(Re)mediation

A research on how the heavy metal soil pollution in the IJmond region caused by the steel industry can be remediated and its social impact can be mediated

Raven van der Steen - 4582705
P5 report - 15/5/2024

Supervised by:
1st mentor - Juliana Goncalves
2nd mentor - Francesca Rizzetto
Delegate - Henri van Bennekom

COLOPHON

(Re)mediation

A research on how the heavy metal soil pollution in the IJmond region caused by the steel industry can be remediated, and its social impact can be mediated

Author: Raven van der Steen (4582705)

First mentor: Juliana Goncalves

Assistant Professor of Spatial Planning & Strategy
Department of Urbanism

Second mentor: Francesca Rizetto

Researcher Environmental Technology and Design
Department of Urbanism

Msc 3/4 Urbanism 2023/ 2024
Date of publication: June 2024

Technological University Delft
Faculty of Architecture and the Built Environment
Julianalaan 134, 2628 BL, Delft

TU Delft

TABLE OF CONTENT

GRADIENT

The colour of the beam of the top of every page represents the gradient of the soil being remediated throughout the research. Starting with a brown colour that represents pollution, and ending iwith a blue colour that represents a healthy and remediated soil.

Polluted **Remediated**

0A. ABSTRACT

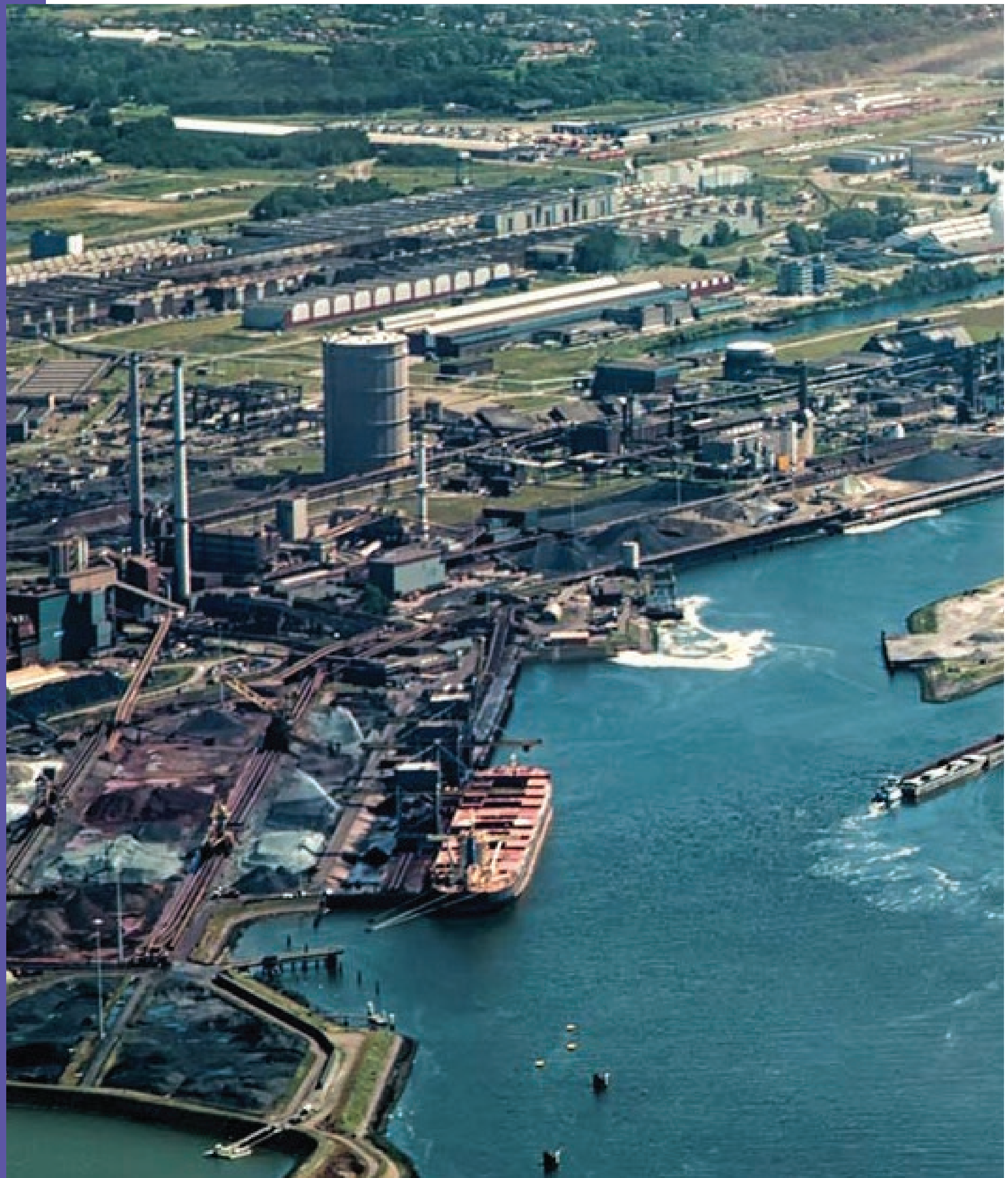
This research addresses the heavy metal soil pollution of the IJmond region caused by the presence of the industry for over a hundred years. Currently, Tata Steel's steel industry is transitioning towards Green Steel production, which will decrease air pollution significantly; this does not solve the issue of soil pollution that has accumulated over the years within the region. Even though heavy metals in the soil surpass the legally allowed concentration, nothing is being done about it. Heavy metal soil pollution influences human health when interacting with the soil and can indirectly contaminate produce grown on the soil. Due to this decennia-long pollution of the steel industry, the value of the surrounding landscape (the IJmond region) has decreased, limiting the residents' health and future potential for development. That is why this research will focus on how to return value to the IJmond region in the Green Steel future of the steel industry. This will be done by creating a strategy concentrating on the spatial impact of soil pollution and the societal impact on the residents in working towards healthy soil again.

The revaluing strategy will focus on three sub-values: the current value that should be maintained, the intended value that should be created and the process value of ensuring a just process in revaluing the landscape. The current value is the presence of the steel industry within the region and how it is engrained within the societal structure of the IJmond region. A consequence of the presence of this current value is soil pollution, which causes a conflict with the livability of the region. This is why the intended value is a healthy soil that returns livability and remediates pollution. The process value stresses the need for an inclusive process that creates agency and transparency for residents.

The strategy combines these values by integrating collaborative governance with spatial remediation, both of which are essential to realising healthy soil on a large scale. This is done in four phases that focus not only on planting, maintaining, and harvesting plants that clean the soil through phytoremediation but also on creating stakeholder interaction and engagement.

Keywords: Industrial pollution, steel industry, land degredation, phytoremediation, public-civi partnerhsip

01. INTRODUCTION



The research introduction will provide a short overview of the research's structure. The goal is to make the reader aware of the research's starting point and clarify the assumptions that will be used throughout the research.

Firstly, the scope of the research is established, focusing on the region surrounding the steel industry, specifically the IJmond region. The research does not aim to discredit the presence of the steel industry within the region, but rather to find a way to balance its presence with a healthy surrounding landscape. The current focus on how the steel industry can improve to pollute less disregards the yearlong polluting impact it has had on the surrounding landscape. This discrepancy between the focus on the steel industry and its impact on the surrounding landscape underscores the societal relevance of this research, making the reader feel the urgency and importance of the research. This all leads to the research question and main aim of this research: How to revalue the industrially polluted landscape of the IJmond region.

Tata Steel and it sea lock (Omgevingsdienst Noordzeekanaalgebied, 2022)

Setting the scene

Furnaces of the steel industry (own image, 2023)

Windturbines of the steel industry (own image, 2023)

Climate change is an undeniable reality. Its roots can be traced back to the Industrial Revolution and the advent of the steam engine, which significantly increased efficiency and productivity. This period marked the beginning of an all-encompassing need for economic growth, which quickly became society's highest goal. The long-term environmental consequences of this drive were not recognized until much later, by which time capitalism and continuous economic expansion were deeply embedded in societal structures. As a result, economic growth emerged as the core driver of climate change, making it a critical issue that demands systemic change. Addressing climate change now requires us to confront and transform the very economic foundations that have historically prioritized growth over sustainability. Now, regarding the future, the world has to deal with the consequences of climate change. Sea water levels are rising, and floods and extreme droughts are not the only crises that the world currently has to deal with. Lack of housing, immigration, and food scarcity are also entangled within the complex system of societal issues.

With the urgency for change rising, a transition to a circular economy is proposed. An economy that no longer revolves around exploitation and growth but one that is focused on renewable resources and creating circular material loops that take long-term implications into account.

The role of the (heavy) industries is very important in this. Whilst they are currently huge contributors to exploiting non-renewable material resources, excessive production and large-scale pollution, they also form a crucial part of the remediation.

This is not to say that industries will become irrelevant. Looking back in history they have been a huge driver for urbanization by creating employment and helping towns to develop by providing housing for their employees. On top of this industries contribute greatly to the GDP of a country. Large industries and societal development are thus very interdependent. This is no different for the IJmond region and the steel industry. Years of steel production have created employment for generations and put the region on the map. The national Dutch economy also benefitted from the thriving industry in the IJmond region. But the large-scale pollution of CO2, NOx and particulate matter, spread through the air and accumulating within the soil, have been ignored for years. Years in which pollution has devalued the unique landscape of the IJmond region and years in which the economic benefit has been chosen above the health of the residents. Human health and a healthy living environment can be seen as a public good, belonging to one of the responsibilities of the government to guarantee with the help of rules and regulations. In the IJmond region, this

Setting the scene

Theatre in IJmuiden (own image, 2023)

Housing in IJmuiden (own image, 2023)

public good of public health is at stake because of the steel industry and its pollution. Particulate matter, the main focus of this research, contains heavy metals that are spread across the region through the air and accumulate in the soil. In 1975, a report was published that showed the severity of the pollution in a 10km radius around the industry. Concentrations of heavy metals in the soil are much higher than legally allowed, with, as a consequence, increased risk of lung cancer and decreased life expectancy for the residents of the IJmond region (RIVM, 2023). Although this sounds like a pressing issue, it will take years to turn the steel industry into a non-polluting industry. The Green Steel transition is the plan focused on reducing pollution and is supposed to be fully functioning by 2035. The main focus of the Green Steel transition is to create a durable way of producing steel by recycling more scrap metal and using renewable energy sources from hydrogen electricity. Other interventions on the industrial site aim to limit the spread of dust and particulate matter.

The focus must be not only on the shift in the production process but also on the remediation of the existing pollution in the surrounding landscape because the IJmond region is a very valuable piece of land. For one, it is situated higher than its surrounding polder landscape, creating safety from future rising sea levels. Also, it is close to Amsterdam and surrounded by the protected landscape of Natura2000. It is an ideal location to expand, considering the need for housing, which is currently not possible due to its soil pollution levels.

In conclusion, there are two reasons why there is a need for the remediation of the IJmond region's soil: the residents' health and the space's future development potential. On the other hand, it is also important that the steel industry can remain because of the co-dependency. To figure out a way to do this, the current value, the intended value and the process value of the IJmond region will be established that jointly provide an answer to the main research question of "How to revalue the industrially polluted landscape of the IJmond region?". The current value will hereby focus on the role of the steel industry within the region. The intended value will establish ways of remediating soil and how these can be implemented on a large scale. The process value will focus on the stakeholders and the governance structure needed to facilitate an inclusive process.

The result will be a large-scale remediation strategy consisting of four phases combined with a collaborative governance structure that guides the process of revaluing the landscape.

Position

My role as an urban designer in this research will be to create a strategy for spatial remediation that is inclusive of the different relevant stakeholders to the issue of soil pollution within the IJmond region. The goal in this will be to revalue the landscape. An urban designer is a good person for this since they can oversee the complexity of the issue, combining different layers of planning and providing clarity. This means that the output is not strictly spatial but will also focus on the importance of accompanying design by a governance structure (Rocco, 2013). By aligning objectives and creating a coherent approach, instead of ignoring or displacing the issue of soil pollution, it is tackled at the core.

I think it is important to mention here that I will do this by maintaining the steel industry within the landscape. Even though it is still causing soil pollution, I will do my research based on the promise of Tata Steel to make Green Steel by 2030 and reduce its emissions by then significantly. Steel will remain necessary in the future, where it is needed to facilitate the transition to a circular economy by creating solar panels and batteries. The previously mentioned dependence of the Dutch economy on the revenue of the steel industry and the large employment rate are two other arguments for the co-existence with the industry within the IJmond region. An argument against moving the industry to a less dense area/ country is the displacement of its problems. This research really aims to co-exist by not providing a "what-if" scenario for the steel industry if it did not exist anymore but by focusing on creating a balance between conflicting values.

In the words of Donna Haraway (1988), an inspiration for handling complex issues and an advocate for unexpected collaborations to stay with the trouble, purely objective research is impossible to achieve in reality as we are all shaped by our contexts, and so am I. This is to say that this research is conducted and recorded as objectively as possible, without having prejudices, but my interpretation of outcomes is influenced by the progressive and left context in which I have grown up. Added to this my background in studying urban governance explains the extensive focus on including stakeholders, the importance of governance and the goal of creating a just process.

Drawings depicting children's interpretation of the factory as "cloud factories" and "glittery heaps" (own image, 2024)

Kids growing up near the steel industry do not see the negative implications of it yet and refer to the furnaces as "cloud factories" and describe the glittery soot containing heavy metals and other pollutants as "Unicorn dust".

Motivation

‘RIVM: correlation between Tata Steel emissions and chance of sickness’ (NOS, 2023)

‘RIVM: residents close to Tata Steel have a higher chance on lungcancer and shorter life expectancy (NRC, 2023)

‘The scenario no one is talking about: The Netherlands without the furnaces’ (FD, 2021)

‘More poisonous metals in groundwater through steelslag: it destroys all life’ (FD, 2021)

Every Saturday morning, I find the newspaper on my doormat. In this way, I stay up to date on what is happening around the world and important topics under discussion within The Netherlands. That is how I first got acquainted with the conflict between Tata Steel and its surrounding region. In September 2023, the National Health Institute of the Netherlands (RIVM) just published a report about the polluting effects of the steel industry and how it has been jeopardising the health of residents for a long time. It screamed “INJUSTICE” to me and called for an urban designer to have a look at this complex issue.

The report by the RIVM set off a cascade of news articles, diving into the health effects of the steel industry and its societal implications, finding someone to blame without looking for a way forward. That is where my interest in problem-solving was sparked. There are a few reasons why I was specifically intrigued by the case of the steel industry:

- It shows the intricate balance between the market (private sector) and the government (public sector). A big industry like this’s hold on its surroundings seems unhealthy, but how can this be changed? This case shows the interdependencies between the industry and the government, thus calling for a spatial and governance-focused solution.
- Furthermore, this case intrigues me because it portrays a conflict between economic benefits and health values. It shows the difficulty in balancing important values. The steel factory has provided many jobs for the people living in surrounding towns. It thus has indirectly affected the development of these towns, but it now jeopardises the health of the people living here. The same can be said for how, on the one hand, the national economy benefits from the works of the steel industry, but on the other hand, the residents in towns close to the factory have to suffer the health consequences. It seems that one benefit cannot exist without the other disadvantage within this seemingly complex issue.

I think that research focussed on mediating this conflict would be my ideal role as an urban designer since it functions as a boundary spanner between the spatial and the governance and between the societal, the public and the private sectors.

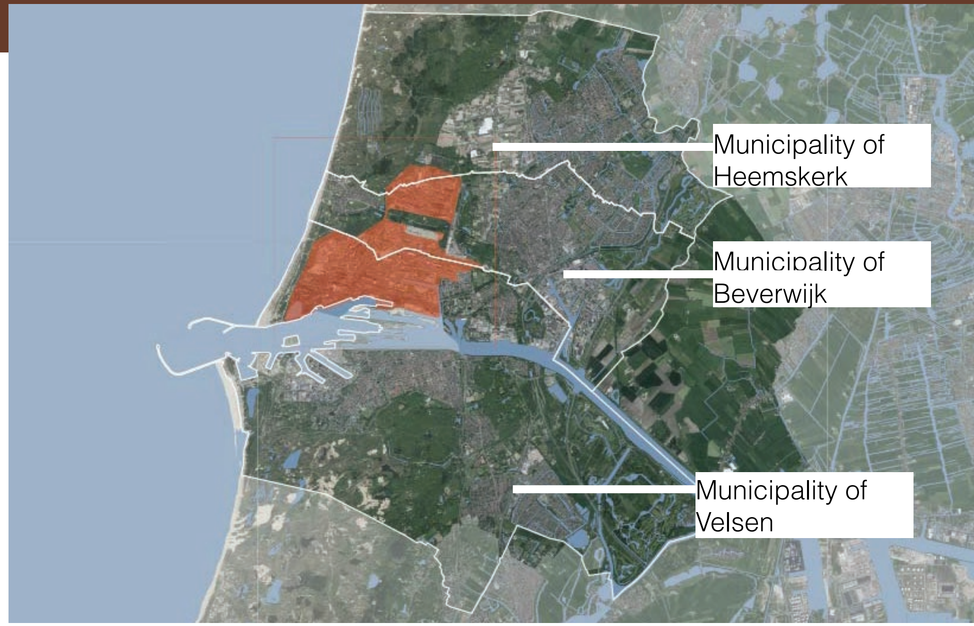
Disclaimer

Even though the current owner of the steel industry is an Indian company called Tata Steel, this name will not be used to refer to the steel industry in this research. The reason is that the steel industry has existed within this region for much longer, so calling it Tata Steel does not do justice to the way the industry is ingrained within the area. Also, it does not seem fair to refer to "Tata Steel" as the cause of soil pollution, whilst the previous names of the steel industry, Koninklijke Hoogovens and Corus, have contributed to the problem just as much. "Tata Steel" will be used when it concerns the stakeholders of the current steel industry, and "steel industry" will be used when discussing the general impact of the existence of the steel industry within the region.

Still from the movie 'Landscape Zero' (Pavic, 2020)

Location

Location of the IJmond region within the Netherlands (own image, 2023)



Research territory map (own image, 2024)

Region: IJmond

Municipalities: Heemskerk, Beverwijk and Velsen

Towns: Heemskerk, Beverwijk, Velsen-Noord, Velsen-Zuid, IJmuiden, Wijk aan Zee, Driehuis, Velserbroek

size: 13200 hectares

Natural characteristics: Bordered by the North Sea and Natura2000 protected area. Crossed by the North Sea Canal, stemming from the river IJ.

The Steel industry's territory, drawn in orange, lies within the territory of three different municipalities: the municipality of Heemskerk, the municipality of Beverwijk, and the municipality of Velsen. These are located in the North of the Netherlands, indicated with the orange 'X'.

Problem statement

Tata Steel as seen from above coming from the North Sea (Depot, 2005)

View on Tata Steel (ANP, n.d.)

The north of the Netherlands, along the coast, is home to the steel industry. It has a surface area of 750 hectares and employs more than 9000 people, producing 7 million tonnes of high-quality steel annually. In this process, many rest materials such as CO_2, NO_x, dust and particulate matter are released into the air, polluting the surrounding region, the IJmond. Pollution accumulating in the soil not only interferes with the ecological balance of the environment but also jeopardises the health of the residents. On the other hand, the steel industry is an essential part of the IJmond region, being located here for over a hundred years, with generations of families having worked here. On top of that, it contributes significantly to the Dutch economy, creating a dependency between the public sector and the steel industry. In the middle of this conflict are the residents torn by the importance of having the steel industry within the region, but the downside is potential health issues, which end in feeling excluded and powerless. Overall, the IJmond region is a victim of the large-scale loss of value, also called land degradation (UNDRR, 2022).

Within a land-scarce and densely populated country such as the Netherlands, land degradation is not something for which there is space. With the risk of long-term function loss and the loss of productivity in the landscape, something needs to be done (Sassen, 2014). Whilst the steel industry is aware of the issue they are causing, the public sector does not acknowledge that transitioning to Green Steel does not mean healthy soil in the surrounding landscape. This discrepancy between thinking that the issue will be mediated once the steel industry has completed its transition and the actual levels of heavy metals within the soil is an issue of which the residents of the IJmond region are the victims. Not failing to acknowledge how the steel industry is integrated within society, a way needs to be found to combine the current value of the steel industry, the intended value of a healthy soil and the process value of an inclusive process into one strategy.

Research question

Cows in the village of Wijk aan Zee next to the steel industry (own image, 2024)

A century of heavy metals accumulating in the soil, stemming from the steel industry, has created a conflict between the economic benefit of a heavy industry and the ethical responsibility of providing a healthy living environment. The goal of this research is to mediate this conflict by returning value to the IJmond region by addressing the question:

How to revalue the industrially polluted landscape of the IJmond region?

To do this, the focus will be on balancing the three main values within the region that acknowledge the main topics of conflict. These values establish the basis of the sub-questions as follows:

- What is the current value of the steel industry that should be preserved?

- What is the intended value of the IJmond region?

- What process value should be ensured during the preserving of the current value and creating the intended value within the IJmond region?

Research aim

P R E S E R V E

C R E A T E

E N S U R E

P R E S E R V E

C R E A T E

E N S U R E

P R E S E R V E

C R E A T E

E N S U R E

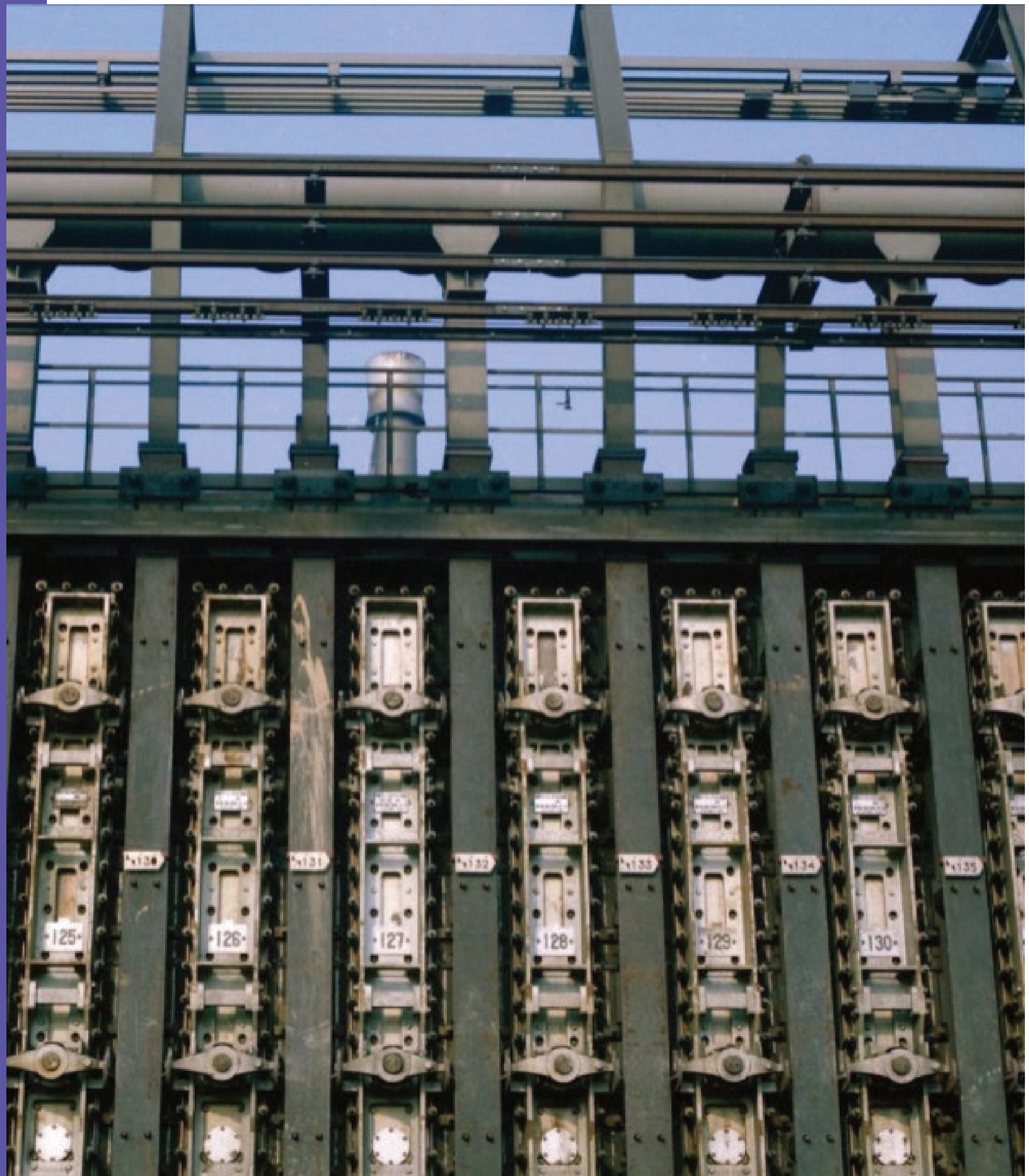
P R E S E R V E

C R E A T E

The steel industry from afar (own image, 2024)

The aim of this research is to come up with a spatial strategy that integrates collaborative governance to provide not only the remediation of the soil but also the mediation of the conflict between the stakeholders involved. The goal is to maintain the steel industry, to use plants for large-scale remediation and to include residents in decision-making.

02. RESEARCH FRAMEWORK



This chapter addresses the first sub-question of this research by establishing the current value of the IJmond region. A location analysis shows how the region has co-evolved with the steel industry and creates a feel for the landscape and the elements it consists of. This ends with the division of the region within functional zones that will provide a structure of analysis for the rest of the research. Next, the steel industry itself will be regarded, as well as how it plays a role in the lives of the people in the IJmond region. This includes the outcome of the site visits. Lastly, industrial pollution due to the current value will be addressed. Unpacking the effect of heavy metal soil pollution and why it is important to address this matter spatially. The chapter ends by spatially determining the conflict between economy and livability within the IJmond region.

Cokes plant (Tata Steel, n.d.)

Conceptual framework

The conceptual framework used for this research is based on Godschalk's (2007) model, which combines the values of economy, environment, and equity with the value of livability to provide a tool for sustainable development. The goal is to show what values should be balanced within sustainable land-use planning. The role of the conceptual framework is to provide the scope of the research and keep an eye on the objective.

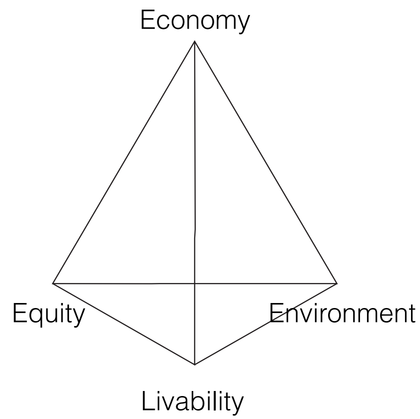
The value of economy signifies the production, distribution, and consumption of goods and services. In this research, Tata Steel represents economic value, where the presence of the steel industry creates employment and financial benefits for the rest of the country.

The value of equity refers to the principle of fairness and justice in the distribution of resources and opportunities. This implies that no actor should be disproportionally burdened by environmental degradation. In the case of the IJmond region, the residents draw the shortest straw. On the one hand, they are dependent on the employment the steel industry provides, while on the other hand, they are burdened with the fact that their living environment is polluted.

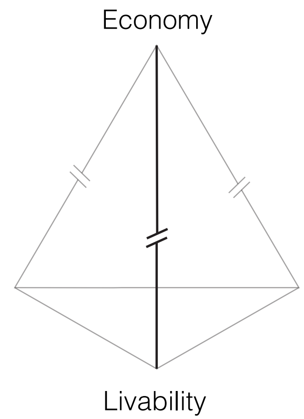
The value of environment entails the context (the natural and the built environment) of sustainable development. This includes the responsibility of preserving the ecological balance regarding artificial infrastructures. More specifically, this addresses pollution reduction, conserving natural habitats, mitigating climate change and adopting sustainable land-use practices. Translated to the steel industry, this value is jeopardised by the pollution that reduces air, soil and water quality, affecting this ecological balance and human health.

The value of livability refers to the quality of life for residents in a particular place and the overall desirability to live, work, or visit that place. This encompasses various factors that contribute to overall well-being, not just spatial but also procedural. In the case of the IJmond region, livability is seriously impacted by pollution. Furthermore, the powerlessness to control this pollution negatively impacts the community within the IJmond region.

Translating these four different values to the case of the IJmond region already signifies the conflict in balancing them. What becomes clear is that the conflicts between values all stem from economy. The existence of a heavy industry produces externalities in the shape of pollution that largely affects the equity, environment and livability of the region. This research will mainly focus on the conflict that arises between the value of economy and livability. The reason for this is that this is the most pressing conflict and societal relevance regarding the revaluing of the IJmond region. The strategy this will bring forward will also assist in remedying the other conflict between the other two values. The conceptual model will provide a framework to focus the research.



Conceptual model adapted from Godschalk (2007)



Focus of the main research question, conflict between economy and livability (Godschalk, 2007)

Literature review

Melted steel (Tata Steel, n.d.)

The literature review addresses different theories and introduces several concepts relevant to this research. The goal is to understand the background of this research theoretically. This will be done by understanding heavy industries and how they conflict with the surrounding landscape. This literature review is structured as follows:

- Industry
- Industrial pollution
- Anti-landscapes
- Values
- Spatial conflict
- Remediation
- Conclusion

Industry


fd.nl

Het scenario waar niemand over praat: Nederland zonder de hoogovens

The scenario no-one is talking about: The Netherlands without the furnaces (FD, 2021)

Heavy industries are big polluters, and within the transition to a circular economy, their role is contested. To be able to create a more sustainable and durable future, industries are necessary to provide the resources to do so, but on the other hand, they contribute to the problem the most. Something needs to change, and within the guidelines for a sustainable future, there are two options for the heavy industries:

- Disappear
- Adept to the new future

Deindustrialisation, for many, is a scenario they would rather not think of. Taking away the industry from a place risks breaking strong communal bonds in industrial regions between people and between the state and the economy (Thomas et al., 2022). Often having a heavy industry in close proximity serves as a source of collective pride and identity for people. This feeling is often strengthened by the interdependence of towns with heavy industry in their development. Where the future is focused on development rather than economic growth, economic development seen from a historical and social perspective should not be undervalued (Thomas et al., 2022). This is to say that industrial development should have a place in the future to sustain a durable balance between sustainable and societal values. The feelings of industrial nostalgia experienced by people living close to heavy industries do not deny its effects on the creation of pollution and unhealthy and unsafe living conditions (Thomas et al., 2022). Heavy industries can thus exist next to towns without residents necessarily thinking negatively about them, even though they pollute their living environment.

Industrial pollution

Historically speaking, industrial processes, including mining and manufacturing, have been the main causes of soil pollution (UN Environment Programme, 2021). The Anthropocene, the point in evolution where most natural biomes have started to be greatly altered by humans, originates from the moment large and heavy industries came into existence (McGregor & Cowdy, 2023). Not only did this increase global greenhouse emissions, but it also spurred urbanisation. Consequently, globally speaking, one of the externalities of this development was pollution. Pollution threatens human and ecosystem health, biodiversity and food security (European Environment Agency, 2020). The impact of pollution depends on a few factors: exposure time to the toxin and the type of interaction or contact with the toxin at hand (Scullion, 2005). Whilst living within a polluted area might affect your health, there is still an acceptable pollution level as long as the exposure time is regulated. Regarding exposure to soil pollution, humans can be directly exposed through skin contact and inhalation. Indirect exposure comes from interaction with the soil and the interaction with its vegetation through ingestion and consumption (Li et al., 2018).

Industries are often well aware of their large-scale environmental pollution, but holding them accountable is

Anti-landscape

Furnace (Tata Steel, n.d.)

difficult. Sanctions may be imposed, which is the responsibility of the public sector. The biggest win to be made in reducing environmental pollution by heavy industries is improving the disposal of toxic waste from industrial processes (UN Environment Programme, 2021). Pollution risks human and natural health and jeopardises the potential use of the polluted landscape itself.

Pollution coming from heavy industries is something to be solved by the industry or regulated by the government. For residents, it is difficult to contribute to large-scale pollution remediation since they lack the resources to do so. Consequently, not just the physical health of people is affected by pollution, but also the mental health, where powerlessness over one's own living environment creates stress and societal unrest. This makes the residents very much dependent on the government to take action, which is often a long and difficult process due to its bureaucracy (Onderzoekraad voor veiligheid, 2023). An indirect effect of this lack of power for residents and governmental institutions' slow course of action is a growing mistrust in the public sector (Onderzoeksraad voor Veiligheid, 2023). In the overall trend of decreasing mistrust in the government in The Netherlands, this is not beneficial.

Industrial pollution is the industry's responsibility, but once it ventures outside of the industry's territory, it becomes an issue for the rest of society. It is difficult to prevent industrial pollution from spreading, but it greatly impacts the surrounding landscape. Pollution is an externality of the processes happening on site. Through the air pollution is spread, not restricted by following the boundaries of the industrial territory. Pollution that gets out into the environment is often a rest-product that is not used by the industry anymore. That is why the uncontrolled release of pollution spreading into the surrounding landscape is a sign of a lack of adequate waste management. Depending on the amount of pollution accumulated in the landscape or the period of time that this has been going on, landscapes risk becoming dysfunctional or so-called anti-landscapes. This is a term coined by the researcher David Nye (2014).

The concept of anti-landscape defines itself further as the inability of a place to sustain life. Whilst anti-landscapes can be created naturally (Nye, 2014), they are often the result of human (lack of) activity. In the case of the steel industry and its extraterritorial pollution, the existence of an anti-landscape is a sign of governmental failure in protecting the public good. The public good is, in this case, the guarantee of being able to live a healthy life within a healthy environment (Government of

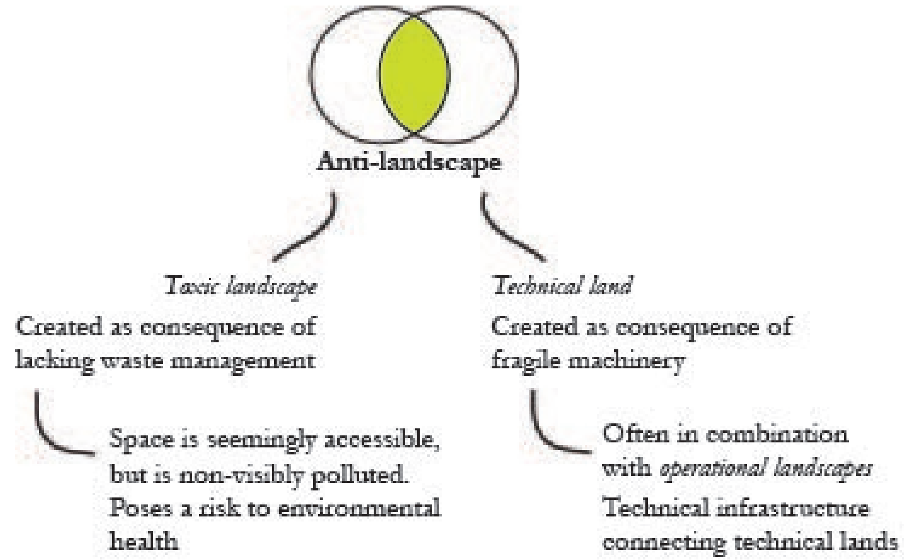
Anti-landscape

The Netherlands, n.d.). The failure to protect the public good also serves as a reminder that growth has limits and sustainability is needed in order to prevent a dystopian environmental degradation through the overuse of resources and the destruction of existing land (Nye, 2014)

Anti-landscapes have two important dimensions of existence: time and location. Anti-landscapes can exist for different periods of time, creating a certain temporality of an inaccessible space that could be hours, months, years or decades. Generally, though, anti-landscapes are a symptom of an underlying issue, creating inefficient and redundant (non-)use of space, portraying the failings of the regulating power of the government. To restore anti-landscapes to healthy landscapes, their value must be articulated, and a way to support life in a broad sense will have to be found again (Nye, 2014).

But there is more to restoring landscapes than just articulating their value. In the case of the IJmond region, there is not just the issue of loss of spatial value but also of non-spatial value (process value). In the book Technical Lands by J. Nesbit and C. Waldheim (2023), a similar phenomenon is discussed that addresses the inaccessibility of land due to their "exceptional" status, being a remote location, having a delimited boundary, secured accessibility or vigilant management. This is to say that not only the spatial characteristics of a landscape change due to heavy industries but also the implications and the associated feelings of a landscape change due to this. Technical land is a concept that refers to landscapes formed as a consequence of big industries. Their industrial infrastructure creates a landscape on a scale different from the human one, connected with the rest of the world through operational landscapes that consist of pipes and wires far removed from the natural world. This definition of technical lands shows how industries can create anti-landscapes that are inaccessible to non-employees but often restricted to the industry's own land.

Anti-landscapes produce a fundamental contradiction between the fixity of a place and the flow of capital, which causes landscapes shaped due to one process to become barriers to development in the next one (Hayrynen, 2014). The issue of industrial pollution degrades the landscape and obstructs new developments on the valuable land surrounding the steel industry. An important notion that this brings up is that the sole focus should not be on what the landscape is in concrete terms but on what it means or how it functions within societal and economic practices (Hayrynen, 2014). Bruno Latour discussed this fundamental difference in 1993, describing it as: "The landscape medium is a hybrid, reducible neither to human nor natural agency.". The difficulty with regard to landscape in such a way is that viewing the landscape as continuously socially redefined and relational lacks practical application for urban planning to persuade and instigate governmental action (Herzog et al., 2023). The takeaway on the value of landscape for this is the importance of multi-contextuality, how the landscape is articulated differently in several contexts with the help of media and institutions (Hayrynen, 2014).



This image illustrates the different types of anti-landscape and what their main differences are. On the right, some of spatial examples of anti-landscapes are given in order to get an idea of how an anti-landscape functions within space (own image, 2023).

Values

Gas extraction industry in Groningen (Cris Toala Olivares, 2021)

Example of an ***operational landscape*** created by the necessary infrastructure to distribute gas mined in Groningen in The Netherlands. Not only does this industry have a direct spatial impact on the landscape, it also has an indirect spatial impact on nearby houses due to the earthquakes caused by the mining.

Caution signs for toxic gasses in New Mexico, USA (Morrison, 2015)

This image shows warning signs for toxic gasses in New Mexico. These gases invisibly pollute the territory, making it inaccessible and threatening human health. A ***toxic landscape*** is created.

Designing with values, essential in identifying, interpreting, and implementing, is important for responsible innovation and development (Rocco et al., 2022). Values can be very obvious or rather implicit, and although they often touch upon general topics such as sustainability, equity, and inclusivity, guarding the interests of different stakeholders is very important (Rocco et al., 2022). This includes making the values of vulnerable or silent stakeholders heard.

Added to this, values are often considered tools in the act of future-imaging/ future-building, and the process management of this act lies at the core of the acceptance of any design (Rocco et al., 2022).

Moving away from development, which is focused on economic growth, a habit humanity got used to after industrialisation, the focus is shifted to developing and sustaining (public) values. Land use planning is expected to create liveable communities and sustainable development (Godschalk, 2007). Regarding other studies, more values like nature conservation, preservation of the past, and changes to the neighbourhood also claim attention within the practice of spatial planning (Herzog et al., 2023). Bringing in the extra element of pollution, which is unique to this area, health and resilience as values are added. All values have in common that they ought to be present in the public space across various levels, also known as public value as conceptualised by Bozeman (2007).

Trying to incorporate all values, it is inevitable that conflicts in aligning different interests make integration more difficult. In the transition to a circular economy, sustainable development is a key objective to tackle the triple planetary crisis of climate change, biodiversity decline and pollution (Government of the Netherlands, n.d.-a). Sustainable development seeks to align current conflicts between economic development, ecological preservation and intergenerational equity; from this, a balance between three “E”s can be distilled: environment, economy and equity (Godschalk, 2007). Balancing these three E’s inevitably creates conflict. These conflicts stand in the way of integrating opposing goals (Godschalk, 2007).

Spatial conflict

Soil pollution causing health issue (own image, 2024)

Remediated soil as the basis of a healthy environment (own image, 2024)

“The spatial arrangement of incompatible land uses may cause land-use conflicts” (von der Dunk et al., 2011, p.149). Spatial or land use conflicts arise over competing interests or priorities related to the environment, equity, economy, and livability. These conflicts are unique and emerge from site-specific social, economic, and ecological interactions; thus, the clashing values are found in these realms. In Western countries, these conflicts often arise from land-use externalities such as noise, smell, or light (von der Dunk et al., 2011). Heavy industries, in particular, contribute significantly to these externalities, exacerbating conflicts due to their environmental impacts and the disturbances they cause to surrounding areas.

The IJmond region exemplifies these challenges, where the proximity of industrial, natural, recreational, and residential zones creates fertile ground for various land-use conflicts. These conflicts manifest in health concerns, loss of trust in governmental institutions, and biodiversity loss. Managing such conflicts is further complicated in peri-urban landscapes, which serve as transitional zones between urban and rural areas. These landscapes, with their unclear land use definitions, lead to differing expectations among stakeholders, adding to the dynamic and contentious nature of the conflicts (von der Dunk et al., 2011).

Remediation

The landscape’s health has been jeopardised, meaning that remediation of the landscape is necessary to bring back its value. Remediating polluted soil is a difficult and expensive task. On top of this, authorities often lack expertise and enough financial and workforce resources to effectively remediate land on a bigger scale (European Environment Agency, 2020). Added to this practical difficulty is how the landscape plays a role in economic and social factors and regulatory regimes establishing its economic viability and its responsibility for sustainability (Scullion, 2005). Pollution does not stick to geographical boundaries, creating difficulty in determining who should be involved in its remediation.

The practical remediation of polluted soil can be done in several ways (Scullion, 2005):

- Destruction or degradation of the pollutants within the soil
- Extraction of the pollutants from the soil
- Stabilization of the pollutants to make them less toxic
- Containment of the pollutants to restrict exposure to the wider environment

Regarding the role of the government there must be a basic monitoring system to assist in implementing environmental protection policies. However, in order to fully reconcile land use conflicts in the long term with changing demands of land use, natural resources and the transition to a circular economy, it is essential that all different values, the ecological, the socio-cultural and the economic, are taken into account in planning and decision making (de Groot, 2006).

One way to mitigate the current land use conflict is suggested by Thomas et al. (2022) and is centred on a place-based scenario, including clean growth discourse of industrial decarbonization and the implementation of sparse flexibility that combines diverse coalitions of institutions, actors, technologies and infrastructure to collaborate on research, development and experimentation. Creating soft reuse through urban green space could provide a possible intermediate scenario for interim use prior to the long-term solution of revaluing the landscape (Bardos et al., 2016). A focus value for achieving this is to create anchor points within the landscape that focus on the surroundings, diffuse from the stigmatized industrial landscape, and take care of each other. The industry of the people and landscape, and the people of the industry.

Methodology

View from the dunes, towards the steel industry (own image, 2024)

The goal of this research is the large-scale soil remediation within the IJmond region that mediates the conflict between the importance of economic value and the livability for the residents. This research will not only focus on the spatial impact of remediating the soil but also consider the design of the process to achieve this large-scale remediation. This strategy aims to be coherent, fair, and orderly, not just to provide a quick fix but also to provide a long-term solution that considers all facets of the complex issue.

