Between the Wings

A bioregional landscape mosaic within a changing Randstad

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Graduation report
TU Delft Urbanism

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ABSTRACT

The model of the Randstad as delta metropolitan system concept is outdated, and a new spatial model and form can be seen emerging nowadays. A model with a North and South Wing. However, authorial decision-making still recognise the initial Randstad model as it was described a century ago.
The misuse of the actual unrecognised model, together with climate change, hydro-geomorphological alterations and unaligned sectoral approaches, have resulted in that nature and its regeneration capacity has started to decay in the Randstad, accelerating the diverse risk and posing complex conditions for its current development.

This report explored a renewed identity for the Randstad / Green Heart region that fosters socio-environmental fellowship, through a spatial planning approach from a bioregional perspective. The project steps away from the Green Heart paradigm and identifies three bioregions; the Coastline, Rijnmond-Drechtsteden and Central Holland, that require unique planning measures based on their hydrogeomorphological and ecological conditions. Using scenario-based design, the project examined alternative spatial futures for the Randstad towards 2100.

The main outcome of the project is that a fundamental shift in spatial planning practice is required, in which natural and ecological systems become the primary structuring layers of urban development. Urbanisation should respond to environmental capacities and risk conditions. As natural and ecological regions often stretch over multiple countries, the project also elaborates the position of the Randstad within the Eurodelta-Metropolis, in which the region will become the ecological heart in a Green Vessel structure.
As last, to achieve all this, a structural change in the framework of European territorial governance is introduced. Where councils of river basins and bioregions will have a strong voice in spatial decision-making, and where cross-border coordination is strengthened.

(Lionspeak, n.d.)

MOTIVATION

Throughout my academic years, my interests have always been guided by the relations between humans and nature. Since the earliest stages of human history, societies have coexisted with nature. Yet, we started to slowly lose our connection with nature since the industrial revolution. Since then, we've been taking a lot from nature, without giving much back.

This shift is also acknowledged by Dutch spatial planning authorities, who recognise that the soil and water structures have reached their limits. A new era demands spatial visions that adapt to the changing natural conditions and climate uncertainty. However, spatial planning is limited by political and economic tensions, leaving little room to experiment with new urban concepts and theories.

To keep the Netherlands, especially the internationally important Randstad region, future-proof and attractive to the world, it is necessary to rethink how housing, water and natural systems can come together in an integral vision. An integral vision that suits the future climate of 2100, as the future climate conditions are underrepresented in the main governmental long-term spatial vision, the Nota Ruimte 2025.
A different mindset needs to be introduced in nowadays spatial planning. One that restores the connection between urban life and natural systems.

"Everything needs to change, if we want everything to stay as they are"
Errik Buursink

This motivates me to focus my thesis on exploring what a socio-environmental framework, that places human-nature coexistence at its core, looks like. As spatial planners are limited to explore new concepts and theories in practise, my thesis focuses on addressing this gap in todays Dutch spatial planning, and strengthen narratives about the future of the Randstad through an integral and explorative design approach.

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1. INTRODUCTION

1.1 Climate change in the Netherlands

The climate crisis

In November 2025, all those involved in the Delta program of the Nederland came together to discuss the future of the country regarding water safety, freshwater availability and climate adaptation (CMEMS, n.d.). In the Delta Program, different national authorities work together to protect the Netherlands against water related threats (Deltaprogramma, 2025).
They discussed climate related topics that are widely recognised around the world; global warming; the increasement of the heat content of the ocean, in the last fifteen years it increased by almost 50 percent (CMEMS, n.d.); and the rising sea levels (KNMI, n.d.). Regions vulnerable to water-related threats will face increasing pressure and will leave the Netherlands with repercussions in the future. The climate is expected to change for quite some time, even in the most optimistic scenarios (KNMI, 2023). Winters will become wetter, summers will become dryer with heavier rainfalls, and the sea level will rise towards 2100 (KNMI, 2023).

What the future climate of 2100 will look like, is going to be discussed in the next subchapter; the future Dutch climate in 2100.

Image 1: photo from a climate demonstration in 2021 (Natuur en Milieufederaties, 2021)

The future Dutch climate in 2100

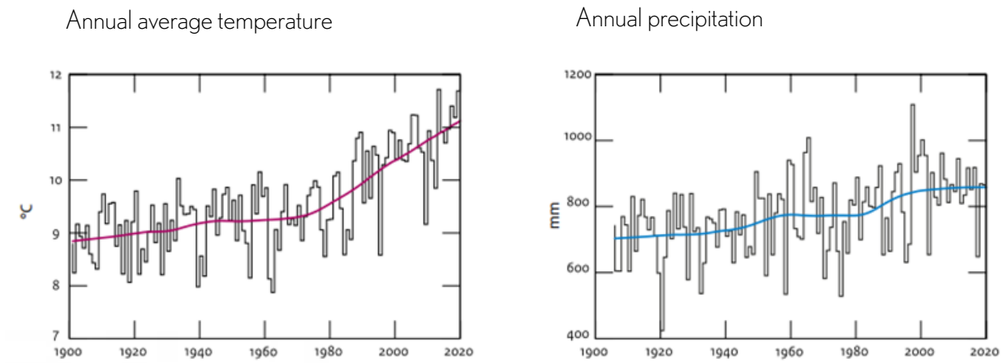


Figure 1: Trends of annual average temperature and precipitation in the Netherlands (De Vos, 2025)

Higher temperatures and longer droughts

As the diagrams above show, the annual average temperature and precipitation have become higher in the last decades. In 2100, the weather is expected to become more extreme.
Climate change will increase seasonal extremes. Winters will become wetter, while summers will become dryer with heavier rainfalls. Elevated water levels will occur more frequently in the winter. While during the summer, the extremer weather will occur in the form of low water levels in rivers (KNMI, 2021).

Summers will become hotter in 2100, leading to more frequent and prolonged periods of heat and drought (KNMI, 2021). The rising temperatures will intensify the Urban Heat Island effect, leaving densely populated regions under higher stress.
The Dutch climate is expected to gradually shift towards conditions more comparable to those currently found in southern Europe, further challenging existing water management and urban systems.

The consequences and future scenario of climate change are known by authorities. More important, authorities recognise that they need to take action. A perspective about new spatial concepts and strategies is essential to take the right steps towards a Netherlands that's rightfully adapted to the future climate of 2100. The hydrogeomorphological (water and soil) system must be made more robust in order to cope with the future climate conditions of the Netherlands in 2100.

Water hazards
The sea level has started to rise faster in the last decades, this can be seen in figure 2. A sea level rise of 1 to 2 meters is expected in 2100 (Deltaprogramma, 2016), with an additional possibility of a rise of 2,5 meters if the ice caps melt faster than expected (KNMI, 2023). This will result in dikes being under higher pressure, leaving residents in a higher floodrisk in the lower parts of the Netherlands.

The increasing sea level, that's partly driven by land subsidence in specific regions, is not only putting the country at a higher floodrisk. It is also increasingly placing growing pressure on freshwater availability (KNMI 2021).

Historically, sufficient river discharge and rainfall were available to flush out saltwater. However, from around 2050 onwards, sea-level rise is expected to significantly intensify salt intrusion through rivers, groundwater and coastal infrastructure like the Nieuwe Waterweg and the Afsluitdijk (Deltaprogramma, 2016). Because of this, agriculture and drinking water supply systems could be heavily affected and have to look for other ways to access freshwater. An increasing dependence on alternative freshwater sources, particularly from the eastern Netherlands and the IJsselmeer, can be expected.

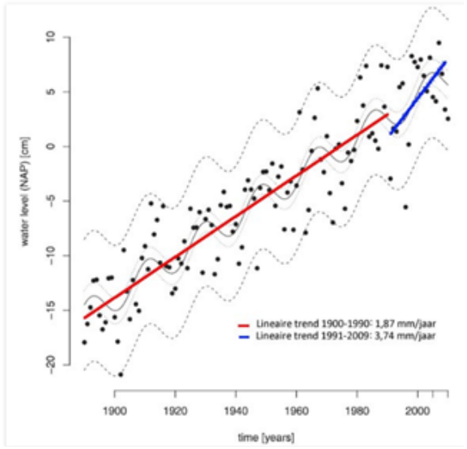


Figure 2: Lineaire trends of sea level rising (De Vos, 2025)

1.2 Randstads environmental pressures
Water

A large proportion of the Netherlands can be seen as such region that is vulnerable to, the previously mentioned, water-related threats. Approximately 59 percent of the Netherlands its surface is prone to flooding, with 26 percent of the surface under sea level (Waterschap AGV, n.d.). A large part of this surface is inside the borders of the Randstad.

The Randstad has already experienced several major flooding events, of which the Zuiderzee flood of 1916 and the North Sea flood of 1953, also known as the Watersnoodramp, were the most significant. During both disasters, large parts of the Randstad were flooded, forcing many residents to evacuate their homes. These events had a profound influence on the way the Dutch managed water. The Zuiderzee flood led to the construction of the Afsluitdijk, while the North Sea flood directly resulted in the development of the Deltawerken.

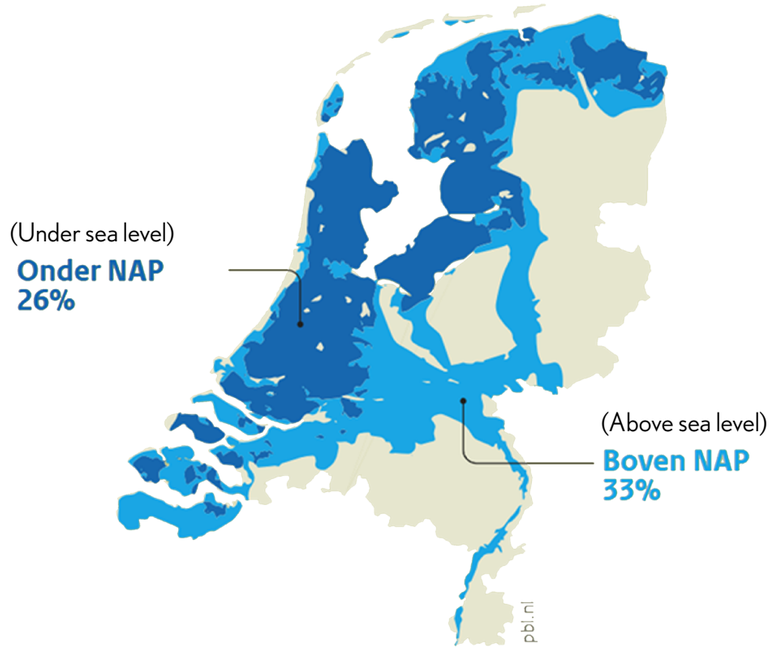


FIgure 3: High floodrisk in the Netherlands (PBL, n.d.)

Image 2: devastation caused by the Zuiderzee flood in Buiksloot, municipality Amsterdam (Klompmaker, n.d.)

Image 3: Dutch army helps residents evacuate during the North sea flood in Rotterdam (stadsarchief Rotterdam, n.d.)

Floodrisk in the Randstad

The Randstad faces the vital challenge to manage its vulnerability to water-related threats like floods. Climate researchers and glaciologists say that the melting of the Antarctic ice cap will have major consequences for the Netherlands, and so Randstad. To prevent a disaster to happen, dikes would have to be build higher, but land subsidence increases the difference between land and sea level even more (Schuttenhelm, 2022).

The greatest floodrisk can be seen in the region called 'the Green Heart', outlined in the map. This region is the lowest region in the Netherlands, and is additionally suffering from soil subsidence. If the Netherlands is looking for ways to minimise floodrisk in the Randstad, this region should play a vital role in flood preventing strategies.

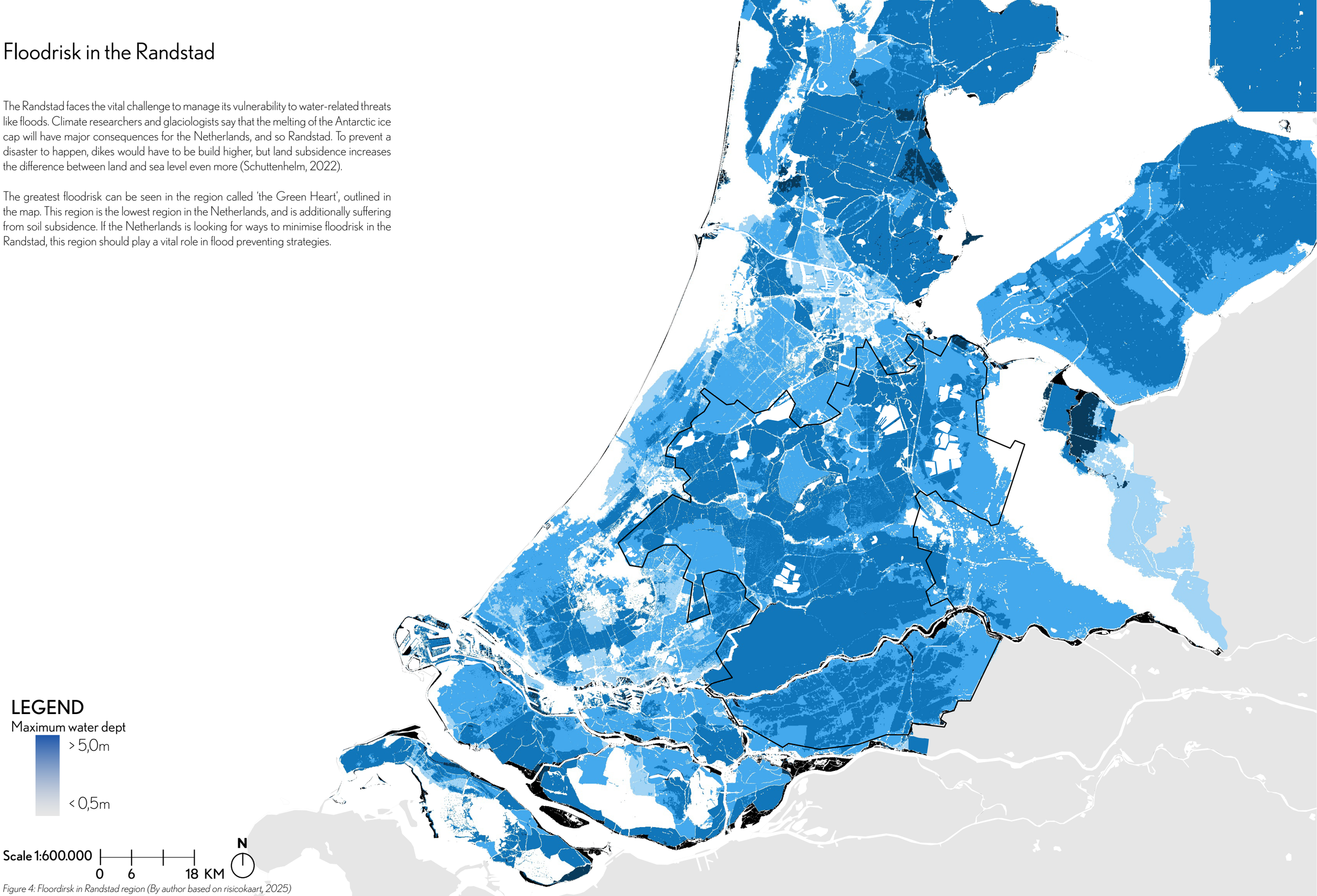


Figure 4: Floordirsk in Randstad region (By author based on risicokaart, 2025)

Soil (subsidence)

In addition to increasing water-related threats, the Randstad region is also affected by soil subsidence. Large parts of the region consist of subsidence-sensitive peat soil. The extent of subsidence, depends on both soil composition and land use, resulting in distinct challenges for rural and urban areas.

In rural peat meadow landscapes, which are mainly used for dairy farming in the Randstad, surface water levels are commonly lowered to enhance soil bearing capacity and agricultural productivity.
However, lowering groundwater levels accelerates peat oxidation, that causes the soil level to decline. And because of this, the surface water levels have to be lowered again, creating a self-reinforcing cycle of subsidence. This process is expected to continue, as peat soils will remain exposed to oxidation (Bestuurlijkplatformgroenehart, n.d.).

In urban areas, soil subsidence is driven primarily by the weigh put on the soil. The weight of buildings, infrastructure, and infill material causes soil compaction, which results in ground level lowering. This could lead to structural damage to foundations, roads, public spaces, sewer systems, and underground utilities. During extreme rainfall events, differences in elevation increase the risk of water accumulation and floods, particularly in areas where drainage and sewer systems are no longer able to cope with the increased hydraulic load (Bestuurlijkplatformgroenehart, n.d.).

Figure 5: Subsidence in Randstad region (By author based on bodemdalingskaart, n.d)

1.3 Urbanisation in the Randstad

Even though the growing risk that living in the Randstad brings with it, the metropole is urbanising rapidly. The Randstad region contains the largest population in the Netherlands (PBL, 2022). With the expectation that its population will continue to grow from 17,6 million inhabitants in 2022 to 19,6 million in 2050 (PBL, 2022) , plans to urbanise the region further are on the agenda. The increasing demographic and urban growth in the Randstad is contradictory with the previously mentioned need for more space for sustainable water and soil management (Zonneveld & Nadin, 2022).

In order to reduce the housing shortage, more than 980.000 new homes must be built by 2030. The national government already invested 7.5 billion euros in plans to rapidly build 400.000 new houses. A large proportion of these new houses will be build within the Randstad (Ministry of Housing and Spatial Planning, n.d.).
In order to facilitate this, green- and farmland have to make way for the urban expansions. Because of that, Randstad has experienced a statistically significant net forest loss (Zhou et al., 2025); the Green Heart is shrinking. Recent research indicates that the Randstad have experienced a decrease in forest land, significantly more than expected.
Furthermore, the government is exploring ways to loosen regulations regarding natural area protection, which the Green Heart is one of (Buurma-Olsen et al., 2025). If this comes through, it would mean that even more green will have to make place for urban areas. The images below show the shrinking movement of the Randstad in the last decades.

Expected population growth in the Netherlands

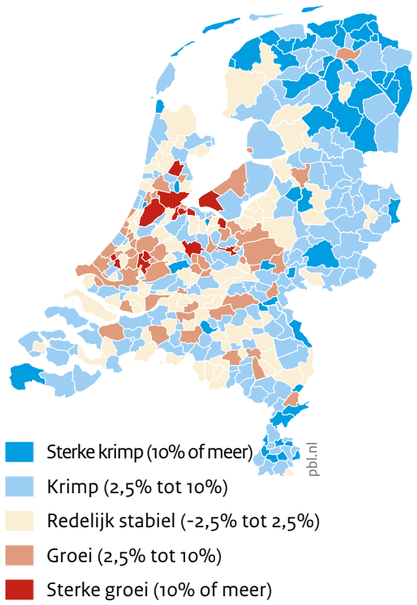
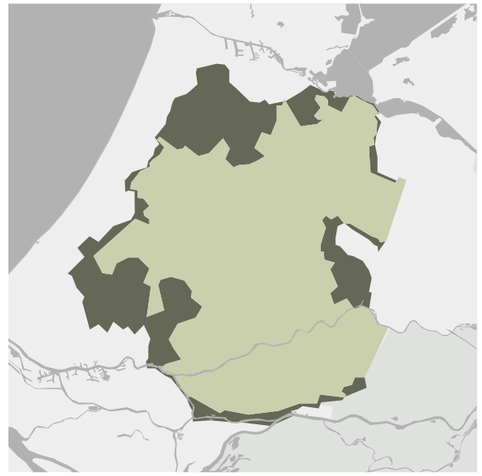
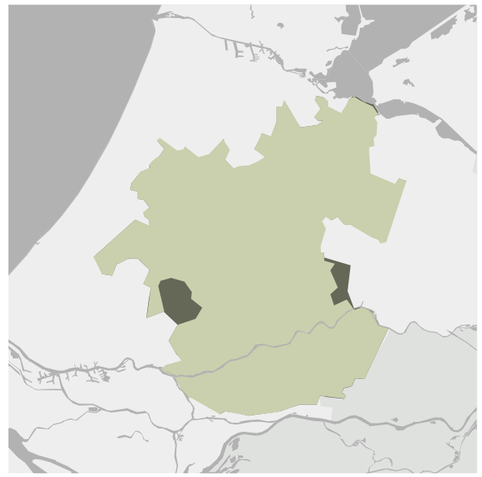


Figure 6: expected population growth in the Netherlands (PBL, 2019)

Green Heart 1960



Green Heart 1990



Green Heart currently

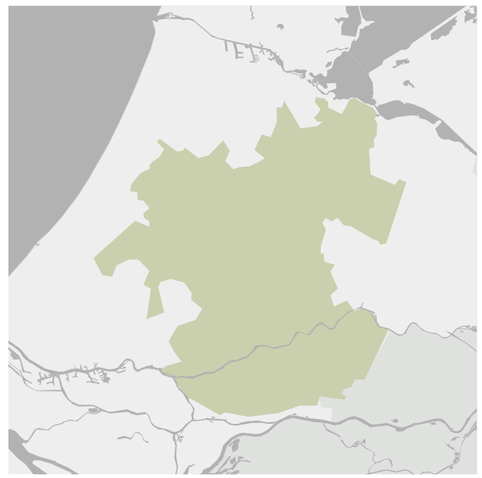


Figure 7: shrinking of Green Heart over last decades (By author based on Tisma & Lörzing, 2023)

1.4 The call for a renewed identity

The Randstad is a spatial concept that arose almost a century ago, and has been important for the spatial configuration plans and strategies from the Dutch government. The concept is as follows:

The Randstad is a delta metropole consisting of three provinces; Noord-Holland, Zuid-Holland and Utrecht, with four main cities; Amsterdam, Rotterdam, The Hague and Utrech, who from the urban ring. All cities have their own specialisation in the polycentric system. Amsterdam is the financial and cultural centre, Rotterdam is the leading port, The Hague houses the national governmental with international institutions, and Utrecht is the national transport hub. Not to forget the both Amsterdam, with its port and airport Schiphol, and Rotterdam, with its worldwide important port, function as the two international mainports of the country (Zonneveld & Nadin, 2022).
There are also smaller cities, lower in the hierarchy, like Leiden and Delft, who developed around education and industry. The functionality between the bigger and smaller cities establish the core configuration of the Randstad model.

At the centre of the urban ring lies a central open space known as the Green Heart. This region represents an unique, green and open landscape within the densely urbanised Randstad. Nature, landscape, a clean environment, cultural history and recreation are considered as main characteristics for the region. The Green Heart is economically significant, featuring a competitive agricultural sector and a strong transport network. The Green Heart area would provide a calm environment that would be used by many residents for recreation and leisure (Zonneveld, 2022).

Since the birth of the Randstad concept in the 1930s, its fundamental spatial interpretation, its identity, has remained largely unchanged. In governmental and planning documents, the Randstad has always been described as the description above says.

Figure 8: Randstad traditional conceptual spatial model, a singular polycentric deltametropole (By author)

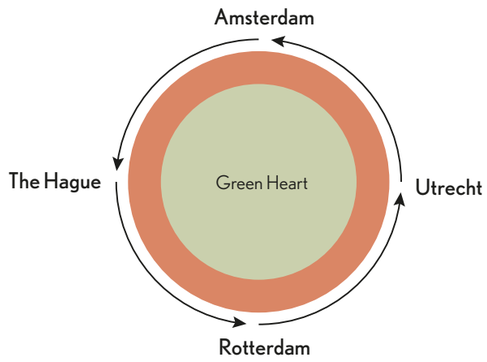


Figure 9: abstraction of the Randstads traditional conceptual spatial model (By author)

However, nowadays Randstad looks different than what the concept describes. Instead of being a single polycentric delta metropolis, the region can be better described by two dominant metropolitan systems in deltaic conditions. These two metropoles are Metropolitan Region Amsterdam (MRA) and Metropolitan Region Rotterdam-The Hague (MRDH). Each of these regions has developed its own economic profile, spatial dynamics, and infrastructural demands, operating more as distinct metropolitan entities rather than components of a unified Randstad system (Van Der Valk & Faludi, 1997).

This shift had consequences for the Green Heart. Municipalities within the area have blamed the central government for being inconsistent with its governance for the Green Heart over the years. While the central government has long emphasised the protection of the Green Heart as an open and green core, national infrastructure projects have simultaneously penetrated the area, stimulating and facilitating suburbanisation (Fazal et al., 2012). This conflict in governmental decision making has resulted in that the Green Heart has started to decay. Strikingly, the Green Heart has grown and developed such that national policy recognises that the population of the Green Heart is urban, and not rural, in character. With the exception of its water bodies, the Green Heart is barely used as recreational area. The rurality of the area is more fictional than fact. The spatial form and structure of the Green Heart was not shaped by the landscape qualities, it was shaped as a negative urban form (Fazal et al., 2012).

This actual urban form of the region poses the fundamental question whether the Randstad itself is a "real" regional unit, or just a concept that is used to help planning and political decision making in the Netherlands. Even if said that the Randstad is a real unit. The spatial model of it has drastically changed over the last decades. The view that the Dutch government and inhabitants have of the region, must be corrected to the real spatial model. If this is not done, regions such as the Green Heart will fall in a further decay. The spatial form of the region is calling for a renewed identity. An identity that is still to be found.

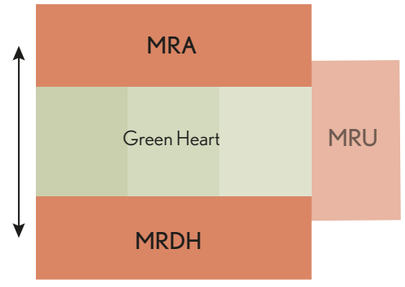


Figure 10: abstraction of the Randstads actual spatial model now (By author)

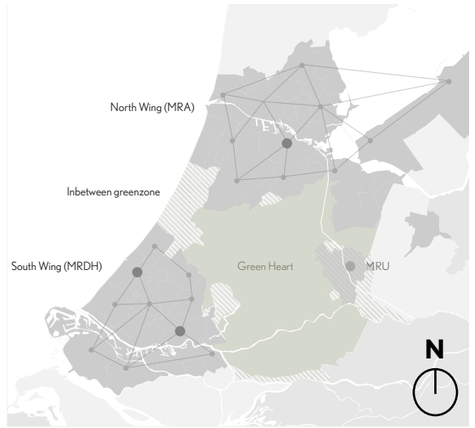


Figure 11: "Randstads" actual spatial model now, a three-layer model with two metropoles in deltaic conditions (By author)

Project scope

Following the matter discussed in the introduction chapter, this project will closely examine the current, unrecognised, model and form of the Randstad / Green Heart region. The Randstad will be viewed as a socio-environmental system under increasing pressures from climate change, urbanisation, hydrogeomorphological alterations and fragmented metropolitan governance.
The project will have a particular focus on the Green Heart, as it is the spatial and ecological core of the region where all the critical conditions meet.
The project will explore how socio-environmental risks, water risk management, and integral landscape management can be reinterpreted and operationalised to foster a more adaptive and future-proof metropolitan form and model.

Image 4: Skyline of Rotterdam photographed from countryside Green Heart (Volkskrant, 2023)

2. UNDERSTANDING THE ROLE OF THE RANDSTAD IN EUROPE

Eurodelta-Metropolis structure

The Netherlands is part of the Eurodelta-Metropolis. The Eurodelta-metropolis is a cross border megaregion in Europe. Covering the Netherlands, Belgium and Germany, the metropole connects three core economic regions; the Randstad, the Flemish Diamond and the Ruhr region. Making it a global hub for goods, services and knowledge. Its main cities (Amsterdam, Rotterdam, Antwerp and Cologne) all contain international significant ports and/or industries, making the region a strong economic cluster.

Figure 12: urban (infra)structure of Eurodelta-Metropolis (By author)

Commuting in Eurodelta-Metropolis

Cross-border commuting between the Netherlands, Belgium, and Germany is mainly concentrated in the southern Dutch provinces Limburg and Noord-Brabant. Dutch-Belgian borders show higher commuting flows than the Dutch-German ones. This is mostly influenced by the fact that Dutch and Belgian regions share the same language (Broersma et al., 2020).
Not just language, but also economic factors such as wage differences, labour shortages, limited Dutch housing availability and different petrol prices act as encouraging factors that stimulate cross-border commuting (Jacobs, 2025).

This show that commuting in the Eurodelta-metropolis is not just infrastructural driven. Different cultural and economic conditions are more dominant factors that stimulate commuting behaviour, especially work commuting (Broersma et al., 2020).
This means that the cross-border integration between the Netherlands, Belgium and Germany is uneven due to cultural, social and governmental differences (Jacobs, 2025). Even though the fact that functional regions in the Eurodelta-Metropolis operate beyond administrative borders.

Figure 13: Cross-border commuting movements between the Netherlands, Germany and Belgium (Broersma et al., 2020)

Rhine river basin

The Netherlands is part of four river basins; the basin of the Scheldt, the Meuse, the Rhine and the Ems. The largest part of the country, including the Randstad region, is part of the Rhine river basin. Therefore, this project focuses on this particular basin.

The Rhine is one of the most important rivers in Europe. It's 1320 km long and stretches over nine countries. In the river basin, which is approximately 185.000 km2, up to 60 million people are living. Starting from the Swiss Alps, the river connects important European regions. The connection between the Ruhr Region and the Randstad is crucial for international trade (Donkers, 2010).
Since the 19th century, humans have been negatively impacting the health of the Rhine river. Countries saw this and to counter this, the 'International Commission for the Protection of the Rhine' (ICPR) was established in 1950. Since then, the water quality has improved (Internationale Commissie ter Bescherming van de Rijn, n.d.).
Though, climate change is challenging the river basin with challenges. To keep the river basin healthy, The ICPR has set goals to achieve in 2040:

- Improve biodiversity in and along the Rhine. Natural areas along the Rhine will help soften the consequences of climate change. Also, the use of softer banks and the protection of fish against turbines and hydropower stations are on the agenda (Internationale Commissie ter Bescherming van de Rijn, n.d.).
- Give the river more space in times of high tides. Over the years, the ICPR has achieved to guarantee a high level of safety along the Rhine. However due to climate change, this will happen more frequent and the must be looked to find more possibilities for the river to spread out (Internationale Commissie ter Bescherming van de Rijn, n.d.).
- Prevent negative effects of dry spells during low water periods (Internationale Commissie ter Bescherming van de Rijn, n.d.).

Figure 14: River basins in the Eurodelta-Metropolis (By author)

Eurodelta-Metropolis - blue-green structures

Looking at the natural structures, it becomes clear that the Randstad has a crucial position in the metropolis. The main rivers of the region, the Rhine and Meuse, both move through the Randstad region before they flow into the North Sea. In addition, looking at the green structure, there can be seen that the megaregion its main green structures meet each other in the Green Heart region.
Also when looking at animal migration routes, it becomes clearer that the Green Heart is an important ecological region. As fish migrate through the rivers moving through the region, and birds follow green- and dune structures to migrate.
If a vision is made for this region, it is crucial to include the blue-green structures at the scale of the Eurodelta-metropolis in the design process as well.

There is already an association looking to promote the cooperation between relevant parties in this megaregion, it's called 'Vereniging Delta Metropool'. Though, as Vereniging Delta Metropool also says themselves, the opportunities associated with the operationalisation of the Eurodelta-metropolis are not being fully exploited, as its challenges are still largely viewed within individual administrative boundaries (Eurodelta-Metropool - Vereniging Deltametropool, n.d.).

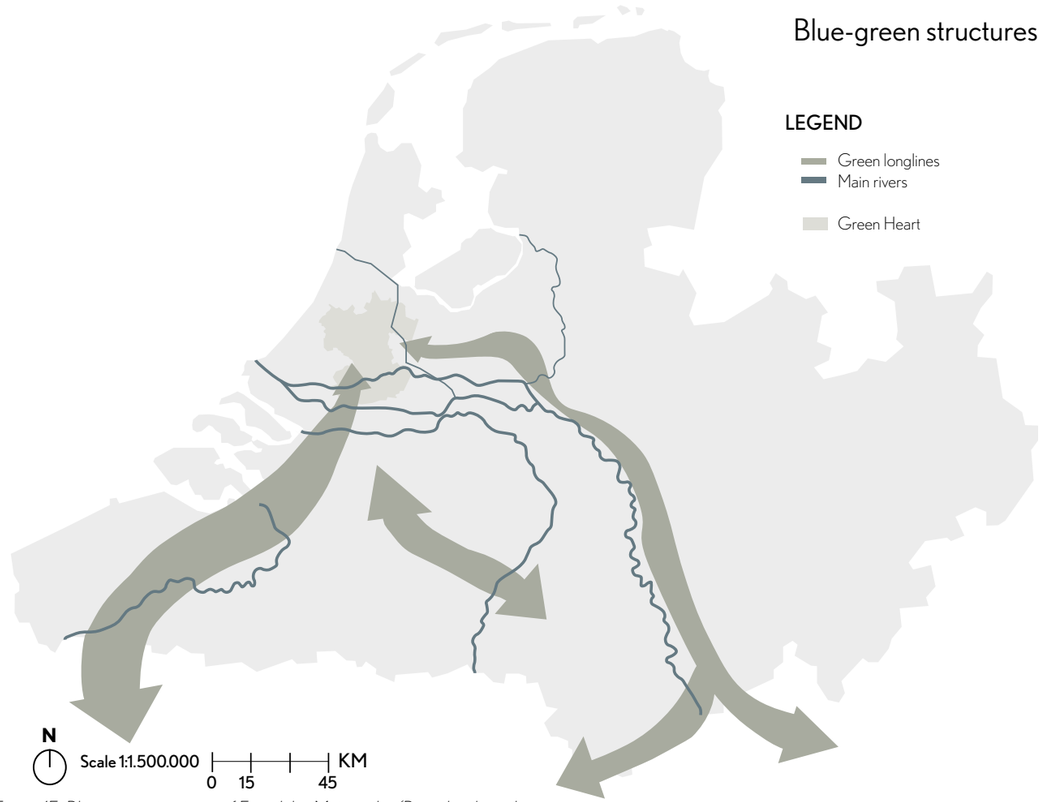


Figure 15: Blue-green structures of Eurodelta-Metropolis (By author based on (Eurodelta-Metropool - Vereniging Deltametropool, n.d.))

