

DOWN TO EARTH

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REGENERATIVE SOIL AS THE SOLUTION FOR AN INNOVATIVE BIO-BASED REGION TO RESTORE ECOLOGICAL SYSTEMS

Down to Earth

Regenerative soil as the solution for an innovative bio-based region to restore ecological systems

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Abstract

‘Down to Earth’ proposes regenerative soil as the foundation of an innovative bio-based region in South Holland, thatconnects society and economy on all scales while restoring ecological systems. Agricultural Practices that haveheavily relied on tilling and the heavy use of chemical fertilizers has reduced the quality of the topsoil compromisingboth food security and the carbon sequestration capacity of the soil. Additionally, Industries along the port ofRotterdam that is heavily dependent on fossil fuel have polluted the land it is based on and emitted large amounts ofcarbon. The most powerful technology we have at hand to draw down this carbon load is healthy soil that can supportplant life and micro-organisms naturally.

The strategy proposed in this report focuses on retaining the economic prosperity of South Holland while remediatingthe soil that supports it. Based on an understanding of the current land uses in South Holland and the level ofdisruption it causes to the natural systems within the soil, the region has been abstracted into pixels. Each spacialtype would have a specific intervention that focuses on keeping the soil in it open and alive.

These interventions are further strengthened by creating links that support the exchange of biodegradable materialand clean energy between stakeholders. This would serve as an additional economic incentive to support the pressingneed to mitigate environmental damage. The guiding principles that make this transition possible include renewableenergy generation, eco-sensitive development, nature-based solutions, valorization of biodegradable waste, and usingpolicies to change consumer patterns and reformulate development trends.

The proposal, along with the layers of soil data that support it is a case of why soil remediation through bio-basedeconomic activity is vital to sustainable growth and a vision of what development within planetary boundaries wouldinclude.

Key words: Soil city, soil remediation, bio-based economy, regenerative faming, nature-based solutions, restoring ecological cycles, Province of South Holland

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Introduction

Soil is the foundation that supports all forms of life on earth and is a primary source of food and raw material. The advent of technology that made it possible to extract more from natural reserves, along with the need to sustain large populations, have compromised the natural systems that sustain life on earth. Erosion and pollution have degraded a third of the earth's arable land over the past 40 years (Ridgman, 1990).

Agricultural practices that heavily rely on tilling and the use of chemical fertilizers has reduced the topsoil to dust, compromising both food security and the carbon sequestration capacity of the soil (Maximillian et al., 2019). In 2014, the UN Food and Agriculture Organisation (FAO) reported that the world's remaining topsoil has been rapidly deteriorating and is expected to be completely degraded in the next 60 years. If nothing is done that leaves only 60 years of harvest left.

The agricultural sector isn't alone in prioritizing economic gains over sustaining the environment it is dependent on. The linear model of industrial practices that is heavily reliant on fossil fuel has both polluted the land it is based on and increased the level of greenhouse gas emissions. One thousand billion tons of carbon have been pumped into the atmosphere, over the past 50 years alone, exacerbating the scale of climate change-induced disasters globally (Keesstra et al., 2016). The most powerful technology we have at hand to draw down this carbon load is healthy soil that can support plant life and micro-organisms naturally. For every 1% increase in organic matter, an acre of soil draws down 10 tons of carbon.

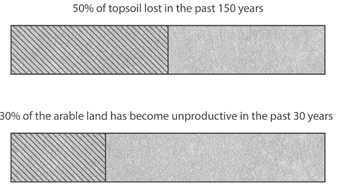


Fig: Percentage of decrese in arable land

"The most powerful technology we have at hand to draw down this carbon load is healthy soil"

The function of soil is to be understood beyond the sphere of food production. It is formed by a complex ecosystem of disintegrated rock, organic matter, water, gases, nutrients, and living organisms through slow processes that span over hundreds of years. In addition to acting as a carbon sink, it regulates and retains rainwater while functioning as a filter to improve the quality of the groundwater (den et al., 2021). Soil degradation not only destroys the most effective means available to capture carbon but also releases organic carbon content as a result of unsustainable land management (Lugato et al., 2018). Despite the mounting scientific evidence that points to unprecedented risks due to climate change, we remain resistant to making bold changes that draw down emissions.

Establishing a biobased economy centered around soil management has the potential to provide a financial incentive that would create an impetus for change, in addition to the pressing need to mitigate climate change. This would improve soil health, restore ecosystem services in addition to ensuring food security, and spearhead innovations that can steer us away from petro-chemical based industries to more biobased industries that valorize biodegradable wastes.

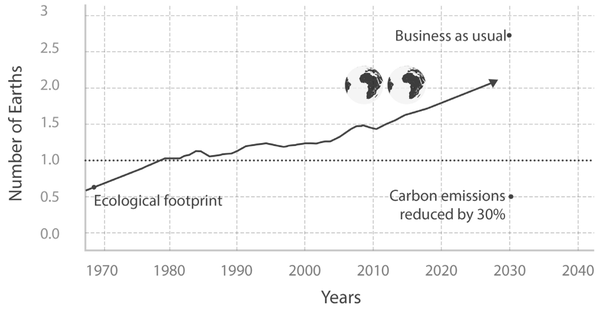
An economy that values soil and its natural functions holds the potential to not only halt emissions but also reverse them. The Nature Conservancy, an environmental organization published a report on a carbon market centered around soil, and through it highlights two categories of land use strategies that account for greenhouse gases (Unger et al., 2018).

The first is carbon sequestration projects that create carbon sinks by growing vegetation to enhance carbon storage. This is where regenerative farming plays a role.

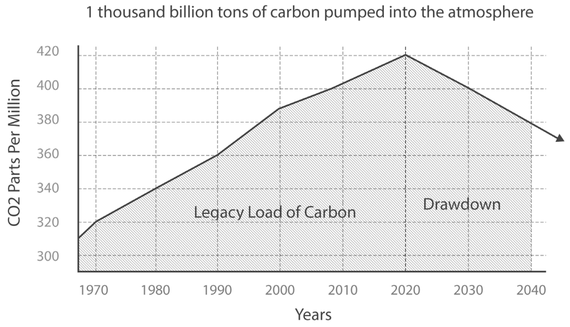
The second is through conservation which is avoiding the release of GHGs by protecting the land against degradation. This is done by restricting development based on environmental limits and factors.

'Down to Earth' proposes a strategy for development in South Holland, that allows such a transition that prioritizes eco-system services, through biobased economic activity.

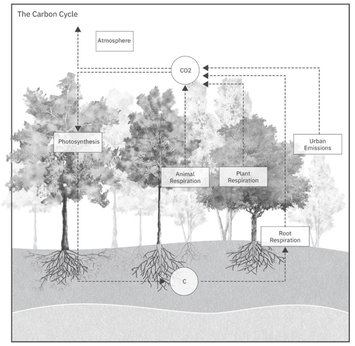
The future requires us to rethink our relationship with the natural system. From the choices that define our consumption patterns to the way, we define land management. As we draw closer to the limits set by the earth, we need to re-evaluate our priorities based on climate justice, resilience, and sustainable growth.



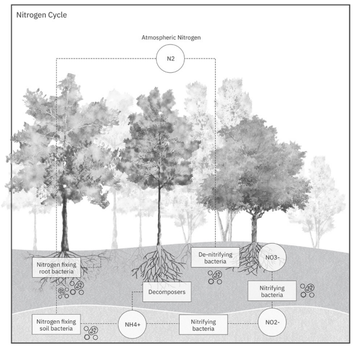
Projected values of ecological footprint if the current rate of emission continues



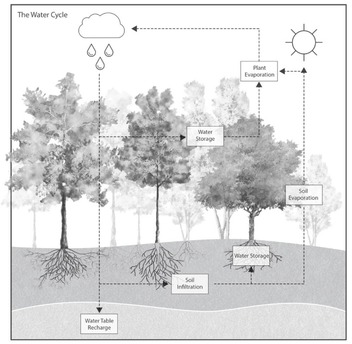
C02 emissions over the years and the projected draw down climate change mitigation needs.



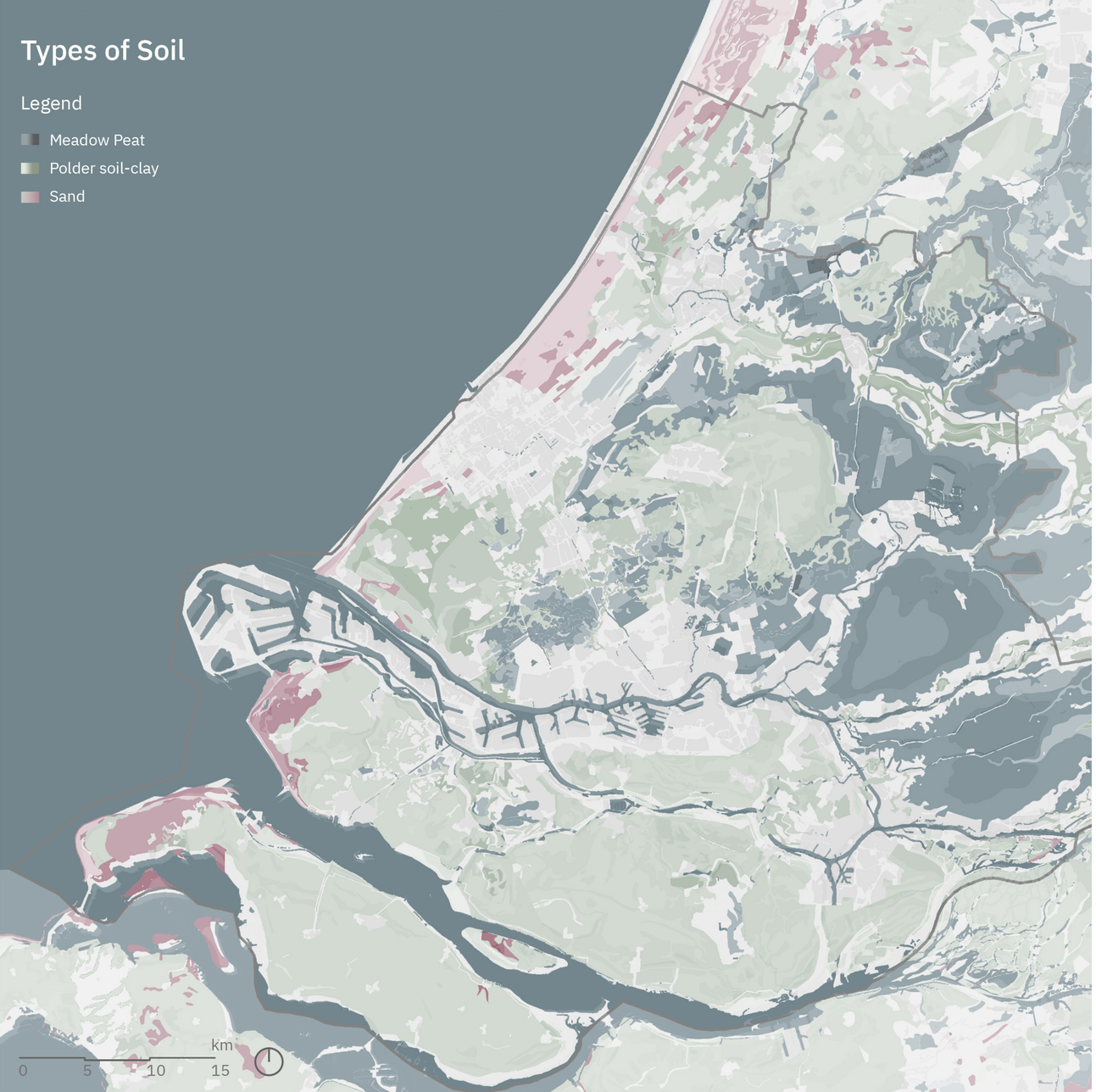
Soil functions in regulating the carbon cycle through photosynthesis



Soil functions in regulation the nitrogen cycle



Soil functions in filtering rainwater and recharging ground water levels



Context

The province of South Holland has a unique delta structure. The soil in the region is affected by the sediment deposits from the hinterlands and the North sea. The banks of the Meuse and Rhine rivers that run along it support one of the densest urbanized regions in Europe.

The soil of South Holland can be broadly classified based on its texture and organic content. In general, they are wet, fertile, and kept in a productive state under intense management (Romkens & Oenema, 2004). The sandy alluvial soil near the coasts supports thriving horticultural and agricultural units. Most notable of these are the flower industry in Bulbland and the fruit and vegetable market in Westland ("Zuid-Holland", 2014). Inland regions have peat and fertile alluvial clay, characterized by agriculture on reclaimed land. This region is supported by a thriving dairy industry, especially in Gouda ("Zuid-Holland", 2014). Peat soils have been intensely cultivated as a result of their high fertility, causing a steep decrease in the level of organic carbon in them (Romkens & Oenema, 2004). Additionally, since the 1960's there has been increased drainage of these areas, since the high water levels made diary farming difficult, creating higher levels of subsidence (Romkens & Oenema, 2004). The marine clay soils of the southern delta regions also support considerable arable farming.

In addition to South Hollands' thriving agricultural sector, an important part of its economy includes the Port of Rotterdam and the industrial belt that stretches across the Nieuwe Maas River. These developments over the years have resulted in human-induced threats to soil quality, whose impacts range from local to regional effects.

Loss of Soil organic matter

Organic matter serves as the substrate of soil life and supports nutrient and water retention. Soils in the Netherlands are rich in soil organic matter. Certain trends suggest that the organic matter in the soil has been reducing due to increased drainage, increased cultivation, frequent land-use changes, and loss of grassland cover. The loss of organic matter is increasing the risk of yield depression in the future (Romkens & Oenema, 2004).

Soil Pollution

High levels of atmospheric depositions of Sulphur and Nitrogen since the 20th century have resulted in eutrophication and acidification of natural areas and changed the chemical composition of the soil.
Industrial activity near the port of Rotterdam has further increased the contents of heavy metals in the soil which hampers soil functions. Furthermore, cultivation near these soils poses a risk to food safety (Romkens & Oenema, 2004).

Soil Covering

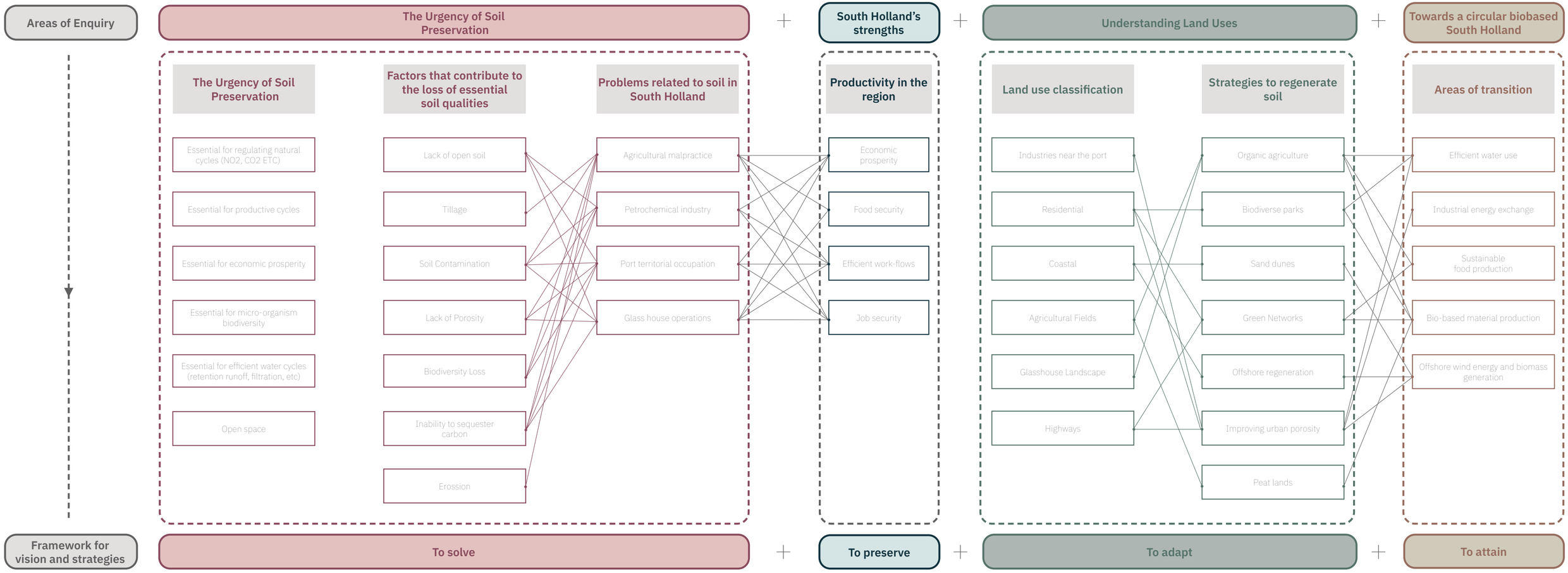
Soil covering is the sealing of the soil surface which effectively reduces the exchange of water and matter between soil and the atmosphere. This results in dead soil that fails to regulate natural cycles. Soil covering is predominant in urbanized and industrial areas, roads, and glasshouses. This coverage changes the flow of water and organic matter. (Romkens & Oenema, 2004).

Problem Statement

The urgency of remediating soil to improve both its fertility and carbon capture capacity is apparent. Soil conditions have a direct impact on economic productivity, the extent of urbanization, and the general quality of life.

Unsustainable land-use practices have resulted in economic prosperity within the region, but this was at the cost of disrupted natural cycles. The current modes of land management and patterns of development need to be reoriented towards remediating and regenerating the soil it relies on.

This transformation should address the problems at hand while maintaining the economic productivity and general social well-being that has been developing over time.



Vision

In our vision, by the 22nd century, South Holland will have a mode of urban and economic development that works in partnership with nature's services.

Our design values are rooted in accepting degraded soil as the core of environmental dilemmas while recognizing healthy soil as the most powerful and effective tool at hand to halt the consequences of climate change. Regenerating soil is about remediating the level of damage that has accumulated over centuries while adapting our needs within planetary constraints.

The Context of South Holland is defined by its land uses and how they interact with soil and the natural systems tied to it. Each land use identified here has the capacity to reorient its modes of operation towards a more regenerative strategy. The framework of a bio-based economy promotes collaborations between stakeholders through the exchange of waste and energy.

Through a holistic understanding of the different ways in which the soil is being polluted in South Holland, we have created a combination of remediation strategies that cater to the varying functional and spatial aspects of the province. These remediation strategies are specifically assigned based on the spatial implications of the adapted land-use strategies.

The future of South Holland is envisioned as a soil city that contributes to the socio-economic welfare of its citizens, improves biodiversity, protects vital landscapes, and ensures climate justice for all.

"In the 22nd century South-Holland has regenerative soil as the foundation of an innovative bio-based region, that connects society and economy on all scales while restoring ecological systems"

Potentials of a soil based South Holland

Overview of goals

Soils are the second largest reservoir of carbon after oceans and when mismanaged, they can become an enormous emitter. Despite its enormous potential in capturing carbon dioxide to lower global emissions, its essential functions are depleted causing it to lose its vital functions.

Remediating soil damaged by pollution, compaction, and sealing is essential to restore its natural organic content, fertility, and porosity. Healthy soil that is kept alive safeguards food security and preserves biodiversity while drawing down carbon emissions.

An increase in population densities and economic demands puts added pressure on natural systems. The infrastructure needed to support denser cities risks sealing soil and polluting it. Systems that support sustainable urban development should not be at the cost of compromised soil quality.

Prioritizing ecosystem services requires supportive policies and networks of institutions, and industries to collaborate. The circular bio-based economy is a backbone to connect stakeholders through a sustainable exchange of material and energy. This promotes resource efficiency and the growth of low-carbon industries.

Existing industrial activity and unsustainable land management practices have already exacerbated climate change in addition to stressing soil. Future strategies must be resilient to scenarios of flooding, and mitigate effects like increased heat stress, and soil subsidence among other mounting threats. Investing in nature-based solutions would ensure healthy livable conditions for all.

Our guiding principles for the vision are based on this understanding of the potentials a soil based city held.



Regenerating Soil Systems



Sustainable Urban Transformations



Creating a Circular Bio-based Economy



Mitigating Environmental Damange

Alignment of Goals with Existing Policy Frameworks

Although international frameworks like the Paris Agreement and European Green Deal do not explicitly address soil, their goals can be met through carbon capture from healthy open soils, and sustainable land management that can reduce current levels of emissions. Their action plans and goals have been co-related to the potentials of a soil-based city in South Holland.

Paris Agreement

The Paris Agreement hopes to limit the increase in average temperature to well below 2°C of pre-industrial levels, by maintaining a balance between emissions and removal by the end of the century.

European Green New Deal

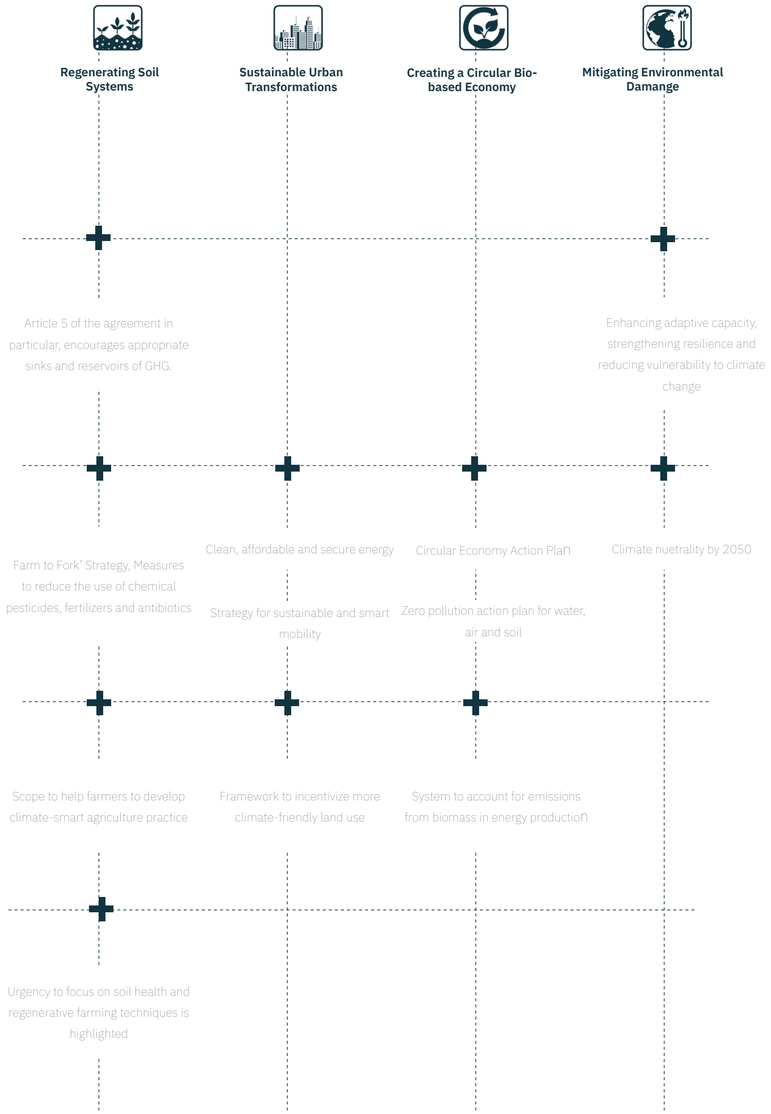
The goals of the European Green Deal is to ensure there is no net emissions of greenhouse gases by 2050, to decouple economic growth from resource extraction, and make sure no stakeholder is left behind.

Land use and forestry regulation for 2021-2030 (LULUCF)

It lays the framework to reach EU climate targets under European Green Deal by recognizing that land-use change can be a factor in CO2 release through agricultural expansion and deforestation. By including activities and mechanisms that remove greenhouse gas from the atmosphere we create carbon Sinks.

Cop 26

Commitments made in the Paris Agreement have been reappraised.



The strategies for the project align with eleven sustainable development goals highlighted in the 2030 agenda set by the United Nations as shown.

17 PARTNERSHIPS FOR THE GOALS

- Better links between agro centers and bio-based activity centered in the port
- Attracting investors for biobased and regenerative ventures.

Economy

8 GOOD JOBS AND ECONOMIC GROWTH

- Creating more jobs centered around sustainable production means
- Re-schooling to adapt to new jobs
- Better economic opportunities for small-scale farmers.

9 INNOVATION AND INFRASTRUCTURE

- Better connections to research units
- Sustainable infrastructure like soil networks, TOD, shared mobility
- Adapting to new technology like hyperloops

12 RESPONSIBLE CONSUMPTION

- Shifting consumer patterns to eco-conscious choices
- Efficient waste management to extract raw material
- Biodegradable Packaging

Society

2 NO HUNGER

- Improving food security
- Increasing biomass production without affecting food prices
- Prolonging soil life

3 GOOD HEALTH

- Improving physical well-being by improving walkability
- Better environmental quality
- Improving mental well-being through better access to green spaces

11 SUSTAINABLE CITIES AND COMMUNITIES

- Creating a soil city
- Improving green corridors and access to nature
- Shift to renewable energy and water systems

Ecology

6 CLEAN WATER AND SANITATION

- Nature-based stormwater runoff filtration
- Reducing groundwater pollution and extraction
- Grey water recycling
- Waterscapes to collect rainwater

14 LIFE BELOW WATER

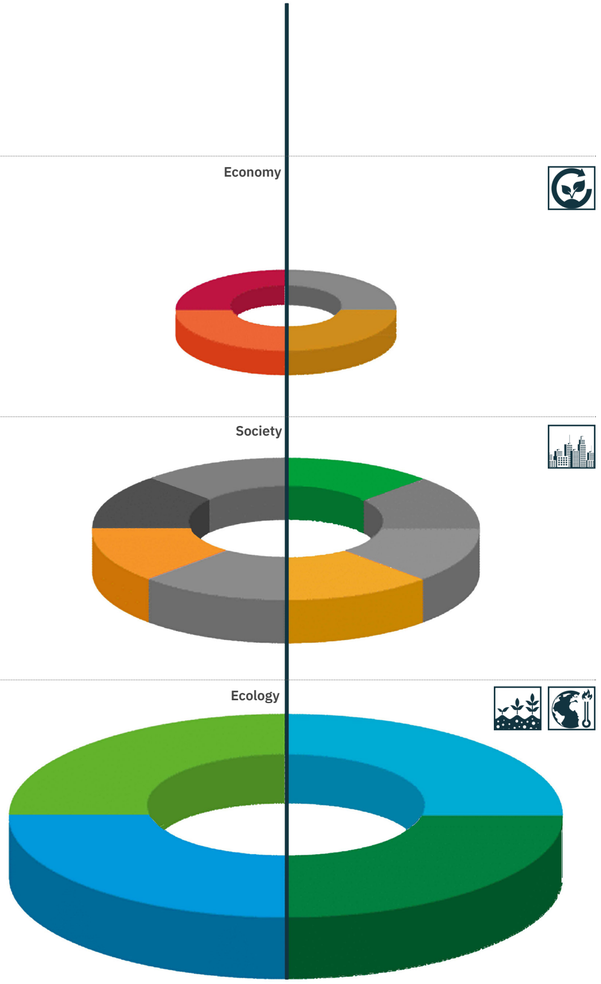
- Creating algae and fish farms to support land-based livestock and agriculture
- Restoring marine biodiversity
- Oyster reefs for biomass and resilience building
- Halting sand mining

13 CLIMATE ACTION

- Restoring ecological cycles
- Promoting carbon sequestration
- Improving flood resilience through coastal measures
- Restoring N_2 cycles
- Improving climate change awareness

15 LIFE ON LAND

- Creating a soil city centered around preserving nature
- Restoring and enhancing biodiversity



Strategies highlighted in the proposal within the United Nations SDG Framework, as depicted around Illustration based on a design from Azote Images (Jerker Lokrantz) for Stockholm Resilience Centre.



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Research Questions



Regenerating Soil

Regenerating soil is vital to restoring soils natural functions and sustaining the systems tied to it.

What are the strategies to restore soil's natural functions, and protect soil types with high potential that has been damaged?

How do we define the limits and transformations of urban development to keep soil systems open and alive?



Robust Shift

Strategies for the future have to be resilient and self sustaining and protect soil quality.

How do we adapt to new technologies and shift away from unsustainable systems that we are locked into?

How do we connect stakeholders with common interests and create a platform that incentivizes soil protection?

How can regenerating soil aid a robust shift towards a circular biobased economy that also mitigates environmental degradation?

How to create financial systems that incentivise the creation of carbon sinks through regenerative agricultural practices?

How do we create a system to valorize biodegradable wastes to improve soil quality on a large scale?

Creating a system that minimizes waste and pollution, reduces fresh water extraction, and uses renewable energy efficiently.

Circular Biobased Economy



What are the nature-based solutions that can build up defenses against flooding, while also contributing to the larger system of soil remediation?

How do we mitigate the degradation of natural systems while ensuring the socio-economic well-being of the stakeholders? involved?

Adressing the need to remediate environmental damage and build up resilience against climate change.

Mitigation



Theoretical Framework

Systems Thinking in Circular Transitions

Concerns over environmental degradation led to the widely accepted UN definition of sustainability as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. This definition has received criticism for being vague in the context of cities since it fails to address the complexities of the urban environment. To address the challenges in the complex field of sustainability, systems thinking is required. Sustainability would be best understood through a holistic view that emphasizes the connection between systems and a rational approach toward incentivizing efficient resource and energy flow. The circular economy plays a role in bringing about change by addressing this (Lindner et al, 2017).

While the traditional linear industrial economy is based on the idea that economic development is impossible without resource extraction, the circular economy “is regenerative by design and aims to gradually decouple growth from the consumption of finite resources”. It is based on three main principles as defined by the Ellen McArthur Foundation. (“Circular economy introduction”, 2021)

- Designing out waste and pollution
- Regenerating natural ecosystems
- Designing durable products that can be refurbished

Circularity as a Regenerative Principle

Circularity itself is one of nature’s guiding principles through which it restores itself (Stahel & MacArthur, 2019). Natural processes make effective use of biodegradable material after its life cycle to regenerate itself.

Regenerative agriculture that focuses on retaining soil health by minimizing the use of chemical supplements by cycling nutrients naturally, combining crops and livestock, and preserving natural capital, reduces the risk of crop failure and is more affordable to small farmers. This includes methods like- no-tillage, cover crop integration, and valorizing agricultural waste, which builds soil fertility and improves the functioning of the water cycle (de Boer & Ittersum, 2018).

Furthermore, regenerating natural capital in dense city spaces is crucial to help it safeguard, restore and increase the resilience of urban ecosystems against natural disasters like flooding.

To support this practice addressing circularity at a regional level is important because systems can be set in place to facilitate circular material flow locally. This helps ensure that the physical structure of the city and its infrastructure allows the effective reuse, collection, and redistribution of resources such as water, organic wastes, industrial byproducts, and household recyclables.

Financing the Circular Economy through a Soil Based Carbon Trading System

Climate Policy and Circular Economy concepts go hand in hand and have been described as “by and large complementary and mutually reinforcing”. The Circular Economy is reliant on a shift in the market to prefer its products and business model while using as little carbon as possible in this effort. Ideas to achieve this include “carbon contracts for difference, carbon budgets for projects, consumption charges, taxes and tax exemptions, sustainable finance, product standards, and public procurement” (Rizos et al., 2020).

Carbon trading is a market-based approach to reducing CO2 levels in the atmosphere, offering economic incentives to industries in return for reducing polluting emissions. It was developed as a response to the Kyoto Protocol which called for a united standard to reduce greenhouse gas emissions. (Reese, 2021)

Both carbon trading and transitions into the circular economic model aim to decouple development from environmental degradation. They are both reliant on using the market values to financially incentivize more businesses and industries to change their models of operation.

A soil-based carbon trading system would allow large-scale industrial emitters to invest in regenerative agricultural practices that offset their emissions. In the meantime, they have a chance to lower emissions as they transition to emission-free models of production (Unger et al., 2018).

Governing the Commons

Soil preservation can be understood as a common pool resource (CPR). Its exploitation by a group of users jeopardizes its climate regulation functions which affect all.

As highlighted in the paper on ‘Revisiting the Commons: Local Lessons, Global Challenges’, solving CPR problems involves restricting access and creating incentives for investments instead of over-exploitation (Ostrom et al., 1999). This approach aligns with our necessity to conserve grasslands and peatlands to avoid the release of GHGs and promote carbon sinks through regenerative agricultural practices.

The benefits of CPR management are more accessible when the knowledge about natural systems as well as valid indicators are openly available to all stakeholders (Ostrom et al., 1999). A nature-centric approach to development with sufficient communication between stakeholders is necessary to understand how their actions affect each other. Available technology can be used to maintain open access to data that indicate soil health.

The links between the stakeholders that manage common soil resources are complex, but they are rooted in a need to preserve biodiversity and reduce climate change. Through creating channels of interdependencies and open communication, we can achieve this common goal.

Conceptual Framework



Fig: Conceptual Framework that alligns social, economic and ecological data around soil functions and the need to remediate soil quality.

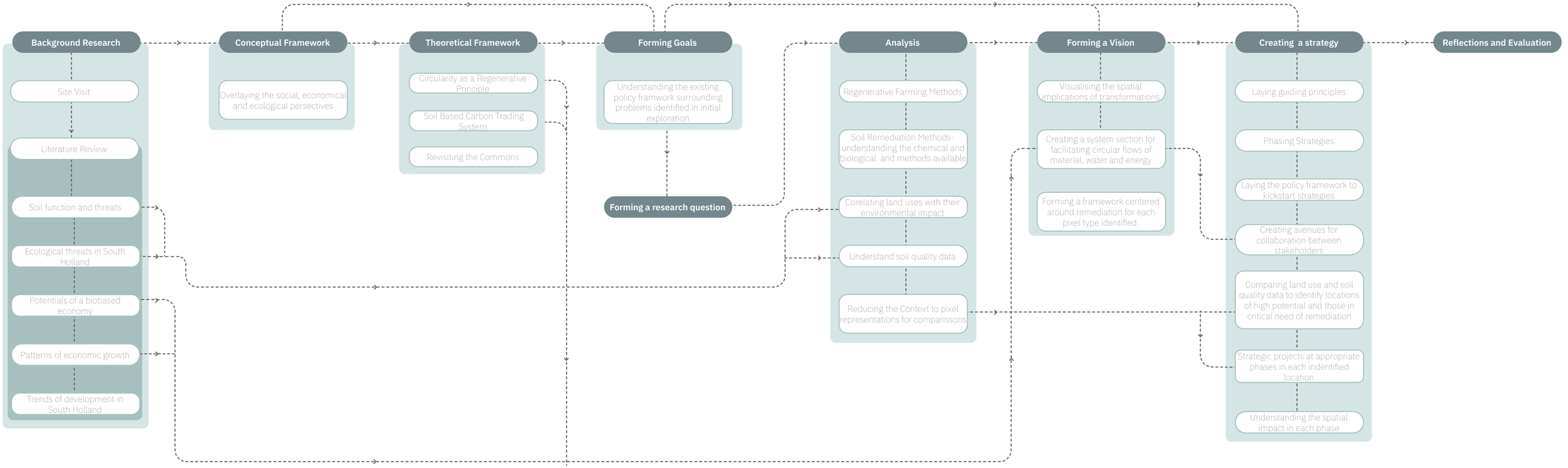
Down To Earth proposes a future where nature coexists with the Anthropocene. Soil forms the foundation of all life and regulates the food webs and natural cycles tied to it. Healthy ecosystems stand to fall under the threat of soil degradation, which is set in motion by human activity (den et al., 2021). In the age of climate change, this approach needs to be re-evaluated.

Soil lies at the convergence of social, environmental, and economic demands. From an economic perspective, it is a source of nutrients and minerals and sustains food and plants that provide us with bio-chemical raw material. The temporality of our demands, and the technical, and organizational innovations that make this extraction possible are rapidly outpacing natural life cycles. This mode of addressing economic growth has caused our land to become extremely fragile (Sassen, 2018).

Indiscriminately tapping into soil to fulfill market demands, compromises liveability. Socially disadvantaged populations are more vulnerable to environmental degradation and the effects of climate change-induced natural disasters. This intersection of social and environmental justice is a critical one. Although the profits from natural exploitation don't reach all, the disruption of our shared ecosystem affects all.

Development must recognize the value of nature's services and the limits set by it. Sustainable sourcing of raw materials and energy holds the potential to rectify the damage done by the linear agro-industrial model of the economy. Fixing the disjoint between the economic and the ecological perspective is vital to ensuring equitable development and climate justice. Our concept diagram highlights how restoring soil quality and acknowledging soil services form the framework that ties together environmental and social justice while maintaining responsible economic activity.

Methododology Flowchart





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Soil Remediation Techniques

The main steps considered in laying out our strategy for soil remediation include, understanding its effect on different land uses, identifying the stakeholders, mapping the level of contamination, and creating an inventory of the technological options available for remediation. These layers of our understanding were analyzed to find the most sustainable way forward. Finally, after the implementation of the chosen strategies, it is essential to set policies in place to monitor its care, and prevent further damage.

There are several soil remediation techniques. They are categorized broadly as nature-based and chemical techniques. Each category can be further subdivided in-situ and ex-situ methods. Chemical techniques are more expensive, because of the cost of excavation and transportation. At the same time, when the soil is excavated there is a risk of spreading contaminants which has an environmental impact. However, one of the advantages of these techniques is that they require considerably less time, and the process is more controllable. Natural remediation techniques which are in situ, where soil is not excavated and transported, are cheaper. Here, the original structure of the soil is preserved, as microorganisms and soil life is conserved. However, it takes a long time to achieve remediation through this process, because it relies on natural cycles.

For our proposal we mainly used nature-based solutions such as phytoremediation, bioremediation, vermiculture, landfarming and compost, where the levels of contamination are low. In areas with high levels of pollution and sites in urgent need of remediation, we propose to use a combination of natural and chemical techniques, such as soil washing, that can accelerate the processes.

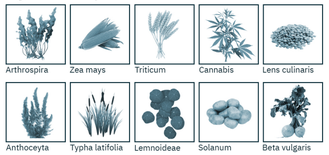
For our proposal, we have researched native flora and fauna to guarantee a successful and sustainable remediation process. Native species are crucial for removing pollutants through Bioremediation and phytoremediation techniques. What is more, they improve the proliferation of microorganisms in the subsurface. This selection is a reduction of a long list of species that can be used for the proposed restoration processes for each type and its characteristics.