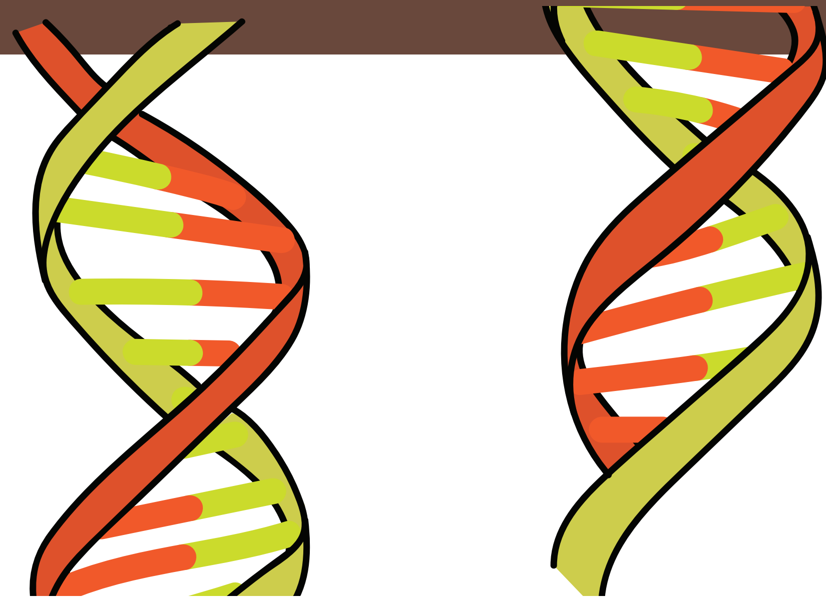
The methods used to unravel the three different values important for the future of the IJmond region are in line with the three different sub-questions and are as follows.

The first sub-question that will pinpoint the current value rests on an analysis of the current role of the industry. The goal is to create an insight into the meaning of the industry within the landscape, visually but also for the people. First, this will be done by examining the IJmond region and the historical role the steel industry has played in its development. Secondly, the current situation of the industry and its future plans will be studied. Thirdly, a site visit to the region will provide some first-hand insight into how people from the region view the steel industry. By emerging oneself on the site observations, smell, hearing, feeling and interaction provide valuable insights that cannot be gained from study on a map (Randall et al., 2007).

The second sub-question pinpoints the intended value. The intended value is a consequence of the existing value, and the main focus is thus on understanding the impact of pollution and researching ways of remediating soil pollution. This is done by reading official reports and documents published by the government and its research institutions and looking at references to how other polluted places have coped with the pollution.

The third sub-question moves away from the spatial implications of large-scale pollution to determine the process value needed for remediation. The goal is to determine the stakeholders needed to accomplish such large-scale and long-term remediation, what resources different stakeholders bring to the table and the terms of cooperating. This is done by conducting an in-depth stakeholder analysis that classifies stakeholders into three main groups: the public, private, and societal. Their mutual relations will be assessed considering the current and intended relations, their resources will be analysed, and the power-interest matrix will be filled in. The power-interest matrix will help guard the process value for the group that does not have the power to do so themselves (Brugha, 2000).
Once the three values needed to mediate the conflict between economy and livability are established, the goal is to create a spatial strategy and develop a collaborative governance collaboration. All the information needs to be compiled to create a cohesive and complete strategy that includes all the different aspects necessary for remediation within this complex issue. The study of references and the trial-and-error through design will assist as a method for this last step.

Output



Drawing showing the interdependence of spatial strategy and collaborative governance in a dna structure (own image, 2024)

A detailed design is not adept at societal changes over time and is thus better suited for short-term interventions. A flexible strategy, on the other hand, has the capacity to anticipate and move with societal changes that could influence the outcome. Since soil remediation is a long-term process, and the future of the Netherlands is unpredictable due to many influences, such as climate change, the transition to a circular economy, large-scale migration, etc., an open-ended strategy is needed that provides resilience. A strategy can provide handles that create an inclusive process for stakeholders to co-decide on decision-making and adapt to potential future changes or surprises.

The spatial strategy will consist of different phases that function as a step-by-step plan over the (long) period of time it takes for the soil to be remediated. Each phase builds on the previous phase and incorporates one of the values determined with the help of the sub-questions.

By being included in all the different phases, the process value will have a unique role within the strategy because it concerns how the remediation is being done. To ensure a just remediation process, it will be important to include all the relevant stakeholders in a collaboration. Collaborative governance is often used in sustainable developments such as remediation (Lima, 2021). The whole strategy is a mutual development of soil remediation, how this will shape the landscape, and the configuration of stakeholders needed to achieve this. The final result of this research will be a strategy that will result in a comprehensive and resilient future for the IJmond region, preserve the region's current industrial value, and create a healthy environment in a just manner.

Societal relevance

View on the steel industry from IJmuiden (van Flymen, n.d.)

The societal relevance of this research lies in its potential to establish collaborative governance, ensuring a fair and inclusive process on a large scale. By translating the values of economy, environment, equity, and livability to the IJmond region, the project aims to balance industrial heritage and social structures with sustainable development. This research will contribute to society by addressing critical issues currently faced by IJmond residents, including health concerns and feelings of powerlessness. It aims to mitigate the negative health impacts caused by industrial pollution and ensure a just process that empowers the community. By aligning these four values of sustainable land use, the research seeks to create a resilient future for the IJmond region, preventing it from being undermined by its industrial success and ensuring a healthier and more sustainable environment for its residents.

Scientific relevance

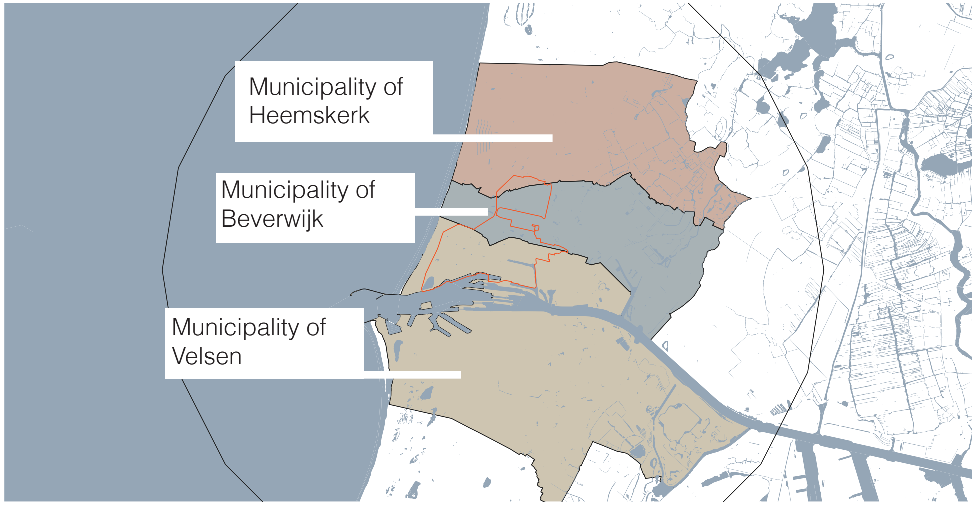
View on Ijmuiden with the road to Beverwijk in front (own image, 2024)

Currently, soil pollution caused by heavy industries is remediated by the public sector only when the soil is used for new housing or other developments. This acupunctural way of remediation only temporarily provides a solution for soil pollution, displaces the pollution somewhere else and can often cause delays. This fastidious strategy of remediation only creates small scale improvements whilst the whole region is polluted. This research aims to fill this gap by researching a way of large-scale remediation within an existing environment, largely maintaining the current use of a space whilst it is being remediated. It will look into how one of the ways of remediation, phytoremediation, can be combined with other uses of a space such as living, recreation and work. It will combine technical knowledge of different types of remediation with the spatial insights of an urban planner. The strategy as the output of this research provides a way to close the gap between top-down, small-scale remediation and bottom-up need for large-scale remediation.

03. CURRENT VALUE

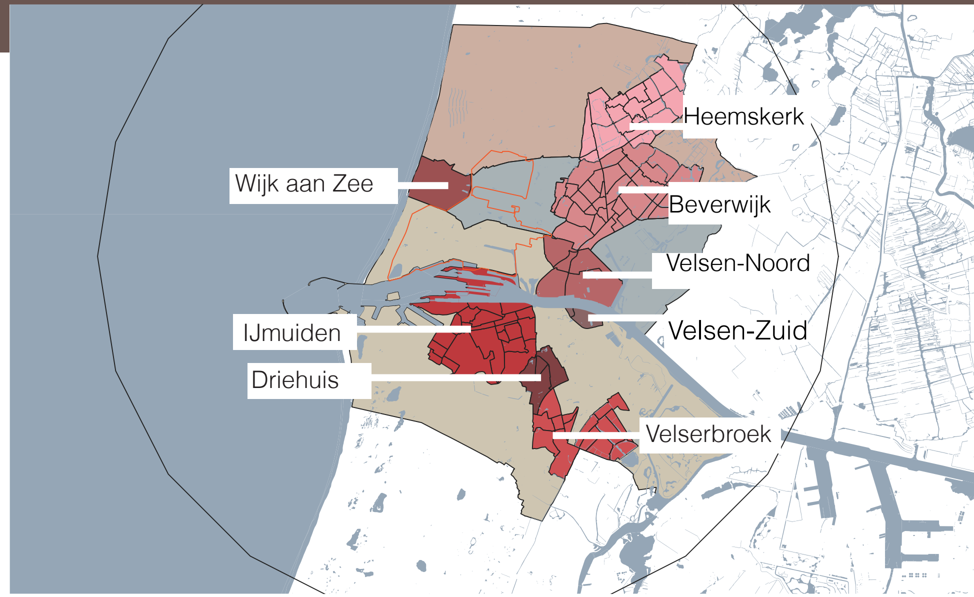
This chapter aims to establish the current value of the IJmond region. A location analysis provides insights to the current mutual relations between the different important aspects of the landscape. Next the focus shifts to the steel industry and how this affects its surrounding landscape. The steel industry is very much embedded in many generations of the residents of the IJmond. People see it as a symbol of prosperity, and are proud of their heritage and what it has brought them. The difficulty is though that this current value is in conflict with the health of the people living in the IJmond region. Jeopardizing the livability of the landscape. What can be concluded is thus that the consequence of the current value is obstructing the health of the people, the intended value. Exploring the source of the soil pollution and heavy metals affecting the health of the people and understanding the health consequences provides insights in what is needed for the remediation of this conflict.

Municipalities and towns



Map showing the municipalities of the IJmond region (own image, 2024)

“IJmond” refers to the mouth of the river IJ. The river IJ is the river that used to be there before the North Sea Canal was dug. The IJmond consists of three municipalities: Heemskerk, Beverwijk and Velsen. The territory of the steel industry stretches across the three different municipalities but is often referred to as Tata Steel Ijmuiden. This shared industry also means that the issue of soil pollution is something the municipalities have to deal with collaboratively. This is especially important when applying for national subsidies, policymaking, and regulations.



Map showing the towns of the IJmond region (own image, 2024)

The town of Heemskerk is at the top of the IJmond and belongs to the municipality of Heemskerk. Furthermore, this municipality also includes a large part of the Natura2000 territory. The municipality of Beverwijk includes the towns of Wijk aan Zee and Beverwijk. The municipality of Velsen includes the towns of Velsen-Noord, Velsen-Zuid, Ijmuiden, Driehuis, and Velserbroek.

Historic development

Historical map of the IJmond region in 1815 (Topotijdreis, n.d.)

Historical map of the IJmond region in 1899 (Topotijdreis, n.d.)

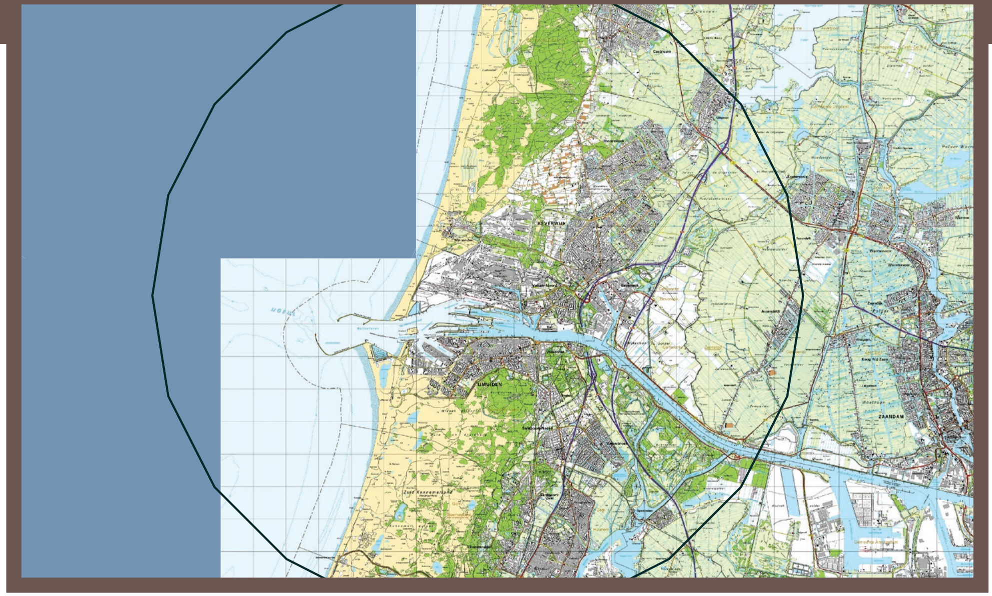
The landscape of the IJmond region has changed considerably over time. The name of the IJmond is derived from the fact that it is the mouth of the river IJ. A brief overview of the region's development and the steel industry's simultaneous development is considered.

1815, a hundred years before the founding of the steel industry, the landscape consists mainly of dunes that protect the Netherlands from the seawater. There is also a big lake, the Wijkermeer, that supplies drinking water to the residents living in the villages. This lake disappeared in 1856 to make space for agricultural land. The largest town close to the IJmond at this time is Haarlem. The towns of Beverwijk, Velsen, Heemskerk and Wijk aan Zee are very much at the beginning of their existence and consist of a church surrounded by a few houses. Next to the dunes, the landscape is already "empolder", which characterises the Dutch artificial way of protecting the land from water.

1899, 25 years before the establishment of the steel industry, the landscape has changed considerably regarding 1815. The North Sea Canal replaced the IJ River, which was dug in 1876, to connect the Netherlands capital, Amsterdam, to the North Sea. This provided an impulse to the development of the harbour in Amsterdam, which existed since the 13th century. This artificial Canal goes hand-in-hand with the building of a sea lock situated right next to the future location of the steel industry. The building of the North Sea Canal also split the town of Velsen into two parts, creating Velsen-Noord and Velsen-Zuid. In 1896, the first big industry within the IJmond region was established, and one that still exists is the fishing industry. A fish auction opened in 1899 to organise the growing fish trade.

Historic development

Historical map of the IJmond region in 1952 (Topotijdreis, n.d.)

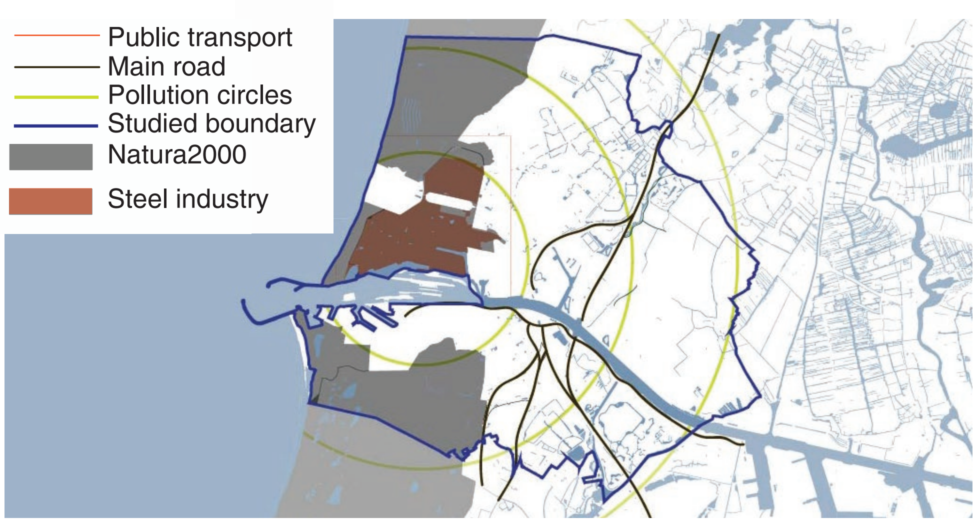


Historical map of the IJmond region in 1999 (Topotijdreis, n.d.)

1952, 25 years after the opening of the steel industry within the IJmond region. The sea lock of the North Sea Canal has developed significantly, widening the mouth of the canal in the process. The transport to and from the steel industry falls outside the lock, saving time by delivering raw materials and exporting steel rolls. Besides the growing fish industry in Ijmuiden, a growing paper industry has established itself along the canal. The steel industry has developed from a small factory with one furnace into a heavy industry with multiple furnaces, providing large-scale employment for residents living in surrounding towns and creating its own infrastructure for transport. The steel industry territory is split into two parts, with a road connecting the village of Wijk aan Zee to the rest of the Netherlands. Furthermore, the reconstruction of Ijmuiden is in full swing after it was heavily bombed during the Second World War.

1999, the steel industry is properly ingrained within the social fabric of the IJmond region. The production of the steel industry is in full swing. There are two high furnaces, and the terrain is fully developed; the territory ended up being 750 hectares big. The towns have developed and grown a lot. The IJmond region has become an ideal location to live near the sea and Amsterdam. However, in 1975, the first report on the effects of pollution was published, not changing anything about its spatial implications. Also, the industrial areas of the towns have developed a lot, providing enough work for the people living in the IJmond region.

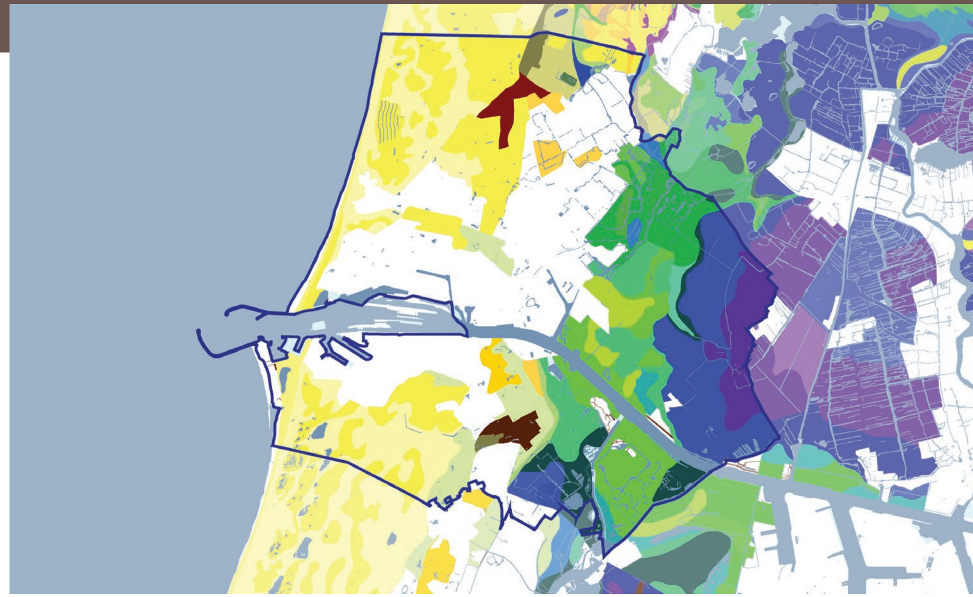
Location analysis



Location map with important situational elements (own image, 2024)

This location map shows the main elements of the IJmond region.

As previously discussed, the North Sea Canal ends in the North Sea and splits the grey-coloured Natura2000 area in two. Natura2000 established by the European Union and is a protected landscape. This means that it is only used for recreational activities that have no permanent impact on the landscape. In between the two pieces of Natura2000, there is the steel industry with its own rail network mostly used for on site, but also connected to the national rail network that passes through the town of Beverwijk. Connecting the north to the south of the region, there is the motorway, the A2 passing through the towns of Heemskerk and Beverwijk.

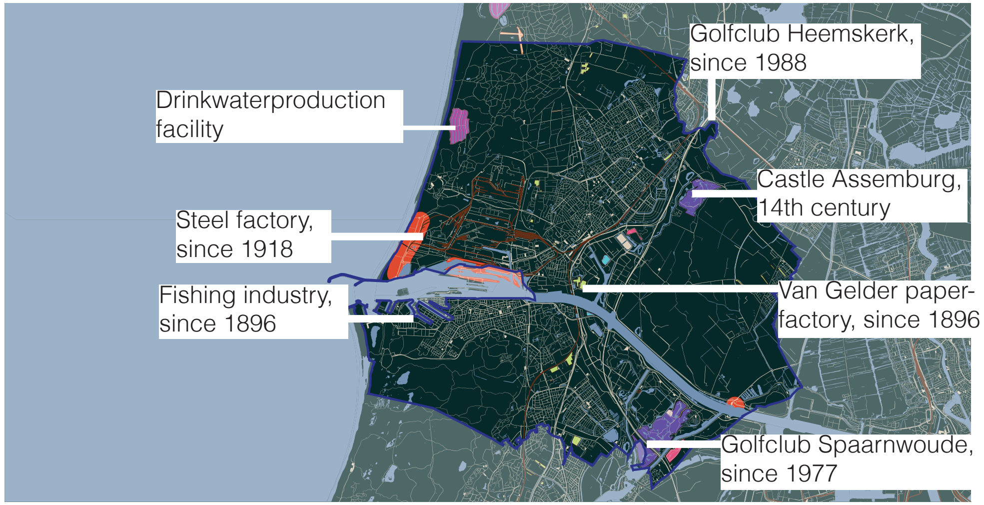


Soil type map, yellow is sandy soil, green is clay soil, blue/ purple is peat soil (own image, 2024)

The IJmond region is a very vertically oriented landscape, stemming from the soil types. Only the North Sea Canal cuts through this vertical structure and connects Amsterdam to the North Sea.

Moving from the sea land inwards there is first the dune landscape. This is a mostly (calcareous) dune soil, coloured in yellow. A soil type that is alkaline, highly permeable and has good drainage, with a high concentration of calcium (McLachlan and Brown, 2006). Most of this dune landscape is protected as a Natura2000 area. Next to this vertical strip of land is a vertical strip of white, this is the build area. Green indicates clay grounds. Currently, this is a polder landscape used for moderate agricultural practices such as the grazing of cows. This type of soil holds a lot of water, is very nutrient-rich, and is suitable for an array of different plants. Clay soils swell during wet times and shrink during dry times (Finch et al., 2014). Next to the clay soil is the former area where the Wijkermeer used to be, which was made dry for agricultural purposes; there is the peat soil. This soil is sinking every year because of the peat compressing. This is also currently mostly used either for leisure activities or the grazing of cows. It holds much water, but cannot bear much load. It is thus not a very useful type of soil for development (Kolay and Taib, 2018).

Interesting sites



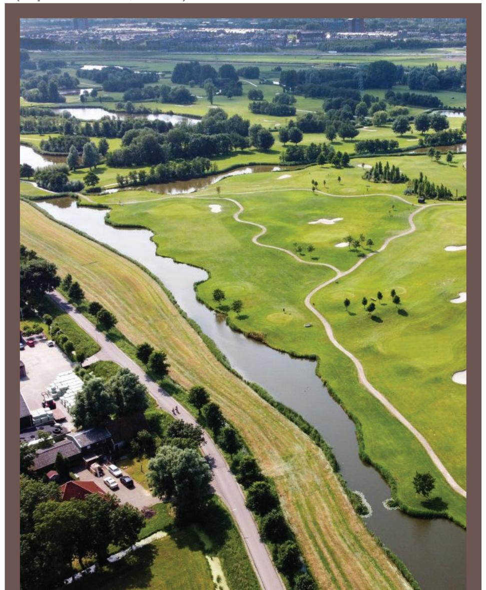
Map that shows the interesting sites of the IJmond region (own image, 2024)

This map localised an array of interesting sites within the IJmond region that provide work for residents or function as leisure activities.

The dune landscape doubles as a space for drinking water production facilities. Two such sites within the region's north have their typical spatial outlook. The steel industry is the most significant in the region, taking up much space and situated within the landscape since 1918. The fishing industry lies opposite the steel industry, with its port for the fishing boats to dock. From here, boats crossing over the North Sea to Newcastle also leave. Following the North Sea Canal is the previously discussed paper factory van Gelder, since 1896. More inland large industries cease to exist, and more leisure activities are situated here. With large empty plots of land, two golf clubs have established themselves. The Castle of Assemburg, a 14th-century castle, provides a beautiful escape from the surrounding towns.

14th century castle, Assemburg (Speelman, n.d.)

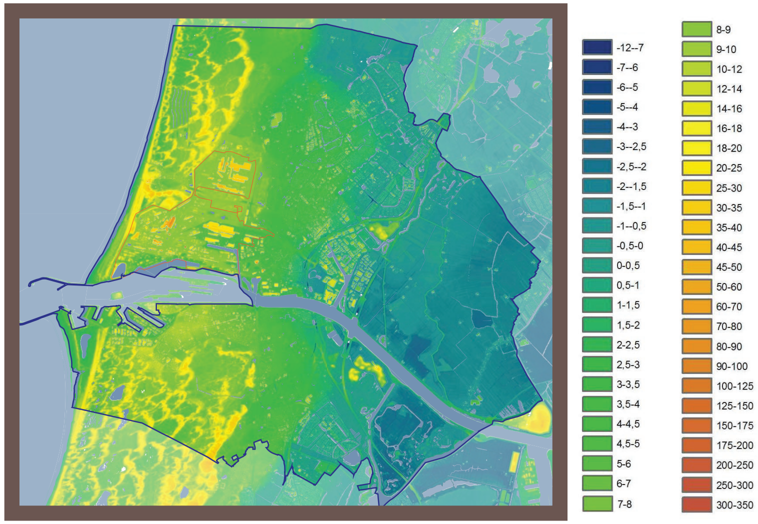
Fishing port IJmuiden (Volkers, n.d.)



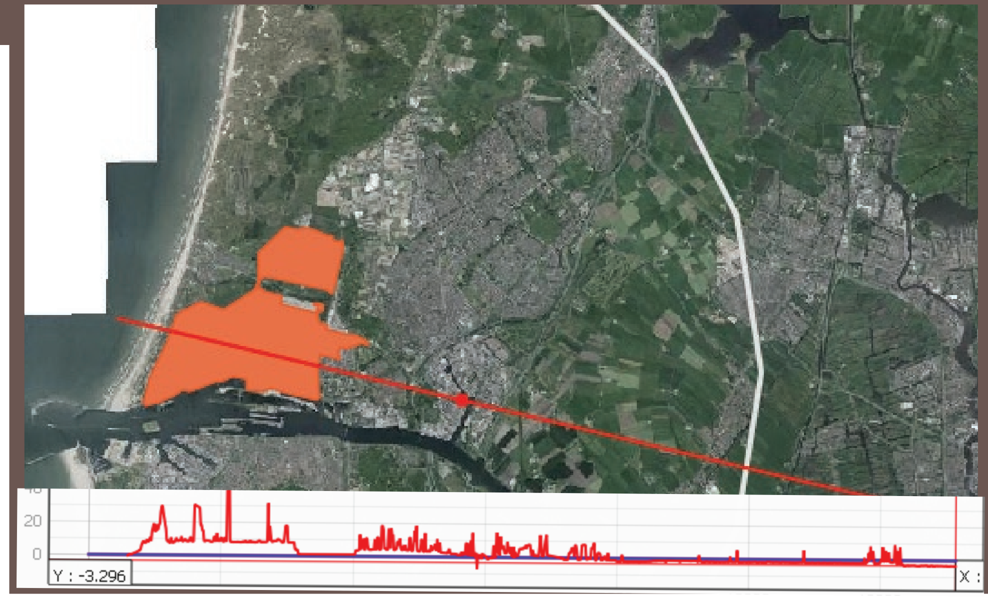
Golfclub Heemskerk (Heemskerkse Golfclub, n.d.)

Van Gelder paper industry (Crown van Gelder, n.d.)

Height profile



Map that shows the height of the landscape (AHN, n.d.)



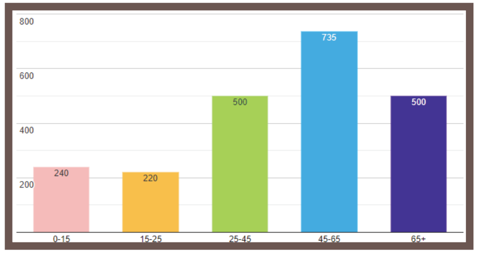
Section of the landscape (own image, 2024)

The same vertical structure can be observed for the height profile of the IJmond region. The sandy soil and the dunes are situated much higher (between 6 and 12 metres high) than the clay (-0.50 metres) and peat soils (-1.5 to 2 metres). The Steel industry is strategically located on the higher soil and is thus armed against rising sea levels. More inland the risk of flooding, with rising sea levels or during heavy rains increases. The historical structure of the landscape is reflected within the height map. The Wijkermeer, which has been dried up, is reflected in the height difference.

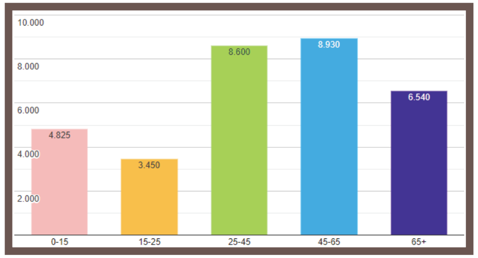
This section spans over a distance of 10km and shows the gradual decline in the height of the landscape. There are a few outliers in the height. The peaks mostly on the left are the buildings at the steel industry site. The second group of peaks more to the right are the residential houses.

This section also shows an aerial photo of the landscape.

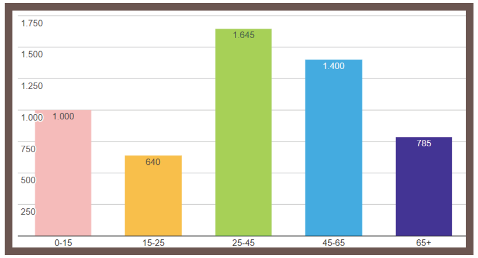
Demographics



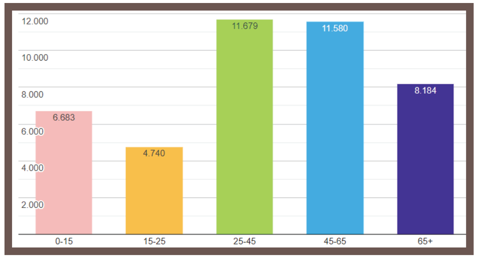
Residents according to age Wijk aan Zee (Allecijfers.nl, n.d.)



Residents according to age IJmuiden (Allecijfers.nl, n.d.)

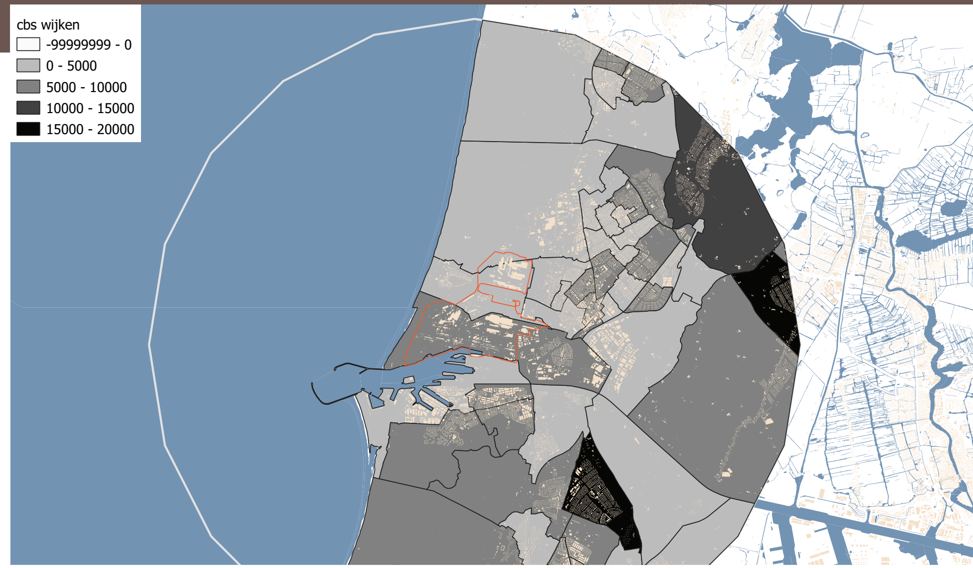


Residents according to age Velsen-Noord (Allecijfers.nl, n.d.)



Residents according to age Beverwijk (Allecijfers.nl, n.d.)

The following demographics provide insight into the societal characteristics of the towns within the IJmond region. The first set of data considers the different ages of residents per town, focussing on the towns of Wijk aan Zee, Velsen-Noord, Beverwijk and Ijmuiden. What is interesting to observe is that there are generally more elderly people within these towns. The age category between 15 and 25 is generally low (people move away to study), and the number of children seems to be higher in Velsen-Noord and Ijmuiden than in Wijk aan Zee. Getting insight into the division of age categories helps understand the urgency of soil remediation. The most vulnerable age categories, prone to health issues caused by heavy metal soil pollution, are young kids because they have a lot of interaction with the soil and elderly people because they have an already weakened immune system. On the other hand, it also provides insight into people who could be willing to help in remediation, since there are many elderly people, potentially retired and willing to help out the region with the help of gardening. All demographics are retrieved from Allecijfers.nl (2023).

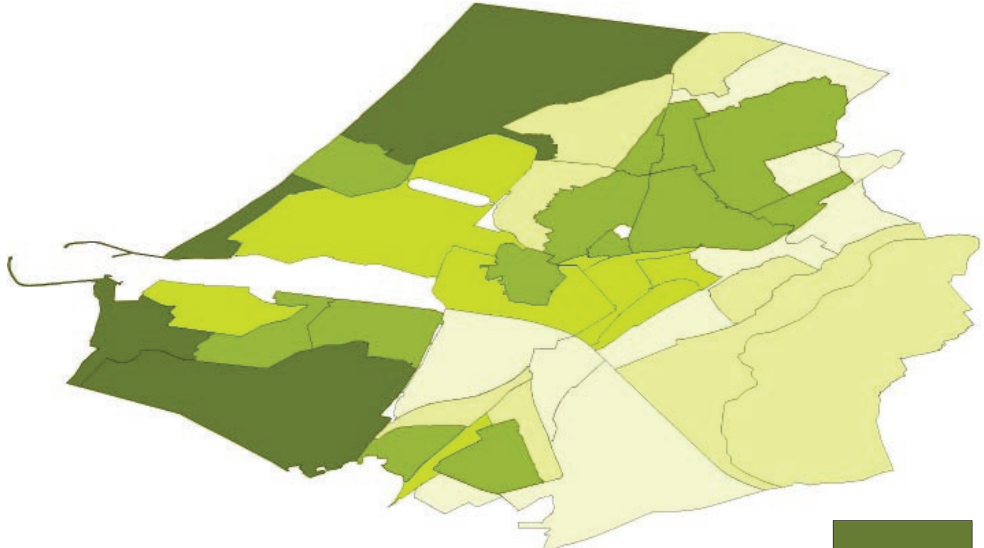


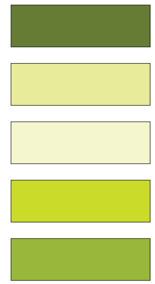
Map with population density per neighbourhood (Allecijfers.nl, n.d.)

This map shows the density of the different neighbourhoods within the IJmond region. What can be seen is that Velserbroek is the most densely populated town within the area. Furthermore, parts of Heemskerk and Beverwijk are also quite densely populated. The municipality of Velsen has 70.000 inhabitants and is spread across a surface area of 52.8 km2. The municipality of Heemskerk has 40.000 inhabitants and spreads across a surface area of 31.7 km2. The municipality of Beverwijk has 42.000 inhabitants and spreads across a surface area of 19.6 km2. In total, about 152000 residents are impacted by the heavy metal soil pollution caused by the steel industry. The number of people impacted by pollution adds to the urgency of creating a remediation strategy.

Functional zones

Map that shows different zones within the region based on municipal divisions. Coloured in means mostly build. Not coloured in is mostly unbuild. (own image, 2024)





Division of functional zones within the IJmond region (own image, 2024)

This map shows different functional zones of the IJmond region, divided by the main use of each municipal boundary. In this way, an abstracted structure of the IJmond region becomes clear and alludes to the vertical structure of the soil types.

The dune landscape along the coast creates a clear vertical line from north to south, called the protected zone. This zone is a Natura2000, characterised by its natural look. It is a hilly dune landscape unique to the rest of the Dutch landscape.

Secondly, there is the production zone, situated on fertile clay soil where produce grows. This zone is characterised by many fields, greenhouses, and pastures. People also live near their land on farms. Not all of the production spaces are still in use.

Then there is the leisure zone, mainly situated along the edge of the IJmond region, where large leisure spaces can exist. This zone is characterised by its planned nature and includes many amenities like parks, a golf court, and event spaces. It is often closely situated to the more significant residential areas to provide green space for the city.

Then there is the industrial zone. In contrast to the more vertically oriented other zones, this zone is clustered along the North Sea Canal for easy access and is characterised by a large amount of paving. Larger and smaller businesses that profit from easy access to the water are situated here. These zones are often situated on the borders of residential zones and provide many employment opportunities for the residents.

Lastly, there is the residential zone, where people spend most of their time, at the heart of all the different functions to provide easy accessibility. This zone is characterised by its presence of dwellings. Furthermore, many amenities can be found here, like shops, playgrounds, educational institutions and cultural facilities.

The next page further explores the different functional zones and their spatial characteristics, an even more extensive characterization of the functional zones is given in the appendix Aa.

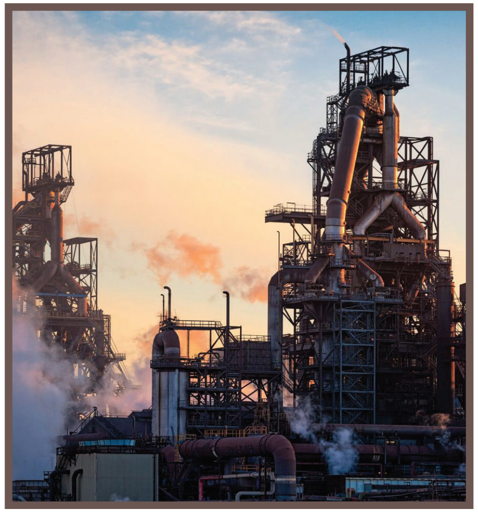
Functional zones

Name	Spatial impression	Small description	Main stakeholders
Industrial zone		This zone is characterisized by the large amount of paving. Many large scale and small scale businesses are situated here. These zones are often situated on the borders of residential zones and provide a lot of employment for the residents.	-Business owners -Employees -Municipality -(in case of Tata Steel) Activists
Residential zone		This zone is characterized by its presence of dwellings. Furthermore an array of amenities can be found here like shops, playgrounds, educational institutions and cultural facilities.	-Small businesses -Residents -Tourists -Municipality
Leisure zone		This zone is characterized by the planned nature, and includes an array of amenities like parks, a golf court and event spaces. It is often closely situated to the bigger residential areas to provide green for the city.	-Businnesses -(park) caretakers (PWN) -Residents -Tourists
Production zone		This zone is characterized by many fields, greenhouses and pastures. People also live near their land on farms. Not all of the production spaces are still in use.	-Farmers -Employees
Protected zone		This zone is a Natura2000 characterized by its natural look. It is a hilly dune landscape unique to the rest of the Dutch landscape. Close to the sea it is sandy dunes, and more inland it has higher vegetation.	-Residents -Tourists

Images from google streetview (Google, n.d.)

Industrial site

Tata Steel (Tata Steel, n.d.)



Furnaces Tata Steel (Tata Steel, n.d.)

Tata Steel territory within the landscape (own image, 2024)

In use since: 1924

Size: 750 hectares

Type of industry: Steel

Current company name: Tata Steel IJmuiden

Company owned by: Tata Steel India

Direct employees: 9200 people

Indirect employees: 47000

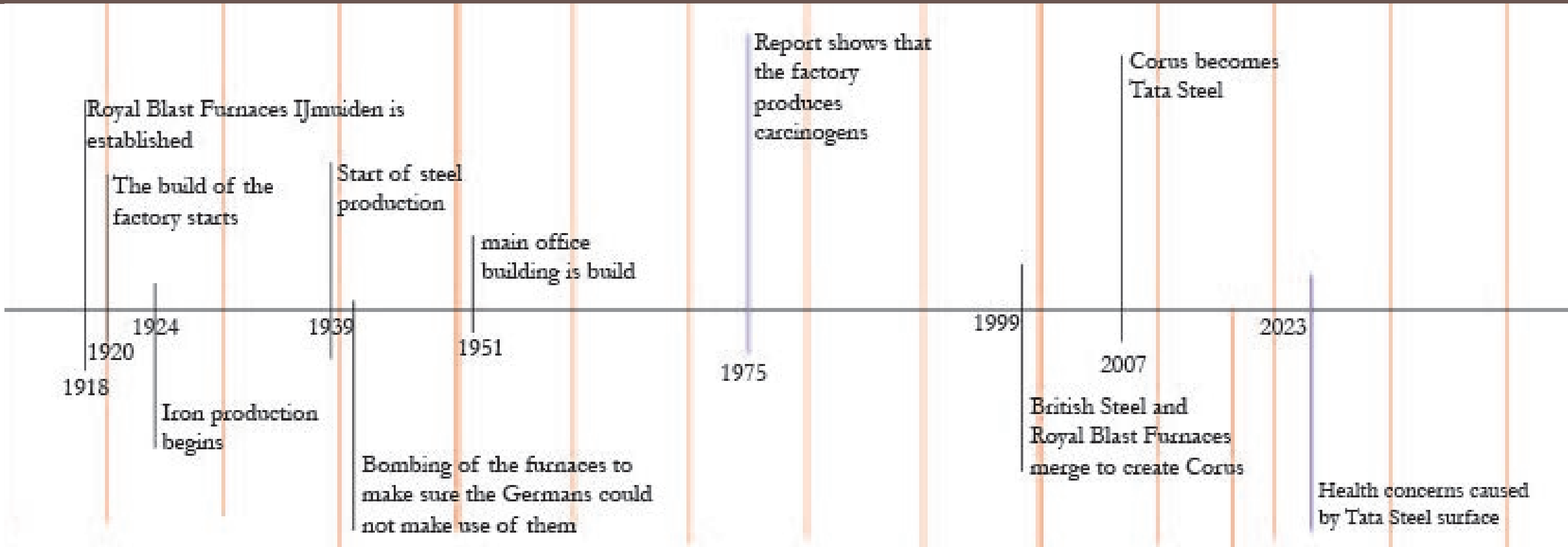
Main products: Cars parts, batteries, solar panels, building material, packaging

For a detailed description of the steel making process see Appendix Ad.

