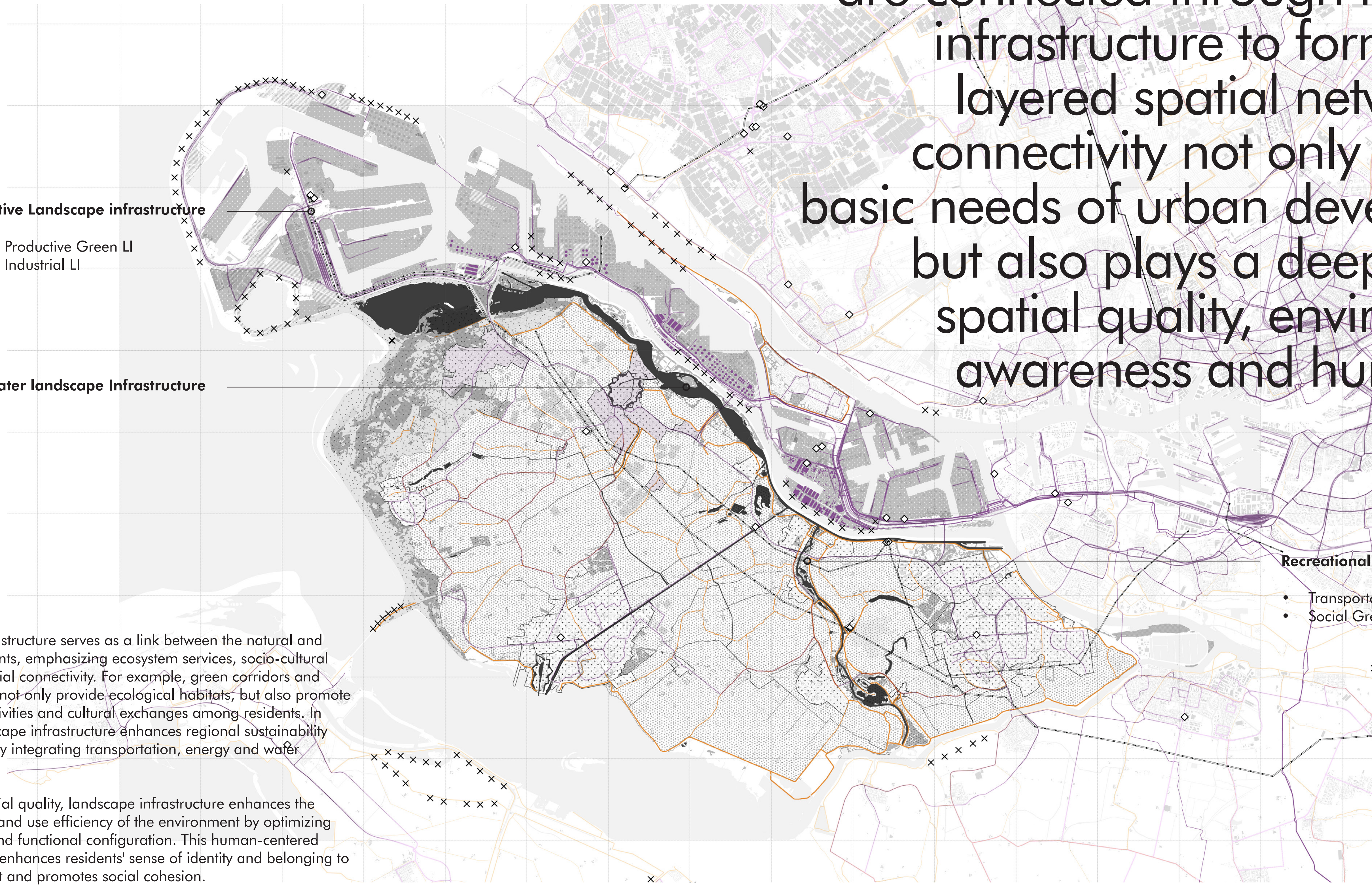
Analysis and Understanding

Analysis and Understanding

- How those landscape typologies connect?
- What are the elements and relations in landscape infrastructure network?
- How landscape systems addressing problems and challenges?

WHAT CONNECTS THOSE LANDSCAPE MOSAICS?

This transitional area exhibits a variety of landscape types, which are connected through landscape infrastructure to form a multi-layered spatial network. This connectivity not only meets the basic needs of urban development, but also plays a deeper role in spatial quality, environmental awareness and human-land relations.

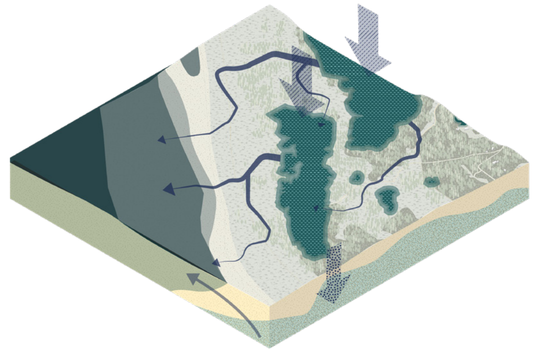


Landscape infrastructure serves as a link between the natural and built environments, emphasizing ecosystem services, socio-cultural values and spatial connectivity. For example, green corridors and water networks not only provide ecological habitats, but also promote recreational activities and cultural exchanges among residents. In addition, landscape infrastructure enhances regional sustainability and resilience by integrating transportation, energy and water management.

In terms of spatial quality, landscape infrastructure enhances the aesthetic value and use efficiency of the environment by optimizing spatial layout and functional configuration. This human-centered design concept enhances residents' sense of identity and belonging to the environment and promotes social cohesion.

WATER LANDSCAPE INFRASTRUCTURE

Water landscape infrastructure refers not only to a collection of man-made hydraulic works and technical facilities, but also to a cross-scale, multifunctional, eco-technical hybrid system. In the port area, the infrastructure is primarily composed of deep-water shipping channels, tidal barriers, and stormwater drainage systems. These elements are typically linear and hardened in form, with a strong focus on tidal protection and navigation. In contrast, the interior of Voorne Island is characterized by lakes, wetlands, and agricultural canals, forming a more flexible water network that serves freshwater storage, ecological regulation, and agricultural irrigation. The two systems are dynamically connected through key nodes such as dikes, sluices, and pumping stations, creating a transitional zone driven by both technical control and natural processes. This system plays a vital role not only in flood protection, water resource management, and ecological restoration, but also in structuring spatial organization, shaping landscape form, and encouraging public engagement. As such, it embodies the synergy between people, water, and technology, serving as a critical foundation for regional resilience and sustainable development.

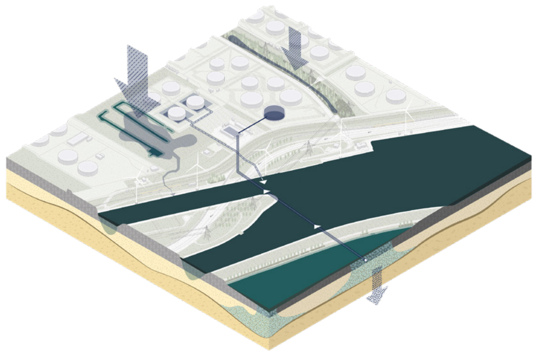


• Dune Water System

Rainwater Capture
●●●●●

Water Supply Capacity
●●●●●

Water Storage Capacity
●●●●●

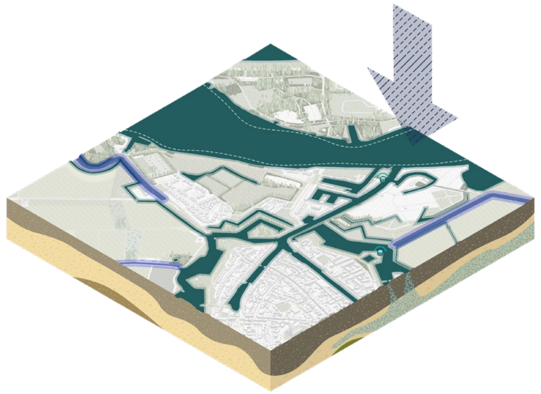


• Dune Water System

Rainwater Capture
●●○○○

Water Supply Capacity
●○○○○

Water Storage Capacity
●●●○○

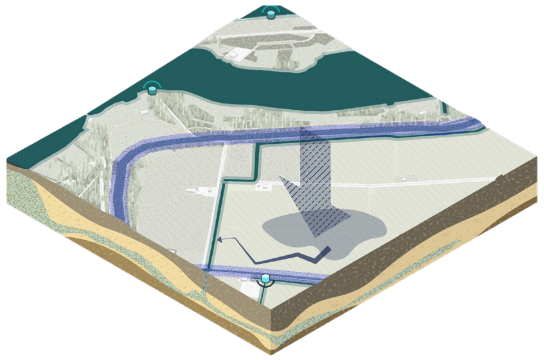


• Lake Water System

Rainwater Capture
●●●●●

Water Supply Capacity
●●●●●

Water Storage Capacity
●●●●●



• Agricultural Water System

Rainwater Capture
●●●○○

Water Supply Capacity
●●○○○

Water Storage Capacity
●●●○○

Brielse Meer is the largesr water surface in the water network, it service as the main fresh water supply for the port and wetland greenhouses also the recreational function

Photo by Author

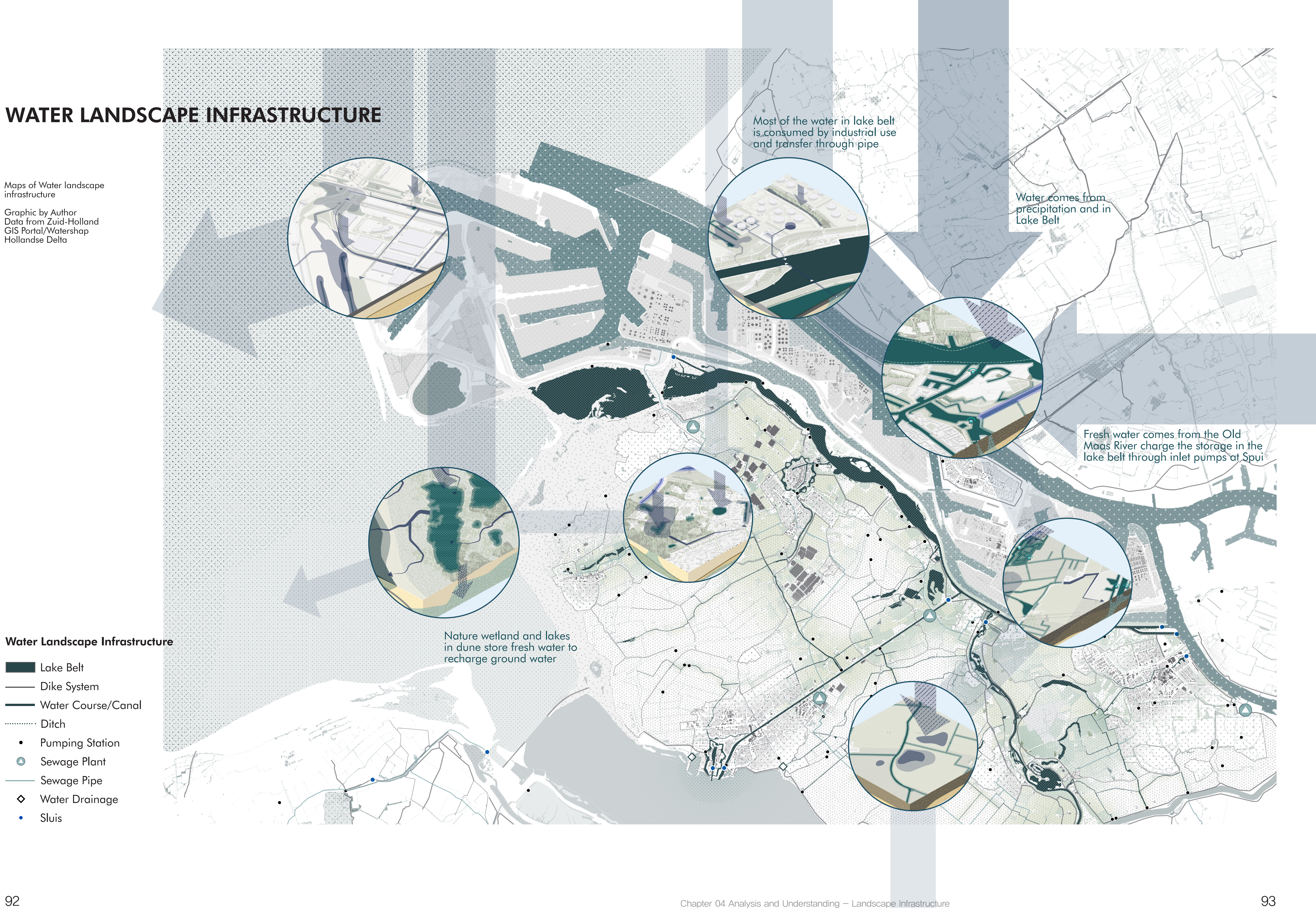
Water ditches and canal in agriculture area and port area are mostly seasonal, like the picture shows the water is higher in the winter and most of the time those ditches have a shallow water

Photo by Gerard Potuijt

WATER LANDSCAPE INFRASTRUCTURE

Maps of Water landscape infrastructure

Graphic by Author
Data from Zuid-Holland GIS Portal/Watershap Hollandse Delta



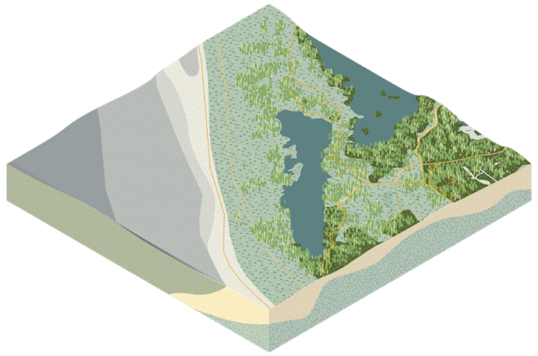
RECREATIONAL LANDSCAPE INFRASTRUCTURE

From the perspective of landscape infrastructure, the recreational landscape infrastructure connecting the port and Voorne Island consists of two interrelated subsystems: social green infrastructure and transportation infrastructure. Together, they form a multifunctional system that balances ecological performance with social use.

Social green infrastructure is primarily located along the edges where the port's industrial zones and office areas meet the residential areas of the island. It includes waterfront parks, ecological wetlands, greenway trails, and shared community green spaces. These elements typically combine linear and areal forms, offering multiple functions such as ecological filtration, buffer zoning, and recreational use. These green spaces not only enhance the environmental quality between the port and nearby settlements but also provide residents and visitors with spaces for birdwatching, walking, picnicking, and informal education.

Complementing this is a comprehensive transportation network made up of cycling paths, pedestrian walkways, waterborne transit, and regional public transport. The slow mobility routes are often integrated with the green infrastructure, forming scenic experience corridors that link the port, villages, and lakes. Additionally, the port area is connected to Voorne Island via ferries, bridges, and other facilities, ensuring smooth transitions of people and landscape flows.

These two subsystems are spatially interwoven and functionally supportive, creating a cohesive landscape infrastructure that strengthens connectivity, accessibility, and regional livability.

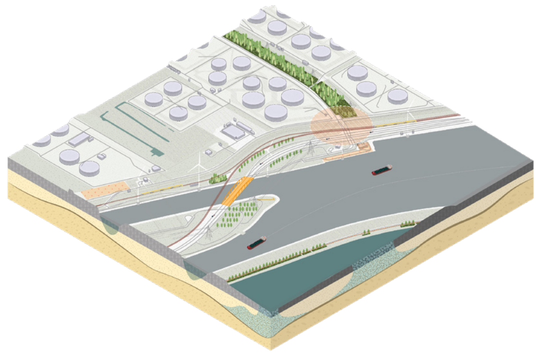


- **Dune Recreational System**

Accessibility
◆◆◆◇◇

Carrying Capacity
◆◆◇◇◇

Nature Contact
◆◆◆◆◆



- **Port Recreational System**

Accessibility
◆◇◇◇◇

Carrying Capacity
◆◆◆◇◇

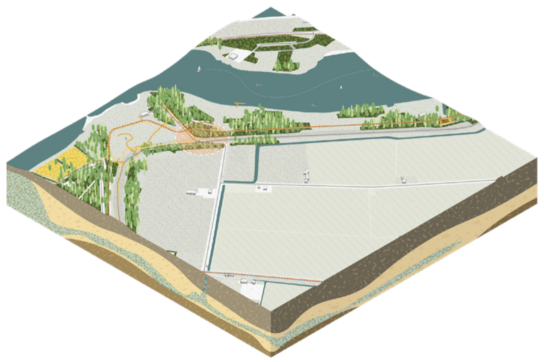
Nature Contact
◆◇◇◇◇

- **Urban Recreational System**

Accessibility
◆◆◆◆◇

Carrying Capacity
◆◆◆◆◇

Nature Contact
◆◆◇◇◇



- **Field Recreational System**

Accessibility
◆◆◇◇◇

Carrying Capacity
◆◆◆◆◇

Nature Contact
◆◆◆◇◇

Brielse Meer is a 10-kilometer-long lake, it offers a wide range of recreational activities, including sailing, windsurfing, swimming, stand-up paddleboarding, and fishing. The lake is surrounded by cycling and hiking trails, marinas, beaches, and picnic areas, making it an ideal destination for outdoor enthusiasts and families alike

Photo by Author

The Port of Rotterdam, also offers limited recreational that reflect its dynamic maritime heritage and innovative spirit, RIB speedboat tours and amphibious bus rides, Nature enthusiasts can explore the Landtong Rozenburg

Photo by Author

RECREATIONAL LANDSCAPE INFRASTRUCTURE

Maps of Recreational landscape infrastructure

Graphic by Author
Data from Zuid-Holland GIS Portal

Soical Green landscape infrastructure

- Forest
- Scrub
- Farmland/house
- Urban Green Edge
- Out Door Sport
- Camping
- Hiking Route
- Cycling Route
- Tree Line

Transportation landscape infrastructure

- Railway
- Primary Road
- Secondary Road
- OV Route
- Train Station
- Parking

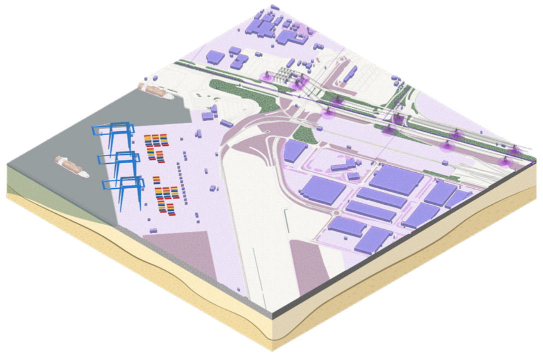
PRODUCTIVE LANDSCAPE INFRASTRUCTURE

For productive landscape infrastructure reflects the spatial overlap and interaction between industrial and agricultural production systems within the landscape.

In terms of productive green landscape infrastructure, the focus lies on agricultural production areas. Voorne Island is primarily characterized by traditional agricultural practices, with key landscape elements including clay/peat polder and small-scale farmhouses. These agricultural features dominate much of the island's open space. Beyond their role in producing crops and vegetables, they also contribute to ecological functions—particularly in peat areas—such as water retention, biodiversity support, and landscape aesthetics. The material flows within the agricultural system center on freshwater irrigation that flushes salt from the ditches, nutrient inputs, and the logistics of agricultural outputs, all of which depend on a close coupling with the surrounding ecosystems and soil conditions.

The industrial landscape infrastructure is anchored by the Port of Rotterdam, one of the world's leading hubs for energy and logistics. Its infrastructure includes docks, high-pressure corridors, underground pipelines, factories, storage tanks, and rail transport lines. These elements reflect a high-density, high-intensity use of land. Their role in the flow of goods, energy distribution, and economic activity is vital. Material flows here are defined by the import and export of bulk commodities, energy transmission, and the handling of industrial byproducts.

The two systems are interconnected and mutually supportive through transportation networks, hydraulic infrastructure, and energy corridors. This integrated and intensive organization of productive landscapes illustrates a synergy of space and function, and highlights a landscape form driven by both functional performance and social utility.

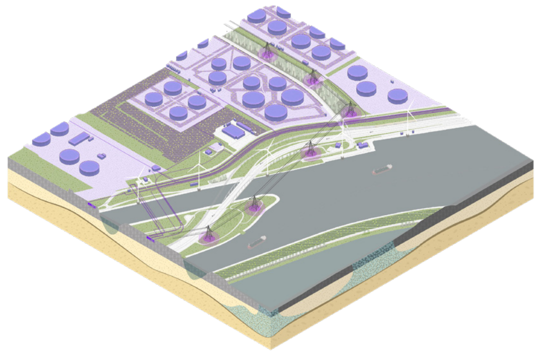


• Expanding Port System

Production Intensity
▲▲▲△△

Resource Consumption
▲▲▲▲△

Emissions
▲▲▲△△



• Developed Port System

Production Intensity
▲▲▲▲▲

Resource Consumption
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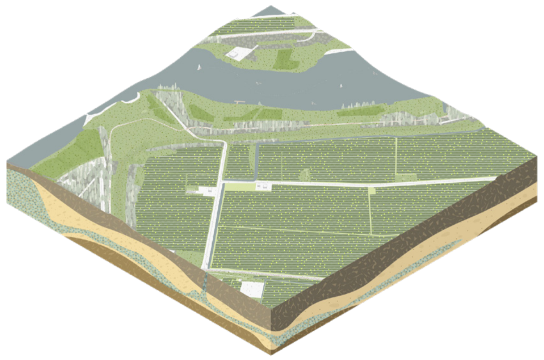

• Clay Polder System

Production Intensity
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Resource Consumption
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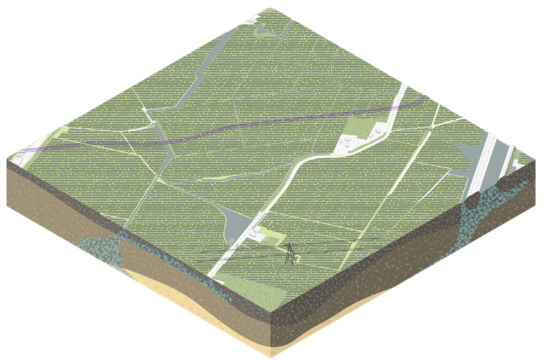

• Peat Polder System

Production Intensity
▲▲▲△△

Resource Consumption
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Emissions
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High-voltage transmission towers and their surrounding spaces form critical corridors of industrial infrastructure. These corridors are often underutilized and lack active management, typically consisting of unmanaged wild vegetation or informal walking trails. Despite their current state, they hold significant potential for development and multifunctional use

Photo by Author

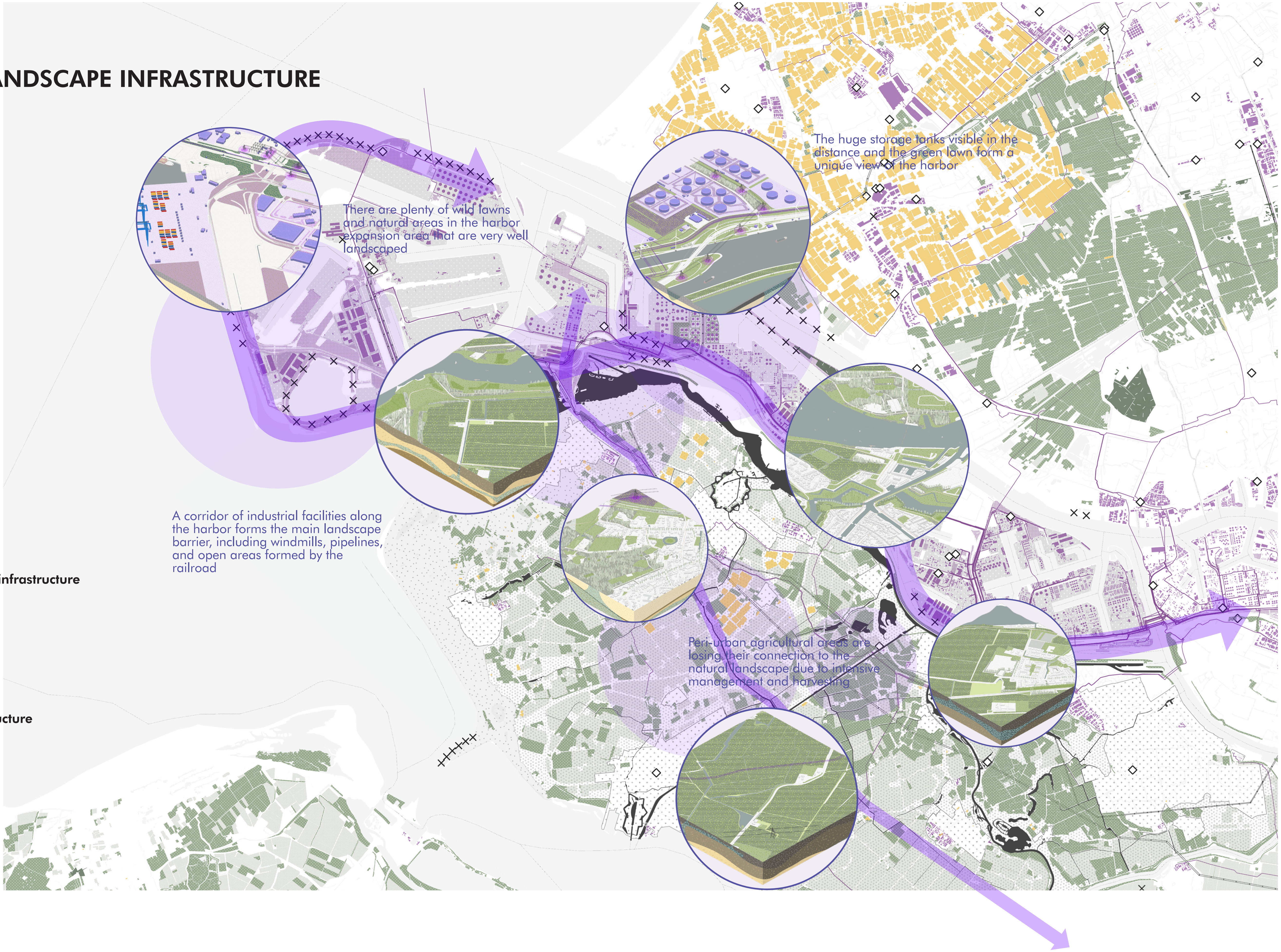
Agricultural production is generally seasonal and intensively managed, which leaves little room for ecological diversity. These highly controlled landscapes require substantial inputs of freshwater and fertilizers to sustain productivity, resulting in significant environmental impacts

Photo from Google map

PRODUCTIVE LANDSCAPE INFRASTRUCTURE

Maps of Productive
landscape infrastructure

Graphic by Author
Data from Zuid-Holland
GIS Portal/Port Authorities



Productive Green landscape infrastructure

- Dry Field
- Wet Field
- Natur Production
- Green House

Industrial landscape infrastructure

- Port Open Space
- Powerline and Tower
- Facilities
- Wind Mill
- Power Station
- Underground Pipe
- Shipping Route

This ecological connection map shows that the NNN network (green dotted area) is narrowed fast from south to north of the island. Nearly lost connection in port area

Map by Author/Data from Zuid Holland GIS Portal

The northern part of Voorne-Putten and its port area displays a diverse range of ecosystems, each shaped by natural processes and human interventions. Key landscape components include coastal dunes and forests, delta mudflats and salt marshes, artificial dikes, industrial green spaces, agricultural land, and urban green areas, all contributing to the region's ecological and spatial complexity.

Coastal dunes and forests dominate the northern coastline and estuarine zones, forming dynamic landscapes influenced by tidal fluctuations and saline conditions. These areas host a mosaic of mudflats, salt marshes, and intertidal habitats, providing essential breeding and foraging grounds for various bird and aquatic species. The delta ecosystem, historically shaped by the natural hydrodynamics of the Rhine-Meuse River, has undergone significant degradation due to port expansion and the construction of the Nieuwe Waterweg, disrupting the original tidal flows and sedimentation patterns.

Artificial dike green spaces, mostly located along the port infrastructure, serve as buffers against coastal erosion and flooding but generally hold limited ecological value. Industrial green spaces, though fragmented and sparse, function as ecological stepping stones, playing a minor role in habitat restoration and environmental compensation efforts. Agricultural land extends across the inland areas, where intensive cultivation limits ecological corridors, confining biodiversity to scattered grasslands and ditches. Meanwhile, urban green spaces, concentrated around towns, offer recreational and ecological benefits, supporting habitat diversity in an otherwise built-up environment.

From a landscape ecological perspective, the northern Voorne-Putten and its port area face increasing ecological fragmentation due to ongoing urbanization and industrialization. The loss of natural connectivity has led to a decline in biodiversity, yet the region still retains key ecological functions that can be strengthened through strategic planning. Future efforts should prioritize enhancing ecological linkages, restoring degraded habitats, and reinforcing tidal ecosystems, particularly in the interface between the port and surrounding landscapes.

FRAGMENTATION-ECOLOGICAL CONNECTION

People trying to make compensation to the ecological connection in port area by building those pond under power lines for amphibians like toads

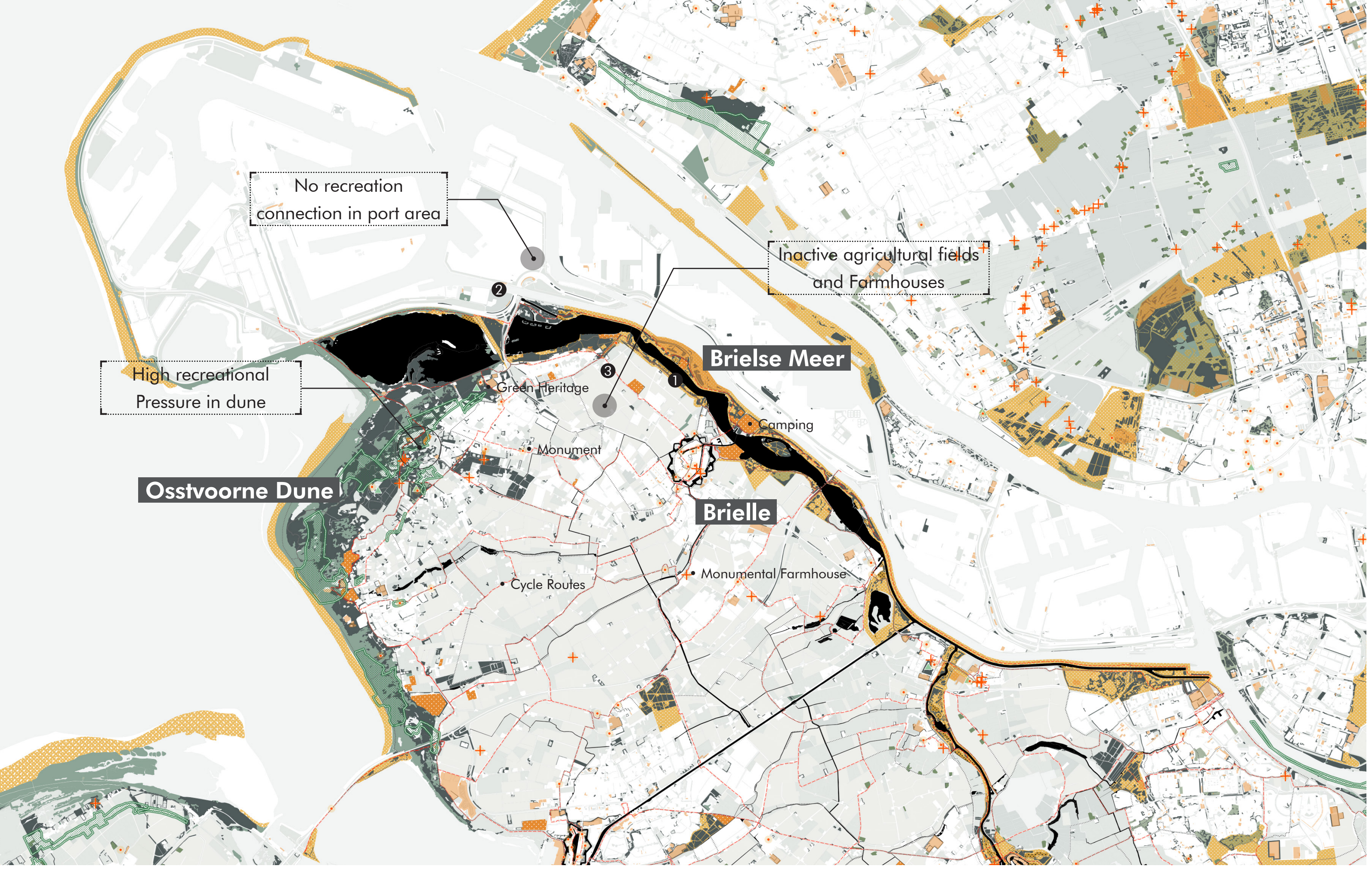
Photo from Portmaps Arcgis

Geuzenbos-The small forest are managed by students in 1987 with nearly 600 Populus, and nowadays are still will functioning as ecological buffers alone highways

Photo from Portmaps Arcgis

Dry field close to Ossterlandseweg showing those land mainly for vegetable production need intensive management and lack of landscape diversity

Photo from Google Map



This recreational connection map shows that the Provincial Recreation Area (Yellow hatched area) is limited within Voorne Dune and Brielse Lake Belt. Nearly lost connection in port area

Map by Author/Data from Zuid Holland GIS Portal

The island features a variety of landscape recreation and experience system, including golf courses, open-air RV camping sites, and water sports centers catering to sailing, kayaking, and other aquatic activities. Most of these facilities are well-maintained, and confronted within the Brielse Lake Belt which enriching the recreational life of local residents.