Species Selection for Ecological Restoration

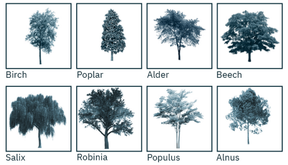
Urban Farmig Species



Agricultural Species



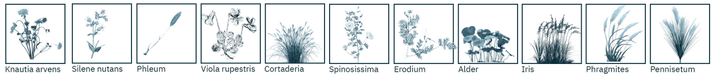
Tree Species



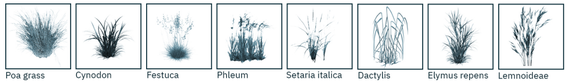
Benthic Species



Dune Species



Grass Species



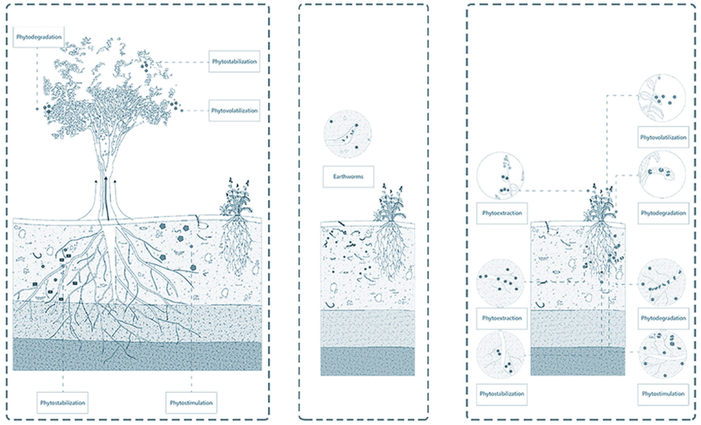


Grass Species



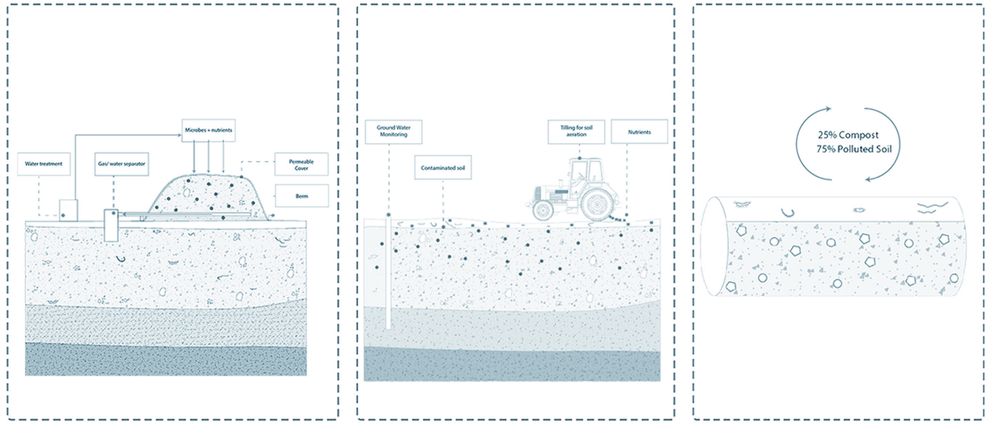
Natural Based Solutions

In-Situ



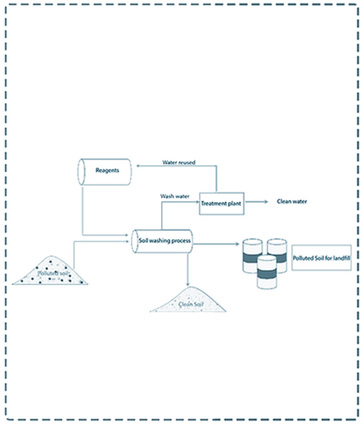
Bioremediation Vermiremediation Phytoremediation

Ex-Situ

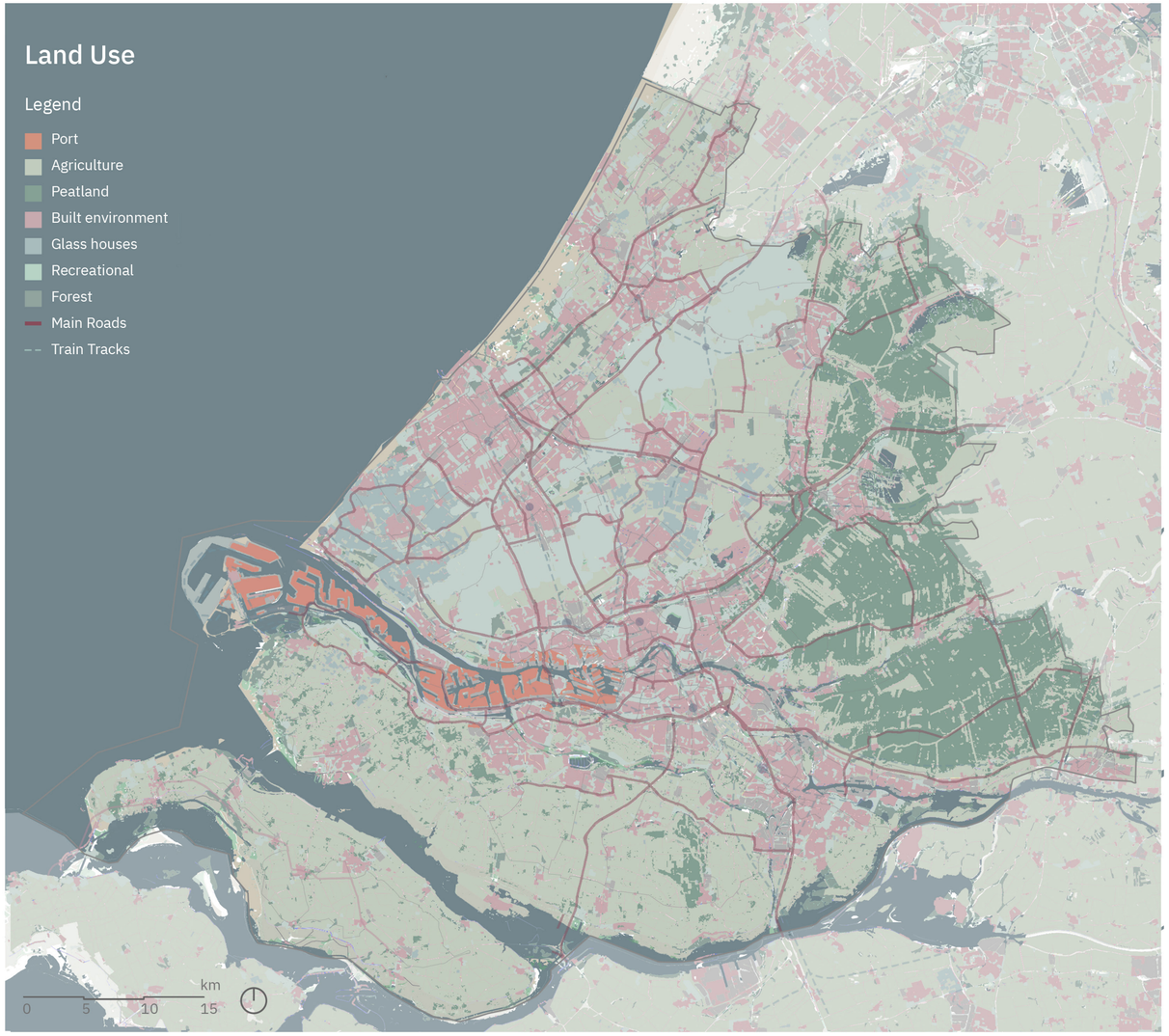


Biopiles Landfarming Compost

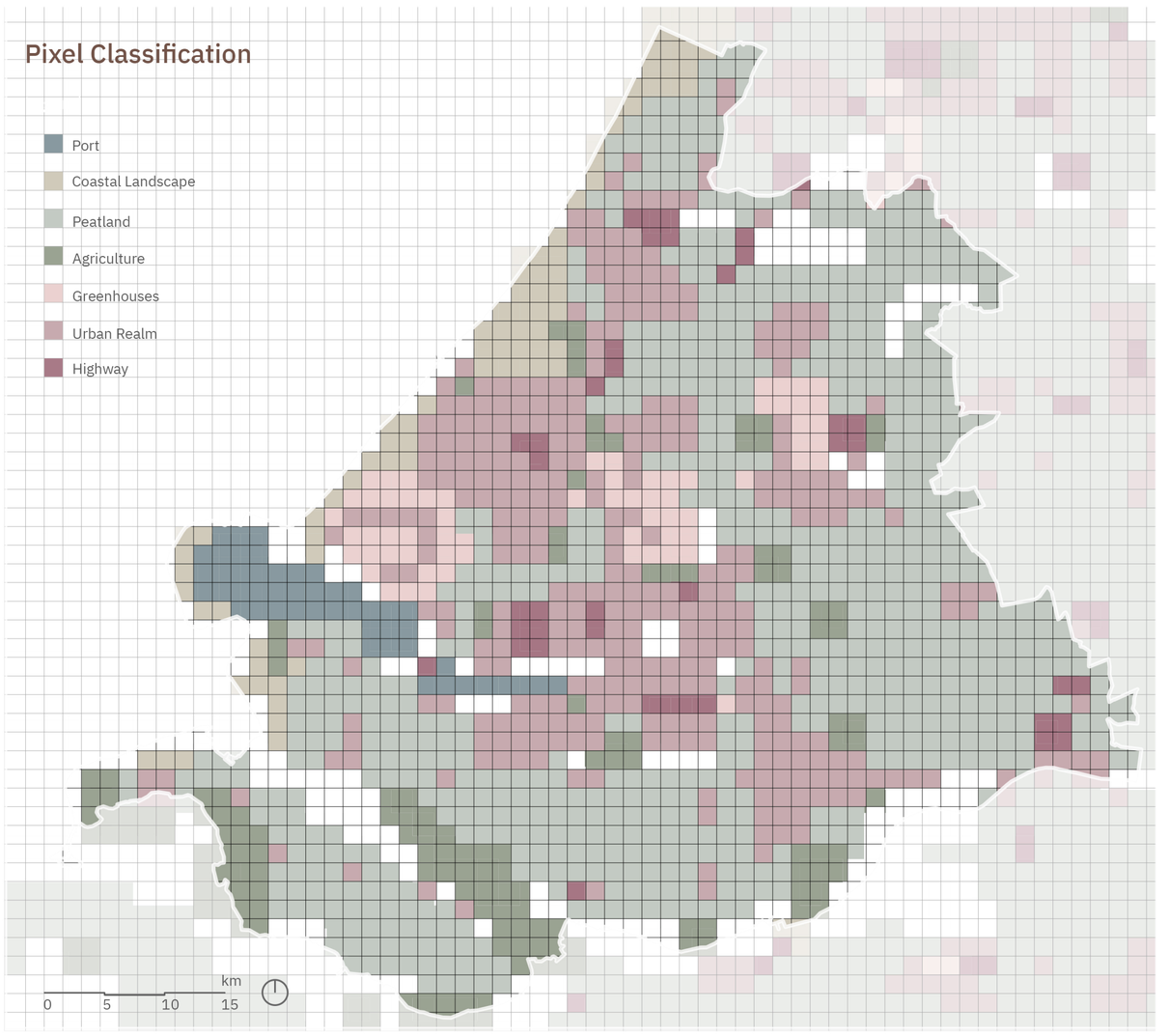
Chemical Solutions



Soil washing



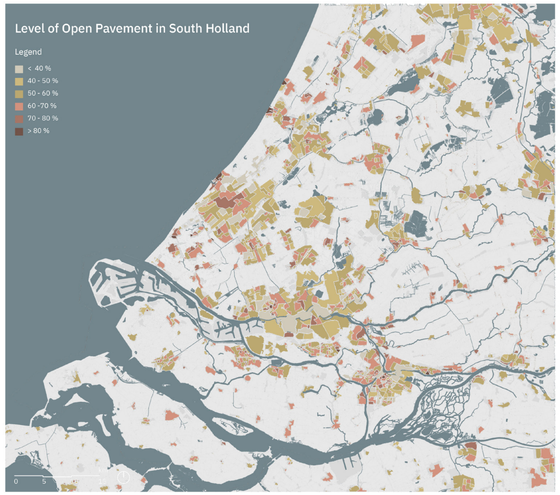
For our understanding it was important to see how different forms of land usage in South Holland interacted with soil, and note the main infrastructure that connected them. From this map it becomes clear how much of the land is covered by the built environment, and the manner in which it is spread out over different regions. The Rotterdam region, together with the port forms an important hub that is well connected by both railway networks and roads. Additionally, the map highlights a strong division between the built environment and its surrounding green landscapes. These landscapes are a combination of agriculture, peatland, recreational green space and forests. Finally, the glasshouse industry covers up a significant part of the soil and is a strong element that defines the region's identity. We can conclude that the current land use is productive economically but it has caused soil pollution, and there is a need to preserve the existing productivity of these systems while shifting to biobased flows. (PDOK, 2018)



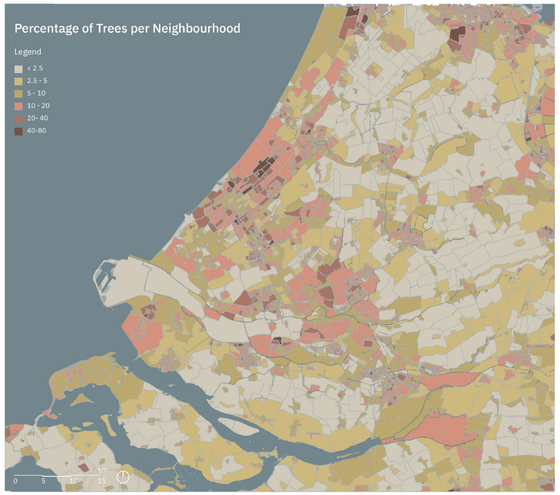
Our methodology was to reduce South Holland to pixels of 1.5 km2, and identify the different distinct spatial and functional characteristics within those pixels. We defined seven categories, which formed the basis for our strategy. After defining each type and its characteristic, we illustrated the soil profile based on point location drillings, and identified the type of soil and its period of accumulation. This understanding was layered with the different ways in which each type of land use is interacting with the soil, and to what extent it affects soils purity, biodiversity, porosity and fertility.

Human Interaction with Soil

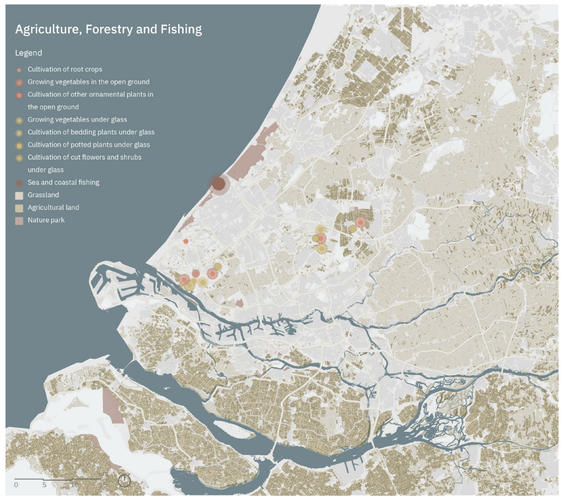
This chapter illustrates human interaction with the soil in South Holland. The different maps show how the soil is being used throughout the region and how productive activities are connected to the soil. From these maps it is clear that there is a strong imbalance in the way .soil is being exploited, and how nature interacts with the built environment and the economy,



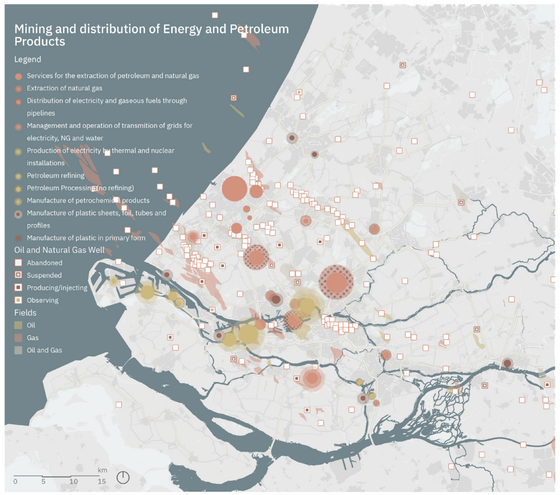
We investigated the level of open pavement and concluded that there are many areas in the urbanized regions that have considerably low levels of open pavement (<40%). This is especially the case for the inner cities of Rotterdam and The Hague, but also in the outskirts of several metropolitan regions. Opening up of the soil in these regions has many ecological benefits and promotes healthy living.(Atlas Leefomgeving, 2022)



The percentage of trees per neighborhood is a clear indicator of how nature is integrated with the built environment. While several neighborhoods in the Hague show a high level of trees (especially in the dune region), there are many zones that show extremely low levels of trees - especially in inner city areas. (Atlas Leefomgeving, 2022)



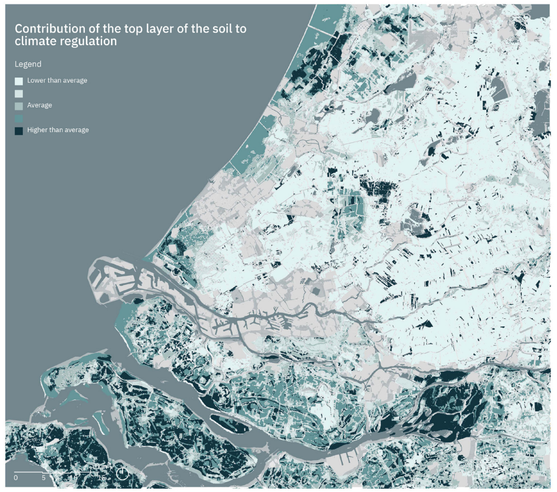
In the southern part of South Holland, agriculture takes up most of the land. The metropolitan region of Rotterdam and Den Hague show a diverse context and is fragmented by the concentration of greenhouses in Westland. Nature parks appear to be scarce and can only be found along the coast line and in the southern part of the region.(ESA, 2022)



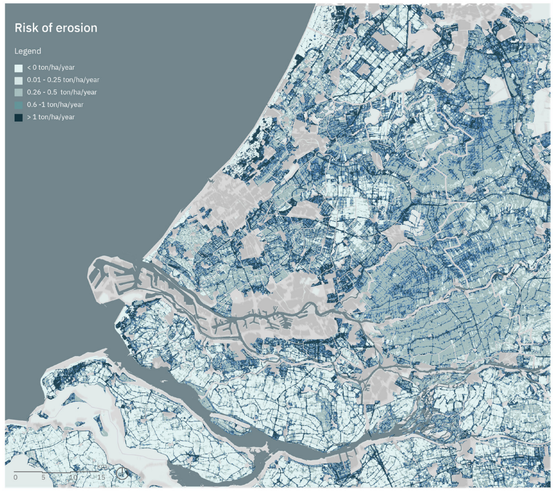
This map indicates how the region is still strongly characterized by the fossil fuel industry. Although many oil and gas wells are abandoned, many are still actively being used. The harbor supports high levels of petroleum processing, refining and manufacturing activities. These activities have a significant impact on the quality of the soil and forms a barrier for the efficient use of open, clean soil. (Fracmapper, 2022)

Loss of Soil Functions

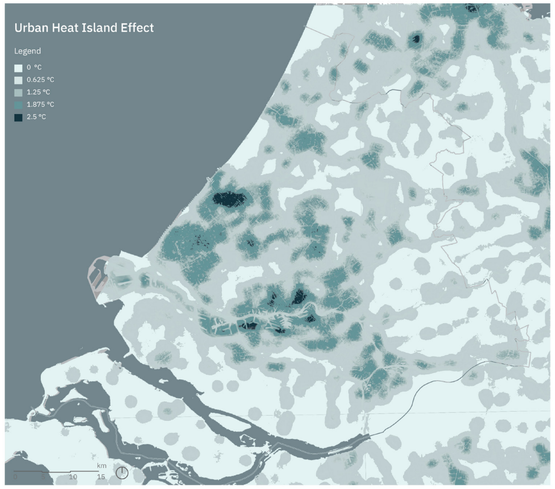
Losing the primary functions of soil is an urgent problem for the province of South Holland. Our findings indicate how different soil qualities impact the region and indicate the threats they pose towards the future development of the area and its inhabitants.



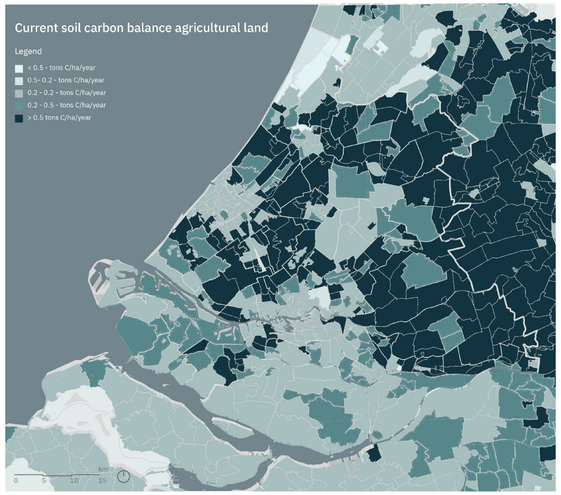
The southern part of South Holland has higher levels of climate regulation than the northern and central part does. The more natural areas play an important role in climate regulation. This demonstrates the necessity to integrate nature with the urbanized areas. (Atlas Natuurlijk Kapitaal, 2018)



The risk of erosion is especially apparent in the urbanized areas and the central part of South Holland. If left untreated, the areas under high risk can erode quickly and drastically draw down the quality and fertility of the soil. (Atlas Natuurlijk Kapitaal, 2018)

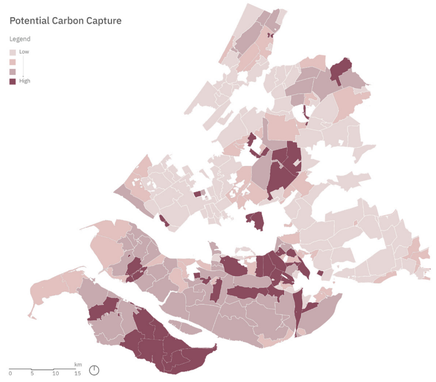


Urban heat islands are generally formed in areas with a high concentration of buildings and infrastructure. The map clearly indicates a strong heat island effect in the inner city of Den Hague, the whole of Rotterdam and its port. (Atlas Natuurlijk Kapitaal, 2018)



The amount of carbon that soil is able to sequester varies in South Holland. While the east and north-east of South-Holland shows a high capacity of carbon sequestration, the south and south-western part of the province show significantly lower capacity.(Atlas Natuurlijk Kapitaal, 2018)

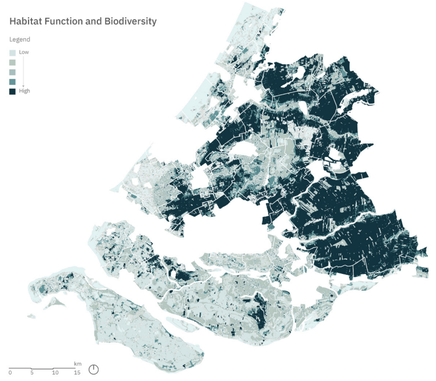
Soil Fuctions



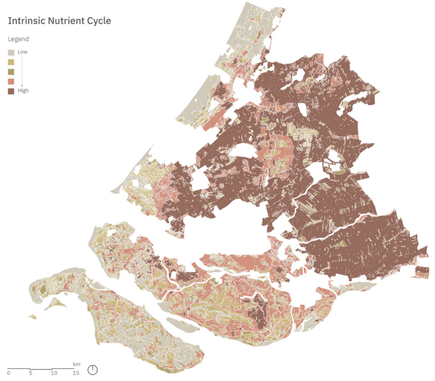
Natural Landscapes and areas with high levels of open soil have a high potential for carbon capture. (Atlas Natuurlijk Kapitaal, 2018)



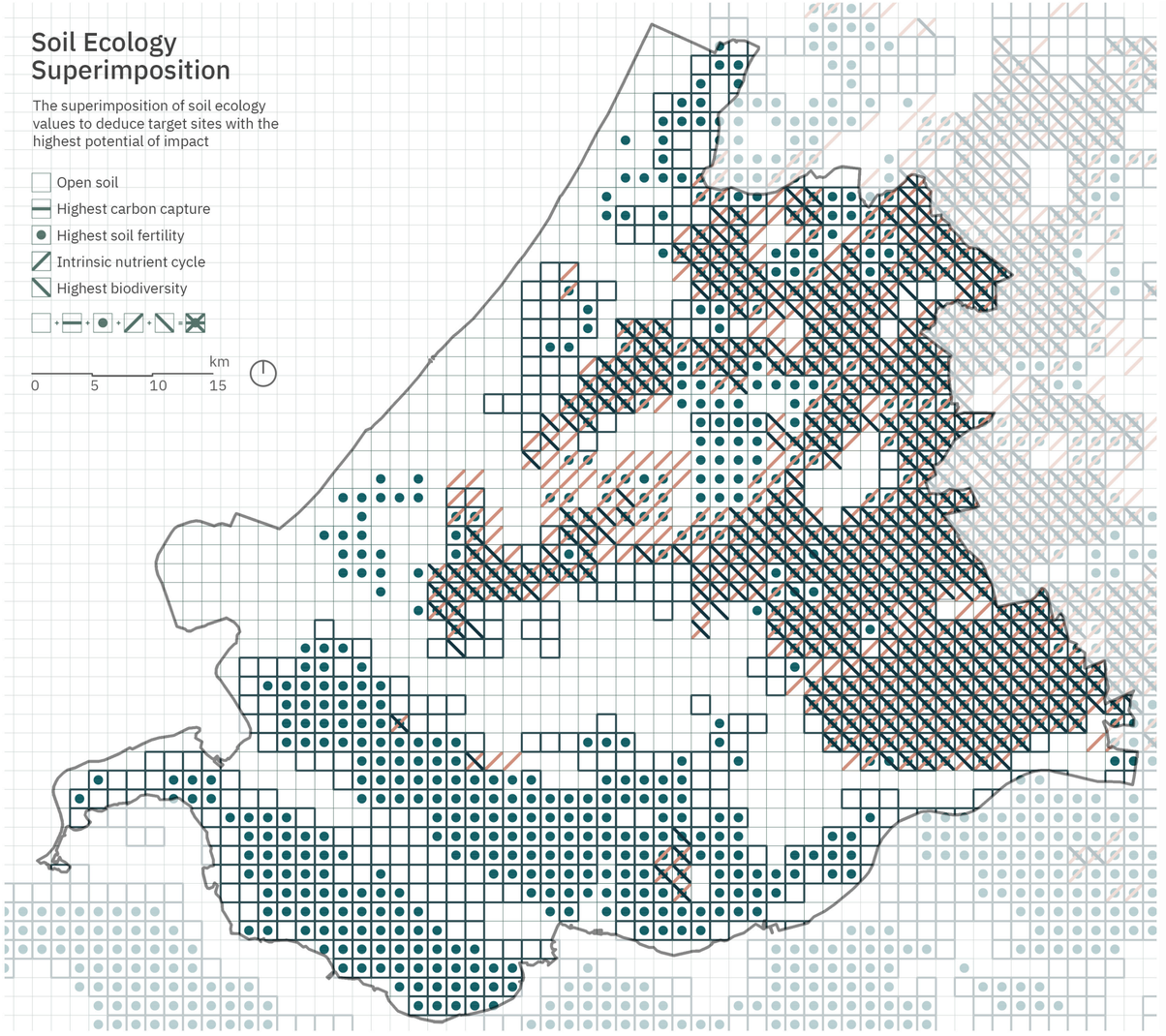
Soil fertility is high throughout South Holland, although several areas (e.g. along the coast) show lower levels of soil fertility. (Atlas Natuurlijk Kapitaal, 2018)



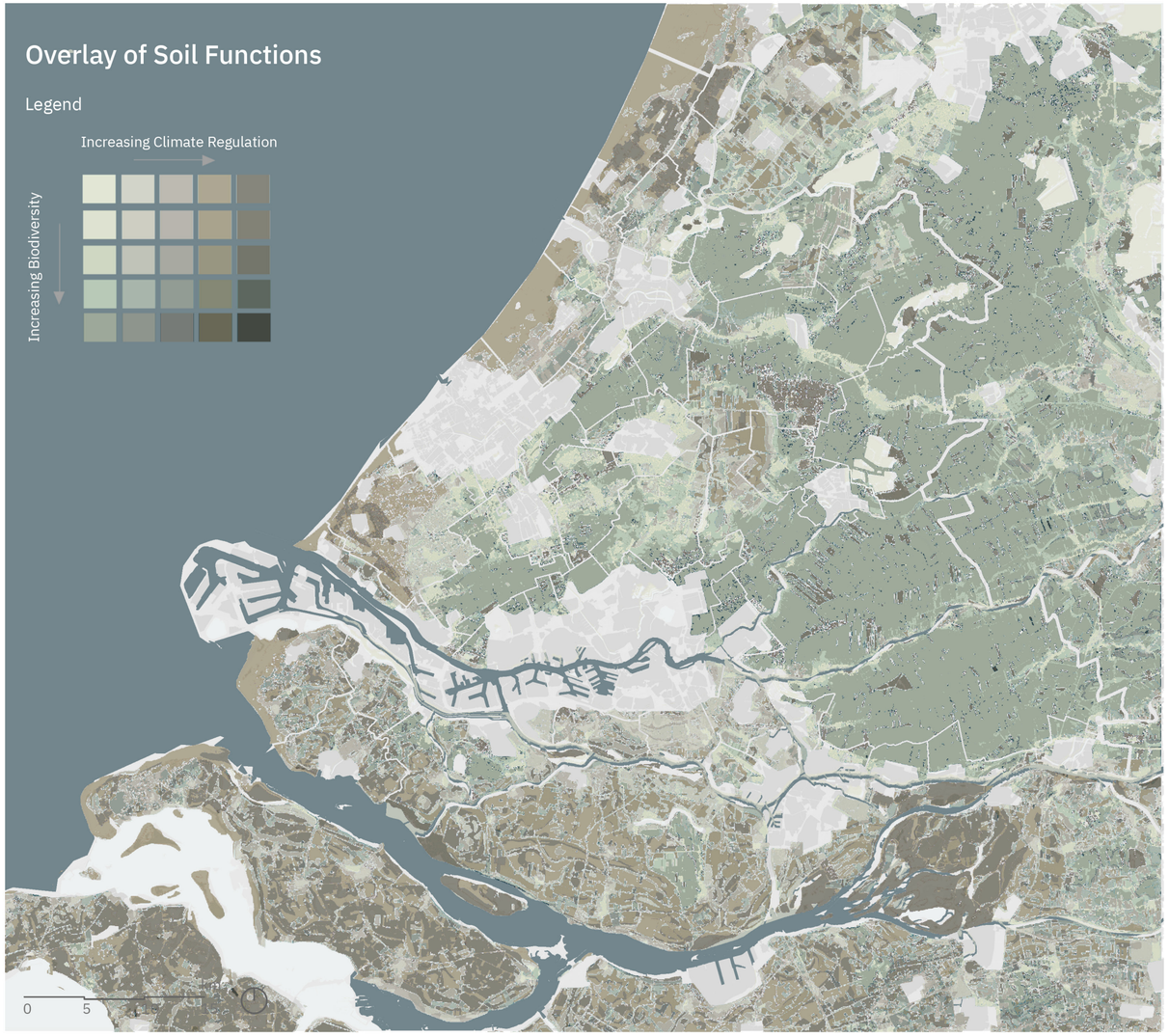
The east and north-east of South Holland shows high levels of habitat function and biodiversity. The southern region, although characterized by its open soil, shows lower levels of habitat function and biodiversity. (Atlas Natuurlijk Kapitaal, 2018)



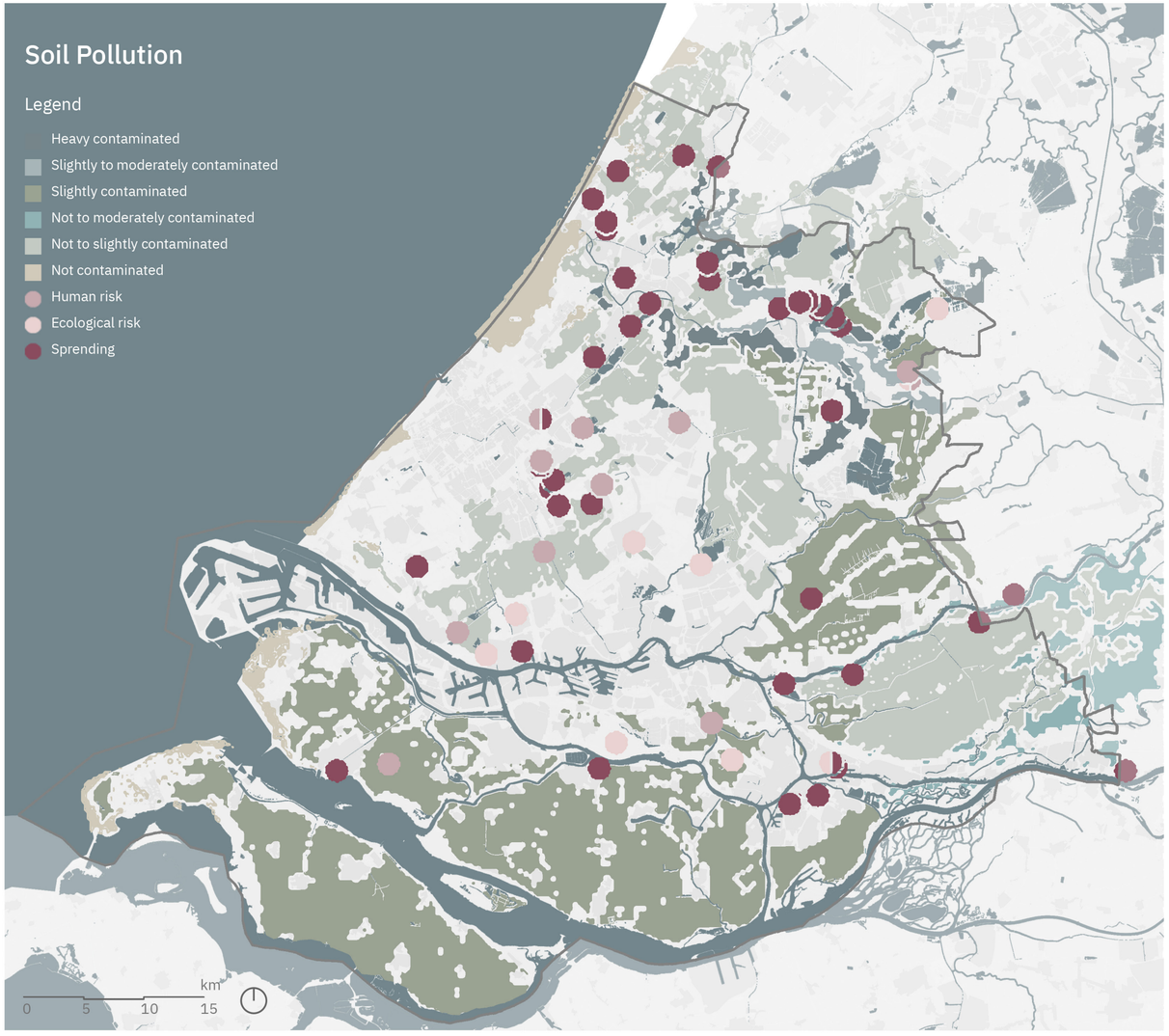
High intrinsic nutrient cycle is seen in the east and north-east of South Holland. (Atlas Natuurlijk Kapitaal, 2018)



Overlapping the different soil ecological values represented by symbols, allows us to target the sites with the highest potential of impact in the region of South Holland. Areas where more symbols are gathered, show a high soil quality. Our strategy choses strategic locations for intervention based on this analysis.



This overlay of soil functions demonstrates how the southern part of South-Holland is particularly important for climate regulation in the area, while the east and north-east contribute significantly to the level of biodiversity within the province. This map guides our vision and shows us the level of remediation needed to restore soil natural functions. Also, It helped us to define the limits of our development. Urban expansion in our proposal has been limited to areas where the soil shows low levels of biodiversity and a low ability to capture carbon.



The soil in South Holland shows significant levels of contamination. There are several critical locations where the contamination is spreading and where there is an ecological risk at hand. Moreover, there are several locations which pose a high risk for humans in the area. This finding helped us in the process of defining where different remediation techniques are applicable. Chemical techniques are proposed in places where there is an urgency or high levels of risk towards humans and ecology. This can reduce the high levels of risk within a short time frame.(Atlas Zuid Holland, 2019)

Trends in South Holland

According to the Province of South Holland (2019) and the Port of Rotterdam (2020), there have been a number of trends going on in the past few years. We have divided them into three categories: economical trends, social trends and environmental trends.

Economical trends

The economical trends are regional spreading of companies, improving the efficiency in transport. Since the pandemic countries have started to become more national oriented again. Furthermore, E-commerce has started to lead to stockpiling. And international companies struggle to meet environmental requirements in the Netherlands.
Besides these trends, there are 12 projects ('Startmotor') in and surrounding the harbour and industry that could lead to more employment (9.000 to 15.000 extra jobs). Projects also contain developments of the international hydrogen hub Rotterdam and pipes to Germany (to Chemelot & Noordrijn-Westfalen). Also projects for sailing without emission, chemical recycling, storage of CO2 and providing the heat coming from the Port towards the region South Holland.

Social trends

One of the major social trends is the housing problem. More and more people are moving to the Netherlands, together with an expansion of the population and the influence of multiple wars going on at this moment.
Rotterdams aspiration for the harbour is becoming a Global Industry Hub: a global hub that is digital & efficient, Europe's Industrial Cluster that's in competition and in transition, connecting harbour, city and region, has space for developments, human capital, innovative ecosystem.
Labour: people whose sector have been hit by the whole pandemic should be able to get education to continue working at another sector that does need more people. (They need more laborers at Rotterdam Port)
For the Port of Rotterdam, international criminality is still occuring, harming the image of the Port. Because of this, a program started: social safety. It partly wants to influence the behaviour but also the physical en digital security.

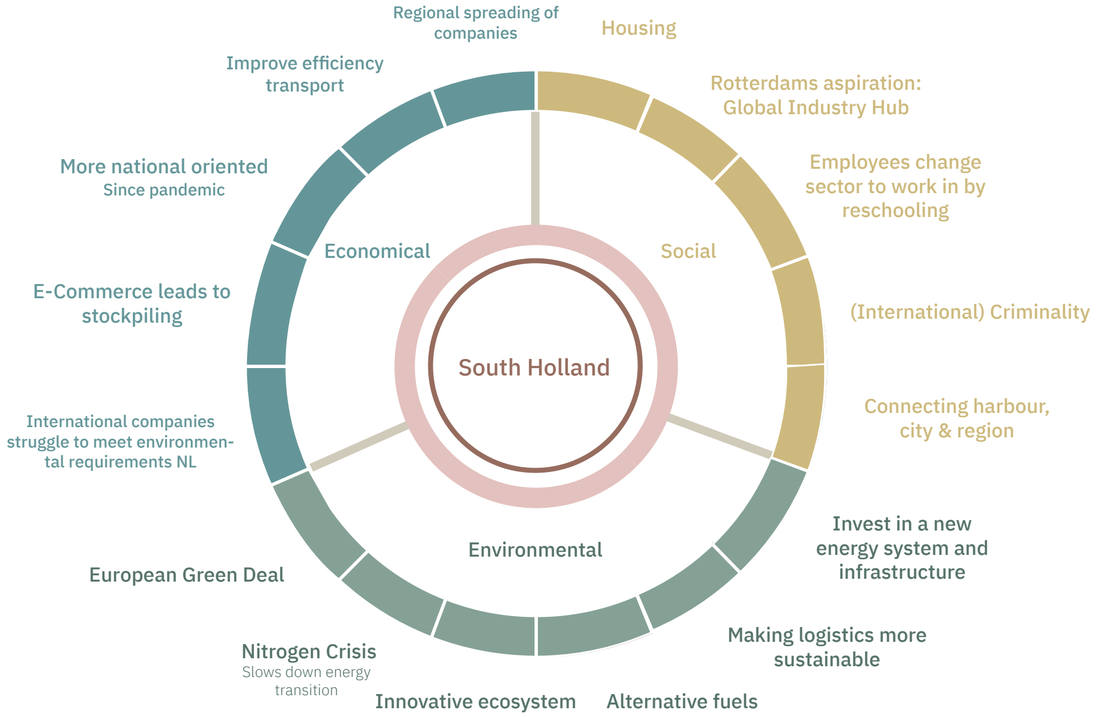
Environmental Trends

The Netherlands has to reach the European Green Deal, among others. According to the Province of South-Holland, reaching the goal of the European Green Deal remains top priority.
Besides that, there is a nitrogen crisis. Nitrogen crisis disturbs the sustainability of the port and slows down the energy transition, since there are less permits provided. With the new nitrogen law, the energy transition has been slowed down. In this law it is said that only temporary construction activities aren't categorized in the law, meaning temporary construction is not restricted by the nitrogen law.

Another trend are the alternative fuels for maritime. Relevant for the port are proposes the broaden the supply and demand of alternative fuels to make the maritime more sustainable.

Making logistics more sustainable, which directly connects with investing in a new energy system and infrastructure, more digitalization to improve the efficiency of transporting goods and proposes to enhance the modal shift in the transport system.

Trends in South Holland

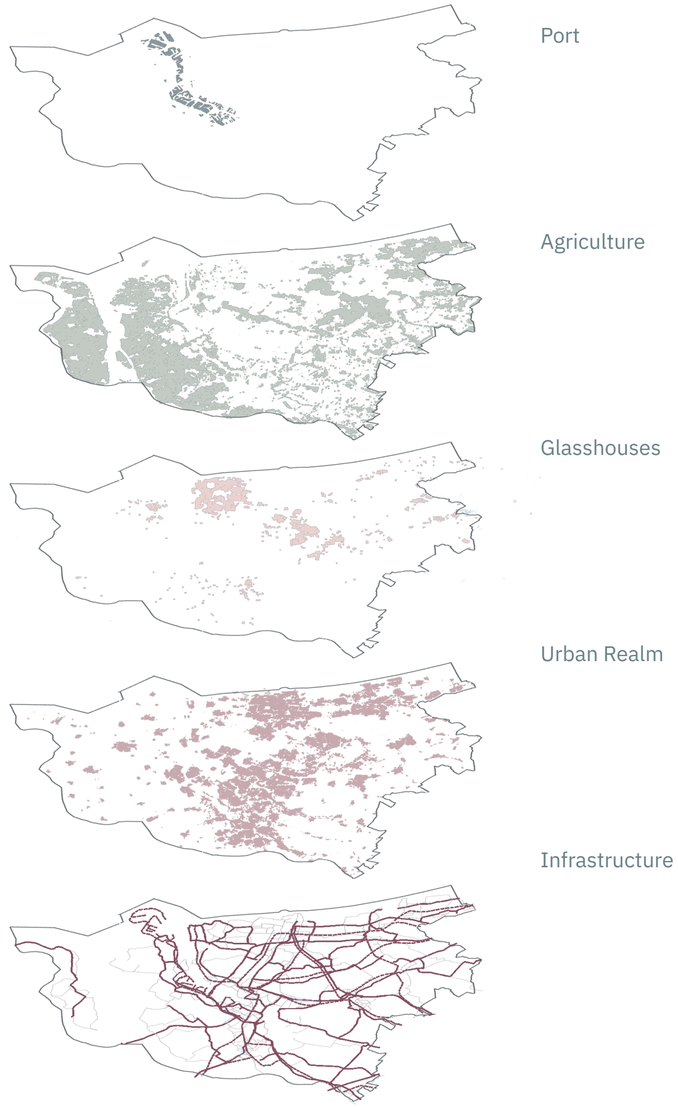


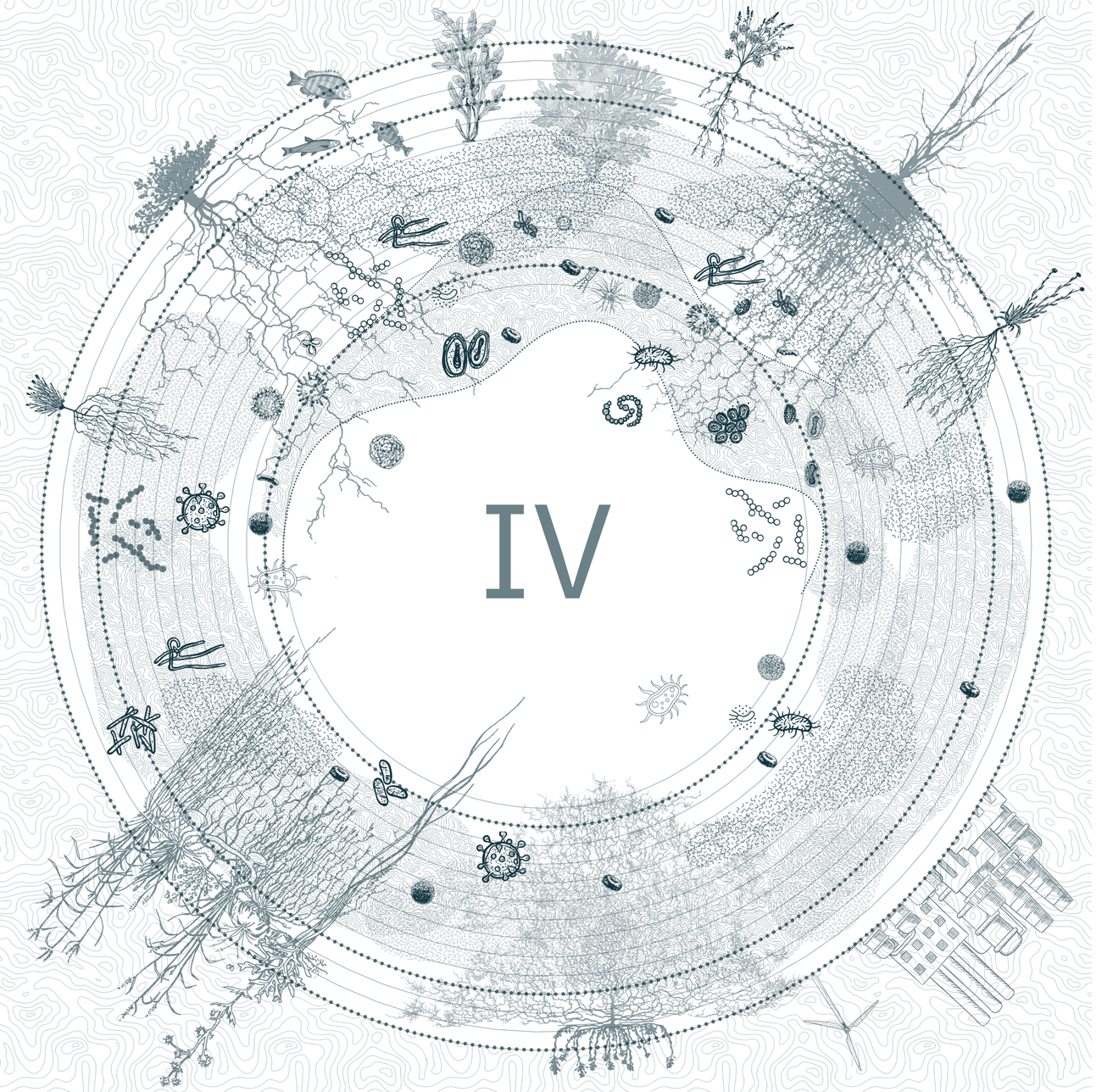
Trends of South Holland, based on the analysis of the Province of South-Holland (Provincie Zuid-Holland, 2019) and of the Port of Rotterdam (2020).

