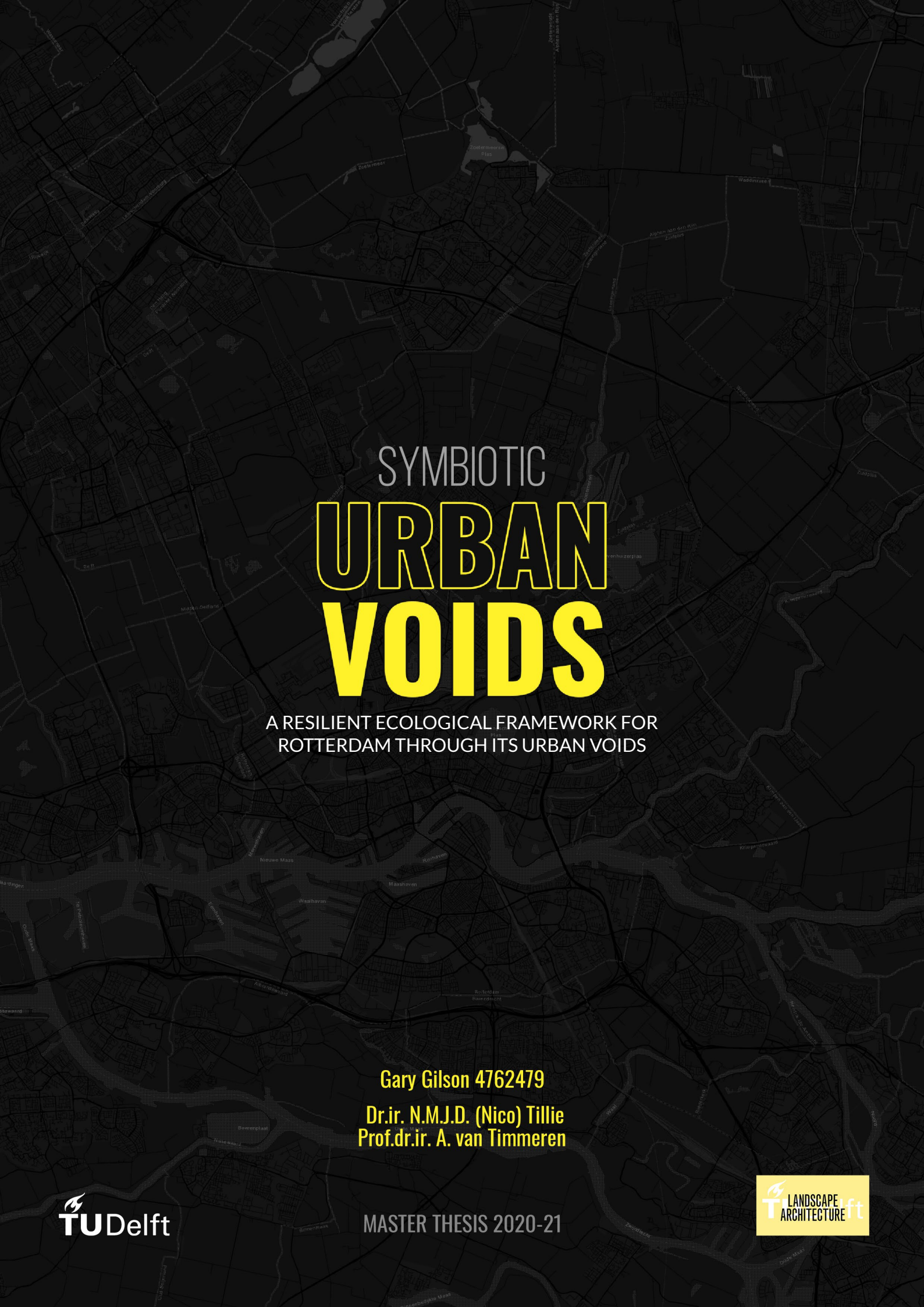

SYMBIOTIC URBAN VOIDS

A RESILIENT ECOLOGICAL FRAMEWORK FOR ROTTERDAM THROUGH ITS URBAN VOIDS

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TU Delft

MASTER THESIS 2020-21

LANDSCAPE ARCHITECTURE

Symbiotic Urban Voids

A Resilient Ecological Framework for Rotterdam through its Urban Voids

Master Thesis
M.Sc. Architecture, Urbanism and the Building Sciences

Department of Urbanism
Landscape Architecture Track

Faculty of Architecture and the Built Environment, TU Delft

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Research Lab: Urban Ecology & Ecocities

First Mentor : Dr.ir. N.M.J.D. (Nico) Tillie

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21st June 2021
Delft, The Netherlands

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Dear Nico,

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To Frits,

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To my dear friends from the LA Track,

None of this would have been possible without you. I am grateful to have been part of our small family. The knowledge shared and discovered over the last two years is irreplaceable, and even the small talks during the breaks have helped me stay happy, motivated, and curious for more—cheers to you all.

To Parents, family, and friends,

Thank you for the love, support, and constant motivation.

Gary Gilson

CONTENTS

Abstract

The Rotterdam urban fabric is built in an area of amalgamation of very interesting landscape conditions surrounding it. Defined by the rich natural and cultural history, this structure has been home to different habitats for a variety of flora and fauna. However, the urban core disconnects these areas due to lack of diverse ecological green and blue networks.

The urban core of Rotterdam is abundant with characterless and unused spaces that can be termed as urban voids. The paved and stony surfaces, large infrastructure, abandoned structures etc in these spaces heat up the unbuilt (or are they really 'unbuilt') spaces and create hotter environments. This, with the changing climate also poses a risk of disasters like flooding, heat islands and habitat loss. These Urban voids are not designed for ecology and resilience to the changing climate.

This project envisions creating an ecological spatial design framework through landscape architectural principles for the urban fabric of Rotterdam by making use of the urban voids, thereby also making it resilient to climate change.

This is achieved by identifying the urban voids on a regional and local scale and intervening at the right degree with the desired toolbox of landscape architectural principles generated through case studies of different typologies. The voids are extended into the surrounding habitat conditions so that the ecological connections become stronger. Theories, mainly the patch-matrix-corridor theory, creates the backbone of the framework strategy. Target species based on the relevance and location of intervention are identified and incorporated in design generation. Design elements tackling issues of heat islands and flooding are incorporated in site design based on the existing situation on site. These are combined with the local characteristics of cultural, ecological and functional layers.

This results in creating a landscape design framework for the Rotterdam urban area connecting the ecological biotopes around the region and catalyzing climate change resilience in the region, by making use of the urban voids. The design will look at creating a network through the urban area on a regional scale by studying the overall regional ecological composition. This is important to create a larger network for biodiversity and ecosystem services in the Rotterdam region that is home to different types of habitats, evolved through historical, natural and cultural processes. This will be followed by detailed spatial design on local scales in the urban voids by taking into account the various characters native to these voids, like the morphological, sociocultural and ecological values. This will result in the creation of a toolbox of different typologies that could be used to reanimate these voids ecologically as well as for climate resilience. These new spaces will bring identity to these spaces and use them to create new local flows respective to the area of design.

Chapter 1

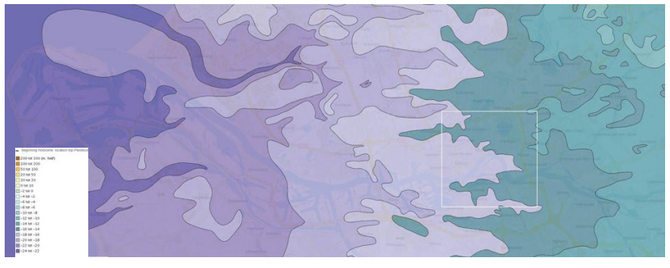
FAMILIARIZING

THE LANDSCAPE OF ROTTERDAM

Every landscape has a story. For understanding the existing landscape conditions and patterns, it is necessary to dig a little into how the layers of the landscape in question were formed over time. The natural and cultural palimpsests and human activities, and natural processes dictate each landscape's story.

1. Rotterdam: The Story of a Landscape

The first step to this project is understanding the landscape and its identity. This step tries to reveal the existing conditions and habitats in the region of Rotterdam and how the urban tissue impacts them.



Beginning Holocene

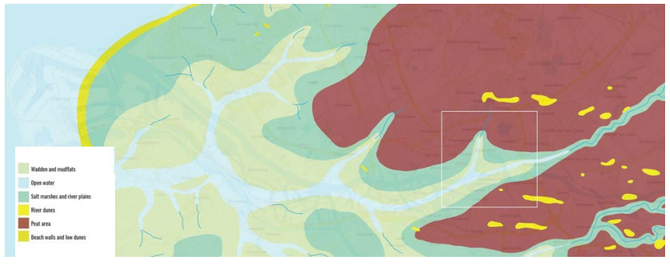
In the beginning of the Holocene, there was a complex and completely natural system of dynamics between water and landforms.

9000 BC: The climate is heating up.

River plains and valleys created along the course of water bodies (Meuse and Rhine). Sediments deposited along the ways, creating landmasses.

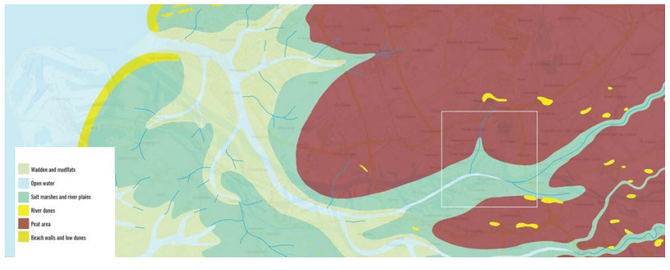
5500 BC: The water is rising.

The region had one large tidal system which later came to be known as the Rhine-Muse Estuary.



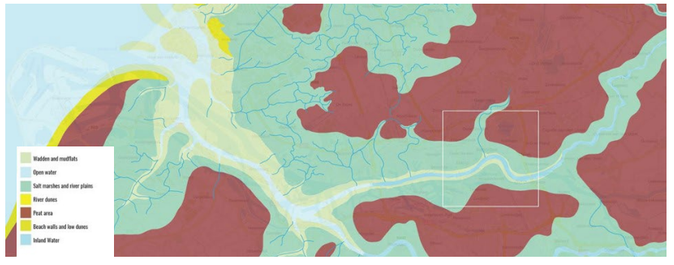
3850 BC: The peat is expanding.

There was high dynamics between the incoming fresh water from the rivers and the tidal sea water. Dynamics between:
1. High and lower river discharges
2. Ebb and flow



2750 BC: Coastline is closing

Sea flows into peat area of Midden Delfland (Swamp forests and creeks) area during high tide. Sea clay polders on south side (Voorne-Putten) was also influenced by these dynamics. Creating a channel-plate landscape condition. some of which silted up high and covered with peat.



100 AD: Man gains influence.

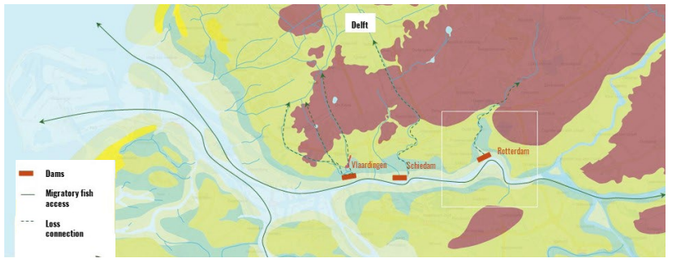
New Urban areas start coming up in the Netherlands. The Rotterdam region is still uninhabited.

1200 AD: Reclamation & canalization.

In this time, people used natural processes to change the landscape. Peat was drained with ditches to make the land suitable for farming. And peat itself was also used as a fuel.

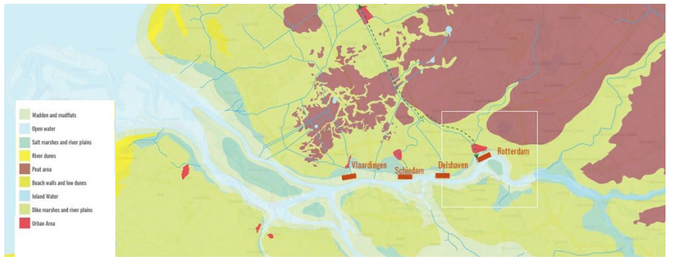
1250 AD: Diking salt marshes & rivers.

Dikes were built as protective barriers against floods, which also resulted in farmers using land permanently. The first peat polders characterized by long ditches were formed.



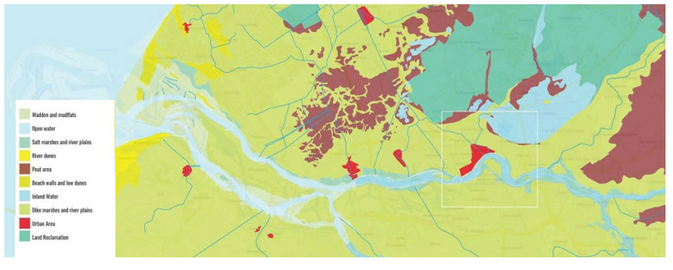
1300 AD: Rotte is dammed.

Around 1300 A dam was built along Rotte river giving rise to the name Rotterdam. This is where the first inhabitants settled. The construction of the dams resulted into a change in salinity of the river and also blocked the direct connection between the rivers and the sea.



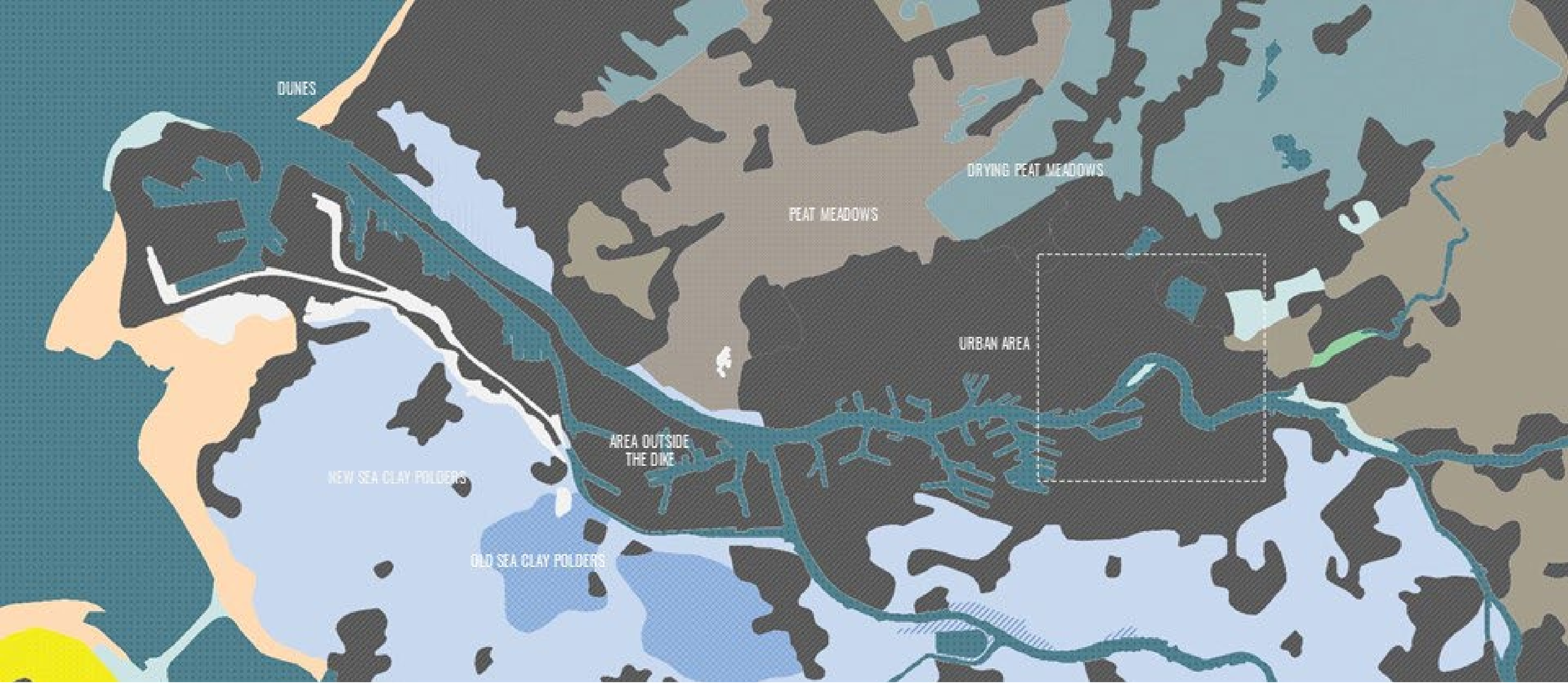
1400 AD: Rotterdam gains power.

Rotterdam built Rotterdamse Schie to have access to Delft. The St. Elizabeth flood destroyed Dordrecht, making Rotterdam the most prominent trade city and grow.



Beginning Holocene

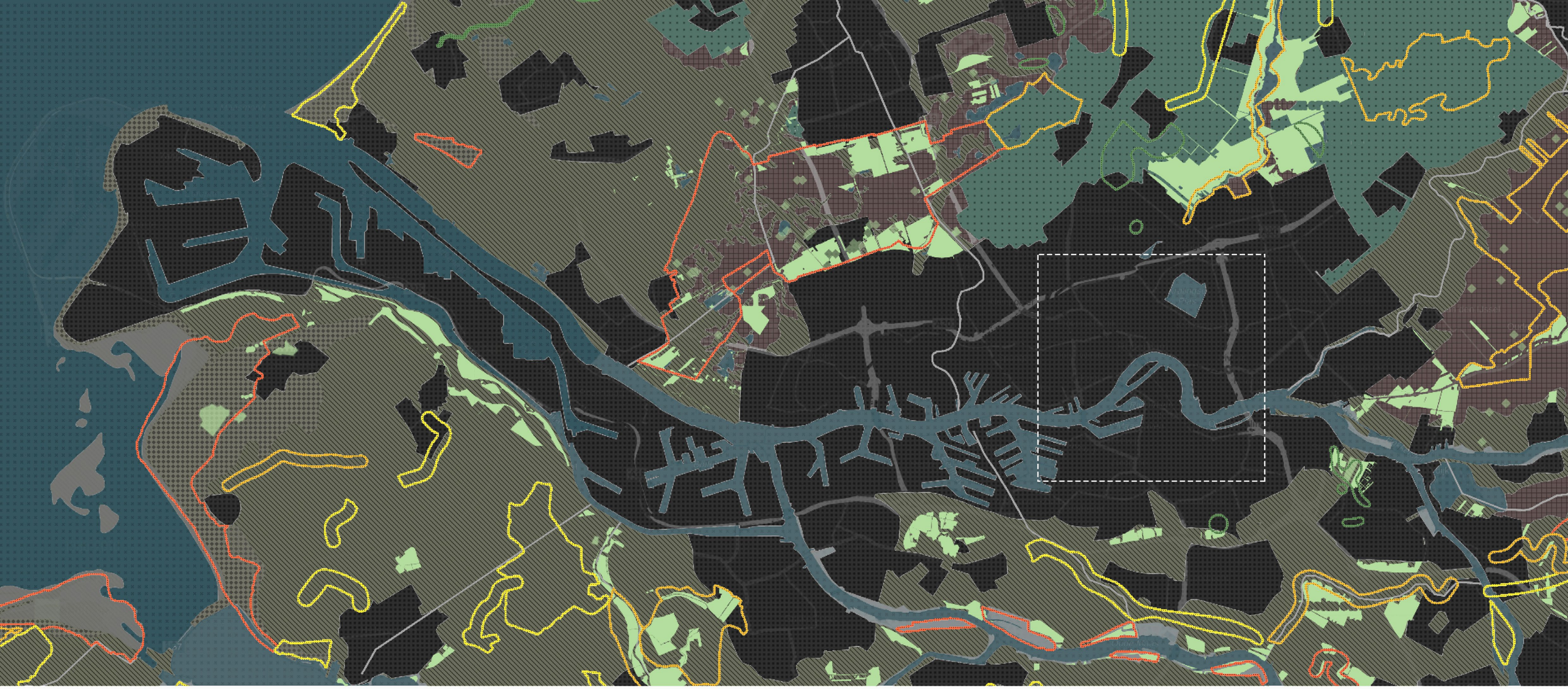
Sea flows into peat area of Midden Delfland (Swamp forests and creeks) area during high tide. Sea clay polders on south side (Voorne-Putten) was also influenced by these dynamics. Creating a channel-plate landscape condition. some



Source: Author, 2020

The Historic Landscape

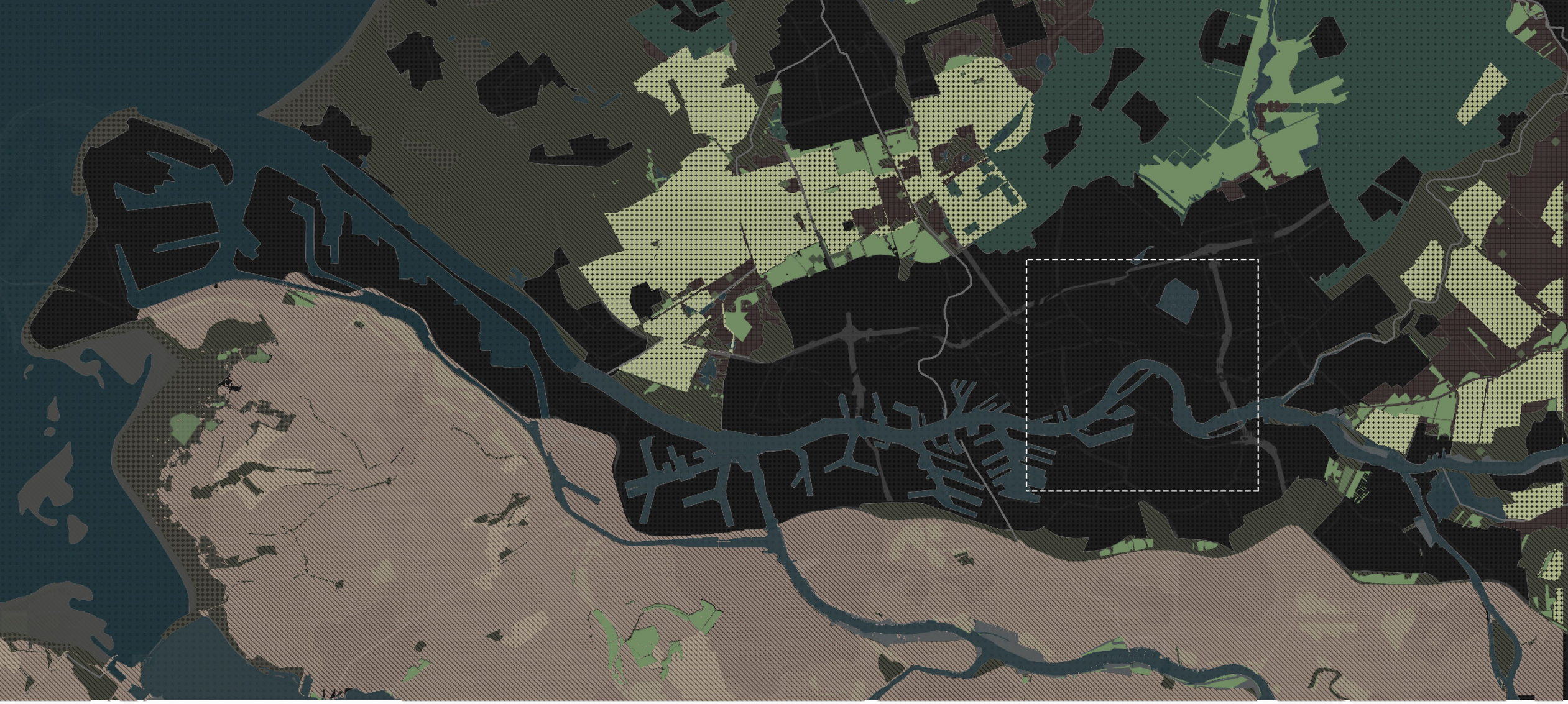
The natural and cultural processes over time have given rise to a landscape amalgamated by different habitat conditions, primarily due to the depositions in soil and the region's water quality. The major landscape types are understood to be 1. Sea Clay-based landscape 2. Peat-based landscape 3. Dune-based landscape 4. Grasslands and 5. Areas outside the dike.



Source: Author, 2020

Green Gems

This region also houses many historic landscape patterns and elements that are geographic and geological treasures. But as it is clear from the maps, the urban expansion tries to dominate the surrounding structures. This, in turn, creates a suffocative condition for the species of flora and fauna that find home and breeding ground and migratory routes in the larger context.



Source: Author, 2020

Arable and Grasslands

The arable and grasslands surrounding the area also restrict the use of the region to be developed in terms of ecology as monoculture dominates in crops. The urban growth that predominantly does not take into account ecological elements creates harsh conditions for different species. Similarly, the outer band of arable lands and grasslands restricts the species from surviving to its full potential.

Urban Area
Wadden and Mudplains > Urban Areas
Beach Walls & Low Dunes
Peat Area
Salt Marshes & River Plains > Reclaimed Land
Green Heritage (Estates/Forestry Commission Areas etc)
Moist meadow bird grassland
River and stream accompanying forest
Water Based Habitats

0 5 km 10 km

Source: Author, 2020

Habitat Types

The region of Rotterdam urban is heavily influenced by the water system, as it is formed by the natural processes that took place along the Rhine-Muse estuary. The habitats thus developed also are predominantly related to wet conditions in one way or the other. The wet vain and dry vain conditions, along with other water-based conditions, create numerous possibilities for species and biotopes to emerge.