For nature-based experiences, the northern lakeside forests and dune ecosystems offer excellent opportunities for birdwatching, hiking, and ecological photography. These areas, characterized by rich biodiversity, are equipped with viewing platforms and designated route, enhancing visitors' interaction with nature. However, the port's industrial zones nearly have no recreational spaces, making it difficult for people to develop a sense of belonging or connection to these areas. Most people just go to port area for work and never consider there as part of living landscape. This absence of leisure functions also affects the overall landscape quality and ecological environment.

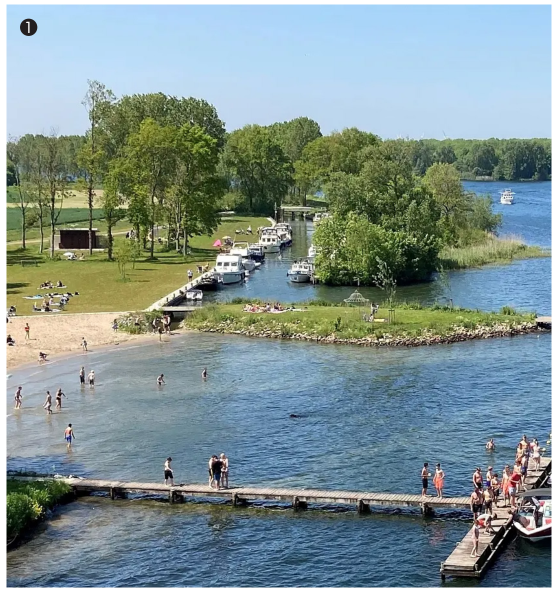
The state of the agricultural landscape is also less promising. The northern part of the island retains large expanses of farmland primarily dedicated to cereal crops, vegetables, and horticulture. However, due to the intensive agricultural production, these areas have limited integration with surrounding recreational landscapes. Additionally, as port expansion, urban growth, and environmental conservation efforts gain priority, some farmland has been reduced, impacting landscape continuity and farmers' interests. Local famers would like to see more about how agriculture space can be taken into account in future plan.

A well-developed slow mobility network weaves through these recreational spaces, linking key natural attractions, historical monuments, and city centers. This network of pedestrian and cycling paths provides a safe and comfortable environment for non-motorized travel, although certain sections are disrupted by industrial zones and major transport corridors. Despite these interruptions, the system enhances accessibility and encourages sustainable exploration of the island's diverse landscapes.

FRAGMENTATION-ECOLOGICAL CONNECTION

Naaktstrand Brielse Meer - The water flows through the area for roughly ten kilometres, and on both shores you'll find grassy banks, marinas, freely accessible moorings, beaches, a naturist area, campsites and bars and restaurants

Photo from Beleefbrielle.nl



Transferium Maasvlakte - Commuters particularly benefit from this public transport hub in which various transport flows. It also offers a panoramic view across the water and industry, where storage tanks, cargo handling and storage of bulk goods and containers as well as a power plant dominate the landscape

Photo from Google Map

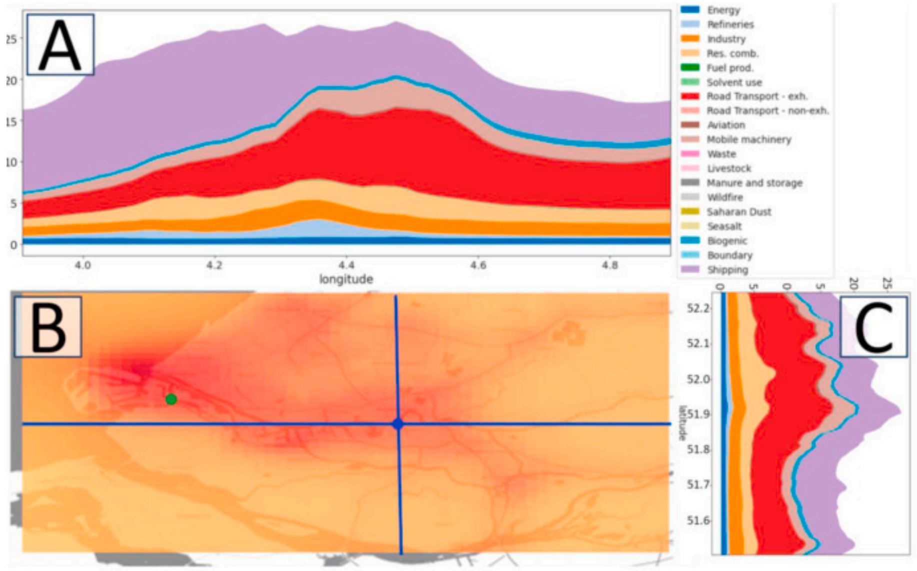
RV Camping site in north field, close to Bollaarsdijk showing those open space can be placed more recreational activities and can also bring profit for land owners

Photo from Google Map

URBAN EXPANSION-CONTAMINATION

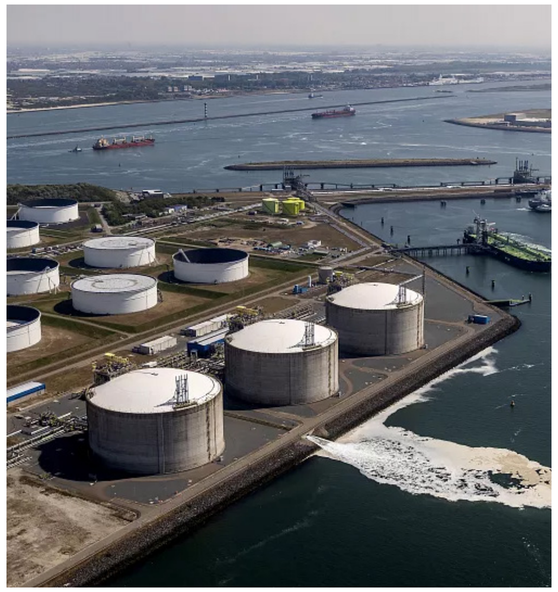
The simulated annual average surface concentration of NO2 around the port of Rotterdam is shown in diagram. It can be seen that the emissions from shipping remains significant (24%).

Diagram from J.P. Tokaya



The port authorities have made a lot efferts to collect and reduce the contamination from the root, however, the real big issue is seeking for a new way of producing and supplying energy

Luchtfoto van de lng-terminal op de Maasvlakte.ANP



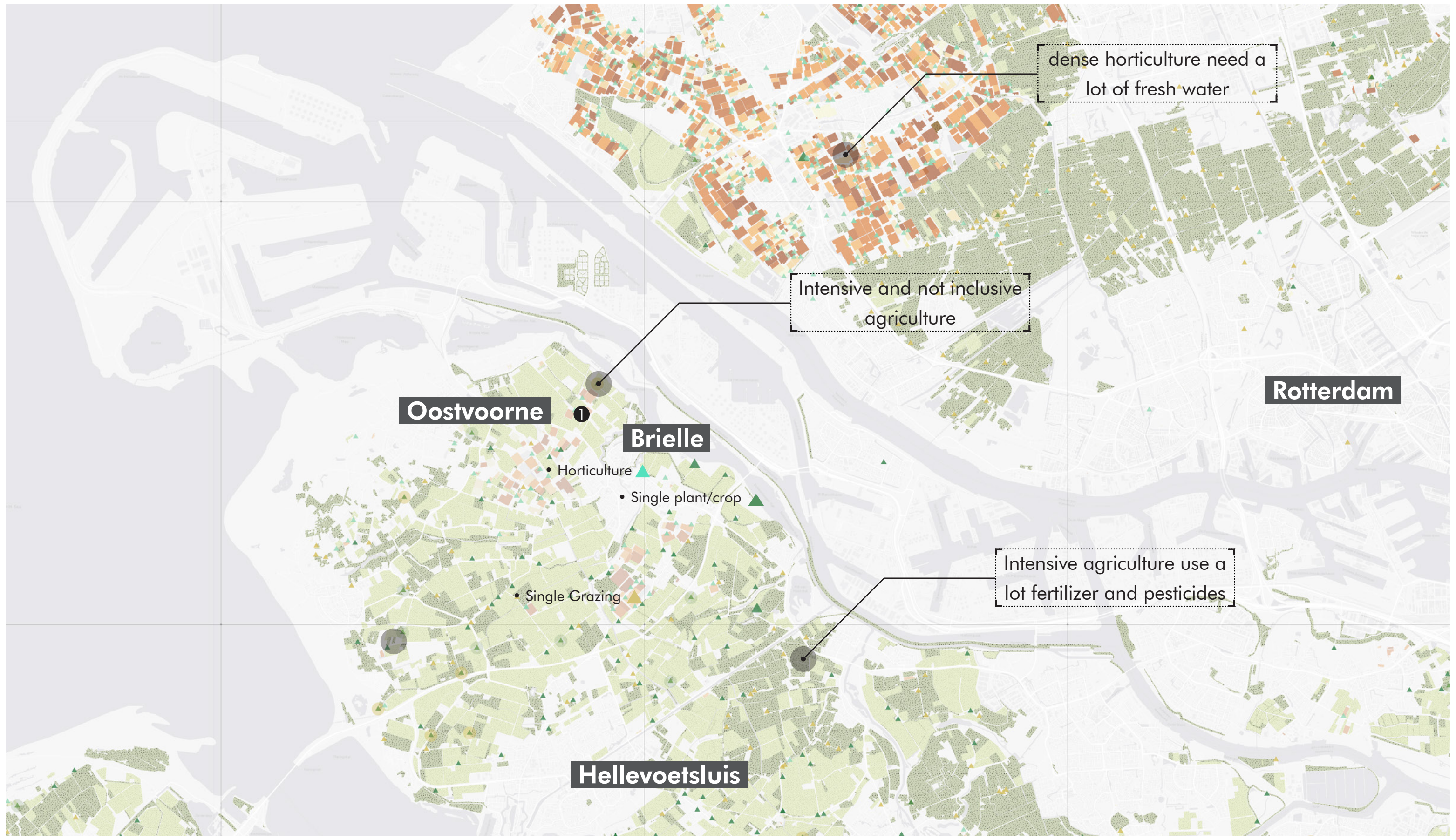
Soil and groundwater contamination in the Rotterdam port area primarily comes from long-term industrial activity, particularly within the petrochemical sector. Key pollutants include benzene, naphthalene, chlorinated hydrocarbons (such as PCE and TCE), and volatile organic compounds (VOCs), which have formed persistent contaminant plumes in the groundwater.

Model projections indicate that by 2035, approximately 11.5% of the primary aquifer will exceed intervention thresholds, with more severe contamination expected in the eastern port zones such as Pernis and Botlek. Furthermore, pollutants are migrating toward the third aquifer beyond the port boundaries, and by 2050, this spread is expected to affect around 10% of the port's perimeter area.

These pollution trends pose a significant threat to future groundwater quality and may compromise compliance with the EU Water Framework Directive. Although natural attenuation and pump-and-treat strategies have been implemented, effective remediation remains challenging due to complex geological conditions. Therefore, an integrated risk management approach is essential to contain pollutant migration and meet environmental objectives.

The orange and brown blocks are the green house built from 2000 to now and the darker ones are more built resently. the green hatches are agricultural fields (light green is dry field and dark green is wet field). From the density you can tell the agriculture is very intensive in these region, and most production way is every unsustainable

Map by Author/Data from Zuid Holland GIS Portal



High levels of toxic substances in water in the Netherlands, study reveals

Photo from iamexpat.nl

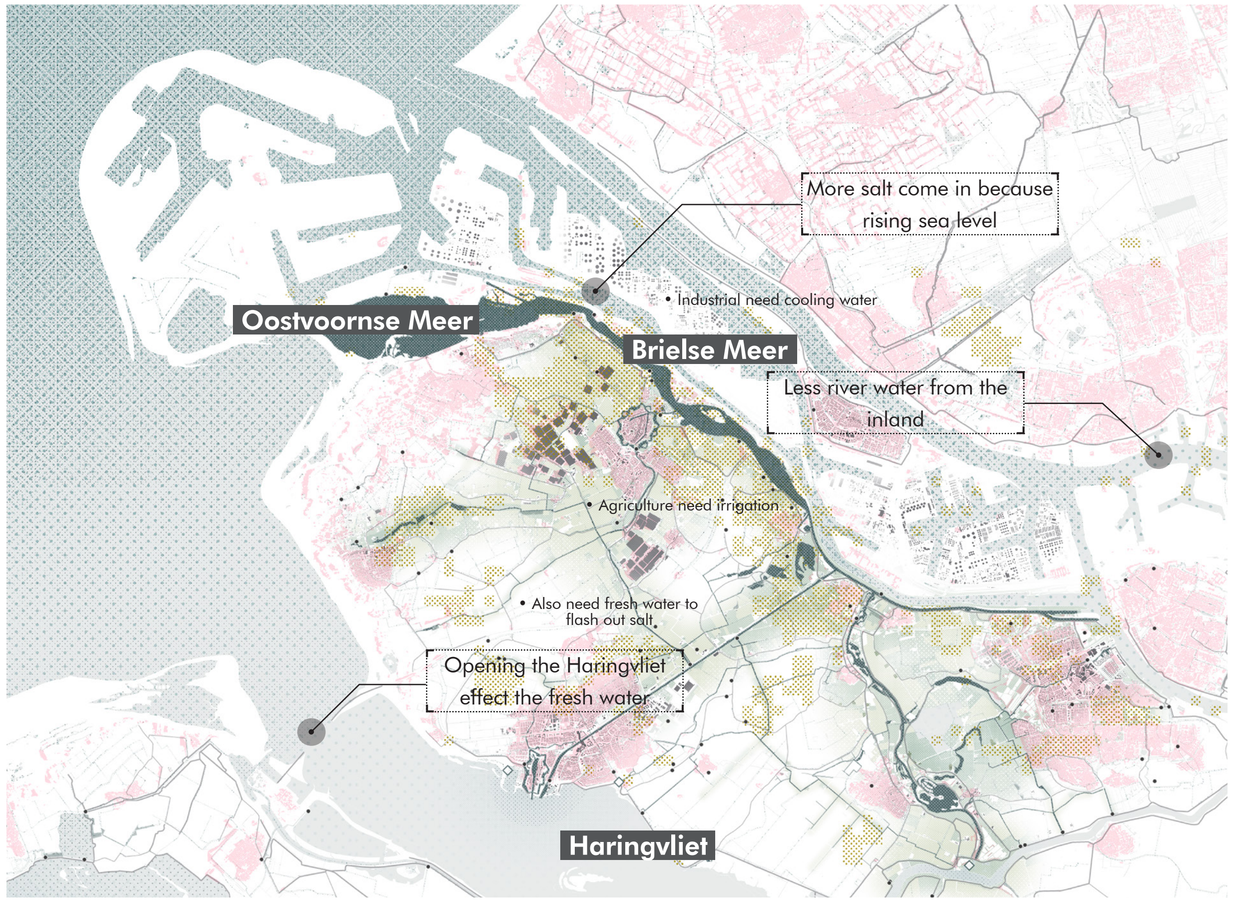
The islands of Voorne and Putten, located near the Port of Rotterdam, are facing severe water pollution issues due to intensive agricultural practices. Long-term application of chemical fertilizers and livestock manure has led to excessive nitrogen and phosphorus leaching into both groundwater and surface water.

In the sandy and loess regions of the Netherlands, nitrate concentrations in groundwater at more than half of the agricultural sites still exceed the EU threshold of 50 mg/L. Moreover, nutrient overload in surface waters has caused a decline in biodiversity, with 44% of water bodies failing to meet ecological quality standards.

These pollution issues not only pose risks to drinking water safety but also threaten the health of aquatic ecosystems. Despite policy interventions, water quality improvement has been slow, and future climate extremes such as droughts may further aggravate the problem.

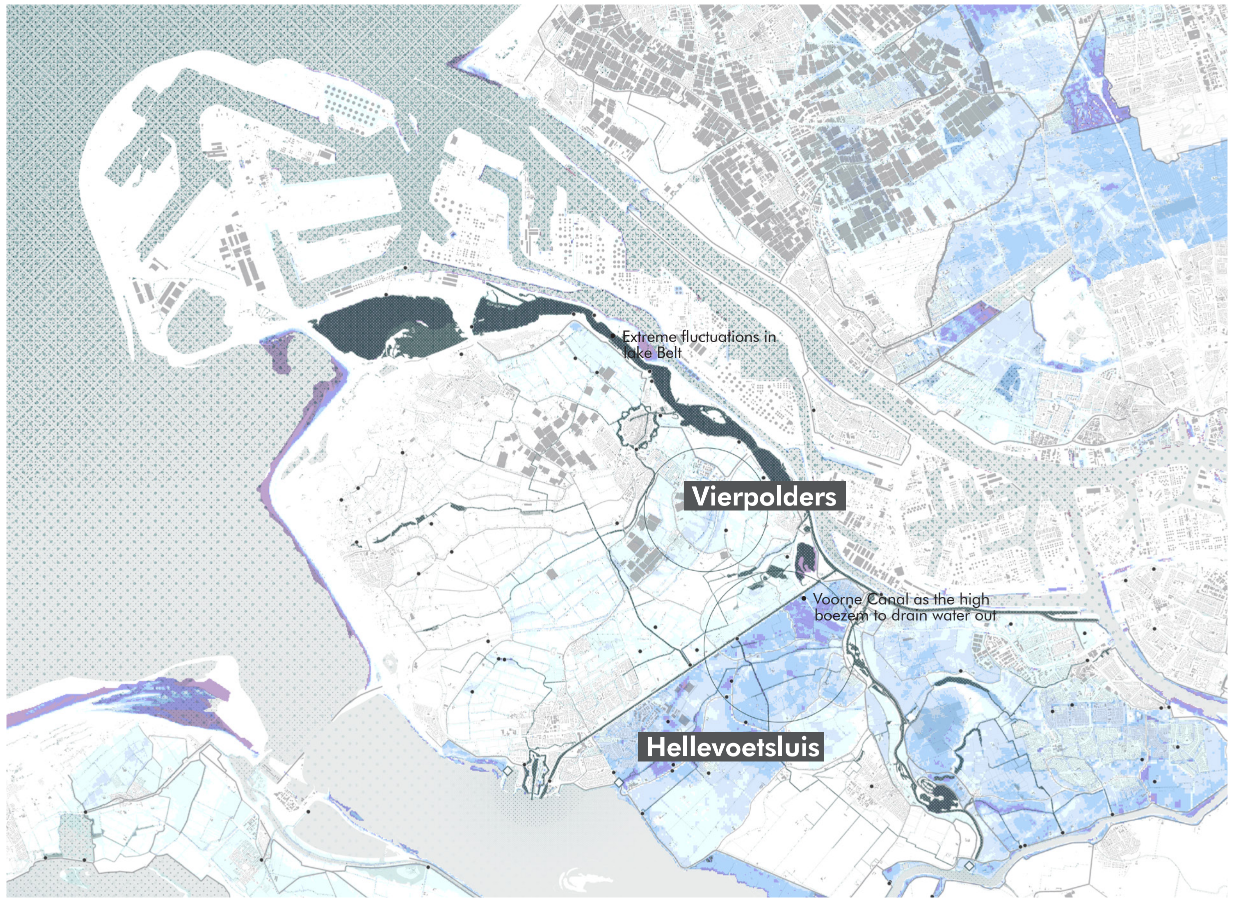
This scenario map shows the relations of over heat in 2022(red hatches) and the salt intrusion area(yellow dot hatches), those most serious area are just located on the most important water resources of this region

Map by Author/Data from klimaateffectatlas.nl



This scenario map shows the relations between too much water and the rising sea level,the dark blue area is the flood risky areas which are mostly alone the high boezem of the island

Map by Author/Data from klimaateffectatlas.nl



CLIMATE CHANGE-EXTREME WATER CONDITION

Climate change is increasingly impacting the operational efficiency of the Port of Rotterdam and the sustainability of surrounding agricultural areas.

Firstly, extreme heat and long drought are causing a significant reduction in freshwater availability. In 2022, for instance, the Rhine River's discharge dropped to just 663 cubic meters per second—one of the lowest recorded levels, far below the average of 1,500–2,000 m^3/s. This accelerate saltwater intrusion, putting critical freshwater resources such as the Brielse Meer at risk of salinization. The consequences are severe for both sectors: industrial cooling and cleaning operations at the port are compromised, while irrigation systems on nearby islands like Voorne and Putten face serious challenges, resulting in crop yield reductions, soil degradation, and decreased agricultural productivity.

On the other hand, climate models predict that by 2050, extreme rainfall events will occur five times more frequently. These intense, short-duration downpours will place tremendous pressure on the drainage infrastructure of the port and surrounding urban areas. Many low-lying parts of Rotterdam have already experienced frequent pluvial flooding, and future scenarios may include transport disruptions, damaged logistics and storage facilities, and even port shutdowns. Additionally, excess runoff can mobilize surface pollutants, further threatening water quality and ecosystem health.

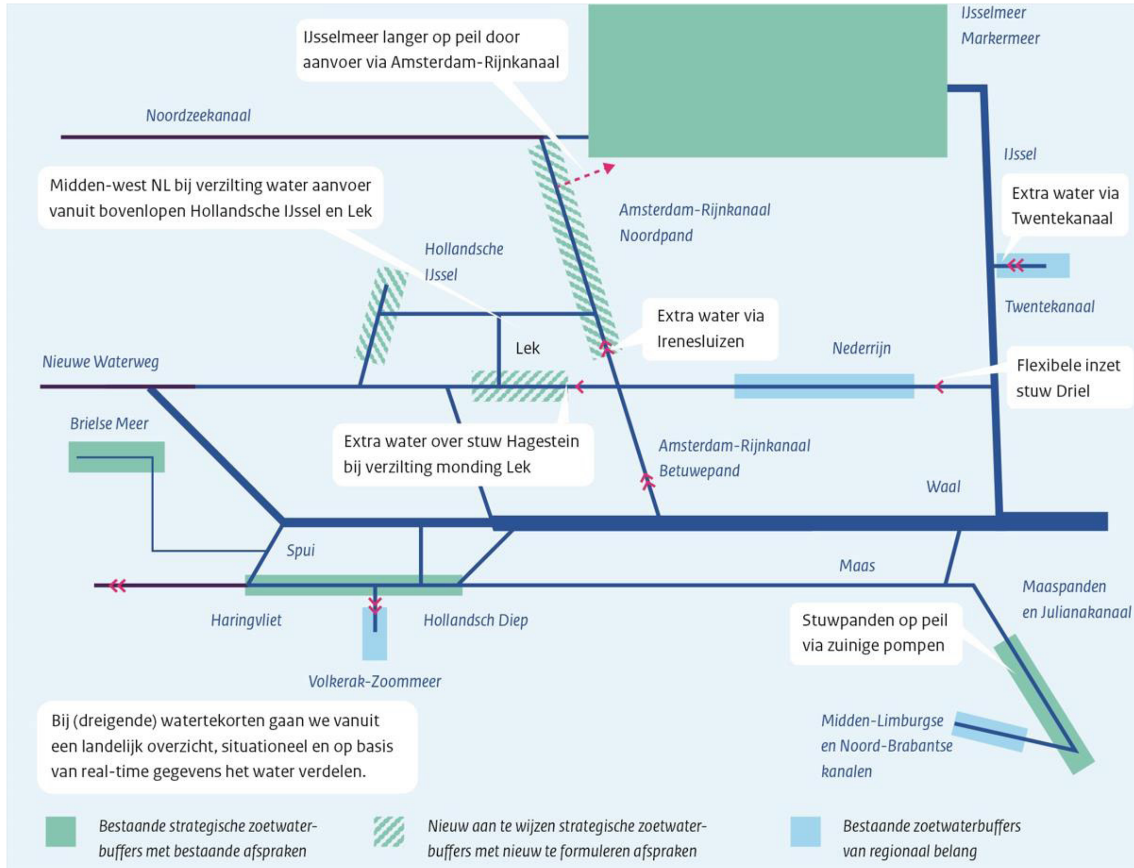
This dual pressure is significantly undermining the ecological resilience and productive stability of the Rotterdam urban delta, signaling the emergence of increasingly complex climate adaptation challenges.

When the water in shipping course is too low because of extreme heat then more water is needed from the lake belt to insure the water level

Photo from iStock

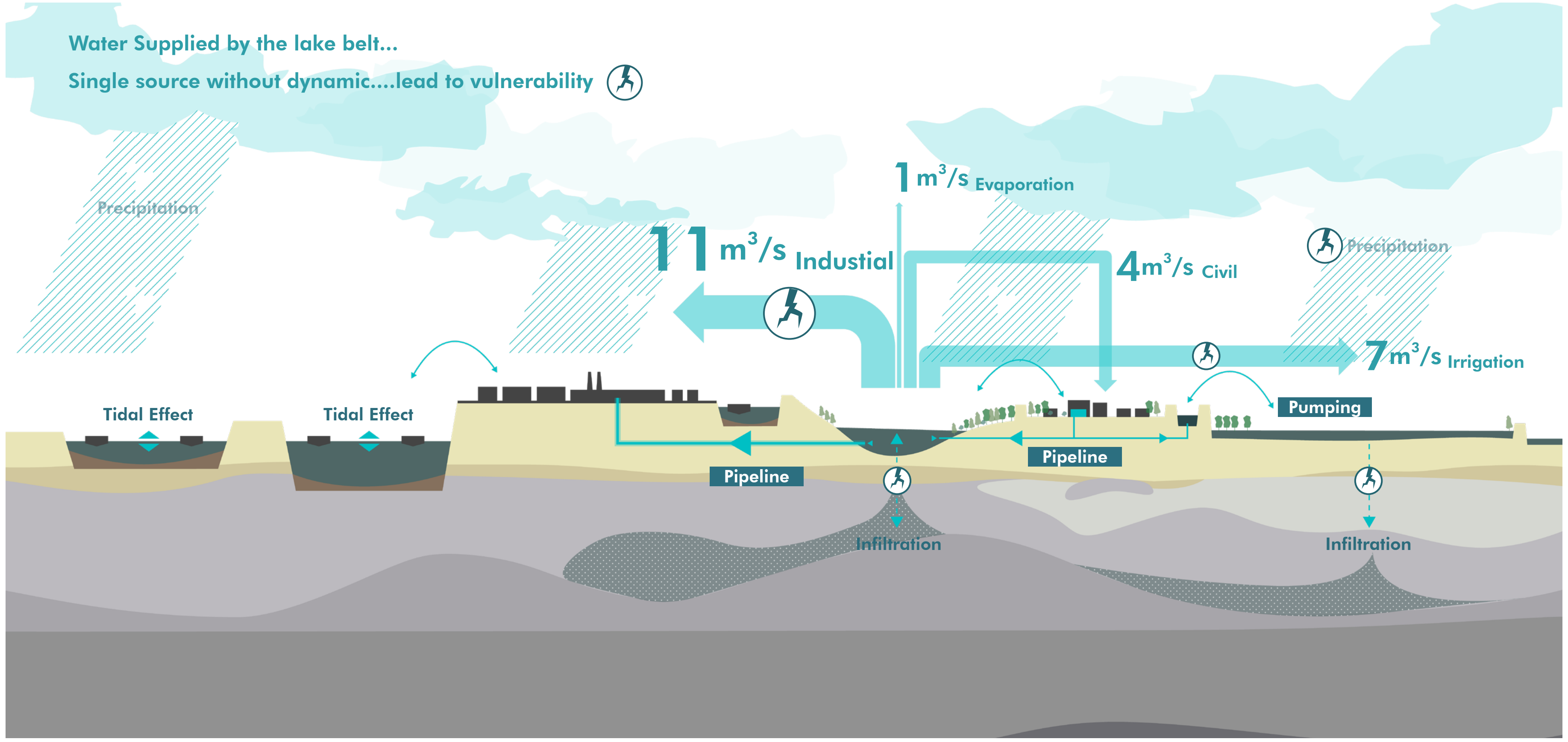
URBAN EXPANSION/CLIMATE CHANGE-WATER SHORTAGE

The first diagram shows how the Dutch national water system responds to droughts and water shortages by transferring freshwater across regions. For example, water is supplied from the IJsselmeer and Twentekanaal through the Amsterdam-Rhine Canal to support the mid-western areas, including the Rotterdam port and Voorne region. These areas are low-lying and influenced by tidal rivers such as the Nieuwe Waterweg and Spui, making them highly vulnerable to saltwater intrusion, especially as sea levels rise and river discharges decrease due to climate change. Measures like extra flow over the Hagestein weir and flexible use of Driel weir are used to keep salt out. However, this system depends heavily on real-time monitoring, complex infrastructure, and coordination between regions. When water shortages occur at a national scale—such as low flow in the Rhine—this approach becomes fragile and may fail to guarantee freshwater security in vulnerable coastal areas.



Schematic representation of the Climate-proof freshwater supply strategy for the main water system

Diagram from Delta Programme 2021



Water supply relationship of Lake belt

Graphic by author
Data Source: Zuid-Holland GIS Portal, Waterschap Hollandes Delta

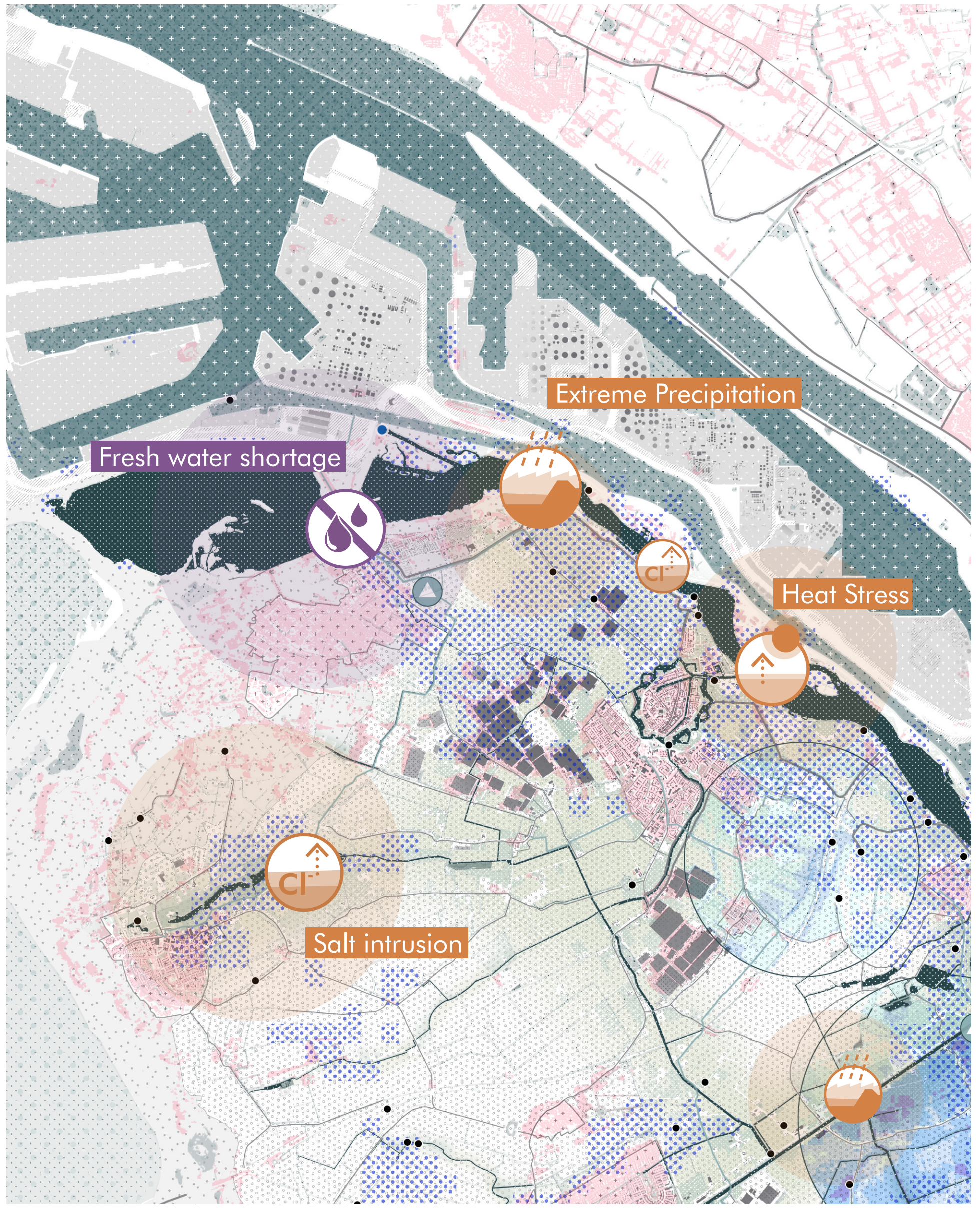
The second diagram explains how the local water supply in the Voorne and Rotterdam area relies mainly on a single source: the surrounding lake belt. Water is delivered through pipelines for industrial (11 m^3/s), agricultural (7 m^3/s), and civil (4 m^3/s) use. However, this single-source setup lacks flexibility. If lake levels drop due to drought or climate impacts, or if any part of the system fails, the whole region could face serious water shortages. At the same time, high industrial demand and limited natural recharge—combined with increasing evaporation—add pressure on the system. There are no clear signs of water recycling or diversified sources, which increases vulnerability. Without changes, this setup will not be able to cope with future climate risks or growing water needs.