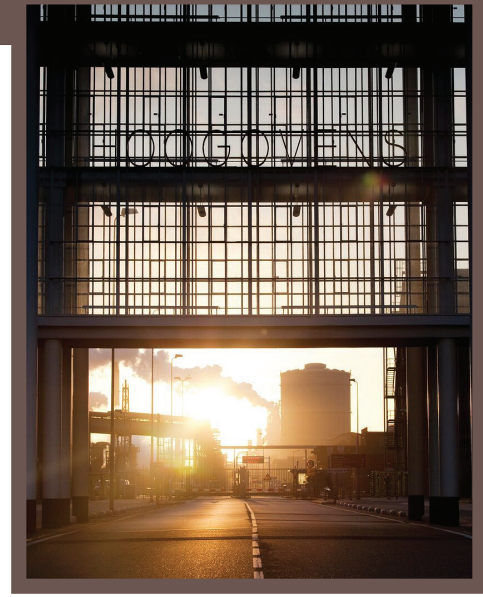
The Indian company Tata Steel owns the steel industry in the IJmond. With a surface area of 750 hectares, it has train tracks to transport steel on-site. The factory is recognisable from far away from its territory because of its distinct furnaces that stand in the middle of the territory. The steel industry imports raw materials from South-East Asia, Canada and Latin America. A large share of steel is exported to Germany; the rest is exported to the South of Europe, the United Kingdom, and America. Steel produced is used for different items like cars and car batteries, solar panels, washing machines, the building sector and food packaging, to name a few (Tata Steel, n.d.).

Within the landscape the industry is situated in between a Natura2000 area, a natural zone protected by the EU. Surrounding the industry is a dune landscape with the North Sea next to it. Furthermore, the North-sea Canal runs next to the industrial site, providing the perfect access to raw materials to the site and a way to export steel produced. Another reason the steel industry is also close to these water bodies is because water is used as a cooling element during the steel-making processes. The steel industry borders the towns of Wijk aan Zee, Beverwijk and Velsen.

Timeline



Timeline that indicates the development of the steel industry in the IJmond region (own image, 2024)



View of the main office Tata Steel in IJmuiden build in 1951 (Tata Steel, n.d.)

This timeline shows the significant events within the development of the steel industry. In 1918, the company 'Royal Blast Furnaces IJmuiden' was established. Starting small, it becomes the most significant steel industry in the Netherlands. In 1924, the industry started with the production of iron and later switched to steel production in 1939. With steel being an essential material for the war, the Netherlands bombed their furnaces so the Germans could not use them for their own good during the Second World War. After the Second World War, the industry was rebuilt, and an extensive and imposing main office was added to create an impactful entrance to the territory.

In 1975, a report was released showing the impact of pollution on the health of the people within the region. It became clear that a lot of carcinogens are emitted in the air. This could have been a big turning point in the production process of steel making, but plans to transition to producing Green Steel were only formed when a CO_2 tax was imposed to combat climate change and move towards a circular economy. The report written in 1975 resurfaced in 2023, spurring change and forming the driver behind the road map aimed at directly reducing the nuisance of noise, smell and dust of the steel industry in the surrounding region.

In 1999, British Steel and Royal Blast Furnaces merged to form Corus. In turn, Corus was taken over by the Indian steel concern Tata Steel in 2007.

Now, in 2024, the steel industry is busy making the necessary changes to pollute less and ensure a steel-producing future with scrap metal and hydrogen gas that can coexist within the Dutch landscape.

Societal involvement

Tata Steel chess tournament (Tata Steel, n.d.)

Green Peace protest at Tata Steel (Greenpeace, 2023)

The role of the steel industry within the region is contested. The Financial Times called Tata Steel an "icon of our national industry" in 2021, but at the same time, it is the biggest emitter of greenhouse gases in The Netherlands. It is an image of paradoxes. Where one sees prosperity in the high furnaces of the industry, the other smells its pollution.

What is remarkable in the debate on the steel factory is that it does not address whether there should be a steel factory, but only how to make it fit within the sustainable regulations of The Netherlands and the EU. The factory is so embedded within the Dutch economy that it is even a point of discussion within the House of Representatives (Stooker, 2021). One of the reasons for this is also that if the Green Steel transition were to succeed, national subsidies would be needed.

A big company like Tata Steel has a wide societal reach. Employees come from all over the region. Many live near the factory, but some travel from Amsterdam or Den Helder.

Tata Steel is involved within the societal structure of the surrounding towns, for example, by organising an annual chess tournament. This tournament, also called the "Wimbledon of Chess," attracts positive media attention and fosters conviviality among the residents.

Another way the steel industry contributes to society's development is by hosting its very own "Tata Steel Academy," aimed at educating people in technical knowledge useful within the steel industry. Here, research is being done to innovate within the steel industry (Tata Steel, n.d.). The Tata Steel Academy also provides space for colleges and universities to research metallurgical processes.

Where this contribution to society creates a lot of good will and conviviality with the local residents of the IJmond region. There is also a lot of anger towards the steel industry and the amount of pollution it produces. There are often protests on the steel industry sites organised by Greenpeace and other environmental organisations that want the steel industry to be held responsible for its impact. However, they are not making enough effort to remediate it (Karst, 2023). Residents attend these protests, but many of the activists come from outside the IJmond region.

Site visit

Inside of the steel factory (own image, 2024)

Grand cafe “STAAL” (own image, 2024)

Steel park with the steel industry in the back (own image, 2024)

Two site visits were done, one month apart from each other. The first site visit focused mainly on exploring the landscape, familiarising myself with the steel industry, and grasping the current value of the steel industry. A “neighbour” tour was done on the site of the steel industry, one where taking photographs was not allowed. There was much room, though, to ask questions about the role of the industry and the effort it is putting into remediating its negative impact on the surrounding landscape.

During the second site visit, I focused on understanding the steel industry’s impact on the urban fabric of the towns. This involved visiting the Tata Steel loket in Wijk aan Zee, a place where residents can express their concerns about the industry. I also had the opportunity to explore the town of Ijmuiden and engage in conversations with its residents, gaining valuable insights into their perceptions and concerns. It was a humbling experience to hear their stories and understand their worries.

In the following sections, I will present the comprehensive findings from the two site visits. These findings, derived from a combination of photographs, observations, and conversations, offer a detailed and nuanced understanding of the steel industry’s impact on the urban fabric and the residents’ perceptions and concerns. This comprehensive overview will equip you with a thorough understanding of the situation.

First of all, across the dunes from the beach, opposite the North Sea canal, and almost everywhere within Wijk aan Zee, the presence of the steel industry is felt. Not only are the furnaces and wind turbines often visible, but also a burned smell and steady white noise can often be observed. This stands out for me as a newcomer: When I ask people about the smell or the noise, many seem oblivious to it, used to it.

Secondly, the ever-present steel industry is reflected in a certain type of pride within the villages. Next to Wijk aan Zee, there is a sculpture park with different sculptures made out of steel, a testament to the industry’s influence. Furthermore, Ijmuiden has a grand café named “Steel”. This pride can also be heard when talking to people on the streets. Residents of the towns all have family members who either work or have worked in the steel industry. The industry has always been a great employer with strict rules on health and care for their employees, a fact that is deeply respected by the community.

However, when venturing into pollution, people let their worries shine through. They are well aware of the Green Steel transition. They are also aware that with their questions and concerns, they can go by the Tata Steel Loket. Nevertheless, the main question that worries many, which is not quickly answered, is what the

Site visit

Hot steel passing through the roller (own image, 2024)

Industrial building on site (own image, 2024)

View on Wijk aan Zee, across the village meadow, with man-made trash dunes in the back (own image, 2024)

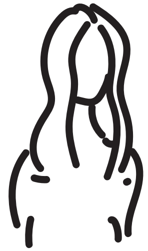
transition means for their employment within the steel industry. With the protests holding the steel industry accountable for its actions, people are worried about the possibility that it has to close. When talking to one lady, she wondered if I was not working for Greenpeace. This shows they are aware of the prejudices against Tata Steel and that it creates more of a divide between people, being for and against than it connects them.

After exploring the industry's role from the outside in, it was time to look inside. What struck me is that the scale of the machinery producing steel differs from that of humans. Additionally, the sight of a glowing piece of steel rolling through the machinery and its heat brings up the feeling of something big happening. Another thing that struck me during the tour of the steel industry is the number of signs that alert employees to potential pollution and the urge to stay safe during work. "Blijf ALERT op stank" (stay alert for smell), "Veiligheid eerst, productie volgt" (safety first production follows) and "We doen het veilig of we doen het niet" (We do it safe, or we do not do it) to name a few. This is a sign of valuing the health and safety of its employees greatly. After the site tour, I ask the tour guide a few questions. She explains that the steel industry is working hard to make the necessary changes for a cleaner future. This is done through adjustments in the steel manufacturing process and by opening a "Tata Steel Loket" in Wijk aan Zee. When asked who is welcome at their neighbourhood tours, her answer is "the whole of the Netherlands, since everyone is in some way impacted/ connected by the industry". In this way, the steel industry wants to allow people to shape their opinions about them based on the media and their experience on-site.

During the second site visit, the Tata Steel loket was paid a visit. The goal here was to understand what is currently being done to remediate the effects of the pollution caused by the steel industry. This led to a conversation about the adjustments made on site, such as big extractor hoods and a windscreen of one kilometre long to prevent raw materials (and particulate matter) from ending up in the surrounding area. However, when asked about the remediation of the pollution once it ends up in the region, the only focus is on the need to clean people's window frames and playgrounds, which only solves the visible pollution issue.

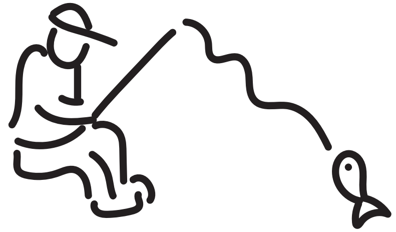
Site visit

This part of the site visit discusses some exciting insights from the people spoken with concerning the IJmond region. These include a municipal representative, employees of Tata Steel and the Tata Steel Loket, a journalist from the region, and people who have lived and worked their whole lives within the region. These interviews and interactions have not been recorded so that they can remain anonymous.

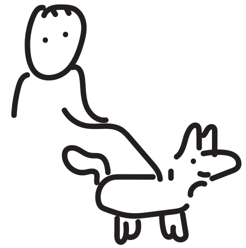


Lady at the Tata Steel Loket in Wijk aan Zee.

Mostly notices residents who wanted to be taken seriously. Lives in Velsen-Zuid and enjoys the region a lot. Organises participatory events in an effort to create more transparency.

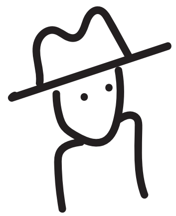


Old fisherman, his dad has worked in the steel industry, he worked in the fishing industry. Is not worried about anything except about the impact of windturbines on the amount of fish



Resident of Wijk aan Zee. Is happy with the fact that the industry keeps housing prices low. He is used to the dust and is a former employee of the steel industry. His wife experiences stress concerning the lack of information on

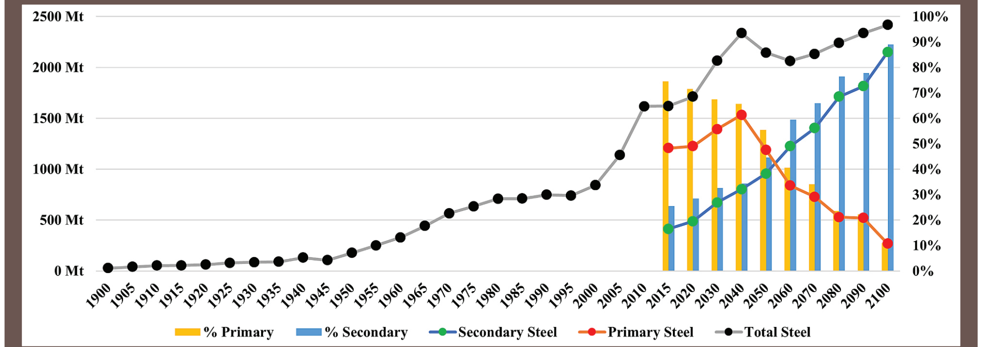
Journalist who has lived in the IJmond for a long time, reporting on the steel industry. Reflects on the fact that it is convenient to live close to Amsterdam



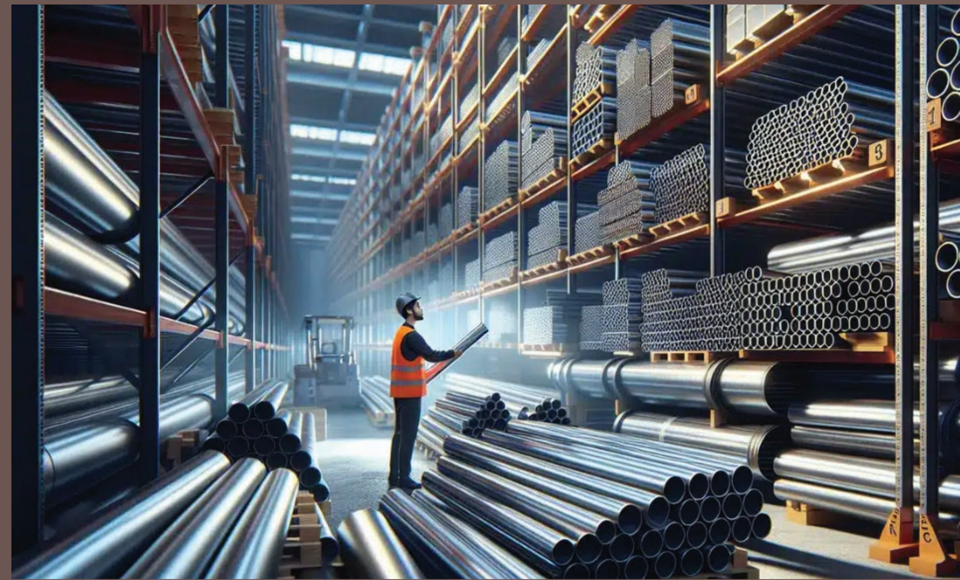
A forester not originally from the region, but acknowledges the beautiful and unique vertical dune landscape of the region.

Representative of one of the municipalities. Explains that the IJmond region is actively involved in trying to get subsidies from the central government for the green steel transition. They do not want to lose this big industry in their region, but do want a cleaner living environment.

Future developments



Expected rise in steel demand until 2100 (Wang et al., 2021)

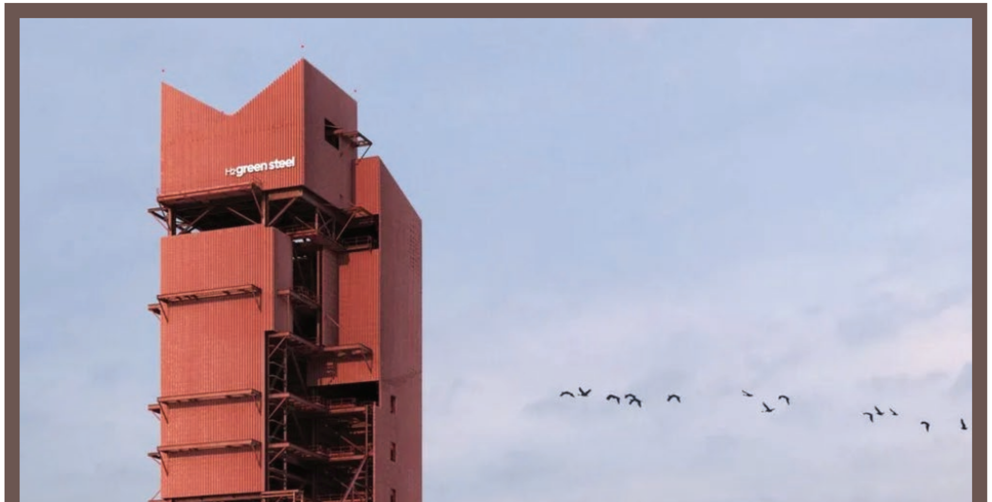


AI generated image portraying the steel industry (Federal steel supply, 2024)

Global societal trends influence the future demand for steel and, thus, the livelihood security of the steel industry. Climate change and the transition to a circular economy are two significant trends that will influence future development. While putting pressure on the steel industry to reduce their emissions significantly, the Green Deal also presents opportunities. The steel produced by the industry is essential for producing circular products such as batteries for cars, wind turbines and solar panels. Steel, a durable, strong, and flexible material that can be easily recycled, is considered one of the 'major metals' that society relies on for meeting basic human needs (Watari et al., 2020). The predictions are that until at least 2100, the steel demand will continue to rise (Lopez et al., 2022). The need for steel will persist, but the steel industry does not have the ambition to expand. An insecurity within the future of the steel industry that worries many people is the impact of the Green Steel transition on employment.

Climate change and the transition to a circular economy are not the only two trends influencing the steel industry's future. Digitalisation and automation, as well as the role of artificial intelligence in this, are other societal developments that will influence the course of the steel industry. Digitalisation and data integration can potentially manage production cycles more effectively by creating a streamlined production process and keeping track of data (Herzog, 2022). When these processes become more efficient, less of a workforce will be needed. Considering the trend of automation, human interaction will be limited to maintenance, process development and handling unexpected situations (Herzog, 2022). Artificial intelligence can play a role in optimising industrial processes in such a way that, combined with digitalisation and automation, the process of producing steel is efficient and with minimum human intervention. Employees will be needed to oversee these processes but not to carry them out.

Green Steel transition



Hydrogen storage at Tata Steel in Port Talbot, Wales (Tata Steel, n.d.)

New furnaces replacing the polluting ones (Tata Steel, n.d.)

Climate change and EU regulations are forcing the steel industry to adjust to the future. For this reason, Tata Steel has come up with the Green Steel transition. A transition to a green, clean and circular production of steel. Green Steel production entails using more recycled steel (from 17% to 30% scrap metal). Also, it aims to use alternative sources of electricity, switching from coal to gas and later to hydrogen as soon as it is sufficiently available. The clean transition of steel production is realised by drastically reducing particulate matter emissions. The raw material storage will be covered, and the furnaces will be closed by the end of 2040.

On top of this Green Steel transition, another change is happening at Tata Steel. With the pressure from the residents and the public sector to reduce environmental pollution, a Roadmap Plus has been composed that focuses on decreasing different types of pollution emitted in the region, such as dust, smell, PAK's, and sound (Tata Steel, 2023). This Roadmap aims to decrease this nuisance by 2025. Concerning dust (particulate matter and heavy metals), the adjustments made to reduce this are a one-kilometre-long windscreen preventing wind from spreading the raw materials into the towns. Furthermore, a considerable extractor hood is placed at the furnaces, ensuring that dust does not enter the environment. In due time, the furnaces will be entirely replaced, decreasing the amount of particulate matter emitted.

Spatial additions to the process of green steelmaking to the site will be:

* Wind turbines produce necessary renewable energy so the installations function accordingly. And to help in the creation of hydrogen

* An electrolysis installation is needed for the sustainable production of hydrogen on-site. This will also be powered by electricity from the wind turbines.

* Electric arc furnace: This furnace can heat the necessary elements more accurately and is powered by electricity.

* Hisarna is an installation that replaces the blast furnace and reduces the step of making cokes and pellets separately to one that is combined with the immediate production of liquid metal (Tata Steel, 2023).

References

Tata Steel Port Talbot, Wales (Mckeown, n.d.)

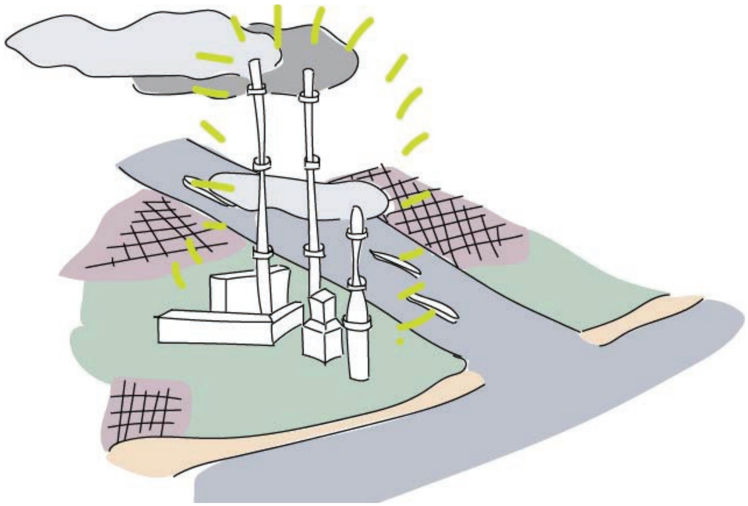
The LIBERTY steel group steel factory in Australia (Liberty steel group, n.d.)

Port Talbot, Wales, is home to another Tata Steel factory. There are many similarities between the development of the steel industry and the residents' dependence on factory employees. Nevertheless, there is also a need to reduce greenhouse gases here. Similarly to the Green Steel transition in the IJmond region, considerably reducing the CO2 emissions of Port Talbot brings up many insecurities (Duffy, 2023). One of the insecurities is the job loss. Due to the significant cut in emissions, the polluting has to close soon, whilst an alternative way for producing green steel using scrap metal and hydrogen is not yet in place. This is said to cost 3000 people their job. Whilst unions in Port Talbot call for the extended use of one of the blast furnaces, meaning fewer job losses, Tata Steel cannot do this since it would align with the sustainable regulation. The town of Port Talbot is very dependent on the steel industry as a source of employment, and the loss of as many jobs is disastrous. Big job losses due to greener steel production provide a basis for the worries of their job for the people of the IJmond region.

Liberty Steel Group in Australia is a steel industry that deals with issues similar to those in Europe. It has set its ambition for fully producing green steel in 2030. If they were to achieve this goal, it would make them the first steel industry, setting a tremendous example for the rest of the world. This ambitious goal comes after being set for a trilemma where steel production makes up 8% of the world's global CO2 emissions, steel demand goes up globally by 50%, and governments set regulations to decrease the emissions of greenhouse gasses significantly.

In order to make it to this goal, they will build electricity arc furnaces that will recycle scrap metal as a local source for steel and emit less greenhouse gasses by replacing furnaces functioning on coal. Using scrap metal as a resource for steel production reduces emissions by saving natural resources and preventing scrap from ending up in landfills (LIBERTY Steel Group, n.d.). This case differs from the one in the IJmond because it is closely located in a mining area where high-quality magnetite ore is won. This is an essential ingredient to the green iron and steel production. Regarding the situation in the IJmond, there is no magnetite to be won, which will thus have to be imported from elsewhere, delaying the large-scale transition to fully producing green steel.

Current value - industrial heritage

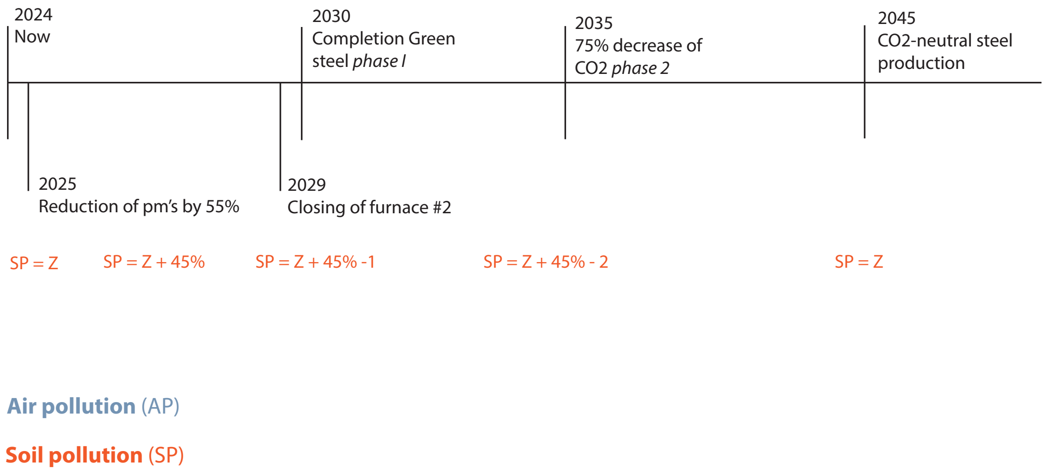


Value of the steel industry (own image, 2024)

The industry behind the dunes, iconic value (Versteeg, n.d.)

The steel industry is the primary source of conflict within the IJmond region. By producing steel, pollution is emitted within the surrounding region that jeopardises soil health and human health. On the other hand, the role of the steel industry within the region is important. People have grown up seeing the furnaces in the distance (Zembla, 2008), and families have worked here for generations. Thoughts of potential job losses cause stress. Furthermore, the existence of the industry and the pollution it emits creates a divide between residents who want the industry to remain and the rest of the Netherlands, who protest against the lack of action of the steel industry. Going to the steel industry with the idea of pollution and negativity, seeing the work being done and talking to people created another image of an unmissable element within the region. With plans being executed to reduce the spread of particulate matter and to create a future where the production of steel can be green, it becomes clear that the steel industry can remain within the region. Thus, this entails maintaining the steel industry's current value and industrial heritage. How this will help revalue the landscape will need to be found in how the future of the industry will evolve with the landscape and how it contributes to the conflict it is currently causing.

Consequence current value



Timeline that indicates the disalignment between emitted pollution and accumulated pollution within the region (own image, 2024)

Current situation (own image, 2024)

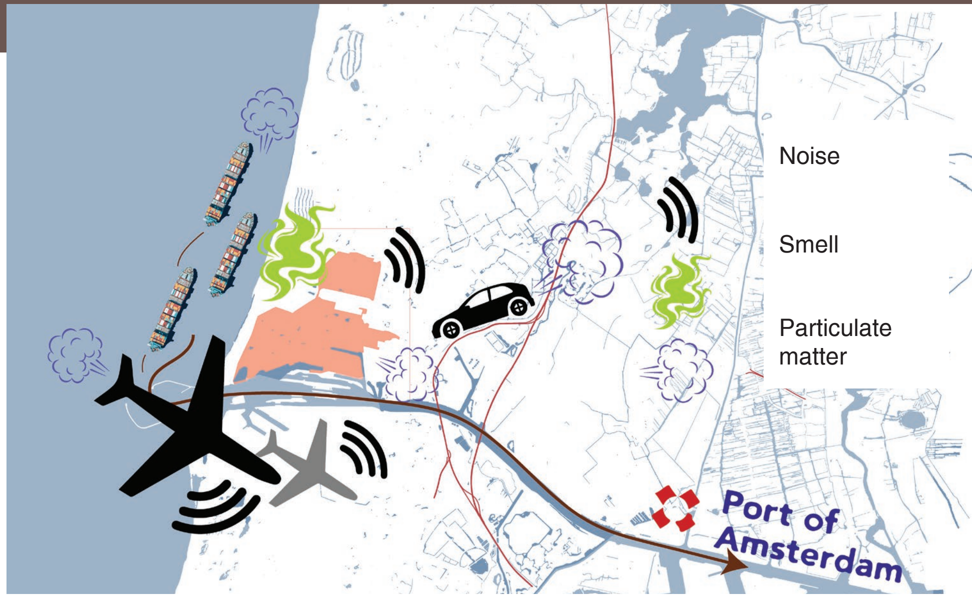
Green steel future, 2030 (own image, 2024)

Where the Green Steel transition provides a solution to the current emitted pollution, it does not take into account the damage to the region that has already been done. Over the years, heavy metals have accumulated in the soil, severely polluting it. So whilst maintaining the industrial heritage within the region is a way of preserving current value, it is also the source of conflict between the economic benefit and the region's livability. In order to remediate this conflict, a way for soil remediation is needed that will bring back the value of health within the region.

Thus, the intended value is seen as a consequence of the current value. To understand the extent of soil pollution and its effect on the territory, particulate matter within the region will be analysed. In the next chapter, ways of soil remediation will be researched to establish the intended value.

Industrial pollution

Drawings of sensitive nuisance caused by the steel industry such as smell and noise (own image, 2024)

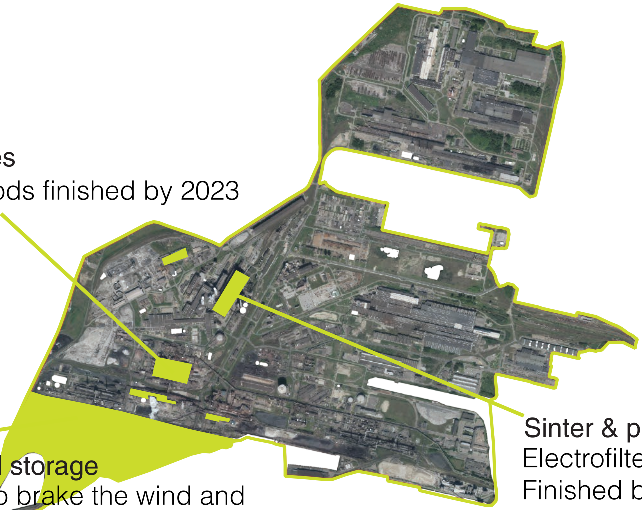


Map that shows alternative sources of pollution (own image, 2024)

Dust and particulate matter are spread through the air before it lands on the soil. The size of the dust and particulate matter influences the spread greatly. PM10 and PM2.5, with a size of respectively 10 micrometres and 2.5 micrometres, can be transported for large distances through the air before they depose on the ground. More coarse dust deposes closer to the source of its pollution. How far precisely particulate matter travels is subordinated to the wind, the direction, the speed and the amount of precipitation. Being situated along the coast, many strong winds are coming inland, increasing the spread of particulate matter. The southwest wind is the most present within this region, meaning that Wijk aan Zee and Ijmuiden are subject to the most pollution from dust and particulate matter. The type of terrain where the particulate matter is deposited also influences the local concentrations of heavy metals in the soil (RIVM, 2022).

Particulate matter consists of dust, dirt, soot smoke, liquid droplets and heavy metals dependent on its emission source (Department of Energy & Environmental Protection, 2020). Sources of the spread of particulate matter are often traffic and large industries. Within the IJmond region, the largest producer of particulate matter is the steel industry. However, other sources are boats waiting for the coast of the Netherlands until they can enter the port of Amsterdam, cars driving along the A2 highway and planes flying over on their way to or from Schiphol. A way to remediate the conflict between economy and livability might also help address these alternative sources of nuisance.

Sources of particulate matter



Steel industry site, with particulate matter producing spots (Tata Steel, n.d.)

Raw material storage (Tata Steel, n.d.)

Pellet- and Sinterfactory (Tata Steel, n.d.)

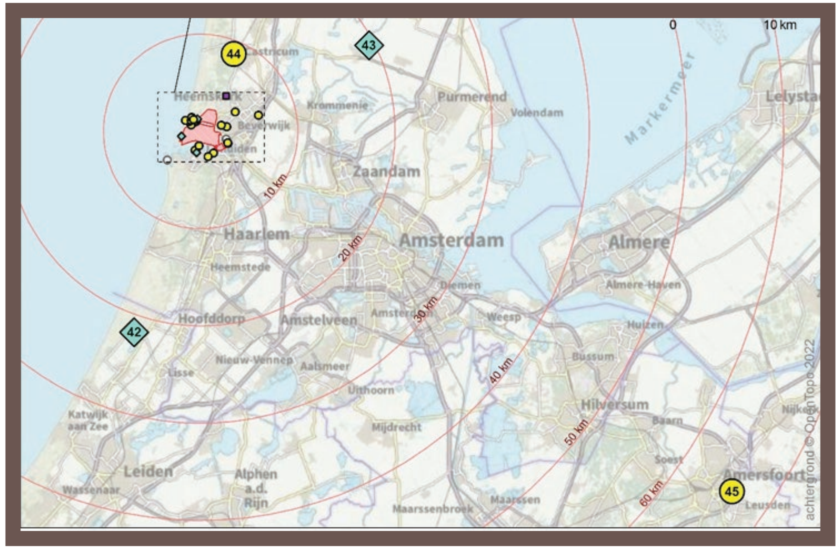
The places on the steel industry territory causing soil pollution are shown on this map. Several measures are already being taken to reduce the spread of this pollution mentioned, such as the building of a kilometre-long windshield that runs along the south-west edge of the territory (the same direction as the wind is most potent), dedusting installations near the furnaces and electro filters. These interventions help prevent more soil pollution, but since they are interventions happening only on the industry site, they do not solve any issue with the existing soil pollution.

Let's zoom in on the specific sources within the industry site that are contributing to the spread of particulate matter. The first is raw material storage, where raw materials from various parts of the world, including Australia, South America, India, and Scandinavia, are gathered and stored in large heaps. Given the factory's coastal location and strong winds, this method of storage is prone to wind dispersion. To address this, raw materials are now being sprayed with water to increase their weight, and a 1km wind screen is under construction, expected to be completed by 2024, to mitigate wind speed. The goal is to cover the raw material heaps, but due to the other adjustments to the process, this is not yet clearly planned to happen anytime soon. The windscreen thus functions as a temporary solution that does not effectively prevent particulate matter from spreading considering different wind directions.

Pellet and Sinterfactories are where the iron ore is prepared in workable chunks called pellets and sinters to later be melted to iron in the furnace. To mediate the pollution coming free during this process, the so-called largest "vacuum cleaner," an extractor installation, was installed in 2022. Furthermore, the furnaces will have extractor hoods that intercept much pollution.
The steel industry needs national subsidies to fully finance this Green Steel transition. To this end, the industry has teamed up with the municipalities of the IJmond region to appeal for a subsidy from the national government. Without this subsidy, the steel industry will not be able to finance its own transition fully and would thus have to close in 2030. The steel industry will likely receive the necessary subsidies.

Soil pollution

Map indicating the measuring spots (RIVM, 2023)



Map indicating the measuring spots (RIVM, 2023)

The report published by the RIVM in 2023 researches the deposition of heavy metals within the soil. The focus is primarily on locations close to the steel factory, but one measurement is done in Amersfoort to have control measurements. The charts on the next page show an overview of which locations exceed the legally allowed maximum concentration as established by the RIVM. These are the national norms; it is interesting to note that the EU norms are much lower than the national ones.

The measurements are taken from various places, indicated on the left. After this report was published, it became clear that many people were exposed to a variety of toxic substances within the IJmond region. The next step is gathering more information concerning pollution's effects and more insight into its scope.

To make the diagrams readable, I will show here which number corresponds to which place on the map:

26 - Wijk aan Zee

29 - Beverwijk

49 - Velsen-Noord

34 - IJmuiden Oost

35 - IJmuiden Sluizen

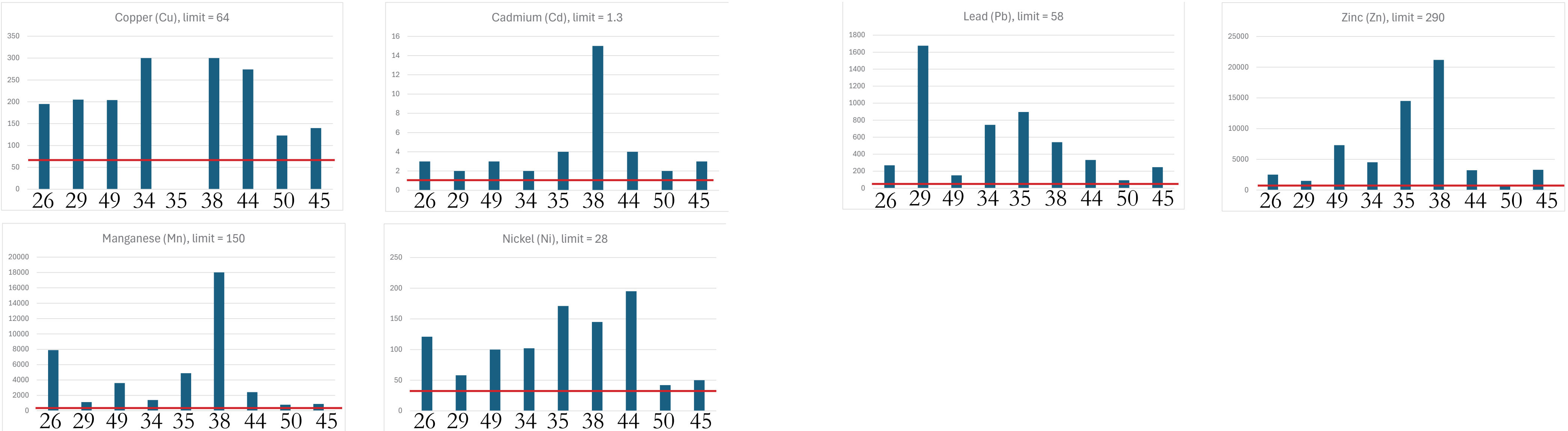
38 - Reijndersweg

44 - Castricum

50 - Heemskerk

45 – Amersfoort

Soil pollution



Heavy metal concentrations on different locations within the IJmond region and their corresponding maximum concentration in red adapted from RIVM (2023) (own image, 2024)

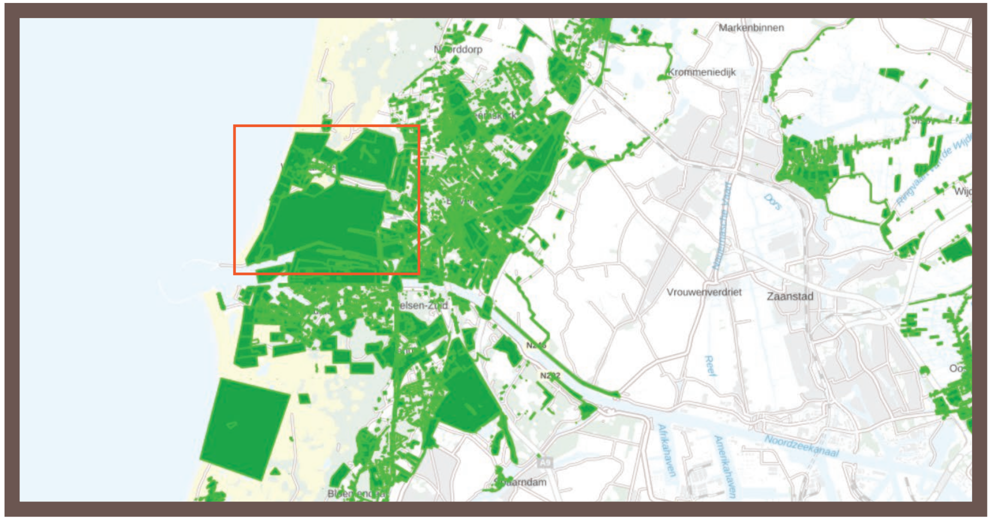
This is a selection of heavy metals in the soil that exceed the legal limit. The legal limit of the corresponding heavy metal is shown in red. What becomes clear is that limits are exceeded by a lot, indicating that the soil is polluted. While most soil pollution stems from the steel industry, other sources of particulate matter, such as cars and planes, also contribute to the accumulation of heavy metals in the soil.

What is also interesting to observe is that Amersfoort (45), the zero measurement, always contains more heavy metals than the limit, but together with Heemskerk (50), it always remains quite close to the limit.

A few outliers are often found along the Reijndersweg (38) and Beverwijk (29). Reijnderweg is a road running between the coast and the Tata Steel factory, where no one lives, and thus, it does not directly impact people’s health. Beverwijk, on the other hand, is a busy residential area where people are constantly exposed to this kind of soil pollution.

The effects of this increased concentration of pollution in the soil will be discussed later.

Polluted territory



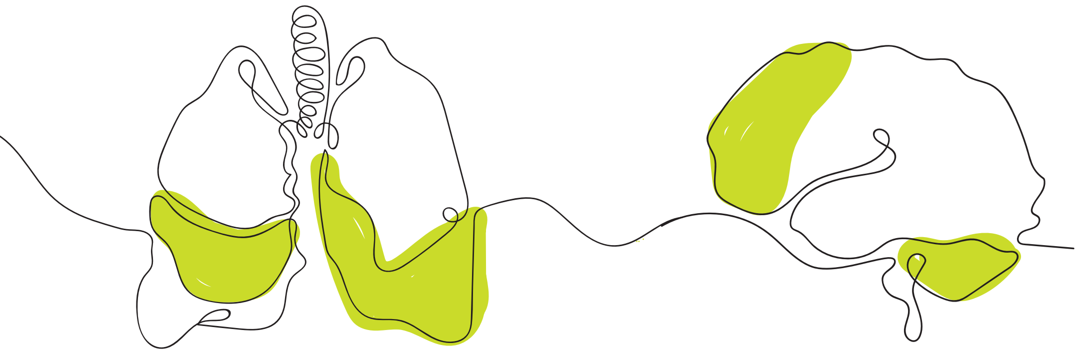
General pollution measurement map IJmond region over the years (Nazca Solutions, n.d.)

This map shows the measurement areas within the region to check for different types of pollution within the IJmond region at different points in time. It becomes clear that the pollution is greatest close to the steel industry, and this map thus provides a basis for the scope of the remediation strategy later. This map also shows considerably more pollution in the south than in the north, which can be explained by the dominant wind direction.

General pollution zone (own image, 2024)

The second map presents the focus territory for this research. Based on the biggest necessity of soil remediation and the area of influence of the three main municipalities of Heemskerk, Beverwijk and Velsen. The three yellow circles indicate the intensity of the spread of pollution. The closest circle to the steel industry accumulates the most pollution and the third circle accumulates less pollution over the years. The middle circle is where the RIVM measurement was being done.

Health effects



Drawings that indicate the health effects caused by the heavy metals within the soil (own image, 2024).

Heavy metals are commonly found in the natural environment, and the human body needs them in small amounts to maintain good health. However, too large quantities can be toxic and endanger human health. "Heavy metal toxicity can lower energy levels and damage the functioning of the brain, lungs, kidney, liver, blood composition and other important organs." (Jaishankar et al., 2014, p. 245).

In contrast to air pollution, which is released in the air through big clouds of smoke that settle on windowsills in heaps of dust, soil pollution is more difficult to observe. The soil functions as a universal sink, the last stage of the cycle of pollution where pollution accumulates. When left untreated, soil pollution directly and indirectly affects human health.

There are three direct ways in which human interaction with contaminated soil affects human health: inhalation, eating, and skin contact. Inhalation happens when people are working with the soil. When particulate matter is disturbed, it floats around again and could be absorbed by the body, often affecting the respiratory tract.

Eating refers to the accidental ingestion of soil, for example, by not washing vegetables well, not washing hands after working with the soil, or small children eating soil whilst playing outdoors.

Skin contact with soil pollution can be toxic to human health only considering certain types of toxins such as arsenic which is not the the case within the IJmond region.

On the other hand, indirect contact with contaminated soil is also possible, which can jeopardise human health. This lies within food security and the uptake and accumulation of toxic substances within plants used for consumption or livestock ingesting these contaminated plants. Heavy metals can be a concern within food crops since the plant can take up excessive amounts of metals and concentrate them in the edible parts of the plant. This often happens on private agricultural lands, making it more difficult to foresee the problem's true scale and potentially apply large-scale remediation.

The people most impacted by soil pollution are children and the elderly. Children are affected because they use their hands a lot while playing with the soil, and the elderly are affected because they have a weakened immune system due to old age (European Environment Agency, 2022).

This next section discusses the impact of long-term exposure to the following heavy metals. Note that the type of interaction with the soil will largely influence the potential effect of the heavy metal. Also, high concentrations within the soil and the interaction with the soil increase the risk of these diseases, but it does not mean that you will definitely get them.

Cadmium (Cd) causes kidney damage, bone disease, increased risk of lung cancer and difficulty with reproduction.

Chromium (Cr) causes an increased risk of lung cancer and is a human carcinogen, also increasing the risk of cancer.

Copper (Cu) causes liver and kidney damage after long exposure, gastrointestinal issues such as vomiting and constipation, and other intestinal problems after short exposure.