Source: Author, 2020

Urbanization

The rapid urbanization of the city of Rotterdam is pushing its boundaries towards the outside areas. This is overwhelming for the existing habitats and natural conditions that sustain life in these regions—both for flora and fauna. The arable lands and intense agriculture also creates the scene worse.

Source: Author, 2020

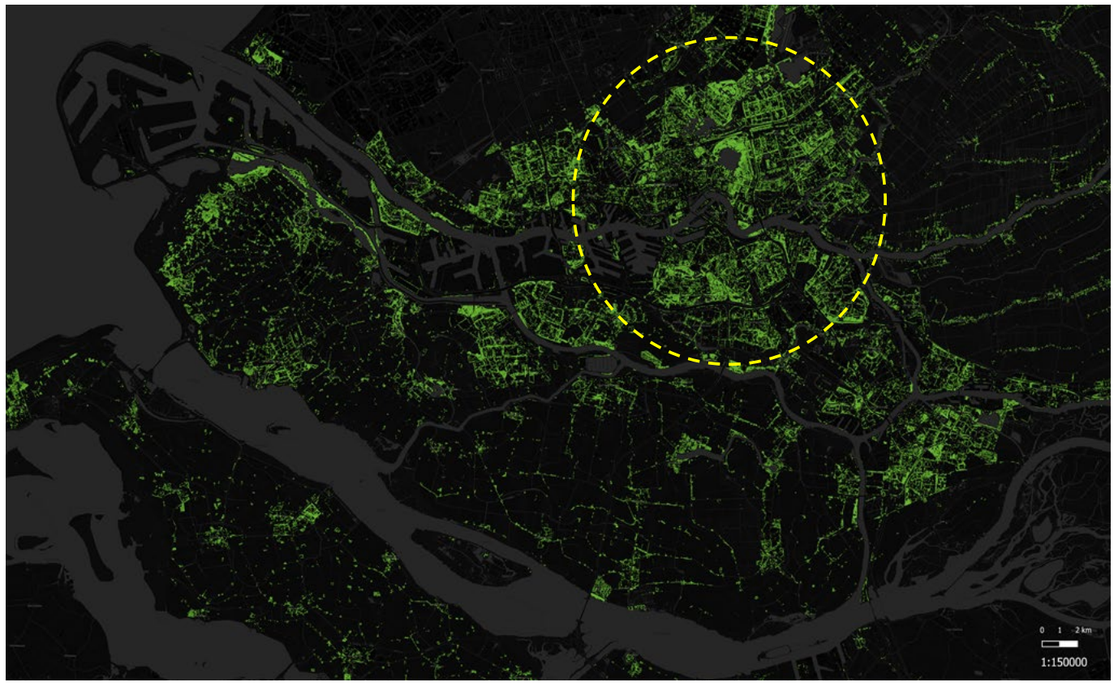
The Landscape Now

The landscape of Rotterdam now faces an urgent challenge that needs to be addressed- the loss and disconnect of habitats and in and around its urban core. The high-paced development of the urban system poses a threat of further loss of the same. It is important to look at ways in which a connection or gradient can be re-established for the area.

Chapter 2

DELINEATING

PROBLEMATIZING



Map of green cover in the Rotterdam area. (Source: GIS mapping by Author)

So much green, yet so little.

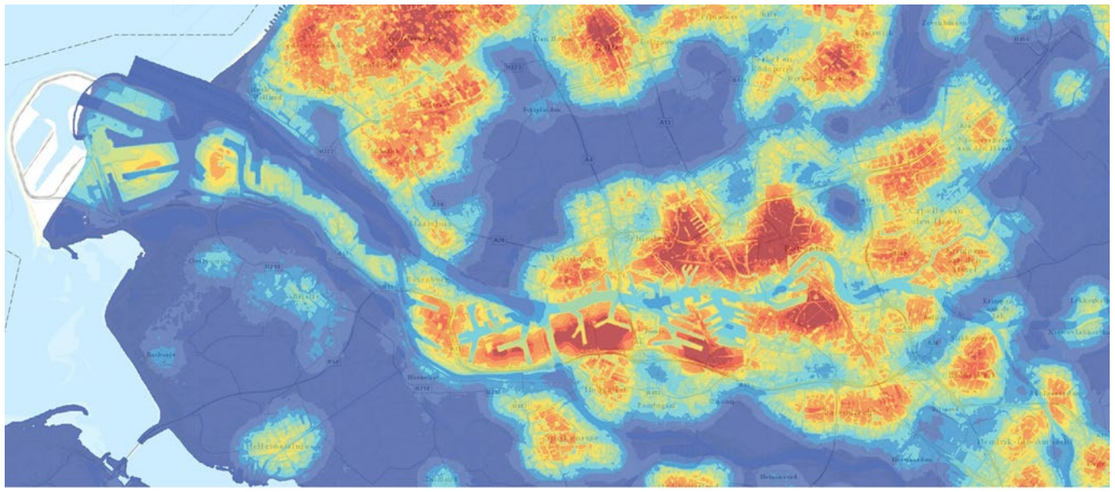
It is important to look at what the current green-blue network in the urban area of Rotterdam has to offer in terms of biodiversity. Are the conditions pleasant and receptive of various animal and plant species for their survival and breeding? Analyzing the green distribution per neighborhood, it is clear that the core urban region is lacking. This can be related to how the spatial design treatment of these areas is carried out. The urban system is anthropocentric, with little to no regard for ecological factors.

Green per neighbourhood in Rotterdam (Source: ArcGIS Klimaateffectatlas)

Green edges along the Rotte river outside the urban periphery. (Source: Google Maps)

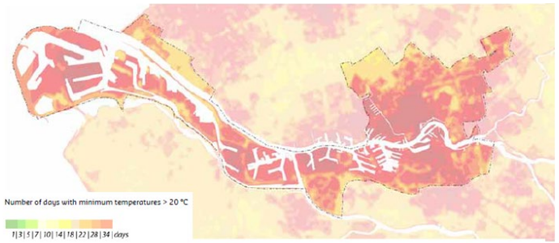
Hard and stoney edges along the Rotte river in the urban core. (Source: Google Maps)

Monoculture of trees that do not offer much space to accommodate biodiversity along the urban roads. (Source: Google Maps)



Map of Urban Heat Island Effect in Rotterdam (Source: ArcGIS Klimaateffectatlas)

Urban Heat Islands 2021



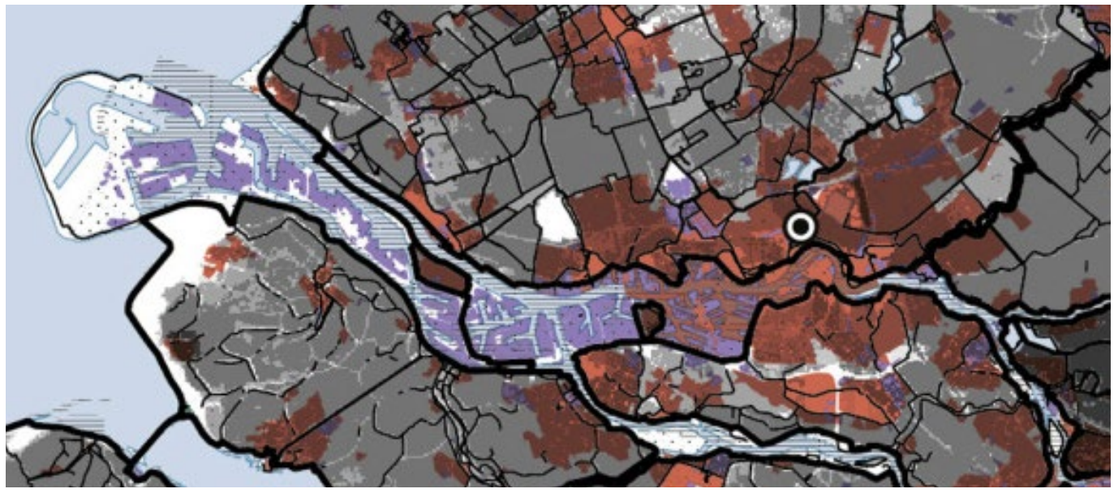
Urban Heat Islands Scenario 2050

Map of hard Paved areas in Rotterdam (Source: ArcGIS Klimaateffectatlas)

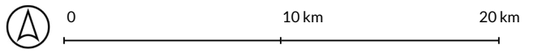
Heaviliy paved area in Waalhaven, Rotterdam (Source: Fundainbusiness.nl)

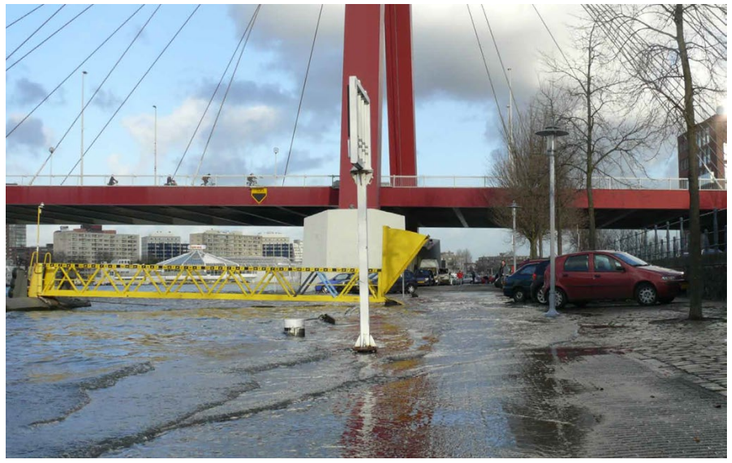
The Urban 'Unbuilt'

The excessive use of concrete paving and hard materials in the urban 'unbuilt' has proven to be heating up the region. If we look closely, it is clear that the in-between spaces heat up the environment due to its inability to disperse off the absorbed heat, this creating hotter urban conditions unfavorable for both humans as well as for other species. So these 'unbuilt spaces,' as we commonly term them, aren't actually unbuilt per se.



Flood-prone Areas: flood depth in gray, build area in red and industrial areas in blue (Source: Dutchdikes.net)

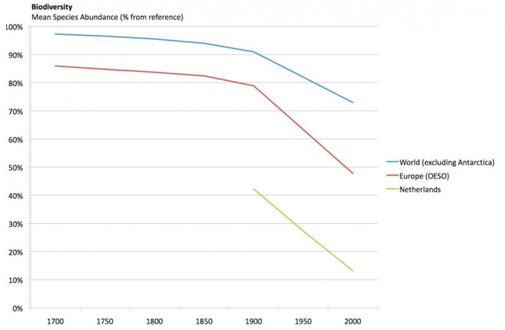




Rotterdam flooding and water stagnation. (Source: Rotterdam Climate Change Adaptation Strategy)

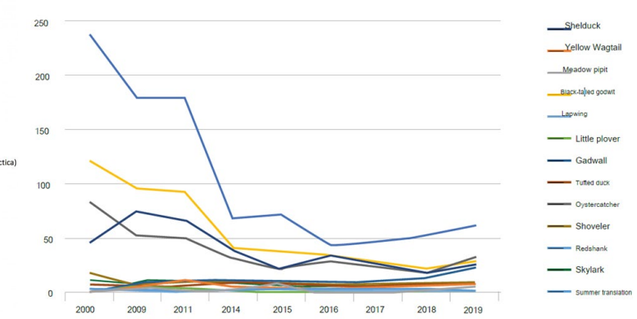
Flooding in Rotterdam

With increased precipitation (26% increase over the last 100 years) and rising sea levels, there is a high risk of flooding in many parts of the city. With the traditional dikes not enough to withstand the current climate-change crisis and stormwater runoff, it is important to make sure the future of the region is safe from rapid and short as well as heavy and longer floods.



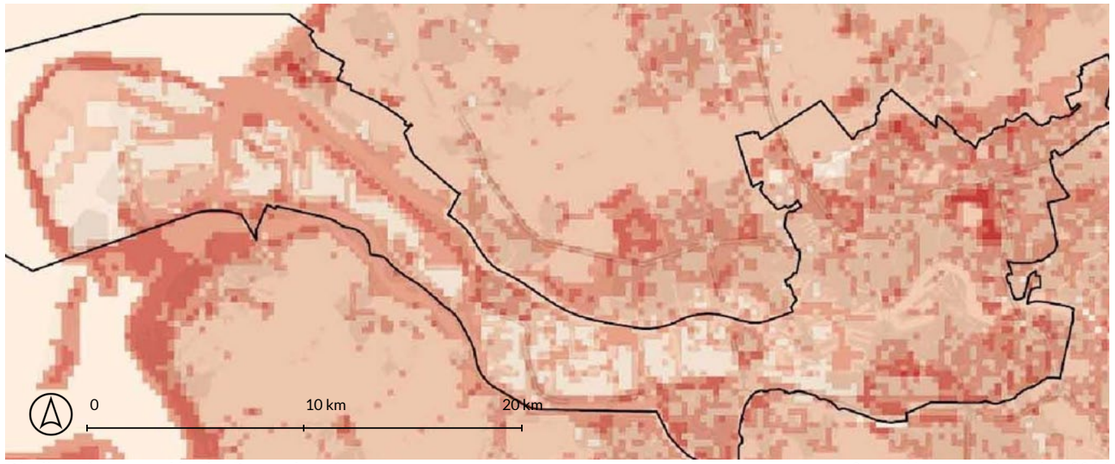
Graph showing biodiversity trend in urban areas.

Source:
Implementation agenda Biodiversity-Rotterdam Municipality, 2020



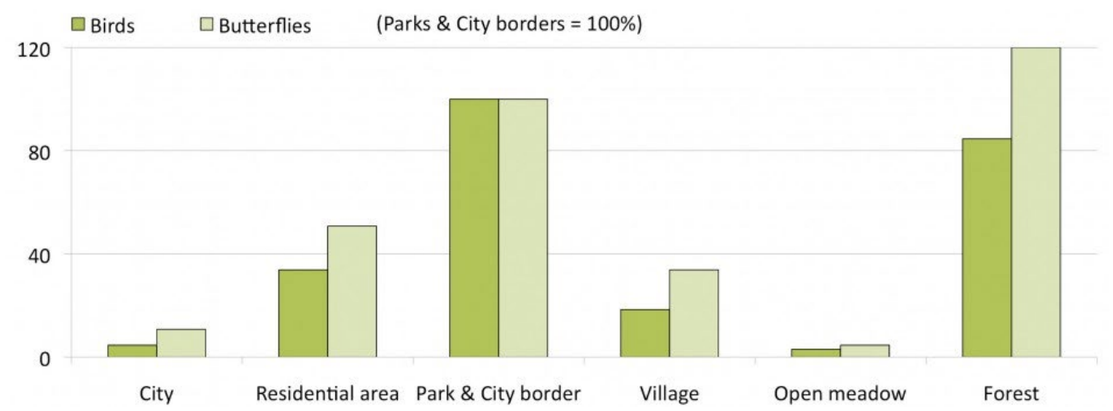
Number of meadow birds in Polder Schieveen 2000-2019

Source:
Netwerk Ecologische Monitoring



Biodiversity spread in the Rotterdam Area.

Source: Naturemap Rotterdam 2014

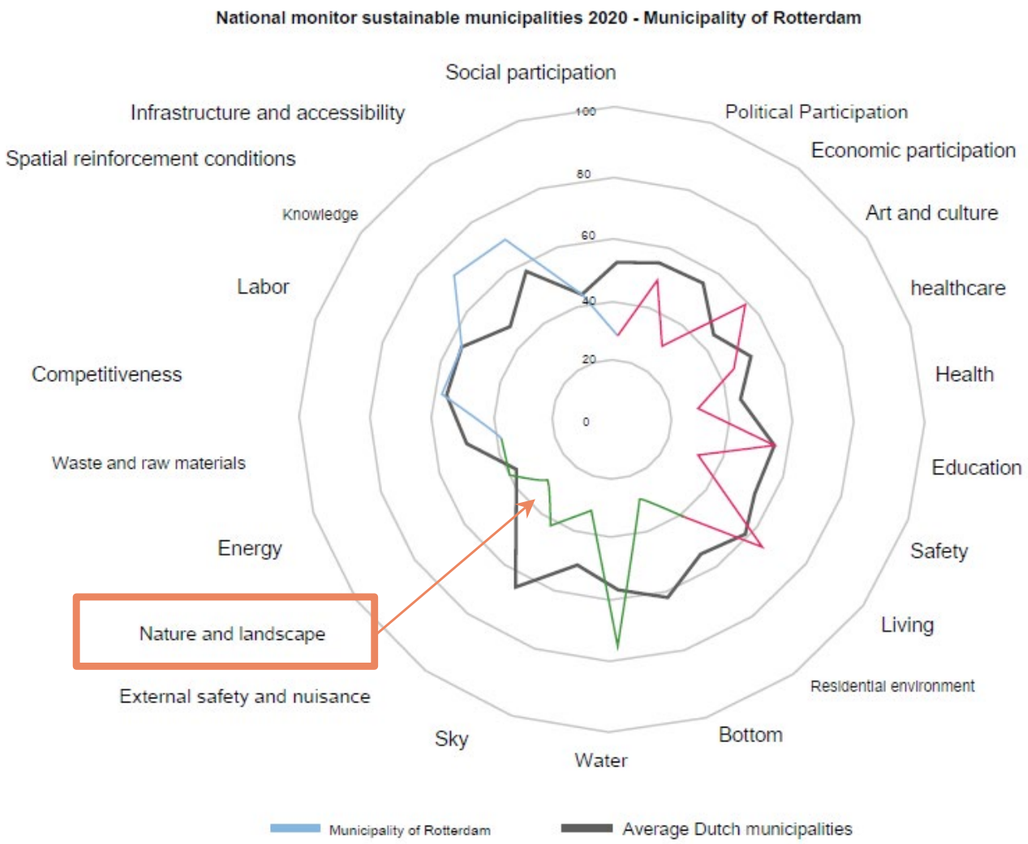


Biodiversity spread in the Rotterdam Area.

Source: Naturemap Rotterdam 2014

Impact on Biodiversity

With increased urbanization and urban sprawl, biodiversity is dwindling at an alarming rate from the cities and around. The Netherlands has seen a decline of 70% over the last century (PBL, 2010). As more cities are human-centered, there is less space for other species. It is also evident from the map that hotspots for biodiversity are seen in greener areas, not close to the urban core. This trend is on the rise as more and more species start disappearing from the city limits.

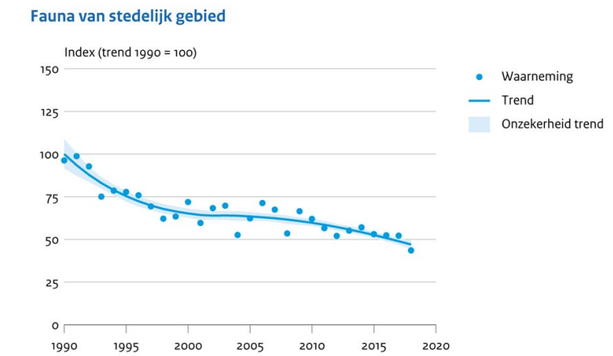


Rotterdam's economic, socio-cultural and ecological capital. *Source: https://www.clo.nl*

Soort	Gebieds-doel	Functie	Aantal in	13/14	14/15	15/16	16/17	17/18	18/19	trend	Start trend	Trend sinds start	Trend sinds 07/08
Aalscholver		f	seiz. gem.	131	155	142	136	120	147	grafiek	1991	+	-
Brandgans		f	seiz. gem.	2052	2231	2404	1595	1383	1558	grafiek	1989	++	~
Goudplevier		f	seiz. gem.	160	216	?	138	271	147	grafiek	1980	-	-
Grauwe Gans		f	seiz. gem.	1327	1811	1810	1744	1503	1995	grafiek	1980	++	~
Grutto		f	seiz. gem.	82	60	28	58	45	74	grafiek	1991	--	--
Kievit		f	seiz. gem.	1266	1921	1928	1130	1810	1193	grafiek	1987	0	0
Kleine Rietgans		f	seiz. gem.	65	91	53	104	30	23	grafiek	1980	++	~
Kleine Zwaan		f	seiz. gem.	1	3	2	3	?	2	grafiek	1990	--	--
Knobbelzwaan		f	seiz. gem.	215	224	230	236	289	282	grafiek	1980	++	0
Kokmeeuw		f	seiz. gem.	1166	1221	1201	600	808	826	grafiek	1991	-	-
Kolgans		f	seiz. gem.	3932	4351	4938	2751	3260	2641	grafiek	1980	++	~
Lepelaar		f	seiz. gem.	3	3	3	4	7	?	grafiek	1991	+	~
Meerkoet		f	seiz. gem.	1056	1085	1134	1176	1466	1166	grafiek	1989	0	0
Slobeend		f	seiz. gem.	70	119	131	93	126	161	grafiek	1989	-	0
Wulp		f	seiz. gem.	592	540	617	332	378	386	grafiek	1980	0	-
Zilvermeeuw		f	seiz. gem.	301	232	186	146	262	98	grafiek	1991	-	-

Winter migratory birds statistics 2013-2019 *Source: Netwerk Ecologische Monitoring*

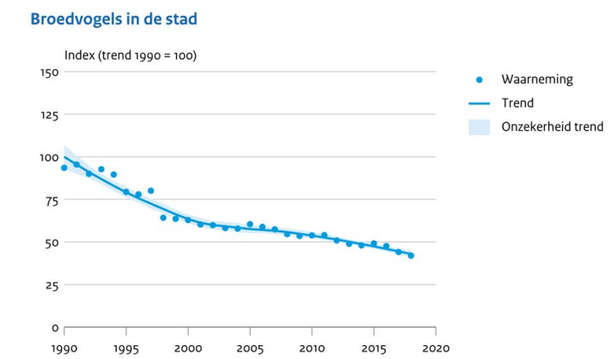
Rotterdam scores are extremely low in nature and landscape category in the nation's ecological capital criteria graph. The statistics indicate that number of migratory birds has also declined considerably. This is also directly related to the decline in urban fauna and other dependent breeding birds and insect populations n the city.



Source: https://www.clo.nl

Fauna of urban areas, 1990-2018

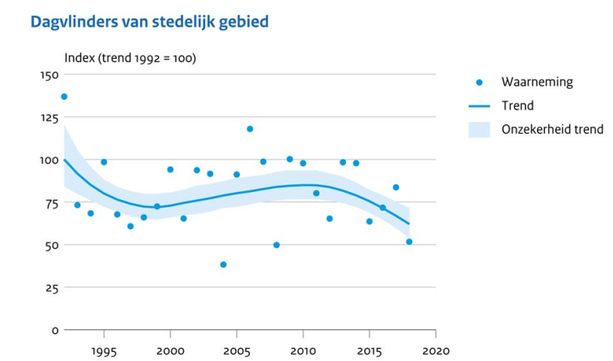
Between 1990 and 2018, the characteristic fauna of urban areas declined in numbers, by an average of almost 50 percent. This concerns the breeding birds and butterflies of the city.



Source: https://www.clo.nl

Breeding Birds of urban areas, 1990-2018

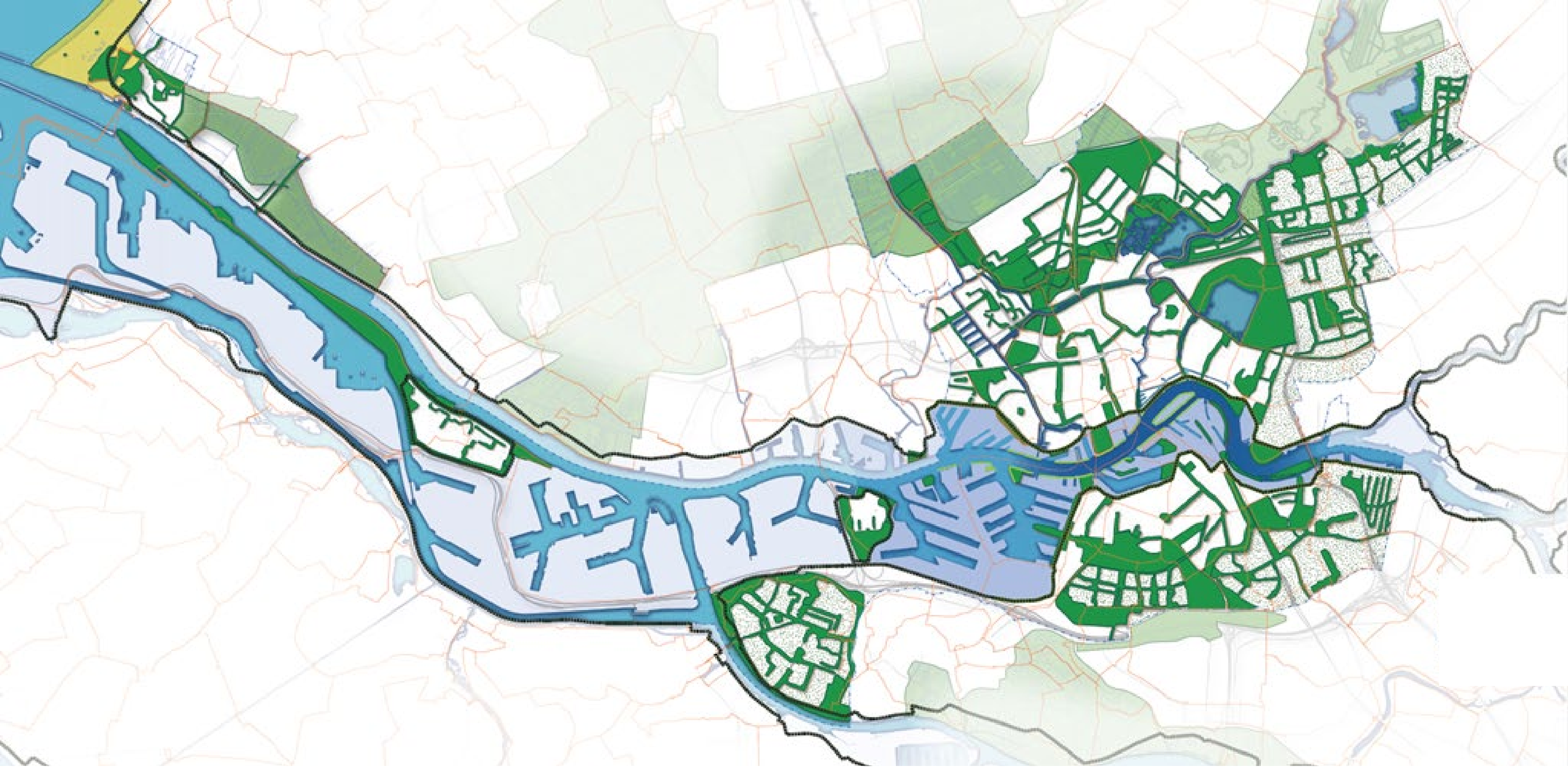
Urban breeding birds as a group have declined by more than half since 1990. Only one of the 20 urban bird species has increased in numbers in urban areas since 1990: the house martin. But this does follow a decrease of about 80% in the decades before.