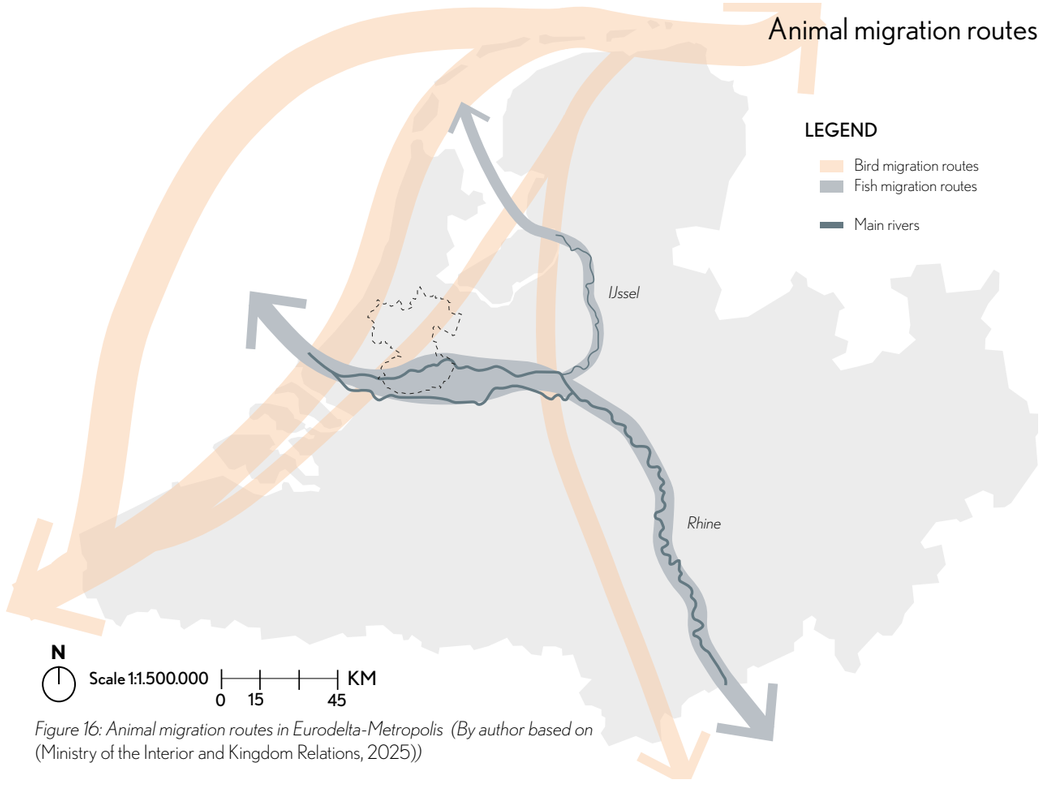


Figure 16: Animal migration routes in Eurodelta-Metropolis (By author based on (Ministry of the Interior and Kingdom Relations, 2025))

3. UNDERSTANDING THE RANDSTAD MODEL

3.1 The formation of the urban structure of the Randstad

In the eleventh century, the silting of the Rhine mouth caused the Rhine's main discharge to shift southward via the Lek, merging with the Meuse.
Also, storm-driven land loss and human exploitation led to significant land subsidence (Zonneveld & Nadin, 2022).
The formation of the Zuiderzee and Southwest Delta transformed the region into a highly flood-prone landscape, extensive dike systems were constructed for flood protection.
Eventhough there was a higher flood risk, the formation of the Zuiderzee and Southwest Delta created new opportunities for trade and water discharge. These developments formed the foundation for the Dutch water transport network (Zonneveld & Nadin, 2022).

From the 1600's, cities such as Amsterdam and Rotterdam emerged at strategic river mouths, where dams served flood defence, drainage control, and trade regulation, making cities key nodes in the water management system. This shifted spatial emphasis to the edges of the Holland region and laid the first foundations for the Randstad; big urban concentration were forming on the north- southside.
The rise of the United East India Company in Amsterdam increased the cities specialisation in trade, creating an hierarchy between the main cities in Holland. International trade became associated with mainly Amsterdam, but also Rotterdam (Zonneveld & Nadin, 2022).
These cities became dominant economic centres within the Dutch Republic, supported by advanced water management techniques that were further refined for both economic growth and water defence (Zonneveld & Nadin, 2022).

The Netherlands ca. 1000

The Netherlands ca. 1600

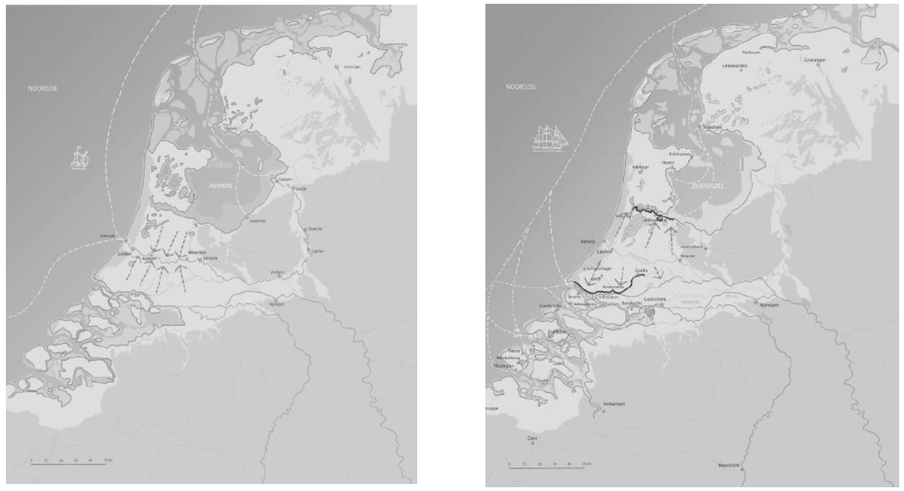


Figure 17 & 18: Randstad in 1000 and 1600 (Zonneveld & Nadin, 2022)

As a result of extensive urban development on the northern and southern sides of the Holland region, demand for energy increased significantly. The central part of Holland, nowadays known as the Green Heart, was seen as the major energy source, as its soil consisted of peat. Peat could be used as a cheap and accessible fuel, leading to large-scale extraction in response to rising energy demand (Zonneveld & Nadin, 2022).

The peat dug-outs left extensive water bodies, called peat lakes, behind. During this period, there was little interest in urbanising this part of Holland. Instead, its primary function was to serve as an energy landscape that would support the expanding urban concentrations. In 1840, the province of Holland was split into two halves, Noord- and Zuid-Holland, to balance power between both sides (Zonneveld & Nadin, 2022).

Between 1800 and 1900, central Holland faced growing challenges related to resource depletion and declining navigability of key waterways. As these challenges exceeded the capacities of local and regional authorities, governmental body Rijkswaterstaat was established at the end of the eighteenth century.
Amsterdam and Rotterdam were made more accessible through the large-scale infrastructural constructions like the North Sea Canal and the Nieuwe Waterweg. These projects restored port accessibility, improved river discharge and reshaped water management. Port activities in both Amsterdam and Rotterdam exploded.

Furthermore, land reclamation of peat lakes transformed central Holland into an important economic region, fostering agricultural growth and enabling the development of Netherlands first airport, Schiphol (Zonneveld & Nadin, 2022).

The Netherlands ca. 1800

The Netherlands ca. 1900

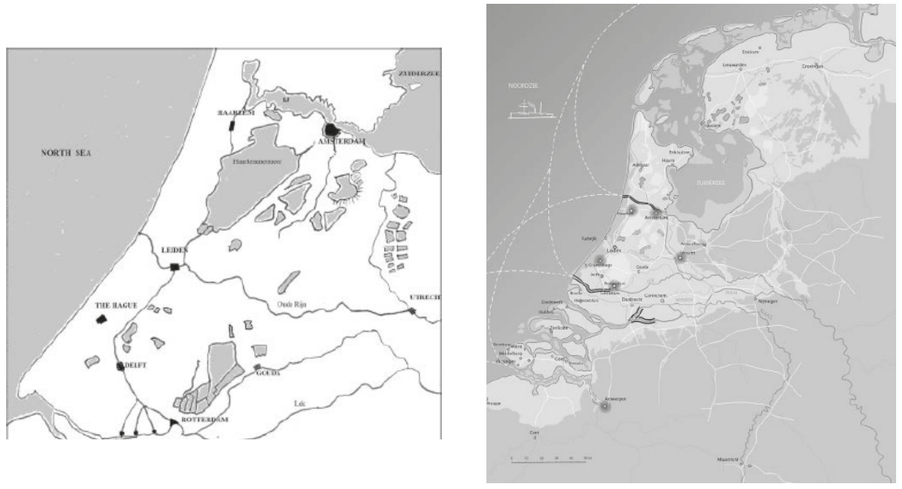


Figure 19 & 20: Randstad in 1000 and 1600 (Zonneveld & Nadin, 2022)

During the twentieth century, the Netherlands experienced several devastating flood disasters. In 1916 and 1917, heavy storms struck the northern part of Holland. And in 1953, the North Sea flood, also known as the Watersnoodramp, struck the southern part of the region (Zonneveld & Nadin, 2022).

These events prompted decisive action to improve national flood safety. The construction of the Afsluitdijk and the Delta Works transformed the Dutch coastal defence system by significantly shortening the coastline. As part of this transformation, the Zuiderzee was enclosed and transformed into a large freshwater lake, known as the IJsselmeer.

The shortened coastline enabled outward urban expansion of the Randstad. However, government institutions warned that continued urbanisation could cause the Randstads cities to merge into a single, uncontrollable metropolis, potentially resulting in congestion, social inequality, poverty, public health issues and rising crime rates (Zonneveld & Nadin, 2022).

The Netherlands ca. 1980

Figure 21: Randstad in 1000 and 1600
(Zonneveld & Nadin, 2022).

3.2 The Randstad model throughout the decades

Changing interpretations

Since its emergence of the Randstad, the model has undergone several reinterpretations in response to changing spatial, economic, and societal conditions throughout the last decades. Initially, the concept was seen as a spatial model describing an urban ring surrounding an open landscape, but it gradually evolved into a more integrated metropolitan concept shaped by infrastructure, commuting patterns, and international competitiveness. Each reinterpretation reflects a shift in perspectives on the relationship between cities and regional development. This subchapter explains the main phases in the evolution of the Randstad concept and the planning logic associated with each.

1930-1960: urban ring

The first model of the Randstad concept was about the region consisting of an urban ring formed by four main cities (Amsterdam, Rotterdam, Den Haag, and Utrecht), surrounding an open green landscape known as the Green Heart. Within this model, the Randstad was primarily understood as a spatial configuration, emphasising urban form and the physical separation between cities and landscape *(Zonneveld & Nadin, 2022)*. A more detailed explanation of this initial model is provided in Chapter 1.4.
Main logic: spatial form.

1960-1990: polycentric urban network

In contrast to the initial 'urban ring' model, this interpretation of the Randstad model redefined the Randstad as a polycentric region consisting of the four, now interconnected, core cities. Instead of functioning as separate urban entities, growth and metropolitan functions were distributed across the region to create a more balanced urban structure. In this model, the Randstad was no longer understood solely as a spatial form, but as a coordinated urban network shaped by connections, accessibility, and functional complementarity between cities (Van Eck & Daalhuizen, 2005).
Main logic: balanced urbanisation through infrastructure.

1990-2010: single functional urban region

As infrastructure improved, travel between the core cities became more and more efficient, allowing residents to live in one city while working in another. As commuting intensified, functional relationships between cities strengthened and the Randstad increasingly began to operate as a single metropolitan labour market (Van Der Werff et al., 2005). This development required a new interpretation of the Randstad model, shifting the focus from a coordinated urban network to a functionally integrated metropolitan region driven by mobility and daily interaction between cities .
Main logic: functional integration.

2010-NOW: global metropolitan region

As the Randstad developed into a larger and more integrated metropolitan region, the Netherlands saw how the role of the Randstad shifted from a nationally focused urban system to an internationally competitive metropolis (De Vries, 2012). Economic growth became increasingly driven by global connectivity through (air)ports, the knowledge sector, and collaborations with international significant companies. now, the Randstad is understood as a internationally competitive metropolitan region, with spatial and political decision-making strongly focused on strengthening the economic and global position.
Main logic: international economic competitiveness.

Constants

Despite the changing interpretations of the Randstad model, several core principles have remained consistent throughout its development. One of these constants is the compact city model, in which urban growth is concentrated to prevent uncontrolled urban sprawl. Though, urban sprawl is something that is slightly happening now, but this will be explained in chapter 3. Closely linked to this is the constant about the preservation of openness in the centre, the Green Heart, to maintain spatial distinctions between urban areas (De Vries, 2012). As last, mobility has consistently been understood as a key mechanism to strengthen regional cohesion, where infrastructure fosters accessibility, urbanisation and connections between cities.

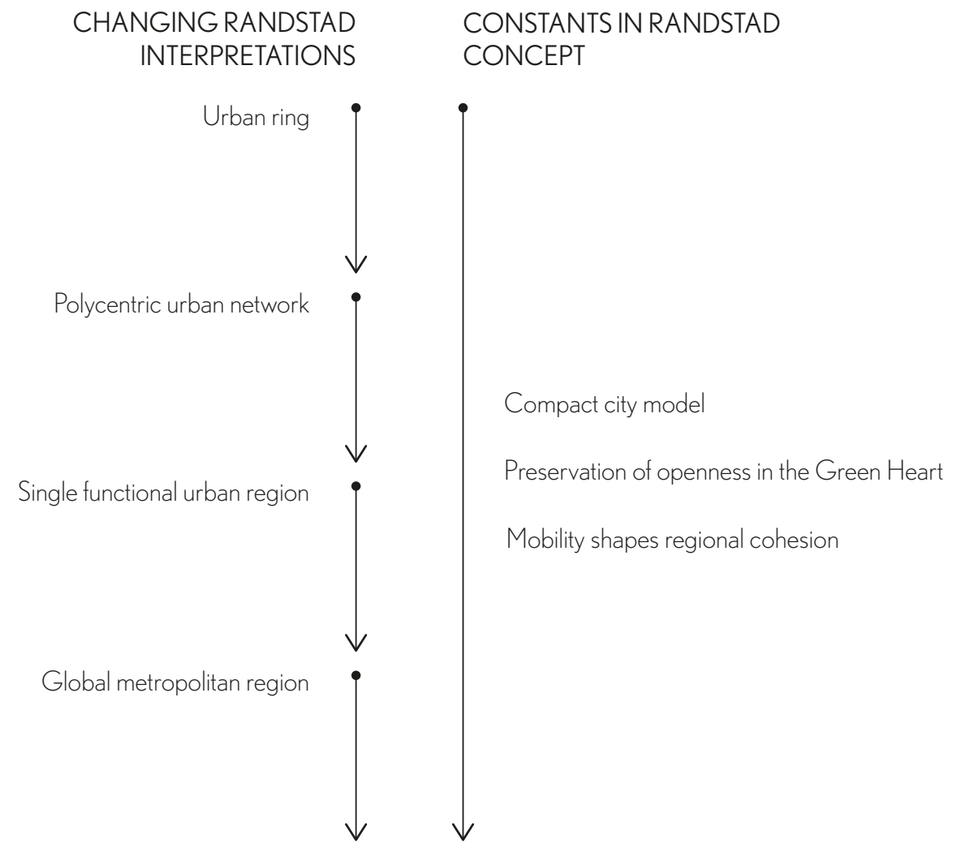


Figure 22: Changing and constand interpretations and concepts of the Randstad model (By author)

3.3 Randstads current spatial model

Nowadays, like discussed in the introduction, the Randstad spatial model and form is currently different than the the initial model. There is no case of a 'delta metropole', as the spatial model and form can now be described as two metropoles in deltaic conditions. There is one metropolitan region on each north- and southside. On the northside, metropolitan region Amsterdam (MRA) is dominant, and on the southside its metropolitan region Rotterdam-The Hague (MRDH).
In the MRA, Amsterdam is the core city. It's the main economic driver with its international significance. Also, the region got two international mainports; Schiphol airport and the port in Amsterdam.
In the MRDH, both Rotterdam and The Hague function as pivotal centres. The Hague is important because the Dutch government is located there, and Rotterdam is crucial because of its international port, the biggest one in Europe.
Inbetween both sides, the Green Heart is located. Within the Green Heart, different zones can be identified based on natural conditions and its function; agricultural, delta and a risk zones. In the risk zone, natural risks like subsidence and salinisation occur.

Plans of MRA, MRDH and Green Heart representatives are in large lines the same on blue-green development. Though, all parties involved have small differences in development objectives, and contribute to the slow decay of green in the region. All parties work on the same goals, but a proper large scale vision for the Randstad is not there. There is no real identity currently, as the identity the Randstad is holding on to is not corresponding to todays spatial model. It is urgent that the region finds a refreshed identity to align the vision of all parties.

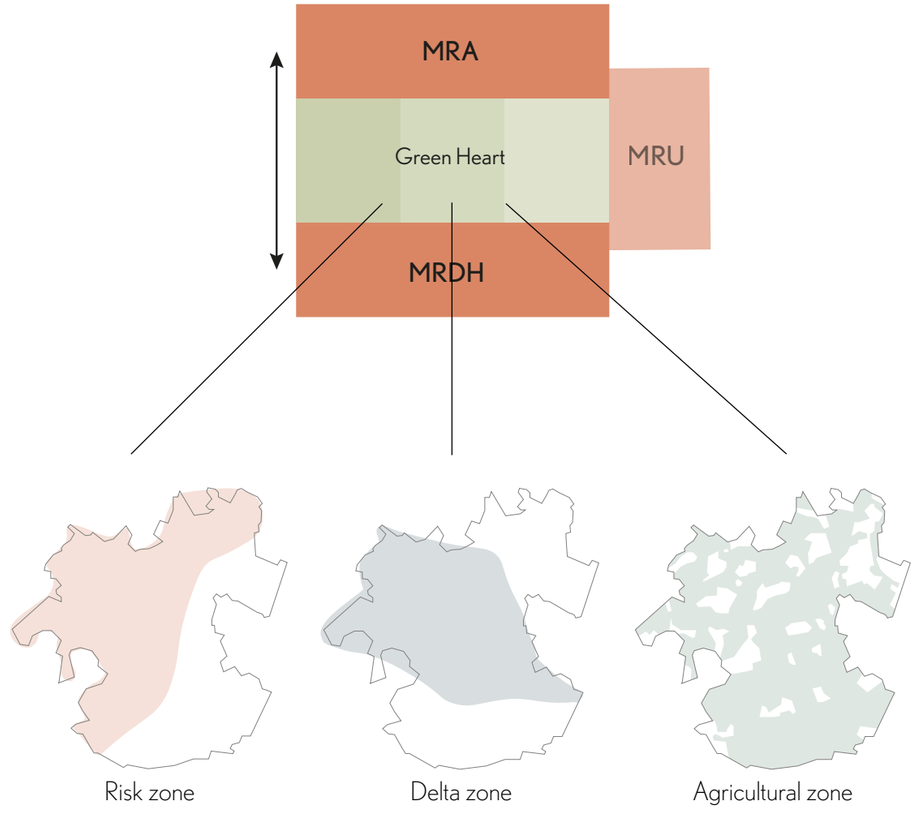


Figure 23: different zones in Green Heart that can be identified through natural conditions and function (By author)

Randstads actual model

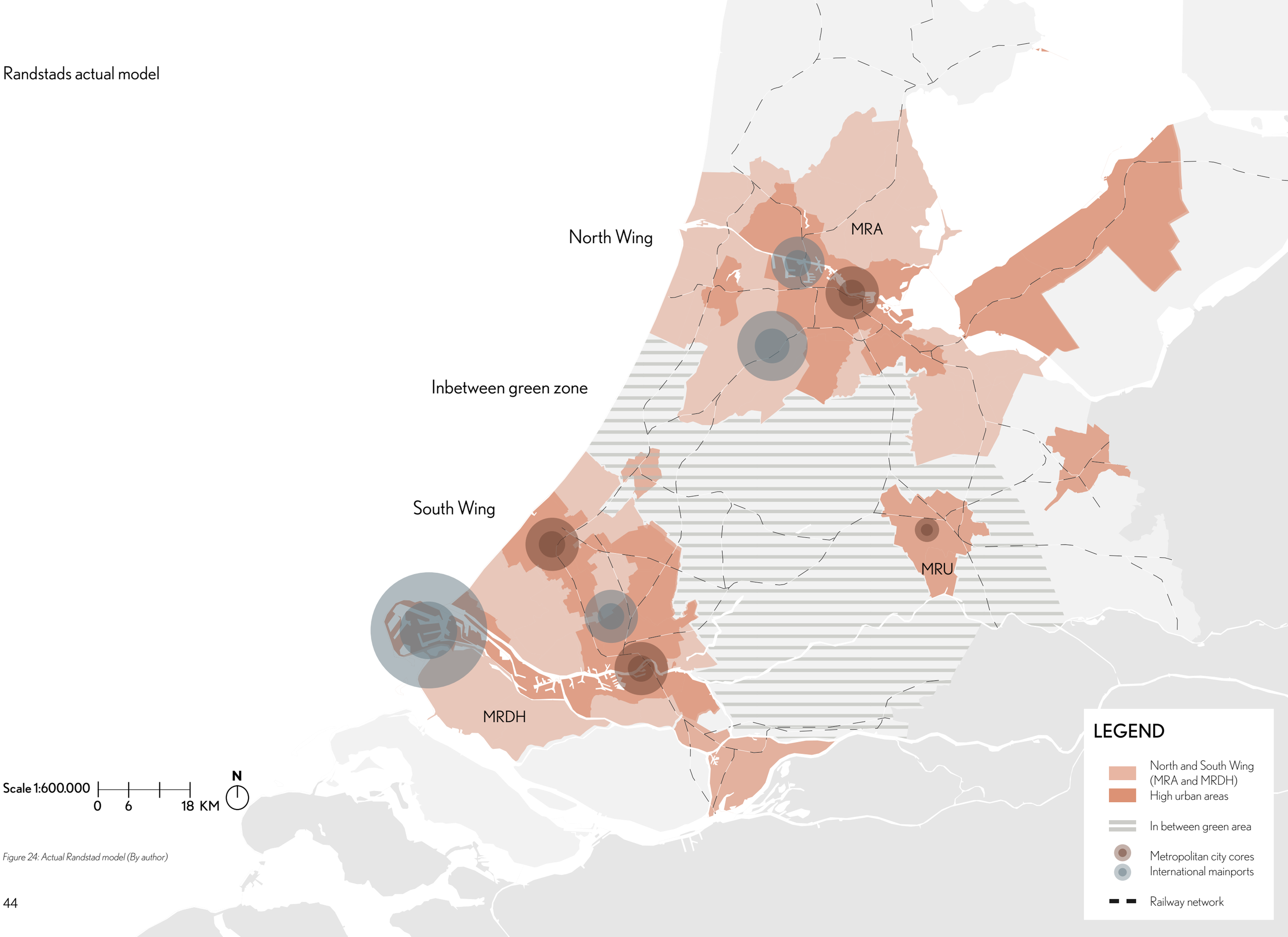


Figure 24: Actual Randstad model (By author)

3.4 The Green Heart model

The Green Heart is the geographical core of the Randstad. It's a peat meadow region that functions as a vital green buffer at the centre of Randstads urban ring. Multiple provinces, metropolitan regions, waterboards and municipalities have borders in this region.
The main idea of the Green Heart is be an open landscape that offers space for agricultural practices, and for residents of the high urban Randstad ring recreational open space. It can be stated that the spatial form of the Green Heart has not derived from landscape qualities, but from a negative urban form (Fazal et al., 2012).
The Green Heart forms a major economic significancy, as the agricultural sector thrives in the region. A large proportion of the land is used for agriculture, it takes up to 67 percent of the Green Heart area (Monitor Landschap, 2023).

However, the government was contradicting their idea to keep the open character of the region. They initiated multiple infrastructural incursions through the Green Heart in the past. This resulted in failure to keep open space due to inconsistency in governmental decision-making (Van Der Valk & Faludi, 1997).
The Green Heart could be seen as a planning doctrine. When a doctrine is valued long enough, people could have the desire to sustain it. This could prevent creative solutions to new problems from being adopted (Van Der Valk & Faludi, 1997). There is a high probability that authorities held onto the Randstad concept for probably too long, and contemporary problems slowly started growing in the region. Resulting in a decay of nature, the core feature of why the Green Heart was established.The Green Heart can be seen as a landscape mosaic, as besides natural, anthropogenic threats like urbanisation are putting the region at risk (European Commission, 2024).
Governmental inconsistency is still affecting the Green Heart today. Over the last decades, the Green Heart has been under attack from (sub)urbanisation, this attack could also be mentioned as urban sprawl. And since 1960, the boundaries of the Green Heart have been adjusted because of urban expansions for multiple times. It got so out of hand that in the most recent national policy recognizes that the population of the Green Heart is urban and not rural in character (Kühn, 2023). Just 5 percent of the Green Hearts land is used as natural area, while 92 percent of the Green Hearts land-use is taken in by agricultural land, water, urban area and infrastructure (Monitor Landschap, 2023).

LAND-USE	AREA (ha.)	PROPORTION
Agriculture	122.000	67%
Water	20.400	11%
Urban area	18.700	10%
Infrastructure	7.800	4%
Nature	6.000	3%
Forests	3.900	2%
Orchards	1.300	1%
Greenhouses	700	0%
TOTAL	181.00	100%

Figure 25: diagram of proportions in land use in the Green Heart in 2022 (By author based on monitor Landschap, 2023)

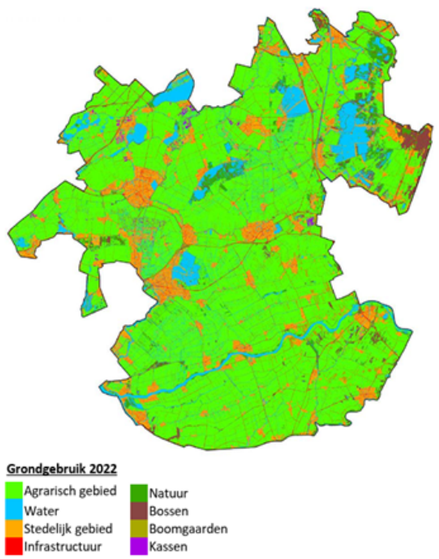


Figure 26: map of land use in the Green Heart in 2022 (Monitor Landschap, 2023)

3.5 Urban sprawl

Urban sprawl has been an ongoing urbanisation process in the Randstad for centuries. The phenomenon is defined as a scattered, low-density urban expansion development occurrence without systematic, large-scale, planning (Bruegmann, 2005).

Two types of urban sprawl can be identified:
1) A classical pattern of monocentric sprawl within the Randstad urban ring: larger cities lost substantial populations while smaller municipalities around them grew.
2) Sprawl extended from the polycentric Randstad urban ring, outwards into the Green Heart and outer ring.

Around 60 years of urbanisation and urban sprawl have profoundly reshaped the Randstads morphology. Today, the Randstad functions as an interconnected urban network, combining cities, suburban areas, business parks, and extensive network infrastructure.

There is little reason to expect the process of urban sprawl to cease. Growing pressures on the Dutch housing market prompted the government in 2018 to announce plans for one million new homes by 2030. In addition, the re-elections of 2025 followed the same pattern, where the winner announced ten "new" cities to counter the housing crisis (D66, 2025).

If urban sprawl won't be contained. There is a possibility that (sub)cities within the Randstad and Green Heart region will continue to grow uncontrollably, resulting in massive losses of nature and the formation of a single, uncontrollable city, instead of the desired polycentric metropolitan region.

	1960–1970 (%)	*1970–1980 (%)*	*1980–1990 (%)*	*1990–2000 (%)*	*2000–2010 (%)*	*2010–2017 (%)*	*Population 2017*
Randstad urban ring	4.8	−5.3	0.4	4.4	4.8	6.1	4,680,440
of which							
Cities > 250,000	−4.3	−15.0	−2.2	2.6	7.8	8.2	2,347,527
Cities 100,000–250,000	10.0	2.9	2.6	8.2	3.9	5.0	811,018
Cities 50,000–100,000	18.4	5.0	1.7	5.6	−0.5	4.2	776,920
Other	32.1	13.9	4.7	4.4	2.9	2.8	744,975
Green Heart	33.9	32.5	13.9	9.5	7.0	1.9	1,216,026
of which							
Cities > 50,000	31.1	58.5	27.8	13.8	14.0	2.8	470,031
Other	34.8	23.5	7.7	7.3	3.1	1.4	745,995
Outer ring	30.2	30.5	23.0	16.6	8.6	3.0	1,847,278
of which							
Cities > 50,000	68.7	66.4	63.9	25.7	13.2	5.7	730,612
Other	23.3	19.0	8.8	11.2	5.7	1.3	1,116,666
Total area	11.0	4.3	6.7	7.5	6.1	4.9	7,743,744
Netherlands	13.5	8.7	5.7	6.5	4.5	3.1	17,081,507

Figure 27: population change 1960-2017 (CBS)

3.6 Daily social systems

Business commuting relations

Over the past decades, daily commuting in the Randstad has increased significantly. The maps below illustrate commuting relationships between municipalities for both 1998 and 2023. The thickness of the lines represents the number of people commuting daily, while the size of the circles indicates the number of jobs within each municipality.
If both maps are compared, a clear shift from relatively separated commuting systems to a more integrated urban network can be seen in the Randstad (PosadMaxwan, 2025).

People now travel more frequently between the four main cities; Amsterdam, Rotterdam, Den Haag and Utrecht, than before. In addition to the increase in commuting flows, travel distances have also grown. In 2023, people lived further away from their workplace on average than in the past. Improved infrastructure has made these longer distances possible (PosadMaxwan, 2025).
Though, as stated earlier in the introduction, these national infrastructure projects have penetrated the Green Heart, stimulating and facilitating urban development within the region (Fazal et al., 2012).

Both developments, higher daily commuting and suburbanisation in the Green Heart, highlight the importance to have a balance between them. As people live further away from work, improved and adaptive infrastructure is needed. Though, the consequences of this shouldn't lead to suburbanisation in the Green Heart.

Business commuting relations between cities - 1998

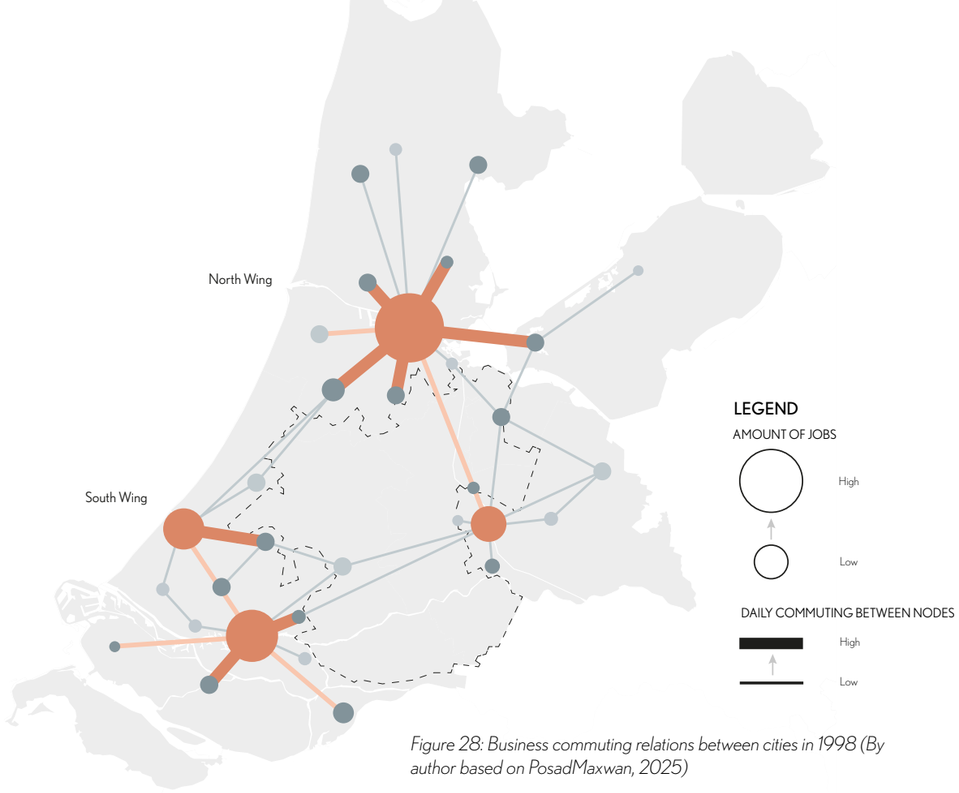


Figure 28: Business commuting relations between cities in 1998 (By author based on PosadMaxwan, 2025)

Business commuting relations between cities - NOW

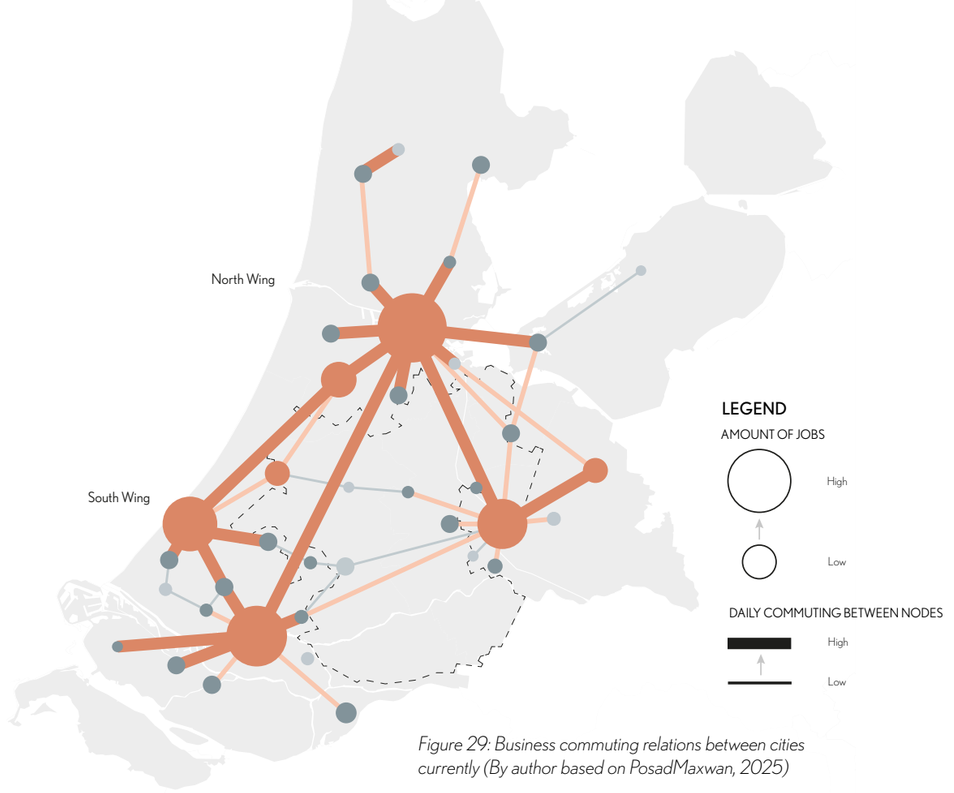


Figure 29: Business commuting relations between cities currently (By author based on PosadMaxwan, 2025)

Commuting relation differences

Another finding is that commuting patterns are different depending on the purpose of travel. Business commuting is done throughout the whole of the Randstad. Rather than being concentrated on individual urban cores, business travel extends across the whole region. This indicates that, economically, the Randstad functions as a singular metropolitan system.

In contrast, shopping commuting is more spatially concentrated and tends to focus on the centres of the major cities. People stay closer to their homes and rarely cross to the opposite side of the region for shopping purposes. Here, Randstad's model of the North and South Wing becomes more visible.