SWOT
South-Holland



Land-use
Subtitle



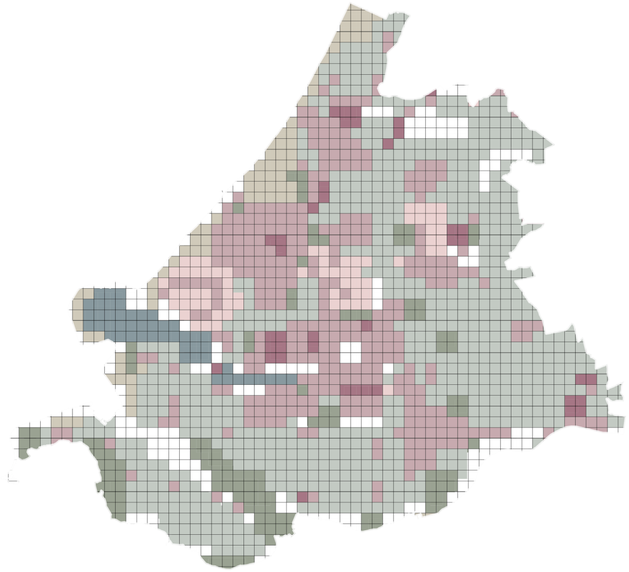


Vision

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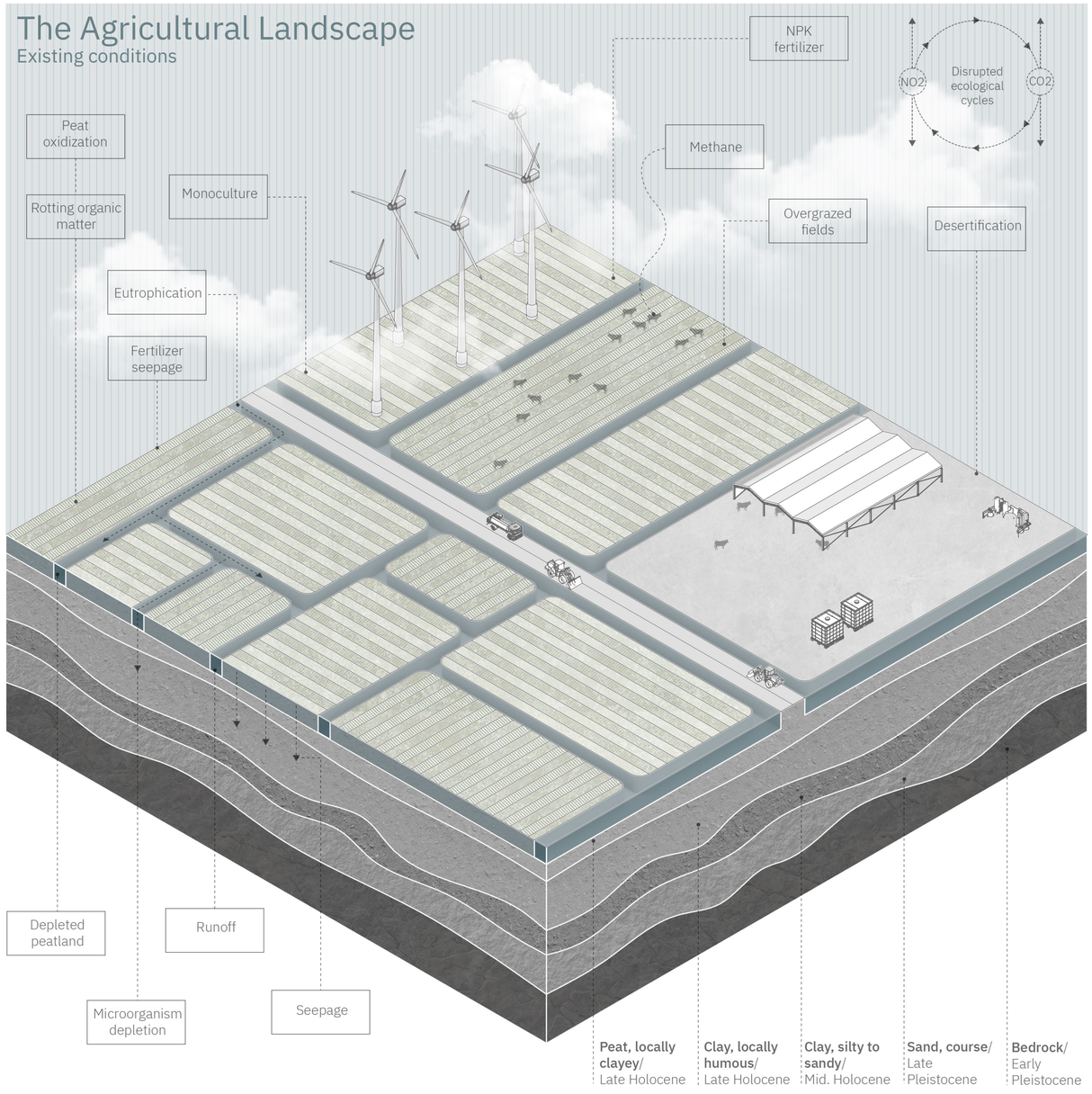
Vision

South Hollands' context has been understood in terms of the dominant land uses that define it. The context has been reduced to an abstraction of pixel types, to explore the activities it relies on and how they upset the environment.
The soil profile of each type of pixel, along with the man-made infrastructure that exists on it has been detailed in axonometric representations of the context. Through this analysis, we have envisioned future potentials where these activities can be reoriented to be both environmentally restorative and economically functional.



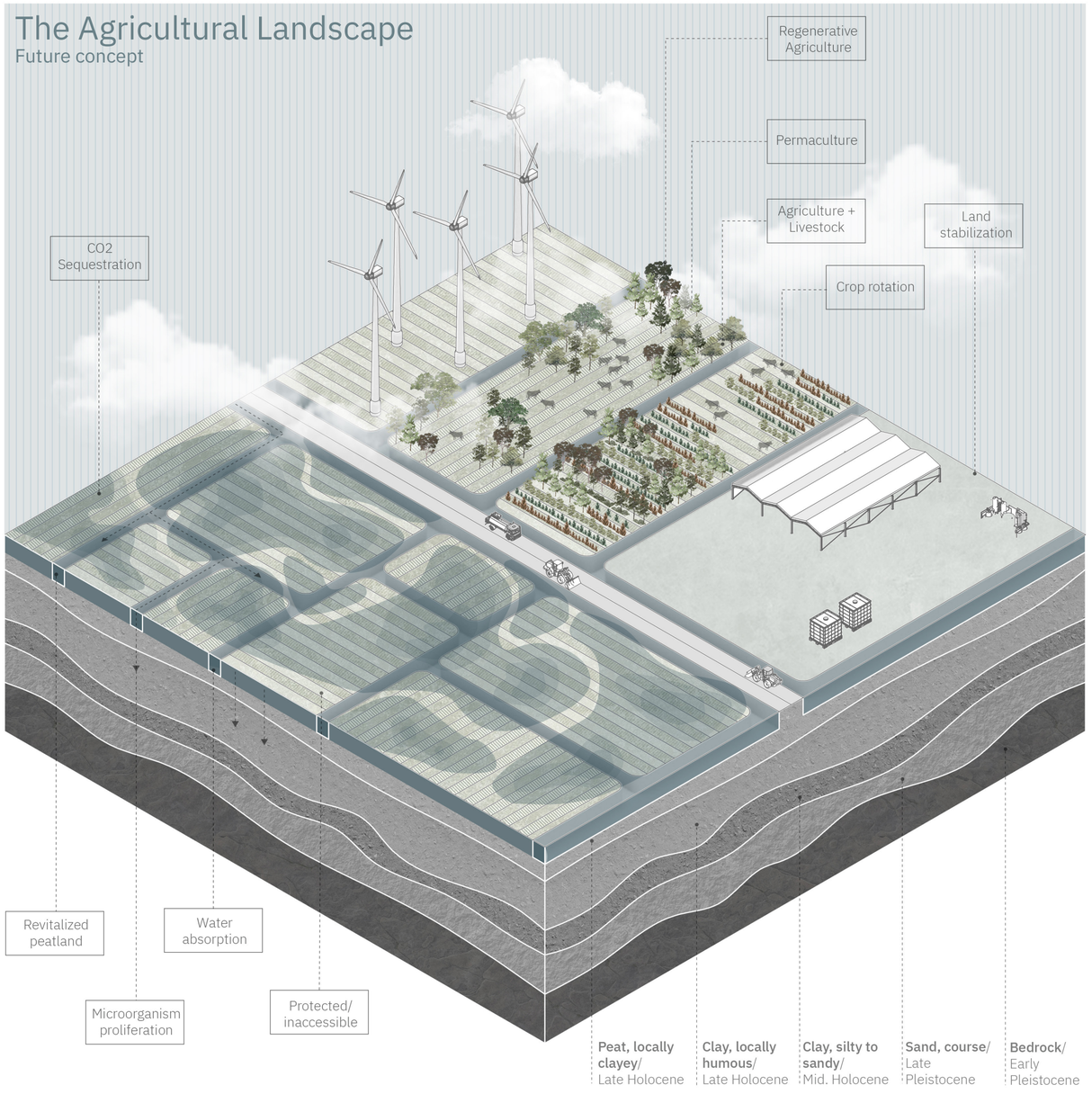
The Agricultural Landscape

Existing conditions



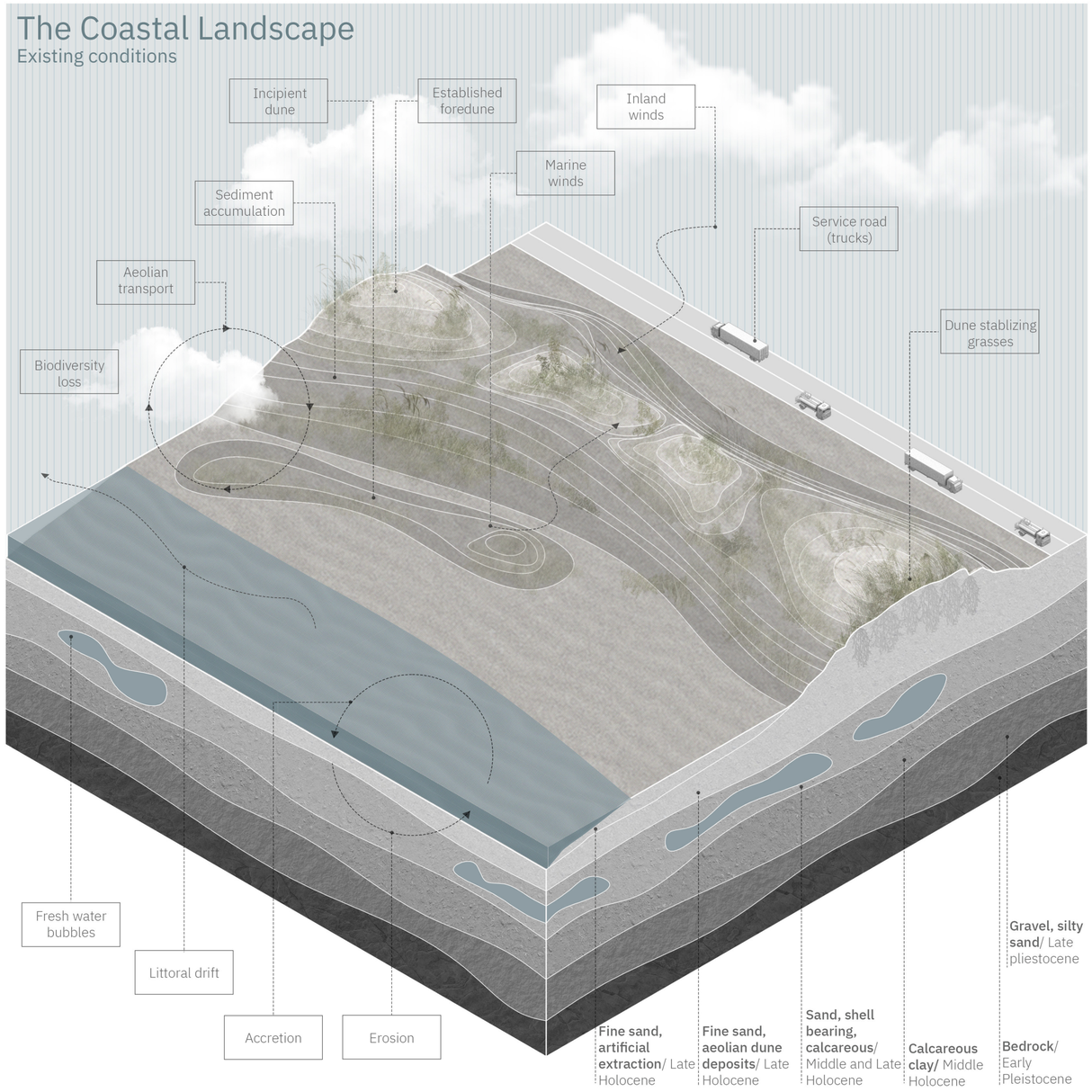
The Agricultural Landscape

Future concept



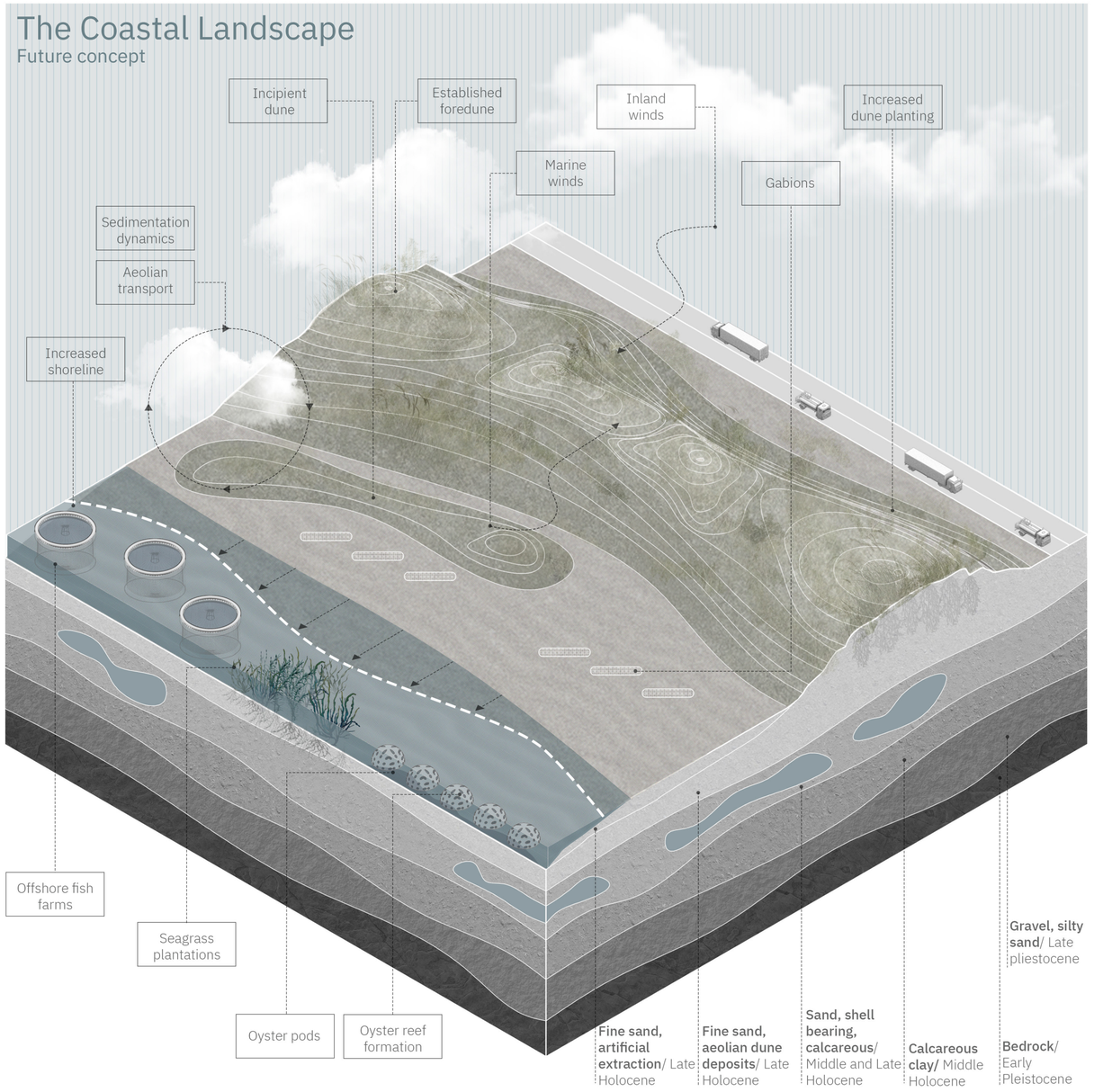
The Coastal Landscape

Existing conditions



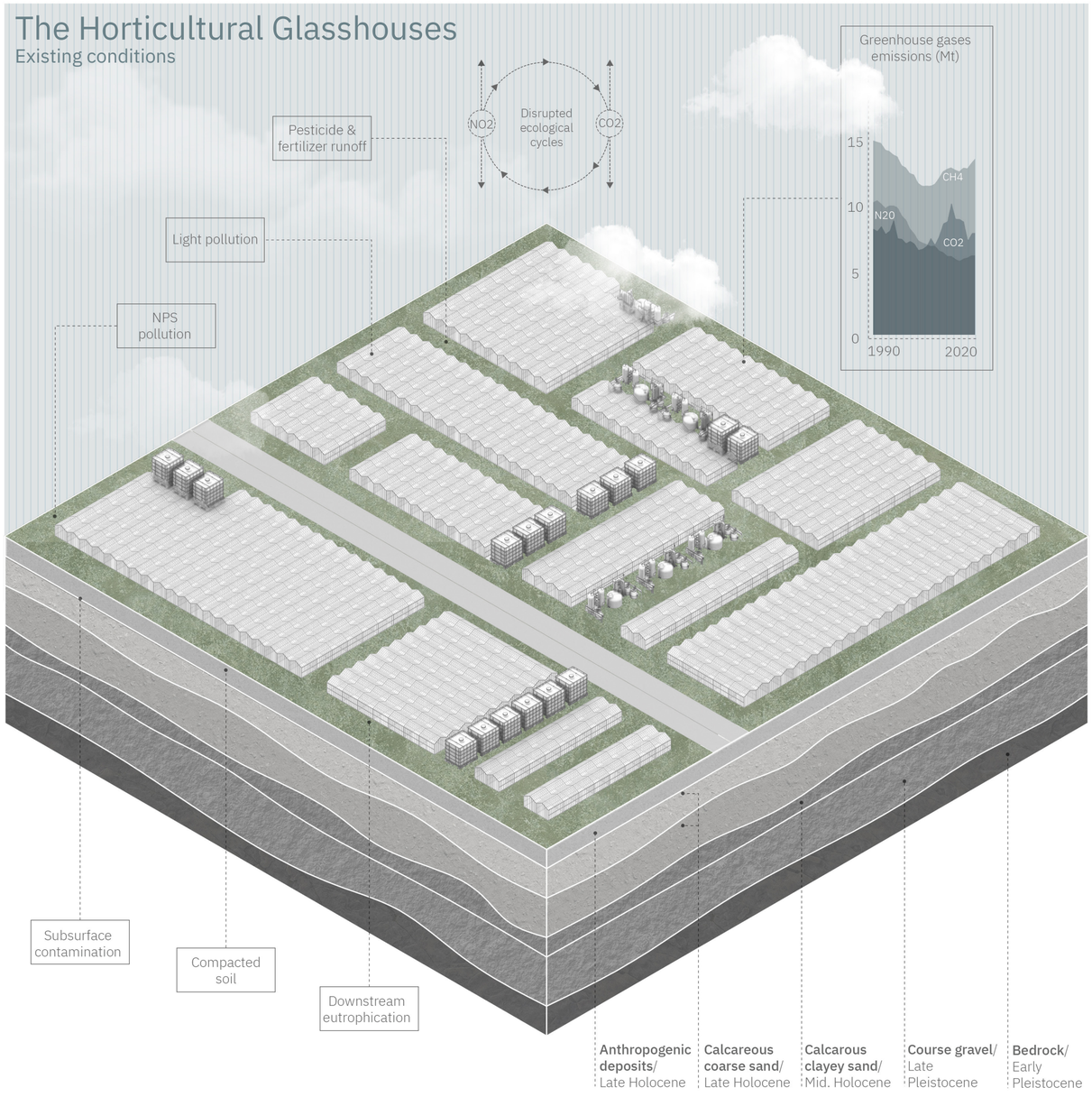
The Coastal Landscape

Future concept



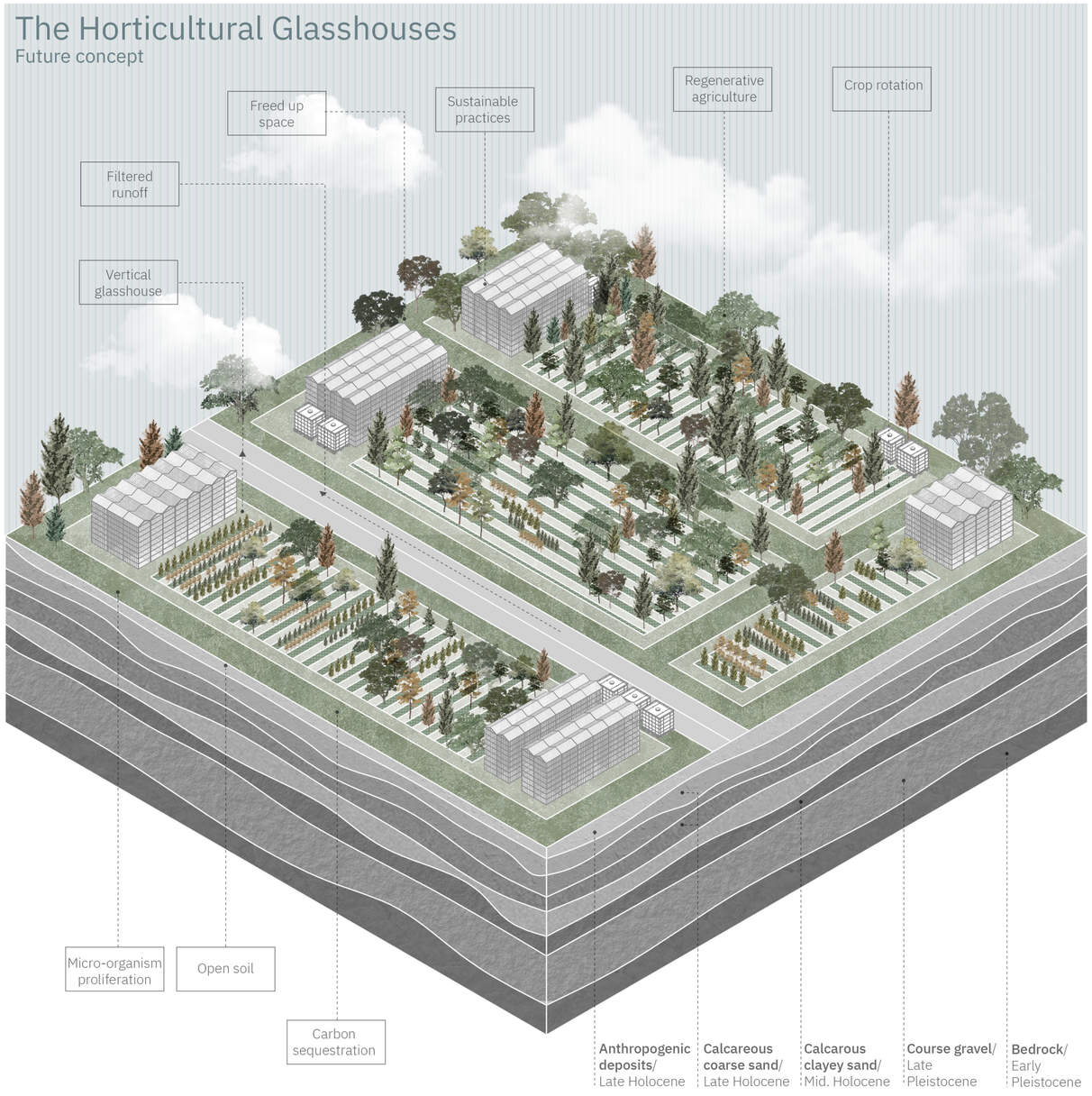
The Horticultural Glasshouses

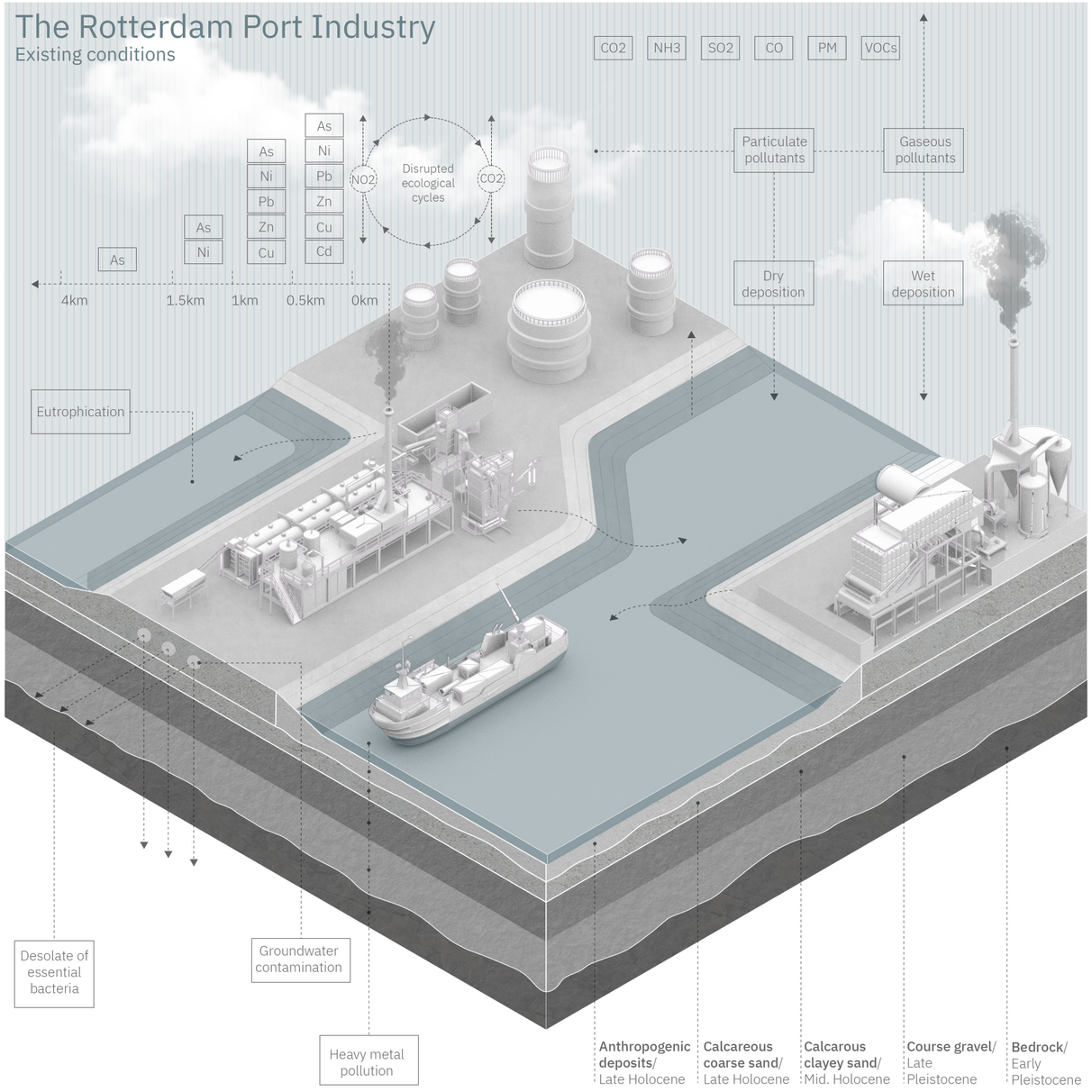
Existing conditions

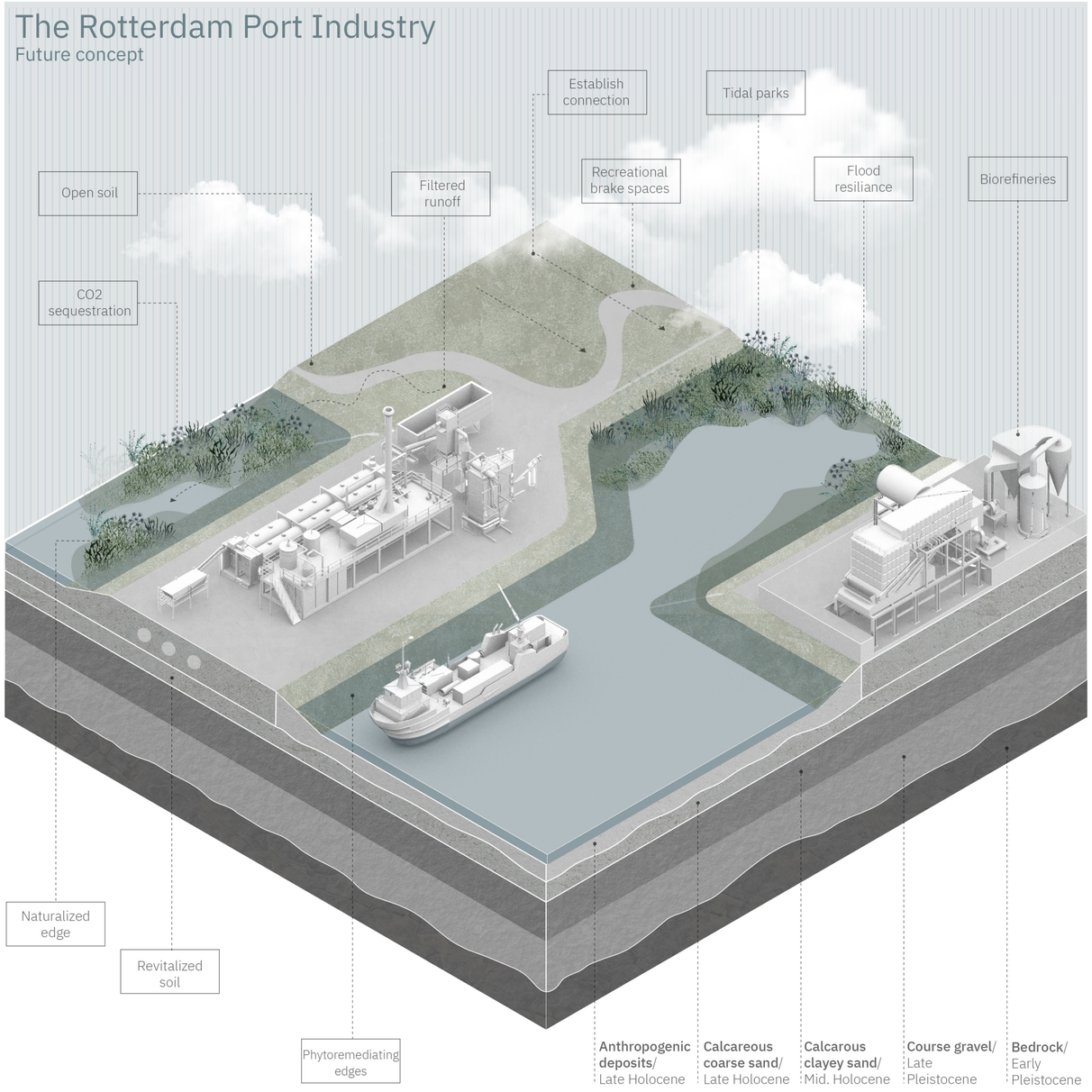


The Horticultural Glasshouses

Future concept

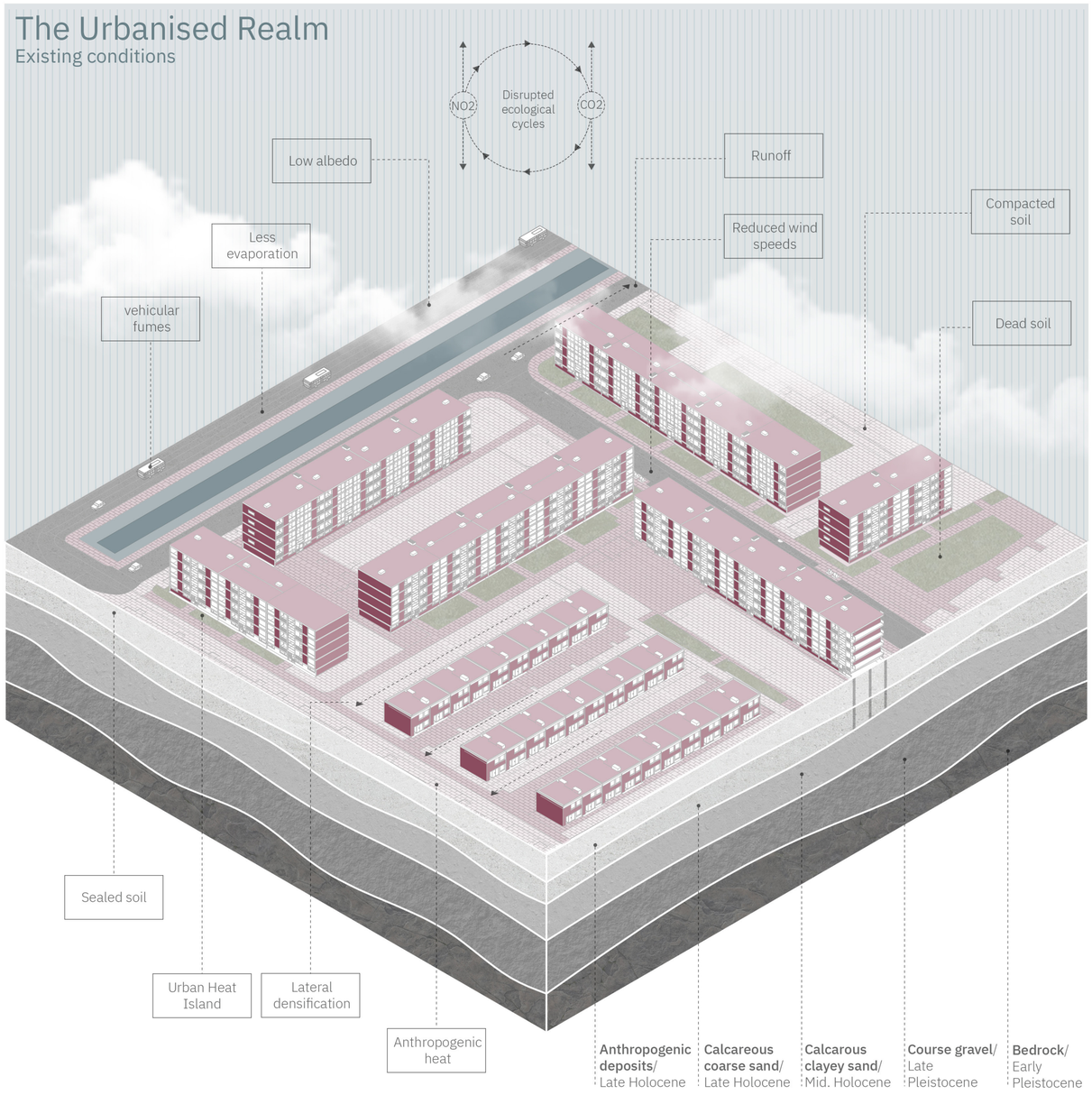



The Rotterdam Port Industry
Existing conditions
CO2
NH3
SO2
CO
PM
VOCs
As
Ni
Pb
Zn
Cu
Cd
NO2
Disrupted ecological cycles
CO2
Particulate pollutants
Gaseous pollutants
Dry deposition
Wet deposition
4km
1.5km
1km
0.5km
0km
Eutrophication
Desolate of essential bacteria
Groundwater contamination
Heavy metal pollution
Anthropogenic deposits/ Late Holocene
Calcareous coarse sand/ Late Holocene
Calcarous clayey sand/ Mid. Holocene
Course gravel/ Late Pleistocene
Bedrock/ Early Pleistocene


The Rotterdam Port Industry
Future concept
Establish connection
Tidal parks
Open soil
Filtered runoff
Recreational brake spaces
Flood resiliance
Biorefineries
CO2 sequestration
Naturalized edge
Revitalized soil
Phytoremediating edges
Anthropogenic deposits/ Late Holocene
Calcareous coarse sand/ Late Holocene
Calcarous clayey sand/ Mid. Holocene
Course gravel/ Late Pleistocene
Bedrock/ Early Pleistocene