Source: https://www.clo.nl

Butterflies of urban areas, 1990-2018

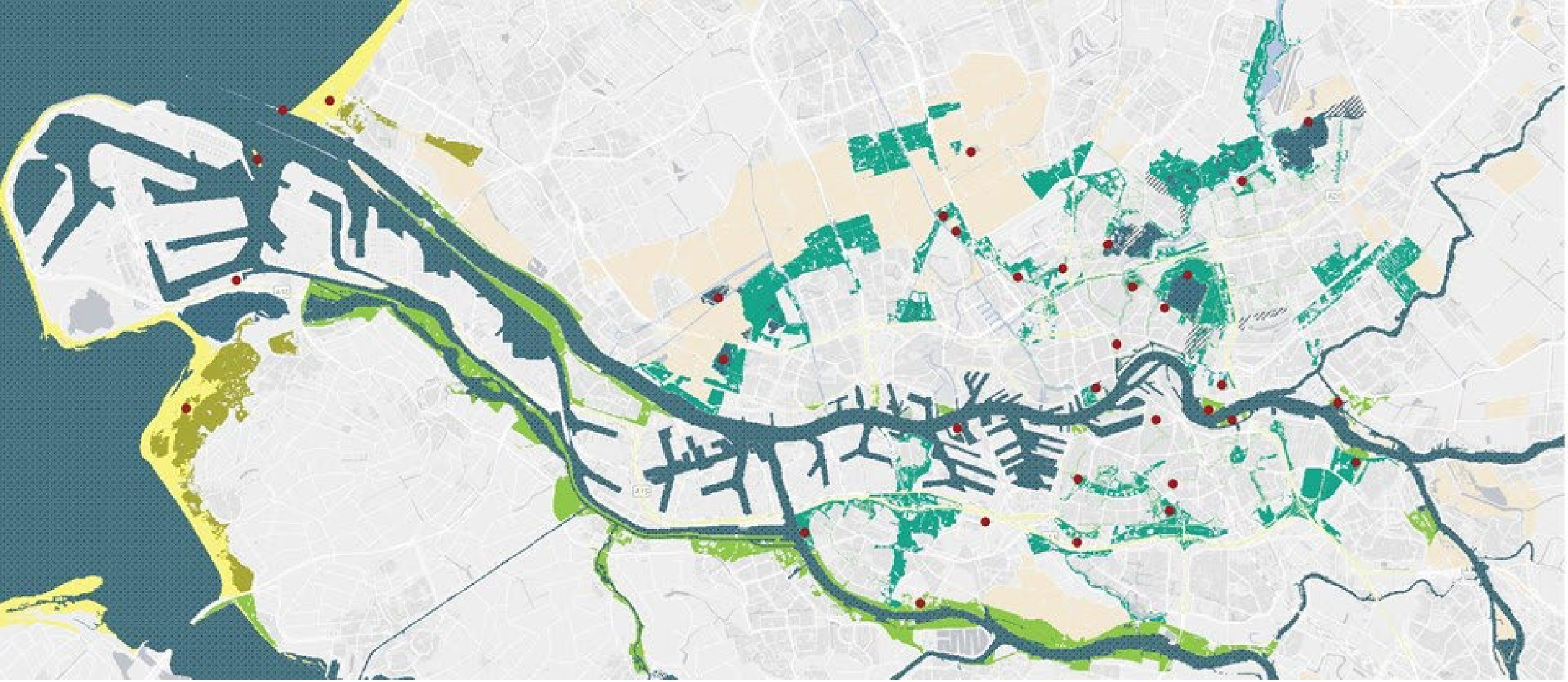
During the period 1990-2018, the butterflies in urban areas remained stable on average, although with annual fluctuations. Butterflies in the city are completely dependent on the green areas in the city and their management is decisive for their survival. Mowing/ Maintenance takes away pupa/ caterpillars.



Source: Natuurkaart Rotterdam

Rotterdam Vision Map

The municipality of Rotterdam has already laid out an ambition map for the urban area that envisions new green connections through the urban core. It is important to take into consideration this vision map, as the proposed design in this project has to go in coherence with the same. The aim of the project is to make the existing connections stronger and also find new connections that enhance the ecological qualities through the urban system as well as the surrounding landscapes.



Source: Gemeente Rotterdam

Opportunities

Opportunity for greener river banks

Connections

Large gardens: privately managed gardens that contribute to the ecological structure of the city.

Green neighborhood crossing: based on the potential connection map. See more info at 'about'.

Gradient ribbon: often raised and accompanied by trees and flowery verges with lower ditches.

Dry ribbon: landscaped linear landscape elements. This mainly concerns the verges and embankments of the railway lines and roads indicated on the map.

Core areas

Dune: sand hills that are mainly located on the coast.

Dune forest: the dune grasslands change into dune forest. Here, a varied tree planting often grows in the shelter.

Tidal nature

Tidal river: a river under the influence of ebb and flow.

Parkbos: landscaped parks and recreational areas that are of great importance to the ecological structure of the city.

Lake: large water surfaces with spacious banks.

Polder with nature management: polders / meadows where Natuurmonumenten cooperates with local farmers.

Water network: network of rivers, canals and smaller waterways that are interconnected.

0 5 km 10 km

Core Areas and Connections

In the existing condition, the more robust blue and green network is mostly only on the periphery of the urban core and concentrated on the North. This is also one of the reasons why the urban ecological structure is not strong. But having such a strong and versatile band of ecological systems in the periphery gives opportunities for linking new urban green to outer habitats.

PROBLEM FIELD & RESEARCH QUESTION

Problem Statement

The Rotterdam urban fabric is built in an area of amalgamation of very interesting landscape conditions surrounding it. These are home to different habitats for a variety of flora and fauna. The urban core however, disconnects these areas due to lack of ecology supporting green and blue networks. The urban core of Rotterdam is abundant with characterless and unused spaces, that can be termed as urban voids. The paved and stony surfaces in these spaces heat up the unbuilt (or are they really 'unbuilt') spaces and creates hotter environments. This, with the changing climate also poses a risk of disasters like flooding, heat islands and habitat loss. These Urban voids are not designed for ecology and resilience to the changing climate.

The urban fabric of Rotterdam disconnects the ecological network around it by creating identity-less and unused voids that are not welcome for biodiversity. Such spaces also pose a threat of disasters like flooding and heat islands.

Research Question

How to create an ecological spatial design framework for biodiversity through landscape architectural principles for the urban fabric of Rotterdam by making use of the urban voids, thereby also making it resilient to climate change?

1. *What are the theories on urban voids, biodiversity and ecological resilience?*
2. *What is the existing habitat typologies in the Rotterdam Urban core?*
3. *What are the urban voids that can be used to create a new network of ecological patches and corridors?*
4. *What ecosystem services can be combined through spatial design for ecology and resilience?*

Research Methodology

In the existing condition, the Blue and Green network is mostly only on the periphery of the urban core and concentrated on the North.. This in turn poses several ecology related issues.

Chapter 3

APPROACHING

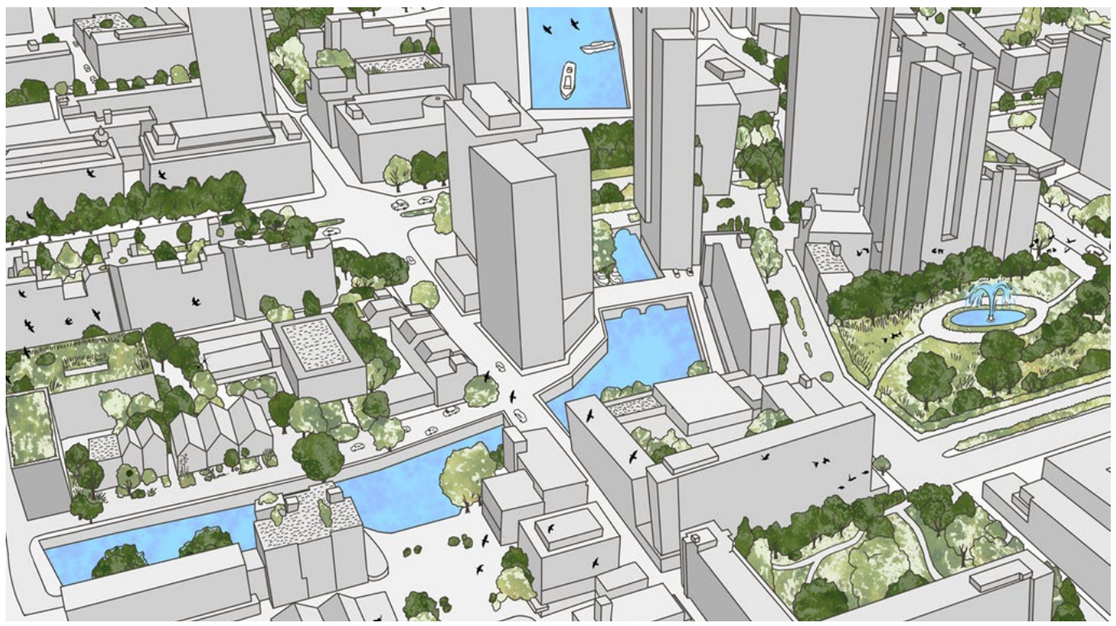
THEORETICAL FRAMEWORK

In the following section, several theories, literature, and case studies are discussed in order to understand the underlying principles and processes that help in formulating design principles and toolboxes for the later steps. These are mainly concerned with urban ecology, biodiversity, climate resilience and urban voids.

Urban Ecology: The city as an Ecosystem

Cities can be seen as a complex ecosystem of interdependent biotic and abiotic elements and their flows. The interaction of organisms, built structures, and the physical environment, where people are concentrated (Foreman, 2014) is called Urban Ecology. The city is not just for humans but also for other organisms. Birds like the Peregrin Falcona and Pigeons find a home in tall urban structures, while hedgehogs and bees use low areas. The dynamics of the city are constantly changing, and it is forcing such species to abandon the area due to lack of food, shelter, and favorable conditions for survival. The flows of elements like water, nutrients, nitrogen, and carbon also dictate the use of the city by various flora and fauna. Due to climate change, there is an increase in unfavorable climate and conditions due to imbalances in the flows and disasters like flooding and heat islands. Thus, this project sees the site as a complex ecosystem that has many interdependent layers and flows of biotic and abiotic factors.

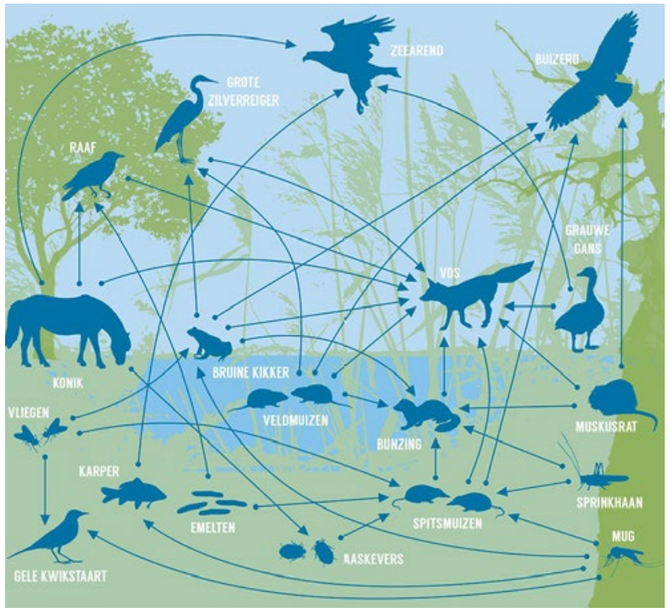
Source: City Nature Policy Note For a liveable and biodiverse The Hague



Source: Making Urban Nature- Jacques Vink, Piet Vollaard, Niels de Zwarte

Biodiversity and Ecosystem Services

Biodiversity is the shortened form of two words, “biological” and “diversity.” It refers to all the variety of life that can be found on Earth (plants, animals, fungi, and micro-organisms) as well as to the communities that they form and the habitats in which they live. (pbl.nl) Biodiversity is important because of the interconnections between species and their environment. This creates resilience and stability to the ecosystem, which helps in accommodating multiple tiers and processes within the system.



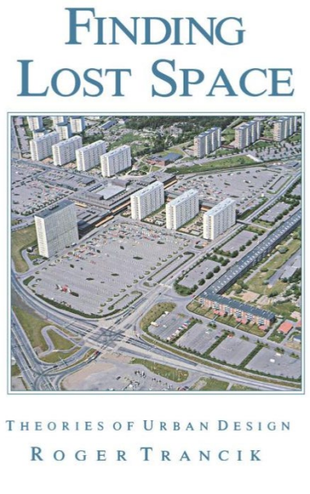
Source: Working together on rich Rotterdam urban nature Implementation agenda Biodiversity

Source: Tillie, N. (2020) Lecture

Ecosystems provide services to humankind. Those may involve the provision of a product, a regulatory authority, a cultural service, or a service that supports the services mentioned earlier (wur.nl). These are services that are of fundamental importance to human well-being, health, livelihoods, and survival (Costanza et al., 1997). These services help to create better living conditions when integrated in the right way. The project uses the concept of ecosystem services as a byproduct of the design process, where the design principles applied can not only generate ecological value but also added value in the form of ecosystem services.

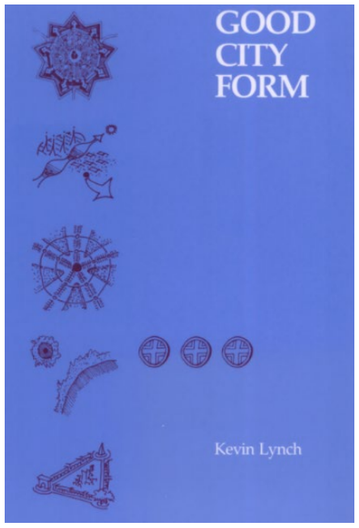
Urban Voids

The urban unbuilt entirely cannot be termed as ‘urban voids’. Most places hold some kind of character that makes them stand out functionally or culturally. However, there many patterns on the urban and regional landscape that spread out in between these elements without an identity or use. These spaces could be considered territories that do not belong to a particular functional or cultural genre. In this project, the use of the term urban void needs proper understanding in order to carry out the design process. There are multiple interpretations of the term, and some of them have been studied to narrow down the patterns of spaces that will fit into the category.



Undesirable urban area that makes no positive contribution to the surroundings and which is ill-defined, without measurable boundaries and fail to connect elements in a coherent way, by calling them ‘lost space’.

Finding Lost Space, Trancik (1986)



Waste spaces are described as neglected, unused, dead spaces. These spaces are created because of fixed functions spaces which leftover spaces usually are located next to the spaces with fixed function such as (highway, railway, under bridges…etc.).

He argues that these spaces have potential for reuse and relief by increasing flexibility of spaces to appropriate all time’s need.

Good City Form, Kevin Lynch (1981)

Greenberg and other scholars have defined those abandoned lands as Temporarily Obsolete Abandoned Derelict Sites (TOADS).

Greenberg et al., 1990; Perera & Amin, 1996; Greenberg et al., 2000

On the other hand in declining industrial cities, due to suburbanization and decrease in population various ‘vacant land’ has emerged.

According & Johnson, 2000

Vacant land refers to many different types of unutilized and underutilized parcels with abandoned buildings and structures.

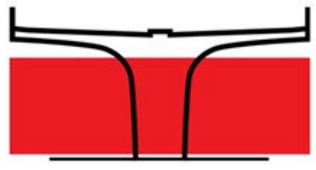
Pagano & Bowman, 2000

Edge/Buffer Voids

Setbacks between spaces, marginal and residual spaces. Urban Edges. Indefinite spaces caused by action/expansion.

Transportation Voids

Oversized streets/oversupplied streets. Improper distribution of space. No regard for ecology. Same specie of trees in row.



Infrastructural Voids

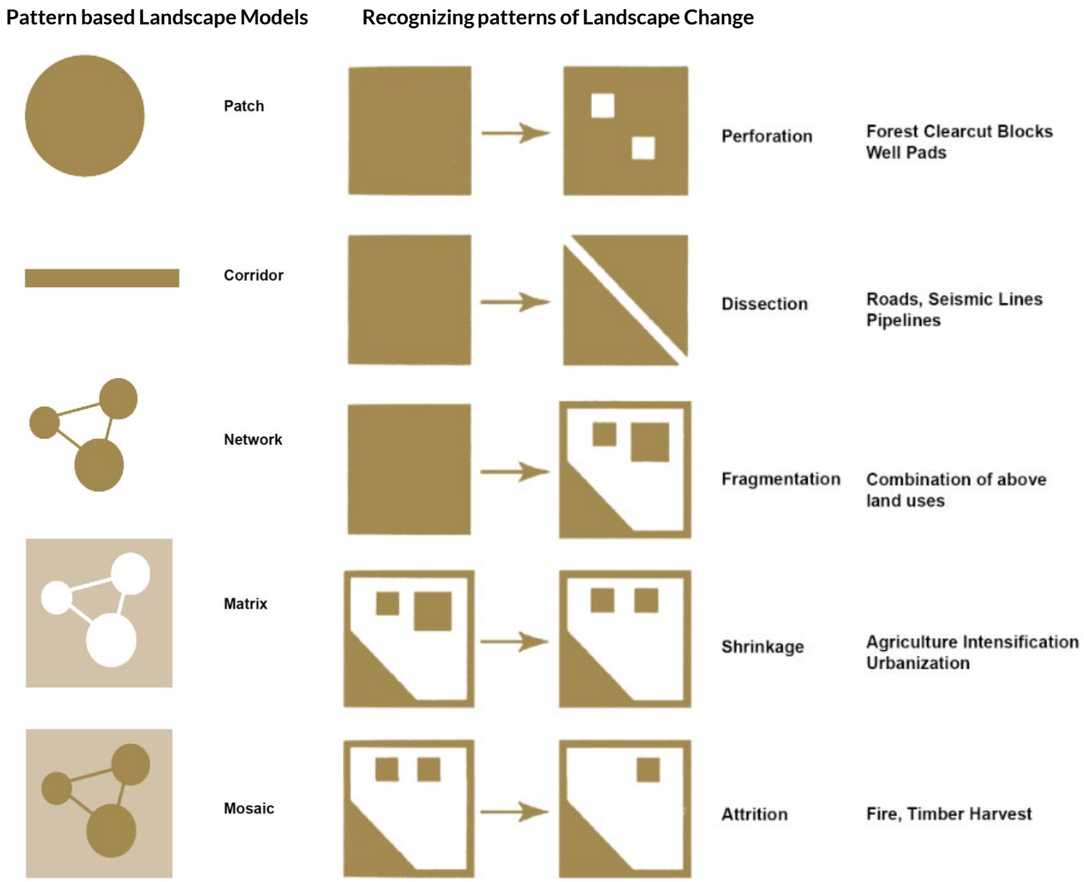
Dead spaces in and around public infrastructure. Waste of useable space. Runs through the larger landscape connecting them. Creates contextual gap.

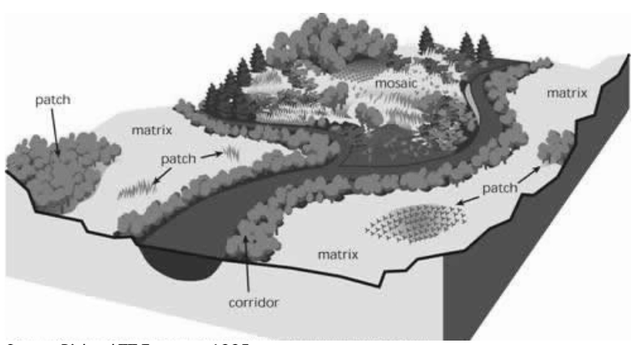
Large Scale Plots

Parking Lots create heat islands, unused lands, abandoned areas like industries. Not for people or ecology.

Patch-Matrix-Corridor Theory

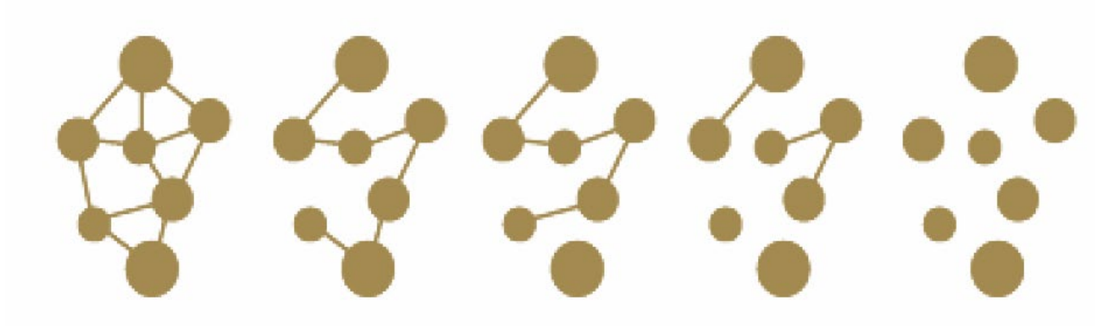
According to Foreman and Gordon (1981, 1986), the landscape can be explained with three constituting elements: patch, matrix, and corridors. Patches constituting habitats are connected through corridors, which in turn form a larger network at the regional level. The matrix is the background land cover that dominates (Foreman, 1995). An ideal landscape comprises large stable patches along with smaller stepping stone patches of heterogeneity.



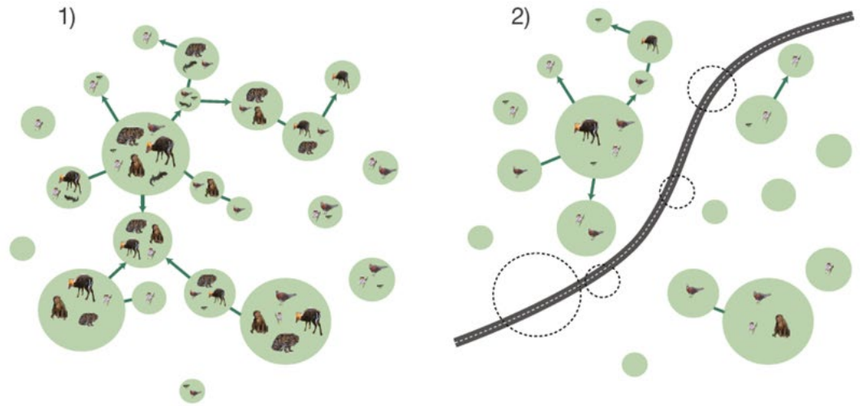


Source: Richard TT Foreman, 1995
Landscape Patterns-Environmental Quality Analysis, Oldman Watershed Council, 2013

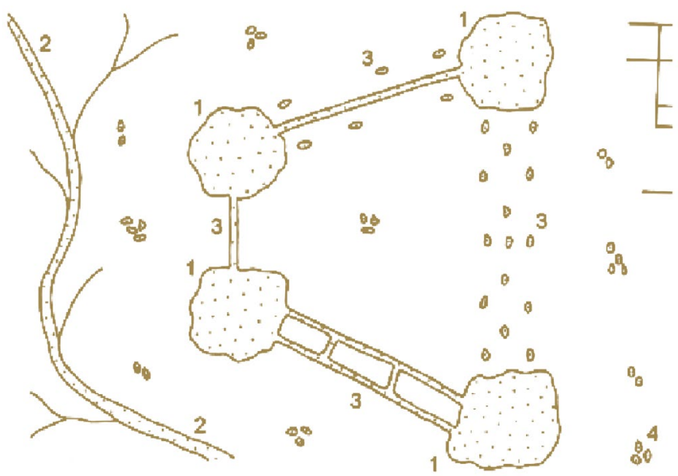
Landscape can be changed in different ways like perforation, dissection, fragmentation, shrinkage, and attrition, which causes loss and isolation of habitats. Hence it is important to connect patches with corridors to mitigate habitat fragmentation and loss of ecological identity.



The probability of survival of a species decreases as network connections decreases.



1. Landscape with high patch connectivity.
2. Landscape Fragmented by Road.



1. Large patches of natural vegetation.
2. Riparian Corridors
3. Connective Corridors and Stepping Stones
4. Heterogeneous fragments of natural vegetation in the matrix.

CASE STUDIES & DESIGN PRINCIPLES

Several successful projects have been carried out in the recent past that incorporates ecology in the urban system. These are site-specific and relating to the local ecology and habitats. Most of these projects address climate change resilience as well. The design principles used in such projects can be adapted to similar projects around the world. The case studies are used to create a design toolbox consisting of landscape architectural spatial design principles that address, among others, mainly ecology, climate change resilience.