Shopping commuting relations between cities - NOW

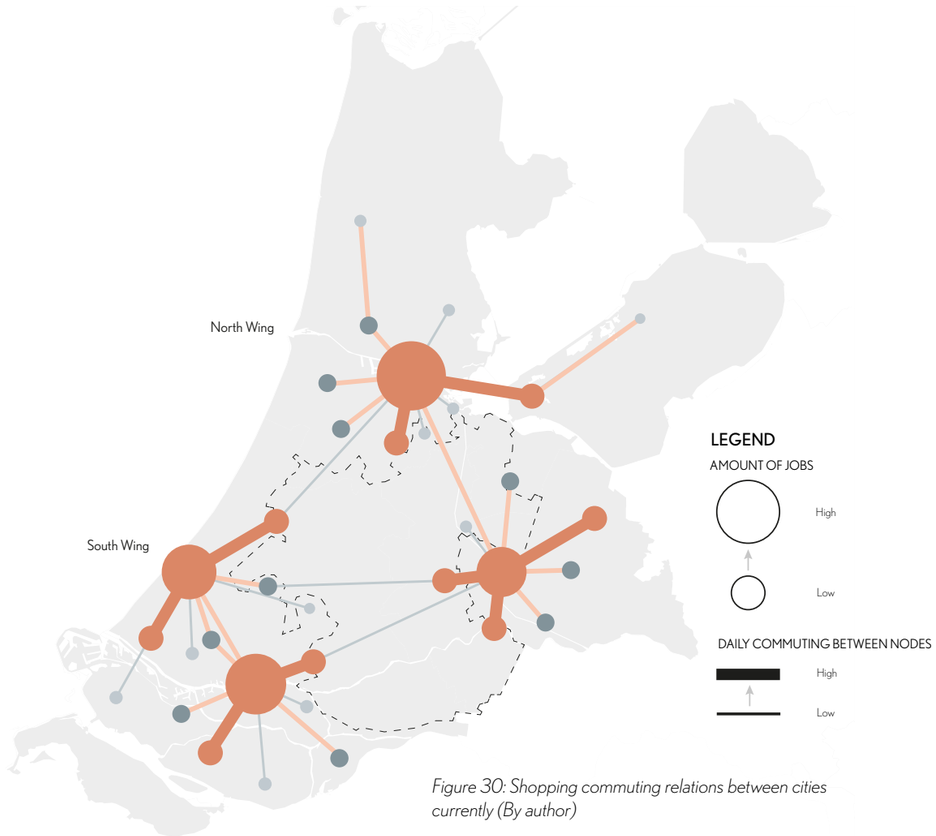


Figure 30: Shopping commuting relations between cities currently (By author)

Business commuting relations between cities - NOW

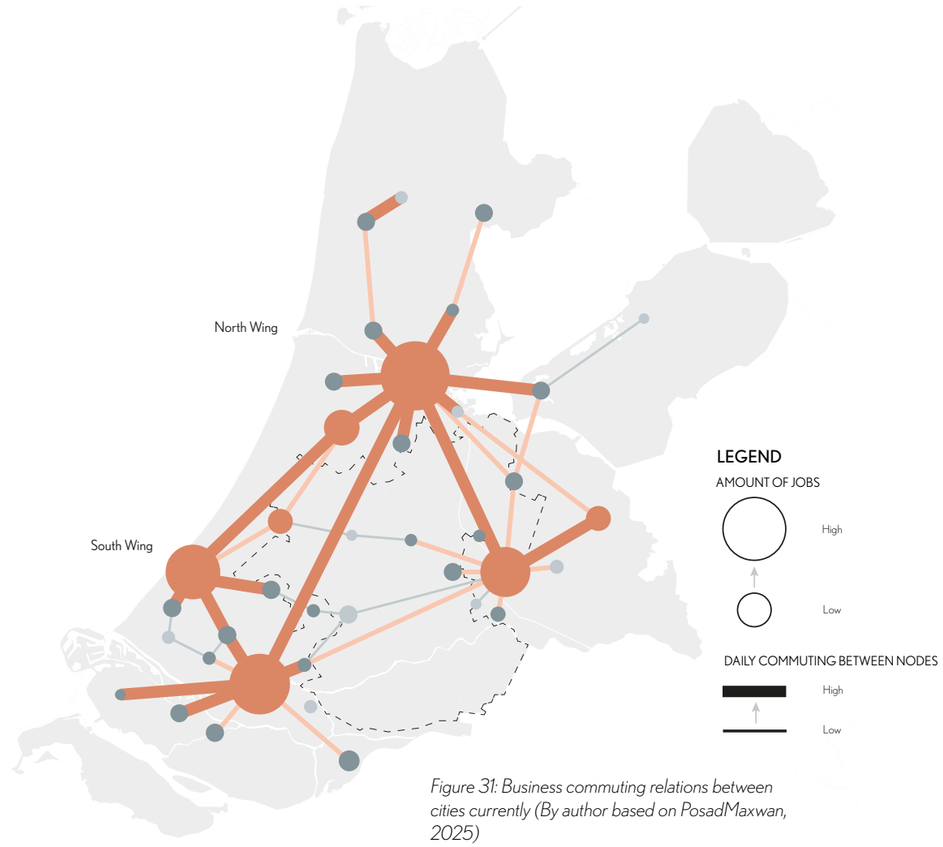


Figure 31: Business commuting relations between cities currently (By author based on PosadMaxwan, 2025)

Infrastructure under pressure

Looking at the instruments citizens use to travel between cities, there can be seen that high- and railway structures connect the major cities in a "circular" structure. Enabling movement across the Randstad as one metropolitan unit.

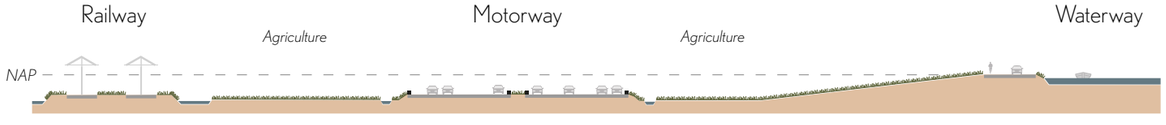
Decisions were made to let infrastructure go through the central open space of the Randstad, the Green Heart, to bolster this metropolitan system. Though, the Randstad model is moving towards a model with a North and South Wing. As the North and South Wing systems are functioning more separately, the consequences of qualitative infrastructure through the Green Heart become more and more noticeable, as urbanisation within the region puts natural systems under more pressure.

Not just natural systems are under pressure in the Green Heart. The infrastructure itself are under subsidence and floodrisk pressures too. As motor- and railways move through subsidence prone areas, and are already under sea level, floodings could cause massive problems for infrastructure in the Randstad.

Figure 32: Infrastructure in Randstad (By author)

Scale 1:600.000 0 6 18 KM N

Section A-A'



Section B-B'

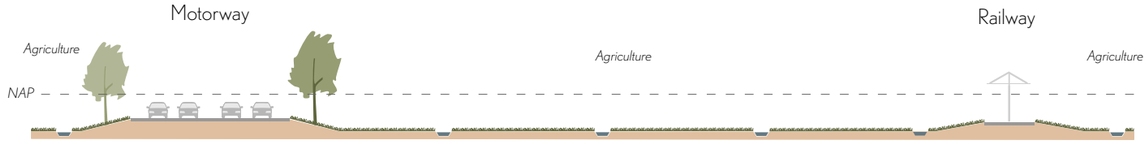


Figure 33 & 34: Sections showing pressure on infrastructure (By author)

Leisure system (natural landscapes)

As mentioned before one of the intentions of the Green Heart was to become a green recreational area in the middle of the dense urban ring. However, leisure areas in the Randstad show the opposite. High concentrations of qualitative walk and bike routes can be seen on the edges of the Green Heart and Randstad. With just five percent of the Green Heart its land is taken in by natural land (Monitor Landschap, 2023), most of the Green Heart area is not really green and/or not accessible for residents.

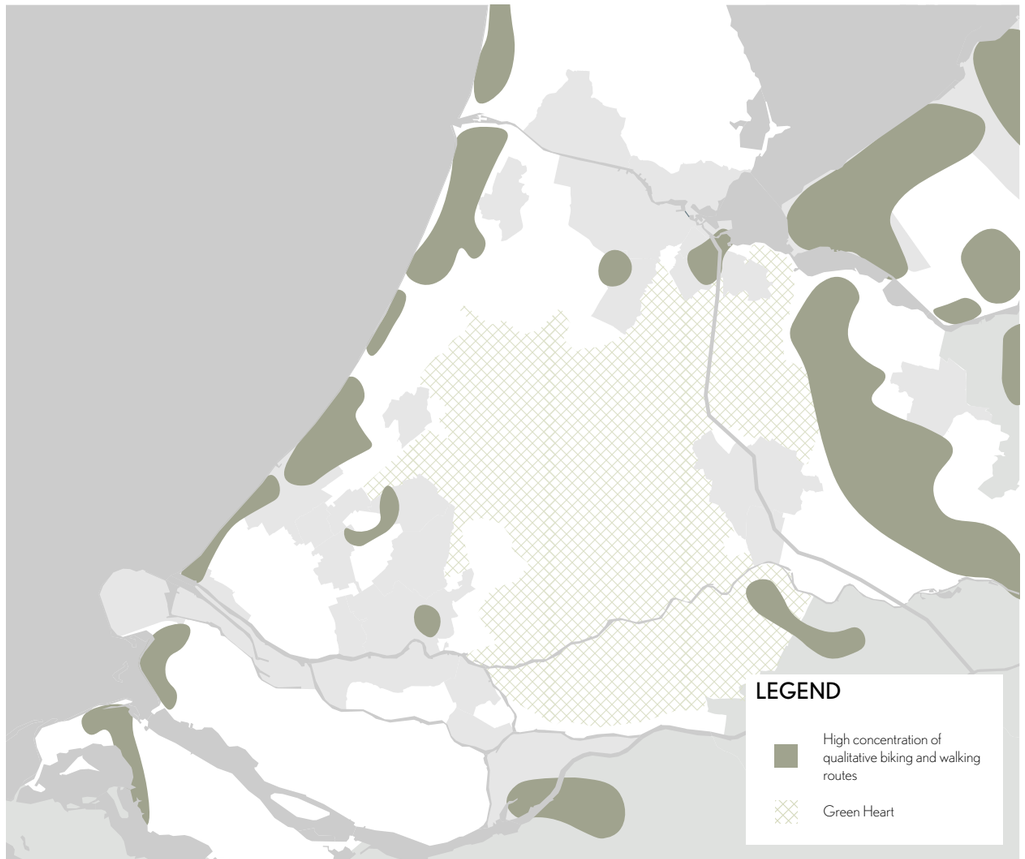


Figure 35: Leisure system of the Randstad (By author based on PDOK, n.d.)

3.7 Randstads current metropolitan demands

The Randstad region faces increasing metropolisation issues as demographic, economic and environmental pressures meet each other.
The most significant issue is the housing crisis that the Netherlands has to deal with. The housing demand exceeds the housing supply. Since 2023, the number of homes for sale did not increase and the average housing price has been increasing (Wijvliet, 2023). It's expected that this trend will continue for the next years. These ever-rising housing prices have a negative impact on households with two average incomes. For those households, it will become almost impossible to buy a house in the Randstad (Wijvliet, 2023).

To tackle the housing crisis, the Dutch government has plans to build more houses, like discussed in the previous subchapter. But this has led to an intensified competition between the built environment and open landscapes, placing housing, green space, and infrastructure under pressure of each other within a limited space the Randstad offers.
This growing tension between urban expansion and natural preservation highlights the challenge of balancing "red" and "green" interests in the most densely populated region of the Netherlands.

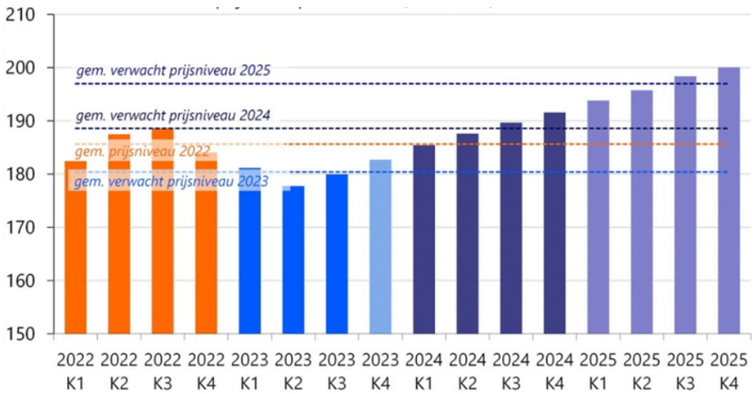


Figure 36: Dutch housing prices per quarter (K) (Wijvliet, 2023)

Simultaneously, effective spatial developments are complicated by fragmented governance structures. In the past, when the Randstad concept was elaborated, the region served as a guiding concept for Dutch spatial planning for decades. It was supported by extensive, subsidised housing programmes, green projects and new infrastructure, who all got substantial government funding (Zonneveld, 2021).
However, this is not the case anymore. Spatial planning has changed from a centralised, to a decentralised structure. Nowadays, spatial planning is no longer based on a articulated vision for the layout of the Netherlands.

This is seen in the way how different sectors within the Randstad are planning and functioning separately from each other. This separation was sparkled in 2007, when a never-put-into-practice proposal was submitted for the Randstad province (Van Der Valk & Faludi, 1997).
After that, the Randstad was figuratively speaking split into two parts; the north wing and south wing. Where the Metropolitan Region Amsterdam (MRA) rose in the north wing, and the Metropolitan Region Rotterdam-The Hague (MRDH) in the south wing. Both MRA and MRDH function as separate polycentric regions. Both the MRA and MRDH rose quickly partly because research had shown that these scales of these regions were more applicable functional entities than the Randstad as a whole (Zonneveld, 2021). The Randstad became more decentralised.

This "separation" resulted in that authorial risk management approaches were struggling to respond effectively to risks related to climate change, water management and urbanisation, due to a lack of integration across sectors and authorities (Zonneveld, 2021). All of these demand space, infrastructure, and long-term planning. These transitions further intensify spatial competition and require coordinated strategies that transcend sectoral boundaries.
Despite all these challenges, maintaining the Randstads economic significance remains the priority of the national government, as the region functions as the main economic engine of the Netherlands.

Addressing these metropolisation demands therefore requires an integral spatial vision that aligns housing, soil, water and governance to ensure a resilient and competitive future for the region. If the Randstad wants to function as a polycentric region again, the governing system should be restored to a more centralised system.

4. GOVERNANCE OVER THE GREEN HEART

4.1 Governance structure

Within the Green Heart, governance responsibilities are shared across different levels of authorities. The area spans its authority over 3 provinces, 5 water boards, 3 metropolitan regions, and up to 37 municipalities, each of which has developed its own spatial visions and strategies for the core of the Randstad. Although these authorities largely recognise shared goals and challenges, their ideas are not always fully aligned, especially about the Green Heart region. The following subchapter further elaborates on this.
In addition to these regional and local authorities, the Dutch national government exerts influence over the Green Heart through various ministries and programs.

What stands out in the big web of authorities of the Green Heart, is that there is a foundation, called Stichting Groene Hart, that aims to support alignment among visions and strategies for the region. While the foundation holds no formal decision-making power, it is their mission of the foundation to preserve and develop the core qualities of the Green Heart by engaging governmental bodies, organizations, and individuals in collaborative processes (Stichting Groene Hart, 2025). A key objective of the foundation is to raise awareness across all levels of government of the need for an integrated approach to the future of the Green Heart (Stichting Groene Hart, 2025).

The hierarchy of the mentioned authorities are illustrated in figure 37.

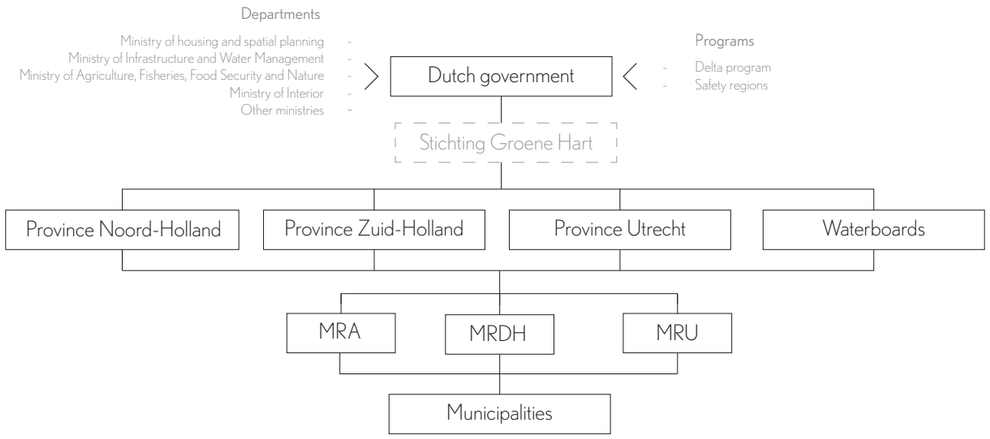


Figure 37: hierarchy of authorities in Green Heart region (By author)

4.2 Future plans for the Green Heart

As for the current state of the Green Heart, the beforementioned authorities see that the region has to deal with its challenges and must adapt to the future environment. However, these authorities all work through different scales. Normally, that should not be a problem, as the greater authorities make the large scale plans and the smaller ones adapt it to their smaller scale. Though, there can be seen that plans are not totally in sync with each other. The plans are all addressing the same common challenges, but the focus is put on different topics.

Major authorities

A difference can be seen between the province of Zuid-Holland (including MRDH) with the provinces of Noord-Holland and Utrecht (also including MRA and MRU). The province of Zuid-Holland, who also got the most elaborated vision for the Green Heart, puts the emphasis on inner-city densification. While in contrast, the other provinces allow more outer-city expansion, which inevitably leads to further urbanisation within the Green Heart.

Regarding soil and water management, the policy objectives for water- and soil management are largely in line with each other. All emphasise the importance of preserving the Green Heart's historical landscape character and biodiversity. Additionally, they also see the urgency of addressing soil subsidence and increasing water-related risks.

Though, the difference in ideas about urbanisation could become a bulge in the collective plans to maintain the Green Heart current form. The land-use alterations, together with the growing urban demands, will leave less space to tackle the water- and soil risks, thereby undermining long-term resilience.

	URBANISATION	WATER	SOIL
Rijkswaterstaat (government)	-	Generate energy from water & water safety	Keep biodiversity
Room for the River program	-	Make the river area future-proof + concerns about space to safely drain water away	Stop erosion & raise the riverbed
Province Zuid-Holland	New homes in suitable locations in the Green Heart region	Keep the peat meadow open character of the Green Heart	Use peatlands as space to build on, depending on the pace of innovation
Province Noord-Holland	-	Create a climate-adaptive and healthy water system	Boost biodiversity & reduce soil subsidence
Province Utrecht	Give urbanisation space on outskirts of the Green Heart	Develop a water system that can handel extreme weather and droughts	Reduce soil subsidence & build further on characteristic parcel structure
MRDH	Densification in inner-city & more clean and accessible mobility	-	-
MRA	Densification is both inner- and outcity (multi-core)	Strengthen blue-green environment to improve biodiversity and water management system & maintain peat meadow character	Develop blue-green network that grows alongside more urbanisation
MRU	Accelerate the pace of housing construction	Look for water storage areas to prevent drought & create groundwater protection zones	Develop blue-green ambitions

Figure 38: Green Heart ambitions of major authorities (By author)

Urban expansion plans of largest authorities

Differences in urbanisation misalignments by the largest authorities in the Randstad; Dutch government, provinces and metropolitan regions, are made visible in figure 39. All three authorities want to urbanise in certain areas. Though, there can be seen how little these areas correspond with each other. In most of the urbanisation zones, there is low authorial alignment. Which means that just one of the three authorities wants to urbanise in that area. Medium means two of the three find that area interesting to urbanise, and high means all of them.

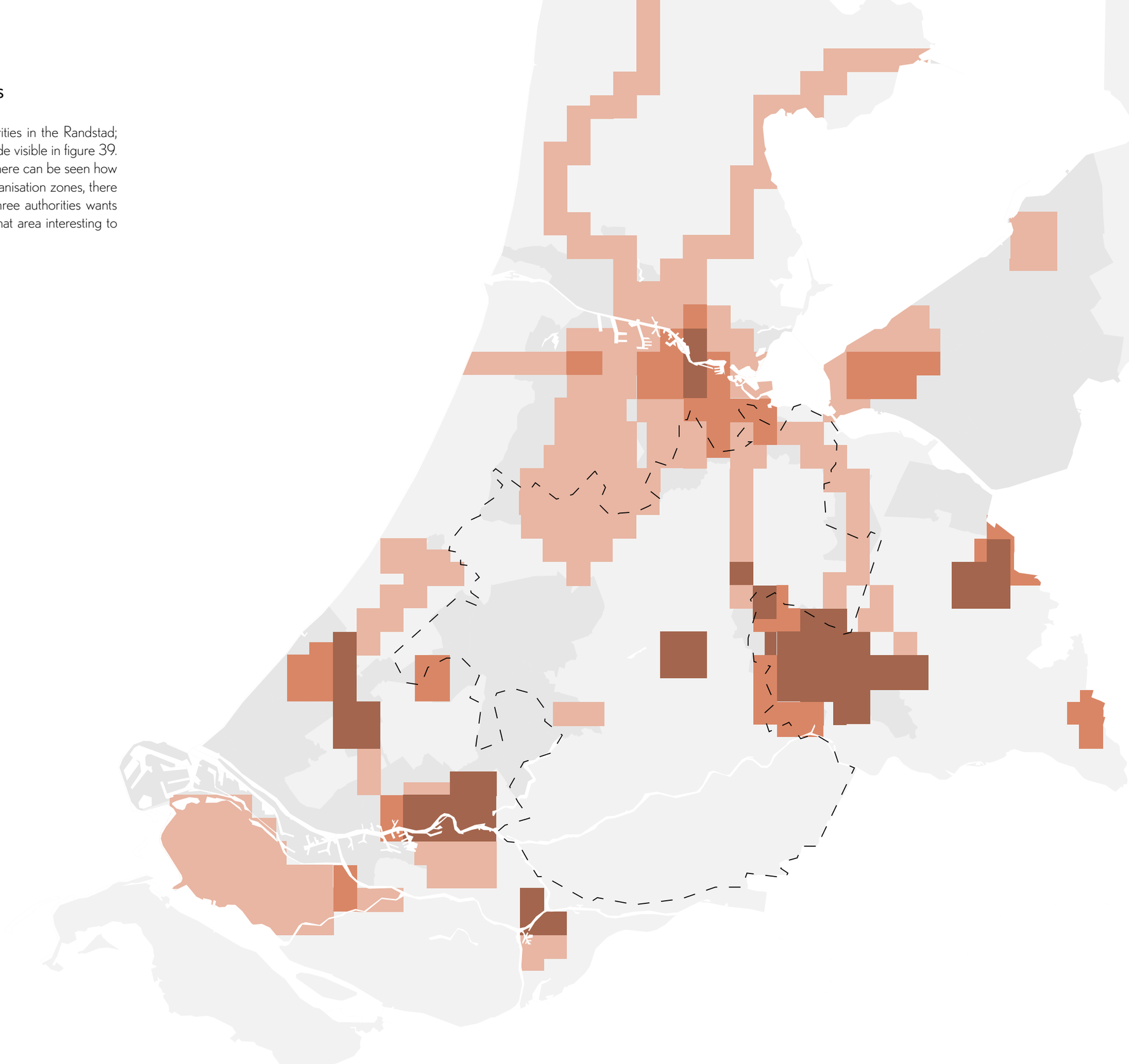


Figure 39: Authorial alignments in urbanisation areas (By author)

Urban expansion plans of municipalities

Differences in focus can also be seen when looked at the spatial visions and strategies on municipal level in the Green Heart. This raises the question whether all municipalities in the Green Heart actively use, or have accessibility to, the same vision to define long-term objectives.
Smaller municipalities tend to adopt the core qualities articulated by Stichting Groene Hart in their visions; embracing the open and peat character of the Green Heart & maintaining the peace and quietness that the region brings within the busy Randstad.

Tensions become particularly apparent when municipal urbanisation ambitions are compared. Municipalities located on the edges of the Green Heart, especially those close to highly urbanised (metropolitan) areas, seek to balance business orientation and urban expansion with the preservation of the historical qualities of the landscape. In contrast, municipalities situated more centrally within the Green Heart prioritise maintaining the green and peaceful character.

A key observation is that the municipalities on the edges are looking for ways to urbanise more. If municipalities continue to explore these opportunities, the Green Heart will shrink further in the future. This process has already been ongoing for decades; the "edge municipalities" are urbanising. These regions become part of the bigger urban regions, pushing the edges of the Green Heart further back and giving the opportunity to the "new" edge regions to urbanise.

While the core values of the Green Heart are well known by all the municipalities, their spatial visions remain fragmented, particularly between municipalities at the edges and those in the centre of the Green Heart. The question rises if there must be a governmental body specifically for the Green Heart. One that has the leading authority and makes sure that there is one main vision for the Green Heart that others need to follow.

The Dutch government also acknowledges that the cooperation between different authorial scales could be improved. Stating that effective governance and collaboration among stakeholders is essential to develop a shared long-term vision that balances preservation of landscape qualities with economic and social functions (PBL, 2015).

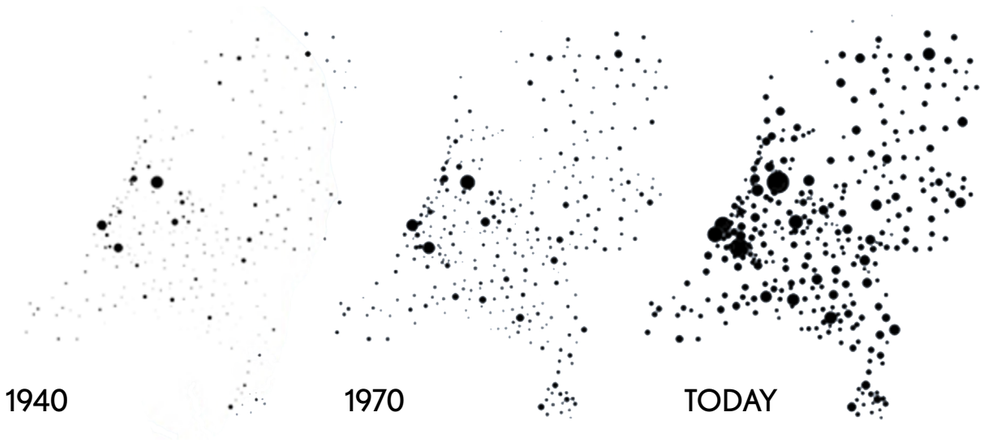
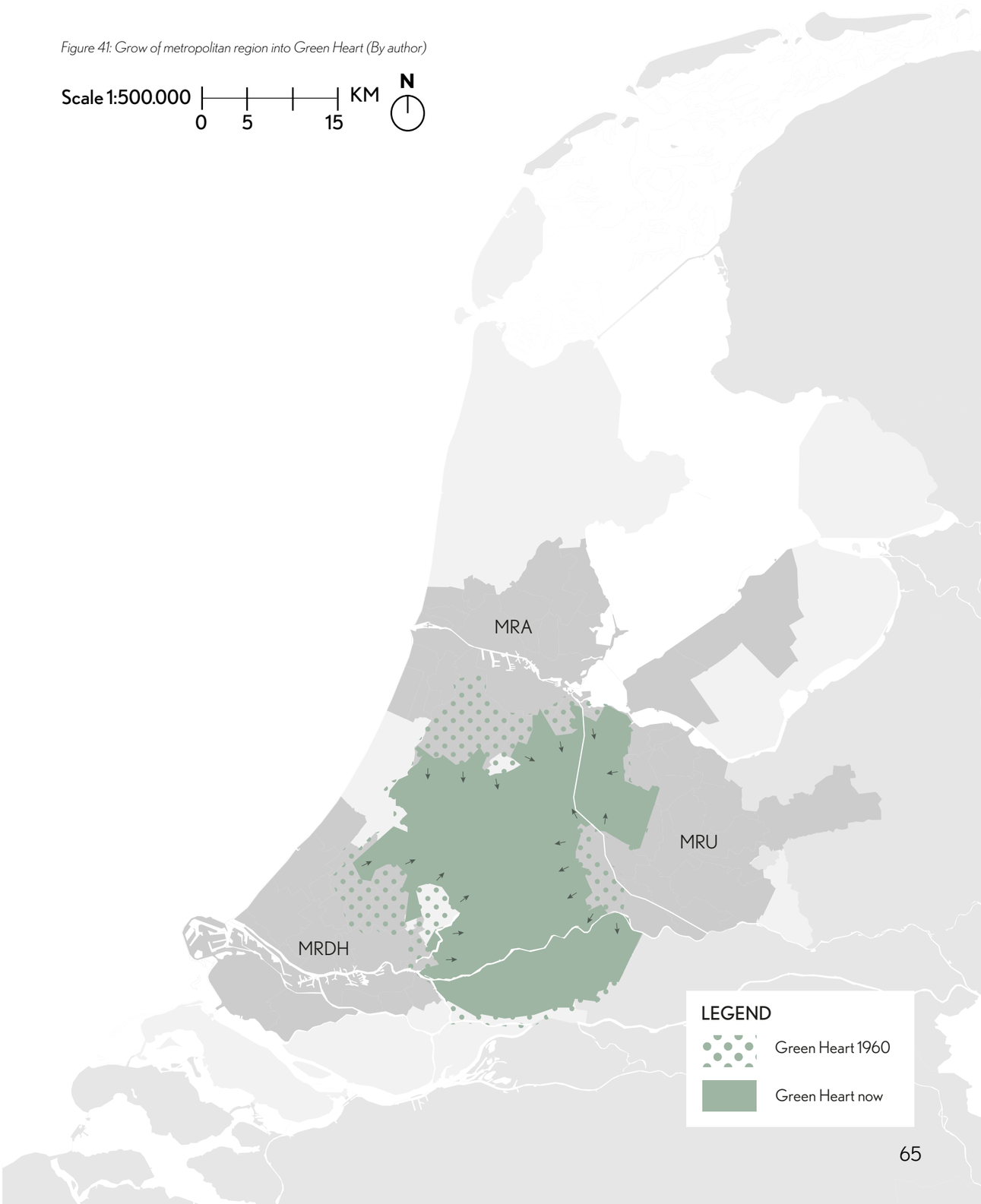


Figure 40: Growing urbanisation throughout the years (PosadMaxwan, 2025)

Figure 41: Grow of metropolitan region into Green Heart (By author)



5. BIOPHYSICAL SYSTEMS IN THE RANDSTAD / GREEN HEART

5.1 Hydrogeomorphological systems

Geomorphology - soil

In the Randstad, the soil can be divided into five categories; high sandy soil, river area, peat soil, sea area and dunes. This mosaic of diverse types of soil is challenged by closures of natural water systems, like the IJssel- and Markermeer, and the Scheldedelta.. Furthermore, an imaginary line can be put through the middle of the peat soil area. This line, that also goes through the middle of the Randstad, shows a change from high sandy and river area soil types, to the sea area soil type and dunes.
It shows a geomorphological connection between the MRA and MRDH, and a disconnection of the MRU. Apart from the economic and international drivers of the regions on the North and South Wing, geomorphological drivers could also become increasingly important.

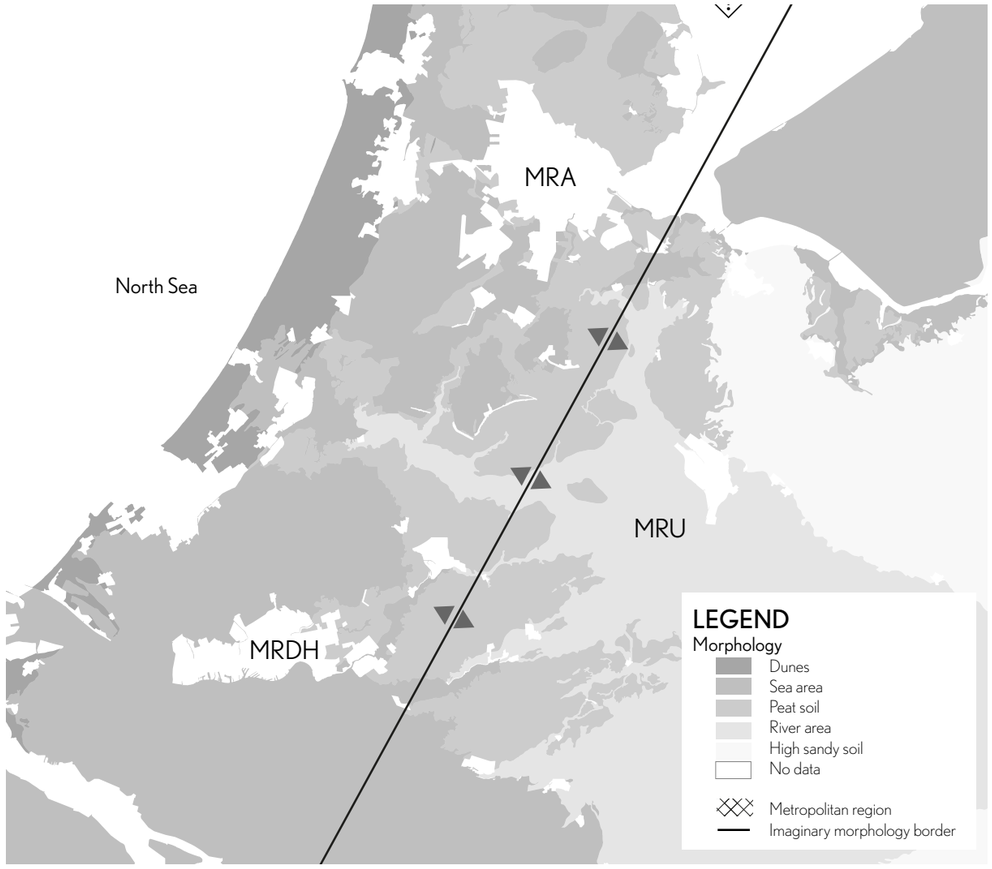


Figure 42: soil structure of the Randstad (By author based on bodemdata, n.d.)

Geomorphology - subsidence

One of the major problems in the Green Heart is subsidence. A large proportion of the Green Heart consists of peat soil, and the highest amounts of subsidence can be seen on this type of soil. The subsidence occurs because of peat oxidation in the region, which also contributes to the emission of greenhouse gases (Stichting Groene Hart, n.d.).