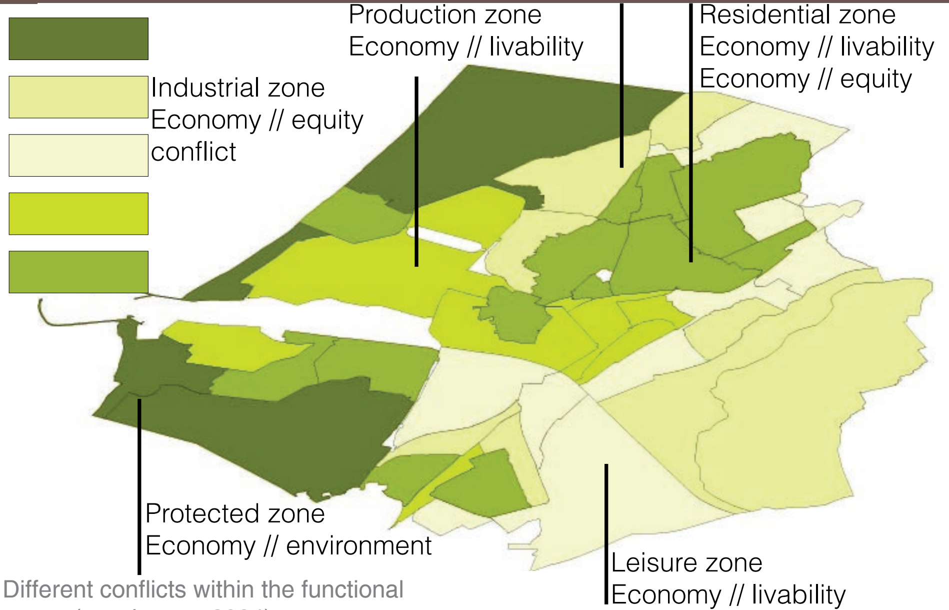
Lead (Pb) causes nervous system problems, development delays in children, reduced IQ, anaemia and behavioural disorders.

Nickel (Ni) causes an increased risk of lung cancer.

Zinc (Zn) affects the body's copper and iron metabolism, which is needed for respiration.

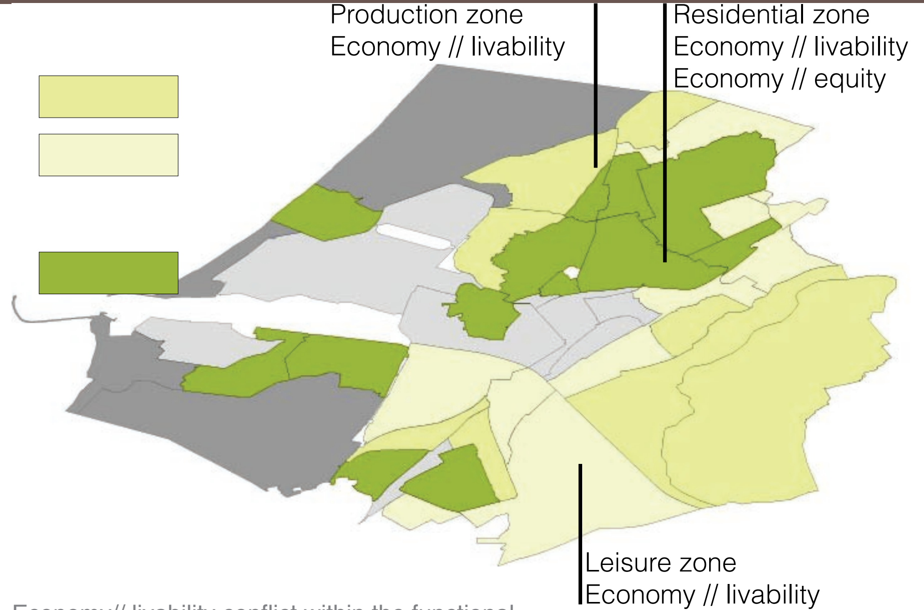
Manganese (Mn) has a neurological impact and is linked to higher chances of Parkinsons' disease.

Spatial conflict



Different conflicts within the functional zones (own image, 2024)

In order to create a focus on where the intended value of healthy soil that jeopardises livability is primarily present, the value conflicts have been spatialised. Looking back at the previously established functional zones, it shows that within the protected zones, the conflict is mainly between the economy, industrial pollution, the environment, and the soil health that influences the natural landscape. The industrial zone, not regarding the steel industries territory, is subject to the conflict between economy and equity. Doing work and the focus of the public sector in supporting other industries are overshadowed by the worries for the steel industry. The production zone is subject to a conflict between economy and livability. The soil pollution poses a risk to the agricultural function of the land, with the possibility of being absorbed by the produce grown on the land. If this is the case, there is the risk of an indirect influence on human health through heavy metals. Furthermore, there is much direct interaction with the soil in this zone, increasing health risks for people working there. This zone thus needs soil remediation, considering the economy and livability conflict.
The leisure zone is also subject to economic and livability conflicts. Although people do not spend as much time here, this landscape has much open space for people to recreate. This means there is a lot of interaction with the soil, during walks



Economy// livability conflict within the functional zones (own image, 2024)

in the park, kids playing in the forest or during a game of golf. Limiting these activities would influence the experienced livability of the users of this space. Lastly, there is the residential zone, which is subject to a conflict between economy and livability and between economy and equity. People spend a lot of time here, and this zone's population is most dense. Their use of the space could potentially be limited by soil pollution. When working in the garden, or letting kids play in the playgrounds or other mundane everyday activities, become something to be aware of pollution. On top of this, when construction work is near, dust might spread the pollution in the air again.

All in all, this means that the priority of remediation of soil pollution will be on the residential, leisure and production zones to remediate the conflict between the economy and livability effectively. Techniques used within these zones might also apply to other zones; this will be discussed in the next chapter.

04. INTENDED VALUE

The consequence of the presence of the current value in the IJmond region is polluted soil. From this stems the intended value, which is to return healthy soil to the IJmond region through remediation. This chapter looks at the different ways that can be used to remediate the soil and get rid of the unhealthy effects of heavy metals within it. The chapter will end with an indication of which type of remediation is most suitable for the large-scale remediation of the conflict between economy and livability.

Dunes with the steel industry in the back (own image, 2024)

Types of remediation

Remediation	Sub-category	Subsub-category	Origins
No spatial intervention			
	Regulations		
	Adjusted interaction with the space		
	Adjusted time spent in the space	0-1 hour	
		1-4 hours	
		4-8 hours	
	Creating awareness		
		Through information	
		Through art	
Cover up			
	Natural		
		soil	River bed
			Import
			x
		water	
		compost	
	Artificial	Non-permeable	Concrete slab
			Steel
			Waste material
		Permeable	Cloth
Excavate			
	Temporary (Ex situ)		
		Remediate in a different place	
		Soil washing	
	permanent		
		Leave empty	
		Replace with clean soil	
		Replace with water	
Bioremediation	(in situ)		
	Phyto remediation	(See separate table)	
	Mycoremediation		
	Bacterioremediation		

Table that displays the different types of remediation identified. There are four main categories that can all be subdivided.

Four main categories of soil remediation have been established for this research. As can be seen in the table, they all have different ways of coping with pollution. This influences the time it takes for remediation and how thoroughly the pollution is removed from the region.

These four categories can be subdivided and provide multiple ways of remediating the soil. A functional zone can often be more affiliated with a specific type of remediation. However, it is essential to make decisions regarding the actual implementation of the remediation and when to use which remediation technique will be discussed later.

The main technique for the large-scale remediation of the IJmond region will be phytoremediation, a technique that uses plants to extract pollutants from the soil. The other remediation techniques are discussed as well since they can still be used in combination with phytoremediation

Regulate

Signs that indicate prohibited acces (own image, 2024)

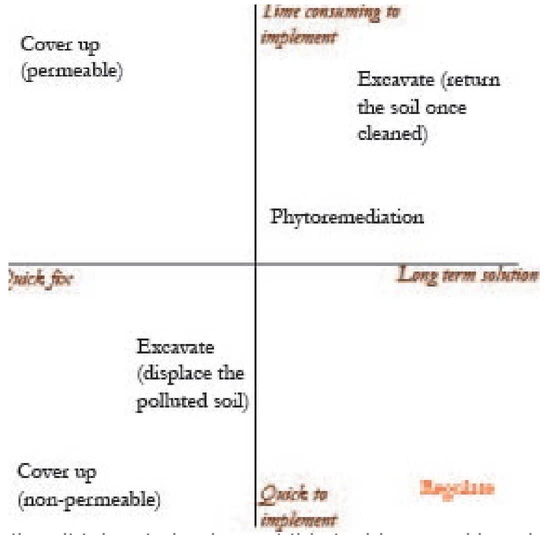


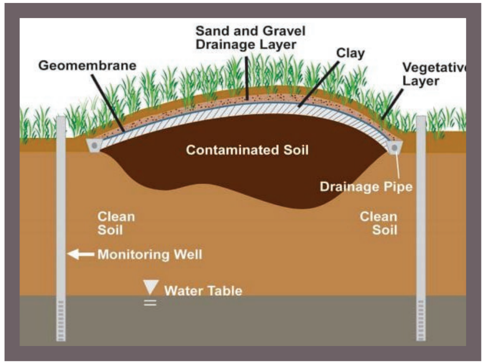
Diagram showing the time it takes to implement this techique and how long the remediation will last, focussed on 'regulate' (own image, 2024)

The first option, no spatial intervention, suggests ways of dealing with soil pollution and creating a healthy co-existence. This does not mediate the problem. In these places, spatial remediation is often impossible, for example, because it is a protected natural area like Natura2000. The goal of this option is to change the way people interact with the soil. This can be done by creating top-down regulations that limit space users. Furthermore, the interaction with a space can be adjusted by advising a time limit for spending within a particular area or suggesting alternative activities. Lastly, providing information on the risk of entering a polluted area helps create awareness. Awareness can also be created using artworks that draw attention and allude to pollution. Awareness helps people make a conscious decision about whether to use a space or not. While regulating space provides a long-term solution for handling soil pollution, and it can be easily and quickly implemented, it does not remediate the soil. Within the IJmond region, this way of regulating space is already done within the protected zone. However, the main goal here is to protect nature rather than human health. It does have the same result, though.

Remediation	Sub-category	Subsub-category
No spatial intervention		
	Regulations	
	Adjusted interaction with the space	
	Adjusted time spent in the space	0-1 hour
		1-4 hours
		4-8 hours
	Creating awareness	
		Through information
		Through art

Table that shows the types of remediation by not spatially intervening.

Cover-up



Technical overview of how to cover polluted soil (EPA, 2012)

Westergasfabriek in Amsterdam (Agile city, 2017)

Another technique to deal with soil pollution is to cover the polluted soil. This can be done in different ways that vary in the time needed to cover up the polluted soil and the length of time that it will be effective. The Westergasfabriek, a polluted terrain in Amsterdam, has chosen to cover the polluted soil with large concrete tiles; in this way, direct contact with the soil is prohibited, and there is no interaction between the soil and the people. If the use of the space were to change, though, and the tiles were removed, another way of dealing with the pollution would need to be found. Covering up in a non-permeable way is thus a temporary way to remedy soil pollution.

Considering a permeable way of remediating soil pollution, a way can be found to store the polluted soil in the place where it was but to cover it in a way that allows for a change of use of space. As shown in the illustration, a way of growing plants can be found within this remediation technique. A disadvantage of this is that it heightens the soil considerably.

Both variations of covering up the soil provide a way of handling soil pollution that does not remove it, so they are classified as quick fixes. Considering the non-permeable cover-up, this is also really quick to implement. The permeable cover-up takes longer to implement but is more effective for different uses.

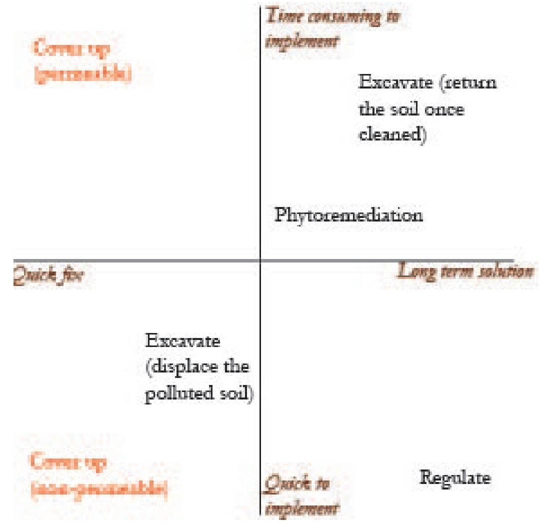


Diagram showing the time it takes to implement this techique and how long the remediation will last, focussed on 'cover-up (permeable) & cover-up (non-permeable)' (own image, 2024)

Remediation	Sub-category	Subsub-category	Origins
Cover up			
	Natural		
		soil	River bed
			Import
			x
		water	
		compost	
	Artificial	Non-permeable	Concrete slab
			Steel
			Waste material
		Permeable	Cloth

Table that shows the types of remediation by covering up the polluted soil

Excavate

Freshkills park on top of a landfill (NYC parks, n.d.)

One way of remediation that really removes polluted soil from the territory is to excavate it. The amount of pollution in the soil will determine the depth of excavation. What happens to the removed soil also answers the question of whether the issue of soil pollution is not just displaced.

On the one hand, excavated soil can be temporarily displaced, cleaned through soil washing or phytoremediation, and returned to its original site. Another option is to dump polluted soil somewhere else and leave a hole in the ground, creating a significant height difference, or replace it with healthy soil. Removing soil and replacing it with water could solve the rising sea levels of the Netherlands.

Removing the soil to treat it and returning it to its original place is a comprehensive but time-intensive method for remediation. It takes a long time to be effective, and it takes a lot of effort to implement. Displacement of polluted soil, with the primary goal of removing pollution from the site, is much quicker, but it leaves much empty space and is not ethically responsible.

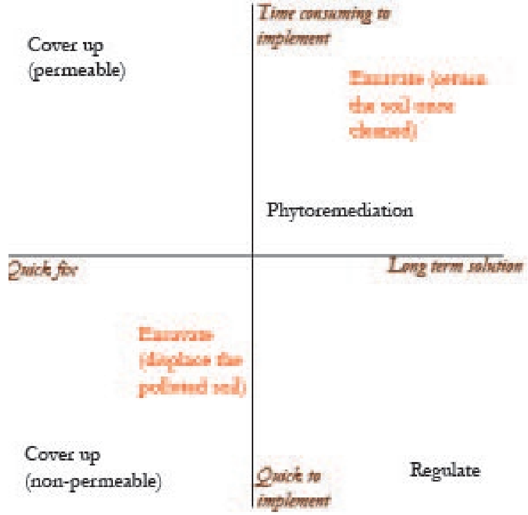


Diagram showing the time it takes to implement this techique and how long the remediation will last, focussed on 'Excavate (return the soil once cleaned) & Excavate (displace the polluted soil' (own image, 2024)

Remediation	Sub-category	Subsub-category	Origins
Excavate			
	Temporary (Ex situ)		
		Remediate in a different place	
		Soil washing	
	permanent		
		Leave empty	
		Replace with clean soil	

Table that shows the types of remediation by excavating the polluted soil

Bioremediation

De Ceuvel Amsterdam (Superbass, n.d.)

The last technique of remediation is called bioremediation. This is a technique of removing pollution from the soil through organisms. This remediation is conducted on the polluted site and can be done with different organisms, such as plants, fungi or bacteria. These techniques are called phytoremediation, mycoremediation, and bacterioremediation. The advantage of this natural remediation technique is that after an initial investment of time and material, introducing either plants, fungi or bacteria to the polluted soil, the organisms remediate the soil. Bioremediation does take a long time, though; a 1-meter deep layer of soil can take up to a decade for a significant [pollution decline] effect to be noticed (Grotenhuis et al., 2015). Whilst this is moderately time-consuming to implement, it is easy to maintain and provides long-term soil remediation without any negative externalities. It does take a long time to make a significant difference in the concentration of soil pollution and, thus, is not suitable to combine with all different types of uses within the different functional zones.

Phytoremediation is the technique that uses plants to extract pollutants from the soil. This will be the focus of the large-scale remediation of the IJmond region within the rest of this research.

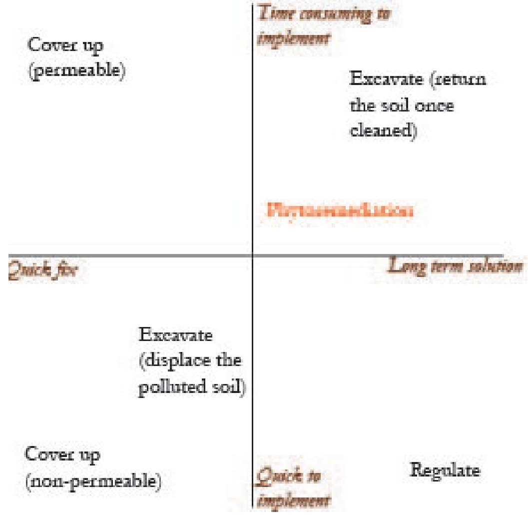
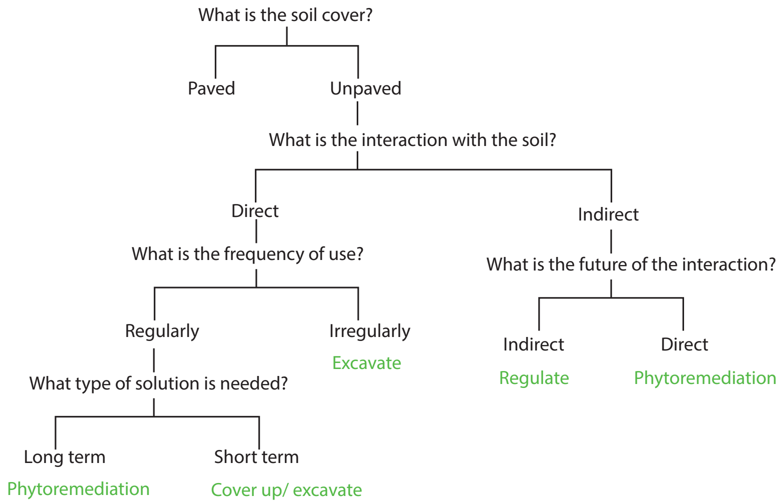


Diagram showing the time it takes to implement this techique and how long the remediation will last, focussed on 'phytoremediation' (own image, 2024)

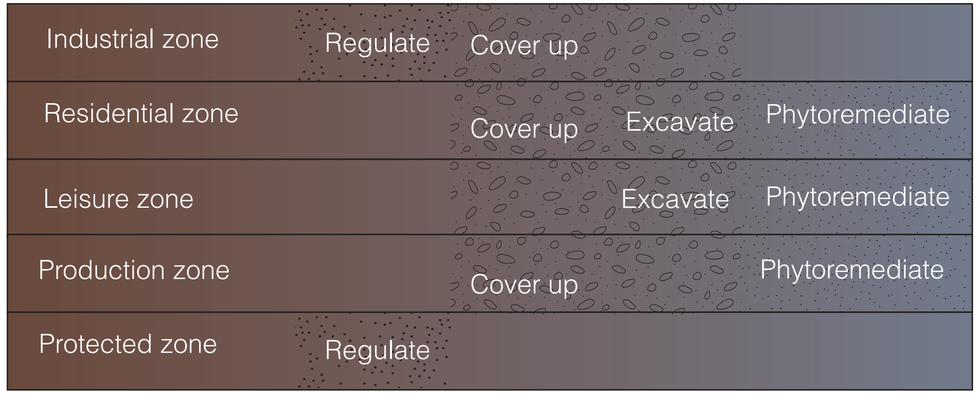
Remediation	Sub-category	Subsub-category	Origins
Bioremediation	(in situ)		
	Phyto remediation	(See separate table)	
	Mycoremediation		
	Bacterioremediation		

Table that shows the types of remediation that classify as bioremediation of the polluted soil

Decision tree



Contaminated site being phytoremediated (Dan, 2020)



Functional zone and what type of remediation (own image, 2024)

A decision tree that takes into account all important factors necessary to make an educated decision about what type of remediation fits what functional zone has been made. It not only takes into account the different characteristics of the functional zone but also the different characteristics of the types of remediation.

Direct contact can be problematic if it stirs up dust, if children get it on their hands and ingest it or if there is direct skin contact with toxic pollutants. This could happen during activities like gardening, playing in a playground, sports, or preparing a building site.

Regular and irregular use refers to the frequency of use. If it is a daily activity, it indicates regular use and the need for a quick but thorough remediation. If it's irregular use, it indicates a less pressing need for remediation. Considering the future use of space, potential housing, or more interaction with the soil helps in deciding whether to have thorough or less thorough remediation.

It is good to know that although this decision tree provides an overall indication of the type of remediation most suitable, the results might differ on a smaller scale. It is also good to be aware that this is based on the primary use of a functional zone; it might be possible that the best type of remediation is a combination of multiple remediation types.

The type of remediation for functional zone can also be a combination.

The industrial zone is in need of a quick fix, and there is not a lot of interaction between user of the space and the soil. That makes this an ideal zone for covering-up the soil pollution or regulating the use of space.

The residential zone is one that is in need of thorough remediation, this can be done by phytoremediation, but to make the use of phytoremdation more flexible it can be combined with covering up, or excavating.

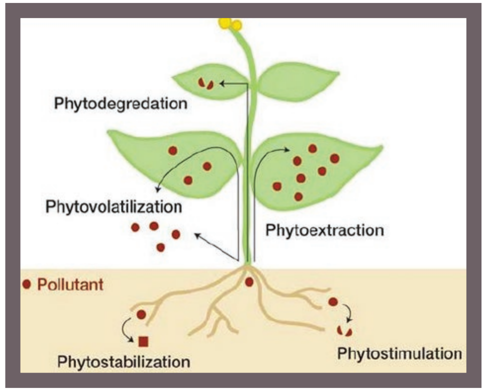
The leisure zone is a space with potentially a lot of interacting between the soil and the the users of a space. That is why the soil pollution really needs to be removed from the site either through phytoremediation or excavating.

The production zone, and the agricultural use of a space is also in need of a thorough remediation since food is grown on the soil. That is why phytoremediation provides a fitting remediation. On the other hand, considering green houses, and preventing interaction with the soil, cover-up would provide a quicker solution.

Lastly there is the protected zone, since this is space is regulated on an EU level, the only way to remediate is to influence the length and the type of interaction users have with this space.

Workings of phytoremediation

Contaminated site being phytoremediated (Dan, 2020)



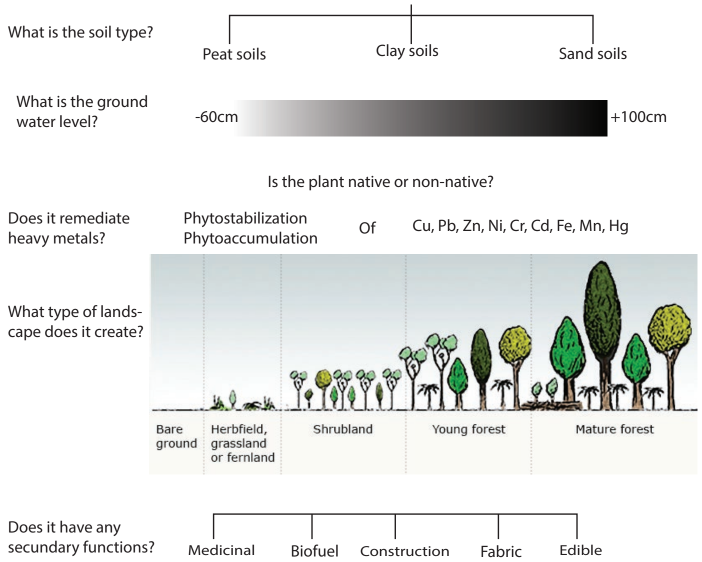
Different ways of phytoremediation through plants (Rigoletto et al., 2020)

Phytoremediation is the name given to nature-based technologies that use plants and microorganisms to remove or break down toxic environmental contaminants. One of its main uses is remediating soil pollution due to heavy metals (Grotenhuis et al., 2022). Phytoremediation is a fairly new technique that is not being used on the large scale much as of yet.
The way in which phytoremediation works, the process of extracting heavy metals from the soil, is that the plant absorbs pollution within its tissue. Depending on where the plant accumulates the heavy metals, the plant can later be used for other functions such as food, making of fabric or timber. There are different types of ways in which the plants handle the pollution. Plants that do not have a logical secondary use can always be used for biofuel; how then to get rid of the heavy metal pollution in its tissue will be discussed later.

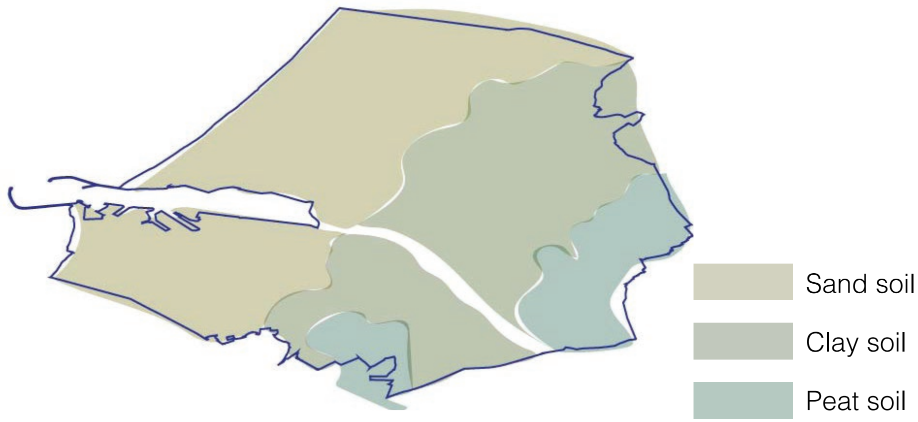
Photodegradation is when the plant breaks down the contaminant into less harmful substances. Phytoextraction is when the plant accumulates pollutants within its parts above ground. Phytovolatilization is when the pollutant is extracted from the soil and released into the air (again). Phyto stabilisation is when the plant does not absorb the pollutant itself but stabilises it within the soil to keep it from spreading. Moreover, lastly, Phyto stimulation/ rhizodegradation is when soil organisms break down the pollutants.

For this research only phytoextraction, phytostabilisation and phytostimulation are relevant in effectively remediating heavy metal soil pollution. This depends on the type of plants used within the IJmond region's large-scale remediation. Phytovolatilisation would not be convenient since the goal is to subtract the pollutants from the system, and photodegradation breaks down elements, whilst heavy metals are often already in their elemental status (Kennen et al., 2015).

Phytoremediating decision tree



Phytoremediation decision tree (own image, 2024)



Map that shows the three main soil types of the IJmond region (own image, 2024)

The use of phytoremediation depends heavily on the site's spatial characteristics. Similarly, a plant's characteristics also contribute to its suitability for a space. So, many decisions on plant types and the intended landscape must be made when planning large-scale soil remediation through phytoremediation.

It is important to know the answers to a few important questions in order to determine what type of plants fit where within the large-scale remediation of the IJmond region. To assist in the decision-making process, a phytoremediation decision tree has been compiled. This chapter also discusses the different characteristics of the plants that grow on the different soil types of the IJmond region.

These questions are based on previous research on Dutch soils and their corresponding plants and literature focussed on phytoremediation, such as the book "Phyto" by Kate Kennen and Niall Kirkwood (2015). Websites such as bodemdata.nl and ahn.nl are essential for retrieving information about the region's soil characteristics. Lastly, the open-source database on phytoremediation by van Waijjen et al. (2022) provides a list of native phytoremediation plants together with the specifics on which heavy metals they remediate have contributed significantly to providing an educated insight into which plants are ideal to use.

The role of succession is a very important element within the phytoremediation decision tree. Succession refers to an ecological process of groups of plants that replace each other over time. The early stage of succession often consists of pioneer plants, also known as weeds, that grow easily on nutrient-deprived or, in this case, polluted soils. As the soil becomes more nutrient-rich, the biodiversity of the plants changes towards an end stage of often trees (depending on the soil) that could persist in a location if not disturbed. spontaneous succession is an unavoidable part of long-term phytoremediation. In these long-term phytoremediation projects, it is important to monitor and manage them to ensure that succession will not disturb the effect of soil remediation (Chen et al., 2019).

When designing the large-scale implementation of phytoremediation within the IJmond region, it is important to consider the different types of landscapes created by the different plants. Different soils will start with similar landscapes consisting of pioneer plants and low shrubs, but they will develop differently. Some parts will end up in 10 or 20 years as a more forest landscape, whilst the lower-lying area within the IJmond region is more prone to developing a wetland landscape.

Phytoremediating plant list

Wild poppy - Escholzia

- remediates Copper

Sunflower - Helianthus annuus

- remediates Cadmium, Zinc, Nickel

Plant images (Grotenhuis et al., 2015)

The next pages will discuss the different phytoremediation plants identified that grow on the soil of the IJmond region. They are discussed per soil type in the three main stages of succession.

For every plant, its common name, Latin name, which heavy metal it absorbs, secondary function, type of vegetation, and measurements are listed.

In addition to the benefits phytoremediation plants provide, plants also have an array of general benefits that contribute to mediating the conflict of livability within the IJmond region.

This page shows some general phytoremediation plants that grow in most places and effectively accumulate soil pollution. These plants could be ideal within the residential zones or less clearly defined functional zones.

An excel sheet of what the characteristics are of different Dutch phytoremediation plants is added in the appendix Ab.

Thistle - Carduus pycnocephalus

- remediates Cadmium, Chromium, Copper, Nickel, Lead and Zinc

Marigold - Tagetes patula

- remediates Cadmium

Pollard willow - Salix

- remediates Cadmium and Zinc

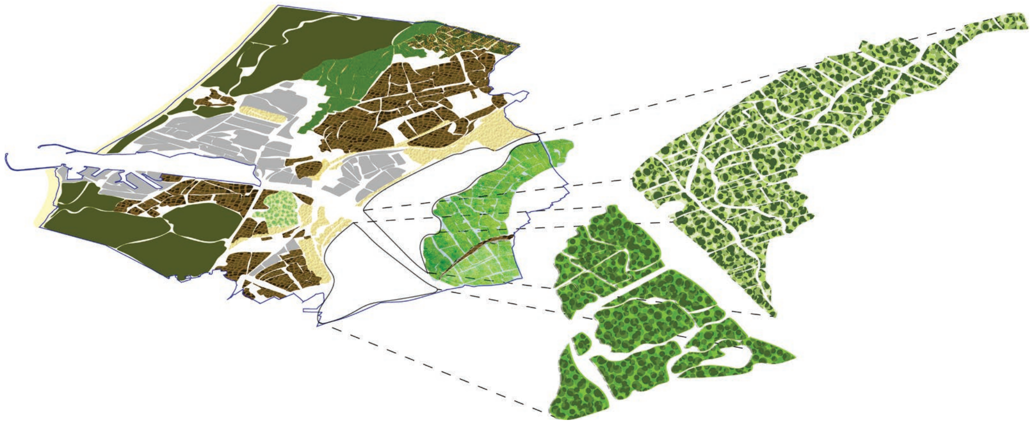
Poplar - Populus

- remediates Cadmium and Zinc

Holm oak - Quercus ilex

- remediates Cadmium

Phytoremediation clay soil



Remediation map and focus area of clay soil (own image, 2024)

Clay soil landscape as it looks in the IJmond region (Google, n.d.)

There is clay soil in the middle of the IJmond region territory, split in two by the North Sea canal. This dry clay landscape knows three stages of succession referred to:

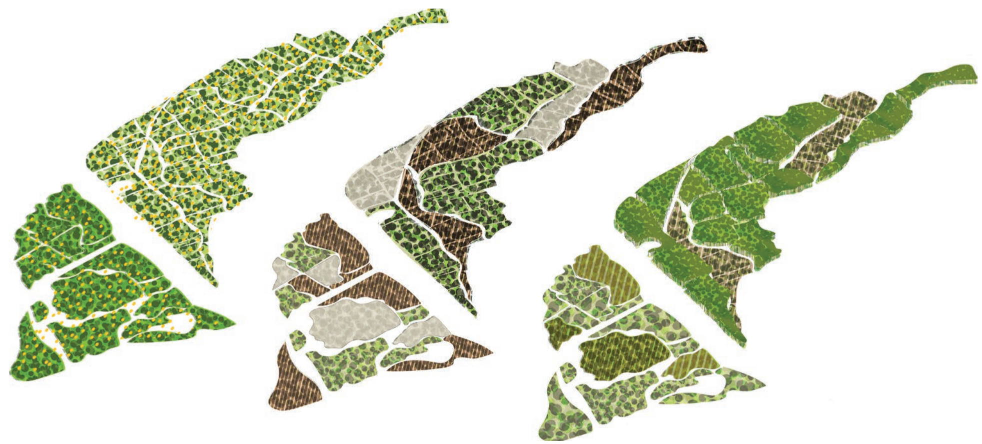
-Dry clay pasture

-Dry clay roughs

-Dry ash-elm forest

The main characteristic of this type of landscape is that it is often a landscape close to the sea or the river (this is where the clay initially comes from). In its early pasture stage, it often has a flowery outlook, attracting many insects, small mammals and birds. If left untreated, the clay pasture develops into roughs, a landscape that attracts many birds and consists of shrubs. It is a vibrant and nutritious landscape. The dry ash-elm forest consists of many trees but often has a well-developed undergrowth important for biodiversity. Many of these forests are planted and often combined with poplar, a tree that is a hyperaccumulator of heavy metals. The development of such a forest takes 20 years (Jansen, 2023).

The image shows the current look of this dry clay landscape.



Pioneering stage Intermediate stage Climax stage

Succession of plants on clay soil (own image, 2024)

Dry clay pasture

Plant images (Grotenhuis et al., 2015)

Rumex acetosa - Common sorrel

-Remediates Copper (Cu), Cadmium (Cd)

-Secondary function: Medicinal qualities

-Vegetation type: herbaceous

-60 cm in height

Arrhenatherum elatius - False oat grass

-Remediates heavy metals

-Secondary function: medicinal qualities

-Vegetation type: Weed

-50 to 150 cm in height

Taraxacum officinale - Dandelion

-Remediates Zinc (Zn)

-Secondary functions: can be used for consumption

-Vegetation type: Weed

-10 to 60 cm in height

Impression of dry clay pastrue landscape (Jansen, 2023)

This impression of a dry clay pasture is along the river IJssel in Gelderland. It characterises a pioneering landscape with a lot of wild flowers blooming in spring. The main secondary function of these plants is their potential medicinal use.

Dry clay roughs

Urtica dioica - Stinging nettle

-Remediates Zinc (Zn), Lead (Pb) and Cadmium (Cd).

-Secondary function: can be used for consumption

-Vegetation type: Weed

-30 to 250cm in height

Galium aparine - Cleavers

-Remediates Cadmium (Cd).

-Secondary function: can be used for (medical) consumption

-Vegetation type: Weed

-30 to 120cm in height

Tanacetum vulgare - Common tansy

-Remediates Lead (Pb).

Vegetation type: Weed

-80cm in height

Plant images (Grotenhuis et al., 2015)

Impression of dry clay roughs landscape (Jansen, 2023)

Phragmites australis - Reed

-Remediates Lead (Pb), Zinc (Zn), Copper (Cu)

-Secondary function: bioenergy

-Vegetation type: herbaceous

-90 to 150 cm in height

These dry clay roughs are slightly more developed than dry clay pasture, forming a landscape that has bushes and some higher plants growing. An example of this landscape can be found in Grevelingen in Zeeland, like the image above.

Dry ash elm forest

Populus - poplar

-Remediates Copper (Cu), Cadmium (Cd), Zinc (Zn)

-Vegetation type: tree

-15 to 20m in height

Fraxinus excelsior - common ash

-Prevents heavy metal spread

-Secundary function: can be used as timber

-Vegetation type: tree

-25 to 30 m in height

Salix - willow

-Remediates Cadmium (Cd), Zinc (Zn), Copper (Cu)

-Secundary function: traditional furniture making

-Vegetation type: tree

-12 to 15 m in height

Plant images (Grotenhuis et al., 2015)

Impression of a dry ash elm forest landscape (Jansen, 2023)

The Oranjewoud in Friesland is an example of a dry ash elm forest. Here a variety of trees grow, that are all very suitable for their use of timber. To develop a forest like this, takes time though. In the low vegetation the previous mentioned plants grow.

Phytoremediation peat soil

Remediation map and focus area of peat soil (own image, 2024)

Peat soil landscape as it looks in the IJmond region (Google, n.d.)

On the right side of the territory, there is peat soil; this landscape is also referred to as the dried-out peat landscape and knows three different stages of development:

-Peat meadow

-Peat roughs

-Ash-alder forest

This landscape is characterised by most of its nutrient-rich topsoil being removed for former agricultural purposes. The soil is kept as wet as possible because there is a considerable risk of settling the peat soil further. The first stage of this landscape consists of many colourful flowers that attract butterflies, small mammals and birds. In order to maintain this landscape, it is often grazed with sheep. The roughs have many tall flowering plants, insects, and birds that eat seeds. Roughs become nutrient-rich by themselves, but the soil must be kept wet. Ash-alder forests attract many birds. In this case, planting trees helps speed up the process of succession (Lu et al., 2018)

The image shows the current look of the dried-out peat landscape.

Pioneering stage

Intermediate stage

Climax stage

Succession of plants on peat soil (own image, 2024)

Peat meadow

Peat meadow landscape (Jansen, 2023)

Rumex acetosa - Common sorrel

-Remediates Copper (Cu), Cadmium (Cd)

-Secondary function: Medicinal qualities

-Vegetation type: herbaceous

-60cm in height

Ranunculus acris - Meadow buttercup

-Remediates Iron (Fe), Manganese (Mn), Zinc (Zn)

-Vegetation type: herbaceous

-30-70 cm in height

Trifolium pratense- Red clover

-Remediates Copper (Cu), Manganese (Mn), Nickel (Ni), Chromium (Cr), Lead (Pb)

-Secondary function: medicinal qualities

-Vegetation type: herbaceous

-20-80 cm in height

Plant images (Grotenhuis et al., 2015)

Prunella vulgaris - Selfheal

-Remediates Cadmium (Cd), Zinc (Zn)

-Secondary function: medicinal qualities

-Vegetation type: herbaceous

-5 cm in height

The peat meadow is a very colourful landscape, with many low-growing, blooming plants. An example of this landscape is the Ronde Hoep in Amstelveen.

Peat roughs

Glechoma hederacea - Ground ivy

-Aborbs particulate matter

-Secondary function: Medicinal qualities

-Vegetation type: herbaceous

-30 to 50cm in height

Chelidonium majus - Greater celandine

-Remediates Mercury (Hg), Chromium (Cr)

-Secondary function: Medicinal qualities

-Vegetation type: herbaceous

-30 to 120 cm in height

Anthriscus sylvestris - Cow parsley

-Remediates Cadmium (Cd)

-Secondary function: medicinal qualities

-Vegetation type: herbaceous

-60 to 170 cm in height

Plant images (Grotenhuis et al., 2015)

An example of the peat roughs are the weerribben in Giethoorn. This landscape is characterised by its spikey grasses and small flowering plants.

Peat roughs landscape example (Jansen, 2023)

Juncus effusus - Soft rush

-Remediates Copper (Cu)

-Secondary function: prevent erosion

-Vegetation type: grass

-20 to 100cm in height

Geranium robertianum - Herb Robert

-Remediates Nickel (Ni), Zinc (Zn)

-Secondary function: medicinal qualities

-Vegetation type: herbaceous

-20 cm in height

Ash alder forest

Alnus glutinosa - Common alder

-phytostabilizes the soil

-Secondary function: used as timber

-Vegetation type: tree

-28m in height

Salix aurita- Eared willow

-Remediates Chromium (Cr), Cadmium (Cd), Zinc (Zn), Copper (Cu), Lead (Pb), Nickel (Ni)

-Secondary function: furniture production

-Vegetation type: tree

-3m in height

Ficaria verna - Lesser celandine

-Remediates Mercury (Hg), Chromium (Cr)

-Secondary function: medicinal qualities

-Vegetation type: herbaceous

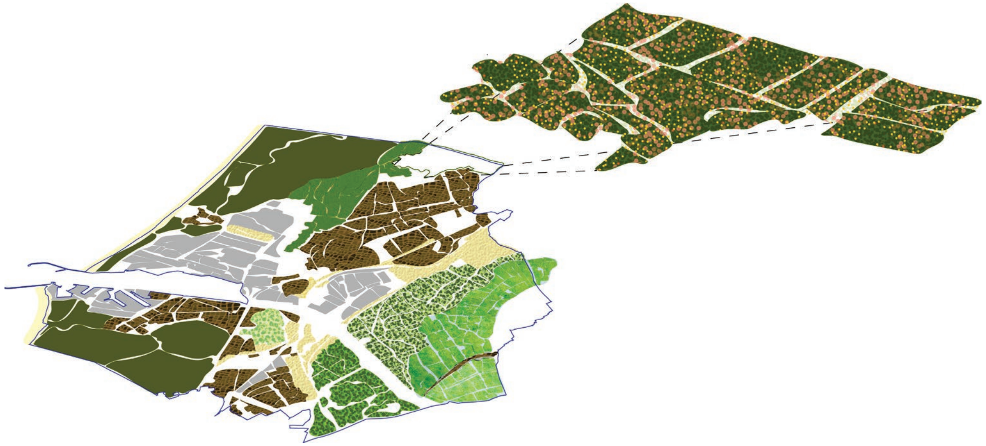
-25cm in height

Plant images (Grotenhuis et al., 2015)

Ash alder landscape landscape example (Jansen, 2023)

The ash alder forest is a forest characterized by its close presence of water. High trees, with an undergrowth of previously mentioned plants. An example of this landscape is the Polder Twiske in the Zaanstreek.

Phytoremediation sand soil



Remediation map and focus area of sand soil (own image, 2024)

Sand soil landscape as it looks in the IJmond region (Google, n.d.)

At the top of the IJmond region territory, close to Castricum, is a patch of dry renatured landscape; this has the potential to develop into the following stages:

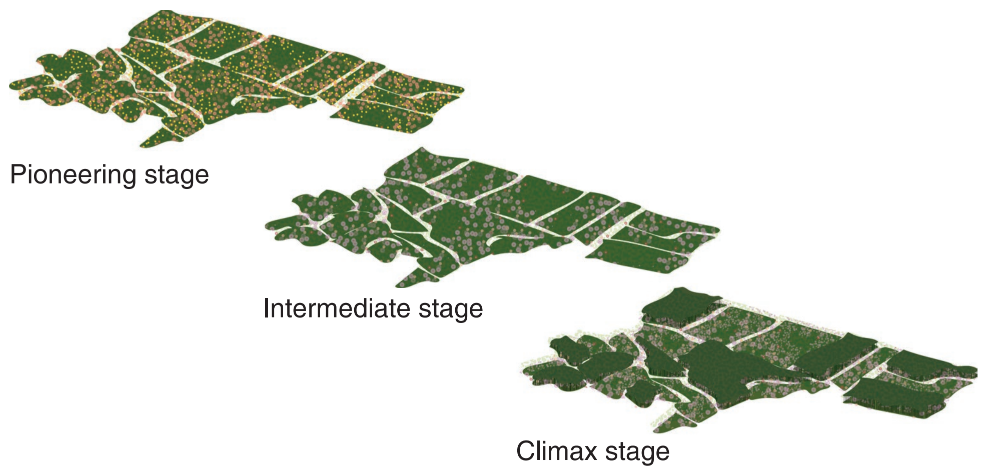
-Flowery arable land

-Dry grass and heathland

-Dry oak-birch forest

This soil has a shallow nutrient level and an arid soil. The first stage of this landscape is often a pretty barren sight. Flowery fields on the poor sandy soils are rare, but flowers like poppies and cornflowers grow there. Plants that return vital nutrients to the soil are essential in this pioneering stage of the flowery arable land. The heathland attracts a unique array of biodiversity, reptiles like the adder and special birds like the stonechat. Heather is one of the main features of this stage. The development of a forest is dependent on good maintenance and reforestation. However, once a forest is there, it attracts larger mammals like deer and roe deer (Lu et al., 2018).