Infrastructural

Infrastructural elements, like roads, highways, fly-overs, train tracks, and bridges, account for some of the largest patterns on the landscape. They are connectors that run through various cities and regions, thus bringing them closer. The use of such elements to accommodate not just anthropocentric but also ecological functions can be beneficial in a big way. Here two such projects are explored where these giant infrastructural urban components also house green.

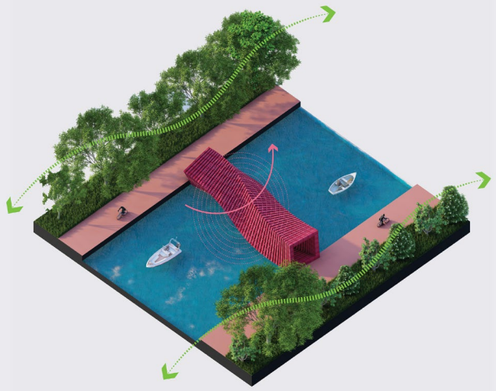
New Chouteau Greenway Plan Knits Together Diverse Neighborhoods In St. Louis

Source: Stoss Landscape Urbanism

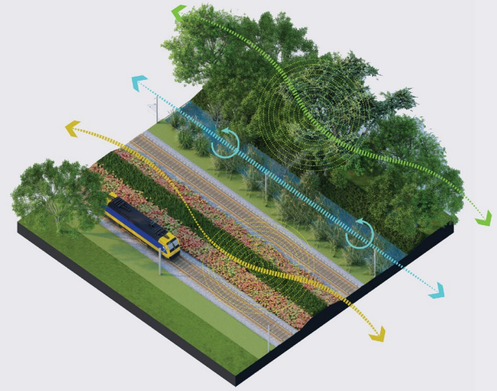
Derelict Rotterdam train tracks being made over into a luscious green park.

Source: De Urbanisten, Lanschapsarchitecten

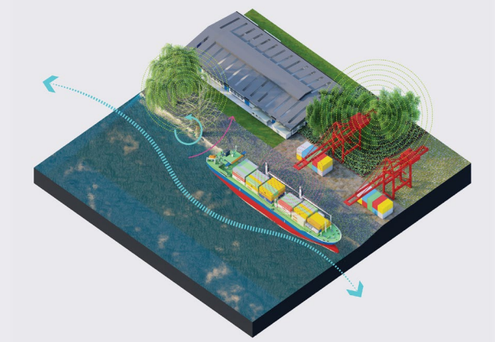
Design Principles



Slits on bridges for bats.

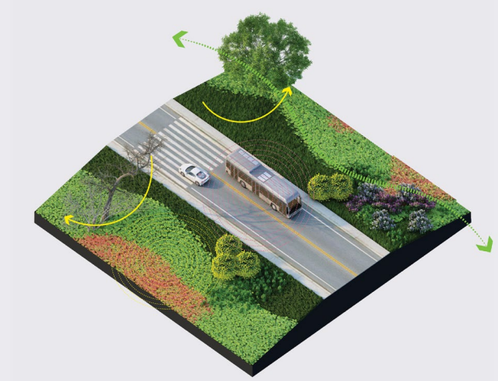


Greening Tram/Train lines.

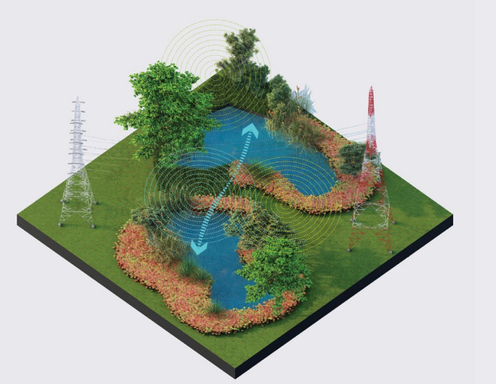


Using gradient water edges.

Using the Flyover bottoms.



Gradients along roads.



Power line green corridors.

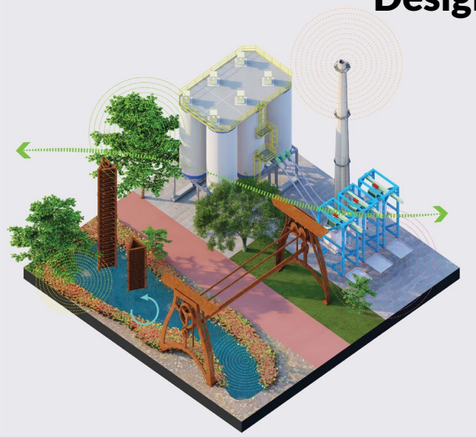
Industrial/Brownfield

Brownfield and leftover industrial sites have a high potential as waste-scapes that have endured heavy pollution and utilization of the site's resources. Many construction, structural and natural situations that emerged here due to its previous use would benefit a lot of species. These example projects exhibit how such sites can be explored to derive a new life to it through landscape architecture.

Landschaftspark Duisburg-Nord
Source: Making Urban Nature, (J. Vink, P. Vollaard, N. Zwarte)

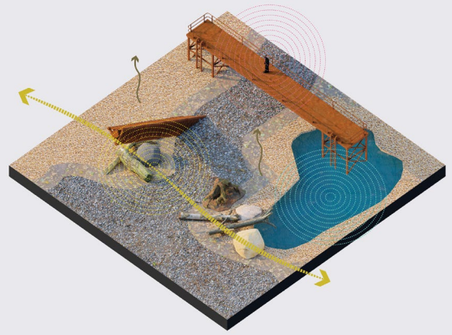
Flowery meadow under the pylons at the port of Rotterdam
Source: Making Urban Nature, (J. Vink, P. Vollaard, N. Zwarte)

Design Principles

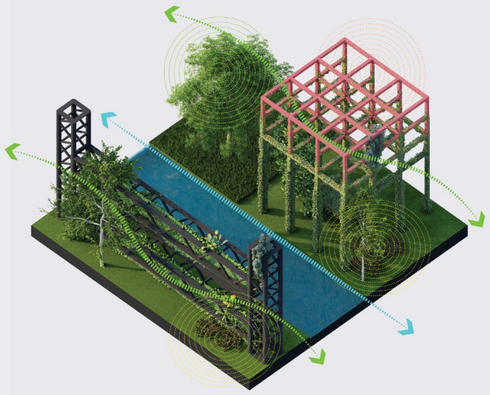


Tall structures for birds.

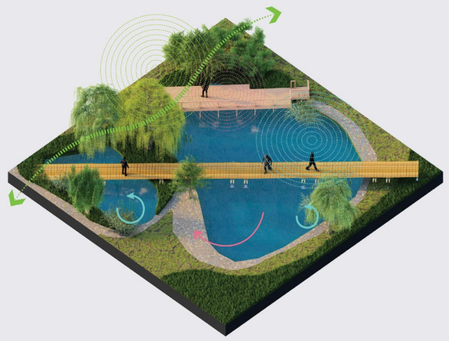
Riparian zones.



Dry Sand for insects.



Truss/Metal structure for green.

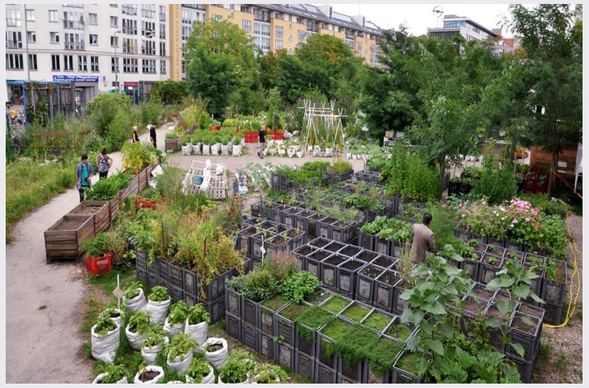


Small ponds for frogs/toads.

Pioneer Species surprises

City District/ Garden Cities

City districts and garden cities are a common neighborhood typology in the Rotterdam urban fabric. As the urban core is becoming increasingly denser with new constructions and developments, these projects exhibit some strategies to incorporate green and ecology.



Urban Farming in Princess gardens, Berlin

Source: Making Urban Nature, (J. Vink, P. Vollaard, N. Zwarte)

Water Square Rotterdam, De Urbanisten

Source: Making Urban Nature, (J. Vink, P. Vollaard, N. Zwarte)

Eco Cathedral-Louis Le Roy

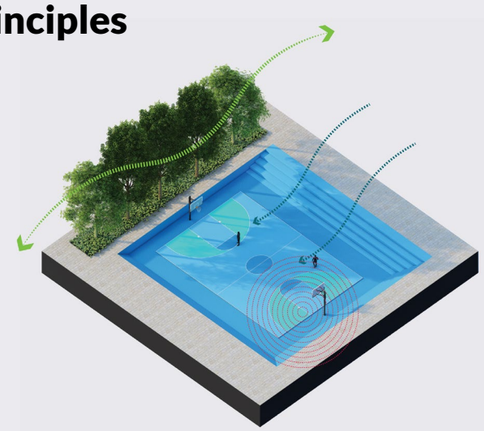
Source: Making Urban Nature, (J. Vink, P. Vollaard, N. Zwarte)

EVA-Lanxmeer neighbourhood Orchards

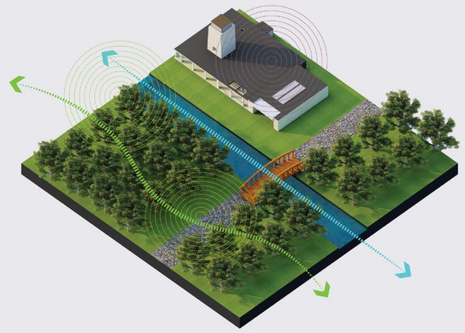
Source: Making Urban Nature, (J. Vink, P. Vollaard, N. Zwarte)

Design Principles

Rooftop Gardens

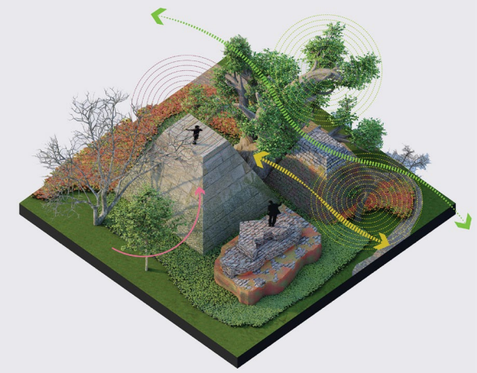


Water squares



Community Orchards

Urban Forests

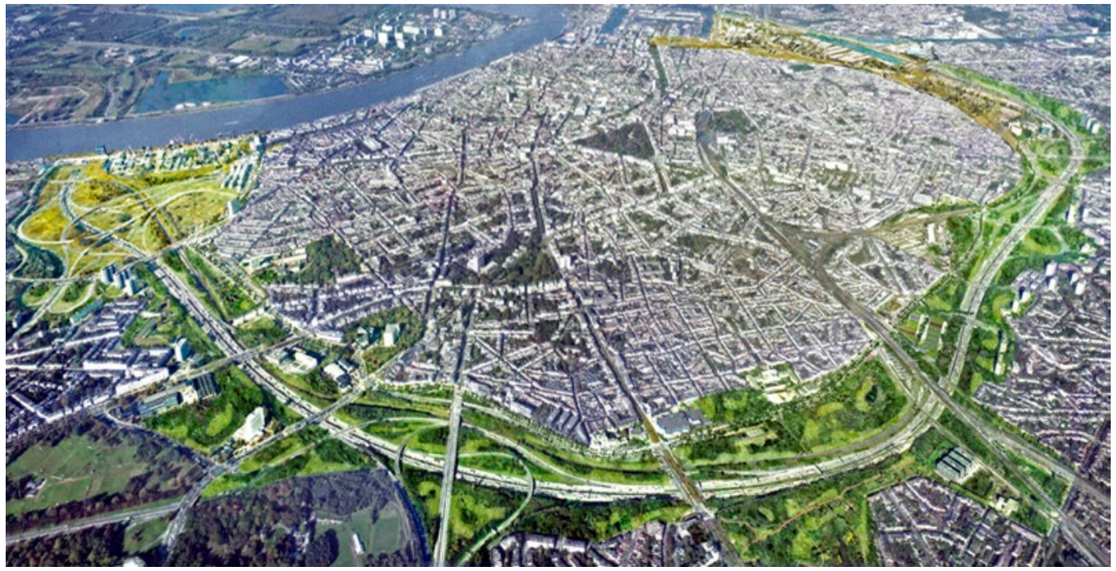


Eco Cathedrals

Forest Gardens

Regional Level

Habitats spread across regional scales depending on the natural processes that gave rise to the landscape and later to the cultural processes on them. Regional and urban scale development and master planning projects need to be studied in order to work on a similar scale. The projects here shows how green rings that act as corridors and connections are established along with patches that sustain nature-based solution for urban development at larger scales. These planning strategies also influence the changes taking place at smaller scale interventions. This connects the biotic with the abiotic and human activities with natural processes and habitats at various levels and thus gives rise to the whole city as an ecosystem.

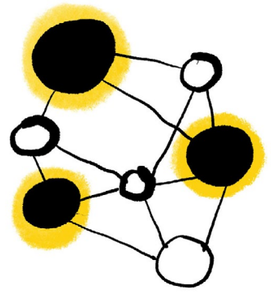


Groene Singel, Antwerpen. Green Singel, Antwerp (BE). Design: MAHK.
Source: Making Urban Nature, (J. Vink, P. Vollaard, N. Zwarte)

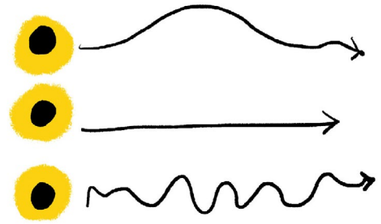
Utrecht Ringpark
Source: Provincie Utrecht

Crown State Masterplan, London

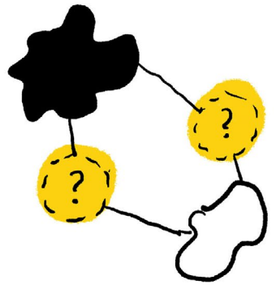
Design Principles



Creating Patch-Corridor system



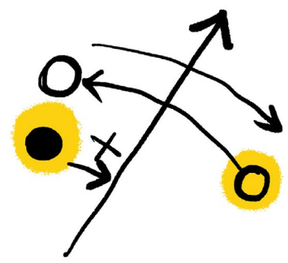
Follow/ Guide Landscape and Development Patterns



Functional Voids/ Natural Voids

Designing through scales

Adapted to context.



Forest Gardens

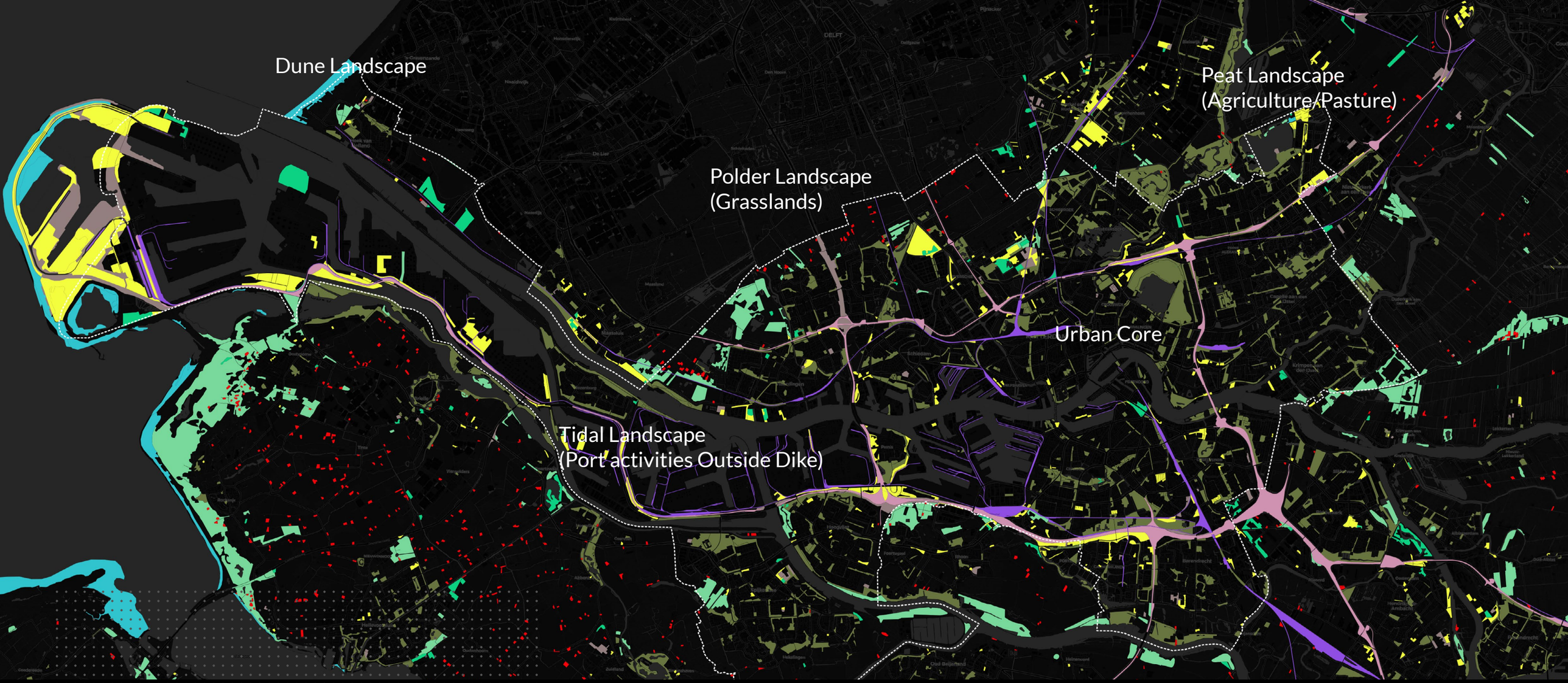
MAPPING VOIDS

Urban voids are spaces that are useless, underused, abandoned or in-between spaces among public and private realms. (Lee et al., 2015). It is important to map these voids in order to find a pattern of existing void networks that could be used as a tool for design. This is done in two scales-regional and local.

Source: Louisa van den Brink, 2020

Regional level Void Patterns

The mapping of regional level void patterns shows the dominance of linear elements comprising of infrastructural connections like highways, train tracks along with block patterns of grasslands, territories in between, greenhouses, etc. This opens up opportunities to create a larger network of regional level designs connecting various habitats that lay around the urban tissue of Rotterdam. These linear elements that run through vast landscapes can become agents that bind together biotopes and strengthen the existing ecological realm of the region.



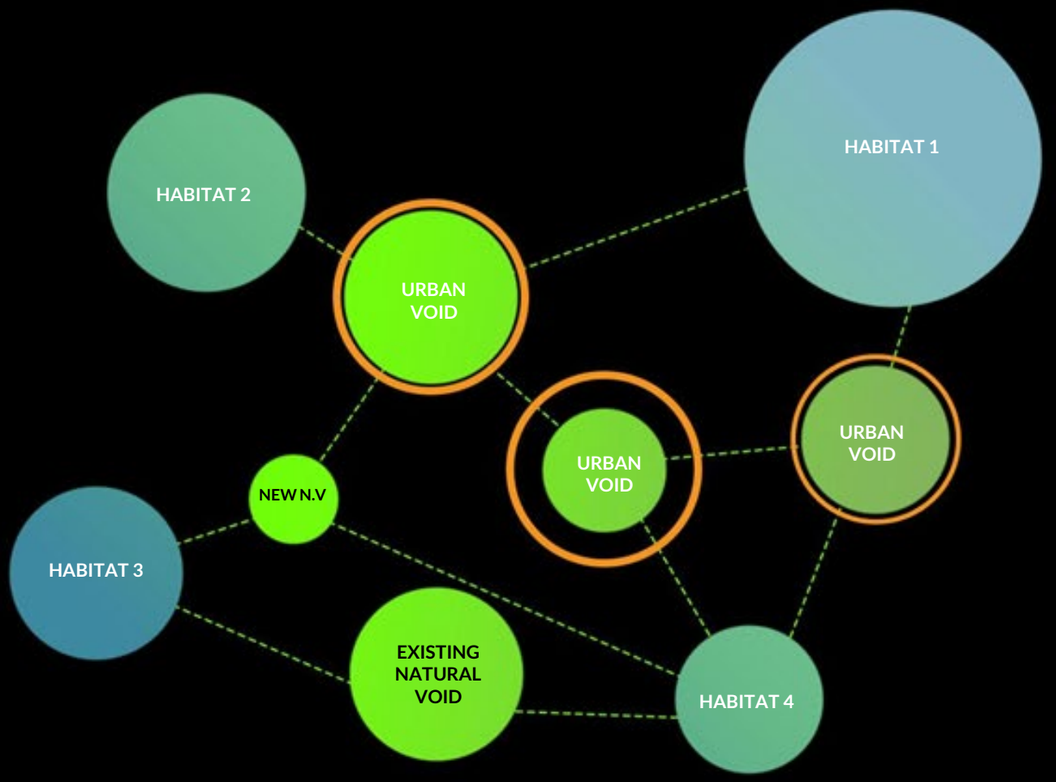
Source: Author, 2020

Urban Scale Voids

Apart from the regional level voids, the presence of local sites in the urban core that qualifies as urban voids is mapped. This consists of sites that are unused, isolated structures, dumpsites, roads, open spaces with little or no vegetation, etc. It is also important to notice the spread of these sites as they are part of different habitats and ecological systems in the larger context. These sites can act as ecology boosters if intervened in the right way with the right design elements.

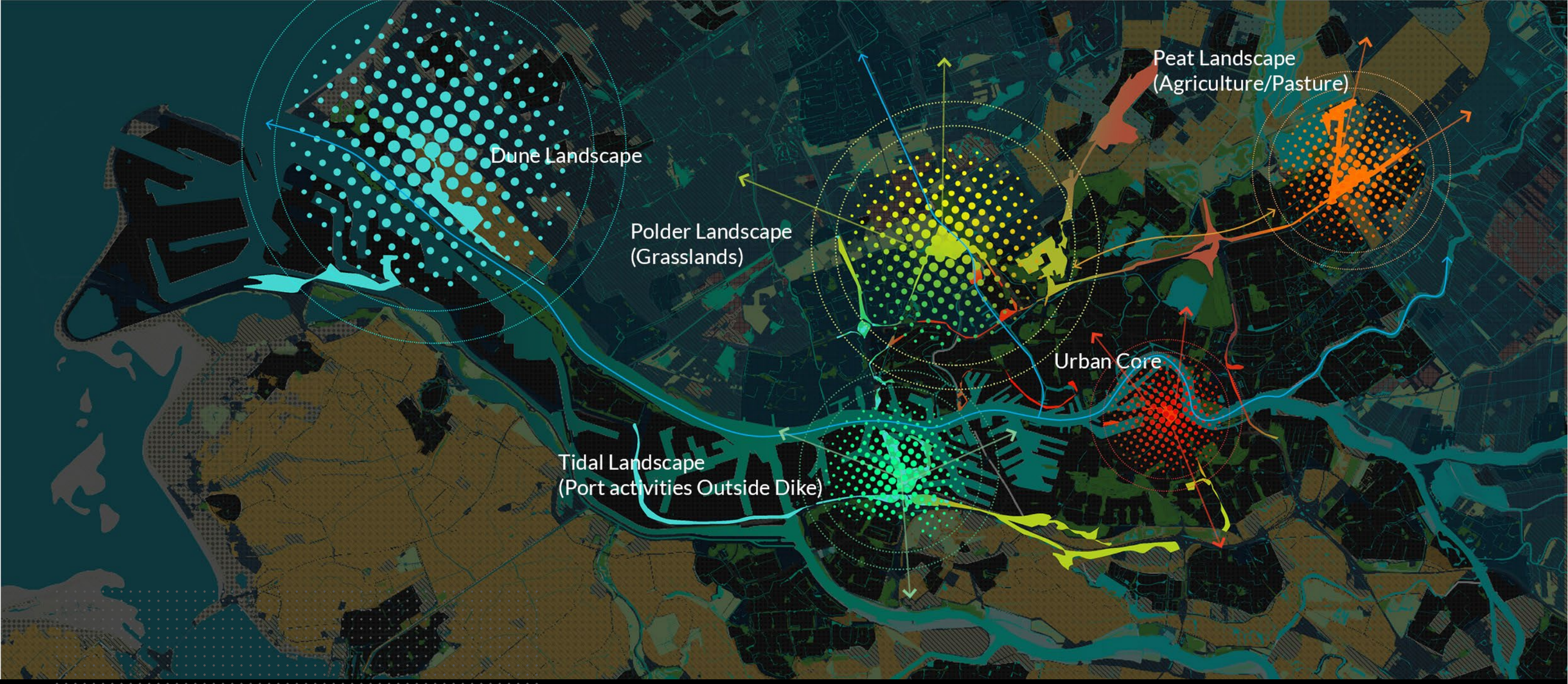
Chapter 4

STRATEGIZING



Void-Habitat Network

In the existing condition, the Blue and Green network is mostly only on the periphery of the urban core and concentrated on the North.. This in turn poses several ecology related issues.