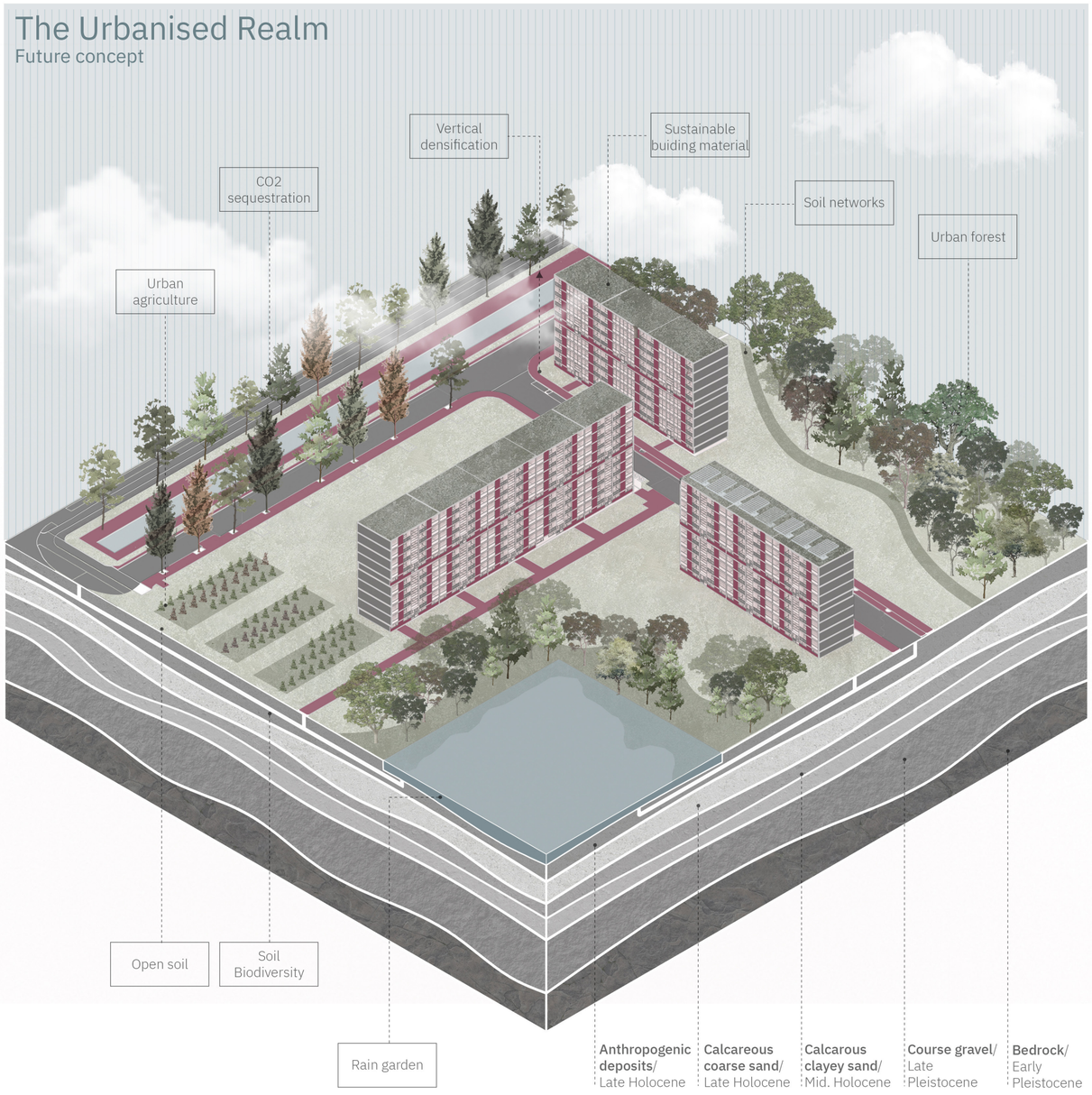
The Urbanised Realm

Existing conditions



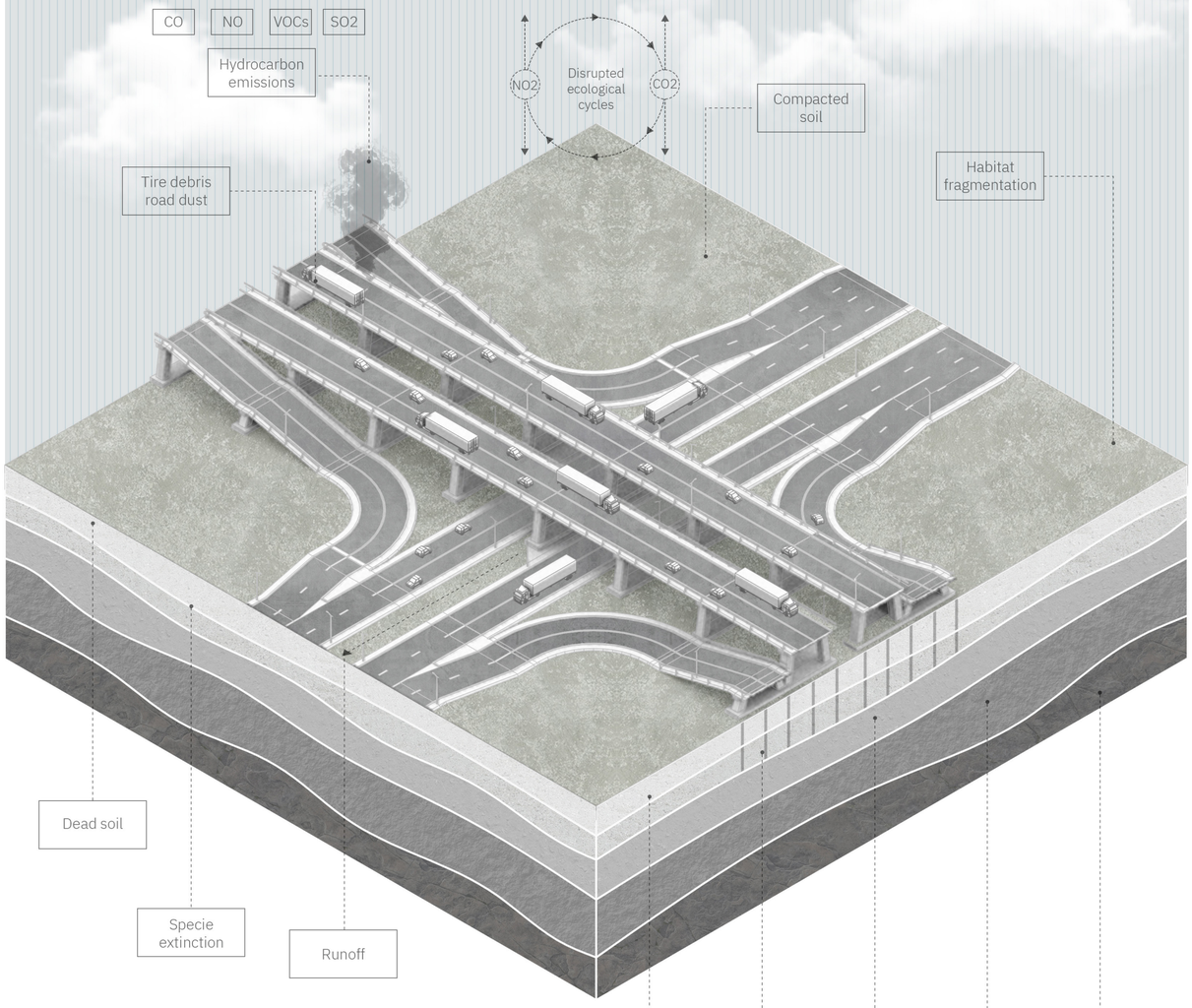
The Urbanised Realm

Future concept



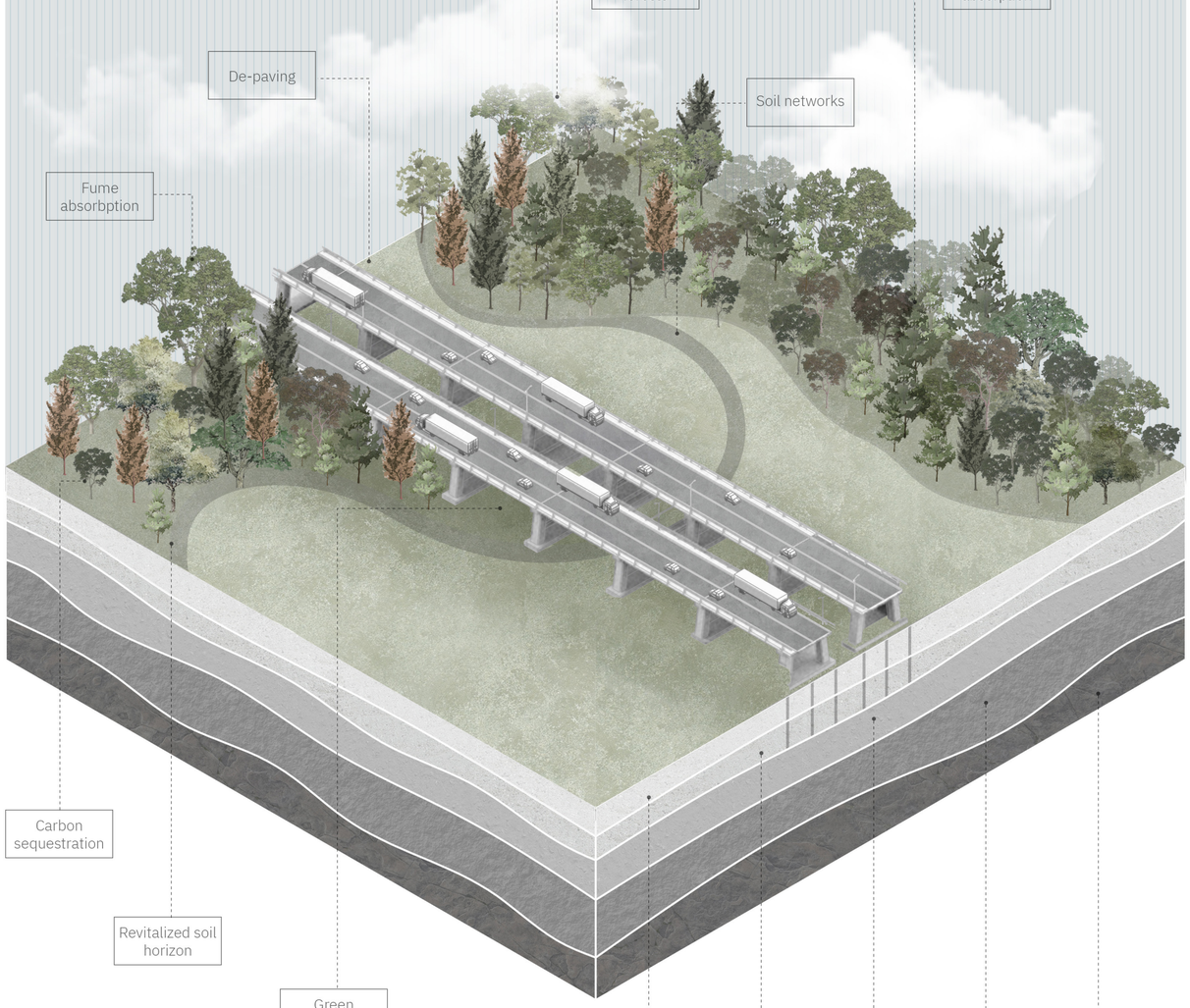
The Highway Networks

Existing conditions



The Highway Networks

Future concept

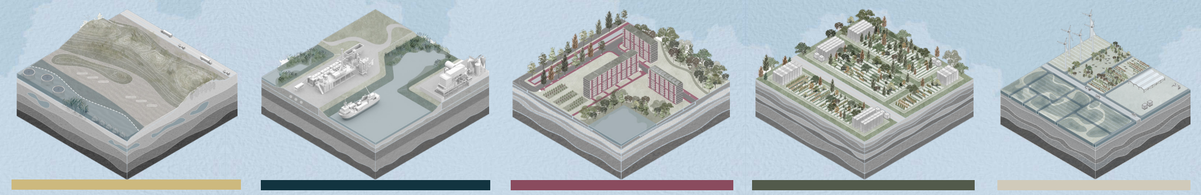


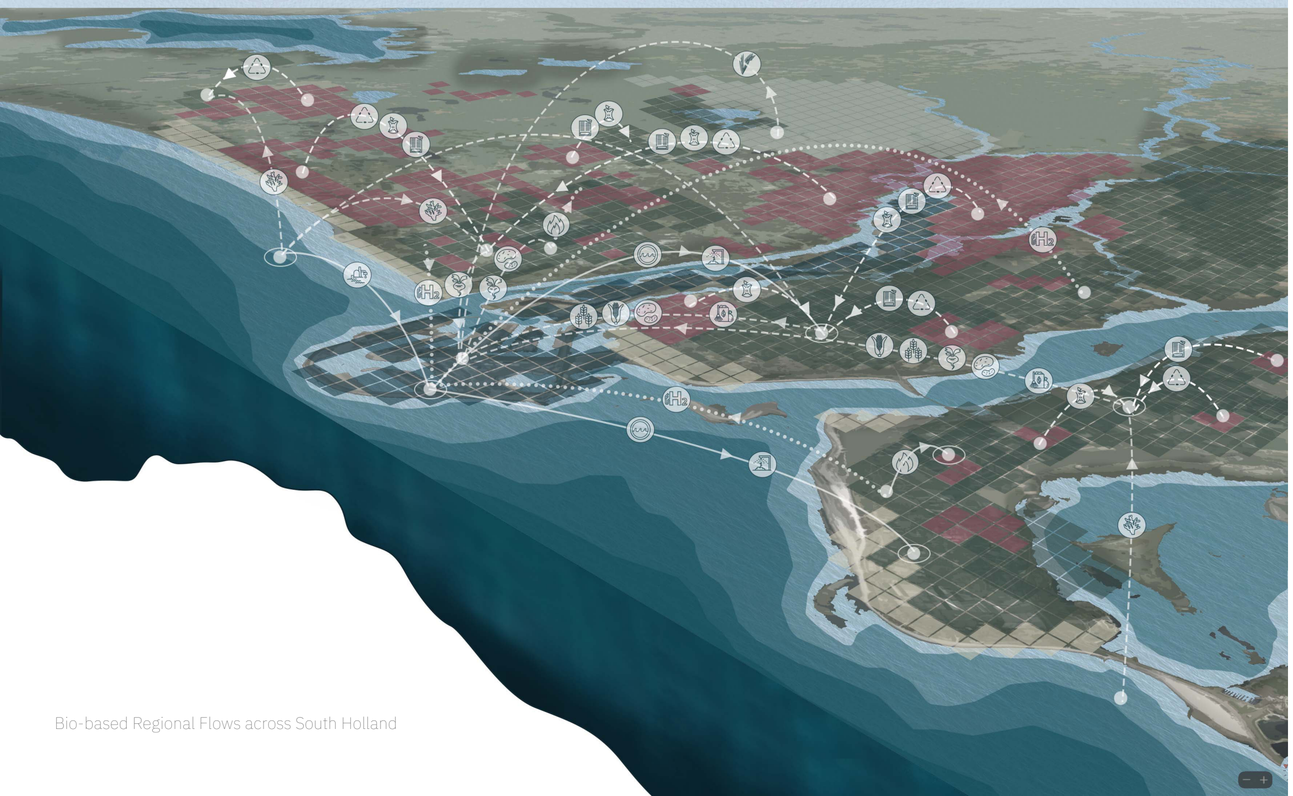


Bio-based flows

Bio-based flows 63
Bio-based Flows in the Region 65
Soil Categories 68

A biofunctional vision for South Holland emboldens the interdependencies of the urbanized realms with the surrounding landscapes.





Bio-based Regional Flows across South Holland

Bio-based Flows in the Region

Circularity in Agricultural Production

Photosynthesis by plants forms the engine of the carbon cycle. Regenerative farming practices, and management interventions by farmers to sustainably manage nutrients and water, help regulate natural processes, preserve soil quality and maintain crop yield.

Intercropping and Crop Rotation

Agricultural monocultures have a detrimental effect on nutrient cycles. Growing crops in the right frequency and sequence are vital for managing resilient yields. Intercropping allows the production of the required mix of starch, protein, and oil crops while maintaining the functionality of the soil (de Boer & Ittersum, 2018)

Maintaining an organic flow of nutrients

Production must focus on staying independent from external outputs. This can be achieved through recycling manure from livestock waste, utilizing organic household waste streams, and growing legume species that fix atmospheric nitrogen. (de Boer & Ittersum, 2018)

Aquatic biomass production

Freshwater aquatic plants and seaweeds are a good source of food and feed and help take pressure off land to contribute to biomass production. Additionally, commercial feed for cows, when mixed with seaweeds was shown to reduce methane emissions (Kinley et al., 2016). Aquatic plantations are a highly productive venture that also helps clean polluted surface waters, near agricultural fields. It recycles nutrient losses from agricultural run-offs, to produce biomass (Meerburg et al., 2010).

Vertical Farming

Although the existing greenhouses are extremely effective in producing high crop yields and maintaining resource efficiency, they seal open soil systems. Adapting this production system to vertical farming helps in maintaining production levels, allows more efficient energy consumption, and opens healthy soil to maintain natural processes and support biodiversity (de Boer & Ittersum, 2018)

Breeding crops for a biobased Economy

A biobased circular economy depends on partnerships between the biobased industries and agricultural land. The production of plants that are essential to biorefining should not compete with essential food crops, in a way that affects food prices. The valorization of agricultural wastes to extract raw materials that are essential to refining would help regulate this (de Visser & van Ree, 2016).

Miscanthus

Miscanthus is a high-yielding perennial crop that stands 3-5 m tall. It is notable for its high efficiency in photosynthesis. It retains nutrients in the soil and increases the soil carbon content. The Netherlands currently has one of the leading positions in Miscanthus cultivation, showing huge opportunities for biorefining. (Breeding crops for a Circular Bio-Economy). Sufficient research is needed to understand high-value opportunities that are currently unexploited due to insufficient knowledge of molecular complexity, processing options, and economic value.

Sugar Beets

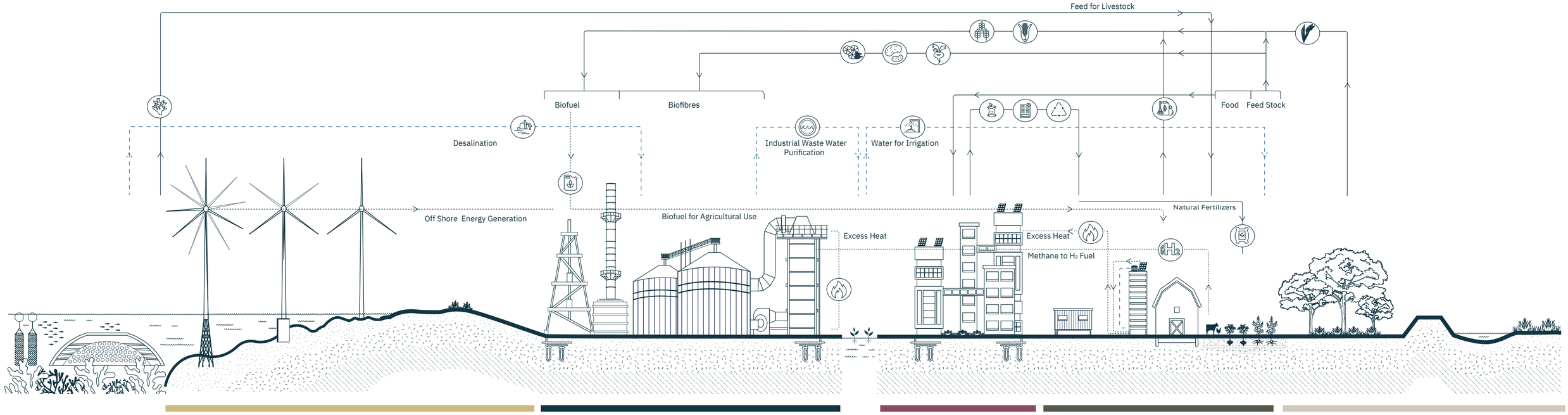
Is an important crop in the Netherlands and the main raw material for the production of sugar. There is a growing body of research that sees its potential in providing chemical building blocks through fermentation. The leaves of sugar beets are a secondary product that can be used as a protein source or left on the fields to regulate nitrogen and phosphate levels of the soil. (de Visser & van Ree, 2016)

Aquatic Plants

Microalgae, duckweed, cattail, and hornwort can be used as a fuel and fiber source, in addition to being used as animal feed. (de Visser & van Ree, 2016).

Potatoes

Potatoes are a source of starch, protein, and fiber. It holds potential for creating bioplastics, and pectins which have potential in medical implants.



Coastal Productioan to take pressure off land

Using coastal interventions to build up ressilience against flooding and produce biomass

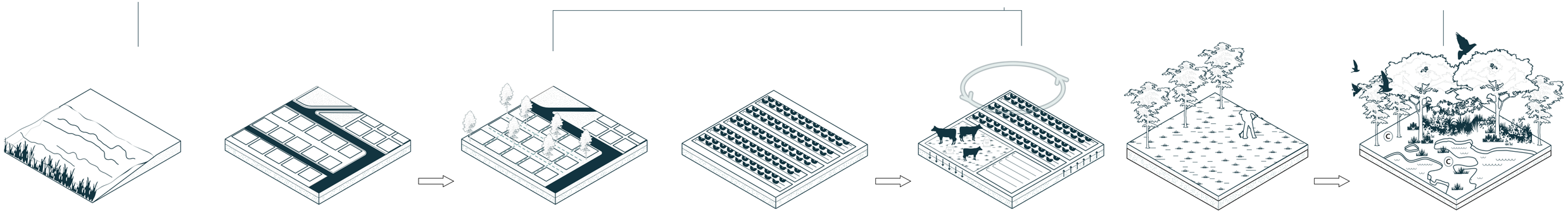
Accessible Open Soil

Creating carbon sinks by growing vegetation to enhance carbon storage.

Productive Open Soil

Protected Soil

Avoiding the release of GHGs by protecting the land against degradation.



Opening sealed soil in urban areas to create soil networks

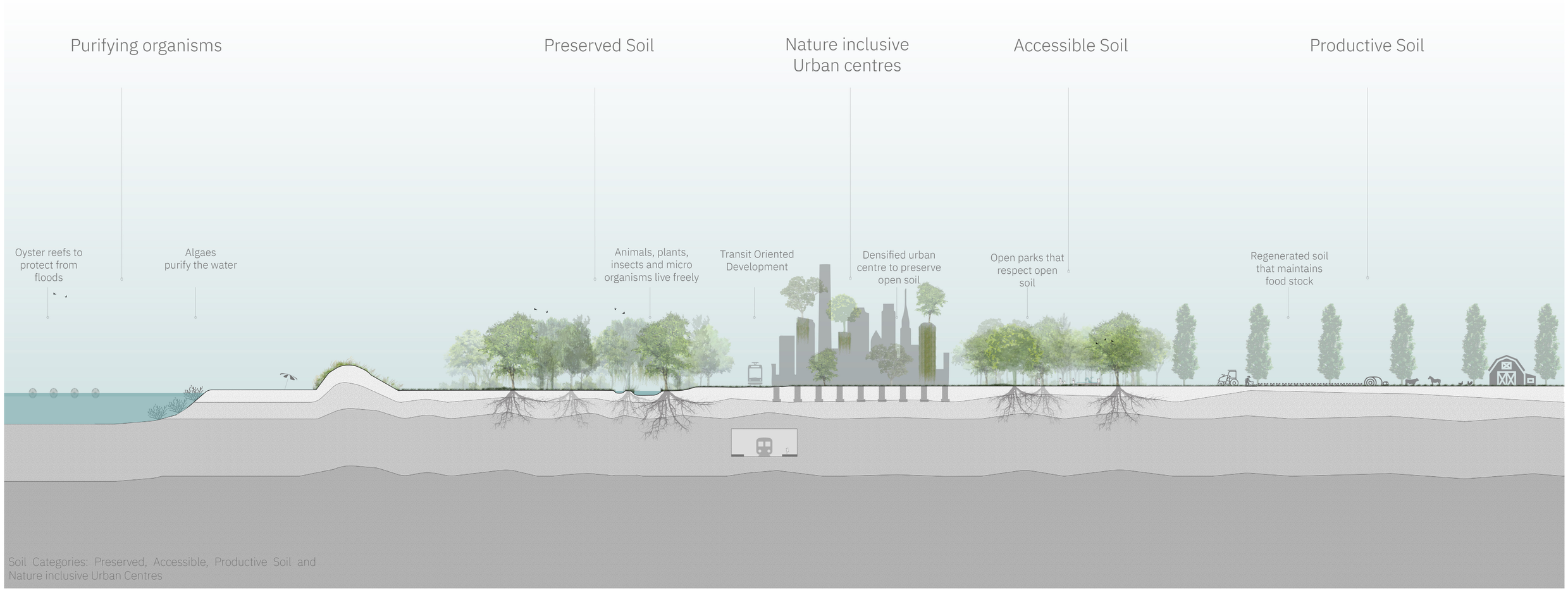
Regenerative farming practices that replace monocultures and chemical fertilizer, and pesticide use

Restoring peat landscapes and protecting it from human access, to improve its carbon sequestration performance

Soil Categories

Preserved, Accessible, Productive Soil and Nature inclusive Urban Centres

Due to the quality of soil and the locations of the soil, the soil can be categorized in four groups:
1. The Preserved soil, where nature can expand and flourish through it being inaccessible for people
2. Nature inclusive city centres, where green networks throughout the city enhance the biodiversity
3. Accessible soil, where the soil with its nature can be recreational and accessible for people to enjoy and learn from
4. Productive soil, where agriculture can thrive through regenerative farming



Soil Categories: Preserved, Accessible, Productive Soil and Nature inclusive Urban Centres



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Transformation across the phases of the strategy

2022



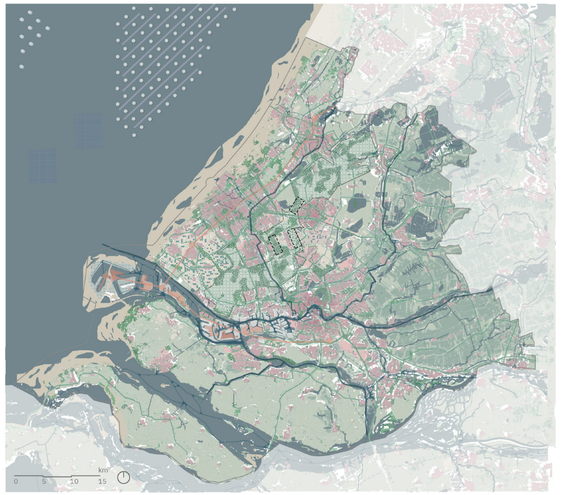
2040



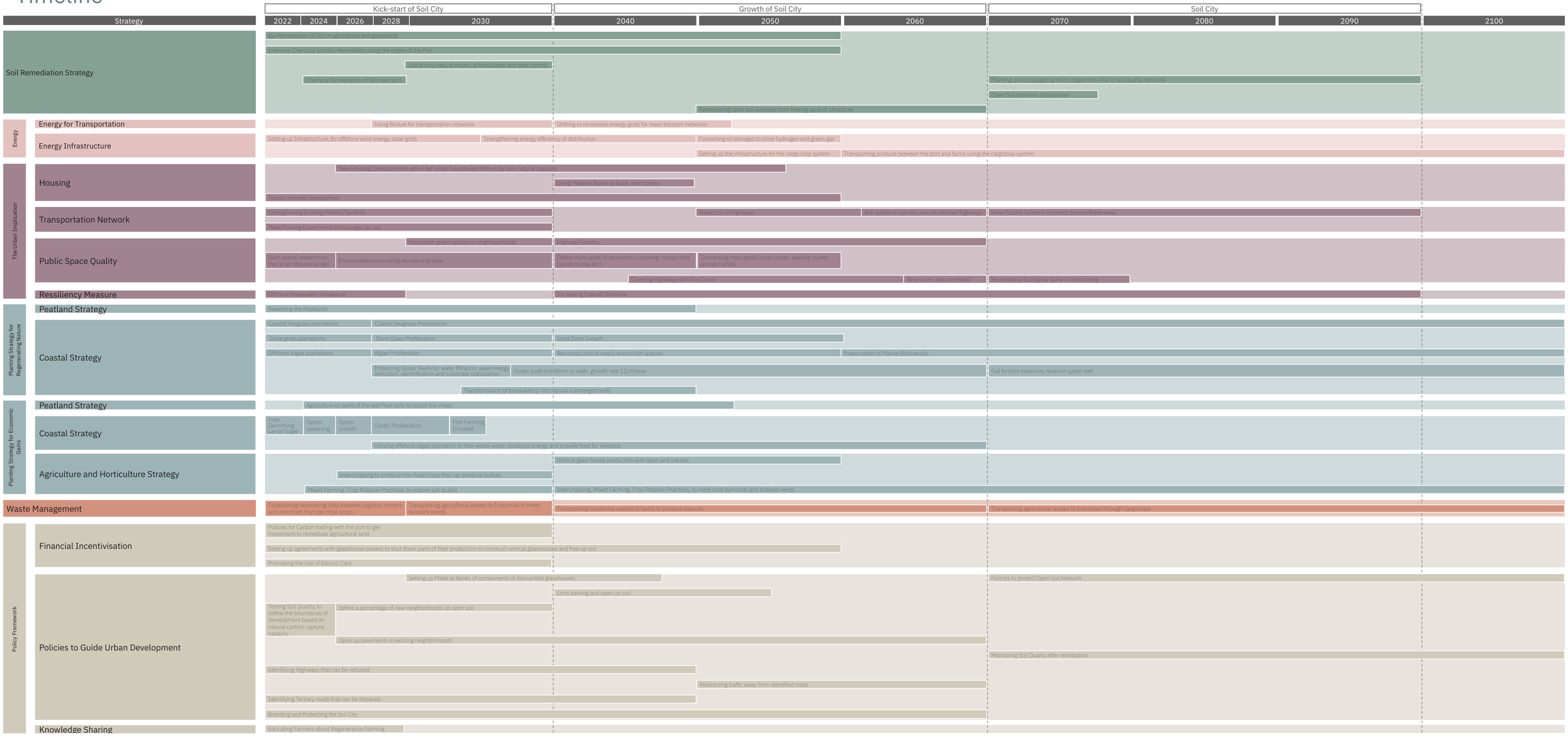
2070



2100



Timeline


Kick-start of Soil City
Growth of Soil City
Soil City
Strategy
2022
2024
2026
2028
2030
2040
2050
2060
2070
2080
2090
2100
Soil Remediation Strategy
Bio Remediation of Soil in agricultural and grasslands
Intensive Chemical and Bio-Remidation along the edges of the Port
Use of only natural means of fertilisation and pest control
Chemical Remediation of Soil near port
Planting, and propogating micro-organisms vital to soil quality networks
Open Soil Networks Established
Remediating open soil available from freeing up built structures
Energy
Energy for Transportation
Using Biofuel for transportation networks
Shifting to renewable energy grids for mass tranport networks
Energy Infrastructure
Setting up Infrastructure, for offshore wind energy, solar grids
Strengthening energy efficiency of distribution
Converting oil storages to store hydrogen and green gas
Setting up the infrastructure for the cargo loop system
Transporting produce between the port and farms using the cargoloop system
The Urban Implication
Housing
New Housing Developments within set urban boundaries defined by soils natural capacity
Using Material Banks to build new homes
Transit oriented development
Transportation Network
Strengthening Existing Mobility Systems
Reduction of highways
Anti-pollution barriers around retained highways
New Mobility Systems Centered around Water ways
Make Parking Expensive to discourage car use
Public Space Quality
More open green spaces in neighbourhoods
Highway Forestry
Start spatial research on the Groen Blauwe slinger
Enhance/expand existing recreational sites
Define main spots of recreation (canoeing, restaurants, places to stay etc)
Connecting main spots (cycle routes, walking routes, animal routes)
Covering Highways with Eco Ducts
New routes are connected
Recreational Ecological Spine is blossoming
Ressiliency Measure
Offshore breakwater installation
Increasing Coastal Shoreline
Planting Strategy for Regenerating Nature
Peatland Strategy
Rewetting the Peatlands
Coastal Strategy
Coastal Seagrass plantations
Coastal Seagrass Proliferation
Dune grass plantations
Dune Grass Profileration
Sand Dune Growth
Offshore Algae plantations
Algae Proliferation
Reintroduction of nearly extinct fish species
Preservation of Marine Biodiversity
Protecting Oyster Reefs for water filtration, wave energy reduction, denitrification and substrate stabilization
Oyster pods transform to reefs: growth rate 11cm/year
Full formed extensive, resilient oyster reef
Transformation of breakwaters into natural submerged reefs
Planting Strategy for Economic Gains
Peatland Strategy
Agriculture on parts of the wet Peat soils to obtain bio-mass
Coastal Strategy
Free Swimming Larval Stage
Oyster spawning
Oyster Growth
Oyster Proliferation
Fish Farming Initiated
Utilizing offshore algae plantation to filter waste water, produces energy and provide feed for livestock
Agriculture and Horticulture Strategy
Vertical glass house production with open and live soil
Intercropping to produce non-food crops that can produce biofuel
Mixed Farming, Crop Rotation Practices, to restore soil quality
Intercropping, Mixed Farming, Crop Rotation Practices, to meet food demands and biofeed needs
Waste Management
Establishing networking links between logistics centers and industries that can close loops
Transporting agricultural wastes to Industries to meet biostock needs
Transporting residential wastes to farms to produce manure
Transporting agricultural wastes to Industries through cargoloops
Policy Framework
Financial Incentivisation
Policies for Carbon trading with the port to get investment to remediate agricultural land
Setting up agreements with glasshouse owners to shut down parts of their production to construct vertical glasshouses and free up soil
Promoting the Use of Electric Cars
Policies to Guide Urban Development
Setting up Material Banks of components of dismantled glasshouses
Policies to protect Open Soil Network
Limit parking and open up soil
Testing Soil Quality, to define the boundaries of development based on natural carbon capture capacity
Define a percentage of new neighborhoods as open soil
Open up pavements in existing neighborhoods
Monitoring Soil Quality after remidiation
Identifying Highways that can be reduced
Redirecting traffic away from identified roads
Identifying Tertiary roads that can be depaved
Branding and Protecting the Soil City
Knowledge Sharing
Educating Farmers about Regenerative Farming

Trends timeline

Trends

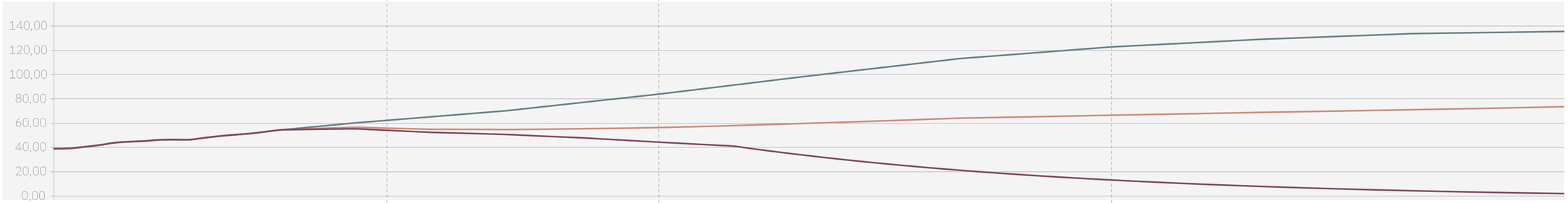
Kick-start of Soil City | Growth of Soil City | Soil City

2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | 2080 | 2090

Global CO_2 Emissions ($GtCO_2$ / year)

- Business As Usual (BAU)
  High emissions scenario
- Intended Nationally Determined Contributions (INDC)
  Emissions stabilise by 2100
- 2-Degree scenario
  CO_2 emissions reach zero by 2100

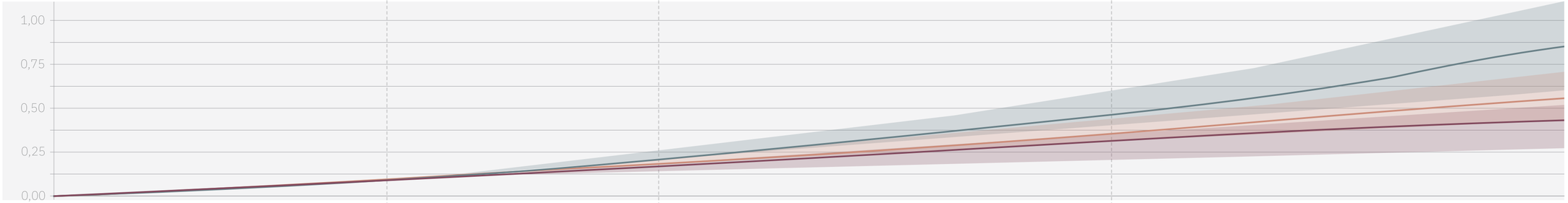
Source: Climate Interactive, & Siegel, L. (2015, 27 september). *Climate Scoreboard* (CROADS Vensim version 3.026s) [Dataset]. Climate Interactive. https://www.climateinteractive.org/ci-topics/climate-energy/scoreboard/



Global Mean Sea Level (m)

- RCP 8.5
  High emissions scenario
- RCP 4.5
  Emissions stabilise by 2100
- RCP 2.6
  CO_2 emissions reach zero by 2100

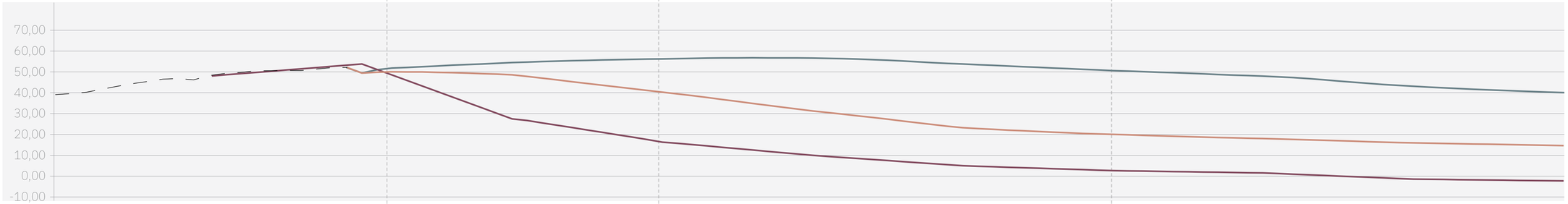
Source: Earth Observatory NASA, & Hamlington, B. (2020, 17 april). *Global Sea Level is Projected to Rise* [Graph]. Earth Observatory NASA. https://earthobservatory.nasa.gov/images/148494/anticipating-future-sea-levels



Global Greenhouse Gas Emissions ($GtCO_2e$ / year)

- Current Policy Projections
  High emissions scenario
- Pledges & Targets
  Emissions stabilise by 2100
- 2-Degree scenario
  CO_2 emissions reach zero by 2100
- Historic emissions

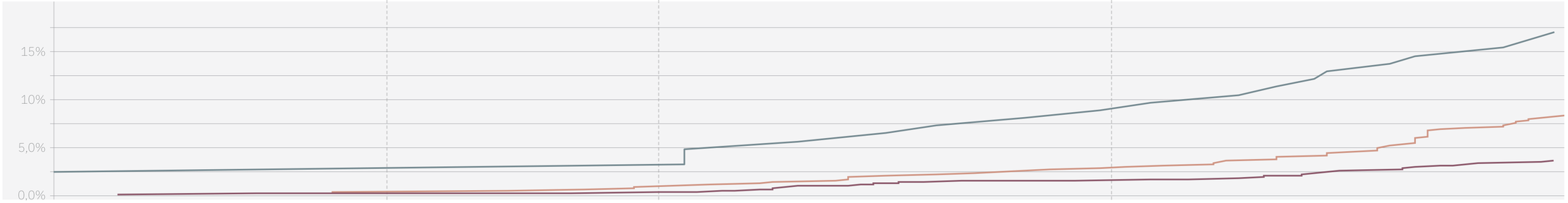
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Distribution of soil lifespans (Cumulative percentage of soils)

- Bare soils
  Plots intentionally kept bare from vegetation
- Conventionally managed
  Farmed soils without conservation practices
- Conservationally managed
  Farmed soils with conservation, no tilling

Source: Evans, D. L., Quinton, J. N., Davies, J. A. C., Zhao, J., & Govers, G. (2020). *Soil lifespans and how they can be extended by land use and management change*. OurWorldInData.org/soil-lifespans • CC BY



Regional transformations

2022 2040 2070 2100

Natural Structures

The natural structures will be brought back into the central part of South Holland and natural corridors will be established to bring biodiversity and carbon sequestration back into the centre of the province.



Soil Remediation

The remediation of the soil will be performed in steps, using the different remediation techniques. Over time, the balance in the soil will be restored and natural fertility and biodiversity levels will be brought back up.



Mobility

The mobility strategy focuses on giving more importance to the water infrastructure and downgrading the road system. Logistics will transition to cargo-loops that have higher efficiency levels and a lower environmental impact. Roads will become available exclusively for autonomous vehicles



Urban Expansion

Our strategy focuses on the densification of areas close to public transport hubs (Transport Oriented Development), in combination with areas where the soil shows low levels of biodiversity and a low ability to capture carbon. In this way, soil will be put to use in the most effective way and housing can be built in well-connected areas.

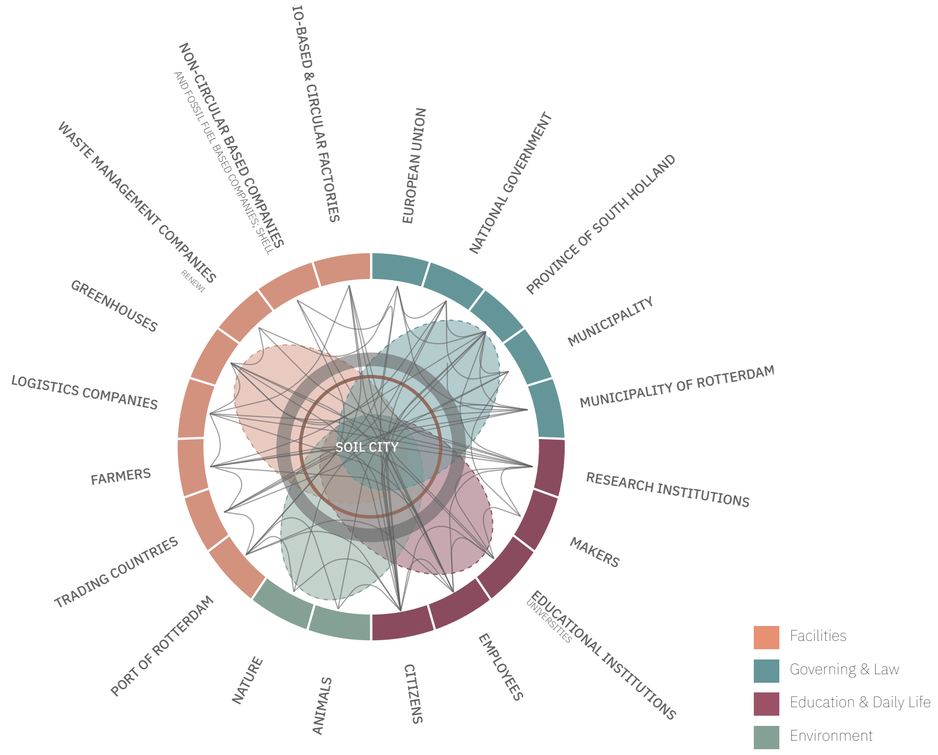


Stakeholders

Actors

There are multiple stakeholders who are involved in the process towards a Soil City, as shown in the diagram on this page, divided into four categories:
1. Governing & Law, including the European Union, national government, the Province of South-Holland and municipalities, with the municipality of Rotterdam having its own sub-category regarding the Port of Rotterdam.
2. Facilities, including companies (bio-based, circular and non-circular), greenhouses, logistics companies, farmers, trading countries and the Port of Rotterdam; Education & daily life with its citizens, employees, research institutions, makers and educational institutions. And last but Most essentially, the environment with its Animals and Nature.

Everyone that is involved in the process of the transition of sustainable development is responsible. However, not all stakeholders are equally motivated. The Private sector can be encouraged to make the transition profitable. There should be a gain to make them want to participate in the process.
Within the perspective of the Public sector the people are the ones that should be represented, with less emphasis on making profit.

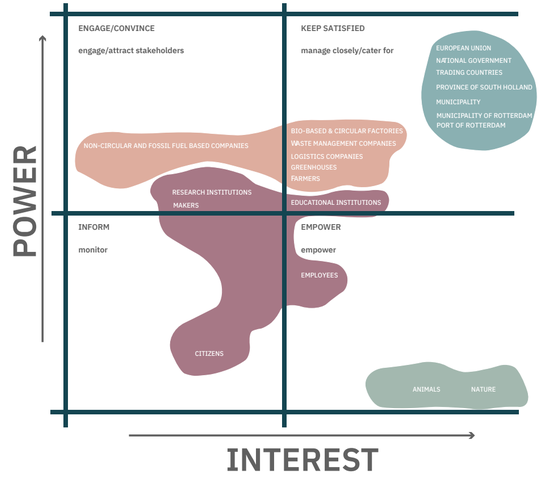


The stakeholders with their relations between each other: everyone is connected

Stakeholder analysis

Power vs Interest

Every stakeholder is involved in the process of achieving the Soil City, with the governing and law having the most power and interest. The companies (both bio-based and nonbio-based), logistics companies, educational institutions and farmers are powerful as well, as they shape the framework of how everything is distributed and taught within society. The non-circular and FOSSIL Fuel based companies have to be convinced to make the transition from non-circular into circular and bio-based.
Nature with its organisms, plants and animals have the most interest, when it gets affected it will have consequences for all those existing on earth in the long run.