CHALLENGE MAP-ON LANDSCAPE INFRASTRUCTURE SYSTEM

FRAGMENTATION/URBAN EXPANSION/CLIMATE CHANGE

By overlaying the problem field identified in Chapter 01—FRAGMENTATION, URBAN EXPANSION, AND CLIMATE CHANGE—with the LANDSCAPE INFRASTRUCTURE SYSTEM, it becomes easier to identify which specific areas in the region are most affected by these challenges. Through spatial mapping, we can reveal critical ecological breakpoints, urban edge zones, and climate-sensitive areas such as lake regions and peat-agricultural zones. This analysis also helps to pinpoint where integrated landscape interventions are most needed—particularly in areas related to industrial and agricultural production processes—providing a strong foundation for defining design priorities and strategies.

WATER LANDSCAPE INFRASTRUCTURE

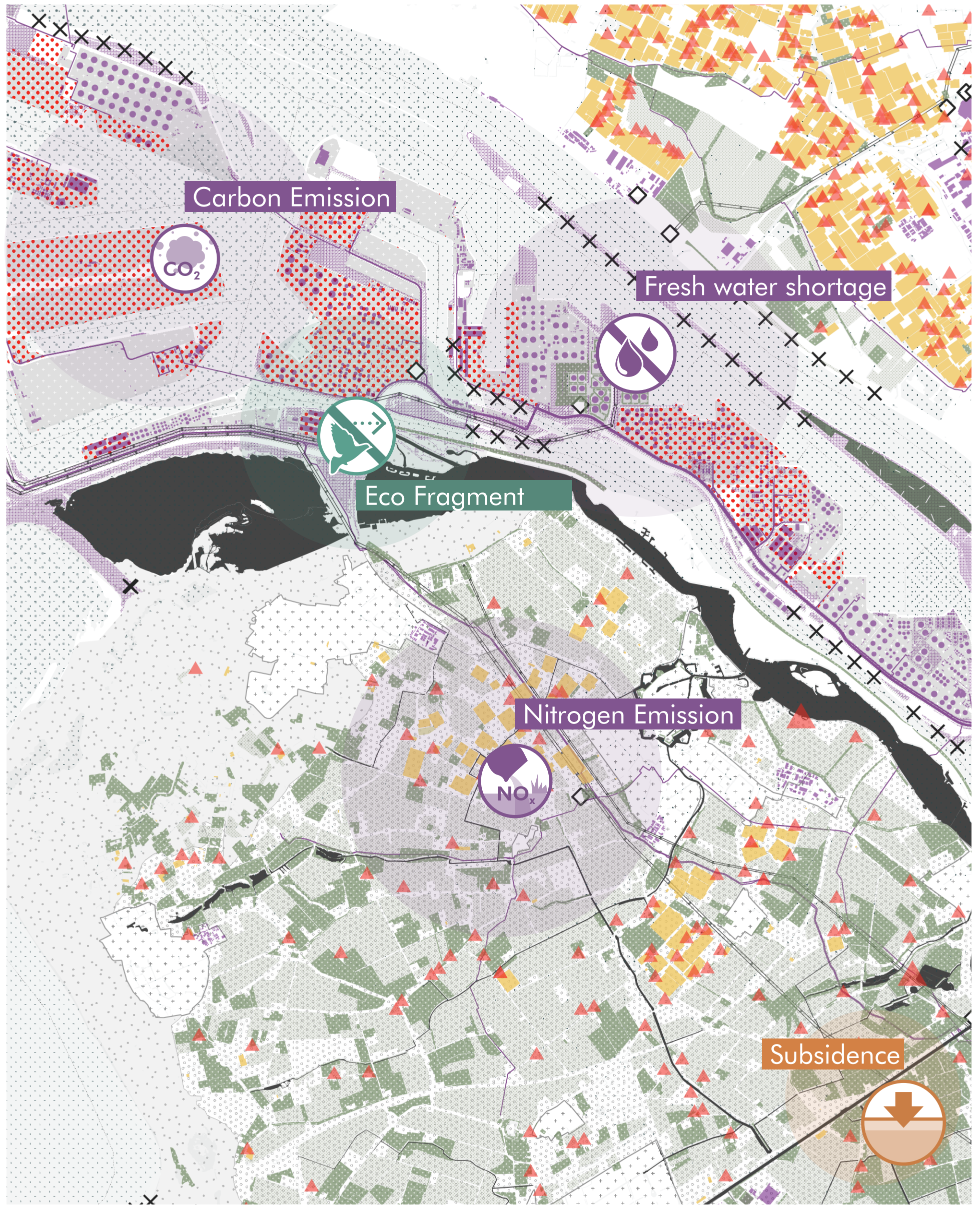


MORE WATER DYNAMIC

RECREATIONAL LANDSCAPE INFRASTRUCTURE

MORE CONNECTED LANDSCAPE

PRODUCTIVE LANDSCAPE INFRASTRUCTURE



MORE NATURAL INCLUSIVE/SUSTAINABLE

SUMMARY OF CHALLENGES

- Understanding/Problem

-What are the key spatial, ecological and functional characteristics of the regional landscape system, **as well as the challenges** and opportunities for designing a connecting green-blue infrastructure ?

Based on the current research, the transitional landscape between Voorne and the Rotterdam Port shows several key spatial, ecological, and functional characteristics, while also facing a range of challenges in designing a coherent green-blue infrastructure system.

Spatially, the area contains a diverse mix of topographys and land uses, including lakes, canals, wetlands, agricultural fields, industrial zones, and expanding urban edges. Water bodies and green spaces are scattered and lack spatial continuity, resulting in a highly fragmented landscape. Urban expansion and industrial infrastructure are steadily encroaching on open spaces, further threatening spatial cohesion.

Ecologically, the region originally supported high biodiversity and strong hydrological regulation. The lake areas, wetlands, and surrounding dunes formed a complex ecological system. However, due to agricultural intensification and port-related industrial development, ecological corridors have weakened, habitats have become increasingly fragmented, and overall ecological connectivity has declined. In addition, peat soil areas are facing serious degradation and carbon emissions caused by fluctuating water levels, while climate change is intensifying pressures from extreme rainfall and droughts.

Functionally, the landscape supports multiple roles, including agricultural production, water regulation, wildlife habitat, and recreational and cultural uses. However, these functions often come into conflict. For example, freshwater for agriculture is increasingly scarce; intensive recreational use of the dunes competes with ecological conservation; and industrial development continues to challenge efforts to protect natural systems.

The main challenges in building a connected green-blue infrastructure include:

- Lack of spatial connectivity: Natural patches are poorly connected, making it difficult to support species migration and continuous ecological processes.
- High complexity in functional integration: The competing demands of agriculture, urban development, and nature make it difficult to coordinate land use and manage shared resources like water effectively.
- Low climate adaptation capacity: Existing infrastructure is insufficient to handle extreme weather events, shifting water levels, and soil salinization. There is a lack of nature-based solutions to address these issues.
- Complex governance structure: The area involves multiple stakeholders across different administrative and functional zones, which complicates integrated planning and implementation of green-blue systems.

Therefore, the design of green-blue infrastructure must not only respond to the region's spatial and ecological structure but also develop systemic strategies that integrate multiple functions, resolve conflicts across scales, and enhance the landscape's long-term resilience in the face of future uncertainty.

CHAPTER 05-POTENTIAL OF TRANSFORMATION

Potentials and Inspirations

Potentials and Inspirations

- What is the chance/motivation to make the next step?
- What is the potential and value of landscape in systematic transformation?
- Experience and perspectives for cases and professional fields.

IN LONG TERN, SYSTEMATIC CHANGE IN LANDSCAPE IS INEVITABLE

The documents PortVision Rotterdam and Samenwerken aan de toekomst van het Rotterdamse havengebied clearly show that the energy and industrial (including agriculture and manufacturing) transition in and around the port is an inevitable trend. This urgency stems from several factors: first, the traditional fossil fuel-based operations are no longer sustainable in the face of global climate challenges. Second, both the EU and the Dutch government are actively promoting decarbonization and the circular economy, requiring ports to stay economically competitive while transitioning to greener systems. Additionally, outdated industrial and agricultural models are increasingly inefficient and polluting, pushing them toward smarter, more sustainable practices.

This transition has several key characteristics:

it is systemic—integrating changes across energy, logistics, agriculture, and industry;

regional—connecting the port with urban and rural networks;

and gradual—implemented through phased goals and experimental projects.

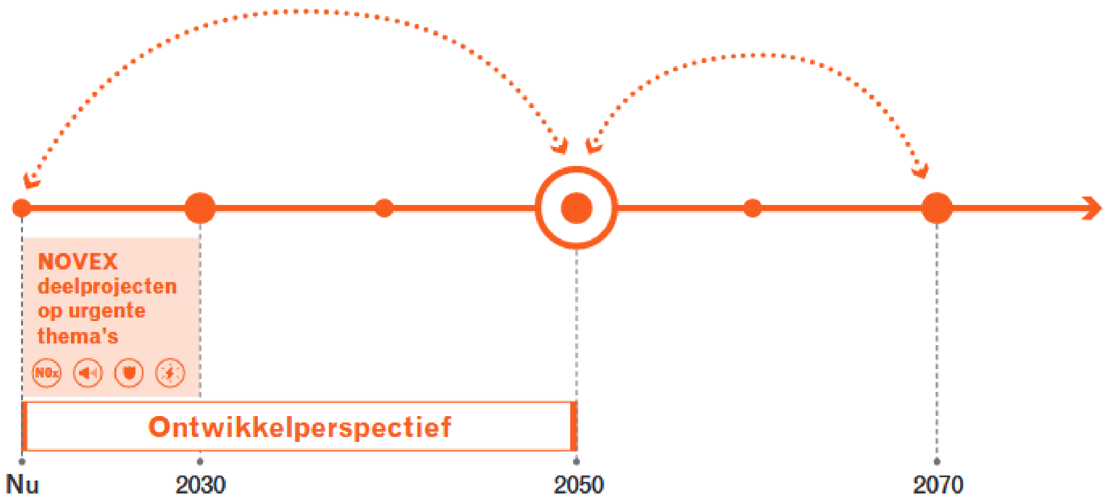
Landscape infrastructure holds great potential in this process. It can serve as a spatial platform to integrate functions such as ecological restoration, energy production, and cultural expression. Design also improves accessibility and public engagement, encouraging community participation and supporting a "technical–social–ecological" co-evolution. In this way, landscape becomes a bridge between the port and the city's future vision, shaping a more resilient and livable port landscape.

The diagram links the three main focus areas—economic transition, social transition, and regional attractiveness—with the Sustainable Development Goals, clearly outlining the priority actions and quantitative objectives for the future development of the Port of Rotterdam

Diagram by Port of Rotterdam

The diagram illustrates the development and transition pathway of the port and its surrounding area from now until 2050 (with a long-term outlook to 2100). It highlights that addressing urgent issues today—such as energy, climate, and spatial use—is a crucial starting point for achieving long-term spatial quality and the broader goal of "well-being for all," reflecting the systemic and forward-looking nature of the port's transformation

Diagram by Port of Rotterdam



LANDSCAPE INFRASTRUCTURE-
CASE STUDY IN REGIONAL LEVEL

Girona’s Shores
designed by EMF Landscape Architecture

“Girona’s Shore” is a long-term framework project led by EMF Landscape Architecture, aiming to transform the neglected urban edges and natural areas of Girona into a multifunctional green infrastructure network with ecological, social, and cultural value. Initiated in 2014, the project follows a “practice-first, plan-later” strategy, gradually expanding through low-cost, small-scale interventions. It covers around 600 hectares of open space, connecting 13 ecological loops and 30 “urban nature” parks, forming the city’s largest public green system. Through collaboration with municipal teams, community organizations, and volunteers, the project not only restores ecological spaces but also strengthens citizens’ sense of ownership and everyday engagement—blurring the boundary between nature and city in a dynamic and inclusive way.

From a landscape infrastructure perspective, “Girona’s Shore” demonstrates how strategic design can build ecologically functional and socially valuable green networks, even under limited resources. The project adopts a phased and modular approach, reducing initial investment risks while remaining adaptable to urban uncertainties. It goes beyond conventional design by integrating maintenance systems, public participation, and natural processes directly into its framework, resulting in infrastructure that is both resilient and site-specific. The landscape serves multiple purposes: flood mitigation, ecological restoration, recreation, education, and community use. This “low-cost, high-impact” model offers a valuable reference for cities facing climate change, urban expansion, and ecological fragmentation, providing a replicable and context-sensitive strategy for sustainable transformation.

maintenance workers selectively manage vegetation to balance ecological growth with public accessibility

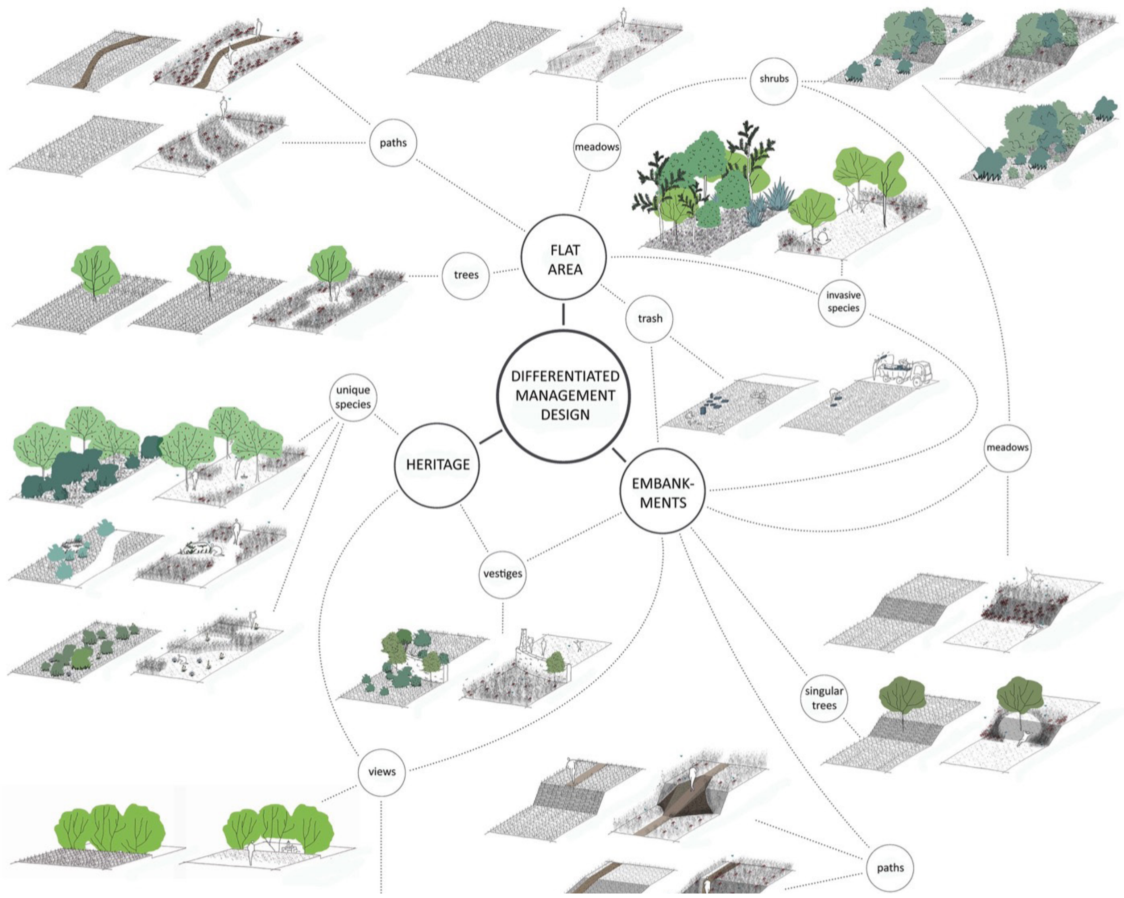
Photo by EMF Landscape Architecture

Green infrastruture
Girona's Shore

Diagram by EMF Landscape Architecture

This diagram, centered on "Differentiated Management Design," illustrates how flexible and diverse maintenance strategies are tailored to various terrains and ecological features to achieve the coexistence of ecological, cultural, and functional values

Diagram by EMF Landscape Architecture



LANDSCAPE INFRASTRUCTURE-
CASE STUDY IN REGIONAL LEVEL

Inpassing reconstructie A12 VEG
designed by H+N+S Landscape

In the A12 highway widening project (Veenendaal–Ede–Grijsoord section) in the Netherlands, H+N+S Landscape Architects, in collaboration with Heijmans, implemented an "ecological facilities integration" strategy. The aim was to enhance traffic flow while minimizing environmental fragmentation. The design treated infrastructure as part of the ecosystem, with a strong focus on supporting small species—particularly reptiles and insects—by improving habitat quality and connectivity. Measures included optimizing embankment structures, selective planting, ecological buffers, and seamless links with nearby heathland reserves. The result is a system of open and semi-open ecological corridors that facilitate species migration and strengthen genetic exchange. The project was developed with strong stakeholder involvement and long-term ecological management in mind, enhancing both biodiversity and public support.

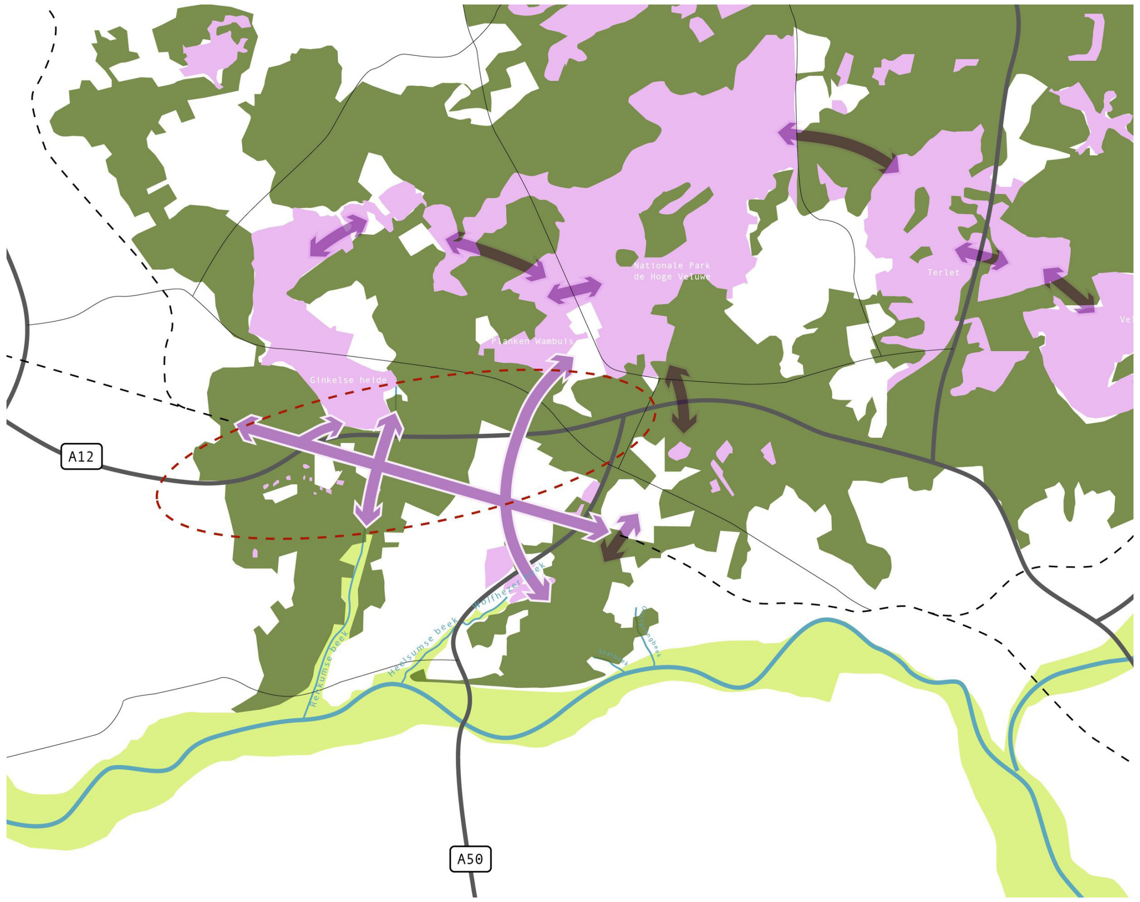
This project exemplifies how landscape infrastructure can successfully integrate ecological services with engineering functionality. By transforming highway edges and slopes into active ecological corridors, it reconnects fragmented landscapes and enhances spatial continuity. Ecological considerations were embedded from the early design stages, avoiding costly retrofits and increasing long-term resilience. The project also operates across scales—from detailed vegetation planning to regional ecological network integration—forming a comprehensive green infrastructure framework. Importantly, the collaboration among governments, contractors, conservation groups, and landowners ensured both the feasibility and sustainability of ecological goals. This case provides a practical and adaptable model for embedding ecological value into infrastructure design, especially in transitional zones between urban development and natural landscapes.

Green corridors and vegetated buffers are embedded into the road layout to support wildlife movement and landscape connectivity

Photo by H+N+S Landscape

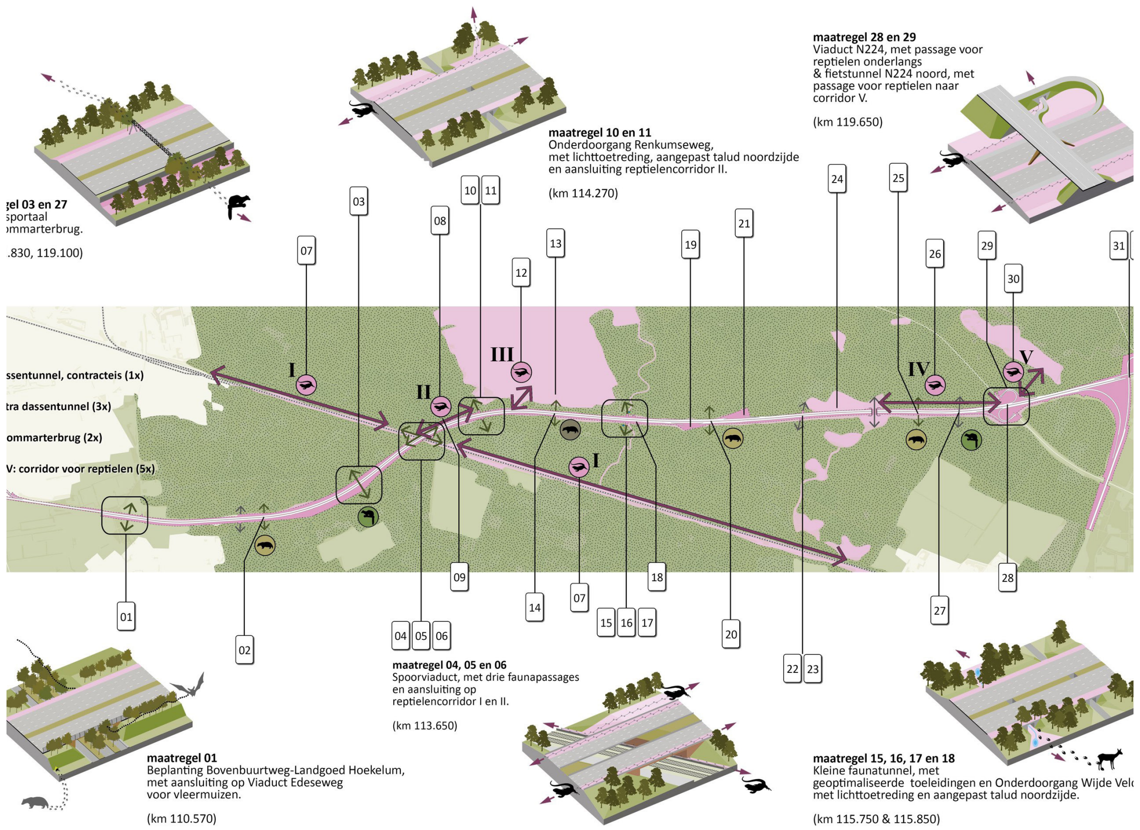
This plan illustrates the ecological connectivity strategy across the A12 highway, highlighting key habitat linkages and proposed corridors that integrate natural areas with infrastructure to support wildlife movement and landscape continuity

Plan by H+N+S Landscape



This diagram provides a detailed plan of ecological interventions along the A12 corridor, illustrating multiple wildlife crossings—including tunnels and bridges—for species such as badgers, pine martens, bats, and reptiles, forming an integrated ecological network across the highway

Diagram by H+N+S Landscape



LANDSCAPE INFRASTRUCTURE-
CASE STUDY IN ZOOM IN LEVEL

Zandweteringpark Deventer
designed by LOF Landschapsarchitecten

Zandweteringpark, located in the northern part of Deventer, the Netherlands, spans approximately 45 hectares and was designed by LOF landscape architects. The project is centered around the Zandwetering watercourse, where excavated earth was reshaped into a linear "terrain wall" that defines the spatial structure of the park. This terrain wall integrates an open-air amphitheater, grass slopes, and habitat zones. The lower-lying areas were designed as wetlands and water bodies for rainwater retention, purification, and ecological habitat creation. Three ponds function as "ecological stepping stones" to support species migration. An existing dam was converted into a fish ladder to enhance aquatic connectivity. The park includes over 7 kilometers of walking, cycling, and nature trails, connecting nearby cemeteries, residential neighborhoods, and open fields, offering a multifunctional and resilient urban green space.

Zandweteringpark exemplifies how urban-scale infrastructure spaces can be transformed into multifunctional landscapes integrating ecological, social, and cultural functions. One particularly valuable aspect is the design and utilization of the high-voltage power line corridor. Instead of treating it as a spatial limitation, the design team activated it through strategic vegetation planning, path systems, and embedded ecological functions—turning a typically neglected infrastructure zone into part of a continuous ecological and public space network. This approach enhances structural coherence in the city's green-blue infrastructure. By combining stormwater management, biodiversity support, and everyday recreation, the project embodies an "infrastructure-as-landscape" strategy, offering a replicable model for cities seeking climate resilience and ecological integration.

Water bodies and natural edges are designed to support both ecological functions and recreational activities, creating a safe and engaging environment for children and wildlife

Photo by LOF Landschapsarchitecten

The integration of topography, water management, and ecological zones within Zandweteringpark, showing how the terrain wall, wetlands, and pathways work together to create a multifunctional and resilient urban landscape

Plan by LOF Landschapsarchitecten

Zandweteringpark creatively utilizes the space beneath high-voltage power lines, transforming it into an accessible green corridor that combines ecological function with public use

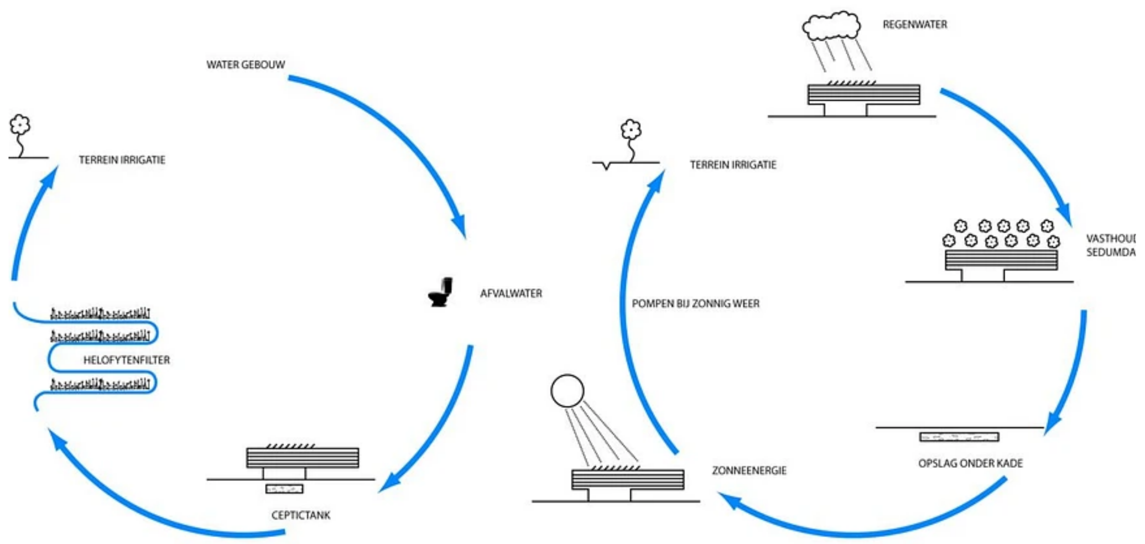
Photo by LOF Landschapsarchitecten

LANDSCAPE INFRASTRUCTURE- CASE STUDY IN ZOOM IN LEVEL

bedieningscentrum Steekterpoort
designed by Bureau B+B

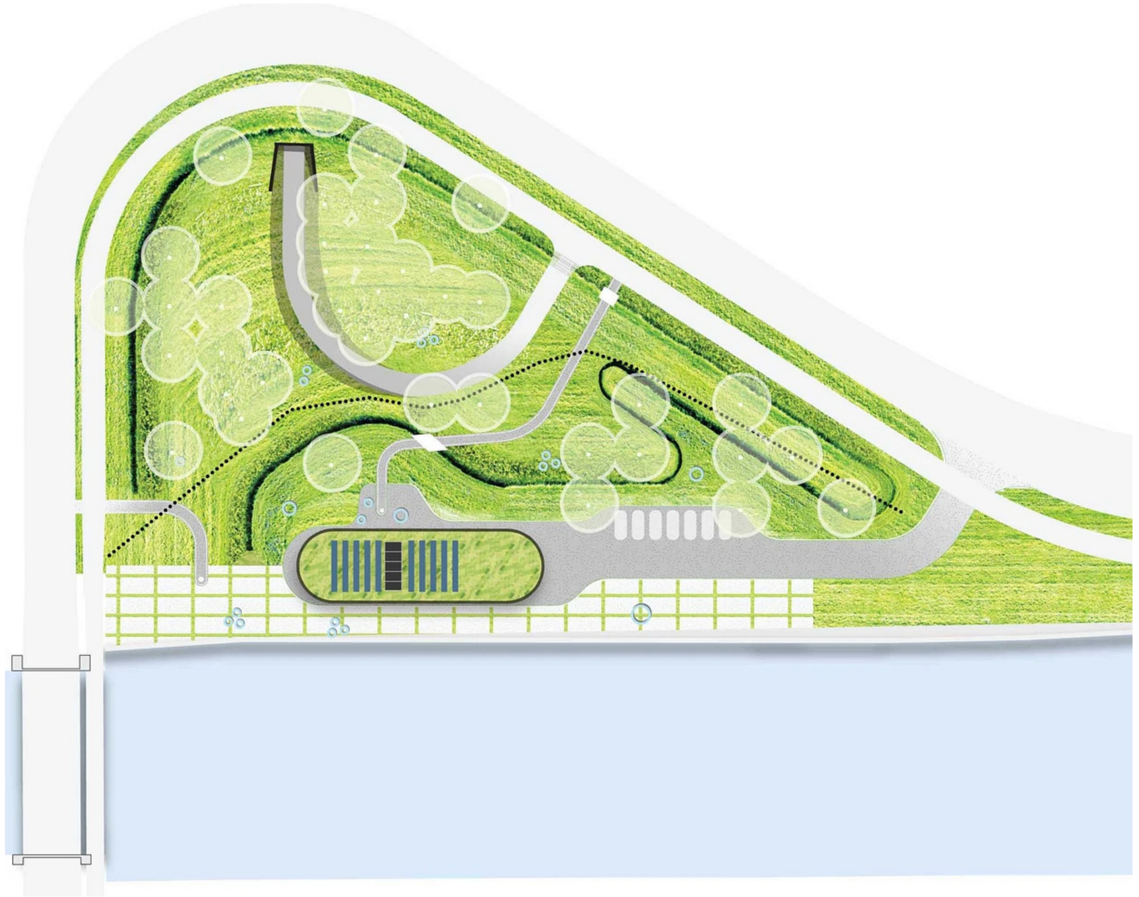
The Steekterpoort project is located in Alphen aan den Rijn, the Netherlands, and was designed by Bureau B+B in collaboration with architecture firm Blok Kats van Veen. Completed between 2011 and 2014, the project aimed to create the most sustainable bridge control center in the Netherlands. The design focuses not only on the sustainability of the building itself but also on integrating it harmoniously with the surrounding industrial landscape and natural environment. The site features a robust quay on the west side and a sloping grassland rich in herbaceous vegetation on the east. It incorporates rainwater collection and purification systems to support a diverse ecological setting. Natural seeding techniques were used to encourage the spontaneous growth of native plants, enhancing biodiversity and the seasonal dynamics of the landscape.

The Steekterpoort project offers a strong example of how green space design can be successfully integrated into industrial areas and around infrastructure-related office buildings. It demonstrates that even in highly functional and environmentally complex sites, thoughtful landscape strategies can create ecologically rich, pleasant, and inviting environments for daily work and relaxation. The design team employed natural topography and native vegetation to introduce a soft green foundation into a hard industrial context, effectively mitigating noise, regulating microclimates, and enhancing biodiversity. By integrating rainwater collection systems, ecological slopes, and path networks, the project transforms port-related infrastructure space into a multifunctional landscape shared by both people and nature. This case highlights how landscape infrastructure not only serves ecological systems but can also play a key role in improving spatial quality in industrial zones, supporting employee well-being, and contributing to broader urban green transitions.