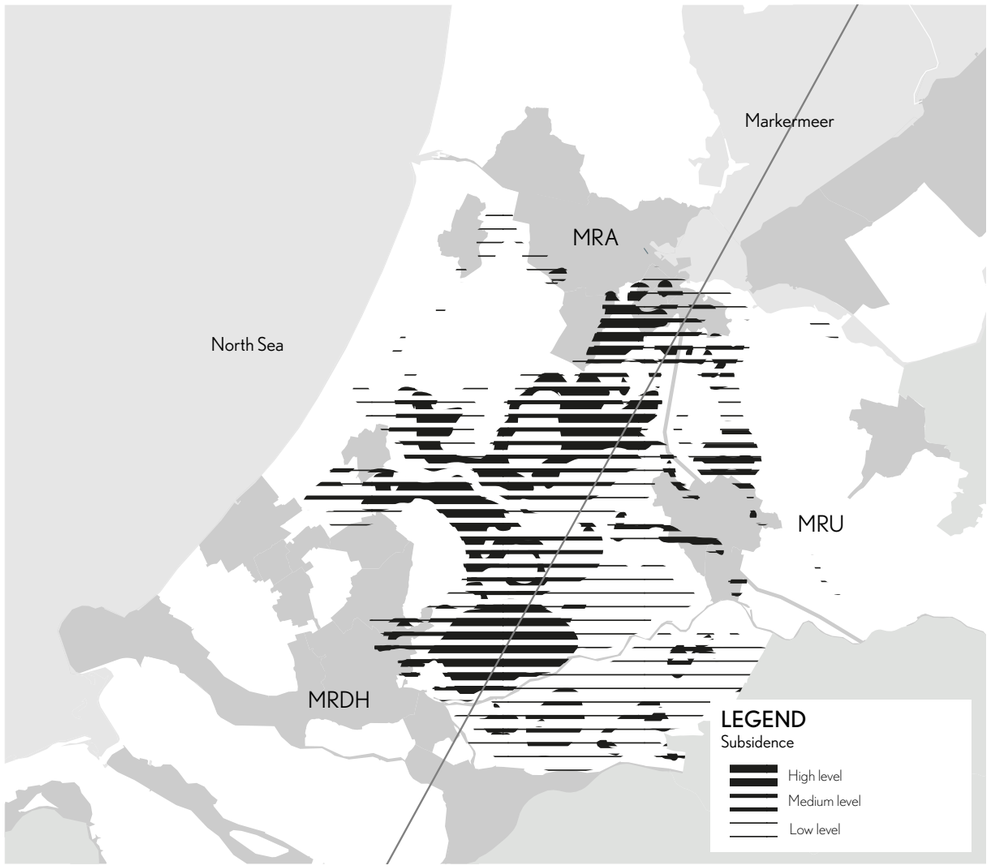


Figure 43: risk level of subsidence in the Green Heart (By author based on bodemdalingskaart, n.d)

Geomorphology - Salinisation and drinkwater extraction

A lot of salinisation can be seen on the Westside of the Randstad. This regions is the closest to the sea, and the two main port areas are located there as well. Again, the imaginary line splits the Randstad into two sides.
The Western side has to deal with a lot of salinisation, while the Eastern side experiences almost none. This also influences drinkwater extraction areas, where this is done through surface water on the Western side (with high salinisation) and through groundwater on the Eastern side (with almost no salinisation).

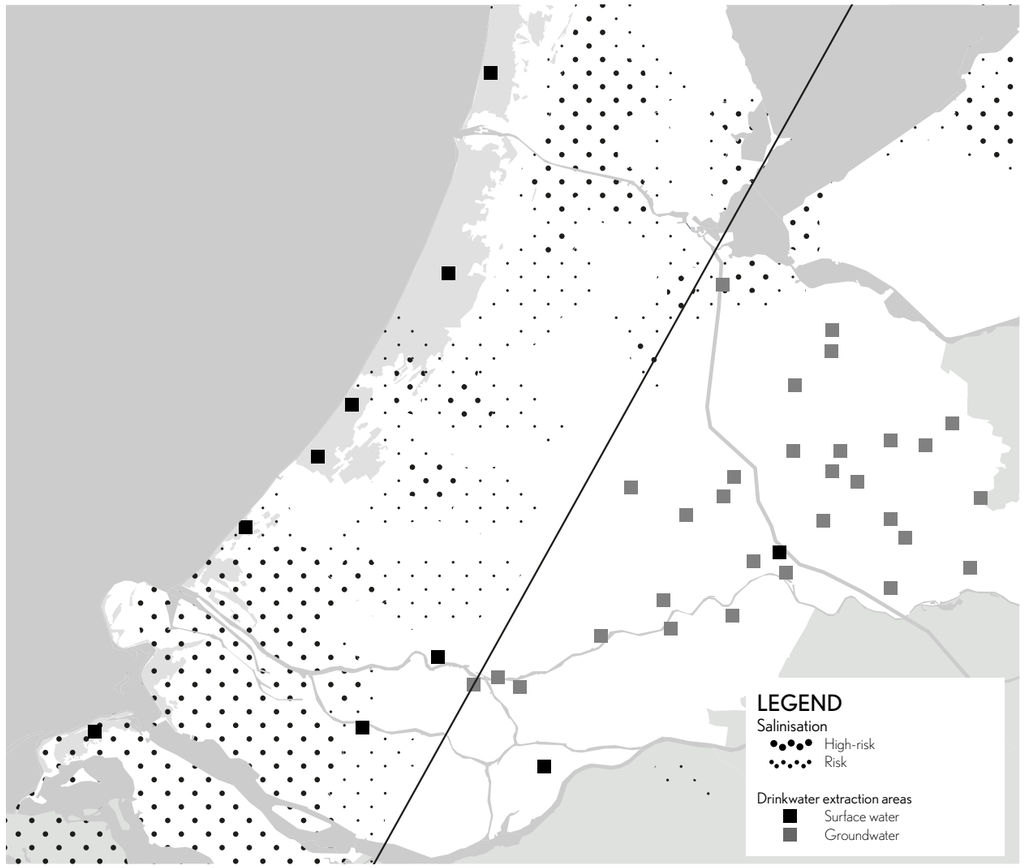


Figure 44: salinisation in the Randstad (By author based on (RIVM, 2018) (GeoServer, n.d.))

Geomorphology - Natural protected areas

There can be seen that various natural areas are protected in the Randstad and Green Heart. What stands out is how the west side of the imaginary line, where most of the subsidence and salinisation occur, is unprotected. This while the nature on the east side of the line is more protected. In this more protected natural area, natural decay does occur way less.

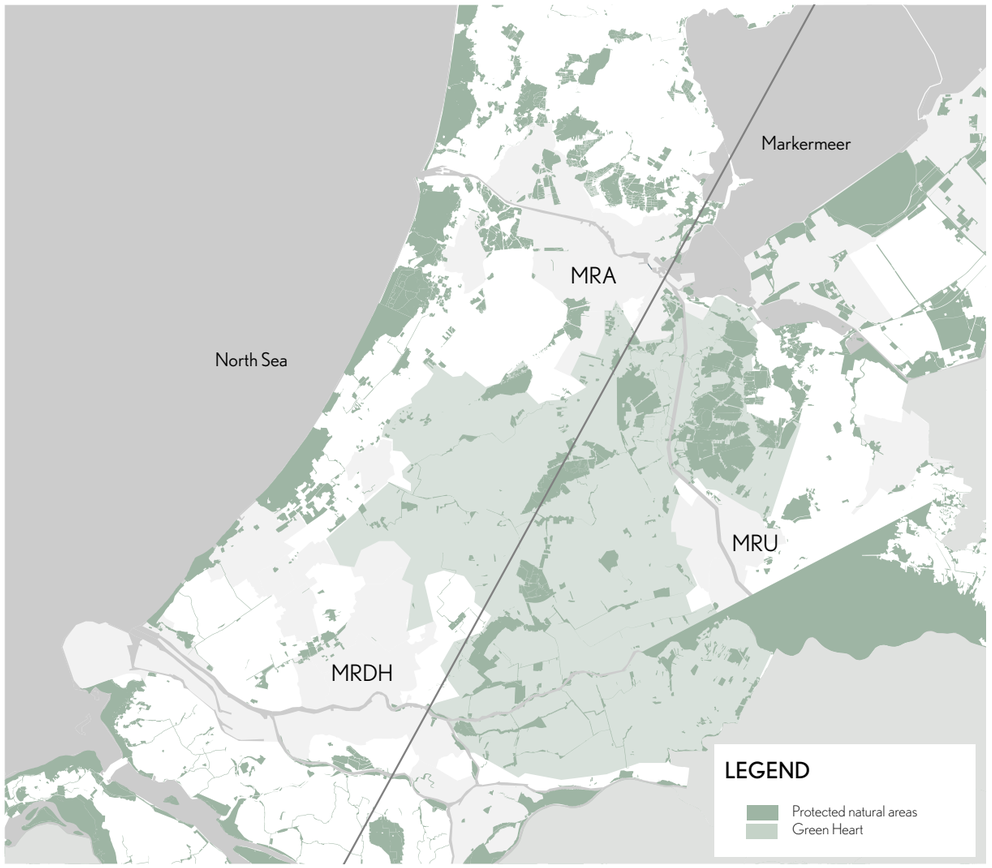


Figure 45: protected natural areas in the Randstad (By author based on PDOK, n.d.)

Hydrological - Water infrastructure

The transport routes of the Randstad, that are used for international transport, are structured around the Green Heart, passing the main ports in Amsterdam and Rotterdam. A division under the transport routes are the main water routes, a vertical structure can be seen that's connecting the North and South Wing. Most of these routes are also used for transport, but on a lower scale.
In the water infrastructure, the two international ports in Amsterdam and Rotterdam are made as accessible as possible, on both international and national scale.

Figure 46: water infrastructure system in the Randstad (By author based on PDOK, n.d.)

Hydrological - Flood risk and protection

A high level of floodrisk can be seen throughout the whole of the Randstad. Though, the Green Heart, together with regions North of Amsterdam and South of The Hague, show the highest level of floodrisk. Proactive measures are taken, with flood barriers in the Southwestern delta and between the IJsel- and Markermeer. Additionally from these floodbarriers, authorities see the need to reserve extra space for future flood measures near dikes, also called dike strengthening zones. These zones could become interesting for future spatial planning.

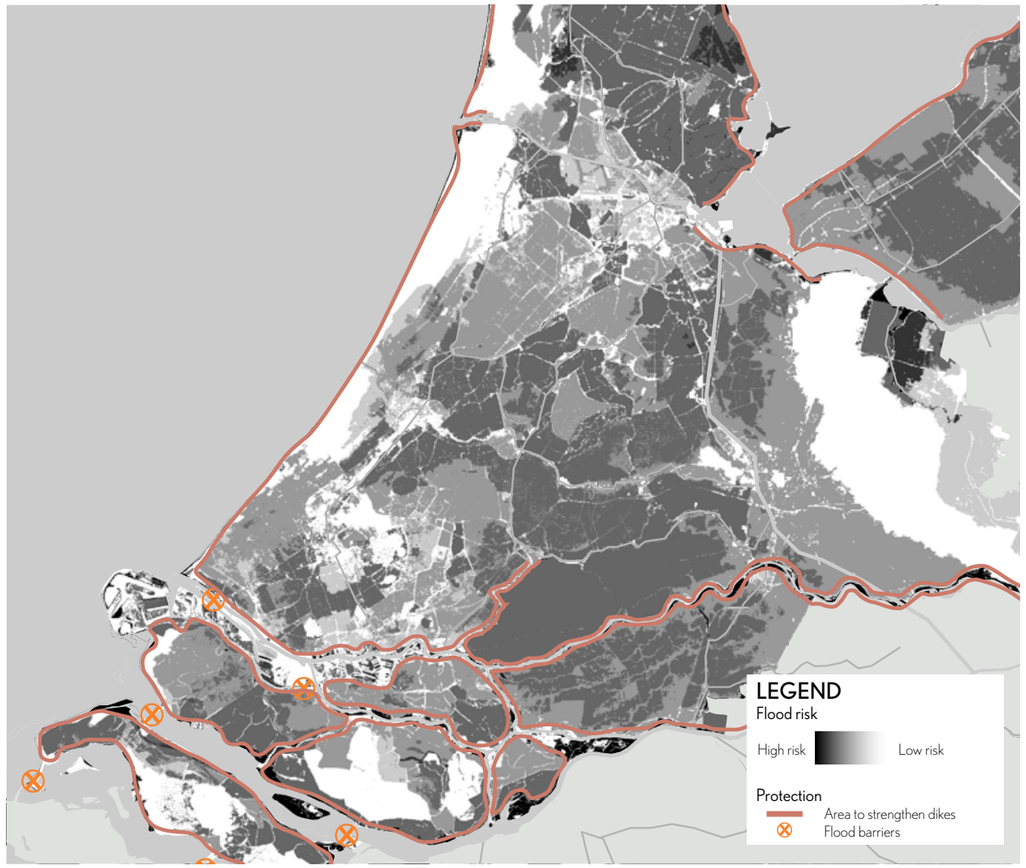


Figure 47: floodrisk and protecting measures in the Randstad (By author based on (risicokaart, 2025) (Defacto stedenbouw, 2025))

5.2 Synergies

Weaknesses of the Randstad and Green Heart

The Randstad and Green Heart can be seen as a landscape mosaic, facing a combination of interrelated natural and anthropogenic (urbanisation) threats. The main natural risks are subsidence, salinisation and an increasing floodrisk. All risks will become more prominent due to climate change, which itself bring other natural challenges like extremer precipitation and droughts. Together with rising urbanisation and authorial contradicting agendas, the Green Heart is under massive pressure. Leading to a deacy of nature in the region.
Outside the Green heart, dike strengthening zones are already under significant stress, as the floodrisk is expected to increase in the coming decades.

Within the Green Heart, the Western part of the imaginary line is particularly vulnerable, experiencing greater pressure from subsidence and salinisation than the Eastern part. In addition, the western part could face stronger urbanisation forces in the future due to its alignment with the MRA and MRDH. As such, this area will play a critical role in shaping the future spatial and environmental resilience of the Randstad.

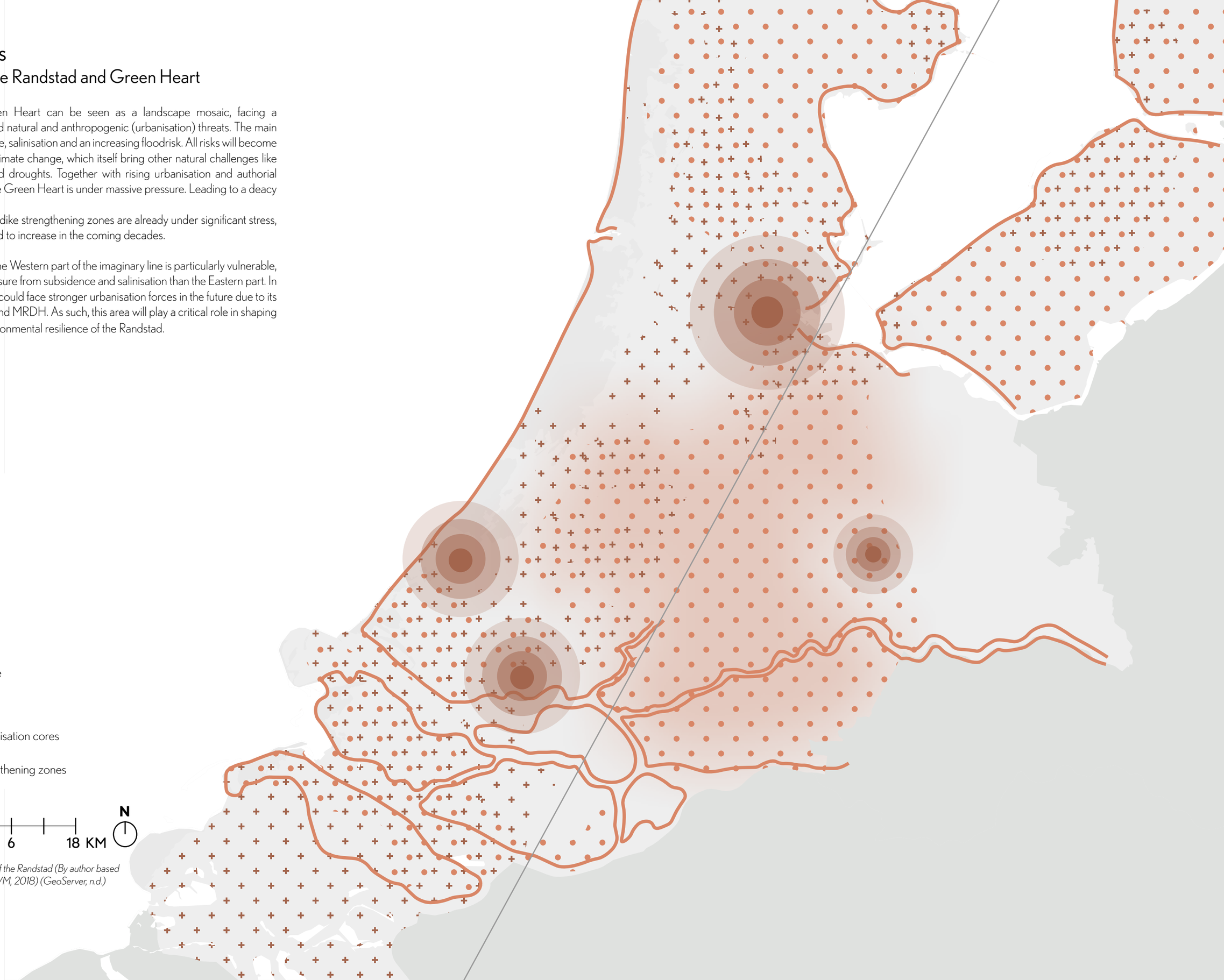


Figure 48: weaknes synergies of the Randstad (By author based on bodemdalingskaart, n.d) (RIVM, 2018) (GeoServer, n.d.) (risicokaart, 2025))

Opportunities for the Randstad and Green Heart

A key opportunity for the Randstad lies in acknowledging and strengthening the current unrecognised spatial model, where the MRA and MRDH function as the primary metropolitan regions in the North and South wing. Both hold the most important international mainports and are the most thriving regions of the country. Transitioning to a form with the North and South Wing will optimise the Randstad model. As infrastructure could be become more efficient when it's more focused on their relevant, smaller, metropole region. And authorial structures could become more concrete in planning and decision-making when the Randstad is divided into two wings.
At the same time, the Metropolitan Region Utrecht (MRU) holds the potential to evolve into a more competitive region, building further on its central location and strategic role as national distribution centre.

With an increasing population and international acknowledgement, the Randstad will remain a region to live and work. Further urbanisation of the Randstad / Green heart will become inevitable. Rather than treating this as a threat, the Green Heart could be repositioned as a green-red zone between the North and South Wings, ensuring urban growth while keeping its values. In this context, the need to reserve space for dike reinforcement and flood protection offers opportunities for the emergence of new urban morphologies that integrate spatial development with water safety and landscape capacities.

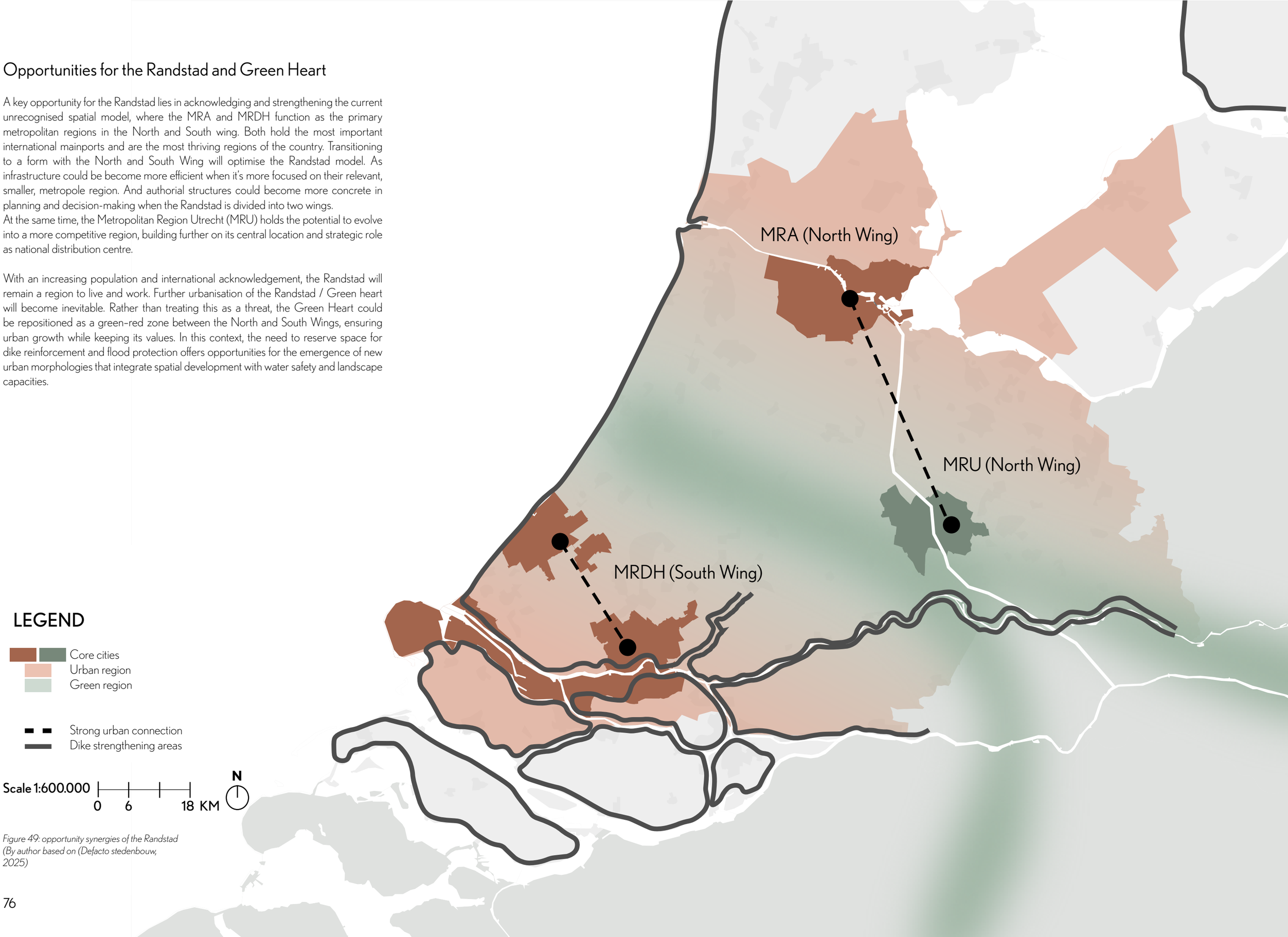


Figure 49: opportunity synergies of the Randstad (By author based on (Defacto stedenbouw, 2025)

6. DESIRED PROJECT OUTCOMES AND METHODOLOGY

6.1 Desired project outcomes

Problem statement

The concept of the Randstad as a delta metropole is outdated, and a new spatial model and form can be seen emerging nowadays. A model with a North and South Wing, and a greenzone in between them. The North Wing holds the dominant MRA, and the South Wing the MRDH. However, governmental planning reports still recognise the Randstad model as it was described a century ago. The misusage of the actual unrecognised model, together with climate change, hydro-geomorphological alterations and different sectoral approaches, have resulted in that nature and its regeneration capacity has started to decay in the Randstad, accelerating diverse risk and posing complex conditions for its current development.

The model, form and perspective of the economic and political central region of the Netherlands, that has always been described by the Randstad concept, needs to change. It needs to adapt to future environmental and metropolisation risks and demands.
These critical conditions in the Randstad, that are introduced in this report, meet in the Green Heart. This region is a critical focus point. The area faces massive pressures; rising urbanisation, substantial water challenges, land subsidence and urban space claims for nature mean that the spatial model of the region is no longer satisfying the current demands.

The Randstad region must find a renewed identity (functional and socio-environmental) to align the sectoral planning objectives, and overcome the socio-environmental challenges it faces. The project will look to find this renewed identity, focusing on the Green Heart region and its current values as vital region in the Randstad metropolitan region..

Aims, objectives and outcomes of the project

The aim of the project is to present a critical perspective on the regional metropolitan cores projected, and find a long-term pathway / vision and perspective on what the Randstad model and form could look like in 2100, when an increased population density and extremer climate conditions will occur in the region.

The objective of the project is to explore a socio-environmental system in the Randstad form and functionality, that's in sync with local biophysical characteristics, dynamics and demands. The Randstad will be explored within a renewed identity. The project will focus on the Green Heart, but as the Green Heart and Randstad regions are nothing without each other, the project will also look into the greater model and form of the Randstad, validating the current and future values that define its future development.

To achieve both the aim and objective as effectively as possible, the outcomes of the project will vary in three scales. All scales will be worked out in the same logic of themes; urban, blue and green.
International 'Eurodelta' scale: Links will be set between the revised Randstad / Green Heart model and the Eurodelta-metropolis. There will be explained how the vision will connect to the biophysical and social systems of the greater European scale.
National 'Randstad' scale: a revised vision for the Randstad / Green Heart model will be introduced. The vision will sketch how the metropolitan regions and Green Heart could adapt to current and future environmental and social demands. Furthermore, the project will propose a governmental framework for this revised Randstad / Green Heart model.
Bioregional scale: there will be looked into three bioregions with different spatial and biophysical characteristics (see next chapter). The diverse Randstad / Green Heart concepts and bioregional conditions will be recognised, forming synergies between them.
Each bioregion will pose a different and unique view of how urban systems could adapt to the future environmental and social demands. A feasible pathway of this will form the base for a set of new opportunities to form sectoral planning alignment in an improved structure.

An addition to existing perspectives on the Randstad model

The project approaches the Randstad as an evolving spatial concept, to which it'll introduce an additional layer to the historical understanding of the Randstad. Rather than rejecting earlier planning logics, the project will build upon them by introducing hydrogeomorphological layer that reframes existing planning principles in response to environmental challenges and long-term landscape dynamics.

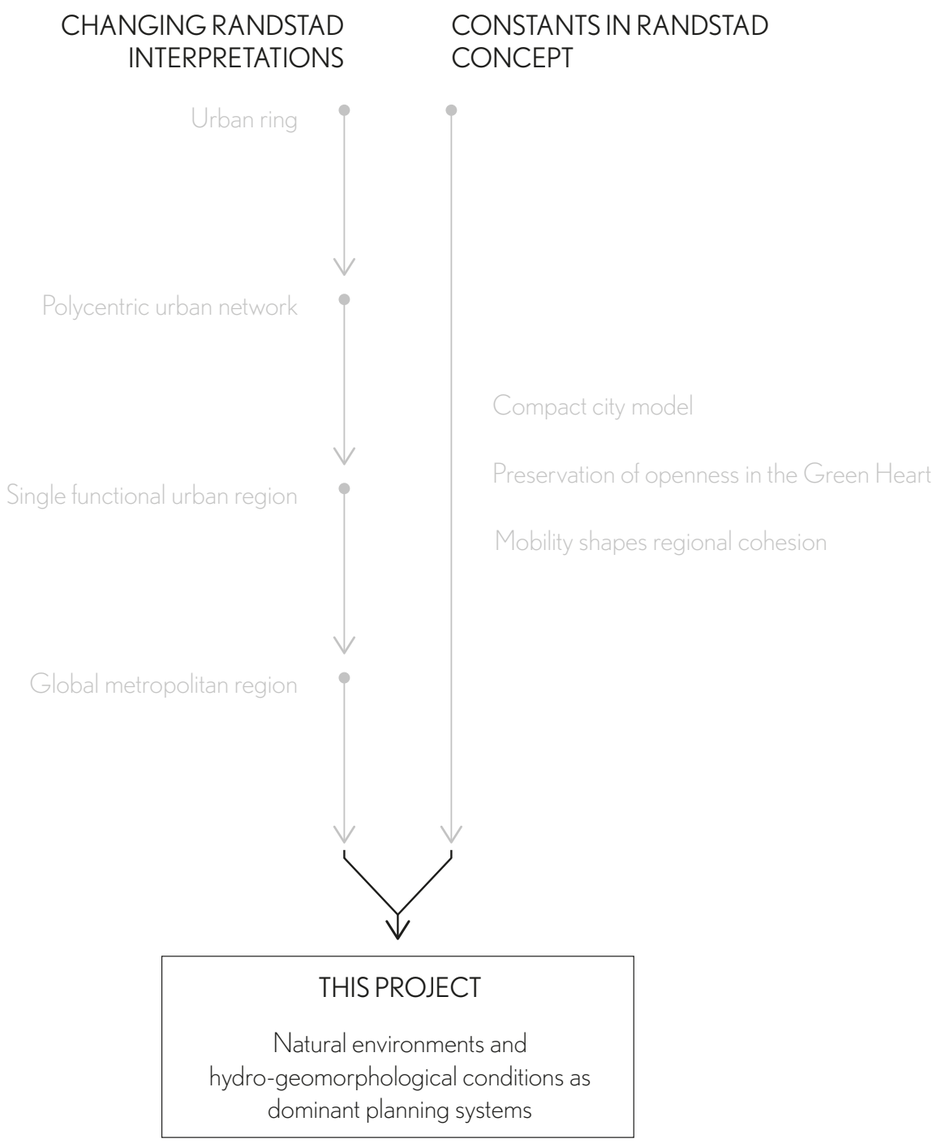


Figure 50: Position of the project in Randstad interpretations throughout the decades (By author)

Sustainable development goals

The Randstad / Green Heart faces increasing pressure from rising urbanisation. Settlements in the Randstad expand, intensifying the demanding for housing and infrastructure, and challenging the balance between urban development and landscape preservation. Without integrated planning, this growth risks undermining long-term spatial sustainability. Therefore, a way of how Sustainable Development Goals (SDG) 9 and 15 could be incorporated in urban planning will be present in this project.

Furthermore, climate change projections toward 2100 further complicate the situation. Rising floodrisk threatens both urban and rural areas. At the same time, hotter summers, colder winters, prolonged droughts and more extreme precipitation events increase vulnerability of agriculture, infrastructure and ecosystems. These climate-related pressures demand coordinated mitigation and adaptive water management strategies across the region. SDG 13 will also be incorporated into the project.
In addition to this, environmental degradation poses another major concern. Ongoing land subsidence accelerates flood vulnerability, damages infrastructure and weakens ecosystems. Salinisation of soil and freshwater systems further threatens agricultural productivity and drinking water supplies. This highlights, again, the need for sustainable water management strategies and ecosystem protection, corresponding to SDG's 6 and 15.

Finally, to glue all the strategies regarding the mentioned challenges and SDG's together. SDG 17 will be included in this project. One of the focuses if this SDG is the multi-scalar collaboration between different sectors, something that is lacking currently. The authorities of the MRA, MRDH and MRU primarily focus on their own territorial interests, which leads to policy misalignments in the management of the Green heart, the shared ecological and spatial system between them. Effective and aligned cross-regional collaboration is essential to address interconnected challenges and ensure progress towards the other SDG's.

Figure 51: Sustainable Development Goals the project touches (By author based on Sustainable development goals, n.d.)

6.2 Methodology
6.2.1 Nexus and research questions

Socio-environmental risk
The Randstad faces socio-environmental risks that stem from the concentration of urbanisation within a delta system under sea level. Ongoing pressures from housing demands increasingly compete with landscape, water and ecological structures, especially in the Green Heart. These dynamics worsen vulnerabilities related to soil subsidence, flooding and climate change. In addition, fragmented governance and sectoral planning complicate an integrated risk management.

Water risk management
Water risk management in the Randstad is challenged by the interaction between intensifying urbanisation and the region's vulnerable deltaic water system. Rising sea levels, increased precipitation extremes, soil subsidence and salinisation place growing pressure on existing flood protection, drainage and freshwater systems. While the Netherlands has a strong tradition of technical water management, it is mandatory to come up with an integral strategy to manage the current pressures.

Integrated Landscape Management
Due to both socio-environmental and water risks in the Randstad, integral landscape management is required to control the region's dynamic delta landscape. Fragmented planning approaches risk the social and hydrogeomorphological coherency of the landscape, particularly in the Green Heart. Therefore, an integral approach is required that recognises the landscape as a socio-ecological system, aligning spatial development, landscape processes and governance structures across scales to ensure a future-proof landscape with a distinct regional identity.

MAIN RESEARCH QUESTION
How can todays outdated model of the Randstad / Green Heart concept be re-envisioned to foster socio-environmental fellowship, considering its hydrogeomorphological alterations, its current type of metropolisation demands, and the future climate conditions towards 2100?

SUBQUESTIONS
- What regions inside the Randstad / Green Heart can be identified that need an unique consideration regarding socio-environmental and water risk management?
- How can metropolisation demands be integrated into hydrogeomorphological and environmental risk management in the Randstad /Green Heart?
- How can the currently fragmented governance model be transformed to support integrated socio-environmental and water management?