Power vs Interest graph: Governing & law, facilities, institutions and makers have the most power to influence the change, while nature has the most interest, together with the governmental bodies who need to reach climate goals within a certain amount of time.

Reasons for Support or Resistance

To deepen our understanding of each stakeholder, a more profound stakeholder analysis has been done. Within this analysis, the reason for support or resistance of each stakeholder towards the transition to a soil city has been analysed. From this knowledge, we've found that there are some main stakeholders that will be likely to have more active stakeholders and some that will be most resistant.

We've found that the active stakeholders are the waste management companies who will be important to close the circular loops, with the logistics companies to make that happen. The bio-based companies will play an important role in this circular economy.
The stakeholders who are most likely to have resistance are the FOSSIL Fuel based companies, non-circular companies and the Port of Rotterdam. The aforementioned still have non-circularity, with fossil fuel, or the refineries in the Port of Rotterdam.

The current pattern of stakeholders are based on a linear model of resource extraction that has disturbed the carbon cycle in addition to other natural cycles. Our shift to a more biobased model of sourcing raw material, has to prioritize sequestering the excess carbon, through open healthy soil. This is vital to climate justice, resilience and sustainable growth.

Stakeholder Analysis

Stakeholder	Impact Level	Reasons for Support or Resistance
Bio-based & Circular Factories	++	Support: As we detransition away from the linear fossil fuel based economy, their importance and the dependence on them increases
Waste Management Companies	+-	Support: They might upscale and may use more advanced technology to extract minerals and nutrients which can be sold to other industries via the logistics companies
Logistics Companies	++	Support: the circular economic model would place them in a more important role in connecting waste flows from one industry towards the raw material needs of others to start a new cycle. They are essential to close the loops, and might have more employment in this sector. Resistance: to change their current way of functioning.
Fossil fuel based companies	---	Resistance: No more using the same product (fossil fuels) which they always had made profit from Support: If making the transition towards a different product (they'll have to in het future) that's non-harming towards the planet this could benefit them
Port of Rotterdam	--	Resistance: The economy that is working well might disappear when implementing a bio-based economy/soil city
Non-Circular based Companies	-/--	Resistance: They can no longer make profit with their current product. Support: They'll need to make a transition towards a different type of fuel/a circular product

The conclusions of the stakeholder analysis: the stakeholders in green who'll support the transition and who'll play an essential role within the Soil City, and the stakeholders in red who will most likely have resistance to it.

Stakeholders Network

Soil Carbon Projects and Funding

The implementation of soil carbon projects is important for two reasons: capturing the CO2 out of the atmosphere (carbon sequestration) and the conservation of the vulnerable natural landscapes, to avoid the release of Greenhouse Gas emissions into the atmosphere.
We need socio-ecological projects that remediate the damage that has been done by industries that have been emitting large levels of. This largely involves the Port of Rotterdam and the fossil fuel-dependent industries that exist along with it.

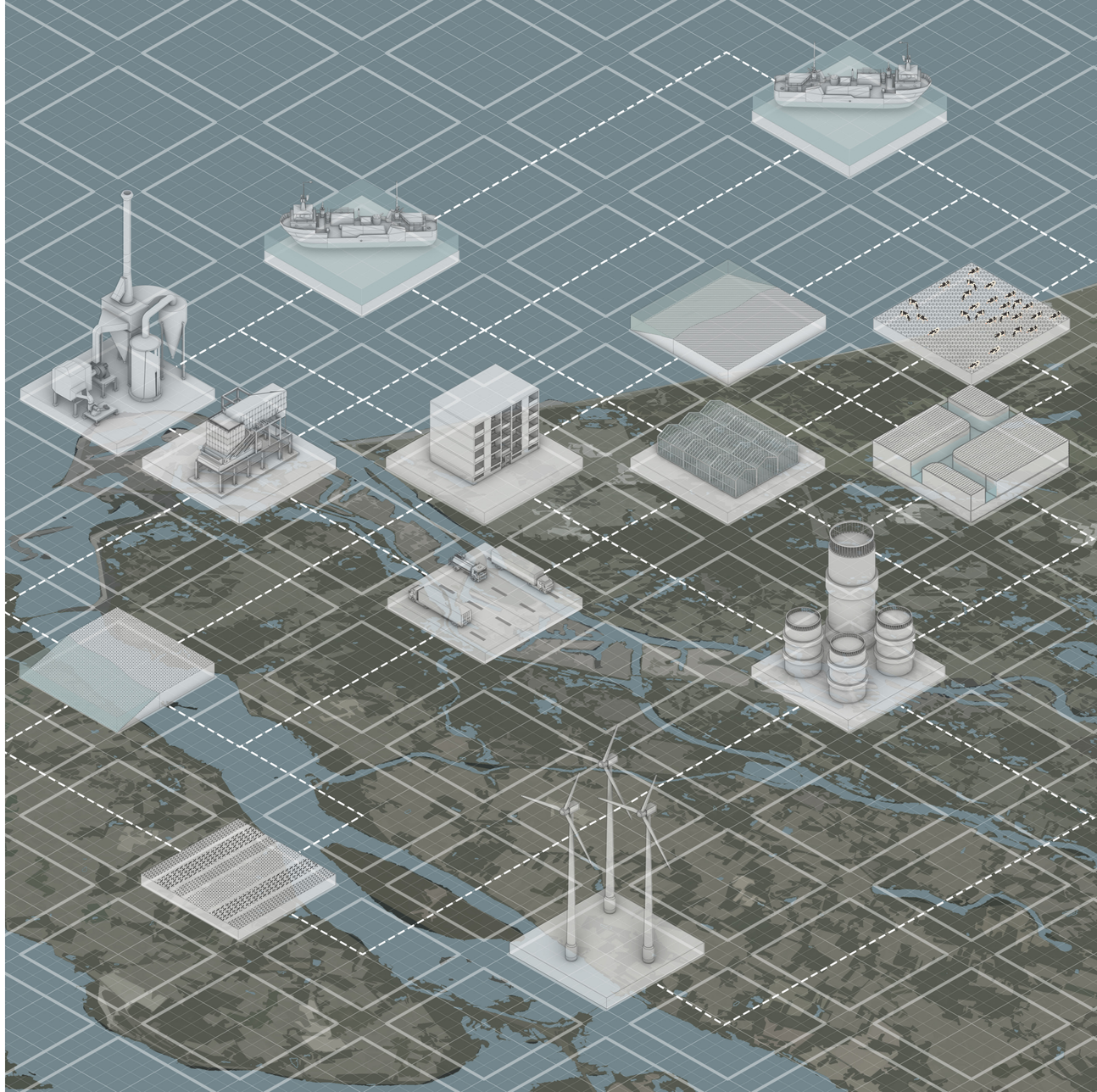
It is necessary to have the necessary policy frameworks, and sufficient financial support to make sustainable transformations feasible. Climate finance is needed through private-sector-driven interventions, in addition to governmental regulations.

There are several funds dedicated to projects that support climate change mitigation. One example of funding offered specifically to soil-centered projects includes the World Bank's, BioCarbon Fund. It offers 20 million US dollars to support 20 projects within areas of carbon enhancement and habitat restoration.

In Europe, the most important funding that existed regarding soil and land use was the European Agricultural Fund for Rural Development (EAFRD), which offered 100 billion Euros for 2014-2020. The six priorities it highlighted included the promotion of resource efficiency; the restoration and improvement of ecosystems connected to forestry and agriculture; and the support of transition towards a climate-resilient and low-carbon economy within the sectors of agriculture, forestry, and food.

According to Silvestrum Climate Associates (von Unger & Emmer, 2018), it's of utmost importance that the government should make sure that the use of funds is guaranteed, or have centralized funds set up to promote demand that is predictable, resulting in a carbon project development

SOIL CARBON – 'A game changer'
Soil is under stress, both as a result of climate change and unsustainable land management.
The carbon within disturbed peat landscapes has become unnatural, eroded, and drained because of the way the land was used. Globally, carbon levels within the peat soil have decreased by 176 GigaTo (GT) in comparison to its levels in an undisturbed, natural state. If soil carbon continues to decrease in this manner, carbon emissions from the soil as a result of land use will increase by 80Gt between 2010-2050. (UNCCD, 2017)
Carbon emissions shouldn't be halted only, but they should be reversed. This can happen if net sequestration from biomass and soil reaches 5-15 Gt CO2eq within every year when 2050 has passed. (Silvestrum Climate Associates, 2018)



Stakeholders Network

Division between public, private and civic

Logistics Companies
Interest: maintaining logistics and making profit. The circular economic model would place them in a more important role in connecting waste flows

Waste Management Companies
Interest: the circular economic model would place them in a more important role in connecting waste flows. They are essential to close the loops.

Province of South Holland
Interest: Towards a circular, bio-based future while still thriving in economy

Educational Institutions
Interest: stay up to date with the new technologies and business models. Well connected to the new job opportunities

Greenhouses
Interest: Maintaining the greenhouses to maintain production and export

Non-Circular based Companies
Interest: Maintaining a successful company and meeting the requirements of the amount of emissions

Municipalities
Interest: Becoming a circular, biobased municipality

Employees
Interest: Remaining an employee, being able to make promotion and evolve

Farmers
Interest: Being able to execute their job, also after 60 harvests

Bio-based & Circular Factories
Interest: Moving away from the linear based economy, increasing importance of bio-based and circular companies

Municipality of Rotterdam
Interest: Becoming sustainable while maintaining a successful economy

Citizens
Interest: Maintaining the way they live in their homes

Trading Countries
Interest: Making sure that the amount import and export will be maintained or increased

European Union
Interest: reaching the goal of the European Green Deal

Research Institutions
Interest: Having innovative circular findings implemented and researching the best solutions

Nature
Interest: Reversing the damage done by the linear economy and create new systems that coexist with nature

Port of Rotterdam
Interest: Maintaining a successful economy and becoming more sustainable

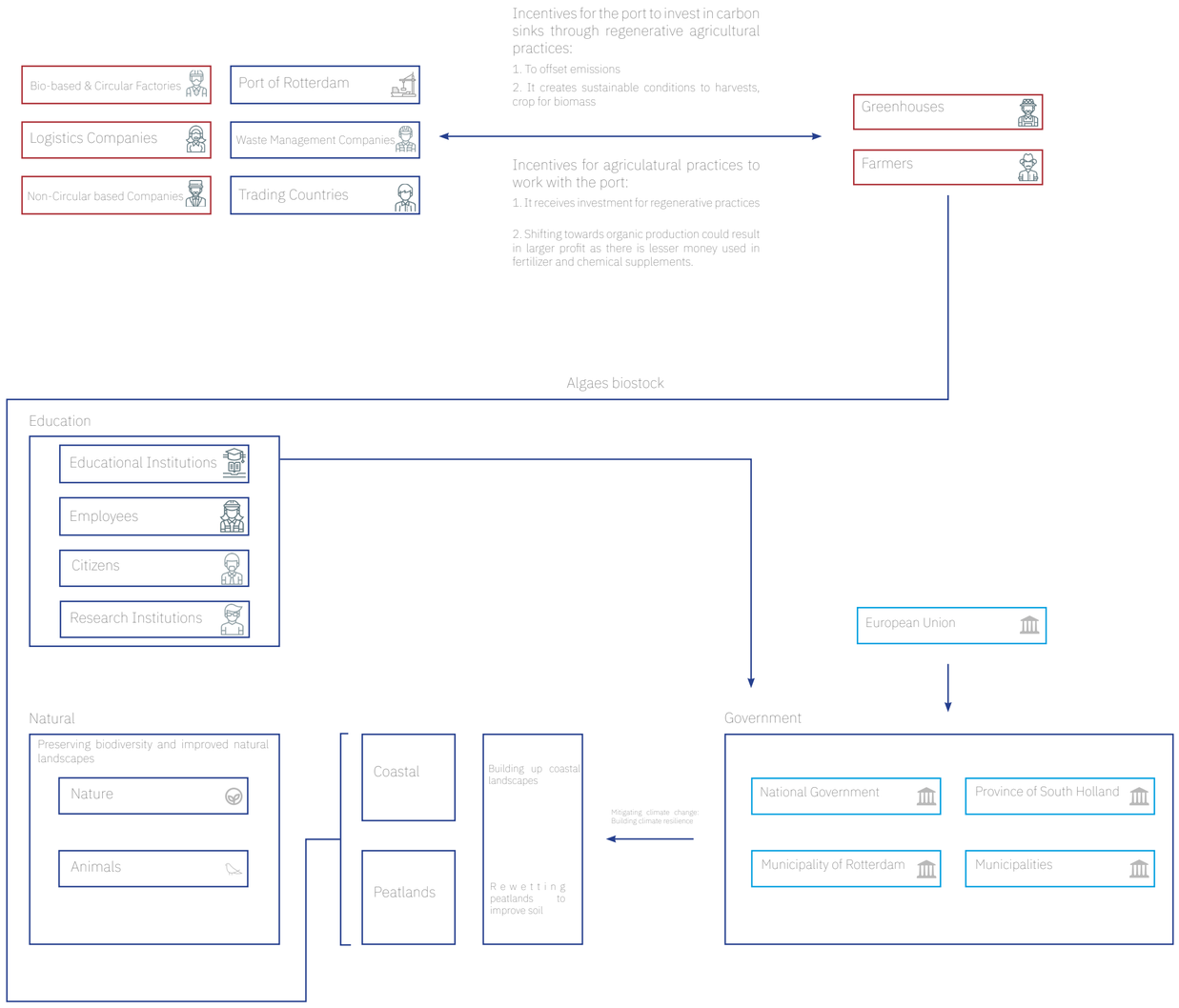
National Government
Interest: reaching the goal of the European Green Deal

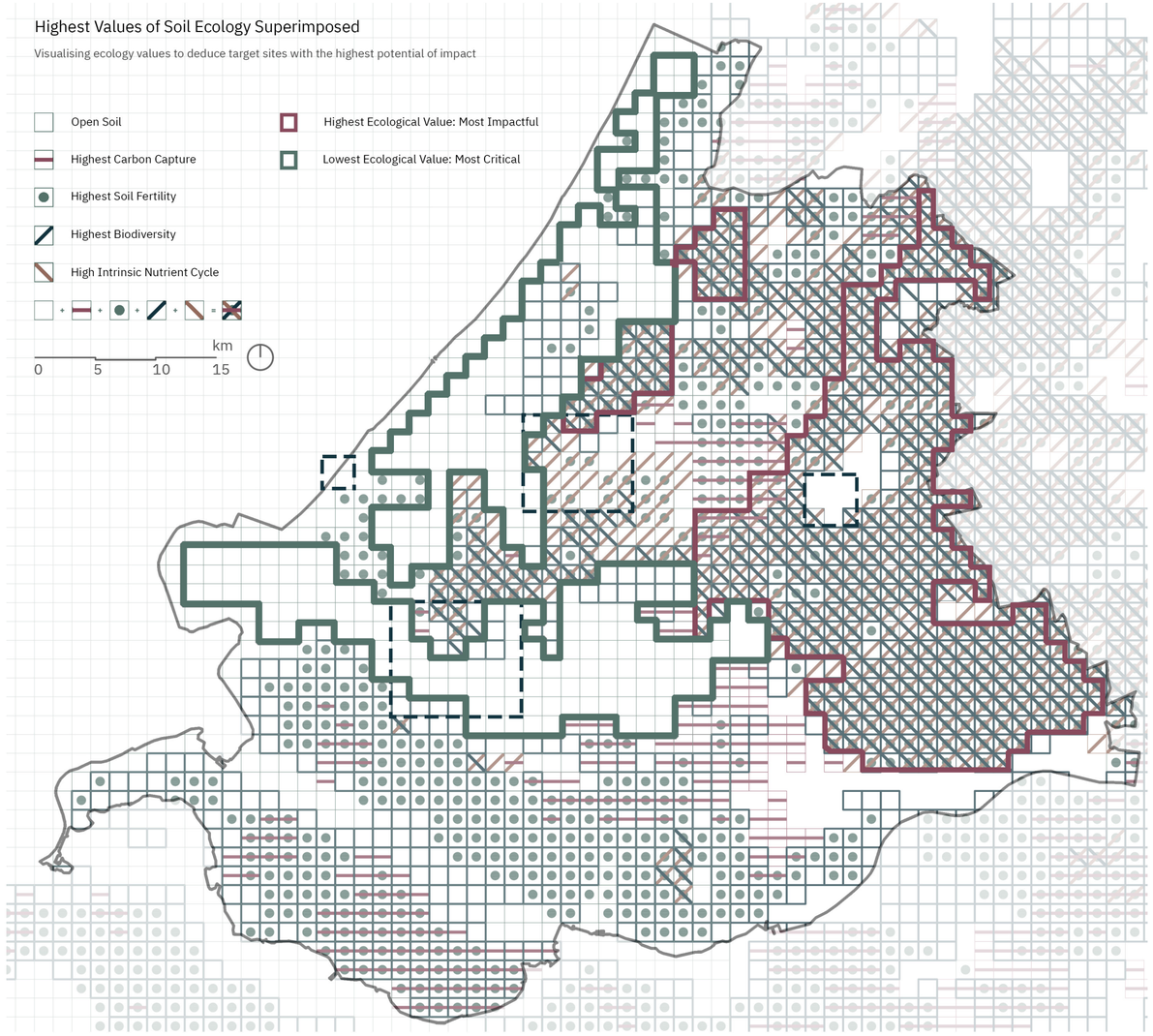
Makers
Interest: Having space for innovations regarding circularity and soil

Animals
Interest: Reversing the damage done by the linear economy and create new systems that coexist with nature

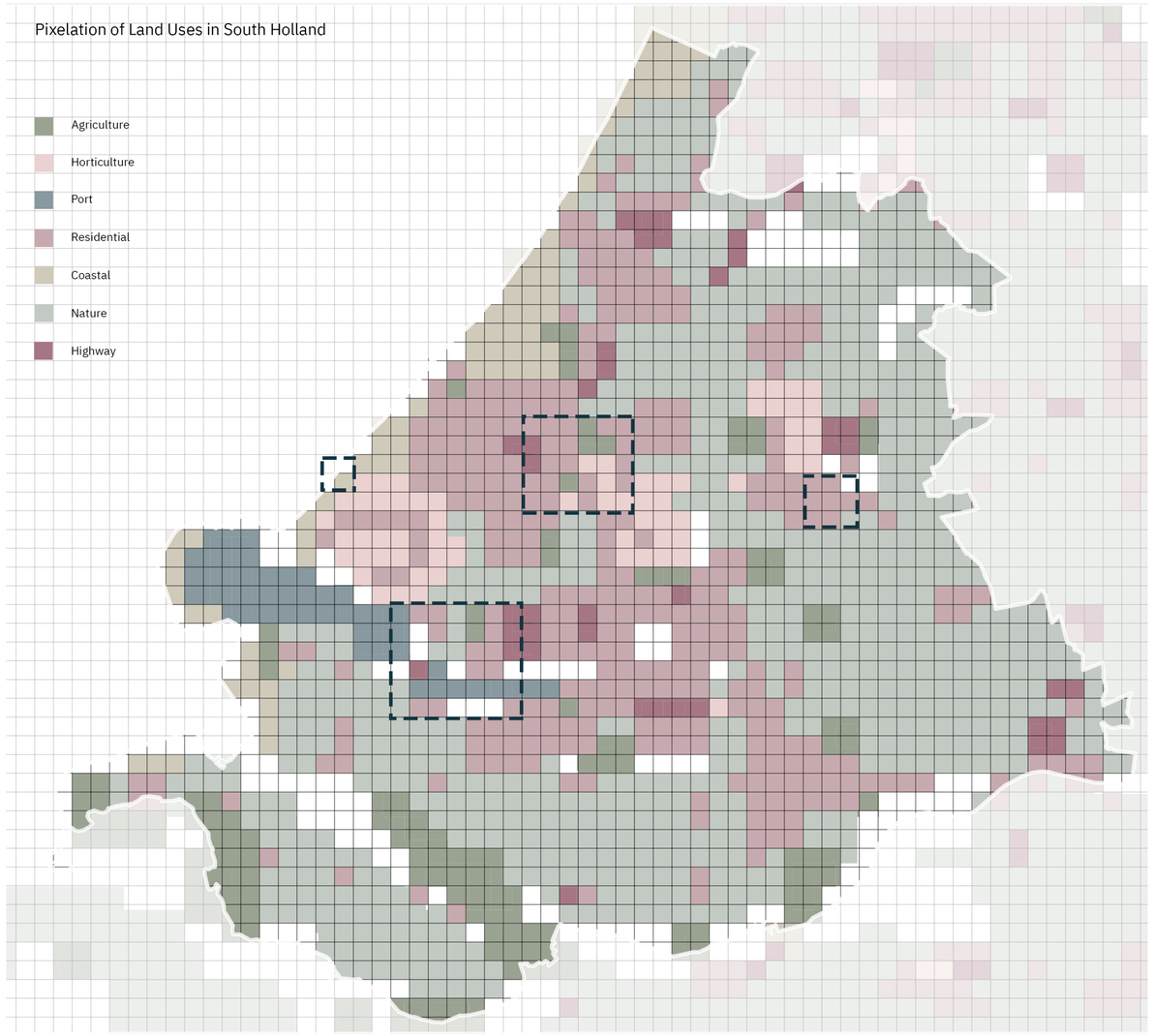
Public
Civic
Private

Stakeholders Network





The selection of sites was based on an understanding of the ecological performance of soil across south holland, and the land uses it supported.
An overlay of the soil carbon capture capacity, fertility, level of intrinsic nutrient cycle, and biodiversity, marks regions of high and low ecological value. The regions with high ecological value need to be preserved to retain their high contributions to natural processes. Consequently, the areas with low ecological value need to be remediated as they are most critical.

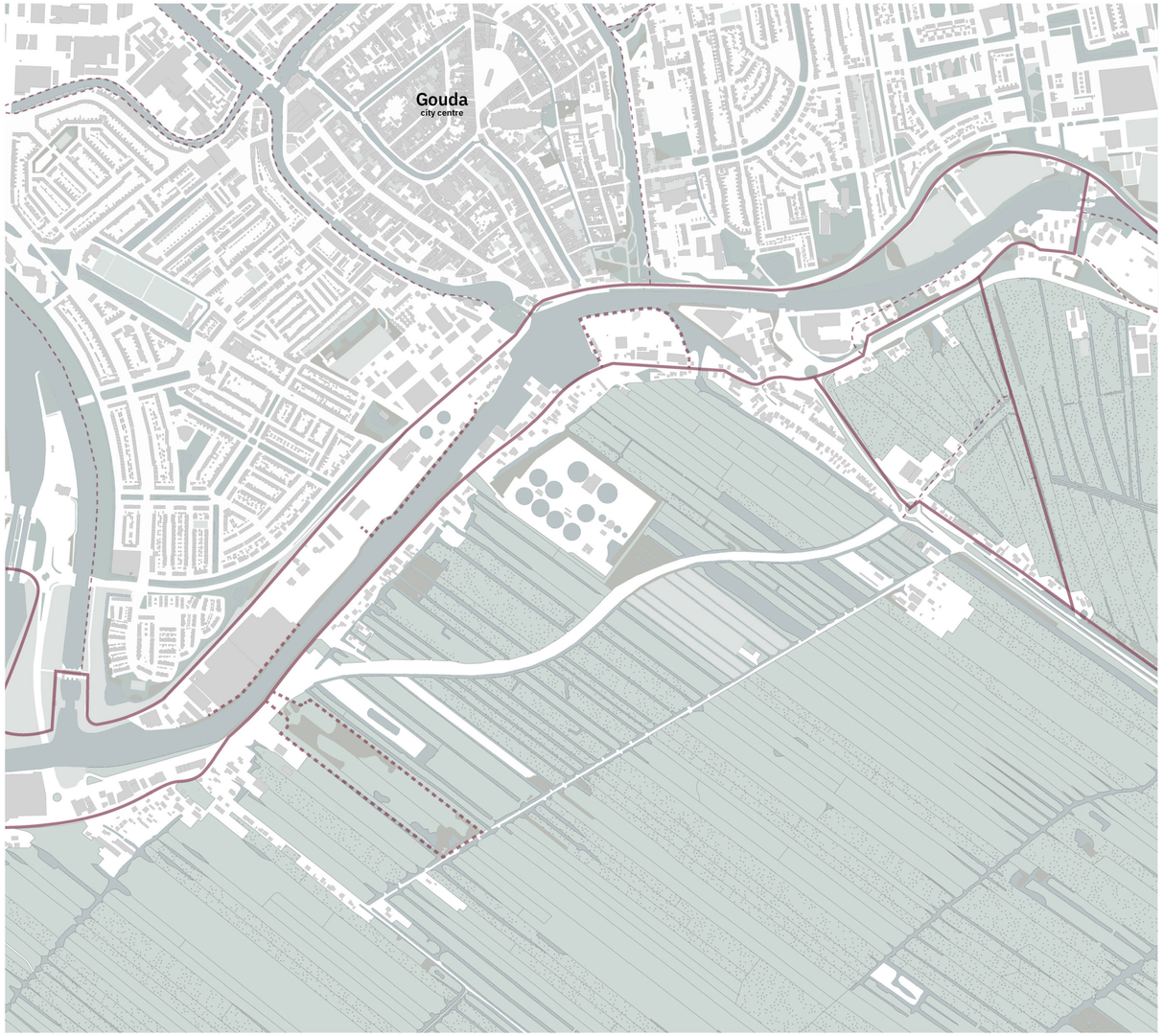


This ecological performance of the site is related to its land use map and the natural infrastructure. The coastal landscape is of strategic importance. This area is connected to important urbanized centers and there's potential to capitalize on natural processes using nature-based production systems. The Green Slinger is a large natural network that although highly fragmented, has direct connections to most urban areas, in South Holland. The selection of our sites combines areas with high and low ecological values and explores different combinations of land use and natural infrastructure.



Gouda

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0 100 m 1000 m

Scale 1 : 10.000

Connection between a historic centre and the peatlands

Gouda 2022

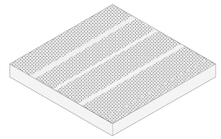
Gouda is a city and municipality in the east of the province of South Holland. Gouda is located at the confluence of the rivers Gouwe and Hollandse IJssel. It has a historic centre and is largely surrounded by nature and peatlands. Traditionally, the Haastrechtsebrug was the connection between the farmlands and the city market. This connection is being maintained.



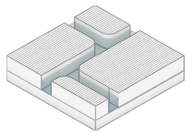
Wind energy



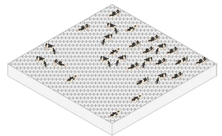
Monoculture

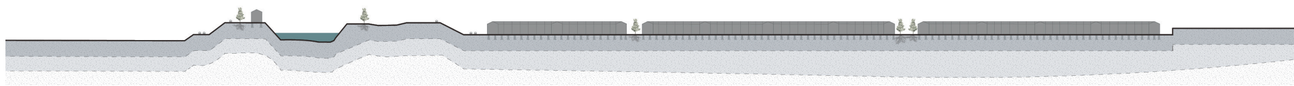


Polders



Farmlands







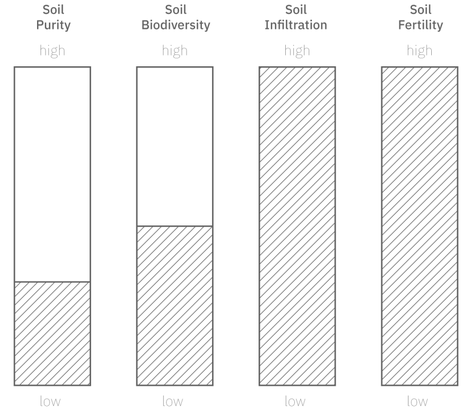
0 100 m 1000 m

Scale 1 : 10.000

Kick-start of re-wetting the peatlands

Gouda 2040

The water of the Hollandse Ijssel is going to rise in the future. Therefore in 2040 tidal parks are established, together with new green structures.



Key points in timeline specific to Gouda

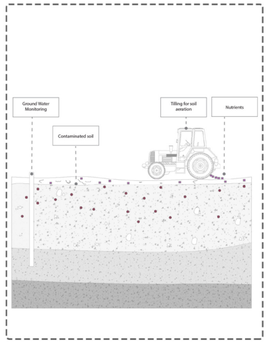
1. Soil Remediation Strategy
- [A] Bio Remediation of Soil in agricultural and grasslands
- [B] Planting, and propagating micro-organisms vital to soil quality networks
- [C] Remediating open soil available from freeing up built structures
- [D] Open Soil Networks Established

2. The Urban Implication
- [A] New Housing Developments within set urban boundaries defined by soils natural capacity
- [B] More open green spaces in neighbourhoods
- [C] Using Material Banks to build new homes
- [D] Transit oriented development

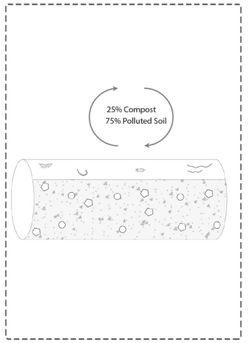
3. Planting strategy
- [A] Rewetting the Peatlands
- [B] Agriculture on parts of the wet Peat soils to obtain bio-mass
- [C] Intercropping to produce non-food crops that can produce biofuel
- [D] Vertical glass house production with open and live soil
- [E] Mixed Farming, Crop Rotation Practices, to restore soil quality
- [F] Intercropping, Mixed Farming, Crop Rotation Practices, to meet food demands and biofeed needs

4. Waste management
- [A] Transporting agricultural wastes to Industries to meet biostock needs
- [B] Transporting residential wastes to farms to produce manure
- [C] Transporting agricultural wastes to Industries through cargoloops

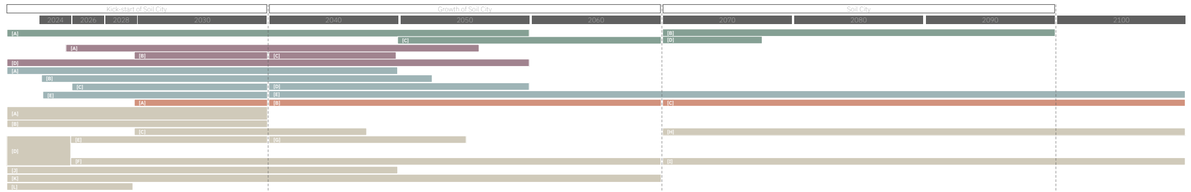
5. Policy framework
- [A] Policies for Carbon trading with the port to get investment to remediate agricultural land
- [B] Promoting the Use of Electric Cars
- [C] Setting up Material Banks of components of dismantled glasshouses
- [D] Testing Soil Quality, to define the boundaries of development based on natural carbon capture capacity
- [E] Define a percentage of new neighborhoods as open soil
- [F] Open up pavements in existing neighborhoods
- [G] Limit parking and open up soil
- [H] Policies to protect Open Soil Network
- [I] Monitoring Soil Quality after remediation
- [J] Identifying Tertiary roads that can be depaved
- [K] Branding and Protecting the Soil City
- [L] Educating Farmers about Regenerative Farming



Landfarming



Compost





0 100 m 1000 m

Scale 1 : 10.000

Gouda as a Soil City

Gouda 2100

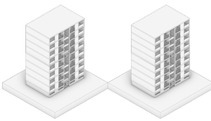
Currently, most of the peatlands are not intact anymore. The existing farmlands will be wetted and turned into paludiculture, which is spreading seeds and planting which is tolerant to flooding. The land is acting as a carbon sink, but simultaneously farmed and productive. The cultivation can be used as animal fodder, construction material, paper and a growing medium for orchids.

The existing grasslands will be used as wetlands contributing to higher biodiversity and could be used for recreational purposes. This will be drained land.

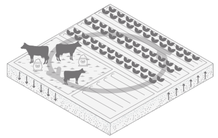
Therefore, by 2100, Gouda is ready to be a Soil City.



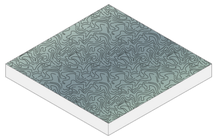
High-rise building



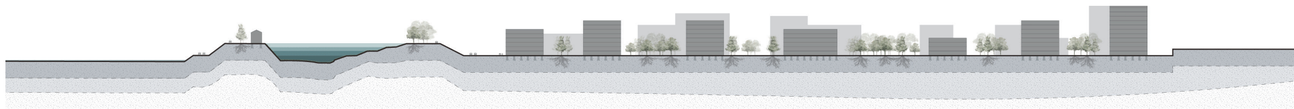
Crop rotation



Wetlands



Paludiculture



Atmospheric impression

Re-wetted peatlands

Reforestation of surrounding landscapes with native tree species restores natural cycles and establishes low maintenance resilience

Rewetting peatlands through Paludiculture restores the groundwater table level

Restored peatlands result in the reintroduction of previously extinct flora and fauna

A sensitively constructed path enables limited access to the peat landscapes, without compromising its regeneration

A selection of phytoremediating species are planted at the periphery of the peat landscape to intercept and filter water runoff. This prevents eutrophication

Most areas of the restored peatlands are completely inaccessible and left alone to regenerate. This is made possible through the deliberate flooding

Farming prectices are transformed to fuse rotational livestock grazing with growing crops. Sustainable grazing practices are put in place.

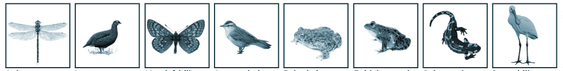
The reintroduced vegetation is selected based on economic and ecological consideration

Regenerated peatland contribute to the largest carbon sink amongst all land-uses. Re-wetted peatland transforms from a Carbon neutal to a Carbon sink

Peat landscapes contribute to the production of biomass, reinforcing the shift towards a circular bio-based economy



Reforestation species



Reintroduced peatland fauna



Reintroduced plant species



Recreational Ecological Spine

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0 1000 m 3000 m

Scale 1 : 30.000

Spine

Existing conditions

The Groenblauwe slinger is a network of green spaces and water bodies that runs through Midden-Delfland, connects with Delft and Zoetermeer and intends to connect with the green heart.

It is a concept that was conceived around 1995 to prevent the merging of the metropolitan areas of Rotterdam and Den Haag and to create a balance between city, nature, water and recreation (Source: Province South Holland video). The official project by the province of South-Holland was completed in 2016. It was seen as an important component in providing high quality to the living environment and it connects a variety of recreational pedestrian- and bicycle paths as well as a diversity of landscape characteristics. What is more, it has a strong ecological importance for the region. It spreads out over around 200km2 and is divided into 6 sub-areas. Nowadays, the historical pattern provides an important underlayer for new developments, in which the landscape can remain ‘readable’ and give the area its own identity (SOURCE Groenblauwe slinger, reflectie op de ruimtelijke kwaliteit; 2013)

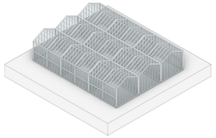
Zoom In.

We zoomed-in on the area of Pijnacker and its surroundings. In this area, the spatial fragmentation of the green spine as a consequence of the glass house expansion and the mobility network, becomes visible.
It is vital to re-connect the green-blue network for various reasons, such as microorganism migration and recreational-ecological connectivity.

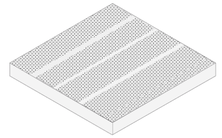
Our strategy is divided into three phases, each with different goals and milestones. Phase 1 focuses on the period of 2022-2040, kick-starting the soil city.where the first steps are to open up the soil, connect stakeholders and converge policies. Phase 2 aims to grow the concept of the soil city in the period of 2040-2070. The goal for phase 3 is sustaining the systems set in place.



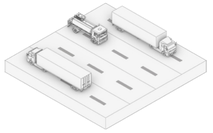
Glass houses



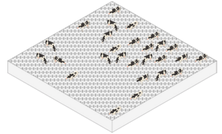
Monoculture

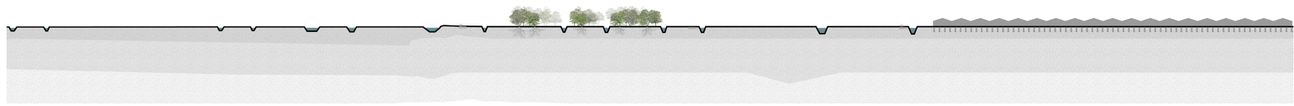


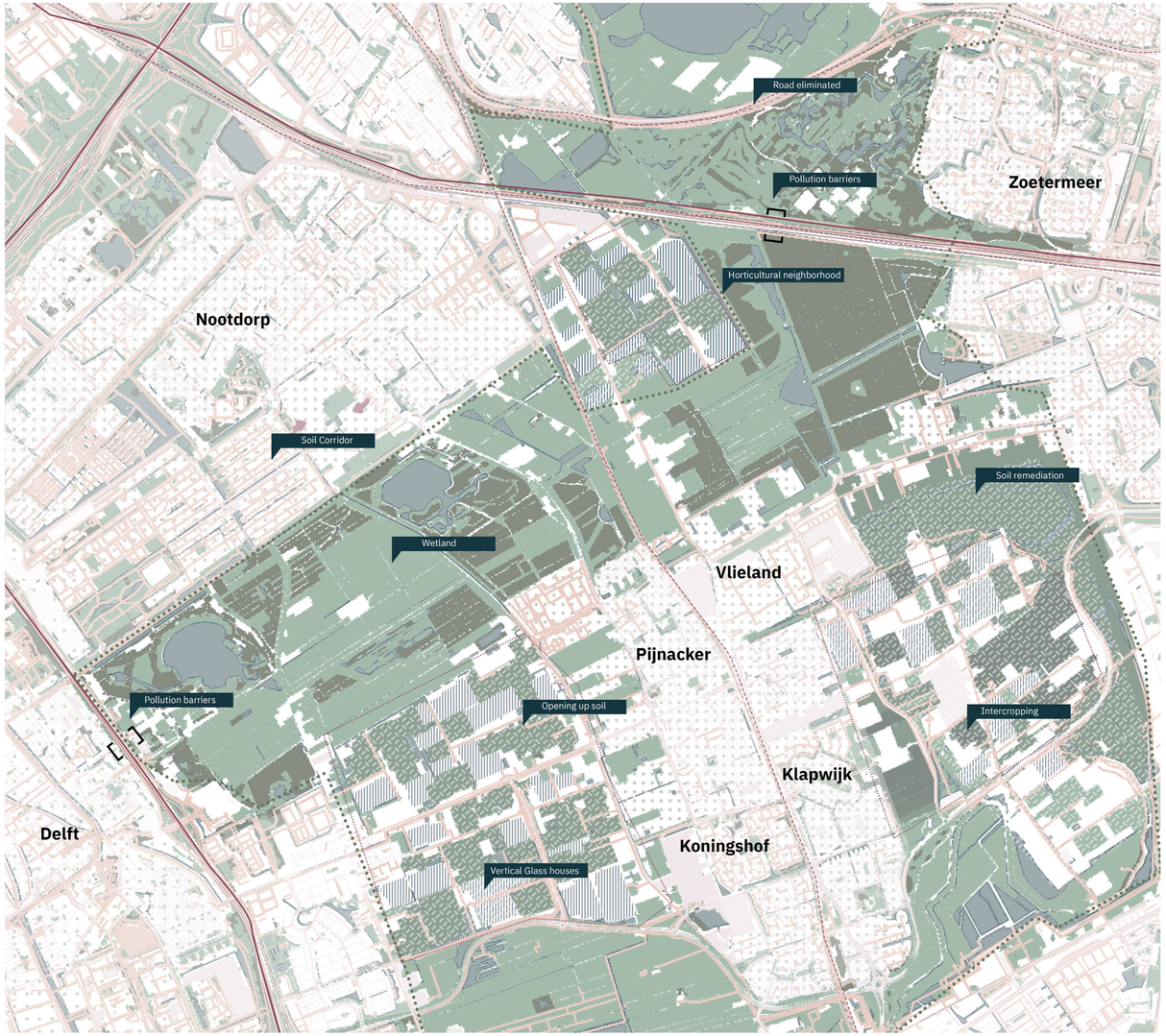
Highway



Farmlands







Scale 1 : 30.000

Spine

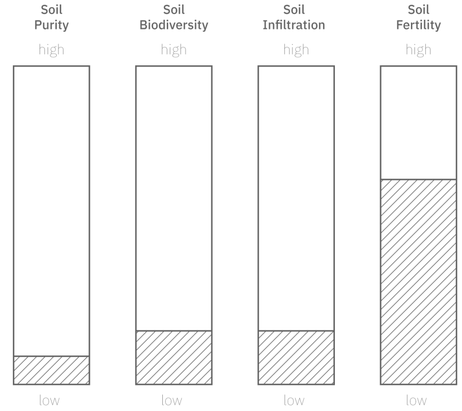
Phasing

Our proposal for 2040 is to start opening up the covered soil and to stop the expansion of the glass houses. The plan is to start opening up soil by approaching the owners of the land and proposing to them to continue with the economic activities in the glass houses but in a vertical manner, on less land, and use the freed up land for the development of new multi-functional neighbourhoods. If they are not willing to develop themselves, they can instead sell the land (to project developers for example). In a worst case scenario, juridical measures might be needed to obtain the land.

In areas where the soil has been opened, natural remediation techniques will be implemented to improve the soil functions. Not only phytoremediation and compost will be the strategies we propose to restore the soil quality but it is also crucial to share knowledge about regenerative farming between the farmers as a way of guaranteeing the maintenance of the soil conditions over time. Furthermore, a strategy for economic gains will be put in place, such as intercropping to produce non-food crops that can be used to produce biofuels and new materials .

Reduction of lesser used highways and roads is another part of our vision of the soil city. However, the highway A12 is still important because it serves an important function as a connection between Den Haag and Arnhem, passing through Utrecht. We propose that this highway will be covered with pollution barriers to connect both sides with pedestrian and bike bridges. In order to achieve this goal, it is vital to strengthen the existing mobility system and improve connections through the urban centres.