The integrated water management system in the Steekterpoort project, showing how wastewater, rainwater, and groundwater are collected, filtered, stored, and reused for landscape irrigation and ecological support

Diagram by Bureau B+B



This site plan illustrates how the Steekterpoort project integrates green slopes, natural vegetation, and curved pathways around an infrastructure facility, transforming an industrial waterfront site into an ecologically rich and user-friendly landscape

Plan by Bureau B+B

Steekterpoort project transforms a technical infrastructure site into a pleasant and accessible green environment, blending industrial structures with natural vegetation and pedestrian-friendly paths

Photo by Bureau B+B

LANDSCAPE INFRASTRUCTURE- SUMMARY OF CASE STUDY

Through the analysis of four case studies—Girona's Shore, the A12 Ecological Corridor, Zandweteringpark, and Steekterpoort—it becomes clear that landscape infrastructure serves as an effective design strategy that integrates ecological performance, social use, and spatial structure across both regional and urban scales.

At the regional scale, landscape infrastructure focuses on ecological connectivity and the co-evolution of infrastructure and natural systems. In the A12 project, a series of wildlife crossings and green corridors reconnect fragmented habitats divided by highways, transforming infrastructure into a platform for biodiversity support. Similarly, Girona's Shore creates a flexible and adaptive green network through phased interventions and community engagement, strengthening the relationship between city edges and natural landscapes.

At the urban and site-specific level, landscape infrastructure enhances everyday spatial quality while embedding ecological function into technical and industrial environments. In Zandweteringpark, rainwater channels and power line corridors are reimagined as multifunctional green spaces that support flood management, biodiversity, and public recreation. The Steekterpoort project demonstrates that even in ports and control centers—typically "grey" infrastructural zones—carefully designed topography, native vegetation, and water reuse systems can create ecologically resilient and socially engaging landscapes.

Ultimately, the strength of landscape infrastructure lies not only in offering ecological and technical solutions but also in reclaiming "unusable" spaces as public, ecological, and meaningful parts of the urban fabric—becoming a key driver of climate resilience and sustainable urban transformation.

Haven Rotterdam OV hub

Photo by Bureau B+B

PROFESSIONAL PERSPECTIVE-INTERVIEW WITH PIET MOUT

Piet Mout

Piet Mout is an active contributor to nature education and ecological policy in the Netherlands. He previously served as a biology teacher and principal at Penta College Jacob van Liesveldt and Bahûrim. After retirement, he became the coordinator of the "Nature and Policy" working group within KNNV Hollandse Delta, focusing on nature management and biodiversity in urban, port, and agricultural areas. Through organizing lectures and projects, he promotes public awareness of ecological issues and advocates for integrating nature into everyday spaces and policy decisions.

Q1: Could you briefly introduce the institution KNNV and your work experience there? What are your daily tasks and responsibilities?

Nature Association Hollandse Delta (KNNV) is an independent department of the National Royal Dutch Nature Association. This association is involved in nature study, nature education and nature conservation.

Our members are mostly amateurs who participate in Nature Study Groups at a professional level (Citizen Science). Our collective knowledge is comparable to that of professional ecologists. This knowledge forms the basis of our nature conservation work. I have been responsible for the Nature & Policy Working Group for a very long time together with Theo Briggeman, our lawyer.

We are concerned with just about everything that is harmful to nature. We see the climate crisis and the nature crisis as two very closely intertwined existential crises of our time. Our main position is that everything that is good for nature is also good for the climate, but not everything that is good for the climate is also good for nature. From this main idea we are involved in nature conservation at regional and provincial level. Our working area is mainly Voorne-Putten and the surrounding areas. Among others the Port of Rotterdam and industrial areas.

I my self have been active as a nature conservationist for more than 40 years.

I am a retired biology teacher and principal of a school community. After my retirement I became even more active in nature conservation.

Q2: I am very curious about the relationship between the ecosystem and landscape in this transition zone between the port and Voorne island. Based on your research and daily work, could you give a brief overview of the ecosystem here and how people interact with that ecosystem?

Voorne is a very special place in the Netherlands. It is located in the middle of the delta of the rivers Rhine and Meuse. Deltas are important places all over the world, because they offer space for extremely high natural values, good and highly productive agricultural land, large cities with ports, industry and transport. All these functions of delta's come together in Voorne-Putten and that makes it an exceptionally special region.

Voornes Duin is the most species rich nature reserve in the Netherlands and is located right between the largest port in Europe and intensive agricultural areas.

These are all three important for the Netherlands but sometimes difficult to reconcile. I am always looking for possibilities to unite these three conflicting interests.

I myself have a revolutionary point of view that I try to propagate in every possible way. I am convinced that a serious paradigm shift has taken place. In the old paradigm, man was the ruler of nature and was allowed to use it as he saw it. It went so far that man started to think that we can exploit, suppress and even destroy nature with impunity. In doing so, we as humanity have exceeded all ecological limits, resulting in the global nature and climate crisis.

That insight has brought about a paradigm shift. The new insight is that from now on everything, everywhere and always must be nature inclusive, climate positive and climate adaptive. In addition, everything must also be sustainable, circular, regenerative and therefore biobased. All of this must also be done in a socially just way.

From that perspective we look at local and regional problems and try to show governments, companies and citizens that things can and should be done differently.

PROFESSIONAL PERSPECTIVE-
INTERVIEW WITH PIET MOUT

This naturally results in major differences of opinion that we try to bridge by entering into a dialogue.

Voornes Duin has various ecosystems that together form a dune ecosystem. That dune ecosystem is characterized by many gradients. From calcareous to less calcic, from dry to wet, from salty to sweet, from high to low, etc. Those gradients form a rich basis for many specialist plant species and animal species. In addition, Voornes Duin is one of the few dune areas with a natural groundwater regime.

What many people do not expect is that in the artificially constructed harbour and industrial areas a similarly rich ecosystem can be found that looks very much like the calcareous grasslands in the dunes. That is because those areas were constructed by spraying sea sand. The same material that dunes are made of. In addition, many of the harbour areas are not accessible to the public for safety reasons. There is therefore an enormous peace in those areas.

The dune area is for most people mainly a recreation area. That regularly leads to disturbance. Between the nature area and the harbor area lies a recreation area, which is intended as a kind of buffer zone and to entice recreationists to go there for recreation, thereby relieving Voornes Duin.

Q3: As an ecologist, what are your insights into the landscape characteristics of this area and its relationship between nature and the ecosystem? From an ecological perspective, how would you describe the landscape value of this region?

The landscape of Voorne-Putten has been severely damaged by four consecutive ecological disasters over the past 80 years.

The first ecological disaster was the Second World War. Parts of Voorne-Putten were inundated with seawater, causing many trees and shrubs to die.

In 1953, there was a major flood when the dikes broke down during a storm. This is called the flood disaster. Many people drowned then. The agricultural area was flooded with salt water with all the consequences that entailed.

After that, a land consolidation was carried out for the benefit of intensive agriculture. In the process, the last so-called landscape elements disappeared.

Finally, after the flood disaster, the Delta Works were carried out. This was a technical feat for which the Netherlands became world famous, but the consequences of the Delta Works were also an unimaginable ecological disaster. Almost all intertidal areas were lost. The gradual transition from fresh river water to salt sea water was also lost and the rivers became almost inaccessible to migratory fish.

Q4: In your advice letter of the Environment Vision from Voorne Municipality, you mentioned perspectives and recommendations regarding the planning. How do you see the potential connections between the port area and Voorne Island in terms of landscape, nature, and human activities? What role do you think the Brielse Meer lake area plays in this system?

In our advice regarding the environmental vision, we have tried to translate our ideas from the new paradigm for the municipality of Voorne aan Zee. Wherever we saw possibilities, we have indicated how everything can be made nature-inclusive and climate-positive and adaptive.

We have tried to show that you can build a house that is nature-inclusive by already taking the starting point in the design that there should be more biodiversity on the site of the house after construction than there was before construction.

That the surface of public greenery in a residential area can be used by not creating lawns but by creating nature in between the houses. We have applied the same principle to business parks, sports fields, cemeteries, in port and industrial estates, along infrastructure and in agricultural areas etc.

We also pledged to make an ecologycal connection between the Oostvoorne Lake and the Brielle Lake by changing the management of a dike that connects both areas.

Q5: Your report highlights the challenges posed by the worsening climate crisis to both natural ecosystems and human activities in this region. Looking ahead 20–50 years, how do you think the relationship between nature, production, and daily life will ideally evolve to adapt to climate change? (For example, changes in watermanagement, agricultural transformation, or shifts in human activities.)

Climate change is unfortunately happening much faster than all predictions indicated. The consequences are already very serious on Voorne-Putten. According to the Hollandse Delta Water Board, large parts of the agricultural area will no longer be suitable for agriculture due to salt seepage. The Rhine is changing from a melting river to a rain river, which means that there will be a much lower water discharge (and sometimes very high in periods). As a result, there is insufficient water to flush the ditches.

Shipping from the Maasvlakte to Germany will also probably experience major disruptions for parts of the year etc.

The climate crisis will also have major consequences for nature. The weather will become increasingly extreme with long dry periods and then again with a lot of rain. Much nature cannot adapt well to this. Strangely enough, there are also opportunities. Nature Based Solutions for solving climate problems also appear to be good for nature.

Q6:In my research and design, I aim to develop a landscape framework that supports the transition of this zone by integrating various landscape infrastructures. I have found that increasing vegetation diversity around the lake—especially forests and wetlands—as well as rethinking the semi-open spaces formed by infrastructures such as high-voltage lines, dikes, railways, and pipelines, could offer opportunities to reshape human-nature interactions.What are your thoughts on this idea?

I think you are right with your plans to try to adapt the landscape around the Oostvoornse Meer and the Brielse Meer to the circumstances in such a way that new opportunities can arise for both the port and industry, for agriculture, for the cities and villages and for nature. Through landscape adaptation, perhaps conflicting interests can now be better coordinated, so that even from a more integral vision all sectors will ultimately benefit.

PROFESSIONAL PERSPECTIVE- INTERVIEW WITH ILYA MUSTERS

Ilya Musters

Ilya Musters is a strategic advisor in the field of water management in the Netherlands, currently working at the Hollandse Delta Water Authority. He has extensive experience in public space, residential environment, and water quality policy, having served as a project manager and policy advisor in various governmental organizations. Musters focuses on integrating water management with spatial planning to promote sustainable development at both urban and regional levels.

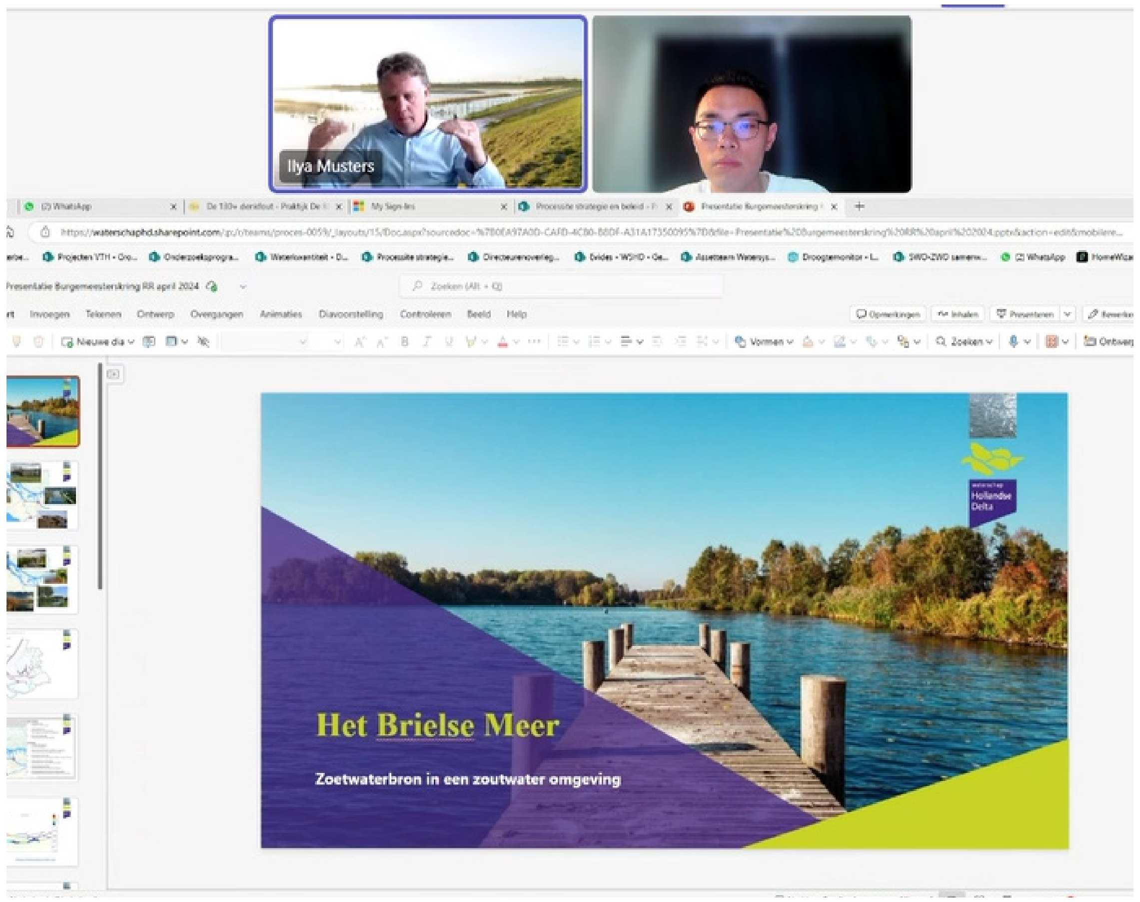
Waterschap Hollandse Delta

Waterschap Hollandse Delta works every day for sufficient (clean) water, strong dikes and safe (water)ways on the South Holland Islands. Below you will find an overview of our activities.

Waterschap Hollandse Delta draws up water area plans to ensure that the water system continues to function properly. In these plans, we examine the functioning of the water system, or the system of ditches and canals, locks and pumping stations for fresh water in the polder. In doing so, we look at the current situation and the future. The plans help us prepare for climate change. Climate change increases the risk of flooding and drought.

Ilya use the presentation to explain the water system and management they practise in Waterschap Hollandse Delta at Brielse Meer

Image by Author



PROFESSIONAL PERSPECTIVE- INTERVIEW WITH ILYA MUSTERS

This image presents the KNMI climate scenarios, outlining four possible futures based on high or low CO_2 emissions and either drying or wetting climate trends, each with varying impacts on temperature, precipitation, drought, and sea level rise

Image by Ilya Musters

This image illustrates four long-term adaptation strategies to climate and water challenges: closed protection, open protection, seaward expansion, and adaptive living with water

Image by Ilya Musters

Management Approach Overview

Waterschap Hollandse Delta has adopted a range of strategies to manage Brielse Meer, a freshwater body surrounded by saltwater, facing increasing pressure from sea level rise, reduced river inflow, growing water demand, and shifting policy priorities. To prevent salinization and freshwater shortages, the authority employs three main approaches: halting external water inflow and relying on internal buffer storage; accepting limited saline inflow while tolerating higher chloride levels; and using pumps instead of gravity-fed systems for water intake. These measures reflect a shift from traditional water engineering to a more adaptive and flexible management model.

Future Possibilities for Water Management

As population growth and climate pressure intensify, the gap between water supply and demand is expected to widen significantly. Increased demand for drinking water due to new housing developments, alongside rising irrigation needs for agriculture, wetland restoration, and urban greening, will place additional strain on water systems. Sea level rise will also increase groundwater salinity and pressure. In response, water management must evolve from simply meeting demand to actively guiding and prioritizing water use. Future strategies may include regional water reuse systems, rainwater harvesting, wastewater recycling, and cross-regional coordination mechanisms. Transformation is no longer optional—it is essential for coping with intersecting environmental and societal challenges.

Impact on Landscape

Changes in water management will have profound impacts on the structure and function of regional landscapes. Freshwater scarcity is likely to intensify surface-level fluctuations, pushing traditional moist agricultural landscapes toward more drought-tolerant or salt-adapted systems. Water bodies will increasingly serve as critical infrastructure for retention, purification, and flood mitigation, rather than purely aesthetic features. Urban public spaces will need to adapt to climate extremes and limited water availability, evolving into modular, multifunctional, and resilient green infrastructure. This transformation is not only technical but also spatial and experiential—reshaping how we design, use, and interact with landscapes in the face of climate and resource uncertainty.

THE MOST DIVERSE ECOSYSTE AS THE BACKUP

Slikken van Voorne

The flow of the water changed due to the port construction. This created a new dynamic coastal landscape on the south side of the Maasvlakte, in which new channels and sandbanks were formed due to the tidal action

Photo by Zuid-Hollands Landschap

2

1

◄ De Oranjeplassen

Just outside Maasluis and near the Nieuwe Waterweg lies the nature reserve, Migratory birds find peace, space and food in the water and reeds and ducks and geese spend the winter there

Photo by Zuid-Hollands Landschap

The Ommeloop ►

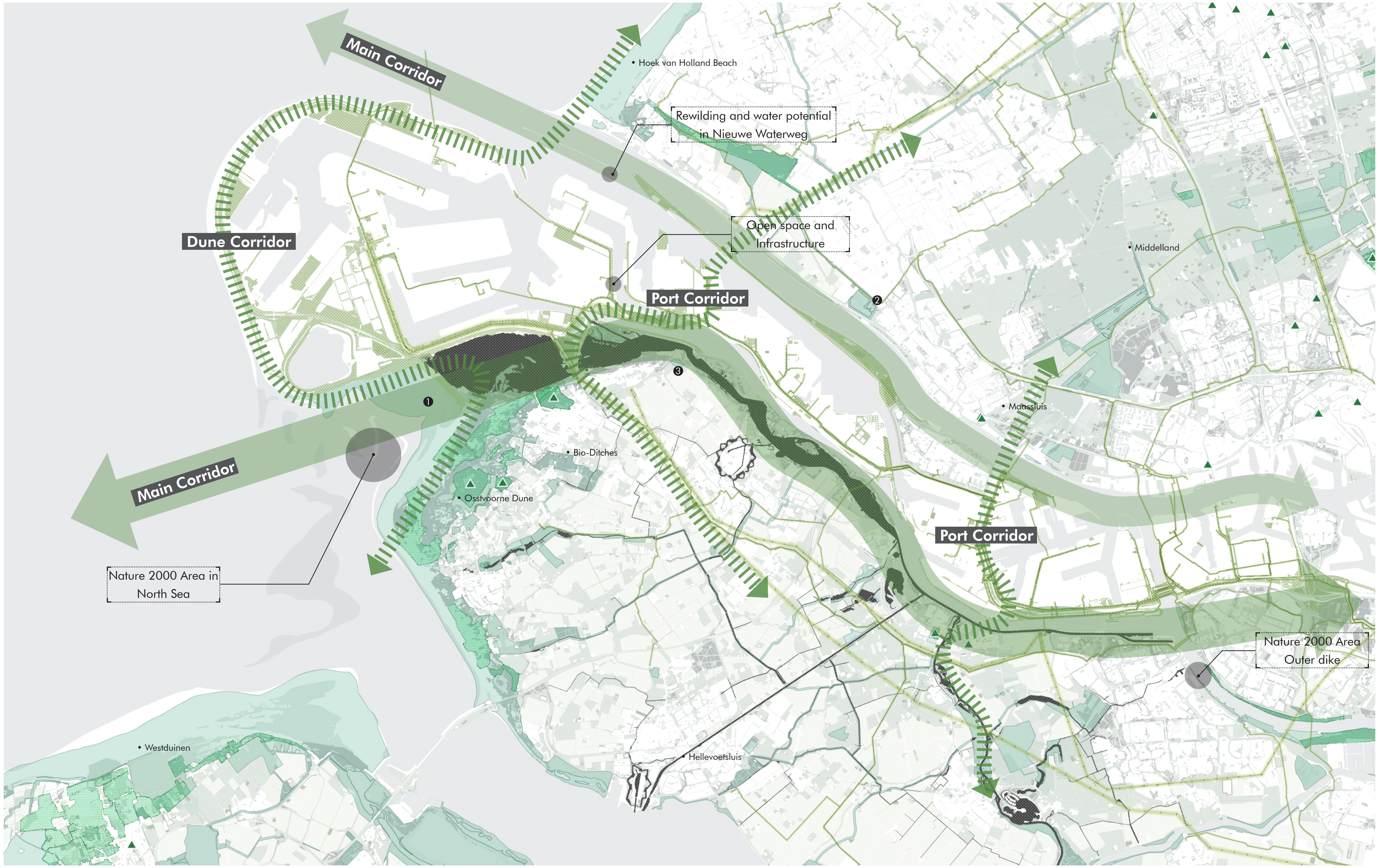
Due to the low location and the salty seepage, special, salt-loving plants feel at home here. The terrain has high cultural-historical values, also because of the nearby presence of the Stenen Baak, a lighthouse from 1630

Photo by Zuid-Hollands Landschap

3

CONNECT AND CREATE NEW NATURE

Although ports and islands are primarily defined by production and transport infrastructure, they often contain large areas of underutilized open space—such as dike slopes, roadside green strips, vacant lots, and high-voltage corridors—which hold significant potential for ecological and landscape transformation. With strategic green interventions, these infrastructural spaces can be reimagined as multifunctional green infrastructure that supports both ecological processes and human use. By linking them with existing nature reserves, historic landscapes, and agricultural green networks, a new ecological corridor system can be established—connecting previously fragmented green areas into a cohesive, multifunctional ecosystem. This not only enhances regional biodiversity and facilitates species migration, but also strengthens the connection between urban environments and nature. Moreover, this integrated green network can support functions such as flood retention, carbon sequestration, and public recreation, offering both ecological restoration and spatial quality improvements. It thus becomes a vital foundation for climate adaptation and sustainable spatial transformation in port and island regions.



There are rich ecological habitats (lighr green hatches)and green heritage (dark green Triangels and hatches) areas on both the northern and southern, as well as the eastern and western sides of the port and islands in the image. These areas can be connected through the open spaces and infrastructure of the port to form new corridors

Map by Author/Data from Zuid Holland GIS Portal

INFRASTRUCTURE AND OPEN SPACE BREED NEW LANDSCAPE

Water ditches in the open space attracts many bird and animals for food and breeding, also acting as part of the surface water system to catch and drain rain water, but most of them are not connected

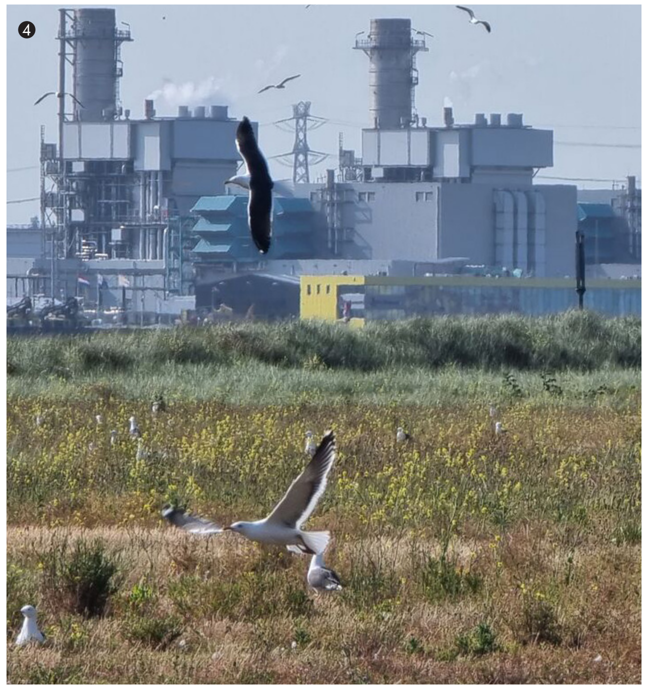
Photo by Author

Smaller dike structures and powerlins have a lot of open spaces, usually they are not well managed in ecological or recreational aspects, which brings them potentials for further use

Photo by Author

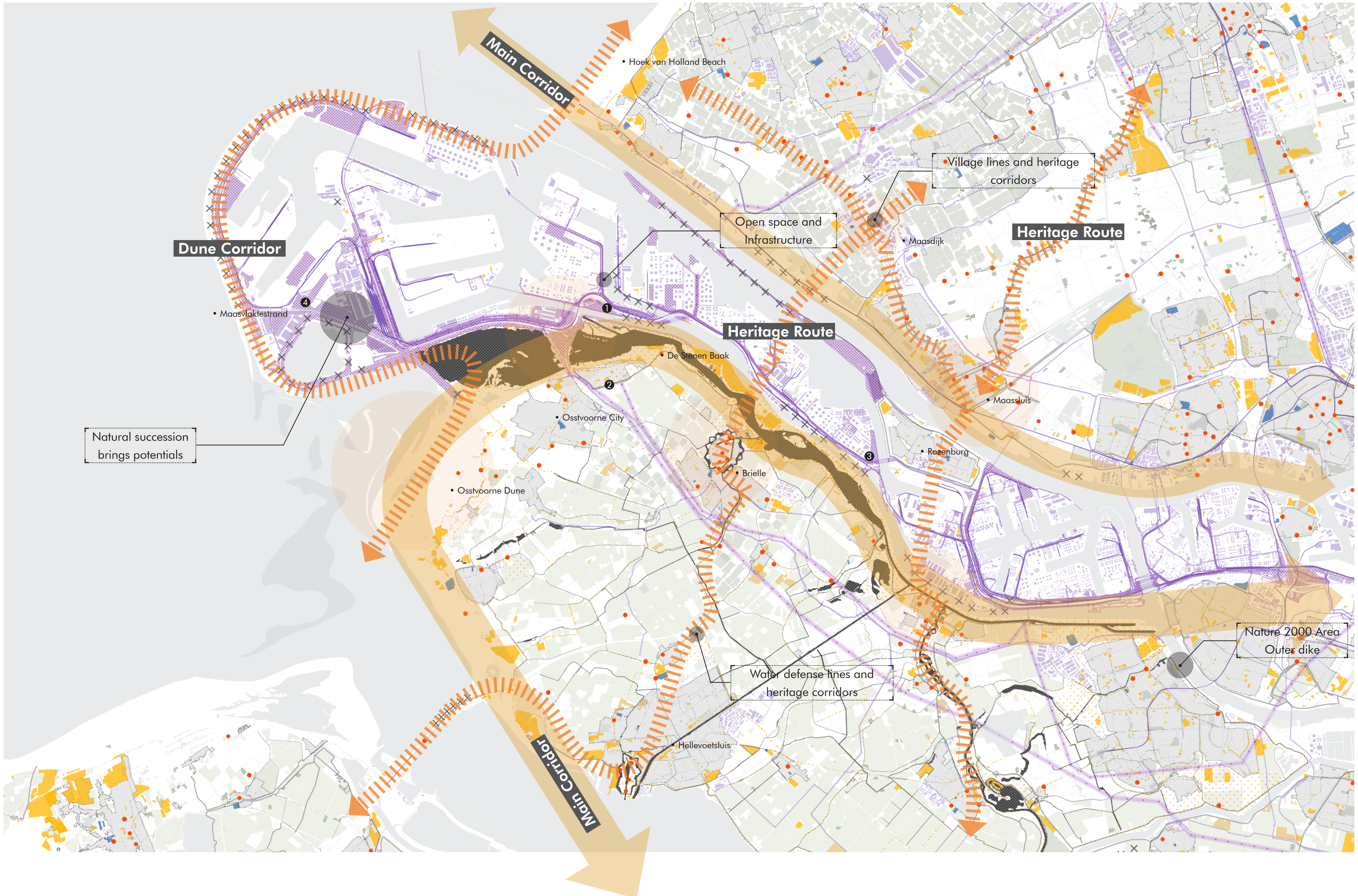
In the Europoort, crude oil is processed into various oil products. The products are stored in enormous tanks. The tank dikes and pipeline strips in the area are places where there are plenty of opportunities for recreation and biodiversity

Photo by Port of Rotterdam



CONNECT AND CREATE NEW LIVING VIBE

The Port of Rotterdam and its surrounding islands contain numerous open infrastructural spaces scattered between warehouses, office areas, and industrial zones. Though fragmented, these spaces hold great potential for integration and activation. By connecting them with the existing slow mobility networks, dike pathways, and heritage sites in both urban and agricultural areas, a new livable spatial network can emerge—linking the dense city with the port and fostering interaction between people, nature, and port functions. This network can serve as an ecological corridor, enhancing regional biodiversity while providing spaces for recreation, exercise, and nature experience for both city residents and port workers. At the same time, natural systems such as wetlands, green embankments, and rainwater retention features can be embedded into infrastructure to support flood management, microclimate regulation, and ecological restoration. These nature-based solutions offer essential support for the port's climate adaptation and green transition. Through this integrated approach to landscape infrastructure, the Port of Rotterdam can move toward a more resilient, sustainable, and livable future.



The lake belt and Osstvoorne dune now service as the main recreational corridor (bright yellow hatches) and blocks) but the open space in port area (light purple hatch)and space alone the infrastructure corridors like pipes and power line(in purple lines)share the same potential of being transfermed into natural like recreational area and connecting heritages on both sides

Map by Author/Data from Zuid Holland GIS Portal

SUMMARY OF POTENTIALS

- Understanding/Potentials

-What are the key spatial, ecological and functional characteristics of the regional landscape system, as well as the challenges and **opportunities for designing a connecting green-blue infrastructure** ?

Based on the current spatial and ecological conditions, the Rotterdam Port and its surrounding islands offer a range of opportunities—alongside certain challenges—for developing a continuous and multifunctional green-blue infrastructure network. Positioned at the intersection of urban, industrial, and natural systems, this area is rich in spatial diversity and transformation potential.

Spatially, the region contains a variety of infrastructural and transitional spaces, such as dikes, high-voltage corridors, rail junctions, and open areas between warehouses, offices, and port logistics facilities. Although scattered and fragmented, these residual spaces are widespread and hold strong potential for connectivity. Through strategic landscape interventions, they can be transformed into ecological corridors, water retention zones, and multifunctional public spaces—enhancing ecological resilience while improving spatial accessibility and user experience.

Ecologically and culturally, the region includes wetlands, waterfront paths, agricultural landscapes, and heritage sites such as old harbors, military zones, and former defense lines. These elements are naturally linked to urban green spaces and nearby nature reserves. By improving vegetative continuity, guiding water flows, and expanding slow mobility networks, a hybrid landscape system can be created—supporting biodiversity, flood regulation, and microclimate balance, while also enabling daily use by residents and port workers for recreation, commuting, and education.

In terms of transformation, the region is undergoing spatial restructuring driven by climate adaptation and industrial transition. Port redevelopment, decommissioned industrial land, and ecological restoration initiatives provide real opportunities for embedding green-blue infrastructure. For example, future infrastructure upgrades can incorporate ecological corridors, and former industrial zones can be converted into wetlands or water buffers, turning ecological function into a driver for spatial transformation.

Therefore, green-blue infrastructure in this context is not just a response to existing challenges, but a systemic design strategy that integrates natural processes, meets social needs, and supports long-term spatial transition. It offers a pathway toward a more resilient, inclusive, and sustainable future for the Rotterdam Port and its surrounding island landscapes.

CHAPTER 06-LANDSCAPE FRAME AND VISION

Strategies and Principles

Potentials and Inspirations

- Landscape infrastructure framework as the backbone to support transformation
- Design and planning through time
- What strategies and principles can be employed to create a well connected, coherent and robust landscape infrastructure framework?

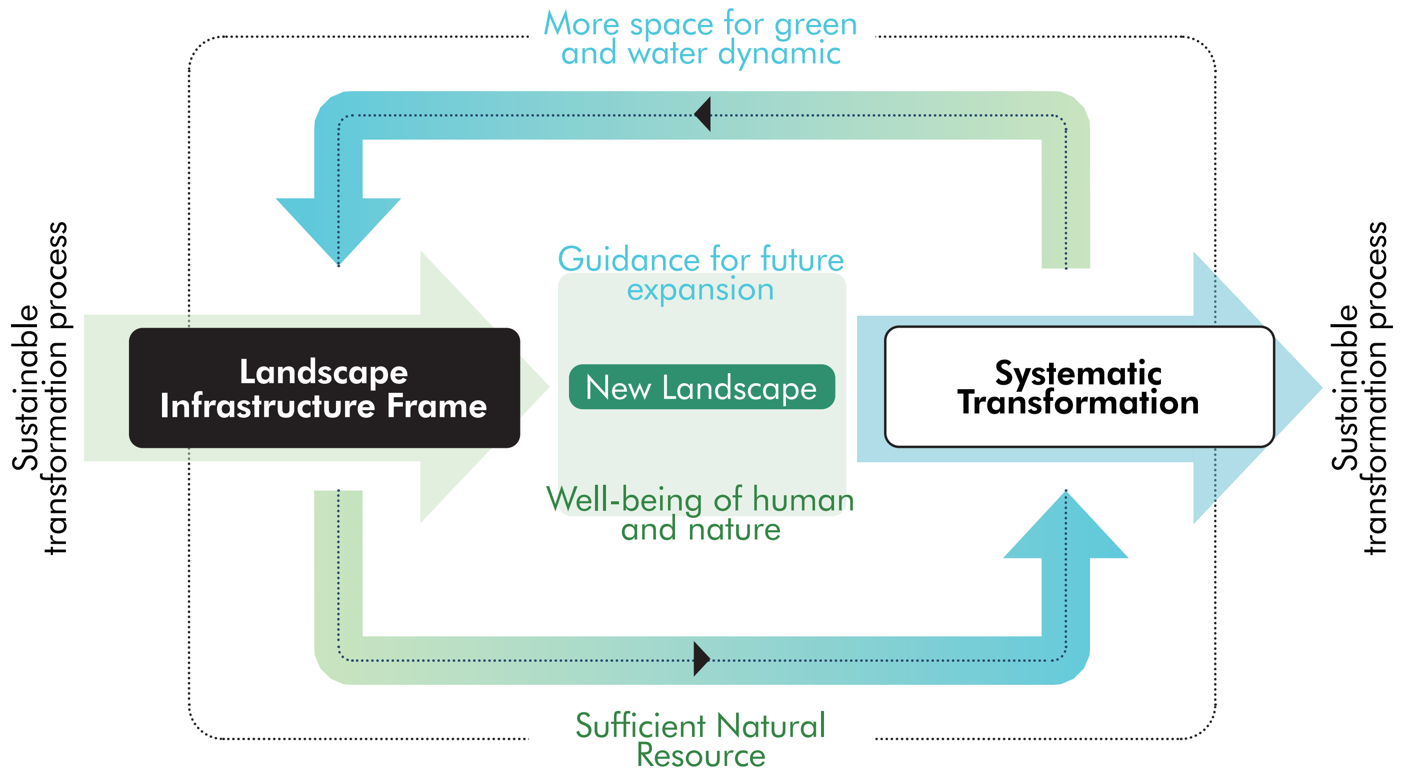
HOW LANDSCAPE CAN MAKE A BIG STEP IN THIS TENDENCY

The Landscape Infrastructure Frame plays a crucial guiding and supporting role in the sustainable transformation of the Rotterdam Port and its surrounding urban areas. It serves not only as a spatial organizing tool but also as a systemic strategy that fosters the coexistence of ecological processes, human well-being, and industrial activity.