6.2.2 Methodological framework

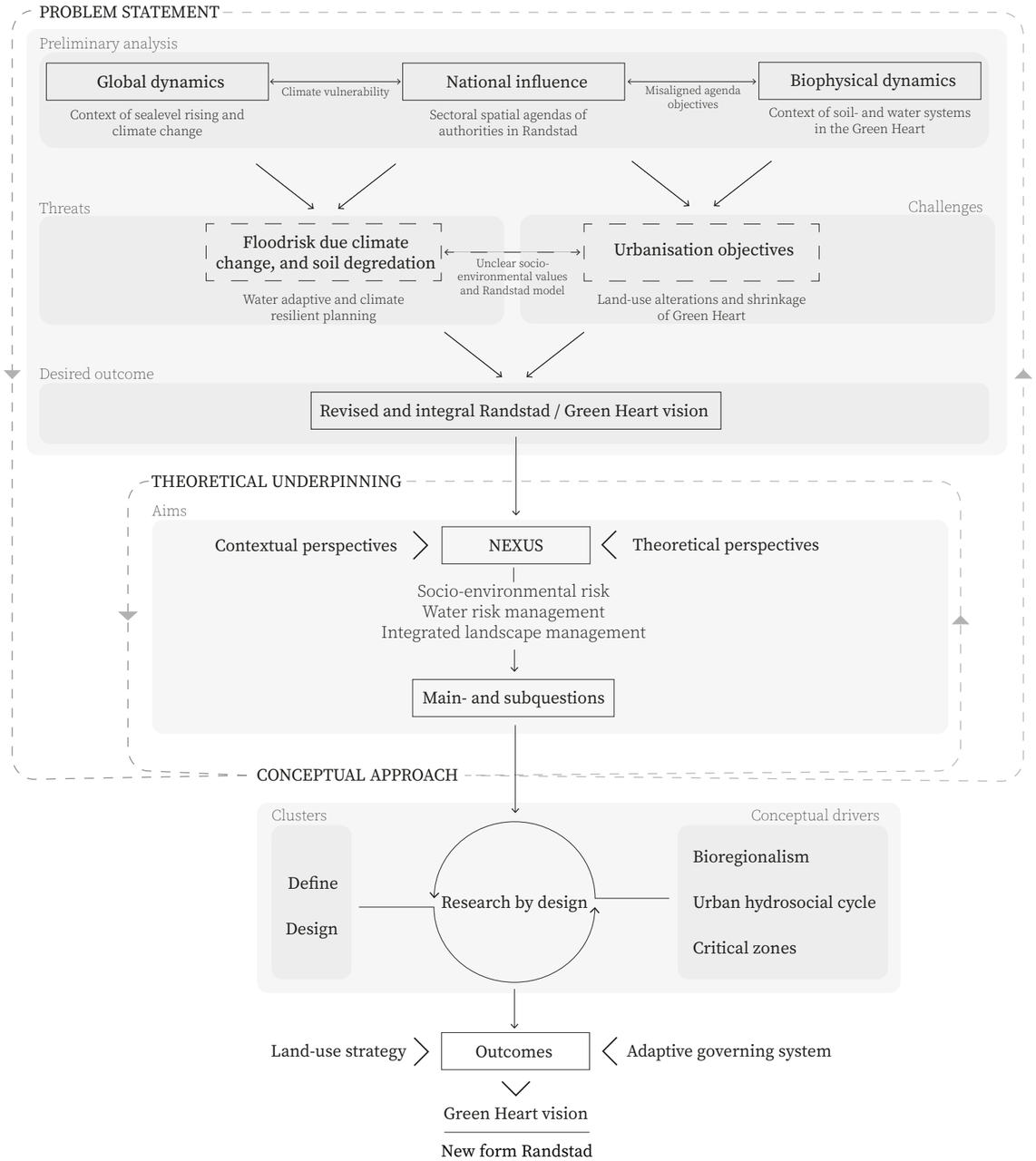


Figure 52: methodological framework (By author)

6.2.3 Theoretical framework

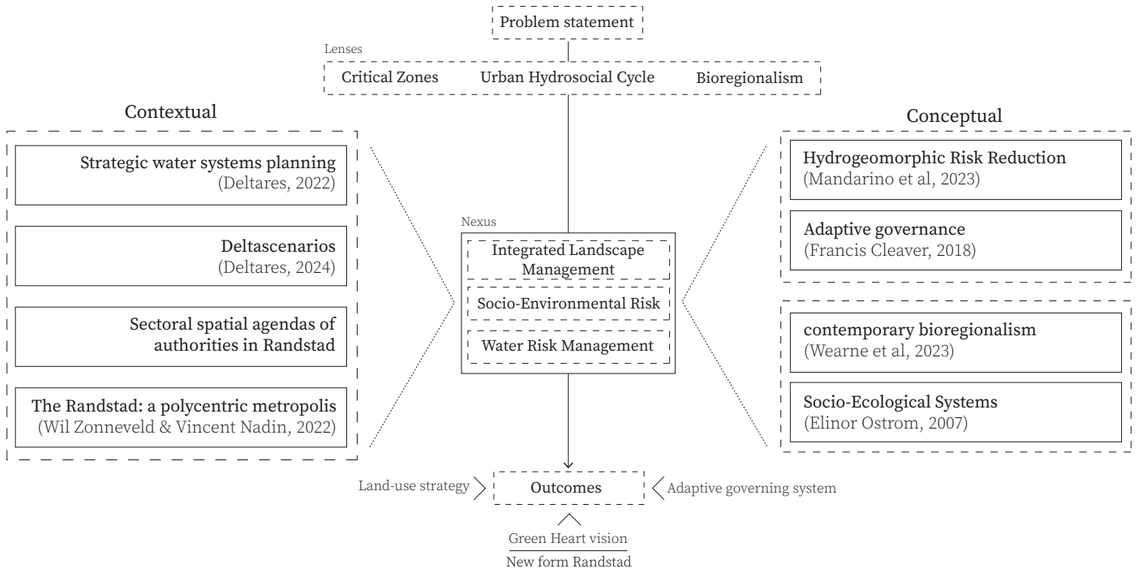


Figure 53: theoretical framework (By author)

The design process is informed by a body of relevant theory approached through three lenses; critical zones, urban hydrosocial cycle and bioregionalism. These lenses form the core of the project and will guide both analytical and design exploration. The key ideas and definition of the lenses are clarified on page 85.
The theoretical foundation to understand the lenses, and how to operationalise them, are split into two categories; contextual and conceptual. The contextual category is based on studies about the Randstad region, together with visions and strategies carried out by governmental authorities. The conceptual category focuses on scientific literature that defines the lenses and explores their potential to operationalise them within a spatial design.
Together, the lenses and their supporting theories are used to deepen the understanding of the projects nexus. The nexus includes socio-environmental risk, integrated landscape management and water risk management. The scope and relevance of these themes are elaborated in the previous subchapter.

Given that the nexus of the project touches relevant and sensitive topics that is much discussed in todays Dutch politics, a thorough study into the contextual theory is essential. This will ensure that the project remains both informed and relevant to Randstads current societal and institutional challenges.

Applying the lenses, together with both contextual and conceptual theory, will ensure the project to find an adaptive and sustainable perspective on the future spatial configuration of the Randstad region. A well-elaborated application and operationalisation of these lenses can increase the systems capabilities to face unpredictable futures.

Critical Zones
Critical Zones argues that right now is a critical moment to re-evaluate how we think about the planet. Our current way of living fails to account for the complex interactions between human activities and Earth systems. Critical Zone is a concept that emphasises to focus on the thin layer of the planet where biological, geological, climatic and human processes intersect. It is an approach where climate change should be understood not merely as an issue deeply intertwined with social systems, values, identities and collective decision-making (Latour, 2020).

Bioregionalism
Bioregionalism is a planning approach that considers natural features of specific regions as the base for political and economic systems. It states that natural (eco)systems and cultural contexts should dictate, or at least influence, how humans inhabit territories in relationship with the capacities and limitations of the natural environment (Wearne et al., 2023). Furthermore, bioregionalism seeks to tackle the unfair allocation of resources that modern economic systems pose on both the environment and local communities (Bove, 2021).
Bioregionalism promotes the organisation human communities within naturally defined units, called bioregions. Bioregions are a central part in the concept and are described as specific geographic areas, categorised based on their unique spatial and ecological characteristics. Such as particular types of soil, watershed systems, climate conditions, and the native flora and fauna found within them (Wearne et al., 2023).

Urban Hydrosocial Cycle
The hydrosocial cycle is a concept that captures the entanglement of water systems and socio-political dynamics. It highlights the fundamentally politicised nature of water management (Budds et al., 2014). The hydrosocial cycle is seen as a process in which water and society make and remake each other repeatedly over space and time. By integrating both socio-political and biophysical processes, the hydrosocial cycle reframes social and ecological outcomes as effects of human power relations embedded in our water systems (Budds et al., 2014).
This project will look through the lens of the 'urban hydrosocial cycle', emphasising the influence the social cycle had, and still has, in urban development. Highlighting how each (technological) water development changed urban configurations. Using the concept as a way to understand urban changes over time, and looking in what way humans can change again, to adapt to future water-related challenges.

6.2.4 Conceptual framework

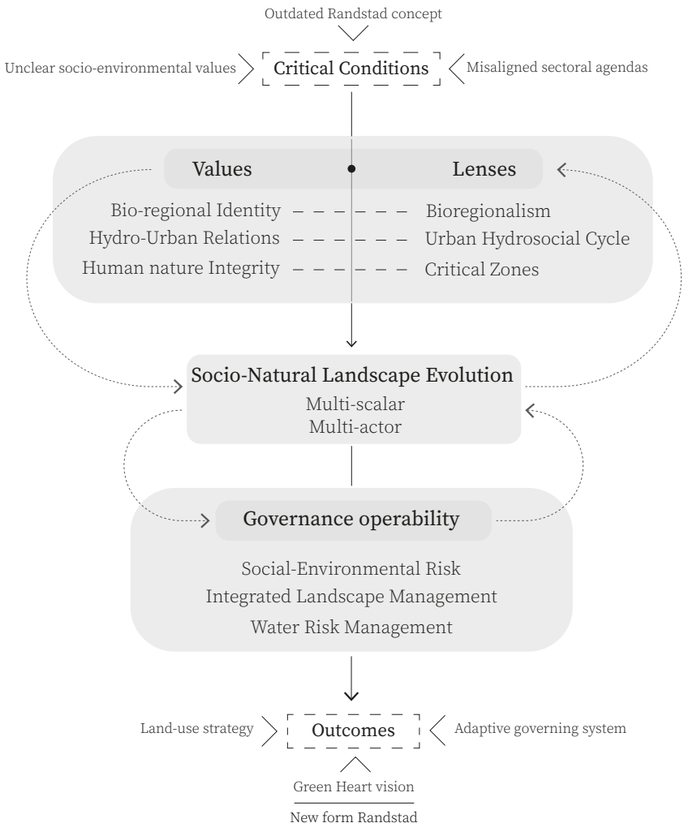


Figure 54: conceptual framework (By author)

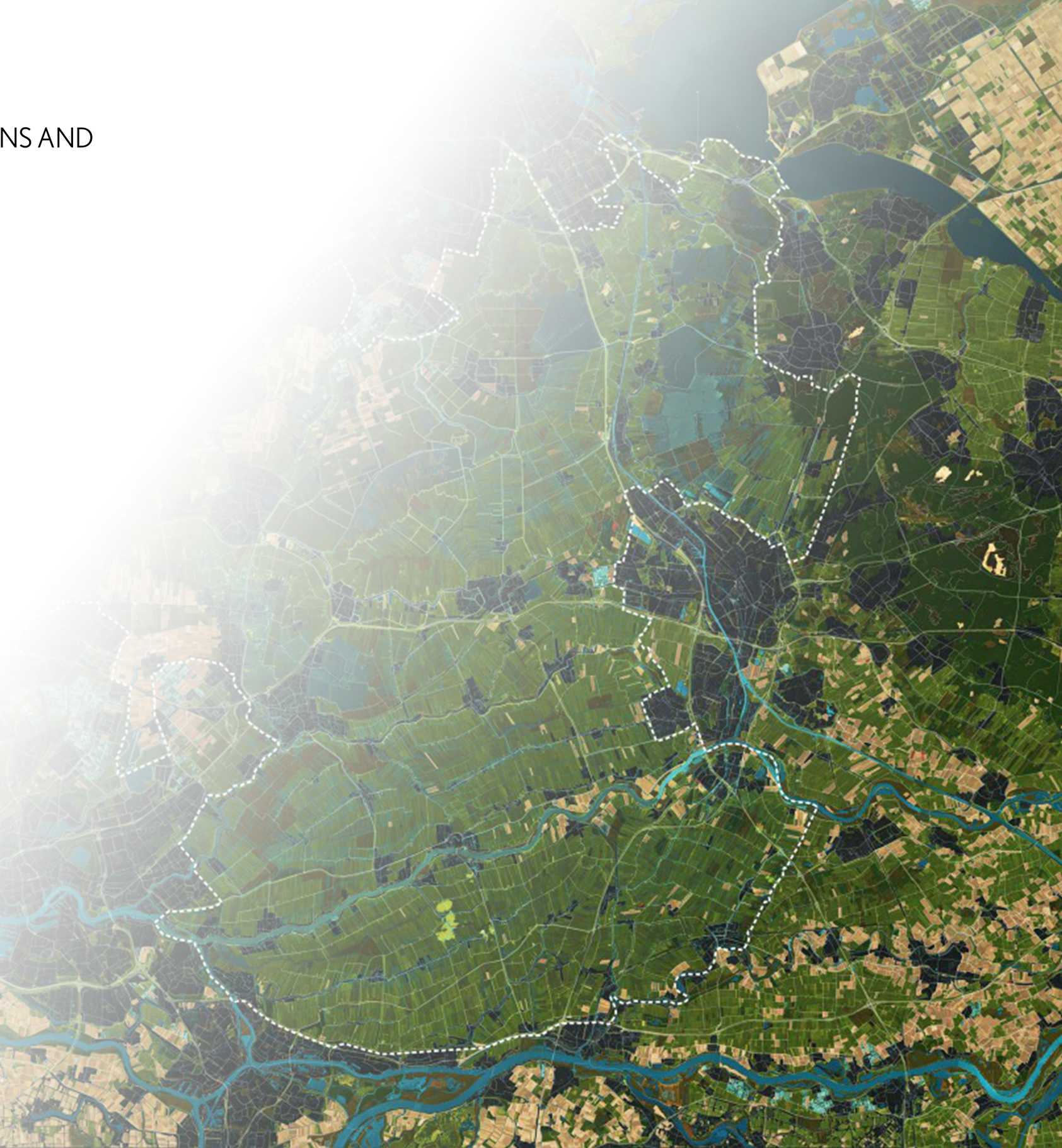
The project its conceptual framework consists of two cycles. Before entering the first cycle, it is essential to establish a good understanding of the critical conditions of the concerned region, the Randstad.

The first cycle explains how the socio-natural landscape evolution can take place if the values, and corresponding lenses, of the desired environment are clear and used as a guide through the design process. This cycle can go round multiple times, making the design proposal more specific every time. 'Research by design' is the main principle of this cycle, where analytical insight and spatial experimentation inform each other.

The second cycle focuses on translating the proposed landscape evolution into a feasible governing structure, addressing authorial and organisational conditions that are required to support the envisioned transformation.

If the two cycles are integrated rightfully, the outcomes of the project will be both conceptually robust and operationally grounded, supporting a realistic pathway towards a sustainable long-term spatial transformation.

7. SIGNIFICANT DELTAMETROPOLE VISIONS AND STRATEGIES



Perspective 2121: land met een plan
Kuiper Compagnons

Land met een plan is an initiative by Kuiper Compagnons to explore the future within the challenges that the future holds for the Netherlands.
The plan proposes a vision that is carefully designed with nature. It looked to find international connections and nature is seen as an asset to soften environmental challenges (KuiperCompagnons, n.d.).
Though, three newly proposed typologies in the Dutch urban landscape stand out the most. These typologies come with different type of housing models and are combined with a vision for green structures (Land Met Een Plan, n.d.) :

1. Kantstad: located on the east side of the nowadays Randstad, people live in small and medium-sized cities within green environments.
2. Duinstad: located along the coastline, cities are formed behind strengthened coastline with higher dunes.
3. Blue Heart: the Green Heart becomes the Blue Heart. Giving more space to water inside this region, as low-lying polders cannot be kept dry forever.

Furthermore, this vision is not shy to take drastic measures. As it proposes that Schiphol Airport will be moved to the North Sea. And the North Sea itself becomes an important region for energy production (Land Met Een Plan, n.d.).

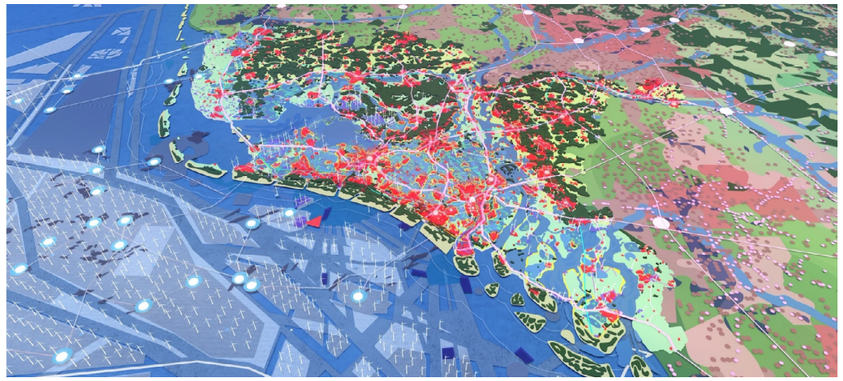


Image 5 : vision NL 2121 (KuiperCompagnons, n.d.)

Note Ruimte 2025
Ministry of Housing and Spatial Planning

The Nota Ruimte is the Dutch government's long-term vision for the spatial planning of the Netherlands. It was presented in September 2025 and serves as a guide for spatial planning decisions relating to housing, nature, water and soil themes. But also other themes such as work, energy and agriculture (Ministry of the Interior and Kingdom Relations, 2025).

As the government states in the introduction of the Nota Ruimte, the government is reassuming national control over spatial planning and the organisation of the physical environment. Making coherent spatial choices stands central. In doing so, the Nota Ruimte sets the direction for spatial development in the Netherlands, with the ultimate aim of achieving an optimal balance between protecting and utilising our physical environment (Ministry of Housing and Spatial Planning, 2025).

Despite that the Nota Ruimte gives a coherent story on how to tackle several important challenges in the Netherlands. The vision is aimed to work on the national, daily urban system scale. And even on this scale, the Nota Ruimte is quiet about the formation of metropoles on both Wings in the Netherlands. Furthermore, a natural system that fits the future climate conditions in 2100 isn't included in the Nota Ruimte.
Making a vision for the Randstad / Green Heart that includes, both the bigger scale (Eurodelta-Metropolis) and a natural system that fits the future climate, could enrich the story of the Randstad region.

Image 6: vision 2050 (Ministry of Housing and Spatial Planning, 2025).

National Delta Program 2026
Deltares

The Dutch government has set a leading strategy to help authorities through all the scales with their decision-making, the National Delta Program 2026. In this program, three main challenges for the county are discussed.

The first topic is about **water safety concerning flood protection**. The goal here is that every Dutch citizen has a basic level of flood protection by 2050 (Deltaprogramma, 2025). With basic flood protection is meant that the chance of big casualties and big economic harm is as low as possible. To reach this goal, more money is given to strengthen dikes, more sand is saved for coastal maintenance and river zones area widened (Deltaprogramma, 2025).
The second goal concerns the **fresh water availability** task, where more fresh water shortages are expected. The main goal here is to find a balance between the distribution of fresh water along all sectors. Also, the execution of measurements need to be prioritised, as a lot of planned measurements have been delayed (Deltaprogramma, 2025).
The last goal concerns **spatial adaptation to a climate-proof future**. More space for green and blue is desired to make our living environment more healthy and climate-proof. Also here, a balance must be found between the use of natural systems, taking artificial measures and accepting damage (Deltaprogramma, 2025). Figure 55 shows how far the government says their progress is in achieving these goals.

To help all involved authorities achieving the goals and tasks set by the Dutch government, knowledge institute Deltares updated their four deltascenarios about what the future of the Netherlands could possibly look like in 2050 and beyond.
The deltascenarios describe future scenarios regarding climate change and socio-economic developments that will take place in the Netherlands. Doubtful developments were made quantifiable to analyse possible hurdles and come up with long-term strategies (Deltares, 2024).
The four scenarios are Steam, Warm, Quick and Spacious, and are set on a scheme with 'socio-economic growth' and 'climate change and emissions of the Netherlands' on both axis. This can be seen in figure 56.

Figure 55: progress of achieving three tasks in the Deltaprogram 2026 (Deltaprogramma, 2025)

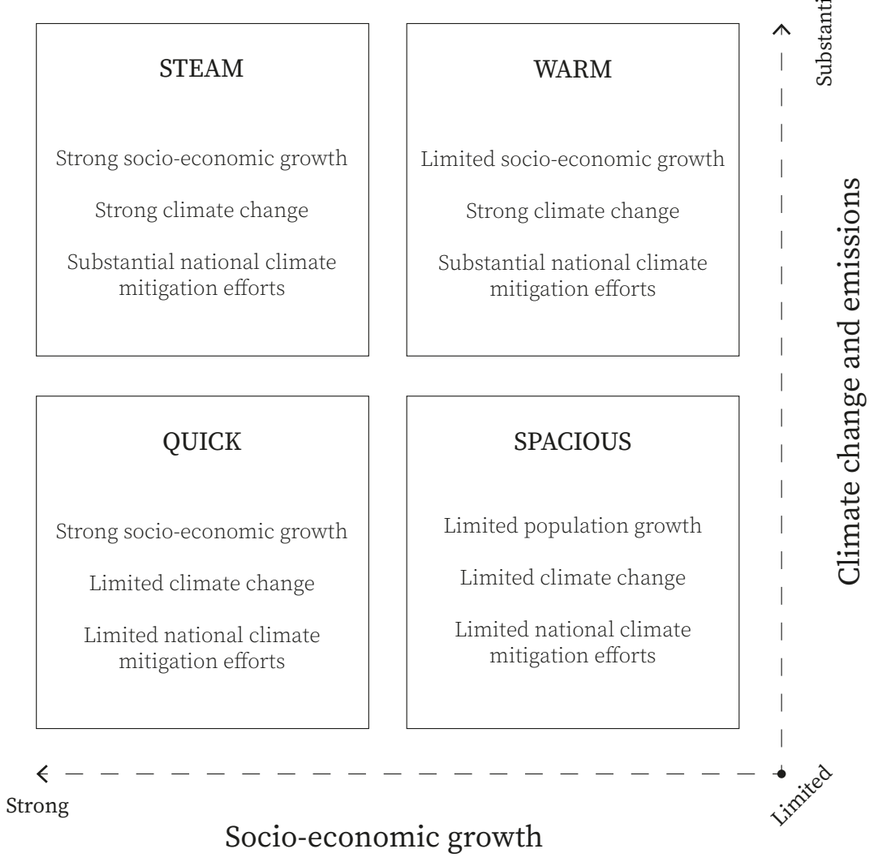


Figure 56: four deltescenarios and their main characteristics (By author based on Deltares, 2024)

8. DESIGN - BIOREGIONAL CHARACTERISTICS

8.1 Defining bioregions

In the Randstad region, three bioregions can be identified; Central-Holland, Rijnmond-Drechtsteden and the Coastline. These regions are also named in the Deltaprogram. Bioregions are described as specific geographic areas, categorised based on their unique spatial and ecological characteristics. Such as particular types of soil, watershed systems, climate conditions, and the native flora and fauna found within them (Wearne et al., 2023). In this project, another layer is added to the definition of bioregions. As natural decay is seen as a hybrid of natural processes and human pressures. Socio-environmental complexities also contributed to the clasification of bioregions.
The bioregions cover different parts of the Randstad / Green Heart. Apart from the fact that these regions faces unique challenges and risks, it is essential that these bioregions are planned together in an integral process. In all bioregions, the gradual weakening of natural foundations of the landscape can be seen. And in each region, the key and most prominant type of decay can be specified;

- The Coastline: loss of dune systems
- Central-Holland: loss of a historic landscape
- Rijnmond-Drechtsteden: loss of water stability

This chapter will look deeper into the signs of degradation, and possible ways on how to tackle them when their natural territory is taken into account.

Figure 57: Location of each bioregion (By author)

8.2 The Coastline
Understanding

The coastline region is the Dutch first natural flood barrier against rising sea levels. In this region, water safety stands central. This is because a lot of coastal towns lay below sea level and are sensitive to soil subsidence. The coastline region is a zone with great values in ecological, economic and infrastructural matters. That is why there must be taken care that nature, recreation and biodiversity. The coastal zone, including its towns and ports, need particular attention and reconsideration, as also this area is urbanising. It is important that they grow along with the changing nature and water conditions (Deltaprogramma, 2025).

Natural processes along the Dutch coastline are no longer in balance. They are increasingly amplified and disrupted by human activities. Although a majority of people would think that the coastline is a natural landscape, it's a highly artificially managed system that would gradually erode without constant human interventions in reality.
In the Coastline bioregion, three main types of natural decay can be identified. They will be explained on the next page.

Image 7: Coastal town Katwijk aan Zee (LogerenAanZee, 2025)

Image 8: Artificial sand replenishment to prevent coastal erosion (Ingenieur, 2025)

Figure 58: Basemap Coastline (By author)

Decay

Coastal erosion

Coastal erosion remains an ongoing challenge, as wind, waves, and currents constantly reshape the coastline, resulting in retreating dune fronts, and the exposure of older dune layers and root systems. This process is intensified by an imbalance between sand supply and sand loss, caused by human disruptions like harbour-, dredging- and coastal engineering activities. As a result, the Dutch coastline has become dependent on artificial sand nourishment to maintain its current form.

Pressure on dune systems

Dune systems are under increasing pressure. Dunes are not just large sandpiles that protect us from the sea, they function as dynamic living ecosystems. Yet, dune systems are experiencing degradation through the loss of (native) vegetation due to trampling and urbanisation.

Biodiversity fragmentation

Biodiversity fragmentation in coastal zones is increasing. Intensive tourism, urban development, and infrastructure create habitat fragmentation, disturb bird nesting areas, and reduce the ecological resilience of coastal ecosystems. With 66 percent of all Dutch plant species living in this region, the coastline is a vital living area for both flora and fauna. Though, this is also being maintained artificially. Plants who don't historically belong in the dune landscapes are being removed, while new plants and trees are being planted by humans to stimulate the biodiversity.

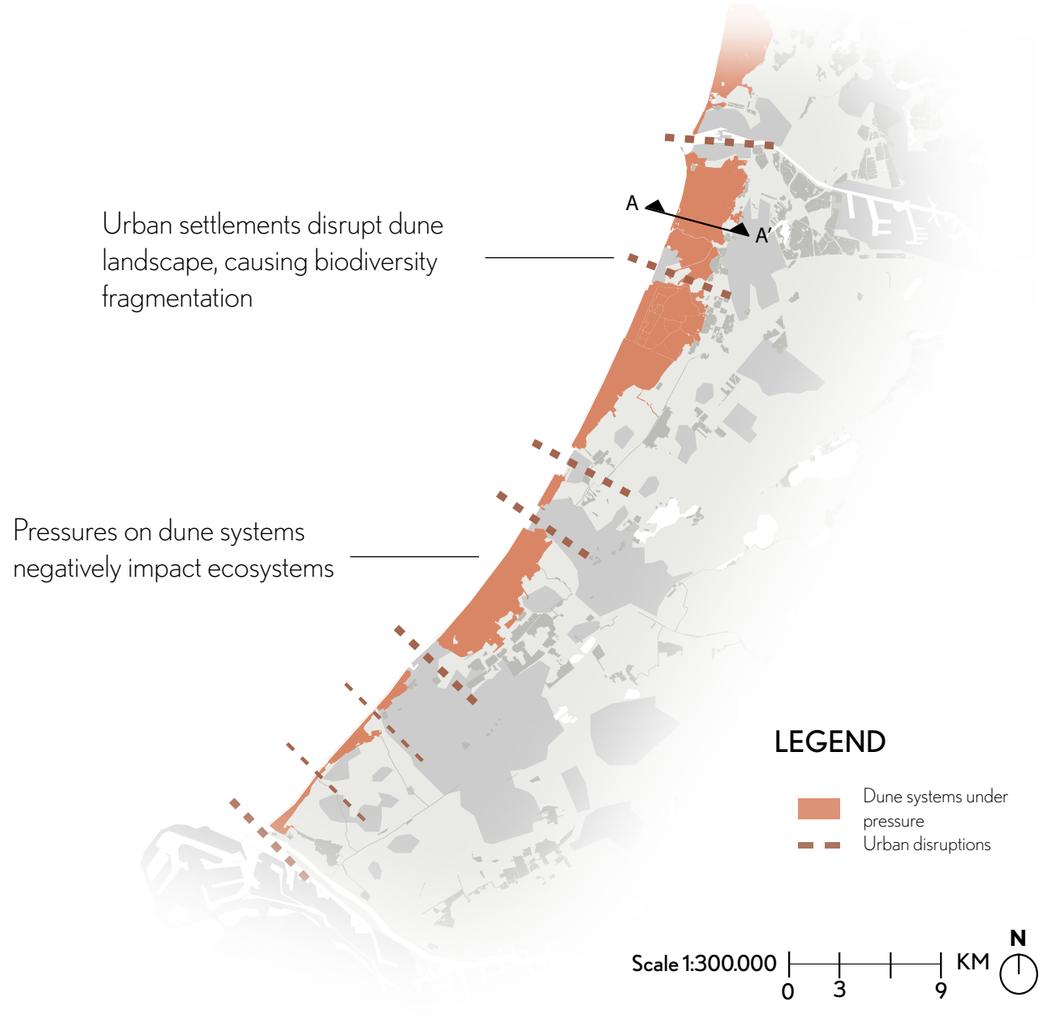
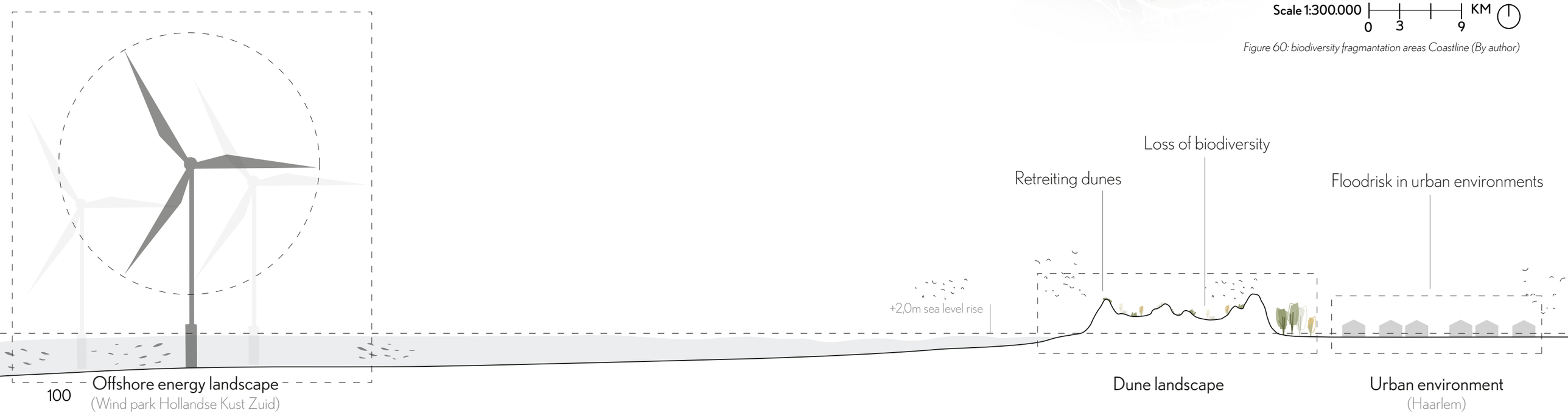


Figure 60: biodiversity fragmantation areas Coastline (By author)

Figure 59: Section natural decay Coastline (By author)



Doom scenario

The doom scenario of the Coastline bioregion occurs when rising sealevels become so high, and weather becomes extremer due to climate change, that the dunes fail to protect the region from floodings and large parts of the bioregion become flooded.

Figure 61: Doomscenario Coastline (By author)

Guidelines

To improve the long-term human-nature fellowship in this bioregion, interventions are needed to address both environmental degradation and ecological fragmentation. Softening the transition between the built environment and natural landscapes can reduce ecological fragmentation. Restoring native flora and fauna is essential to improve biodiversity and strengthen ecosystem health of coastal landscapes.

GREEN

XL -
L All dune areas should be (re)connected to form ecological corridors and **restore regional flora and fauna**
M More projects to restore the dunes, like 'Zandmotor', should be set up to let nature take care of the sand supply and loss imbalance.
S Planting of native flora is highly encouraged to maintain a healthy landscape naturally.

URBAN

XL -
L Urbanisation in the bioregion should be **limited to none existing**.
L Actions should be made for existing coastal towns to be transformed into living environments that are **embedded in the natural structure of the coastline**. And if there are new projects ongoing or scheduled, they should be (re)planned in a way that they become part and **adapt to the coastal structure dynamics**.
M -
S -

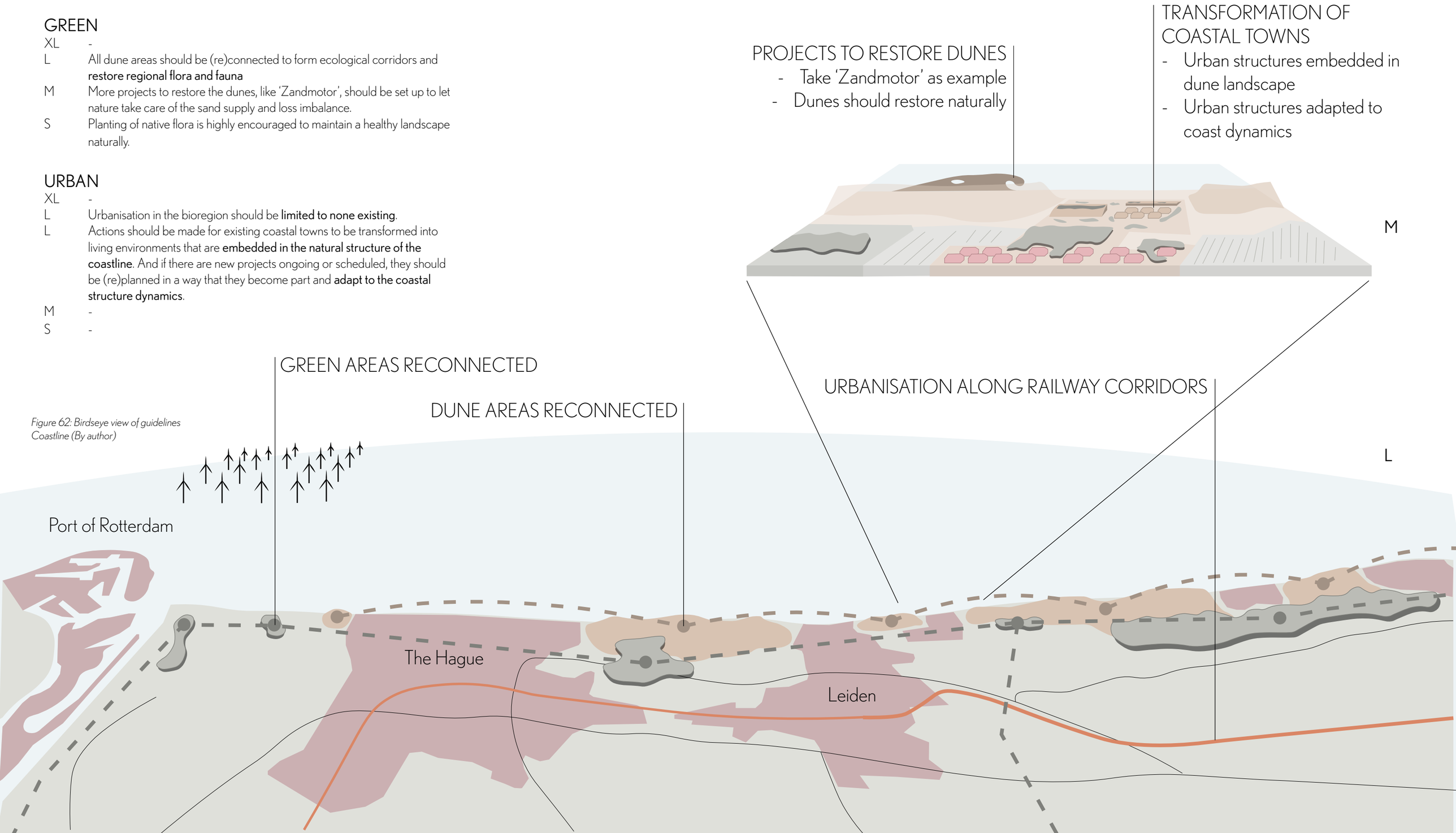


Figure 62: Birdseye view of guidelines Coastline (By author)

8.3 Rijnmond-Drechtsteden
Understanding

Rijnmond-Drechtsteden is focused on the demands of the Green Heart and MRDH. In Rijnmond-Drechtsteden, safety regarding flood risk stands central. Systemic measures regarding flood barriers and extra water storages are key for this region. In addition to this, authorities look at how the region can stay liveable when the sea level rises drastically (Deltaprogramma, 2025).

In Rijnmond-Drechtsteden, landscape decay is increasingly driven by growing water pressures. The types of natural decay in this bioregion will be explained on the next page.

Image 9: port of Rotterdam inside Rijnmond-Drechtsteden (NRC, 2024)

Image 10: high water level causing disturbance in Rotterdam (Lichting, 2024)

Figure 63: Basemap Rijnmond-Drechtsteden (By author)

Decay

Pressures on outer-dike areas

There are increasing pressures on outer-dike areas. In the region, large parts are dependent on extensive flood defence systems such as dikes. Though, outer-dike areas are not directly protected by primary flood defences. As a result, housing, infrastructure, and other spatial functions in these areas are becoming increasingly exposed to water related pressures like sea-level rise, river discharge peaks and storm surges. This points out the fragility of existing spatial water defence systems under intensifying natural forces.