Certainly, the green-blue spine has a key role for the region as a recreational and ecological corridor. For this reason, it is important to enhance and expand these conditions to further strengthen the balance between nature and city.



Key points in timeline specific to the spine

1. Soil Remediation Strategy

[A] Bio Remediation of Soil in agricultural and grasslands
[B] Planting, and propogating micro-organisms vital to soil quality networks
[C] Remediating open soil available from freeing up built structures
[D] Open Soil Networks Established

2. Energy

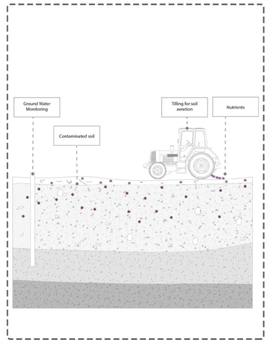
[A] Using Biofuel for transportation networks
[B] Shifting to renewable energy grids for mass tranport networks
[C] Setting up Infrastructure, for offshore wind energy, solar grids
[D] Strengthening energy efficiency of distribution
[E] Converting oil storages to store hydrogen and green gas
[F] Setting up the infrastructure for the cargo loop system
[G] Transporting produce between the port and farms using the cargoloop system

3. Urban implications

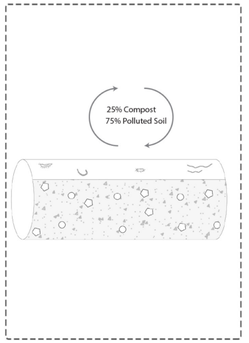
[A] New Housing Developments within set urban boundaries defined by soils natural capacity
[B] Transit oriented development
[C] Strengthening Existing Mobility Systems
[D] Using Material Banks to build new homes
[E] Reduction of highways
[F] Anti-pollution barriers around retained highways
[G] New Mobility Systems Centered around Water ways
[H] Start spatial research on the Groen Blauwe slinger
[I] Enhance/expand existing recreational sites
[J] Highway Forestry
[K] Make Parking Expensive to discourage car use.
[L] Define main spots of recreation (canoeing, restaurants, places to stay etc.)
[M] Connecting main spots (cycle routes, walking routes, animal routes)
[N] Offshore breakwater installation
[O] More open green spaces in neighbourhoods
[P] Covering Highways with Eco Ducts
[Q] New routes are connected
[R] Recreational Ecological Spine is blossoming

4. Planting Strategy

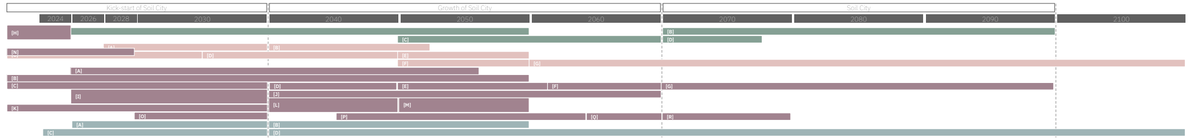
[A] Intercropping to produce non-food crops that can produce biofuel
[B] Vertical glass house production with open and live soil
[C] Mixed Farming, Crop Rotation Practices, to restore soil quality
[D] Intercropping, Mixed Farming, Crop Rotation Practices, to meet food demands and biofeed needs



Landfarming



Compost



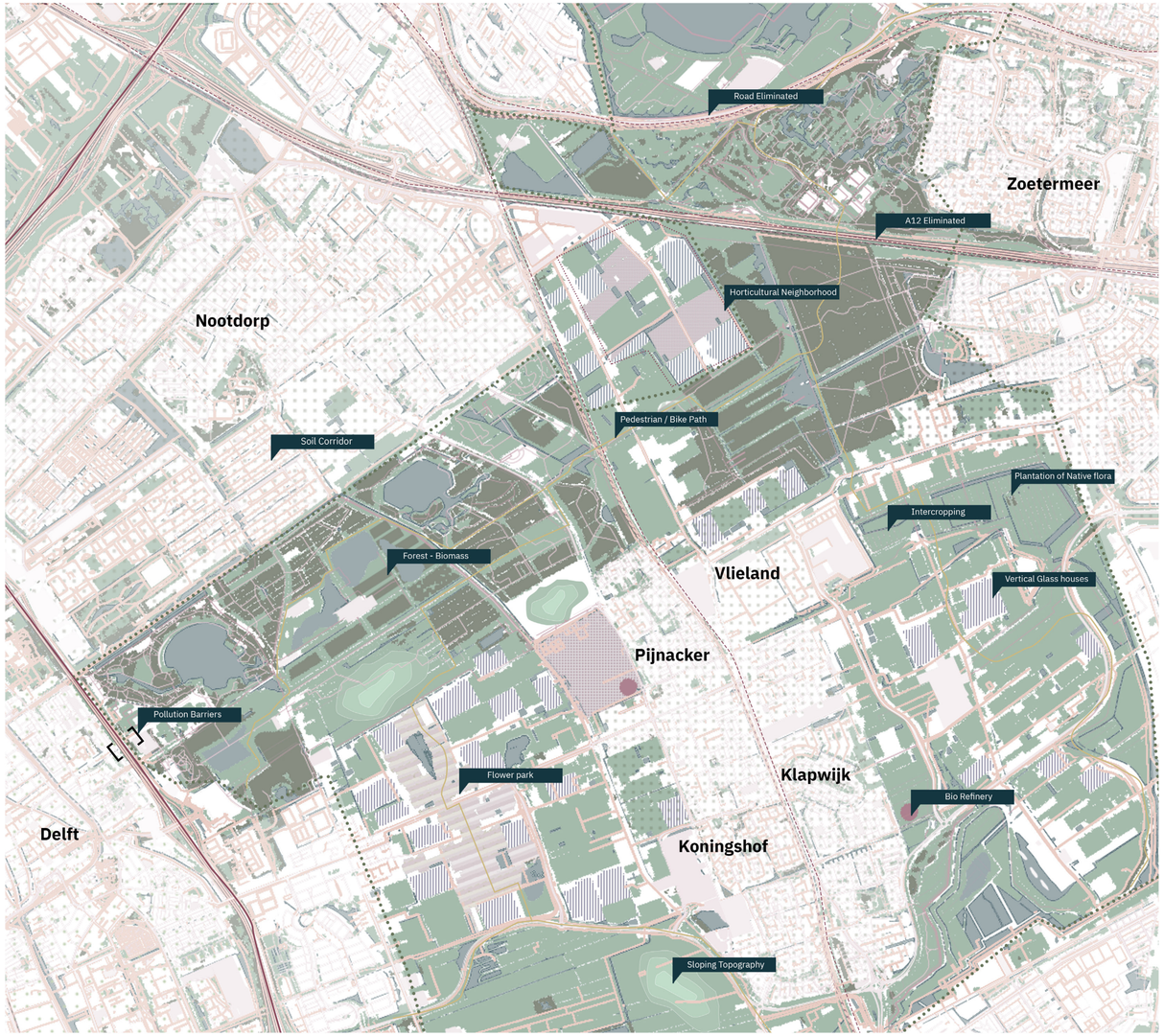
Spine within a Soil City

Recreational Ecological Spine 2100

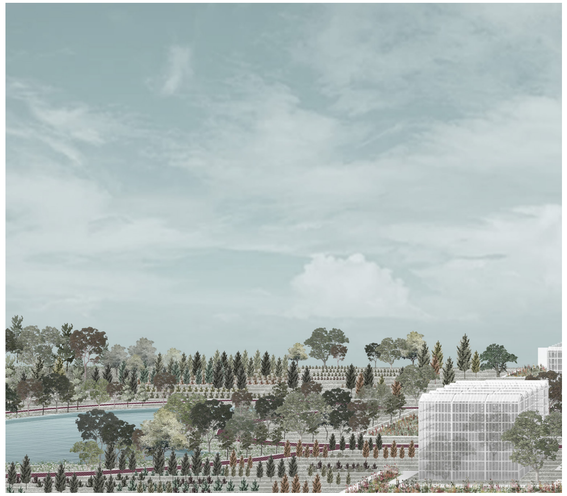
In phase 2, we will continue reenforcing the Green Spine. In doing so, we will have our soil corridors that will go through the multi-city network and the edges of the built environment will merge with the remediated soil and nature. Because of the high level of water in the region, we will create waterways that act as a new mobility network. Important for this phase is that we will have biorefineries and intercropping is going to generate a high volume of biomass. At this stage it is important to have biorefineries that can connect directly with the farmers. The result of all these interventions will make this green spine connected again, with high levels of biodiversity, a healthy soil, more biomass and a prosperous economy.

After the first milestone with more soil unpaved and remediated, the proposal is to convert several free spaces into horticultural neighbourhoods that connect better with the green recreational and ecological spine, and provide a new way of rural living combined with economic activity and innovation.

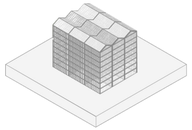
In this phase we propose a flower park as an attraction related with the horticultural activity previously done inside the glasshouses, which is situated between Delft and Pijnacker. Also the replanting of native species, that regenerate natural cycles, boost the proliferation of microorganisms, give shelter,food for insects and other animals. Few input is needed for the successful establishment of native flora and it requires low maintenance.



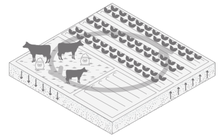
Scale 1 : 30.000



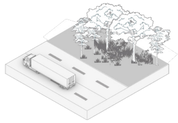
Vertical glasshouses



Crop rotation

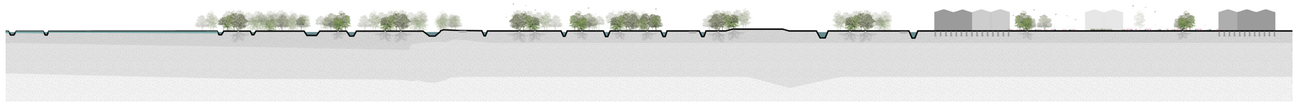


Highway forest



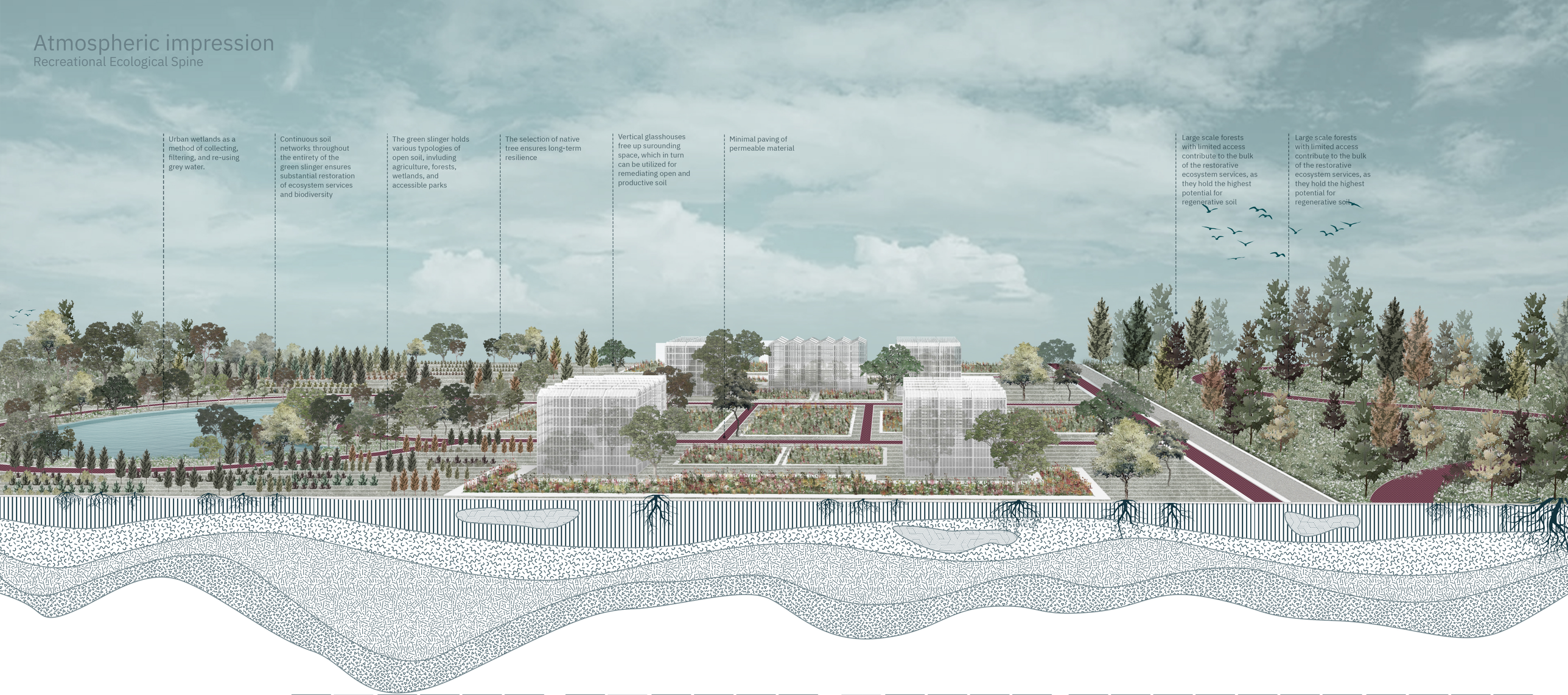
Urban agriculture

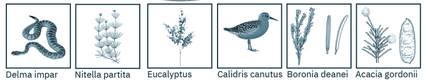




Atmospheric impression

Recreational Ecological Spine

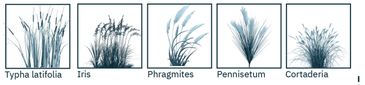




Endangered reintroduced species



Urban farming species



Ornamental grass street planting



Intrinsic sand dune species

Urban key native tree species



Monster

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Scale 1 : 7.500

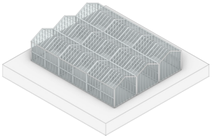
Monster

Existing conditions 2022

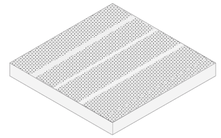
The town of Monster is composed of an amalgamation of glasshouses, industry, and residential buildings, adjacent to the dune scape and coastline. As a recently integrated part of the municipality of Westland, its activities are tied to the glasshouse landscapes. Its coastal location makes it a popular recreational spot, but this can be strengthened to accommodate infrastructure that adds to the region's resilience. The dune's natural landscapes serve as a natural flood defense system, and this requires reinforcement to address future threats. The preservation of the biodiversity in the region is critical



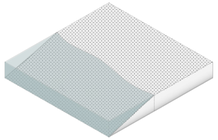
Glass houses



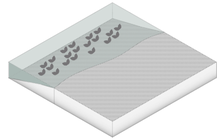
Monoculture

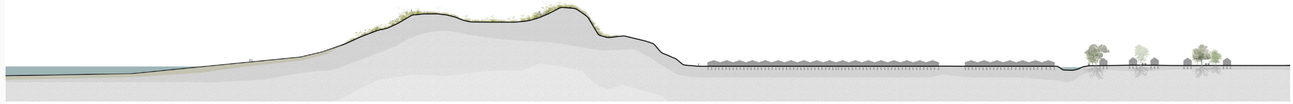


Title



Title





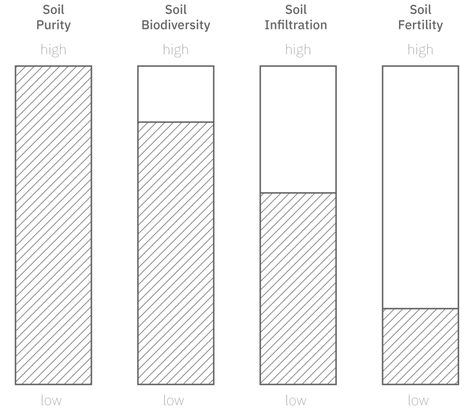


Scale 1 : 7.500

Monster

Phasing 2040

Offshore hybrid breakwaters serve as a flood defense and work in symbiosis with the dunes to increase the shoreline through sedimentation dynamics enhanced by benthic grasses. They are later transformed into oyster farms. Fish farms in controlled quadrats enable the tactical reintroduction of extinct species and add to the economic potential of the area.



Key points in timeline specific to Monster

1. Soil Remediation Strategy

[A] Planting, and propogating micro-organisms vital to soil quality networks
[B] Remediating open soil available from freeing up built structures
[C] Open Soil Networks Established

2. Energy

[A] Setting up Infrastructure, for offshore wind energy, solar grids

3. The Urban Implication

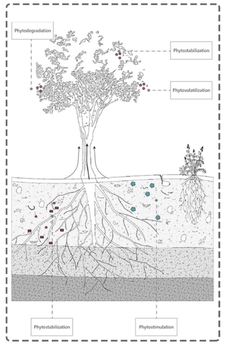
[A] New Housing Developments within set urban boundaries defined by soils natural capacity
[B] Transit oriented development
[C] Strengthening Existing Mobility Systems
[D] Make Parking Expensive to discourage car use
[E] More open green spaces in neighbourhoods
[F] Offshore breakwater installation
[G] Using Material Banks to build new homes
[H] Highway Forestry
[I] Increasing Coastal Shoreline
[J] Reduction of highways
[K] Anti-pollution barriers around retained highways
[L] New Mobility Systems Centered around Water ways

4. Planting Strategy

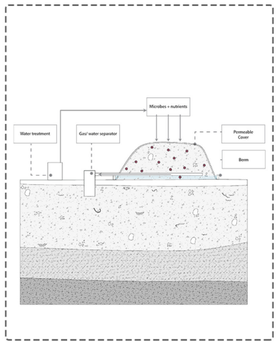
[A] Coastal Seagrass plantations
[B] Coastal Seagrass Proliferation
[C] Dune grass plantations
[D] Dune Grass Profileration
[E] Sand Dune Growth
[F] Offshore Algae plantations
[G] Algae Proliferation
[H] Reintroduction of nearly extinct fish species
[I] Preservation of Marine Biodiversity
[J] Protecting Oyster Reefs for water filtration, wave energy reduction, denitrification and substrate stabilization
[K] Oyster pods transform to reefs: growth rate 11cm/year
[L] Full formed extensive, resilient oyster reef
[M] Transformation of breakwaters into natural submerged reefs
[N] Free Swimming Larval Stage
[O] Oyster spawning
[P] Oyster Growth
[Q] Oyster Proliferation
[R] Fish Farming Initiated
[S] Utilizing offshore algae plantation to filter waste water, produces energy and provide feed for livestock
[T] Intercropping to produce non-food crops that can produce biofuel
[U] Vertical glass house production with open and live soil
[V] Mixed Farming, Crop Rotation Practices, to restore soil quality
[W] Intercropping, Mixed Farming, Crop Rotation Practices, to meet food demands and biofeed needs

5. Waste management

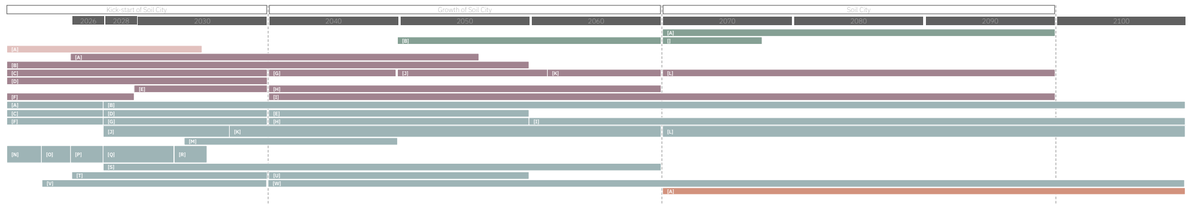
[A] Transporting agricultural wastes to Industries through cargoloops

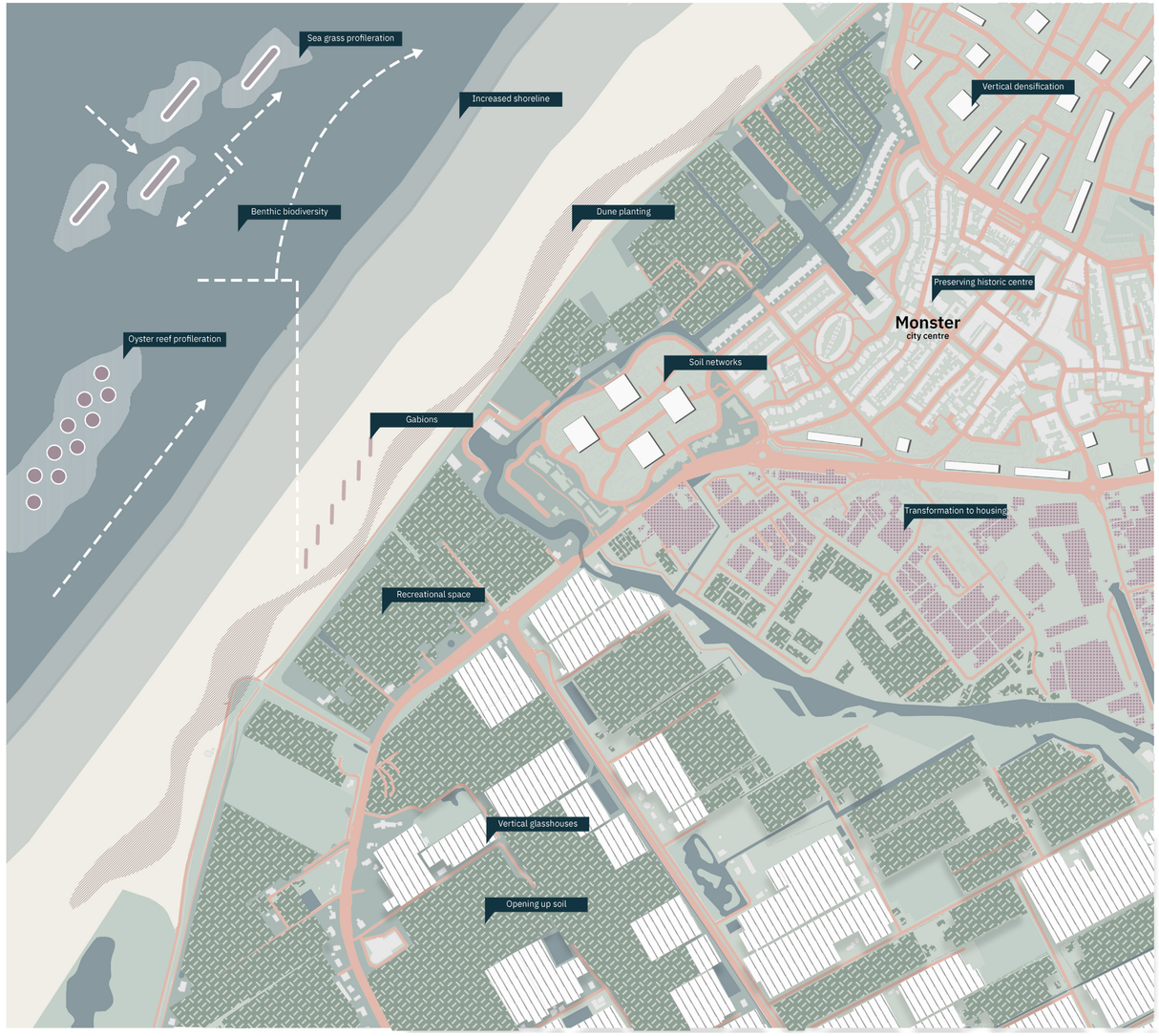


Bioremediation



Bio piles





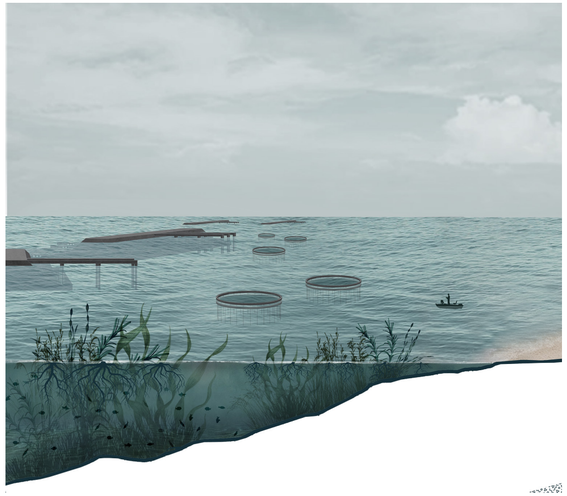
0 100 m 700 m

Scale 1 : 7.500

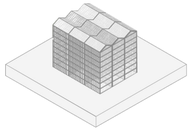
Monster as a Soil City

Monster 2100

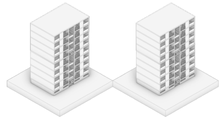
Native grasses proliferate and continue to stabilize the dunes increasing their resilience. Row planting with species capable of remediation between the dunes and the built environment filters water runoff. At this phase glasshouses are made vertical, freeing up a significant amount of the surrounding space. The freed-up space is allocated for phytoremediation through the strategic planting of native species



Vertical glasshouses



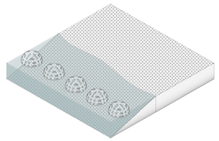
High-rise building

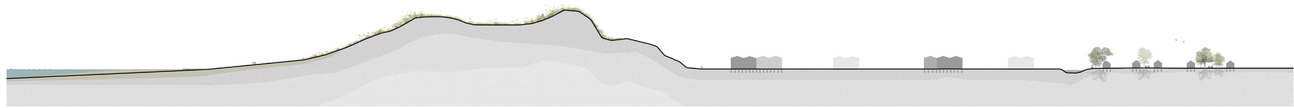


Fish farms



Oyster pods





Atmospheric impression

Resilient coastal landscape

Offshore hybrid breakwaters serve as a flood defence and work in symbiosis with the sand dunes to increase the shoreline through sedimentation dinamics. They later transform into oyster reefs.

Fish farms in controlled quadrats enable the tacical reintroduction of extinct species without compromising the existing benthic habitat. They also reinforce the fish aquatic economy

Benthic grasses are planted to enhance sedimentation dynamics, filter water, contribute to biomass production, and increase biodiversity

Wave action is attenuated through the offshore structures, oyster reefs, and seagrass plantations. This enables the shoreline to gradually increase in symbiosis with natural processes

Shoreline increase establish long term coastal resilience

Sand dunes are protected

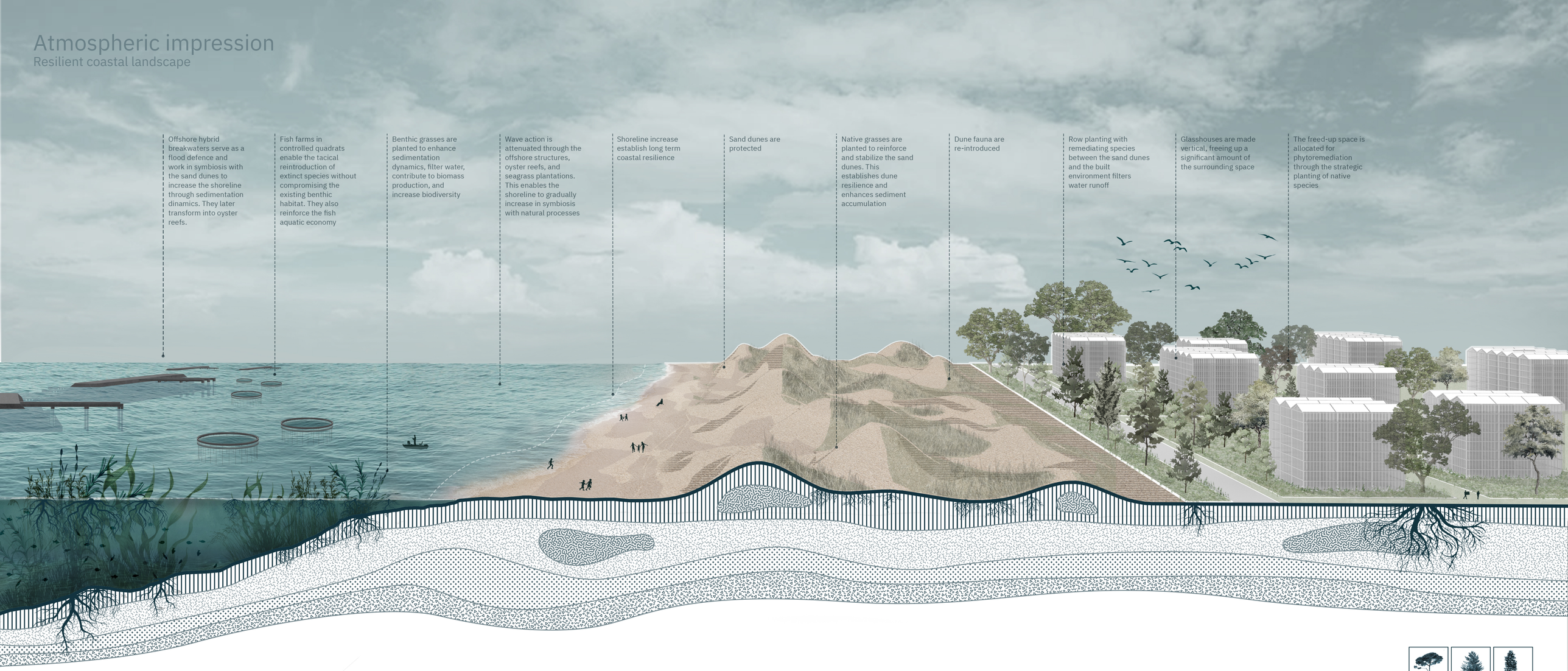
Native grasses are planted to reinforce and stabilize the sand dunes. This establishes dune resilience and enhances sediment accumulation

Dune fauna are re-introduced

Row planting with remediating species between the sand dunes and the built environment filters water runoff

Glasshouses are made vertical, freeing up a significant amount of the surrounding space

The freed-up space is allocated for phytoremediation through the strategic planting of native species





Benthic species



Intrinsic sand dune species



Urban key native tree species



Rozenburg

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Problem Statement 12
Vision 14
Potentials of a soil based South Holland 15
Alignment of Goals with Existing Policy Frameworks 16



0 1000 m 5000 m

Scale 1 : 50.000

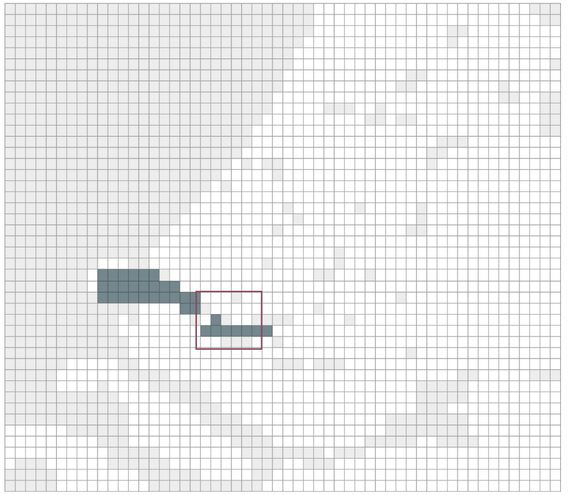
Rozenburg

Existing conditions 2022

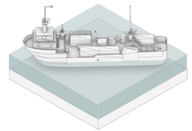
Rozenburg is a town situated next to the Port of Rotterdam and is located on the island Rozenburg. Until 2010, it used to be an independent municipality. Since then, it has been part of the municipality of Rotterdam. It is currently surrounded by industries and has low levels of accessibility by everyday citizens. Its main point of connectivity for the transport of goods is the highway the A15, which is efficient and wide. Additionally, there is a ferry that sails from Rozenburg to the Northside of the river Maas.

Waste management facilities exist within the Port of Rotterdam. However, this is mostly the end of the station within a linear production model of the economy. Besides waste management facilities, there are chemical industries, petroleum refineries, and shipping and logistics companies. Food manufacturing and energy companies industries are located within the Port as well but in fewer numbers.

Southwest of the island Rozenburg, lies agricultural land. The land directly on the southeastern side is mostly agricultural grassland. Potatoes, beets, corn, and grain are the main crops grown around this area. It can be reached from the Port of Rotterdam through a bridge crossing the Hartelkanaal. Rozenburg will have better connectivity to the north of the river since the Maasdeltatunnel will be finished around 2024.



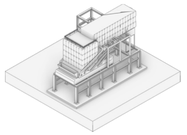
Ship movement



Low-rise building

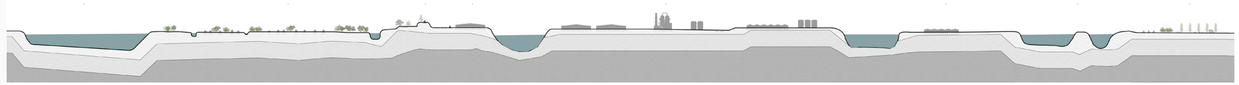


Oil refinery



Water containers







Scale 1 : 50.000

Rozenburg

Phasing 2040

In 2040, soil networks, connect to the surrounding green areas, through the open soil channels. The transitions in the Port of Rotterdam from fossil fuel, petroleum refineries, and other petrochemical companies to biobased refineries strengthened by a circular hub will be made in this phase. Waste management hubs will gain more importance within the network. The infrastructure connecting the Port of Rotterdam is retained to maintain productive connections. Heat grids are built, with the excess heat emitted from the industries transferred to residential areas. The agriculture practices will be regenerative and combine farming and livestock rearing to stimulate healthy soil. Intercropping will take place on the land to grow biomass stock.

Key points in timeline specific to Rozenburg

1. Soil Remediation Strategy

[A] Bio Remediation of Soil in agricultural and grasslands
[B] Intensive Chemical and Bio-Remediation along the edges of the Port
[C] Planting, and propagating micro-organisms vital to soil quality networks
[D] Chemical Remediation of Soil near port
[E] Use of only natural means of fertilisation and pest control
[F] Remediating open soil available from freeing up built structures
[G] Open Soil Networks Established

2. Energy

[A] Using Biofuel for transportation networks
[B] Shifting to renewable energy grids for mass transport networks
[C] Setting up Infrastructure, for offshore wind energy, solar grids
[D] Strengthening energy efficiency of distribution
[E] Converting oil storages to store hydrogen and green gas
[F] Setting up the infrastructure for the cargo loop system
[G] Transporting produce between the port and farms using the cargoloop system

3. The Urban Implications

[A] New Housing Developments within set urban boundaries defined by soils natural capacity
[B] Transit oriented development
[C] Strengthening Existing Mobility Systems
[D] Covering Highways with Eco Ducts
[E] Make Parking Expensive to discourage car use.
[F] Using Material Banks to build new homes
[G] Reduction of highways
[H] Anti-pollution barriers around retained highways
[I] New Mobility Systems Centered around Water ways
[J] More open green spaces in neighbourhoods
[K] Highway Forestry
[L] Start spatial research on the Groen Blauwe slinger
[M] Enhance/expand existing recreational sites
[N] Define main spots of recreation (canoeing, restaurants, places to stay etc.)
[O] Connecting main spots (cycle routes, walking routes, animal routes)

4. Planting strategy

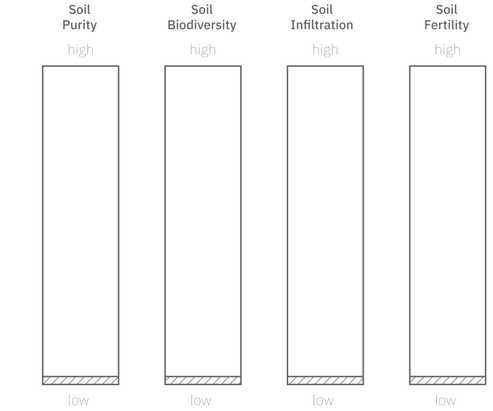
[A] Intercropping to produce non-food crops that can produce biofuel
[B] Vertical glass house production with open and live soil
[C] Mixed Farming, Crop Rotation Practices, to restore soil quality
[D] Intercropping, Mixed Farming, Crop Rotation Practices, to meet food demands and biofeed needs

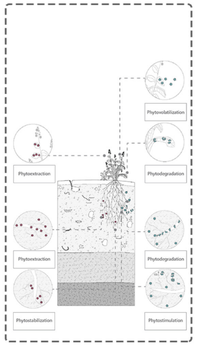
5. Waste management

[A] Establishing networking links between logistics centers, and industries that can close loops
[B] Transporting agricultural wastes to Industries to meet biostock needs
[C] Transporting residential wastes to farms to produce manure
[D] Transporting agricultural wastes to Industries through cargoloops

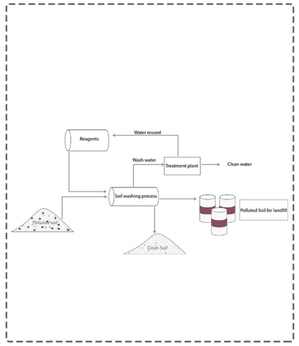
6. Policy Framework

[A] Policies for Carbon trading with the port to get investment to remediate agricultural land
[B] Promoting the Use of Electric Cars
[C] Setting up Material Banks of components of dismantled glasshouses
[D] Testing Soil Quality, to define the boundaries of development based on natural carbon capture capacity
[E] Define a percentage of new neighborhoods as open soil
[F] Limit parking and open up soil
[G] Policies to protect Open Soil Network
[H] Open up pavements in existing neighborhoods
[I] Monitoring Soil Quality after remediation

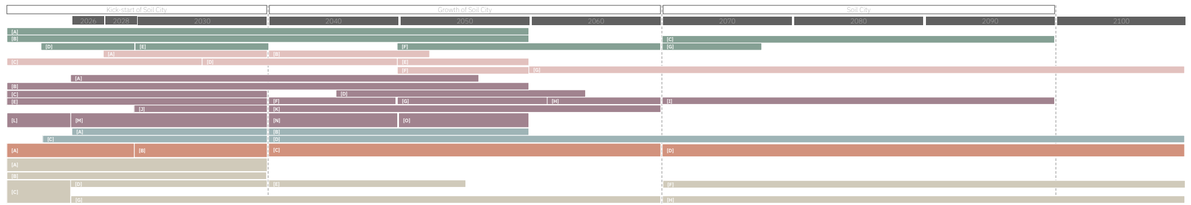




Phytoremediation



Soil washing



Rozenburg as a Soil City

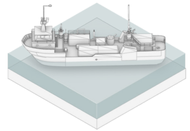
Rozenburg 2100

In 2100, the water transport hubs are established. These will be located in strategic locations, next to the shipping network. According to the Wageningen map 2120, parts of the Port of Rotterdam will be flooded, making it impossible to cross the Hartelkanaal at the previously mentioned bridge. The flooded areas form the base of the 2100 map and create space for renewable energy, for example floating solar parks. The waste management hub will be fully integrated with the biorefineries and the farmland and will become fully circular. The heat grid is also in full use within the residential areas

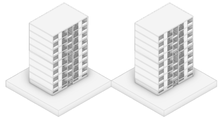




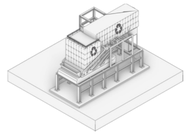
Ship movement



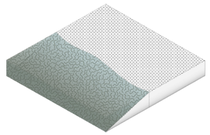
High-rise building

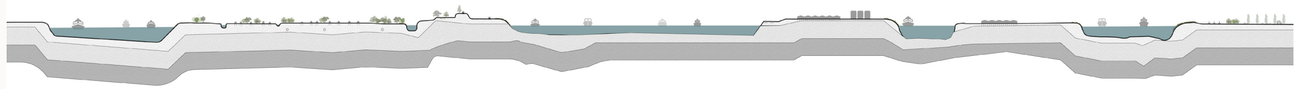


Bio-refinery



Tidal park





Atmospheric impression

Regenerative agricultural practices

Reforestation with native tree species restores natural cycles and establishes low maintenance resilience

Specie selection ensures continuous soil coverage through the combination of deciduous and evergreen trees

Adjacent canals are utilized for gravitational irrigation and water runoff capture

A selection of phytoremediating species are planted at lower elevations, lining canals, to intercept and filter water

Peat landscapes are flooded to prevent the oxidization and sinking of the peat, restoring its essential ecosystem services

Restored peatlands are completely inaccessible and left alone to regenerate. Once healed, they begin to significantly contribute to ecosystem services, primarily carbon capture

Farming practices are transformed to fuse rotational livestock grazing with growing crops. Sustainable grazing practices are put in place.

A selection of phytoremediating species are planted at lower elevations, lining canals, to intercept and filter water

Biorefineries that valourize agricultueal wastes

Locally produced biomass is used to power farmland refineries

Crop rotation is implemented, where the soil is secured with roots year-round.