First, by integrating the residual spaces of existing infrastructure, the Landscape Infrastructure Frame releases more room for green and hydrological dynamics. This spatial reallocation enables ecosystem restoration, improves urban climate regulation, and strengthens the relationship between people and nature, ultimately enhancing the region's ecological carrying capacity.

Building on this foundation, the framework provides strategic direction for subsequent Systematic Transformation. This transformation involves not only the sustainable upgrading of energy and production systems within the port area, but also the multifunctional use of land on the urban fringe and the optimized distribution of natural resources. As a structural backbone, landscape infrastructure supports coordination across different scales and systems.

Through this cyclical mechanism, the framework continuously generates new spatial forms and reconnects fragmented landscape patches (New Landscape), promoting the well-being of both humans and nature. In return, it ensures the availability of sufficient natural resources to support further spatial and systemic evolution. Ultimately, landscape infrastructure serves as a connector between city and nature—driving a resilient, adaptive, and sustainable transformation across ecological, social, and industrial dimensions in the Rotterdam region.



DESIGN TROUGHG TRANSFORMATION- CONSTRUCTION OF NEW INFRASTRUCTURE

The energy and infrastructure transition of the Port of Rotterdam is advancing along two main strategic directions: decarbonization and system integration. On the energy front, the port is shifting away from fossil fuels toward a low-carbon mix centered on hydrogen, shore power, biomass, and synthetic fuels. This is supported by carbon capture and storage (CCS) technologies aimed at reducing industrial emissions, with the ultimate goal of achieving climate-neutral operations by 2050. Simultaneously, the infrastructure network is undergoing significant expansion and reconfiguration—developing pipeline systems for hydrogen, CO_2, and residual heat; implementing smart grids and shore power facilities

Now – 2035
The focus is on laying the foundation for decarbonization. Key initiatives include widespread implementation of shore power to reduce emissions from berthed vessels, the construction of a 30 km hydrogen pipeline within the port area, and the launch of the Porthos CCS project to capture and store CO_2 offshore. In parallel, the port is developing circular economy infrastructure for recycling and reusing industrial materials, setting the stage for long-term resource efficiency.

2035 – 2050
This period marks the expansion and integration of sustainable systems. The port will scale up hydrogen infrastructure as part of the European Hydrogen Backbone, develop the Aramis CCS project to significantly increase CO_2 storage capacity, and transition toward low-carbon feedstocks like biomass and e-fuels. Smart energy grids, including battery storage and microgrids, will enhance flexibility and optimize the port's energy performance.

Beyond 2050
By mid-century, the Port of Rotterdam aims to become fully climate-neutral. This includes total shore power coverage, fossil-free fuels, and closed-loop systems for hydrogen, carbon, and circular materials. The long-term vision transforms the port into a multifunctional green-industrial ecosystem, blending clean industry with ecological integration.

Efficiency and infrastructure

New energy system

Sustainable transport

New raw material and fuel system

New Powerline Corridor

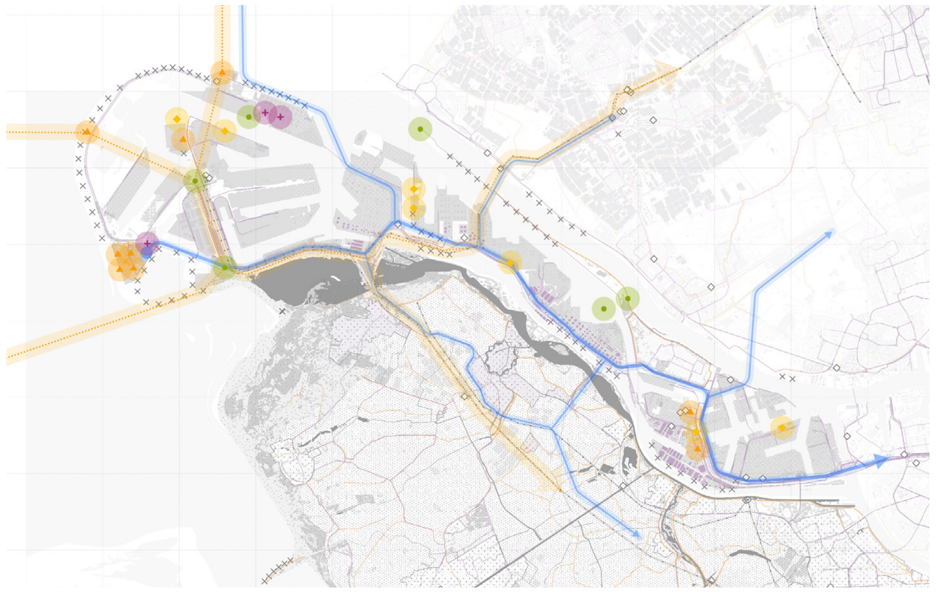
New Pipeline Corridor

2020–2035: Build foundational infrastructure—shore power, hydrogen pipelines, initial CCS capacity

Diagram by Author
Date from Rotterdam Port Authority

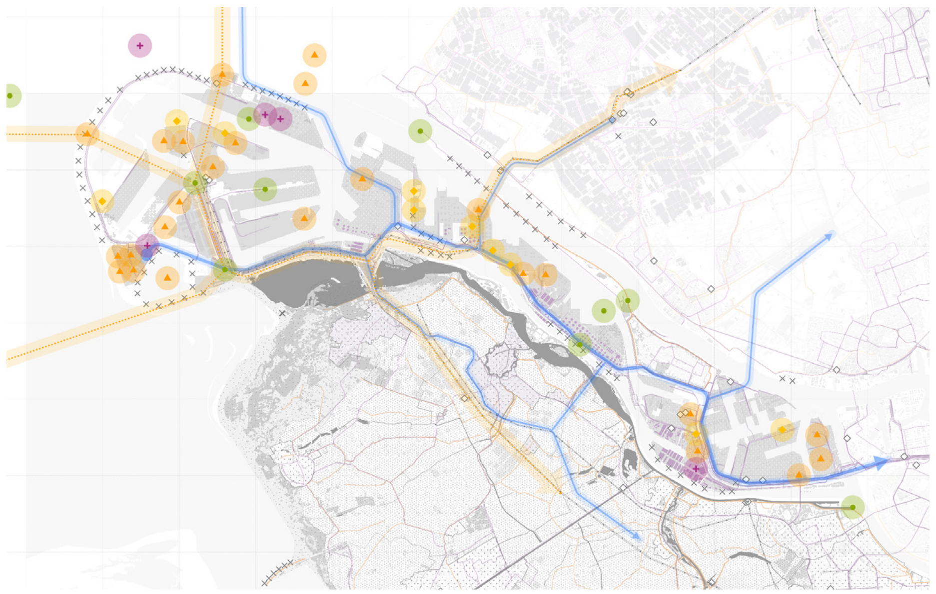
2035–2050: Scale up clean hydrogen systems, expand CCS, transition feedstocks, and optimize energy networks

Diagram by Author
Date from Rotterdam Port Authority



Beyond 2050: Achieve a fully carbon-neutral, circular, and resilient port ecosystem—linking industrial innovation with ecological integration

Diagram by Author
Date from Rotterdam Port Authority

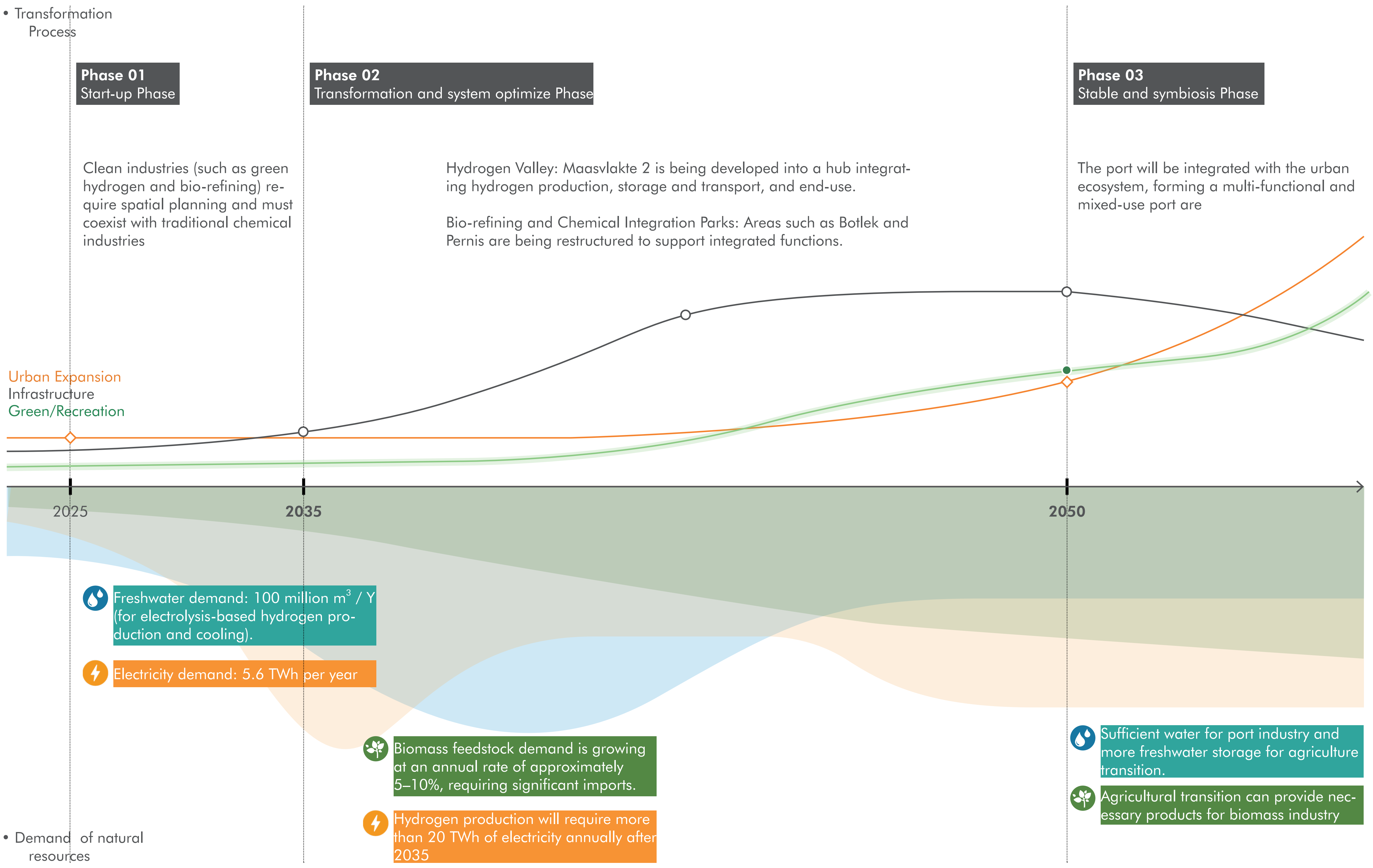


DESIGN TROUGHG TRANSFORMATION-
DEMAND FOR MORE RESOURSE

2025–2035
Start-up Phase:
The landscape strategy aims to provide spatial support for clean industries such as green hydrogen and biorefining, while reducing the ecological pressure from traditional industrial activities. Key actions include protecting coastal dune wetlands, lake ecosystems, and the urban environment by establishing ecological buffer zones and creating green transition corridors between industrial areas and cities. Selective shoreline interventions will enhance water purification functions, and thermal networks like Warmtelinq will be introduced to promote circular energy use.

2035–2050
Transformation and System Optimization Phase:
This phase focuses on the integration of clean industries and ecosystem optimization. Spatial planning will support the expansion and coordination of hydrogen and biorefining hubs, while also accommodating growing port infrastructure needs. Enhancing freshwater systems and increasing rainwater storage and reuse will improve regional water self-regulation and meet rising freshwater demand. Agricultural landscapes will gradually shift toward more diverse and eco-friendly models, potentially producing biomass crops that reduce freshwater reliance and support the clean industry network.

2050–20XX
Stabilization and Symbiosis Phase:
As the system matures, the landscape of ports and cities will become highly integrated. Revitalized waterfront zones will serve as ecological corridors and public spaces, strengthening the connection between people and nature while supporting port regeneration. Abandoned lands and outdated facilities will be repurposed as ecological buffers or renewable energy sites, enabling a symbiotic relationship between energy, ecology, and society.



SPATIAL QUALITY AS THE MAIN SUPPORT OF PRINCIPLES

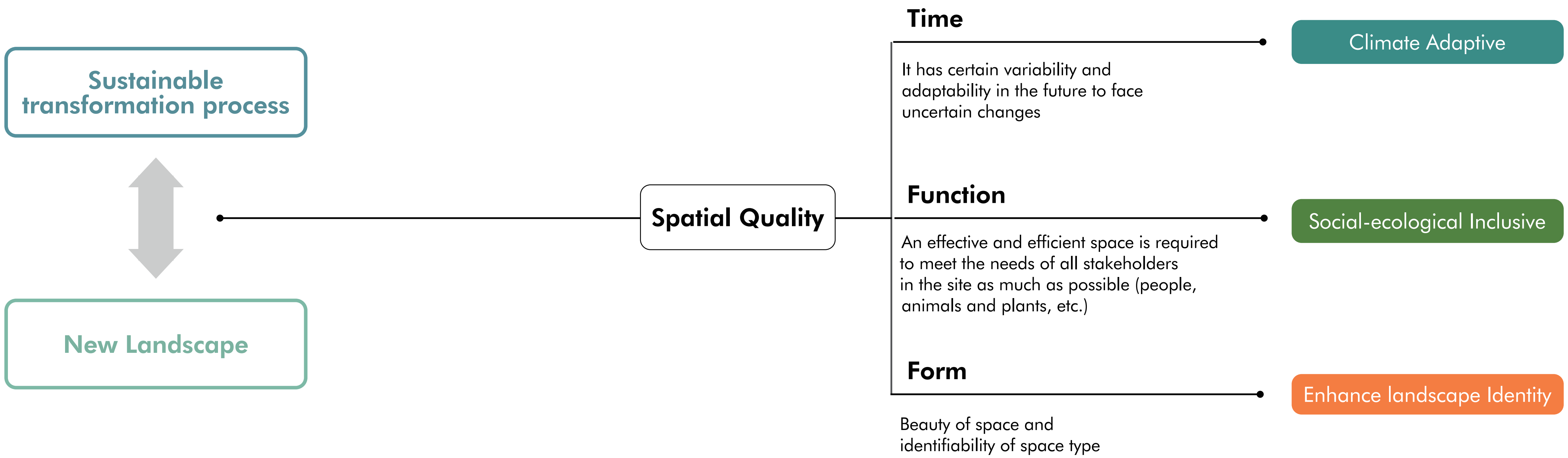
Based on the concept of spatial quality, it can be understood through three core dimensions: Time, Function, and Form. This multi-dimensional perspective offers a robust and adaptable framework for design—especially valuable in the face of future uncertainty and competing interests—and leads to three key design principles.

First, Time refers to a space's ability to adapt to future changes. As climate change intensifies extreme weather events and increases pressure on water systems, design must be climate adaptive. This involves incorporating dynamic systems into spatial planning—such as adjustable flood zones, rain gardens, and multifunctional green spaces—that can respond to scenarios like heavy rainfall, drought, or salinization. These spaces serve immediate needs while evolving over time to fulfill new functions.

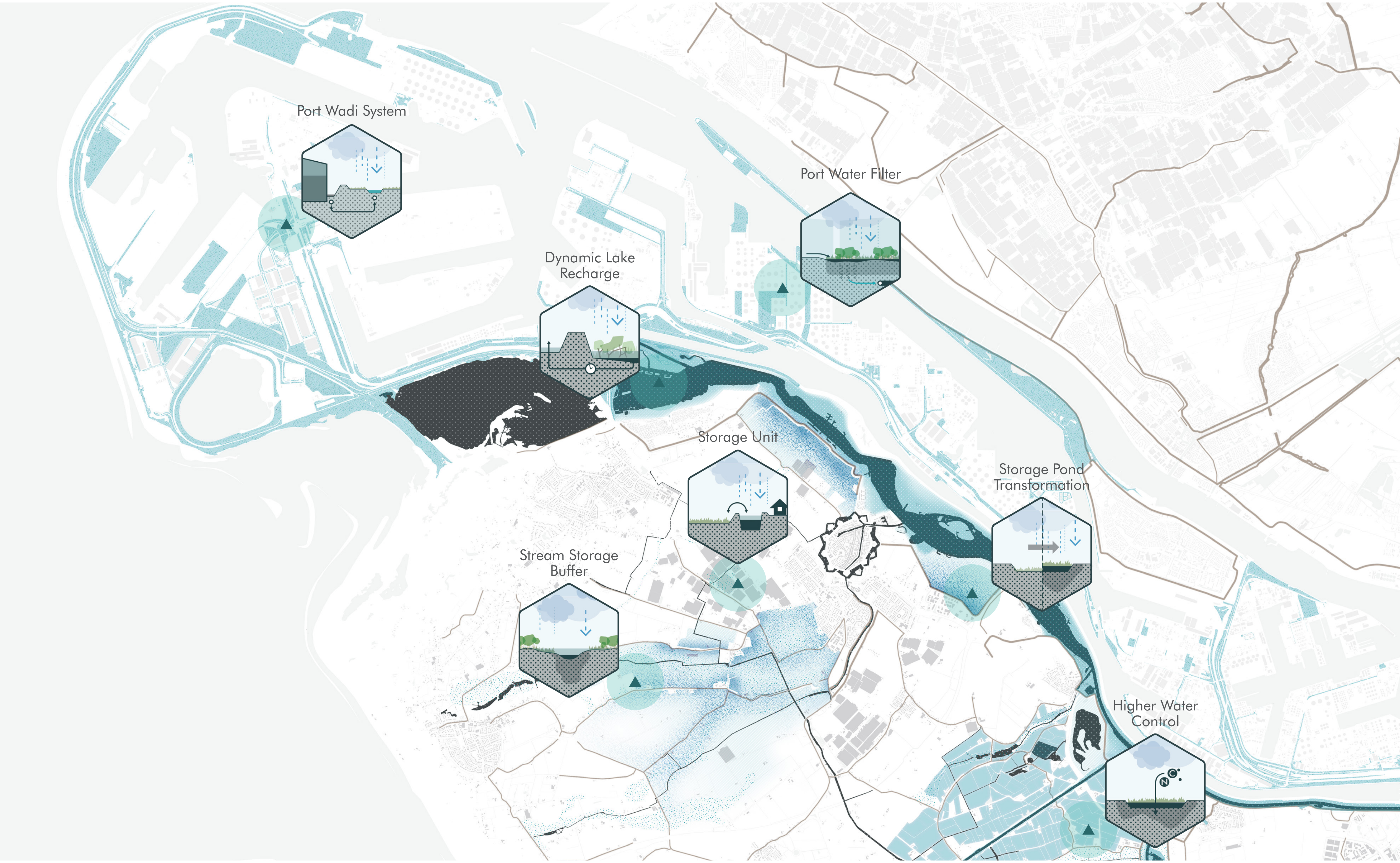
Second, Function emphasizes multifunctionality and the ability to balance diverse user needs, including residents, industries, flora and fauna, and visitors. This calls for a social-ecological inclusive approach. For example, introducing ecological buffer zones in the urban-port fringe can provide habitats for wildlife, serve as recreational parks, and function as flood protection infrastructure—achieving synergies between human use and ecological conservation.

Finally, Form concerns the aesthetic expression and legibility of space, focusing on how design reinforces a sense of place. To enhance landscape identity, projects should integrate local culture, historical context, and natural features. This might involve reusing industrial structures, highlighting water heritage, strengthening visual corridors, and using native plants and materials to create spaces with a distinct regional character—strengthening people's emotional connection and sense of belonging.

In summary, this spatial quality framework—rooted in Time, Function, and Form—leads to three key design principles: **climate adaptivity, social-ecological inclusivity, and landscape identity enhancement**. Together, these principles offer a strategic foundation for guiding sustainable transitions and shaping future landscapes.

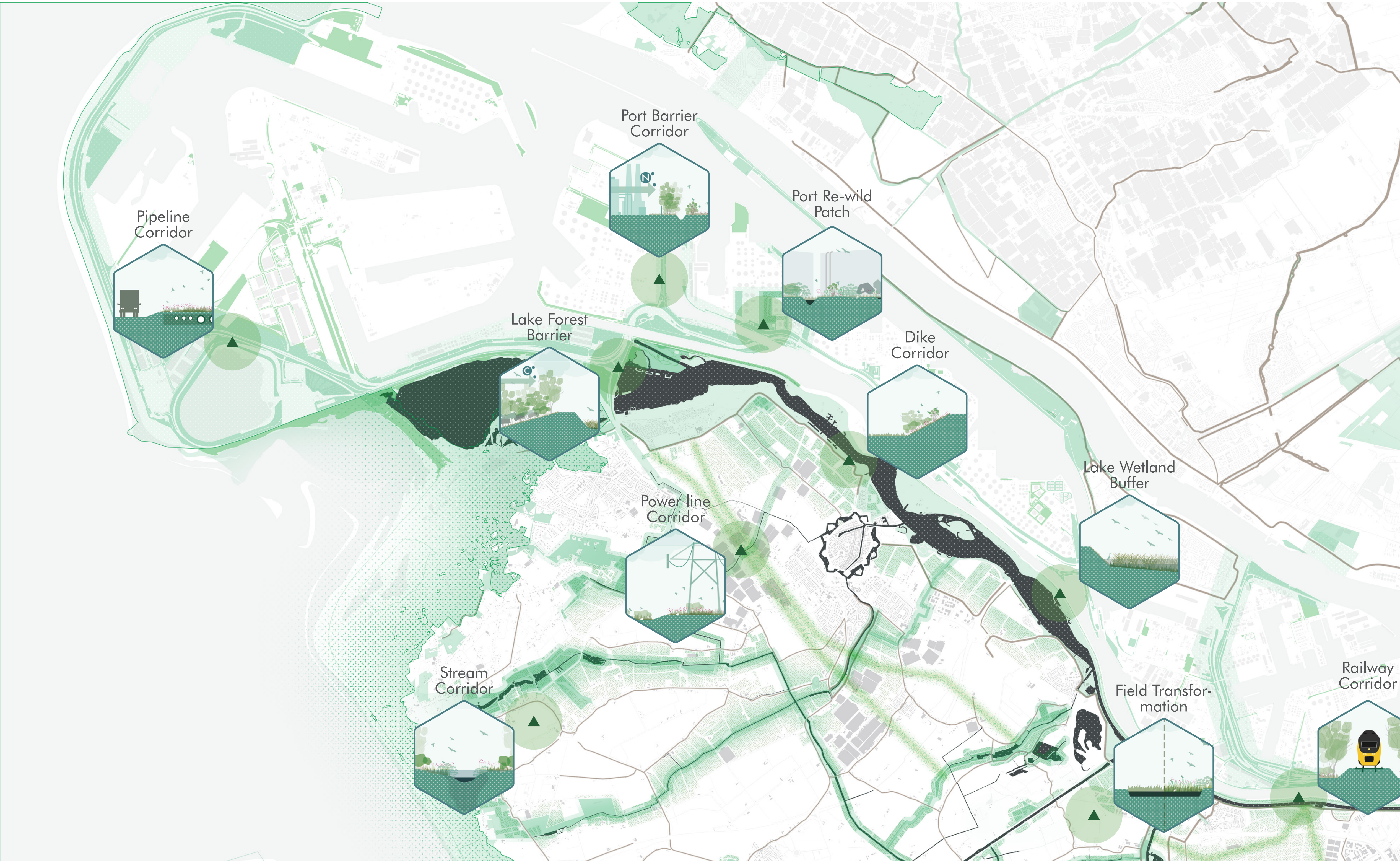


REGIONAL STRATEGY FRAME-
CLIMATE ADAPTIVE



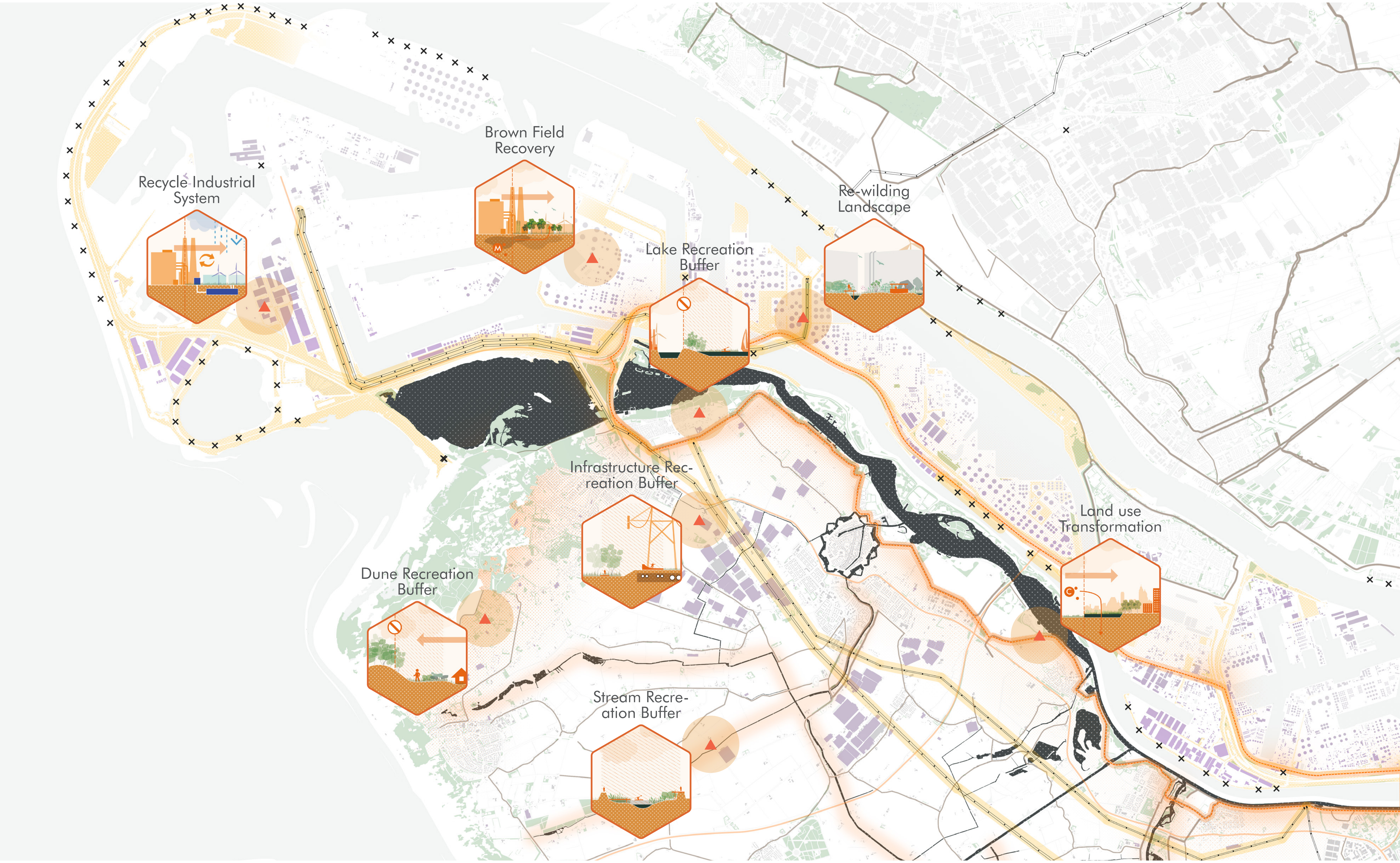
This spatial strategy framework is guided by the principle of climate adaptability, establishing a decentralized yet coordinated regional water system to enhance resilience to climate change. From port areas to agricultural zones, it introduces various hydrological control nodes, including rainwater collection and filtration systems in the port (Port Widi System, Port Water Filter), dynamic lake recharge and urban water storage (Dynamic Lake Recharge, Storage Unit), and upgraded ponds and water level control in rural areas (Storage Pond Transformation, Higher Water Control). These interventions collectively support rainwater buffering, water purification, ecological protection, and seasonal water management. The layout responds to the functional diversity of different zones while integrating ecosystem services, effectively reducing risks such as flooding, drought, and water pollution. It presents a forward-looking and multifunctional approach to climate-adaptive landscape design.

REGIONAL STRATEGY FRAME- SOCIAL-ECOLOGICAL INCLUSIVE



This spatial strategy framework is based on the principle of social-ecological inclusiveness, aiming to create a multifunctional ecological network that spans urban, port, and rural areas, promoting harmony between ecosystem protection and human activity. The plan connects previously fragmented infrastructure and natural systems through various corridors and nodes—such as the Pipeline Corridor, Powerline Corridor, and Railway Corridor—transforming them into multifunctional ecological zones. Buffer zones like the Lake Wetland Buffer and Lake Forest Barrier, along with the Dike Corridor, strengthen ecological functions along water edges and support habitat continuity. In the port area, elements such as the Port Rewild Patch and Port Barrier Corridor serve as ecological restoration zones that provide shelter for wildlife while also offering green spaces for public use. In the agricultural zone, the Field Transformation strategy encourages a shift toward ecological farming or natural restoration, balancing biomass production with ecosystem services. Overall, the framework reflects a balance of the needs of diverse stakeholders—people, wildlife, and infrastructure—creating an inclusive, sustainable, and resilient shared landscape system.

REGIONAL STRATEGY FRAME-
ENHANCE LANDSCAPE EXPERIENCE AND IDENTITY

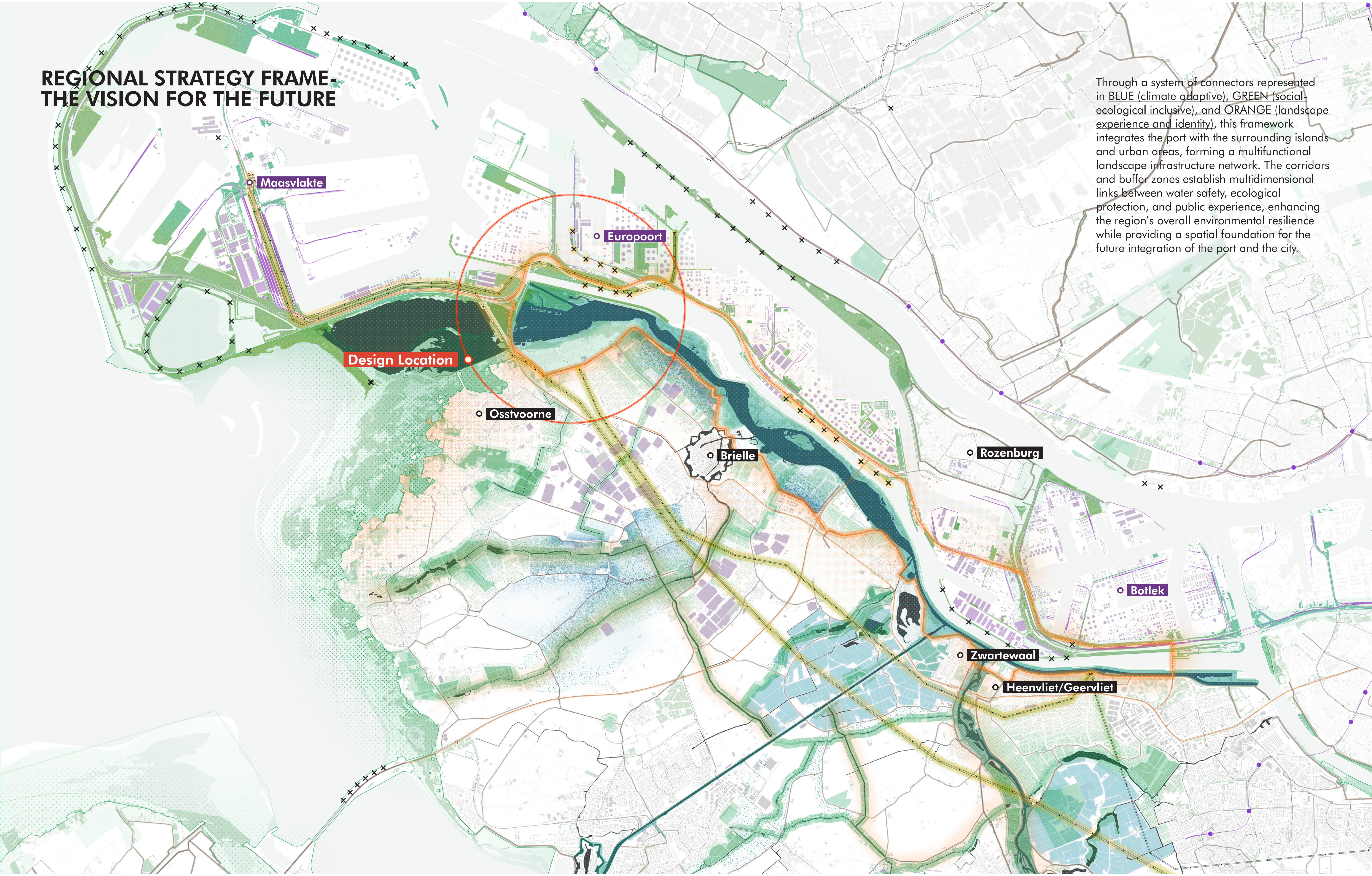


This spatial strategy framework is guided by the principle of enhancing landscape experience and identity, aiming to reshape the spatial character and cultural meaning of the region through landscape renewal and place activation. Various strategy nodes—such as the Lake Recreation Buffer, Stream Recreation Buffer, and Dune Recreation Buffer—develop recreational facilities around the lake area to relieve pressure on the dunes while providing visual and acoustic buffers against port-related pollution and noise. Additionally, strategies like the Infrastructure Recreation Buffer apply landscape design to infrastructure edges, transforming transportation and industrial boundaries into accessible public spaces that also screen environmental impacts from port activities.

