REVIVING

Regenerative decontamination design for industries in the N.W.E DELTA region

RIVERS

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DESIGNING INDUSTRIAL DECONTAMINATION OF THE RHINE MEUSE SCHELDT RIVER BASIN

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Faculty of Architecture and the Built environment

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ABSTRACT

Although the industrial release of pollutant substances into North West European river delta has been decreasing over the last decades, The Netherlands still has one of the worst water qualities in Europe. In this strategic regional design we aim to improve the quality, quantity and distribution of water through the concept of sustainable land use. Industrial waste, waste water and increasing demand for land are the main pressures on our river water system. Considering the future risk of flood and drought there is also a big insecurity about our water quantity. There will be a need for more space and fair use of our water system. The goal is to restore the water quality in the North West European river delta and secure a sufficient water quantity for future use, flood protection and a fair distribution of the water available. In this report research by design is used to develop a spatial vision and spatial strategy that will create spatial water justice and with that a healthy river landscape. There are three themes related to spatial water justice: water quantity, quality and distribution. To meet sufficient standards for these three themes there are three important concepts: a circular industrial water system, decontamination and room for the rivers. All of them deal with the broader concept of sustainable land use. Sustainable land use is the fair and balanced distribution of land and environmental resources. This report shows a regenerative decontamination design for the North West European river delta. It is the development of a catalog of interventions that can be used in the whole river basin. Many small changes make a big difference in an interconnected system like a river basin. Every small intervention that will help clean the water, adds to the whole system and changes the whole system into a healthy and just river landscape. Together with this catalog there is a manual where the interventions are connected to spatial qualities of a specific location. The catalog and manual have been implemented for the case of South - Holland / Rivierenland. This example shows how we assure a sufficient water quality, quantity and fair distribution of water in a long-term perspective in the North West European Delta region.

KEY WORDS

Spatial water justice, decontamination, circular water system, sustainable land use, flood prevention

PREFACE

This report tells you the story of a decontamination design for the North West European river delta. It is a strategic regional design with the aim to improve the quality, quantity and distribution of water through the concept of sustainable land use. These elements together will secure spatial water justice. Industrial waste, wastewater and the increasing demand for land are the main pressures on the river water system. Considering the future risk of flood and drought there is also a big insecurity about the water quantity. There will be a need for more space and fair use of the water system. The goal is to decontaminate the water system by decreasing industrial emission and restoring the water quality in the North West European river delta, moreover this strategy will secure a sufficient water quantity for future use, flood prevention and a fair distribution of the water available.

The first part will give the context of the European river system and the problems we face regarding the water quality, quantity and distribution. The second part sets the conceptual framework that shaped the vision for a river basin wide approach for the decontamination design. The third part shows this vision on the scale of the North West European river basin. This river basin wide vision is then broken down into small interventions that can be implemented on a local scale. This catalogue of interventions is supplied with a manual that matches the interventions with landscape qualities present in North West Europe and a stakeholder analysis that shows what actors are needed to change the river landscape. Moreover the manual introduces a new industrial circular water system that has variations that are applicable in different industrial areas. Lastly, the catalogue and manual are tested in the pilot project of the lowlands confluence. With this project we evaluate if our river basin wide vision can be implemented with strategic interventions on a local scale.

We would like to thank Birgit Hausleitner and Verena Balz for their help and guidance in shaping our vision and strategy. Furthermore we also want to thank Roberto Rocco and Marcin Dabrowski for their input regarding the research and methodology parts of this project.

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From Dieties to the Silent Highwayman

Recognizing rivers as the lifelines of civilizations is not an overstatement. Societies ever since the neolithic revolution and the accompanying need for irrigation have been shaped by rivers; we used and use our rivers for many aspects of life, from agriculture and industrial processes, to drinking water, trade and commerce, and religious activities. In (western) antiquity – and globally in many cultures and civilizations – rivers were deified: Sobek was an ancient Egyptian diety of the Nile, Tiberinus the god of the river Tiber, and Rhenus Pater the river god of the Rhine.

Figure 1.1 Tiberinus, god of the river Tiber. Image via wikimedia commons

The industrial revolution drastically altered our relationship with the waterways. Despite being economic lifelines of Europe still, as river(side)s provided spaces to manufacture, produce, process and transport industrial goods, the river water quality declined rapidly. Yes, the Delta region became a prosperous region with harbours and industrial sites in Rotterdam, Antwerp, Bruges, Amsterdam, Duisburg, Leverkusen and many more; unfortunately, the lifelines turned into societal and environmental disasters, because all these industries discharged their waste and polluted waste water *ad nauseam* into the river system. Filled with diseases, poisonous substances and excrements, the rivers became known not as lifelines but as places of death, as this cartoon (figure 1.3) illustrates.

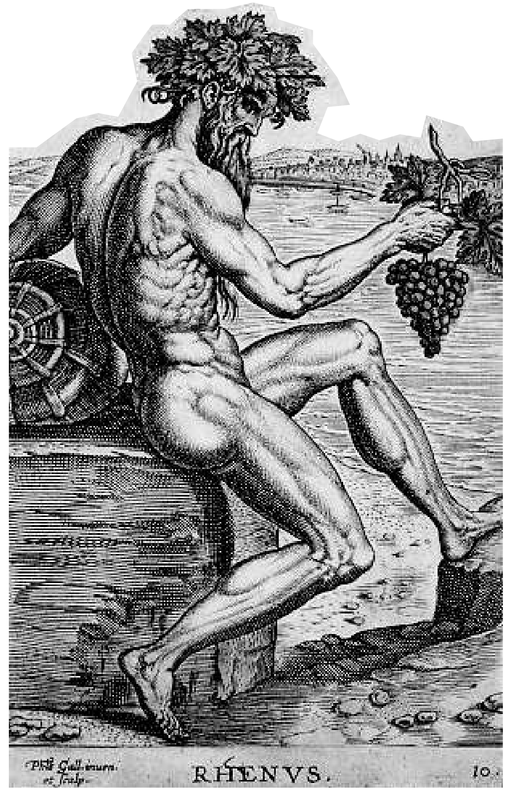
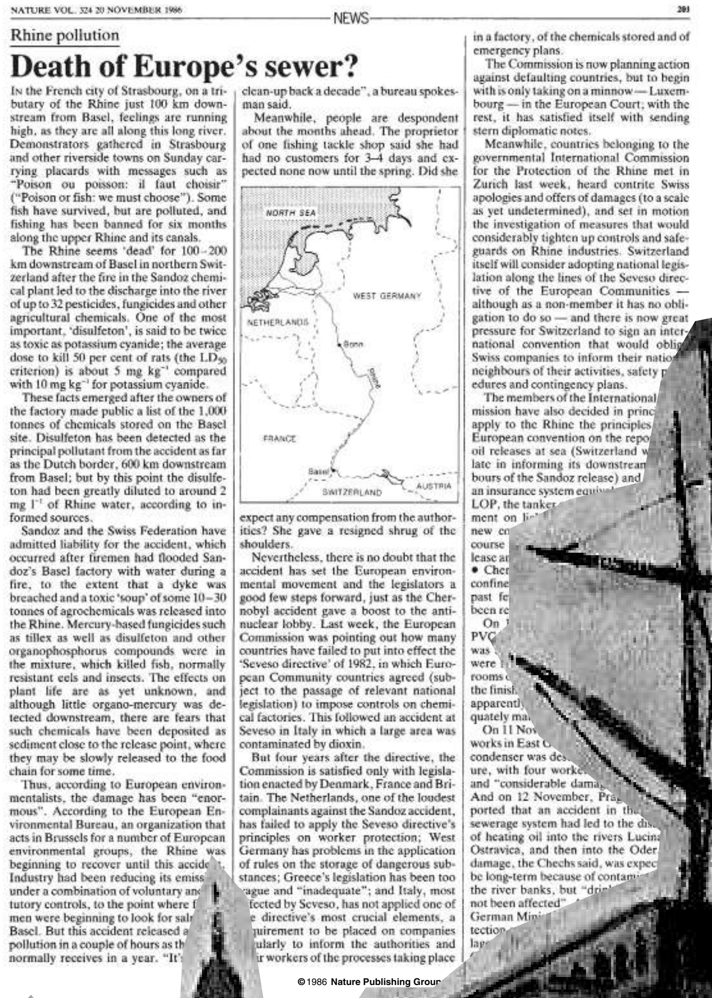


Figure 1.2 Rhenus Pater, river god of the Rhine. Image via wikimedia commons.

Figure 1.3 The Silent Highwayman: Death rows on the Thames, claiming the lives of victims who have not paid to have the river cleaned up, during the Great Stink. Original: Cartoon from Punch Magazine, Volume 35 Page 137; 10 July 1858

Figure 1.4 The Sandoz Chemical spill. Images via https://legallegacy.wordpress.com/2019/11/01/november-1-1986-sandoz-chemical-spill/

The (post-war) modern era saw the nadir of the environmental condition of European waterways such as the Rhine. In 1986, the Sandoz chemical spill effectively wiped out much of the Rhine's remaining ecological systems and turned the river water bright red, and the issue was brought to the public's attention. However, rivers like the Rhine and Seine, pejoratively referred to as "Europe's Sewer" (figure 1.5), were already biologically dead.



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Rhine pollution

Death of Europe's sewer?

IN the French city of Strasbourg, on a tributary of the Rhine just 100 km downstream from Basel, feelings are running high, as they are all along this long river. Demonstrators gathered in Strasbourg and other riverside towns on Sunday carrying placards with messages such as "Poison ou poisson: il faut choisir" ("Poison or fish: we must choose"). Some fish have survived, but are polluted, and fishing has been banned for six months along the upper Rhine and its canals.

The Rhine seems 'dead' for 100–200 km downstream of Basel in northern Switzerland after the fire in the Sandoz chemical plant led to the discharge into the river of up to 32 pesticides, fungicides and other agricultural chemicals. One of the most important, 'disulfeton', is said to be twice as toxic as potassium cyanide; the average dose to kill 50 per cent of rats (the LD_{50} criterion) is about 5 mg kg^{-1} compared with 10 mg kg^{-1} for potassium cyanide.

These facts emerged after the owners of the factory made public a list of the 1,000 tonnes of chemicals stored on the Basel site. Disulfeton has been detected as the principal pollutant from the accident as far as the Dutch border, 600 km downstream from Basel; but by this point the disulfeton had been greatly diluted to around 2 mg l^{-1} of Rhine water, according to informed sources.

Sandoz and the Swiss Federation have admitted liability for the accident, which occurred after firemen had flooded Sandoz's Basel factory with water during a fire, to the extent that a dyke was breached and a toxic 'soup' of some 10–30 tonnes of agrochemicals was released into the Rhine. Mercury-based fungicides such as tillex as well as disulfeton and other organophosphorus compounds were in the mixture, which killed fish, normally resistant eels and insects. The effects on plant life are as yet unknown, and although little organo-mercury was detected downstream, there are fears that such chemicals have been deposited as sediment close to the release point, where they may be slowly released to the food chain for some time.

Thus, according to European environmentalists, the damage has been "enormous". According to the European Environmental Bureau, an organization that acts in Brussels for a number of European environmental groups, the Rhine was beginning to recover until this accide
Industry had been reducing its emiss
under a combination of voluntary an
tutory controls, to the point where f
men were beginning to look for sal
Basel. But this accident released a
pollution in a couple of hours as th
normally receives in a year. "It's
clean-up back a decade", a bureau spokesman said.

Meanwhile, people are despondent about the months ahead. The proprietor of one fishing tackle shop said she had had no customers for 3–4 days and expected none now until the spring. Did she expect any compensation from the authorities? She gave a resigned shrug of the shoulders.

Nevertheless, there is no doubt that the accident has set the European environmental movement and the legislators a good few steps forward, just as the Chernobyl accident gave a boost to the anti-nuclear lobby. Last week, the European Commission was pointing out how many countries have failed to put into effect the 'Seveso directive' of 1982, in which European Community countries agreed (subject to the passage of relevant national legislation) to impose controls on chemical factories. This followed an accident at Seveso in Italy in which a large area was contaminated by dioxin.

But four years after the directive, the Commission is satisfied only with legislation enacted by Denmark, France and Britain. The Netherlands, one of the loudest complainants against the Sandoz accident, has failed to apply the Seveso directive's principles on worker protection; West Germany has problems in the application of rules on the storage of dangerous substances; Greece's legislation has been too
ague and "inadequate"; and Italy, most
fected by Seveso, has not applied one of
e directive's most crucial elements, a
quirement to be placed on companies
ularly to inform the authorities and
r workers of the processes taking place in a factory, of the chemicals stored and of emergency plans.

The Commission is now planning action against defaulting countries, but to begin with is only taking on a minnow — Luxembourg — in the European Court; with the rest, it has satisfied itself with sending stern diplomatic notes.

Meanwhile, countries belonging to the governmental International Commission for the Protection of the Rhine met in Zurich last week, heard contrite Swiss apologies and offers of damages (to a scale as yet undetermined), and set in motion the investigation of measures that would considerably tighten up controls and safeguards on Rhine industries. Switzerland itself will consider adopting national legislation along the lines of the Seveso directive of the European Communities — although as a non-member it has no obligation to do so — and there is now great pressure for Switzerland to sign an international convention that would oblig
Swiss companies to inform their natio
neighbours of their activities, safety p
edures and contingency plans.

The members of the International
mission have also decided in princ
apply to the Rhine the principles
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oil releases at sea (Switzerland w
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And on 12 November, Pra
ported that an accident in th
sewerage system had led to the dis
of heating oil into the rivers Lucina
Ostravica, and then into the Oder
damage, the Chechs said, was expec
be long-term because of contam
the river banks, but "dri
not been affected"
German Mini
tection
lag

Figure 1.5 (right) Article 'Death of Europe's Sewer?' https://www.nature.com/articles/324201a0

Figure 1.6 (below) Cutout from 'The Port of London' by Claude Monet (1870). https://www.claude-monet.com/the-port-of-london.jsp#prettyPhoto[image1]/0/

A European Context

River basins all over the world are ecosystems under pressure. Located at the end of three developed rivers, the Netherlands suffers the most from the deterioration of the water quality in Europe (Novo, 2020). Water has no borders, so there is a need for a river basin wide strategy to clean up the river water system. It is Dutch national policy that there should be an international approach to control the water quantity and ensure the distribution (Ministerie van Infrastructuur en Waterstaat 2022). On the initiative of The Netherlands, the International Commission for the Protection of the Rhine (ICPR) was established in the 1960's to protect the river water quality and quantity. In 1986, following aforementioned environmental disaster, the International Commission for the Protection of the Rhine (ICPR) adopted an action-based approach to protect the environment of the Rhine river and improve the water quality (Walgate, 1986 & Novo, 2020).

Today, the European Union works on protecting and monitoring the water quality in Europe's rivers. They do this via the Water Framework Directive (WFD). The Water Framework Directive (WFD) established a framework for the assessment, management, protection and improvement of the quality of water resources across the EU. EU Member States have been publishing the second River Basin Management Plans (RBMPs) for achieving the environmental objectives of the WFD. To accompany and inform this process, the European Environmental Agency has produced the European Water Assessment on the state of Europe's waters (European Environment Agency, 2018).

Although in the last decades the number of pollutants has been reduced, the main challenges remain in reducing urban and industrial waste and pollution of agricultural sources (European Environment Agency, 2018). The main pressures leading to a bad chemical status are atmospheric depositions and urban wastewater treatment plants. Inputs from urban wastewater treatment plants lead to contamination of over 13 000 water bodies with polyaromatic hydrocarbons (PAHs), mercury, cadmium, lead and nickel (European Environment Agency, 2018). As urban wastewater is a point source with underlying diffuse sources, it is difficult to track down where the pollution is exactly coming from. These sources could be agriculture, port activities, industrial or military activities, mining or other urban and industrial processes. The main pressures on the ecological status are hydro morphological pressures, which are man-made alterations in the riverbed like dams, locks and canals, and diffuse sources like agriculture and discharge of the sewerage systems. Atmospheric deposition and point source pollution are in lower degree also a high pressure on the ecological status (European Environment Agency, 2018). The EU regularly assesses the quality of surface waters, in order to keep a clear view of the issue.

This surface water assessment can be separated in the ecological and chemical quality. The chemical status is defined by limits (Environmental Quality Standards, EQS) on the concentration of certain pollutants. Ecological status shows the quality of the structure and functioning of surface water ecosystems. It shows the influence of both pollution and habitat degradation (European Environment Agency, 2018).

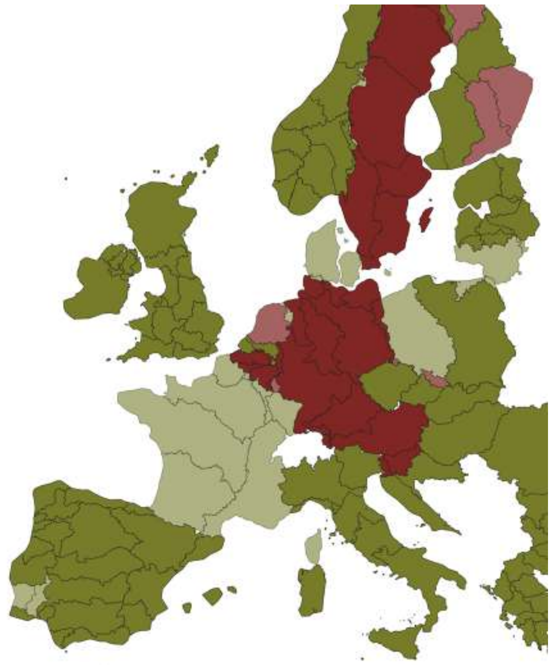


Figure 1.7 Surface water bodies failing to achieve a good chemical status (via EEA, 2008).

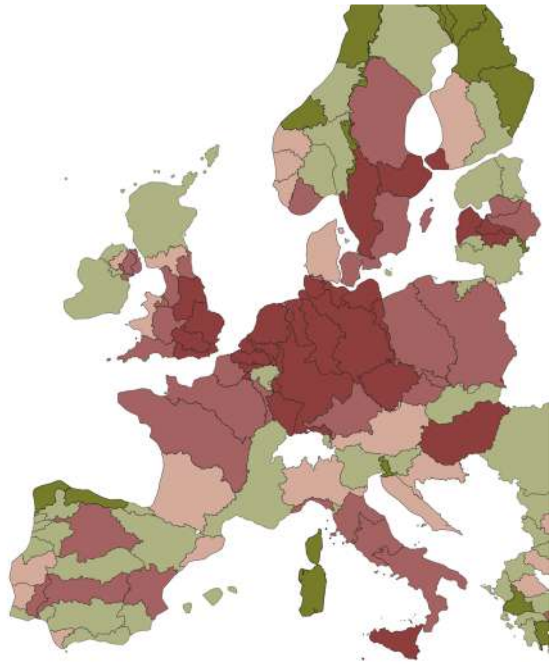


Figure 1.8 Surface water bodies failing to achieve a good ecological status (via EEA, 2008).

Concluding from the European water assessment, the Netherlands has one of the worst surface water qualities in Europe. In Europe around 40% of the surface water bodies are in good ecological status. In the river delta, Belgium, The Netherlands and northern Germany only 10% are in good ecological status (European Environment Agency, 2021). Only 38% are in good chemical status across Europe and in this case The Netherlands has an average chemical status with 39% of surface water bodies achieving good chemical status. As 5 million people get their drinking water from the delta rivers (Rhine, Meuse, Scheldt) and industries have a high demand for river water - industries take up about 54% of the total uptake by human activities (European Environment Agency, 2018) - the task of ensuring better water quality and ensuring enough clean water for the future is of a high priority in policymaking - or should be so.

In the Netherlands Rijkswaterstaat is responsible for the water quality and safety of its waters (Ministerie van Infrastructuur en Waterstaat, 2021). They identified the main causes of the water pollution in the country. These causes are listed in figure 1.9. Comparing this to the European Water Assessment it is clearly visible that the Netherlands has yet to vastly improve the ecological and chemical status in the surface water bodies. The main causes in The Netherlands presented us with two correlations in the water quality problem. Firstly, the water quality and water quantity are strongly connected. With increasing seasonal fluctuation in the river water quantity, the quality is also at risk. Secondly the (heavy) industries historically and currently play an important role in the problem of water pollution.

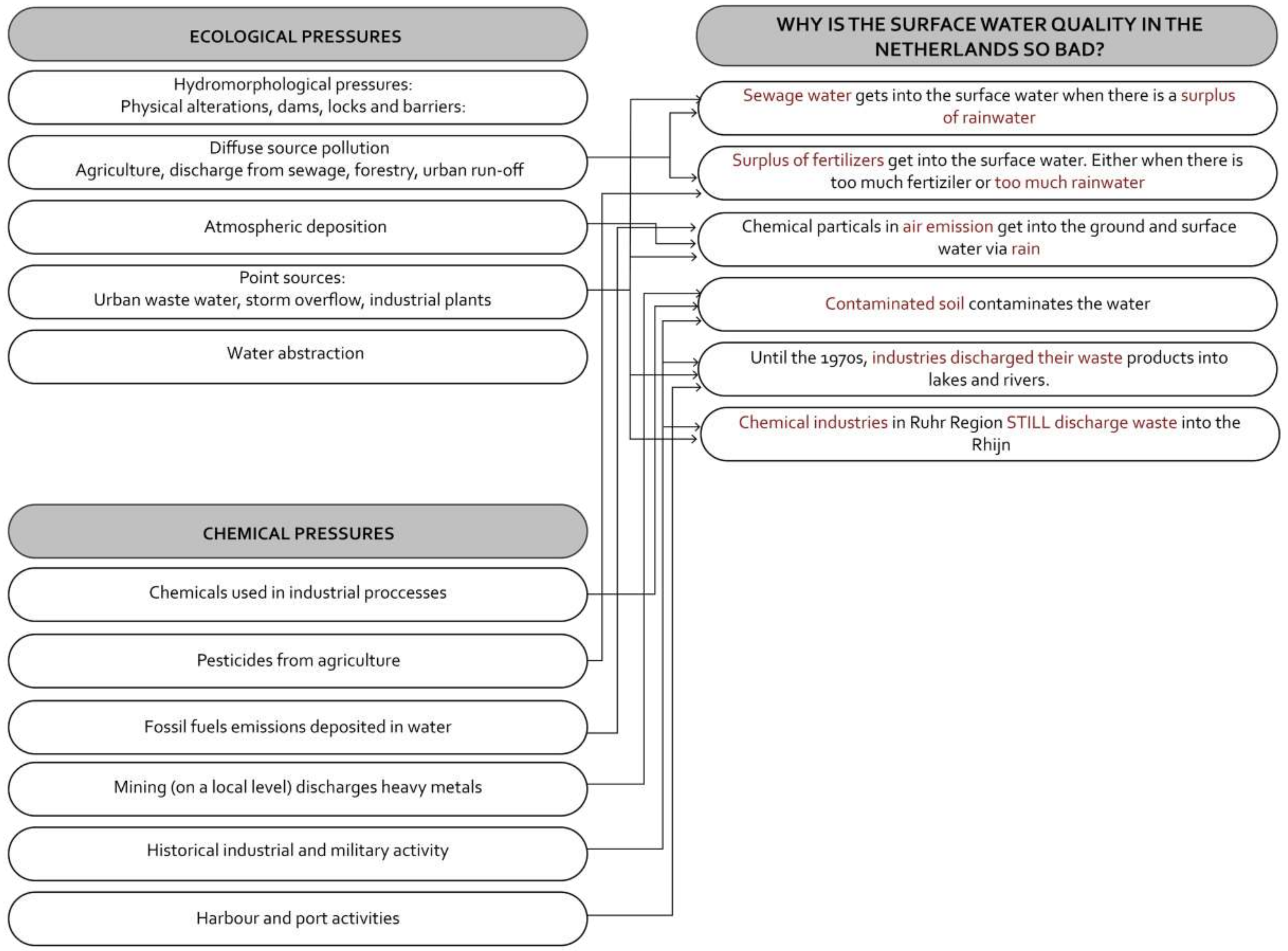


Figure 1.9 Causes of bad water quality in a European context, visualised.

Water Justice through a Spatial perspective

Considering the various challenges, economic demands and developments that have historically created a densely populated and prosperous delta region (PBL, 2021), future society needs more space than it has. More homes for people to live in, more space for the energy transition, more space for water storage to cope with the seasonal fluctuation in the water levels. Taking into account the scarcity of land, there is a big question about justice (PBL, 2023). Who can use the water in times of water scarcity? What sectors or industries have priority on the river bed? Do homes or industries have to move to ensure space for water storage? Who should have priority access to clean water?

We believe that injustice is one of the main issues that the world is facing and therefore justice is also one of the main goals to achieve in the projects of urbanists and planners. Because the focus of this project is water, the goal can be narrowed down to spatial water justice: water justice from a spatial perspective. Spatial water justice can be achieved by attaining three main qualities: fair water distribution, sufficient water quantity and better water quality. These qualities lead to many other qualities. To give a few examples: a high water quality in the right quantity and distribution will be beneficial for the biodiversity (Wronski, Dusabe, Apio et al., 2015); sufficient water quantity and high water quality will provide safety for people and ecosystems, combined with fair distribution they will also secure enough quality water for all users (Harbers & Heijnen, 2022); when we consider distribution also in the form of land use the three combined will make sure of equal access to water. With these qualities we can start to take away the challenges posed in the previous paragraph.

But to take away these issues we need to identify the injustice that exists in the current and future situation. The spatial water injustice is caused by a wide range of problems considering the river landscape, but we found that many of these problems are related to the water quality.

Problem Statement

The Netherlands has one of the worst surface water qualities in Europe (European Environment Agency, 2018), and although the water quality in the Netherlands and all of Europe has been improving over the last decades, we consider further improving biodiversity and assuring a significant water quality and quantity sizable future challenges in the delta region of North West Europe. Furthermore, problems like health issues, restrained access to water and a low quality of biodiversity as a result of bad water quality contribute to socio-spatial injustice.

A second contributor to socio-spatial injustice - next to the bad water quality itself - is the unfair distribution of contaminated water. The correlation between these concepts is shown in diagram XP. Moreover, we have identified six issues from the European water assessment that cause the bad water quality (see figures x and x). In short, historic industrial discharge, current industrial water flows, sewage and contaminated soil are direct causes of the pollution.

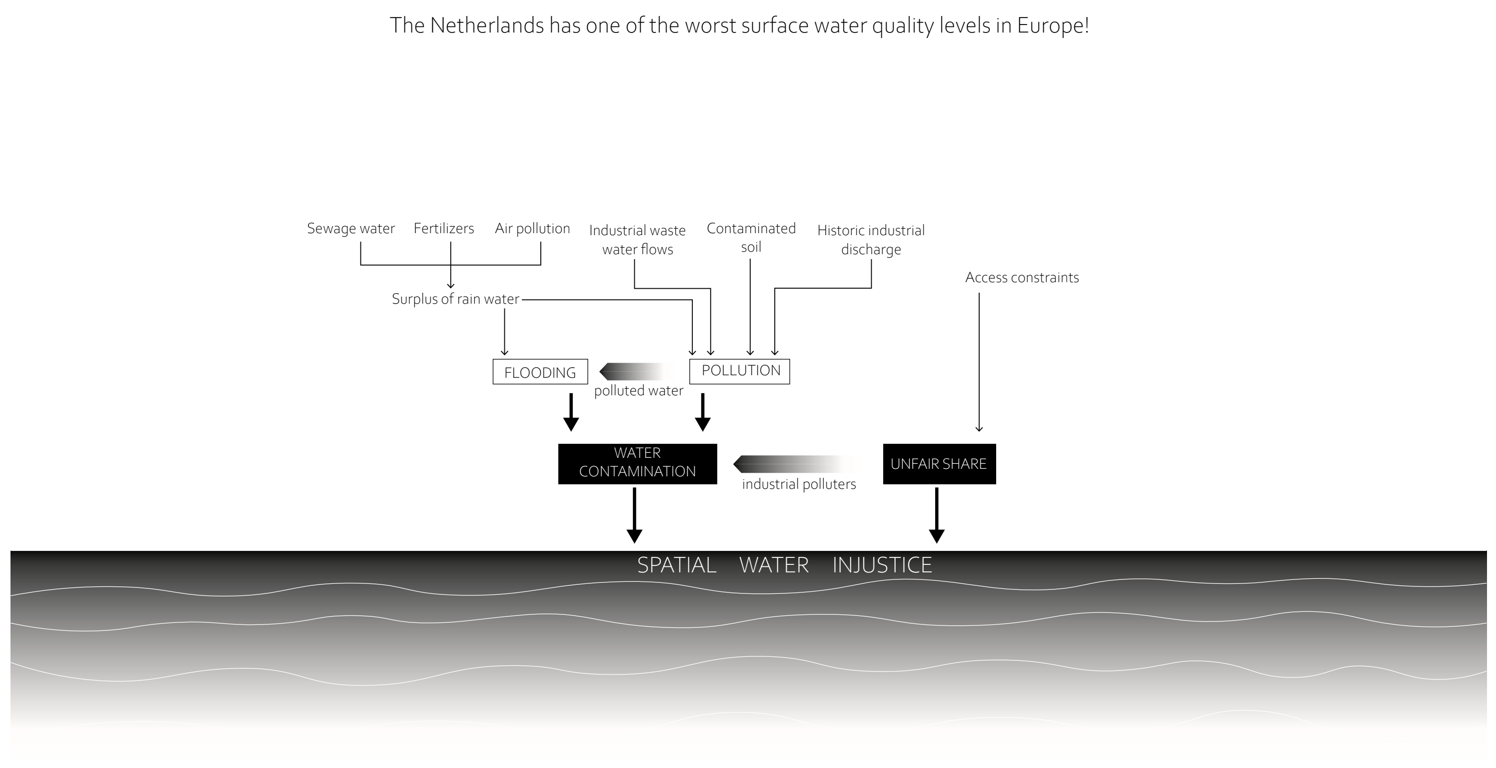
Flooding is also related to bad water quality. This is because the polluted water is part of the flooding water. This polluted water comes directly from sewage water, but also from a surplus of rain water that collects polluted air particles and brings them to the surface water and also takes fertilisers from the land into the surface water. Furthermore, flooding causes erosion, which affects the water quality, and causes safety and justice issues.

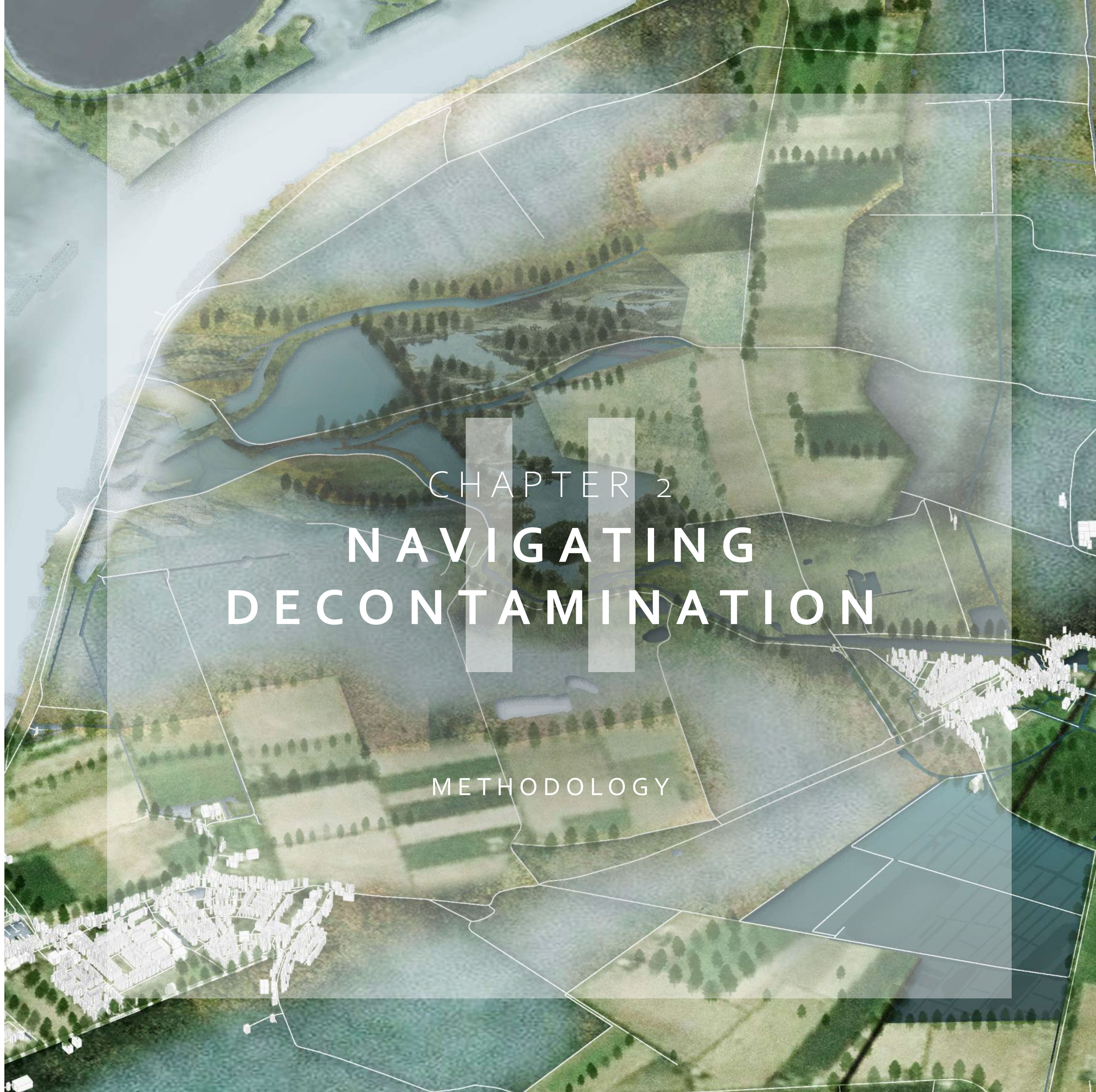
Then there are two other issues that relate to spatial water injustice considering unfair share and, moreover, relate to the industrial sector and bad water quality. The space that industries occupy along the river as well as the amount of water they use and the way they treat the environment in comparison to others raises questions about unequal access to and distribution of the river landscape. Unfair distribution also links directly to pollution, because more industries create more pollution. And because of this same reason the unfair share also leads to a worse water quality through the industrial polluters. This is how bad water quality and unfair share lead to spatial water injustice. In conclusion, the two main issues of spatial water injustice are industrial contamination and flooding.

In the regards of the current discussions about sustainability considering the pressure on ecosystems, health and the quality of future lives, this research project poses ways to resolve issues on these topics from the perspective of water. The surface water issues are one of the greatest environmental issues of today in North West Europe. A lot of these issues are due to industrial pollution. Fixing water pollution problems is key to fixing ecosystems and fixing ecosystems is key to creating a healthy environment and ensuring the quality of future lives.

Therefore, the aim of this report is to contribute to the development of a healthy river landscape, by showcasing possibilities to achieve high water quality, sufficient water quantity and fair water distribution, so it can contribute to achieving spatial water justice. Through the concept of sustainable land use the research relates to the UN Sustainable Development Goals, which too aim to achieve justice with peace and prosperity for people and the planet.

Figure 1.10 Problem statement diagram





CHAPTER 2

NAVIGATING DECONTAMINATION

METHODOLOGY

CHAPTER 2

NAVIGATING REGENERATION

METHODOLOGY

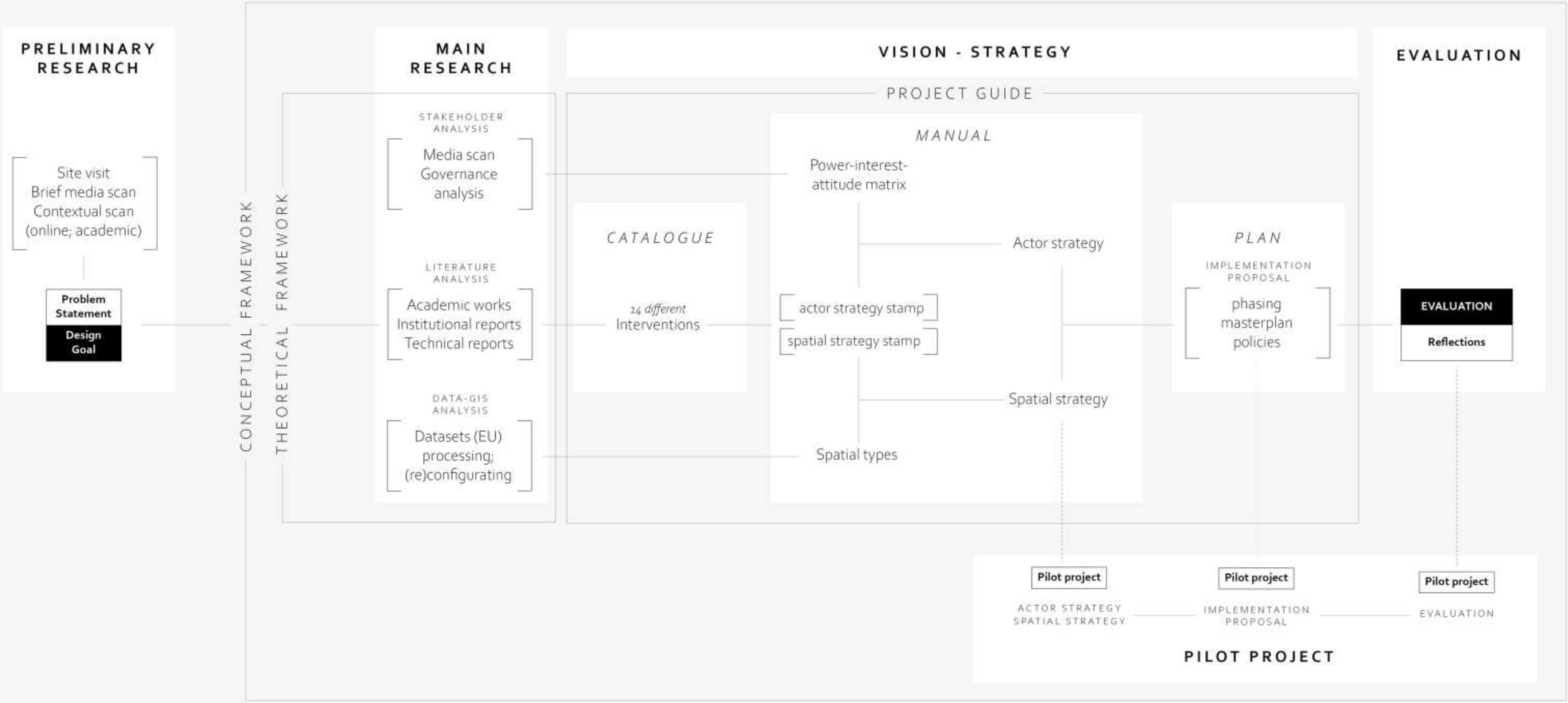
This chapter details the methodology of the research and design project 'Reviving Rivers'. With this project, we aim to answer the research question:

> *How can sustainable land use of riverside industrial areas create a healthy and just river landscape in the north west european river delta?*

Following preliminary research we established our problem statement and design goal(s), resulting in a conceptual framework - highlighting spatial water justice - that functions as guiding theme throughout the project. Subsequently, we focus our main research (i.e. theoretical framework) on core concepts of spatial water justice. Then, building on this in-depth research, we established a catalogue of interventions in river landscapes and a manual to guide policymakers and planners in creating just plans for spatial solutions to decontamination and flood resilience. We illustrate these findings with a pilot project in the Dordrecht region. Finally, we evaluate all findings. The chart (figure 2.1) aside this text visualizes the overview of our methodological framework described here.

In this chapter, the following parts of this methodology are delineated. Firstly, we expand upon the conceptual framework, closely examinating various aspects of 'spatial water justice'. Then, we link our project to the UN's sustainable development goals. Lastly, we detail our theoretical framework we used to build a foundation for the interventions in the catalogue (chapter V).

Figure 2.1 Methodology Chart



Conceptual Framework

In the problem statement we stated that the goal is to achieve spatial water justice. How this can be achieved is shown in the diagram. Spatial water justice can be achieved by attaining three main qualities: fair water distribution, sufficient water quantity and high water quality.

High water quality, sufficient water quantity and fair water distribution exist in a healthy river landscape and are from the perspective of spatial water justice also the main pillars of the healthy river landscape. Derived from the problem analysis the research in this project is concerning industrial pollution. Stressing this topic, the healthy river landscape has three themes that have to do with the named qualities: an industrial, institutional and environmental theme. Industrial is placed between distribution and quality, because industries have influence on them by the way they are using water and land and how they pollute the water (CBS, 2022). Institutional is placed between distribution and quantity, because policy and management affect the way water and access to water is distributed and the way quantity is secured. The environment is placed between quantity and quality, because the state of the environment and its health is very much dependent on the quantity and quality of the water in its ecosystems.

Through the themes of spatial water justice, quantity, quality and distribution, can be met with three main concepts: an industrial circular water system, decontamination and flood prevention. All of them deal with the broader concept of sustainable land use. Sustainable land use is the fair and balanced distribution of land and environmental resources. The concepts are circling the goal and qualities, because they all have an effect on all of the qualities, some more than others. But still the three main concepts can be placed on a specific side where their influence is the largest. The industrial circular water system has its main implementation with industries. Decontamination will have a large effect on the water quality and quantity. Flood prevention affects the distribution of water and also solves problems with water quantity. Finally in the outer ring the interventions can be found. In the diagram a few of them are shown, but just like the concepts, there are many interventions that can be implemented to contribute to achieve the goal. In the strategy we create a catalogue of interventions that will all contribute to a healthy and just river system.

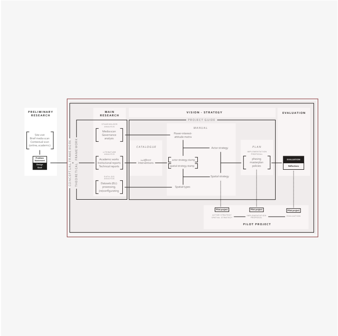
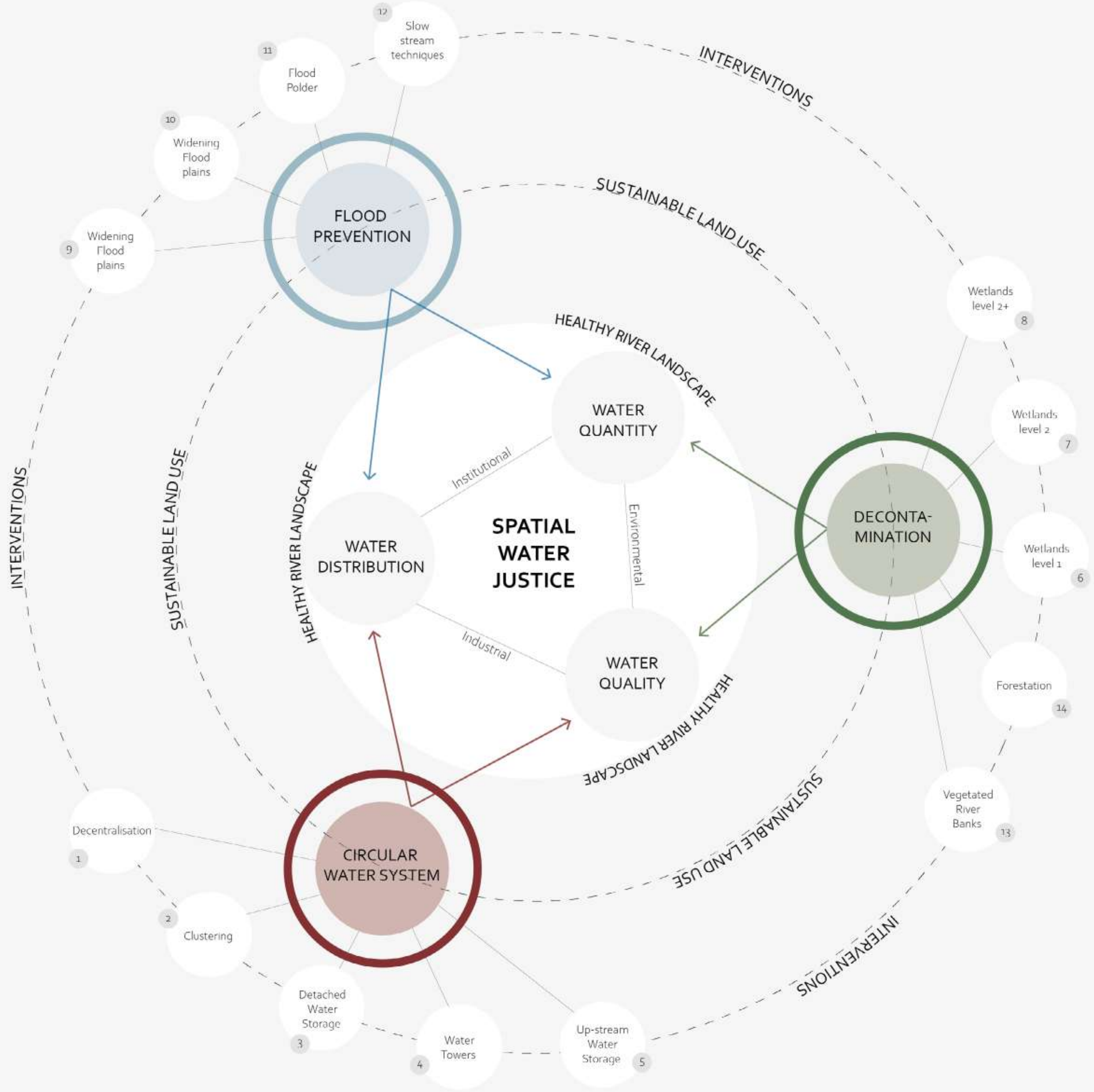


Figure 2.2 Conceptual framework within methodology chart

Figure 2.3 Conceptual Framework



Theoretical Framework

We pose possibilities to contribute to a healthy river landscape. For these possibilities there is a need for more space for detaining, storing and draining water in our spatial strategy. Undeveloped land is scarce and there are a lot of stakeholders involved in our spatial interventions. Taking into account the scarcity of land, there is also a big question about justice (PBL, 203). That is why defining and using sustainable land use is important to our project. Sustainable land use focuses on the efficient use and effective distribution of land cover over an area (Balz & Katsikis, 2023). Because it is about land cover in relation to land use, the concept of sustainable land use is highly intertwined with that of sustainable land management (SLM). This is defined by Hurni (2000) as "a system of technologies and/or planning that aims to integrate ecological with socio-economic and political principle in the management of land for agricultural and other purposes to achieve intra- and intergenerational equity" Hurni (2000). This definition mentions multiple elements. By intra- and intergenerational equity, it is meant that the actions of states and individuals should be to preserve the environment. This is to make sure that both current and following generations have enough resources to get by and have an environment they can benefit from (Brundtland, 1987).