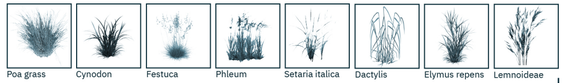
Companion planting ensures efficient nutrient cycling and essential microorganism restoration in the top layer of the soil



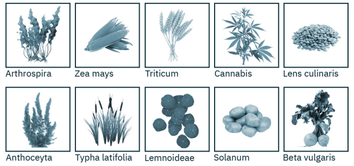
Reforestation species



Reintroduced peatland species



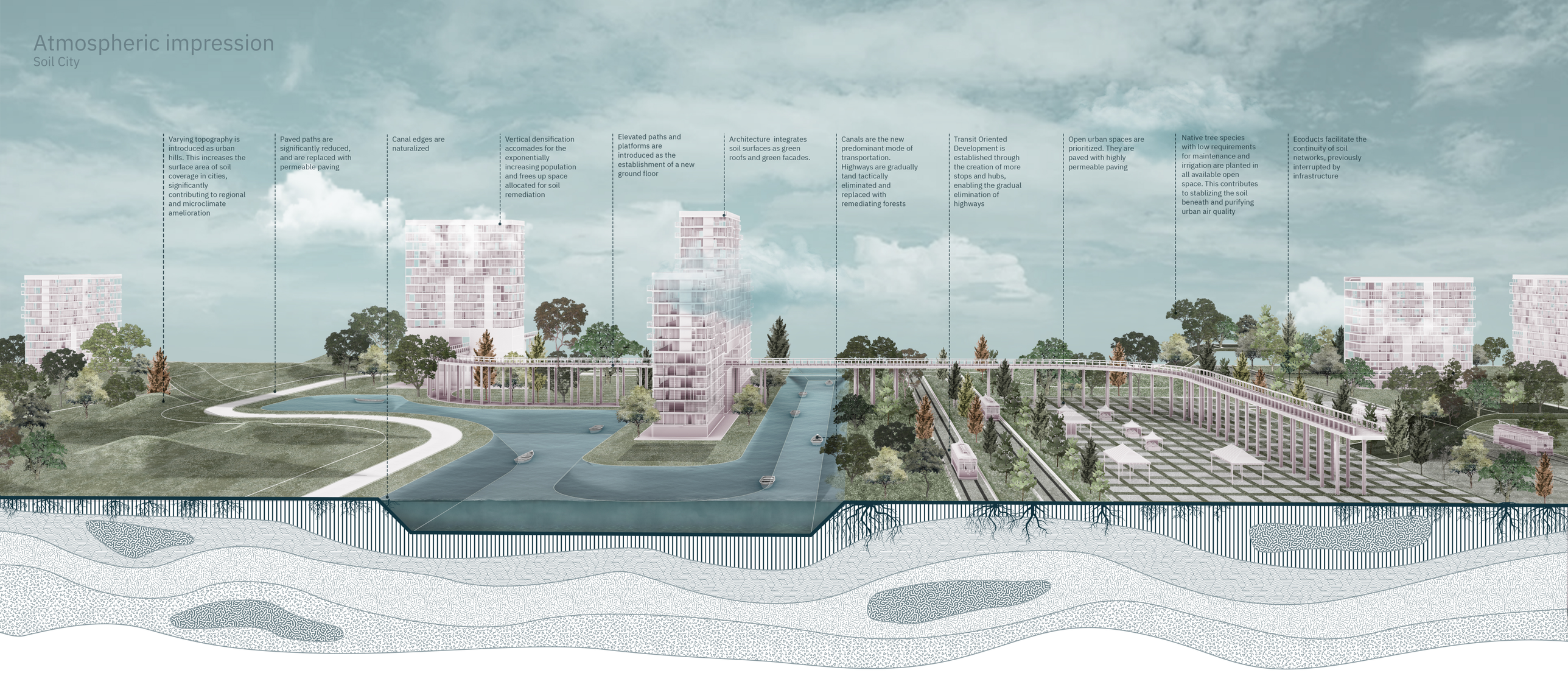
Key grazing species



Key agricultural species

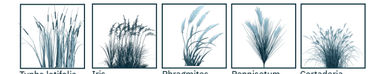
Atmospheric impression

Soil City





Urban farming species



Ornamental grass street planting



Urban key native tree species



Conclusions & Reflection

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Conclusions

While the human relationship with nature has soured since the industrial revolution, the future holds an opportunity to reframe this into a more symbiotic one. Our strategy for South Holland's sustainable future is centered around this redefinition and the understanding that remediating natural systems is vital to sustenance. Soil and its functions, and the potential it holds in sequestering the unprecedented levels of carbon dioxide we are living with, formed the core of our strategy for achieving this.

Down to Earth's approach constantly worked across scales- from understanding the natural cycles that were sustained by the actions of microorganisms, to mapping out geospatial relations and the networks that connect them. We explore the environmental cost South Holland has accumulated as a result of using nature as an economic reserve without checks and balances.

The project lays a framework to conserve areas of high ecological potential, along with a system of financial incentives to achieve ecological restoration in critically degraded landscapes. Through strategies like creating biobased flows centered around regenerative agricultural practices, and making way for infrastructural transformations to open up soil networks, we are proposing a complete reimagination of urban networks. One is based on values rooted in sustaining soil and the systems that sustain life on earth.

Individual reflection Ana Paula Amieva Gomez

In this quarter, I have come to know much about what it means to envision and implement a bio-based economy into an existing urbanized landscape. I have generated a better understanding of why it can be difficult to implement certain policies and the barriers needed to overcome to successfully achieve change; both in spatial terms and in the minds of stakeholders. A region as large as ours is the playing field of a wide variety of public and private stakeholders, which makes it challenging to produce a concept of which all parties benefit from. Personally, it has helped me to delve deeper into the personal motivations and drivers of each stakeholder and use that knowledge to create a vision and accompanying policy that works encouraging and incentivising.

An important part of this, in my opinion, is the breaking down of such a large concept into concrete and comprehensible steps. Using the soil as a tangible object and connecting it to the economy has played a vital role in the construction of our vision. What is more, I have come to see the complexity of generating a vision that aligns and connects a region as a whole by using an inspiring concept, while at the same time leaving room for the different identities that a region of this size holds. Moreover, the complexity of the theme we chose made it challenging at times to demonstrate our interventions in an abstract way while not losing the specific character of our interventions.

Another significant personal realisation during this course has been the identifying of urgencies in a country and economy that is on such a different level of development than my native land, where problems such as poverty, poor living conditions or high levels of crime are generally on the top of the agenda. However, I have come to see that the soil problem in this region is in fact an urgent one and the implementation of new policies to remediate soil can set an example and have an impact on a global scale.

Overall, this quarter has taught me how to think on a large scale and create a vision that connects through all different layers. The role of the government in this is interesting, especially since the government in the Netherlands is divided into many different levels and the power each level of government has is significantly different. I have come to know the Netherlands for its tradition of groundbreaking urbanism. This vision requires a vision from a high level of government, with accompanying budget levels, but should also be able to trickle down to lower levels of government and policy.

Individual reflection Ann Eapen

Our exploration of the quarter three project was firmly rooted in the belief that climate justice and social justice are firmly interconnected. The potential of using open healthy soil to combat the threats of climate change and food insecurity seemed obvious. Laying the groundwork for how this could be achieved, included simultaneously addressing stakeholder motivations, thinking across scales, and using the interdependencies between systems in South Holland to form a strategy. This meant combining the many goals for the future around soil regeneration.

Forming the vision is a tool for shaping attention. The context of South Holland has a diverse set of stakeholders with varying levels of power in decision making, and different purposes tied to how they use land. To build a case for drastic change, we tried to reimagine and visualize how different types of land uses and different stakeholders can interact with nature in a restorative rather than exploitative manner.

Thinking across scales for each intervention allowed us to explore how structural interventions at a regional scale had varied translations when perceived at smaller scales, in relation to their context.

It was challenging to address the role of time in, how we formed the strategy. Although there is a mountain of scientific research highlighting the alarming increase in GHG emissions, its urgency seems to be pushed to the back of our minds in the everyday choices we make. Creating a framework to convince a variety of stakeholders to support a development centered around nature, meant making drastic changes in the current path dependencies that we are locked into. But this was for the promise of a far-off future that needed remediation strategies that span over a human lifetime. We tried to build up the potentials that the transition itself held and highlight the interdependencies between systems that made each shift possible. The circular biobased economy was a means to achieve this and makes an argument for how environmental restoration can be profitable.

Through our analysis process, we were constantly weighing social benefits with environmental costs. By centering development on restoring natural functions and working within the earth's limits we tried to propose a future where social and environmental benefits go hand in hand.

Individual reflection Claudia Engel

Before this quarter, I wasn't aware of the issue of soil turning into dust and the consequences this has on the climate, society and nature. Mostly the importance of the top layer of soil and that a different way of farming can lead to an entirely opposite result in the long run. I think it was Tara who introduced me to this phenomenon. When learning this, I started to overload myself with the information regarding soil. Now, as a Dutch, I am used to having the polders nearby, especially in my hometown. Those are the locations that are great for recreational cycling and walking. However, I wasn't aware that it is mainly preserved because of its historical value. For that reason it made sense for our project to preserve it, and at the same time flood it to restore the soil.

We've gained a lot of insights along the way. When we got the recommendation of our tutors to have a look at the Wageningen 2120 map, which shows the Netherlands in 2120 based on natural solutions, it was a big confirmation for us that we were heading in the right direction, since it provided corresponding and similar solutions like in our project.

Combining all the information on all different scales together in a vision and a strategy that also meets the needs and interests of the stakeholders was a challenge. I think the zoom-in that shows the variety of information of the vision and strategy applied is the zoom-in of Rozenburg, where waste management hubs connect agriculture to bio refineries to create a circular biobased loop, remediating the green edges, the soil networks, partly flooding the Port of Rotterdam which also gives space for renewable energy. Economic, social, ecological and mobility come together in one location.

When we were working on our final presentation, before we had finished this report, I felt confident that we eventually were able to show the multi-layered components of our project within a presentation. Showing all the facets of our projects in a clear way was difficult. With a large amount of data and products, after a lot of discussions, workshops, hand drawing, potential systematic approaches and brainstorms, we decided to first have a look at the story we want to tell before we'd proceed. It has been a challenge to combine such a variety of components within the story; from soil remediation and waste management and biobased hubs to stakeholders with its reasons for resistance/support and regional scale interventions regarding land use (among other aspects) that could actually change ones daily life completely. To conclude, I think that, just like soil, this project has a variety of layers, also regarding the process with our little workshops to share our individual ideas that shaped our end product. We made sure to check everyone's part to ensure quality. And despite we struggled sometimes to get the right structure or finding out how to proceed, as long as it could be with this team, I would do this all over again.

Individual reflection Isa van der Bijl

The planetary damage which has been caused by our ancestors has come to a point where we cannot go back to an unpolluted world. This quarter has shown me the importance of regeneration and restoration of natural cycles.

"In biology, regeneration is the process of renewal, restoration, and tissue growth that makes genomes, cells, organisms, and ecosystems resilient to natural fluctuations or events that cause disturbance or damage."
(Birbrair, 2013)

With the ongoing climate issues, drawdown is crucial. We are the generation who will have to solve the problems which mankind has caused in the past. What has amazed me the most, is that even on the scale of South Holland we are contributing to solving global problems. Working on this regional scale was new to me. Determining the amount of detail you have to put into your work is the hardest question because the more you detail, the more relevant the topic becomes.

Doing the bachelor's at the TU Delft, made me familiar with the context of South Holland. Therefore, I was able to research more on every part of the province, from the Bollenstreek to the Drechtsteden. That way I could highlight crucial ideas and share them with the group. Whenever there was a discussion, we could bring back the regional perspective, since our initial research was very extensive.

The topic of soil was our research and design theme. We were determined to introduce a robust shift to reach a bio-based economy. Resiliency is at the core of our project, this was defined by showing the urgency of remediating soil. By completing our vision and strategy we were able to put our analysis into action both on a timeline and in a design. Our concept became reality.

In nine weeks we went from driving around the port of Rotterdam to creating an integrated project, which tackles local, regional and global dilemmas. Through combining our personal skillsets, we were able to complement each other, learn from one another and compose a versatile proposal together.

Birbrair, A., Zhang, T., Wang, Z. M., Messi, M. L., Enikolopov, G. N., Mintz, A., & Delbono, O. (2013). Role of Pericytes in Skeletal Muscle Regeneration and Fat Accumulation. *Stem Cells and Development*, 22(16), 2298–2314. https://doi.org/10.1089/scd.2012.0647

Individual reflection Tara Kanj

Designing on the regional scale coupled with the topic of circular bio-based economies was challenging, considering the extensiveness of the subject matter. The intricate realm of circular economies, particularly bio-based economies, seemed to keep on unfolding the deeper I dug. The confusion was exacerbated by the challenge to plan on the vast scale of South Holland. Therefore, at the early stages of the project, I attempted to pinpoint a specific issue that was equally significant, urgent, and relevant to the region of South Holland. The exercise was to assess all phenomena contributing to the degradation of South Holland's biological and economical ecosystem and to select the single most impactful one. The result was "soil".

Soil is at the core of every single living organism, and its degradation gravely impacts the ecosystem, the economy, public health, and socio-spatial justice. South Holland contains a significant amount of soil, and while it's severely degraded, it simultaneously carries the potential for crucial amelioration. Delving into the topic of soil and how it has multiple forms and functions unraveled the structure of our methodology. It made the most sense for me to begin with understanding the scientific dimension of the ecological cycles revolving around soil, in which ways they are interrupted, and how they can be restored without compromising existing prosperity.

It was most difficult for me to leap across scales since the scale of the microorganism was just as relevant as the scale of the entire region of South Holland, however, the systematic approach that our group undertook achieved a solid understanding and clarified this disorientation. We started by analyzing the regional scale, zooming in on the different spatial characteristics within that regional scale, followed by the scale of the microorganism, then zooming out again to assess soil quality and potentials, and finally, zooming in again to illustrate key projects.

Attaining a holistic analysis, research, vision, and strategy was made possible by the complementary nature of the group work. Each individual was knowledgeable about a certain relevant topic and contributed by exploring it further.

Reflecting on this quarter, I can certainly say that this is the most I learned in the shortest amount of time.

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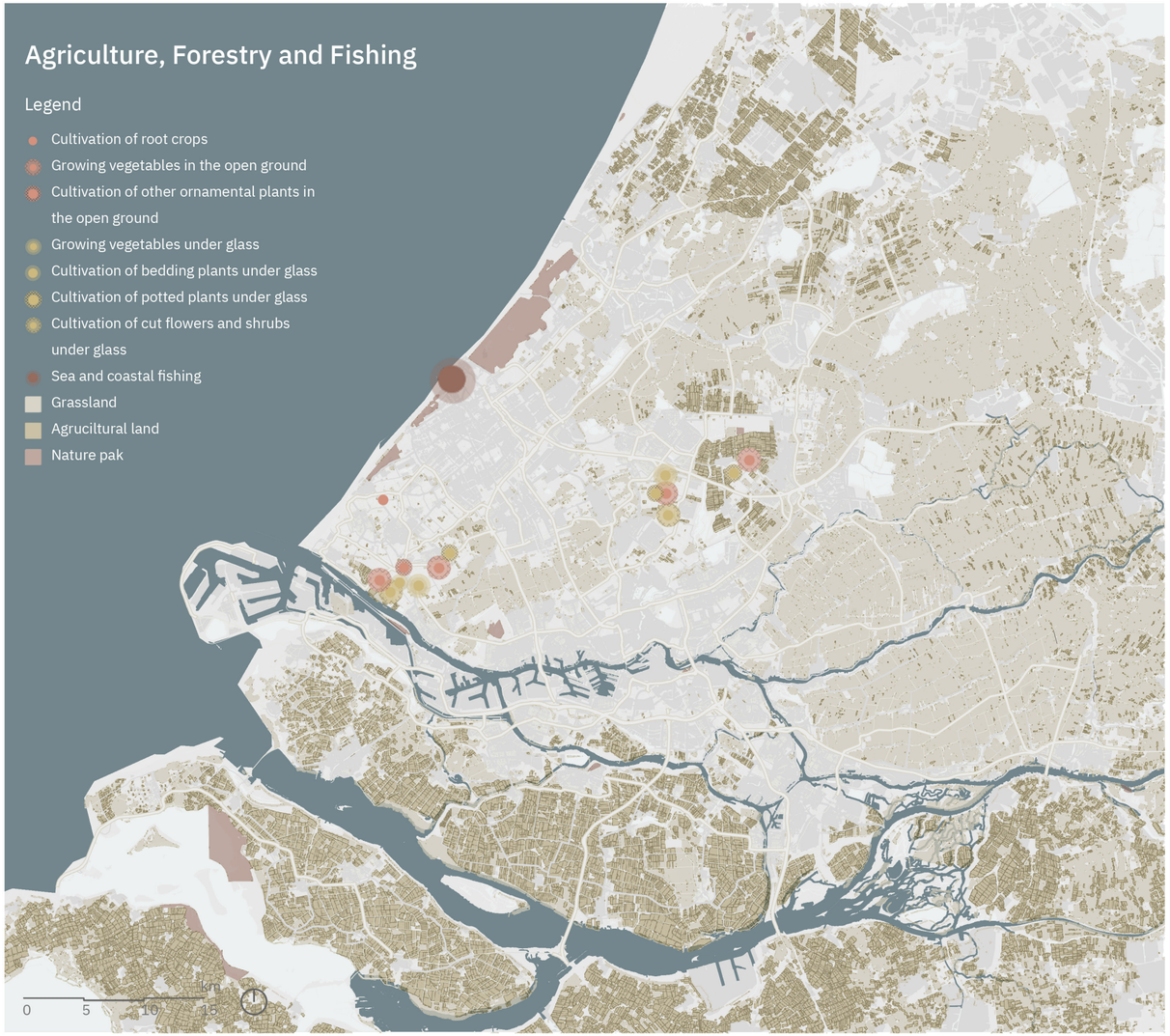
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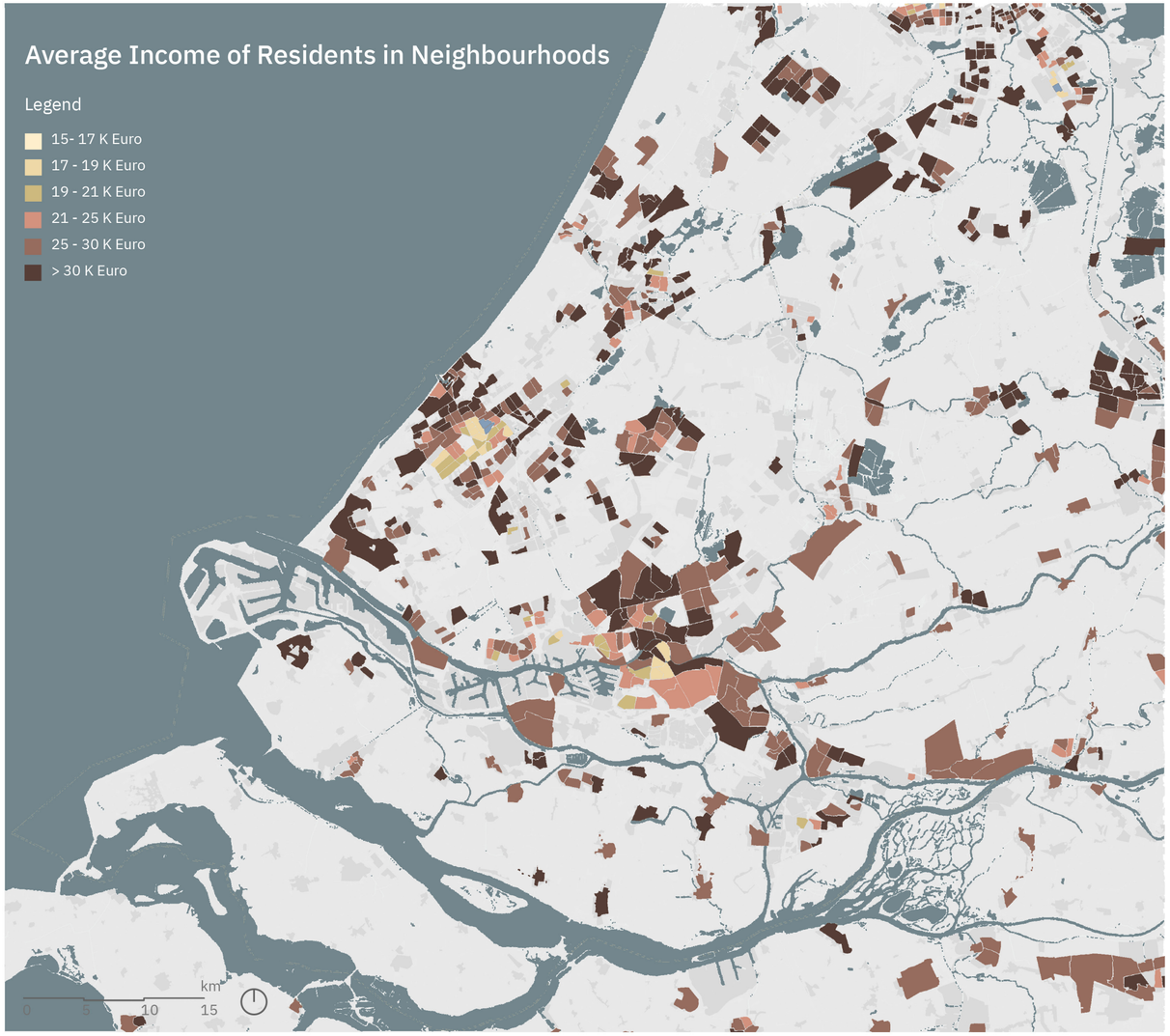
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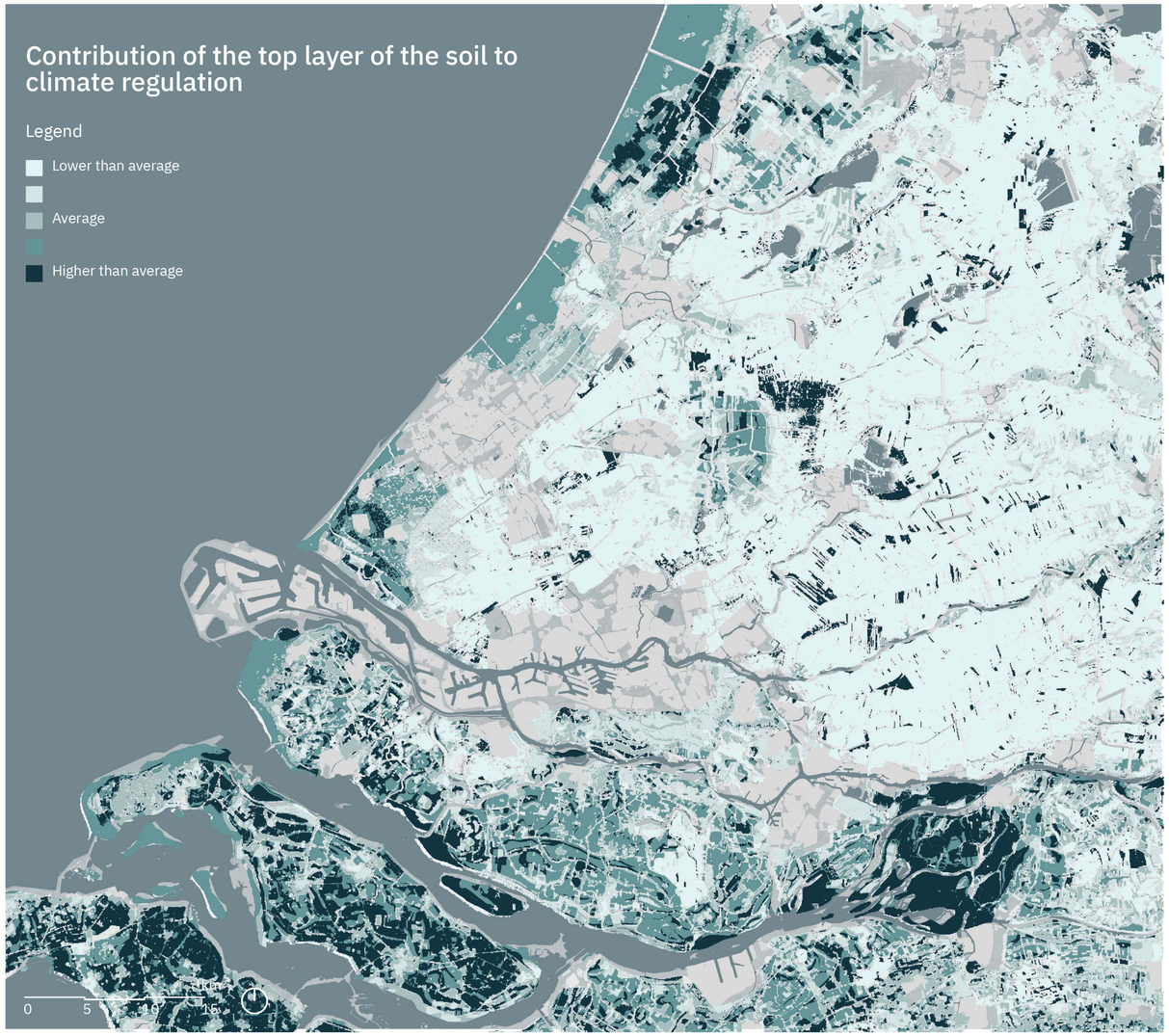
* Note: Cover image drawing adopted from methods of Terra Forma: a book of speculative maps

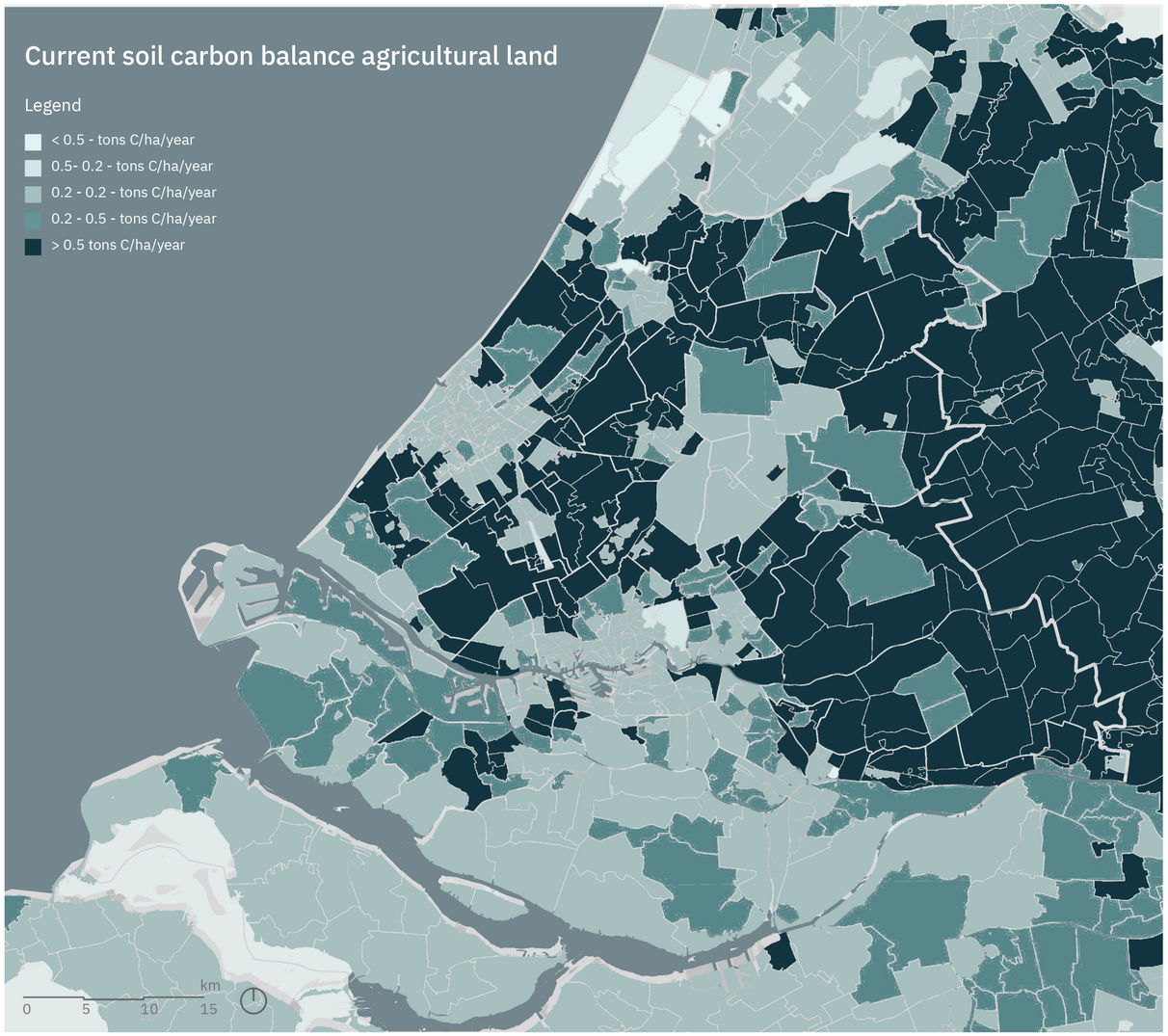


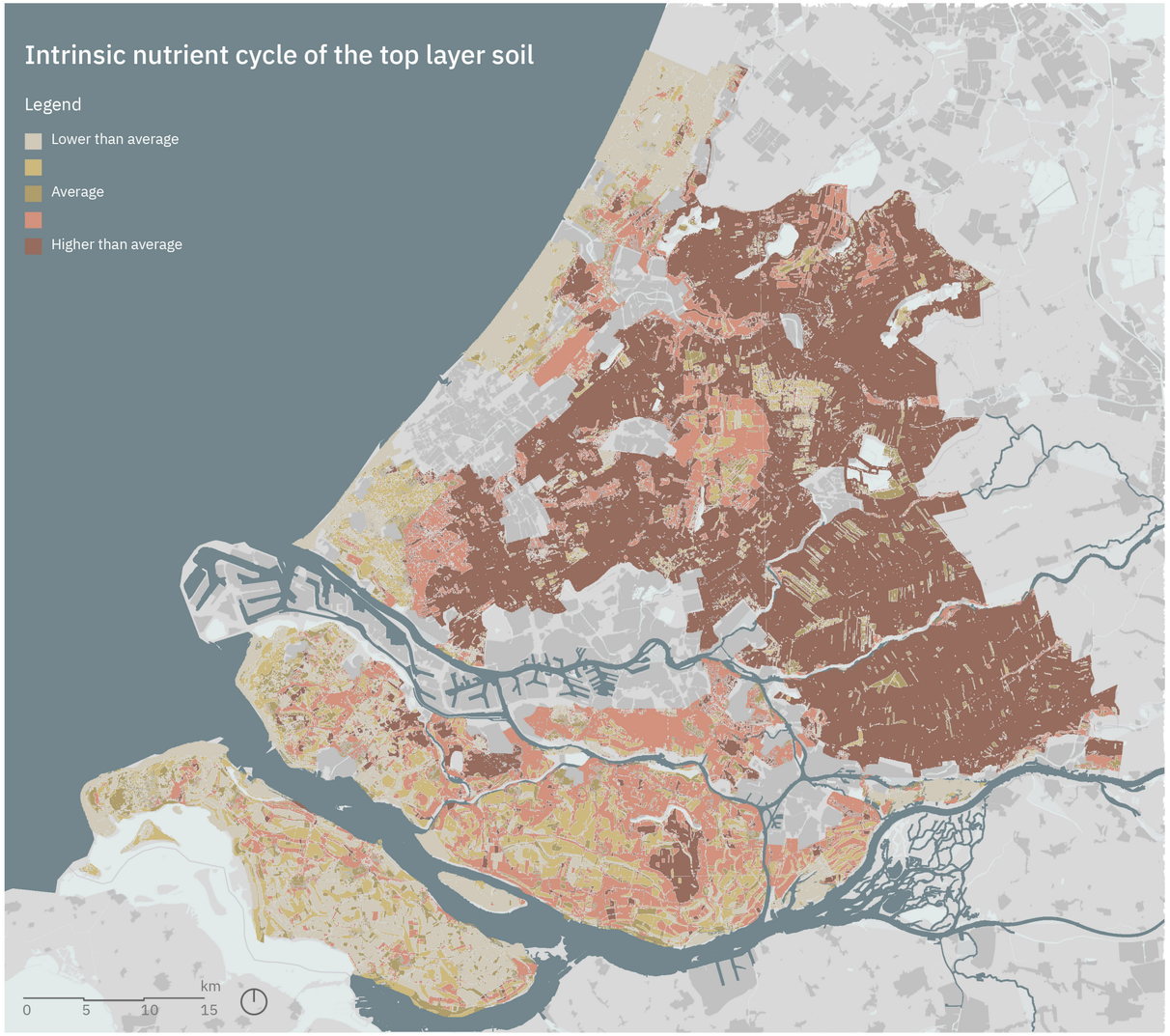
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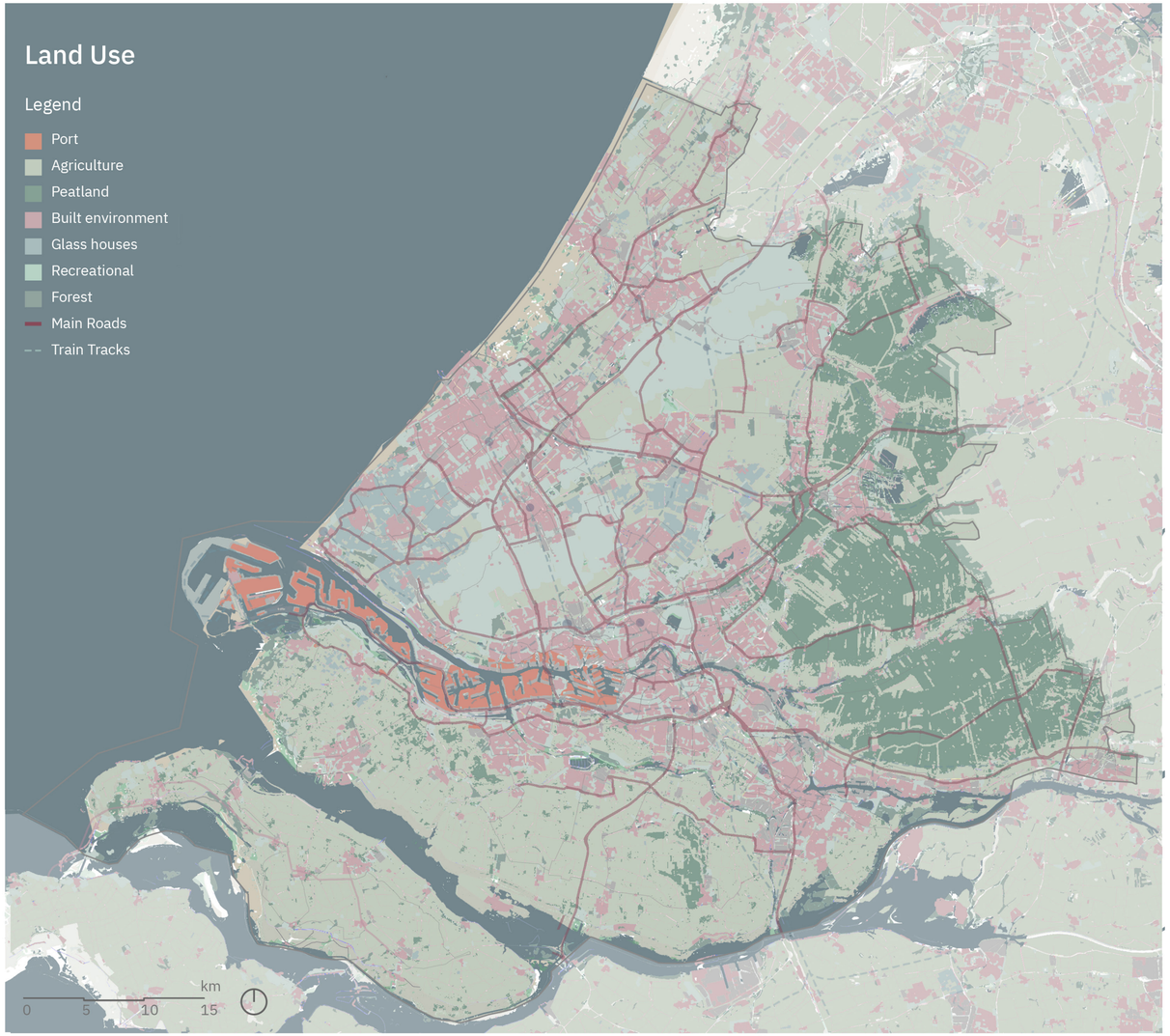

Agriculture, Forestry and Fishing
Legend
Cultivation of root crops
Growing vegetables in the open ground
Cultivation of other ornamental plants in the open ground
Growing vegetables under glass
Cultivation of bedding plants under glass
Cultivation of potted plants under glass
Cultivation of cut flowers and shrubs under glass
Sea and coastal fishing
Grassland
Agricultural land
Nature pak
0
5
10
15
km

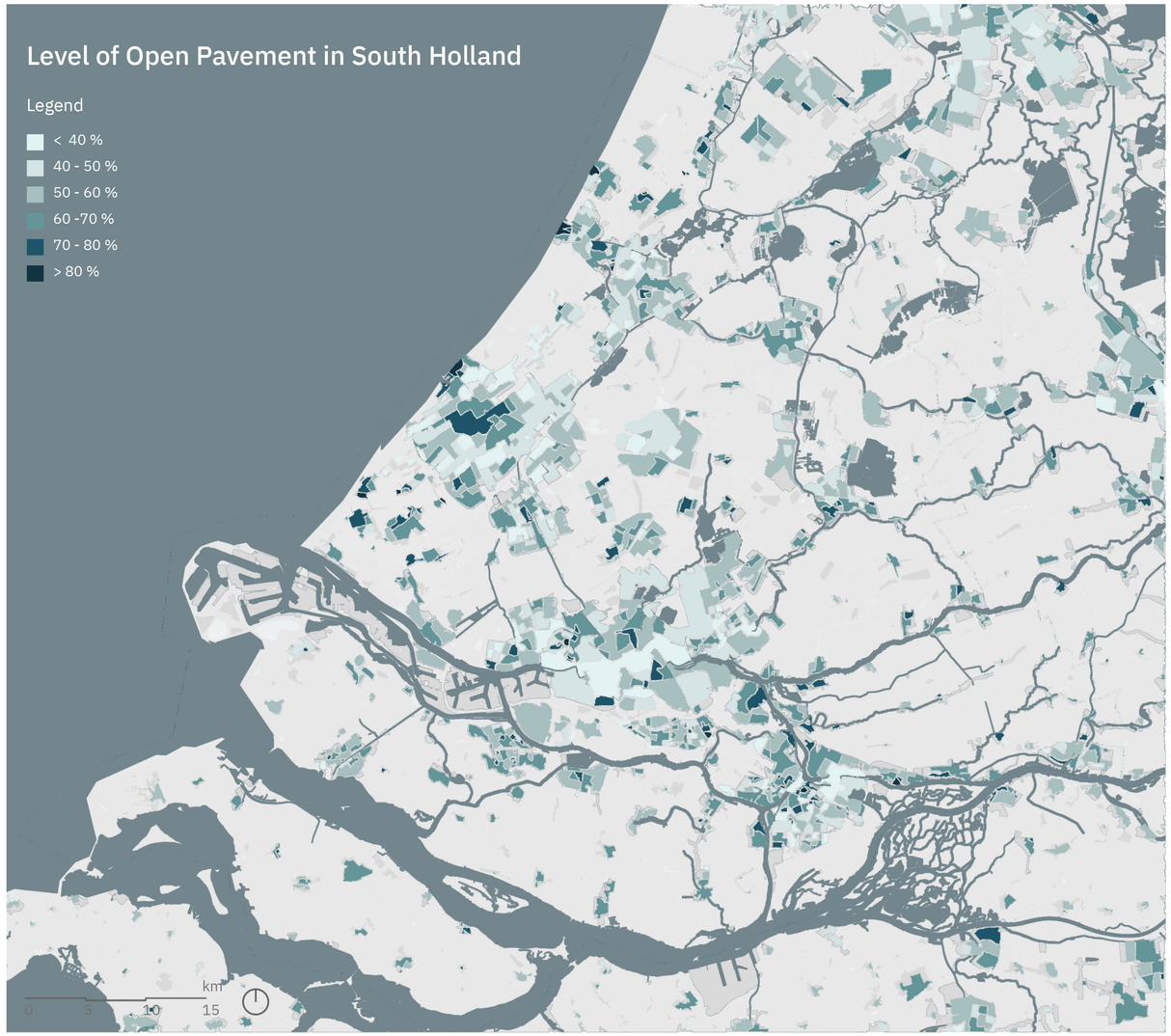

Average Income of Residents in Neighbourhoods
Legend
15- 17 K Euro
17 - 19 K Euro
19 - 21 K Euro
21 - 25 K Euro
25 - 30 K Euro
> 30 K Euro
0
5
10
15
km

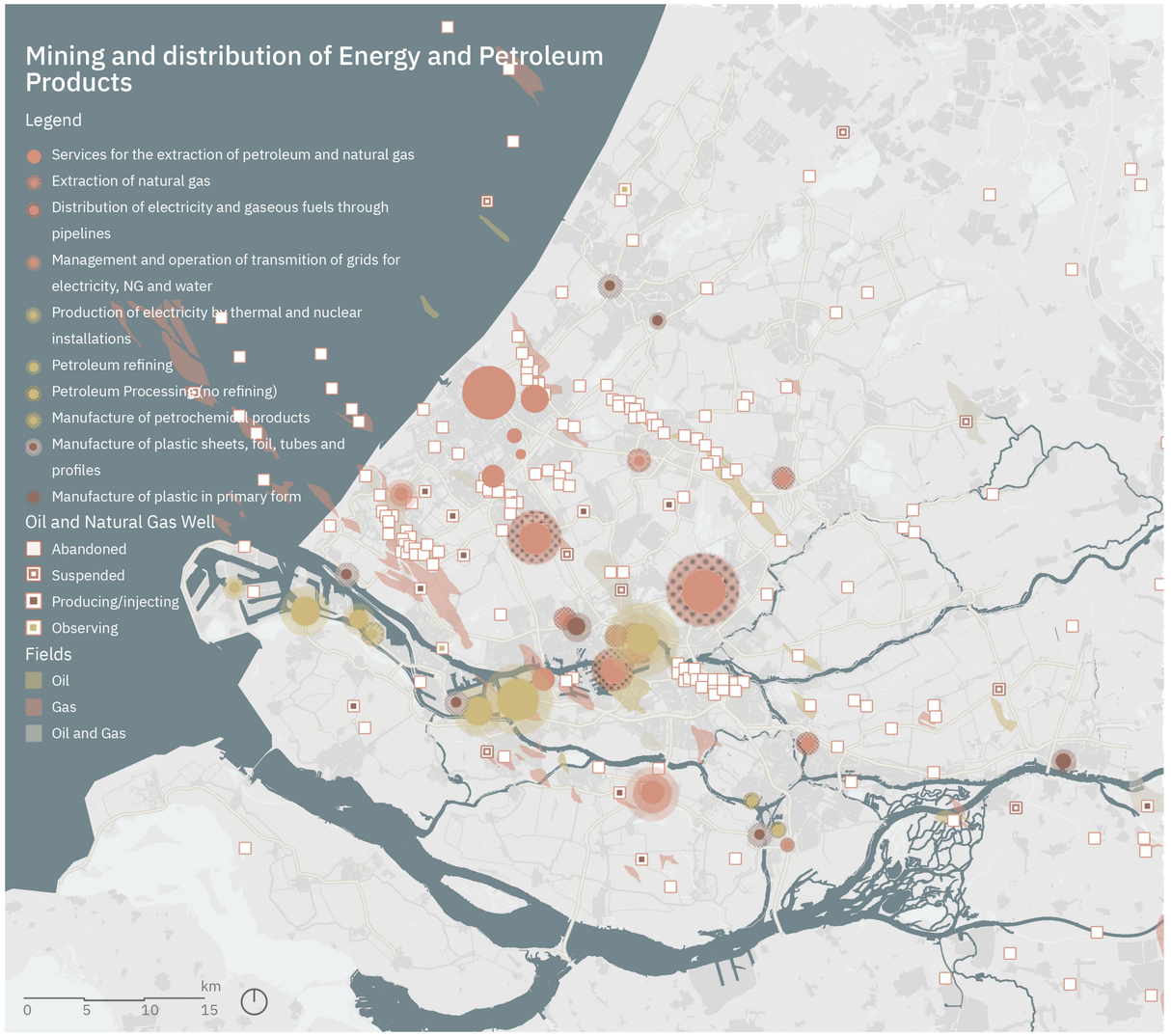

Contribution of the top layer of the soil to climate regulation
Legend
Lower than average
Average
Higher than average
0
5
10
15
km