Ecological instability

Hydrological pressures contribute to ecological instability, as changing water regimes and increasing salinisation threaten the resilience of both natural habitats and human-managed landscapes. Like in Central-Holland, fragmented habitats of flora and fauna, and interrupted ecological corridors can also be found in Rijnmond-Drechtsteden. Contributing to the loss of biodiversity in the region.

Though, unmanaged grasslands and old agricultural land are already naturalising at the edge towards the Biesbosch. In these areas, where human disturbances are limited, the natural transitioning towards its true delta landscape can already be seen.

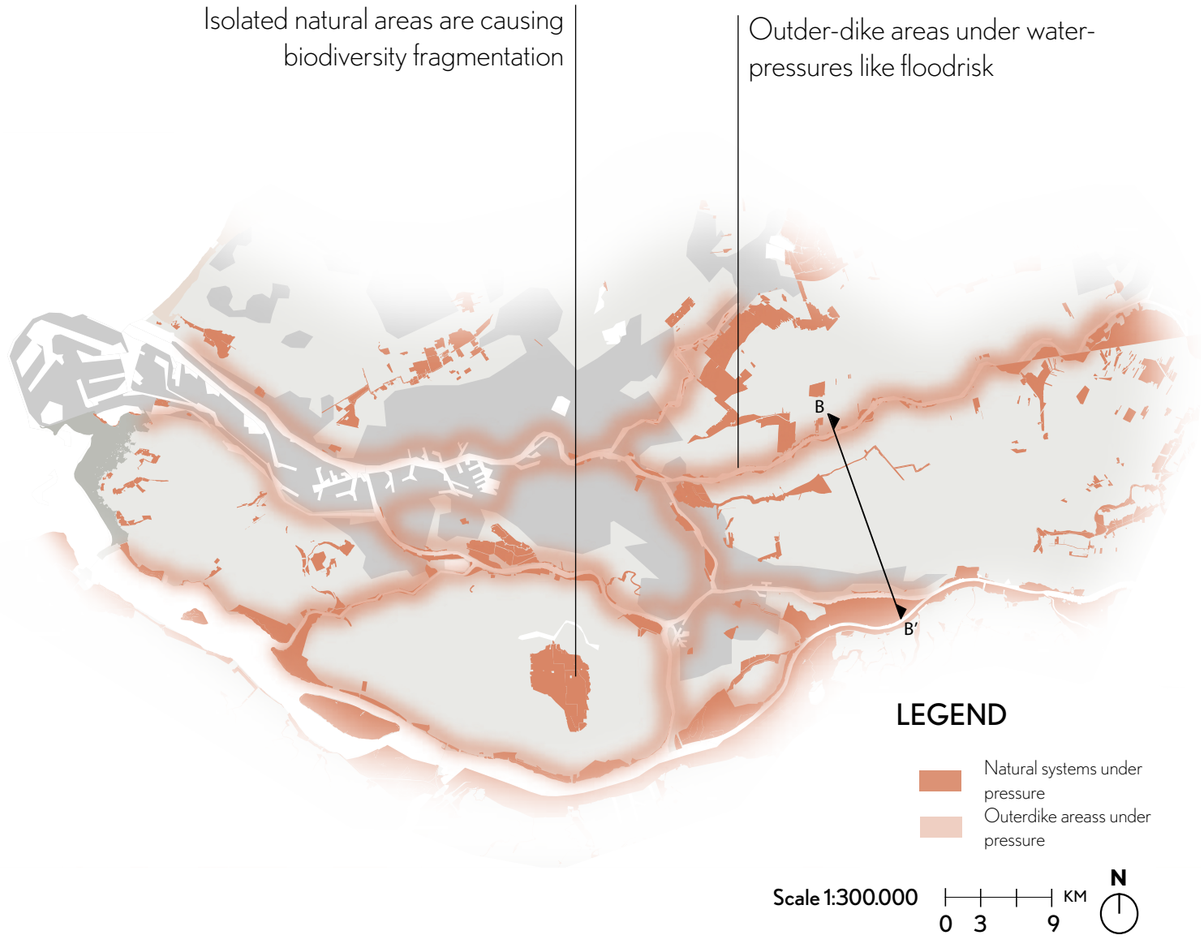
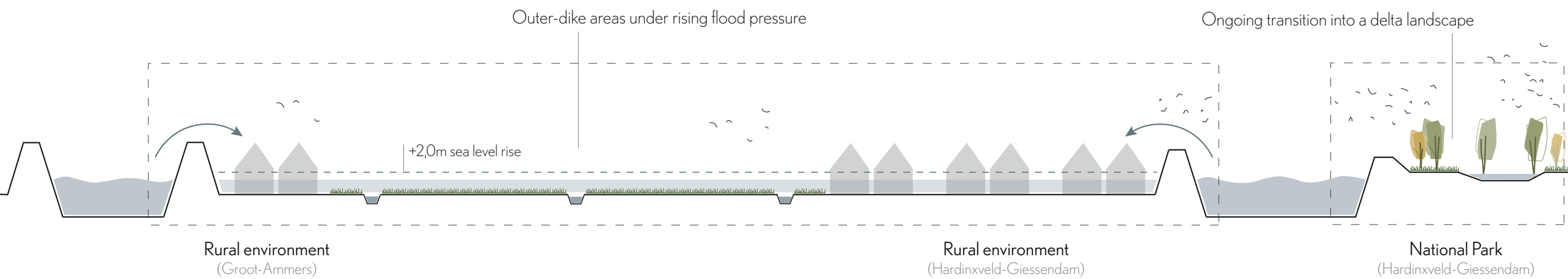


Figure 65: Natural decay map Rijnmond-Drechtsteden (By author)

Figure 64: Natural decay section Rijnmond-Drechtsteden (By author)



Doom scenario

The doom scenario of the Rijnmond-Drechtsteden bioregion occurs when rising sealevels become so high, and weather becomes extremer due to climate change, that dikes fail to protect the region from floodings and large parts of the bioregion become flooded.

Figure 66: Doomscenario Rijnmond-Drechtsteden (By author)

Room for the River Program

Room for the River is a program that works on a design for the river system that is ready for the future. They're looking to maintain a river basin where water can be safely drained, as due to climate change, high water levels will occur more frequently in future scenarios (Ministry of Infrastructure and Water Management, 2026).
Room for the River doesn't work individually, they work together with the Dutch government and other authorities to keep the river areas save (Ministry of Infrastructure and Water Management, 2026).
In their program, they've got three main type of measures they implement in the Rijnmond-Drechtsteden river region; dike widening, river foreland excavations and increasing the water storage of the region. The areas where they're looking to implement each can be seen in figure 67.

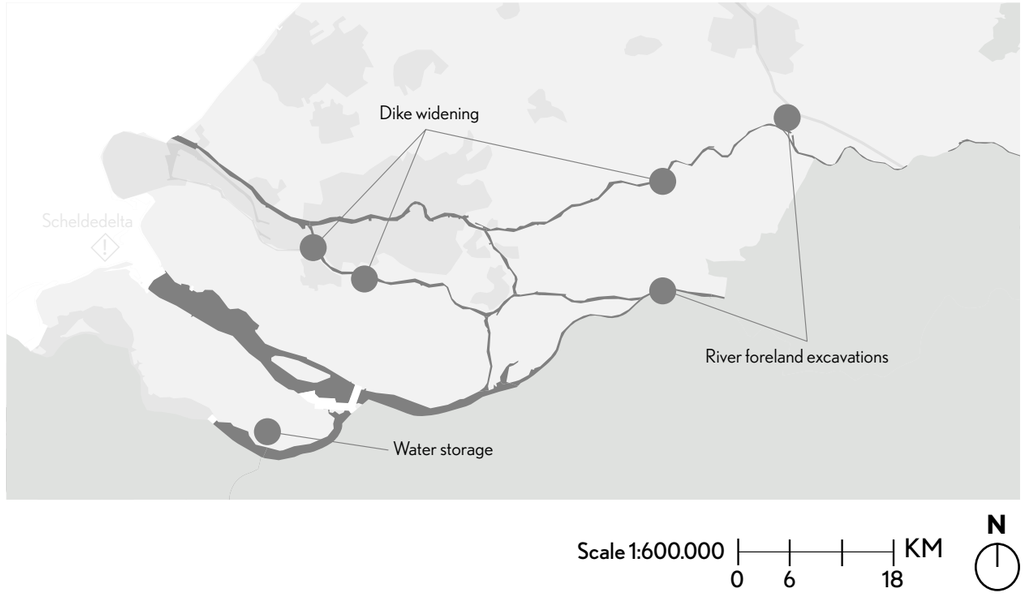


Figure 67: Room for the River measures (By author Based on Ministry of Infrastructure and Water Management, 2026).

Guidelines

To improve the long-term human-nature fellowship in this bioregion, interventions are needed to strengthen dikes and protect settlements from flood risks. The focus should be on outer-dike areas. At the same time, strengthening connections between existing green structures can help restore regional biodiversity.

BLUE

XL Foster the fish migration in the regions river system that flows into the North Sea.

L **Dike areas should be strengthened** to prevent floodings AND/OR minimise the impacts of them. Measures as dike widening, raising dike heights and river foreland excavations (like in the Room for the Rivers project) are interesting to implement.

M **Controlled overflow/flooding zones** in, for example in agricultural landscapes, could help to maintain a safe water level.

M Room for the River measures like more watere storage, dike widening and river foreland excavations must be given a place in the bioregion.

S -

GREEN

XL Use the Eurodelta scale green longlines to emphasise and connect main green structure in the region

L (Re)connect green structure more with each other to form ecological corridors and **restore regional flora and fauna**.

L Ecological corridors should preferably move along rivers/water bodies to improve biodiversity and the movement of species through the region.

M -

S When dikes are strengthened, **nature-based reinforcements** like vegetated forelands could help to create ecological value to dikes at the same time.

URBAN

XL The railway corridor towards Belgium becomes an important urbanisation zone.

L Critical car and train infrastructure should be limited AND/OR detoured to less flood vulnerable areas.

L Inner-city urban expansions should be the focus in the region. If there will be expanded outside these areas, it should be done with respect to the hydro-geomorphological environment. Especially its water related factors.

M Urban expansions in outer-dike areas should be limited. If there will be expanded in these areas, flood-resilient building typologies like stilt housing should be used to ensure safety when floodings occur.

S -

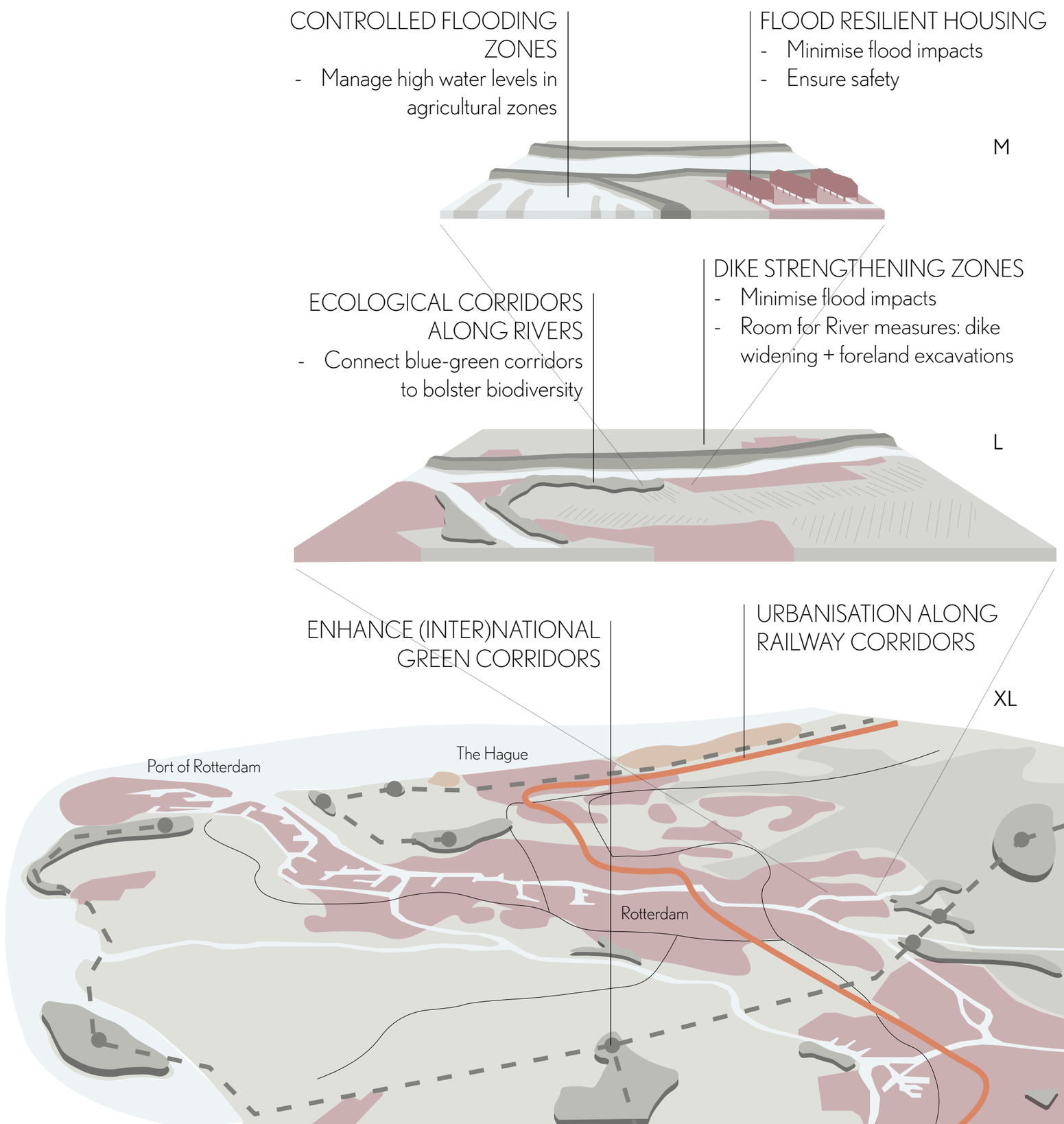


Figure 68: Birdseye view of guidelines Rijnmond-Drechtsteden (By author)

8.4 Central-Holland
Understanding

Central-Holland is focused on the demands of the Green Heart and MRA. The region has to deal with soil subsidence, sea level rising, water shortages, salinisation and extremer precipitation. That is why water and soil have a central role in planning and decision-making for this region, as the current system can't handle the future (spatial) demand regarding climate and housing (Deltaprogramma, 2025).
The approach for this region includes three themes; a robust water system, room for the river and a balance between spatial- and water systems. The desire for Central Holland is to become an unique urban region that is climate-proof, where it is key to move with the changing water- and soil systems (Deltaprogramma, 2025).
The western part of the bioregion will become higher urbanised than it already is, while the eastern part of the region will allow the greenstructures to maintain in the area.

In Central-Holland bioregion, three main types of natural decay can be identified. They will be explained on the next page.

Image 11: Dominant agricultural landscape in Green Heart (Gebiedsontwikkeling, 2023)

Image 12: Amsterdam-Rijnkanaal near Utrecht (Bunniknieuws, 2025)

Figure 69: Basemap Central-Holland (By author)

Decay

Peat oxidation

Peat oxidation is the core issue in Central-Holland. This is particularly the case within the Green Heart, where drained peat soils are exposed to oxygen and gradually decompose. This process leads to subsidence, resulting in a gradually lowering surface. This, together with rising sea levels, are causing that both natural processes reinforce each other in a self-amplifying cycle: drainage leads to oxidation, oxidation causes subsidence, and subsidence requires further drainage. Resulting in that the relative water level rise becomes extremer.

Pressures on biodiversity

Pressures on biodiversity are increasing in the region. Despite the Green Heart its green appearance, much of the landscape consists of grass monocultures with relatively low ecological value compared to other natural peat wetland systems. This has contributed to the decline of meadow bird populations and the loss of wetland plant diversity.

Historical landscape disappearance

The original landscape character is disappearing. Historically, Central Holland functioned as a wet, biodiverse peat wetland system, whereas today it has transformed into a highly managed agricultural landscape that depends on continuous human intervention to remain functional, especially in the Green Heart region.

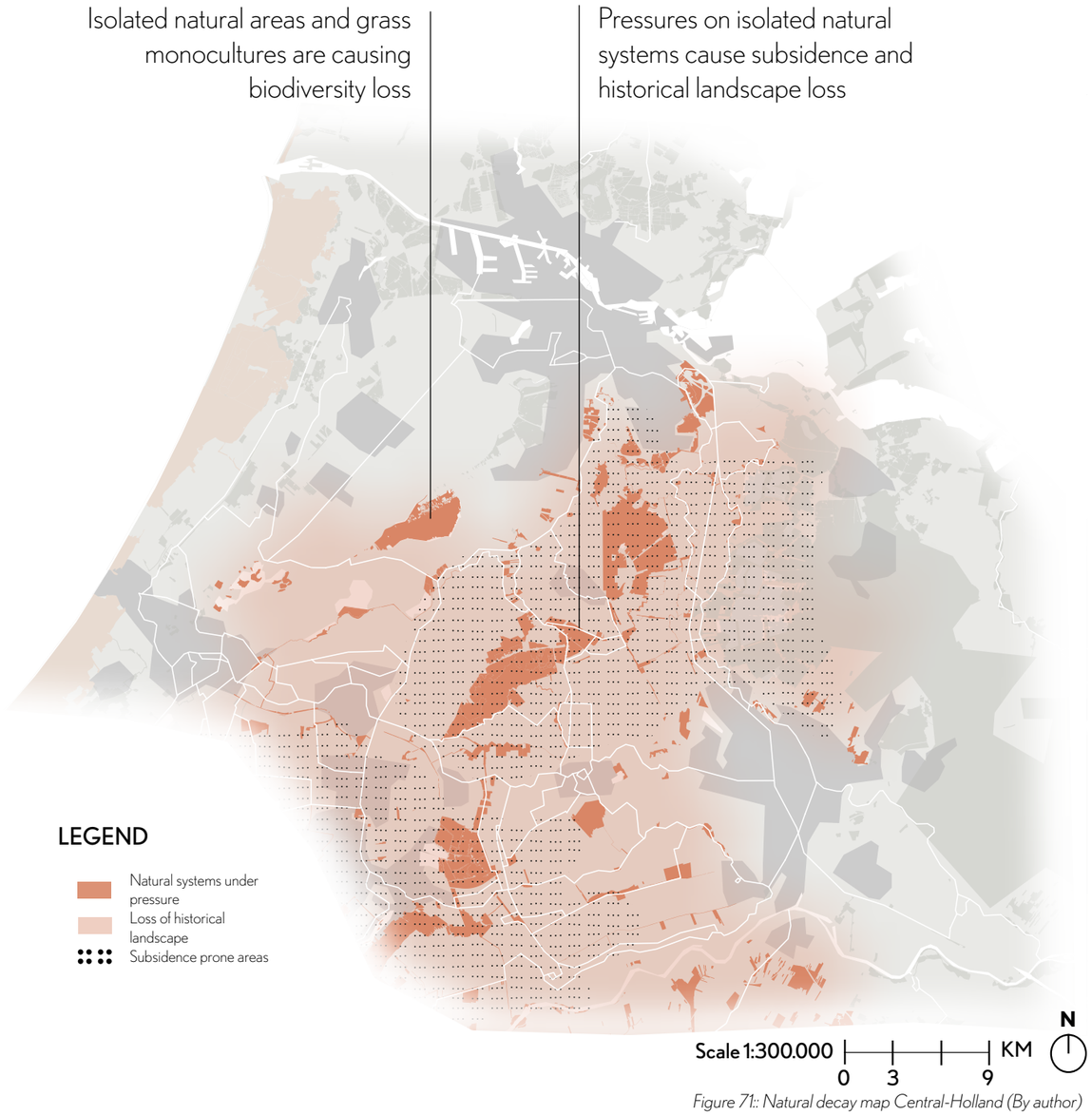


Figure 71:: Natural decay map Central-Holland (By author)

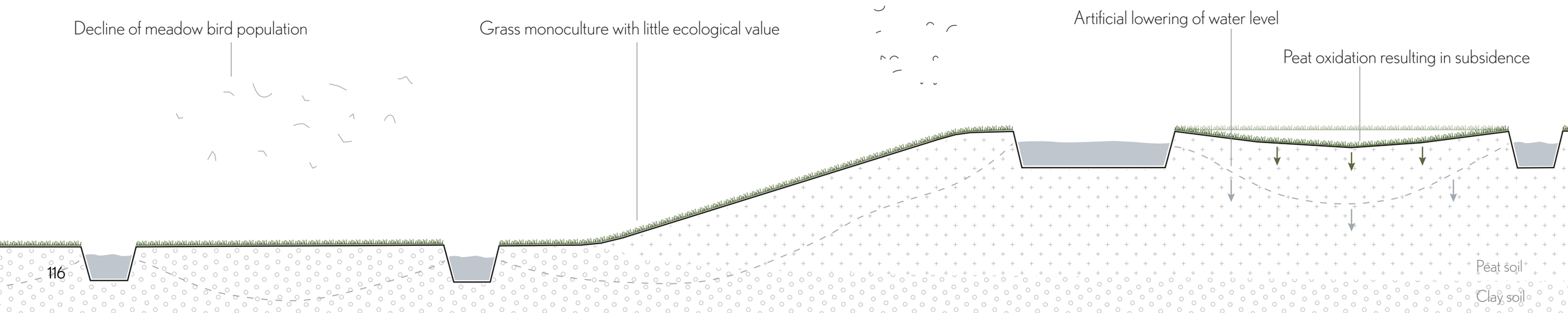


Figure 70: Natural decay section Central-Holland (By author)

Doom scenario

The doom scenario of the Central-Holland bioregion occurs when rising sealevels become so high, and weather becomes extremer due to climate change, that dikes fail to protect the region from floodings and large parts of the bioregion become flooded.

Figure 72:: Doomscenario Central-Holland (By author)

Guidelines

To improve the long-term human-nature fellowship in this bioregion, interventions are needed to address both environmental degradation and ecological fragmentation. Reducing subsidence and peat oxidation is essential to slow down landscape decline and limit the ongoing loss of soil quality. At the same time, strengthening connections between existing green structures can help restore regional biodiversity.

BLUE

XL -

L **Water logging** should be a regional-wide tool used to reduce subsidence and peat oxidation. This could be used to connect blue-green areas. Furthermore, the historic swamp-like landscape of the region could also be restored in specific parts of the region.

M **Controlled overflow/flooding zones,** for example in agricultural landscapes, could help to maintain a safe water level.

M Room for the River measures like more watere storage, dike widening and river foreland excavations must be given a place in the bioregion.

S -

GREEN

XL Use the Eurodelta scale green longlines to **emphasise and connect main green structure** in the region.

L (Re)connect isolated green structure more with each other to form ecological corridors and **restore regional flora and fauna**.

M Where **swamp zones** are created, ecological corridors should go through them to improve biodiversity and the movement of species through the region.

S Planting of native flora is highly encouraged to maintain a healthy landscape naturally.

URBAN

XL The railway corridor towards Belgium and Germany becomes an important urbanisation zone.

L Critical car and train infrastructure should be limited AND/OR detoured to less flood and subsidence vulnerable areas.

L **Little to none urban development** is allowed in **subsidence-prone areas**. If there is built in these areas, they should be planned together and in line with the hydro-geomorphological environment, especially the green environment.

M **Stilt AND/OR amphibious building typologies** could help to build in areas that are prone to floodings.

S -

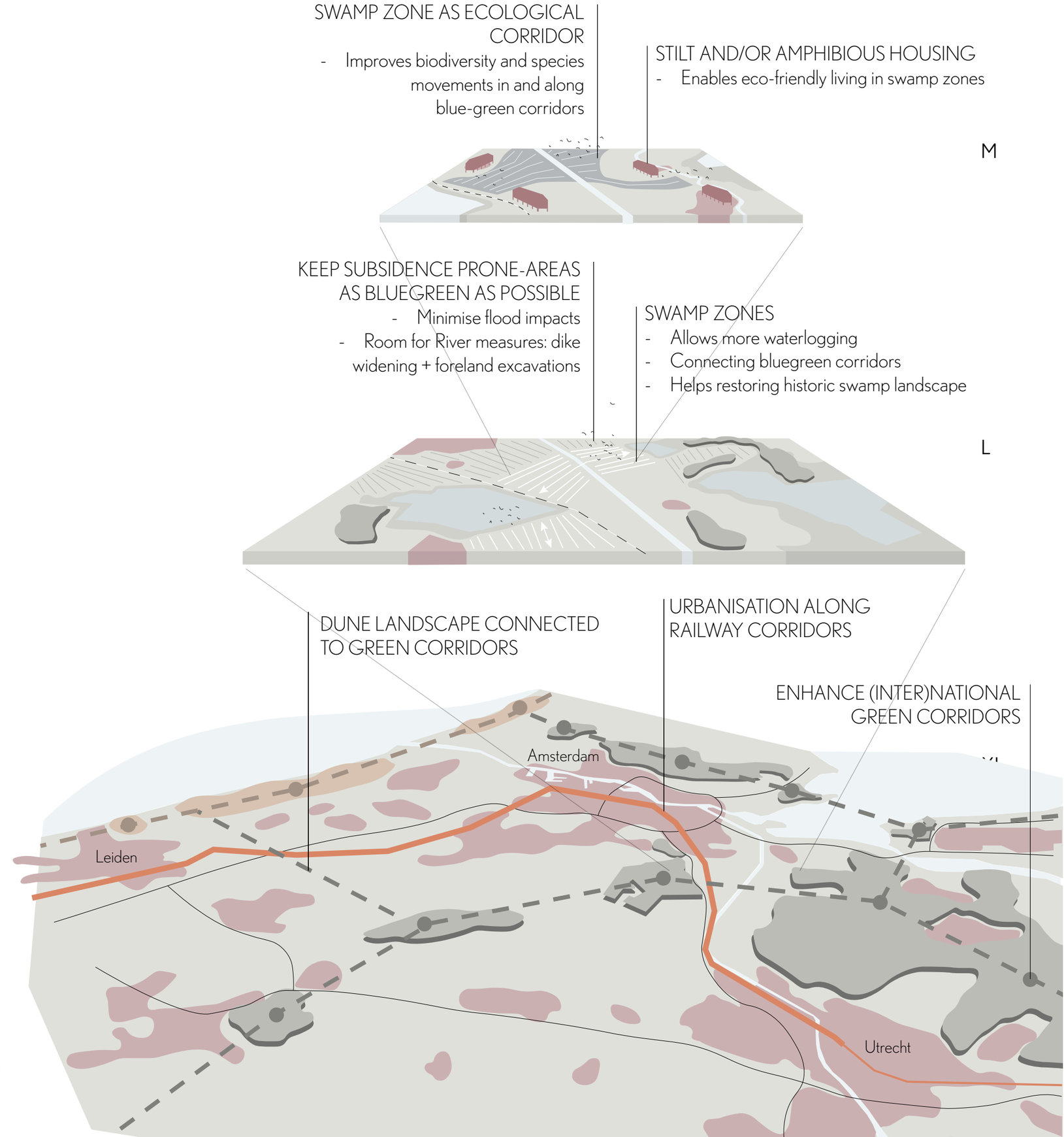


Figure 73:: Birdseye view of guidelines Central-Holland (By author)

9. DESIGN - RANDSTAD LEVEL

9.1 Delta risk strategy and scenarios

Now that the bioregional characteristics and demands are clear, it is important to understand what they imply for a future spatial plan of the Randstad at a larger scale. The Delta Scenarios from Deltares' Delta Programme 2026 are going to help with that. This project focuses on two of the four deltascenarios: the Warm and Quick scenarios.

These scenarios are selected because they represent two extreme conditions in terms of urbanisation and blue-green development, allowing the project to explore a broad range of possible spatial futures for the Randstad.
The quick scenario presumes that there will be a strong socio-economic growth, this is paired with strong population growth. Furthermore, it presumes that there will be limited climate mitigation efforts. So this scenario will focus on strong urban developments.
The warm scenario is the other way around, where it presumes that there will be limited socio-economic growth and strong climate mitigation efforts. So this scenario will focus on bolstering the blue-green network.

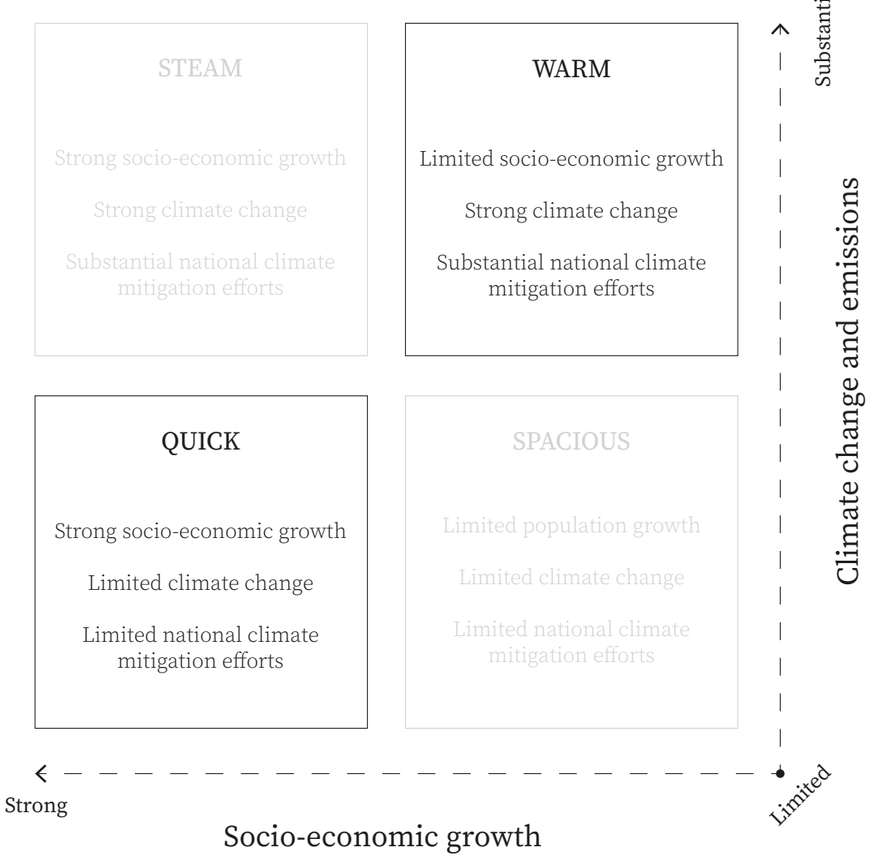


Figure 74: four deltescenarios and their main characteristics (By author based on Deltares, 2024)

A short overview about what is presumed in each scenario.

QUICK SCENARIO

Climate change
- Temperature rise stays limited to 1,7 degrees Celsius. After 2050, climate change reduces. Climatological differences between 2050 and 2100 are minor.
- Sea level will rise ca. 24 cm in 2050, and ca. 44 cm in 2100.

Socio-economic developments
- Dutch population grows to 20,7 million residents in 2050. Economy grows, leading to a further expansion of urban areas. This will be at the expense of agricultural land.
- Forming new natural areas is not a priority.
- The shipping sector benefits from the economic growth, resulting in the increase of the transportation of goods.

Water challenges
- Water challenges will increase until 2050.
- Heavy rainfalls will result in that urban areas will have to deal with more water overflow.

WARM SCENARIO

Climate change
- Temperature has risen with 1,7-2 degrees Celsius in 2050, and with 4,7-5,1 degrees in 2100.
- Sealevel rise not mentioned

Socio-economic developments
- Dutch population will decline to 17,9 million residents in 2050.
- The natural network will expand.

Water challenges
- Water challenges will increase until 2050 and beyond.
- Heavy rainfalls will result in that urban areas will have to deal with more water overflow.

A more detailed explanation of all deltascenarios can be found in appendix 1.

9.2 Deltascenario: Quick

This scenario prioritises the strengthening of the Randstad's urban structure as the foundation for future spatial development.
The high level of population growth drives the North and South Wing to slightly integrate more with each other. Particularly along its western side, where the MRA and MRDH expand toward one another, reinforcing the Randstad's western metropolitan axis. The MRU also experiences growth, though more concentrated in already urbanised areas. Which makes this region a comparatively greener region on the eastern side of the Randstad. Despite the green and urban differences, the MRA and MRU connections will become stronger, reinforcing the North Wing.

The strong population growth will lead to a more urbanised of the Green Heart. Different bioregional characters inside the Green Heart will lead to different typologies inside urbanisation areas. For example in Rijnmond-Drechtsteden, there will be more flood-resilient typologies, while more amphibious typologies in Central-Holland will allow urbanisation to take place.
As a result of this, the traditional separation between urban and rural landscapes will become less pronounced, particularly in areas with strong infrastructural accessibility. As urban expansion will be primarily concentrated along railway corridors, strengthening regional connectivity and accessibility.