The image below shows the current outlook on this landscape.



Succession of plants on sand soil (own image, 2024)

Flowery arable land

Agrostemma githago - Corn cockle

-Remediates lead (Pb)

-Secondary function: medicinal qualities

-Vegetation type: herbaceous

-30 to 60 cm in height

Matricaria discoidea- Chamomille

-Remediates Cadmium (Cd), Lead (Pb), Nickel (Ni)

-Secondary function: medicinal qualities

-Vegetation type: herbaceous

-30 to 50 cm in height

Viola tricolor - Heartsease

-Remediates Zinc (Zn), Lead (Pb), Cadmium (Cd), Copper (Cu)

-Secondary function: medicinal qualities

-Vegetation type: herbaceous

-25 cm in height

Plant images (Grotenhuis et al., 2015)

Flowery arable landscape example (Jansen, 2023)

The flowery arable land is a very colourful landscape characterised by the amount of flowers growing. This landscape is most beautiful in spring like this example of the Reestdal in Drenthe.

Dry grass and heatland

Ulex europaeus - Gorse

-Remediates lead (Pb)

-Vegetation type: shrub

-1 to 3 m in height

Empetrum nigrum- Crowberry

-Remediates Zinc (Zn), Copper (Cu)

-Secondary function: edible berries

-Vegetation type: shrub

-25 cm in height

Festuca ovina - Fine-leaved sheep's

fescue

-Remediates Cadmium (Cd)

-Vegetation type: grass

-60-120 cm in height

Plant images (Grotenhuis et al., 2015)

Dry grass and heatland landscape example (Jansen, 2023)

Cytisus scoparius - Scotch broom

-Remediates heavy metals

-Secondary function: medicinal qualities

-Vegetation type: herbaceous

-1 to 3 m in height

The dry grass and heatland landscape is characterised by its heath that blooms mostly in autumn, creating a colourfull image. An exampe of this landscape is the Dwingelderveld in Drenthe.

Dry oak-birch forest

Pteridium - Bracken/ fern

-Remediates Cadmium (Cd), Copper (Cu), Lead (Pb)

-Vegetation type: shrub

-60 to 120 cm in height

Maianthemum bifolium - May lily

-Remediates Lead (Pb), Zinc (Zn), Iron (Fe), Cadmium (Cd)

-Secondary function: medicinal qualities-Vegetation type: herbaceous

-5 to 20 cm in height

Quercus - Oak

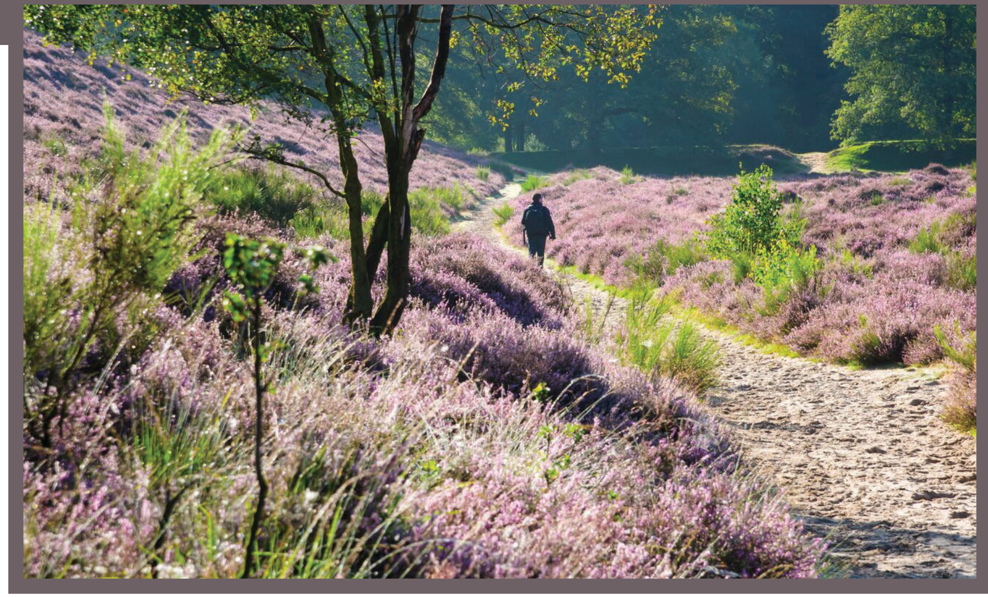
-Remediates Copper (Cu), Zinc (Zn), Cadmium (Cd), Lead (Pb)

-Secondary function: used as timber

-Vegetation type: tree

-15 to 22 m in height

Plant images (Grotenhuis et al., 2015)



Dry oak-birch forest landscape example (Jansen, 2023)

Betula pendula - Silver birch

-Remediates Cadmium (Cd), Zinc (Zn), heavy metals

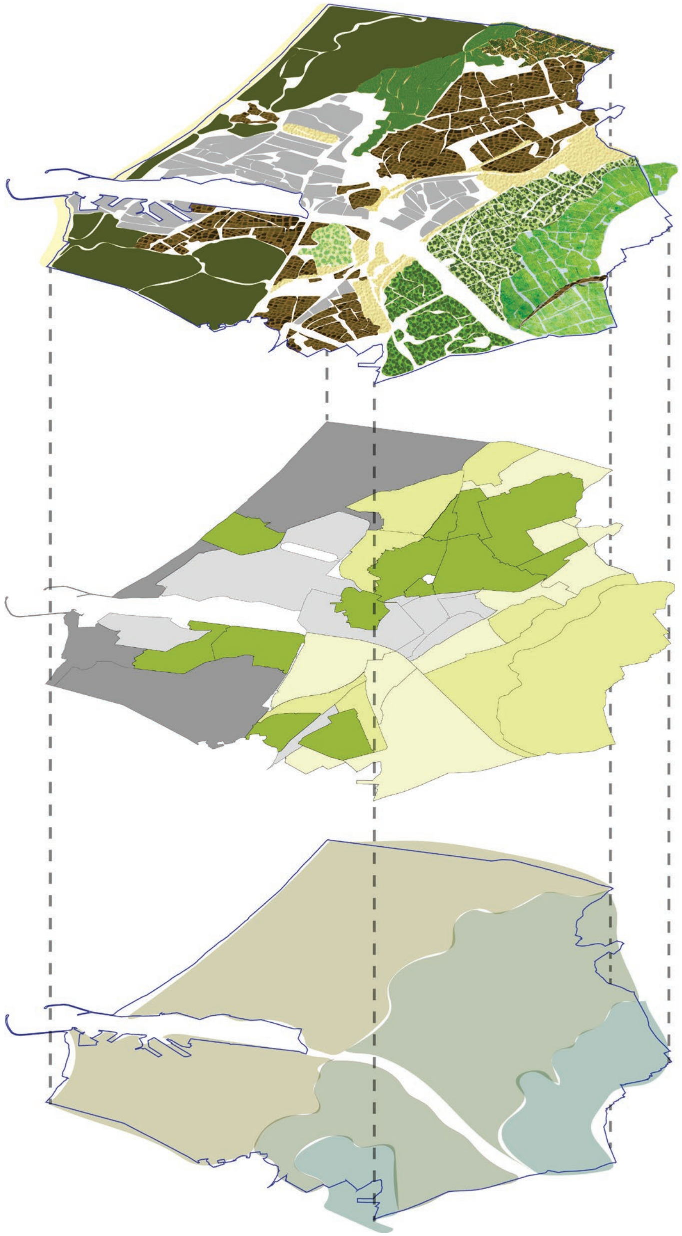
-Secondary function: used as timber

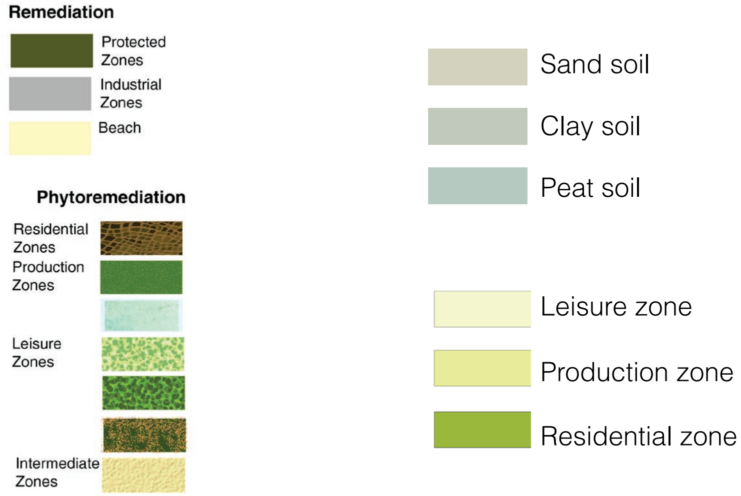
-Vegetation type: tree

-12 m in height

The dry oak birch forest is a very fertile landscape, characterised by the presense of heath and bracken. An example of this landscape is the Veluwe in Gelderland.

Intended value: healthy soil



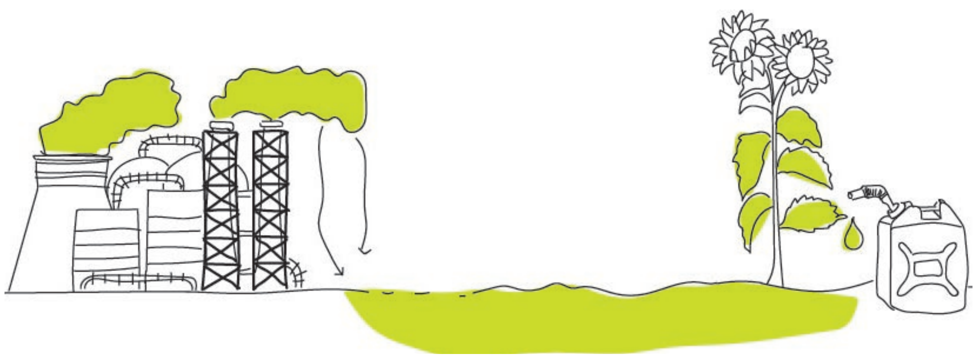


Full remediation map with the different types of landscape, based on the division of the functional zones and the three main different soil types (own image, 2024)

This image shows the factors that influence what type of remediation happens where. The soil type influences what type of plants fit well within the functional zone. The functional zone gives a general idea of the type of remediation used within an area. Some functions such as the protected zone are highly regulated and cannot be remediated in any other way. The residential zone needs a more context specific way of remediation that takes into account ownership and daily use. Layering the functional zone and the soil type over each other creates a remediation map that shows the different approaches of remediation per area.

The protected zone (blue) gets regulated. The industrial zone is mostly paved, and what is not will be mostly covered. The residential zone will be phytoremediated, excavated and covered depending on the specific use within the zone. The production zone will be phytoremediated, since this needs healthy soil to produce healthy food. And the leisure zones will also mostly be phytoremediated.

Disposing of the polluted plants



Circle of phytoremediation (own image, 2024)

To entirely remove pollution from the IJmond region, the plants must be harvested and given a second use. This can be either a functional use, such as timber, fabric, or food, or they can be used as biomass to create biofuel. This last option is open to all plants. In this way, pollution is either permanently stored in reusable products or heavy metals can be mined in the process of turning it into biomass.

Their secondary use was limited in the early days of phytoremediation, which mainly included pioneer plants. This is because secondary uses, such as consumption or medicinal use, often do not mix well with the fact that the plants are heavily contaminated with heavy metals. This leaves the option of biofuel for most of the pioneer plants.

One of the difficulties with biofuel production is that in the process of turning biomass into biofuel, the remaining ashes are still heavily contaminated with heavy metals (Grotenhuis et al., 2015). While the process works similarly to making biofuel from non-phytoremediation plants, the disposal of its ashes needs to be altered. However, using the ashes to mine its metals can be done through phytomining. Since this is a complex task and plants only contain small concentrations of heavy metals, many plants are needed to make it economically feasible (Grotenhuis et al., 2015). One way of creating an economically feasible way of doing this is the concentration of biomass to biofuel and ashes to heavy metals in one place within the Netherlands where everything accumulates. This could, for example, be a company like Shell, which is already looking for ways to transition to more sustainable fuel production and has much money to invest in research and development for phytomining. Another promising company within the biofuel field is Neste, a Finish company situated on the Maasvlakte in Rotterdam (European et al. platform, 2015). Phytomining provides a very interesting way of creating a circular loop with waste (Edgar et al., 2021). Metals that could be used again since they are non-renewable resources.

In the later stages of phytoremediation, more options for reusing plants will become available. This is due to a couple of reasons. First, the process of phytoremediation has been going on for a while, decreasing the concentration of heavy metal in the soil. This is considering that the plants are maintained well and are not hyperaccumulators.

Secondly, once the type of plants evolves over time along the range of succession, more trees will be introduced to the ecosystem. These trees can eventually be used for timber production, which in turn can be used for local projects.

Other types of contaminated plant reuse can be explored, such as biobased design, where plants could be used for insulation material or as facade material, fabric or even food production as time progresses and pollution declines (Grotenhuis et al., 2015). What becomes clear, at least, is that different plants have different characteristics and thus have different secondary uses. Plants with specific secondary uses will be mentioned in the coming pages. Added to this is, of course, the consideration of what type of phytoremediation plant it is; if it accumulates pollution, the place of accumulation within the plant is relevant to the potential secondary use of it.

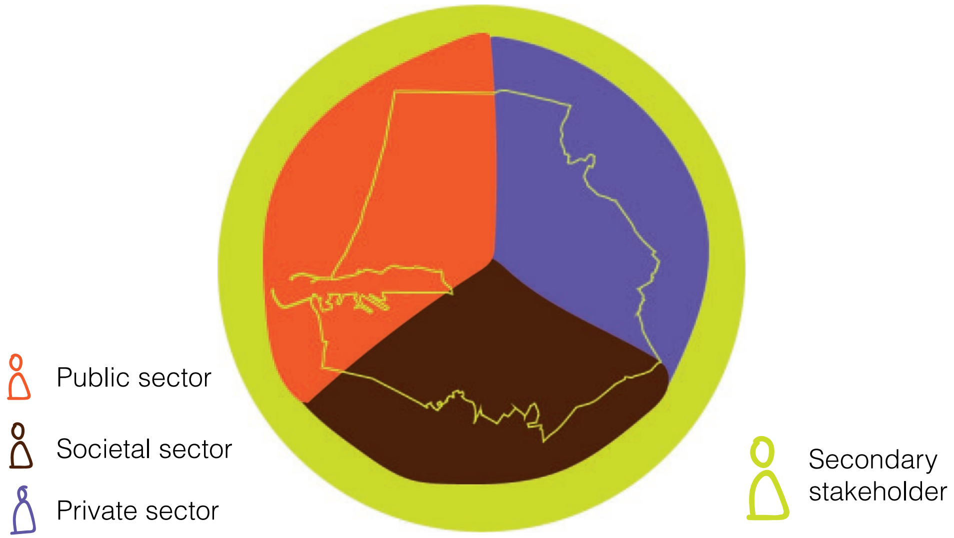
In conclusion, the secondary use of a phytoremediation plant is essential because to close the loop and extract the pollution from the site to create a healthy living environment; the plants must also be removed from the territory. If this were not done, the natural plant cycle would continue, where dead plants compost upon the soil for new plants to use. In the end, this only returns pollution to the soil again.

05. PROCESS VALUE

After establishing the current value of industrial heritage and the intended value of healthy soil through phytoremediation, it is important to establish who is needed to turn this into a successful process. As previously determined, governance is essential in successfully remediating the spatial conflict between economy and livability. To establish this process value, an extensive stakeholder analysis will focus on key stakeholders' different roles and relations. One of the primary outcomes is a need for more inclusivity within decision-making.

View on the steel industry from IJmuiden (own image, 2024)

Stakeholder analysis



Stakeholder division within the region, displaying the public, private and societal sector and secondary stakeholders. (own image, 2024)

In order to get an idea of the stakeholders impacted by the soil pollution or important for the soil remediation a stakeholder analysis is conducted. These stakeholders have different spheres of influence and will be divided according to whether they belong to the public, private, or societal sector. The public sector entails governmental institutions that have decision-making power. These can also be institutions outside of Europe whose decisions influence what happens on the scale of the IJmond region. The private sector entails businesses and related stakeholders who yield many financial resources and are focused on economic growth. The societal sector entails different groups of people within society; these can be individuals or organised groups of individuals.
While primary stakeholders are directly involved, it's important to recognize the significant influence of the secondary stakeholders. This group, though not directly engaged, plays a crucial role in the decision-making process for soil remediation in the IJmond region. Their indirect power is a key factor that cannot be overlooked in our efforts.

The stakeholder analysis is enriched by a variety of input sources. These include reports from the EU, the State, the province, and the municipalities, as well as media such as the documentary “Het gif van Corus” (The Poison of Corus)(Zembla, 2008), the documentary “STAAL” (Steel) (Human, 2023), and news media like NOS, NRC, and NU. These sources provide valuable insights into the diverse attitudes of different groups towards soil pollution and the presence of the steel industry. Your contributions to this analysis are instrumental in shaping our understanding of the stakeholder landscape.

In order to really pinpoint the process value, it is important to understand the discrepancies between the necessities for large-soil remediation and the implementation of phytoremediation, as seen in the previous chapter, and the current stakeholders involved within the decision-making processes. The power interest matrix and the resource breakdown will provide valuable insights into this.

Public sector stakeholders

Public Stakeholders (and their health significant other)	Problem perception	Interest	Goal
UN/ WHO	Soil degredation not in line with WHO regulations jeopardising residents' health	Member states complying with their standards	Creating healthy soil, to ensure human health
EU/ EEA	Soil degredation not in line with EEA regulations jeopardising residents' health	Member state complying with their standards	Creating a healthy soil for human health and biodiversity
The State/ OVV	Concerned with the potential effect of this pollution on the rest of the Netherlands	Creating healthy soils to ensure residents' health and space for future use	Restoring soil health, and making The Netherlands future proof
Province North-Holland / RIVM	Soil degradation jeopardising human health	Creating healthy soils to ensure residents' health	Restoring soil health, and ensuring residents' safety
Omgevingsdienst (OGD), Noordzee-kanaalgebied and IJmond	Lacking enforcement of soil pollution levels	Creating healthy soils to ensure residents' health	Complying with environmental rules and regulations
Municipalities Beverwijk, Velsen, Heemskerk	Soil pollution, declining human health and institutional trust	Creating healthy soils to ensure residents' health	Restoring trust and remediating soil pollution
Village council (Wijk aan Zee)	Residents health and living environment is jeopardised through pollution	Creating a healthy living environment	Finding a fitting solution balancing the industry and a healthy environment
PWN (national park Kennemerland)	Biodiversity loss through soil pollution	Creating healthy soils to ensure nature's health	Remediating pollution to restore biodiversity and create more green spaces
Waterboard	Soil pollution polluting ground water and other water bodies	Taking care of the water health and co-existing with water	Using remediation as a way of making the Netherlands furture proof for water

Public sector stakeholder table discussing their problem perception, interest and goals.

The public sector stakeholders are a diverse group that ranges from the global scale (UN/ WHO) to the European scale (EU), the national scale (the State), the regional scale (the province) and the local scale (the municipalities). The range of influence differs, creating a problem perception that is very much in line with each other and with the general regulations set and agreements made. The PWN and the waterboard are two critical stakeholders that address more an aspect of the region, such as the involvement with nature (the dune landscape and the Natura2000) and the water (such as the North Sea Canal, the groundwater level and the rising sea levels and its consequences).

Private sector stakeholders

Private Stakeholders	Problem perception	Interest	Goal
Tata Steel	Bad publicity and insecurities concerning their existence in the Netherlands	Continuing their work as long as possible	Seize causing soil pollution, mending their reputation
Fishing industry	Less fish, due to a windpark on sea to provide energy for the Green Steel transition	Maintaining their normal way of work.	Co-deciding on the future of Tata Steel, to ensure their best interest.
Agricultural businesses	Bad quality produce because of the high levels of toxins in the soil	Maintaining their usual way of living by selling their produce	Remediating the soil to ensure healthy produce again.
Small local businesses	Less clients and employees if people do not want to live in the IJmond anymore	Creating a healthy environment again	Re-establishing healthy soil to attract customers and employees
Unions (Starfish group)	That the needs and the wants of the employees get overlooked due to the focus on pollution	Continue securing employees rights	Remediate the soil quickly and efficiently to be able to focus on the employees again afterwards.
Investors	Limited space for housing developments because of polluted soil	Valuable development of land for houses	Earning money with the housing developments in the IJmond

Private sector stakeholder table discussing their problem perception, interest and goals.

The private sector stakeholders address the main businesses of the IJmond region. Apart from the steel industry, these are the fishing and agricultural industries. The size of the business influences their problem perception. Small businesses, for example, are impacted more directly by the negative consequences of the steel industry than the fishing industry. On the other hand, the agricultural industry's produce is threatened by soil pollution. Unions are essential private stakeholders that represent the stakes of the employees and provide some counterbalance to the business mindset of the steel industry. Investors are currently not involved within the region but are essential for large-scale soil remediation.

Societal sector stakeholders

Societal Stakeholders	**Problem perception**	**Interest**	**Goal**
Residents: Elderly	Paradox between health of their relatives and a loyal employer for years, fear of change	Regaining a balance between health and the industry	A clean environment to live for their family
Residents: Young families	Worried for the health of their children getting into contact with polluted soil	Clean soil so they can let their children play without worrying.	Remediating the soil for their children
Residents: Home owners	Less value for their houses because the soil pollution is bad for human health.	Making their houses worth money again.	Remediating the soil
Residents: Recently moved	Ending up in a situation that they were not expecting that is bad for their health	Being able to live in their new town carefree	Remediating the soil
Employees	Potentially losing their job because Tata Steel has to take measures	Maintaining their job, or making sure they earn money	Making sure that Tata Steel can stay open and at full capacity.
Residents' organisations	Lack of transparency by Tata Steel on how they are going to secure human health again.	Returning a healthy living environment but also maintaing the status quo	Ensuring health and work for the residents of the IJmond

Societal sector stakeholder table discussing their problem perception, interest and goals.

The societal sector stakeholders address the different groups of residents with different attitudes towards the steel industry and the soil pollution caused. This means that the group of residents have been split up into the elderly, who are prone to health issues caused by pollution; young families, who are raising kids that are also prone to health issues caused by pollution; home owners, whose house value declines due to the decline of the land value and residents who recently moved to the region and were not prepared for the scale of pollution. Employees provide a counterbalance that profits from the steel industry but also has to suffer its consequences. Residents ' organisations are a way in which residents can put more pressure on the private and the public sector.

Secondary stakeholders

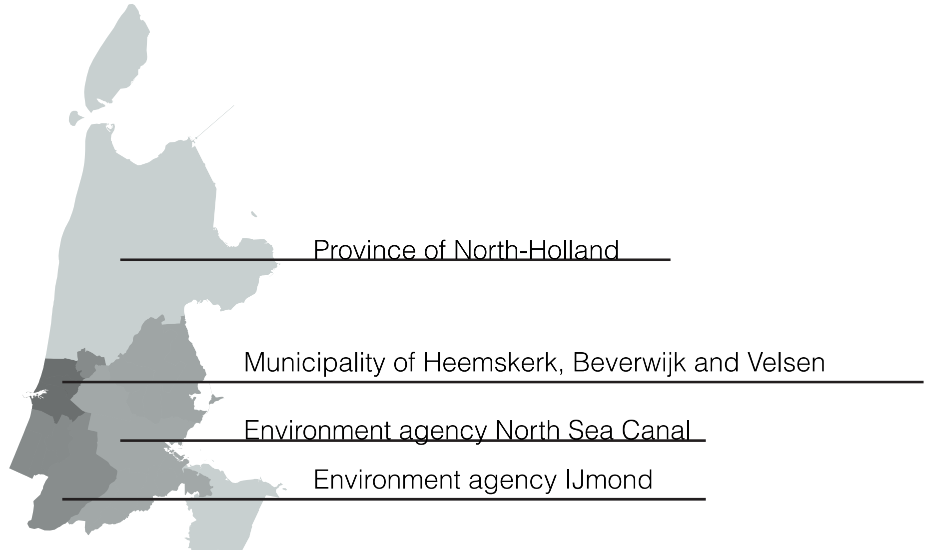
Secondary Stakeholders	Problem perception	Interest	Goal
Schools	Difficulty in preventing interaction with the soil for kids	Potential educational topic on the context of their living environment	Educting children on the importance of soil health and ways of remediation
Activists/ Greenpeace	The health of the Dutch population and the biodiversity is on the line	Ensuring a healthy environment for biodiversity and humans	Remediate the soil and close the steel industry
Tourists	Risk of the town becoming the nieuwe Katwijk aan Zee if the soil is remediated.	Cheap holiday stay in a not too crowded place	Keeping things the way they are, cheap stay in a not too busy town
Academics/ experts	Acknowledging the conflict between the economy and livability	Mediating this conflict	Mediating this conflict
Media	Tata Steel is polluting the Netherlands without repercussions	Getting interesting stories and providing an incentive to take action	Showing people the objective truth of the IJmond region

Secondary stakeholder table discussing their problem perception, interest and goals.

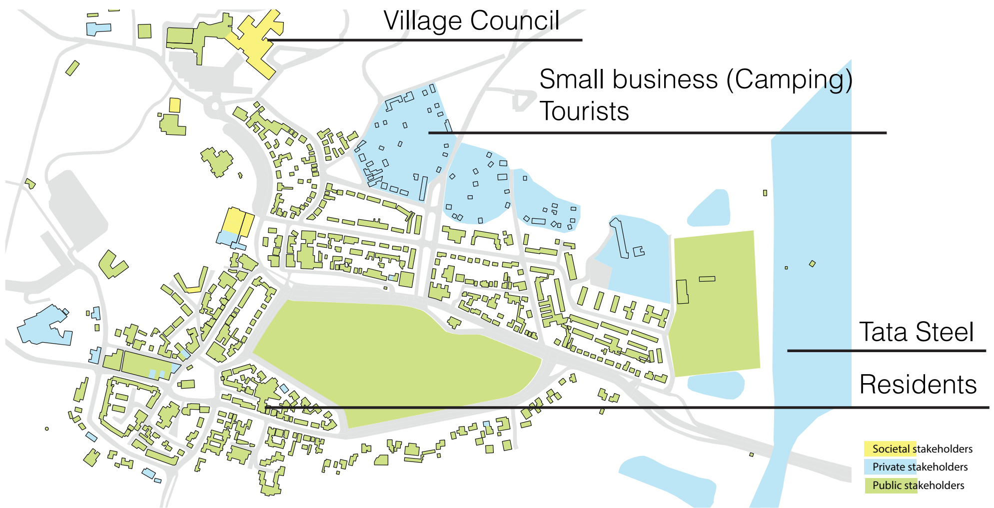
Secondary stakeholders, such as activists, the media, and tourists, play a significant role in the current and future state of the IJmond region. Activists are exerting pressure on the steel industry to change and take responsibility for their actions. The media, with its power to shape perceptions, has a substantial influence on how the IJmond region is viewed beyond its borders. Tourists, while often unaware of the region's issues, contribute to the local economy and enjoy the unique dune landscape and beach proximity.

In the future, schools have the potential to become significant stakeholders, benefiting from the lessons learned from the large-scale remediation. This future involvement of educational institutions holds promise for the region. Academics and experts, with their valuable insights, can play a crucial role in the ongoing soil remediation efforts.

Stakeholders spatially



Division of public sector stakeholders (own image, 2024)



Stakeholder division within Wijk aan Zee (own image, 2024)

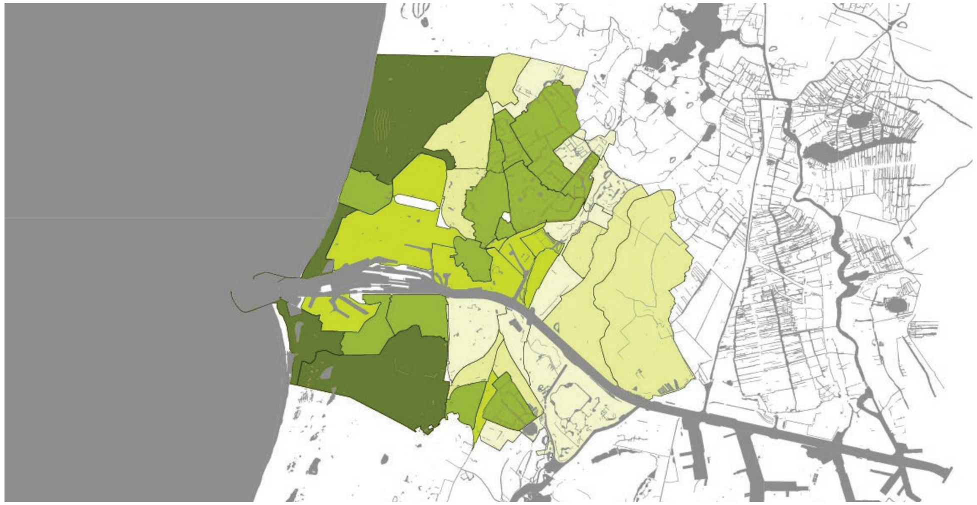
These maps illustrate the spatial influence and location of various stakeholder groups, including public sector entities, societal stakeholders, and private stakeholders, as discussed in this report.

The first image shows the realm of influence of the different public sector stakeholders. The UN, the WHO, and the EU, specifically the EEA, write out health norms that member states must adhere to. Considering the Netherlands as a state within the IJmond region, the Ministry of Economics, with the two advisors Weijers and Blom, and the Ministry of Infrastructure and Water, with the inspection of the living environment, set out national regulations that municipalities have to keep in check.

The province of North Holland has a large area of influence, and its work is primarily concerned with giving out permits. The environment agency of the North Sea canal area and the IJmond region have a large role in handing out permits, supervising, and enforcing regulations. Both the environment agency of the North Sea Canal area and the IJmond region are involved in considering the pollution of the steel industry because of the pollution that spreads through water. Lastly, the three municipalities of IJmond, Heemskerk, Beverwijk, and Velsen function as a boundary spanner between the things within the towns and the rules and regulations of the public sector. That means that also, within the case of the steel industry, they function as a mediator trying to come up with a solution for the pollution caused while maintaining the importance of the steel industry within the region.

Moving from the big to the small scale, the spatial influence of the private and societal sector stakeholders becomes more apparent. As an example, the village of Wijk aan Zee is regarded. Housing is often societally owned, private property of the residents of the IJmond region. What is unique about the village of Wijk aan Zee is that the village meadow in the middle of the town is also owned by the societal sector, which collaboratively takes care of this meadow. Activities like festivals, car-booth sales and other events are organised here. The village council has a spatial location with the village as well. The private sector stakeholders are spread out across the village. The steel industry has an extensive territory on the right side of the village. Furthermore, small businesses represent the private stakeholders within the village, often providing amenities such as food, clothes, other necessities, and leisure activities.

Stakeholders per functional zone



Map of functional zones division (own image, 2024)

In order to understand the stakeholders impacted by the conflict between the economic and the livability value, a division of stakeholders is made according to the different functional zones. What can be observed is that Tata Steel, as a stakeholder, affects all the different functional zones. Similarly, every functional zone connects to one or more public sector stakeholders, and these connections range from scale of influence. Overall, many stakeholders come together in the industrial and residential zones.

Leisure stakeholders
PWN (national park)
Province of North-Holland
The municipality
Tata Steel
Small businesses
Residents
Tourists

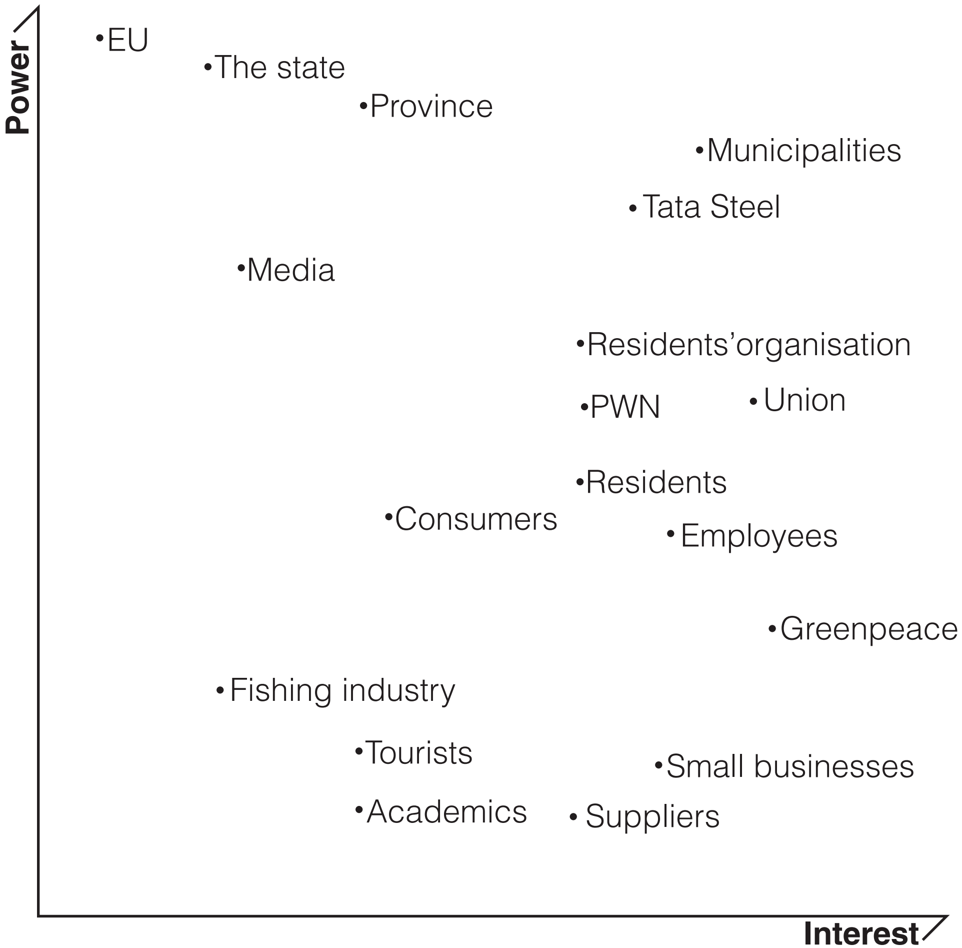
Industrial stakeholders
Municipalities
Ministry of economics
Tata Steel
Employees
Union (Starfishgroup)
Small businesses
Fishing industry
Suppliers
Consumers
Greenpeace

Residential stakeholders
Municipalities
Tata Steel
Small businesses
Residents: young families
Residents: employees
Residents: elderly
Residents: homeowners
Residents: recently move there
Residents' organisation
Consumers
Tourists
Activists
Media
Academics/ experts

Protected stakeholders
PWN (national park)
EU
Province of North-Holland
Tata Steel
Residents
Tourists

Production stakeholders
Province of North-Holland
The municipality
Tata Steel
Agricultural businesses
Residents
Employees
Consumers

Current power/interest matrix

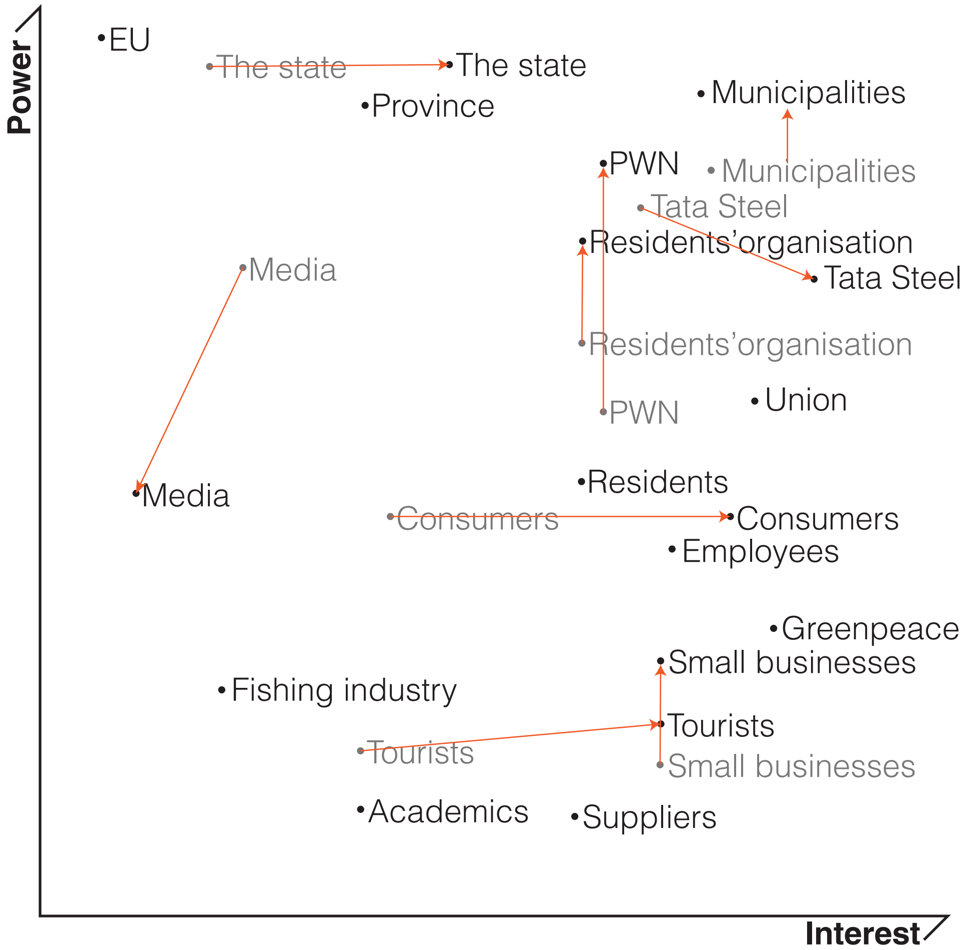


Adapted power/interest matrix, current situation (own image, 2024)

This power/ interest matrix shows the current position of different stakeholders considering the soil pollution caused by Tata Steel within the IJmond region. The placement is based on the stakeholder analysis. It is interesting to note that secondary stakeholders such as the media, tourists, and academics are essential in shaping the opinions of other stakeholders regarding the situation within the IJmond region. What is interesting to note, though, is that their genuine interest within the region is not necessarily that high. The people directly impacted have a lot of interest, such as the residents, but are missing the power to improve anything about their living situation. This creates a feeling of powerlessness that causes stress for people within the region. Organised groups of residents, such as the residents' organisation, the union and the village council, have more power but lack decision-making power.

On the other hand, some stakeholders with a lot of (rule-setting) power stemming from the public sector, such as the EU, the State and the province, are not so directly involved and impacted by the pollution. For them, it is one problem of many for which they create policies and regulations but do not get directly involved. However, they are essential to the remediation process because they hold many resources for change, such as money and power. Engaging or mediating some of their powers to the directly involved municipality is essential for large-scale remediation.

Future power interest matrix

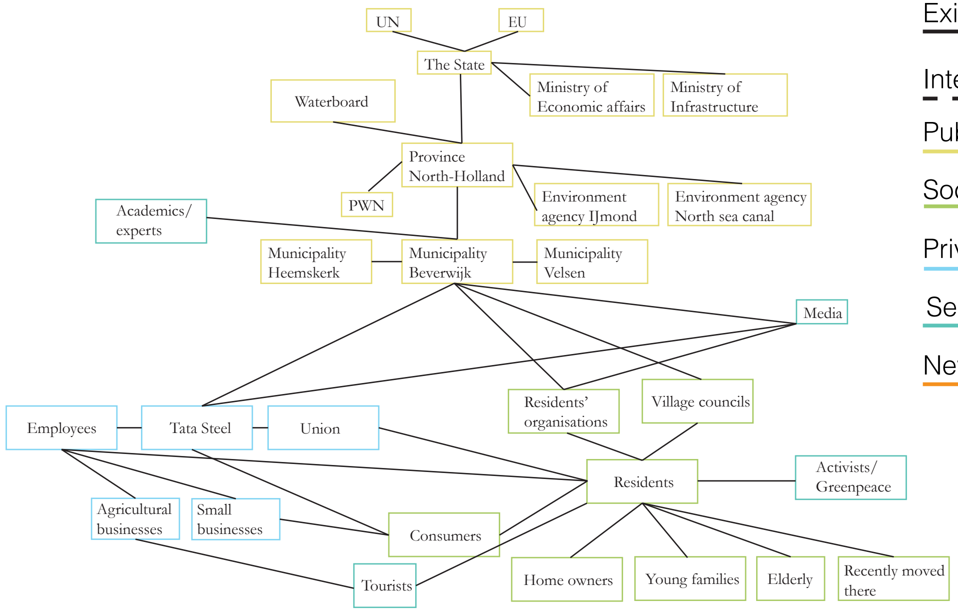


Adapted power/interest matrix, future situation (own image, 2024)

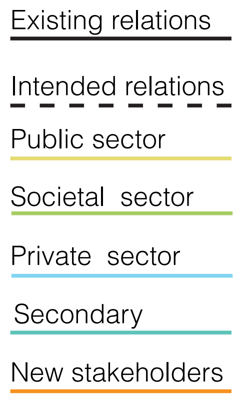
This second power/ interest matrix shows what needs to be changed with the power interest division to remediate the soil and revalue the landscape. The first category of stakeholder concerns the increase in their interest. These stakeholders potentially have a lot of resources beneficial to soil remediation. This concerns the state that can distribute subsidies for the Green Steel transition. It also concerns consumers who consume without always knowing its consequences, and their awareness could help in creating the capacity to remediate. Furthermore, the potential of tourists and creating a way to engage them to learn and experience the landscape differently could add to the capacity needed for remediation.