Source: Author, 2021

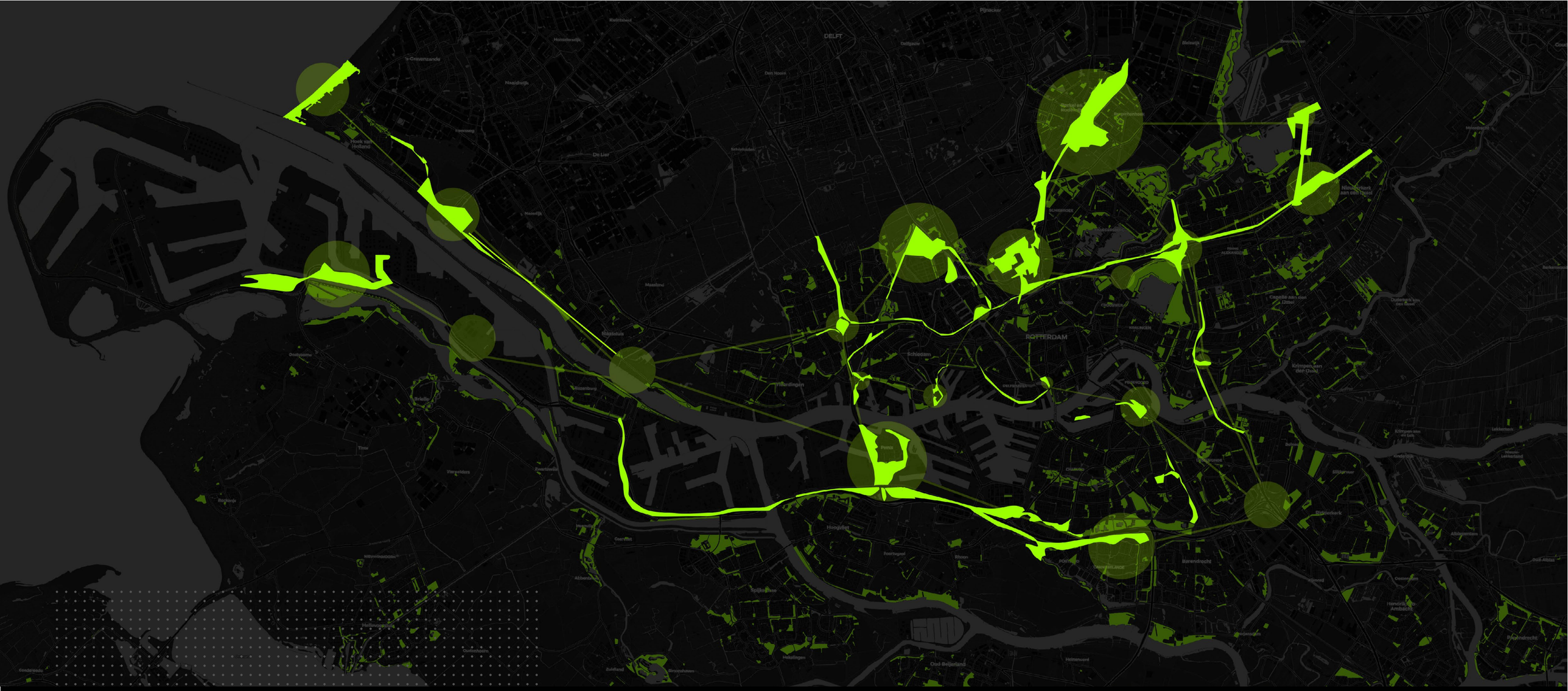
The Urban Ecological Gradient

At a regional scale, the strategy is to create gradients in the larger network of the urban realm, connecting the habitats that surround it. This will consist of creating conditions that transition from patches such as peat meadow landscape to polder landscape and from dune landscape to hardcore urban ones. Such gradients connected through ecological corridors serve the purpose of species migration and provides a breeding ground. This, in turn, facilitates better ecological services for humans as well.

Source: Author, 2021

Patch-Matrix-Corridor Scheme for Rotterdam

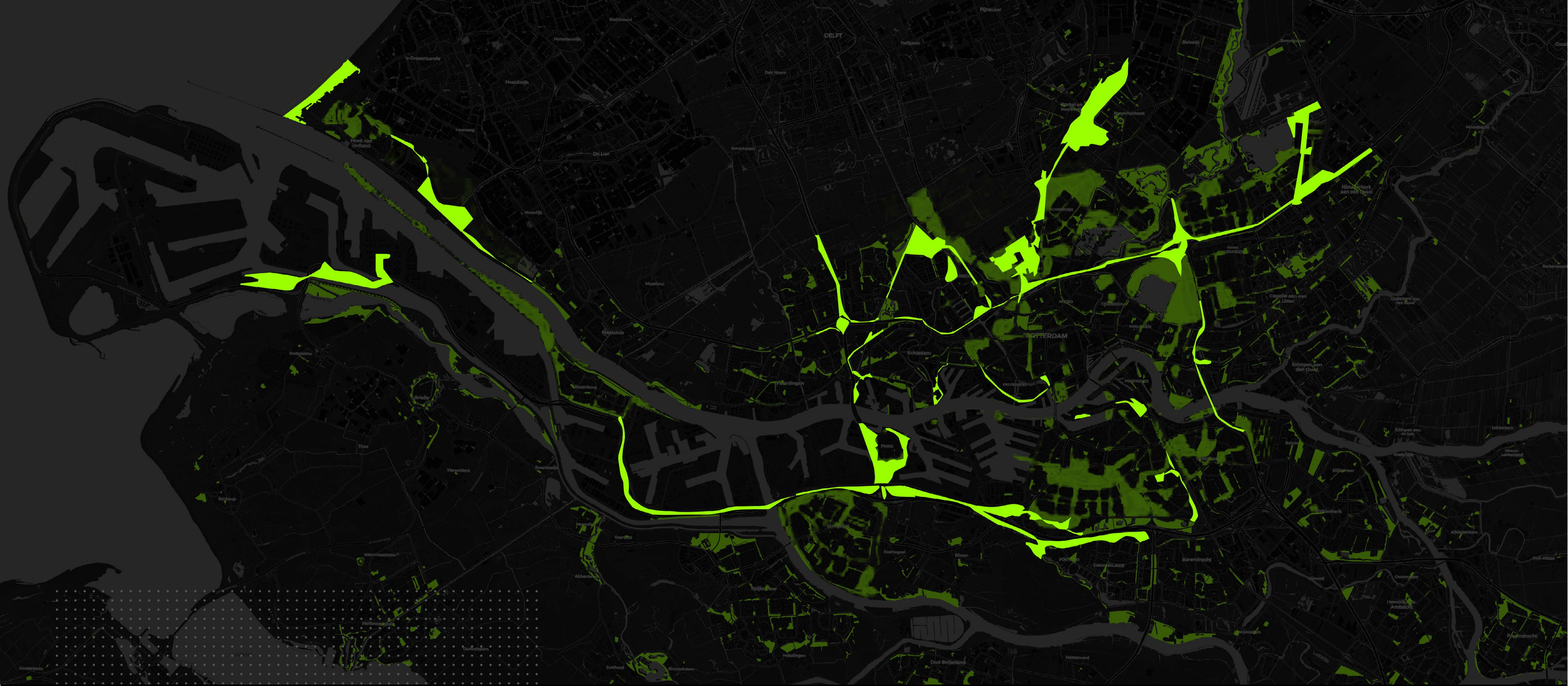
The adapted patch-matrix-corridor scheme for the city of Rotterdam links selected urban voids that connect to different habitats. These are sites that can be modified or made stronger with the right design interventions and landscape architecture principles. These sites are also interlinked through corridors at a regional scale.



Source: Author, 2021

A New Network connecting Voids

This new network makes use of the regional level patterns mapped and the local level voids. A new green fabric of these voids is envisioned.



Source: Author, 2021

0 5 km 10 km

Proposed Network vs Rotterdam Vision

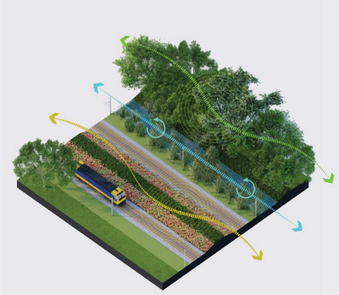
The new green network of voids adds to the existing green structure and vision of the Gemeente Rotterdam, making it stronger and coherently connected. The voids spread out across the habitats in the urban frame superimposes itself with new possibilities of landscape architectural interventions, which can lead to creating a more robust and sustainable network of blue-green, not only for humans but also for other dependent species.

Source: Author, 2021

Selecting Test Sites

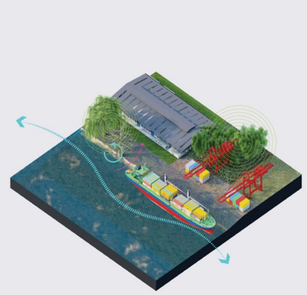
Further 2 test sites are selected to detail out the possibilities of design intervention using various principles evolved from the case studies and theoretical framework. Here the sites are chosen based on the opportunity to work with the unique tidal nature landscape. The two sites are that of Pernis, a neighbourhood fused to the industrial zone of Rotterdam Port. The next one is teh Kop van Zuid area including the Rijnhaaven and Maashaven.

Slits on bridges for bats.



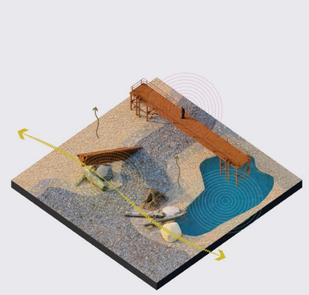
Greening Tram/Train lines.

Tall structures for birds.

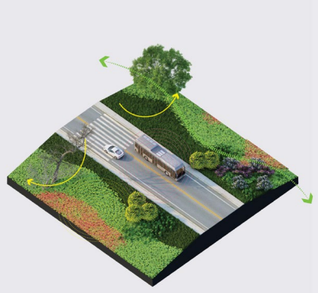


Using gradient water edges.

Using the Flyover bottoms.



Dry Sand for insects.

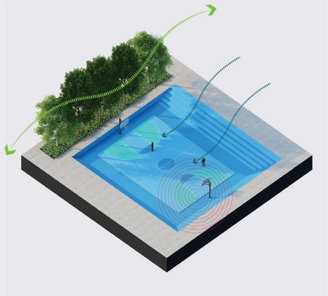


Gradients along roads.

Power line green corridors.

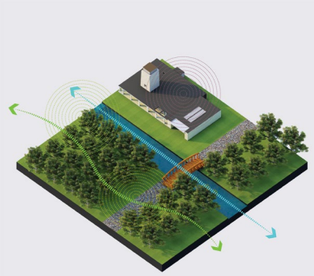
Small ponds for frogs/toads.

Rooftop Gardens



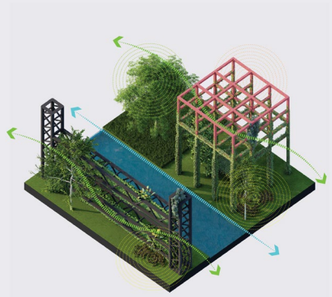
Water squares

Riparian zones.

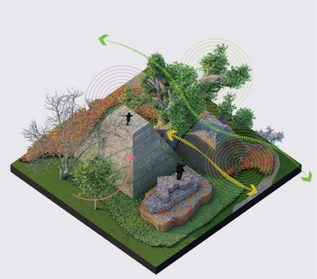


Community Orchards

Urban Forests



Truss/Metal structure for green.



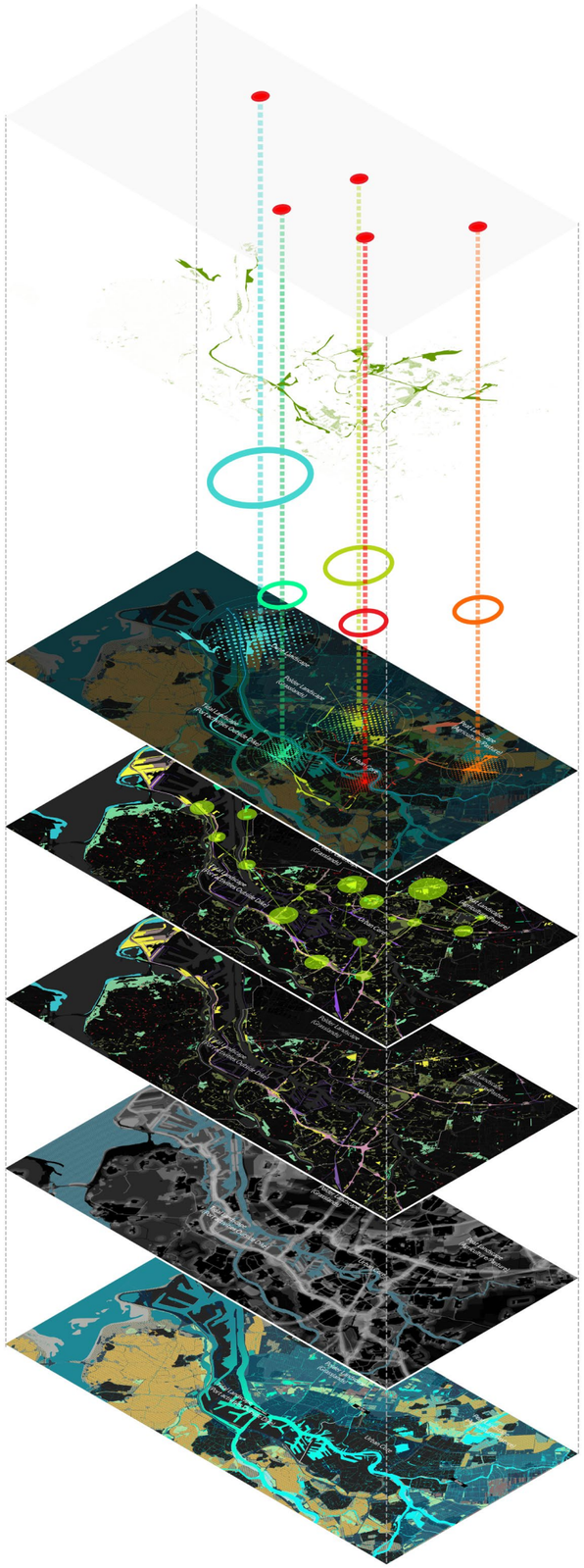
Eco Cathedrals

Forest Gardens

Pioneer Species surprises

The Design Toolbox

The design toolbox evolved from the case studies and theories helps in spatializing the void design according to the typology the site belongs to. These are guiding principles by which the site can be developed along with themes that might need to be integrated new into the sphere of design according to the site selected and analyzed.



SITE LEVEL DESIGN

Site level interventions and application of design principles.

NEW GREEN NETWORK

A new green network adding to the existing green-blue structure.

LOCAL ECOLOGY

Understanding the ecology and choosing target species for each biotope.

URBAN SCALE GRADIENT

Connecting the outer habitats through a gradient urban ecological network.

VOID NETWORK

Envisioning a new ecological void network within the urban core.

LOCAL VOIDS

Identifying local voids in the urban tissue.

REGIONAL VOIDS

Defining void patterns in the regional level.

HABITATS

Understanding the underlying and existing habitat network of the region.

Design Framework for the project.

Source: Author, 2021

Design Framework

The result is an ecological spatial design framework developed through landscape architectural principles for the urban fabric of Rotterdam by making use of the urban voids, thereby also making it resilient to climate change. This is achieved by identifying the urban voids on a regional and local scale and intervening at the right degree with a toolbox of landscape architectural principles applicable to different spatial typologies, respecting the prevailing biotopes and natural processes. The framework can be applied to any similar city, with context-specific analysis and design at different scales.

Chapter 5

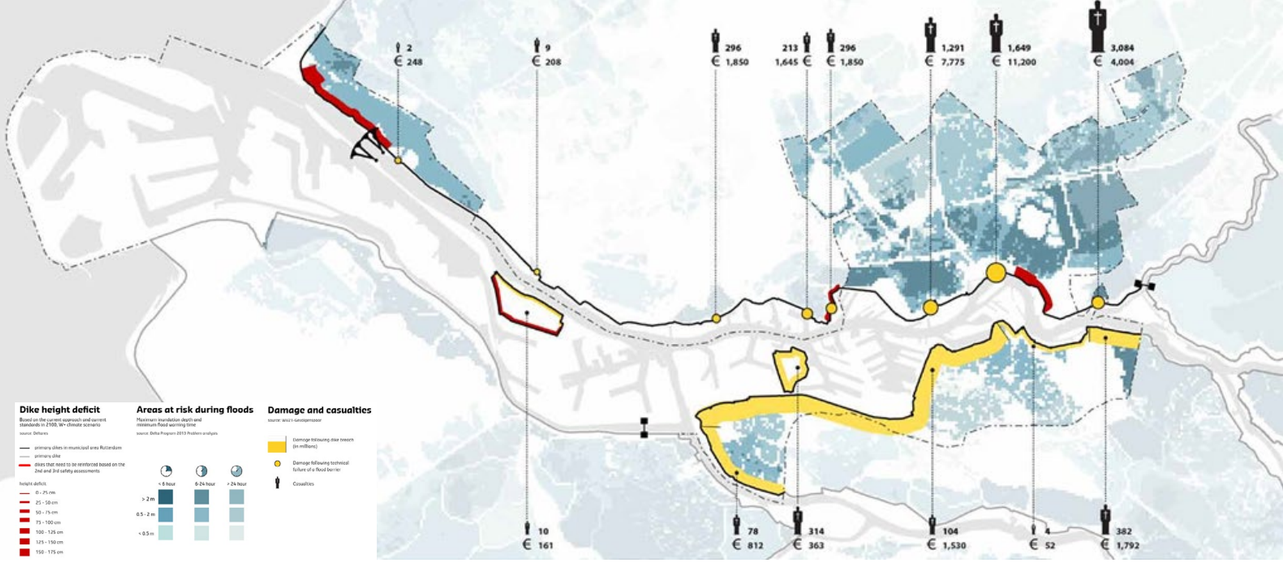
SPATIAL DESIGN

A New Tidal Nature

The tidal nature in the Rotterdam area where the water from Nieuwe Maas is in contact with the saline water from the North Sea. The creation of tidal parks and utilizing this as an opportunity to enhance the tidal dynamics, ecology, and human use. Such tidal systems are unique in this part of the world, and around 70% of the water stretch in contact with the river is hard paved, inaccessible to humans, and detrimental for other species as well. A new system of tidal parks increase biodiversity, provides flood resilience, and creates a public space for human activities. The careful application of design principles can boost the ecological value of the area and make it an ecological hotspot for several target and accompanying species as well.

The sites chosen here are Pernis and Kop van Zuid. Both these sites have an industrial history and are categorized as urban voids. These sites also poses a threat of being vulnerabe to calamities like flood and heat islands.

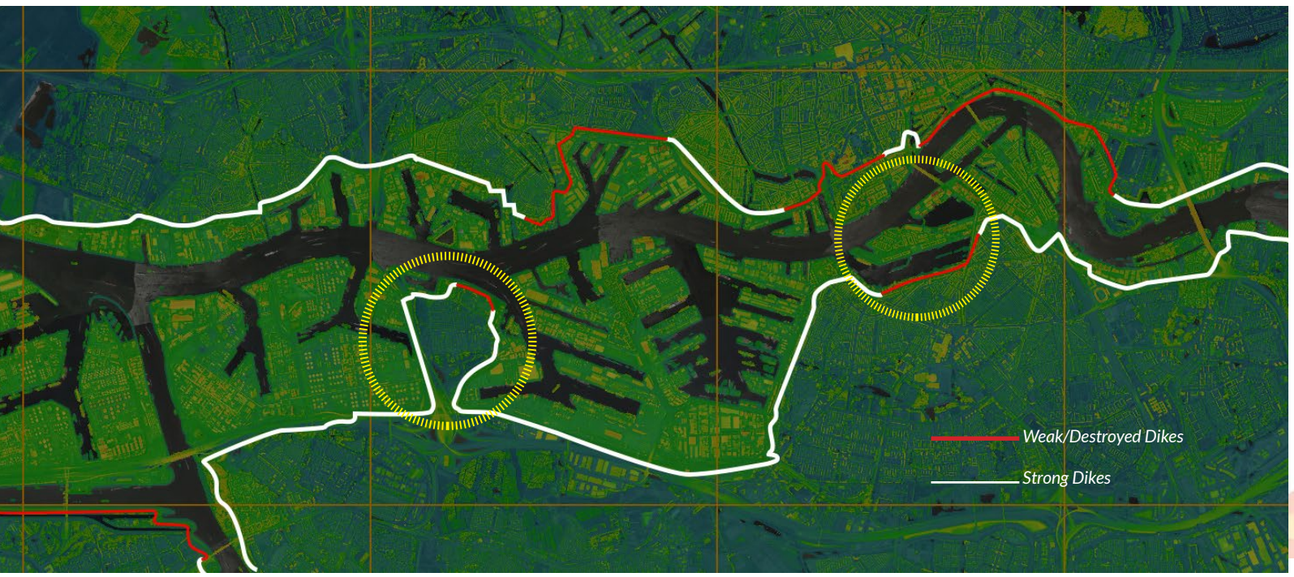
Dike Layout (Satellite)



Flooding vs Economic Loss

Source: Rotterdam Climate Change Adaptation Strategy

0 10 km 20 km



Dike Layout - Outside dike areas are in different shade.

Heat Island Map

Source: Rotterdam Climate Change Adaptation Strategy

Dike Vulnerability

As it is evident from the maps. the dikes at many places are weak and need serious reconstruction and enforcement. This weakness turns into vulnerability as the change in global climate and precipitation levels are on a rise, leading to recurring floods. The rise in water-level threatens the neighborhoods inside the dike areas as well.

Flood Damage and Heat Islands

The island dikes are exposed to breakage and overflow, and the old dike is no more seen on the landscape. This, in turn, causes the threat of flooding and related economic losses. The inner settlements are heavily paved. As a consequence, the maps show that this area also suffers from urban heat islands.

- The A4 Highway runs adjacent to the Pernis.
- Built structures mainly consist of neighbourhoods of houses and warehouses for port functions.
- Paved surface dominates the area. Result of the Industrial/Port Use.
- Water in the Nieuwe Maas affected by tidal water from the North Sea

  The green structure is primarily flat grass lawns.
- Composite Site at Pernis

Source: Author, 2021

Site Structure-Pernis

The island of Pernis is wedged between the harbors Petroleumhaven and Eemhaven. It still holds the neighborhood identity with a village character in a heavily industrialized area. The neighborhood started losing its value as more and more port and industrial activities and calamities started happening. The void on this island could be described as one that surrounds the settlement on the water edge. The neighboring sites are industrial and contaminated with port activities. The spatial typology and spread of hard concrete surfaces pose to create an environment harsh and prone to climate change disasters like flooding.

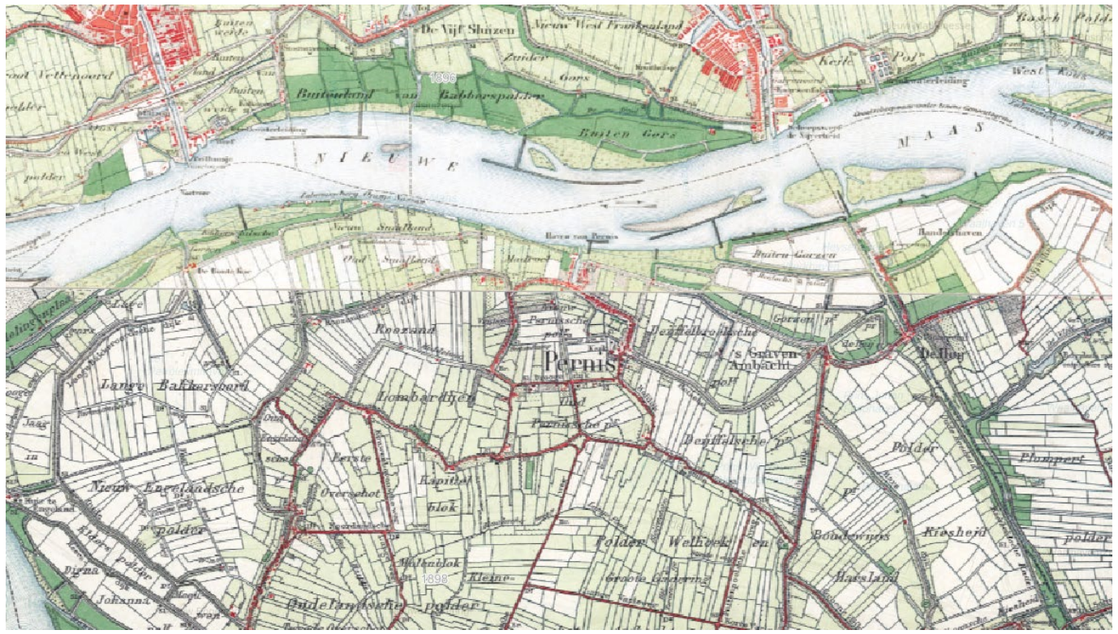
- The RijnHaven/Maashaven Stations, S122 Road go adjacent. The Erasmus bridge is a landmark.
- Built structures mainly consist of neighbourhoods of houses, industries, commercial areas and warehouses for port functions.
- Paved surface dominates the area. Result of the Industrial/Port Use.
- Water in the Nieuwe Maas affected by tidal water from the North Sea

  The presence of green is very scarse. Dominated by port activities.
- Composite Site at Kop Van Zuid

Site Structure-Kop van Zuid

The design location at Kop van Zuid encompasses the void characterized by the vacant land next to the S122 city road. The area also consists of the iconic Maashaven and Rijnhaven port areas. It is located on the south bank of Nieuwe Maas opposite the center of town. The character of the area is mostly industrial and commercial with a lot of hard surfaces intended for industrial and port activities. The water banks are closed off with 90-degree edges with no room for green. The whole area is devoid of any parks or nature-based recreational areas.