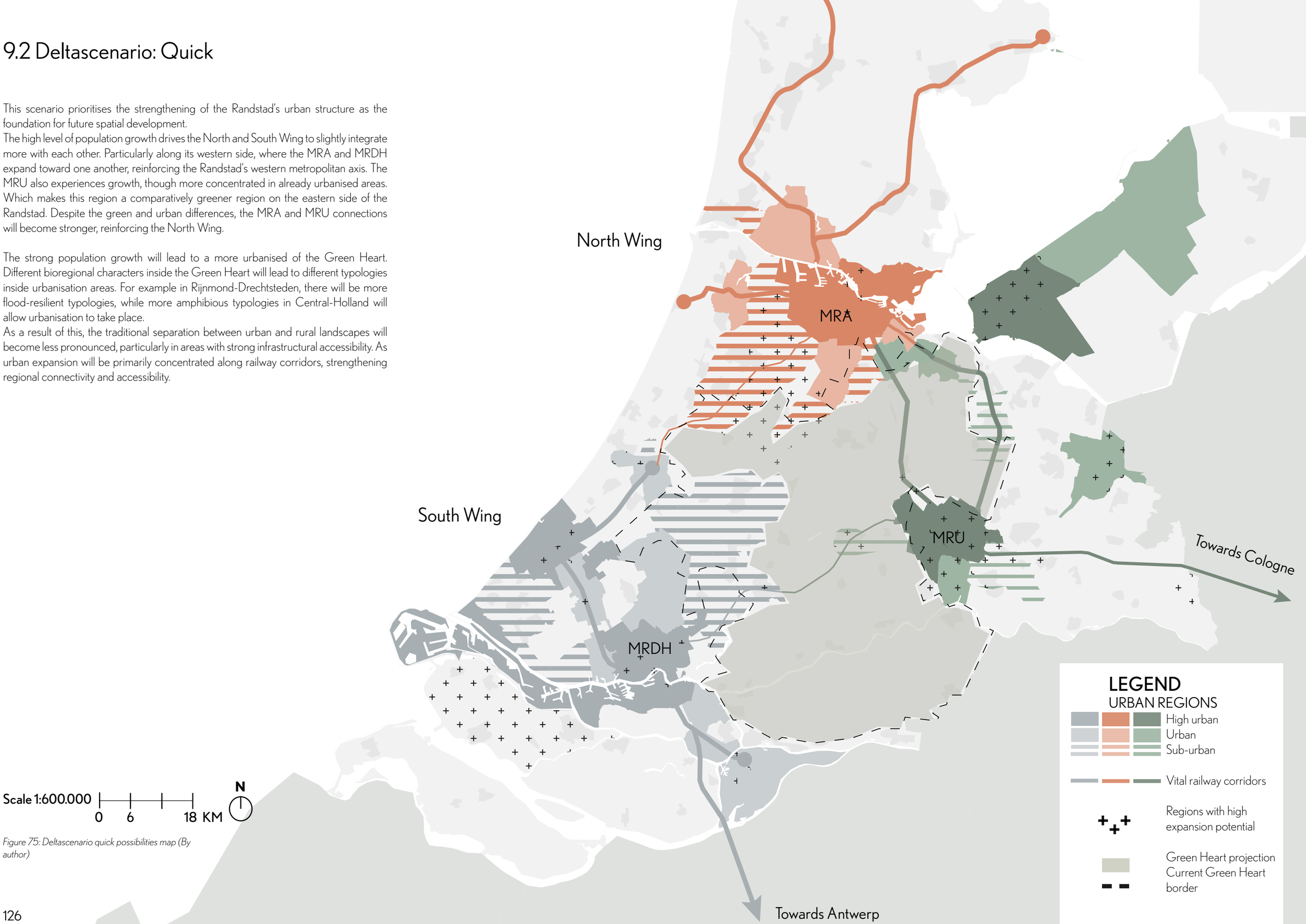


Figure 75: Deltascenario quick possibilities map (By author)

9.3 Deltascenario: Warm

This scenario prioritises the strengthening of the Randstad's blue-green structure as the foundation for future spatial development.
The Biesbosch, Utrechtse Heuvelrug, Veluwe, Nieuw Land and dune landscapes will be the most important ecological landscapes. Stronger and more robust landscape longlines connect these natural areas. These lines will form the backbone of a bolstered ecological network.
In the Rijnmond-Drechtsteden region, additional space can be created for Room for the River zones, reinforcing ecological processes along river corridors and improving the relationship between water management and the green longlines.

In this scenario, currently fragmented and isolated green areas within the Randstad will form a singular interconnected ecological system. By strengthening links between natural landscapes, ecological networks become more resilient, creating conditions in which biodiversity and natural systems can thrive across the region.

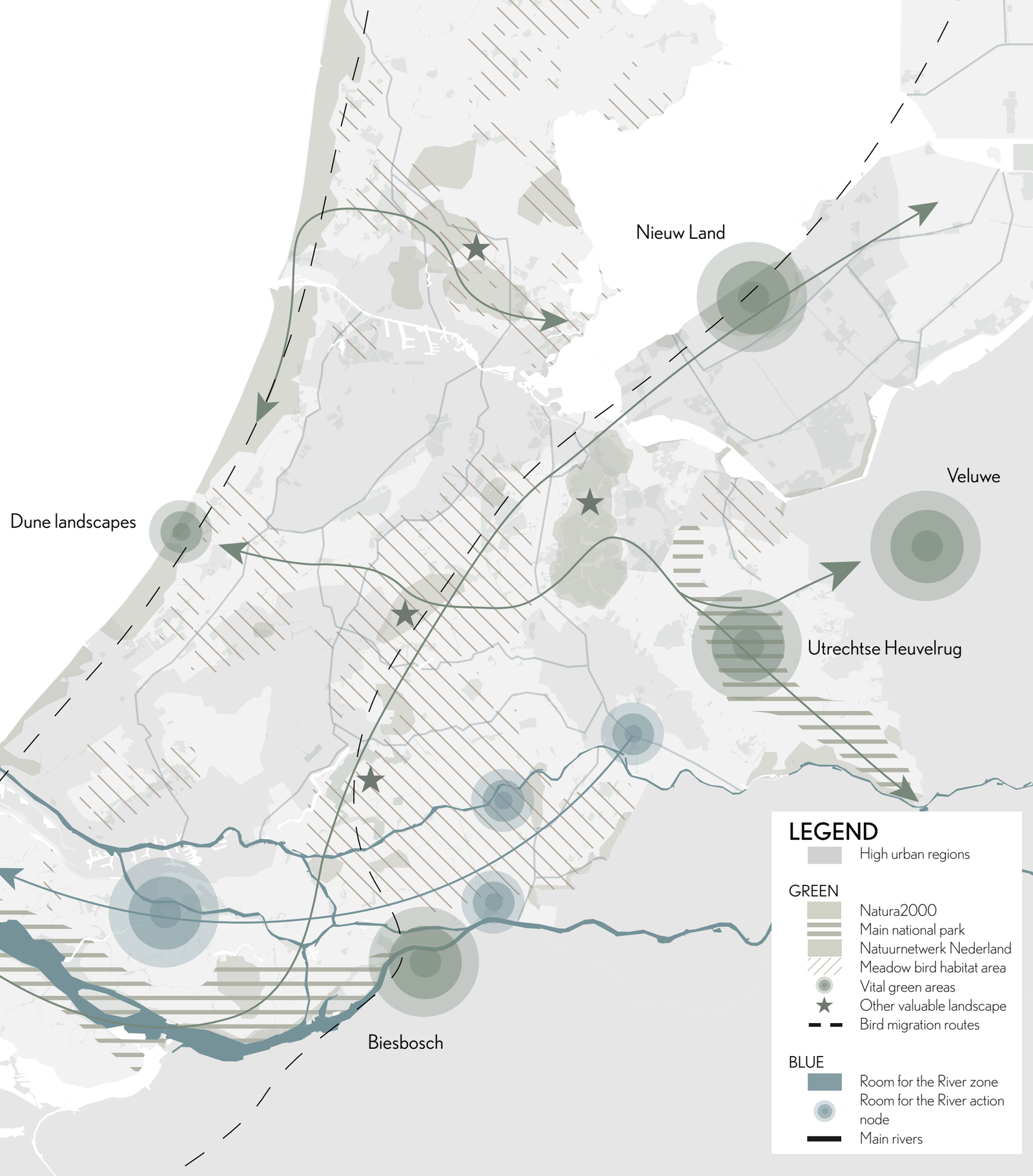


Figure 76: Deltascenario Warm possibilities map (By author)

9.4 Deltascenarios compared

East vs West diferences

Looking at both visions, an high urbanised (red) side and a lower urbanised (green) side can be distinguished. The main border between both sides is the imaginary vertical line that was found earlier in chapter 5.
In the western side, the MRA and MRDH will grow towards each other. While on the eastern side, green structures could still remain more dominant over urbanised regions.

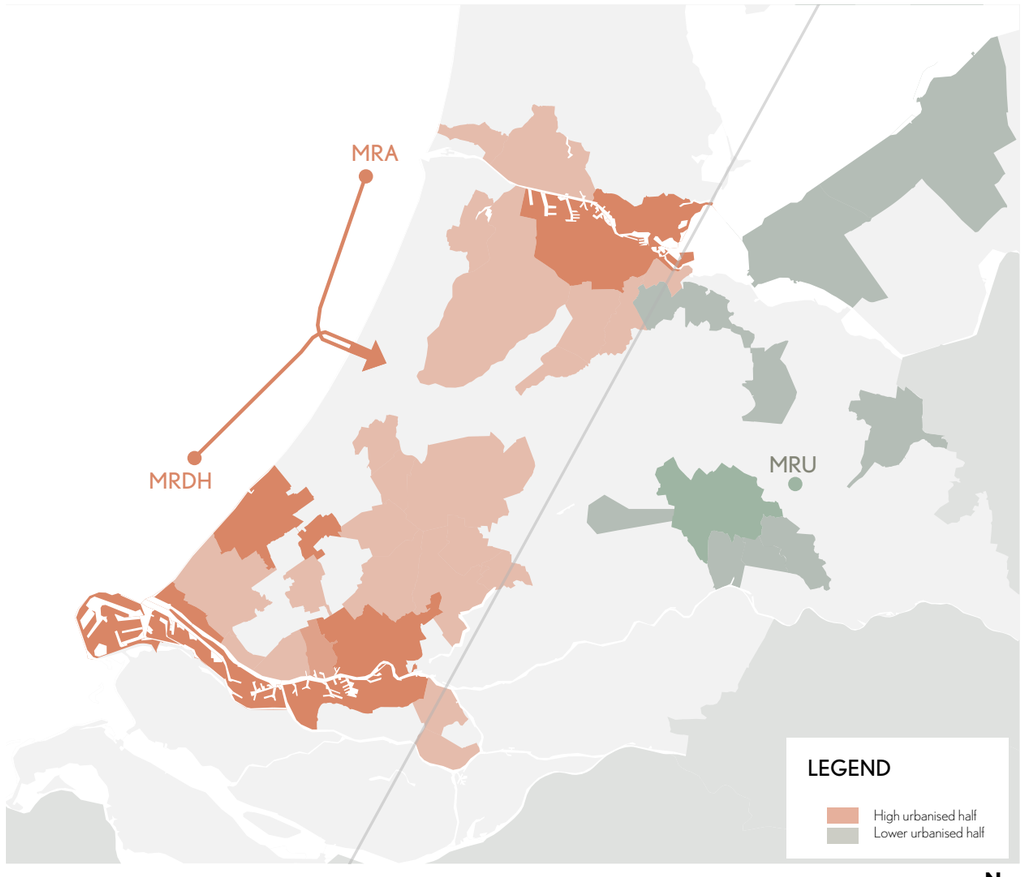


Figure 77: East and West differences synergy map (By author)

Urban (infra)structure

Looking at urban (infra)structure, the MRA and MRU will form a stronger North Wing that will function as a counterpart of the South Wing, where the MRDH will still be the dominant region. Railway corridors will form important connections between both wings, as they will also be used as urban densification corridors, especially between the MRA and MRDH. Furthermore, the railway corridors will become even more important on the international scale, forming stronger connections with Belgium and Germany. Though, the railway corridor going form the MRA, through the MRDH and towards Antwerp will play a more vital role than the corridor going towards Cologne, as more commuters are expected between the Netherlands and Belgium.

Figure 78: Urban (infra)structure synergy map (By author)

Natural structures

There are two main green longlines moving vertically, connecting the Dutch ecological system to the one of Belgium. One of them moves over the imaginary line and the other follows the coastline. There is one horizontal longline connects the Dutch system to the one of Germany. All these green longlines could form important structures for a revised vision.
Vital water infrastructure for shipping is split into to parts, one going through the North Wing and the other going through the South Wing. In the current Green Heart region, the other main rivers move vertically, connecting both Wings.

Figure 79: Natural structure synergy map (By author)

10. RENEWED RANDSTAD / GREEN HEART VISION 2100

10.1 Vision 2100
Vision exploded

The vision is developed carefully through the bioregional perspective. This is done through specific steps in the project. What follows is a general explanation of the steps used to form a vision where socio-environmental fellowship stands central:

1. NATURAL STRUCTURES
There is carefully looked into blue-green structures. In this phase, natural and ecological systems in the region should be well-understood.

2. BIOREGIONAL CHARACTERISTICS
There is looked into the unique conditions and challenges of different regions. When these are distinguished, they form the base for the formation of bioregions. In each bioregion, there should be looked into how the unique socio-environmental challenges could be dealt with. In this phase, it becomes clear in which areas the ecological conditions should be improved, and which areas could be suitable for urban expansions and what type of urban expansion.

3. POLYCENTRICITY
When the natural conditions are clear, there is looked into the polycentricity of the region. The question is asked which (inter)national longlines are and will become important. In the vision, these lines could form important regions to urbanise. These precautions are made to make the vision adaptable to future scenarios, as population growth is important to take into account.

4. URBANISATION
As last, when the socio-environmental challenges of each bioregion and the important longlines of the region are clear, sites where urbanisation could take place are pointed out.

In this vision, the relationship between urban development and nature in spatial planning is fundamentally reversed. The natural systems and conditions form the starting point for decision-making. These will point out where urbanisation is possible regarding the landscape conditions, ensuring that spatial developments responds to the capacities and constraints of the landscape.

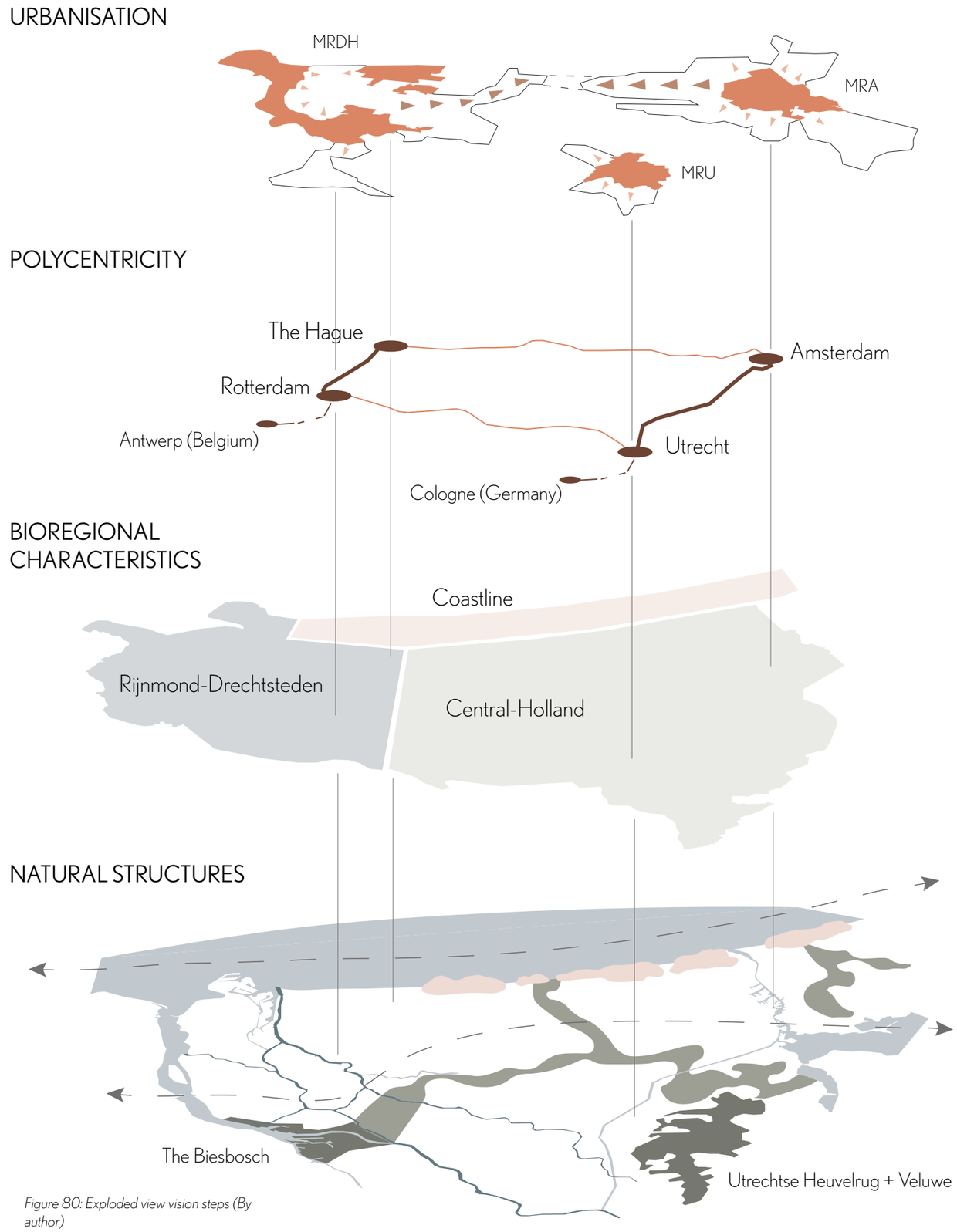


Figure 80: Exploded view vision steps (By author)

Vision exploded

Originally seen as a green counterform to urban development, the Green Heart no longer responds sufficiently to nowadays hydro-geomorphological and environmental conditions. Maintaining the current Green Heart will put the region under increased pressure in future environmental scenarios.
The vision proposes that crucial (inter)national green structures will be reconnected through a Green Vessel system, that will form the backbone for ecological systems. In the Vessel system regions, urban expansions must remain limited.
Bioregional dynamics within the Randstad will become the dominant factor in spatial decision-making. The identified bioregional guidelines are essential, as each bioregion has its unique way of dealing with socio-environmental pressures.

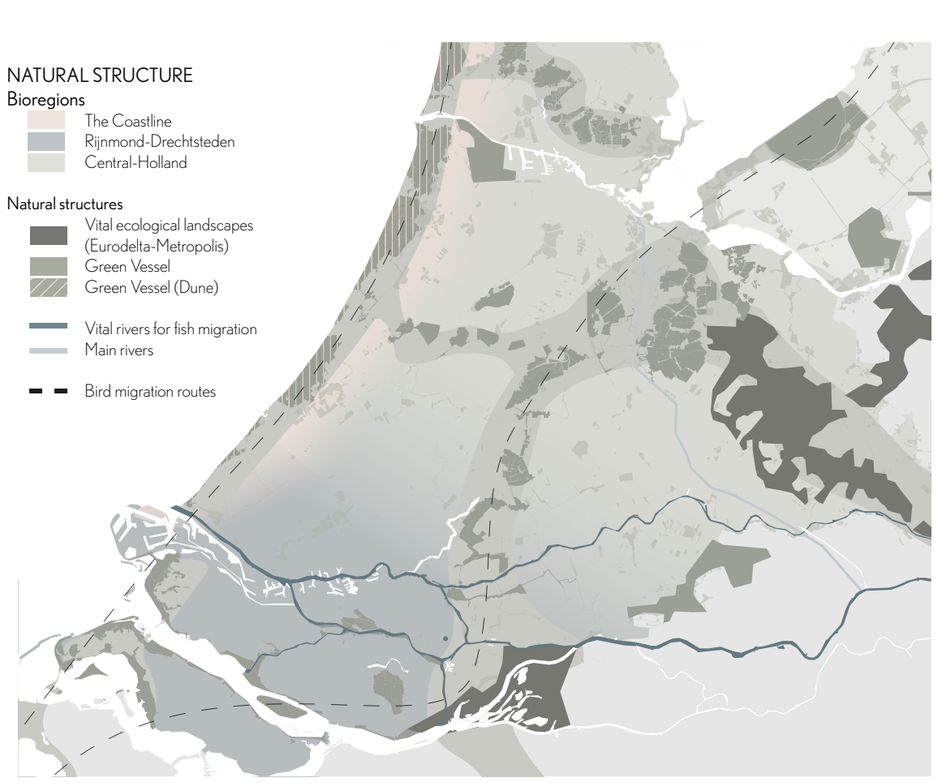


Figure 81: Vision natural system (By author)

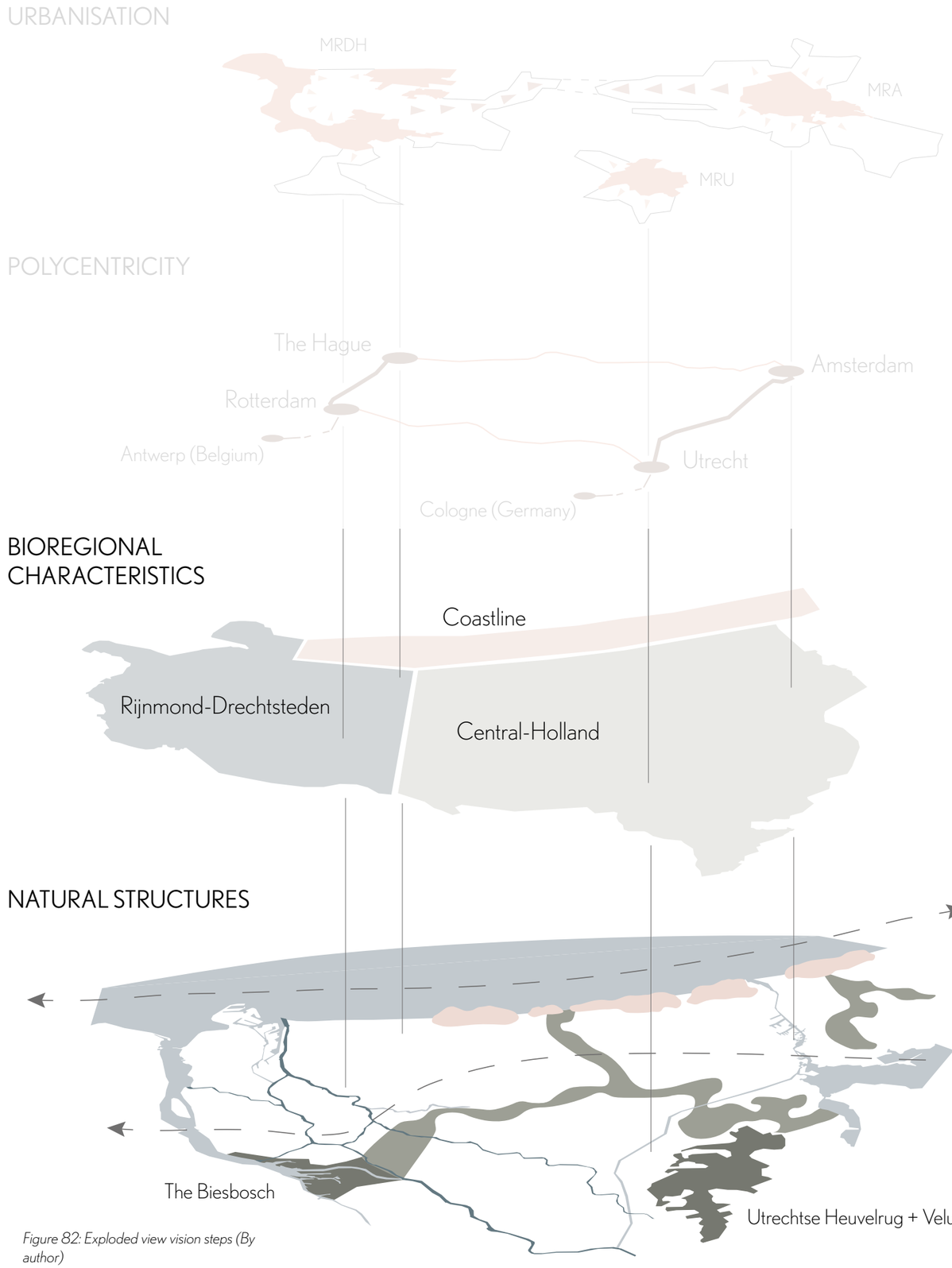


Figure 82: Exploded view vision steps (By author)

Vision exploded

As Randstads population growth will continue towards 2100, urbanisation is accommodated in the patches outside the Green Vessel system, and railway corridors will form the main urbanisation zone. In the Rijnmond-Drechtsteden bioregion, urbanisation should take place in the form of flood-sensitive housing typologies. And in Central-Holland, there must be looked to construct more amphibious housing, as parts of this area will be given the chance to return to its historical landscape form by allowing more swamp zones. In the Coastline bioregion, limited to none urban expansions are allowed, as it's part of the Green Vessel system and dune and dike areas need to be strengthened naturally in the Randstad.
Furthermore, on the westside of the Randstad, the MRA and MRDH grow towards each other. While the MRA and MRU will also form a strong North Wing, further strengthening the North and South Wing model of the Randstad.

Figure 83: Vision urban system (By author)

Figure 84: Exploded view vision steps (By author)

Vision map

Ultimately, the vision shifts the paradigm of the Randstad from a metropolis where infrastructure steers spatial planning decisions, to a metropolis where bioregional dynamics become the main structuring element that guides spatial developments.

North Wing
MRA + MRU

South Wing
MRDH

Scale 1:600.000
0 6 18 KM
N

LEGEND

NATURAL STRUCTURE

Bioregions
- The Coastline
- Rijnmond-Drechtsteden
- Central-Holland

Natural structures
- Vital ecological landscapes (Eurodelta-Metropolis)
- Green Vessel
- Green Vessel (Dune)
- Vital rivers for fish migration
- Main rivers
- Bird migration routes
- Agricultural area

URBAN STRUCTURE

Urbanisation
- High urbanisation
- Medium urbanisation
- Low urbanisation

Housing typologies
- Flood-sensitive
- Amphibious

Infrastructure
- Main railway corridor

Figure 85: Vision map 2100 (By author)

10.2 Relation with the Eurodelta-Metropolis

Green network

The Biesbosch, Utrechtse Heuvelrug, Veluwe and dune landscapes form the most important ecological landscapes of the region. The Green Vessels connect them by following and bolstering natural protected areas in the Randstad, they form green longlines. These longlines move beyond the Dutch border and also follow Natura2000 areas in the Eurodelta-Metropolis.
Currently, protected areas often functioning as isolated reserves, the Green Vessels connects these landscapes to form international ecological structures that support biodiversity and bird migration movements.

Figure 86: Green network Eurodelta-Metropolis vision map (By author)

Blue network

A pivotal blue connection of the Randstad with the Eurodelta-Metropolis is the corridor of the Rhine and Meuse river. This river is an international trade route and forms connections between ports and other industrial regions, the most important connection is the port of Rotterdam with the Ruhr region of Germany. This corridor not only supports economic flows, but also define ecological structures. For example, the corridor serves as a migration route for fish. This river corridor is a crucial structuring element, integrating infrastructure, economy, and ecology.

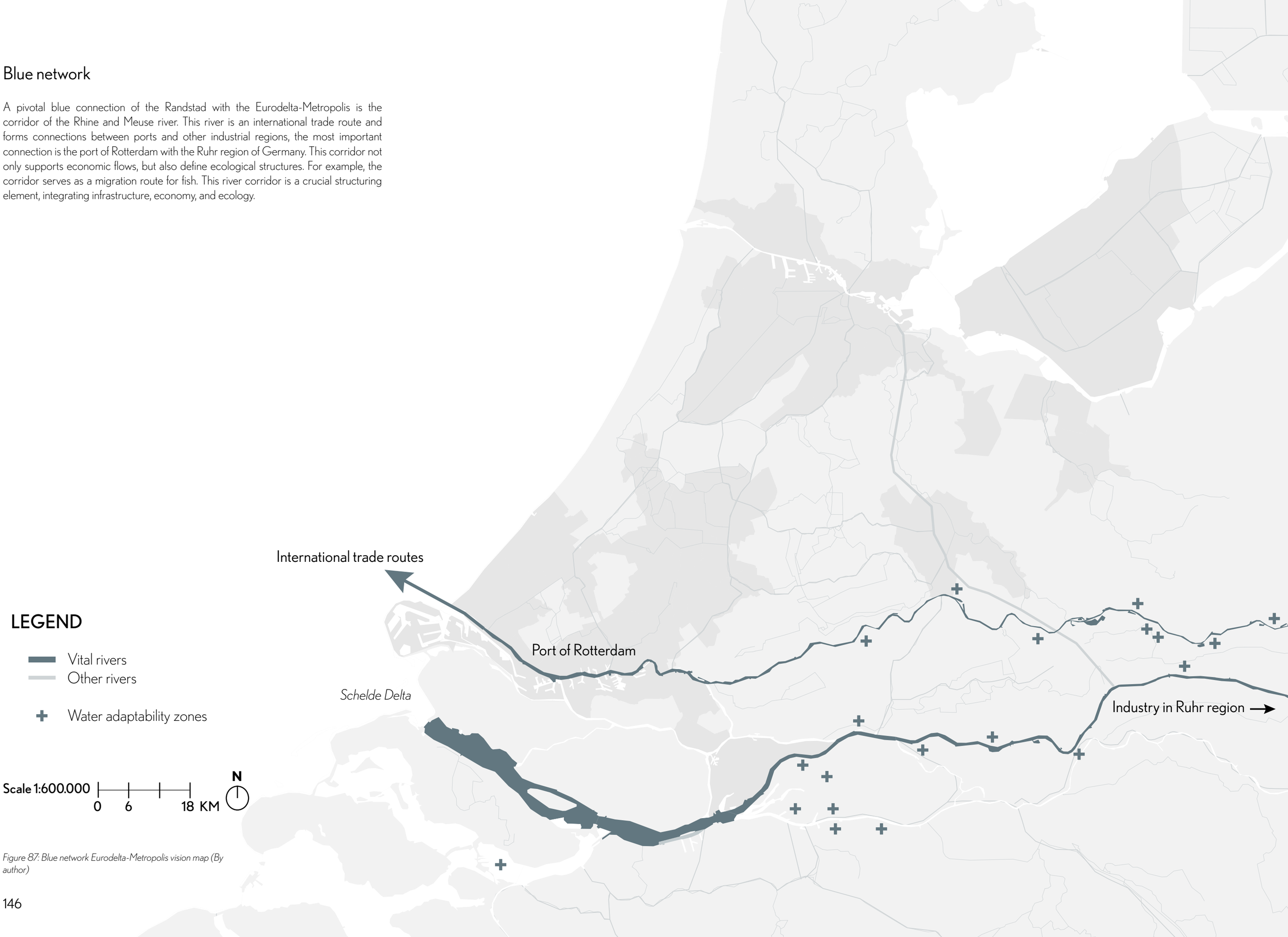


Figure 87: Blue network Eurodelta-Metropolis vision map (By author)

Urban network

Railway connections will become important assets in plans for the Eurodelta-metropolis. Between the Netherlands and Belgium, people are more comfortable to travel because both countries share the same language, this is something that cannot be said about the Netherlands and Germany. Because of that and other cultural and social differences, cross-border integration between the Netherlands, Belgium and Germany is uneven (Jacobs, 2025). With that in mind, the railway connection between the Amsterdam and Antwerp will be more significant than the one between Amsterdam and Cologne.

Not only on the scale of the Eurodelta-Metropolis becomes the use of railways important. Railway corridors are already named often as interesting urbanisation zones in plans from different scale national authorities in the Randstad.
Looking at the Randstad scale, the railway corridors Amsterdam - Antwerp and Amsterdam - Cologne will become the most important internationally. Though, the railway corridors going towards The Hague and Utrecht will become equally important if looked at the national scale and connections.

Figure 88: Urban network Eurodelta-Metropolis vision map (By author)

10.3 Vision translated to the Eurodelta-Metropolis

Green and urban network

Looking at the whole of the Eurodelta-Metropolis, six natural areas will function as the vital nodes in the Green Vessel structure; Veluwe (NL), Biesbosch (NL), Bosland (NL), Hoge Kempen (BEL), Eifel (GER) and Sauerland (GER).
The main longlines of the Vessels tend to follow their particular river basins, reflecting their shared hydro-geomorphological and ecological conditions.

Furthermore, commuting differences emerge at a larger scale. The corridor between Amsterdam and Antwerp will become more significant, as the Netherlands and the Flemish part of Belgium share the same language. Stronger spatial integration across the southwestern part of the metropolis can be seen. Expected is that more people will commute between Amsterdam and Antwerp than between Amsterdam and Cologne. More people will commute in this corridor, resulting that improved (railway) infrastructure will become crucial. As for the rail freight corridors, the one between the port of Rotterdam and the Ruhr region will become the most important corridor in the Netherlands to move freight for overseas trading.

GREEN VESSEL STRUCTURE

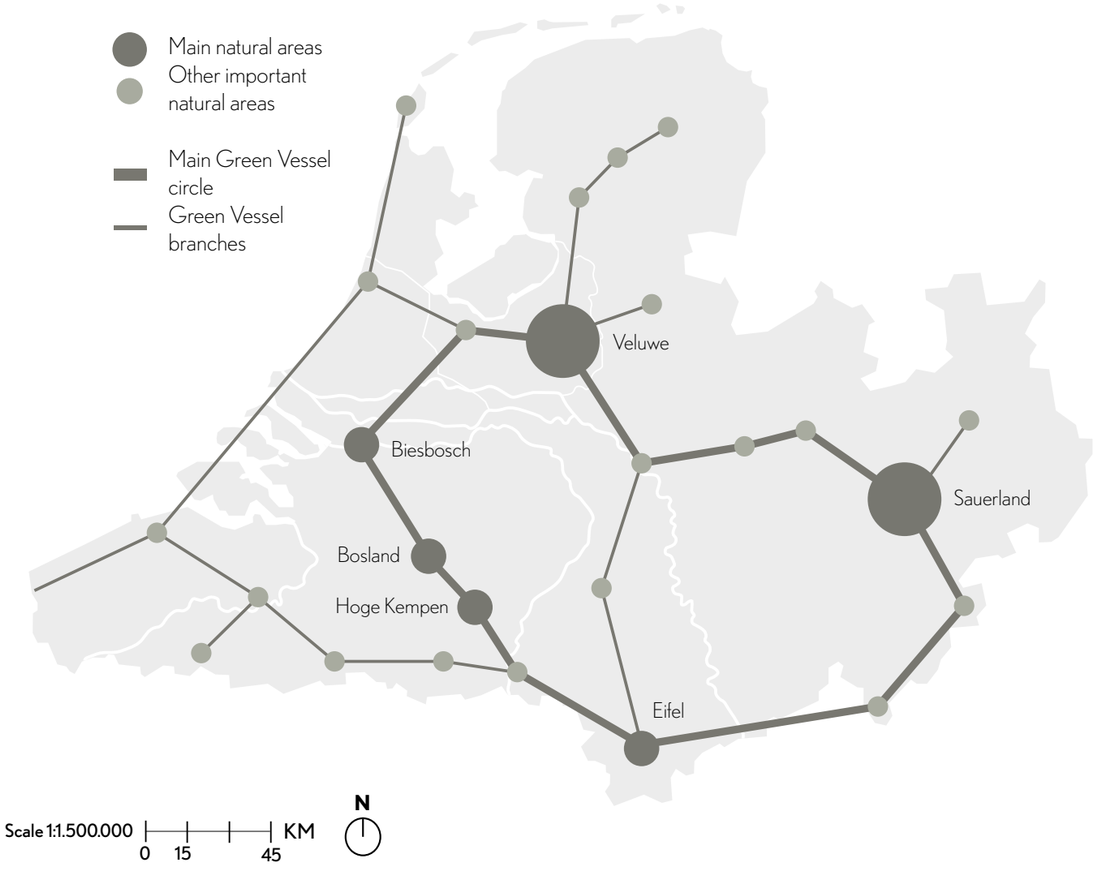


Figure 89: Natural structure Eurodelta-Metropolis vision map (By author)

URBAN STRUCTURE

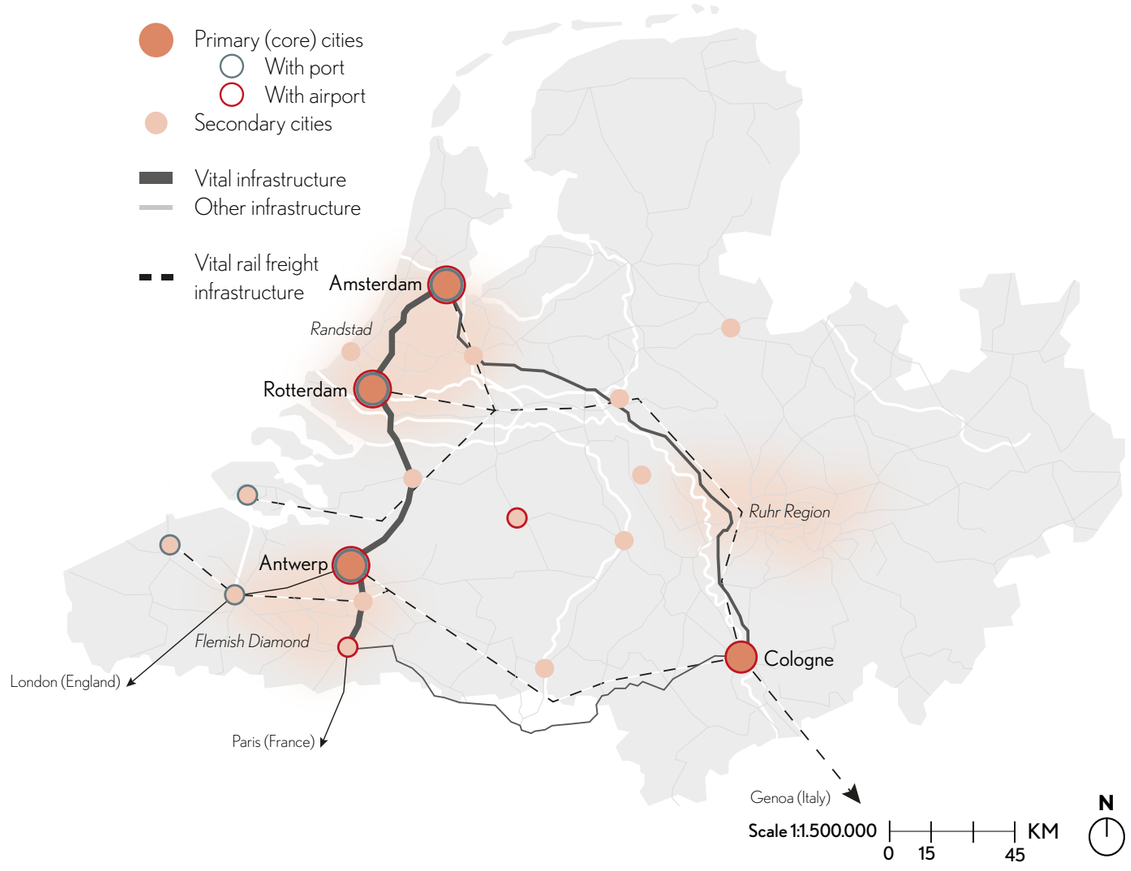


Figure 90: Urban structure Eurodelta-Metropolis vision map (By author)

Translated to the Eurodelta-Metropolis

In the perspective on the natural systems of the Eurodelta-Metropolis, isolated ecological "islands" should be connected with each other to form the continuous system of Green Vessels structured around landscape and hydrological relations. The Vessels will follow their particular river basins, reflecting their shared hydro-geomorphological and ecological conditions. Alongside systems, the dune landscape across the Netherlands and Belgium functions as an unique region with its own environmental dynamics.
Connecting the different landscapes and systems with each other will form a coherent ecological framework across the Eurodelta-Metropolis.