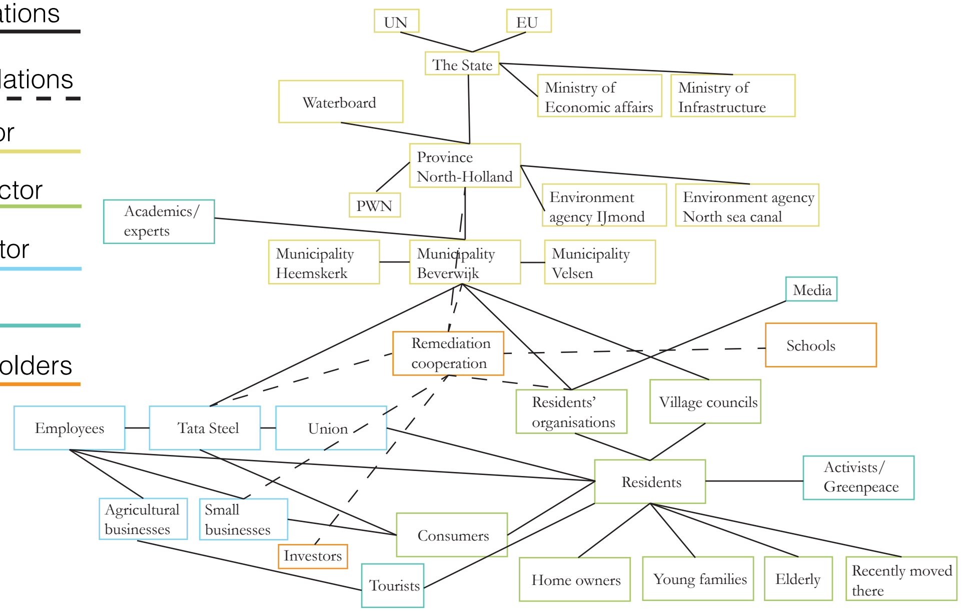
Another category of stakeholders is one from which the power needs to decrease because they cloud the view of the real goal at hand, a healthy living environment through healthy soil. The media, for example, holds a lot of power in shaping the understanding of the pollution issue in the rest of the Netherlands. This creates a lot of pressure on the regional stakeholders for fast change, whilst hasty decisions are not always the best ones in the long term. If the power of the media decreases, the pressure of hasty decision-making will also decrease, creating space for a comprehensive way of remediation that focuses not only on the factory itself but the whole region. The power of the media could, on the other hand, help activate residents and other people to help with remediation and capacity creation. Also, the power of Tata Steel to negatively influence its surroundings should decrease, and its interest in maintaining a healthy environment should increase. This power can be decreased by creating a lesser dependency on the employment of the steel industry. Lastly, the PWN and the waterboard have much expert knowledge relevant to remediation and should thus be included more in decision-making. Residents need more power to combat the feeling of being excluded and their lack of agency within the pollution of their living environment.

Stakeholder relations



Current stakeholder relations (own image, 2024)





Future stakeholder relations (own image, 2024)

These two stakeholder relations diagrams show the current and intended relations of the different stakeholders to remediate the soil on a large scale. What can be seen on the stakeholder relations diagram on the left is that there is a very top-down structure considering the public sector that culminates in the role of the municipality as a boundary spanner regarding balancing the rules and regulations and the values of economy (the private sector) and the livability (the societal sector). There is little mutual influence between Tata Steel and the societal sector, except between the union and employees. Regarding the relationship between the public and societal sectors, most communication is between the municipalities, the residents' organisation and the village council. Secondary stakeholders influence other stakeholders' perceptions and interest in considering different topics. The three different municipalities have joined forces to appeal for subsidies from the national government to assist in the Green Steel transition of the steel industry. The letter that asks for this help can be found in Appendix Ac.

The lack of communication between the steel industry and the societal sector creates a feeling of powerlessness and agency considering influencing the course and effect of pollution. The steel industry does try and combat this by having a Tata Steel loket for questions and inquiries within Wijk aan Zee. But the sense of powerlessness and the lack of agency regarding the pollution pertains. On top of that the collaboration of the steel industry and the municipalities regarding the IJmond region adds on to the feeling of exclusion within important decision making of the societal stakeholders. Regarding the process value of the large-scale remediation, it is thus essential to create an inclusive process that helps the societal stakeholders regain agency and feel a sense of purpose again.

The second stakeholder relation diagram shows the adjustments needed to create a more inclusive decision-making process and give back agency to the societal sector stakeholders. What is important to note is that a neutral middle-ground stakeholder is created that combines stakeholders from the different stakeholder sectors. A level-playing field is created within the cooperation so that the different stakeholders have the same level of influence in the decision-making process for large-scale remediation. In order to finance this, though, investors are needed on top of the national subsidies and their contribution to the steel industry. Furthermore, schools are added to the stakeholder relation diagram as stakeholders that can benefit.

Stakeholder resources

Stakeholder	Resources	Needs
EU	Knowledge	Workforce
The State	Financial resources	Workforce
Municipalities	Knowledge/ Permission	Workforce
PWN	Knowledge	Financial resources
Tata Steel	Financial resources	Knowledge
Employees	Workforce	Financial resources
Suppliers	Knowledge/ Financial resources	Motivation
Agricultural businesses	Knowledge	Financial resources
Unions	Workforce/ knowledge	Financial resources
Small businesses	Workforce/ knowledge	Permission
Consumers	Financial resources	Motivation
Residents	Workforce/ knowledge	Permission/ Financial resources
Residents' organisations	Workforce, knowledge	Permission
Media	Workforce	Knowledge
Activists	Knowledge/ Workforce	Permission
Tourists	Financial resources	Motivation

Table that shows stakeholders from different sectors corresponding to their main resources they have to offer, and resources they need for successul soil remediation.

The goal of this table is to list the resources within the region and the needs of different stakeholders to assist in the remediation of soil and creating a healthy IJmond region. Making a list like this makes it clear who the stakeholders can complement in this task. The primary resources to have are:

Financial resources mostly refer to money. This is needed to finance the large-scale remediation. Investment costs have to be made for the purchase of the necessary equipment and to pay the workforce that helps implement the phytoremediation.

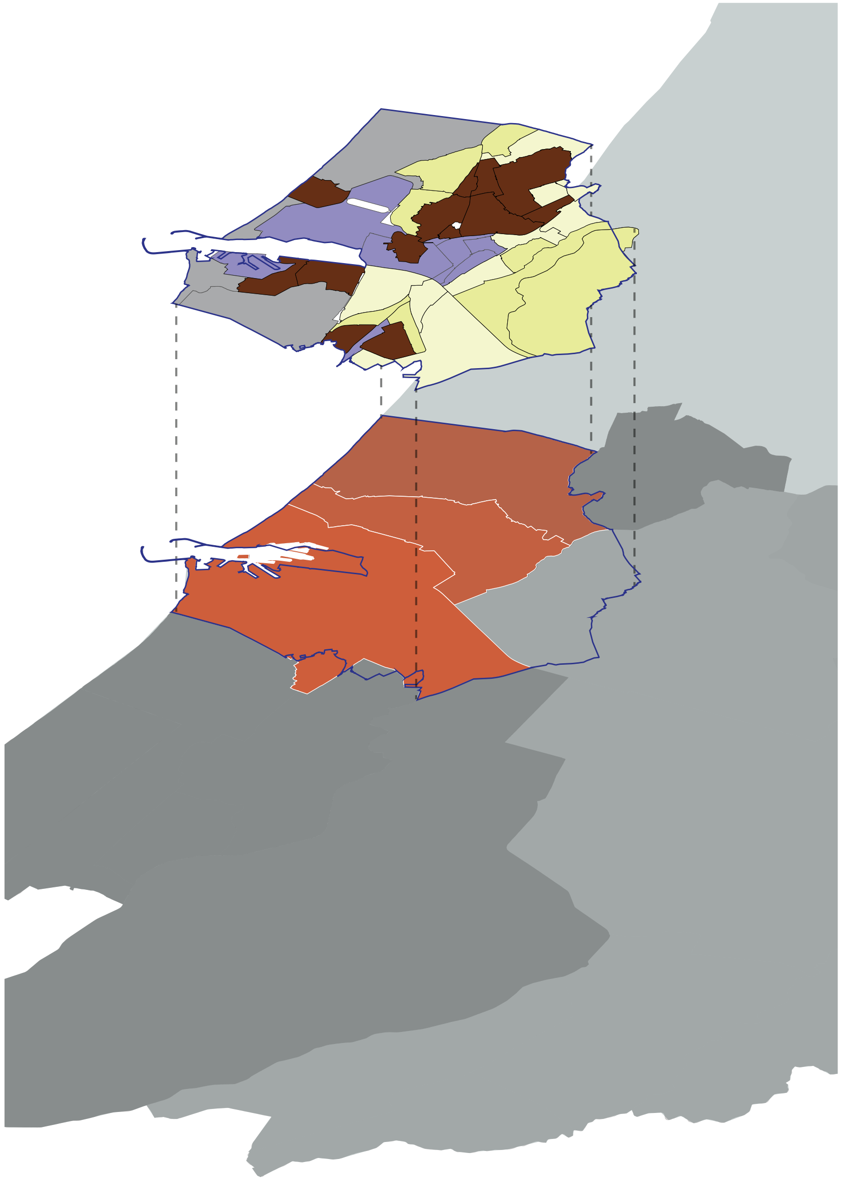
People in the workforce are needed to implement phytoremediation on a large scale. Plants need to be planted, maintained to grow well, and harvested to remove the pollution from the site entirely. For this, many hands are necessary.

Knowledge is important in creating a remediation plan that provides long-term soil remediation and is catered to the context's needs. This knowledge can be expert knowledge on particular technical processes, but street-level knowledge on how to engage people is also very relevant.

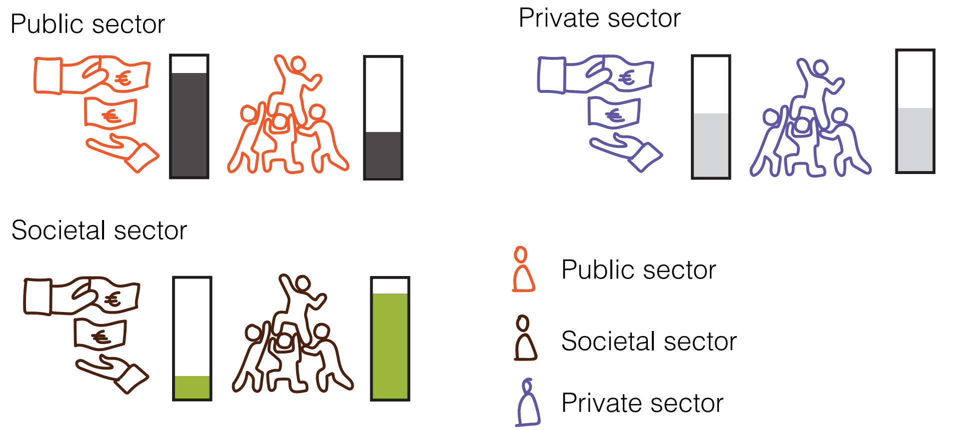
Permission is a resource the public sector has, which entails final decision-making power and the power to give a go or no-go to activities. This process of permission giving is a very hierarchical and bureaucratic process that is all relevant to walk through for a successful remediation. Because of this, giving permission can take much time, slowing down the implementation of the remediation.

Lastly, there is the resource of motivation, which indicates an incentive for stakeholders to voluntarily contribute to the remediation of soil pollution.

Stakeholder resources



Functional zone division map with corresponding resources per sector (own image, 2024)



Legend that belongs with the stakeholder territory map on the left that shows the amount of resources that each sector generally holds (own image, 2024)

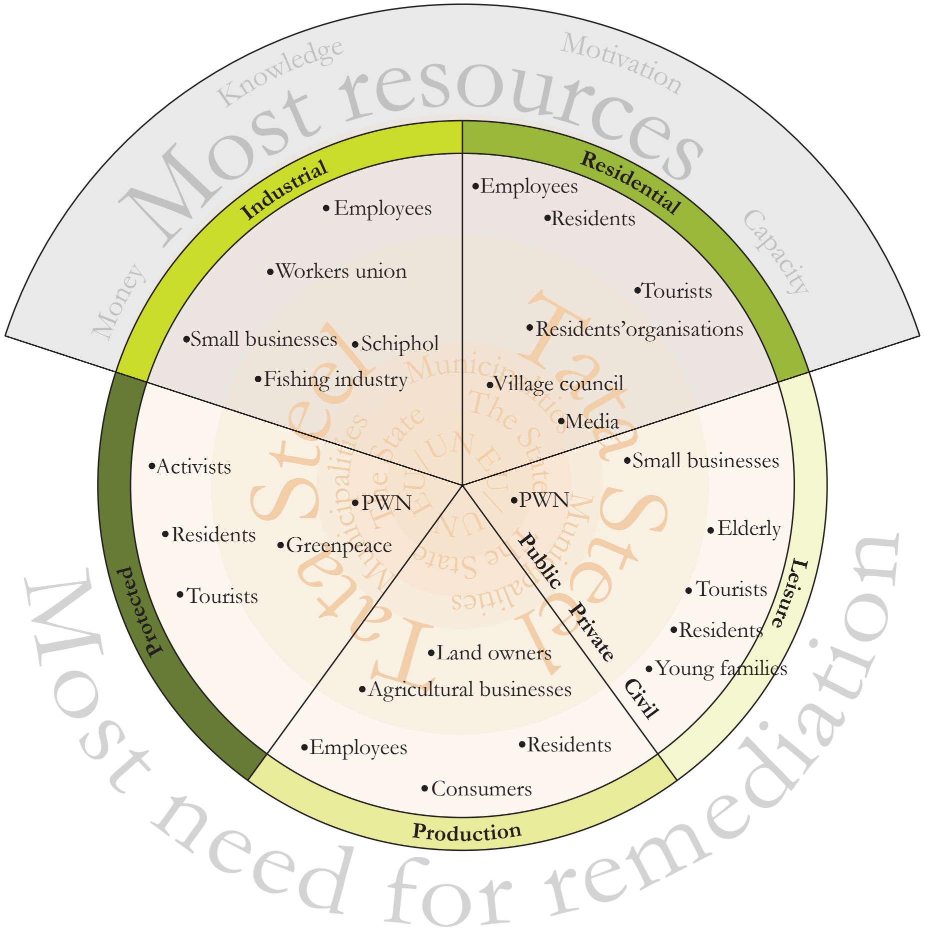
This final map summarises the different resources different stakeholders have per sector and suggests ways they could complement each other and collaborate to create a structure for large-scale soil remediation.

It shows that for the remediation of the IJmond region, the public sector holds a lot of financial resources but lacks the workforce to implement phytoremediation on a large scale. The societal sector, on the other hand, holds a lot of workforce, people willing to contribute to the remediation of the soil to better their living environment, but they lack the resources and the permission power to do so. These two sectors can complement each other by providing a workforce in exchange for financial resources and creating a collaboration that ensures a more inclusive remediation process.

The private sector has a fair amount of financial resources and workforce to contribute to large-scale remediation. Their incentive to contribute is that they share in causing the need for remediation and thus have an ethical responsibility to help solve this issue.

Regarding the different functional zones, we see that even though the industrial zone is not directly subject to large-scale soil remediation through phytoremediation, its resources are necessary for remediation in the other zones.

Process value: inclusive



Stakeholder summary (own image, 2024)

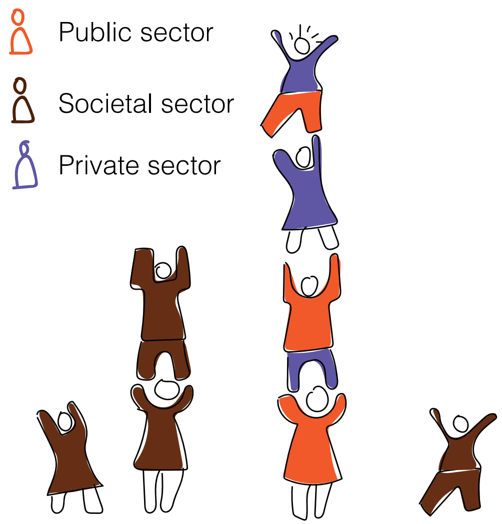


Diagram indicating the need for a more inclusive process (own image, 2024)

This stakeholder diagram summarises the main findings of the stakeholder analysis. What it shows are the different functional zones, with their corresponding key stakeholders organised according to the sector they belong to. What can be seen is that Tata Steel, the three municipalities of Heemskerk, Beverwijk and Velsen, as one entity and the EU, because of its regulatory power, are stakeholders that heavily influence the five different functional zones. The challenge lies in fairly distributing the necessary resources for large-scale soil remediation. Most resources, such as financial resources and workforce, are concentrated within the industrial and residential zones.

The soil remediation process presents two significant challenges. The first is the need for active engagement from stakeholders across the different zones. Their contributions are vital to the success of the remediation efforts.

It is crucial to motivate stakeholders not only to contribute to the remediation of their immediate environment but also to the functional zones that yield fewer resources. This comprehensive approach is key to an effective soil remediation strategy.

In order to do this, there is a need for the engagement of different stakeholders, as well as inclusivity and transparency within the decision-making process. From the several interactions with residents of the IJmond region, who together create a large working force, this is one of the main things they lack within the current situation. Providing this could activate a large group workforce and bring back the non-spatial value to the IJmond region.

06. REVALUING STRATEGY

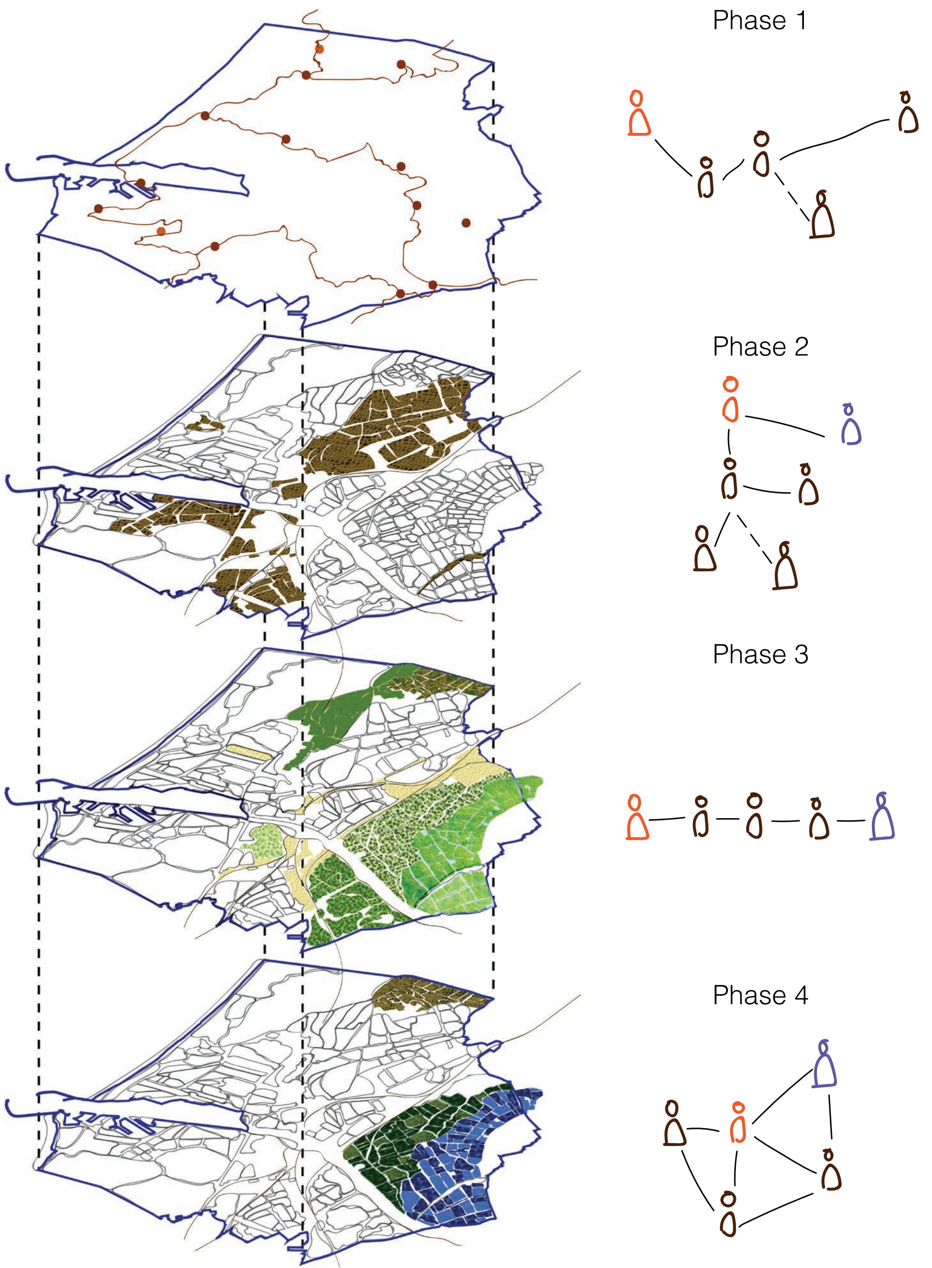
To balance the previously established values of industrial heritage, healthy soil, and an inclusive process, a spatial remediation strategy and a collaborative governance framework have been created. This chapter discusses this strategy per phase of implementation necessary to work towards full soil remediation.

The first phase concerns creating interaction through artistic intervention within the landscape. The second phase focusses on residential remediation, where the conflict between economy and livability is most pressing. The third phase elaborates on this by expanding to the production and leisure zone. The fourth phase poses a plan that makes use of the new potential of the remediated landscape of the IJmond region.

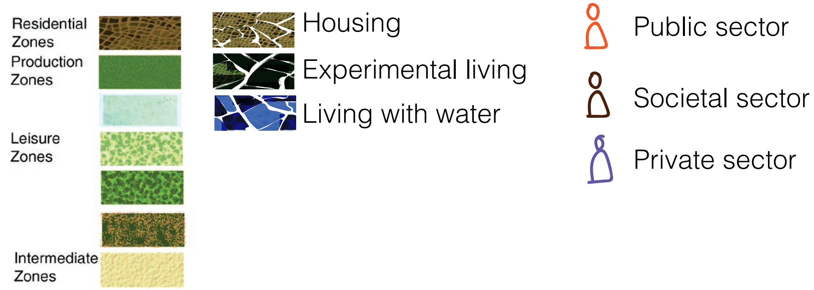
Every phase will be accompanied by the implications for stakeholder relations and the intended configuration needed for this phase to be successful.

Steel art work park with the steel industry in the back (own image, 2024)

Spatial strategy and collaborative governance



Spatial strategy per phase, and evolving stakeholder relations (own image, 2024)



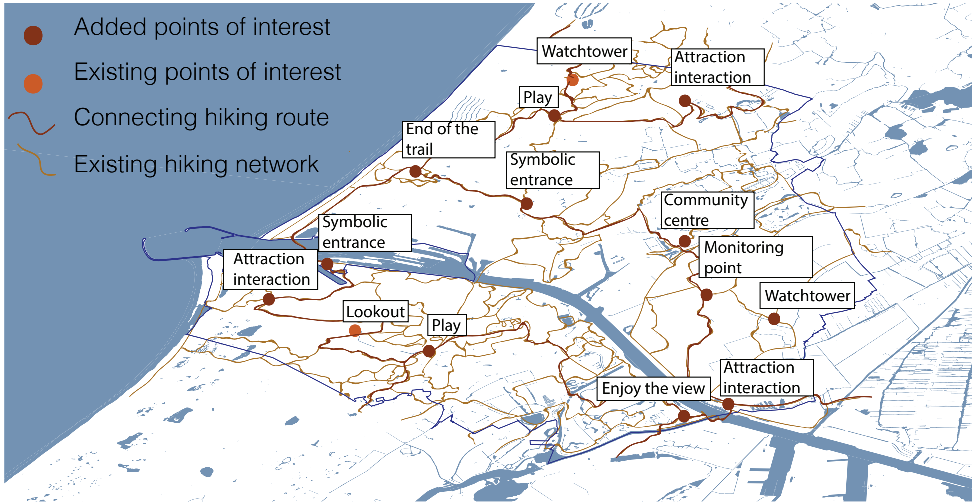
The proposed strategy for large scale soil remediation for heavy metals takes shape in four different phases. These phases are composed in a way that aligns stakeholders and resources over time. Stakeholders and the spatial impact of remediation are thus closely linked within this strategy, and are both part of the solution. The strategy mostly focusses on how local stakeholders can be used for large scale phytoremediation.

This chapter will zoom in to the different phases of the strategy and explain how they work, who is involved and how it relates to the next phase.

Phase 1 focusses on the so-called temporary interaction creation. Along a hikingnetwork artworks and other places for interaction are created that stimulate awareness for soil pollution, education on its effects and interaction between like minded people. The goal of this soft use layer is engaging people in order to create a community willing to assist in the soil remediation of the surrounding municipalities. Phase 2 focusses on the remediation of the soil within the residential functional zones. Together with the engaged community and other relevant stakeholders the residential part of the IJmond region will be collaboratively turned into a healthy environment again. Phase 3 builds continues with the creation of a healthy environment, but broadens its scope to the whole of the IJmond region. At this point, the community will get an upgrade in organsiation and scale by changing into a paid partnership with the municipality. This soil remediating company will tackle the soil pollution of the surrounding landscapes that do not have their own resources to do so. At the end of phase 3, the soil within the focus area will be fully remediated.

Phase 4 provides a potential future use for the IJmond region. But since the community and the partnership have been such important actors within the remediation of the landscape, they will also have the most say in what this future and its space will be used for. The boundaries that will be set from the public sector will be discussed though, and some potential uses will be explained.

Phase 1: Interaction creation



Hike trail with artistic interventions and meeting points (own image, 2024)

Phase 1 kicks off the strategy with the goal of creating interaction between people and engaging potential stakeholders for future soil remediation. This phase evolves around using artworks and design objects within the public space as interventions in the landscape that draw attention and encourage interaction. This can be interaction between different stakeholders needed to remediate, like the municipality, Tata Steel or residents between each other, or interaction more focussed on the individual and the landscape.

Both are important in order to break down barriers and set the basis for an inclusive soil remediation strategy.

On the other hand, artworks within the landscape also create more interaction between the people and the landscape. This helps create more awareness of the beauty of the landscape and the pressing need to create a healthy environment again. The artworks and design interventions are connected through a trail based on existing hiking trails within the region. The trail is chosen according to exciting points within the region and easy accessibility from the towns within the IJmond region. Along the trail, there are several points where an artwork or a design intervention will be located, all encouraging a different type of interaction from the people. The following pages will discuss these different types of interaction and

“Art by itself doesn’t make change but art together with smart organizing and strategy can be very powerful” (Cucuzzelle et al., 2020)

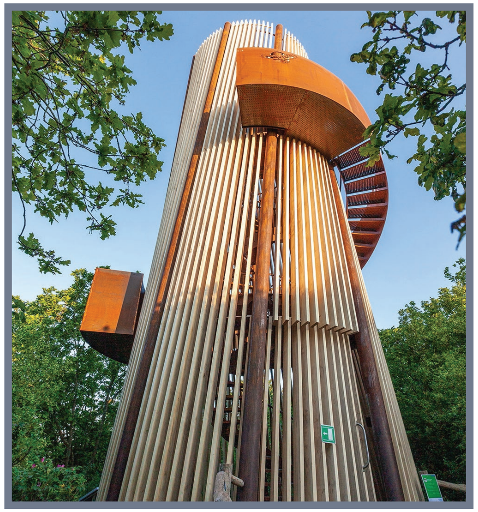
show examples. At the same time, the interventions function as markers within the landscape and are also helpful for wayfinding.

Art is part of this creation of interaction because art within the landscape is a fast way of intervention and is an essential tool for creating awareness and showing people that something is happening. In this case, art will act as a pioneer, alluding to the future change within the landscape and providing interaction that is not only relevant now to observe the current. However, it will remain relevant in the future to observe the progress. Within the public space, much interaction happens, and art can help assist the engagement between people, and the public space contributes to the public space as a public forum (Cucuzzella et al., 2020).

Artworks within this stage become both a way of creating awareness and symbolic value for the landscape. The works will stand out within the still barren, unremediated landscape, and as an allusion to the importance of the steel factory, the materialisation will be in steel. Art can frame the steel industry and create awareness of its beauty and contribution to the landscape. Thus, it becomes a part of appreciating the industrial heritage and its current value.

Regarding the stakeholder relations in this first phase, this interaction between people creates the basis for a community. It is a natural selection of regional stakeholders concerned with their surrounding landscape and motivated to protect and save it from pollution. Information at these different interaction points should inform people of why these artworks are placed and the goal. Ideally, people spend time in these places, meeting others and discussing their concerns. This will later be relevant as input when the remediation is upscaled. The community provides the basis for the main remediation workforce.

Points of interest



Watchtower Kruisberg (PWN, 2023)

Watchtower

Goal: Provide a look out over the landscape, across the trees

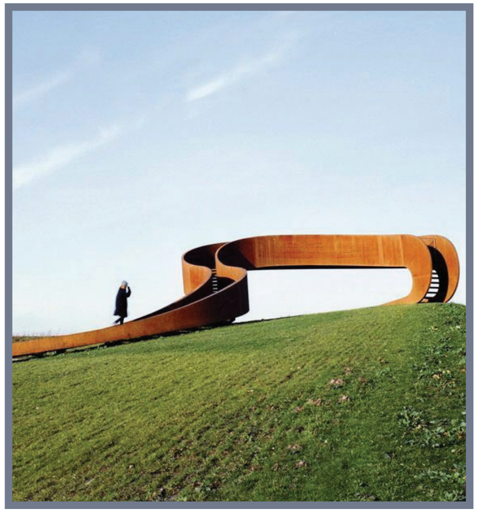
Use: Provide a 360-degree view of the surrounding landscape

Target audience: Everyone

Location: a landscape with trees/ forest

Reference: Architect BoschSlabbers

Climbing the watchtower and looking out over the trees people see the different elements within the landscape. They are able to orient themselves within the landscape. The space within the watchtower can be used for educational purposes.



Lookout on a hill (Meisner, 2014)

Lookout

Goal: Provide a look out over the landscape

Use: bridge to create interaction with the hilly landscape

Target audience: Everyone

Location: On top of an existing hill/ dune

Reference: The elastic perspective by NEXT architects

The movement of the bridge creates different views across the landscape. The bridge's material is steel, alluded to by the steel factory.

Sound enhancing statue (Candiani, n.d.)

Playful education point

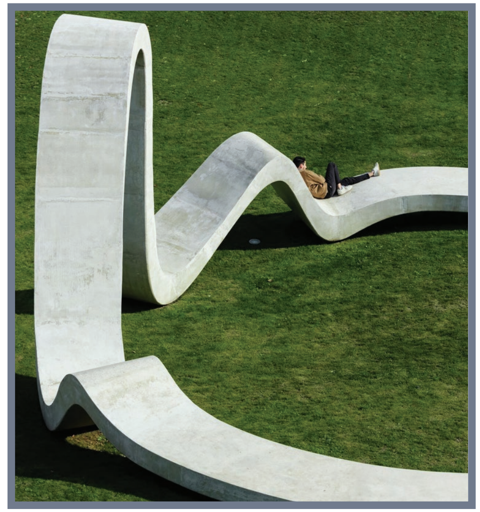
Goal: Make people aware of sounds, smells and sights within the region

Use: Create awareness and provide interaction with the landscape

Target audience: Kids/Everyone

Location: scattered within the region
Reference: Unknown

A work of art like this creates a moment to stand still and pay awareness to the sounds of the landscape. Close to the factory, its processes will be heard. Other similar sensory interventions could focus more on smell or sight.



Concrete sitting element(FAHR 021.3, 2019)

Resting spot

Goal: Provide a spot to take a rest

Use: create spontaneous interaction between different users

Target audience: Everyone

Location: crossings of paths, resting spots

Reference: Loop by FAHR 021.3

The undefined shape provides different (playful) ways of interacting with the object. It can be used to sit down, lie down, walk underneath, and take photos of the landscape, and thus, it is also a perfect moment to create awareness of the landscape and its need for remediation.

Points of interest

Sitting point and photography point (Eihem, 2006)

Photo point

Goal: slowing down and having a look at the landscape

Use: Creating a space for conversation and appreciating the environment

Target audience: Everyone

Location: a place that provides wide views over the landscape

Reference: BergmeisterWolf

People passing by can choose to sit alone or with someone else. The different designs of these sitting places invite photos and, in turn, create awareness of the beauty of the landscape and the importance of maintaining it.

Steel portals (van Vaerenbergh, 2019)

Entrance

Goal: Symbolic entrance point to the Tata Steel territory, and framing the views on the factory

Use: creating awareness and a moment to reflect on the role of the factory on the landscape

Target audience: Everyone

Location: in sight of the factory

Reference: Arcade by Gijs van Vaerenbergh

The way that the arches build on top of each other creates an entrance pathway. The material of the arches is steel, alluding to the steel factory. It frames the views.

Wind pavillion (Observation projects, 2012)

Meeting point

Goal: showing the presence of wind

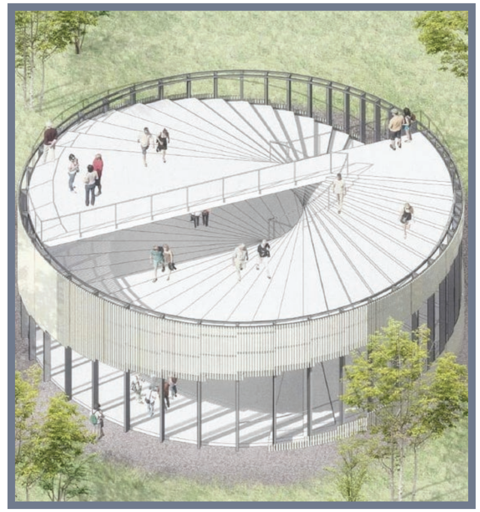
Use: an object to interact with, walk through and get to know

Target audience: Everyone

Location: Close to the sea, at a windy spot

Reference: Spiral garden by Observatorium projects

This meeting point close to the sea shows the presence of wind. Wind is a very important actor in the spread of pollution. Being aware of this creates a moment to educate people about pollution, its effects and its remediation



Stairwell pavillion (Nieuw, 2019)

Pavillion/ research centre

Goal: create a space for information, education, interaction and research

Use: Central meeting place that doubles as a viewpoint

Target audience: Everyone, community members

Location: central spot within the landscape, easily accessible to different stakeholders

Reference: Pavilion of the future by studio “new”

A research centre and icon in the landscape that provides education like a visitor centre. Is inviting to anyone to see what is happening concerning the remediation of the IJmond.

Reference

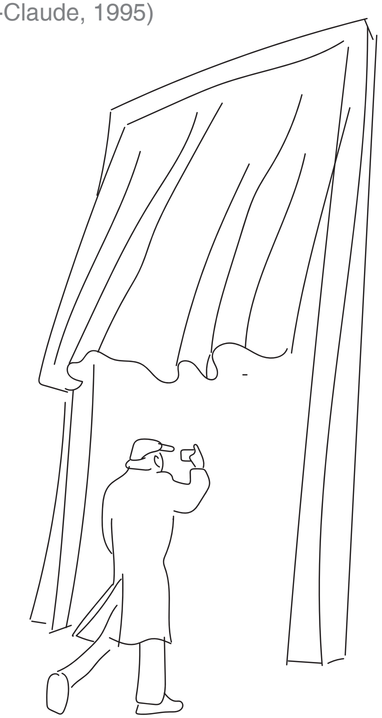
Portal by Christo in New York in 2005 (Willens, n.d.)

In fabric wrapped Reichstag in 1995. (Christo and Jean-Claude, 1995)

The different interactive interventions described in the last few pages will be connected through a tangible route with the help of portals inspired by Christo and Jean-Claude. These portals indicate the route that can be taken from one point of interest to the other. They help frame the landscape at several points in time. Similarly to the previously described meeting point, the curtain in the portal creates awareness of (direction of) the wind. When the wind blows strongly, the curtains will flutter more, meaning there is a higher risk of dust and particulate matter spreading from the steel industry. Information along the path educates people on the implications of soil pollution and the purpose of soil remediation through phytoremediation.

Thus, this artwork will help raise awareness of the necessity of remediation and spread knowledge through social media by creating a unique object within the landscape.

Just like Christo and Jean-Claude used to do, the construction of these portals is done with the help of local people. In this way, it becomes clear who is willing to help out, indicating potential members for the later described ‘community’. It also creates a way to bond more with the landscape and prepare for the work needed for soil remediation.



Christo portal line drawing (own image, 2024)

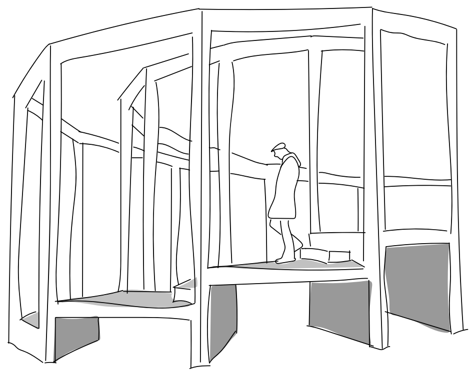
Impressions

Zollverein park on an old industrial site in Essen (RVR, n.d.)

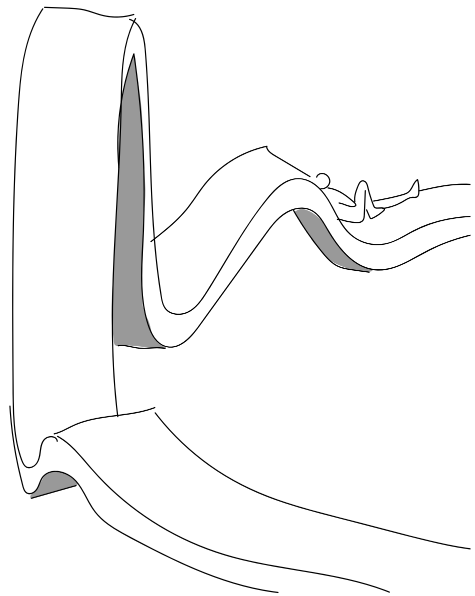
Impression of Freshkills park. (Freshkills park, 2023)

These two images give an impression of how the first phase of the strategy, can create places for interaction and overseeing the landscape.

With the architecture of the structures, they will refer to the steel industry creating a need for this trail. These special places within the landscape provide an incenvtive for people to venture out, for kids to play and for adults to learn about the necessity of these interventions.



Viewpoint impression (own image, 2024)



Resting point impression (own image, 2024)

Community

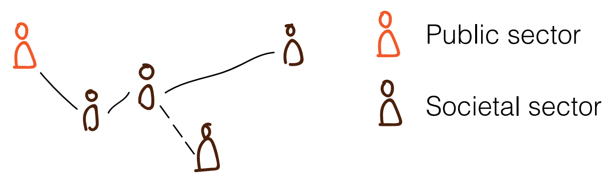
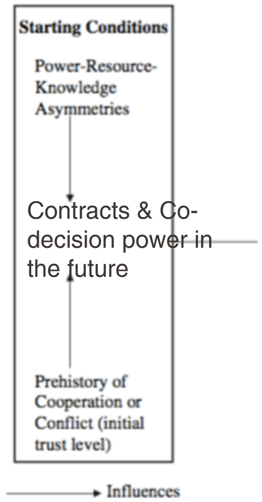


Diagram showing the stakeholder relations within phase 1 (own image, 2024)



Starting conditions building up to the collaborative governance framework (Ansell and Gash, 2007)

The main goal of the first phase of this strategy, and one of the main reasons for stimulating interaction through spatial interventions and art, is creating a community. This community will represent the societal sector stakeholder within the intended collaborative governance throughout remediation. This involves a group of concerned residents willing to help restore health to their living environment through an organised partnership with the public sector that provides an employment counterbalance to the steel industry. Phase 1 will thus take the first step in creating favourable conditions for collaborative governance; this will be done with the help of the collaborative governance framework by Ansell and Gash (2007).

In order to create a good basis for collaborative governance, it is necessary to provide the starting conditions. These are mediating power-resource-knowledge asymmetries, creating incentives and constraints for participation, and having an initial level of trust.

The creation of interaction through engagement points and artworks along the trail assists in gathering like-minded people who are concerned with the landscape. These will mostly be residents living in the IJmond region, ranging from residents who have spent most of their lives here and want to restore its value to residents who are new to the region and want to raise their children in a healthy environment. The municipality must coordinate and finance the initial steps of remediation, and the steel industry has an ethical responsibility to contribute to the remediation as a source of pollution. For an effective collaboration on a large scale, there must be a certain level of trust in the community. This trust will develop between the stakeholders throughout the process, and the collaborative installation of the portals by Christo and Jean-Claude provide the first step in this. By setting up agreements in contract and creating co-decision powers by the different community members, power-resource asymmetries are mediated, and a level-playing field is created where the different stakeholders can function on a horizontal power level. The contract, speaking of here, is introduced in phase 3, but experts and academics as stakeholders already contribute to levelling the playing field in this first phase.

The stakeholder relations in this first phase have not changed much yet. While the intention is to start including residents more in the remediation process and the decision-making process concerning this, time needs to be spent creating a steady basis for this, which is being done in phase one. Communication with the municipality will thus be still very hierarchical and mostly done through residents' organisations.

Phase 2: residential remediation

Residential remediation territory (own image, 2024)

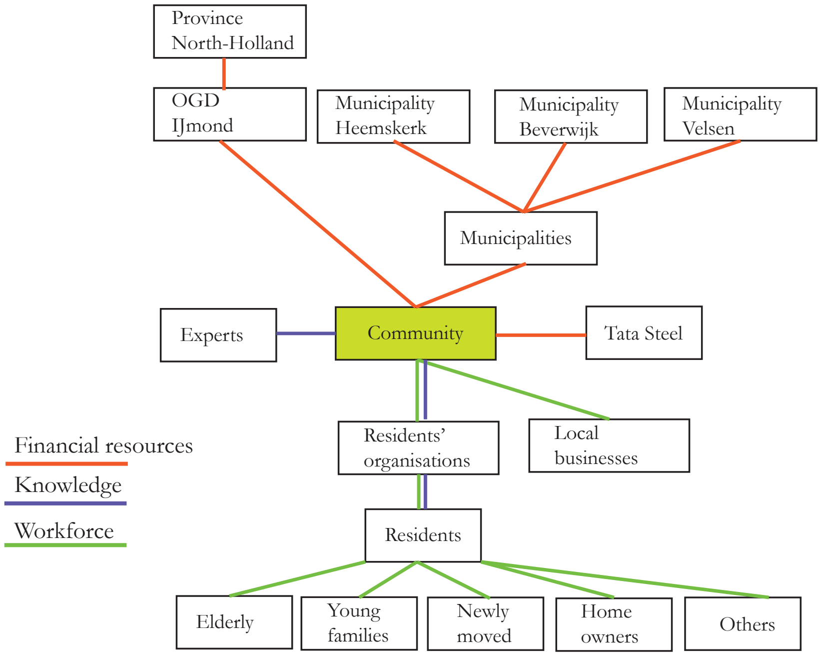
Empty plot of land in IJmuiden (Google, n.d.)

Playground in Wijk aan Zee (Google, n.d.)

Phase 2 is the first step in the actual soil remediation, and this starts within the residential zones. The reason for this is that the residential zone is the zone within the region with the most interaction with the soil throughout the day and, thus, where people are most exposed to pollution. Another reason to start within the residential zones is that there is an intrinsic incentive for people to voluntarily help with the remediation since it will directly impact the livability of the living space and the feeling of powerlessness experienced. Furthermore this residential remediation will form a practice round of the cooperation skills of the community, for when the remediation will need to be upscaled to the rest of the region.

The spaces within the towns that will be subject to remediation are the public and recreational spaces within the neighbourhoods, as shown in the images, and people's front and back gardens. To illustrate how phytoremediation can be used to remediate the soil, in combination with different uses of space and different ownership of space, a case study is done on the village of Wijk aan Zee, a small town along the sea that belongs to the municipality of Beverwijk.

Stakeholder relations



Stakeholders that contribute to the community and the resources they contribute (own image, 2024)

Phase 2 is a pivotal stage that relies on the active involvement of the community. While phase 1 was about generating interest and engaging potential community members, phase 2 shifts the focus to the community as the driving force behind the remediation efforts within the residential zone.