The reason why SLM and Sustainable land use (SLU) are of interest concerning the water system is due to several pressures resulting from socio-economic challenges currently ongoing. The most pressing one is that of climate change. Rising temperatures lead to an increase in extreme weather, as was seen in the last years. Droughts and excessive rains result in a need for better water management throughout the year. This requires a change in land use (Hubert, Klaus, Armin, & Katharina, 2003). Furthermore, the increasing urbanisation increases a demand for water from both industries and urban areas put further strain on both the availability of water as well as the quality (PBL, 2021). Allowing for an improved water quality will also require a different land use. The water system along the Rhine, Meuse and Scheldt is a major ecosystem within Northwest Europe. National and international goals around the improvement of ecosystems often arise from adjusting land use to a more sustainable system (OECD, 2020).

Changes to land use along a wide system such as a river basin require a clear and cooperative approach among many stakeholders. As Hurni mentioned in his definition of SLM, SLM is a system of many aspects. Yet, it is unclear how such a system would work within a broad system of stakeholders, scales and ecosystems. When mentioning ecosystems within SLM and SLU the focus lies on the services that are provided. These cover elements such as water quality and supply (Deng, Li, & Gibson, 2016). When looking at these services from the perspective of SLU, it becomes clear that conflicts arise, for instance between agriculture and nature reserves. Pressures concerning the broader water system require a change in land use towards a more sustainable approach. Such an approach might result in policies spanning different timescales and interventions on both different time and spatial scales. Nevertheless, such research should result in a system of policies and interventions where repurposing of land should result in improvement of the water quality and quantity and ensuring intra- and intergenerational equity. For the design discussed in this report it means the following. Interventions will be looked at

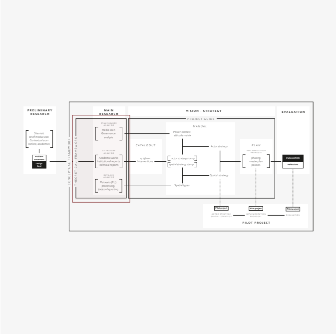


Figure 2.4 Theoretical framework within methodology chart

from both an ecological standpoint and effects on stakeholders. Ecologically the interventions are in line with the predetermined goals of water management and regeneration. Adding to that, a set of desired ecological aspects is formed focusing on aspects concerning water. These are adequate water supply, clean water, expanding biodiversity and providing new areas for recreation and nature protection. The next important step for the interventions to be in line with sustainable land use is looking at the existing land use. Agriculture makes up the largest land use in non-urban areas in all three major river basins (Copernicus, 2018). On the other hand, industries are the largest consumer of water (CBS, 2022). Interventions that aim to create water management or wetlands should allow room for negotiation and adjustment to reach a compromise between ecological systems and needs of local stakeholders. Of course, each site or stakeholder has different desires. This should be reflected through both the interventions as policies. These policies focus on restructuring land use through subsidising, setting up community boards, adjusting land plans amongst a few.

In this project we introduce multiple interventions. These interventions come from theoretical research. They will be further explained in chapter three. This theory is categorised in four main topics: closed loops, decontaminating wetlands, the matter of vegetation and room for the river for flood prevention.

The introduction of closed loops comes from a pilot project in Brazil, where the architects of Ooze (2016) made a system to recycle wastewater. They describe four elements that we apply in our systems for industrial wastewater: a contaminator, a rough filter, a fine filter and a water storage. These systems are the core of the project and the most direct solution to decontaminate the surface water and ensure sufficient water quantity. The way the systems are implemented influences the fair distribution of water. These systems link multiple interventions when it comes to spatial implementation, because the systems can add more value than solely the clean water cycles. In order to understand these interventions, we elaborate on their theory.

The wetlands are the key element to the strategy for reaching the goals. There are many types of wetlands and a lot of them can be constructed wetlands, which can be used as fine filters. Moreover they have a function in water detention, the health of ecosystems and the well-being of humans (Slaney, 2016). This makes them a vital part of a healthy river landscape.

An important part of the wetlands is the vegetation, just like it is important all over the river basin. Vegetation boosts biodiversity, prevents erosion and slows down run-off. These functions are important to the river basin because they enable the system to persist, clean itself and protect itself (Threlfall et al., 2017).

The aspect of protection is further elaborated in the theory of flood prevention. Flood prevention of the rivers is established through the principle of room for the river. This principle is based on giving surface water room to flow outside of its borders in a safe manner, without damaging valuable land, instead of enhancing the borders like dykes (Ministerie van Infrastructuur en Waterstaat, 2019). Flood prevention is important to ensure safety, prevent further contamination and contribute to equity. These theories lead to the interventions introduced in chapter five.

Data usage

In this project we make use of online GIS-datasets. Since the Aarhus convention was signed in the late 90's, European governments are actively pursuing a policy of opening up various datasets regarding the environment to the public. Moreover, the Kyiv protocol of 21 May 2003, adopted by the European Community and EU, legally enforces the inventory and publication of Pollutant Release and Transfer Registers (PRTR), known within the EU-context as E-PRTR. These datasets are invaluable in any project regarding industrial pollution, for researchers, policymakers, journalists and the public alike. In our research on the topic of industrial river (de)contamination in the Rhine-Meuse-Scheldt river basin, we analyse a number of these databases: E-PRTR, EU-DEM, CLC-2018, and ESDB. The chart on the next page show initial processings of the raw data. Reconfiguring and recombining this data results in the analyses shown in Chapter 3.

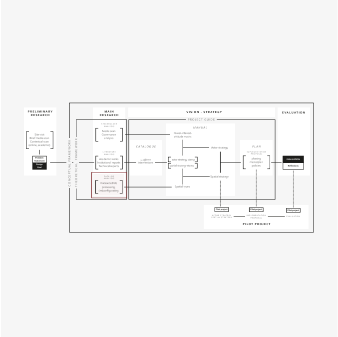


Figure 2.5 GIS-data analysis within methodology chart

Origin of datapoints in E-PRTR dataset

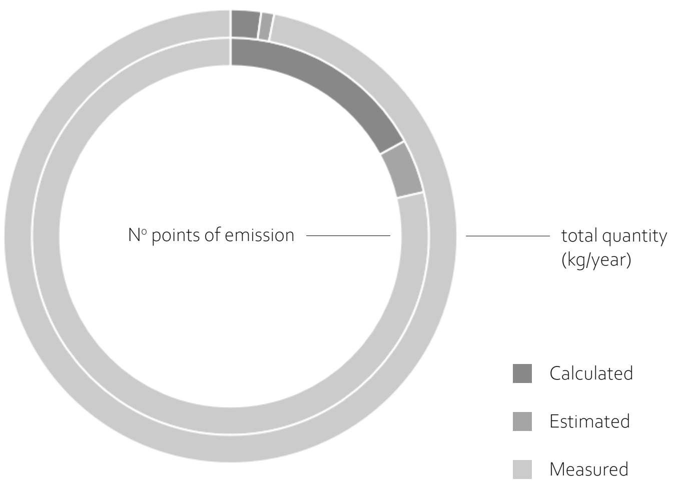
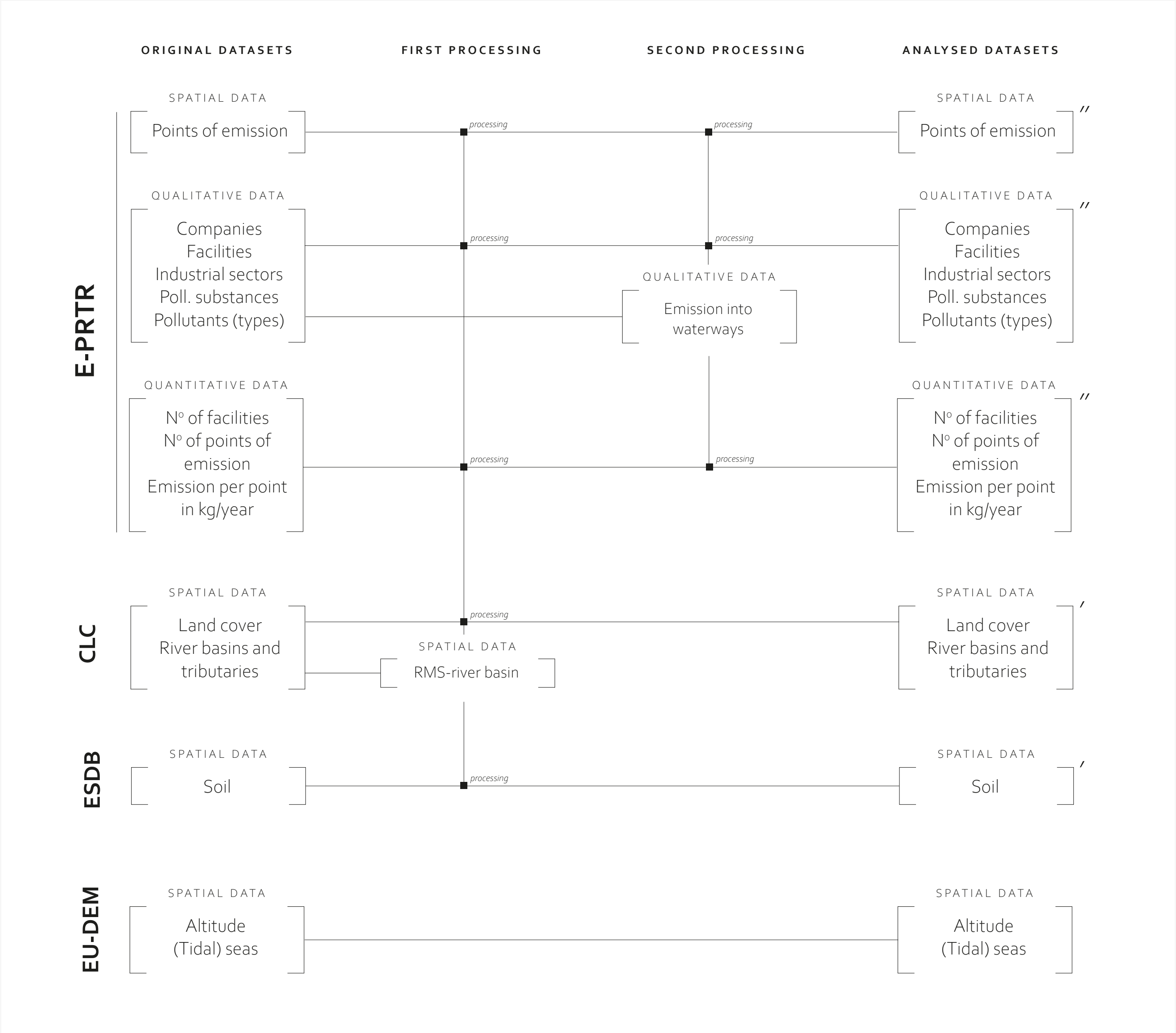


Figure 2.6 Processing of GIS-datasets



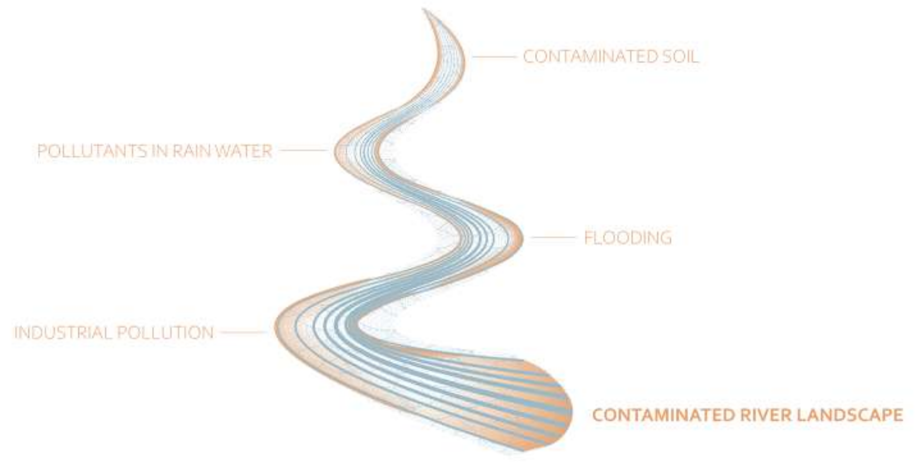


Figure 2.7 Problem Statement visual

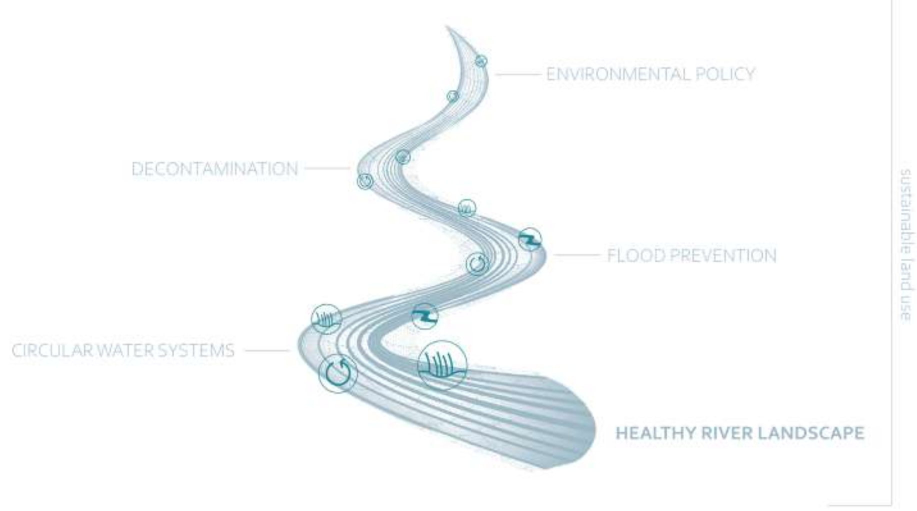


Figure 2.8 Vision visual

Visualisations

The method that we use to come to the problem statement and similarly to the vision can be visualised like in figureX. A river basin is a big interlinked system where everything is somehow interconnected. What happens at one spot, will flow through the whole river. That is why pollution or contamination at one very local spot in the river will influence the whole river basin. Many points of pollution will result in a contaminated river system like we have now. If rivers flood the contaminated water will spread beyond the river bed. All together it is a big contaminated system.

To change this into a healthy river landscape. We envision small local interventions that create a bigger clean system. Firstly there is a need for environmental policies for the whole river basin. Industrial circular water systems, decontamination or flood prevention can be implemented very locally but if the whole river basin changes their behaviour there will be a healthy river landscape.

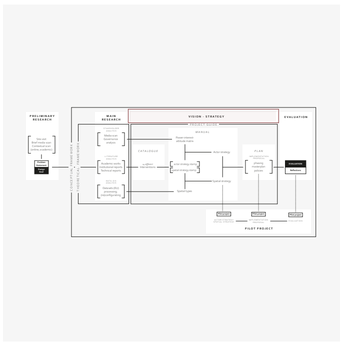


Figure 2.9 Vision-strategy within methodology chart

Contribution to the UN Sustainable development goals

The Sustainable Development Goals are seventeen objectives adopted by the United Nation Member states. They are "a shared blueprint for peace and prosperity for people and the planet, now and into the future" (UN, 2015). The sustainable development goals are important pillars for development towards a just future. Some of the Sustainable Development Goals are also considered public goods in North West Europe, for example Clean water and sanitation, Good health and Well-being and the Quality of Education. Sadly public goods differ per country and are not always distributed equally. Because of this, public goods are not necessarily just. The Sustainable Development Goals are the global framework for just development and therefore more interesting to relate to the project. On this page we explain how the project contributes to the different Sustainable Development Goals.

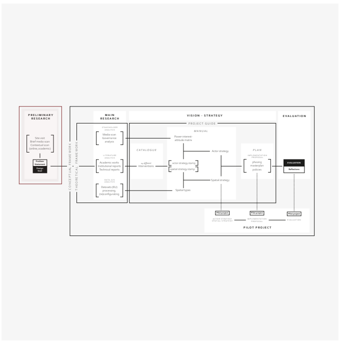


Figure 2.10 Preliminary research within methodology chart

By SDG

SDG 3: Good health and well-being. A healthy river landscape does not only have a positive effect on the natural system; there are great systemic improvements in (mental) health and well-being of nearby residents too. Moreover it will assure safe and high quality drinking water for the population in the river delta.

SDG 6: Clean water and sanitation. A healthy river landscape builds upon the concepts of water quantity, quality and distribution which ensures clean water and sanitation for people and nature. A clean and healthy water system will enrich biodiversity, support nature and provide clean drinking water.

SDG 9: Industry, inovation and infrastructre. The direction of industry, innovation and infrastructure is designed by the principles of sustainable land use. In our project we change and innovate the industrial sector so they have a circular water system and stop emitting pollutant substances into the water.

SDG 12 (to a lesser degree): Responsible consumption and production. We address responsible consumption in the form of water consumption. Responsible consumption is important because the changes in water quantity in our river system will be more extreme in the future.

SDG 13 (to a lesser degree): Our project is also about climate action because the river water system is an almost dead ecosystem and can be our next big environmental crisis. We need to take action now to restore these ecosystem and ensure water justice.

SDG 14: Life below water is highly influenced by the quality, quantity and distribution of water that is provided for by a healthy river landscape. A healthy and just river landscape is highly beneficial for the animals living in the river.

SDG 15: Life on land is highly influenced by the quality, quantity and distribution of water, because water is a fundamental element of life, and this is provided by a healthy river landscape. In our project water will be more present in the living environment of humans. A healthier water system will also have healthier humans.

SDG 17: Partnerships for the goals. International environmental goals can only be achieved by good partnership for the goals. Our project crosses institutional borders and therefore partnerships and international regulations are very important. Justice is an important issue in this case, because The Netherlands is the end of multiple river deltas.

Figure 2.12 Sustainable Development Goals (UN, 2015)

Project Approach

Previously we discovered that small intervention changes the river water system. Our strategy focuses on small scale interventions that can be implemented in different situations, thereby changing the contaminated river system into a healthy river landscape. Our strategy is a project guide to make small scale changes for the river basin wide vision. That is why our strategy consists of a catalogue of interventions that can be implemented throughout the whole river basin. This catalogue of interventions is accompanied with a manual that matches the interventions with the spatial and stakeholder analysis. This is how we generate a spatial and actor strategy for the interventions. This strategy can be implemented in a local project plan, the implementation. We illustrate the implementation and test the use of the manual with the pilot project in the Lowlands Confluence. After the pilot project we reflect on the manual and our project guide.

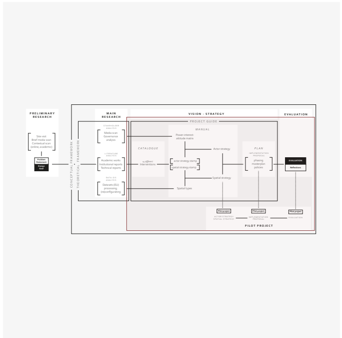


Figure 2.13 Project guide and pilot project within methodology chart

CHAPTER 3

MAPPING THE RIVER BASIN

ANALYSIS

CHAPTER 3

MAPPING THE RIVER BASIN

ANALYSIS

Succeeding our preliminary research into establishing the topic of industrial pollution in North Western Europe, this chapter lists the main results from our in-depth analysis presented here. In light of our chosen methodology, our analysis focuses on two main aspects: the spatial component and the actor component; this chapter thus consists of two analyses: a spatial analysis and a stakeholder analysis. The results from both analyses will be used extensively in strategizing implementation plans - more in this in chapter V and VI.

Spatial Analysis

Our primary aim of this analysis is to grasp the scope of the issue of industrial river pollution: a total picture of emission quantities, substances, industries, facilities, etc. and to spatialize these findings: what – where? For this part, we make use of multiple databases described in the methodology chapter (see: page x), especially the E-PRTR dataset.

Scope

The situation map on the next page shows the location of 1.773 facilities legally emitting pollution into the river basin. Clearly visible are concentrations in industrial areas in the lower basin. For each of these facilities, the dataset lists the number of emission points and the quantity also. Using this data, we could calculate the total amount of emissions: **58.208 kiloton per year**.

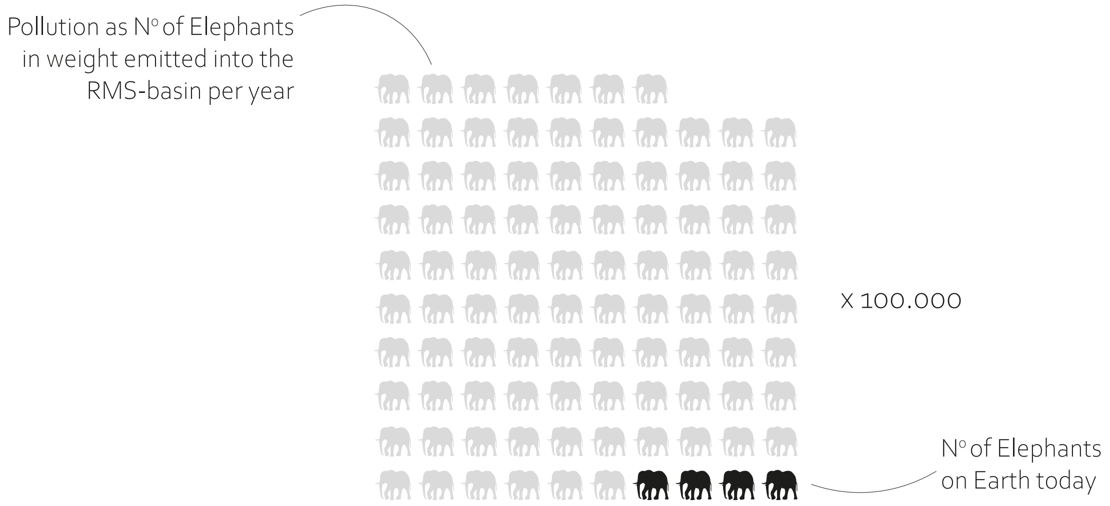


Figure 3.1 Scope of industrial pollution into the RMS-basin per year, using African elephants as reference. It is estimated that there are 400.000 African elephants on Earth, each weighing 6.000 kilogrammes.

An important distinction is to be made between parent companies, facilities, and points of emission, as they differ greatly in spatial properties and number. Their relation is shown in figure 3.2. Parent companies own one or more facilities, which quite often have multiple points of emission. These aspects are quantified for the entire river basin in figure 3.3.

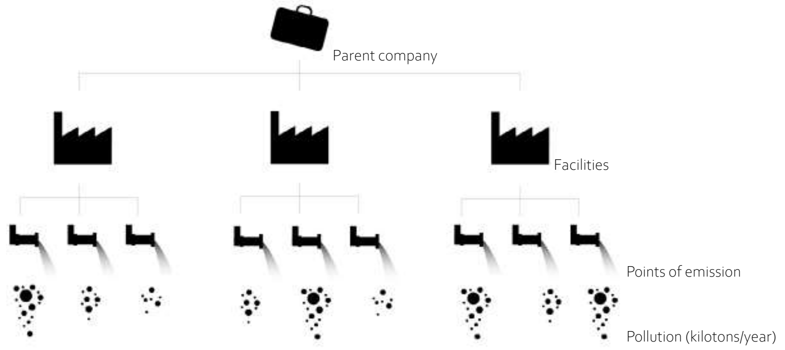
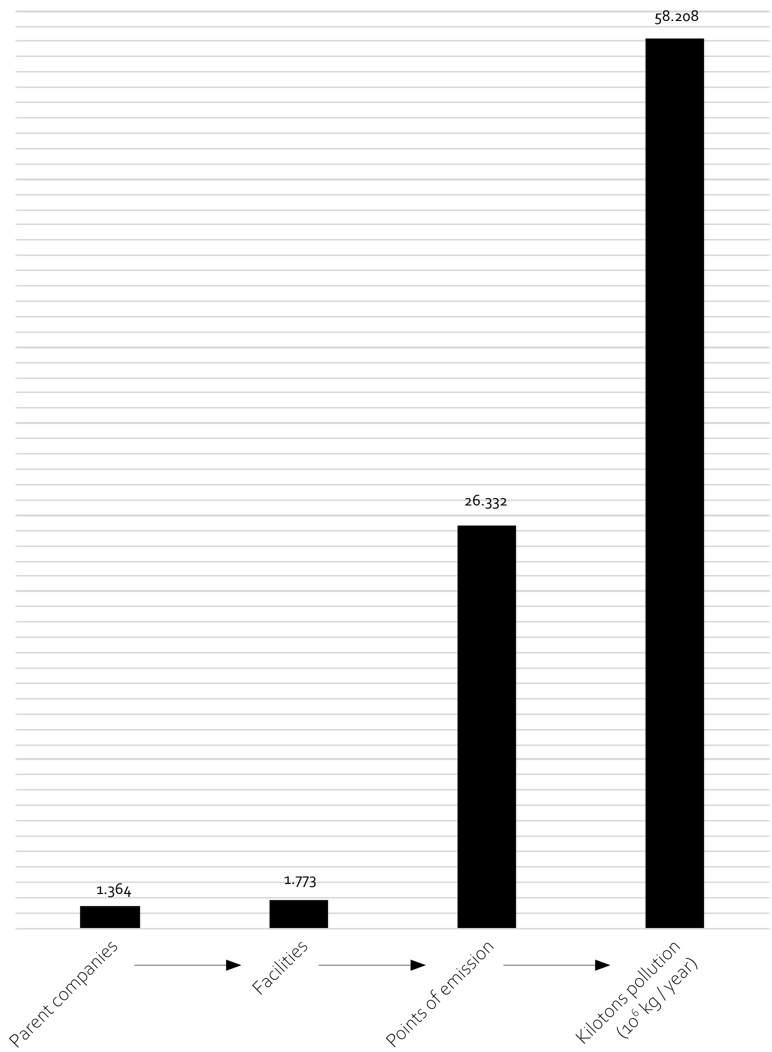
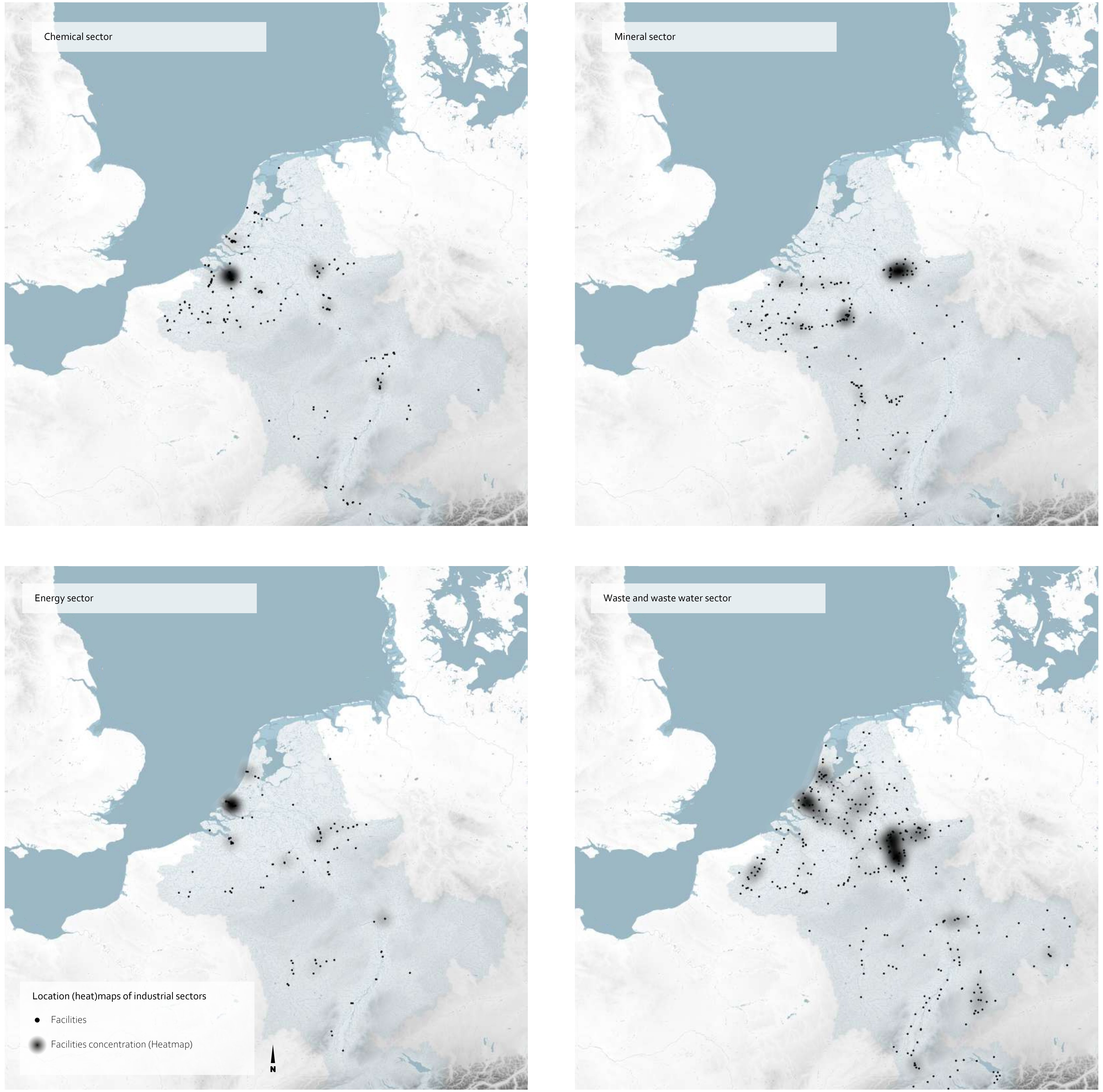


Figure 3.2 (left) Relation between parent companies, facilities, points of emission and total pollution.

Figure 3.3 (below) Parent companies, facilities, points of emission and total pollution in exact numbers for the RMS-basin.

The situation map on the next page shows the location of 26.332 points of emission into the Rhine-Meuse-Scheldt river basin. Once again, the industrial concentration in the lower basin is clearly visible. Quantifying these observations, we count 3.026 (11,5%) points of emission in the delta region (which can be mainly attributed to the Rotterdam and Antwerp harbours: 900 and 1.156 points respectively), and 3.483 (13,2%) points of emission in the Rhine-Ruhr area. Together with the Northern Randstad centered around Amsterdam (655 points; 2,5%) the lower river basin accounts for just more than a quarter (27,2%) of all emissions. However, the nature of pollution waterways is that pollutants flow to this area as a result of natural drainage. The map also shows these flows of polluted substances to the delta region. We can conclude that this issue needs to be addressed on two levels: locally, at the point of emission, and supranationally, seeing the Rhine-Meuse-Scheldt river basin holistically as one system.





Differentiating sectors

Using the quantitive data again, we conclude that four sectors stand out significantly above all other sectors: the chemical sector, the energy sector, the mineral sector, and the wastage sector (compare with 'other' in figures 3.4-3.6!). An interesting distinction can be made looking at the quantity of emission versus the number of points of emission: the chemical industry dominates the former, whereas the wastage industry dominates the latter (see figures 3.4 and 3.5). Combining these two datasets, we create a resonably 'total overview' of pollution per sector (figure 3.6).

Spatializing this information - i.e. analyzing datapoints per sector - we again find interesting differences between these major polluting sectors. The chemical, energy and mineral industries are clearly seperated, being concentrated in the Antwerp, Rotterdam, and Rhine-Ruhr regions respectively (see the maps on the previous page). The wastage industry shows a different pattern: not concentrated in one specific area, rather dissipating among industrial areas and intermediate regions.

Figure 3.4 Quantity of emission in kiloton/year by industrial sector

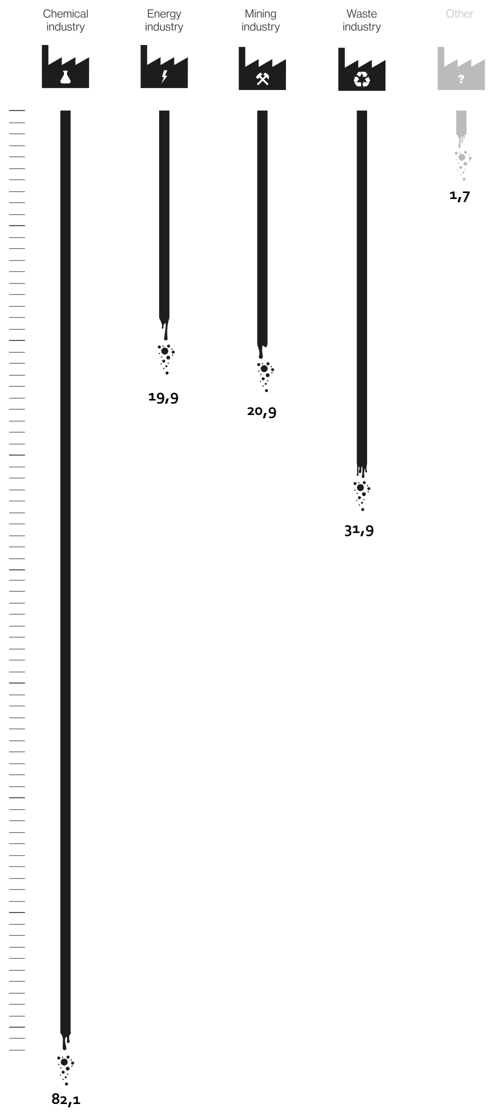


Figure 3.5 Points of emission by industrial sector

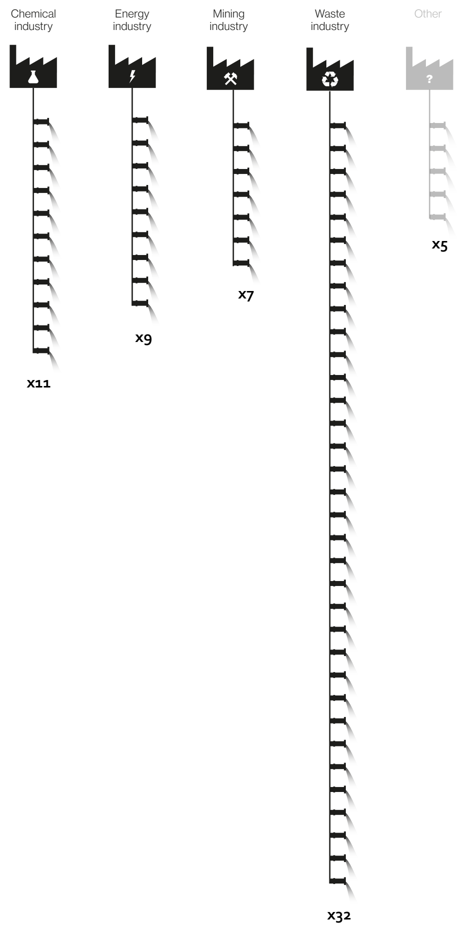
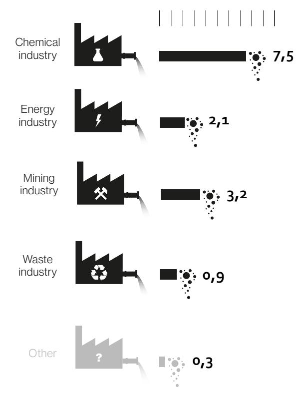


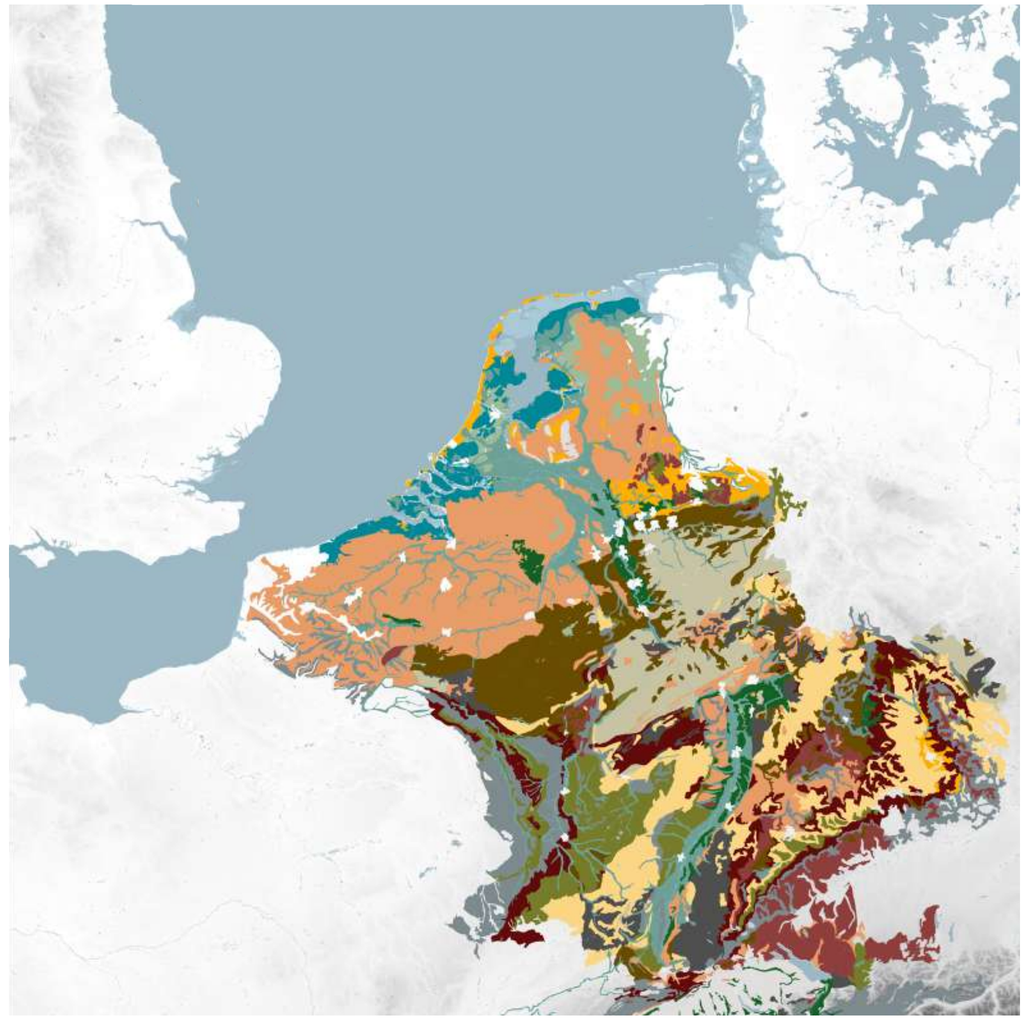
Figure 3.6 Kilotons of emission per year per points of emission by industrial sector



Landscape: soil, cover

A river flows through a variety of different landscapes, therefore it is important to map what these landscapes look like. We used the Corine Land Cover dataset by Copernicus Land Monitoring Services (Copernicus Land Monitoring Services, 2018). This map shows the distribution of different types of non-urban land cover. This is important for our project because interventions regarding the land around the river will depend on what time of land cover is already there. An intervention that fits in the existing land cover and natural landscape, will be easier to implement than something completely different.

For the soil we used the European Soil database. This dataset is provided by the European Soil Data Centre (ESDAC) under the supervision of the European Comission (European Soil Data Centre, 2012). In the soil map you can clearly see how the landscape changes throughout the river basin. From the mountains in the Alps to the river delta confluence in the Netherlands. Land cover and soil together determine the existing situation for the implementation of our interventions in the landscape.



Soil

- Glaciofluvial deposits
- Limestone
- Rocks (volcanic & plutonic)
- Slate
- Marine and estuarine clays & silts
- River terrace sand or gravel
- Clay & silts
- Claystone & mudstone
- Clay (stony, boulder, residual, tertiary)
- Loess (loamy & sandy)
- Chalk
- Sandstone
- Sand (dunes, eolian, outwash)
- Organic material
- Marl

N

Based on the ESDB EU-dataset on European Soil. See: https://esdac.jrc.ec.europa.eu/ESDB_Archive/ESDB/ESDB_Data/ESDB_v2_data_smu_1k.html

Industrial wastewater: current system

Industries need water for their production process. This can be used for cooling, distilling, cleaning, removing and other processes present along the broad range of industries. Where this water is sourced and how wastewater is managed has several issues in the current system. The diagram below shows how the current water system works in broad terms. Water sources such as ground and surface water are filled and replenished by rain throughout the year. This is used as the main source of water for a Central water treatment plant (CWTP) where water gets treated to become potable. This is then divided over both industries and urban areas. Focusing on industries, water is stored on site in towers or pools. When needed, water is added to a processing step where it gets mixed with pollutants. In the current system, this water is partially treated on site, but also partially dumped back into the water source, the same one used by urban areas (European Environment Agency, 2019). Partially treated water is then combined with urban waste water to be treated at the Urban Waste Water Plant (UWTP) to then be released back into the water source. This system has several issues. First being the dumping of pollutants directly into the water source. In a new system this should be avoided. Secondly, the mixing of both urban water systems and industrial water systems together creates some imbalances, this is made clear in periods of drought when water is scarce in the same source while it needs to be provided to both urban areas and industries. To resolve these issues, the urban water system and industrial systems need to be decoupled.

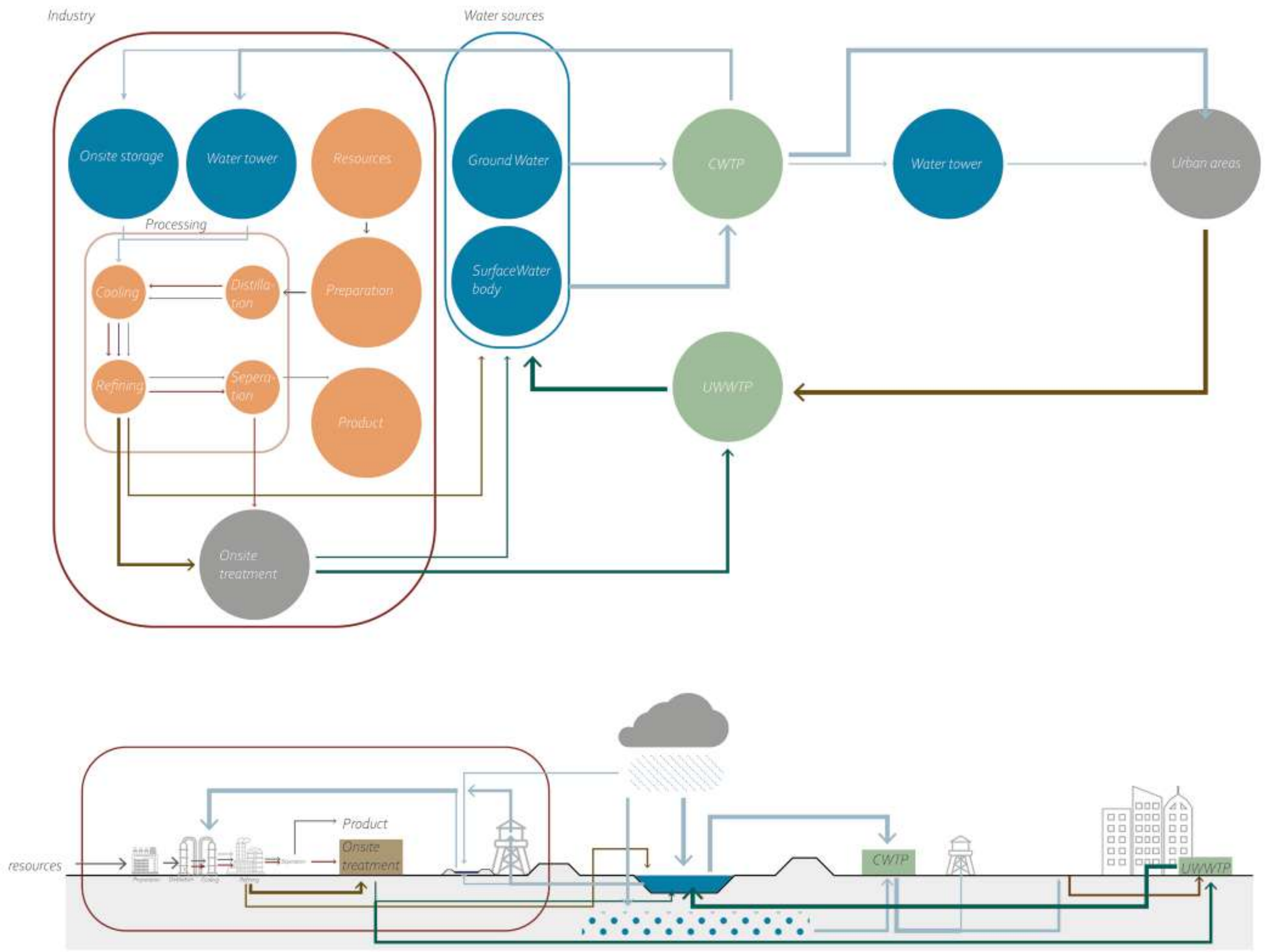


Figure 3.7 Current state of the industrial water system in diagramme and section.

Industrial wastewater: proposed system

Focusing on industrial water systems, these should have their own water storage, reusing urban greywater. Grey water is water used for cleaning or rainwater within urban systems (European Environment Agency, 2019). This can be an added source for industries instead of using the same source as urban areas. Next to this, Industries should both decrease the use of heavy metals and inorganic substances while creating local opportunities for decontamination. When space is available, this should be through sustainable or natural means that benefit the entire area. If space is constrained, technical solutions can be used. The result will be closed industrial water loops that source their own water on site from grey water and precipitation while treating all waste water on site. The final aim is that along with the improvement of water quality, is the decontamination of surface and groundwater. Creating separate closed loops for industries helps achieve that. Below, this new water system is illustrated in a diagram and section.