In future phases of land use and industrial transformation, strategies such as the Recycle Industrial System and Brown Field Recovery focus on repurposing post-industrial sites and brownfields into spaces for education, exhibition, and cultural exchange, preserving industrial heritage and reinforcing local identity. Rewilding Landscape and Land Use Transformation promote land diversification and ecological aesthetics through natural succession and open-space design, strengthening people's sense of belonging and connection to place. Overall, the strategy integrates ecological restoration with cultural expression and social interaction, creating a multi-functional landscape system rich in identity, beauty, and shared value.

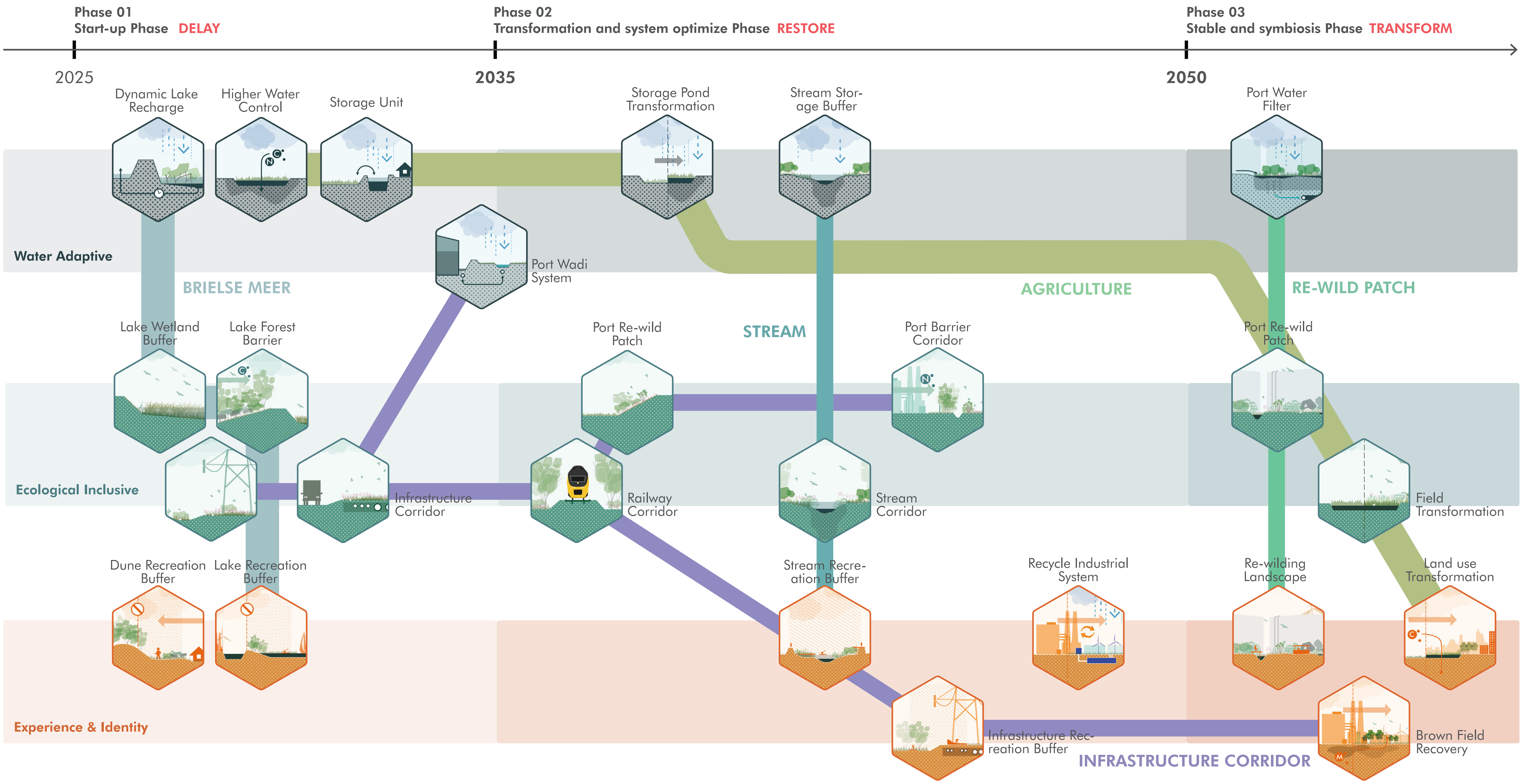
REGIONAL STRATEGY FRAME-THE VISION FOR THE FUTURE

Through a system of connectors represented in BLUE (climate adaptive), GREEN (social-ecological inclusive), and ORANGE (landscape experience and identity), this framework integrates the port with the surrounding islands and urban areas, forming a multifunctional landscape infrastructure network. The corridors and buffer zones establish multidimensional links between water safety, ecological protection, and public experience, enhancing the region's overall environmental resilience while providing a spatial foundation for the future integration of the port and the city.



IN TIME SPAN, HOW DIFFERENT REGIONAL REGIONAL STRATEGIES COMBINED

This diagram illustrates the evolution of the spatial strategy framework across three phases: Start-up, Transformation, and Symbiosis. Different types of strategies—blue for water-adaptive systems, green for ecological-inclusive networks, and orange for landscape identity—are introduced and reinforced over time in response to changing spatial needs. For example, early interventions focus on water storage and control, the mid-phase strengthens ecological corridors and port rewilding, while the final phase emphasizes land use transformation and enhancing landscape experience. This phased approach ensures continuity and system integration, supporting a sustainable regional transition.



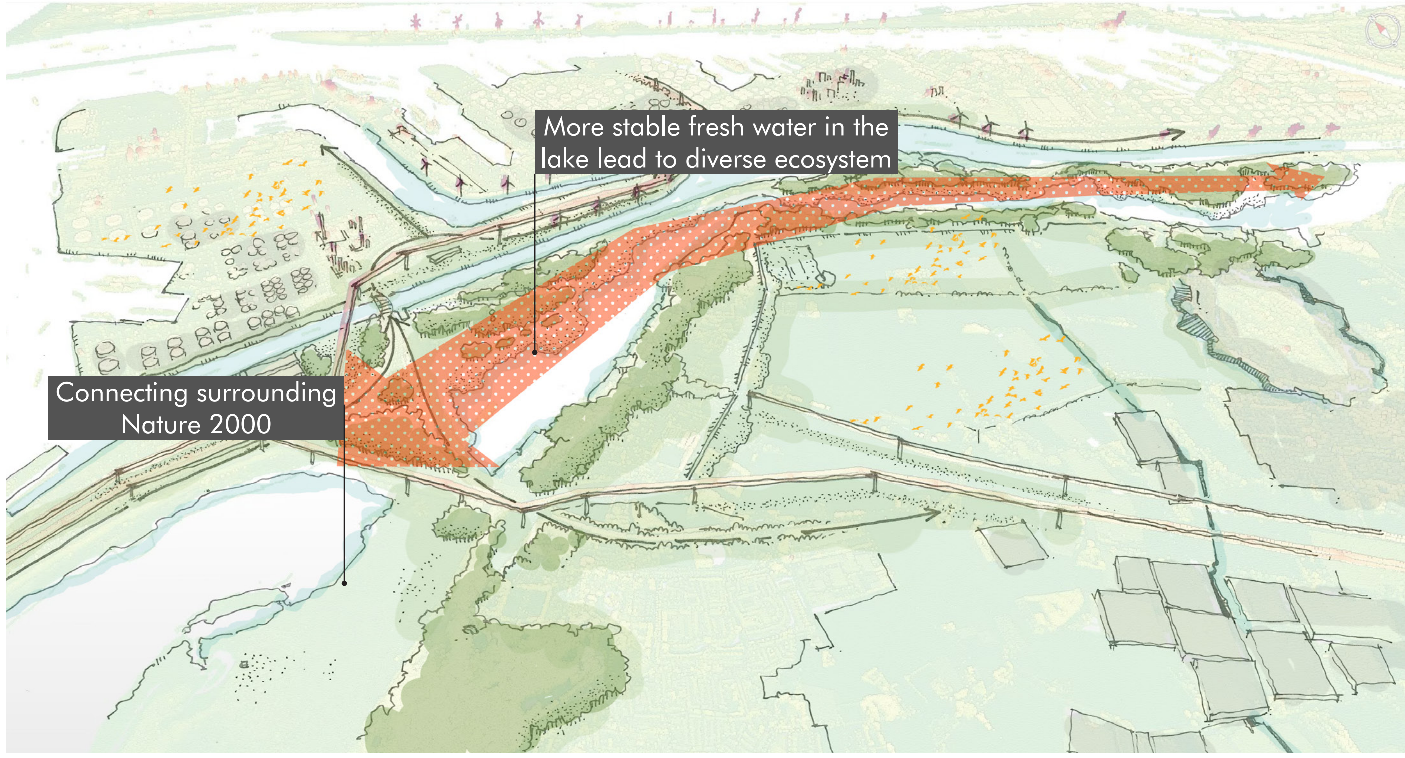
VISION PHASING THROUGH TIME-IMAGING FROM NOW TO 2050

In the 2025–2035 Start-up Phase, the landscape infrastructure frame begins to take shape, focusing on enhancing ecological connectivity and water stability. As shown in the image, linking nearby Nature 2000 areas and stabilizing freshwater input into the lake creates favorable conditions for biodiversity. This phase prioritizes ecological restoration and system activation, laying the groundwork for future transformation.

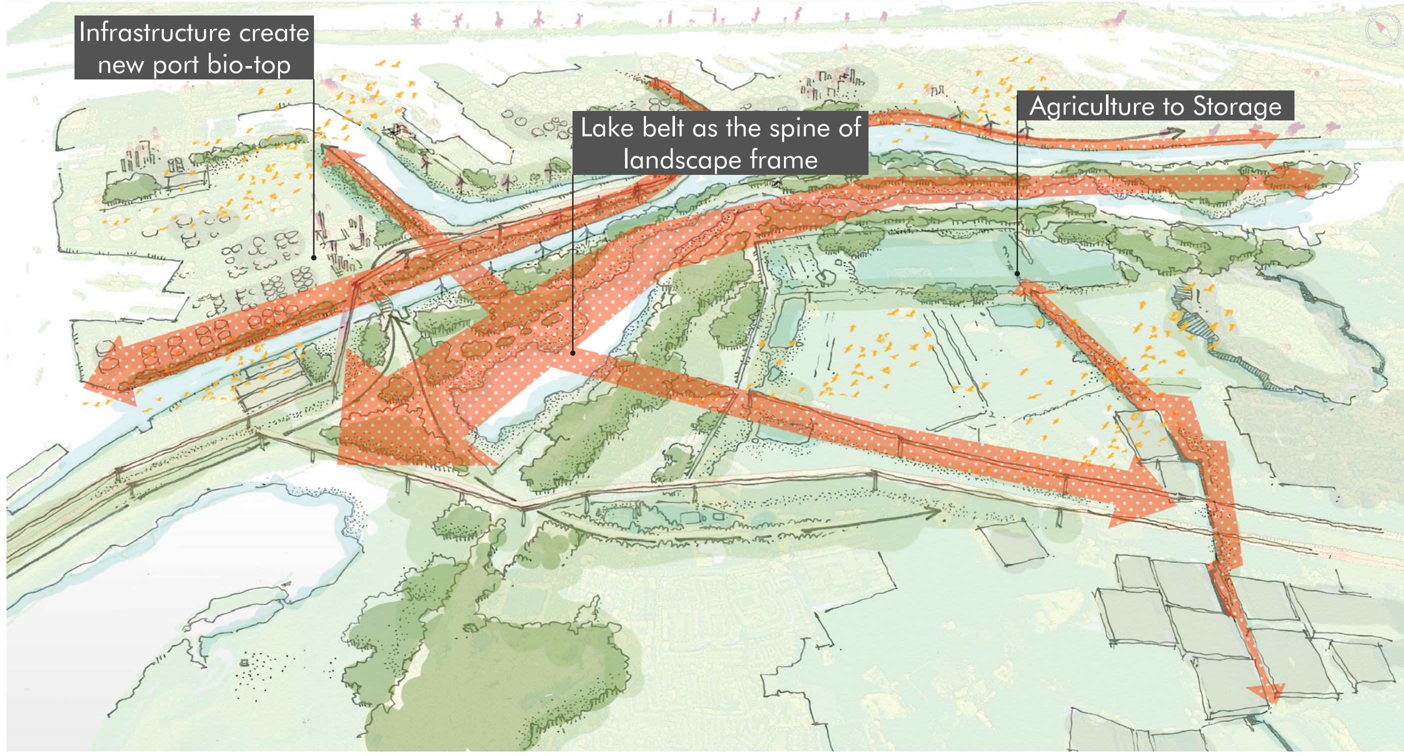
In the 2035–2050 Transformation and Optimization Phase, the framework expands and evolves into a dual-purpose system with both ecological and functional roles. The lake belt becomes the central spine of the landscape structure, while agricultural areas shift toward water storage functions. Infrastructure corridors are integrated into the ecological network, forming new port biotopes and multifunctional green systems that support collaboration between agriculture, infrastructure, and ecology.

By the 2050–20XX Symbiosis Phase, the landscape infrastructure becomes a fully developed and guiding system. Industrial transformation releases more space for nature, while the extended ecological framework reaches the urban edge, serving as a spatial guideline for urban expansion. This final phase illustrates the landscape's role as a mediator between city and nature, achieving long-term harmony and resilience.

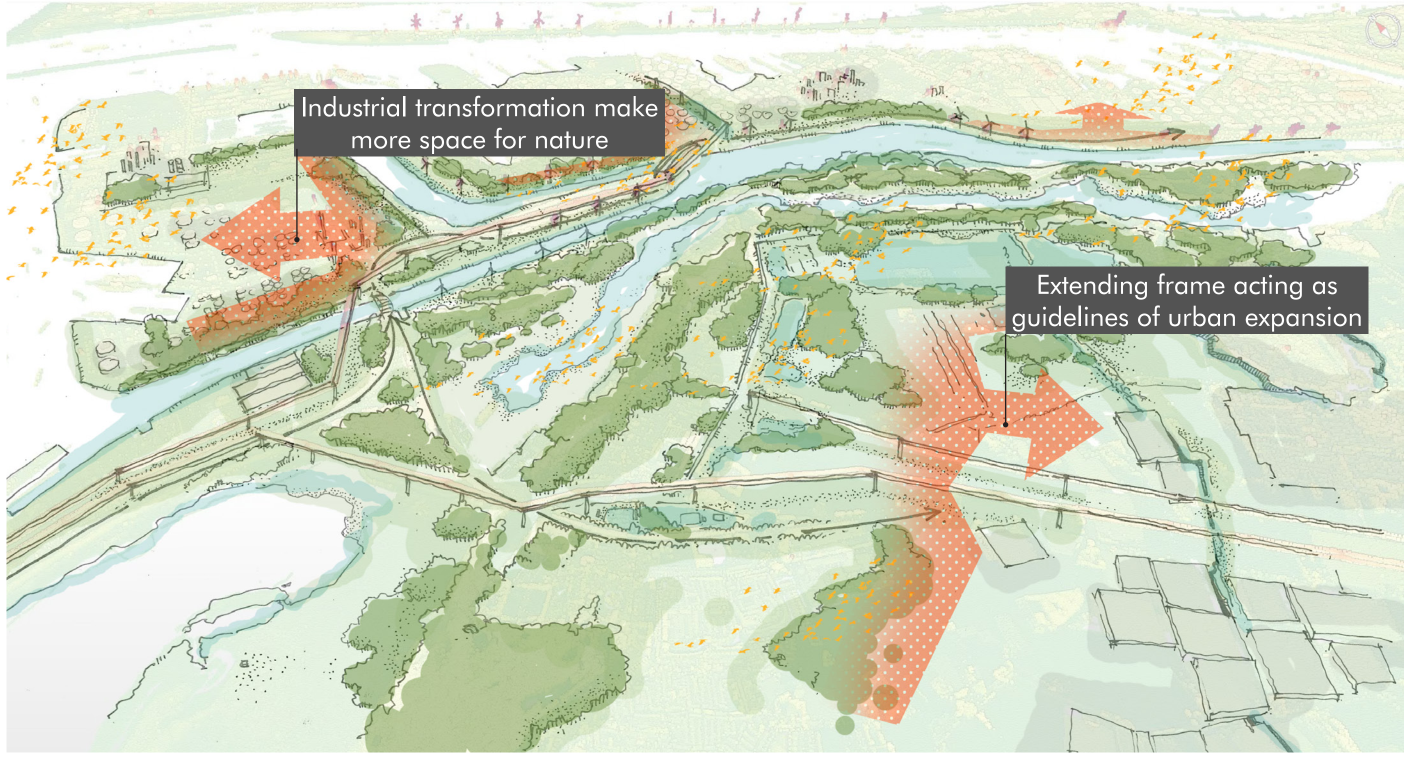
SCENARIO OF 2025-2035



SCENARIO OF 2035-2050



SCENARIO OF 2050-20XX



SUMMARY OF ENVISION

- Strategy/Principal

-What landscape-based design strategies and principles can be employed to create a well connected, coherent and robust landscape infrastructure network?

The transformation of the Rotterdam Port and its surrounding urban areas presents a comprehensive landscape infrastructure framework that operates across both spatial and temporal dimensions. This framework reflects a set of coherent, resilient, and adaptive regional strategies.

1. Spatial Strategies: Building a Multi-Scale, Multifunctional Network
Establishing Core Ecological Structures: The lake belt serves as the central ecological spine, connecting agricultural lands, port industrial zones, and protected areas (e.g., Nature 2000), forming a nature-based backbone for the region.

Integrating Layered Corridor Systems: By combining ecological corridors (forests, wetlands), infrastructural corridors (railways, water channels, power lines), and agricultural buffer zones, a multifunctional and interlinked corridor system is created, bridging ecological, productive, and residential spaces.

Activating Edge Spaces: Through brownfield regeneration, industrial site reuse, and port ecological restoration, formerly peripheral or degraded areas are transformed into accessible, publicly beneficial green spaces.

2. Temporal Strategies: Responding to Phase-Specific Needs
Short Term (2025–2035): Focus on ecological restoration and water system stabilization, enhancing connectivity and preparing conditions for biodiversity.

Medium Term (2035–2050): Optimize agricultural and infrastructural functions by transitioning agriculture to water storage or eco-farming, while reinforcing landscape continuity and habitat diversity.

Long Term (2050–20XX): Enable industrial land to gradually convert to natural areas, extend ecological frameworks to the urban fringe, and guide urban expansion in harmony with ecological systems.

3. Design Principles

- Climate Adaptive: Enhance regional resilience to climate uncertainty through water retention, wetland systems, and stormwater management.

- Social-Ecological Inclusive: Balance ecological functions with human activities and social needs, fostering coexistence between ecosystems, production, and public life.

- Landscape Identity & Experience: Reinforce local character and spatial identity by preserving cultural memory and enhancing landscape aesthetics, strengthening public engagement and sense of belonging.

In conclusion, a well-connected and robust landscape infrastructure network should be spatially rooted in natural systems and supported by multifunctional corridors, evolve through phased development over time, and be guided by design principles that prioritize ecological resilience, functional integration, and cultural continuity. This enables a long-harmonious relationship between people, cities, and nature.

CHAPTER 07-DESIGN EXPLORATION

Shaping Flowscape

Shaping Flowscape

- Workshop and exploration with design office and Zuid-Hollands Landschap
- Why choosing this place for detail design?
- Spatial strategies of interpreting flowscape
- A visit note to the in-between places
- Detail sites design-showcase for future transformation

WORKSHOP WITH-
ZUID-HOLLANDS LANDSCHAP
BUREAU B+B LANDSCAPE

Presenting our workshop to Zuid-Hollands landschap and B+B designers, showing the protentials of using harbor to connect the landscape mosaics

Photo by Steffen Nijhuis

Two main participants are from landscape design office and NGO organization Zuid-Holland Landschap

B+B
Urbanism and landscape architecture

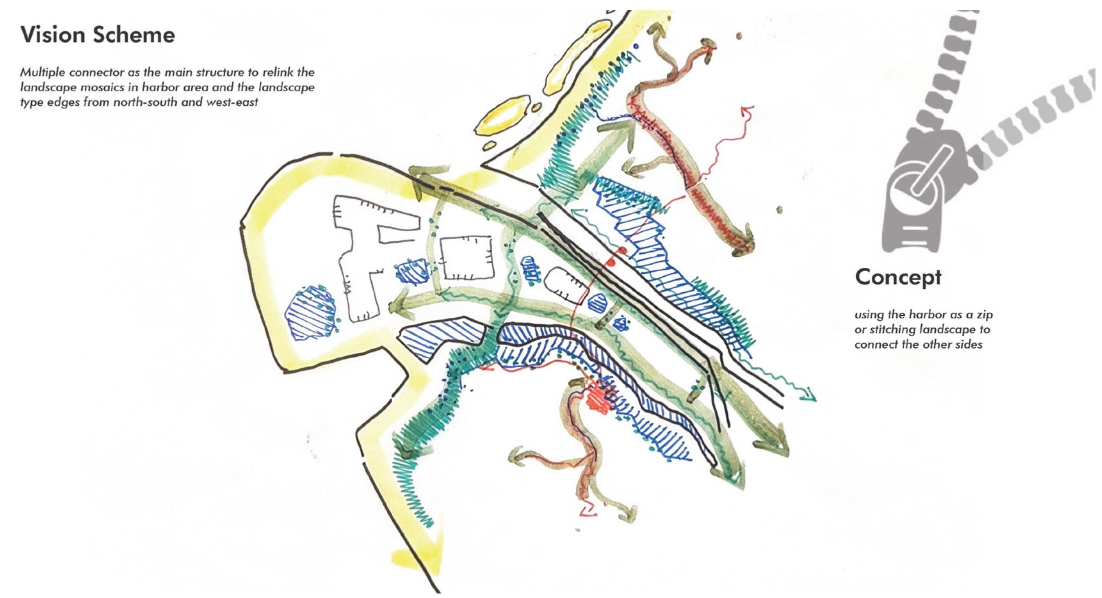
Zuid-Hollands Landschap
natuurlijk dichtbij

This design masterclass focuses on the future development and spatial design of regional parks in South Holland, bringing together two influential Dutch organizations. B+B Landscape Architects, based in Amsterdam, is a renowned design firm known for its work in public spaces, urban transformation, and natural landscapes. Their projects emphasize a strong sense of place, ecological integration, and community involvement. Zuid-Hollands Landschap is a non-profit organization dedicated to the protection and sustainable management of natural and cultural landscapes in the South Holland region through ecological restoration, land stewardship, and public engagement.

During the workshop, participants will work under the guidance of Jacob Gorski (B+B) and Michael Moerman (Zuid-Hollands Landschap) to explore two selected regional park sites. Activities include site visits, issue mapping, concept development, and sketch-based design sessions. Working in small groups, participants will be encouraged to think from multiple perspectives and collaborate across disciplines. The workshop will result in a set of creative and practical design concepts that offer new insights for the sustainable future of regional parks in South Holland.

In the scheme proposed by our group we envision the harbor serve as a zipper to continue the landscape structure shared by both sides

Diagram by Author



This vision focus on 3 main topics from natural inclusive to human mobility to enhance the connectiong, make use of water buffer potential in the lake belt and swampy area in the polder

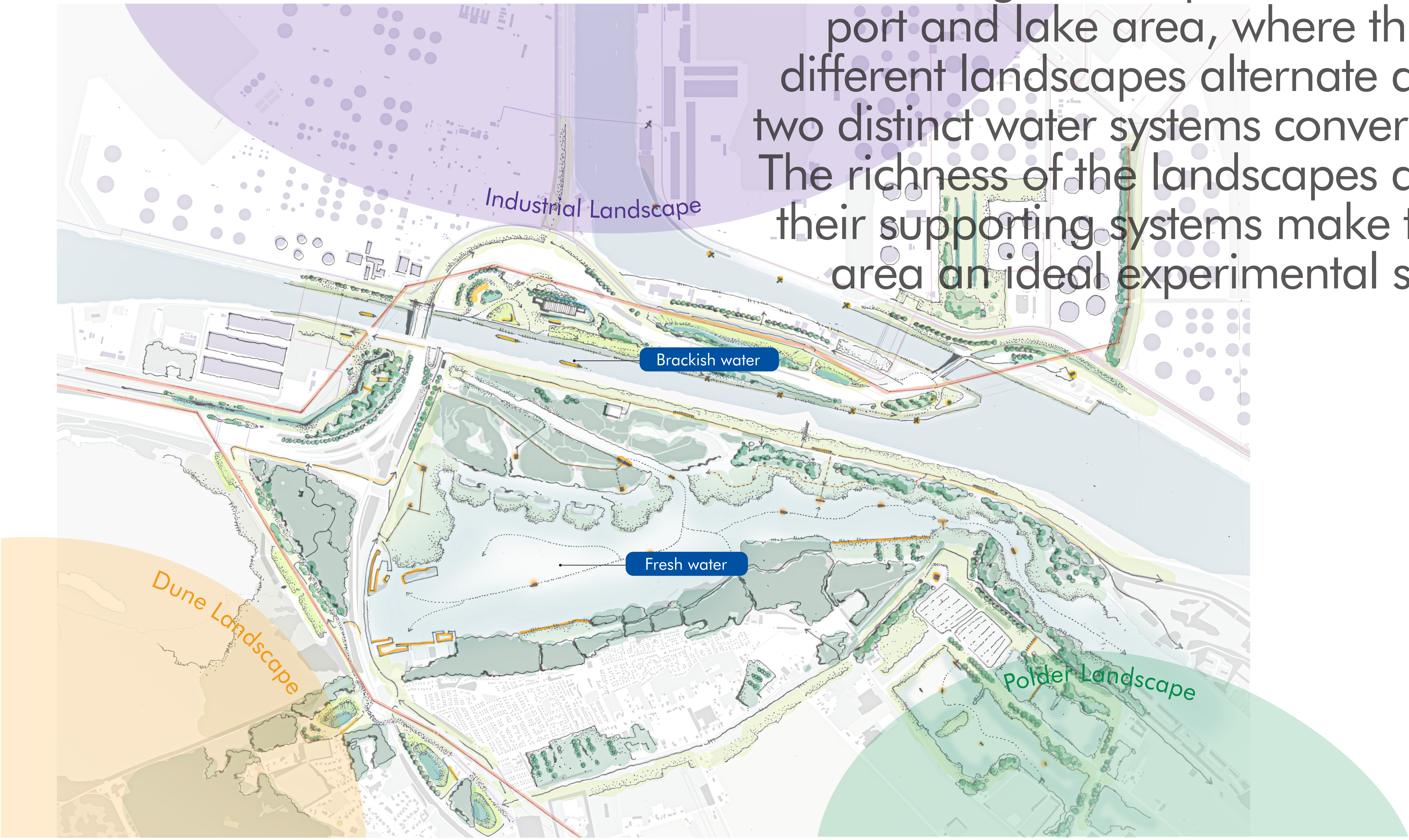
Diagram by Group member of harbor zip line

In the South Holland Regional Park Workshop, the Harbor Zip Line group proposed a landscape design concept centered on the idea of "harbor stitching," aiming to reconnect the fragmented landscape mosaics surrounding the Port of Rotterdam. The design team, composed of three landscape architecture students from TU Delft—Jiaming Huang, Robin Zwartsenberg, and Marziyeh Tahmasbi—developed this rapid concept under the guidance of Steffen Nijhuis, Michael Moerman, and Jacob Gorski. Although the brainstorming session lasted only four hours, the outcome was remarkably rich and comprehensive.

The central concept envisions the harbor as a "zipper" or stitching element, reconnecting the region through multiple green corridors and ecological transitions along north-south and east-west axes. The design emphasizes ecosystem transitions—from coastal dunes and dune forests to swampy wetlands—creating "water buffer corridors" that enhance ecological performance and improve water management. The masterplan introduces a variety of spatial typologies, including a cultural-nature mosaic, water buffer wetlands, eco-industrial islands, and green corridors. These elements combine traditional water culture and spatial heritage from both sides with the modern infrastructure of the port, forming a new, continuous cultural landscape axis.

WHY THIS PLACE FOR DESIGN EXPLORATION?

The reason why I focus on the design at the junction of the port and lake area, where three different landscapes alternate and two distinct water systems converge. The richness of the landscapes and their supporting systems make this area an ideal experimental site.

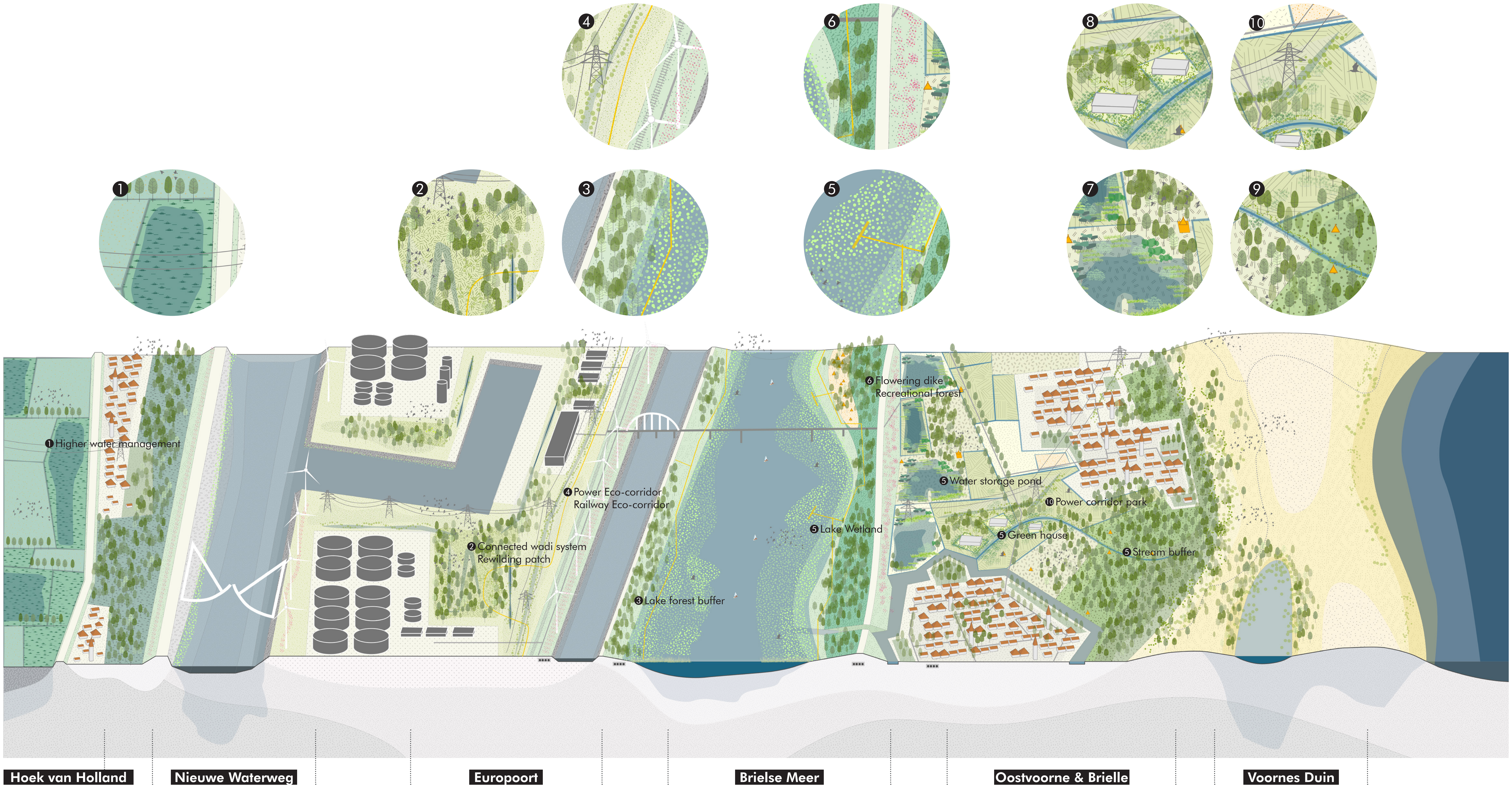


FLOWSCAPE-
OPERATIVE LANDSCAPE STRUCTURES ALONE INFRASTRUCTURE

Many of these flowscape spaces are shaped and influenced by functional infrastructure interventions—for example, areas beneath high-voltage power lines, spaces along pipeline corridors, or even the ecology and vegetation quality along lake edges, which are affected by fluctuating water levels and often lack appeal. However, from the perspective of an integrated system that combines soil and hydrology, these very spaces hold the potential to be reimagined and integrated to create more interactive and engaging environments.