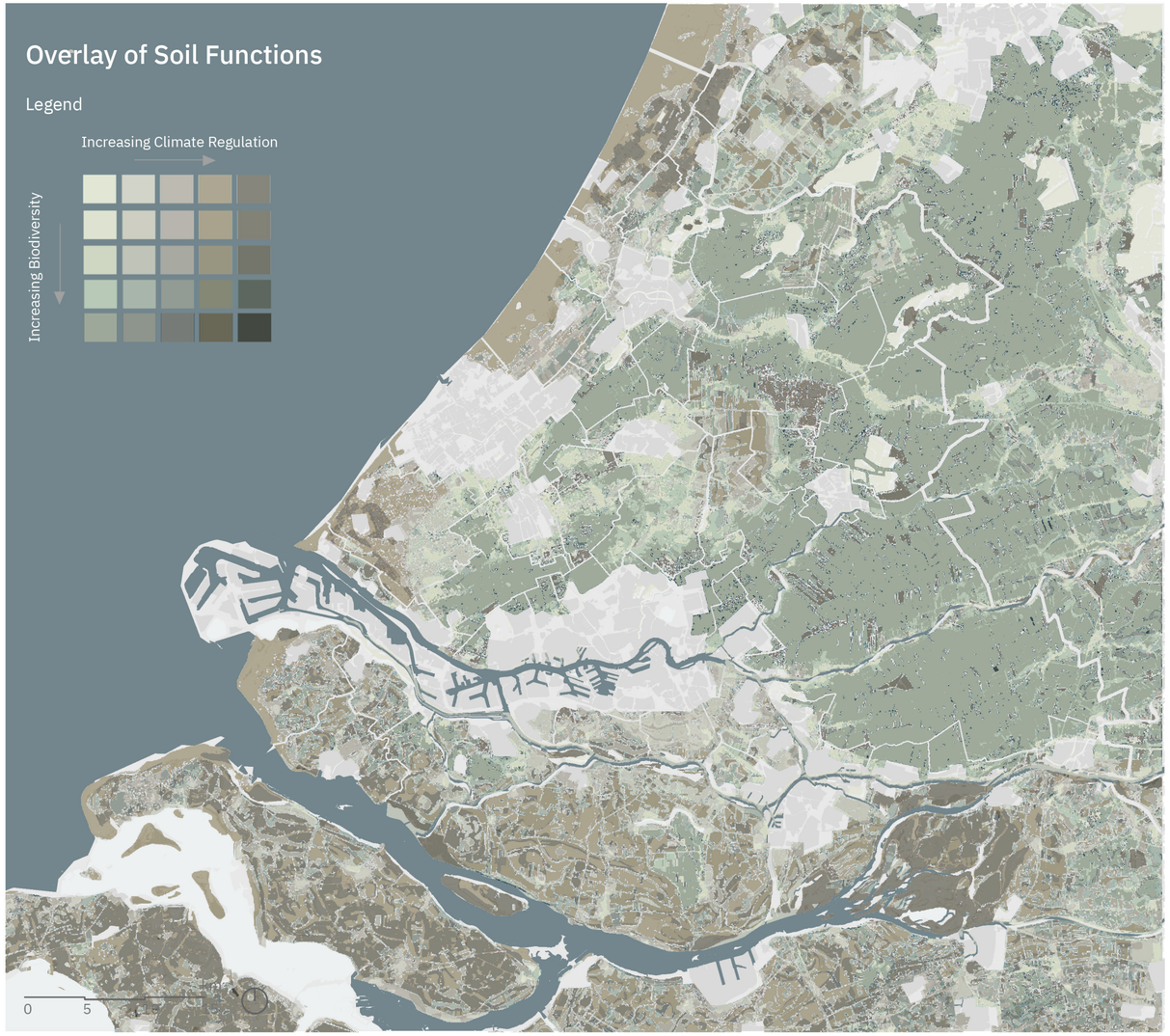

Current soil carbon balance agricultural land
Legend
< 0.5 - tons C/ha/year
0.5- 0.2 - tons C/ha/year
0.2 - 0.2 - tons C/ha/year
0.2 - 0.5 - tons C/ha/year
> 0.5 tons C/ha/year
0
5
10
15
km

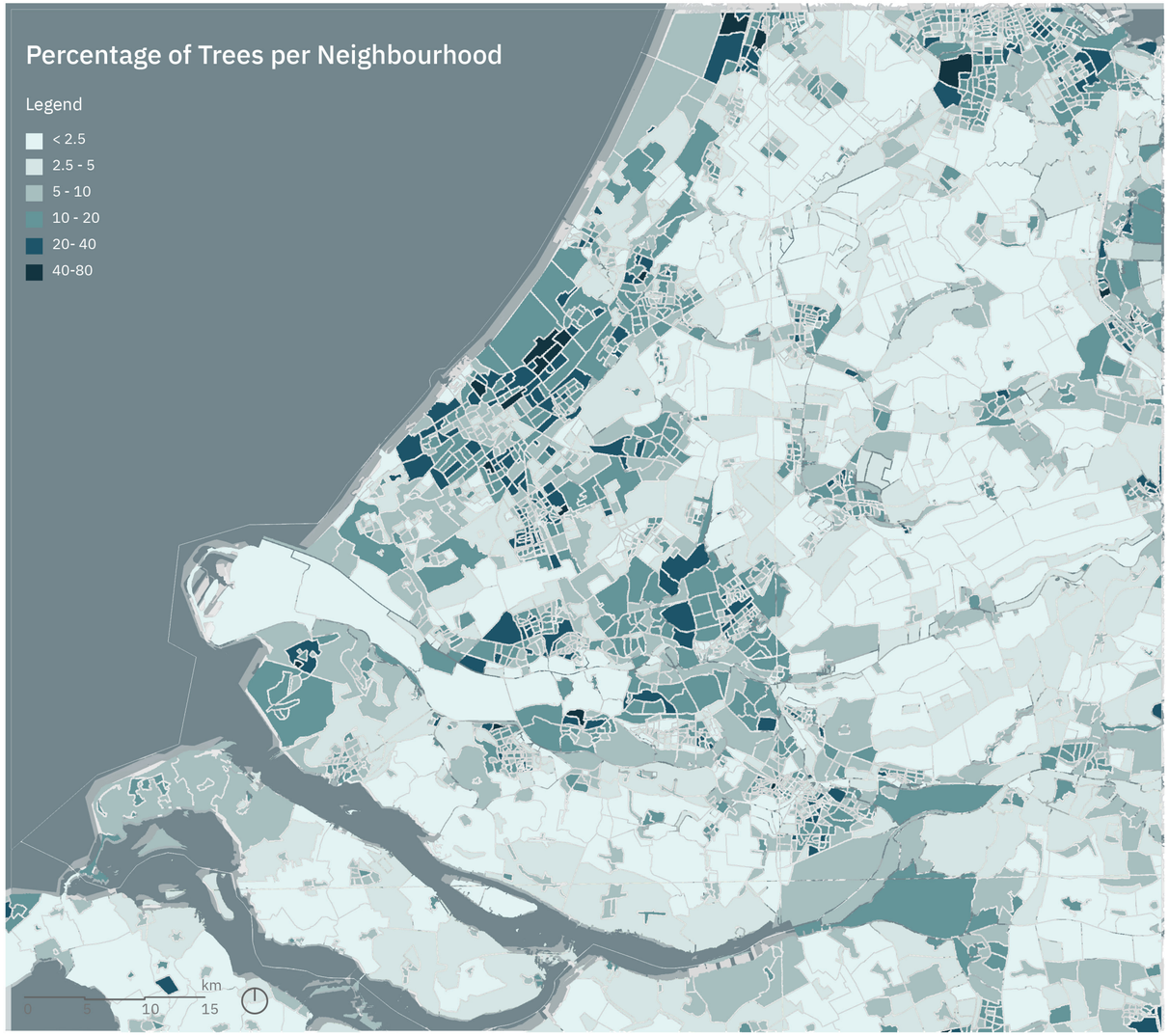

Intrinsic nutrient cycle of the top layer soil
Legend
Lower than average
Average
Higher than average
km
0
5
10
15

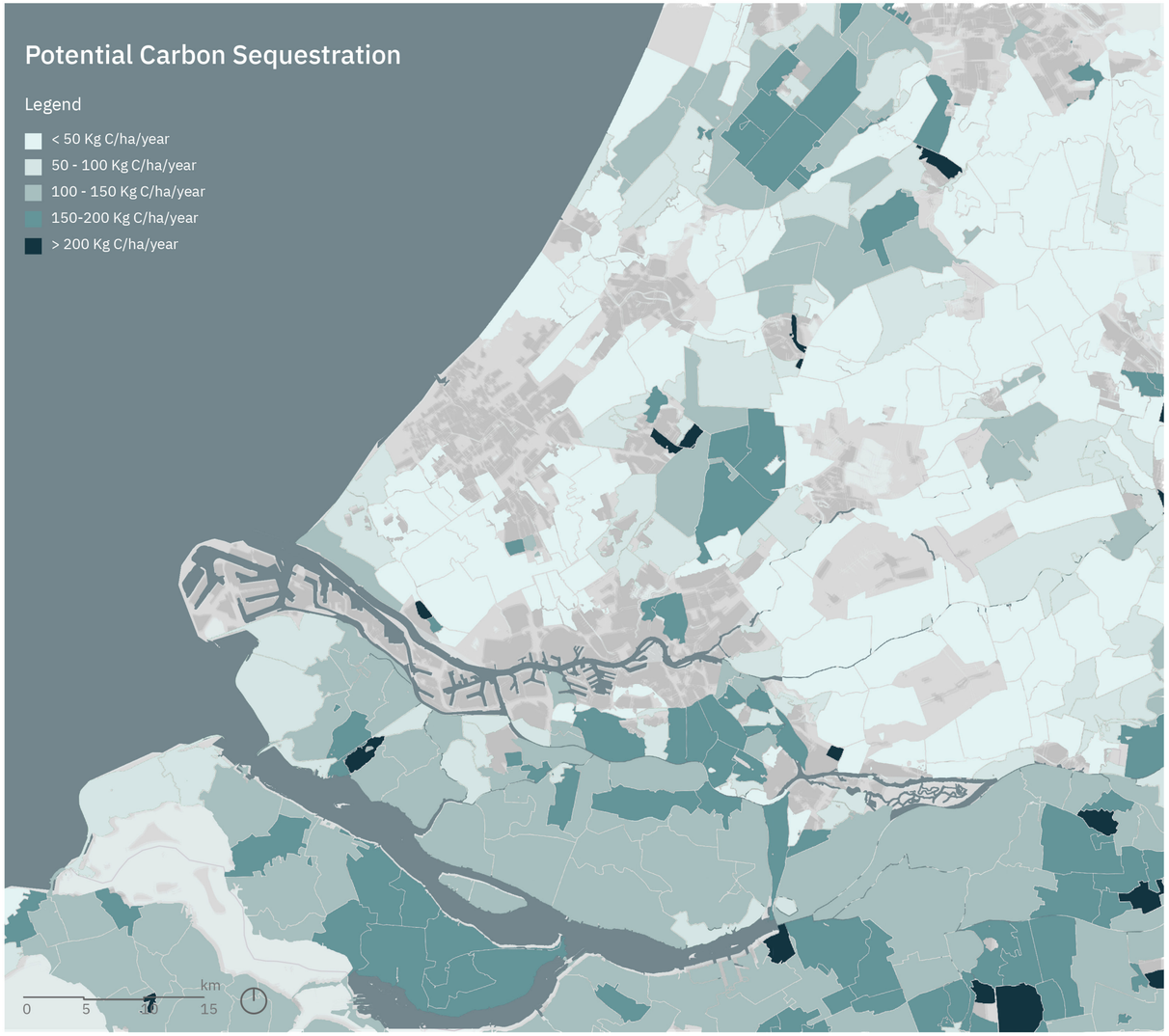

Land Use
Legend
Port
Agriculture
Peatland
Built environment
Glass houses
Recreational
Forest
Main Roads
Train Tracks
km
0
5
10
15

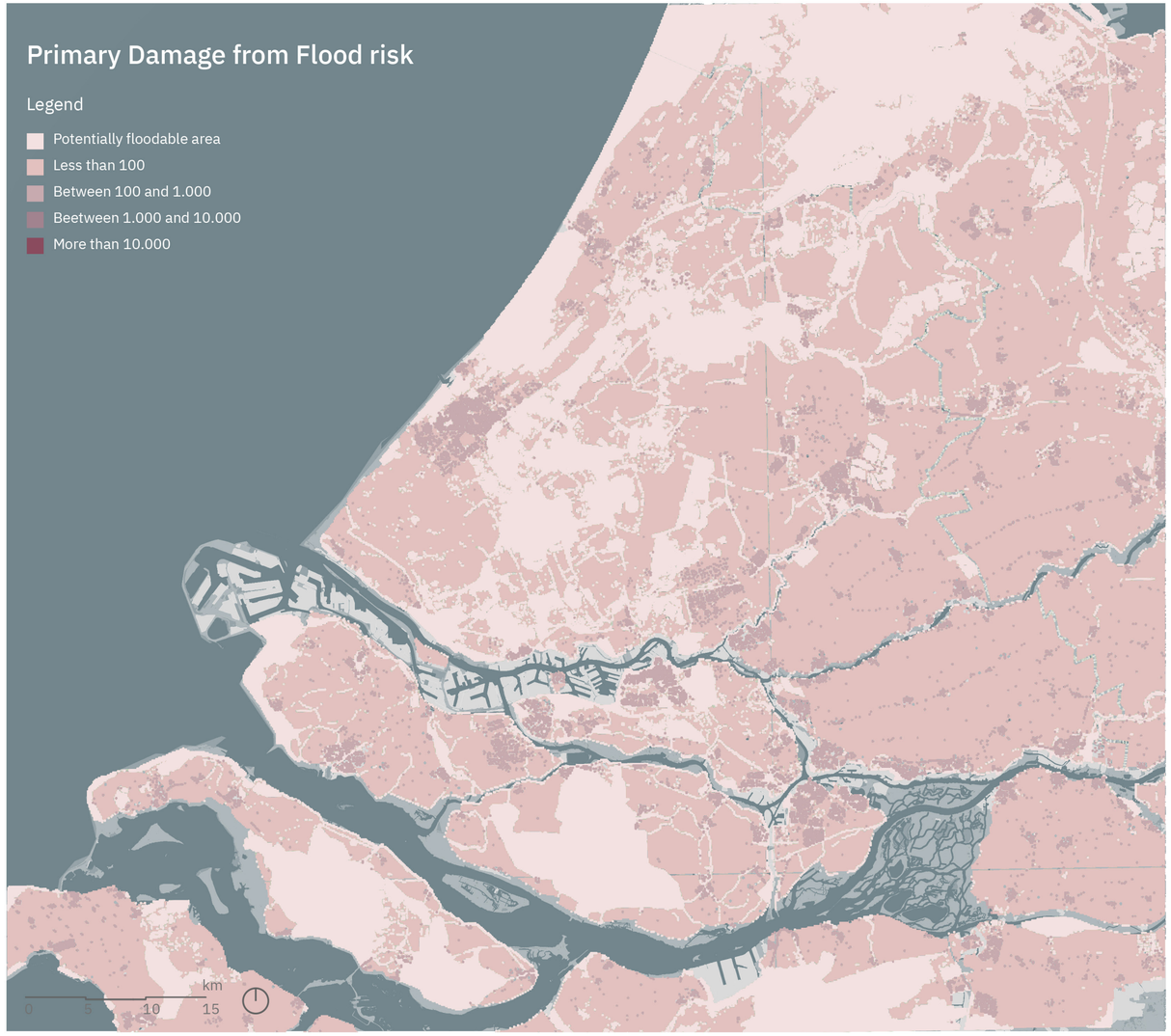

Level of Open Pavement in South Holland
Legend
< 40 %
40 - 50 %
50 - 60 %
60 -70 %
70 - 80 %
> 80 %
km
0
5
10
15


Mining and distribution of Energy and Petroleum Products
Legend
Services for the extraction of petroleum and natural gas
Extraction of natural gas
Distribution of electricity and gaseous fuels through pipelines
Management and operation of transmition of grids for electricity, NG and water
Production of electricity by thermal and nuclear installations
Petroleum refining
Petroleum Processing (no refining)
Manufacture of petrochemical products
Manufacture of plastic sheets, foil, tubes and profiles
Manufacture of plastic in primary form
Oil and Natural Gas Well
Abandoned
Suspended
Producing/injecting
Observing
Fields
Oil
Gas
Oil and Gas
km
0
5
10
15

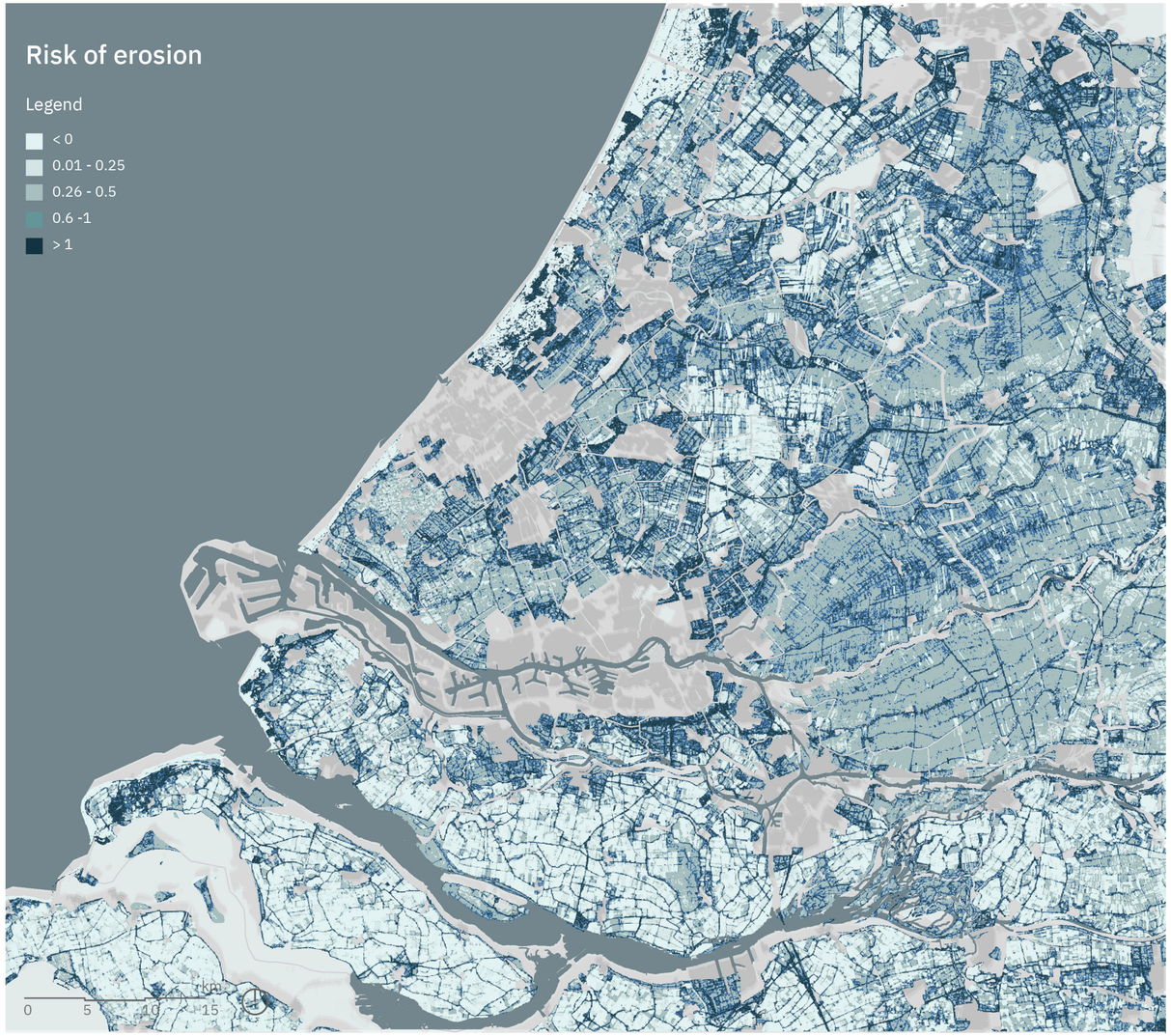

Overlay of Soil Functions
Legend
Increasing Climate Regulation
Increasing Biodiversity
0
5


Percentage of Trees per Neighbourhood
Legend
< 2.5
2.5 - 5
5 - 10
10 - 20
20- 40
40-80
km
0
5
10
15

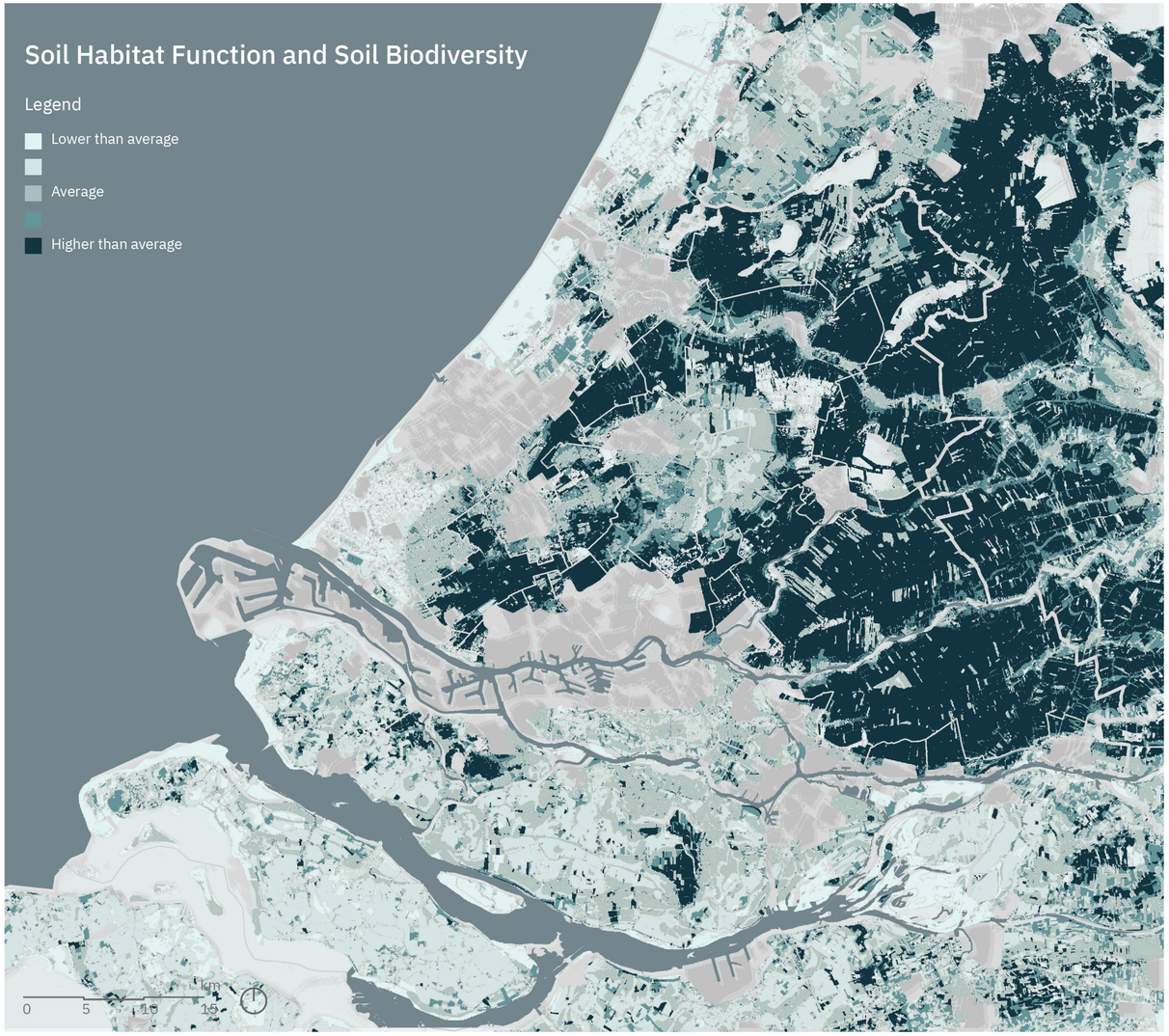

Potential Carbon Sequestration
Legend
< 50 Kg C/ha/year
50 - 100 Kg C/ha/year
100 - 150 Kg C/ha/year
150-200 Kg C/ha/year
> 200 Kg C/ha/year
km
0
5
10
15

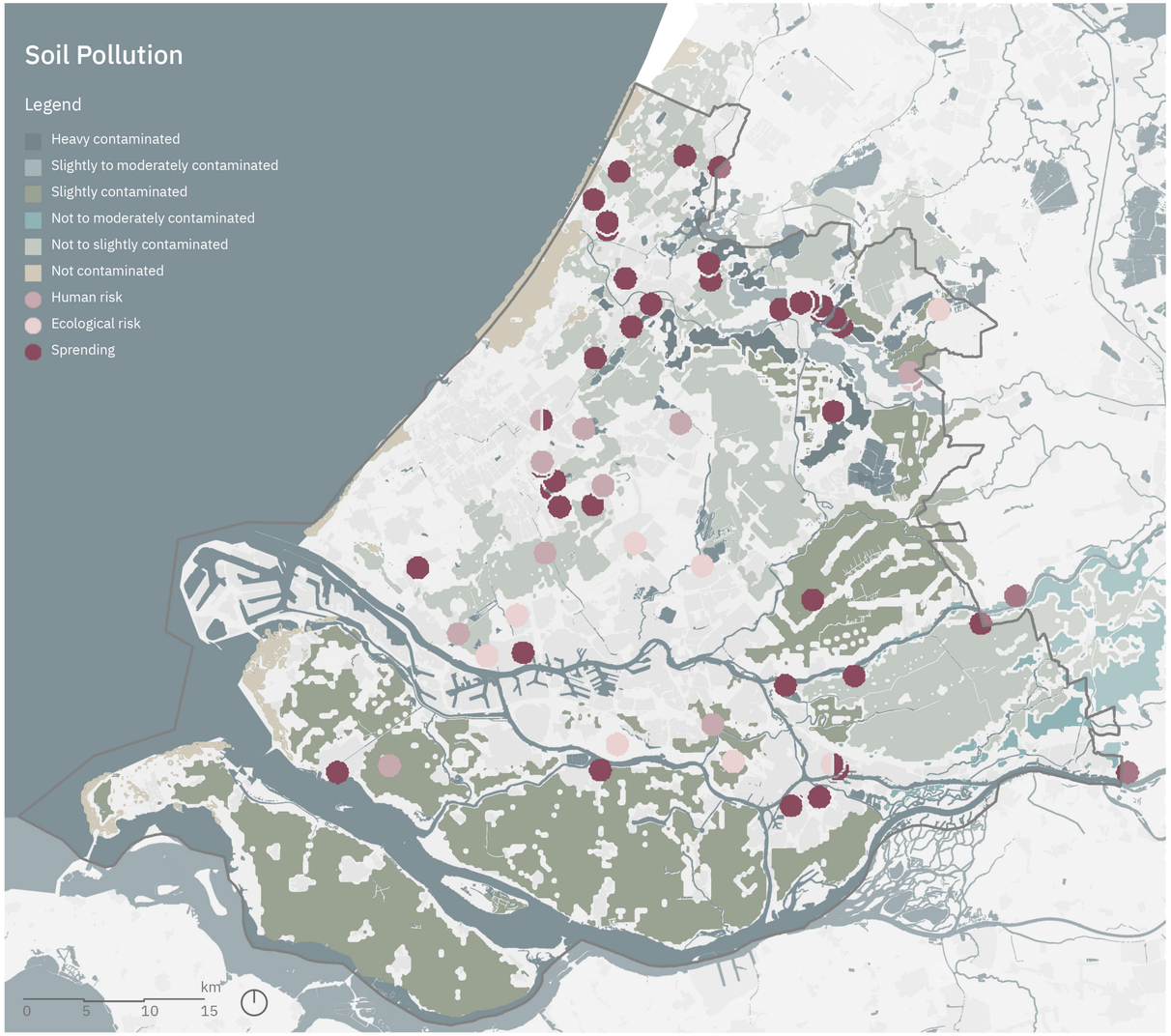

Primary Damage from Flood risk
Legend
Potentially floodable area
Less than 100
Between 100 and 1.000
Beetween 1.000 and 10.000
More than 10.000
km
0
5
10
15

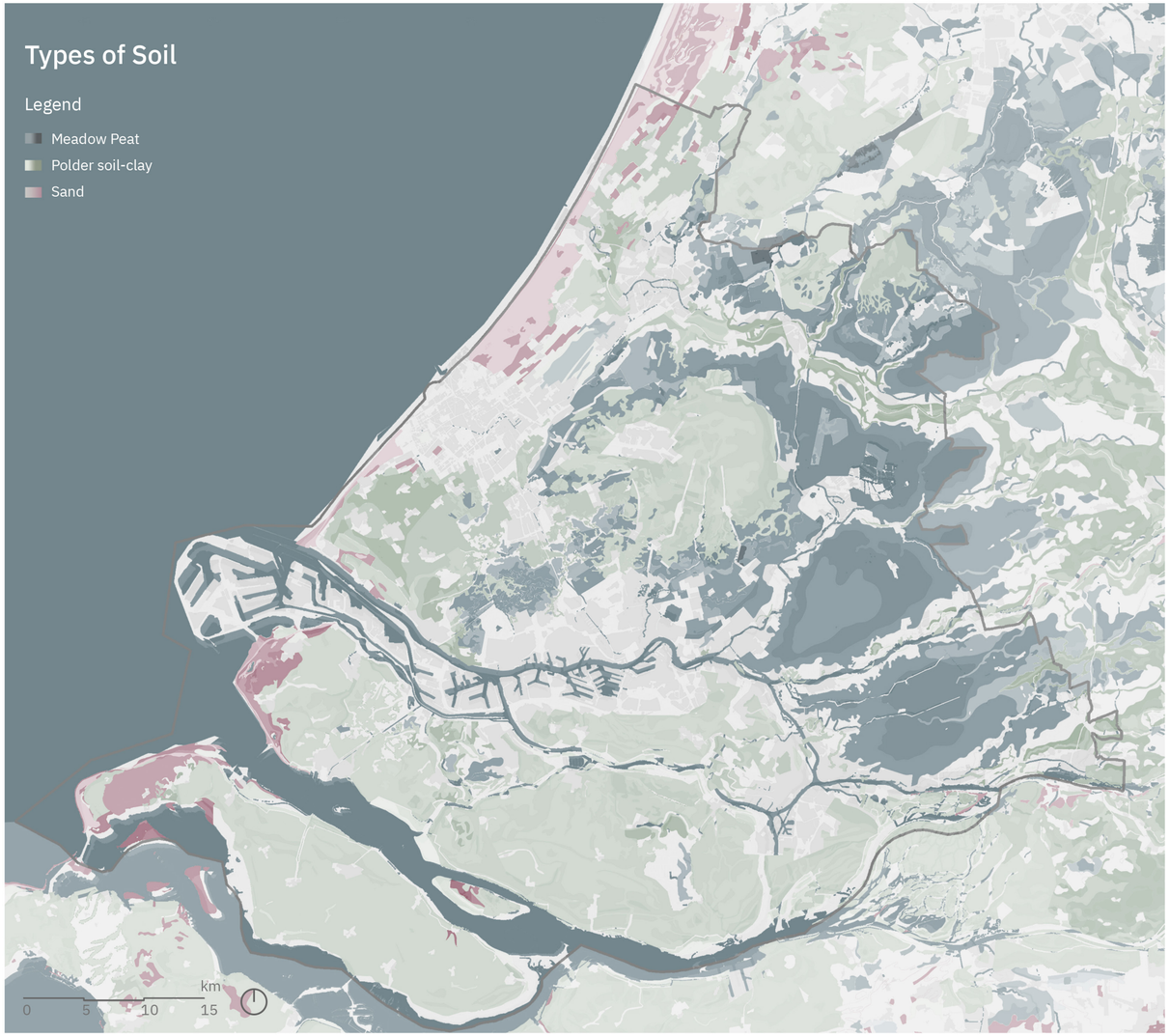

Protected Coastline
Legend
Protected Landscape
km
0
5
10
15

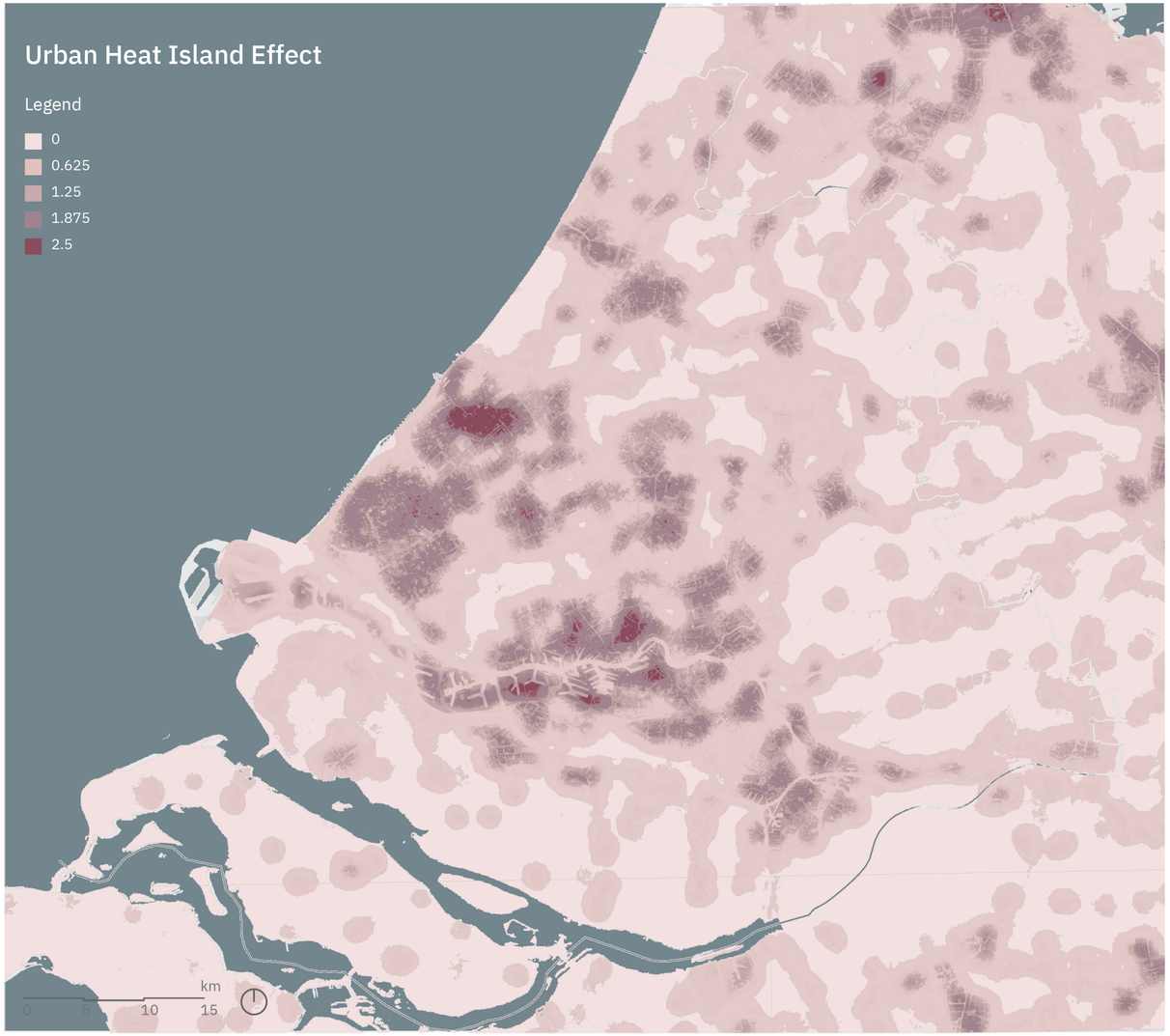

Risk of erosion
Legend
< 0
0.01 - 0.25
0.26 - 0.5
0.6 -1
> 1
km
0
5
10
15

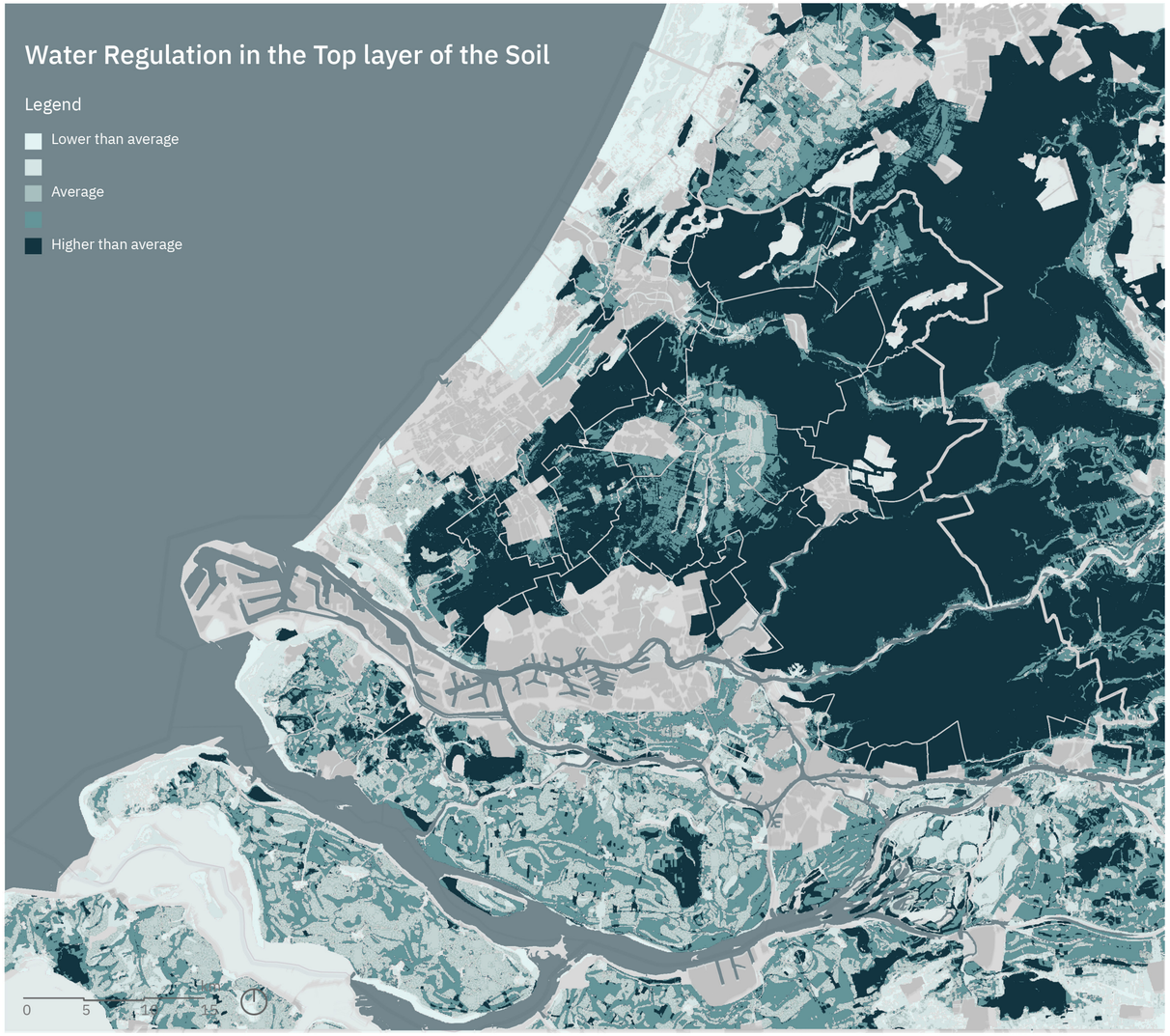

Soil Fertility for agriculture
Legend
Agricultural Areas - Fertile soil
Agricultural Areas - Less Fertil Soil
Nature Reserves - Fertile Soil
NAture Areas - Lees Fertile Soil
0
5
15


Soil Habitat Function and Soil Biodiversity
Legend
Lower than average
Average
Higher than average
0
5
15
km


Soil Pollution
Legend
Heavy contaminated
Slightly to moderately contaminated
Slightly contaminated
Not to moderately contaminated
Not to slightly contaminated
Not contaminated
Human risk
Ecological risk
Sprending
km
0
5
10
15


Types of Soil
Legend
Meadow Peat
Polder soil-clay
Sand
km
0
5
10
15


Urban Heat Island Effect
Legend
0
0.625
1.25
1.875
2.5
km
0
5
10
15


Water Regulation in the Top layer of the Soil
Legend
Lower than average
Average
Higher than average
0
5
15