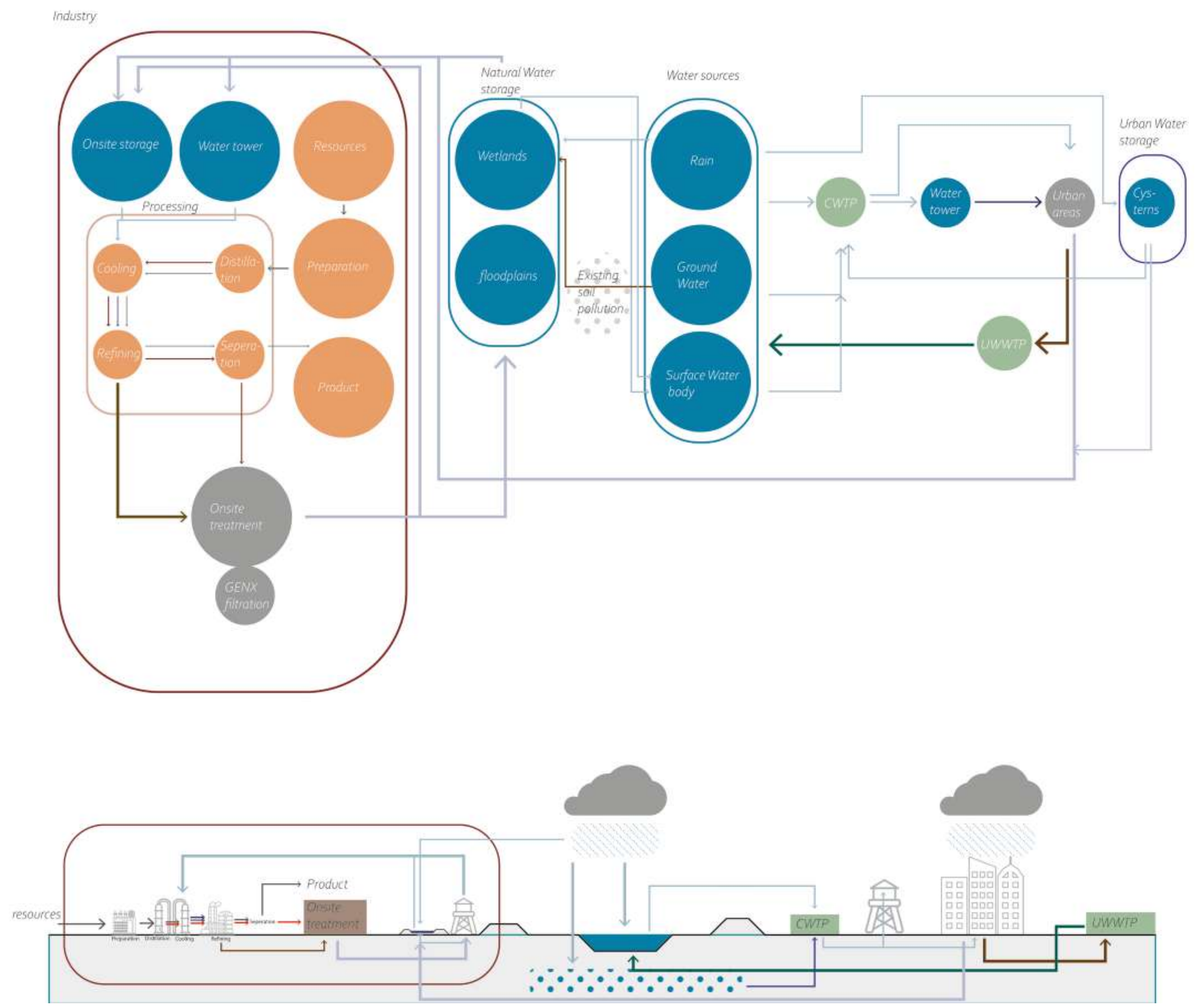


Figure 3.8 Proposed state of the industrial water system in diagramme and section.

Literature study

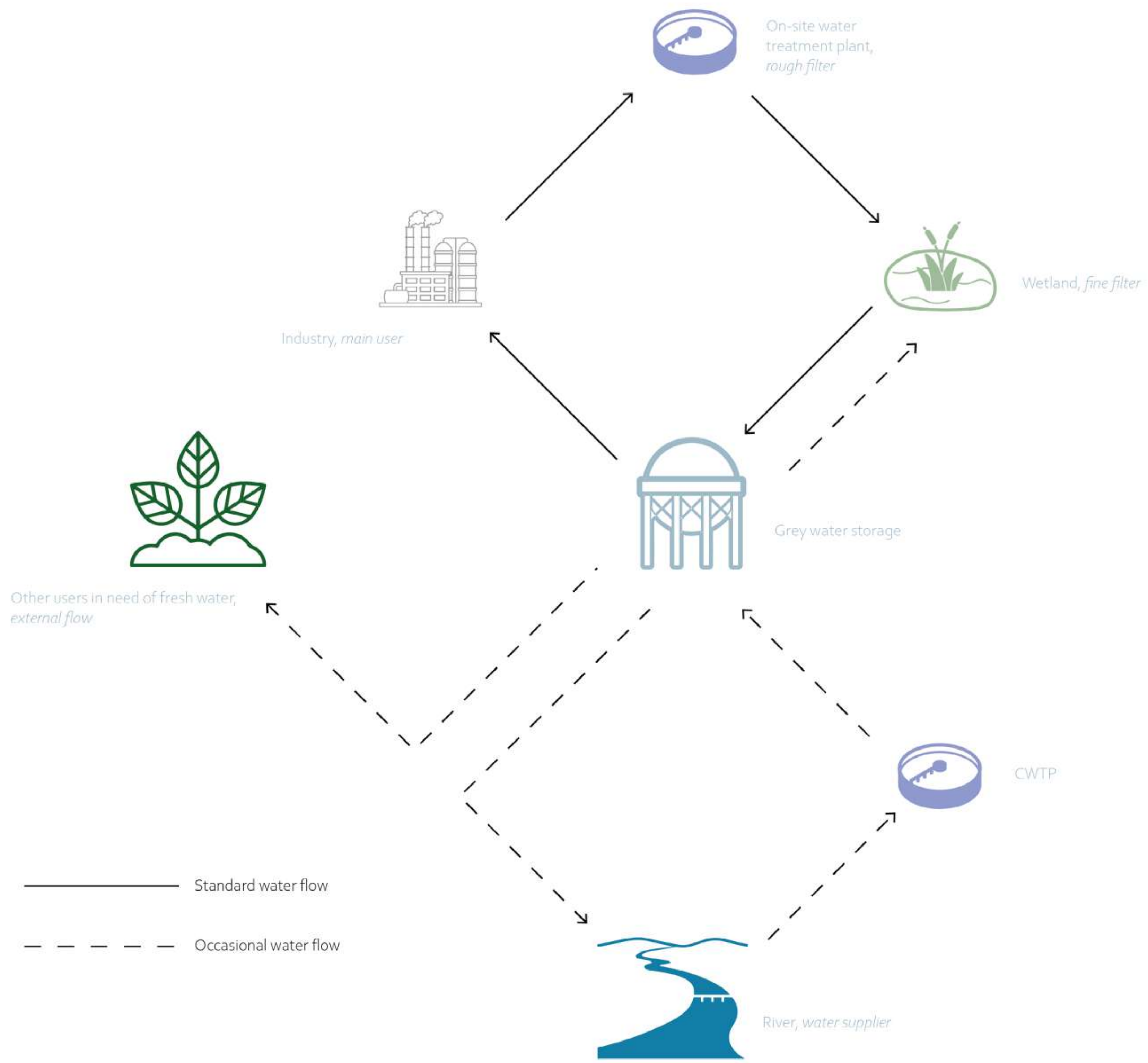
Closed industrial wastewater loops

In this project we search for solutions to ensure a high water quality, sufficient water quantity and fair water distribution in the river basin. That means that we need a system that can provide for sufficient amounts of water of high quality that can be fairly distributed and accessed among users. In the Água Carioca project by Ooze (2016) the architects introduced a wastewater system connected to a wetland as a fine filter.

We applied the system to industrial wastewater. The system has four main elements: the contaminating industry, the rough water treatment plant, the fine water treatment wetland and the retaining water storage. These four elements function in a loop. The industry uses water from the water storage for its industrial processes and contaminates the water in the processes. Then the water needs treatment, firstly in a rough filter to protect the fine filter, thereafter in the fine filtering wetland to thoroughly clean the water. The clean water can be stored in the water storage again after which the loop can be repeated. This loop is the standard water flow.

The system becomes resilient and providing with the addition of occasional water flows. These flows are the connection of the water storage with the river and the connection of the water storage with other users and additionally the possibility of the reversed flow between the wetland and the water storage. In times of water surplus the water storage and wetland can take water from the river and in times of drought the water storage can provide the river with water. The water flow between the river and the water storage is treated by a treatment plant, because the river water is polluted. The clean water from the water storage can also be used for other purposes, provided that the water storage is large enough to support multiple users. This occasional flow is external and will not be brought back into the system. The river water can be used to replete the wastewater system.

The disconnection of the industrial wastewater flows from the river contributes to the decontamination of the river and the loop systems care for clean water themselves, so they contribute to high water quality. The detention of water in the loop systems ensures sufficient water quantity in difficult times. The way the systems are implemented in the landscape allow for fair distribution of water and equal access to water.



Literature study

Decontaminating wetlands

One of the main solutions that we bring to the project is the implementation of closed industrial waste water loops. The key element to establish such loops is the element of a fine water filter. A natural and sustainable type of fine filter is a wetland. Wetlands are beneficial for their filtering function, but they also contribute to healthy ecosystems, temporary water detainment and the well-being of humans (Slaney, 2016).

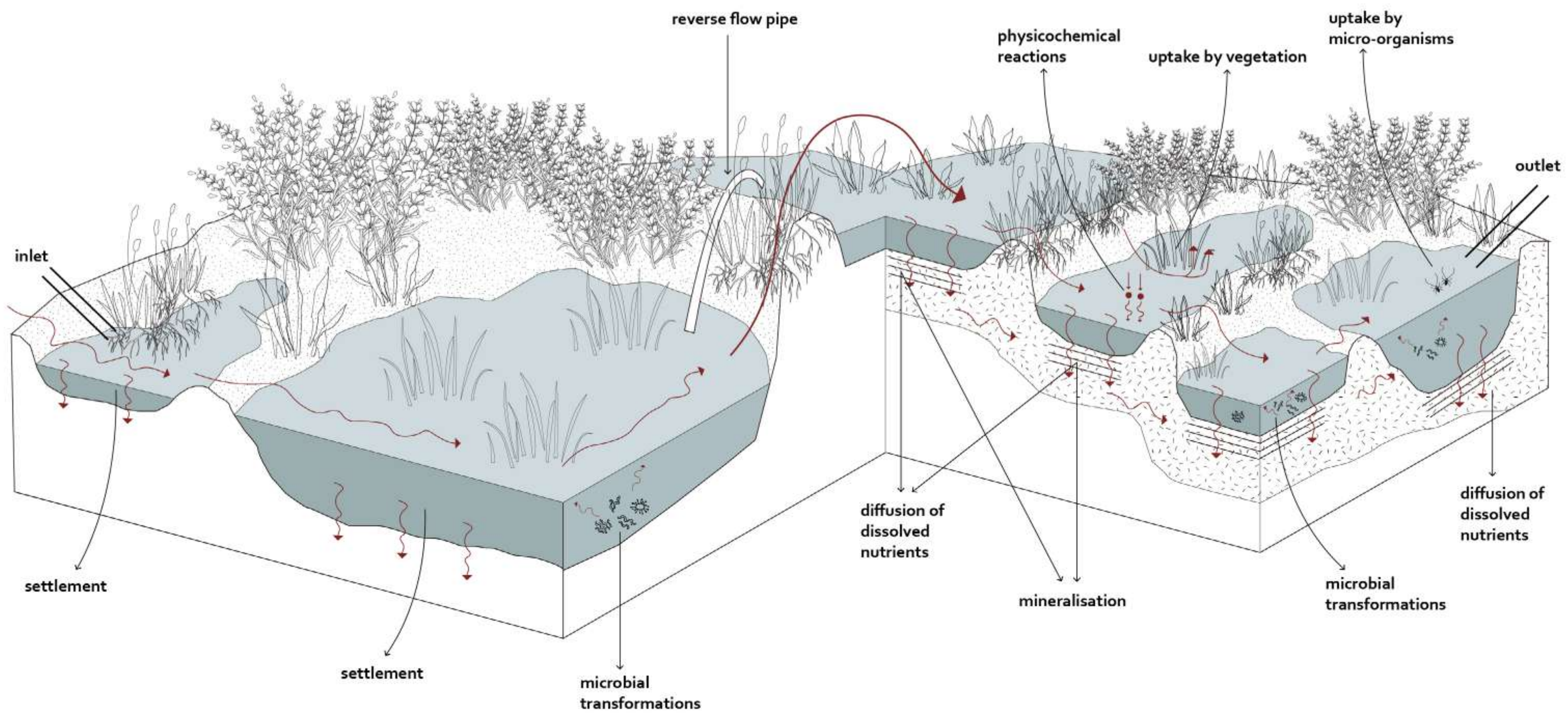
There are many types of wetlands around the world. They vary in size, location, water source and vegetation. Scientists are still not unanimous about the classification of wetlands and that is primarily due to the fact they exist in so many different climates and topographies and that makes scientists create criteria from different perspectives. The U.S. Fish and Wildlife Service bases their classification on the Cowardin System, which is also widely acknowledged around the world. Cowardin classified systems dominantly based on topography and hydrologic regime. The five types according to Cowardin are: marine, estuarine, riverine, lacustrine and palustrine wetlands (Federal Geographic Data Committee, 2013). Palustrine wetlands are the most dominant in the classification by The U.S. Fish and Wildlife Service, that classifies wetlands based on vegetation, landscape position and hydrodynamics. They identify marshes, swamps, fens and bogs (United States Environmental Protection Agency, 2023).

All of these types have their own typical vegetation and nutrients and thus filtering functions. Conditionally they can all be used for the design of a constructed wetland, a wetland specifically designed for water detainment and water treatment. This depends on the context where they are being constructed, such as the vegetation and soil type of the location. Constructed wetlands can be used to create the industrial waste water loops. Slaney (2016) set up technical instructions to design constructed wetlands. He divides the wetlands into three main levels: level 1, level 2 and level 2+. In the following paragraph it is explained how the wetlands function.

Wetlands filter water with several methods and in constructed wetlands these methods can be optimised. They filter in horizontal and vertical ways. First of all, they slow down the water flow so much that suspended solid pollutants will sink and settle in the soil. Depending on the soil layers used, the water can also filtrate vertically into the sediment. During this filtration, there is a process of diffusion of dissolved nutrients, because of the attraction with the particles in the soil and oxidation. Simultaneously organic materials mineralise and settle. Then there is purification through the vegetation and micro-organisms. This happens through the uptake of nutrients and microbial transformations of the pollutants into gases. Finally, there are physicochemical reactions between elements of the pollutants and elements of the sediment, which result in new sediments (Vermeulen & Meuleman, 1999).

Coming back to the three levels of Slaney (2016), all three are capable of these filter methods,

Wetland level 2



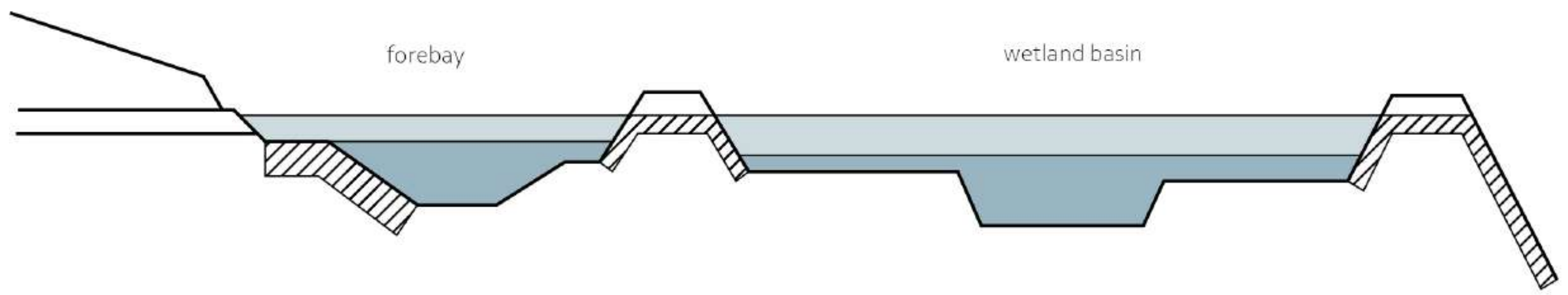
but the one performs better than the other. The most preferable type in most cases is the level 2 wetland, shown in image X2. Level 2 wetlands are the biggest type, but are consequently the most practical too. They can filter and detain the largest amount of water and can be detailed well to create high performance. They consist of multiple cells. All three types have a forebay to protect and to maximise the functioning of the wetlands by controlling the inlet and filtering the rough particles, but level 2 wetlands also have a bigger wet pond and multiple smaller purification cells. The pond contributes to the settlement of suspended solids and to a smaller extent to the microbial processes and nutrient uptake by vegetation and micro-organisms. More important is the increased resilience that is created by the pond, because it buffers the water of the wetland, so it can withstand longer periods of drought or flooding. Conjointly it has a function in flood prevention and water detention. The other cells are where the profound filtering happens. A reverse flow pipe connects the pond with the successive cells. They can be designed in detail with each cell given different characteristics to optimise the purification process. The cells benefit from diverse vegetation and filtration layers to cover every aspect of the filtering.

Level 1 wetlands are basically the simpler versions of the level 2 wetlands. They only consist of two cells: the forebay and the basin. The level 1 wetland basin is much more uniform. The basin can have the same functions as the level 2 wetland, but to a smaller extent, because every process needs to happen in the same water body, which makes it less fit for detailed filtering and that leads to a lower performance. They are a great option for a small-scale implementation.

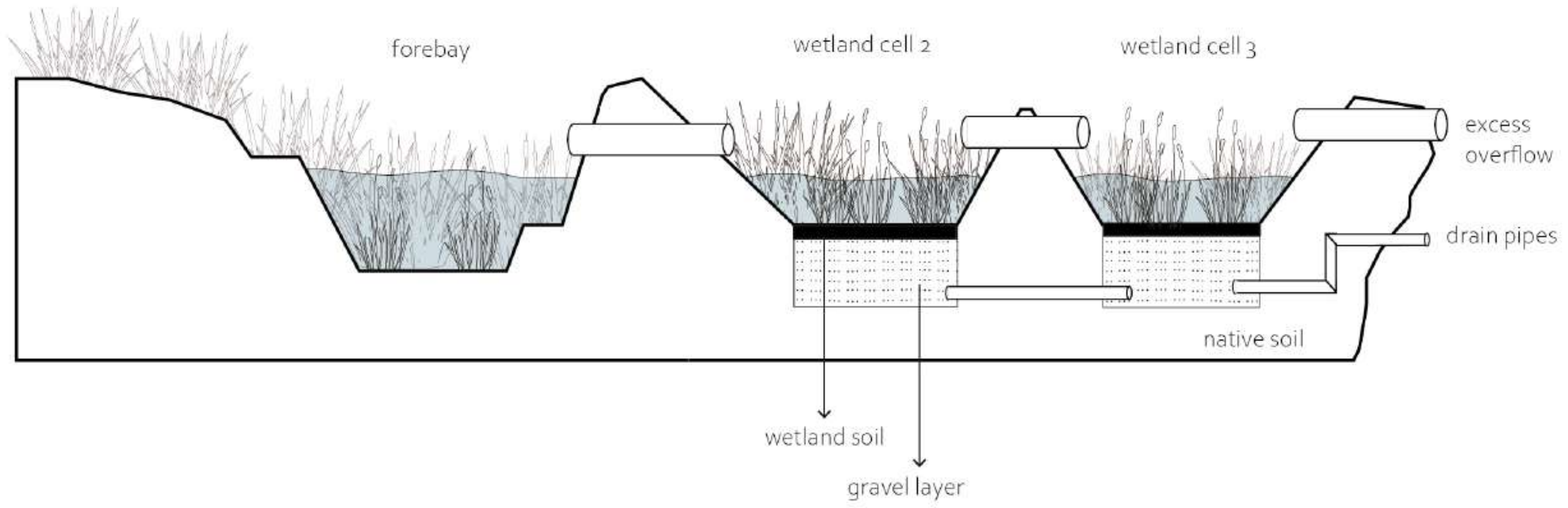
Level 2+ wetlands are a separate category, because of their high performance and specific filtering capabilities. They consist of three parts: the forebay and two cells. Special about these wetlands is that they have a saturated subsurface gravel layer. They have a mechanical design with gravel and subdrain pipes. These wetlands have flow-through cells that first filter the water with the vegetation and soil and subsequently with the gravel layer that is rich with microbes. Level 2+ wetlands are a modification of the other wetlands but do not detain as much water as level 2 wetlands. They have high performance rates and do especially well on filtering nitrogen. On the other hand level 2 wetlands are better phosphorus filters (Slaney, 2016).

Besides the filtering function, wetlands are beneficial for the detention of water, the health of ecosystems and the well-being of humans. More on this will be explained in the following paragraphs, but it helps to have a quick overview. Wetlands can detain large amounts of water, because of their slow water movement. They will fill up and slowly drain the water. The wetlands are to some extent resistant to fluctuations of the water level and can survive multiple days or even weeks of drought or flood (Slaney, 2016). Wetlands boost biodiversity because of their ability to provide many different nutrients to even more different organisms. They are bridging between different ecosystems and enhance the resilience of their surroundings by providing food and clean water. Additionally, wetlands have socio-economic value. They have high potential in sustainable commercial development, which is economically beneficial in the long term, for purposes like water treatment, tourism and natural production yielding. Moreover, wetlands and their environmental benefits have value to humans' mental and physical well-being (Denny, 1994).

Wetland level 1



Wetland level 2+



Literature study

The matter of vegetation

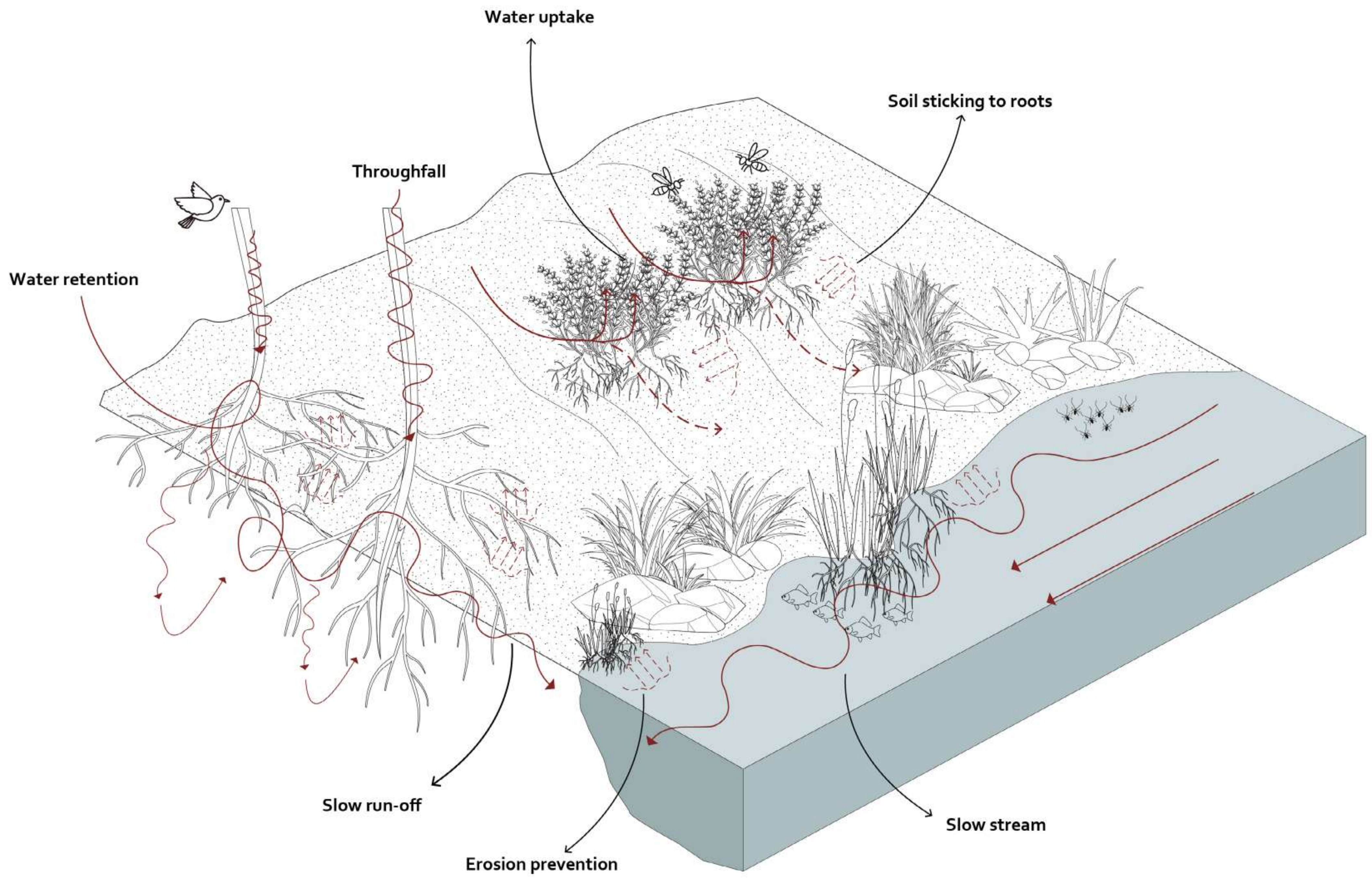
In addition to wetland ecosystems, we found that vegetation in general is important for healthy river landscapes. Vegetation is necessary for the preservation of biodiversity, the prevention of erosion and the retention of water by slowing down run-off.

The lives of flora and fauna are very much intertwined and dependant on a variety of species. Vegetation is used for food, shelter and reproduction (Schulz-Zunkel et al., 2022). This dynamic of ecosystems is based on native species. The systems are developed with native species and interference with foreign species might disrupt the systems. Additionally it is important that there is all kinds of vegetation, because they all work together, so not only trees or only grasses, but rather a mix of many species. The biodiversity is just as valuable on the river side as it is on land. A rich biodiversity enhances the resilience of an ecosystem, which reduces future environmental issues (Threlfall et al., 2017).

Secondly, vegetation plays a major role in the prevention of erosion. Roots of plants and trees keep the soil in place and locally they do so in places where, without the roots, the soil would not be able to compose itself because the terrain is too steep. Nonetheless, flat surfaces need roots to prevent erosion, to be better protected against the weather and the river stream. Forests prevent landslides and vegetation on the river bank keeps the bank intact. Moreover they prevent pollution that is caused by erosion. Erosion is a great cause of water pollution, because substances that are released in the process saturate with other substances in the water that deteriorate the water quality. In addition, the vegetation takes up some of the pollutants for their nutrition. Vegetation is able to retain the soil because of their thorough spreading and diffuse surfaces where soil particles can cling to (Anderson, Hoover & Reinhart, 1976). It is just like a smooth floor is slippery, but a carpet is not.

Finally, with the same principles the vegetation also has a major function in slowing down run-off from riverine floods or heavy rainfall. Vegetation takes up some of the water running down, decreasing the amount of water. Trees and plants do this by taking up water with their roots on the ground and with their leaves and exterior during rainfall, covering the vegetation in water. Some of this water will never even reach the ground, but evaporate. More vegetation results in more water retention (Anderson, Hoover & Reinhart, 1976). Furthermore, vegetated ground slows down the water flow. During floods the vegetation forms obstacles for the water flow, slowing the water down and partly retaining it. This works on land and along the river bank. The lower velocity of the stream is beneficial in three ways: it lowers the risk of flooding, it makes floods less dangerous and it causes less erosion, making it contributing to water decontamination (Schulz-Zunkel et al., 2022).

Effects of vegetation



Literature study

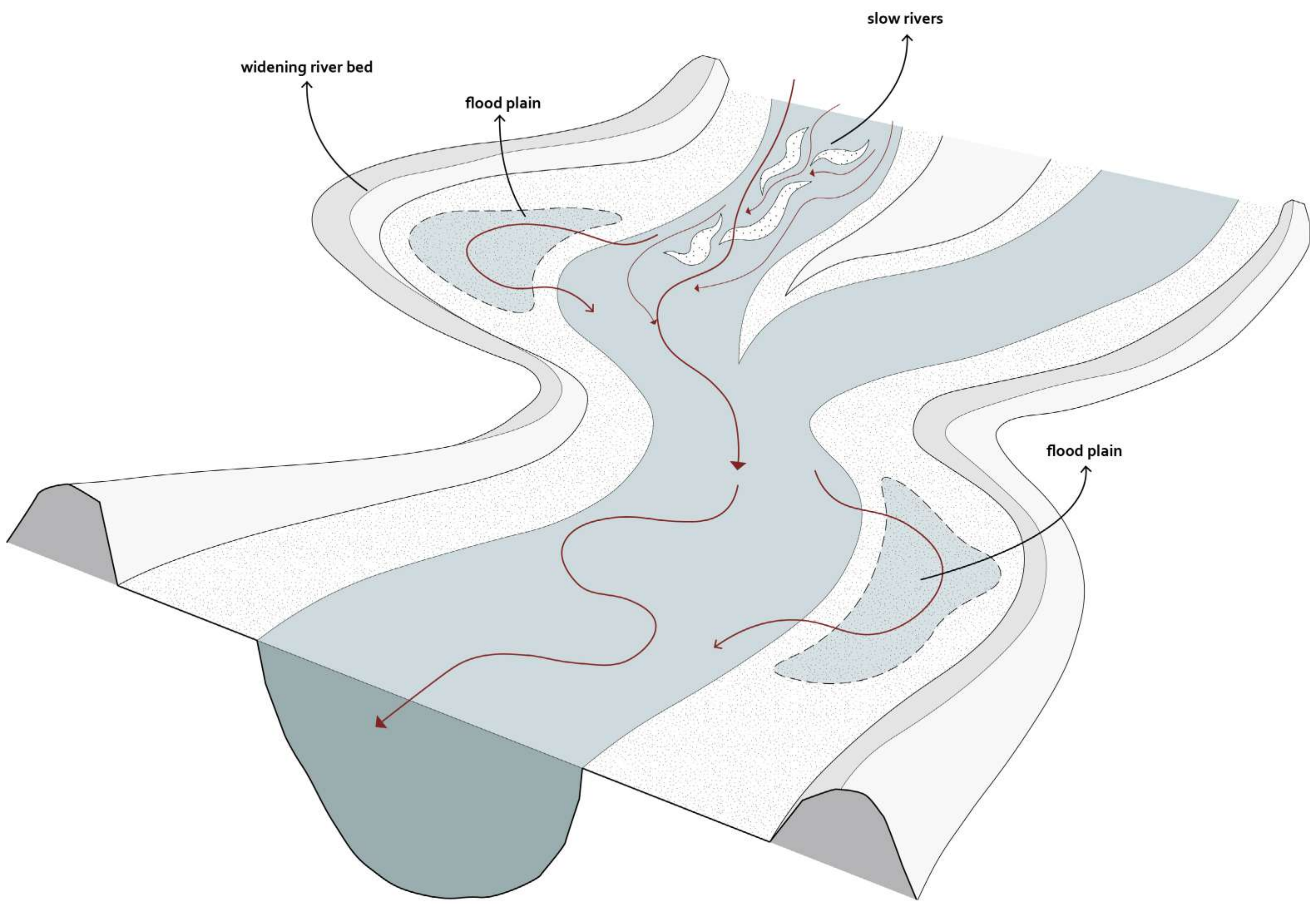
Room for the river for flood prevention

Accompanying a vegetated river bank is often a natural soft soil, that is, not a hardened solid river bank, such as concrete quays. Soft river banks help to slow down the river stream as well. The soft soil, especially with vegetation, creates a buffer zone between the bank and the stream, where the water can press on the bank. Gravity forces the water down-stream. When entering a curve with a hard bank, the water will bounce off of the bank and retain its speed. When pressing on a soft bank, the water will be caught into the buffer zone and slowed down like an object on a cushion (Raj & Singh, 2022). This is a method for flood prevention, since the flood risk diminishes with a slower flow.

Other methods that we use for flood prevention follow the concept of room for the river. This concept poses ways to decrease the risk of flood damage. Flood damage occurs when there is an excess of water from rain or up-stream river water. When the river is overloaded it will exceed its regular banks and flood valuable land. The traditional way to deal with this is to protect the valuable land with dykes. Nowadays the preferred way is to provide the river with room to flood without damaging valuable land. Flooding happens with a combination of an excessive volume of the water and an excessive velocity of the water flow (Ministerie van Infrastructuur en Waterstaat, 2019).

The first principle to counteract the flooding is to make the river bed able to contain the water volume. This is simply done widening the river bed. The more room there is in the river bed, the more water it can contain. The room is preferably created in places where the excess water can do no damage (Ministerie van Infrastructuur en Waterstaat, 2019). The second principle here is to slow down the water stream. Previously given was the method of soft river banks. Another way to decrease the velocity is to augment the surface. The water will take more time to travel a distance when it is spread over a larger surface. The surface can be augmented over the length of the stream or over the width of the stream (Rizal Fahmi et al., 2018).

Room of the river



Stakeholder Analysis

Next to spatial analysis a stakeholder analysis is very important to understand the river basin. The river basin is an international water body. Therefore there are a lot of actors and stakeholders involved in the river basin. Different countries also have different approaches to the management and policies regarding surface water quality. The map on the right shows the three river basins of the Rhine, Meuse and Scheldt and the governance involved in these river basins.

Governance

The overarching body monitoring the water quality internationally is the European Union. They have different agencies regarding the river basins and water quality. For example the European Chemical Agency which controls and regulates the chemical substances in the surface water. For every river basin we mentioned one main polluter. This has been done because this way we could do a case study for the political powers and other bodies involved in managing and controlling the water emission of these industrial polluters. The Rhine river mainly flows through Germany (partially through Switzerland). The Meuse & Scheldt flow mainly through Belgium (partially in France). To simplify the governance constellation Switzerland and France have been left out of this drawing. But it could be concluded that they have similar bodies with the same power relationships.

In general a top down approach for the legislation around industrial water emission is visible. The national governments have the power to legislate the industries, while mostly local or regional governments have the authority to check the industries (Luimes & Van hest, 2023). In The Netherlands the environmental services (milieudienst) is in charge of the environmental permits, which can also limit the allowed industrial water emission. While executing political powers like RIVM emphasise legislation is needed the national legislatures have little attention to the problem as the direct consequences are mainly visible on the local scale (Luimes, 20230).

Concluding we could say there are many actors involved in the governance of industrial water emission. While the problem and urgency is mainly visible on the small scale (many municipalities want to do something about the pollution), action on a national or international scale is still limited. The European Union and executive parties play an important role as overarching bodies of power in the North West European river delta.

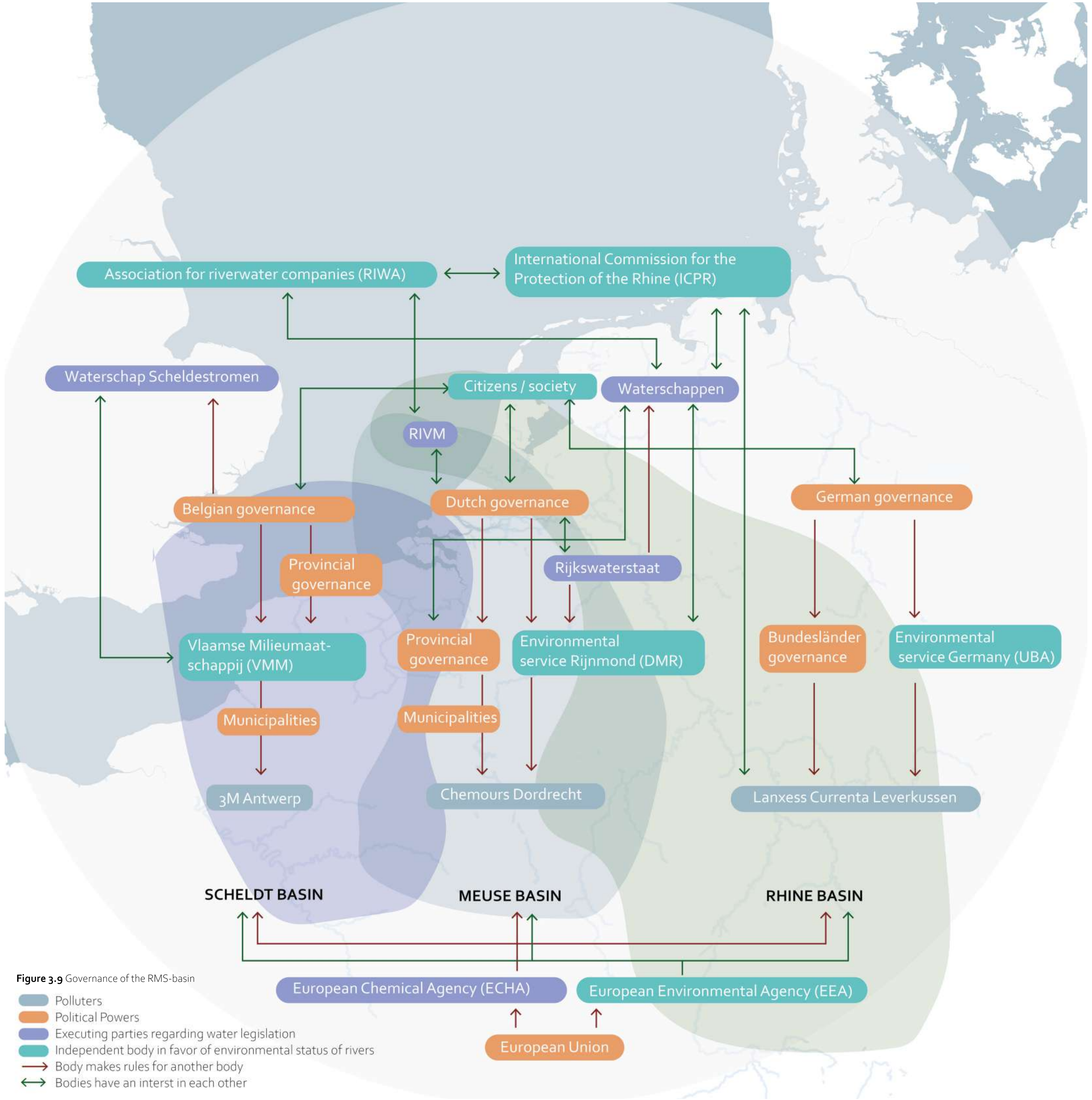


Figure 3.9 Governance of the RMS-basin

Power/interest matrix

On the previous page we have seen that the governance of a river basin is a difficult process. On this page we gathered stakeholders and put them into a power-interest matrix. The stakeholders are divided into three sectors: public sector, private sector and civil society.

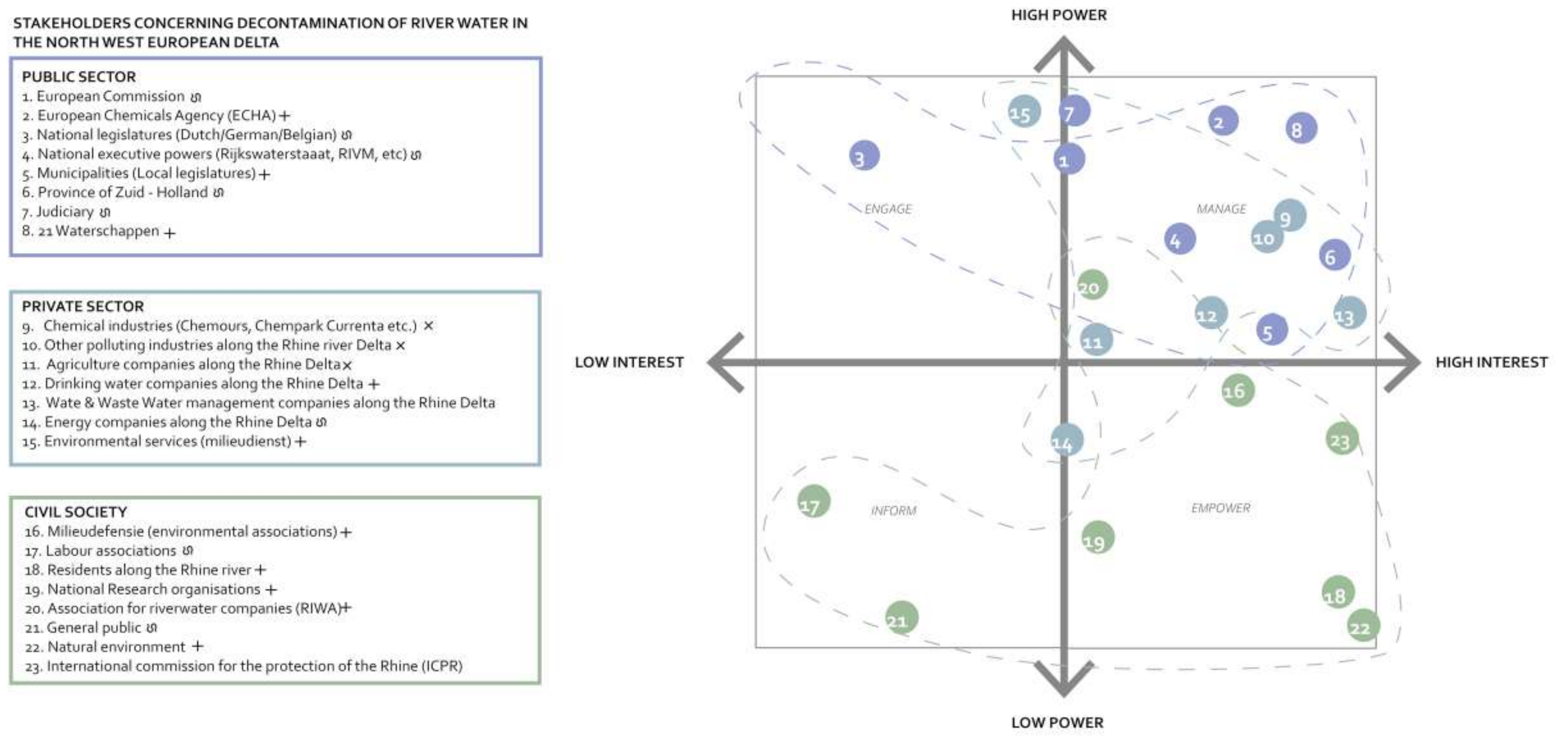


Figure 3.10 Power-interest matrix

In the **public sector** are stakeholders owned or under control by the government. From a big scale to a small scale these are the European Commission, National legislatures, Provinces and Municipalities. On a European scale there is a high interest in our project. But on the national scale there is a lack of urgency, thus a low interest. Smaller legislatures have a little more interest in our project, but have lower power. For the national executive powers we mainly focus on the bodies that do have interest in our problem, because there are many executive bodies and most of them are not relevant to our goal, but do have a say in the national legislation. Judiciary is the highest power in our matrix, because they can force industries to change to European and national norms and rules. In general the public sector has high power and diffuse interest in our problem.

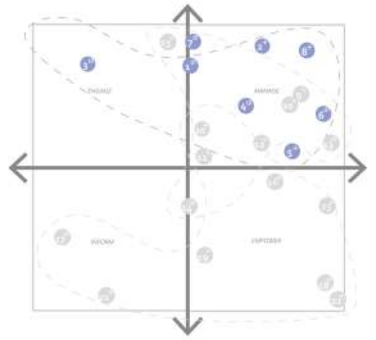


Figure 3.10 Power-interest matrix: public sector actors

In the **private sector** are most of the industries along the river basin. The chemical industries are the main polluters, among many small polluters and the waste & waste water management that emits water run off from diffuse sources into the surface water system. These are the industries with the highest interest in our project. The other industries have less interest in our project, but still they benefit from a decontaminated surface water system, especially drinking water companies. Environmental services are also a private body, they do have high power, but to this point they show limited interest in our problem as they say the public sector is responsible for the legislation (Luimes, 20230). In general the whole private sector has high power and high interest in our project, because they are the main cause of our problem, but also the main bodies that need to change.

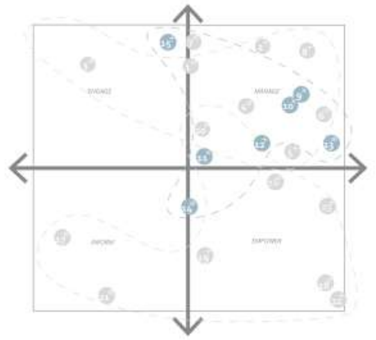


Figure 3.11 Power-interest matrix: private sector actors

In the **civil society** are local, national and international bodies that organised themself to have something to say about our river basins. Most of the civil society bodies have low power, but high interest in our project. They exist because they want to improve the river water quality or environmental status of rivers. The general public is also within the civil society. While local residents along the river have a high interest in the problem, the general public does not see the urgency of the problem and therefore have a low interest. The silent stakeholder in this matrix is the natural environment. Because it has a high interest in our project, but no power to do anything. In general the civil society has low power and a diffuse interest in our project.

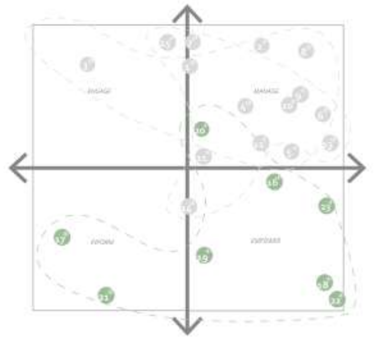


Figure 3.12 Power-interest matrix: civil society actors

Generalised power interest matrix

Because there are many stakeholders with complex relationships we generalised the stakeholders into bodies that have more or less the same power and interest. It became clear that the international, national and local governments have very different interests in our project. But they are the ones that can legislate industrial pollutant emission. Meanwhile the industries are lobbying to keep the public sector happy and keep doing what they are doing. Although they know they need to change, they are not going to do so as long as they make profit and it is not needed. The civil society can be grouped into the general public, local residents, nature (silent stakeholder) and environmental and river associations interest in the pollution problem. The civil society can call attention to the public sector, with the power of the general public they can force legislation.