FLOWSCAPE-
DETIAL SPATIAL STRATEGIES

Translating regional-scale strategies into site-specific design requires careful integration of ecological conditions—such as vegetation, hydrology, and soil—with spatial functions and visual experience. Vegetation analysis helps identify ecological corridors and biodiversity hotspots, guiding the selection of native species and planting strategies. Hydrological studies reveal water flow paths and retention points, informing the design of wetlands, rain gardens, or gentle slopes to enhance water storage and purification. Soil types and load-bearing capacity influence land use and topography, allowing for low-impact, sustainable interventions. At the same time, visual and spatial analysis helps shape view corridors and organize spatial sequences, transforming regional landscape features into tangible, functional, and experiential site spaces.



MASTER PLAN-CONNECTING PORT AND ISLANDS

N

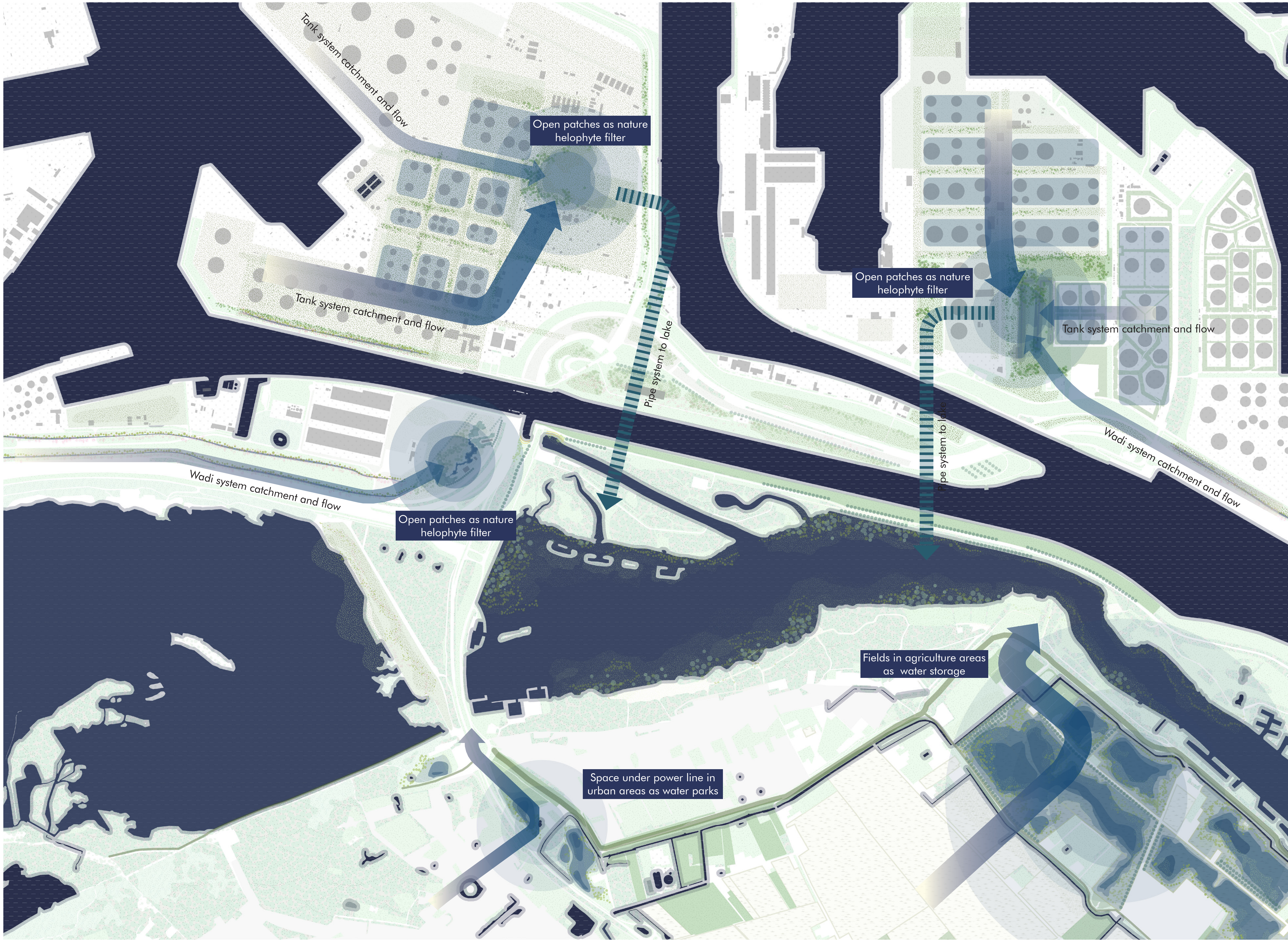
Scale 10000:1

Legend

1. Climate parks
2. Flower meadow alone Powerline
3. Exploration garden assemble
4. Water ditches alone powerline
5. New Porthos station with garden
6. Tempary habitat
7. Green extension between tanks
8. Water ditches alone pipeline
10. Lighthouse-De Stenen Baak
11. Flower meadow and woods alone dike
12. Buffer forest/tree line
13. Water terrance/Tidal park
14. Lake wetland and plank road

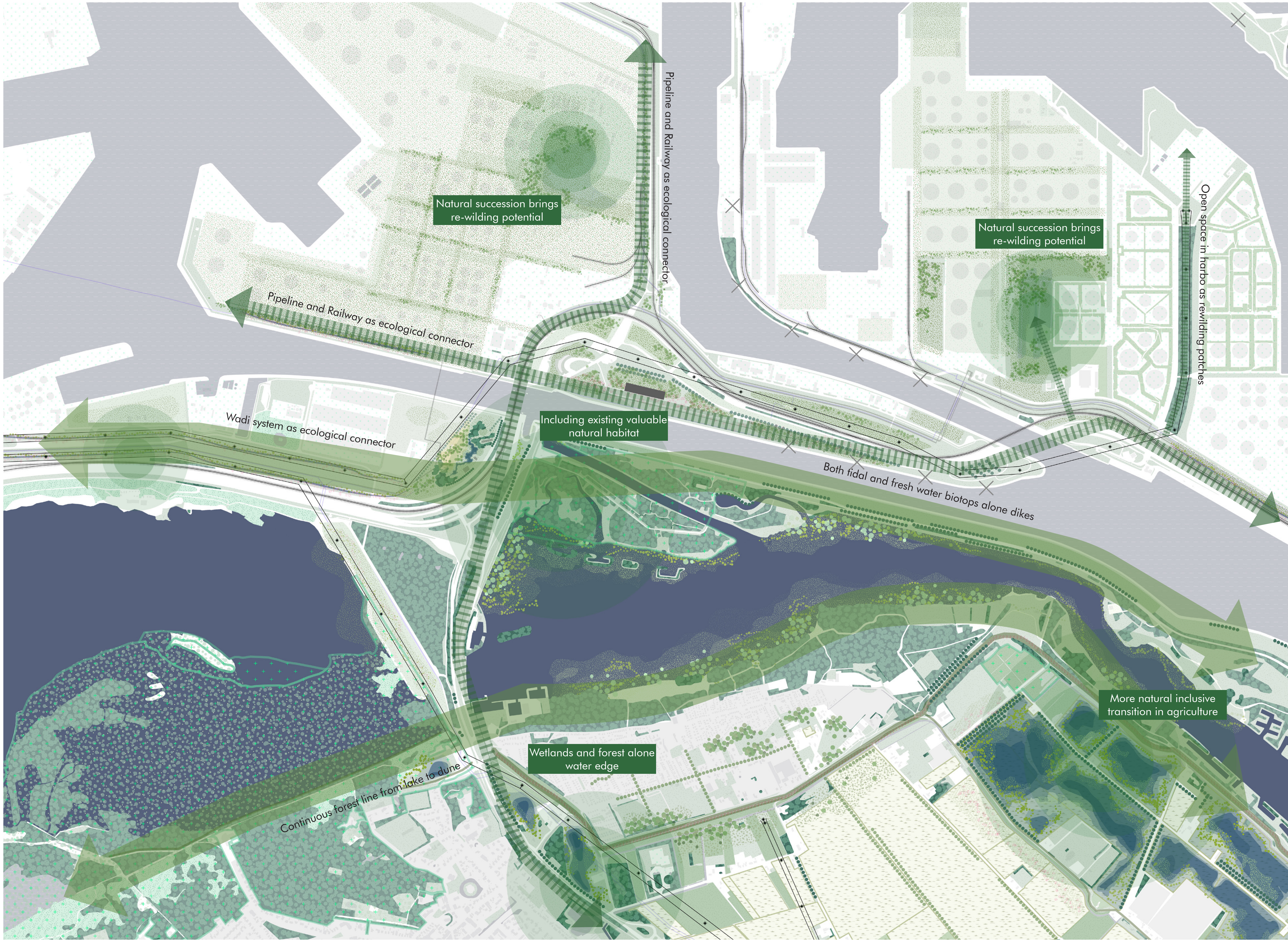
MASTER PLAN-
WATER MANAGEMENT AND RECHARGE

At this scale, water circulation and management are achieved through the integration of natural systems with port infrastructure to fulfill multiple objectives. The drawing illustrates how rain gardens, natural retention areas, and ecological filters are employed to effectively direct and purify surface runoff, enhancing the region's capacity for water storage and purification. The design clearly defines the catchment pathways of the "wadi system" and "tank system," with natural helophyte filter patches placed at the endpoints to purify water through plant-based filtration. Additionally, agricultural fields are designated as buffer zones for seasonal flooding, serving as temporary water storage areas. Underutilized spaces beneath urban powerlines are transformed into urban water parks, promoting multifunctional land use.



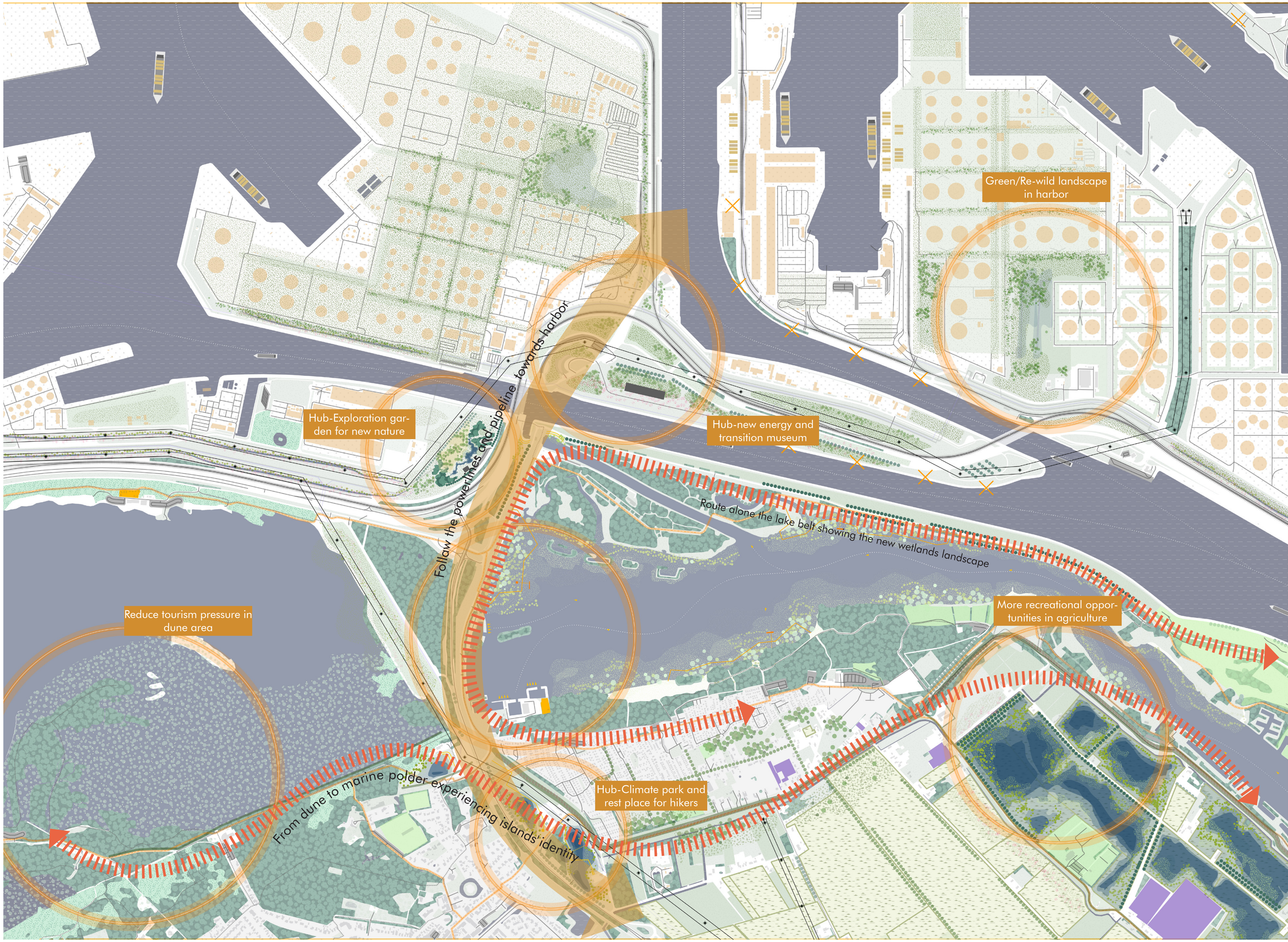
MASTER PLAN- ECO-INCLUSIVE AND DIVERSITY

Ecological corridors and stepping-stone habitats are key strategies for enhancing biodiversity and ecological connectivity. The diagram illustrates a multi-layered network of ecological corridors formed by pipelines and railways, the wadi system, and tidal and freshwater biotopes along the dikes. These corridors link existing high-value natural habitats within the port area and restore ecological structures through zones of natural succession, providing continuous migration routes for species. Meanwhile, wetlands and forests along the waterfront serve as ecological stepping stones, offering habitats and breeding grounds for birds, aquatic species, and other wildlife. The design also transforms agricultural areas into more ecologically inclusive landscapes, using gradual land-use transitions to strengthen the interaction between farmland and natural systems.

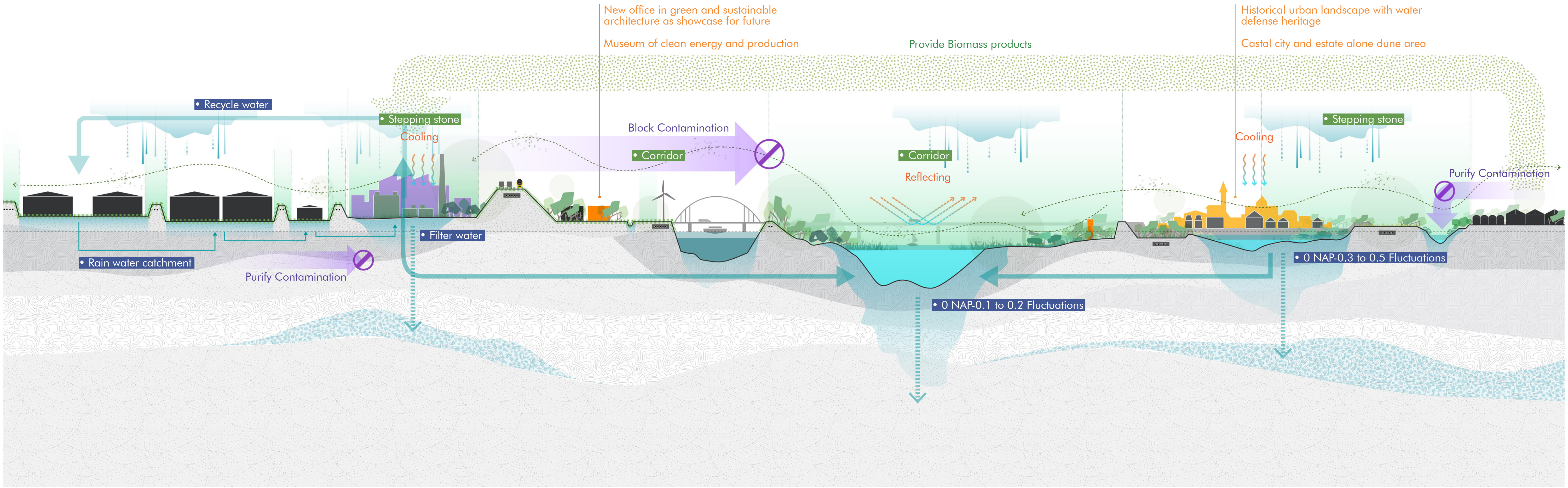


MASTER PLAN-
SOCIAL INTERACTION AND IDENTITY

As a vital medium for enhancing social interaction and place identity, recreational spaces are thoughtfully integrated into the multifunctional landscape structure. The diagram highlights several "hub" nodes—such as the Energy Transition Museum, Climate Park, and Exploration Garden—that link diverse thematic public spaces, offering a wide range of activities for both residents and visitors. These hubs serve not only educational, recreational, and ecological functions but also strengthen the connection between the port area and surrounding communities. A continuous walking and biking network connects the waterfront green spaces, agricultural lands, and nature reserves, creating a varied landscape experience. In the dune area, diversion points are introduced to reduce tourism pressure and protect ecologically sensitive zones, while enhancing the overall visitor experience. In agricultural areas, the introduction of more accessible open spaces allows for a productive yet recreational land-use model.



MASTERPLAN SECTION-SYNERGETIC LANDSCAPE INFRASTRUCTURE FRAME



The key to connecting the Port of Rotterdam lies not in the independent functioning of a single system, but in the synergy and mutual reinforcement between multiple systems. Water management, ecological restoration and the activation of cultural heritage all work together. Industrial areas support ecological corridors and stepping stones by recycling and purifying rainwater, thereby enhancing biodiversity. Green office buildings and clean energy exhibition spaces not only promote sustainable development but also serve as showcases for future innovation. On the other side, cities, agricultural zones, and lake areas benefit from freshwater storage and climate adaptation strategies, ensuring water security and agricultural productivity to support new biomass industry. This integrated, multi-system approach forms a resilient, sustainable, and vibrant landscape network extending from the inland to the port.

SITE VISIT-
ROUTE ACROSS LANDSCAPE AND INFRASTRUCTURE

This route begins at the bus stop in Oostvoorne and heads north, passing through rural fields, water infrastructure, and eventually reaching the BP Rotterdam industrial area. It represents a typical linear landscape infrastructure corridor that spans natural, agricultural, and industrial environments.

Starting from the bus stop, the path enters an open landscape of low-density housing mixed with farmland. The space feels expansive, with distant views of hedgerows and scattered farmhouses. Rows of poplars and acacias line the road. As the route continues northward, shelterbelts narrow the view, leading into an ecological transition zone dominated by secondary forests and shrubs. The vegetation is dense and diverse, birds are frequently heard, and occasional walkers and cyclists appear—this is where the interaction between humans and nature is most evident.

Further along, the route reaches the Pump Station area, where the land noticeably dips. This is a key point in regional water management. The landscape here is defined by the technical structures of the pumping facility and drainage channels. Vegetation mainly consists of aquatic plants and low grasses, with ducks sometimes seen on the water. Though heavily engineered, this section retains a certain natural beauty due to the nearby lake and open green spaces.

Crossing the Hartelkanaal canal, the space suddenly opens up. A bridge provides wide views toward the port's industrial zone. The strong wind and the sound of vehicles underline the shift in atmosphere. The massive scale and orderly layout of the industrial structures contrast sharply with the natural scenery to the south.

After passing Spuisluis Rozenburg, the route enters the edge of the BP Rotterdam industrial park. Vegetation disappears, replaced by concrete roads, oil tanks, and pipelines. The space feels enclosed and highly artificial, but also reveals the strength and logic of heavy infrastructure.

This route exemplifies the layered character of a landscape infrastructure corridor—transitioning from nature to engineering, from ecological zones to industrial cores. Its clear spatial rhythm makes it an important pathway for understanding regional structure, ecological connectivity, and landscape transformation.

Diverse plants alone water in urban area of Osstvoorne
-Photo by Author

The cycle path and the tree corridor alone N218
-Photo by Author

Deep grass and tree canopy in the shadow
-Photo by Author

Across the national road the open field with very dry dike showed up
-Photo by Author

A cyclist moves through a quiet green corridor where dense woodland meets open grassland, framed by towering power lines that mark the intersection of natural and infrastructural landscapes
-Photo by Author

Standing along the landscape infrastructure corridor, the traveler observes a transition zone where natural vegetation, utility structures
-Photo by Author

A narrow dirt path winds through a grassy valley beneath towering power lines, guiding the eye toward a dense woodland edge
-Photo by Author

Layered landscape where a quiet marina meets open grassland, framed by industrial chimneys and wind turbines in the distance—highlighting the coexistence of recreation, nature, and infrastructure
-Photo by Author

Vibrant marina nestled between lush greenery and light industrial buildings, where leisure boats, working vessels, and modern facilities coexist along the calm waters
-Photo by Author

Peaceful stretch of road and bike path running alongside the lake, framed by tall grasses and dense woodland
-Photo by Author

A serene lakeside view where small islands and distant wind turbines coexist, reflecting the harmonious blend of natural ecosystems
-Photo by Autho

Tranquil wetland scene where reeds and aquatic plants frame a calm water body, with waterfowl drifting peacefully and wind turbines rising above the forested horizon
-Photo by Author

Taken near the freshwater sluice, the diffrences of fresh water and salt water can elaborate clearly
-Photo by Author

Near the freshwater sluice, captures the striking transition from natural grassland and woodland to the industrial edge of the harbor
-Photo by Author

Hartelkanaal freshwater sluice where the canal connects, showcases the dramatic interface of hydraulic engineering, industrial infrastructure, and transport systems
-Photo by Author

Highlights the contrast between hard infrastructure and soft ecology, as a lone swan glides along the engineered shoreline
-Photo by Author

The open space surrounding the sluice, captures a moment of human-scale exploration amid rough vegetation, exposed stones, and infrastructural embankments
-Photo by Author

A pile of porous concrete blocks slowly being reclaimed by pioneer vegetation—illustrating how even the most industrial materials can host unexpected moments of ecological succession
-Photo by Author

Cars, cyclists, and pedestrians move beneath massive highway bridges, with the industrial skyline and calm waterway unfolding toward the port in the distance
-Photo by Author

along the Hartelkanaal, presents a striking industrial waterscape—where a quiet cycling path runs parallel to the canal, flanked by fuel storage tanks and distant cranes, revealing the vast scale and spatial order of the Rotterdam port infrastructure
-Photo by Author

The textured riverbank where wild grasses and red poppies soften the edge of a stone revetment
-Photo by Author

the transitional fringe between infrastructure and logistics, where power lines, fenced industrial zones, and paved accessways meet a sparse, semi-wild grassland—illustrating the in-between space shaped by utility and low-maintenance vegetation
-Photo by Author

A patchy, unmanaged field under power lines, observing the intersection of utility and abandonment
-Photo by Author

This photo reveals a denser section of spontaneous vegetation, where low shrubs and trees gradually reclaim unused land beneath transmission towers
-Photo by Author

Broader clearing framed by woodland edges, where meadow-like vegetation hints at passive ecological succession
-Photo by Author

wild growth in the foreground with large oil tanks and pylons in the distance, highlighting the layered coexistence of heavy industry and rewilded landscapes
-Photo by Author

A wide canal flanked by grassy embankments and lined with wind turbines, emphasizing the corridor-like openness of the site
-Photo by Author

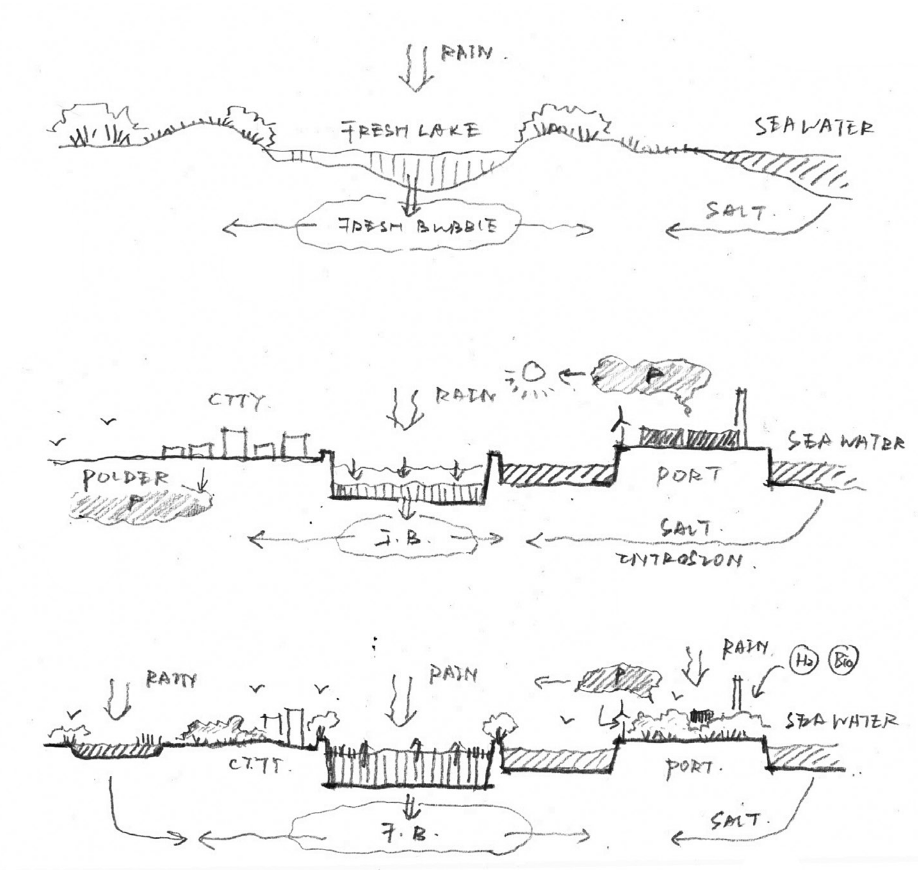
Contrasts dense refinery structures with roadside signs, signaling the proximity of heavy industry to open land
-Photo by Author

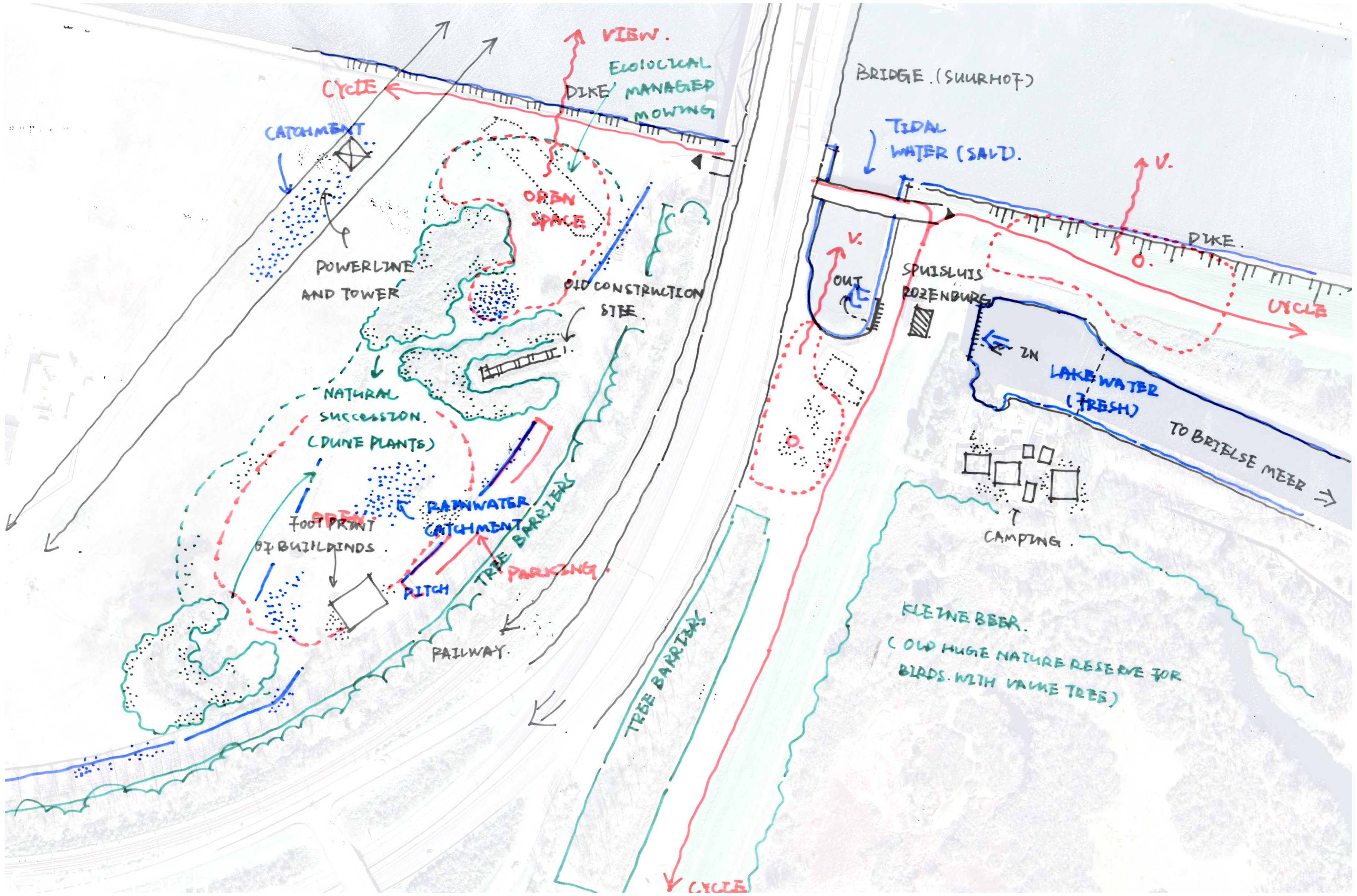
Intersecting roads and pathways surrounded by patchy vegetation and overgrown ditches
-Photo by Author

EXPLORATION GARDEN- CONCEPT AND ANALYSIS

In the detailed site design, we draw inspiration from the dynamic relationships of the original delta landscape, reintroducing processes and vegetation as design materials to strengthen the resilience and stability of the current port and island landscape. The hand-drawn concept sketches illustrate the transformation from a natural freshwater lake system to a hardened port environment. Historically, rain-fed "freshwater bubbles" created natural buffers against saltwater intrusion. However, with the expansion of urban and port infrastructures, these soft ecological systems were replaced by rigid constructions, leading to saline intrusion, freshwater scarcity, and ecological degradation.

Our design re-establishes a new "freshwater bubble" zone between the urban, port, and coastal layers—a multifunctional landscape unit for freshwater retention and ecological regeneration. By creating diverse wetland typologies and introducing native, salt-tolerant vegetation (such as halophytes, emergent plants, and tidal woodland species), the site becomes a habitat-rich biotope supporting biodiversity and ecological connectivity.
At the same time, various hydrological boundaries—including rainwater catchments and underground freshwater lenses—are integrated into a systemic water regulation network, enhancing the site's capacity to adapt to climate change and sea-level rise.



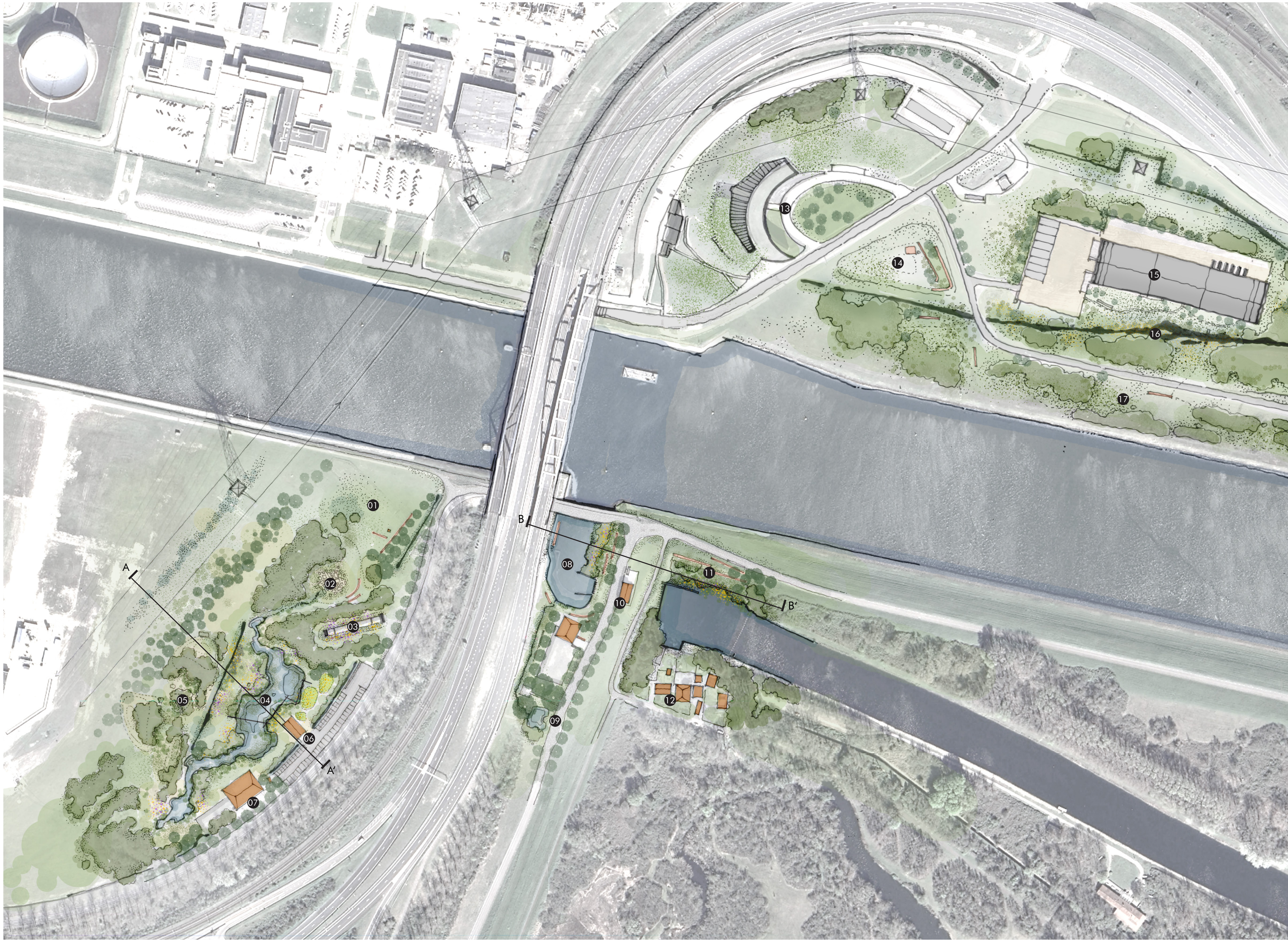


From the simple analysis of the landscape elements of the site, it can be seen that there are rich infrastructure and ancillary space, such as high-voltage lines, drains and some left over industrial buildings. At the same time, it also has rich natural conditions. The meadows here have adopted the ecological management method. At the same time, the space under the high-voltage line and the natural succession of vegetation communities near the site have the value of research and protection. The broad vision and rich landscape make it a good choice for practicing landscape strategy and education.