Development over Time: Pernis

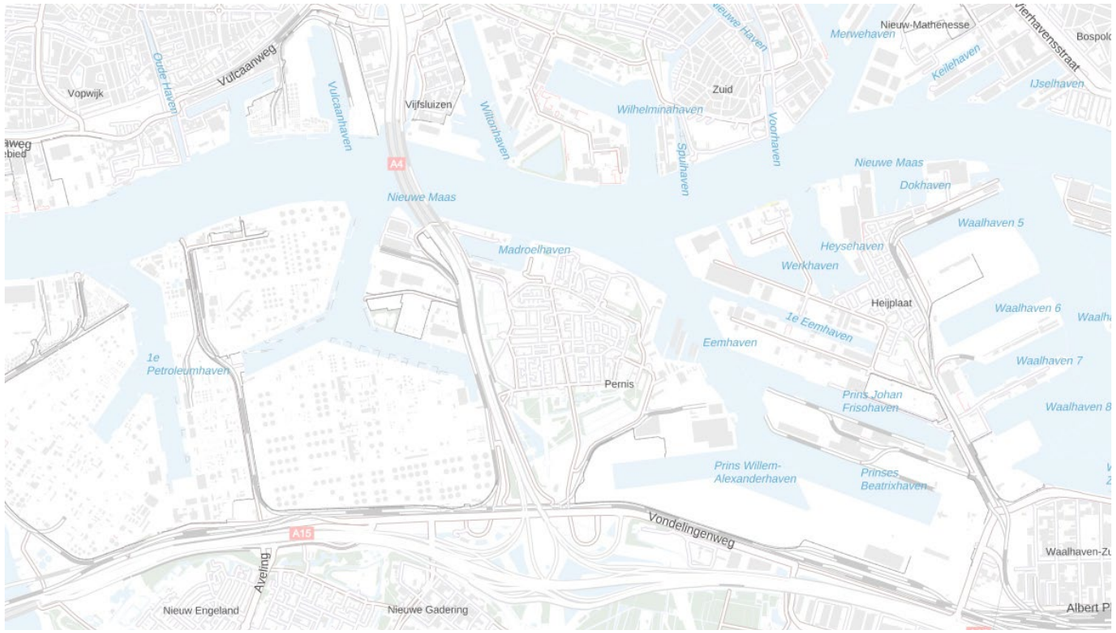


Pernis in 1900

Source: CultGIS

Pernis in 1959

Source: Anneke Krak (Pinterest)



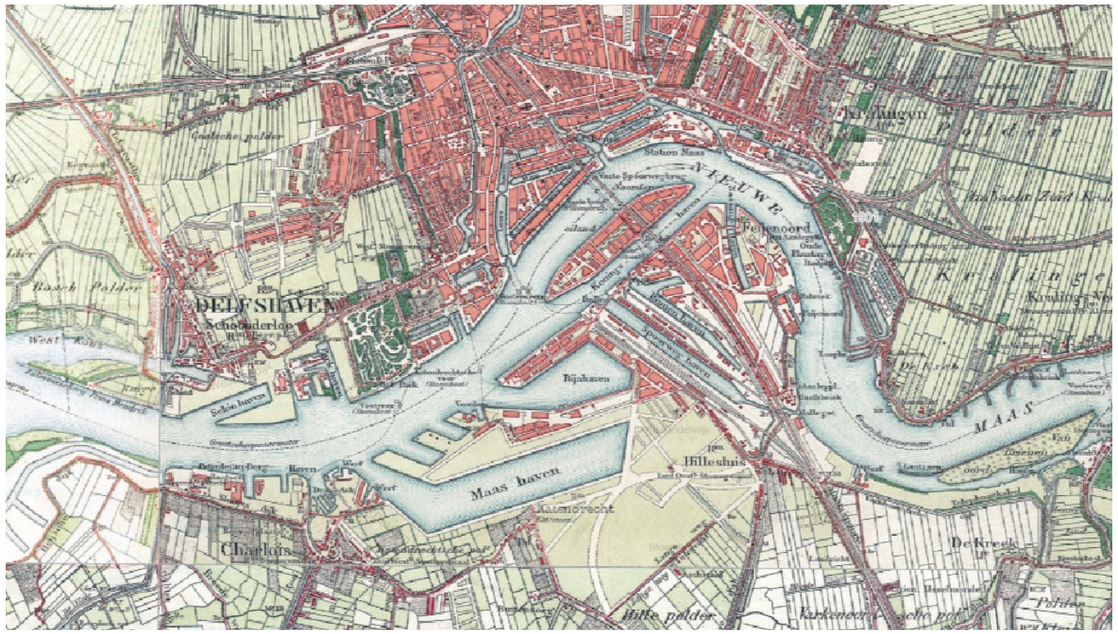
Pernis in 2021

Source: CultGIS

Pernis in 2021

Source: Siebe Swart

Development over Time: Kop van Zuid



Kop van Zuid in 1900

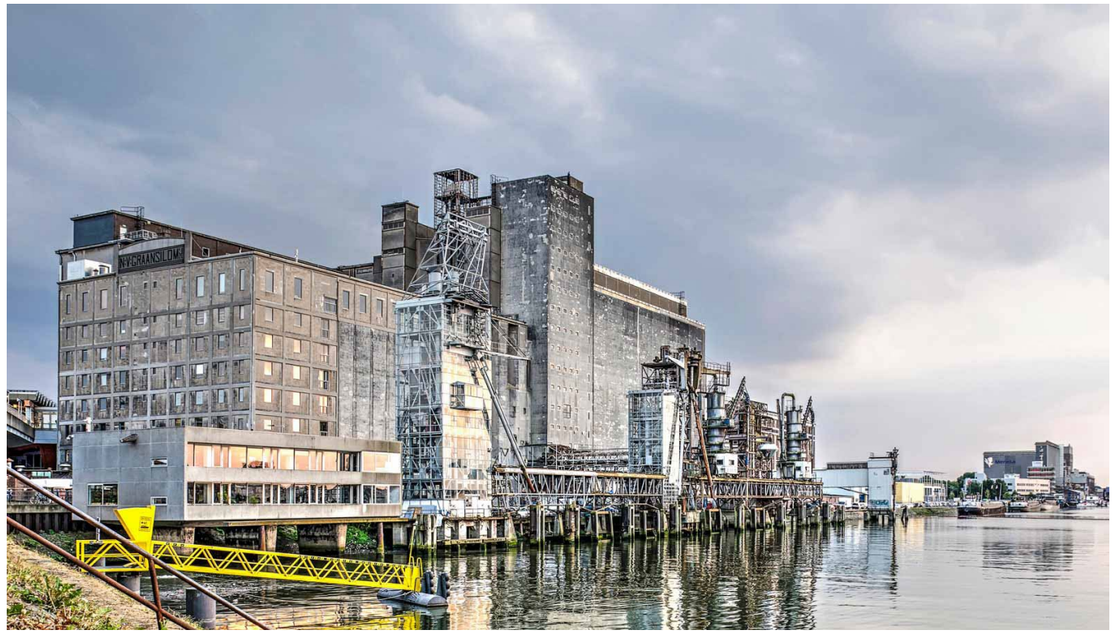
Source: CultGIS

Maashaven (Kop van Zuid) in 1920's

Source: https://architizer.com/projects/maashaven/

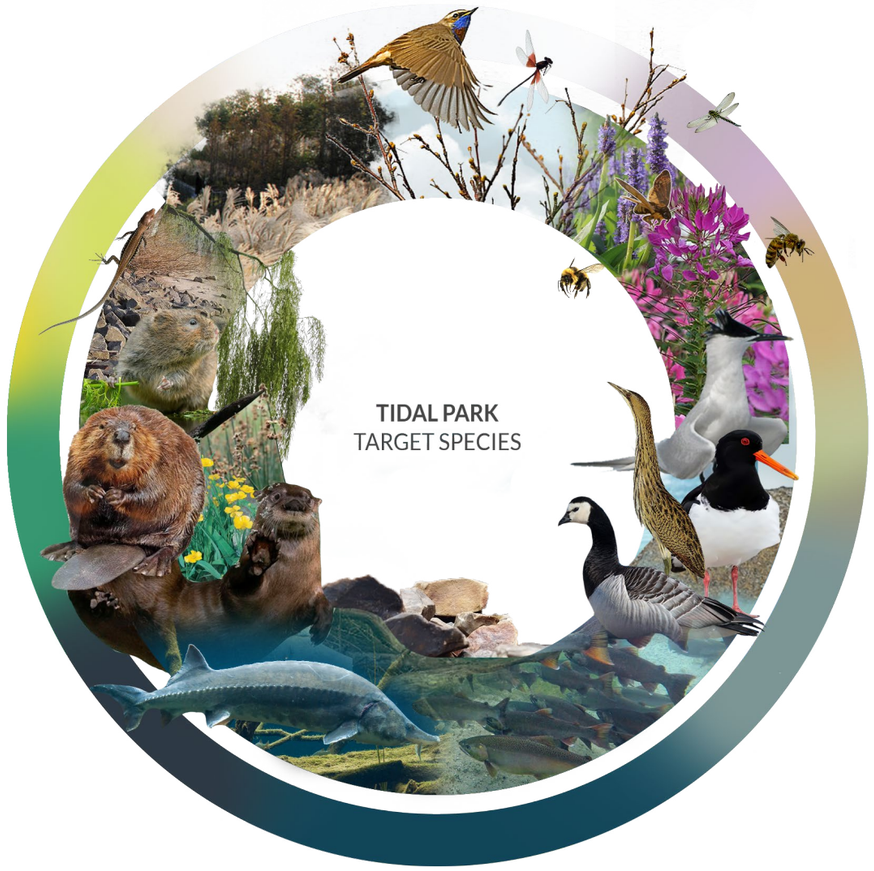
Kop van Zuid in 2021

Source: CultGIS



Maashaven (Kop van Zuid) in 2021

Source: Frans Blok 3develop.nl



Source: Author, 2021

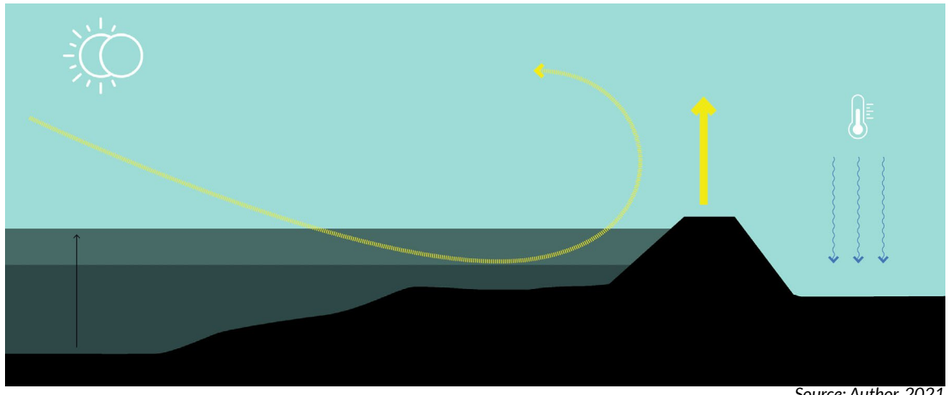
Sturgeon	Beavers	Oyster Catcher	Bumblebees	Lizard
Salmon	Barnacle Goose	Arctic Vole	Reeds	Moths
Otters	Sandwich Tern	Blue Throat	Spider Flower	Cattails

Ecology

From an ecological perspective, a tidal park with varied gradients and biotopes facilitates the inflow, breeding, and utilization by many species dependent on water and wet conditions. The salmon and sturgeon can now swim to cleaner water and use it as resting grounds. Species like the arctic vole rests on higher grounds, while beavers and otters can be introduced as well. Birds like sandwich tern and barnacle goos can make use of uninterrupted grounds for laying eggs and breeding. Bumblebees and insects like lizards and moths can make use of sandy edges as per design.

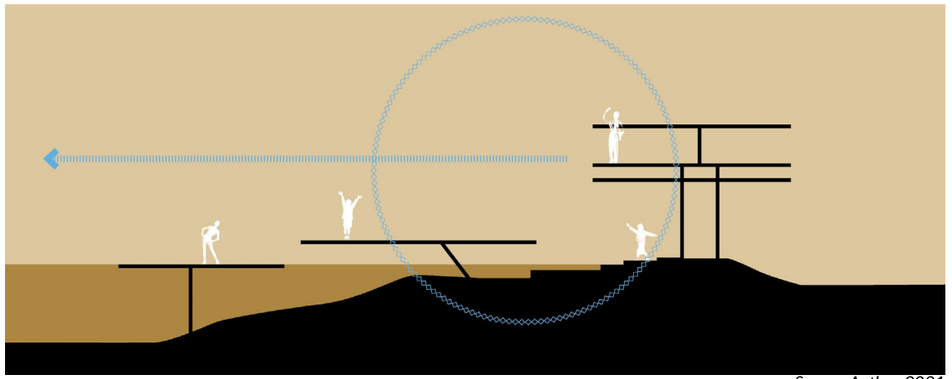
Source: Author, 2021

The site as an ecological hotspot.



Source: Author, 2021

The site as an agent of climate change resilience.



Source: Author, 2021

The site as a destination for recreation.

Design Goals

The objective of the tidal park design at Pernis and Kop van Zuid is threefold. 1. Creating a hotspot for biodiversity, 2. A climate change-adaptive strategy for the area, and 3. A recreational destination for people. When leisure is combined with ecological elements, the value of the river and tidal landscape increases, and so does the overall outlook of the area. Gentle and vegetated gradients along the banks in combination with several built and unbuilt design interventions will help in breaking the waves down as well.

Test Site 01

Pernis

Overall Design

The Tidal Park at Pernis encapsulates the water edge of the island and envisions a new identity for the otherwise forgotten area. The park system comprises walking and biking paths along the new and reinforced dike, which also creates a strong boundary between the void and the housing area. The void, therefore, becomes a destination for recreation. Several planting and vegetation schemes clubbed with the different water quality areas add ecological value to the park. The soft gradient banks with multiple combinations of ground setup with a layer of mixed riparian and other vegetation invite different fauna into the realm. The land formation gives way to creeks and ponds, while the last civil layer adds multiple architectural constructions from wood and corten steel to emphasize the industrial history of the area.

Source: Author, 2021

Source: Author, 2021

The tidal park becomes an extension of the housing neighborhood of Pernis, as the dike gradually grades down into the park, creating a subtle but visually contrasting outer green ring along the river. The edge conditions alter at different points, giving opportunities for varied species and activities to take place.

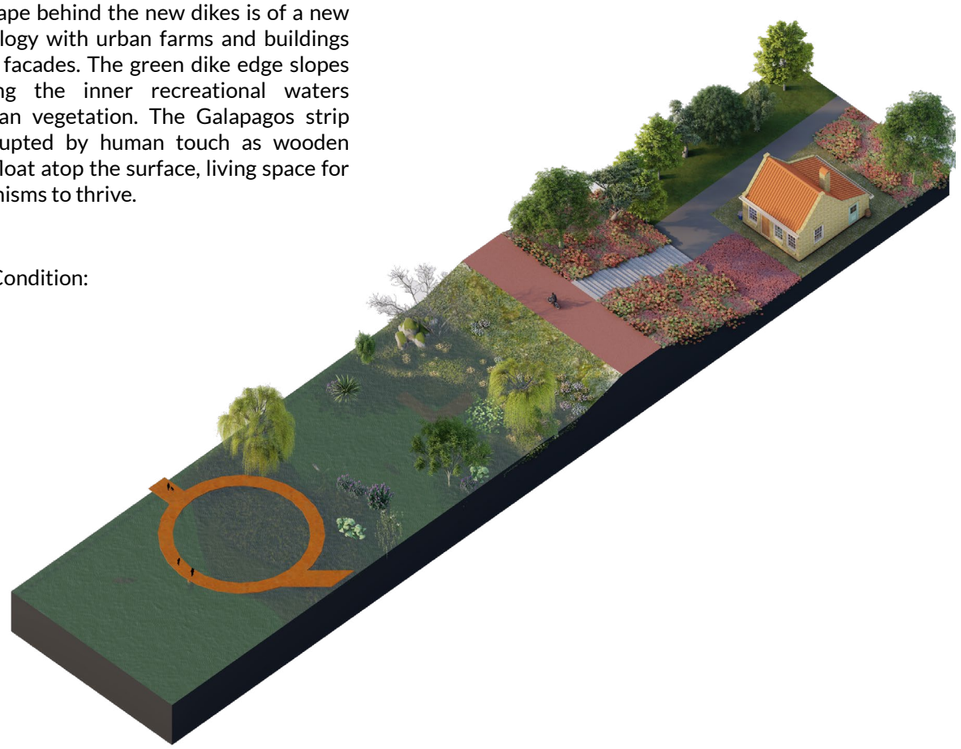
Source: Author, 2021

Spatial Combination 1

Low Tide Condition:

The landscape behind the new dikes is of a new green typology with urban farms and buildings with green facades. The green dike edge slopes down along the inner recreational waters with riparian vegetation. The Galapagos strip is uninterrupted by human touch as wooden walkways float atop the surface, living space for other organisms to thrive.

High Tide Condition:

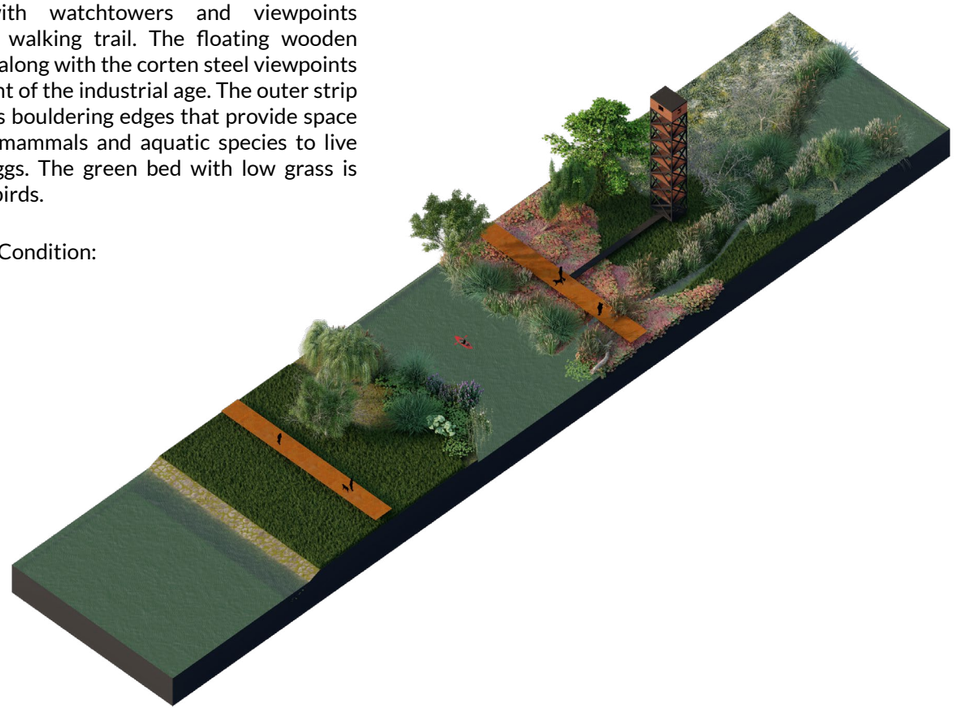


Spatial Combination 2

Low Tide Condition:

The natural character of the creek and the riparian waters makes the ecological strength boost, and at the same time, provides recreational values with watchtowers and viewpoints along the walking trail. The floating wooden elements, along with the corten steel viewpoints reminiscent of the industrial age. The outer strip of land has bouldering edges that provide space for many mammals and aquatic species to live and lay eggs. The green bed with low grass is home for birds.

High Tide Condition:

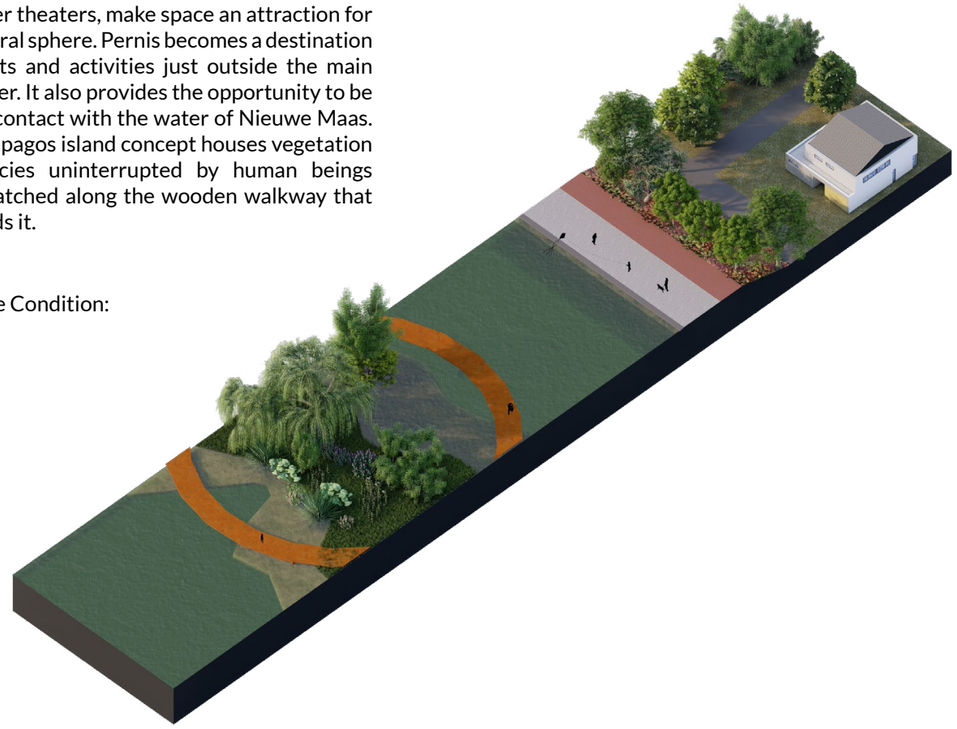


Spatial Combination 3

Low Tide Condition:

Hard water edges of concrete, with exhibition and water theaters, make space an attraction for the cultural sphere. Pernis becomes a destination for events and activities just outside the main city center. It also provides the opportunity to be in close contact with the water of Nieuwe Maas. The Galapagos island concept houses vegetation and species uninterrupted by human beings but is watched along the wooden walkway that surrounds it.

High Tide Condition:

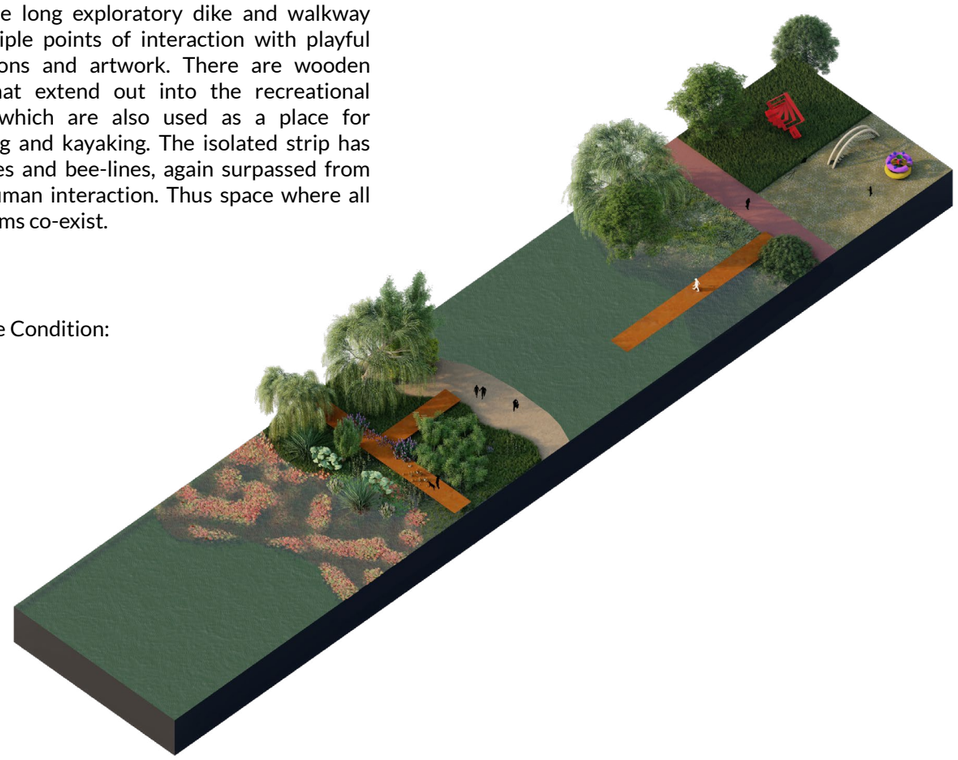


Spatial Combination 4

Low Tide Condition:

Along the long exploratory dike and walkway are multiple points of interaction with playful installations and artwork. There are wooden decks that extend out into the recreational waters, which are also used as a place for swimming and kayaking. The isolated strip has butterflies and bee-lines, again surpassed from direct human interaction. Thus space where all living forms co-exist.