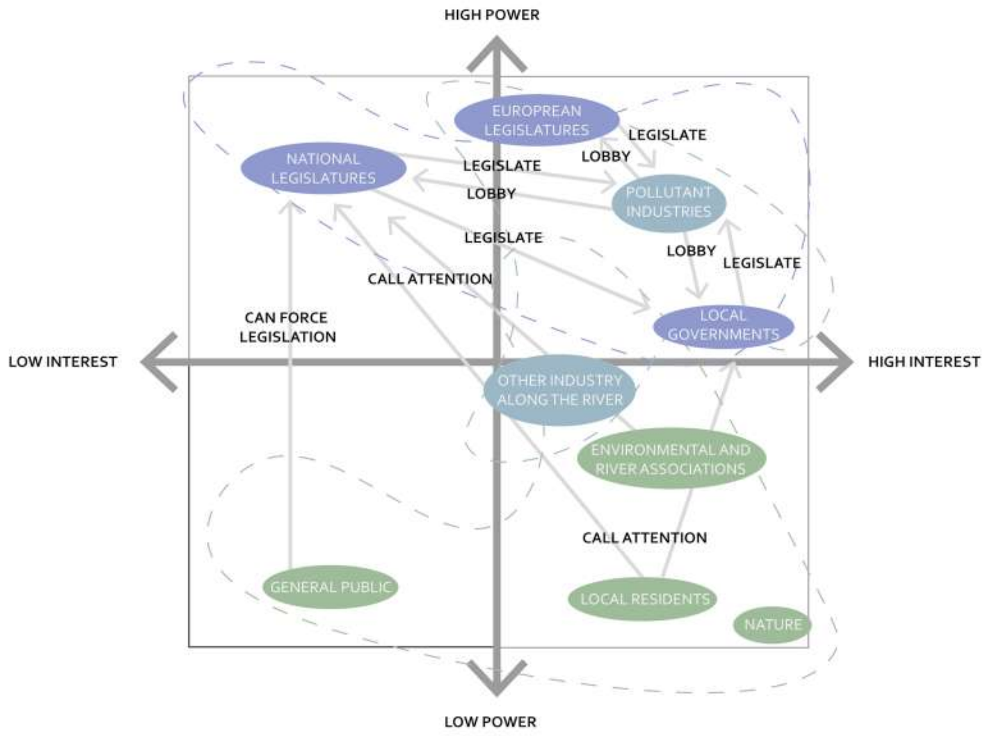
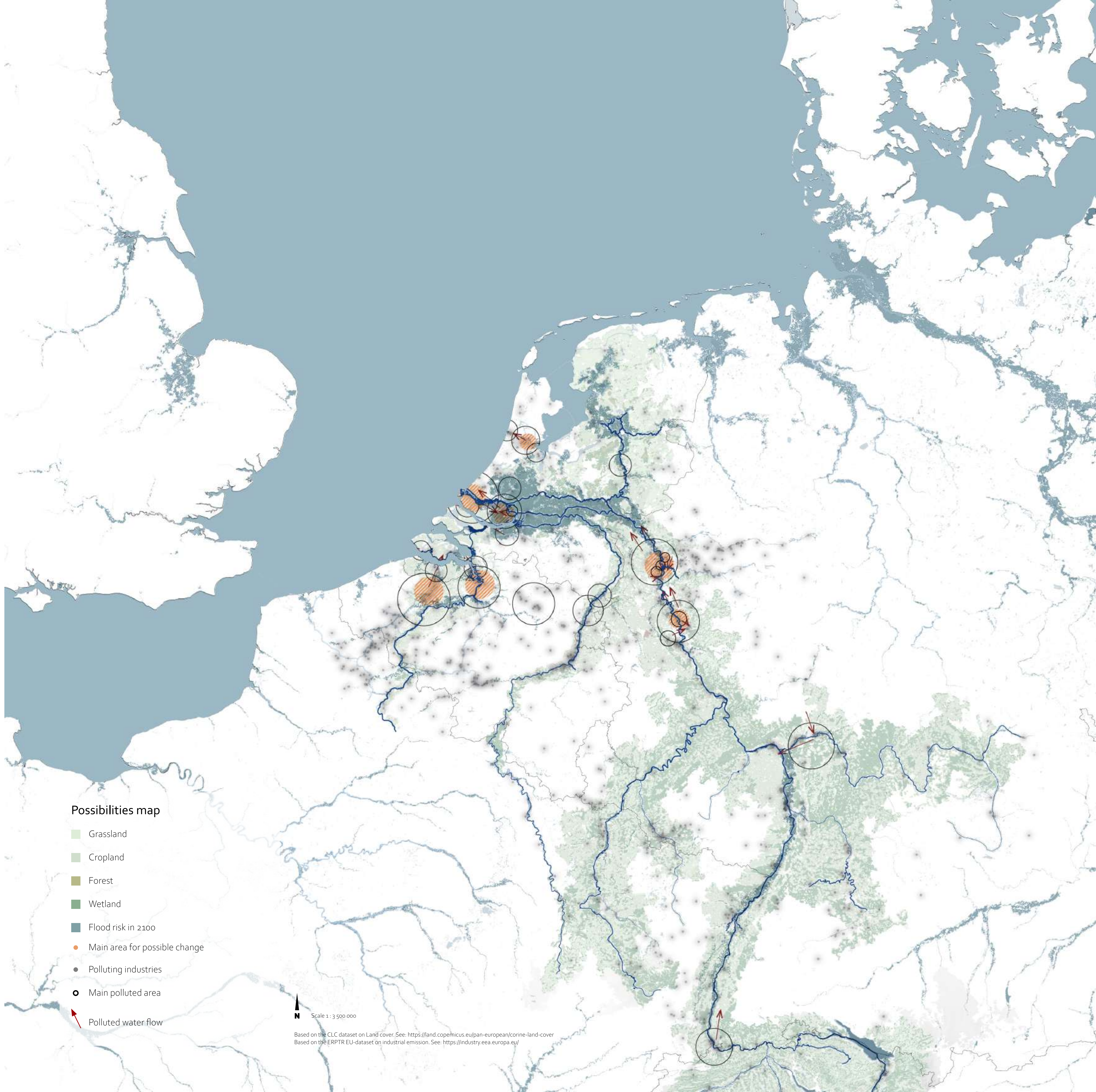


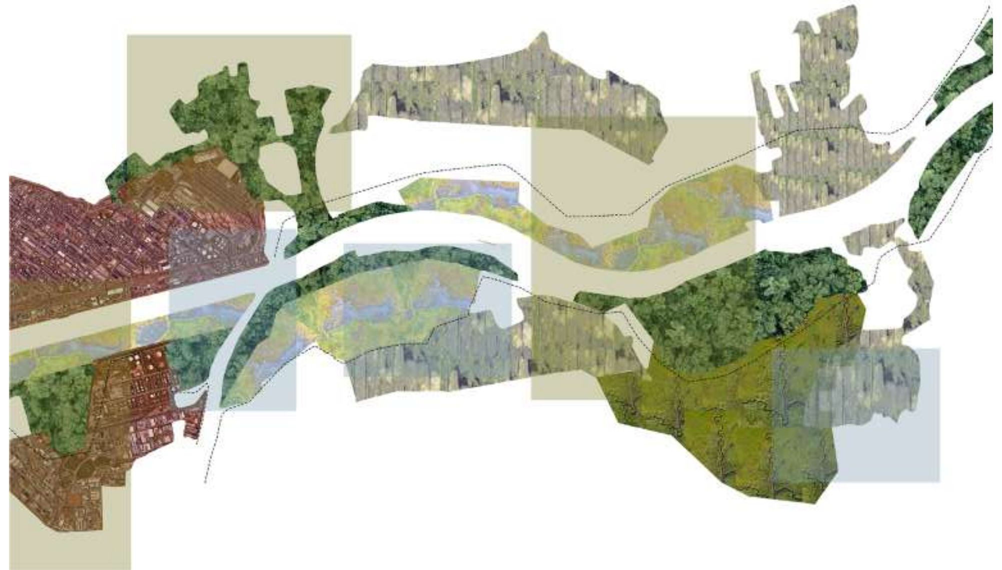
Figure 3.13 Generalised power interest matrix

Possibilities Map

Concluding from the spatial analysis on the North West European river basin we produced a possibilities map. This map shows the main cluster of industrial water emission points, these are our main areas of interest. Clearly visible are strong clusters of the industrial emission problem in the German Ruhr region, the Belgium harbours and the Dutch delta region. The lands along the river that are most interesting for the spatial intervention are the non urban areas as identified in the land cover analysis map. Also important to note is the future risk of flooding. Therefore, a the flood risk map is overlaid with the industrial emission points. In the Dutch river delta, these layers all overla: this is where there is a lot of industrial emission and also a big area of land is exposed to flood risk in the future.

The map is thus a combination of our problems identified. Nevertheless, it also shows the places in need for a change. These are the areas most interesting for our project and, therefore, this map is above all a *possibilities map*. The orange highlights show the main polluted, but also the most important regions for our strategy.






IV
CHAPTER 4
A HEALTHY
RIVER LANDSCAPE
VISION

CHAPTER 4

A HEALTHY RIVER LANDSCAPE

VISION

With the problem defined in chapter I and conceptual framework established in chapter II we determined our vision for the North West European river basin. The vision focuses on the three concepts: circular water system, decontamination and flood prevention. The vision shapes a regenerative decontamination design for the river landscape focused on industrial areas. Secondly the vision shows examples of landscape typologies that shows how our concepts can be implemented on a smaller scale.

Vision for the entire basin

Our vision is built up out of three main elements: flood prevention, decontamination and circular waterloops. These three elements are shown in separate maps to later create one large vision map. The aim of this map is to illustrate that the vision concerns the entire river basin while also consisting local changes.

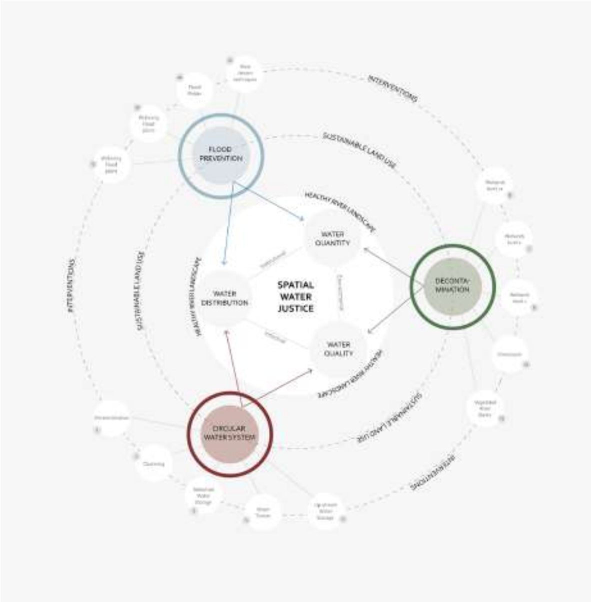
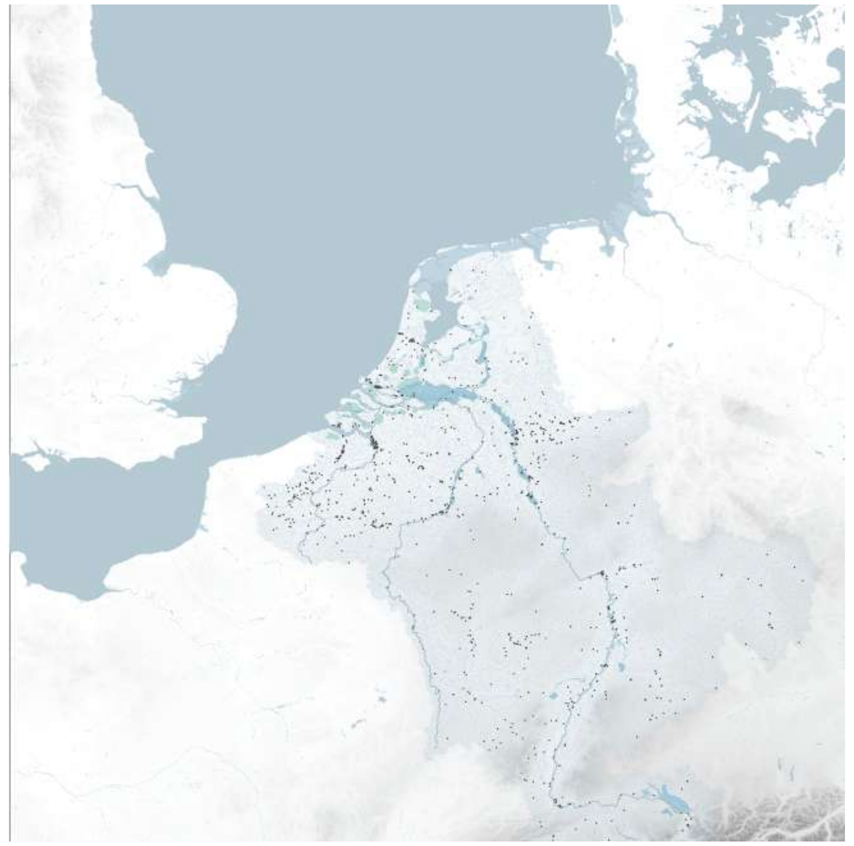


Figure 4.1 Conceptual Framework: vision elements highlighted

Figure 4.2 Vision: element 'flood prevention'

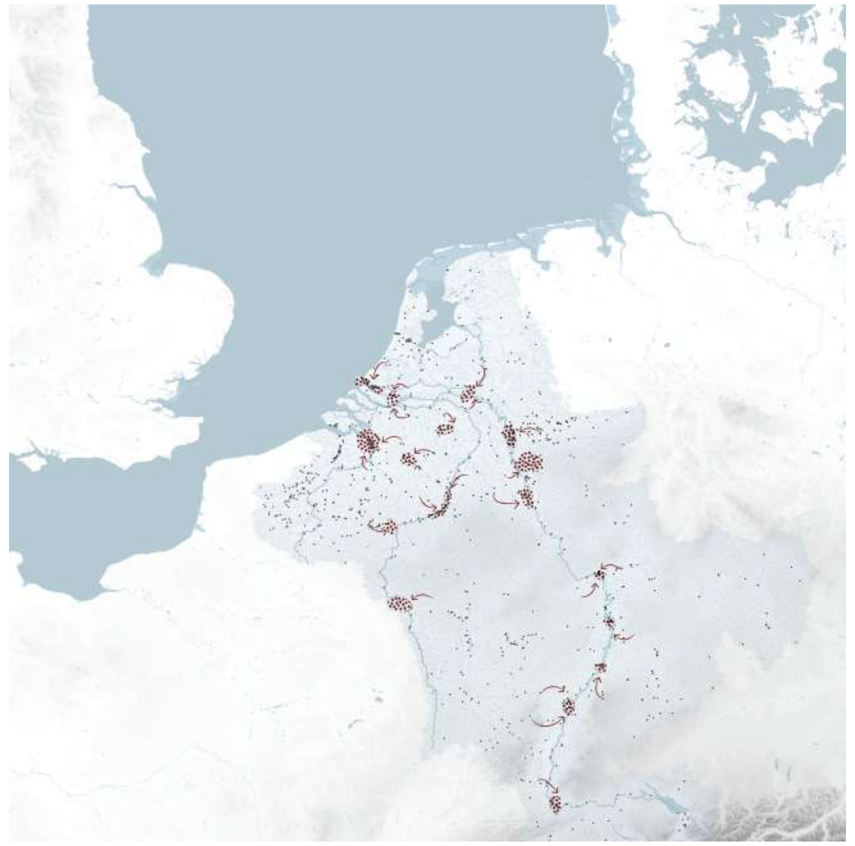


Shown first is water storage. This vision element focuses on retention of water and prevention of flooding. For this, three different ideas are used. This is based on the different landscapes and topologies present along the river. In low lying areas vast swaths of land can be used as water storage through permeable water lands and reusing polders as possible storage. Here, this element looks more at flood prevention. In higher ground areas, water storage is more local and concerns more in water retention. This allows prevention of drought as more water is added to the basin and river throughout the year.

Figure 4.3 Vision: element 'decontamination'

The second element is the decontamination. This is made up out of wetlands, forests and regenerative polders. These focus on cleaning up pollutants from the river basin. Wetlands and forests are the largest of these. Similar to flood prevention, wetlands are more focused on lower lying areas while forests are more in higher grounds and hinterlands. Aside from decontamination, these have an added effect of creating new ecological links. The third part of regenerative polder can add flood prevention to wetlands with the aim to create more multifunctional landscapes.

Figure 4.4 Vision: element 'circular water system'



The final main element is the creation of circular water loops. This focuses on the industrial system and how they can contribute to decontamination. By grouping certain industries, they can manage water use together and decontaminate their own water. When an industry is location specific or too far to move into a cluster, they can create a separate closed loop to decontaminate their own water. The aim of these closed loops is to remove sources of water pollution.

Together with the decontamination, the entire river basin will be cleaned up bit by bit while new water storage ensures improved water availability. As a river flows from source to mouth, many different landscapes are passed. Six of these landscapes are highlighted in a satellite image. These form the basis of a zoom in of a river course through six panels.

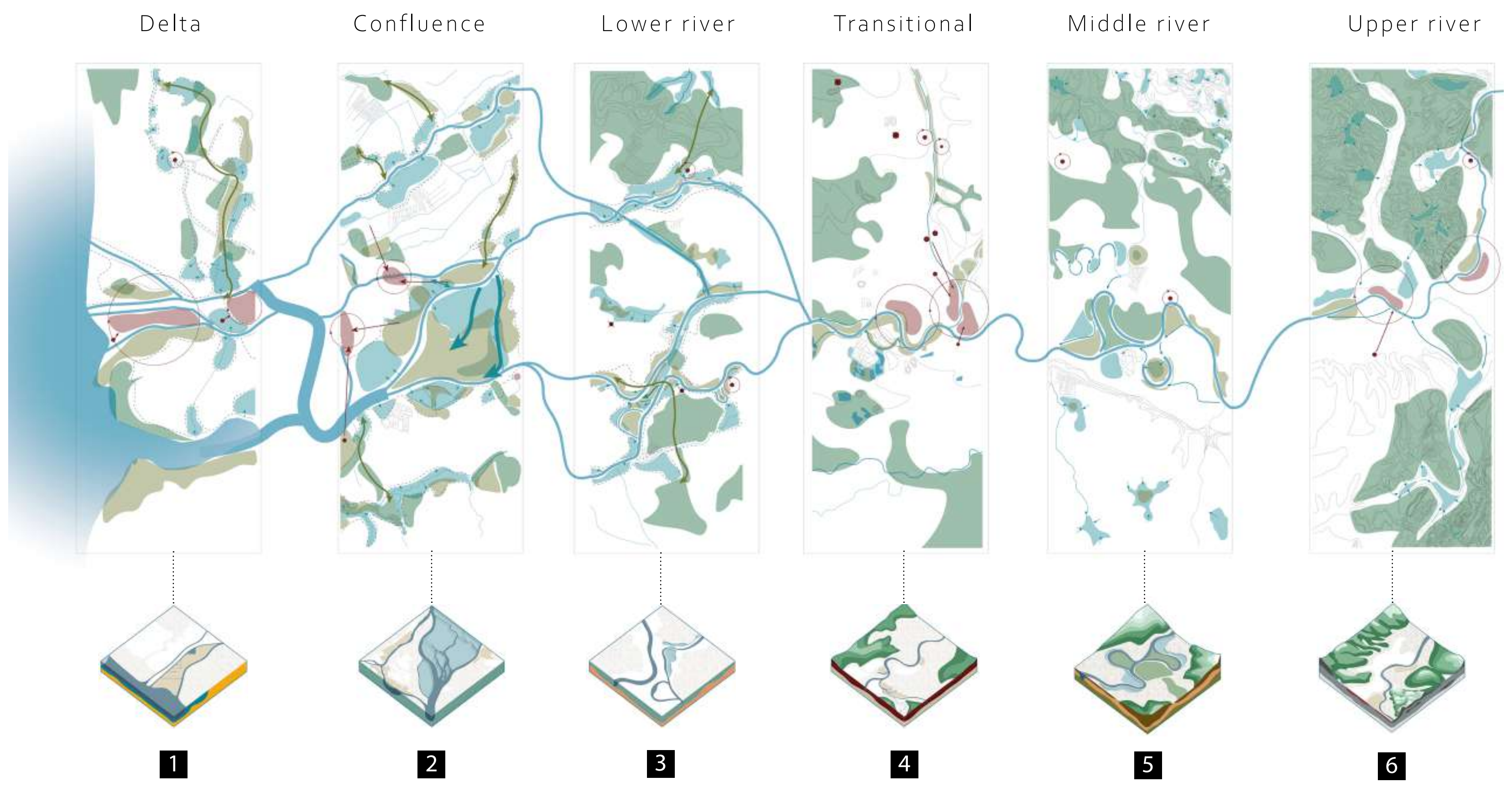
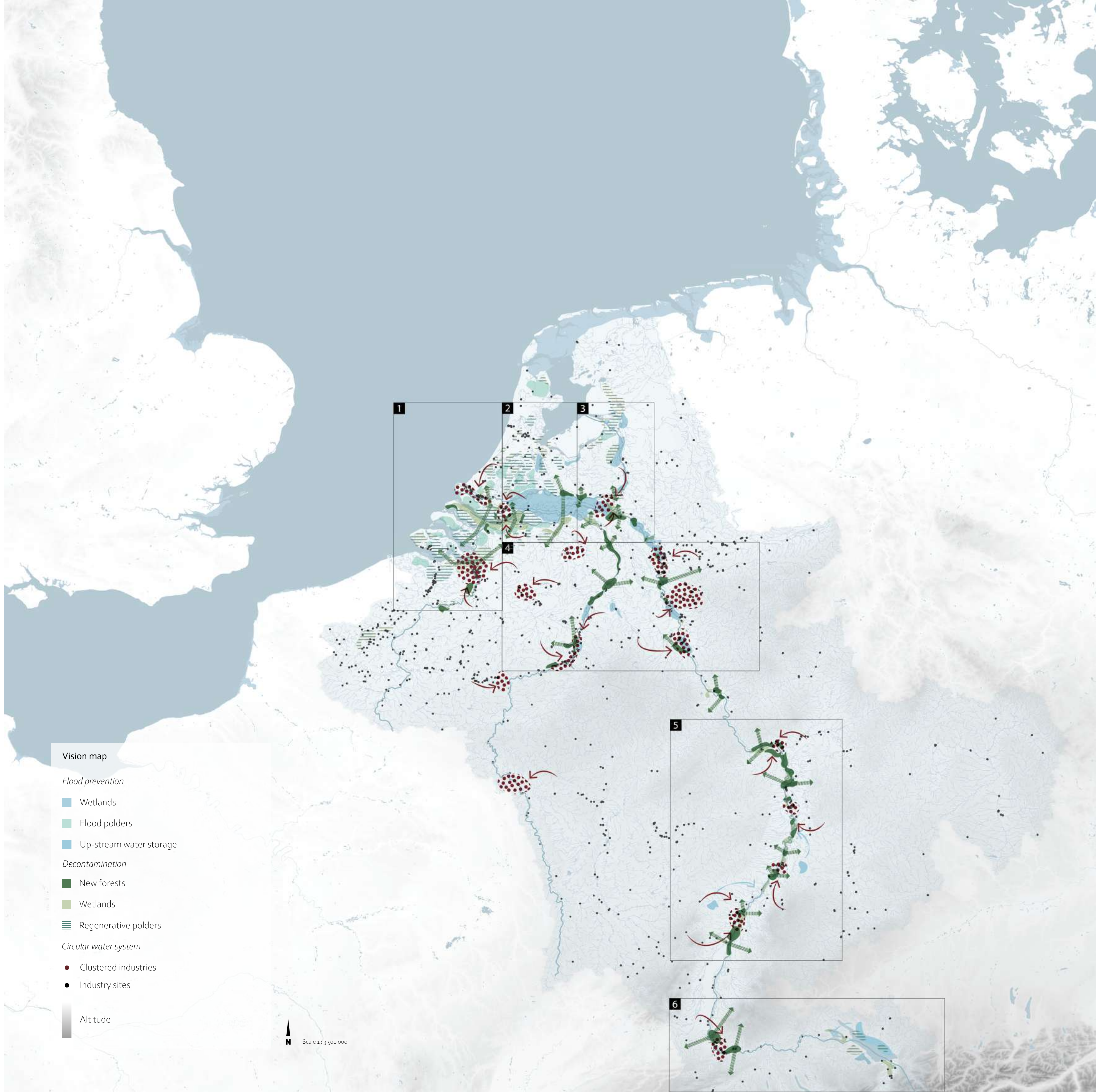


Figure 4.5 Six landscapes represented as panel and as icon



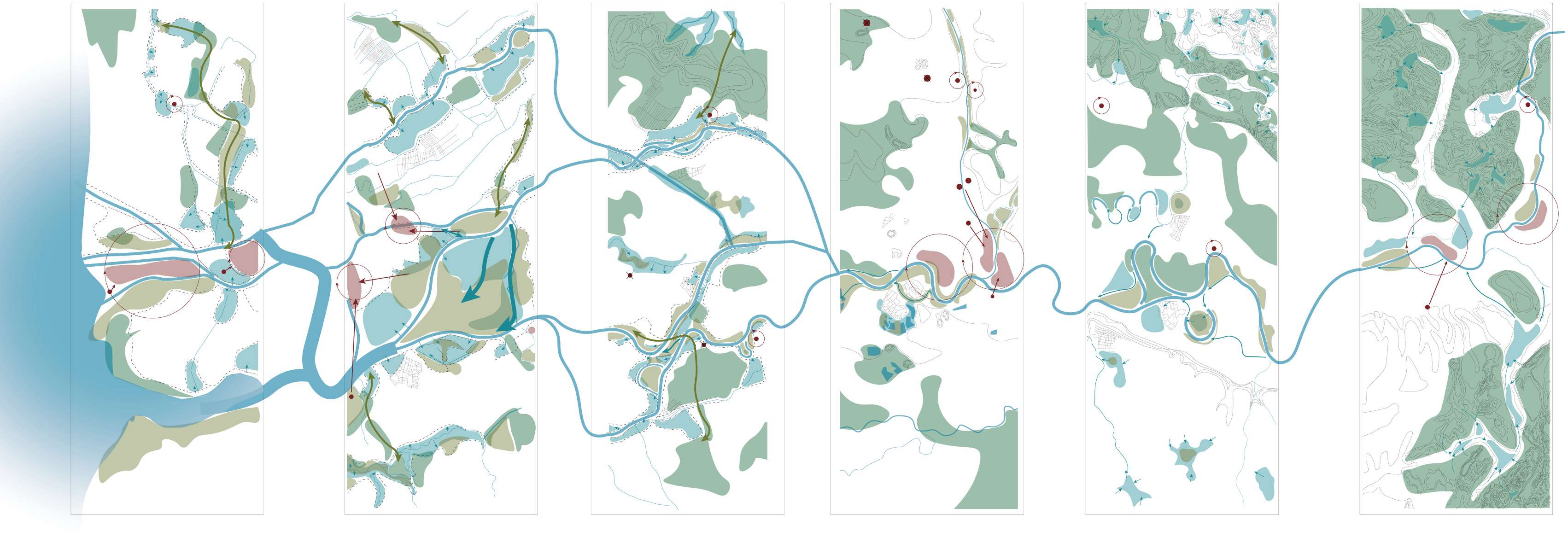


Figure 4.6 Six river landscapes represented as vision panels

River basin wide panels

The Rhine River basin is a complex system of both land use and land cover. Together with elevation the river flows through a few distinct landscapes. These are shown in the panel diagram on the previous pages. In this diagram, a representation of the Rhine flows from right to left through 6 distinct landscapes.

The first landscape it passes through is the **upper river landscape**. This is characterised by steep mountains on both sides and valleys with scattered villages. While there is little room for vast wetlands for decontamination, forests and water storage within the valleys is possible. This allows local decontamination of rainwater before releasing it into the river, removing the pollutants that are added to the river from rain and melting water. Within the river valley itself, local industries can create clusters by grouping together and decontaminate their own water while the most solitary industries can uncouple themselves from the water system and create their own closed system.

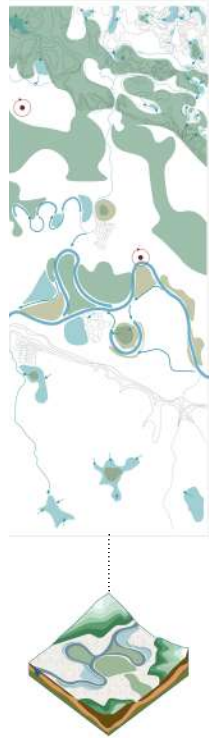
After flowing through the upper river, the hills open to create a wide river valley within the **middle river landscape**. Here a meandering path with oxbow lakes provides room for vast wetlands to slow the river down, decontaminate water and avoid flooding downstream. Within the hills and plateaus, there can be local water storage with a mix of small forests and wetlands, functioning the same way as the water storage and forests in the highlands. The industries present are mainly solitary. These should create their own closed loops to avoid adding pollutants to the river.

From the middle landscape, the river flows along **transitional hills**. Here, elevation differences become less dominant, and the river continues meandering. This is a densely urbanised landscape where lots of industries are present. These industries can create clusters, that decontaminate the direct area and their own wastewater together. In the few hills present, forests can clean up groundwater while widened riverbanks and floodplains can create wetlands and water storage. These new wetlands also have the added effect of creating new nature areas within a highly urban area.

Upper river

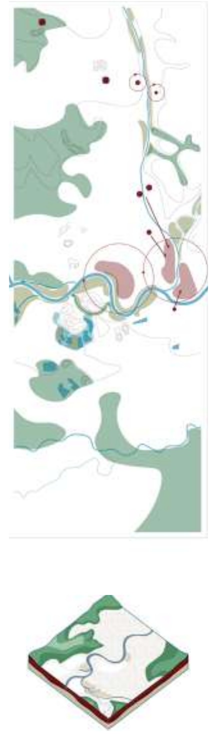
6

Middle river



5

Transitional



4

After the transitional hills, elevation differences barely have any effect on the course of the river. In the **lowlands river landscape**, dykes become a new addition in the landscape. These hold the river course back and prevent flooding in the hinterlands. While this is a constraint, this also provides opportunity to create wider banks and floodplains. This helps decontaminate the existing pollution and the pollutants missed up stream. When combined with forests it can even create new natural areas and connections with existing ones.

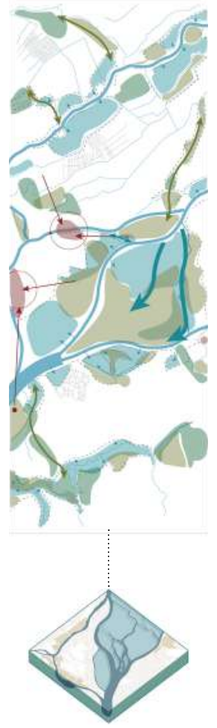
From the lowlands river landscape, the river reaches **confluences** with other rivers or branches of itself. Becoming wider and more susceptible to tides, the area is characterised by wetlands. Expanding these along the banks and adding water management behind dykes, both help decontaminate and store water. This landscape is characterised further by multiple creeks that flow either through small valleys or in polder landscapes. These can be widened with wetlands. This is an added decontamination since industries are more scattered here. The clusters present can be enlarged by moving a few industries into them and creating closed loops. New forests link up existing ones, extending green corridors and improving biodiversity.

The final panel illustrates the **delta**. Here the river is at its widest. Aside from that, a large port industry characterises one branch while the other is less developed. In the port, a cluster can be created to decontaminate the industry while in the other river branch, vast wetlands can both decontaminate and store water. Further away from the main river, creeks can be given more room to allow flooding and wetland creation. This has possible effects of green corridors, linking existing nature areas within a dense urban and port landscape.

Lower river

3

Confluence



2

Delta

1

Section

Adding to the panel map, the section shown here illustrates the new water system that results from the three main concepts. Next to the wide river flow from source to sea and back through rain, there are multiple small loops that get created along its course. In red are the closed loops of industries. These are paired within larger decontamination loops between urban areas and wetlands. Next to these two loops are flood prevention loops which are directly along the river banks. It illustrates that many small loops exist within the river basin system and that loops are also linked with each other through the river water.

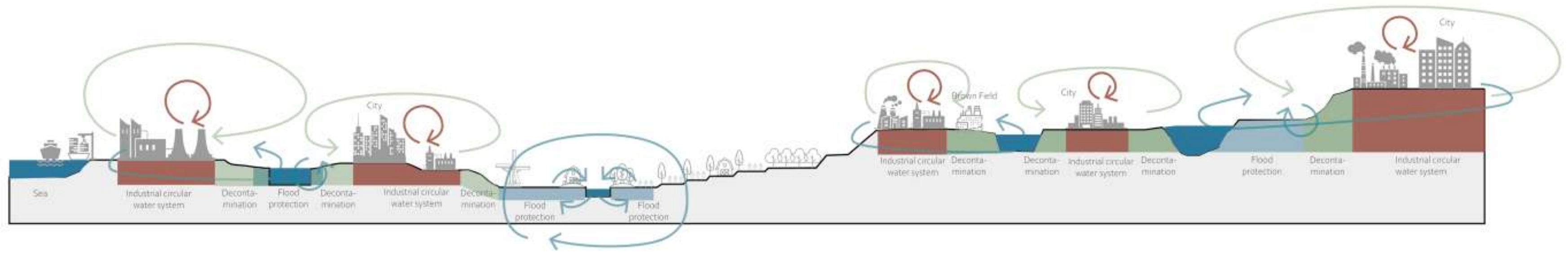


Figure 4.7 Section of a new total water system.

Collages

Using the three main elements and the different landscapes one might wonder how the vision might look on a local level. For this, several collages are made for a few landscapes. Each landscape is shown in a satellite view and ground level view.

The first images (figures 4.8 and 4.9) illustrate the lowlands confluence. Here, vast wetlands help decontaminate water while clusters create closed loops. The wetlands offer space for multiple functions creating multifunctional land. The next images (figures 4.10 and 4.11) show lower river landscapes. Here, little industries are present, allowing mostly space for decontamination and leisure along the rivers. In later fases, these wetlands can become sustainable farming. The images illustrate how a river landscape can be used. The vast wetlands along the river create a soft border between agriculture and the river, decontaminating pollutants in the soil and surface water before it gets to the main river. Aside from the wetlands decontaminating the agricultural land, industries stay present in the landscape but create their own loops and decontaminate their own water.

In conclusion, our vision is a decontamination design for the North West European river delta. It shows that small scale interventions contribute to the system as a whole. Therefore many small interventions can change the contaminated river landscape into a healthy river landscape. The vision shows that we want to establish a strategy that can be implemented everywhere in the river basin and executed on a smaller scale.

Figure 4.8 Plan and impression collages of the confluence landscape #1

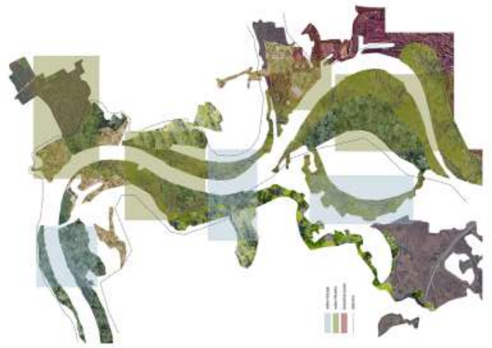
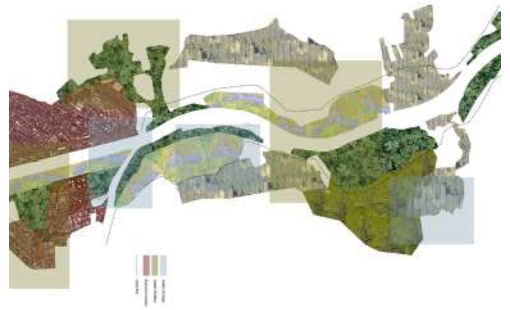


Figure 4.9 Plan and impression collages of the confluence landscape #2



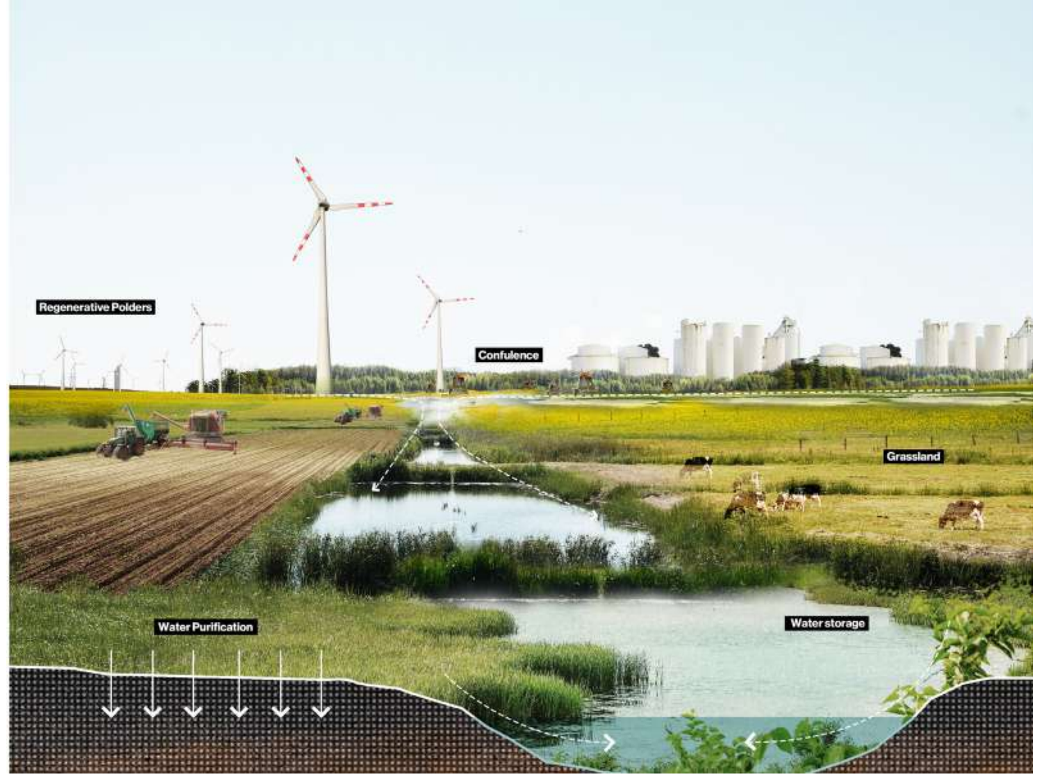
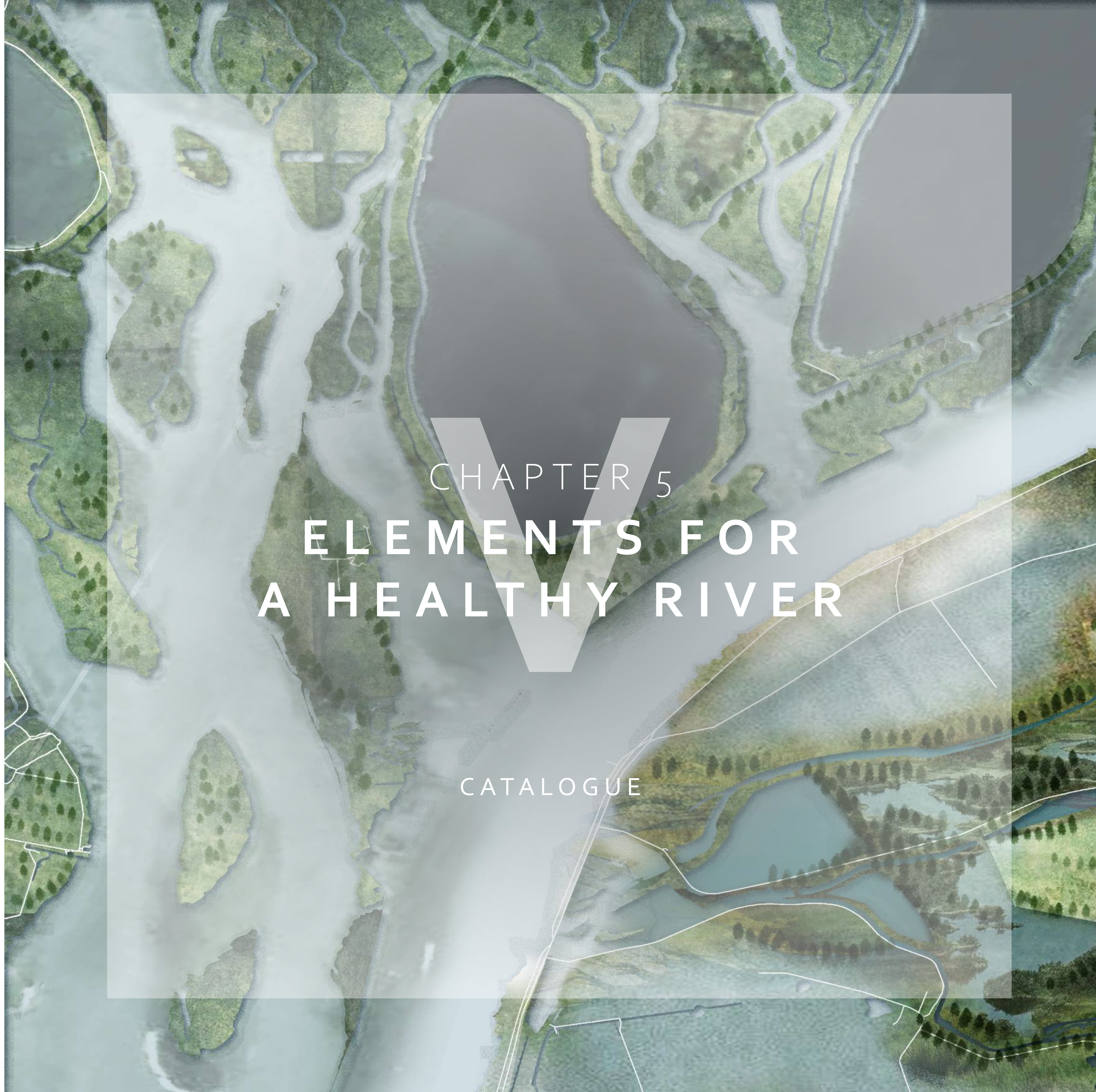


Figure 4.10 Plan and impression collages of the lower river landscape #1

Figure 4.11 Plan and impression collages of the lower river landscape #2



CHAPTER 5

ELEMENTS FOR A HEALTHY RIVER

CATALOGUE

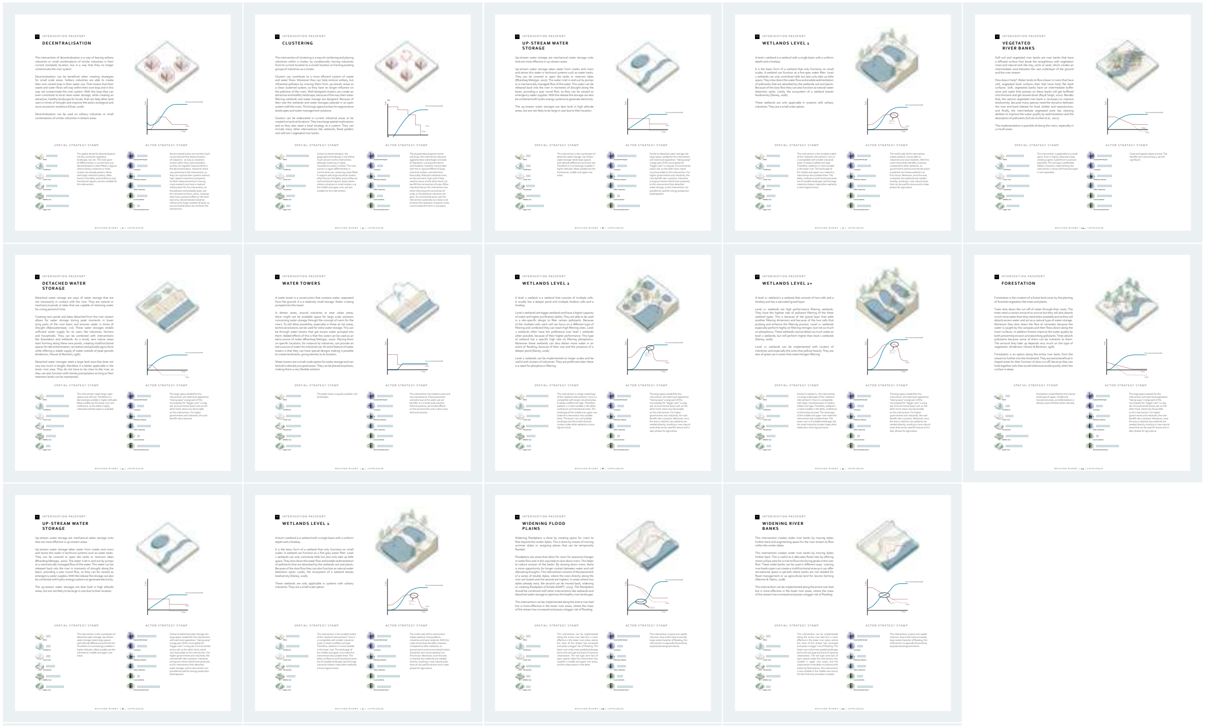
CHAPTER 5

CATALOGUE

OVERVIEW OF INTERVENTIONS

In the vision we have shown that small scale interventions can decontaminate the river system as a whole. Therefore we used data and literature studies to establish a catalogue of fourteen interventions that can be implemented in all of North West Europe. Every intervention has a small description describing why it helps with a circular water system, decontamination or flood prevention. Every intervention has a cost/benefit graph to show how easy or difficult it can be to implement the intervention. Lastly every intervention has both a spatial stamp and actor stamp. The spatial stamp shows with which spatial qualities the interventions match. The actor stamp shows if our main actors as stated in the analysis (chapter III) have little or much support for this intervention.