What stands out the most is that the Randstad becomes the ecological "heart" of this European scale Green Vessel network. Connections between major natural systems in the Netherlands, Belgium, and Germany meet in the region.

As discussed on the previous page, commuting between the Netherlands and Belgium will become higher than between the Netherlands and Germany. Towards Cologne, green structures are given the chance to dominate, as key economic connections between the port of Rotterdam and the Ruhr region are concentrated along water and railway infrastructure.

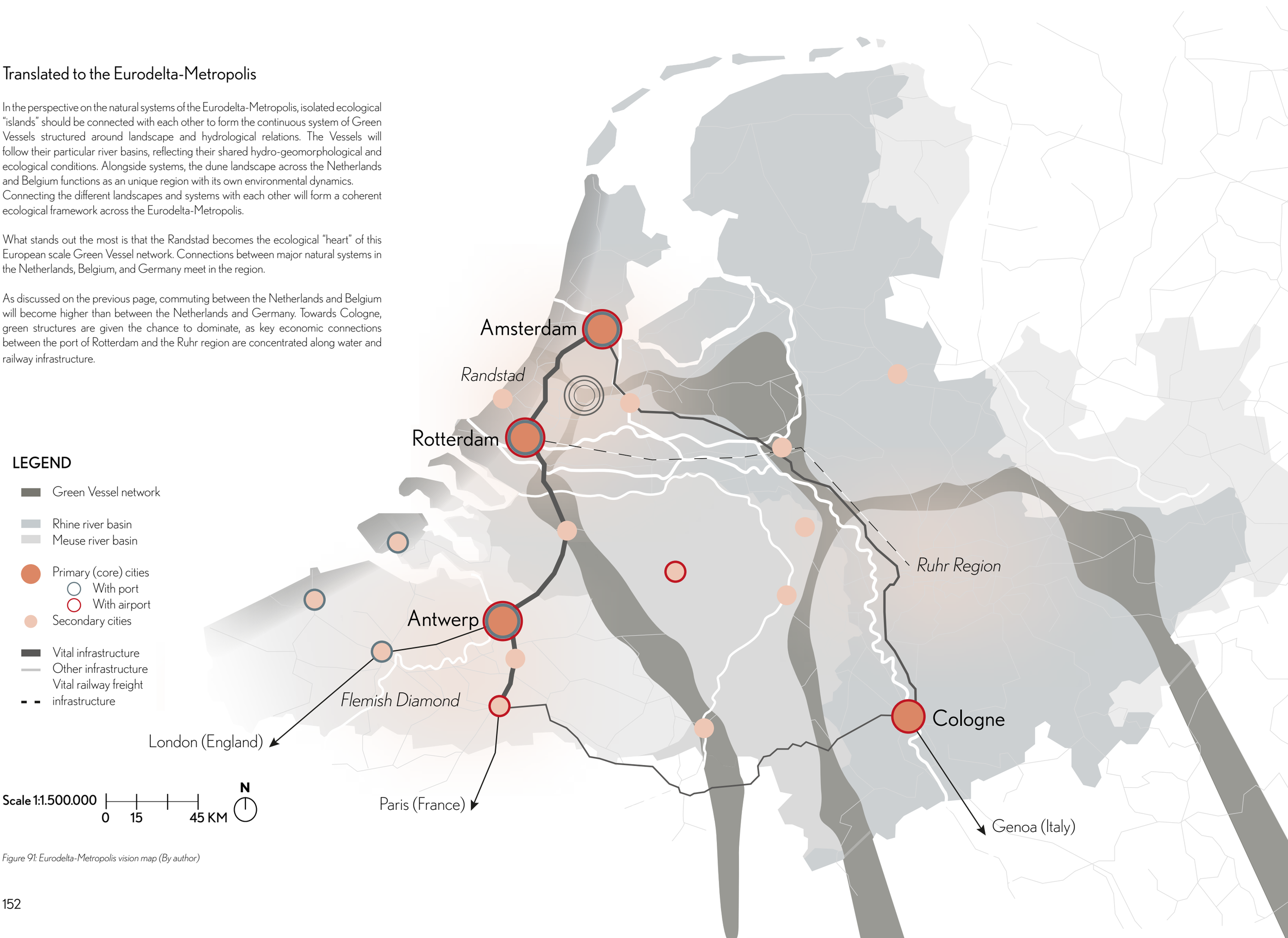


Figure 91: Eurodelta-Metropolis vision map (By author)

11. IMPACT ON RIGHTS OF NATURE

From controlling to planning with nature

Historically, the Randstad has been planned around human priorities, with infrastructure, economic growth, and urban expansion functioning as dominant factors of spatial decision-making. This approach has enabled spatial integration and metropolitan development of the Randstad. Though, the consequences of hydro-geomorphological decay; subsidence, floodrisk, salinisation and ecological degradation, have increased. This revealed the limits of the previous Randstad models.

This project introduces a shift in planning values from a Rights of Nature (RoN) perspective. It repositions natural systems as active structuring elements rather than passive land available for human use. The project implies that urbanisation should respond more directly to bioregional dynamics and environmental capacities.
We could ask ourselves an existential question when taking this RoN perspective that goes further than just this project:

What changes in spatial planning when natural systems are treated as actors with agency and ecological limits, instead of landscapes to be engineered around human needs?

From a RoN perspective, this projects looks into what the Randstad could possibly look like when bioregions form the main planning tool. This bioregional perspective on spatial planning requires recognising that urban development is evolved under diverse socio-environmental conditions that vary across the Randstad. Different bioregions expose region-specific natural capacities, vulnerabilities and dynamics. A singular approach to urbanise the Randstad wouldn't work.

A RoN perspective calls for a reordering of the pecking order within spatial planning. Historically, planning in the Randstad has largely prioritised economic growth, accessibility, and housing development as dominant drivers of decision-making. However, increasing environmental pressures suggest the need for a different hierarchy, in which hydro-geomorphological- and ecological systems become the primary foundations, shaping both opportunities and limits for spatial development.
Within this approach, urban and economic growth are not abandoned, but repositioned in relation to the capacities and limits of natural systems. Hydro-geomorphological and ecological systems should no longer be treated as secondary factors, but instead form the basis for urban development.

Reordering planning values

A change in the spatial design hierarchy requires a reconsideration of territorial management and governance structures. Currently, a socio-environmental governance mismatch exists, as governing structures don't mirror the boundaries of environmental systems. As a result, existing governance often fail to align with the logic of environmental systems.
Cross-border and inter-provincial coordination between governance entities should be organised, or moved up in the hierarchy. These entities should cooperate, ignoring the made up borders of todays world, and allowing bioregional and river basin dynamics to guide spatial decision-making.
Such a governmental framework should be more responsive to hydro-geomorphological and ecological systems, allowing bioregional systems to form the backbone for spatial decision-making and long-term territorial management.

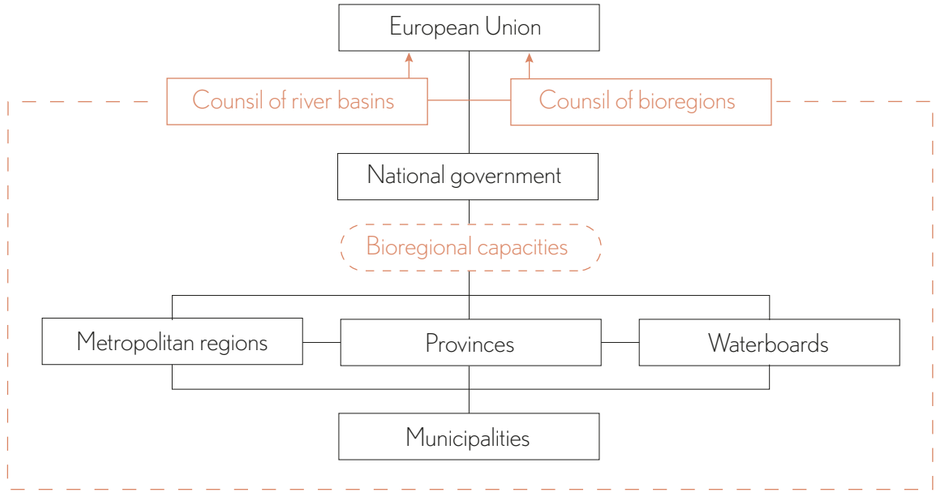


Figure 92: renewed hierarchy of authorities following the RoN perspective (By author)

Reordering planning values

Applying the proposed governance framework will bring consistency across all bioregions, while recognising that decision-making complexity differs in each region according to the number and diversity of stakeholders involved. For example in Rijnmond-Drechtsteden, there are four waterboards and one metropolitan region and province. While Central-Holland has a more complex government system with three waterboards, three provinces and two metropolitan regions. Strengthened coordination is essential for coherent spatial and ecological governance.

Within the proposed framework, metropolitan regions, provinces, waterboards and municipalities are all able to report to councils of river basins and bioregions, creating a structure in which local and regional perspectives about socio-environmental complexities will be better represented. As both councils function as independent governmental bodies with a strong voice in European Union decision-making, they could strengthen coordination between spatial, ecological and hydrogeomorphological policies.

In doing so, all levels of governance would gain greater influence in nature-based planning, contributing to more coherent decision-making regarding both urban development and environmental management.

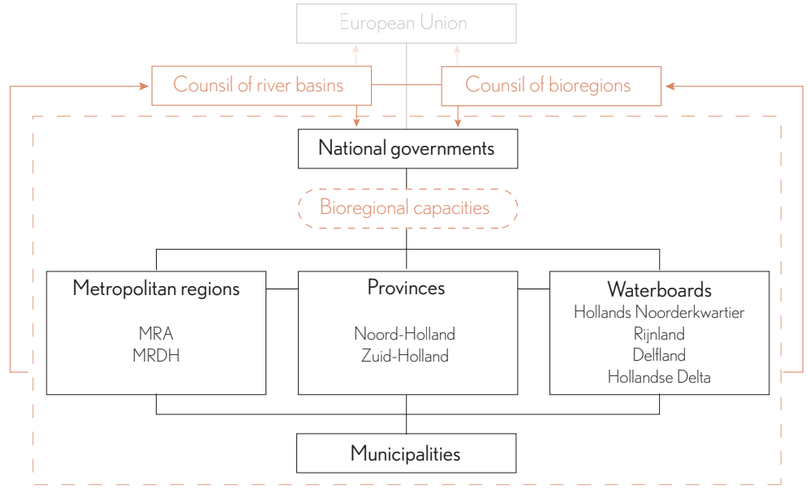


Figure 93: renewed hierarchy of authorities in the Coastline bioregion (By author)

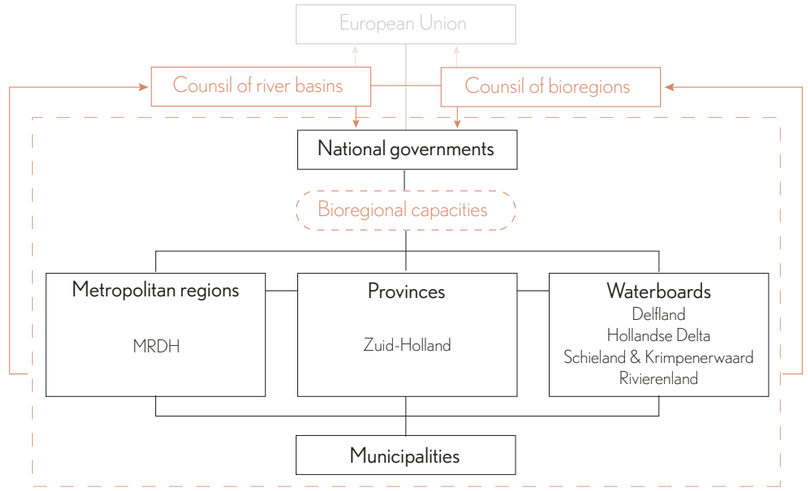


Figure 94: renewed hierarchy of authorities in the Rijnmond-Drechtsteden bioregion (By author)

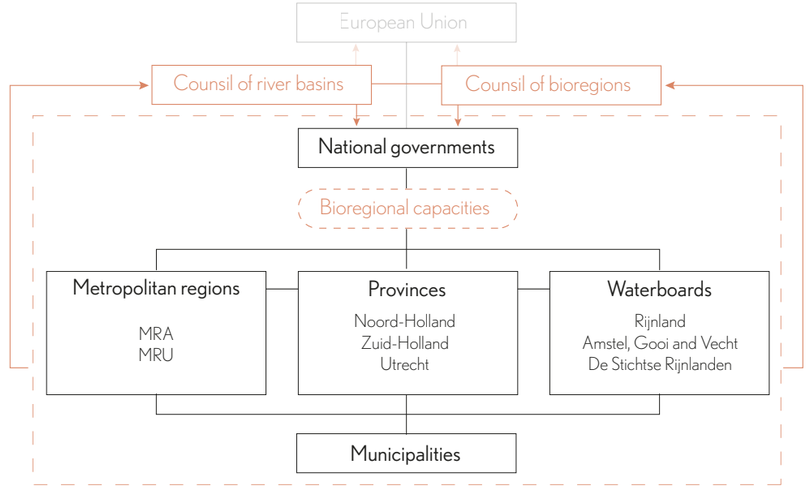


Figure 95: renewed hierarchy of authorities in the Central-Holland bioregion (By author)

Bioregional conditions should become dominant in the framework for spatial decision-making, requiring urbanisation to negotiate with landscape capacity. Hydro-geomorphological systems, environmental dynamics and ecological systems should therefore become the backbone for future regional developments, marking a transition from planning against nature towards planning with care for nature.

Figure 96: Illustrative Eurodelta-Metropolis map (By author)

Results

Main research question

How can todays outdated model of the Randstad / Green Heart concept be re-envisioned to foster socio-environmental fellowship, considering its hydrogeomorphological alterations, its current type of metropolisation demands, and the future climate conditions towards 2100?

The thesis found that the transition from the current Randstad / Green Heart into a model where socio-environmental fellowship is fostered, requires a fundamental shift in how spatial planning is practised. In contrast to earlier interpretations of the Randstad, which prioritised urban and economic growth and allowed hydrogeomorphological decay to grow, the thesis proposes a shift in perspective in which natural and ecological systems become the primary structuring layer for urban development. Future spatial plans should therefore be aligned with the local hydrogeomorphological conditions and anticipated environmental changes towards 2100, ensuring that urban development respond to long-term landscape dynamics.
The thesis follows its own proposed approach on four steps that must be made to come to an spatial plan that fosters socio-environmental fellowship:

1. Understanding the natural systems that the design area is part of.
2. Distinguishing unique characteristics and/or conditions of the natural systems to form bioregions.
3. Finding crucial urban and polycentric longlines to make the design adaptable to socio-urban developments.
4. Designate areas where urban development is possible without putting natural systems under pressure.

Achieving such a transition also depends on changes in European territorial governance structures. Strengthened cross-border coordination is necessary, as ecological and hydrological systems operate beyond national boundaries and require integrated management across all planning scales.
In this context, bioregionalism and the urban hydro-social cycle provide conceptual frameworks for understanding human-nature coexistence. They enable a planning approach in which spatial development is explicitly negotiated with environmental processes.

Within this framework, areas that are highly sensitive to ecological disruption or that play a critical role in hydrological and ecological systems should be excluded from urbanisation, as development in these locations would put pressure on its natural conditions. Where urbanisation is appropriate, it must be directly informed by natural risk conditions, ensuring that spatial interventions remain compatible with the adaptive capacities of the environment. For example in flood/water prone areas, where the thesis allows urbanisation in forms of flood-resilient and amphibious housing typologies.

Overall, the thesis reframes spatial planning in a way that human should coexist with nature, instead of controlling them.

Subquestions

What regions inside the Randstad / Green Heart can be identified that need an unique consideration regarding socio-environmental and water risk management?

Within the Randstad / Green Heart, three bioregions can be identified; the Coastline, Rijnmond-Drechtsteden and Central-Holland. Each of these regions is characterised by unique environmental conditions and associated challenges. Because of this, each bioregion requires individual, but integral, strategies and measures, ensuring that spatial planning strategies are aligned with local socio-environmental and hydrological realities.

How can metropolisation demands be integrated into hydrogeomorphological and environmental risk management in the Randstad / Green Heart?

To integrate metropolisation demands with the hydrogeomorphological and water-related risks in the Randstad / Green Heart, natural systems need to be the primary structuring layer for urban development. This implies that urban development is only appropriate in areas where it is able to adapt to existing hydrogeomorphological dynamics. Such approaches would allow forms of urbanisation within ecological sensitive zones, while maintaining the capacity of the landscape to regulate environmental processes.

How can the currently fragmented governance model be transformed to support integrated socio-environmental and water management?

The fragmented governance model could be transformed to support an integrated socio-environmental and water management model, when a fundamental shift takes place towards bioregional-based planning on both the national as international scale. As blue-green systems do not correspond to national boundaries, stronger cross-border coordination is essential to align hydrogeomorphological and ecological governance across interconnected landscapes and river basins. The establishment of a council of bioregions and water basins could provide a new governance layer with an strong advising role in European decision-making. It would integrating authorial and sectoral policies across (inter)national scales, ensuring that spatial planning is consistently informed by socio-environmental and hydrological realities.

Discussion

Interpretation of project lenses

Critical Zones

Like discussed in the methodological chapter, Critical Zones argues that right now is a critical moment to re-evaluate how we think about the planet and that our current way of living fails to account for the complex interactions between human activities and Earth systems (Latour, 2020).
The main conclusion of the project is that a fundamental shift in how we practise urban planning is needed to foster human-nature coexistence, and how we must reevaluate our role in the tree of life. Furthermore, the Critical Zone lens argues that we should understood natural systems as something deeply intertwined with social systems, values, identities and collective decision-making (Latour, 2020). There can be stated that the thesis interpretates this project lens very much like Latour meant with it.

Bioregionalism

Bioregionalism is a planning approach that considers natural features of specific regions as the base for political and economic systems. It states that natural (eco)systems and cultural contexts should dictate, or at least influence, how humans inhabit territories in relationship with the capacities and limitations of the natural environment (Wearne et al., 2023). The way the project interpretates the bioregionalism concept is very much in line with this definition.
Though, there is a grey area in how the project interpretated Bioregionalism. In literature, bioregions are large regions crossing immense parts of continents, with ecoregions crossing multiple countries. This project focuses on a much smaller scale; the Randstad / Green Heart. To find bioregions, this scale would be too small the distinguish multiple of them. Bioregionalism was interpreted with a set of added characteristics. Apart from natural and ecological systems, there was also looked at different types of decay and urban developments caused by humans to identify bioregions. This is not really in line with the bioregional lens, but as the scale of the project was too small to identify multiple bioregions, the usage of socio-environmental complexities was a interesting way to characterize them. As socio-environmental risk was one of the topics in the project nexus.

Urban Hydrosocial Cycle

Looking at the interpretation of the Urban Hydrosocial Cycle, there can be said that the proposal is largely in line with it. The proposal starts a new cycle, not a cycle where new technologies necessarily change urban configurations, but a cycle where the way humans adapt to hydrological systems is shifting. Hydro-sensitive urban typologies will have a more excessive role in the proposal. Instead of creating technologies that would allow humans to overcome water-related challenges by altering hydrological systems, humans will adapt to water-related challenges by living with and planning around it in the proposal.

Flexibility of proposal

The thesis proposes a framework that fundamentally shifts the way how spatial planning is practised. Although the thesis focuses on the Randstad / Green Heart region, not all outcomes are not bound to this specific region.
Some parts of the project are bound to the Randstad / Green Heart region. Like the guidelines for each bioregion, those are specifically considered together with the natural systems the different regions is part of.
But for example the framework for the proposed order in which urban plans should be designed (first the understanding of natural structures, than the organisation of bioregions, and with that knowledge looking at polycentricity and urbanisation), which is the most crucial part of the proposal, could be implemented in every part of the world.
With that in mind, there can be said that, apart from the limitations that will be discussed on the next page, the proposal is highly flexible.

Reflection

Choosing the 'Critical Environments: Rights of Nature' cluster for my graduation project came from a growing interest of natura-based planning I developed during the Urbanism Master. I became increasingly interested in the relationship between ecological systems and the growing urbanisation, particularly in how natural conditions could influence the organisation of urban regions. In the thesis, knowledge, perspectives and values I obtained in previous courses were used; my Q1 of the Master was focused on creating a flood-resilient design of Amsterdam, Q2 focused on how biophilic design could impact the daily life in The Hague and Q4 was centred on how a bioregional design for the Greater Bay Area in China could prevent or lower the impacts of natural decay.
The knowledge gained from these courses came together in this thesis, allowing me to combine theoretical perspectives, analytical methods and design thinking into this spatial proposal for the Randstad. In this sense, the project became an academic- and a personal exploration of the type of urban planner I aspire to become.

The methodological and design process itself changed fundamentally over time through inspiring mentoring sessions and ongoing discussions with myself. Many projects during the Masters tend to present an "ideal" or "finished" future condition, this became also my idea for the thesis at the start of the process. Though, the project gradually shifted towards proposing a shift in how we currently practise spatial planning. Instead of working towards a perfect form for the Randstad, the thesis became a proposal for a fundamental change in planning logic. One in which natural systems and bioregional dynamics guide urban development. The value of the project therefore lies less in presenting a final solution, and more in demonstrating a possible process and direction for future spatial planning. In doing so, it aims to encourage others to reconsider how urban environments are designed in relation to hydrogeomorphological and ecological systems.

During the design process, it was quickly realised that the project had to expand its horizon. At first, the focus was on the Randstad and the national systems linked to the region. Though, the boundaries of the project had to expand to international systems. Practising the bioregional and ecological perspectives, there must be looked at the whole natural systems. And these systems often cross multiple borders and authorities.

From a scientific perspective, the project contributed to a broader understanding of how spatial design can function as a research method for investigating future territorial development. The thesis explored how metropolitan regions might be reorganised in response to environmental change, ecological fragmentation and changing urbanisation dynamics. This is something that needs to be done more often to understand how we can adapt to changing environments.
At a personal academic level, the thesis also marked an important step towards the professional direction I wish to pursue after completing the Urbanism Master. It has deepened my understanding of complex metropolitan systems, while expanding my knowledge of regional design, bioregional thinking and scenario-based spatial planning. Furthermore, it has broadened my perspective on what spatial design can become and reinforced my belief that designing with natural systems is becoming an essential skill in a world with changing environmental and societal complexities.

Limitations

Though, the project has clear limitations. Focusing on the Randstad and Eurodelta-Metropolis region introduced an immense level of complexity, bringing together a wide range of spatial, environmental, economic and societal issues. To make the project more manageable and to define a clear problematisation, it was necessary to narrow the scope and prioritise certain themes over others. As a result, other dimensions such as economic systems and agricultural transitions, that would normally be taken carefully in consideration in decision-making in the Randstad and/or Eurodelta-Metropolis, were not addressed in this project. This means that certain findings and spatial proposals do not fully correspond with real-world political or economic realities.

Recommendations

My recommendations are that further scientific and practical research must be done to finetune the proposal. Further scientific research must further elaborate on the three identified bioregions within the Randstad / Green Heart by translating the framework and proposed fundamental shift of the thesis into more detailed and spatially specific design and planning strategies. This includes exploring how the proposed bioregional approach can be operationalised into realistic and implementable spatial plans that account for the different hydrogeomorphological and ecological conditions of each bioregion. An example is how flood-sensitive and amphibious typologies would realistically actually look like in the bioregion.

In doing so, future research should also focus on the practical applicability of the proposal within real-world spatial planning and governance contexts. This includes investigating how the proposal can operate within existing institutional frameworks, legal systems and decision-making processes, as well as identifying where structural modifications may be necessary to support long-term ecological and hydrological objectives.
At the same time, practical research should critically examine how stakeholders (governments, urban planners, water authorities, and local communities) can participate in and adapt to such a transition. The proposal implies not only institutional change but also a fundamental the mindset of us humans.

In addition, further research should expand the scope of analysis to include related but underexplored domains, such as agricultural and economic systems. These factors play a significant role in shaping spatial development in the Randstad, but are not addressed in this thesis due to its focus on socio-environmental and water-related dynamics, and the time given for the thesis. Integrating not-yet-touched dimensions would allow for a more comprehensive understanding of the region and could help to align ecological objectives with economic viability and land-use transitions.

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GeoServer	https://geoserver.org/
PDOK	https://www.pdok.nl/
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Appendix 1

Explanation of the four scenarios from Deltares

QUICK SCENARIO

Climate change

- Temperature rise stays limited to 1,7 degrees Celsius. After 2050, climate change reduces. Climatological differences between 2050 and 2100 are minor.
- Sea level will rise ca. 24 cm in 2050, and ca. 44 cm in 2100.
- Summers become hotter with an average of 1,2 degrees Celsius. Summers will become dryer as well.
- Winters become wetter, but the amount of precipitation per year stays the same.

Emission reduction

- The Netherlands reduces greenhouse gas emissions like agreed in the climate agreement.
- Measures are taken to heighten surface water to 0,2 meters under ground level to prevent CO2 emissions due peat oxidation.

Socio-economic developments

- Dutch population grows to 20,7 million residents in 2050. Economy grows, leading to a further expansion of urban areas. This will be at the expense of agricultural land.
- Forming new natural areas is not a priority.
- The shipping sector benefits from the economic growth, resulting in the increase of the transportation of goods.

Water challenges

- Water challenges will increase until 2050.
- The freshwater availability task becomes greater, impacting agriculture, nature, shipping and industries.
- Along the shoreline, more salinisation will occur.
- Due to economic and population growth, the water demand increases.
- Water shortages will start to occur more frequently.
- Heavy rainfalls will result in that urban areas will have to deal with more water overflow.

WARM SCENARIO

Climate change

- Temperature has risen with 1,7-2 degrees Celsius in 2050, and with 4,7-5,1 degrees in 2100.
- Sea level rise not mentioned.
- Summers become hotter with 2-5 degrees Celsius until 2100. Summers will become increasingly dryer until 2100 as well.
- Winters become wetter.
- Weather becomes extremer in terms of duration and intensity.

Emission reduction

- The Netherlands is not fully emission neutral in 2050.
- Agreements are made to heighten surface water to a maximum of 0,4 meters under ground level to prevent CO2 emissions due peat oxidation.

Socio-economic developments

- Dutch population will decline to 17,9 million residents in 2050.
- The natural network will expand.
- The transportation of goods increases slightly.

Water challenges

- Water challenges will increase until 2050 and beyond.
- Along the shoreline, strong salinisation will occur.
- Due to economic and population growth, freshwater demand increases. Resulting in that competition between water-demanding functions will increase.
- Water shortages will occur more frequently and it will not always be possible to get enough water to the right places
- Heavy rainfalls will result in that urban areas will have to deal with more water overflow.

SPACIOUS SCENARIO

Climate change

- Temperature rise stays limited to 1,7 degrees Celsius. After 2050, climate change reduces. Climatological differences between 2050 and 2100 are minor.
- Sea level will rise ca. 24 cm in 2050, and ca. 44 cm in 2100.
- Summers become hotter with an average of 1,2 degrees Celsius. Summers will become dryer as well.
- Winters become wetter.

Emission reduction

- The Netherlands reduces greenhouse gas emissions like agreed in the climate agreement.
- Agreements are made to heighten surface water to a maximum of 0,2 meters under ground level to prevent CO2 emissions due peat oxidation.

Socio-economic developments

- Dutch population will decline to 17,9 million residents in 2050.
- The natural network will expand.
- The transportation of goods increases slightly.

Water challenges

- Water challenges will increase until 2050.
- The freshwater availability task becomes greater, impacting agriculture, nature, shipping and industries.
- Along the shoreline, more salinisation will occur.
- Due to economic and population growth, the water demand increases.
- Water shortages will start to occur more frequently.
- Heavy rainfalls will result in that urban areas will have to deal with more water overflow.

STEAM SCENARIO

Climate change

- Temperature has risen with 1,6 degrees Celsius in 2050, and with 4,4 degrees in 2100.
- Sea level will rise ca. 24 cm in 2050, and ca. 44 cm in 2100.
- Summers become hotter with 2-5 degrees Celsius until 2100. Summers will become increasingly dryer until 2100 dryer as well.
- Winters become wetter.
- Weather becomes extremer in terms of duration and intensity.

Emission reduction

- The Netherlands is not fully emission neutral in 2050
- Measures are taken to heighten surface water to 0,4 meters under ground level to prevent CO2 emissions due peat oxidation.

Socio-economic developments

- Dutch population grows to 20,7 million residents in 2050. Economy grows, leading to a further expansion of urban areas. This will be at the expense of agricultural land.
- Forming new natural areas is not a priority.
- The shipping sector benefits from the economic growth, resulting in the increase of the transportation of goods.

Water challenges

- Water challenges will increase until 2050 and beyond.
- Along the shoreline, strong salinisation will occur.
- Due to economic and population growth, the freshwater demand increases. Resulting in that competition between water-demanding functions will increase.
- Water shortages will occur more frequently and it will not always be possible to get enough water to the right places
- Heavy rainfalls will result in that urban areas will have to deal with more water overflow.

Appendix 2

Population growth numbers calculation

DUTCH POPULATION

Currently: 18 million
2050: 20,7 million (quick -> growth of 15%) & 17,9 million (warm -> minor decline)
2100: stays similar to population 2050

PERCENTAGE GROWTH OF THE RANDSTAD POPULATION per corop region (CBS, 2022)

Agglomeratie 's-Gravenhage:	15,27	Agglomeratie 's-Gravenhage:	10,46
Agglomeratie Haarlem:	14,55	Agglomeratie Haarlem:	7,18
Agglomeratie Leiden en Bollenstreek:	7,28	Agglomeratie Leiden en Bollenstreek:	3,25
Delft en Westland:	16,03	Delft en Westland:	5,88
Flevoland:	16,45	Flevoland:	11,73
Groot-Amsterdam:	18,67	Groot-Amsterdam:	11,77
Groot-Rijnmond:	9,30	Groot-Rijnmond:	4,76
Het Gooi en Vechtstreek:	8,37	Het Gooi en Vechtstreek:	4,38
IJmond:	6,05	IJmond:	3,07
Oost-Zuid-Holland:	13,76	Oost-Zuid-Holland:	5,32
Utrecht:	11,78	Utrecht:	6,52
Zaanstreek:	13,36	Zaanstreek:	2,30
Zuidoost-Zuid-Holland:	5,44	Zuidoost-Zuid-Holland:	2,38
Average growth till 2035:	**12,02%**	**Average growth 2035-2050:**	**6,08%**

EXPECTED GROWTH IN RANDSTAD

2/3 of the 2,7 million growth will be inside the Randstad region. So in 2050, 1,8 million extra people will live in the Randstad.
Highest growing COROP-regions are Groot-Amsterdam, agglomeratie 's-Gravenhage, and Flevoland. Followed by Utrecht and Oost-Zuid-Holland. Both of these have a great proportion inside the Green Heart. More people living in the Green Heart are expected.

MUNICIPALITIES WITH HIGH EXPECTED GROWTH (RANDSTAD)

Zuid-Holland: Alphen a/d Rijn, Delft, Gouda, 's-Gravenhage, Maassluis, Oegstgeest, Rijswijk, Rotterdam, Schiedam, Vlaardingen, Waddinxveen, Westland, Zoetermeer, Zoeterwoude, Zuidplas
Noord-Holland: Amsterdam, Amstelveen, Beverwijk, Diemen, Haarlem, Haarlemmermeer, Hillegom, Hilversum, Ouder-Amstel, Uithoorn, Weesp, Zaanstad
Utrecht: Bunnik, Bunschoten, Eemnes, Nieuwegein, Utrecht
Flevoland: Almere, Lelystad, Zeewolde

MUNICIPALITIES WITH HIGH EXPECTED GROWTH (GREEN HEART)

Zuid-Holland: Alphen a/d Rijn, Gouda, Waddinxveen, Zoetermeer, Zoeterwoude, Zuidplas
Noord-Holland: Amstelveen, Haarlemmermeer, Hillegom, Hilversum, Ouder-Amstel, Uithoorn, Weesp
Utrecht: Nieuwegein, Utrecht

Appendix 3

Timeline of project planning