High Tide Condition:



Aerial view of the Pernis Tidal Park

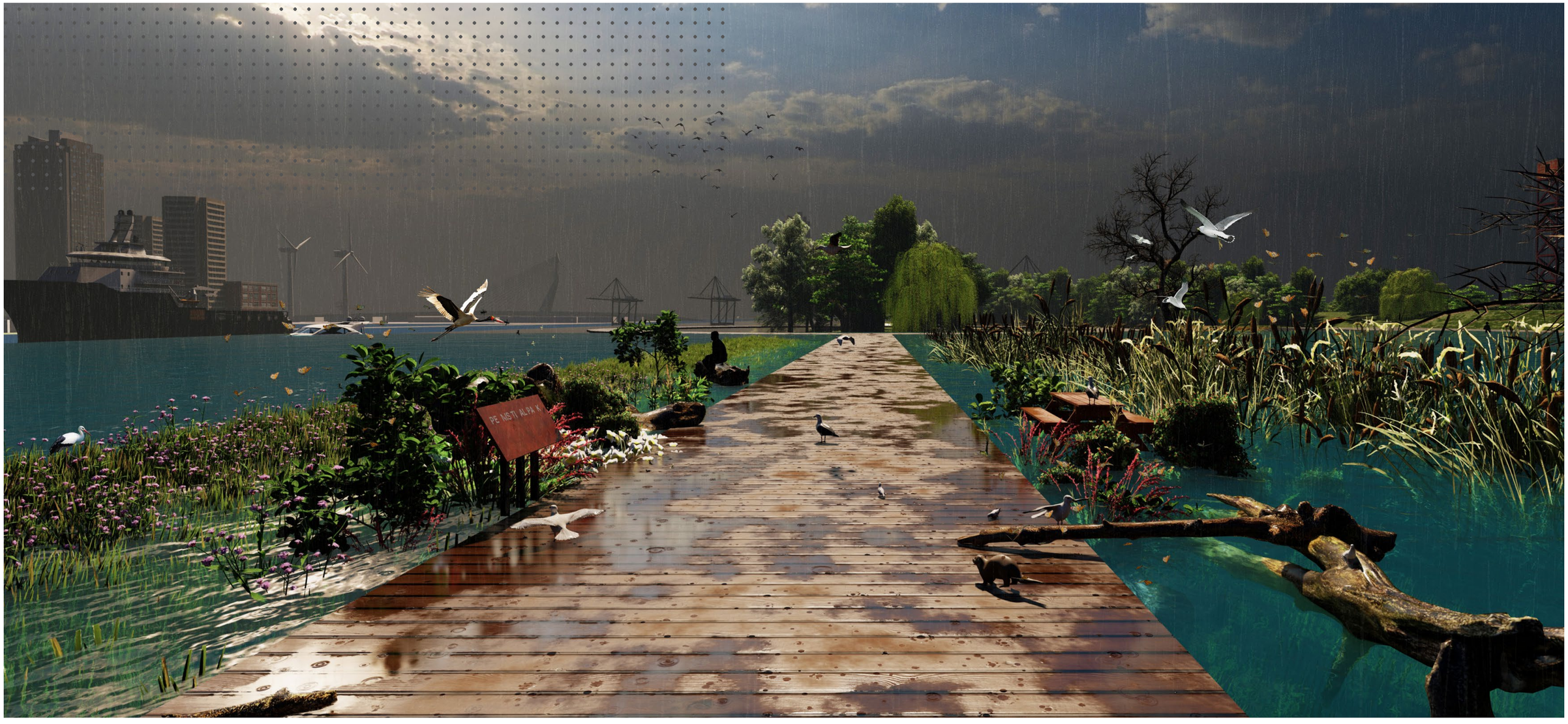
Source: Author, 2021

Impression of the new Pernis Tidal park spatial characters

Source: Author, 2021

Impression of the new Pernis Tidal park during flooding

Source: Author, 2021

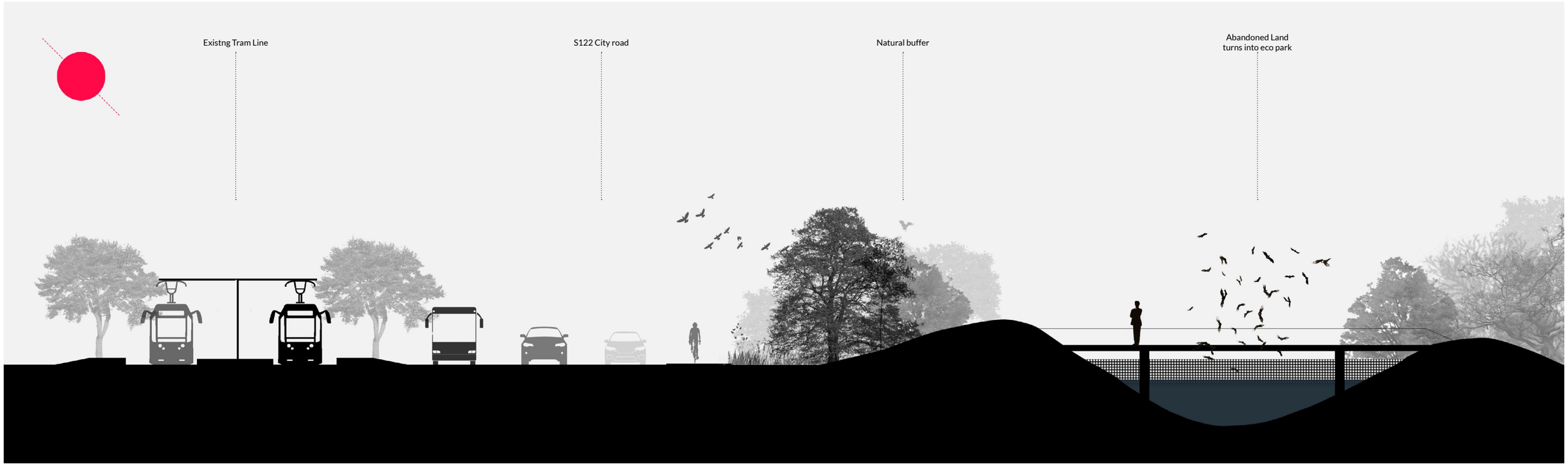


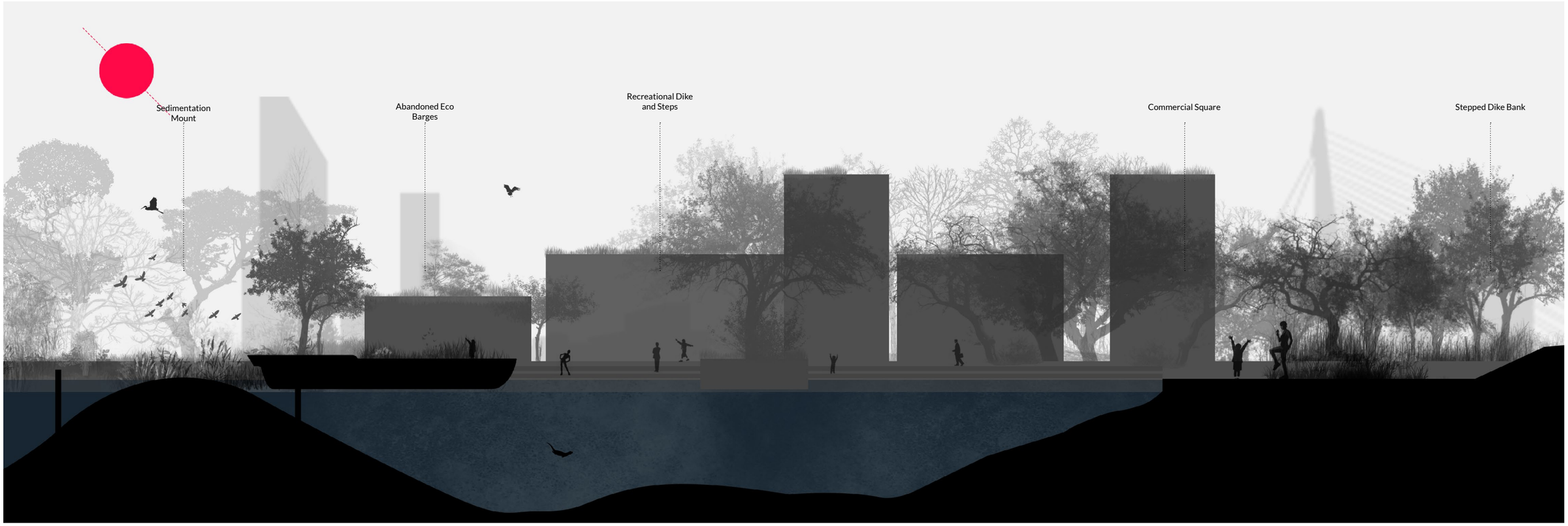
Test Site 02

Kop van Zuid

Overall Design

The new green nature at Maashaven and Rijnhaaven is characterized by the establishment of new nature as per tidal effect and time. The groins provide space for sedimentation to take place over time. A new wetland system is developed over the years, housing more fauna and flora that belong in freshwater situations. This area also transforms into a local recreational zone with an industrial character, commemorating its original identity. The old dikes are strengthened by new resilient and multifunctional new dikes.

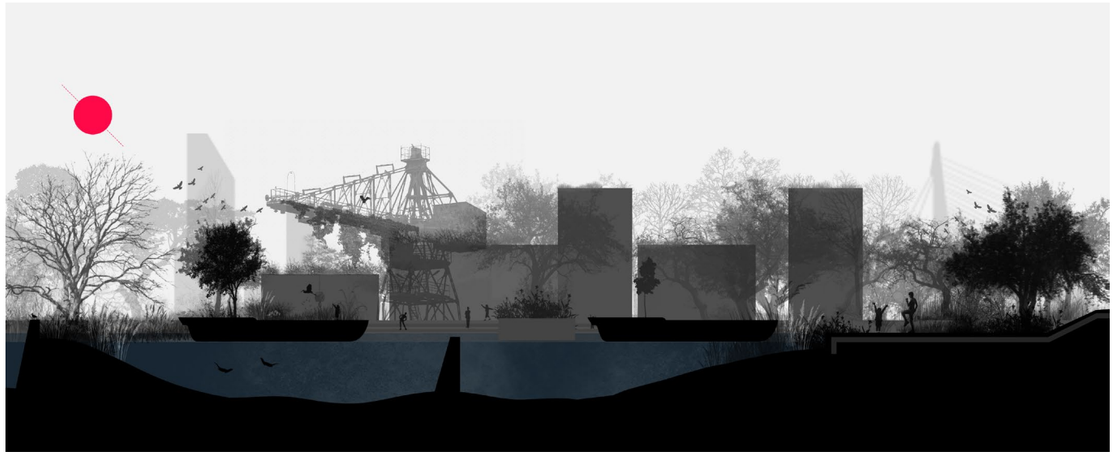

Existng Tram Line
S122 City road
Natural buffer
Abandoned Land
turns into eco park


Sedimentation
Mount
Abandoned Eco
Barges
Recreational Dike
and Steps
Commercial Square
Stepped Dike Bank

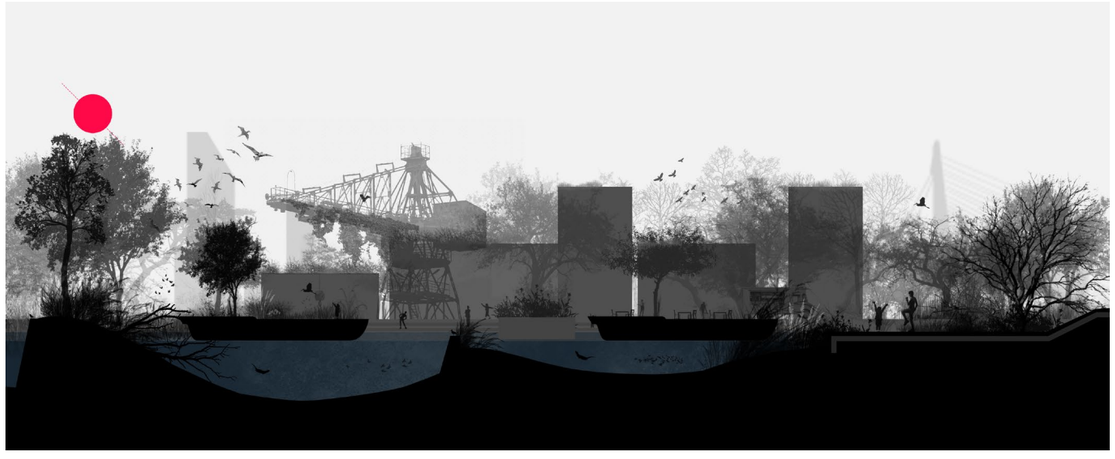
Temporality

2021 Scenario

2030 Scenario: Sedimaentation, Introduction of new Groynes



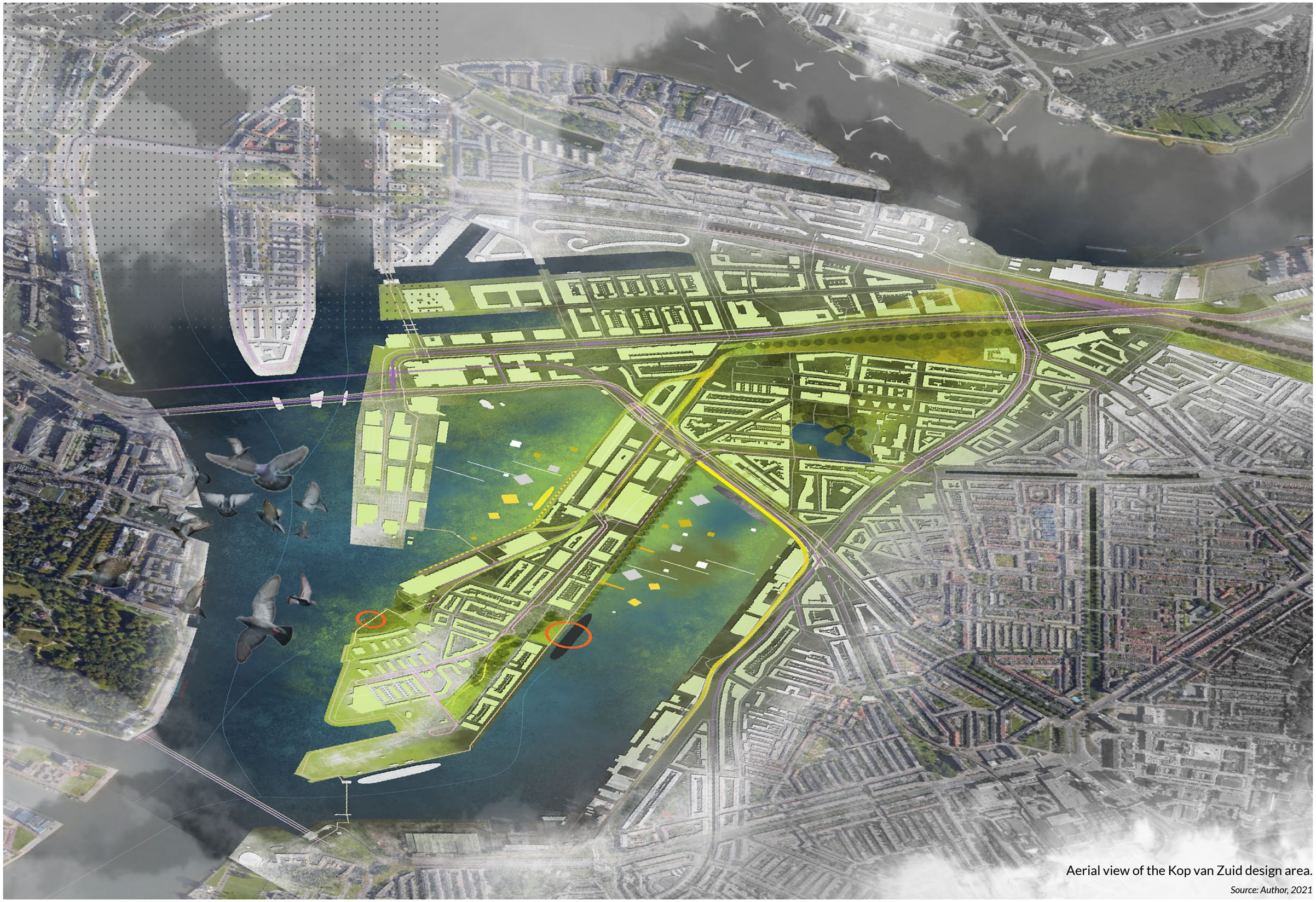
2050 Scenario: Creation of Marshland



Low Tide Condition:

The new low dikes enhance the spatial quality that separates the commercial and industrial core from the new green edge of the area. The water edges turn into eco-zones and congregation and festive zones. The dikes reinforce the safety from water rise. The paved areas are made into a combination of green and blue with green facades for the buildings as well, seriously bringing down the urban heat island effect.

High Tide Condition:

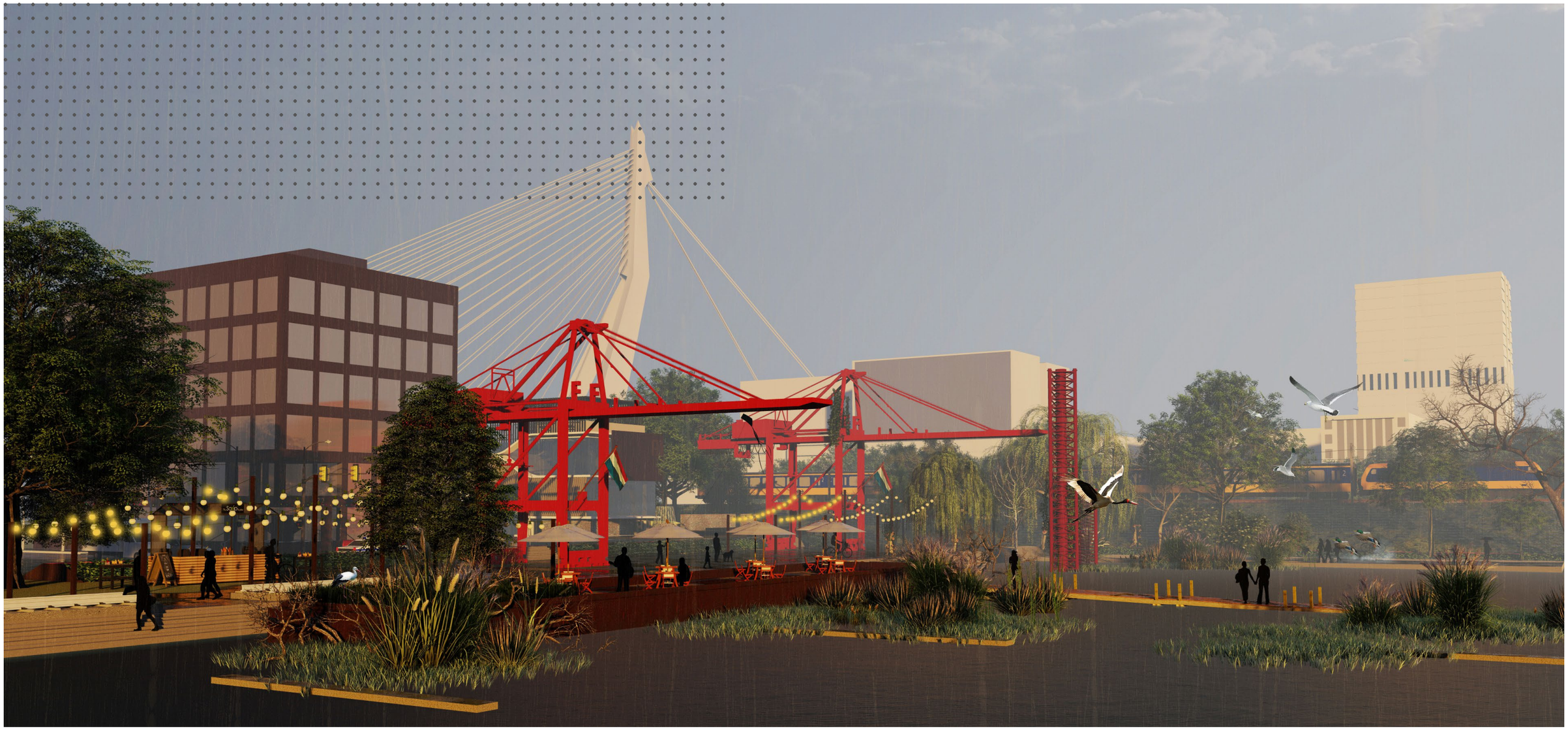


Aerial view of the Kop van Zuid design area.