Figure 5.1 Overview of interventions catalogue



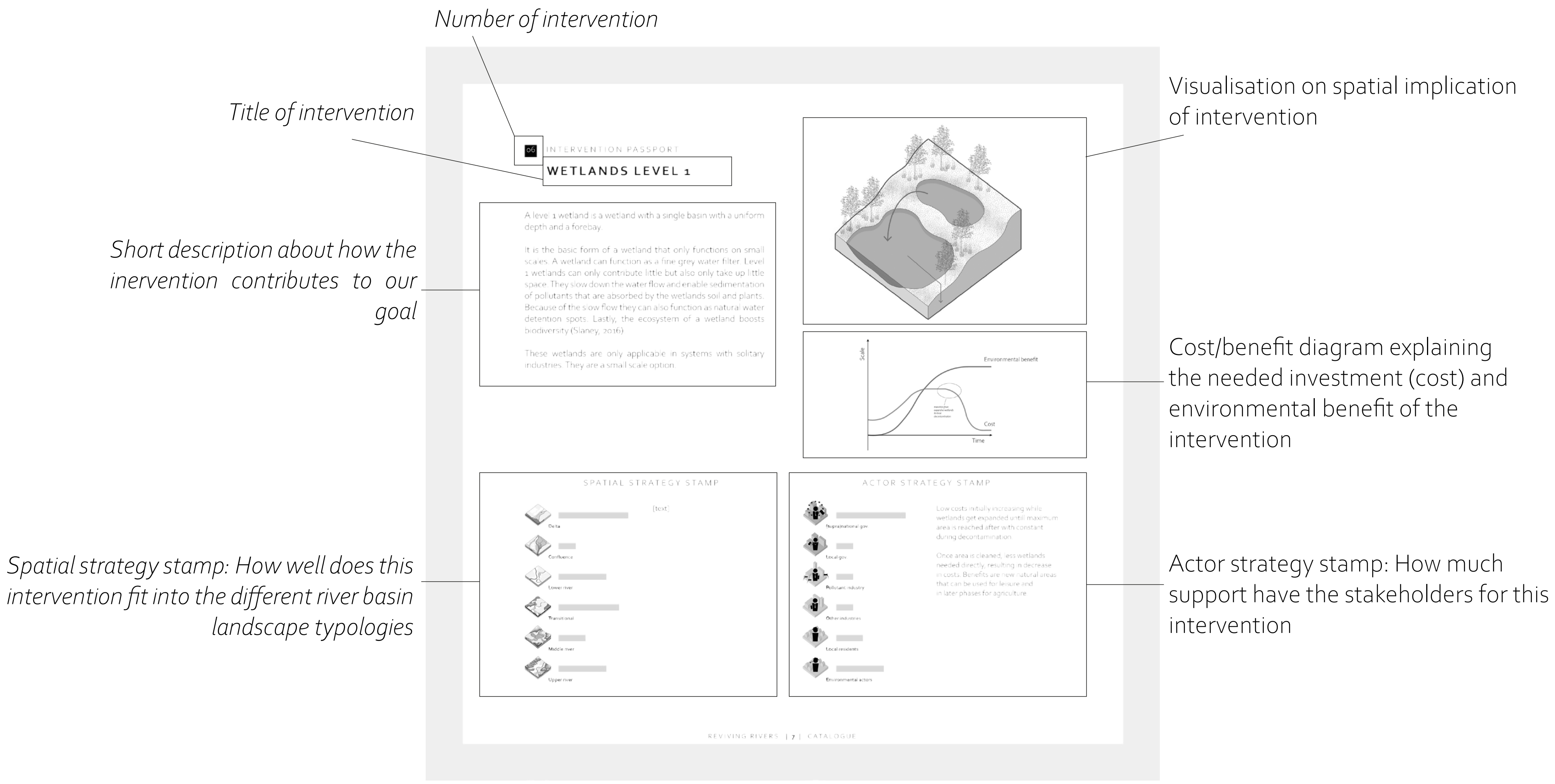
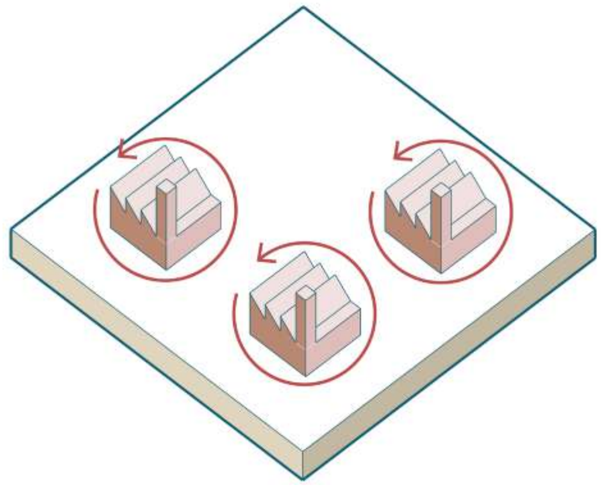


Figure 5.2 Intervention catalogue guide

01 INTERVENTION PASSPORT

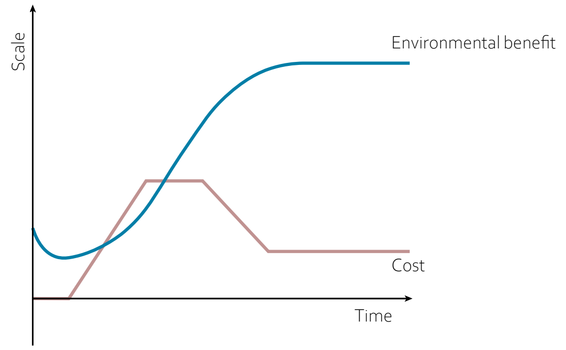
DECENTRALISATION



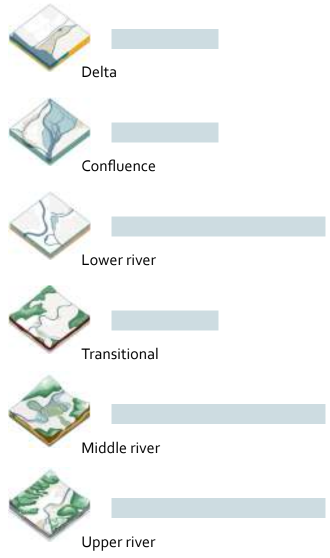
The intervention of decentralisation is a way of leaving solitary industries or small combinations of similar industries in their current (isolated) location, but in a way that they no longer contaminate the river system.

Decentralisation can be beneficial when creating strategies for small scale areas. Solitary industries are able to create their own closed loop in their water use. That means that their waste and water flows will stay within their own loop and in this way not contaminate the river system. With this loop they can even contribute to local clean water storage, while creating an attractive, healthy landscape for locals, that can help other land users in times of drought and improve the area's ecological and socio-economic resilience (Ooze, 2016).

Decentralisation can be used on solitary industries or small combinations of similar industries in distant areas.

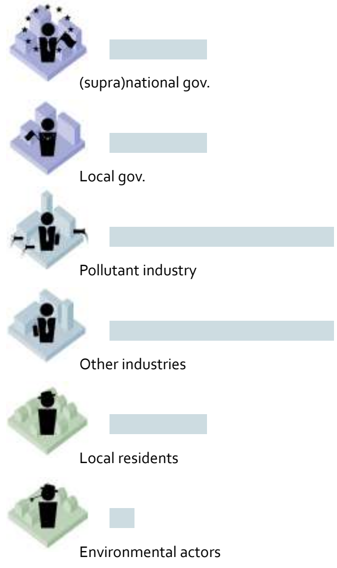


SPATIAL STRATEGY STAMP



The spatial stamp for decentralisation has few contraints regarding landscape, soil, etc. The main point of differentiation is current land-use: decentralisation is best fitted in regions where solitary industries or small clusters are already present. Areas with large industrial clusters, often found in the delta, and confluence and transitional regions, are less suitable for this intervention.

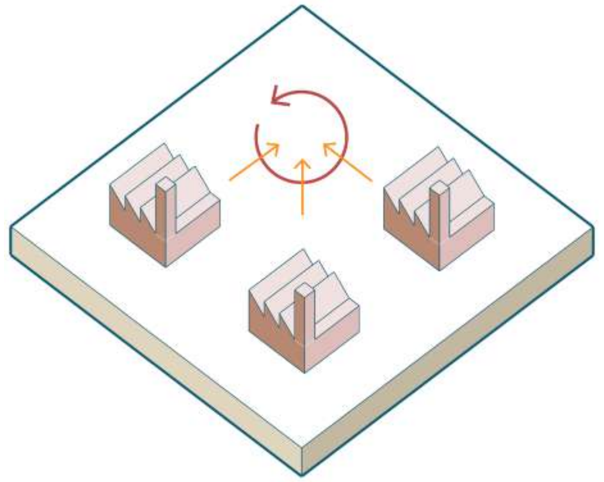
ACTOR STRATEGY STAMP



Governmental actors are not that much concerned with the (exact) location of industries - as long as industries remain within their judicial borders, so they can regulate improvements in the decontamination. Industries stand very positively to this intervention, as they can improve their systems without high capital investment (compared to other measurements) or moving. Local residents too have a medium enthousiasm for this intervention, as the pollution will probably lower, yet the industries remains, which, however, does have a positive effect on the local economy. Decentralised industries influence far larger swathes of lands, so environmental actors do not favor this intervention.

02 INTERVENTION PASSPORT

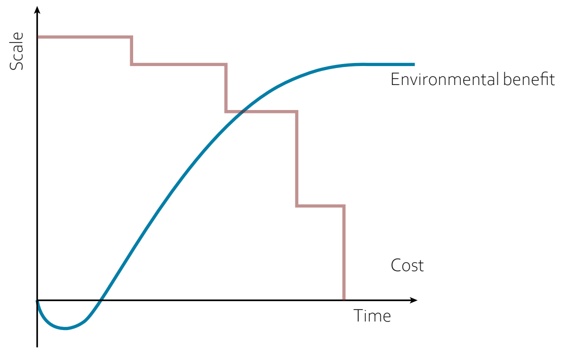
CLUSTERING



The intervention of clustering is a way of combining and placing industries within a cluster, by conditionally moving industries from its current location to a cluster location or framing existing groups of industries as a cluster.

Clusters can contribute to a more efficient system of waste and water flows. Moreover they can help remove solitary, but influential polluters by moving them from up-stream areas to a clean clustered system, so they have no longer influence on the pollution of the rivers. Well-designed clusters can create an attractive and healthy landscape, because of the way their water filtering wetlands and water storage are designed. Because of their size the wetlands and water storages operate in an open system with the rivers. This brings opportunities for regenerative landscapes and water management solutions.

Clusters can be elaborated in current industrial areas or be created on tactical locations. They have large spatial implications and so they also need a total strategy as a system. They can include many other interventions like wetlands, flood polders and soft soil / vegetated river banks.



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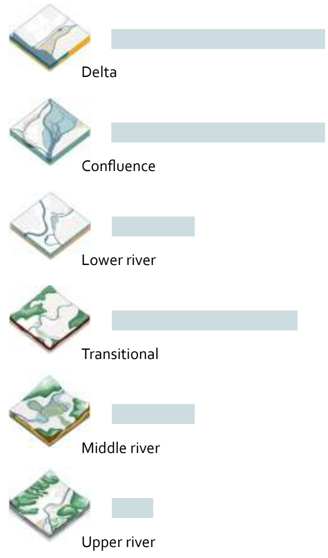

Similar to decentralisation, the geographical landscape is not of that much concern to this intervention, although clustering in highly mountainous areas is harder. The main concern is again differentiation is current land-use: clustering is best fitted in regions with large industrial clusters, often found in the delta, and confluence and transitional regions. Areas where solitary industries or small clusters, e.g. the middle and upper river, are less suitable for this intervention.

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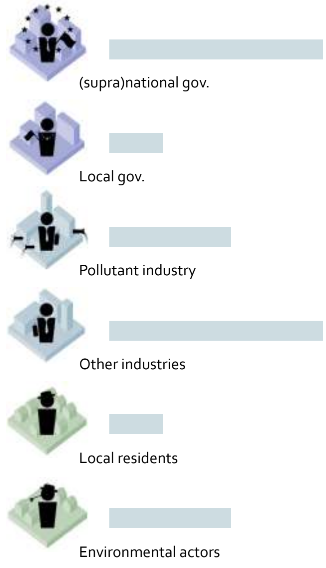
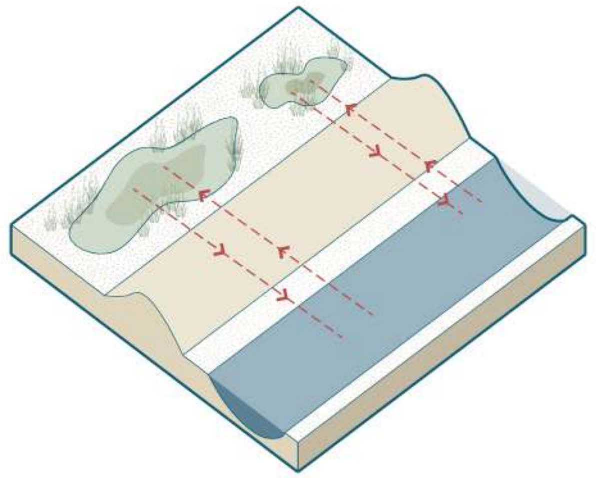


The (supra)national governments will favour this intervention because of agglomeration advantages and ease of regulation. Local governments and residents, however, have to deal with the on-ground effects of large industrial clusters, and stand less favourably. Pollutant industries have, on the one hand, high costs if they need to move, on the other hand, can benifit from economies of scale. Other industries favour this intervention too: either they enjoy the economies of scale, or the pollutant industries are gone. Environmental actors see this intervention positively as it clears a lot of areas from pollution, however it also concentrates the harm in one place.

03 INTERVENTION PASSPORT

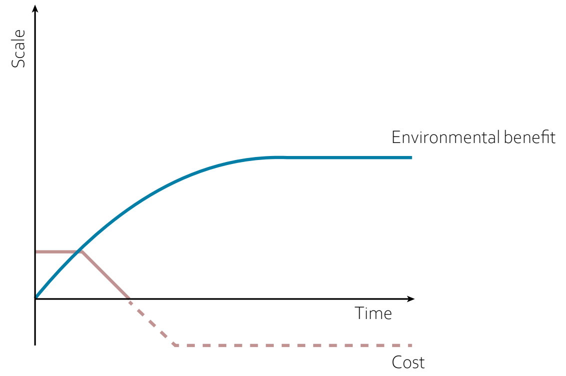
DETACHED WATER STORAGE



Detached water storage are ways of water storage that are not necessarily in contact with the river. They are natural or mechanical ponds or lakes that are capable of retaining water for a long period of time.

Creating new ponds and lakes detached from the river stream allows for water storage during peak moments in lower lying parts of the river basin and ensures water in times of drought (Rijkswaterstaat, n.d). These water storages enable sufficient water supply for its users like industries, farmers and households. They can be combined with interventions like forestation and wetlands. As a result, new nature areas start forming along these new ponds, creating multifunctional spaces for decontamination, recreation and possibly agriculture while offering a stable supply of water outside of peak periods (Anderson, Hoover & Reinhart, 1976).

Detached water storages need a large land area that does not vary too much in height, therefore it is better applicable in the lower river area. They do not have to be close to the river, as they can also function with merely precipitation as long as their retention levels can be maintained.



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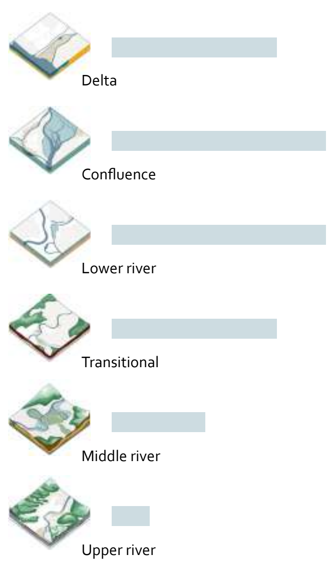

This intervention needs large, open spaces and soft soil. Therefore it is decreasingly suitable in higher altitudes. Most suitable are the lower river and confluence, as the delta is highly urbanised and less space is available.

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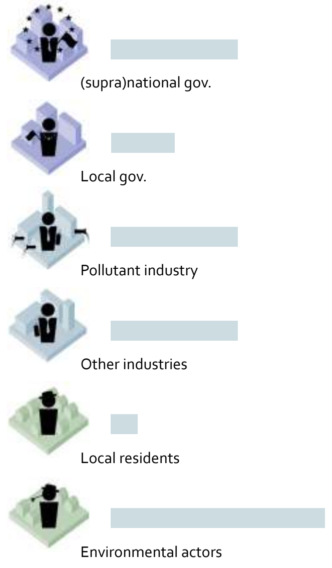
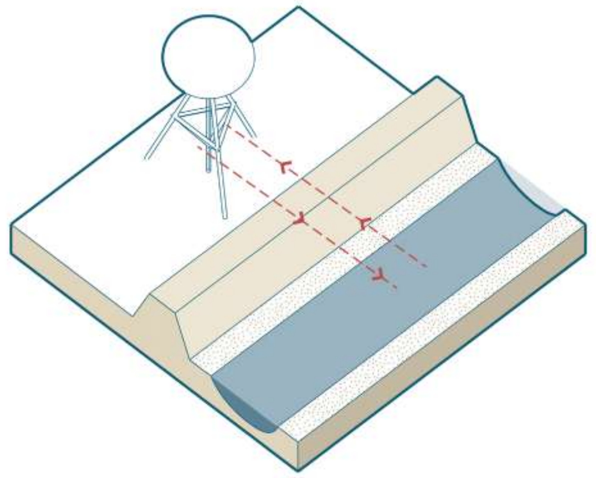


The large space needed for this intervention will meet local opposition: "taking away" a large part of the municipality for "bigger uses" is a big ask. Environmental actors will, on the other hand, stand very favourable on this intervention. For higher governments and industries, the cost-benefit rate is positive.

04 INTERVENTION PASSPORT

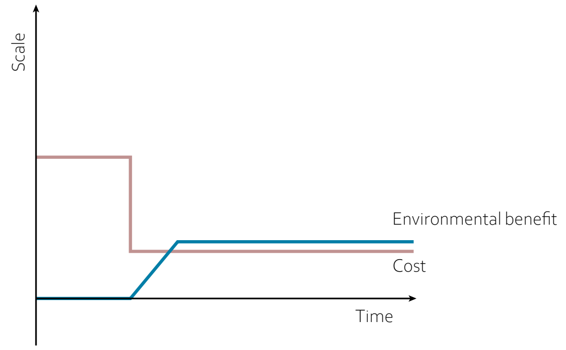
WATER TOWERS



A water tower is a construction that contains water, separated from the ground. It is a relatively small storage. Water is being pumped into the tower.

In denser areas, around industries or near urban areas, there might not be available space for large scale solutions concerning water storage through the concept of room for the rivers. To still allow possibility, especially in these at risk areas, technical solutions can be used for extra water storage. This can be through water towers that get excess water pumped into them. Added effects of this is that this water can be used as an extra source of water (Bhardwaj Metzgar, 2001). Placing them on specific locations, for instance by industries, can provide an extra source of water for industrial use. An extra feature of water towers is that they can have special designs making it possible to create landmarks, giving identity to its location.

Water towers are a small-scale option for water storage and can be built in densely occupied areas. They can be placed anywhere, making them a very flexible solution.



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The water tower is equally suitable in all landscapes.

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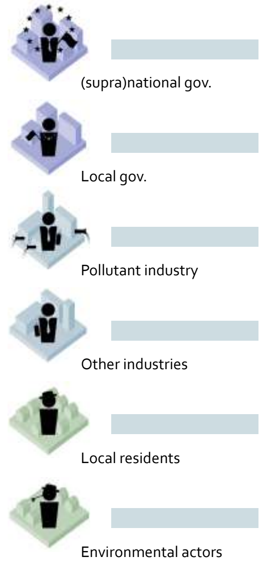


This intervention has medium costs and low maintenance. Flood prevention and extra source for water use are benefits. It is a small scale solution that has positive, yet limited effects on the environment, and is also a very technical solution.

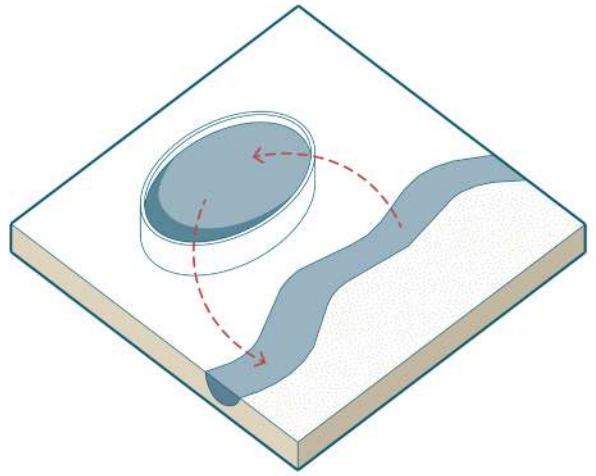
05 INTERVENTION PASSPORT

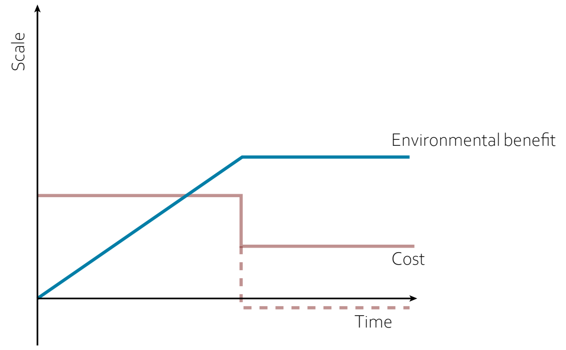
UP-STREAM WATER STORAGE

Up-stream water storage are mechanical water storage units that are most effective in up-stream areas.

Up-stream water storage takes water from creeks and rivers and stores this water in technical systems such as water tanks. They can be covered or open like tanks or reservoir lakes (Bhardwaj Metzgar, 2001). The water is let in and out by pumps or a mechanically managed flow of the water. This water can be released back into the river in moments of drought along the basin, providing a year round flow, so they can be viewed as emergency water supplies. With the release the storage can also be combined with hydro-energy systems to generate electricity.

The up-stream water storages are best built in high altitude areas, but are not likely to be large in size due to their location.





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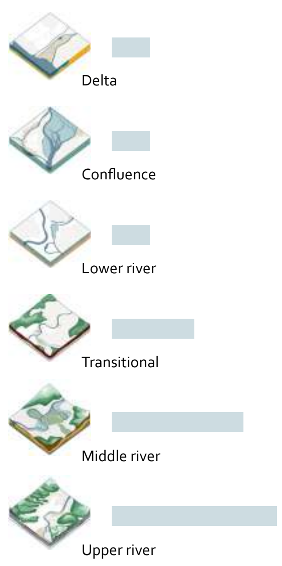

This intervention is the counterpart of detached water storage. Up-stream water storage needs large spaces with altitude differences and hard soil. Therefore it is increasingly suitable in higher altitudes. Most suitable are the transitional, middle and upper river areas.

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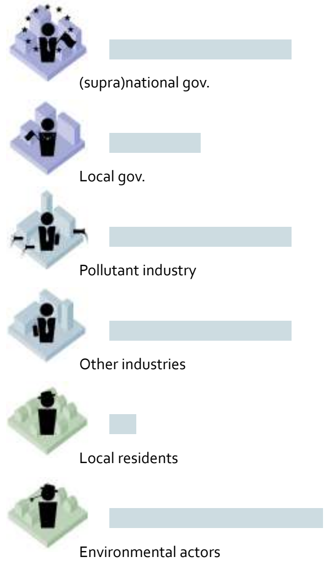


Similar to detached water storage, the large space needed for this intervention will meet local opposition: "taking away" a large part of the municipality for "bigger uses" is a big ask. Environmental actors will, on the other hand, stand very favourable on this intervention. For higher governments and industries, the cost-benefit rate is positive. Industries and governments stand more positively to this intervention than detached water storage, as this intervention can possible be used for energy production (hydropower).

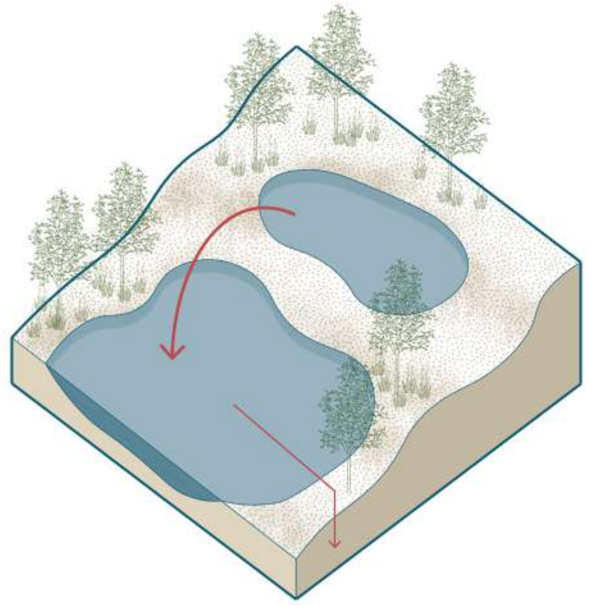
06 INTERVENTION PASSPORT

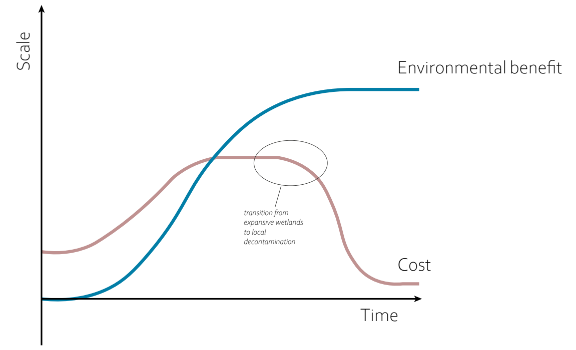
WETLANDS LEVEL 1

A level 1 wetland is a wetland with a single basin with a uniform depth and a forebay.

It is the basic form of a wetland that only functions on small scales. A wetland can function as a fine grey water filter. Level 1 wetlands can only contribute little but also only take up little space. They slow down the water flow and enable sedimentation of pollutants that are absorbed by the wetlands soil and plants. Because of the slow flow they can also function as natural water detention spots. Lastly, the ecosystem of a wetland boosts biodiversity (Slaney, 2016).

These wetlands are only applicable in systems with solitary industries. They are a small scale option.





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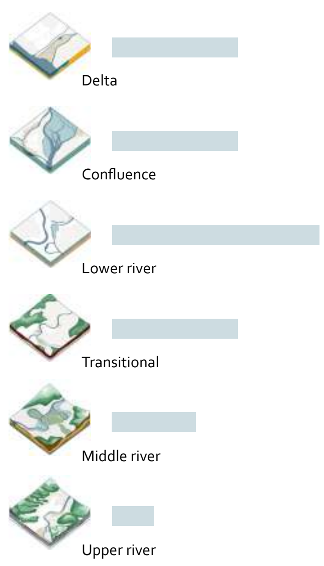

This intervention is the smallest scaled of the "wetland-interventions", thus it is compatible with smaller industrial areas. It needs a soft(er) soil type. Therefore, wetland 1 is most suitable in the lower river. The landscape of the middle and upper river make this intervention less suitable there. The delta, confluence and transitional areas are of suitable landscape, but the large industrial clusters make other wetlands a more logical choice.

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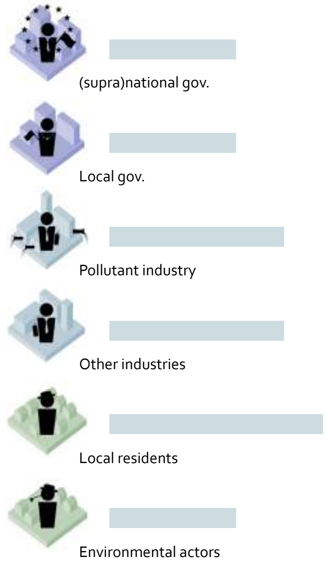
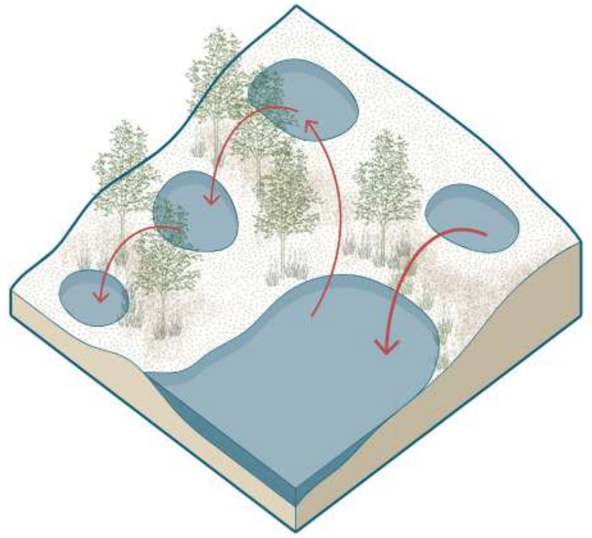


The small scale of this intervention makes wetland 1 favourable to industries and local residents. With this scale come lesser benefits, however, compared to other wetlands, so governments and environmental actors would like not choose wetland 1 as first choice. Moreover, once the area is cleaned, less wetlands are needed directly, resulting in new natural areas that can be used for leisure and in later phases for agriculture.

07 INTERVENTION PASSPORT

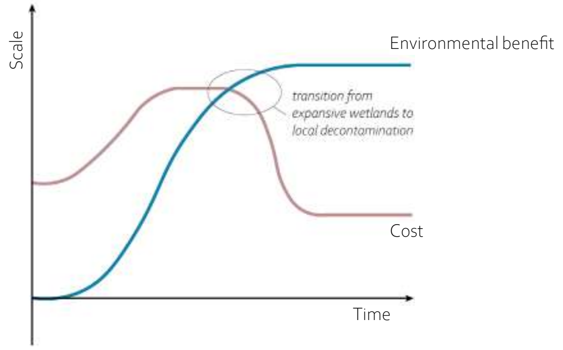
WETLANDS LEVEL 2



A level 2 wetland is a wetland that consists of multiple cells. It usually has a deeper pond and multiple shallow cells and a forebay.

Level 2 wetlands are bigger wetlands and have a higher capacity of water and higher purification ability. They are able to be used in a site-specific design to filter certain pollutants. Because of the multiple cells, each cell can focus on a different type of filtering and combined they can reach high filtering rates. Level 2 wetlands often have the preference over level 1 wetlands when possible, because of their higher performance. This type of wetland has a specific high rate on filtering phosphorus. Moreover these wetlands can also detain more water in an event of flooding, because of their size and the presence of a deeper pond (Slaney, 2016).

Level 2 wetlands can be implemented on larger scales and be useful with clusters of industries. They are preferred when there is a need for phosphorus filtering.



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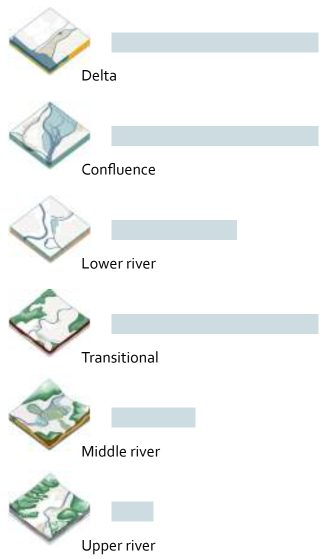

This intervention is a large scaled type of the "wetland-interventions", thus it is compatible with larger industrial areas. It needs a soft(er) soil type. Therefore, wetland 2 is most suitable in the delta, confluence and transitional areas. The landscape of the middle and upper river make this intervention less suitable there. The lower river is of suitable landscape, but the small industrial clusters make other wetlands a more logical choice.

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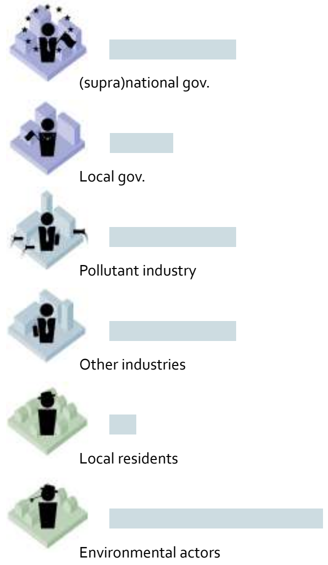
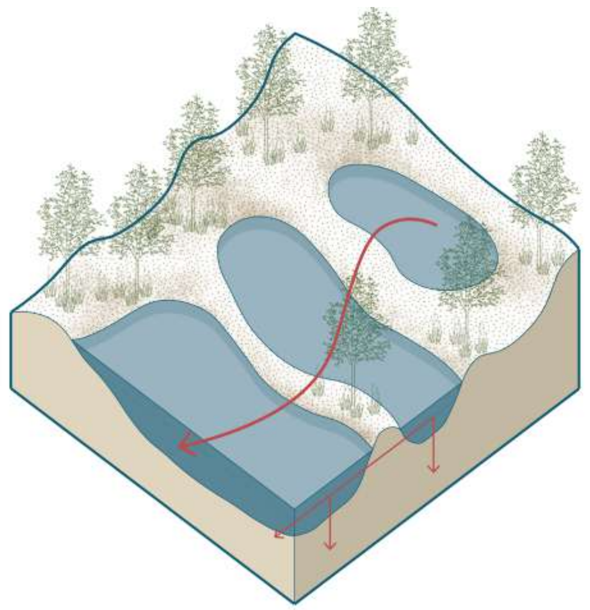


The large space needed for this intervention will meet local opposition: "taking away" a large part of the municipality for "bigger uses" is a big ask. Environmental actors will, on the other hand, stand very favourable on this intervention. For higher governments and industries, the cost-benefit rate is positive. Moreover, once the area is cleaned, less wetlands are needed directly, resulting in new natural areas that can be used for leisure and in later phases for agriculture.

08 INTERVENTION PASSPORT

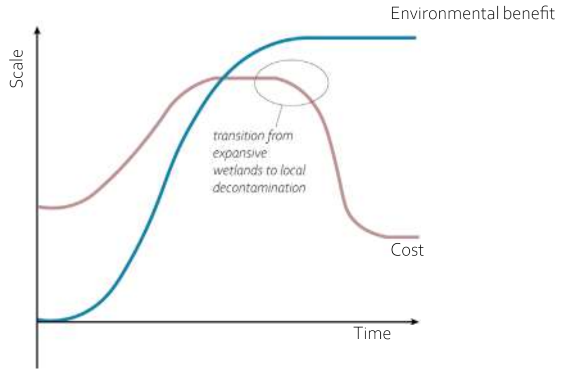
WETLANDS LEVEL 2+



A level 2+ wetland is a wetland that consists of two cells and a forebay and has a saturated gravel layer.

Level 2+ wetlands are high performance filtering wetlands. They have the highest rate of pollutant filtering of the three wetland types. This is because of the gravel layer that adds another filtering dimension and because of the two cells that prolong and enhance the filtering process. Level 2+ wetlands especially perform highly on filtering nitrogen, but not so much on phosphorus. These wetlands cannot detain as much water as level 2 wetlands, but still perform higher than level 1 wetlands (Slaney, 2016).

Level 2+ wetlands can be implemented with clusters of industries and especially the ones that pollute heavily. They are also of great use in areas that need nitrogen filtering.



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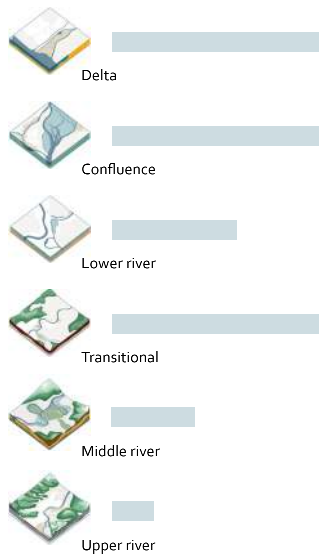

Similar to wetland 2, this intervention is a large scaled type of the "wetland-interventions", thus it is compatible with larger industrial areas. It needs a soft(er) soil type. Therefore, wetland 2+ is most suitable in the delta, confluence and transitional areas. The landscape of the middle and upper river make this intervention less suitable there. The lower river is of suitable landscape, but the small industrial clusters make other wetlands a more logical choice.

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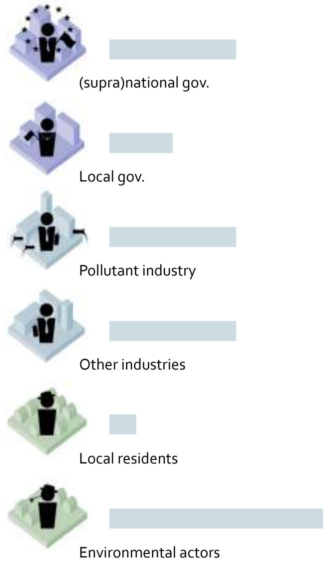


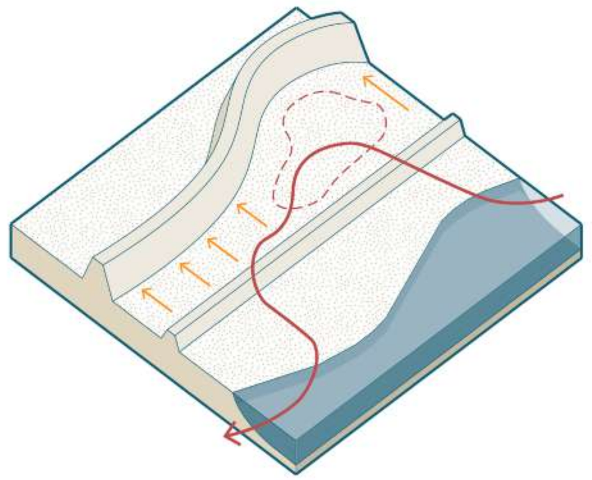
The large space needed for this intervention will meet local opposition: "taking away" a large part of the municipality for "bigger uses" is a big ask. Environmental actors will, on the other hand, stand very favourable on this intervention. For higher governments and industries, the cost-benefit rate is positive. Moreover, once the area is cleaned, less wetlands are needed directly, resulting in new natural areas that can be used for leisure and in later phases for agriculture.

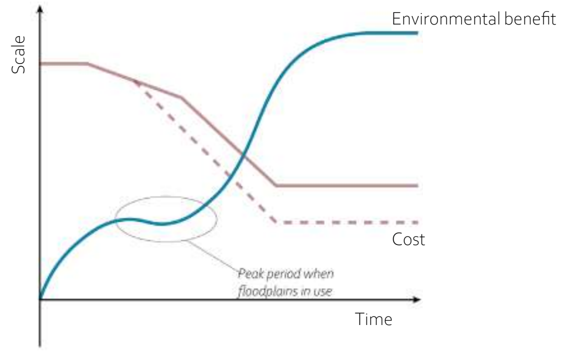
09 INTERVENTION PASSPORT

WIDENING FLOOD PLAINS

Widening floodplains is done by creating space for rivers to flow beyond the winter dykes. This is done by means of moving summer dykes or assigning places that can be temporarily flooded.

Floodplains are areas that allow for room for seasonal changes in water flow and in this way help to slow down rivers. This helps to reduce erosion of the banks. By slowing down rivers, there is more opportunity for longer contact between water and soil alleviating droughts. This intervention consists of the placement of a series of double dykes, where the ones directly along the river are lowest and the second are highest. In areas where two dykes already exist, the second can be moved back, widening or creating floodplains (Climate ADAPT, 2023). The floodplains should be combined with other interventions like wetlands and detached water storage to optimise the healthy river landscape.





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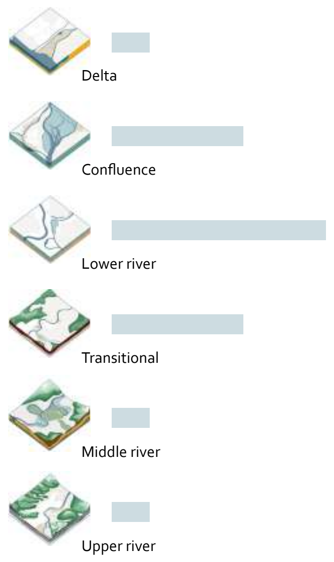

This intervention can be implemented along the entire river bed but is more effective in the lower river areas, where the mass of the stream has increased and poses a bigger risk of flooding. The lower river is the most suitable landscape due to the soil type and (lack of massive) urbanisation. The soil type (and lack of open space) make this intervention less suitable in middle and upper river areas, and the urbanisation in the delta.

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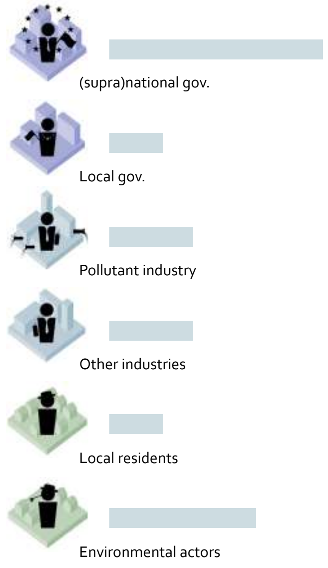
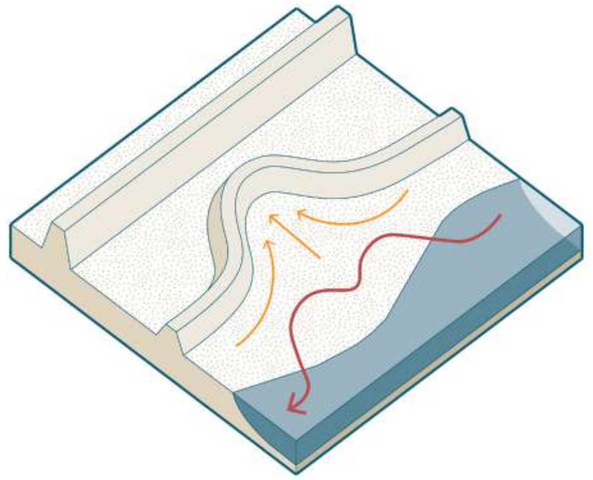


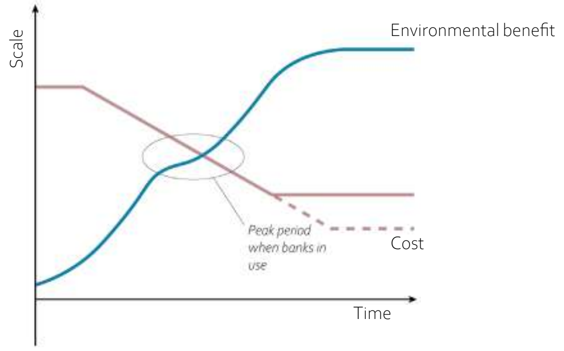
This intervention is space and capital intensive. Due to the interconnected, large-scale character of flooding, this intervention is especially favoured by (supra)national governments.

10 INTERVENTION PASSPORT

WIDENING RIVER BANKS

This intervention creates wider river banks by moving dykes further back and augmenting space for the river stream to flow within the winter dykes. This is useful as it alleviates flood risks by offering more surface area for a river to flow into during peaks in the river flow. These wider banks can be used in different ways. Leaving river banks open can create a multifunctional area as it can offer recreational space in periods where banks are not needed for flood management or as agricultural land for bovine farming (Weimer & Talens, 2018).





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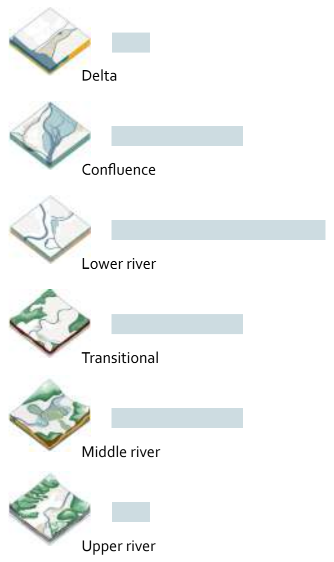

This intervention can be implemented along the entire river bed but is more effective in the lower river areas, where the mass of the stream has increased and poses a bigger risk of flooding. The lower river is the most suitable landscape due to the soil type and (lack of massive) urbanisation. The soil type (and lack of open space) make this intervention less suitable in upper river areas, and the urbanisation in the delta. In contrast with widening flood planes, this intervention is also suitable in the middle river due to the fact that only one dyke is needed.

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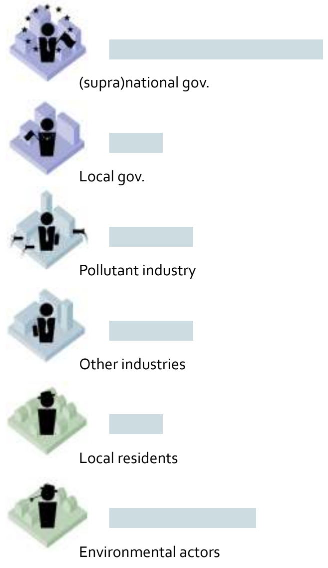
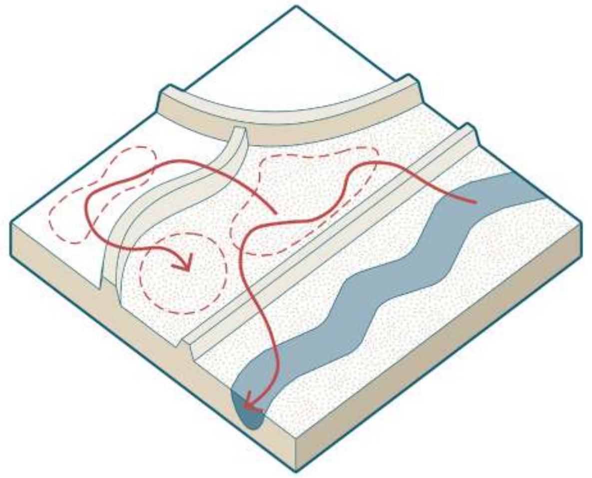


This intervention is space and capital intensive. Due to the interconnected, large-scale character of flooding, this intervention is especially favoured by (supra)national governments.

11 INTERVENTION PASSPORT

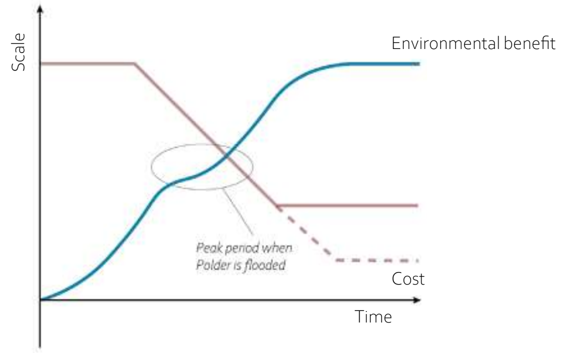
FLOOD POLDER



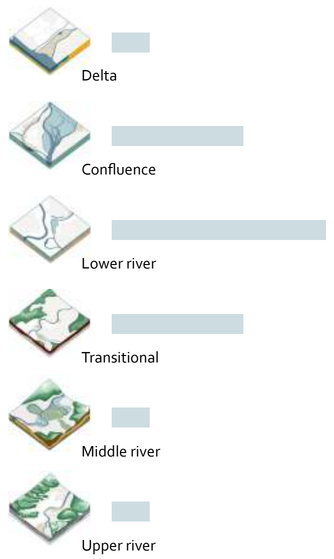
This intervention looks at reusing existing polders for the concept of room for the rivers. Dykes along the river banks can be lowered along its entire length or breached at strategic locations while residences and farms can be moved onto manmade knolls ("terpen") or in between higher dykes.

Making new channels or lowering some sections can direct water in the desired direction. During peak water flow the area can be flooded, providing extra room for the river. When extra storage is not needed, the polders can be used for agriculture or other functions (De ingenieur, 2015). The flood polders can be designed with tidal parks, wetlands and other ecological features to boost the health of the landscape and help decontaminate the rivers. Farmers could use methods like agroforestry and crop rotation to enhance the decontamination.