DETAIL PLAN- EXPLORATION GARDEN AND PORTHOR OFFICE

In the design plan, the open space on the left is transformed into garden assemble to try to create a kind of sand dune landscape. Combined with the transformation of infrastructure space, it forms a garden combination park with different biotops. The main purpose is to practice the collection and recycling of rainwater and explore the possibility and vegetation type of similar open space wilderness and natural restoration. The drainage outlet on the right is transformed into a tidal Park, which changes the slope on the side and increases the breaker to promote sedimentation and form a new vegetation community. The ecological comparison of fresh water and salt water on both sides can realize the miniature and educational significance of the landscape.

On the other side of the canal alone the BP Rotterdam office will be a new station for Project Porthor which works on carbon storage. the idea in here is to connecting and expanding the edge of existing wadi and ditches to make wet gradient to encourage water circular.

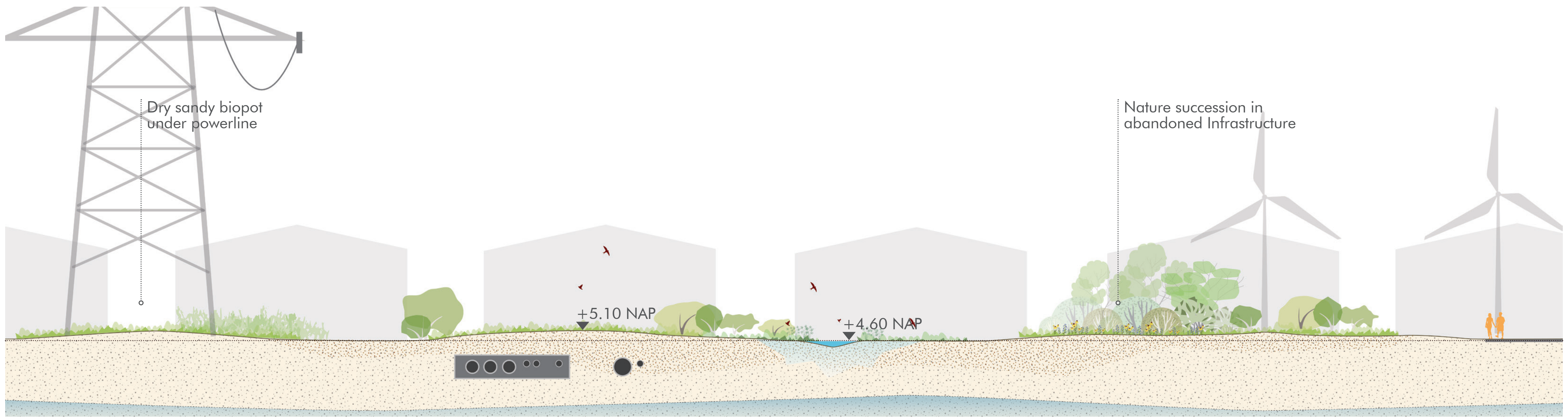


01 Open Meadow
02 Water Detention Garden
03 Industrial Heritage Garden
04 Wetland Educational Garden
05 Dune Garden
06 Tourist Center
07 Cafe
08 Tidal Park
09 Rain Garden
10 Sluis Rozenburg
11 Wetland Terrance
12 Camping Complex
13 BP Rotterdam
14 Grass Slope
15 Porthor Station
16 Open Ditch
17 Path with Benches

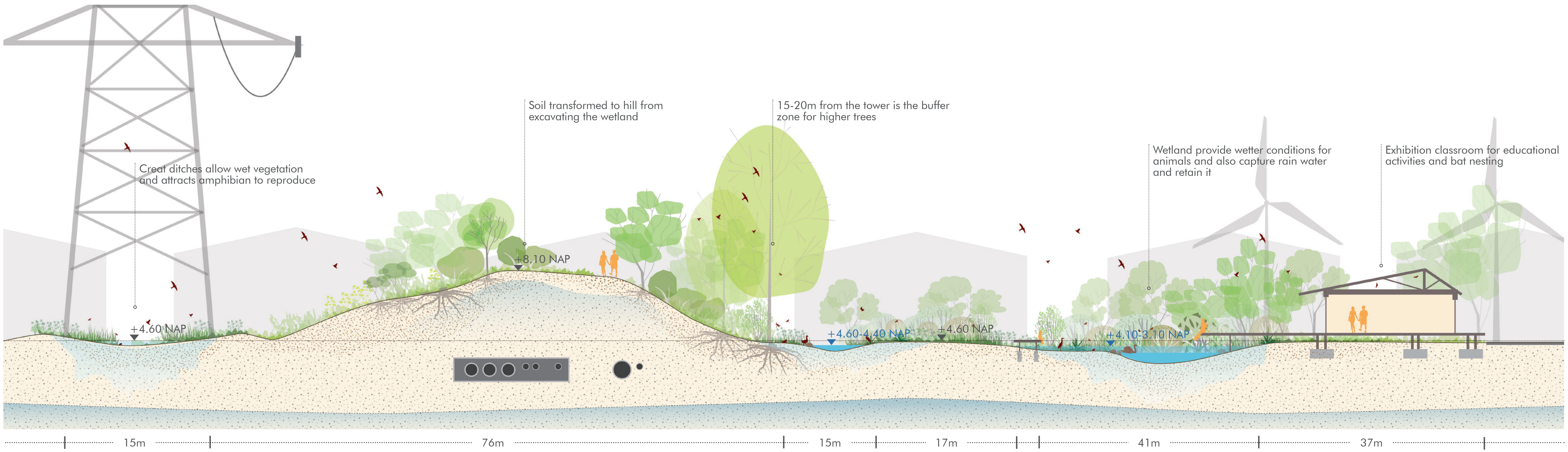
DETAIL SECTION- EXPLORATION GARDEN

In this section, the garden design highlights how variations in elevation and moisture conditions can create more diverse vegetation and ecological habitats that attract wildlife. At the same time, it serves as an experimental site to test the effectiveness of water management strategies. These changes in topography and hydrological conditions are inspired by natural dune systems. The design also emphasizes the use of locally sourced building materials and native plant species to strengthen the role of natural succession over time.

• **Current Situation A-A'**



• **Designed Phase to 2035 A-A'**



PROCESS SECTION- EXPLORATION GARDEN

In the process of nature-inclusive dune construction, the development from dune formation to natural succession can be divided into three stages. In the first stage (years 1–3), pioneer species such as marram grass (Ammophila arenaria) are planted to stabilize the sand and form embryonic dunes. In the second stage (years 3–6), the landscape transitions into grey dunes, where vegetation becomes more diverse, including herbaceous species like Festuca. In the third stage (years 6–10), the ecosystem further develops into a more complex and diverse structure with shrubs and some tree species, while low-lying areas gradually evolve into wet dune habitats. This process relies on the natural spread of native species combined with appropriate human management, such as ecological mowing once every one to two years and selective pruning of shrubs. Ultimately, it leads to a highly biodiverse and self-sustaining natural environment.

Herbaceous Species

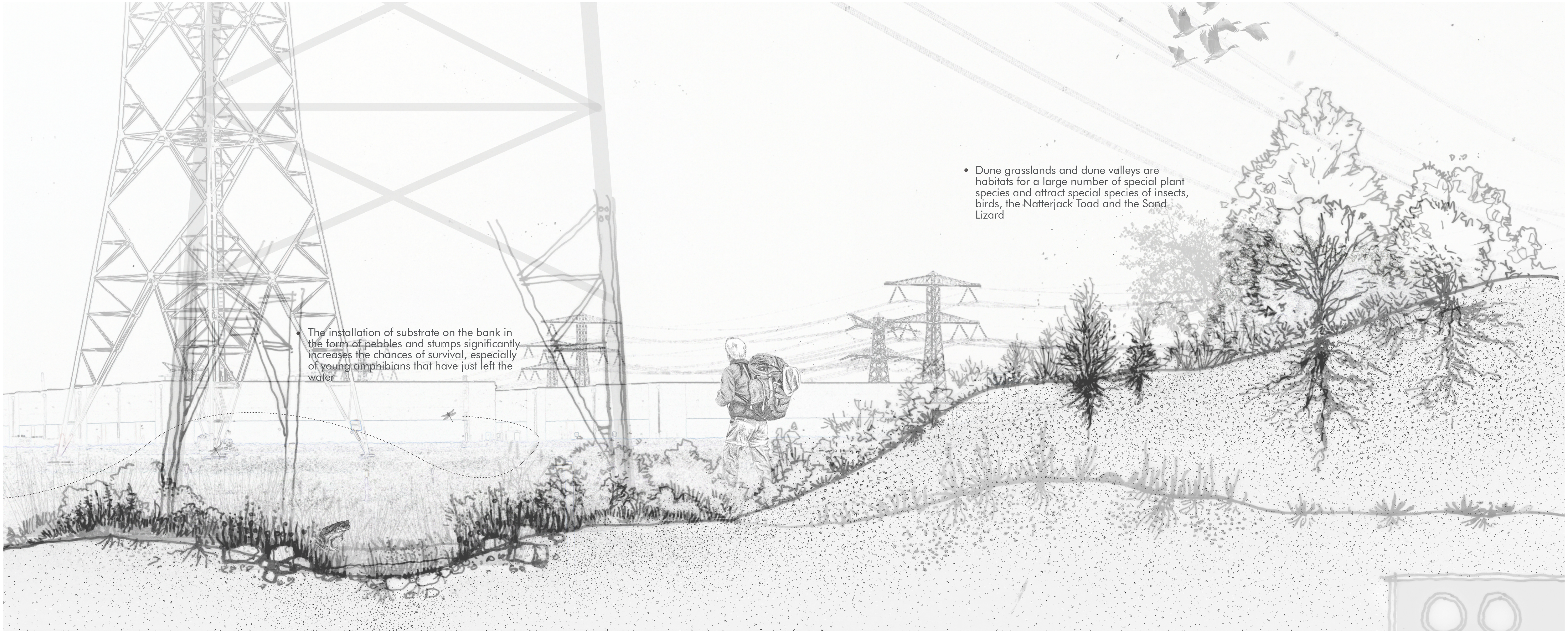
- *Ammophila arenaria*
- *Festuca rubra*
- *Carex arenaria*
- *Helichrysum arenarium*
- *Viola curtisii*

Shrubs

- *Salix repens*
- *Hippophae rhamnoides*
- *Juniperus communis*
- *Empetrum nigrum*

Trees

- *Betula pubescens*
- *Populus tremula*
- *Quercus robur*



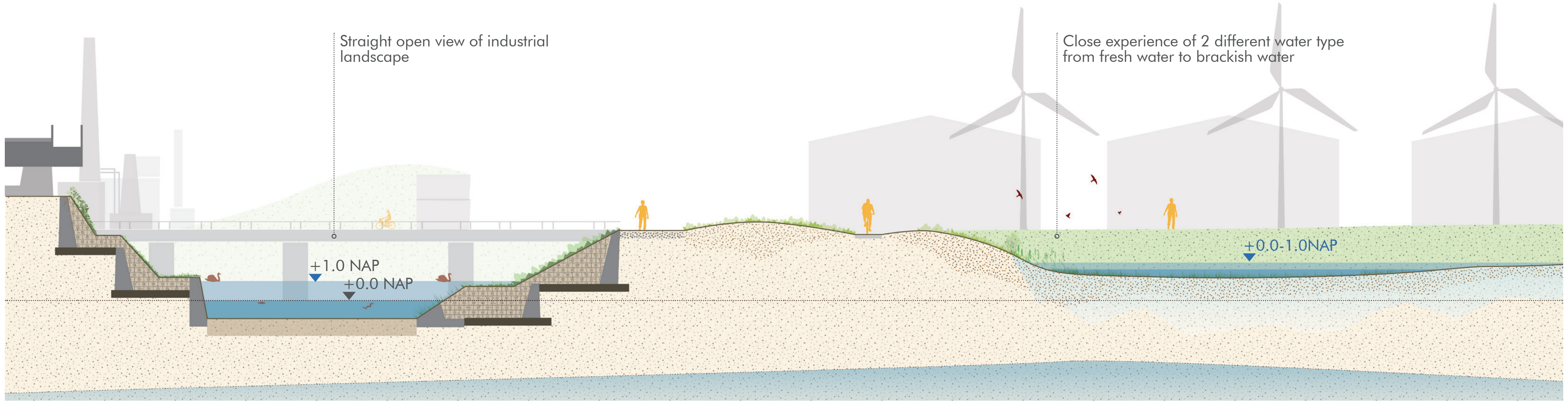
The view from wetland educational garden, the tree line and dune make up for the skyline and wetland brings vibrant ecosystem

The view from water detention garden, the garden surrounded by native plants and bricks can be recycled as pave martials

DETAIL SECTION- TIDAL PARK AND WATER TERRANCE

In this section, the tidal garden design emphasizes how to enhance the perception and awareness of two distinct types of water—freshwater and brackish water.
The corresponding vegetation and natural typologies form a microcosm of the broader regional landscape. The contrast between this miniature natural environment and the vast industrial backdrop of the port reveals a subtle poetic quality embedded within the landscape.

• **Current Situation B-B'**



• **Designed Phase to 2035 B-B'**

PROCESS SECTION- TIDAL PARK AND WATER TERRANCE

In the tidal transition zone of South Holland, such as the Hartelkanaal in the Port of Rotterdam, ecological sedimentation flats can be developed using a "nature-based" approach. The strategy is implemented in phases: in the initial stage (years 1–2), sediment-guiding structures are installed to induce the deposition of silt and clay carried by the tides; in the middle stage (years 3–6), salt-tolerant pioneer species such as Spartina anglica and Salicornia europaea are introduced to stabilize the sediment and create a foundation for further vegetation succession; in the final stage (years 7–10), a structurally diverse wetland community is established by introducing species like Phragmites australis, Bolboschoenus maritimus, Aster tripolium, and native shrubs. Throughout the process, regular ecological monitoring and limited interventions are carried out to ensure the stable evolution and long-term resilience of the ecosystem.

Salt Marsh Species

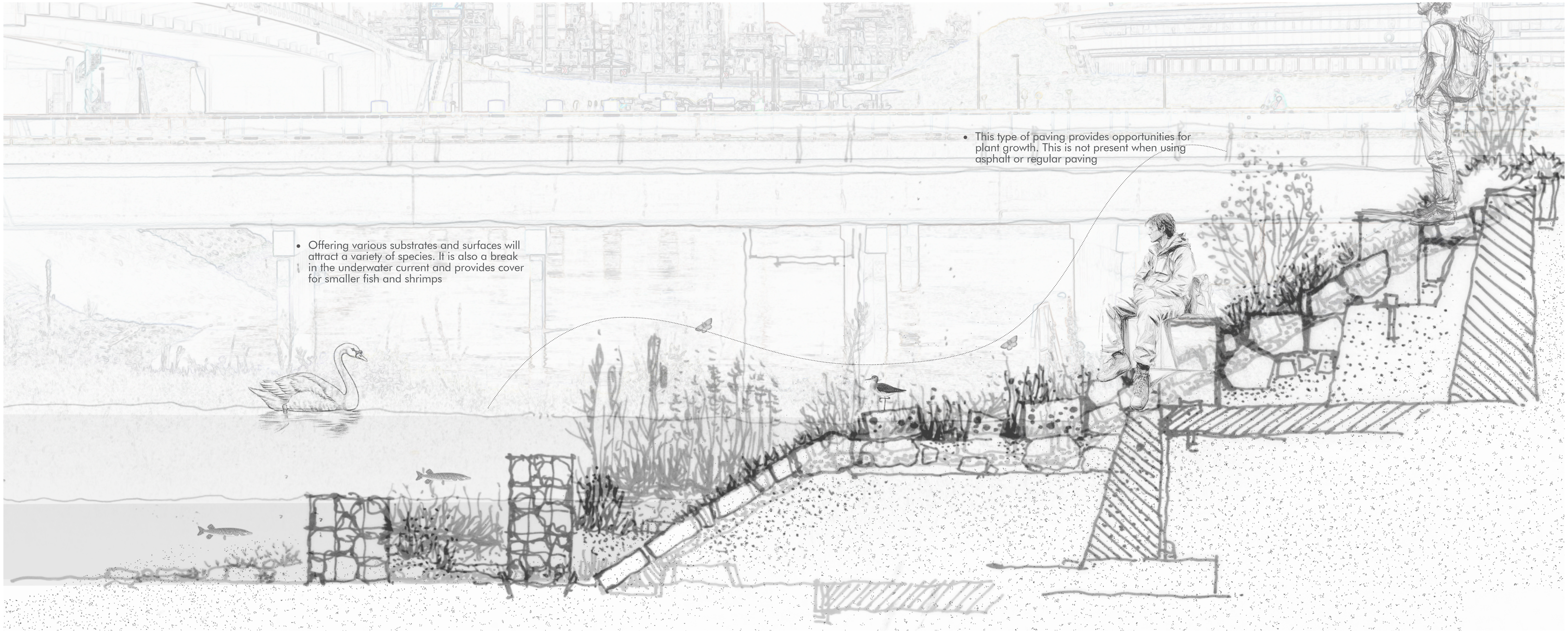
- *Spartina anglica*
- *Salicornia europaea*
- *Phragmites australis*
- *Bolboschoenus maritimus*
- *Aster tripolium*
- *Carex spp.*

Herbaceous Species-Rocky

- *Sagina procumbens*
- *Polypogon monspeliensis*
- *Mentha aquatica*
- *Portulaca oleracea*

Shrubs

- *Salix alba*
- *Corylus avellana*
- *Cornus sanguinea*
- *Sambucus nigra*



The view from tidal park, stone blockers encourage sediment process and bring back salt marsh plants and animals

The view from dike alone Brielse Meer, the plants become more diverse because the water level management

SUMMARY OF DESIGN EXPLORATION

- Application

-How to apply design strategies and principles across scales and what's the connection between landscape infrastructure design in regional and detail scale ?

In the sustainable transformation of the Port of Rotterdam and its surrounding areas, the landscape infrastructure design demonstrates a clear logic that bridges regional and site scales—from strategic vision to detailed implementation. At its core, it establishes a layered, multi-scale, and integrated system that aligns ecological, social, and industrial functions.

At the regional level, the strategy builds a multifunctional infrastructure network through blue (climate-adaptive), green (social-ecological inclusive), and orange (landscape identity) corridors and nodes. For example, the lake belt acts as an ecological spine linking agricultural zones, urban areas, and port industries. Existing hard infrastructures such as railways, pipelines, and powerlines are transformed into ecological or public corridors, integrating ecological processes and providing spatial guidance for future development.

At the local level, the design concept of "Flowscape" translates regional strategies into tangible and experiential spaces. In the "Exploration Garden," for instance, regional water strategies are materialized through rain gardens, wetlands, and retention ponds, combined with native planting and microtopography. This ensures the continuity of ecological logic while enhancing site-specific biodiversity and water management.

A key strength lies in the continuity of system logic and spatial language between scales. The regional structure of "lake–corridor–node" is echoed in the site as wetlands, forest belts, and public spaces. This seamless transition ensures that users can perceive and experience the spatial narrative from large-scale frameworks to local interventions.

Finally, the project constructs a landscape infrastructure system that evolves over time and supports multi-system coordination. It advances through distinct phases—Start-up, Transformation, and Symbiosis—while integrating water management, ecological restoration, energy transition, cultural identity, and public interaction. Each component serves multiple purposes: powerline corridors become both ecological connectors and community spaces; water systems support flood control and biodiversity. Through this collaborative and adaptive structure, landscape infrastructure becomes more than a planning tool—it serves as a long-term driver of sustainable regional transformation.

The connection between the regional and detail scales is established through the continuity of system logic and spatial language. Regional strategies provide overall direction and structural guidance, while detailed design localizes and practise these strategies, giving them a sense of place and practical applicability.

CHAPTER 08-FUTURE OF THE FRAME

Conclusion and Reflection

Conclusion and Reflection

- what is the conclusion of this research?
- Future of the frame-Guidance of urban expansion
- Reflection about research and design aspects

CONCLUSION

BACK TO THE RESEARCH OBJECTIVE

How does this research help to connects Voorne-Putten and the Port of Rotterdam and regenerates a robust nature, water and productive new landscape ?

This research establishes a multi-layered framework that bridges theory and practice, centering on the concept of systemic landscape transformation. By progressively deconstructing problems, formulating strategies, implementing design interventions, and reflecting on outcomes, it supports a sustainable future for the region.

Theoretical and Practical Framework Summary
Following the research framework, the study is structured around four key sub-questions:

1. Understanding Challenges and Potentials (Sub Question 01)
Through spatial, ecological, and functional analysis of the Voorne-Putten and Port of Rotterdam region, the study identifies three major challenges to establishing a green-blue infrastructure: fragmentation at both ecological and social levels, expansion of urban and port development, low climate adaptation capacity, and complex governance structures. Simultaneously, it reveals potential transformation opportunities in underutilized infrastructure, open industrial lands, and waterfront buffer zones—elements that could be integrated into a broader ecological network.

2. Strategy and Design Principles (Sub Question 02)
Based on the previous analysis, a transformation framework is developed around four key dimensions: time, space, function, and system. The strategy emphasizes four core principles—ecological corridor development, multifunctional integration, water system resilience, and cultural identity—to guide a phased transformation process over 2025–2035–2050.

3. Design Application (Sub Question 03)
The transitional zone between Voorne and the Port of Rotterdam is selected as a pilot site. A masterplan at the regional scale is developed, followed by detailed design at the local level. The design demonstrates continuity between system logic and spatial language by integrating green-blue corridors, thereby facilitating synergy between ecological restoration, water management, and urban development.

Research Conclusion: Connecting Voorne-Putten and the Port of Rotterdam for a Robust Nature, Water, and Productive Landscape
1. Reconnecting Ecological and Water Systems
In complex transition zones, green-blue systems are often fragmented by dense grey infrastructure. This study reinterprets grey infrastructure through the lens of landscape infrastructure, especially in the context of ports and islands. It identifies opportunities to repurpose infrastructural corridors for ecological management and reconnection. By analyzing soil and water systems, the study recognizes the dynamic interplay between sandy and clay soils and uses the variation between freshwater and brackish water systems to stimulate a regenerative hydrological cycle. These two foundational systems—soil and water—are key to reconnecting fragmented landscapes and enabling ecological restoration.

2. Reconstructing a Productive Landscape
While Voorne-Putten has traditionally relied on agriculture and the port has focused on logistics and industry, their functions have long been at odds. This research proposes a hybrid model that integrates ecological and productive functions. Agriculture is reimagined as water-buffering, eco-farming, or carbon-sequestering systems that serve as both ecological buffers and water reservoirs. Meanwhile, redundant industrial sites are transformed into spaces for ecological restoration, water purification, or renewable energy production. This new productive landscape enhances land-use resilience and fosters a diversified, adaptive regional economy.

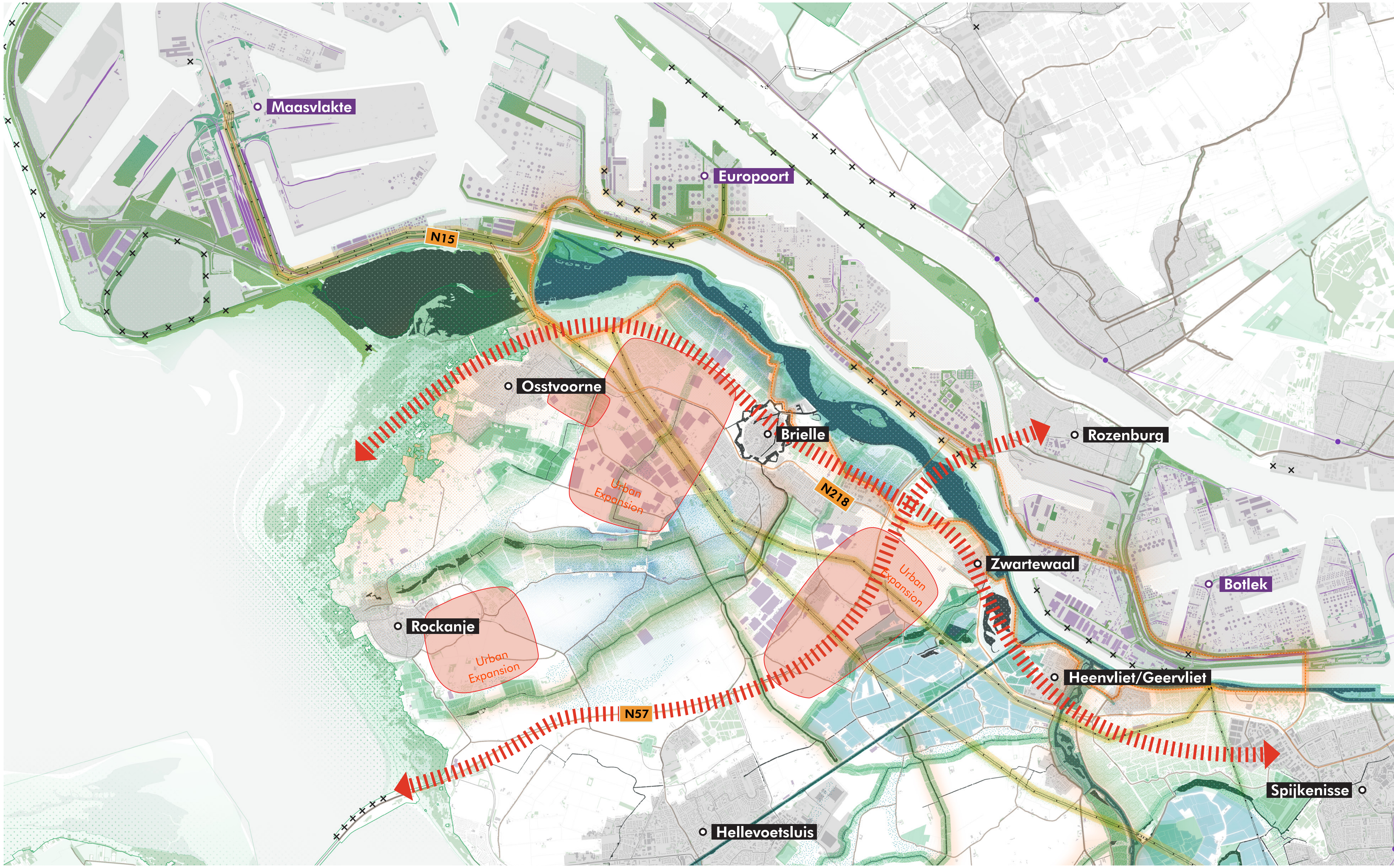
3. Integrating Spatial and Cultural Layers
The interface between the port and Voorne has historically been a grey zone—physically and culturally. This study introduces a "place-based strategy" to translate systemic design into legible and meaningful spatial experiences. Historic water lines, industrial memory, and military traces are embedded into the landscape design to strengthen identity. Slow mobility routes, public spaces, and interactive zones ensure accessibility and human engagement with ecological infrastructure. Furthermore, by involving local residents, port workers, and farmers in the design and transition process, the project encourages cultural continuity and the evolution of new land-use relationships. This approach brings coherence between systemic strategy and localized expression.

In summary, this research demonstrates how a systemic, multi-scale landscape infrastructure approach can reconnect Voorne-Putten and the Port of Rotterdam. By activating ecological systems, restructuring productive functions, and creating spatial-cultural continuity, it offers a resilient, adaptive, and inclusive future model for the region's transition.

FUTURE OF THE FRAME-
GUIDANCE OF URBAN EXPANSION

In the future development and expansion of cities, high-quality landscape infrastructure not only enhances ecological and living conditions but also serves as a guiding framework for spatial planning and urban growth. As illustrated in the diagram, the green corridors and ecological zones formed by the lake area, streams, and sand dunes create vital ecological patches that provide valuable natural resources and a structural backbone for the surrounding urban areas. These landscape systems help foster stronger connections between new urban developments and the natural environment.

Looking ahead to 2050 and beyond, urban development is expected to intensify along the axes defined by the lake area and the N57 highway, forming a more integrated and advanced urban network. This network will not only strengthen the link between the port and nearby agricultural zones but also attract a larger population and labor force to support regional development. As such, landscape infrastructure will play a strategic role in shaping the spatial and functional structure of future cities, serving as a crucial foundation for sustainable urban planning and decision-making.



REFLECTION

1. Lessons Learned: A Shift Toward a Systemic Perspective

One of the most important takeaways from this research is the recognition that landscape infrastructure is not merely a spatial intervention, but a systemic mechanism for organizing ecological, social, and economic relationships. While conventional projects often focus on localized sites or single functions, this study emphasizes the continuity between regional systems and local places, enabling more effective responses to climate change, land-use conflicts, and resource pressures. This systems-based understanding has laid a strong foundation for my future work in complex site design and regional planning.

2. Research and Design: Driving Depth and Precision

The research process—especially problem identification, spatial analysis, and theoretical synthesis—directly informed the generation of design strategies. For example, by identifying ecological disconnections between Voorne and the Port of Rotterdam, I was able to locate key green-blue corridor nodes. Insights into the interplay of freshwater, brackish water, and soil conditions helped shape hydrologically adaptive ecological structures. This closed loop from "knowledge creation" to "design implementation" ensures that the design is not just a visual or formal response, but a spatial expression grounded in logic and evidence.

3. How the Method Helped Me: A Navigational Tool for Design

The methodology—structured around the sequence of problem–potential–strategy–application, and supported by multi-scalar analysis (regional, intermediate, local) and spatiotemporal dimensions—helped me clarify logic, organize content, and advance the design process. Especially when dealing with fragmented landscapes and diverse stakeholders, this method provided clear decision-making paths and evaluation criteria. It strengthened the research's coherence and gave me confidence in managing the full process from strategic vision to site-specific design.

4. Limitations: Gaps in Real-World Testing and Collaboration

Although the research presents a complete theoretical and design framework, it remains at an academic level and has not been fully tested against real-world governance structures, policies, or investment mechanisms. Moreover, insights into social groups (e.g., port workers, farmers) were primarily based on secondary data and assumptions, lacking direct field interviews or participatory processes. This limits the human and cultural depth of the project. Future collaboration with governments, enterprises, or communities would greatly enhance the project's practical relevance and impact.

5. Future Research: Governance Mechanisms and Digital Tools

Future studies could expand in two key directions. First, by delving into governance mechanisms—exploring how multiple stakeholders can co-manage regional water systems and how green infrastructure can be institutionalized through policy. Second, by incorporating more digital tools (e.g., remote sensing, big data, machine learning) to support dynamic analysis and scenario-based feedback, increasing adaptability under climate uncertainty. A comparative study applying this framework to other port-island systems could also test its replicability and broader relevance.

OUTLOOK

" To study the urban landscape as a system of dynamic actions, and as a system of the interaction of space and process, opens up new perspectives of interdisciplinary spatial intervention, more in accordance with a society in perpetual transformation, a society in which the user feels more involved, committed, and in harmony with the environment. "

-Urban landscape infrastructures Designing operative landscape structures for the built environment by Steffen Nijhuis/Daniel Jauslin

The project provides a landscape-based and systematic solution to the current problems facing the transitional areas between Port of Rotterdam and Voorne-Putten. Unlike the current rigid management of fresh water, the landscape approach builds systems that are more adaptive and robust. In this project, the establishment of a connective and robust landscape system is based on the landscape infrastructures. Based on the framework, it provides generic strategies for industrial and agricultural areas. The new landscape system can not only address the problems of the present, but also flexibly respond to the unknown future, and at the same time serve as an example to influence the establishment of landscape frames for similar sites.

Overall, the project aims to promote and advocate a shift in thinking from facilitating urban and industry through infrastructure to prioritize landscape structures as future guidance, and to provide instruction, toolbox, and examples for this process.

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