Source: Author, 2021

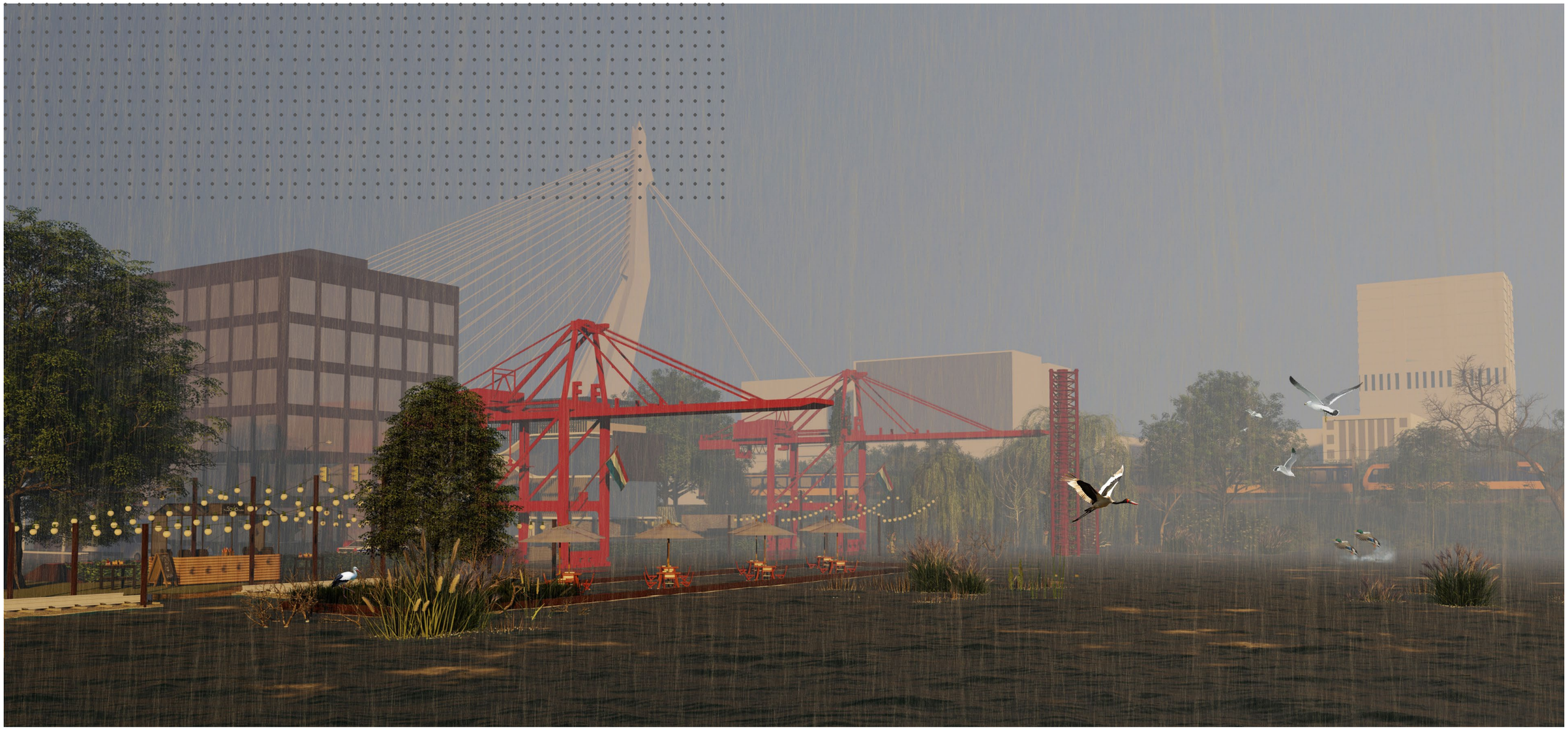
Maashaven Regular Scenario

Source: Author, 2021



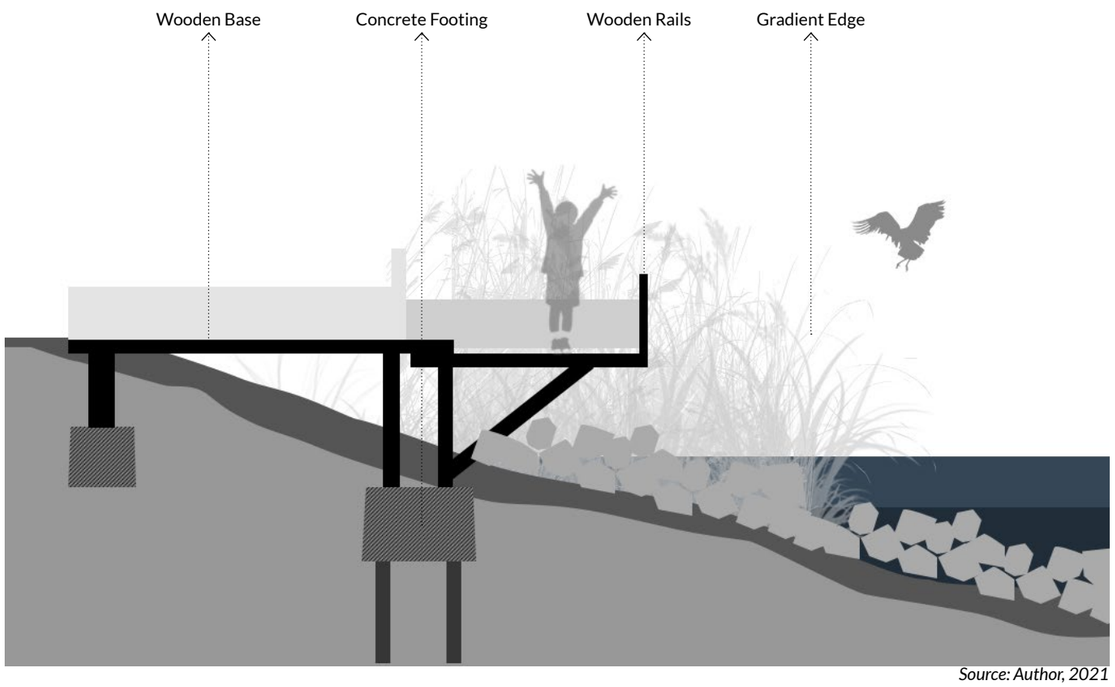
Maashaven Flooding Scenario

Source: Author, 2021



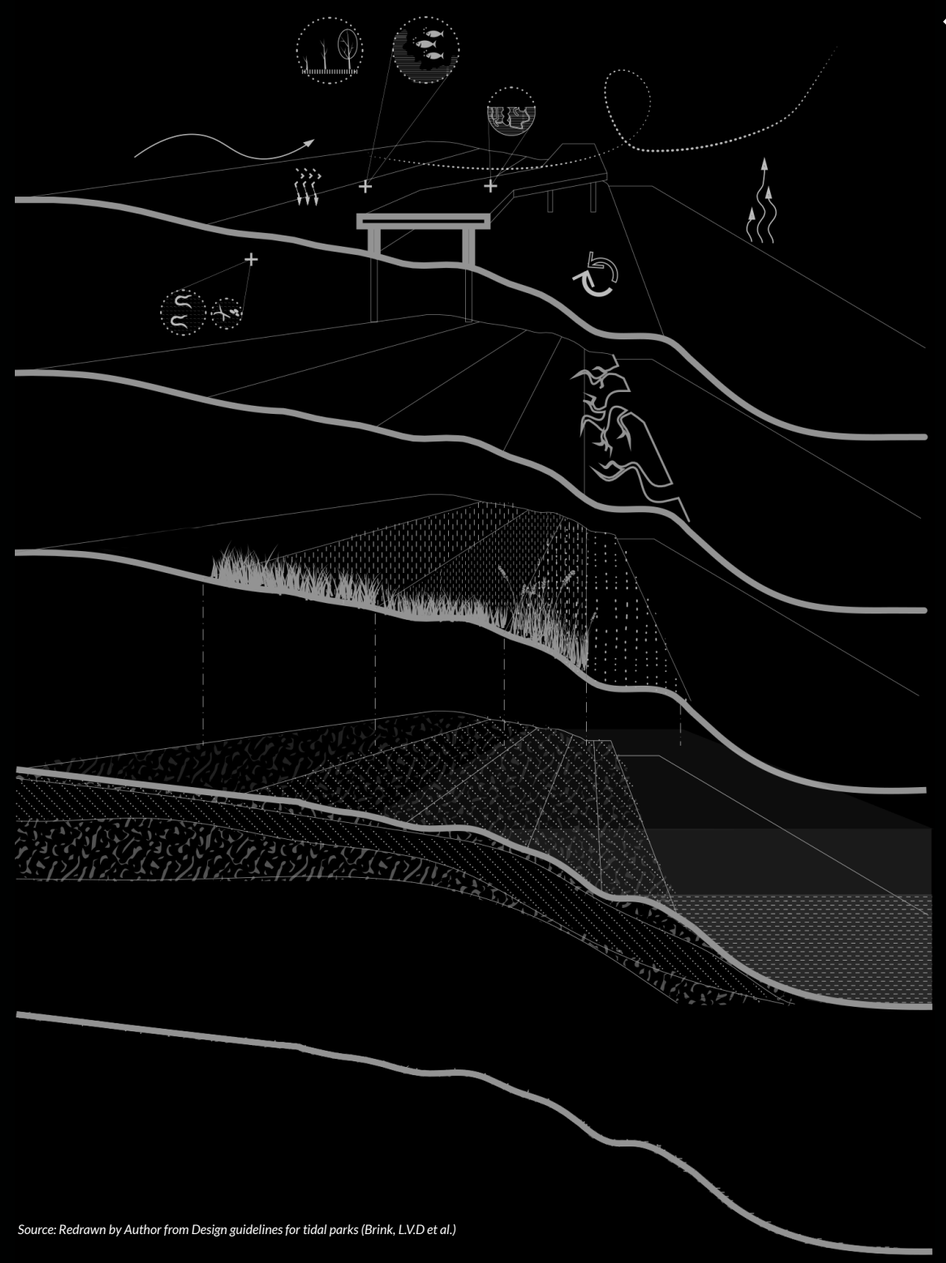
Details

Source: Author, 2021



Source: Author, 2021

Composition Strategies

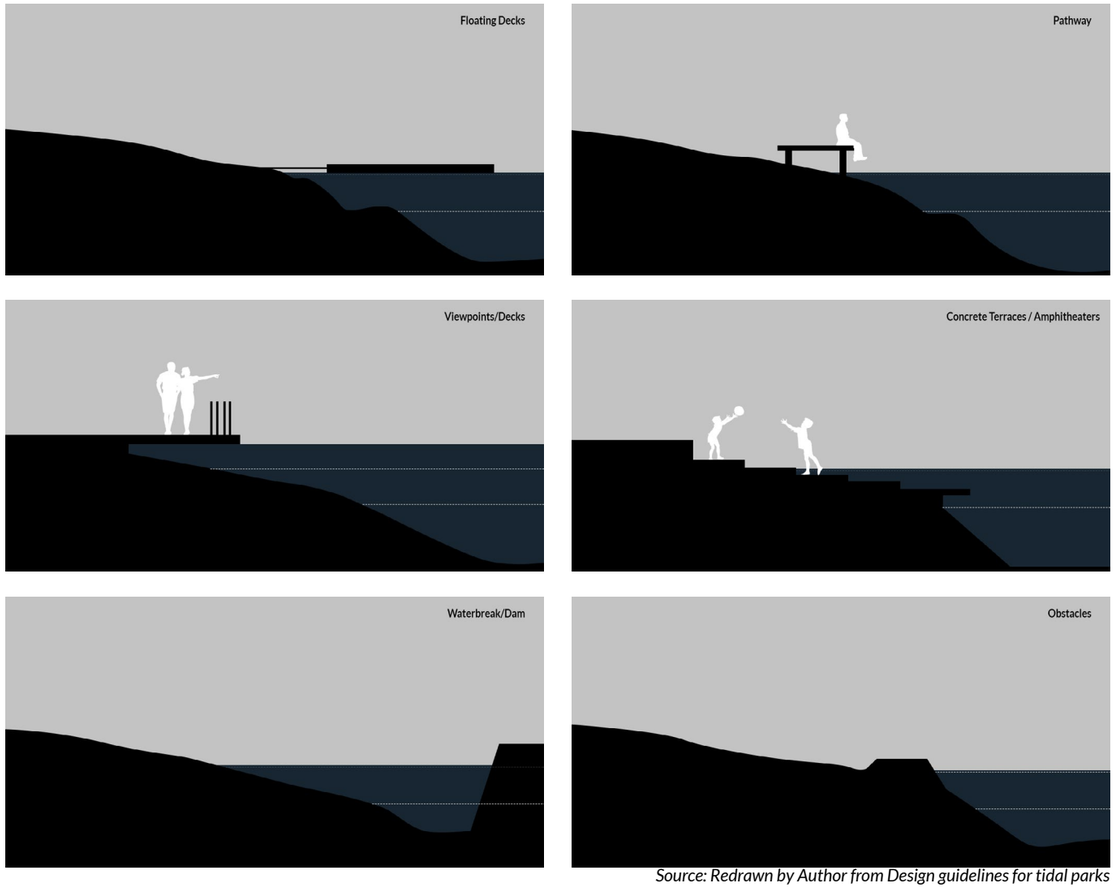


Source: Redrawn by Author from Design guidelines for tidal parks (Brink, L.V.D et al.)

Ground Setup	Vegetation	Land Formation	Civil Works
No filling	Equal Distribution	Creek Formation	Deck
Filling Sand + Clay	Unequal Distribution	Creek Creation	Obstacle
Filling Rock			Path
Stablization			Viewpoint
Rock			Terraces
Concrete			Foreshore

Water Edges

Water dynamics and salinity are two major factors that determine the ecology along the banks of a tidal river system. Salinity and inundation periods determine what species can survive. The project explores different edge conditions where design interventions and material combinations are worked out to give varied conditions for species. These are clubbed with recreational purposes and climate adaptiveness.



Source: Redrawn by Author from Design guidelines for tidal parks

Source: Redrawn by Author from Design guidelines for tidal parks

WILLOW TREE

SPINDOTTER

REEDS

OYSTER CATCHER

BARNACLE GOOSE

SANDWICH TERN

BLUE THROAT

BUMBLEBEES

MOTHS

LIZARDS

ARCTIC VOLE

OTTERS

BEAVERS

STURGEON

EUROPEAN EEL

ATLANTIC TWAITE SHAD

ATLANTIC SALMON

Wetland Forest

Riparian Zone

Emergent Vegetation

Submergent Plants

Floating Plants

Algae

Highest Astronomical Tide

Mean High Water Spring

Mean High Water Neap

Mean Low Water

Lowest Astronomical Tide

Upper Marsh

Middle Marsh

Lower Marsh

Pioneer Zone

Mudflat

Above Tide

Intertidal

Subtidal

Ecology

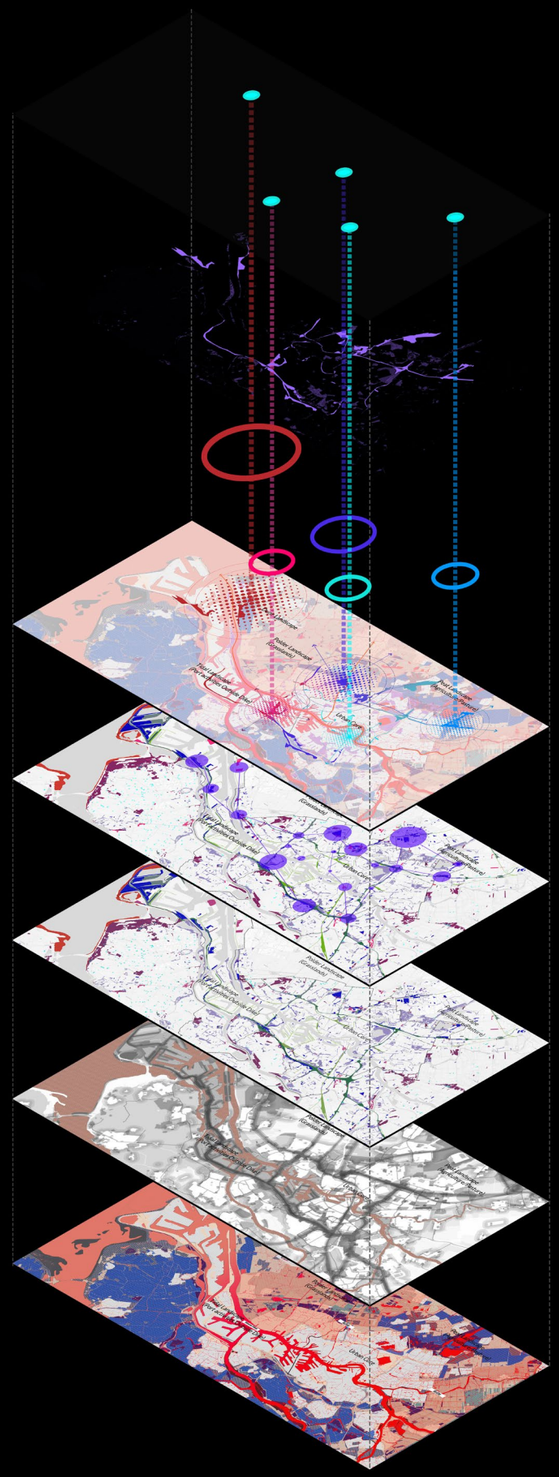
Source: Redrawn by Author from Design guidelines for tidal parks (Brink, L.V.D et al.)

Chapter 6

REFLECTION

Symbiotic Urban Voids

A Resilient Ecological Network for Rotterdam through its Urban Voids



Rapid urbanization and globalization have resulted in the uncontrolled and chaotic distribution of cities and man-made elements over the natural landscape. Such a paradigm exists in the Rotterdam urban region as well. The historical landscape and its natural qualities, with regard to habitats, ecology, and processes, have been overtaken by the bustling need for new constructions and developments. The urban tissue disconnects the surrounding landscape qualities and habitats, thus forming an ecological void in the region. The 'unbuilt' is no more unbuilt. The in-between spaces, even in the urban fringes, are dominated by concrete paving and hard surfaces. This dissociates the cultural layer from the natural processes and components like various other species dependent on this ecosystem. The landscape and is vulnerable to more habitat loss and species diminishing day by day.

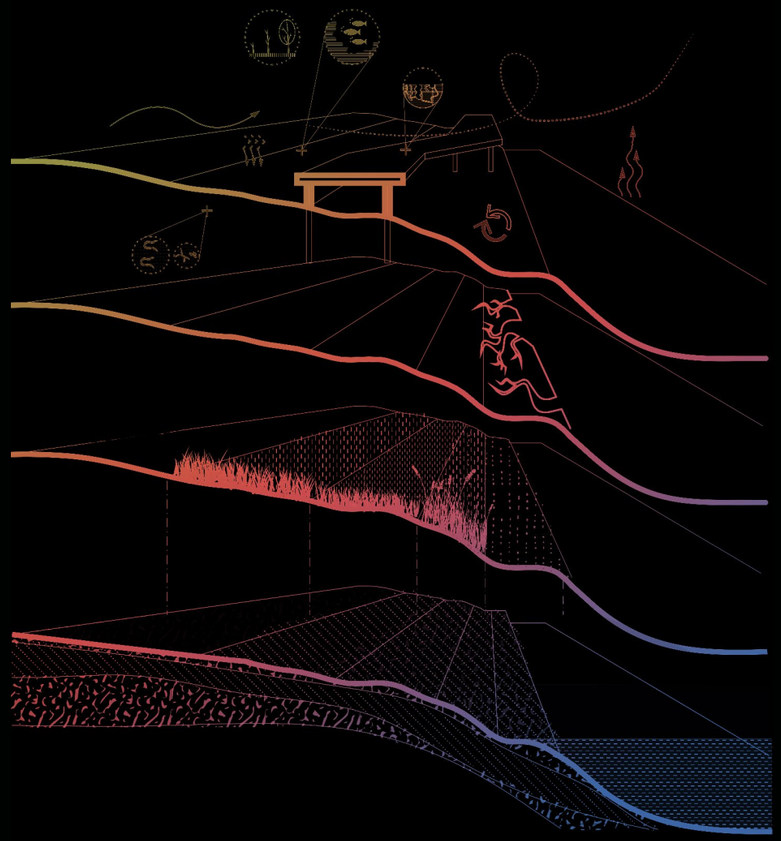
The graduation project Symbiotic Urban Voids aims to envision a landscape architecture framework for Rotterdam through its urban voids, characterizing these into spatial typologies depending on the local conditions. The project also takes into account climate adaptation in the form of flood resilience and mitigation against the urban heat-island effect. The project aims at connecting the surrounding habitats to each other and creating an urban ecological gradient through several urban voids through landscape architecture principles.

Evaluating the Design Proposal:

The project is coined by an initial analysis of the Rotterdam historical landscape and its evolution over time. Different layers of natural and cultural layers are explored to understand the underlying problems in the region. The vulnerability of the native habitats to be taken over by the expanding urban tissue is evident through statistics that show a steep decrease in the ecological qualities of the region. This further disconnects the habitats around the developments, creating fragments of habitats spread out across the landscape, all superimposed and dissociated by the city. Looking closer at climate-related issues, the uncontrolled and anthropocentric constructions in the name of development threatens the existence of mankind as well as other species. Effects of climate change become visible through mapping heat islands and flooding scenarios in the area. The overuse of concrete and other hard materials for paving and covering the 'unbuilt' or rather 'outdoors' has drastically heated up the urban environment. Heavy rains cause water to stagnate, and the rising sea levels threaten the breakage of dikes that protect the land below sea level.

The literature study consisting of theories and design projects that incorporate ecology and climate change adaptiveness helped in developing landscape architectural design principles that belong to an array of typologies. These principles can be applied in similar contexts and sites through the course of the design. Mapping voids at regional and local scales help reveal the pattern of void distribution at different orders. These consist of linear and large voids that run through multiple landscapes like highways and train lines and also smaller sites that are unused or abandoned.

The understanding of the underlying layers, habitats, and vids helped in correlating it to a network that could be envisioned for the region through the voids, connecting the habitats. The understanding of the existing green structure and proposed green vision by the municipality of Rotterdam was coupled with the new void network to create a stronger ecological network through the urban core.



The final step is the selection of individual sites for detailing based on the context and habitat it connects to. The sites selected relate to the water salinity and the main focus here is on the Tidal Park at Pernis. This is a unique tidal river landscape where the possibility of ecological robustness, climate change adaptiveness, and recreational goals are met.

The project is presented as a part of the Urban Ecology and Ecocities Lab, where integrating ecology and nature-based solutions to future cities is the main goal. In relation to this, the project focuses on re-establishing lost habitats and reconnecting them through the urban system in Rotterdam. The project surfs through multiple scales at regional as well as site-level detailing, all with the theme of urban ecology and ecocities.

Relation to the Landscape Architecture Track at TU Delft

The graduation lab Urban Ecology and Ecocities focus on research and design revolving around the whole of interactions of organisms, built structures, and the physical environment where people are concentrated. My graduation project titled ‘Symbiotic Urban Voids’ focuses on using the urban unbuilt (or are they really unbuilt?) to create a network for ecology and thereby creating resilience to climate change through ecosystem restoration strategies through a landscape architecture approach. The goal is to contribute to the larger vision of Rotterdam as urban ecosystems developing towards ecocities. The ecocity principles are used to create spatial design, spatial quality, and spatial experience that are contextual and temporal to the ever-changing world.

This involves understanding the history of the site, both materialistic and cultural qualities which form the departure of the design. The layers of scale, time, and process are be addressed in regional and local scales of the Rotterdam urban area. The design is situated at the formation of a larger ecological design framework as well as curated architectonic ensembles. Palimpsests are layered, ordered, and spatially transformed to create new meanings, which creates a continuity in the story of the region, both physically and culturally. This is achieved by utilizing the unused or underused urban spaces that are termed as ‘voids’ of different characters, creating site-specific ecological landscape architectural interventions.

Relevance of the Project

The process and method of this project can also be replicated with a new language to similar urban contexts suffering from rapid urban sprawl, ecological decay, and climate change-related issues. The project also takes into account the vision for the Rotterdam region by the municipality and therefore hopes to add to the existing research of the professional bodies. It helps in creating an identity to lost spaces in the urban areas that are the results of various geographical, planning, and functional voids. The project can propose certain design components at local scales by studying the urban, social, and functional characteristics of the same, which would be helpful in real-time design interventions as well. The work can add to how unused or identityless spaces in urban areas can be transformed ecologically into spatial typologies.

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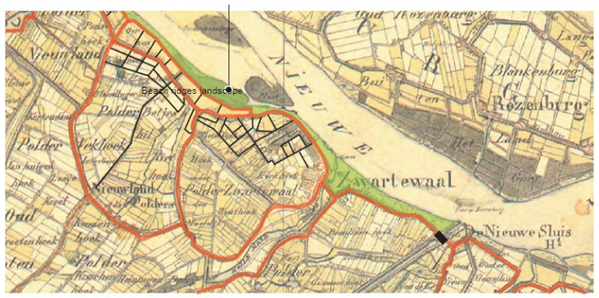
APPENDIX

Landscape Typologies in Rotterdam

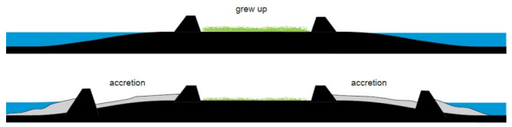


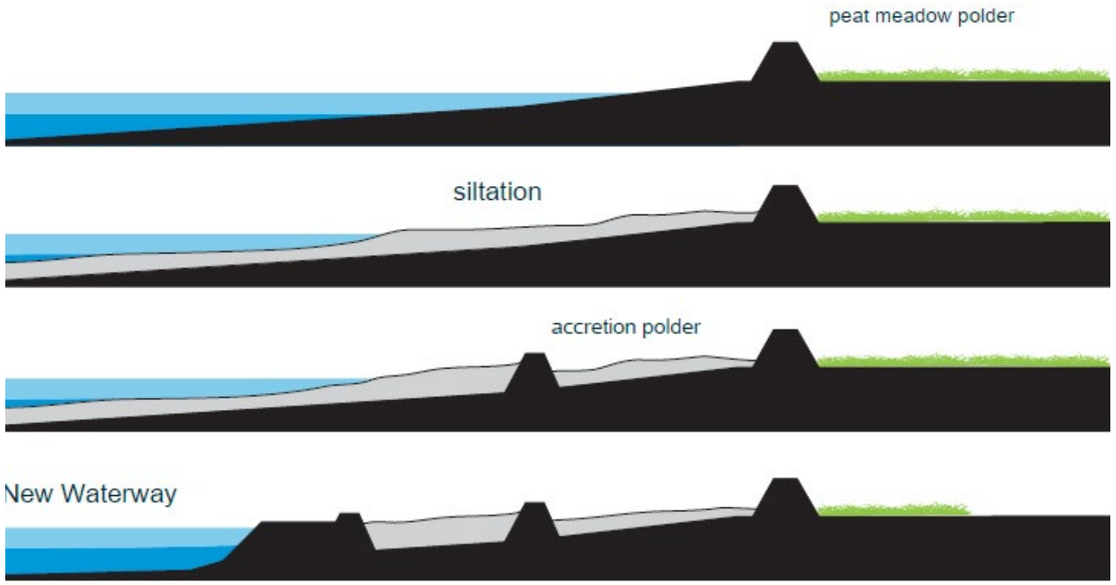
Block allotment up to the dike, foreland and tide behind it (1850)

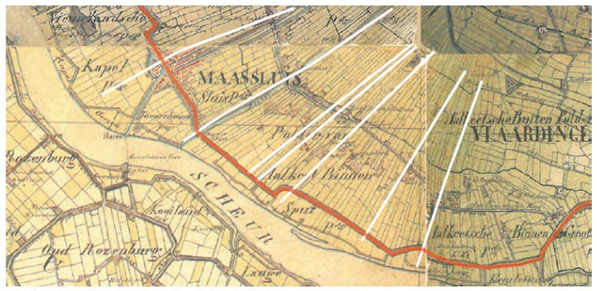

Ring dikes with ash, willows, poplars

1. Sea Clay Landscape

- Characterized by ring-shaped polders.
- Dikes are often planted with trees such as ash, poplars and willow trees.
- Zones of the ring dikes outside the dikes grew-accretion.
- The dike thus forms the boundary between the inner and outer dike.
- Largely urbanized areas.





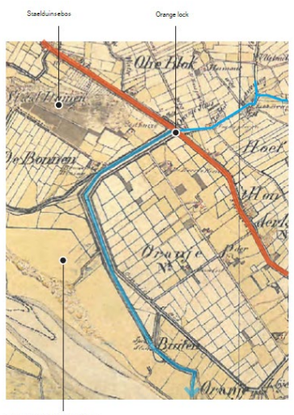


Extending allotment of the peat meadow landscape to the water (1850)


Successive allotment in the peat meadow polders behind the dike front in Central Delfland

2. Peat Meadow Landscape

- Characterized by the many ditches that lie in long fans in the landscape.
- Buildings are spread along ribbons in the
- landscape.
- Woods and groves have been created on the edges of the polder- Randstad green structure.
- The pattern of ditches continues up to the river.
- The dike is therefore not a boundary between inner and outer dike, but a thin line under which the polder landscape runs.
- Large parts urbanized.



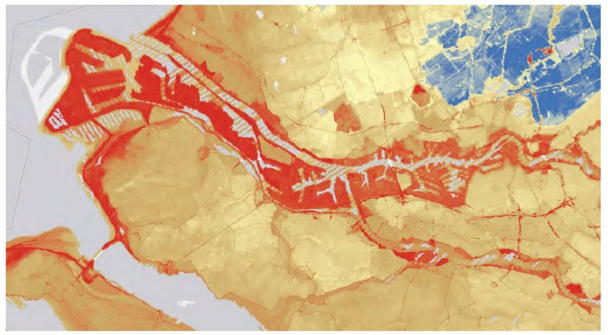
Complex knot of inland water (creeks) joining the river (1850)


Ring polders (aanlandpolder) on the low parts (De Bonnen)


Presence of dunes (Staelduinsebos)

3. Landing Polders on the North

- Where creeks border the outer dike area are complex nodes.
- The land polder at Hoek van Holland only took shape much later, when the NieuweWaterweg was constructed.
- This area is in fact the residual space between the Maasdijk and the NieuweWaterweg.


The landscape outside the dikes has largely been raised and urbanized

4. Landscape Outside the Dikes

- Construction of harbors and industrial areas in the area outside the dykes.
- About 70% paved with stone embankments and quays.
- Ground level of the banks is about 4 meters above sea level- Due to accretion and port activities.
- Mostly urbanized.


Dune landscape Hoek van Holland at the mouth of the NieuweWaterweg


Dune area at Hoek van Holland on the other side of NieuweWaterweg, 1874

5. The Dunes

- Located on the west side of Hoek van Holland.
- Recreational functions.
- On the south side, the entire dune area has been transformed into a port area with industry and canals.

Source: Nature Map Rotterdam 2014

Neighbourhood Typologies of Rotterdam

In the existing condition, the Blue and Green network is mostly only on the periphery of the urban core and concentrated on the North.. This in turn poses several ecology related issues.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