Flood polders are an intervention to be implemented in areas dominated by polders and they are easiest to implement at places where there is a curve of the river. They are most effective in the lower river areas where the mass of the stream has increased and poses a bigger risk of flooding.

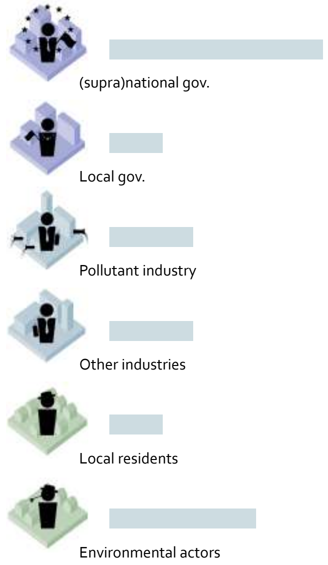


SPATIAL STRATEGY STAMP



This intervention can be implemented along the entire river bed but is more effective in the lower river areas, where the mass of the stream has increased and poses a bigger risk of flooding. The lower river is the most suitable landscape due to the soil type and (lack of massive) urbanisation. The soil type (and lack of open space) make this intervention less suitable in middle and upper river areas, and the urbanisation in the delta.

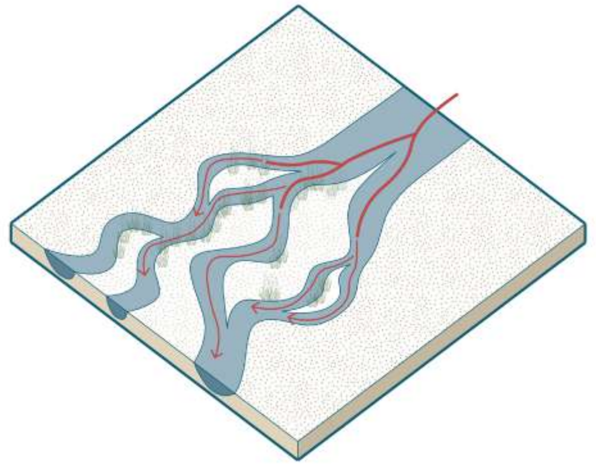
ACTOR STRATEGY STAMP



This intervention is space and capital intensive. Due to the interconnected, large-scale character of flooding, this intervention is especially favoured by (supra)national governments.

12 INTERVENTION PASSPORT

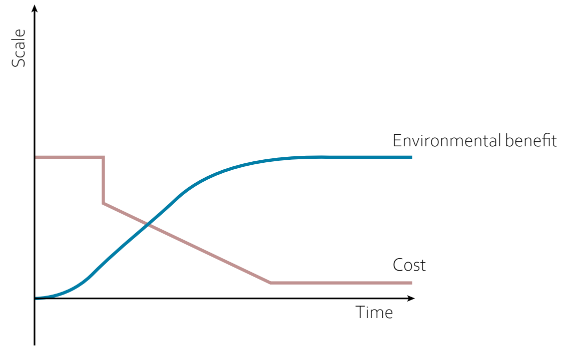
SLOW STREAM TECHNIQUES



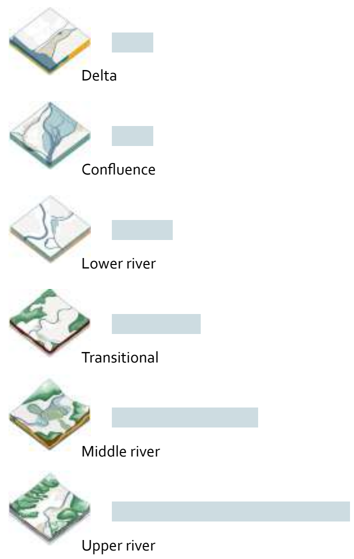
In this intervention the river stream is either split up or stretched out by a structure that breaches the straight flow or that expands the river's meandering.

This technique is used to slow down the water flow. It is based on augmenting the water flow surface to spread the mass of the water. This has two principles: the water flow's actual distance is prolonged over the absolute distance, so the water will need more time to flow along the same absolute distance, resulting in a lower absolute velocity, and the water mass is spread, so the flow needs a lower velocity to move the same mass of water down the stream (Rizal Fahmi et al., 2018). A lower velocity of the water stream leads to less erosion, which means less contamination, and lowers the risk of flooding and the danger of the flooding. This intervention can be easily combined with other interventions like vegetated river banks, widening river banks and wetlands to enhance its decontaminating and flood preventing functions (Superpositions, n.d.).

These techniques can be implemented anywhere along the basin but are easiest constructed in smaller streams and have a larger effect in the up-stream areas.

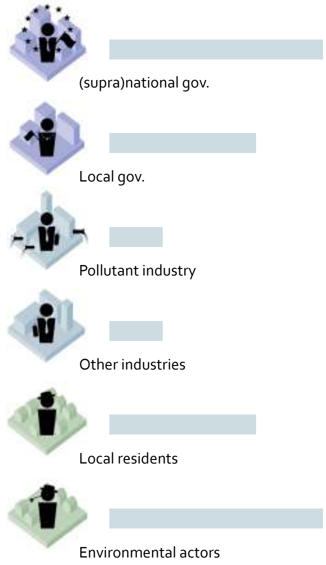


SPATIAL STRATEGY STAMP



This intervention can best be implemented in up-stream areas, and is decreasingly suitable for the lower river. Up-stream areas have large altitude differences and high water velocities in small creeks, which benefit the most from this intervention. Furthermore, implementing this intervention in waterways that are used for shipping is not advisable; so the urbanised areas in the lower river, confluence and delta are not suitable.

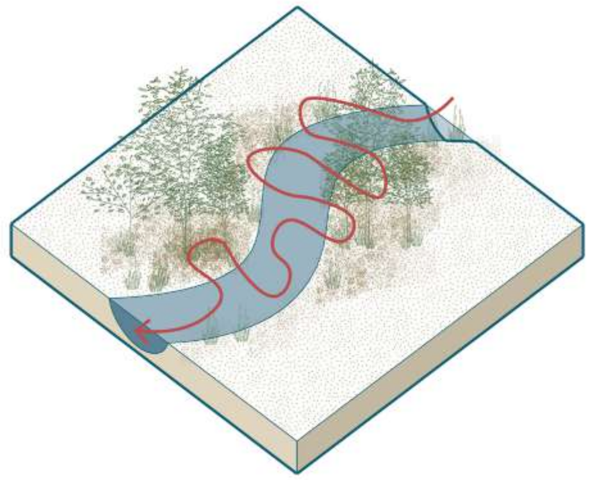
ACTOR STRATEGY STAMP



For environmental actors and (supra) national governments, slow stream techniques create benefits with almost no downsides, as the costs are small and upfront. For local governments and residents, the area will likely turn into a more prosperous wetland. Industries stand less favourable to this intervention, because a slower stream is less suitable for wastage or shipping usage.

INTERVENTION PASSPORT 13

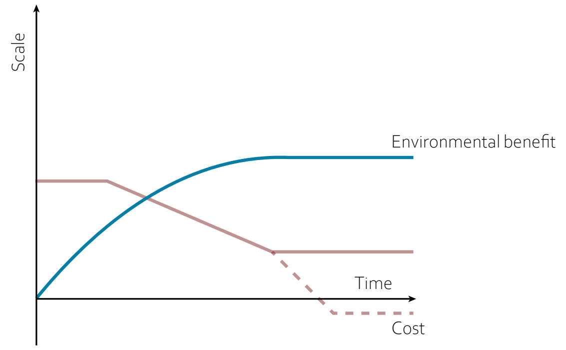
VEGETATED RIVER BANKS



Soft soil and vegetated river banks are river banks that have a diffused surface that break the straightness with vegetation roots and natural soils like clay, rocks or sand, which creates an intermediate zone between the vast underlayer of the ground and the river stream.

How does it help?: Water tends to flow slower in rivers that have soft, vegetated bank surfaces than that have hard, flat bank surfaces. Soft, vegetated banks have an intermediate buffer zone and water that presses on these banks will get buffered into the bank and get slowed down (Raj & Singh, 2022). Besides that, the natural vegetated river bank is necessary to improve biodiversity, because many species need the dynamic between the river and bank habitat for food, shelter and reproduction, and finally, the intermediate vegetated zone has cleaning abilities to improve the water quality by sedimentation and the absorption of pollutants (Schulz-Zunkel et al., 2022).

The implementation is possible all along the rivers, especially in un-built areas.



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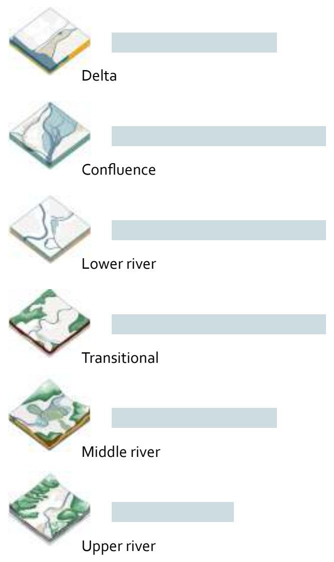

This intervention is applicable to a small space. Even in highly urbanised areas, creating a green waterfront is a proven possibility. The soil type is preferable soft(er), however, implementing this intervention in areas with hard soil types is not impossible.

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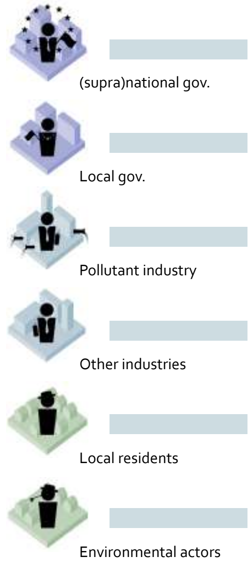
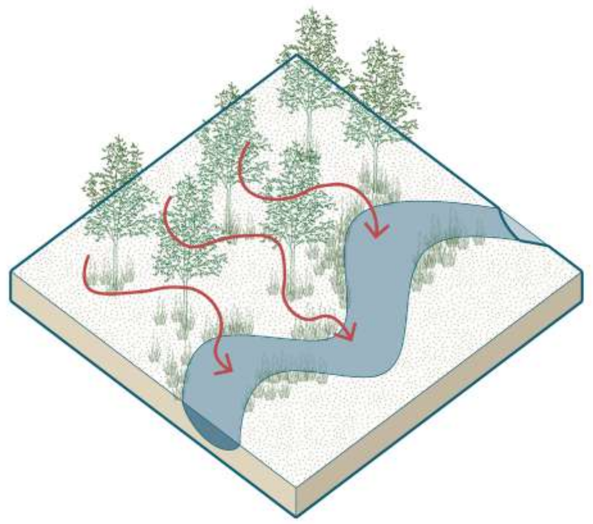


Costs and spatial impact are low. The benefits are not enormous, yet still significant.

INTERVENTION PASSPORT 14

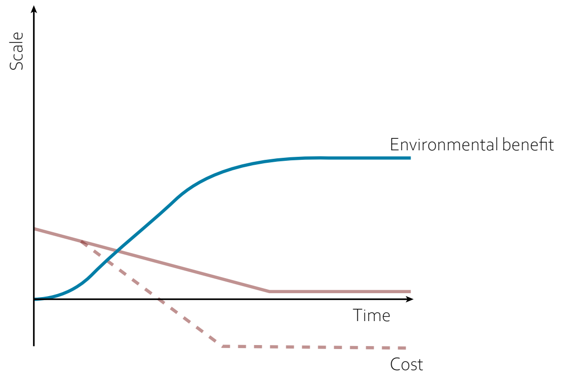
FORESTATION



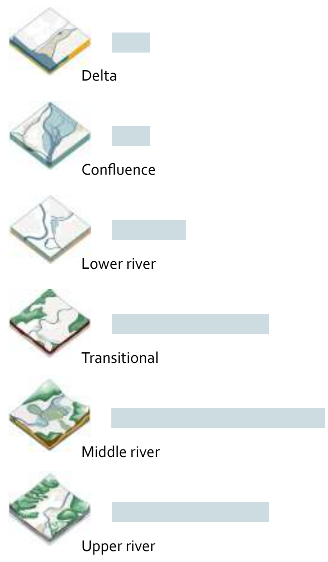
Forestation is the creation of a forest land cover by the planting of forestial vegetation like trees and plants.

Trees slow down the run-off of water through their roots. The trees need a certain amount to survive but they will also absorb much more water than they need when available and so they will absorb excess water and act as a natural type of water storage. Moreover they slow down the flow of rainwater, because the water is caught by the canopies and then flows down along the trees' surfaces. In addition forests improve the water quality by both preventing erosion and absorbing pollutants. Trees absorb pollutants because some of them can be nutrients to them. The amount they take up depends very much on the type of vegetation. (Anderson, Hoover & Reinhart, 1976)

Forestation is an option along the entire river bank, from the stream to further into the hinterland. They are extra beneficial in sloped areas for their function of slow run-off, because they can hold together soils that would otherwise erode quickly when the surface is steep.

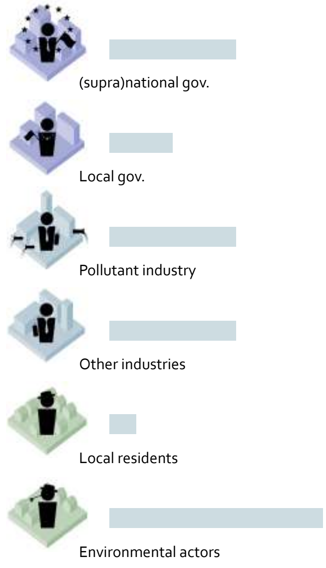


SPATIAL STRATEGY STAMP



Forestation is best fitted to the natural landscape of upper, middle and transitional areas, as (re)forestation is already a part of these areas naturally.

ACTOR STRATEGY STAMP



The large space needed for this intervention will meet local opposition: "taking away" a large part of the municipality for "bigger uses" is a big ask. Environmental actors will, on the other hand, stand very favourable on this intervention. For higher governments and industries, the cost-benefit rate is positive. Moreover, once the area is cleaned, less wetlands are needed directly, resulting in new natural areas that can be used for leisure and in later phases for agriculture.

VI

CHAPTER 6

HOW TO REVIVE THE RIVER BASIN

MANUAL

CHAPTER 6

HOW TO REVIVE THE RIVER BASIN

MANUAL

Now we established the catalogue of interventions, there is a need for a manual to use the interventions correctly. In this chapter we explain how to match the interventions with location specific qualities. First we explain different variations of the industrial circular water system. Secondly we match the interventions with landscape qualities and consequently determine in what landscape typology they fit but. Lastly we broaden the stakeholder analysis to determine the attitude of the stakeholders towards our project.

Closing the water loop in different industrial systems

The circular water system consists of a few elements that create a clean water loop for industries. The first step is that industries have on site water treatment plants which is a rough filter for contaminated water. After the rough filter there will be a natural filter in or around the industrial site. This is a wetlands where natural elements function as a fine filter. This process has been explained in the analysis (Chapter III). After the water is mostly decontaminated it can be stored in a water basin or water tower, which is the water supply for the industries. Occasionally, depending on the overall water quantity, the industrial system will need more water supply from the river or has a surplus of water stored and supplies their surplus of water to other users.

This system can be implemented in different variations. What system fits best in which situation depends on the space of land available and the type of industrial clusters that are present. For a decentralised industry the water system is as described above. Every individual industry needs a water treatment plant, wetland and on site water storage. Multiple, or clustered, industries can likewise be connected to the basic circular water system. Important to note is that multiple industries use more water, thus need more water treatment plants, a bigger wetlands and more space for water storage.

The third variation are individual industries with their own decontamination loop, but shared water storage. The fourth variation is an open wetlands system where multiple industries share the same fine filter wetlands. In general there is more space needed for wetlands if there is more water contamination and more need for water storage if more water is used in the industrial process. For every industry or cluster of industries it should be individually assessed what system fits best in that area.

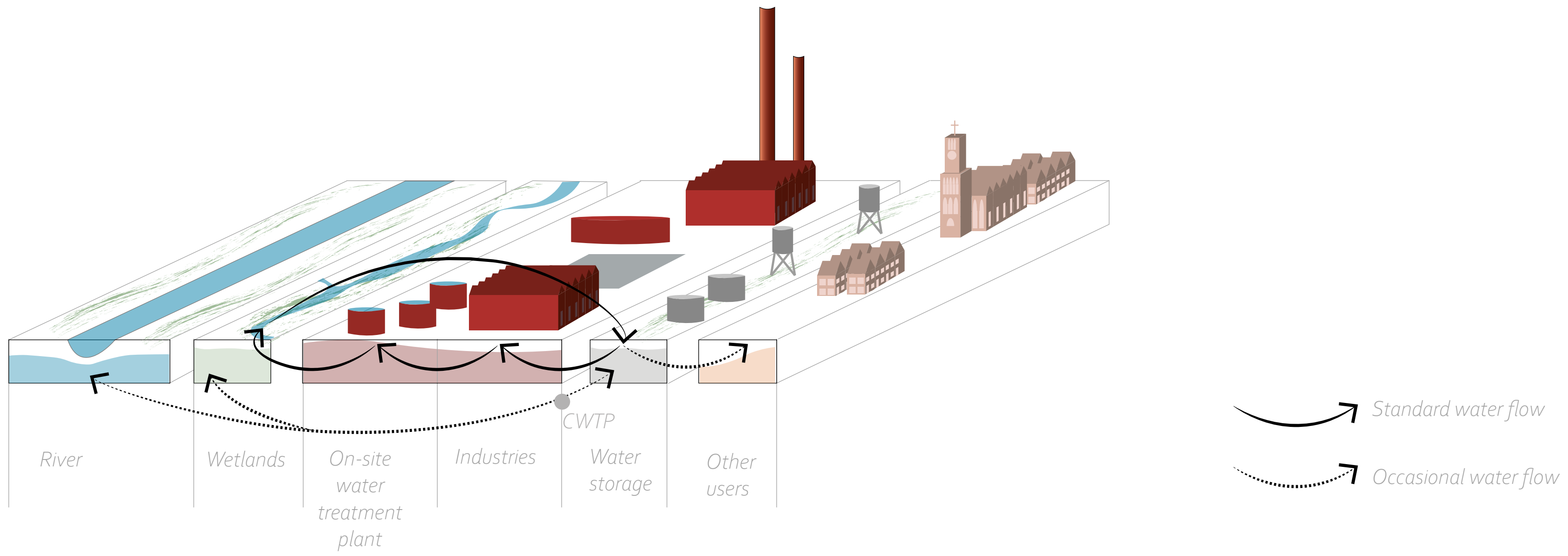


Figure 6.1 Clean closed water system

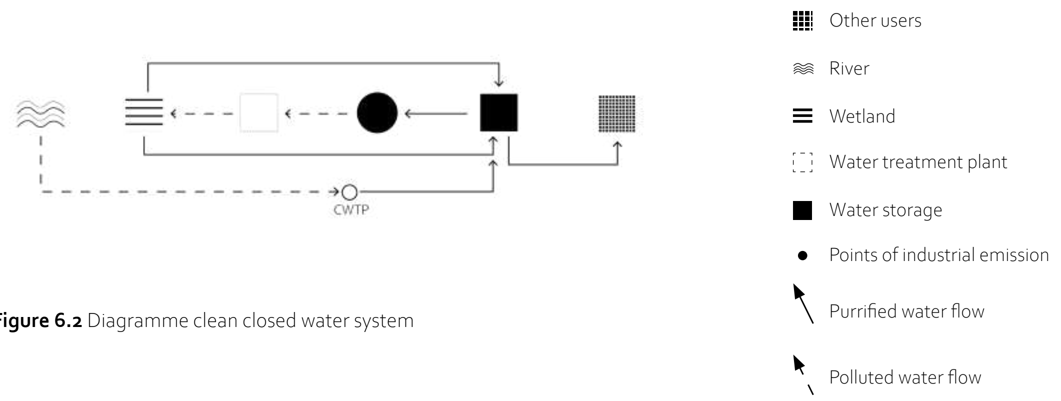


Figure 6.2 Diagramme clean closed water system

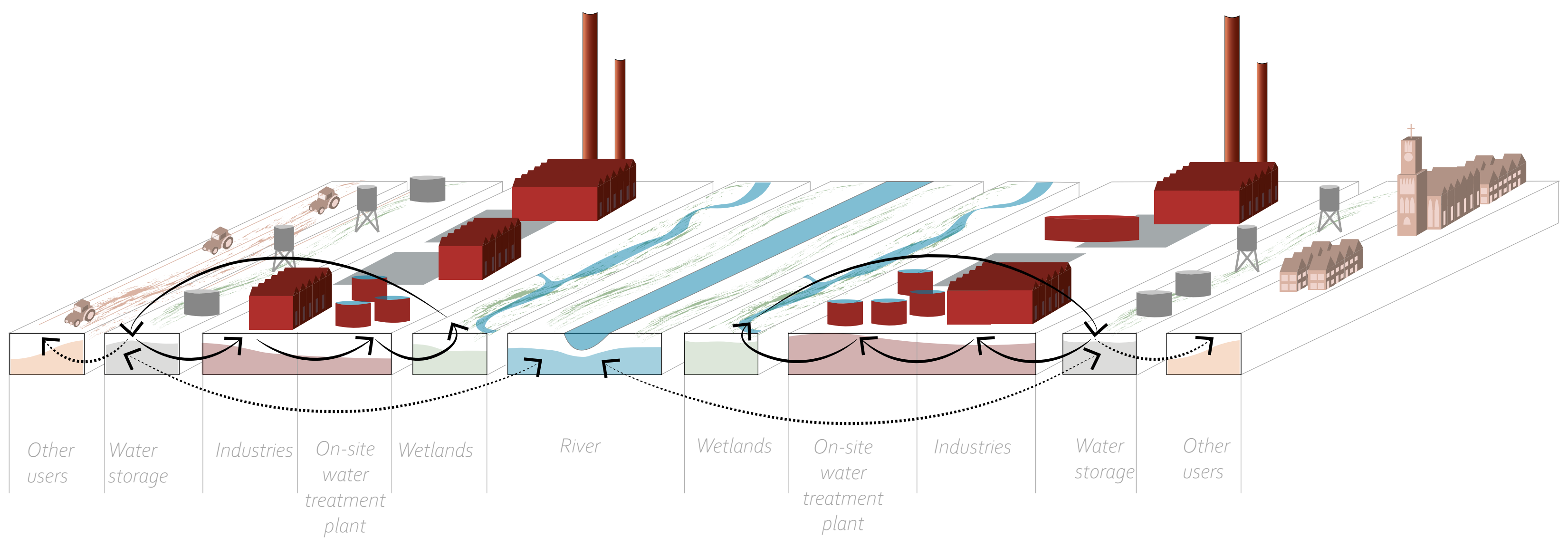


Figure 6.3 Decentralized closed loops

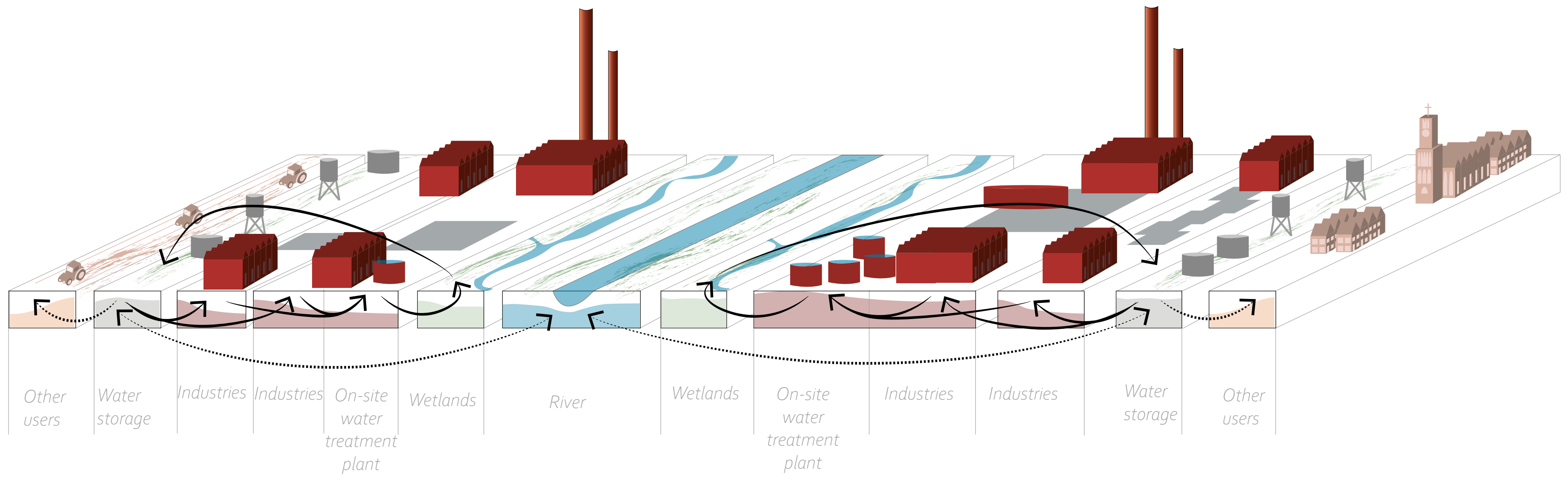


Figure 6.4 Clustered industries closed loops

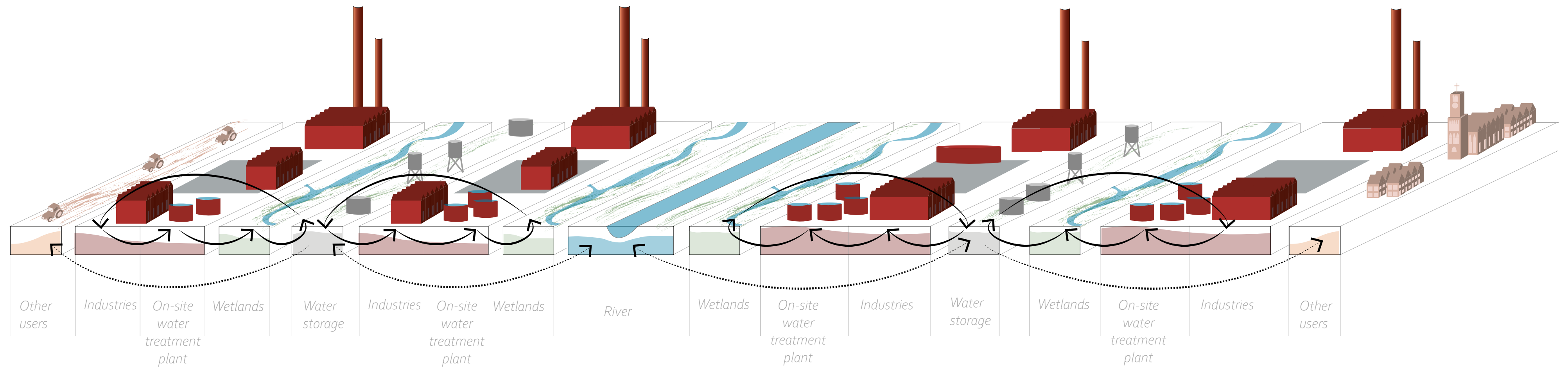


Figure 6.5 Decentralized closed loops with collective water storage

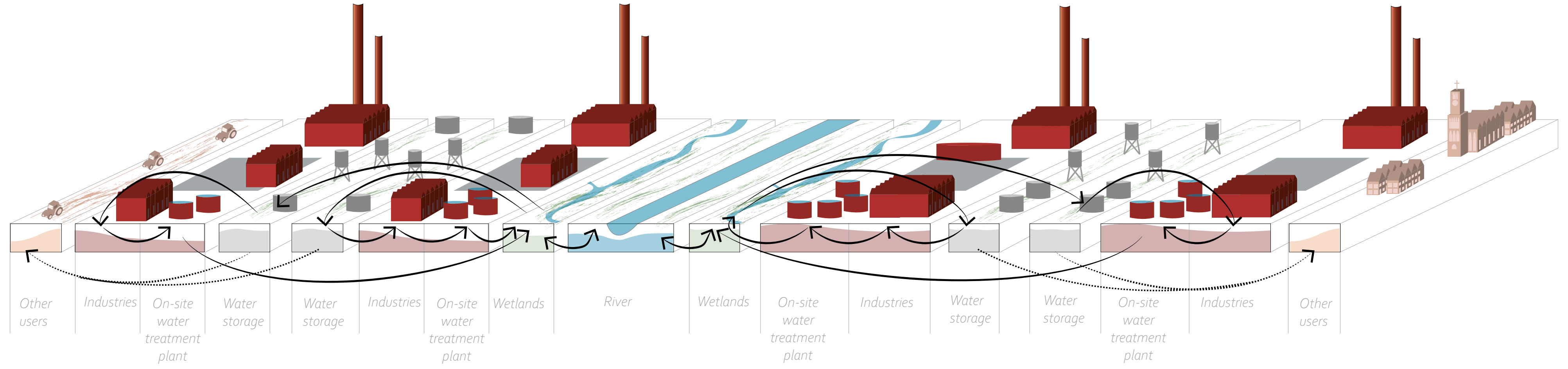


Figure 6.6 Open wetlands system

Intervention	ALTITUDE DIFFERENCE			SOIL							LAND COVER				LAND USE							TYPE OF INDUSTRY			
	Upper river	Middle river	Lower river	Rocks	Limestone	Marl	Sand or gravel	Clay & mudstone	Loess	Clays & silts	Forest	Wetlands	Grassland	Cropland	Forestry	Mining	Agriculture	Ports	Small villages	Urban area	Industrial clusters	Solitary Low quantity	Small cluster Low quantity	Small cluster High quantity	Big clusters High quantity
Decentralisation of industries	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●	●●	●●	●●	●	●●	●●	●●●	●●	●●	●●●	●●●			
Clustering of industries	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●	●●	●●	●●	●	●●	●●	●●●	●●	●●	●●●		●●●	●●●	●●●
Ponds & lakes behind dykes		●●	●●●					●●●		●●●	●	●●●	●●	●●	●	●	●●	●	●●	●	●	●●●	●●●	●●●	●●●
Watertowers	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●	●●●	●	●●●	●●	●●●	●●●	●●●	●●●	●●●	●●●
Up-stream water storage	●●●	●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●	●●●	●	●	●●	●	●●●	●●●	●●●	●●●	●●●
Wetland level 1	●	●●●	●●●			●●	●	●●●		●●●	●	●●●	●●	●	●	●	●●	●	●●	●●	●	●●●	●●●		
Wetland level 2	●	●●●	●●●			●●	●	●●●		●●	●●●	●●●	●●●	●	●●	●	●●	●	●●	●●	●●●	●●	●●	●●●	●●●
Wetland level 2+	●	●●●	●●●			●●	●	●●●		●●	●●●	●●●	●●●	●	●●●	●	●●	●	●●	●●	●●●	●●●	●●●	●●●	●●●
Widening floodplains		●●					●●	●●●		●●●	●	●●●	●●●	●●	●●	●	●●	●	●	●	●	●●			
Widening river banks		●●●					●●	●●●		●●●	●	●●●	●●●	●●	●	●	●●	●●	●●	●●	●	●●			
Flood polder		●●						●●●		●●●	●	●●	●●●	●●●	●	●	●●●	●●	●	●	●				
Velocity techniques	●	●●	●●●				●●	●●●		●●●	●●	●●●	●●●	●●	●●	●	●●	●	●	●	●	●●	●●	●	
Vegetated river banks	●●●	●●●	●●●	●	●●	●	●●●	●●●		●●●	●●●	●●●	●●	●	●●●	●	●●	●	●●●	●	●	●●●	●●●	●●●	●●
Forestated landscape	●●	●●	●●		●●	●●●	●●●	●●	●●●	●●	●●●	●●	●	●	●●●	●	●●	●	●●●	●	●	●●●	●	●	●

Figure 6.7 Table of interventions linked to spatial types

Table of interventions linked to structures

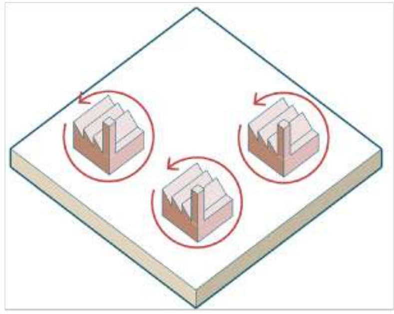
In this table the interventions are valued with the landscape qualities present in the North West European river basin. The landscape quality variables are altitude difference, soil, land cover, land use and type of industry present. For every intervention it shows if it either fits in a landscape quality or not.

Legend
●●● = *fits perfectly*
●● = *fits nicely, but is not the best option*
● = *Is possible, but is difficult to accomplish*

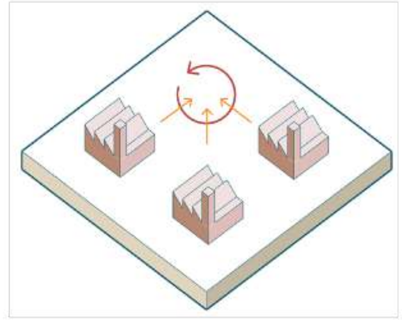
Interventions and Landscape typologies (next pages)

Concluding from the table we can give every intervention a description that mentions what landscape qualities they fit in best.

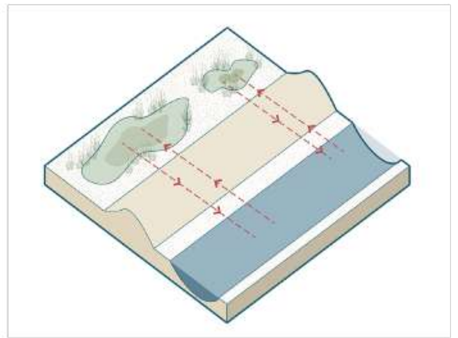
Combining this information with the river basin landscape typologies it is clearly visible which interventions fit best in which area of the river basin. For our pilot project we will zoom into the lowlands confluence to show the implementation of the interventions.



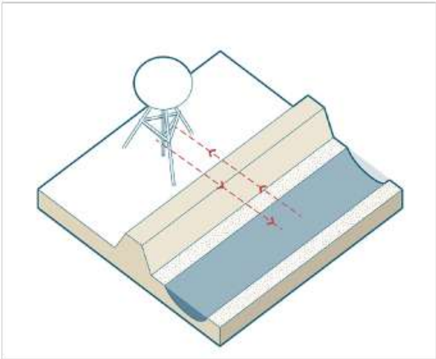
Decentralisation
Altitude: all
Soil: all
Land cover: all
Land use: ports; industrial area
Types of industry: solitary industries



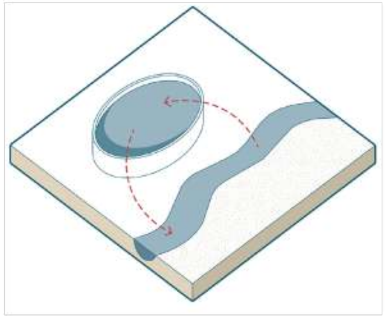
Clustering
Altitude: all
Soil: all
Land cover: all
Land use: ports; industrial area
Types of industry: Small & big clusters



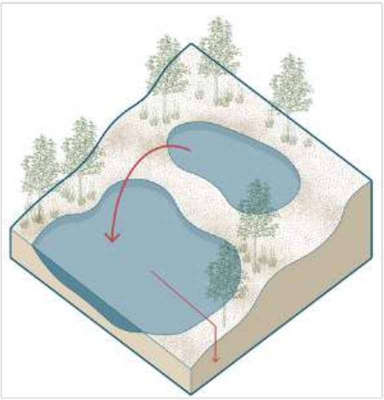
Detached water storage
Altitude: lower river
Soil: clay & mudstone; clays & silts
Land cover: wetlands;
Land use: agriculture; small villages
Types of industry: all



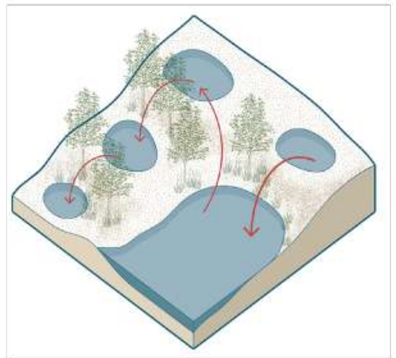
Water Towers
Altitude: all
Soil: all
Land cover: all
Land use: all
Types of industry: all



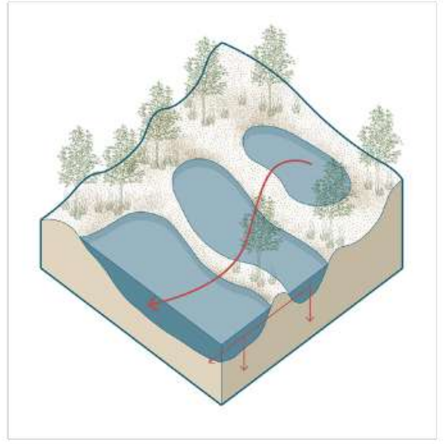
Up-stream Water Storage
Altitude: upper river
Soil: all
Land cover: all
Land use: all
Types of industry: all



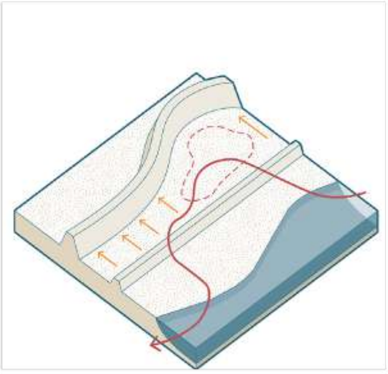
Wetland Level 1
Altitude: middle river; lower river
Soil: marl; clay& mudstone; clays & silts
Land cover: wetlands
Land use: agriculture; small villages; urban area
Types of industry: Solitary industries



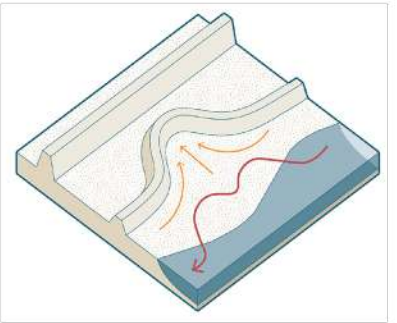
Wetland Level 2
Altitude: middle river; lower river
Soil: marl; clay& mudstone; clay & silts
Land cover: all
Land use: agriculture; industrial area; forestry
Types of industry: Bigger clusters



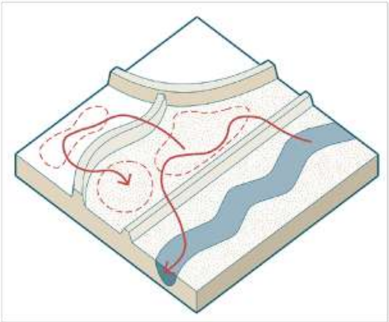
Wetland Level 2+
Altitude: middle river; lower river
Soil: marl; clay& mudstone; clay & silts
Land cover: all
Land use: agriculture; industrial area; forestry
Types of industry: Small clusters



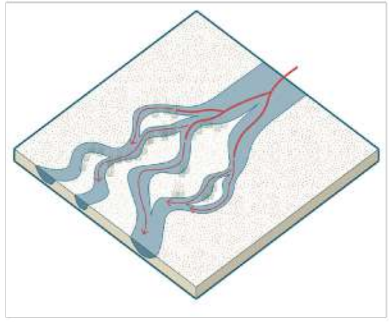
Widening Floodplains
Altitude: middle river; lower river
Soil: clay& mudstone; clays & silts
Land cover: wetlands; grassland
Land use: forestry; small villages; agriculture
Types of industry: Solitary industries



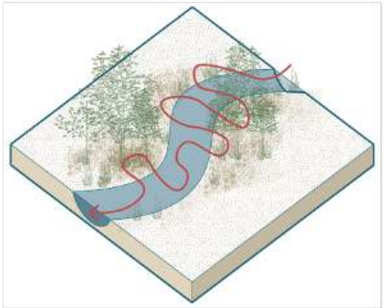
Widening River Banks
Altitude: middle river; lower river
Soil: clay& mudstone; clays & silts
Land cover: wetlands; grassland
Land use: agriculture; ports; urban area
Types of industry: Solitary industries



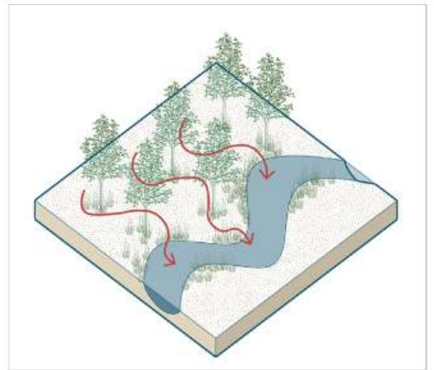
Flood Polder
Altitude: middle river; lower river
Soil: clay& mudstone; clay & silts
Land cover: cropland; grassland
Land use: ports; agriculture
Types of industry: none



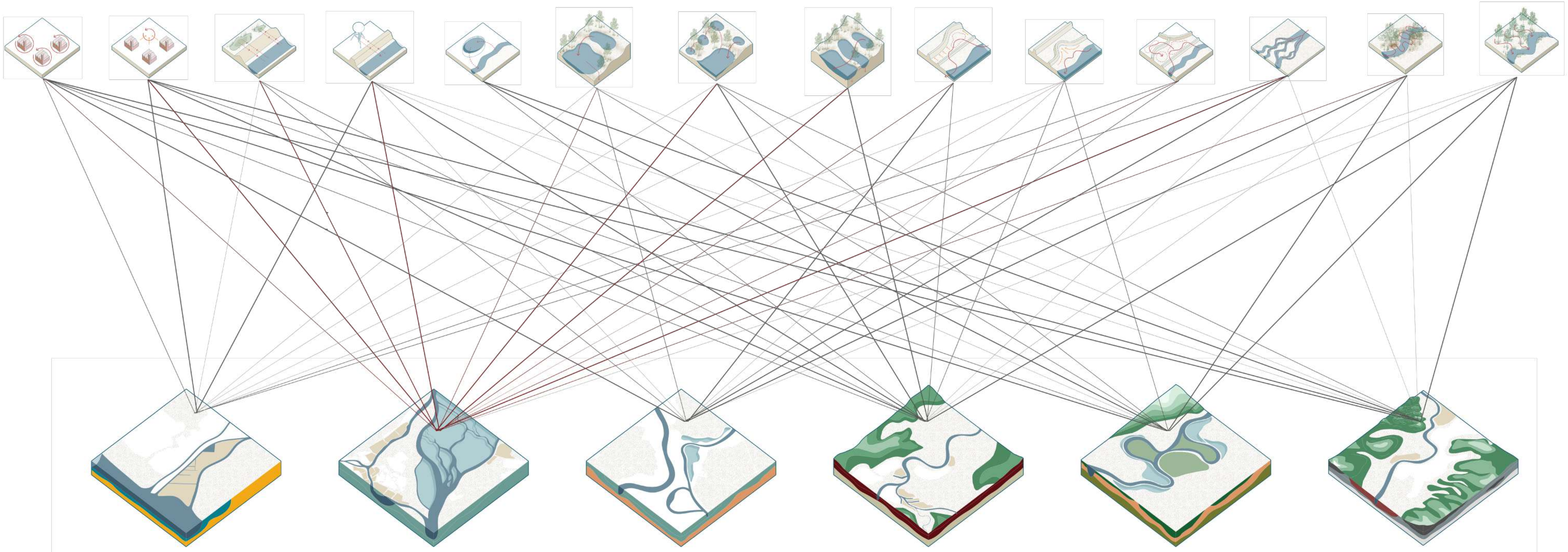
Slow stream techniques
Altitude: lower river
Soil: clay- & mudstone; clays & silts
Land cover: wetlands; grassland
Land use: forestry; agriculture
Types of industry: small clusters or individual industries



Vegetated River Banks
Altitude: all
Soil: sand or gravel; clay & mudstone; clay& silts
Land cover: forest; wetlands
Land use: forestry; small vilages; agriculture
Types of industry: All



Forestated Landscapes
Altitude: all
Soil: all but rocks
Land cover: forest; wetlands
Land use: forestry; small villages; agriculture
Types of industry: Solitary industries



RIVER DELTA

Altitude difference:

Less than 10cm per km (lower river).
Rivers diverge into delta (into sea).
Polders below sea level.

Soil:

Marine estuarine clays & silts + sand dunes

Land cover:

Cropland

Land use:

Urban area, industrial clusters, ports, agriculture

Point of industrial emission:

Big clusters; high quantity of emission

LOWLANDS CONFLUENCE

Altitude difference:

Less than 10cm per km (lower river).
Lowlands converging river landscape
Polders below sea level.

Soil:

Clays & silts

Land cover:

Cropland, grassland, wetlands

Land use:

Urban area, industrial clusters, agriculture

Point of industrial emission:

Big & small clusters; high quantity of emission

LOWLANDS RIVER LANDSCAPE

Altitude difference:

Less than 10cm per km (low river).
Lowlands meandering river landscape

Soil:

Clays & silts + Loess

Land cover:

Grassland

Land use:

Agriculture, Villages along dykes

Point of industrial emission:

Solitary industries; low quantity of emission

TRANSITIONAL HILLS

Altitude difference:

Between 10cm - 1m per km (middle river)
Ocassional hill landscape with
hillside plateaus, less meandering.

Soil:

Slate, claystone & mudstone

Land cover:

Cropland , forested

Land use:

Urban area, agriculture, industrial area, mining

Point of industrial emission:

Big & small clusters; high quantity of emission

MIDDLE RIVER LANDSCAPE

Altitude difference:

Between 10cm - 1m per km (middle river)
Hill landscape medium meandering river

Soil:

River terraces; sand or gravel, loess, marl

Land cover:

Forested, Cropland

Land use:

Small urban area, agriculture, forestry

Point of industrial emission:

Small clusters; high quantity of emission

UPPER RIVER LANDSCAPE

Altitude difference:

More than 1m per km (upper river).
Mountain landscape, no meandering

Soil:

Limestone, rocks, clay, glaciofluvial deposits

Land cover:

Forested, meadows, bare rock

Land use:

Villages in valleys, agriculture, forestry

Point of industrial emission:

Solitary industries or small clusters; low quantity of emission

Stakeholders and their attitude

Stakeholders fit into different sectors, but within these sectors there are stakeholders with very different attitudes towards our project. Therefore we turned the power/interest matrix into a power/interest/attitude matrix. For every stakeholder we have determined if they are a proponent, opponent or have a neutral attitude towards our project.