By working together with residents of the different towns within the IJmond region, a better understanding is gained of the necessities and priorities. This also helps in remediating the feeling of powerlessness and creating a more inclusive decision-making process for the residents. The benefits of having a local community to assist in remediation are that they have local knowledge, help overcome opposition, boost the acceptance of the remediation plan within the rest of the towns, strengthen the mutual relations between the community, create spatial justice by being inclusive and it enhances transparency and accountability for decision making (Coleman et al., 2023)

In the context of stakeholder relations, the municipality plays a crucial role as

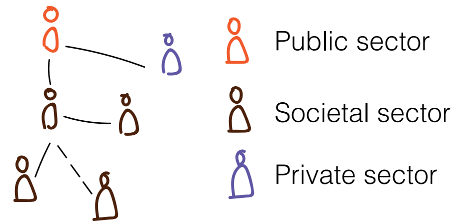


Diagram showing the stakeholder relations as vertical power relations of phase 2 (own image, 2024)

the facilitator and planner in this initial phase. Its financial resources are essential, and the community's active participation and trust-building are key to establishing a solid foundation for collaborative governance. This hierarchical relationship is evident in the communication between the public sector and the residents. However, the private sector, particularly the steel industry, is also a stakeholder in this phase, contributing to the residential remediation as part of their ethical responsibility and a gesture of goodwill, given their significant role in the need for remediation. On the left, an elaborate breakdown of members of the community is given, and the resources they contribute to the remediation. The public sector, the municipalities and the OGD directly contribute to the community with the help of financial resources, and the same goes for the steel industry. The residents organise themselves within the residents' organisation and include an array of people. They contribute by providing workforce

Community and its secondary stakeholders contributing to remediation (own image, 2024)

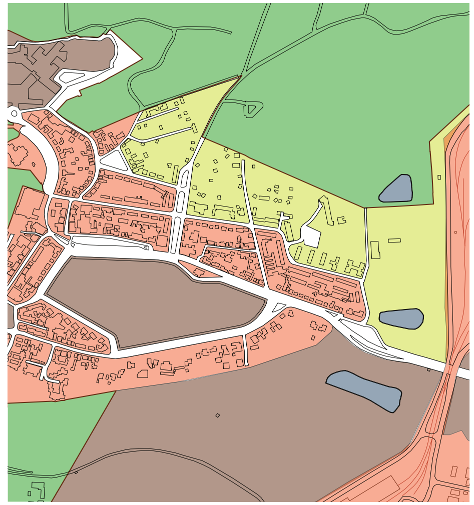
and street-level knowledge. Local businesses know that they will profit from remediated soil in the long run and thus contribute to this phase with the workforce. Lastly, some experts contribute with expert knowledge on how phytoremediation works best and which plants to use.

For this phase, the community alone will not be enough to remediate all the soil within the towns. That is why the community forms the core of remediation, but the help of other volunteers, direct neighbours of a place being remediated, tourists looking for a fun activity or activists wanting to give something back to the region are needed to help with planting plants. Planting plants will take up the most time, but it is also an activity that almost anyone can do. The community will oversee processes like these, but non-directly involved residents are what make this phase successful. Their motivation to contribute is the direct effect their help will have on their living environment.

Zoom in to Wijk aan Zee

Situation of Wijk aan Zee (own image, 2024)

Functionmap within Wijk aan Zee (own image, 2024)



Public to private map within Wijk aan Zee (own image, 2024)

Wijk aan Zee is the town where the implementation of residential remediation will be illustrated. This location serves as an interesting case study. On the one hand, the town is surrounded by the Tata Steel factory and Natura2000 protected area. Considering the proximity to Tata Steel, Wijk aan Zee has had to endure much pollution. These spatial characteristics are shown on the map. Three designs are proposed, each showing how phytoremediation can be used for three different types of use within the town. On the other hand, there is the realm of influence in remediating soil pollution. Where public space can easily be co-decided over and remediated, private space is less easily remediated. To do this, a strategy is needed to engage residents and adjust their attitude to create cooperation to remediate within their own living space.

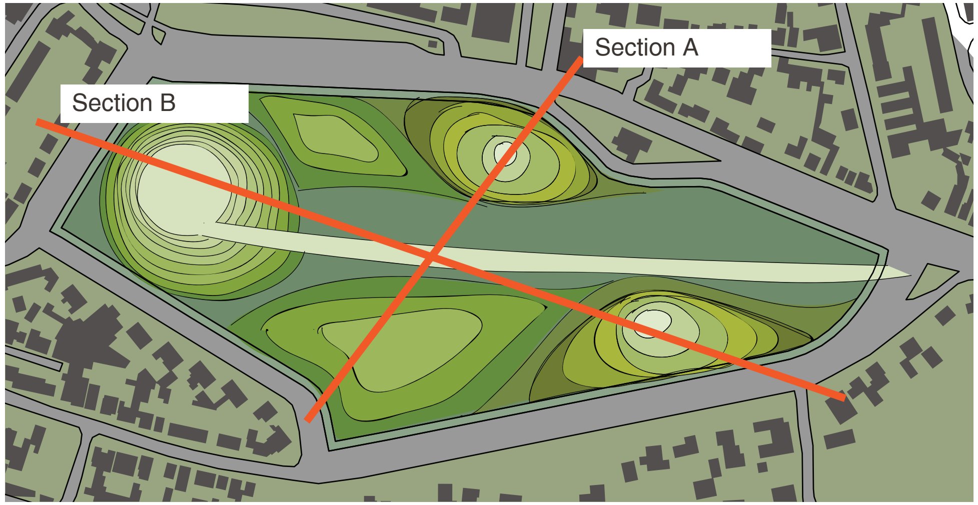
The three locations of remediation are:

- The village meadow, a public space
- Camping terrain, a semi-public space
- Housing, private space

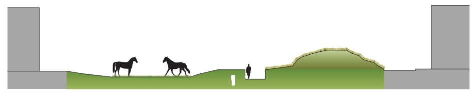
Public: village meadow

Location of the intervention in Wijk aan Zee (own image, 2024)

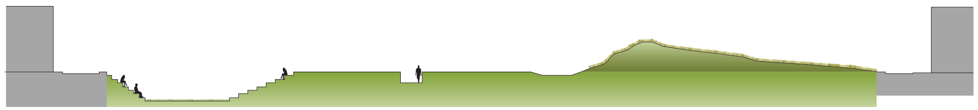
Current use of the village meadow (Google, n.d.)



Suggested plan for the village meadow, indicating the sections (own image, 2024)



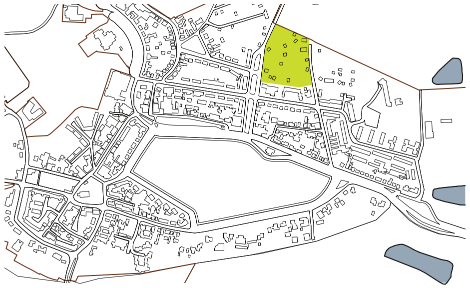
Section A of the village meadow (own image, 2024)



Section B of the village meadow (own image, 2024)

The first design is for the village meadow, a community-owned public space. The village meadow is used for car boot sales, small-scale festivals and community gatherings. Throughout the year, the only permanent function is for horses to graze. It is essential to leave space for these activities to remain and remediate the soil since there is occasional interaction with the soil. The village meadow is also one of the first things people see when entering Wijk aan Zee and thus can provide a space for a symbolic entrance to the town. These contextual factors have led to a design that combines the techniques of excavation and phytoremediation playfully. A sunken amphitheatre is created on the side of the town; this provides space where people can perform at village festivals or a spot to enjoy the outside space. The soil excavated to create the amphitheatre will be piled into two small hills. These will be phytoremediation hills where polluted soil is collected, and phytoremediation is done in a concentrated space. With space to graze in mind, next to the hills, two lightly excavated, level sites will be created that provide a natural boundary for the horses to graze. From the entrance of Wijk aan Zee towards the centre of the town, a sunken path is created that leads to the amphitheatre and provides a grand entrance to Wijk aan Zee. The surrounding area will remain a space for potential car boot sales, but interaction with this soil will be restricted for just these times.

Semi-public: camping terrain



Location of the intervention in Wijk aan Zee (own image, 2024)

Current situation of the camping ground (Google, n.d.)

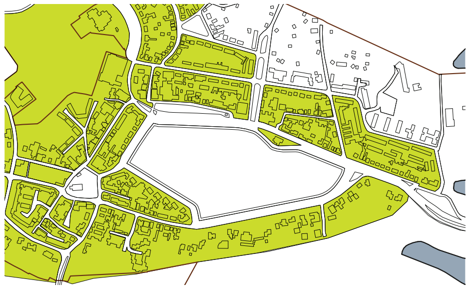
Suggested design in plan (own image, 2024)

The second design is for the camping terrain, a semi-public space. There are existing mobile homes that need to remain on site. Furthermore, space for tents should be created, with minimum interaction with the soil. In order to do this, similar to the Ceuvel project in Amsterdam, the camping ground is elevated by creating a boardwalk with platforms. The boardwalk connects the mobile homes and creates a route across the camping ground. The platforms serve as spaces where tents can be put up. Since the boardwalk is elevated, phytoremediation plants can grow underneath, and interaction with the polluted soil is prevented.

It will be a costly change to the campsite, but it will pay off by providing a unique way of camping and attracting more tourists once the soil is cleaned. Tata Steel could assist in the construction with materials or money, and the OGD would provide subsidies for soil remediation.

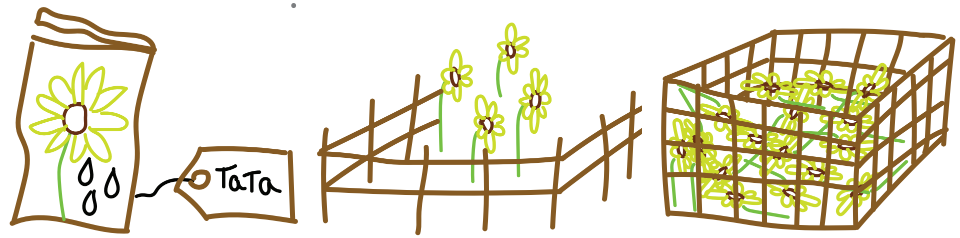
Impression of camping and phytoremediation (own image, 2024)

Private: Housing

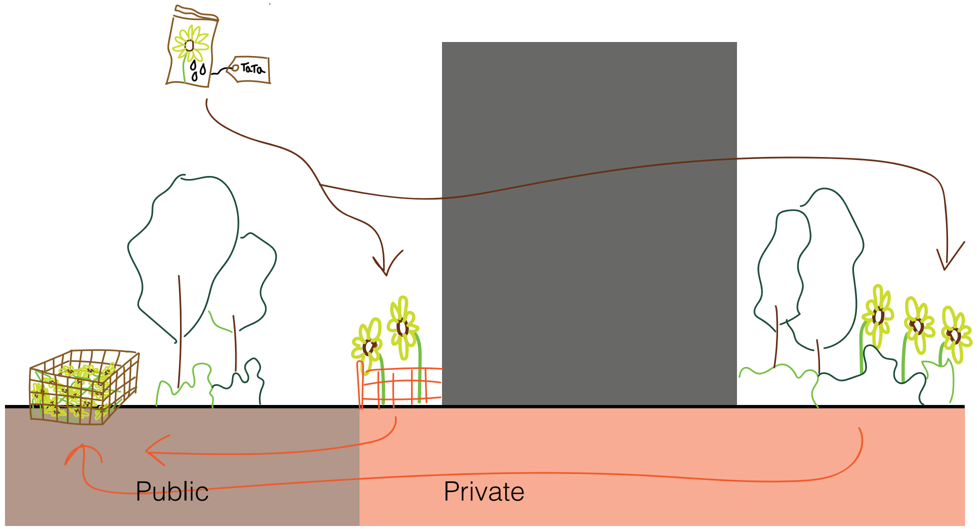


Location of the intervention

Leave collection bin in Venlo (Venlo, 2022)



Seed packets, planting plants and collection bins for the plants (own image, 2024)



Interaction of the seed packets with the public and private realm (own image, 2024)

The third design focuses on a change in the attitude of residents by focusing on a small strategy for housing in the private domain. This is done by engaging people and creating awareness for soil pollution by spreading seed packets. These seed packets will contain sunflower seeds, poppy seeds and marigold seeds. These are all pioneer flower plants that have phytoremediation qualities. Also, they are easy to plant and maintain. Residents will receive these packets at the start of spring, and the flowers will bloom throughout spring and summer and then wither. As discussed earlier, removing the plant biomass from the site for long-term remediation is essential. Collecting and removing this biomass from the private gardens, collection bins will be placed within the neighbourhoods where people can dispose of their contaminated biomass. This is a system that is used in Venlo every autumn to collect the leaves from trees. It is a system operated by the municipality. The bins are temporarily placed in the public space; if they are complete, they are emptied by the municipality. Within the towns of IJmond, this could function similarly. The contaminated biomass could be sold to biofuel factories. For this intervention to contribute to soil remediation, it would have to happen in consecutive years. However, the effect of this engagement through flower seeds is twofold. On the one hand, it engages people quickly and colourfully to contribute to the soil remediation of their private land. On the other hand, it also raises awareness of the pollution in the soil, its risks, and the future large-scale soil remediation project.

Phase 3: large scale remediation

Phase 3 large scale remediation territory (own image, 2024)

Sunflowers along the road (Freepik, n.d.)

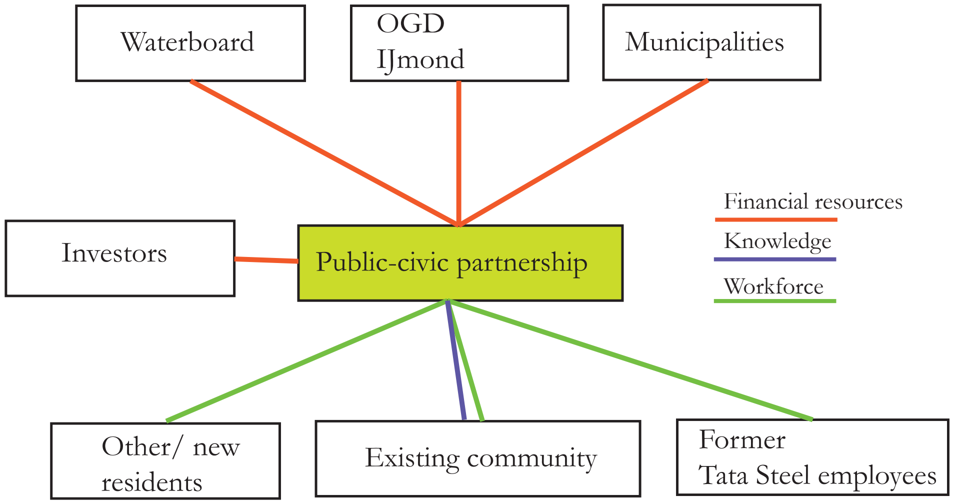
This third phase, a significant step in our journey, will commence once the residential remediation plants have been planted. It's a promising move that focuses on expanding soil remediation to the rest of the region. The zones that will be remediated in this phase are the production zones, the leisure zones and the undefined spaces between the A2 road that passes through Beverwijk. In due time, this will create three very different types of regions, following the plants and their succession stemming from the type of soil. In the north, the sandy soil will transform into a colourful, bushy landscape that grows out into a forest. The leisure zone in the east of the region, situated on the clay soil will evolve into a very fertile and green forest. And the production zone in the east, which is no longer in use will develop into a wetlands type of landscape, a testament to our commitment to environmental restoration.

Sunflowers will be planted on the intermediate pieces of land between the roads and along their edges. These spaces are indicated with yellow on the map. They create a lot of biomass for biofuel, look beautiful in the spring, and also help reduce particulate matter coming from cars.

Phytoremediating soil with plants can take up to twenty years or more. Factors that influence this time needed for remediation are the concentration of soil pollution, the depth of the soil pollution, and the type of soil pollution. Phase 3 concerns mostly zones situated furthest from the steel industry, but a minimum of two decades is needed to remediate this soil.

Phase 3 is also where the use of collaborative governance culminates in the creation of a public-civic partnership (PCP) that contracts community members to create an incentive to contribute to large-scale soil remediation. How this works in practice will be explained on the next page.

Public-civic partnership



Stakeholders that make up the public civic partnership (own image, 2024)

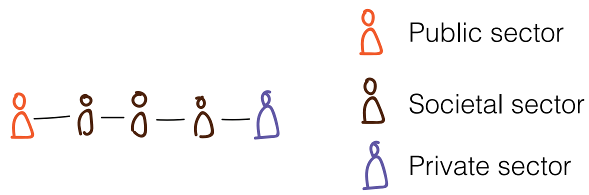


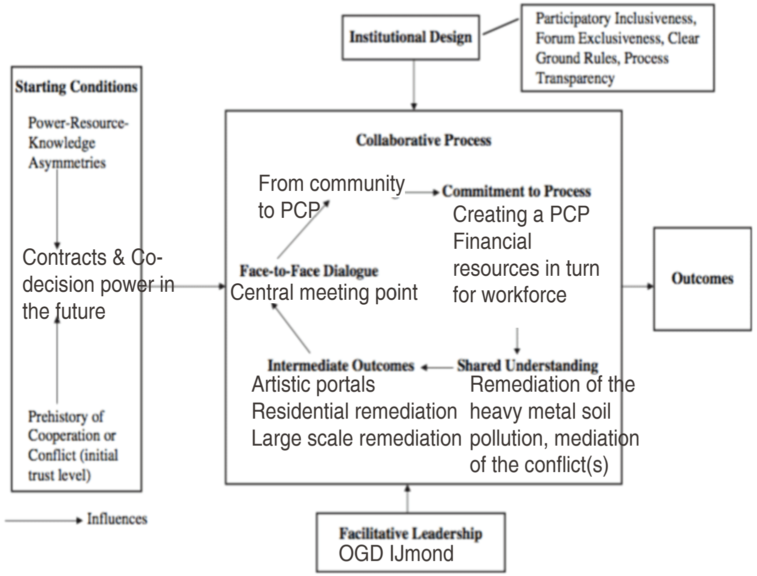
Diagram showing the stakeholder relations as horizontal power relatins of phase 3 (own image, 2024)

The success of phase three rests on the willingness of the community to evolve into a public-civic partnership (PCP). After the remediation of the residential zone, the voluntary willingness to plant, maintain and harvest polluted plants to create a direct livable environment needs to be replaced by an incentive that remediates the zones that indirectly affect the region's livability. A public-civic partnership would do that by contracting the community members and creating a collaborative governance structure with horizontal stakeholder relations that, through co-decision-making, decide on the progress of remediation whilst its members are getting paid for it. Thus, it would make money to sustain its employees; the only difference is that the main goal is not to profit but to remediate the soil. To shape this PCP and to have enough initial investment for buying the plants, distributing the plants across the territory and paying employees, the municipalities, the OGD and the waterboard contribute with financial resources. Because a lot of money is needed, additional financial resources come from investors who get a share in the development of phase four of the post-remediation phase. More on financing the remediation will be discussed later.

Moreover, the PCP not only serves the purpose of environmental remediation but also acts as a beacon of hope for the workforce. The workforce for the PCP is drawn from the existing community, and other/ new residents who have become aware of the large-scale remediation over time. Learning from the Green Steel transition in Port Talbot, where 2500 jobs were cut, one-third of the employees there are losing their jobs (Trouw, 2024), and Tata Steel in IJmuiden also has to cut about 800 jobs to save money for the Green Steel, the PCP provides a counterbalance of employment for these people. By reducing the dependency on the steel industry and creating alternative job opportunities, the PCP instills a sense of security and peace of mind for those worried about their job loss.

The tasks of the PCP will entail the initial planting of phytoremediation plants across the polluted territory. It also includes the maintaining of these plants, making sure they grow well and in the places they are supposed to grow. Lastly, when flowers have bloomed, in the autumn they need to be harvested, so pollution is actually removed from the site. The PCP does the same within the residential neighbourhoods where necessary. Considering plant growth, more people are needed during the peak seasons of planting and harvesting (spring and autumn), than the off-peak season of maintaining the plants (winter and summer). The PCP will work throughout the year on the core

Public-civic partnership



Collaborative governance framework by Ansell & Gash (2007) filled in to fit the large-scale remediation of the IJmond region.

tasks, other secondary stakeholders, such as schools, tourists and activists, can contribute during peak season on voluntary basis. Furthermore, the PCP will be structured by clearly defining responsibilities within specified tasks and by creating rules and legislative frameworks (Cultural Creative Spaces & cities, 2018). When the soil has been remediated, the PCP, now the experts on the IJmond region, will play a crucial role in deciding, planning and designing the future of the remediated soil. They are not just participants, but key decision-makers, essential in bringing out the future potential the IJmond region holds.

Regarding the collaborative governance framework, the first two phases have created ideal starting conditions for an inclusive, collaborative process. Face-to-face dialogue is encouraged at one of the meeting points or the community centre constructed within Phase 1. Furthermore, there is trust between the members of the PCP since they have done previous activities together, such as the remediation of the residential zone. The employees of the PCP are committed to the process since they stem from the intrinsic motivation of wanting to create a healthy living environment and are now getting paid for it. On top of that, the employees have a shared understanding that they feel the need to maintain the steel industry within the region, but only based on the soil pollution being remediated. Lastly, intermediate outcomes such as residential remediation, teamwork that brings together different stakeholders, and inclusivity in decision-making create a vital process value to keep residents motivated. To ensure that all these factors work towards the same goal, facilitative leadership is needed, provided by the OGD and the municipalities, to help provide expert knowledge and a network for remediation. The municipalities are also crucial in keeping the PCP in check where necessary since there is a higher risk of free-riding behaviour in these types of ventures. Collaborative governance can be very time-consuming, but by structuring it well and with clear communication, many of these potential issues can be mediated (Ansell & Gash, 2007). Overall, resources are shared between the members of the PCP, and there are horizontal power relations between the different stakeholders. Collective control and ownership of assets and resources by residents and local experts can address systemic injustices (Heron et al., 2021). The output will be fully remediated soil in twenty years, a restored trust within the public sector of the IJmond region and a public-civic partnership that understands the importance of the different values within the region.

Phase 4: post-remediation

Phase 4 post remediation territory (own image, 2024)

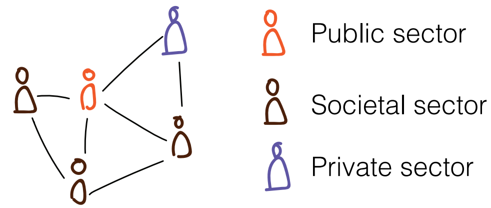


Diagram showing the stakeholder relations as a network of phase 4 (own image, 2024)

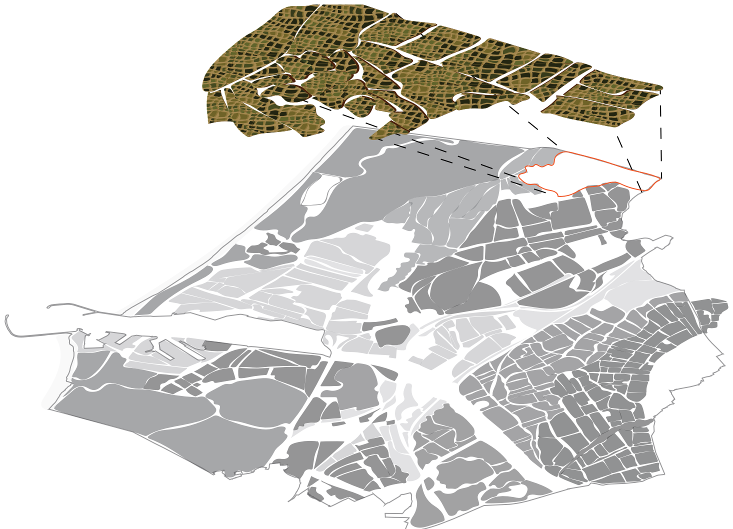
Phase 4 provides the conditions for the future development of the IJmond region once the soil is remediated. The soil is considered to be remediated when tests by the RIVM show that the concentration of heavy metals in the IJmond region has declined sufficiently to consider it healthy for residential use. This will take about twenty years, and the phytoremediation plants will have fully developed by then, creating a landscape of a young to mature forest.

To guide further development of the remediated landscape, a top-down zoning plan that values the region's potential is proposed. This plan is directed towards pieces of land that do not have a distinctive function, currently or in the future, such as parts of the productive zone that are being used as pastures for cattle to graze and empty pieces of land between towns, like between Heemskerk and Castricum.

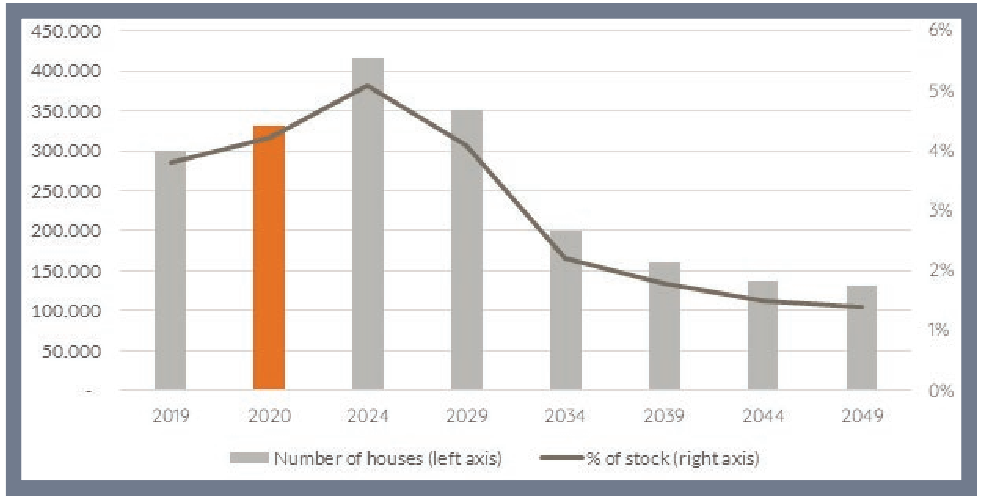
The zoning plan, designed to address future trends, will be implemented zone by zone. Each zone will tackle a specific trend, such as the housing crisis, sea level rise, and food scarcity. The responsibility for filling in this plan lies with the PCP. Investors will play a significant role in developing a solution for the housing crisis in the north of the IJmond region, while the community will have a major stake in the experimental living situation with nature in the east of the IJmond region.

Within this last phase, stakeholder relations evolve into a more natural and mutually gained type of relationship. Stakeholders will focus on the zone where their interest lies and complement each other's knowledge and resources where necessary. This means that not everyone is involved in all the decision-making anymore, creating more of a collaborative network between stakeholders that depends on the task at hand and who collaborates. The public sector remains the most central point within this stakeholder network since they have to oversee all the decisions made in order for them to contribute to financial resources.

Future zone 1

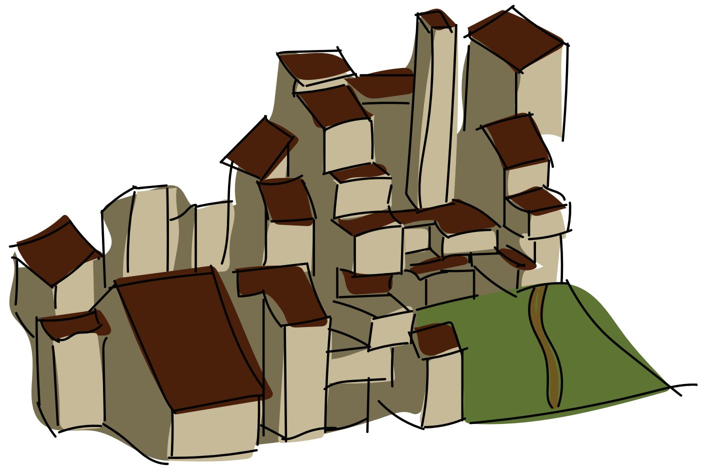


Location for housing developments (own image, 2024)



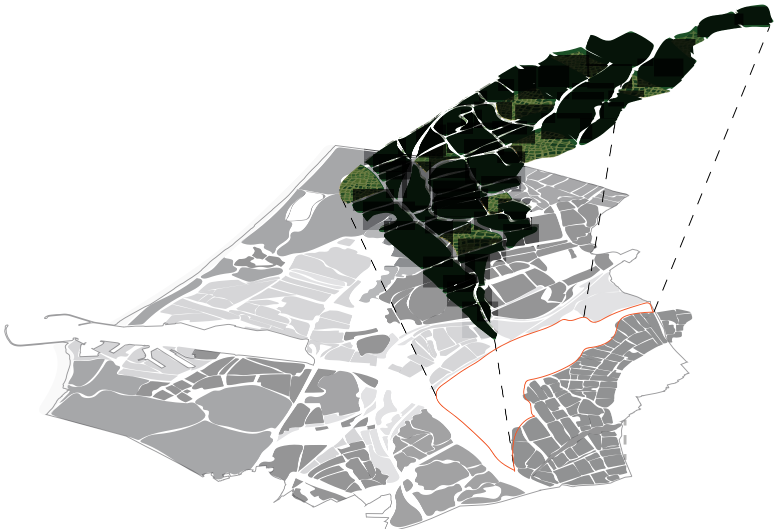
Housing crisis in the Netherlands (Primos, 2020)

The housing crisis is a battle the Netherlands has been fighting for a long time already, and the IJmond region provides an ideal location for densifying and adding extra housing. Currently, there is a need for 415000 extra houses. In order to build new housing, the soil must be clean so that the health of the new residents does not suffer the pollution of the previous land users. This is being taken care of by the significant scale remediation. Furthermore, this zone makes an ideal location for more housing since it is between the two existing towns of Heemskerk and Castricum and is thus very accessible. It is also closely located in Amsterdam and the North Sea. This part of the IJmond region is also located comparatively high in the surrounding landscape, which lies below sea level. This is an excellent asset in a future where the sea level rises and these lower-lying spaces potentially flood. Investors will also see these advantages and have been waiting and investing in the remediation of this space for a while to develop housing here. It is up to the municipality to ensure an inclusive mix of housing is being built and provide space for social housing, middle-class housing, and higher-class housing.

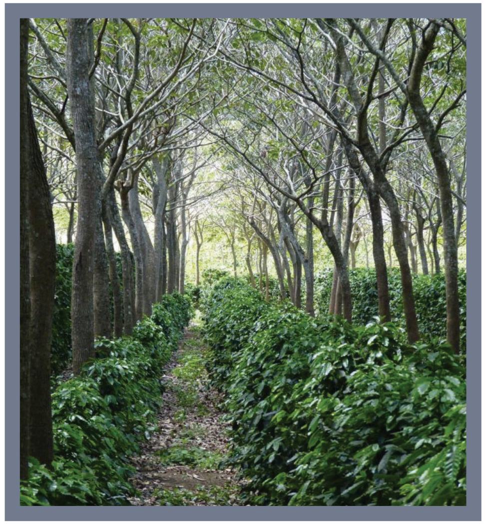


Mixed housing development (own image, 2024)

Future zone 2



Location for experimental living and ecofarming (own image, 2024)



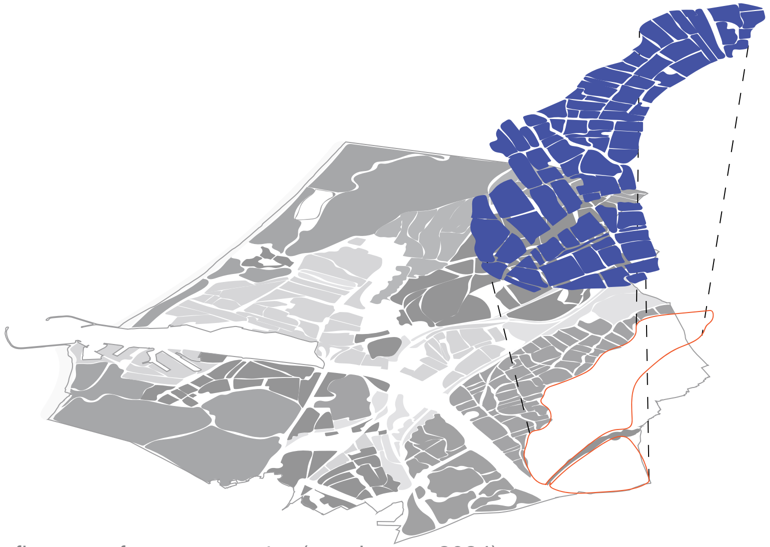
Agroforestry (UMR-systeem, n.d.)

Experimental living in the forest (own image, 2024)

Rising sea levels and the increased risk of heavy flooding are unavoidable and, thus, something the Netherlands will have to design for in the future. The IJmond region is also prone to this, especially the peat soil landscape near the North Sea Canal. An area that was once a thriving production zone for peat and for cattle to graze is now becoming increasingly useless. This part is about two meters under sea level (AHN, n.d.). With the growing need for more space for water within the Netherlands to make sure that other places do not flood, this area is an ideal part of exploring the opportunities of urban wetlands or living with water. This does not mean that this whole space should be flooded, but it implies occasional flooding when more space for water is needed during heavy rain and wet seasons. This could provide an exciting space for living with water in several ways, like at the Maarsseveense plassen, where water adds quality to the outside space, and another recreation layer, such as swimming or sailing a boat.

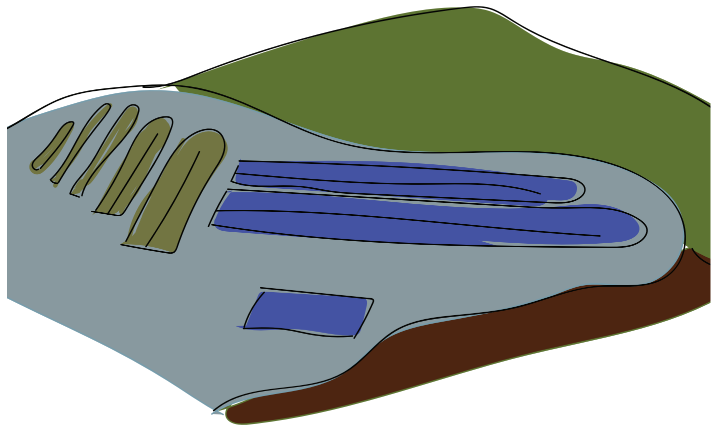
The potential of large-scale algae farming can be explored as compensation for the loss of productive landscape. Algae can be used to replace chemical fertilisers, improve soil health, produce nutritious food, and produce biofuel, and it can even be turned into fabric (Serafin, 2023). Algae farming not only caters to future needs but also provides a lucrative future business.

Future zone 3



Location overflow area for excess water (own image, 2024)

Living at the Maarsseveense Plassen near Utrecht (Janssen de Jong, n.d.)



Algae farming (own image, 2024)

The community that has been part of the PCP throughout the years of large-scale remediation gets more say in the future of their region. This is done on the clay soil landscape, where, over the years, a very fertile forest has developed. This space provides an ideal testing ground for experimental living and ecofarming.

The experimental living, like tiny housing or community living, is something that can be initiated before the soil is fully remediated. Ways of living with nature and on the land can be explored and tie in with the future need for housing in the Netherlands. Successful ways of experimenting with living can provide input for the whole housing part in the North of the IJmond, and ideally in many other places within the Netherlands. Living with nature caters to the need for more housing and a greater diversity of housing.

Sustaining this way of living that is more aware of its context, also called genius loci, calls for its own food production. That is why this space also lends itself to eco-farming or agroforestry. This can only happen once the soil is significantly remediated. Both of these ways of food production are sustainable and future-proof and try to combine the values of economy, ecology, and equity as best as possible. Together with experimental living, a test site for sustainable living is created.

Financing

Such large-scale remediation as the one in the IJmond region cannot be financed alone by the municipalities and the OGD. This means that alternative sources of money need to be found to create a successful remediation. The money is needed to buy the plants, plant them, buy the equipment needed to do so, and pay the employees who are doing this.

The steel industry will, needless to say, also finance part of the remediation. However, the investment costs of the Green Steel transition already put pressure on the industry's employment, and it would be counterproductive to make this even worse. Luckily, the steel industry can also contribute to the remediation by providing a workforce or equipment to maintain the plants.
So, other than the stakeholders mentioned above, other sources of financing need to be found.

It is not only the responsibility of the municipalities and the OGD to ensure a healthy living environment. The public sector as a whole is responsible for this standard of health, thus including the province of North Holland and potentially the state as a provider of subsidies for the remediation as well. Another public sector stakeholder that will become more important in the future of the IJmond region and thus also potentially in the financing of the remediation is the waterboard. Part of the remediation territory is a low polder landscape that, in the future, will be used to explore options for living with water. On the other hand, there is also the fact that soil pollution can wash out to the water bodies and thus also contaminate the water. Tackling soil pollution thus helps prevent water pollution. Both reasons fall under the waterboard's jurisdiction, incentivising them to finance the remediation partially.

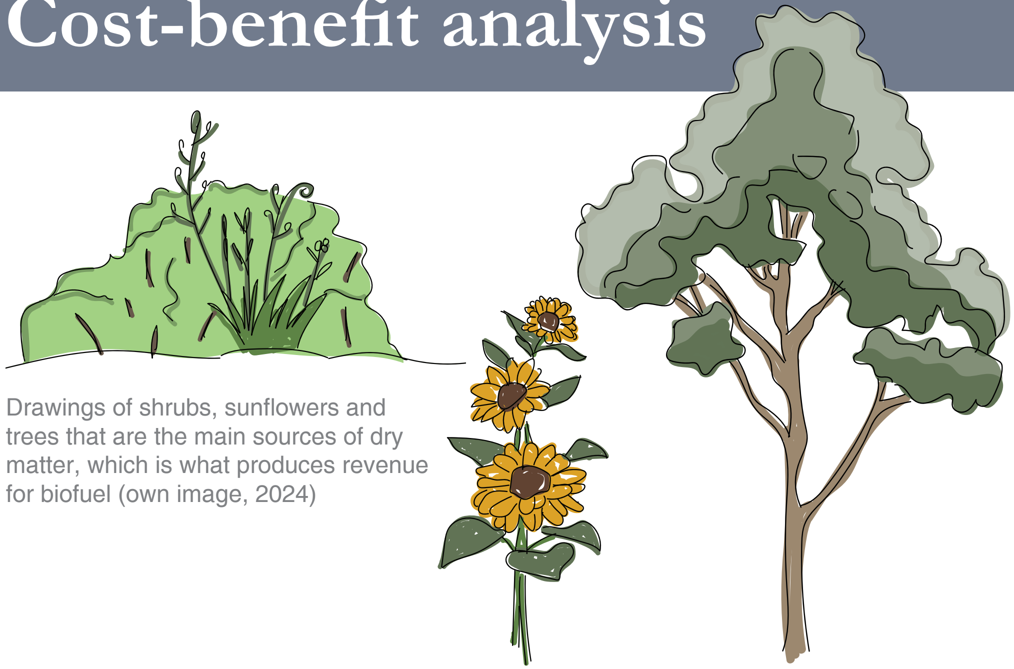
A new stakeholder that will become important in the financing of the remediation from phase three is investors. They hold many resources, and creating an incentive for them to contribute to the large-scale remediation creates a win-win situation. This incentive is the agreement that they will be part of the housing development that is planned to happen in phase 4 of the strategy between Castricum and Heemskerk. Their contract within the PCP will ensure their part in this development, but also sets guidelines on the type of development. This means there should be a fair division of housing types, including social housing. It is good to note that if investors agree to contribute, they cannot only choose to finance the housing part, but it is a package deal. The other pieces of soil remediation that are not necessarily intended for large-scale housing are part of this.

The revenue from phytoremediation plants' reuse and secondary function generates another steady potential income. The primary source of revenue would be to sell the dry matter biomass of the plants to companies that will turn them into biofuel. The sunflowers from phase three are highly suitable for this, but it can be done with any plant. Considering the plants that contain heavy metal pollution, though, an extra step needs to be taken in turning the biomass into biofuel, which is biomining the heavy metals from the ashes. This is extremely necessary to complete the cycle of removing pollution from the environment and not just displace the pollution issue. Specialised companies exist that do this. Ashes contain minimal heavy metals, but a fair amount can be won back on a large scale. Also, large plants will be harvested annually, and a fair amount of money can be made to finance the full-scale remediation.

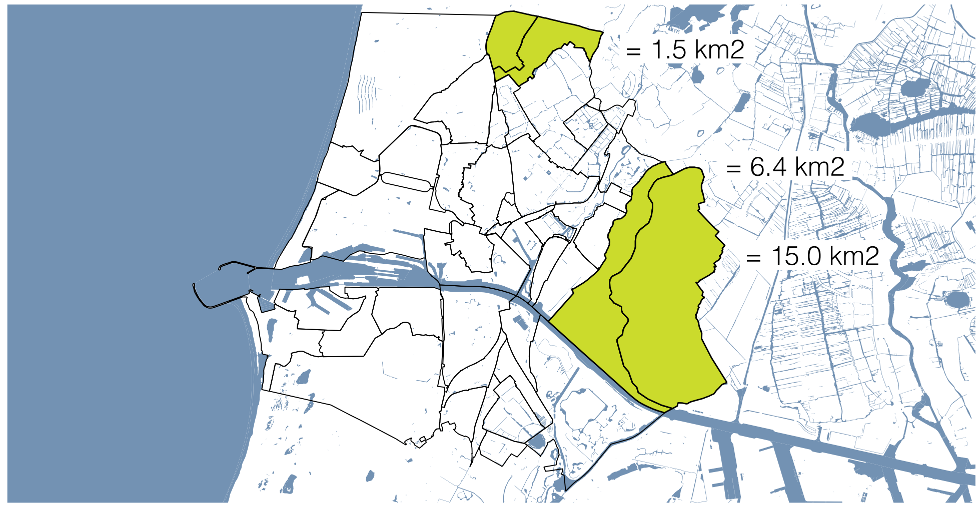
Once the plants develop, more and more valuable plants are growing within the landscape, such as trees or plants that can be used to make fabric. They can be sold to the corresponding companies to generate revenue. Since the remediation needs to be in full swing for plants to generate revenue, this will not be part of the initial investment for the remediation process to start.

Lastly, the IJmond region has the potential to grow into a tourist place. Responding to this potential could benefit the region's small businesses and hotels, generating money in the long run. Using the extensive scale remediation as a pioneering case for other places in the world and providing test sites for future housing, farming and living with water attracts people who want to experience this as well. Tours could be given, and other ways of interacting with tourists could be created to attract revenue. This is also one of the ways of receiving financial resources in the later stages of the large-scale remediation.

Cost-benefit analysis



Drawings of shrubs, sunflowers and trees that are the main sources of dry matter, which is what produces revenue for biofuel (own image, 2024)



Main areas of remediation, their total is about 23 km2 (own image).

A rough cost-benefit analysis has been conducted to gain insight into how much contribution from Tata Steel and the subsidies are needed on top of the plant revenue to finance the large-scale remediation.

This takes into account the total cost of phytoremediation, and regards the profit that can be made of the plants over a surface area of 23km2. An extended calculation has been done, this is added within the appendix (Ac). For a calculation like this many things have to be taken into account. One of the important ones for this calculation is that not all plants are harvested every year, and thus not all plants provide revenue every year. Weeds and sunflowers, grow fast and can be harvested every year. Trees and bushes on the other hand need more time to grow, and thus only provide revenue every five years. Furthermore an estimation is also made if this large-scale remediation will weigh up to the job losses of the steel industry within the transition to Green Steel. For this it is good to be aware of the fact that the amount of employees needed differ per season.

The drymatter of sunflowers creates a revenue of 10.125 euros each year, for an area of 1.5 km2.

The drymatter of shrubs and weeds creates a revenue of 69000 each year for an area of 23 km2.