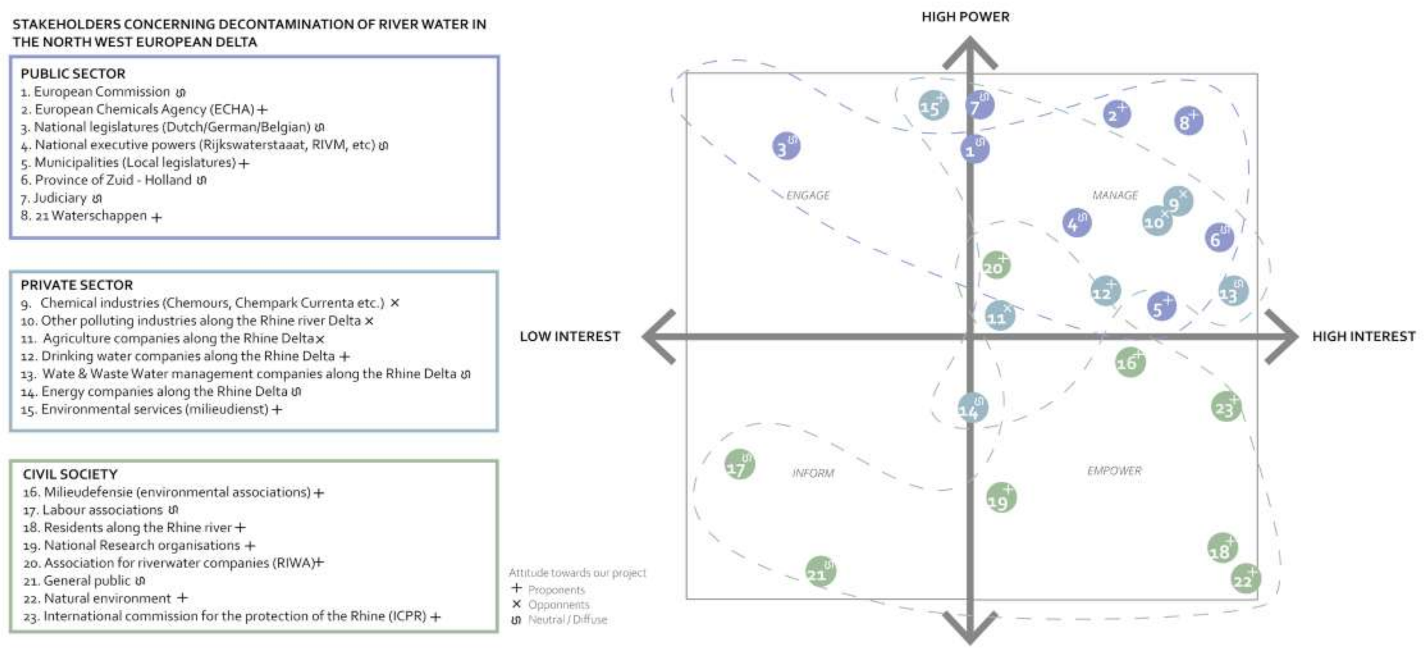


Figure 6.8 Power-interest matrix updated with attitudes

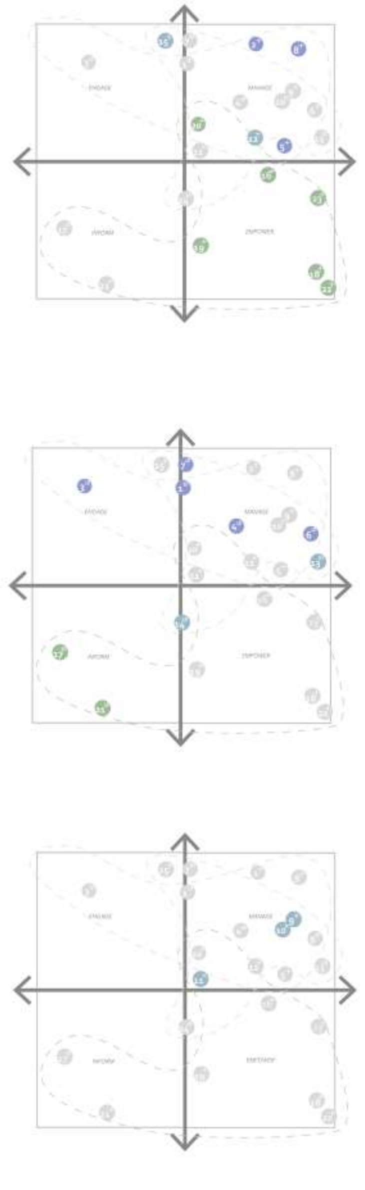


Figure 6.9 Power-interest matrix updated with attitudes, by attitude (top: positive, middle: neutral, bottom: negative)

The public sector has a neutral/diffuse attitude towards our project. The legislative bodies on national and international scale stand behind our idea, but they have other priorities than decontaminating the river water system. Only the local governments like municipalities see the urgency of the problem. Also the Waterschappen, which are in charge of the water management in The Netherlands see the urgency to clean the river system and are proponents of our project.

The private sector has very different opinions. The polluting industries are in general an opponent of our project, because we demand big changes from them. There are also industries with a neutral attitude because the water quality is not that important for them, while the water quantity is important for them and will be more important in the future. Then there are also industries that are dependent on the water quality and quantity and therefore would be proponents of our project.

The civil society is generally a proponent of our project, but the general public can not see the urgency there is to change the water system. Most other civil associations in our matrix are especially focused on the river water quality and quantity and therefore are big supporters of our project.

	ATTITUDE	REASONS FOR SUPPORT/RESISTANCE	ATTITUDE WE NEED	ATTITUDE TOWARDS COSTS/BENEFITS
EUROPEAN LEGISLATURES	Neutral	Support: Need to assure water safety for European citizens, big problems in biodiversity Resistance: Differences in urgency within Europe. Difficult to legislate nations and economic activity	Better regulation with international laws & regulations	Longterm costs for longterm benefits. Costs can be high for a longer period of time
NATIONAL LEGISLATURES	Neutral	Support: Need to assure water safety in quality and quantity for European citizens Resistance: Lack of urgency in regulations because industries are important economic activities	More interest in the problem, legislate pollution, laws & regulations	Longterm costs for longterm benefits Costs can be high for a longer period of time
LOCAL GOVERNMENTS	Proponent	Support: Need to assure drinking water safety, flood protection, healthy living environment. Resistance: Industries are important economic activities and employment opportunities.	Prioritize the problem water problem over economic activitiy	Longterm costs for longterm benefits. Acceptable costs are limited
POLLUTANT INDUSTRIES	Opponent	Support: Are aware that they need to change Resistance: Growth has priority, there is no technology or money to change, there are no strict regulations	Invest in new technologies for filtering. More co-operation to create a cleaner system	High shortterm costs allowed if benefits are visible on shortterm too and will be more than the costs
OTHER BUSINESS ALONG THE RIVER	Neutral	Support: Want clean water for themselves and others Resistance: Some also need to change and do not have the financial opportunity or urgency to do so	More interst in the problem. Invest and co-operate with each other for a clener system	High shortterm costs allowed if benefits are visible on shortterm too and will be more than the costs
LOCAL RESIDENTS	Proponent but also neutral	Support: Are the main users of drinking water, recreational waters and need flood protection Resistance: Do not have the feeling they can change something. Part of the people do not care	Come together and enforce legislation and change	Shortterm costs and shortterm benefits
ENVIRONMENTAL AND RIVER ASSOCIATIONS	Proponent	Support: Scientific prove that we need to change our water quality / river landscape to assure safety for our whole biodiversity Resistance: Impotence, not enough possibilities for action	Enforce legislation with research and keep protecting	Longterm costs for longterm benefits. High investment needed but can not do it themselves
GENERAL PUBLIC	Neutral	Support: We all want cleaner water and water safety and space for animals Resistance: Individual interest above shared interests	Come together and enforce legislation and change	Shortterm costs and shortterm benefits
NATURE (SILENT STAKEHOLDER)	Proponent	Support: Safe our planet, safe our biodiversity and river landscape Resistance: X	More environmental disasters needed to show the urgency	Longterm costs for longterm benefits. High investment needed but can not do it themselves

Figure 6.10 Table of grouped stakeholders and their attitude, plus attitude changer.

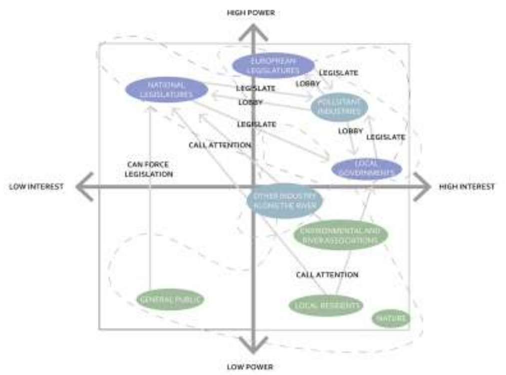


Figure 6.11 Groupings of stakeholders

For the generalised matrix we made a detailed table with why stakeholders support or have resistance towards our project and what change in attitude we need from them to achieve our goal. The stakeholders are grouped using the matrix from the analysis (see figure 6.11). The grouped stakeholders thus correspond to the 'actor strategy stamp' of each intervention; the qualitative data presented here can therefore now be applied to a (pilot) project area.

VII

CHAPTER 7

THE REVIVED LOW-LANDS CONFLUENCE

PILOT PROJECT

CHAPTER 7

LOWLANDS CONFLUENCE STRATEGY

PILOT PROJECT

After going through the catalogue of interventions and the manual all the information is present for an implementation proposal. In this chapter we explore the pilot project called lowlands confluence to discover if our strategy is working. Firstly there is a local landscape and stakeholder fit to determine the location specific qualities and have a suitable actor and spatial strategy. We show the suitable interventions in a regional strategy map and zoom into different strategic interventions to show the industrial circular systems in relationship to their surroundings. Secondly we develop a phasing strategy to develop our pilot project in the upcoming 60 years. Lastly there is a policy recommendation for both river basin wide and local policies that should be implemented to support and achieve our vision. Now we have tried to implement the catalogue and manual into a pilot project, we end with an evaluation of the manual and recommendation for the whole river basin.

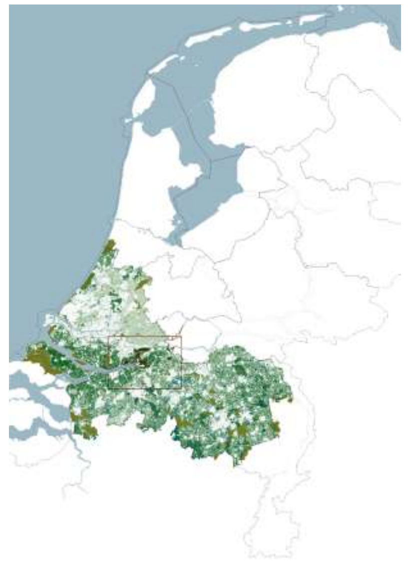
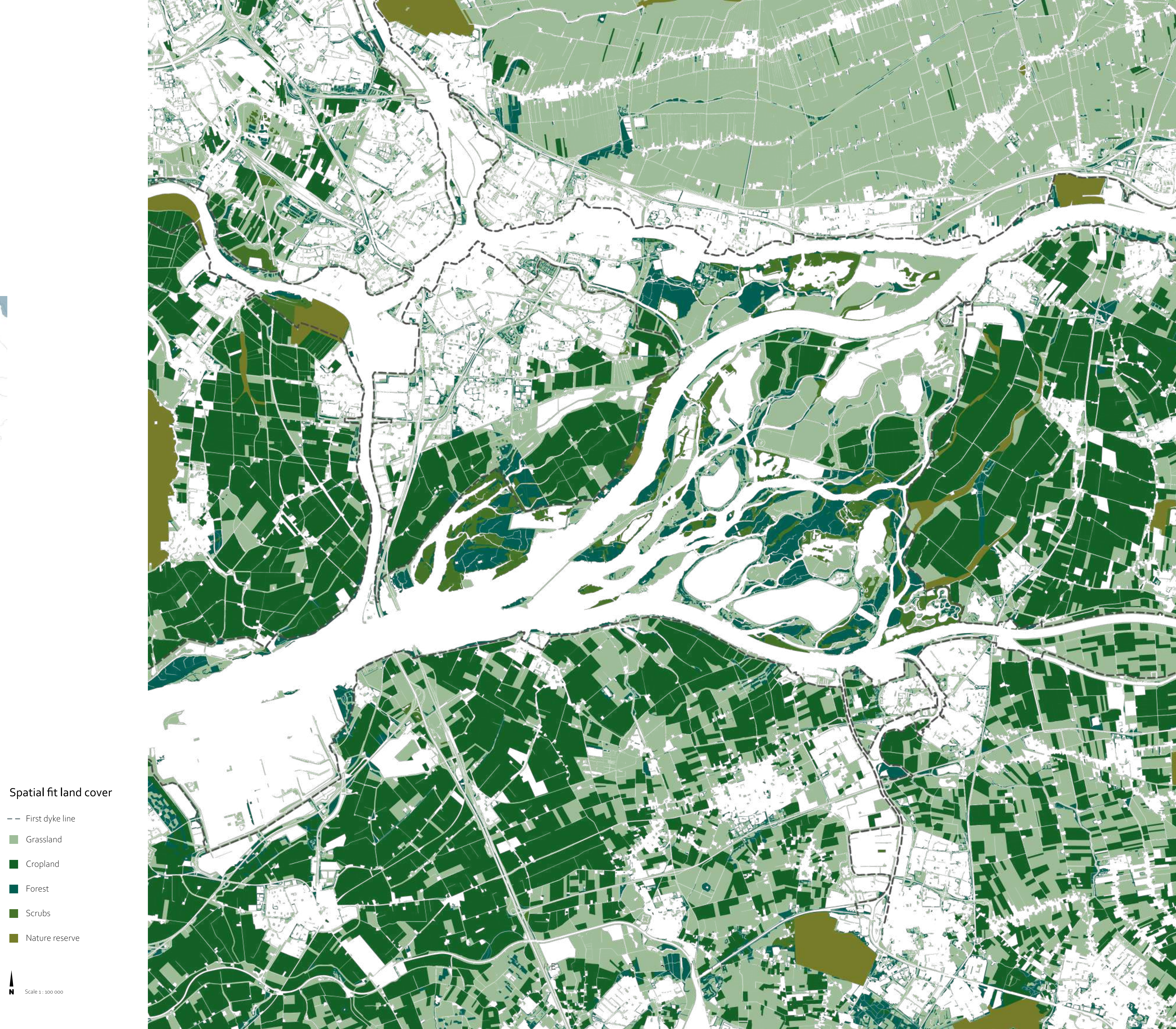


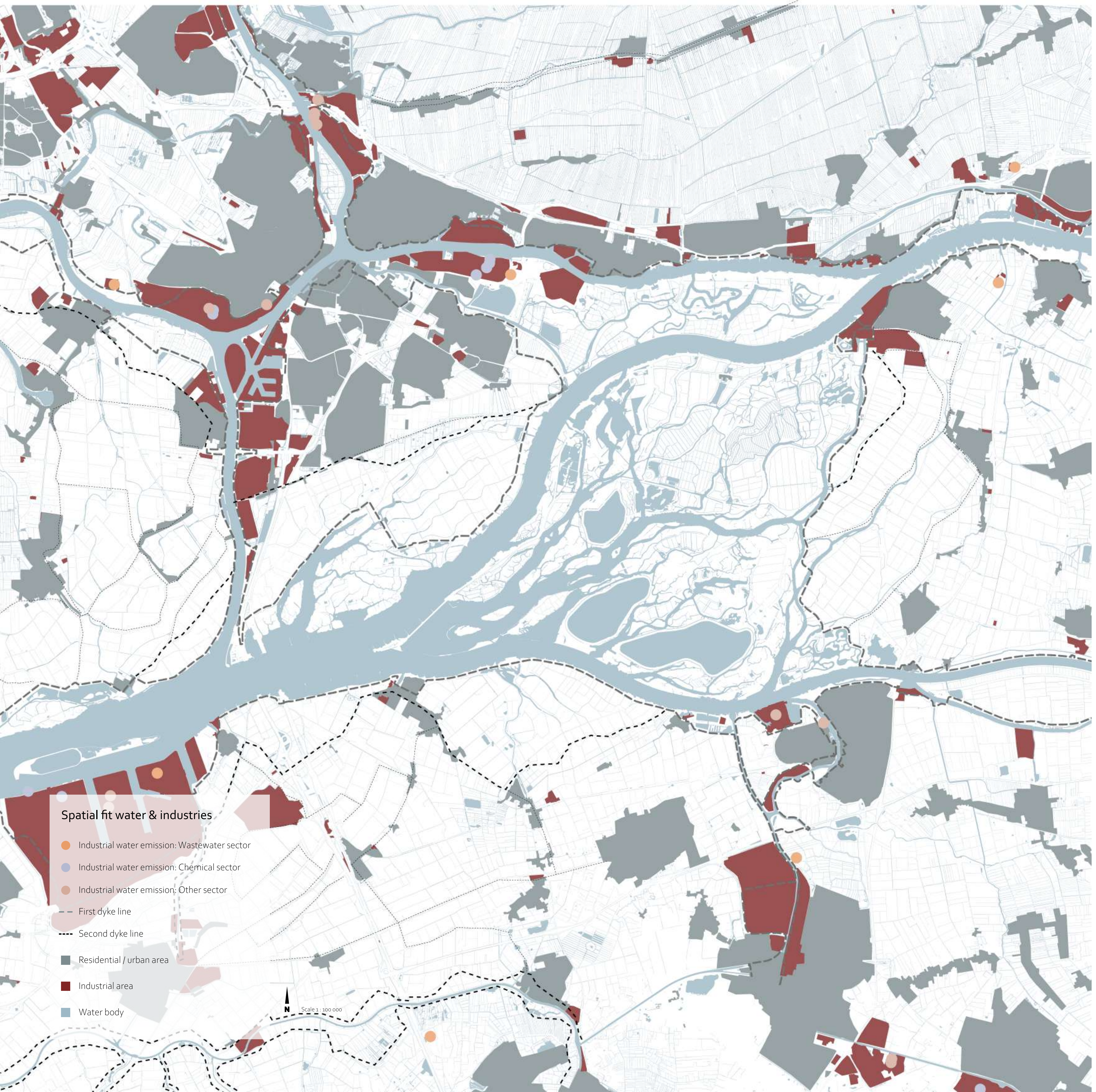
Figure 7.0 Pilot area

Spatial Fit

To discover which interventions are suited within the area containing the Biesbosch, dordrecht and North-West Brabant, it must first be looked at based on the same factors as used in the catalogue of interventions. These were altitude, soil, land cover and use and points of industrial emission. While this area has minimal height differences, there are many dykes and areas below 1m elevation. Thus altitude is represented in dykes and flood prone areas. Adding to this deviation, flow directions are shown as this area has many small creeks and rivers flowing into the main river.

From these maps we can see the current spatial structure of the region around Dordrecht. The first map shows the land cover present. From this it is visible that land cover and land use varies considerably in the area. The southern part of the area is characterised by fragmentation of agricultural land. This part is within the province of North Brabant. Contrary to North Brabant, South Holland has a clearly defined use of land per area. The western portions focus mainly on cropland while the Northern edge of the area is completely specialised on bovine farming. Aside from the agricultural difference. Brabant has several forest covers. Together with the Nature reserve of the Biesbosch these are the only large areas with natural cover. The presence of forests can be attributed to the transition from clay soil to sand soil in the southern edge.





In the second map, the industrial sites are shown. From this, it is clear that several points are already grouped together, while a few solitary industries exist too. Added, the two main dyke lines are shown with connecting dykes in between. The most important element of this is that the area between these two dykes is most prone to flooding. From this it is visible that industries are located outside of the dykes. If they get flooded, pollution would be spreaded over a large area.

Summarising the spatial fit a set of diagrams shows the main elements of the area are.

The first diagram shows that aside from the main river flow, multiple small rivers flow into the main branches. These smaller rivers even have small gulleys as tributaries. If one wants to decontaminate the entire basin, it might be interesting to look at solutions for these small rivers and their connections to the main river.

The second diagram briefly illustrates how the dyke network looks and which parts are prone to flooding. In these areas, interventions for flood prevention might be more suitable and take up more space.

The third diagram illustrates that there are two soil types present. The largest one is clay. This can be sea and river clay. Coincidentally, the clay areas are also the ones most prone to flooding. The small dark gray corner in the bottom shows that there is some sand soil present within the area. This overlaps with the forested areas in the final diagram

The final diagram shows the main land covers within the area along with industrial polluters. In white, urban areas are shown, these are surrounded by mainly agricultural areas, However, there are some nature reserves present, these are either forested areas or nature parks such as the national Park Biesbosch in the middle.

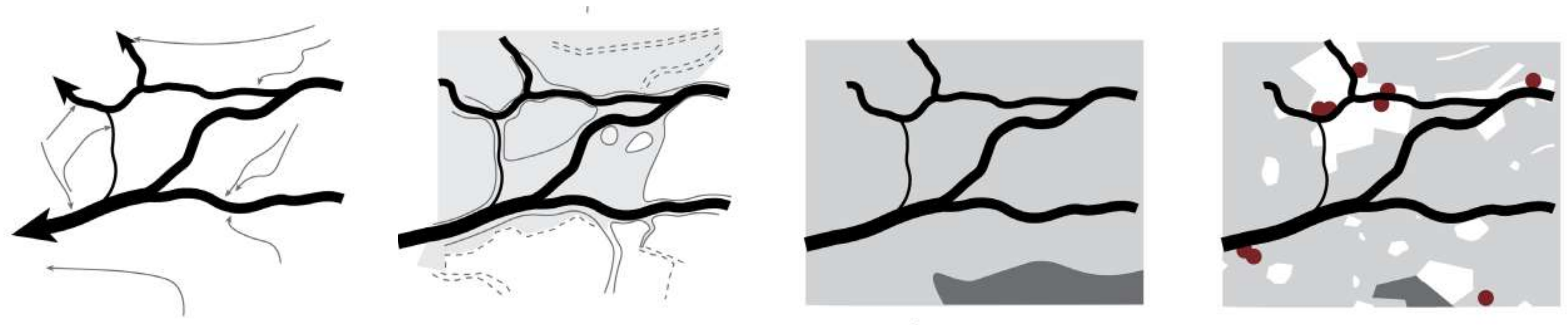
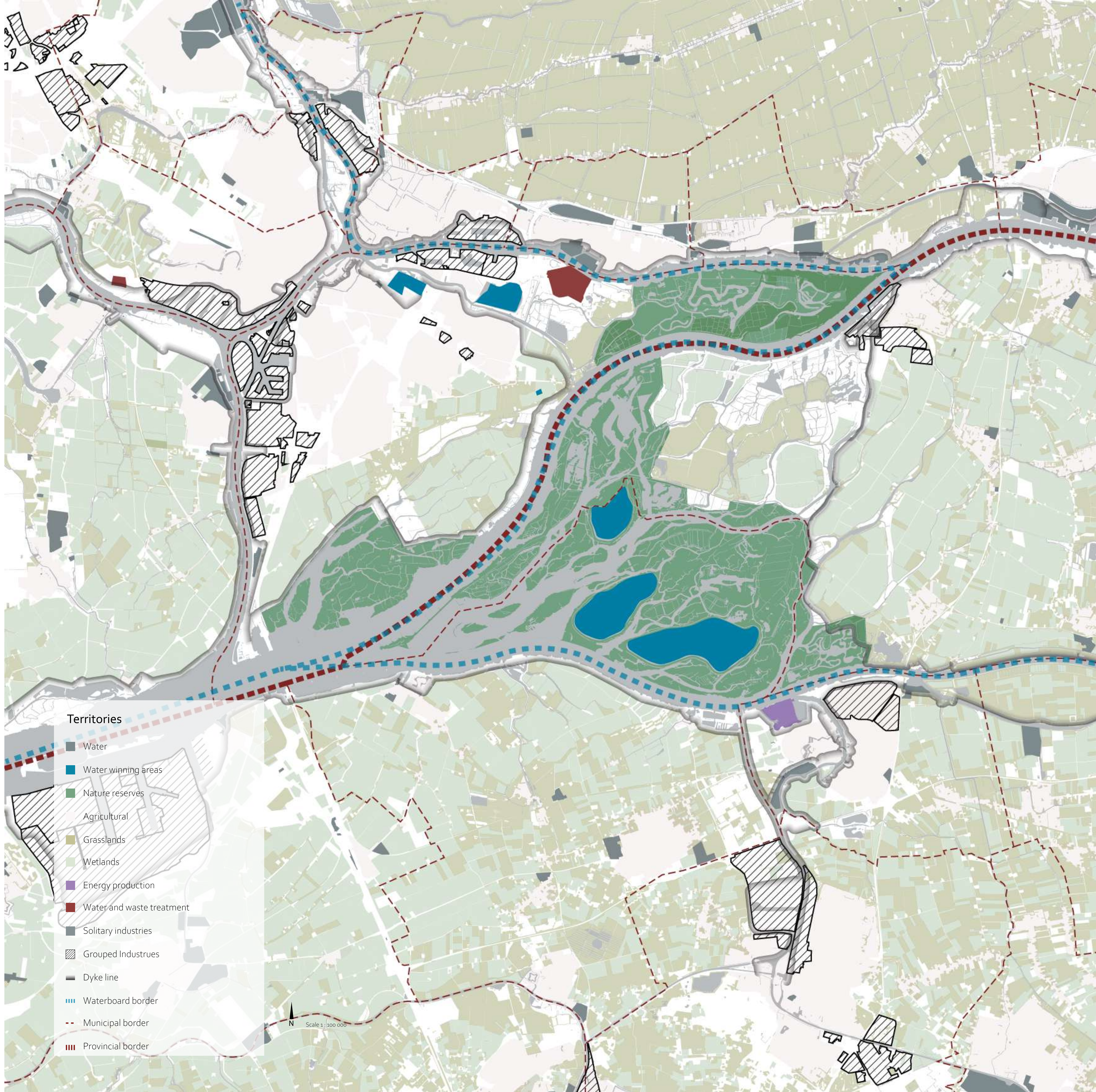


Figure 7.1 Abstract diagrammes interpreting the spatial organization of the pilot area.

Stakeholder Fit

While the last set of maps focused on the different spatial structure present in the pilot area and which interventions can work, this section focusses on the stakeholders present in the area. As defined in the analysis chapter, there are three main groupings of stakeholders present. These were the public sector, private sector, and civil society. These sectors all have multiple stakeholders that play a role in the pilot area. This is illustrated in the map on the next page, illustrating the territories of several stakeholder. These territories aim to illustrate that stakeholders have an area where they have an influence on. Looking at the territories map, it is visible that there are many stakeholders that play a role in governing territory.



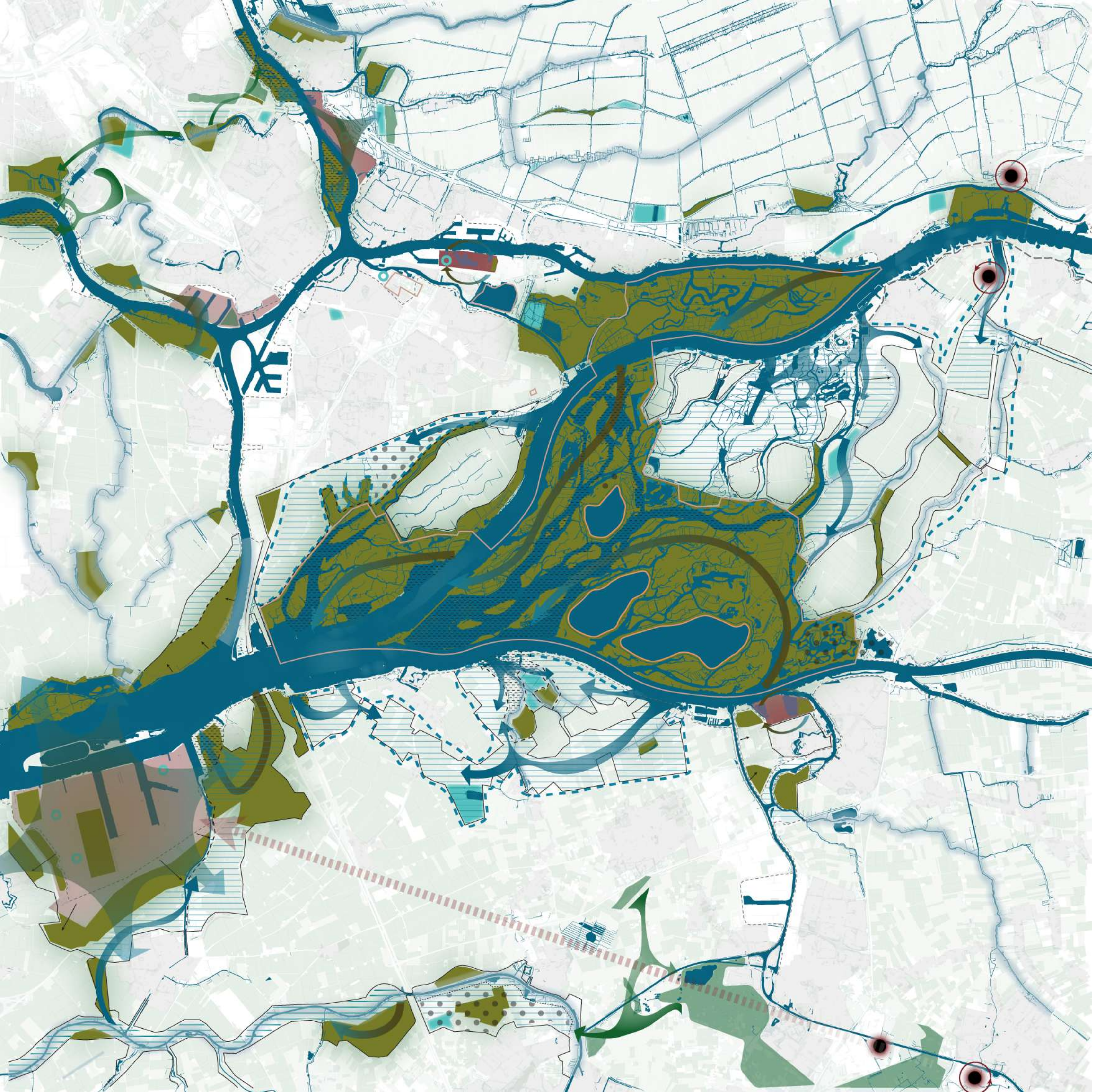
The first sector that has the largest role is the public sector. These are represented by governmental institutions. On the national level, Staatsbosbeheer and Rijkwaterstaat have a role within the area. Staatsbosbeheer governs the Nature reserve of the “Biesbosch”. They have an aim to maintain nature and improve biodiversity. Rijkswaterstaat is mainly concerned with the maintenance of Dykes and waterways within the area. These two stakeholders represent the National government in the area. As executive actors, they have little power in creating policies, but can push governments in certain directions. Below these national stakeholders are the provinces. North Brabant and South Holland are the policy makers in the area. Nevertheless, current political climates in the two provinces make it uncertain what their stance is on issues and interventions concerning decontamination and water storage. Nevertheless, they form the connection in policy making between the national stakeholders and the local ones. These local stakeholders within the public sector are the waterboards and municipalities. Waterboards govern local water maintenance. They can form plans for water storage, water purification and the supply of water. Still, they span multiple municipalities and often provinces. This means that for their plans they need both cooperation on the local and provincial level.

The multiple stakeholders within the public sector illustrate that there is both a top-down approach in policies while also providing room for a bottom up approach. This bottom up approach is most exemplified by the private sector and civil society. The private sector is present in the territory through the water winning areas and waste management. These are run by water companies which fall under the policies of water boards. The biggest player in the private sector is the agricultural sector. This is a combination of smaller civil stakeholders. Since they now have a large political representation in both water boards and provinces, they can steer regional policies from the bottom up. Municipalities themselves allow bottom up approaches through town hall meeting where residents voice concerns and desires.

Every single stakeholder present in the area has interests concerning the larger vision. Based on this the vision and stakeholders have a conflict that needs to be resolved, this can be done through a set of policies aimed at each stakeholder. Resulting from this, the strategy can have slight changes in each region.

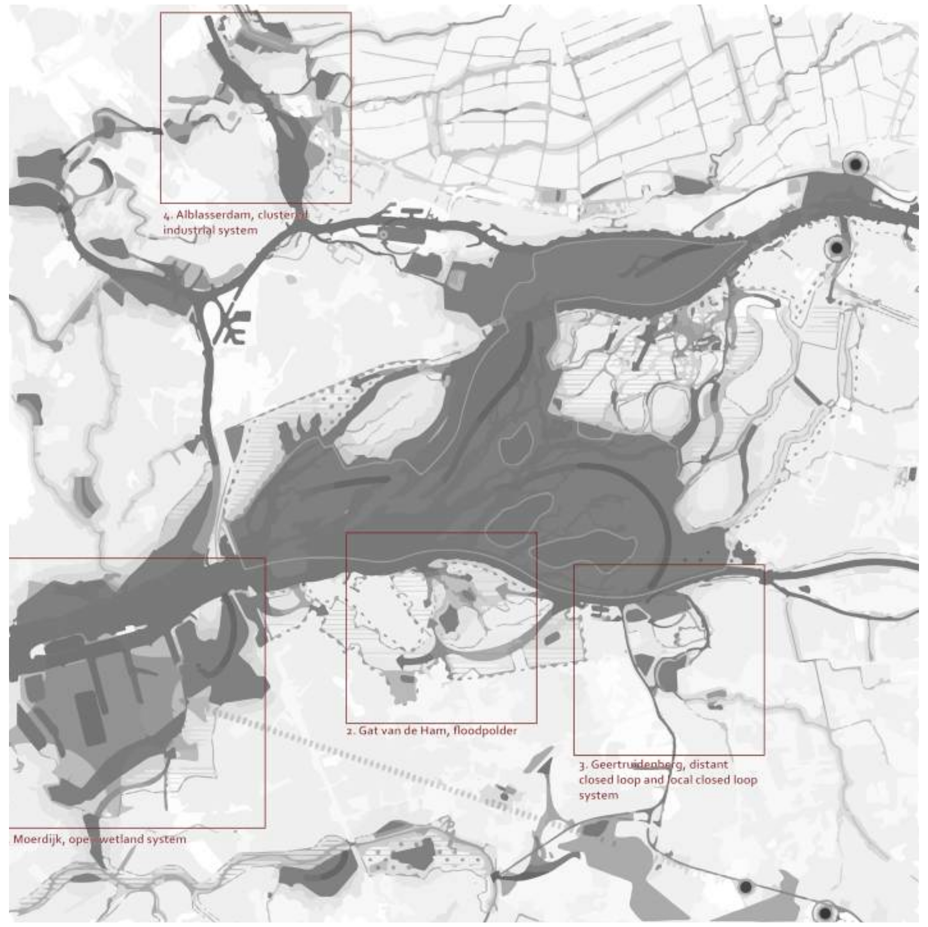
STAKEHOLDERS IN THE DESIGN REGION	INTERESTS OF STAKEHOLDER	ENVISIONED SITUATION	VISION FIT	CONFLICT SOLUTIONS
EU	Less emissions/ improved water quality	Policies on emissions	+	×
ICPR	Less emissions/ improved water quality	Help realise vision	+	×
RIJKSOVERHEID	Amount of costs required	Subsidising projects	×	Costs might end up higher
RIJKSWATERSTAAT	?	project implementation	×	Need clear policies
STAATSBOSBEHEER	New nature areas	Expand wetlands	+	×
RIWA	Less emissions/ improved water quality	Help realise vision	×	×
NOORD BRABANT	?	Creating spatial plans	×	Uncertainty in new assemblies
ZUID HOLLAND	?	Creating spatial plans	×	Uncertainty in new assemblies
RIVIERENLAND	Retention of water/flood prevention/ improved water quality	focus on decontamination	+	×
HOLLANDSE DELTA	Improved water quality/decontamination	focus on decontamination	+	×
BRABANTSE DELTA	Retention of water/ flood prevention	focus on water managment	+	×
MUNICIPALITIES	Reduced costs/ Jobs	new functions along wetlands	+	×
MUNCIPAL AGENCIES				
ENVIRONMENTAL SERVICES	Keeping industries	focus on clustering / decontamination	+	×
INDUSTRIES				
PETRO INDUSTRY	Staying on location	Will be phased out	×	Want to stay while transition wants them to leave
CHEMICAL	Staying on location	clustering/decontamination	−	clear policies, incentives and possibilities needed
PRODUCTION	Staying on location	clustering/decontamination	−	clear policies, incentives and possibilities needed
CONSTRUCTION	Staying on location	Decentralisation	+	×
AGRICULTURE				
CROPLAND	No land use change	Mixed farming practices	×	clear policies, incentives and possibilities needed
BOVINE	No reduction/ no dispplacement	Mixed farming practices	+	×
HORTICULTURE	Added space/ no dislpacement	Less use of water	−	clear policies, incentives and possibilities needed
GREENHOUSE HORTICULTURE	No displacement/ Flood prevention	clustering	×	clear policies, incentives and possibilities needed
RESIDENTS	Clean water/ space for leisure	Extra leisure space	+	×

Figure 7.2 Table of stakeholders in the pilot area with attitudes.



Regional Map

Shown here is the regional strategy. This map focusses on areas that will have spatial changes through different interventions. Along creeks there is a focus on vegetated banks, allowing agrcilture to continue on these banks. These vegetated banks end up in wetlands. This allows local decontamination before water gets added to the main river. Alongside this intervention, wetlands get created near new industrial clusters. These are linked to the cluster, depending on the system of a cluster. The biggest spatial changes result from floodpolders. These require new dyke lines while also creating new water storage through ponds and implementing wetlands within them. Added to these spatial interventions, new connections and interactions are created. The most important ones are the decontamination that wetlands offer and the extent of each industrial system. Finally, the most effective governing stakeholders are shown through the nature reserved and old dyke lines.



Moerdijk, Open wetland system

Moerdijk is the first zoomed-in area. The large industrial area is directly along the river and is surrounded by vast agricultural lands. Because there are numerous pollution points in this area, they must be managed in a centralised system to avoid flowing directly into the river, as they currently do.

When it comes to dealing with industrial sewage, an open wetland system strategy is far more appropriate for this large-scale industrial site. Each highly contaminated plant would have its own water treatment plant. Following collection by this system, the polluted water will be purified by the surrounding wetlands, and some of the cleaned water will be dumped into the river, while others will be collected in the water storage system. The wetland is the core of this system.

Due to the large scale of the industries and the high level of pollution, more wetland space is required for landscape treatment. In order to preserve existing wetlands, a portion of cropland must be converted to wetlands. Furthermore, because Moerdijk is at a crossing of the Meuse confluence, more landscape barges such as widening floodplains or soft soil - green river banks are required.

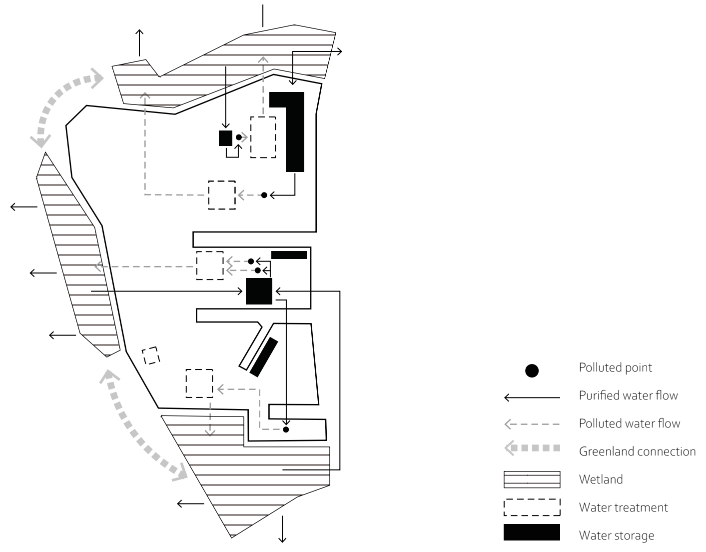
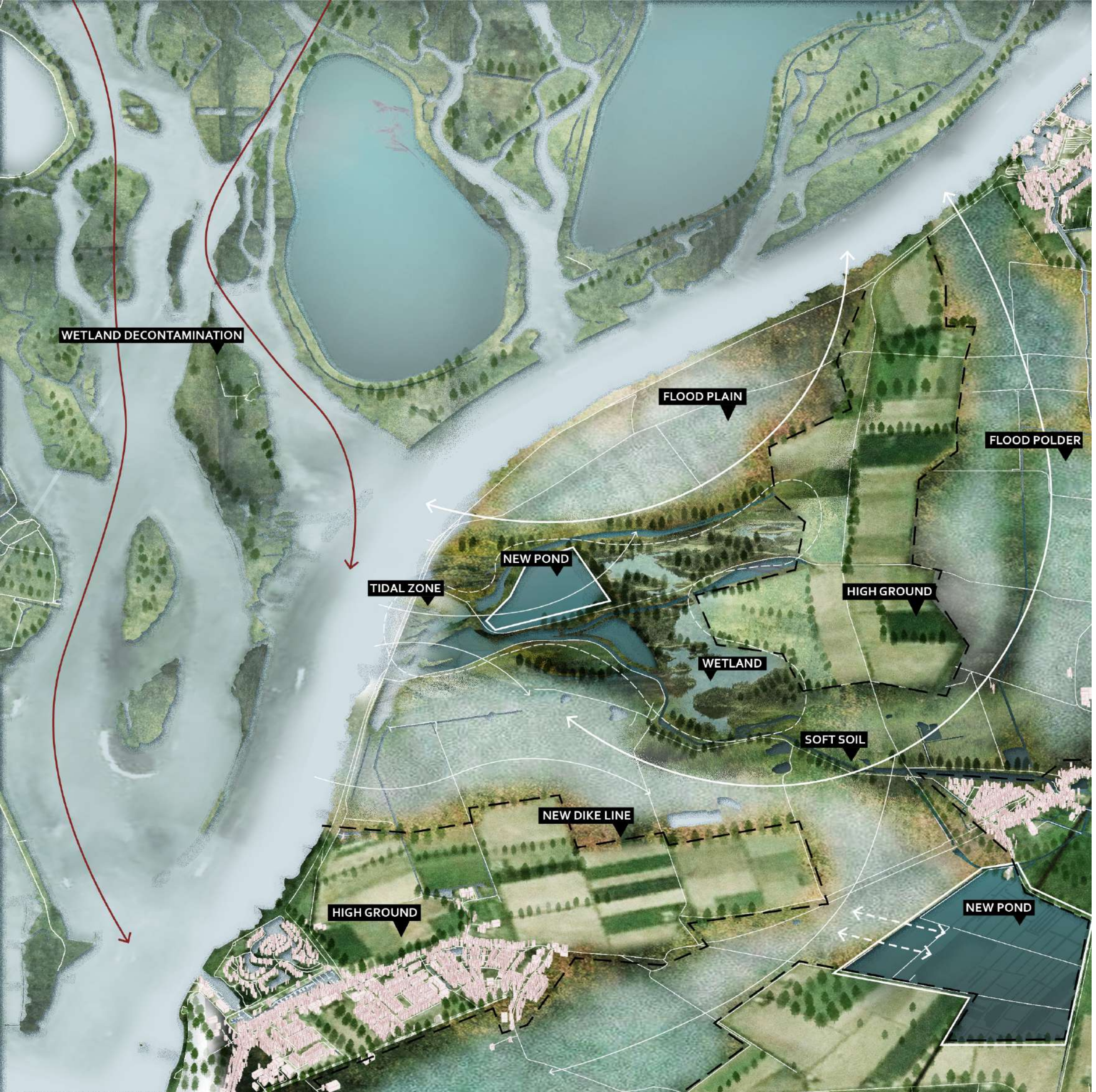


Figure 7.3 Moerdijk open wetland system



Gat van Den Ham, Flooding prevention system

This area is located at the diversion of the river and is subject to a huge river volume, yet the current natural landscape of this area is largely agricultural and therefore cannot effectively solve the future flooding issues.

The establishment of a new dyke line is the main intervention here. The existing dyke lines are located on the river banks, so by removing them backwards more space along the river can be freed up to build a river buffer zone. The existing cropland will be converted into floodplain and flood polder, and soft soil banks will be added on both sides of the stream bank deep inland and new lakes will be added to cope with the future flooding risk. Through these actions, the village and rest of the cropland will become high ground, while the other parts will be turned into resilient space for flood prevention.