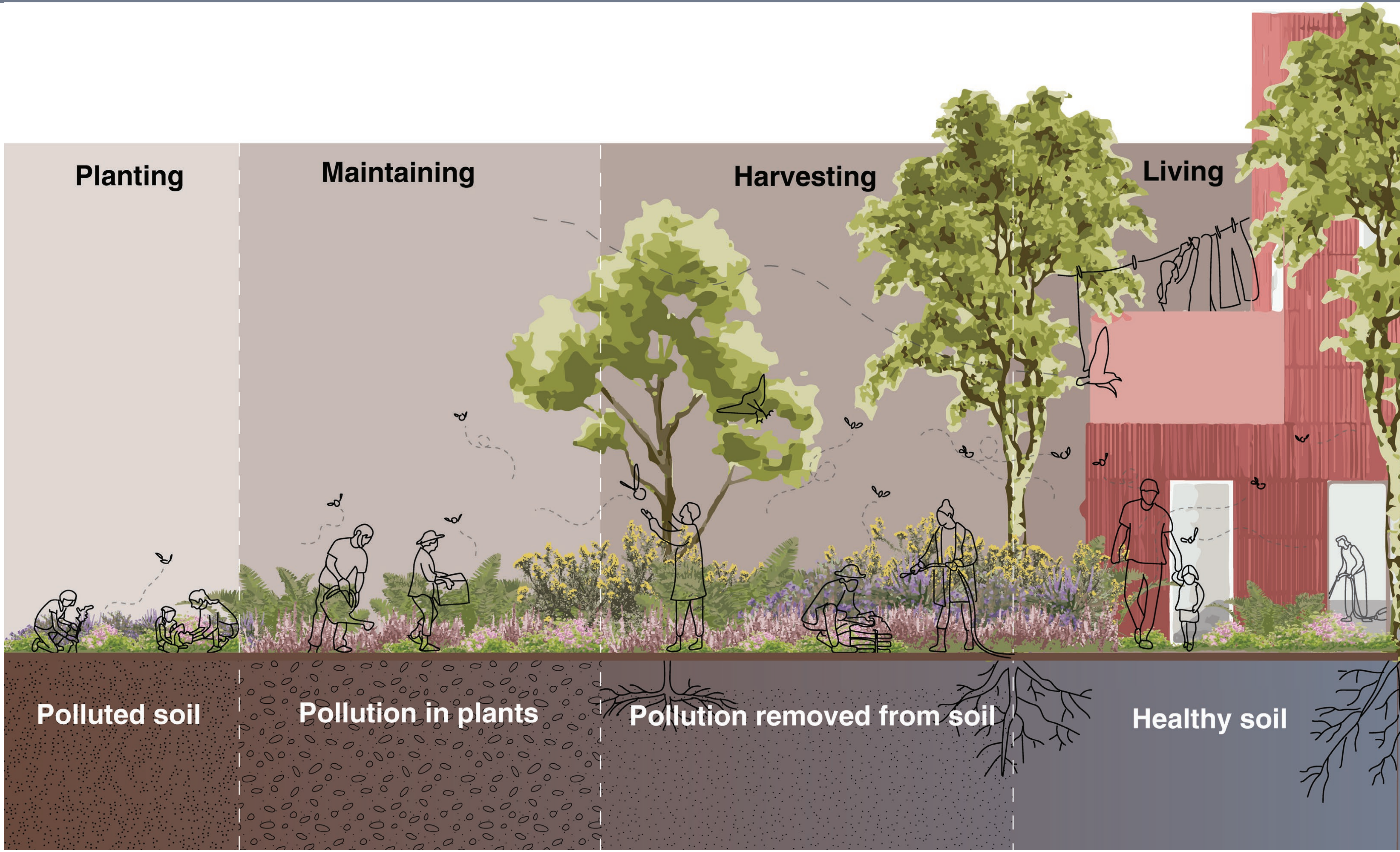
The drymatter of trees create a revenue of 1.125.000 on an area of 23 km2, but they will not be harvested often. This thus does not contribute to the revenue, except at the end of remediation.

The costs of phytoremediation, including initial capital, operational costs, the cost of infrastructure and fertilizer for an area of 23 km2 is 160.425 euros (Wan et al., 2016).

That means that in one year, the indicated zones on the map produce a revenue of 79.125 euros. An initial investment will thus be needed from the steel industry, the public sector and investors, but this will be compensated in two years and than the PCP can start making money.

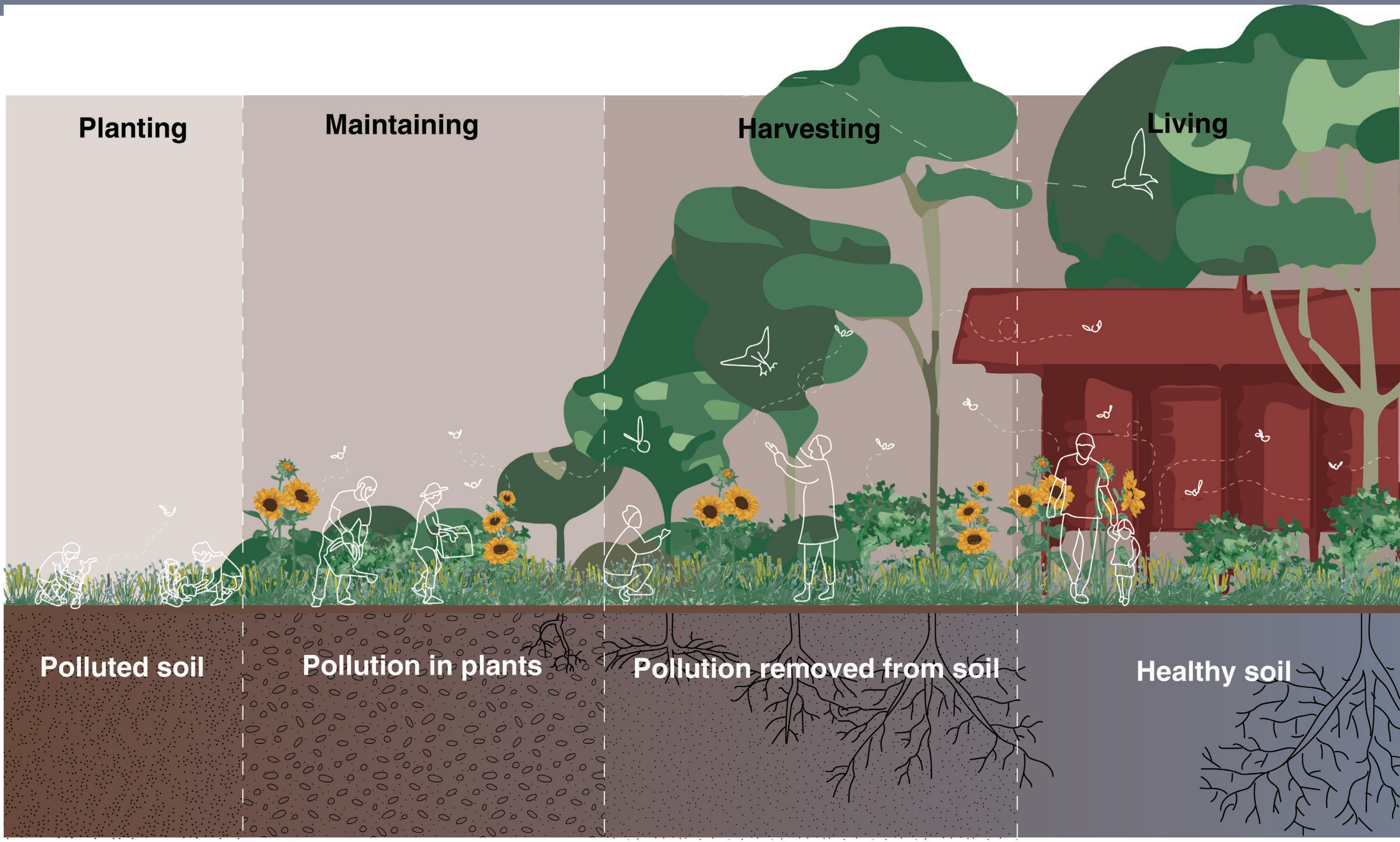
Regarding employees, peak workers and off-peak workers would be need that would range from 60 people in a season to 10-20 people (this is based on reforestation projects) (Eden reforestation projects, n.d.).

Succession section sand soil



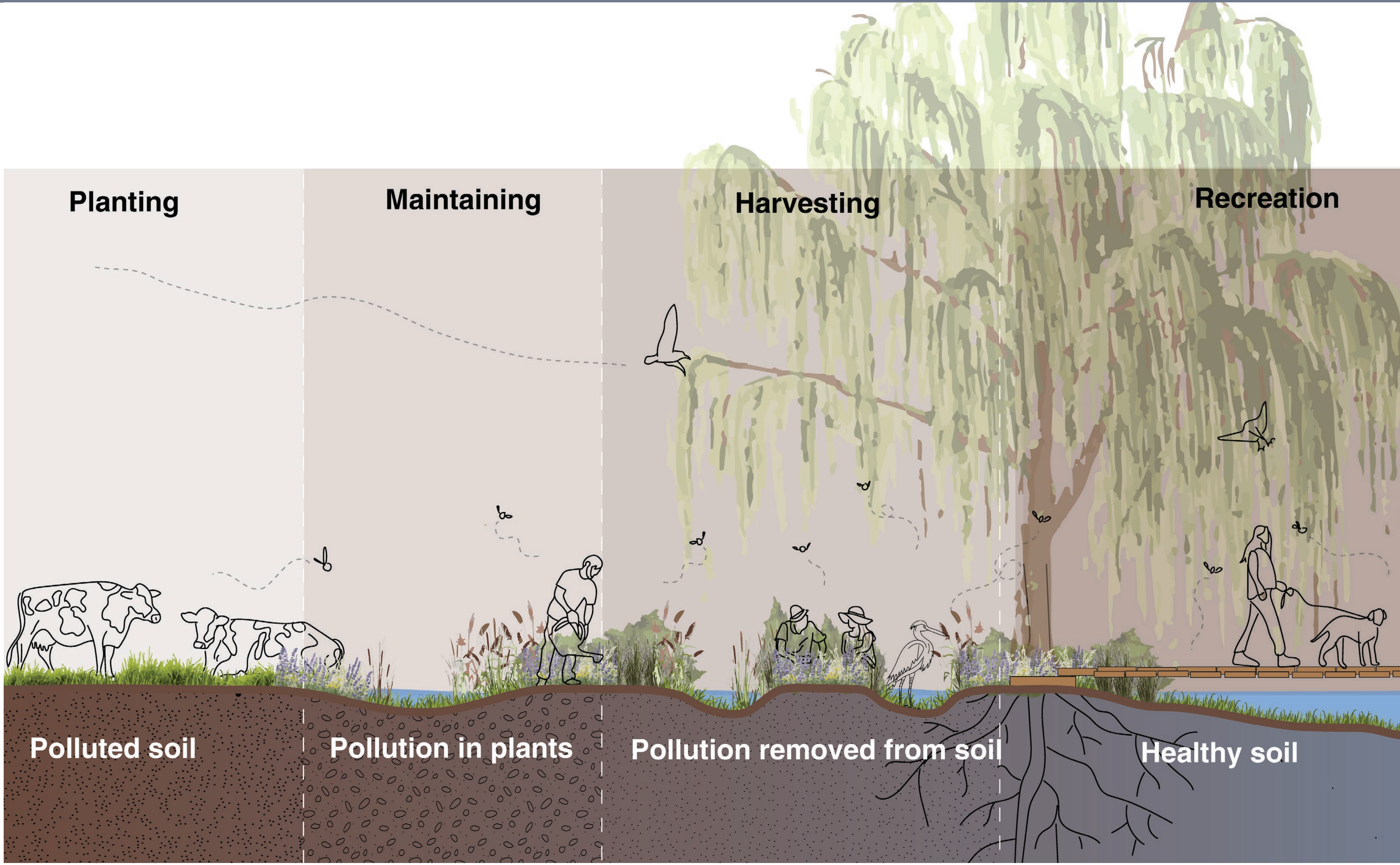
Succession of plants, evolvement of activities and remediation of soil (own image, 2024)

Succession section clay soil



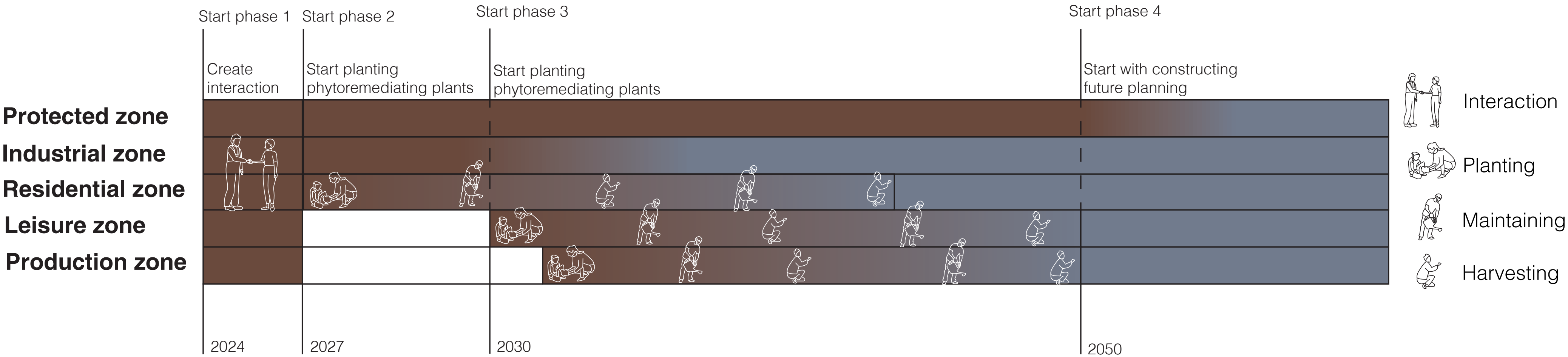
Succession of plants, evolvement of activities and remediation of soil (own image, 2024)

Succession section peat soil



Succession of plants, evolvement of activities and remediation of soil (own image, 2024)

Strategy timeline

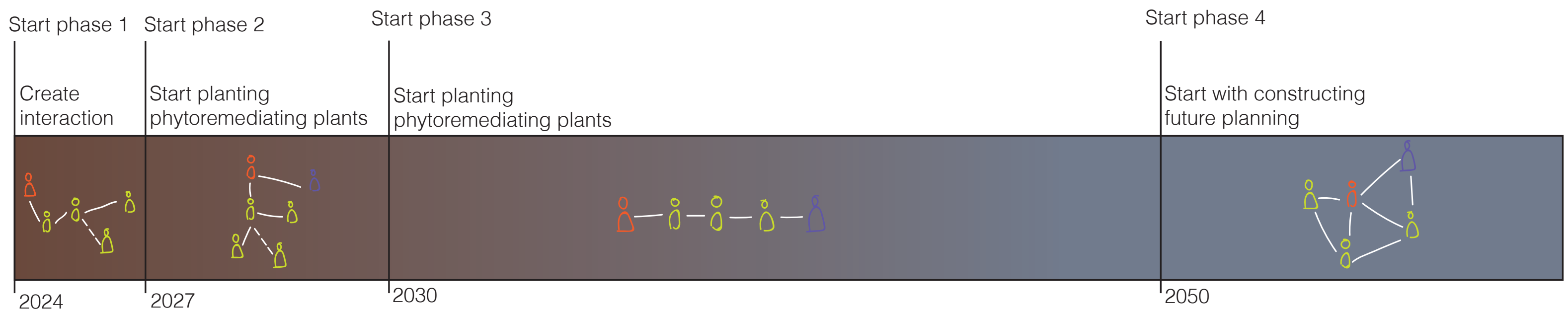


Timeline of remediation summarising the phases of the strategy and showing different activities that are part of each phase that need to be done (own image, 2024)

These two timelines show how the strategy evolves over time and at what rate the soil gets remediated. The first timeline shows the actions of the community and the PCP needed to remediate the soil. It starts with planting and then maintaining and harvesting the plants. It can be seen that while the soil of the residential zone is being remediated, the remediation process of the rest of the region is started.

The other two zones, the industrial zone and the protected zone, are also shown in order to compare the remediation of the soil through regulation (protected zone) and excavation (industrial zone).

The second timeline shows how stakeholder relations have evolved over time since the start of the phase to create an inclusive process of remediation.



Timeline that shows

07. CONCLUSION

The conclusion reflects how the main research question is answered with the help of the sub-questions, which serve as a guiding structure throughout the research.

It will also summarise how the spatial strategy and collaborative governance formed the output of this extensive research.

Lastly, a reflection is written that discusses the course of the research. From a personal point of view, it reflects on the content of the research, its structure, and the process of research itself. It explains limitations and topics of interest for future research.

Conclusion

The conflict between the steel industry's economic benefits and the human and environmental health of the IJmond region has significantly impacted its livability. For years, the industry polluted the landscape with heavy metals, creating a public health risk and degrading the environment. Despite preventive measures now being implemented, such as the focus on the Green Steel transition, the Roadmap Plus, and the municipality's involvement in this, soil pollution is not being addressed systematically.

A large-scale soil remediation strategy is essential to revaluing the IJmond landscape. This strategy maintains the steel industry's presence while addressing soil pollution remediation through a just and inclusive process. The conceptual framework guided the research by balancing economic benefits, environmental health, and social equity. The balanced outcome of this strategy is the remediated soil and a public-civic partnership that jointly lay the basis for the future of the IJmond region. This will benefit the IJmond region and the rest of the Netherlands in the future, where land is becoming more scarce, and the IJmond region will provide an ideal location to develop further.

The current value of the steel industry is deeply intertwined with the region's identity, reflecting mutual dependence between the residents and the industry. Acknowledging this, the strategy's first phase uses art to raise awareness and retain the industry's symbolic role. Simultaneously, the dependency on the steel industry's employment, which causes a lot of unrest and stress concerning the Green Steel transition, is counterbalanced by providing alternative employment through the Public-Civic Partnership that organises large-scale soil remediation. The steel industry will thus remain the most significant industry within the region, something that people can be proud of, but its pollution and significant dependency within the region will be mediated to create a healthier balance between the current value and the overall value of the landscape.

The intended value focuses on restoring soil health compromised by industrial pollution, thereby improving the region's livability. Different ways of remediating the soil have been identified, such as regulation, covering-up, excavating, and phytoremediation. Considering the large scale, the costs and the practicalities, phytoremediation is most suitable for large-scale remediation within the IJmond region. On top of that, phytoremediation is a sustainable solution for removing pollutants from the soil with the help of plants. It provides a way that not only displaces the pollution from the site but also makes sure that it is correctly disposed of. Using phytoremediation will change the current polder landscape, create a healthy environment, and provide future potential for the region's development after remediation. Maintaining plants on a large territory such as that of the IJmond region, together with harvesting the plants, are tasks performed by the PCP that contribute to removing the pollution from the soil. This effort of large-scale phytoremediation begins within residential zones and expands to industrial and leisure areas, fostering collaboration among residents, municipalities, and local businesses.

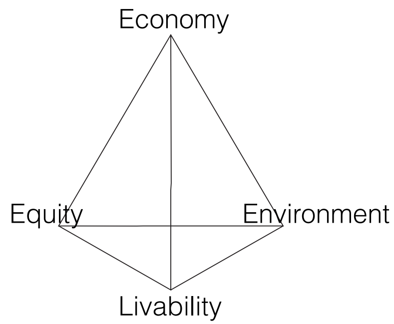
The process value emphasises the importance of an inclusive remediation process to rebuild trust and agency among residents. This can be done by focusing on residents as essential stakeholders in the remediation process and actively involving them in decision-making. A collaboration like this needs time to develop and thus starts in the first phase of the strategy by creating a community of motivated residents willing to contribute to the remediation. They will first voluntarily help in the remediation of their direct living environment within the residential zones, which will later develop into a PCP venture that is employed for large-scale remediation. This is the peak of collaborative governance that ensures an inclusive process and returns not only the physical livability to the region but also the long-term and mental livability.
A strategy for inclusive soil remediation is needed to answer the main research question and revalue the industrially polluted landscape of the IJmond region. The strategy aligns the current, intended, and process values established with the sub-questions into a large-scale approach that remediates the soil through phytoremediation. The strategy is supported by the inclusion of different stakeholders through collaborative governance that, in turn, reduces the dependency on the steel industry and creates a healthy balance between residents and the steel industry. In due time, this creates a clean slate for the residents of the IJmond region and returns value to make the IJmond region flourish.

Reflection

This reflection looks back on the development of the master thesis of urbanism within the studio of Planning Complex Cities. The result of this research is a strategy combining spatial remediation and collaborative governance to create a healthy and inclusive livable environment within the IJmond region. To get to this point, a long process of designing a research setup, conducting research, planning, and concluding has been carried out. Although planned well at the start of the thesis, this process never entirely goes according to plan. There were many hurdles to be taken throughout the research, and acknowledging these and understanding why they were a hurdle helps create an understanding of the whole process and improve future research. Being aware of my process, how I work, and how this can sometimes be beneficial and sometimes not helps steer me in the right direction for future projects (Reymen & Hammer, 2002). On the other hand, this reflection is also meant to acknowledge the things throughout the research that went well to see how far I have come and to be proud of this.
Firstly, I will look back at the previous reflection done at P2 and assess whether things went according to plan and why they did or did not. Secondly, I will reflect on the overall process of the research and whether the approach worked or not. Thirdly, I will discuss some of the limitations of the research, and lastly, I will discuss the recommendations for future research.

From P2 to P4

The process until P2 is aimed at setting up the research structure, finding theories about what you think the research will be about, and working out a plan for what the research is about and how to conduct it. From P2 on, the plans and intentions set have to be made into reality. Meanwhile, P2 was structured by the studio, guiding you through what needs to be done and when, and getting to P4 needed to be done on your own, with no top-down planning apart from an intermediate p3 presentation. I structured my process and managed what to do when it was difficult. Not because the planning was too ambitious but because the problem that my research addressed was difficult to grasp. This prevented me from creating a structured approach to conducting my research since I did not fully know what the intended output would be. I regained this structure with the help of my mentors, Juliana and Francesca, who provided some insights into organising my research. It turned out that I did not know what the problem was; I did not manage



Conceptual framework by Godschalk (2007)

to organise it well. The conceptual framework by Godschalk (2007), which focused on sustainable values but also addressed the issues that this creates, is what, in the end, provided this structure. This framework also helped me to understand the output I was working towards; not a top-down enforced design was needed, but a collaborative strategy. The research slowly deviated from the analysis, design and present loop I discussed in the previous reflection. I do think the design method is beneficial. However, within the strategy development, there was a need to make connections between different research topics addressing spatial remediation and governance structures. This research method is more suitable for spatial design and regional development (Kempenaar, 2020). Looking back, it seems more evident that the ADP method is ideally used for urban design and that my project, on the scale of the IJmond region, is more fit for a regional development approach.

The process remains iterative, but the focus is less on the design and more on developing an understanding of the different stakeholders to create a strategy embedded within its context.

Knowing this, combined with a practical conceptual model summarising the problem within the IJmond region, provided a solid basis to shape my way of handling the issue through strategy. This strategy, which shows what is needed to remediate soil on a large and how local actors can be engaged in order to achieve this, is something that I am proud to present.

Approach reflection

The choice of method was threefold to distinguish the three values of the current, the intended and the process in their fitting way. For the current value, this meant an analysis of the role of the industry and a site visit, including a tour of the site and interaction with some of the employees. For the intended value, this meant in-depth research on different ways of soil remediation. For the process value, this meant a stakeholder analysis focussed on interests, resources and needs to create a just process.

Looking back now, I think this practical approach pinpointed the different values. However, how to get to the conclusions of these

Reflection

methods was less effective. In the heat of the research, many different parts of the analysis happened simultaneously, and it was not easy to distil the necessary information from this. Again, the lack of structure made it difficult for me to see what I had learned and what was needed to strengthen the argumentation of my research. A moment like this helped me take a step back, look back at the conceptual model, and envision the strategy. This is something that both of my mentors helped me see.

An interesting approach for future research would be creating a stakeholder panel and testing the strategy. Addressing the same problem and envisioning the same output but only changing the methodology to see how to process value is something to be implemented not only once the project has already started but also when setting up the project's structure. In that case, the researcher would take on the mediator role and discuss with local actors what they need to realise large-scale soil remediation. Whilst the spatial implications of the research might not necessarily change, the analysis would be more grounded within its context.

Whilst I gained much expert knowledge on how steel is made, what soil pollution is and what its implications are, and which different types of remediation are fit for which situation, the most important things I learned are about the process of research and the development of a spatial strategy. I learned I value creating logical reasoning structures (such as decision trees) to guide decision-making. This is in contrast with the more associative thinking in order to design that I practised with during the Delft approach design intensive (Casakin, 2011)

Another important lesson I have learned is the value of others in developing an idea. My two mentors, Juliana and Francesca, served as experts in guiding me through the research. They helped me get back on track when I risked losing structure. However, other people, friends and peers also helped me learn how to explain my research and gave me insights into their views on my research. Gaining this knowledge of the importance of collaboration and discussing different points of view is a real asset in my future urbanism career, but it also applies to other aspects of life; I am grateful.

From p4 to p5

Going from P4 to P5 was challenging. On the one hand, you feel that the studying is over, and on the other hand, you want to present your best work yet. With not that much time between P4 and P5, this was quite the challenge. Luckily, my mentor's guidance helped me, as always, see clearly where real improvement could be made and how I could make something special out of my P5 presentation.

I found a way to engage the audience during the P5 presentation by bringing part of the strategy to life and using them as a test panel to determine whether the strategy could really work if they were the residents of the IJmond region.

Reflection on the studio

The studio of planning complex cities is very much reflected in my research. From the beginning, I have been trying to get a grip on the complex issue of soil pollution in the IJmond region. Often, this made me lose sight of the goal in mind, but it also illustrates how interlinked different issues are within one complex topic. Working in this scattered research approach on multiple topics simultaneously was helpful in the analysis part of the research but proved challenging to combine in one strategy. Again, this hurdle was tackled by talking about it with people and asking peers for help to gain fresh insight into the topic.

On the other hand, I missed a particular structure or inspiration I hoped to find within the studio.

After P2, there were no lectures or workshops that would encourage the mutual exchange of ideas between peers or references from practice that could help as a source of inspiration. This means that projects throughout the studio of complex cities have developed very broadly. In my process, I could have benefited from exchanging with peers from my studio. Now, this exchange of ideas is more common among friends and people from other studios.

Activist warning for the steel industry (own image, 2024)

Future research

There are a few limitations of the implications of this research that are important to address.

First of all, the strategy aims to reduce heavy metals within the soil according to the national regulations for soil pollution. These norms vary significantly from the WHO norms set by the United Nations. These are much lower and would thus take longer to achieve. This is one of the limitations that addresses the necessary knowledge needed to know how high the concentration of heavy metals in the soil can be in order for it to create a health effect in people who regularly interact with it.

Another limitation, and a potential future recommendation, is the type of pollution that has been researched. If the goal is to bring back livability, other sources that directly threaten the health of the environment stemming from the steel industry or any other industry would also have to be included. It would be interesting to see the long-term effects of air or water pollution on the region. Because of time constraints, this was not done during

this research.

Limitations

There are two recommendations that I would like to make concerning potential future research.

The first one uses a different method to create a strategy that builds up towards a collaborative, participatory strategy and uses collaborative methods between stakeholders to create a comprehensive strategy. In this way, the strategy would practice what it preaches: a more inclusive decision-making process.

The second recommendation for future research is based on the conceptual model used as a guide throughout this research. Where the research evolved around mediating the conflict between economy and livability, the complexity would increase by adding the conflict between economy and equity and economy and environment. However, to remediate the entire IJmond region, these other protected and industrial zones would also have to be included. Especially knowing that future development is complicated to predict, these zones might switch functions in the coming decennia. Future research could thus look into how the strategy and the collaborative governance would change when the other two conflicts between economies are remediated and all the different zones are included.

0b. BIBLIOGRAPHY

AHN. (n.d.). *Actueel Hoogtebestand Nederland.*

Allecijfers.nl. (2023). *Informatie in cijfers en grafieken.*

Ansell, C., & Gash, A. (2008). *Collaborative Governance in Theory and Practice.* Journal of Public Administration Research and Theory, 18(4), 543–571. https://doi.org/10.1093/jopart/mum032

Bardos, R. P., Jones, S., Stephenson, I., Menger, P., Beumer, V., Neonato, F., Maring, L., Ferber, U., Track, T., & Wendler, K. (2016). *Optimising value from the soft re-use of brownfield sites.* Science of The Total Environment, 563–564, 769–782. https://doi.org/10.1016/j.scitotenv.2015.12.002

bodemdata.nl. (n.d.). *Bodemdata.*

Bozeman, B. (2007). P*ublic Values and Public Interest: Counterbalancing Economic Individualism.* Georgetown University Press.

Bristol Climate & Nature partnership. (n.d.). *Lets transform Bristol. Fast. Fairly. Together.*

Brugha, R. (2000). *Stakeholder analysis: a review.* Health Policy and Planning, 15(3), 239–246. https://doi.org/10.1093/heapol/15.3.239

Casakin, H. (2011). *Associative thinking as design strategy and its relation to creativity.* International Conference on Engineering Design.

Chen, F., Yang, Y., Mi, J., Liu, R., Hou, H., & Zhang, S. (2019). *Effects of Vegetation Pattern and Spontaneous Succession on Remediation of Potential Toxic Metal-Polluted Soil in Mine Dumps.* Sustainability, 11(2), 397. https://doi.org/10.3390/su11020397

Cucuzzella, C., Chupin, J.-P., & Hammond, C. (2020). *Eco-didacticism in art and architecture: Design as means for raising awareness.* Cities, 102, 102728. https://doi.org/10.1016/j.cities.2020.102728

Cultural creative spaces & cities. (2018). *Toolkit for Homes of Commons - Public-civil partnership.*

de Groot, R. (2006). F*unction-analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes.* Landscape and Urban Planning, 75(3–4), 175–186. https://doi.org/10.1016/j.landurbplan.2005.02.016

Department of Energy & Environmental protection. (2020). *What is particulate matter.*

Duffy, S. (2023, November 3). *Port Talbot Tata steelworks: What are the key issues?*

Eden reforestation projects. (n.d.). *Eden reforestation projects.*

Edgar, V.-N., Fabián, F.-L., Mario, P.-C. J., & Ileana, V.-R. (2021). *Coupling Plant Biomass Derived from Phytoremediation of Potential Toxic-Metal-Polluted Soils to Bioenergy Production and High-Value by-Products—A Review.* Applied Sciences, 11(7), 2982. https://doi.org/10.3390/app11072982

European Biofuels Technology platform. (2015). *Neste invests in its world scale renewable products refinery in Rotterdam.*

European environment agency. (2020). *Progress in the management of contaminated sites in Europe.*

European Environment Agency. (2022). *Soil pollution and health.*

Finch, H. J. S., Samuel, A. M., & Lane, G. P. F. (2014). *Soils and soil management.* In Lockhart & Wiseman's Crop Husbandry Including Grassland (pp. 37–62). Elsevier. https://doi.org/10.1533/9781782423928.1.37

Frantzeskaki, N., & Rok, A. (2018). *Co-producing urban sustainability transitions knowledge with community, policy and science.* Environmental Innovation and Societal Transitions, 29, 47–51. https://doi.org/10.1016/j.eist.2018.08.001

Godschalk, D. R. (2007). *Land Use Planning Challenges: Coping with Conflicts in Visions of Sustainable Development and Livable Communities.* Journal of the American Planning Association, 70(1), 5–13. https://doi.org/10.1080/01944360408976334

Government of The Netherlands. (n.d.-a). *Accelerating the transition to a circular economy.*

Government of The Netherlands. (n.d.-b). O*p weg naar een veilige en gezonde leefomgeving.*

Grotenhuis, T., van Vianen, L., Wijnja, A., & Bruijnes, J. (2022). *Phytoremediation as Accelerator of Transformation towards Regenerative Cities.*

Haraway, D. (2016). *Staying with the trouble.* Duke University Press.

0b. BIBLIOGRAPHY

Harvard University. (n.d.). *Use images and media to enhance understanding.*

Häyrynen, M. (2014). *Lost Landscapes: Degraded Landscape as Anti-Landscape.* BRILL. https://doi.org/10.1163/9789401211697_010

Heron, K., Milburn, K., & Russell, B. (2021). *Public-Common Partnerships: democratising ownership and urban development.*

Herzog, R. H., Gonçalves, J. E., Slingerland, G., Kleinhans, R., Prang, H., Brazier, F., & Verma, T. (2023). C*ities for citizens! Public value spheres for understanding conflicts in urban planning.* Urban Studies. https://doi.org/10.1177/00420980231207475

Human. (2023). *STAAL.* NPO3.

Jaishankar, M., Tseten, T., Anbalagan, N., Mathew, B. B., & Beeregowda, K. N. (2014). *Toxicity, mechanism and health effects of some heavy metals.* Interdisciplinary Toxicology, 7(2), 60–72. https://doi.org/10.2478/intox-2014-0009

Karst, B. (2023). *Hundreds of activists on the Tata steel site to stop the toxic pollution of the steel factory.* Greenpeace.

Kempenaar, A. (2020). *The Connection Between Regional Designing and Spatial Planning. In Shaping Regional Futures* (pp. 59–69). Springer International Publishing. https://doi.org/10.1007/978-3-030-23573-4_5

Kennen, K., & Kirkwood, N. (2015). *Phyto.* Routledge.

Kolay, P. K., & Taib, S. N. L. (2018). *Physical and Geotechnical Properties of Tropical Peat and Its Stabilization.* In Peat. InTech. https://doi.org/10.5772/intechopen.74173

LIBERTY steel group. (n.d.). *Green Steel.*

Lima, V. (2021). *Collaborative Governance for Sustainable Development* (pp. 1–11). https://doi.org/10.1007/978-3-319-71066-2_2-1

Lopez, G., Farfan, J., & Breyer, C. (2022). *Trends in the global steel industry: Evolutionary projections and defossilisation pathways through power-to-steel.* Journal of Cleaner Production, 375, 134182. https://doi.org/10.1016/j.jclepro.2022.134182

Lu, H., Condés, S., del Río, M., Goudiaby, V., den Ouden, J., Mohren, G. M. J., Schelhaas, M.-J., de Waal, R., & Sterck, F. J. (2018). *Species and soil effects on overyielding of tree species mixtures in the Netherlands.* Forest Ecology and Management, 409, 105–118. https://doi.org/10.1016/j.foreco.2017.11.010

McGregor, A., & Cowdy, M. (2023). *Biourbanism | cities as nature: A resilience model for Anthromes.* Science Talks, 7, 100238. https://doi.org/10.1016/j.sctalk.2023.100238

McLachlan, A., & Brown, A. C. (2006). *The ecology of sandy shores. Coastal dune ecosystems and dune/beach interactions* (Second edition).

Nesbit, J., & Waldheim, C. (2023). T*echnical lands: A critical primer* (1st ed.). Jovis.

Nonet, G. A.-H., Gössling, T., Van Tulder, R., & Bryson, J. M. (2022). *Multi-stakeholder Engagement for the Sustainable Development Goals: Introduction to the Special Issue.* Journal of Business Ethics, 180(4), 945–957. https://doi.org/10.1007/s10551-022-05192-0

Nye, D. E., & Elkind, S. (2014). *The Anti-Landscape.* BRILL. https://doi.org/10.1163/9789401211697

Onderzoeksraad voor veiligheid. (2023). *Emissie kooksovengas bij Tata Steel.*

Randall, D., Harper, R., & Rouncefield, M. (2007). *Fieldwork for Design.* Springer London. https://doi.org/10.1007/978-1-84628-768-8

Reymen, I., & Hammer, D. (2002). *Structured reflection for improving design processes.* International Design Conference.

RIVM. (2023). *De bijdrage van Tata Steel Nederland aan de gezondheidsrisico's van omwonenden en de kwaliteit van hun leefomgeving.*

Rocco, R. (2013). *Why governance will make urban design and planning better: Dealing with the communicative turnin urban planning and design.*

Rocco, R., Thomas, A., & Novas-Ferradás, M. (2022). *Teaching design for values: concepts, tools and practices.* TU Delft Open Publishing.

Sassen, S. (2014). *Expulsions: Brutality and Complexity in the Global Economy.* Harvard University Press.

Scullion, J. (2006). *Remediating polluted soils.* In Naturwissenschaften (Vol. 93, Issue 2, pp. 51–65). https://doi.org/10.1007/s00114-005-0079-5

Serafin, A. (2023). *Algae-powered crops.* European

Investment Bank.

Sheridan, T., Sayre, N., & Seibert, D. (2014). *Stitching the West back together.* University of Chicago Press.

Stooker, C. (2021). *Het scenario waar niemand over praat: Nederland zonder de hoogovens.* Financieel Dagblad.

Tata Steel. (n.d.). *Innovation in Tata Steel.*

Tata Steel. (2023). *Tata Steel's roadmap Plus.*

Thomas, G., Cherry, C., Groves, C., Henwood, K., Pidgeon, N., & Roberts, E. (2022). *"It's not a very certain future": Emotion and infrastructure change in an industrial town.* Geoforum, 132, 81–91. https://doi.org/10.1016/j.geoforum.2022.04.003

Trouw. (2024). *Grote ontslagronde bij Tata Steel in Wales.*

UN Environment Programme. (2021). Global assessment of soil pollution: Report. FAO and UNEP. https://doi.org/10.4060/cb4894en

UN environment programme. (2021). *Planetary action.*

UNDRR. (2020). *Land degradation.*

van Waijjen, H. (2022). *Nature-based nutrient and micropollutant removal by sustainable plant-diverse floating treatment wetlands.*

von der Dunk, A., Grêt-Regamey, A., Dalang, T., & Hersperger, A. M. (2011). *Defining a typology of peri-urban land-use conflicts – A case study from Switzerland.* Landscape and Urban Planning, 101(2), 149–156. https://doi.org/10.1016/j.landurbplan.2011.02.007

Wan, X., Lei, M., Chen, T. (2016). *Cost-benefit calculation of phytoremediation technology for heavy-metal-contaminated soil.*

Watari, T., Nansai, K., & Nakajima, K. (2021). *Major metals demand, supply, and environmental impacts to 2100: A critical review.* Resources, Conservation and Recycling, 164, 105107. https://doi.org/10.1016/j.resconrec.2020.105107

WHO. (2005). *Regulations regarding quality standards for soil and ground.*

Zembla. (2008). *Het gif van Corus.*

0c. IMAGE LIST

Agile city. (2017). *Zuiveringsgebouw Westergasfabriek*

ANP. (n.d.). *View on Tata Steel.*

ANP & Versteeg, H. (2022). *Tata Steel climate neutral in 2045.*

Ansell & Gash. (2007). *Collaborative governance framework*

Candiani, T. (n.d). *Landscape sound amplifier.*

Chirsto & Jean-Claude. (1995). *Arc de triomphe.*

Crown van Gelder. (n.d.). V*an Gelder papier fabriek.*

Dan. (2020). *Phytoremediation: what is it, and why might it be right for your contaminated site?*

Depot. (2005). *Tata Steel as seen from above.*

Eihem. (2006). *Bergmeisterwolf landscape frame.*

EPA. (2012) *Technical overview to cover polluted soil.*

FAHR 021.3. (2019). *Rest landscape.*

FD. (2021). *The scenario no one is talking about, The Netherlands without the furnaces.*

Federal Steel supply. (2023). *Emerging trends in the steel industry for 2024.*

GGD Amsterdam. (2021). *PM10 average a day in the IJmond.*

Google. (n.d.). *Google streetview.*

Greenpeace. (2021). *Tata Steals: the pollution of tata Steel for humans, animals and nature.*

Grotenhuis, T., van Vianen, L., Wijnja, A., & Bruijnes, J. (2022). *Phytoremediation as Accelerator of Transformation towards Regenerative Cities.*

Heemskerkse Golfclub. (n.d.). *Golfclub Heemskerk*

Janssen de Jong. (n.d.). *Maarsseveense plassen*

Jerney & Spilling. (2018). *Algae farming.*

LIBERTY steel group. (n.d.). *Green Steel.*

Mckeown. (n.d.). *Tata Steel Port Talbot.*

Meisner. (2014). *The elastic perspective.*

Nazca solutions. (n.d.). *Vervuiling over de jaren.*

Nieuw. (2019). *Pavilion of the future.*

NOS. (2023). *RIVM correlation between Tata Steel emissions and chance of sickness.*

NRC. (2023). *Wijk aan Zee and the steel industry.*

NYC parks. (n.d.). *Freskills park on top of a landfill.*

Observation projects. (2012). *Spiral garden*

ODIJmond. (2022). *Birdseye view.*

ODNoordzeekanaalgebied. (2022). *Opening of the biggest sealock of the world.*

Pavic. (2020). [movie]. *Landscape zero.*

Primos. (2020). *Housing crisis in the Netherlands.*

PWN. (2023). *Uitkijktoren Kruisberg.*

Railton. (n.d.). *Succession process.*

Rijkswaterstaat. (n.d.). *The Netherlands below sea level.*

Rumping. (2023). *Dunes.*

RVR. (n.d.). *Zollverein park in Essen.*

SLA. (2019). *Copenhill in Copenhagen.*

Snigiri architects. (2018). *Passive house, living in green.*

Speelman. (n.d.). *Castle of Assemburg.*

Superbass. (n.d.). *De Ceuvel Amsterdam.*

Tata Steel. (n.d.). *The process of steel making.*

Tata Steel. (2023). *Green steel adjustments.*

UMR-systeem. (n.d.). *Agroforestry.*

Van Genuchten. (2023). *Removing of pollutants from soil and water.*

Van Vaerenbergh. (2019). *Arcade.*

Venlo. (2022). *Bladkorven in Venlo.*

Volkers. (n.d.). *Vishaven IJmuiden*

Wang. (2021). *Expected rise in steel demand until 2100.*

Willens. (n.d.). *Portals by Christo.*

(Re)mediation

This research addresses the heavy metal soil pollution of the IJmond region caused by the presence of the industry for over a hundred years. Currently, Tata Steel's steel industry is transitioning towards Green Steel production, which will decrease air pollution significantly; this does not solve the issue of soil pollution that has accumulated over the years within the region. Even though heavy metals in the soil surpass the legally allowed concentration, nothing is being done about it. Heavy metal soil pollution influences human health when interacting with the soil and can indirectly contaminate produce grown on the soil. Due to this decennia-long pollution of the steel industry, the value of the surrounding landscape (the IJmond region) has decreased, limiting the residents' health and future potential for development. That is why this research will focus on how to return value to the IJmond region in the Green Steel future of the steel industry. This will be done by creating a strategy concentrating on the spatial impact of soil pollution and the societal impact on the residents in working towards healthy soil again.

The revaluing strategy will focus on three sub-values: the current value that should be maintained, the intended value that should be created and the process value of ensuring a just process in revaluing the landscape. The current value is the presence of the steel industry within the region and how it is engrained within the societal structure of the IJmond region. A consequence of the presence of this current value is soil pollution, which causes a conflict with the livability of the region. This is why the intended value is a healthy soil that returns livability and remediates pollution. The process value stresses the need for an inclusive process that creates agency and transparency for residents.

The strategy combines these values by integrating collaborative governance with spatial remediation, both of which are essential to realising healthy soil on a large scale. This is done in four phases that focus not only on planting, maintaining, and harvesting plants that clean the soil through phytoremediation but also on creating stakeholder interaction and engagement.

(Raven van der Steen, 2024)