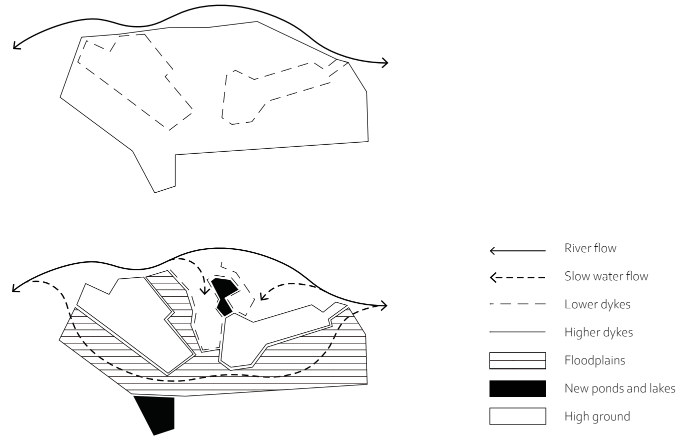
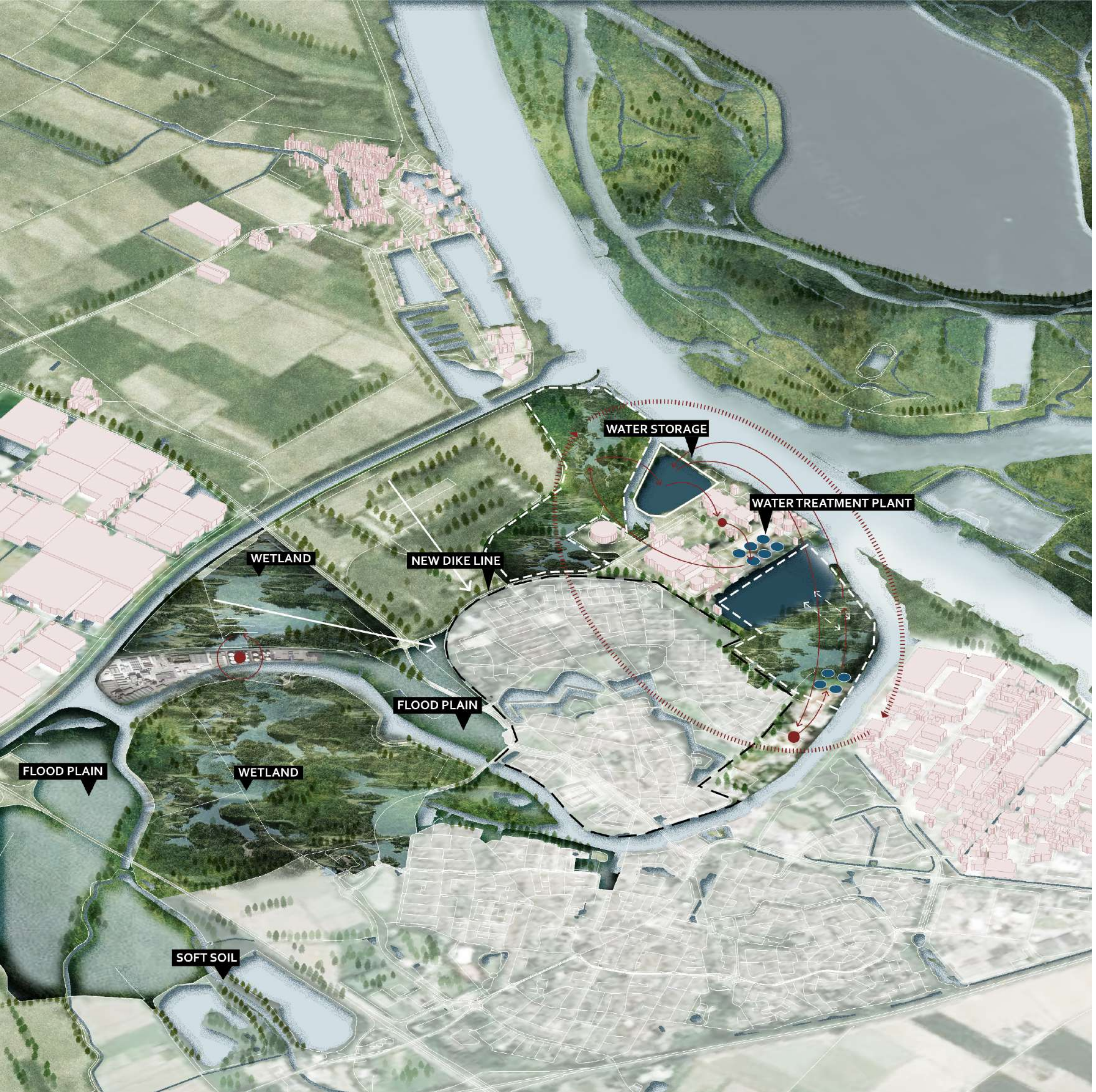


Figure 7.4 Gat van Den Ham flooding prevention system



Geertruidenberg, Distant closed loop system and Local closed loops system

The water polluting industrial zone in this area is due to only two industries, that are surrounded by green land, so the connected loops system is more suitable to purify the wastewater here.

Two separate wetlands will be constructed in this industrial area on the riverbank to clean the water from each chemical plant. Every single industry needs a water treatment plant and wetland, but all the purified water will be collected in the same storage.

There is a separate pollution point in the inland industrial zone, which is a wastewater treatment plant. Clearly, local closed loop is more appropriate here. This plant has on site water treatment and wetland. After the water is mostly decontaminated it can be stored in a water basin or water tower, which is the water supply for the industries and a water storage for other users.

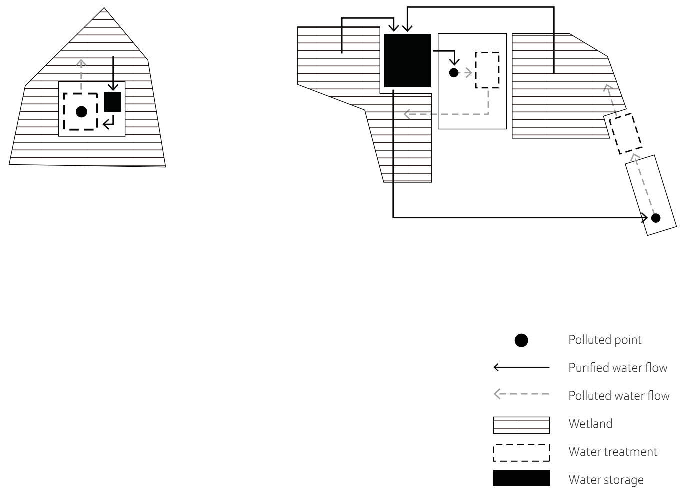
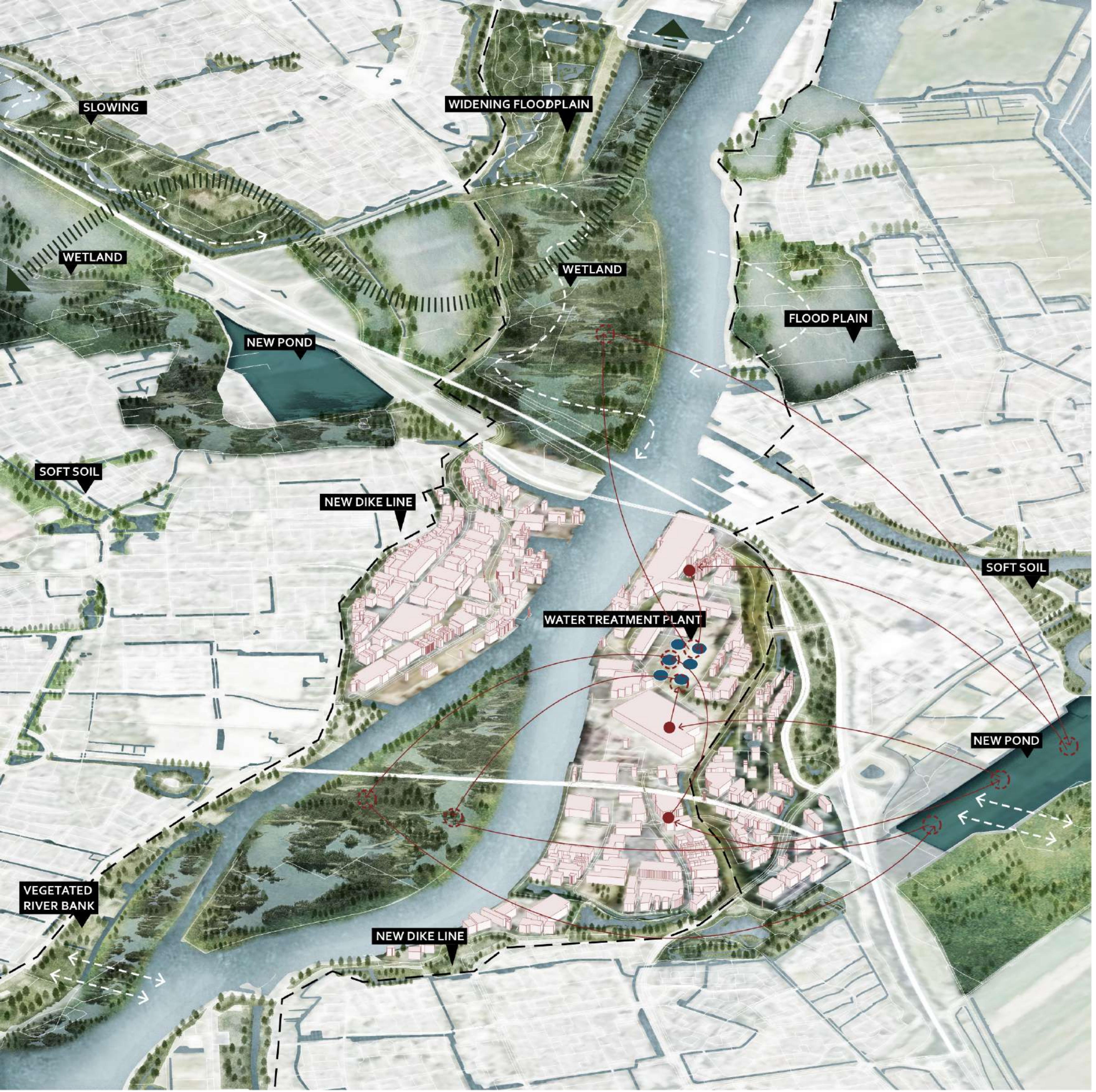


Figure 7.5 Geertruidenberg distant closed loop system and local closed loops system



Alblasserdam, Clustered industries system

Since the industrial areas are located in close proximity to urban neighborhoods and there are two large, scattered wetlands, the effluent from the different plants can flow into these two large areas separately. Therefore, the industrial cluster system is more suitable for this area.

Different from the connected loops system, the wetlands in this system are larger in scale and do not only support a single industry, they will collect wastewater from several nearby industries and clean them. Moreover the wetlands do not only serve the industries in this system for they are too large, so they serve other users as well.

Unlike the open wetland system, the purified water will all be collected in the same storage area, as there are no large dispersed storage lakes to use in the urban area. In addition, more soft soil barges and vegetated rive banks are used in the landscape treatment of this area, with these interventions to soften urban hard boundaries and create a flood buffer between the city and the river. The dykes will also be moved back a little.

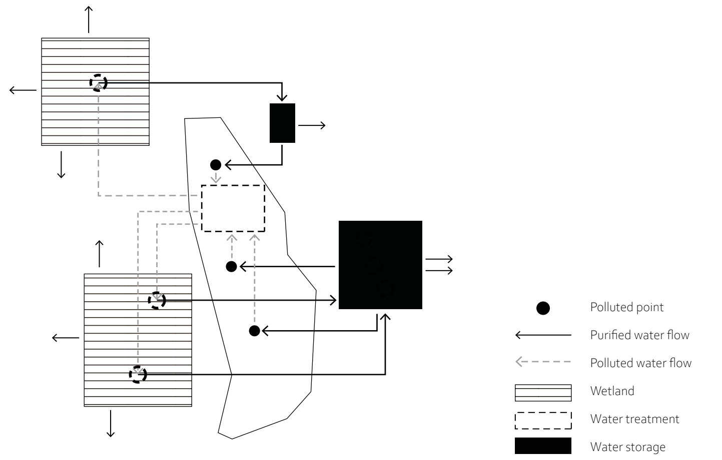
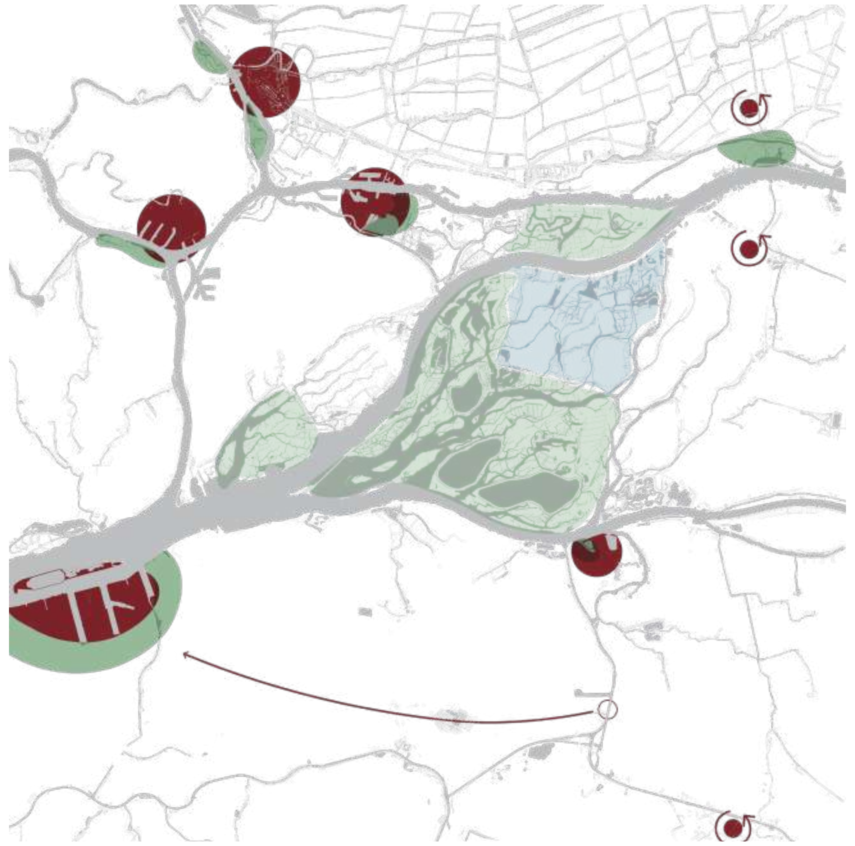


Figure 7.6 Alblasserdam clustered industries system

Phasing

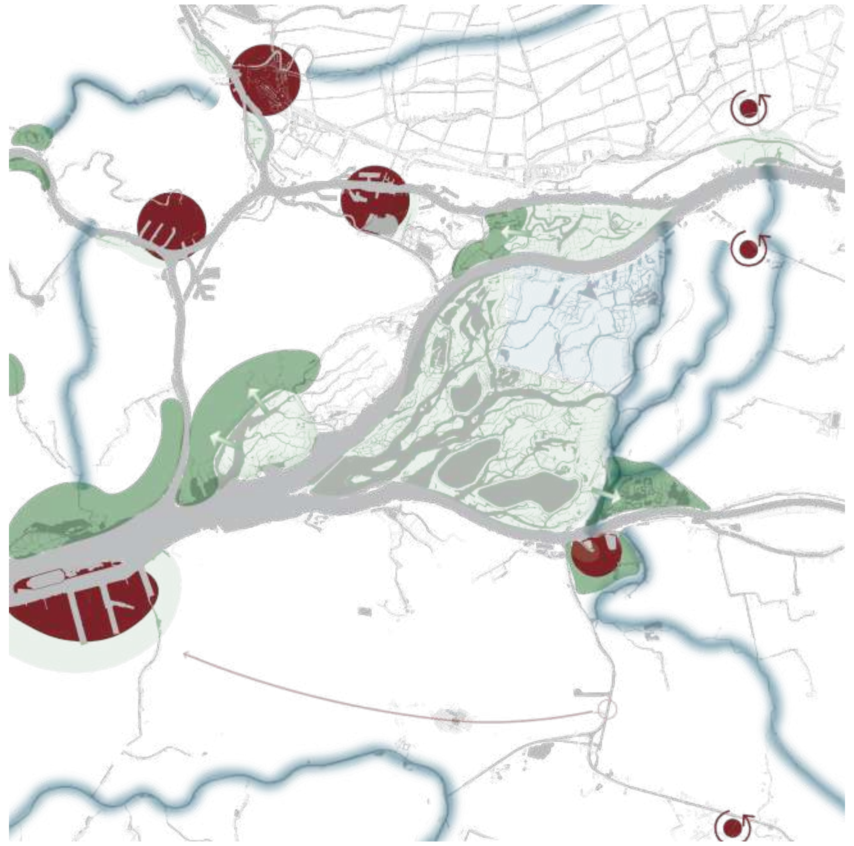
In the phasing timeline the implementations of our three concepts are shown together with the policy framework needed to guide the implementation. The implementation is on a local level, while in the first place there are policies needed on a river basin wide level. These policies guide the change in different areas along the river basin. Without the policy on a river basin wide level the local implementation is not possible. Therefore this policy framework is shown on top of the phasing timeline. Every local implementation has the same phases, but the interventions are different along the river basin and that is why the timeline is different for every local implementation of our intervention. This phasing timeline shows the phasing in the pilot project lowlands confluence.

Figure 7.7 Pilot project phase 1



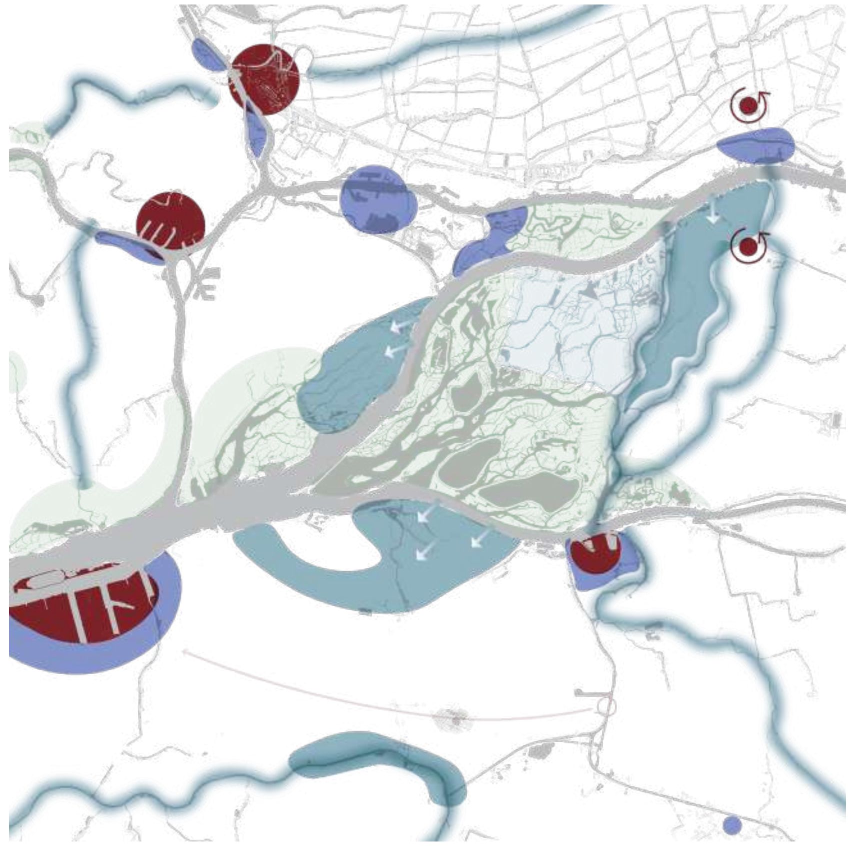
Phase 1 is focused on a circular industrial wastewater system. In the first place industries need to determine if they can have their own decentralised circular system or if they need to cooperate with other industries close by to create a clustered circular system. Industries need to determine what variation of the circular water system they need and start the construction of the elements needed to decouple their waste water system from the urban wastewater system. The goal is to have an obligated closed wastewater system for industries by 2040. This will complete phase 1.

Figure 7.8 Pilot project phase 2



Phase 2 is about complete decontamination of the river. While industries won't emit their pollutants into the surface water system anymore, the emission is not zero yet. In this phase non-sustainable industries will phase out, these are the industries that can not have a suitable closed wastewater system or are non-sustainable for other reasons and are going to disappear. Wetlands and other decontamination interventions will expand along the whole river basin, to keep decontaminating the whole river basin. This phase will end in 2060 when there is no more industrial water emission.

Figure 7.9 Pilot project phase 3



The third phase is focused on flood prevention and repurposing. If there is no industrial emission, wetlands around the industries are not needed anymore to clean the industrial waste water. These wetlands can be repurposed into recreational areas or other future needs, for example housing. Brownfields of phased out industries should also be repurposed in this phase. Flood prevention is a process that is already going on, to a lesser degree it happens in phase 1 en 2. Nevertheless the big expansion of flood plains and flood polders are planned in phase 3. The wetlands that are being repurposed can also be used for flood prevention or water storage in the future.

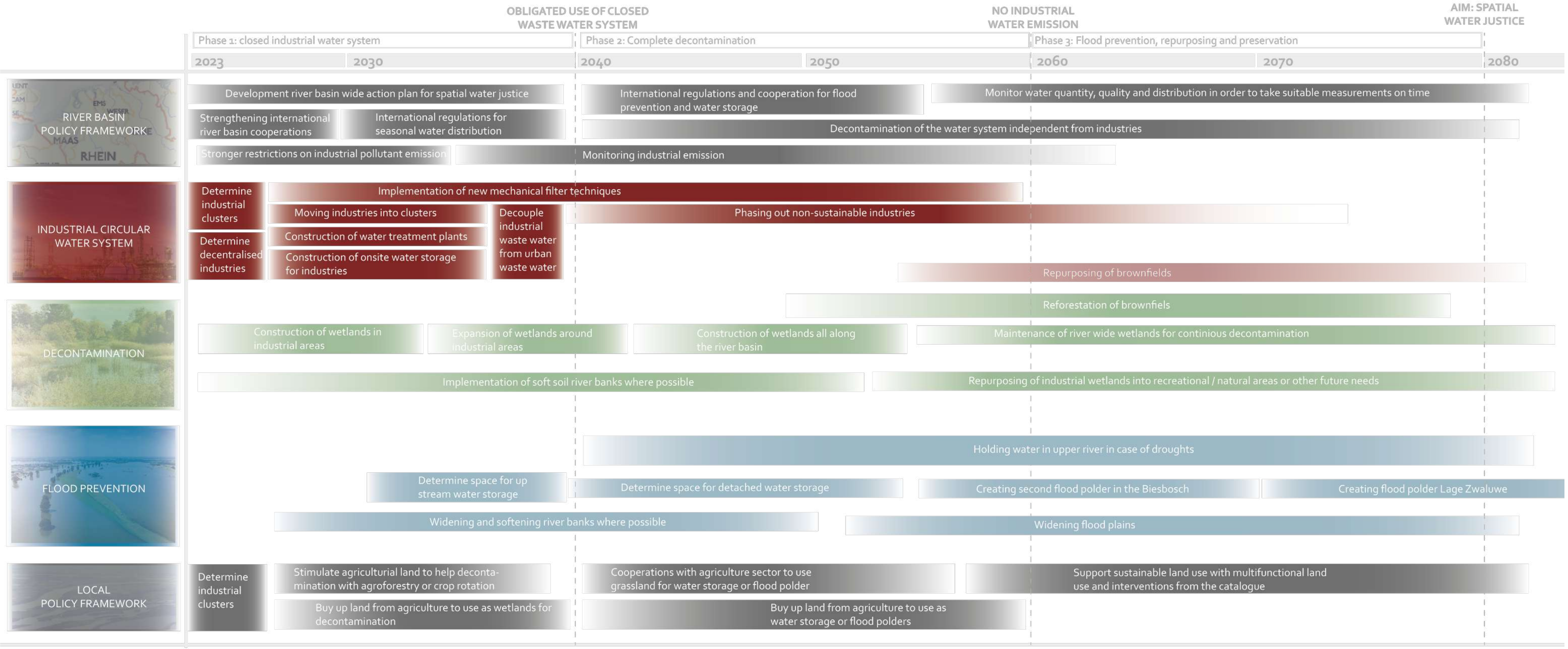


Figure 7.10 Pilot project total phasing

Policy Recommendations

Executive summary

To achieve the goal of spatial water justice there is a need for new policies and cooporations that support a healthy river landscape and phase out the industrial water emission. Overarching policies are crucial to start decontaminating the river system, because many individual actors are involved in the pollution process. Non-sustainable industries will phase out, while other industries will keep existing and polluting if nothing will be done. The supranational character of a river basin makes it more difficult to regulate what happens along the way. The Netherlands, as the downstream riparian country, suffers the most from the deterioration of the water quality, but should not be the only country taking measures to solve the problem.
A multilevel approach for the governance of the river basin is needed to achieve our goal of a healthy and just river landscape. Therefore supranational policies should be established. For the North West European delta, this will most likely be done by the European Union. On the other hand local policies are needed to implement the interventions. It can be concluded that the river basin level policies provide a framework towards our goal. While the local level policies guide the implementations towards our goal of a healthy and just river landscape.

Most important stakeholders on a river basin level

The most important stakeholders on a river basin level are the European Union, International Cooperations and the national governments. International Cooperations are river basin wide cooperations that can use their (political) influence to bring the importance of a clean river to the attention of policy makers. Two examples of such cooperations are the International Cooperation for Protection of the Rhine (ICPR) & RIWA. They use a bottom-up approach within their organisations. But lobby on a European level for a top-down approach to enforce rules and legislations to decontaminate the river system (RIWA Rijn, 2018). The European Union and the national governments are the main stakeholders making the laws & regulations regarding emission, decontamination & water distribution. This project needs some laws & regulations to achieve the goal of a complete healthy river system. Together these parties provide the framework for change.

Most important stakeholders on a local level

On a local level the most important stakeholders are the waterschappen, municipalities and land owners (including industries). They form the parties that implement the change. Therefore they all want to have some sort of cooperation, although they have different interests. Municipalities can provide room for the local stakeholders to voice concerns and create local policies together. Furthermore, they can combine the desires from local stakeholders and represent these when

discussing issues with higher levels of government and stakeholders. This results in a bottom up approach that takes the civil society and stakeholders with the lowest power as base.

Provinces are implementing the national policies and desires while also shaping a region specific plan. Here, the plans from municipalities meet the national ones. Provinces as a result become the link between top down and bottom up. Therefore, they should already be taken into account while making larger level policies.

Discussions of alternatives

In general there are two options to guide the change: Cooperations or laws & regulations. Laws & regulations are needed on either a European or national scale. We need laws & regulations to decrease the industrial water emission and force the industries into a circular water system. This can only be done with river basin wide rules and limits for industries.
Something that could be helpful to execute the laws & regulations is the incorporation of European wide waterschappen.

Cooperations can have different scales. There are already existing river basin wide organisations. To better connect these organisations with the legislative parties there will be a need for more international fora. On a fora, research about the water system can be shown and implemented and different associations can discuss and help each other to decontaminate the river system. There is also the need for new organisations, for example industrial clusters. The different industries cooperate within a cluster if they have a shared wetlands or shared water storage. We also need new cooperations regarding the interventions and land ownership. That is because there is a need for extra space, but also a scarcity of land. Ideally sustainable land use will be used to give a piece of land multiple functions. This way land can keep its economic function while also contributing to the decontamination of the river water system.

Policy Recommendation

To achieve our goal we need a few laws & regulations on the European scale. By 2040 all industries should be separated from the urban waste water system and have onsite water treatment. It should be required by law that all industries have a circular water system for themself. Secondly the European Union should make more strict laws and regulations for industrial emission. By 2060 we want to achieve a zero water emission policy so no industries pollute the water. Consequently, non-sustainable industries that can not have a closed water system and stop their emission are going to disappear. An action plan towards these deadlines can be provided by the European Union in cooperation with the international river basin associations. The targets and laws should be set by the European Commission.

Most of the space we need for the decontamination process or water storage is currently agricultural land. In areas with much resistance from the agricultural sector, there must be alternatives possible to reduce the local emissions from farmers and use their land to contribute to decontamination. This can be achieved through new types of farming. Farming such as agroforestry and crop rotation can be implemented.

Agroforestry is the Combination of agriculture with forestry. This can help create more biodiversity and retain more water. Agroforestry can be implemented in different variants: Alley cropping, where between rows of trees, crops are grown; forest farming, where trees provide shade for crops while also growing fruits and nuts themselves; silvo pastures is the combination of pastures with trees. In each form, trees can be used as a source for timber alongside providing shade and regulating moisture contents and ground water. Closer to rivers, implementation of agro forestry can create new riparian areas with trees and shrubs that filter the runoff from farming activities (USDA,n.d).

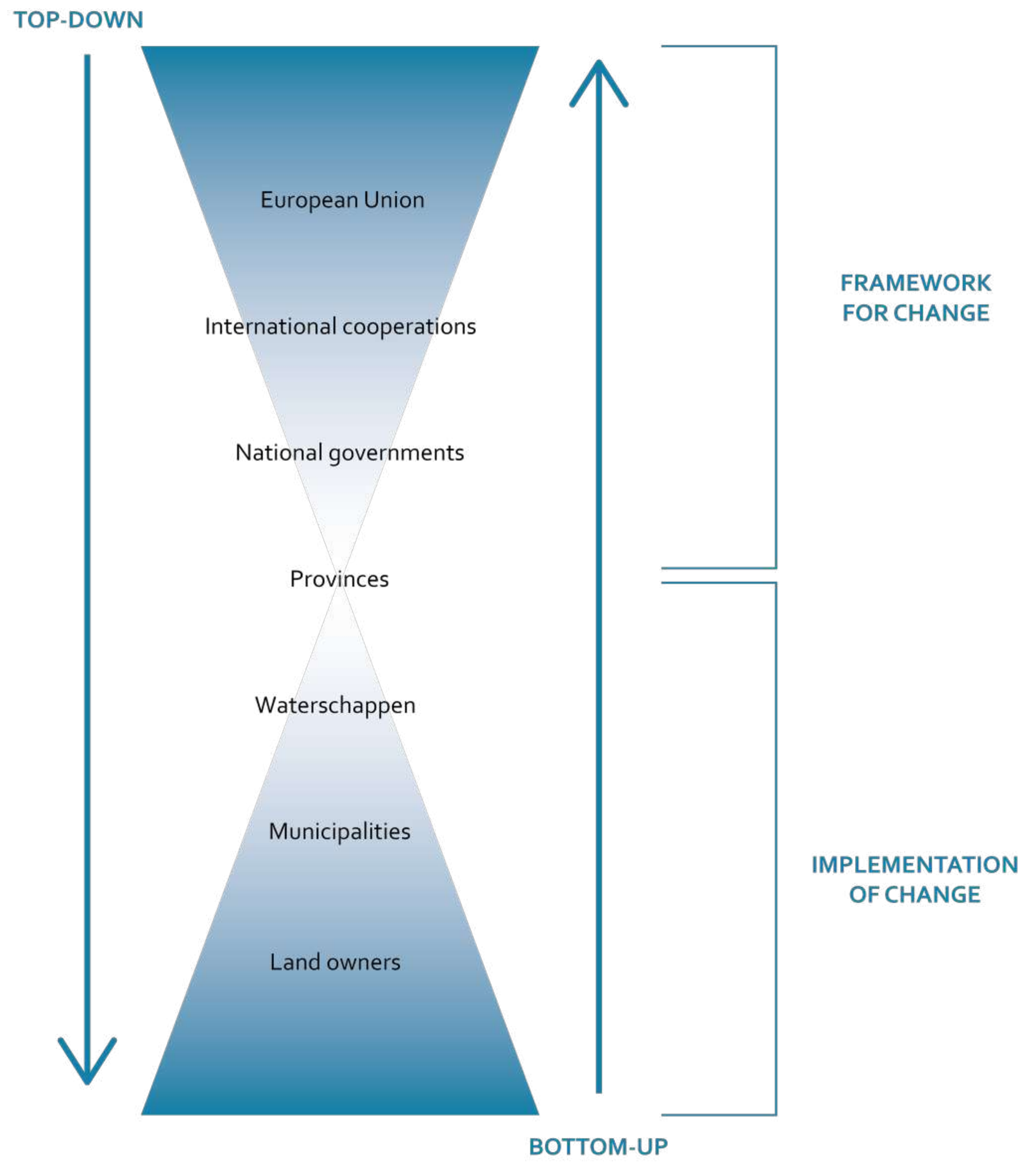
Next to agroforestry, crop rotation is an option. This can yield benefits in soil structure. More macro pores improve water filtration, leading to more retention. Improved soil structure decreases the amount of runoff into surface water, removing contaminants at the source (Tirlan Farm life, 2017).

These options for farming alternatives can be implemented in later phases when less wetlands are needed for decontamination. Using these ensures that no new pollutants get added back into the water system.

REFLECTION ON THE MANUAL

It is important to note that the strategy is made for a small area within the entire river basin. While interventions are used based on the manual, landscape fit and stakeholders, the question arises if this approach works for other areas. The landscape fit itself uses the interventions and elements of landscape that can be quantified. In this sense, the manual can be implemented along the entire basin. When looking at the stakeholders, it is clear that stakeholders in the confluence area can vary from those in the middle river valley. As the specific stakeholders are not researched for each landscape, there are multiple uncertainties from the manual. The Netherlands have a structure of government and policy making that allows quicker bottom up approaches and backcasting. The manual and stakeholder analysis do not provide enough information about policy structures in Germany, Belgium and Switzerland. These countries and the regions the river flows through might have different approaches to policy making. Researching the stakeholders further in depth is a step that the manual can be expanded on. This can be done through a territory map or other means. The manners used for the strategy map made for the confluence are in no way fixed.

Figure 7.11 Policy diagramme



CHAPTER 8

CONCLUSION

EVALUATION AND REFLECTION

This chapter is the conclusion and reflections of the strategic regional design for the North West European river delta. First we conclude the project. Secondly we individually reflect on the project and project process.

Concluding...

The aim of this chapter is to summarise the goal of this report and mention the main findings. These will be discussed on how they contribute to public goods, broader research as well as where future research is needed.

The main goal of this report was to answer the question "How can sustainable land use of riverside industrial areas create a healthy and just river landscape in the north west european river delta?" This question itself consists of several important concepts that have been defined and discussed in chapter I, II & III. The first concept was that of sustainable land use. This was defined as a restructuring of land use through policies and spatial design to achieve a multifunctional land use that benefits inter- and intragenerational equity. Within the framework of water, this concept focuses more on the use and distribution of water. This concept formed the means with which "a healthy and just river landscape" is achieved. The definition of a healthy river landscape in this project is a river basin with high water quality, sufficient water quantity and fair water distribution. Focussing more on spatial justice surrounding water, three main elements flowed from the research. These were, water quality, quantity and distribution.

These three concepts form the basis to achieve spatial water justice. For each of these concepts, a principle linked to sustainable land use was chosen. Linked to water quality, decontamination is the principle where the aim is to improve water quality while also retaining water, thus improving water quantity as well. Circular water systems provide additional improvement to water quality, as different sources of wastewater no longer get mixed. Creating separate systems for industries and urban areas allows more availability of water as each system becomes its own loop. The final main principal is linked to water distribution and quantity. This is that of flood prevention. Here the prevention of floods and storage of peak period water allows a constant supply of water.

After linking three principles of sustainable land use to spatial water justice, a set of interventions are created which can be implemented along the river basin depending on local situations of land but also of stakeholders. This already illustrated how the design made in this project can help create a more healthy and just river landscape. The use of a catalogue of interventions and a subsequent manual on how to use the interventions combine the elements of sustainable land use into several spatial interventions. Implementing the catalogue and manual on a pilot project illustrated further how an initial top down approach through the catalogue can be used through bottom up on local levels. Having stakeholders taken into account from the start of the catalogue already makes certain that the implementation of interventions takes into account needs and desires from stakeholders, creating a more just approach.

While the design itself incorporates a healthy river landscape, several social benefits flow forth from the design. These are a result of the fact that plans have the most success when they meet the needs of users and are beneficial on multiple aspects. With every project there should be a discussion that goes beyond yields versus costs. Many values of a project cannot possibly be solely expressed in money. The goal of this project is to contribute to spatial water justice. And the measurements prompted to achieve this goal all have an environmental element. Therefore it is useful to look into ecosystem services.

Ecosystem services are environmental systems that provide services for humankind. The Wageningen University & Research (2023) defines four types: the provision of a product, a regulatory authority, a cultural service or a service that supports the other services. The first one is the type of service that provides humans with resources, like wood. The second is a service that enables cycles to function, like reproduction. The third one incorporates the human perception of the environment and the emotional and mental connection that humans have with the environment, such as the recognised beauty of nature. The fourth service supports the other services with necessary elements, like the water cycle.

The implementation of wetlands as natural water purification systems has been done before and was rarely considered profitable (Wiegleb et al., 2017), but it is the combination of these wetlands with the ecosystem services that are met in this project that make their implementation a viable option. The healthy river landscape that we envision clearly brings socio-economic improvement in the long term. People can benefit a lot from a healthy river landscape, for instance in personal health, recreation and cultural belonging. Sustainable land use implies that society can remain using resources without over-exploiting the environment and thus ensure resources for future generations. Eventually industries, which primarily have economic purposes, profit from sustainability since society bases its actions on moral, cultural and economic values and in the end the industries depend on the needs and demands of society. These moral and cultural values also include the preservation of the ecosystem services (Denny, 1994).

The moral values dominantly emanate from care ethics. As human beings with a lot of technological power we have the moral duty to care for our environment and others, now and in the future. Care ethics concern the duty of caring as well as the assessment of people of how the care should be established. The assessment is based on the context and fairness in the relationship between the caring one and the one cared for (Burton & Dunn, n.d.). Denny (1994) divides the assessment of human care for the environment in multiple arguments. The first one is precautionary: we are not sure about the outcomes of the way we treat the environment, so it is wise to be cautious. Ensuing is the moral and indicative argument: humans are in power to influence the future of the planet and they are enabled to anticipate by indications from the environment, like global warming. Finally, there are aesthetic, cultural and economic arguments: people's relationship with their environment is strongly connected to aesthetic, cultural and economic value and therefore they should be cared for.

A healthy river landscape provides for all of these arguments. There is precaution, because external factors, such as pollution and flooding, are diminished. There is morality, because the interventions are argued by indications that the current status quo is harmful to the future and that action is needed. And lastly, the aesthetic, cultural and economic values are taken into consideration by the preservation of beauty, recreation, culture, health, safety and sustainable economy that a healthy river landscape enables.

Discussion

This report adds to existing research by combining several broadly defined concepts such as Sustainable land use and spatial justice and linking them to issues concerning water quality, quantity and distribution. Furthermore, the incorporation of both decontamination and flood prevention within sustainable land use expands on "Room for the river". Instead of creating monofunctional lands, multifunctionality is increased both through the interventions and policy framework. This combination of elements can form a basis for future research that wants to focus on water pollution issues. Nevertheless, this report has some points that need to be expanded in future research. Firstly, the manual is limited in the research of stakeholder interests. The main issue here is the uncertainty of political stakeholders within the Netherlands. Aside from that, stakeholder structures outside of the Netherlands are taken less into account. Sections of the river basin located in Germany or France might have a different structure of stakeholder participation. Instead of the mixed approach illustrated in the manual, there might be a fully top down or completely bottom up. Secondly, the use of wetlands, while important for decontamination, can also be uncertain. The creation of wetlands is dependent on both human participation as natural developments. Further research can dive into the exact creation of wetlands to make sure that they are successful. While these issues are limits, the report itself provides a good basis for anyone interested in a healthy and just river landscape.

INDIVIDUAL REFLECTION

JINGYI CHEN

ON THE MEANING OF REGIONAL PLANNING

More complex issues, communicative cooperation, more macroscopic perspectives, more abstract solutions.

About our topic

A surprising finding in the process of research is that the actions against water pollution in Europe are rarely mentioned, especially in the South Holland region, where the majority of water-related projects are flood prevention, construction of dykes, and reclamation of land. However, industrial development throughout the years has polluted rivers, which is contrary to the sustainable development advocated today. Therefore, we initially chose the theme of water pollution, while including the topics of rational allocation of resources, socio-spatial justice, and enhancing water quality in several different directions. But as the process deepened, it was recognized that solving water pollution is very complicated, involving the interests of many companies, the habits of local people, and the integration with flood control projects. What we have been able to do so far is also very idealistic, so it is called a pilotproject, which is probably just an experimental project.

About interventions

Since essentially all of the treatment used in decontamination is landscape, more forests and wetlands need to be created, which requires higher maintenance costs as well as the potential for land use conflicts and economic benefits to be lost when implementing these strategies. Therefore after the first step, the benefits of greenland should also be realized. Perhaps other features of green space could be explored.In the case of flood protection we have mainly considered delta areas, such as widening of dykes and lowland buffer strips, while actions for Germany and other countries have not been mentioned.Industry-related measures are universal, it's also interesting to see if the future model of plant operation will be more sustainable. For example, can plants achieve a self-balancing of pollution emissions and purification, a balance between economic and natural benefits.In conclusion, our manual of interventions is currently only a preliminary version of our thinking, and more details can be added.

About the public issues

The first point is that on a larger regional scale, there is a large gap in policy and cooperation at the national level, with separate regional approaches to industrial pollution emissions. Therefore, to achieve the goal of healthy and just river landscapes, it is necessary to develop policies between countries, and it is up to us urban planners to coordinate the different stakeholders. Considering a long-term benefit should be the main topic for many years to come.Secondly, at a smaller local scale, the most relevant argument when implementing our interventions is the proper distribution of resources. To create new systems, land use needs to be changed first, such as cropland into wetlands and factories into brownfields, while local interests do not always hold a supportive view. But only by changing the status quo can we gain more benefits and build a more sustainable society. Ideally, it may be possible to achieve cooperation by compensating different stakeholders, if necessary by setting up new laws and regulations to enforce them.

About the cooperation

What I have improved the most during this term is learning to communicate. In the beginning, due to the barrier of second language and poor background related to Eu industry and river governance, I rarely put forward my opinions and more often chose to listen, which would make my teammates feel less involved. After receiving the comments mid-term, I made an effort to give more ideas and learned to actively express what I was good at and what tasks I would prefer to take on in the team.I really realized what an effective teamwork can really accomplish. In previous teams, we usually agreed on what each person would be responsible for, and then did our own thing. But in the end, the collaborative work was simply a matter of putting together what each person had done, with all the individual characteristics too obvious. This makes collaboration useless and it feels like someone is just doing more stuff. But in this project, my teammates were very active in communicating with each other, looking at one another's work and giving feedback in time, making sure that our whole project was integrated and none of the parts were too personal. This made the project more complete and smooth.

INDIVIDUAL REFLECTION

JORIAN HULST

ON RESEARCH AND DESIGN IN A GROUP PROJECT

The relationship between research and design in our group project had changing shapes. I think there was a re-circling around the research that we did to the design and then going back to more in-depth research to elaborate on the design. In this project we made a lot of steps made on educated guesses. With these guesses we proposed design to later discover that some elements needed re-design or further elaboration to make the elements clear. I seems to me that along the weeks we dug deeper into information that filled the body of the project. That also means that some parts had to be revisited. A good example of this is the functioning of wetlands.

This is a main topic in our project, so it was necessary for us to know how they actually work. The first information about the wetland systems came from a pilot project that did not give much information about the wetland itself, so to proceed we made some assumptions about how the wetland functions in the system. Not all of them turned out to be true after doing more thorough research. Without notice, some miscommunication came into the group, that incidentally disturbed the group process, because of the misunderstanding about wetlands. In the end the strategy did not have to be much adjusted after the new information and it actually strengthened the implementation of the wetlands.

This project is a regional design. I think that such projects sometimes lack a little elaboration. In most parts this is because the story line has priority over information. This is logical because the reader should be able to understand what the researcher is trying to convey, but on the other hand it can be a pitfall to not fully investigate the dynamics in a project. The research in a project should be coherent but at the same time comprehensive. I think it is also an aim of the researcher to convince the reader of their knowledge. After all, a design has a better position in the discussion, when its aspects are well-argued and its flaws are eliminated, enabled by thorough research.

Another aspect specific to a group project is that the group members should make an effort to make everyone aware of new knowledge, so that all members can make decisions that are based on good argumentation. If one group member lacks information that is necessary for new steps to take, this might mean that the efficiency of the group work decreases. I think that this group has been able to eliminate most of the times by having group discussions and updates regularly. If a discussion could not be solved, it would be suspended and the group members would have given tasks to be able to enhance the argumentation in the discussion. This led to easier decision-making.

INDIVIDUAL REFLECTION

LIEKE VAN LUN

ON THE ROLE OF A VISION IN STRATEGYMAKING

The first thing that stood out to me during this course was the complexity of regional design. In the first few lectures we were introduced to a variety of topics that can be addressed on the regional scale and the complexity of these topics in relation to each other. Consequently it took us a few brainstorm sessions to figure out what we were going to do with our theme regarding water. There are many possibilities and they are all related to each other as water spreads so easily through our countries, oceans and seas. Narrowing down our theme was one of the first difficult tasks to do and we had to be really careful to not broaden the topic too far. In this stage of the project I learned a lot about group work and balancing everyone's opinion.

This was a stage of the project I really enjoyed because it gave me many new ideas on how to approach this project (or any design task). The group work provided the opportunity to discuss different ideas and reflect on the best outcome. Something I individually do not always do in depth, as I get impatient rather quickly. Establishing a strong problem statement made it a lot easier to switch to a vision. I feel like forming and shaping the problem and vision were the most difficult tasks in our group project. Mainly because it involves a lot of managing of the group process. Managing the group process was something that we could have done better in the end. We did not divide roles for most of our process, although it was really enjoyable to use everyone's strengths and switch between roles, it also made the process somewhat chaotic.

Nevertheless it was in this chaotic process when the value of a strong and coherent vision became clear to me. Our vision together with our conceptual framework became important red threads throughout the process. Once we had a strong conceptual framework and vision the strategy just came naturally and was established within no time. Looking back it made me realise the importance of a common vision to achieve the goal of a team assignment. This was also made clear in the lecture about Strategy Making by Verena Balz (Balz, 2023). We established a clear plan to put our wider goals into practice and guide the change we envision.

Concluding this project I gained a lot of new knowledge about the complexity of regional planning and the role and relations that planners have in this spiderweb of stakeholders. Moreover I gained valuable insight in my own characteristics in a group process that are helpful for the rest of my career.

INDIVIDUAL REFLECTION

NIEK LURLING

ON GOVERNANCE ASPECTS IN PLANNING AND DESIGN

In which way is the governance aspect embedded in the planning and design proposal of your group project and what are the reasons for this embedding?

The governance and planning of waterbodies and waterways is notoriously difficult. Aquatic systems more often than not disregard administrative boundaries, thus falling under various or overlapping jurisdictions, and form integrated systems through scales and time that do not necessarily mirror established institutions. Moreover, interstate waterways (such as the Rhine) are governed largely by complex international arrangements, and in this complexity quite often delegate governance to private sector ("self-regulating") or civil society actors. Indeed, the argument could be made that in outer seas - outside of national jurisdiction - non-state actors such as private companies, or civil societies and conventions excercise nearly all governance. Top-down design and planning is a difficult method in this context.

In our project, 'Reviving Rivers', we aim to have our proposed *project guide* overcome this complexity of governance by introducing a stakeholder-strategy early on - working with the constellation of stakeholders almost identically as one would work with an analysed landscape; we introduce a "stakeholder-landscape", so to say, from a territorial perspective. As a result, a common thread throughout the report is the equal status of specific spatial characteristics and actor characteristics in analyses, listings, text, etc.

Apart from creating a model that makes the governance and planning complexity easier to grasp and more manageable, early stakeholder involvement has more advantages. Projects are seen as more legitimate by the public and will probably meet less public resistance as a result. Additionally, projects are more feasible, as the constraints of actors that ought to provide needed capital (in the broad sense of the word: monetary, political, etc.) are taken into account with the same seriousness as the physical geography.

A catch to this strategy is one inherent to any strategy that does not exclusively take the physical environment as concern: the possibility of sub-optimal, or seemingly illogical, allocation of land uses. Not using the most fertile soil for agriculture because major actors oppose to this function, for example. This effect might counteract advantages described above, as *seemingly* illogical plans are hard to sell to the public. Also, this effect increases over time, as actors are more susceptible to change than landscapes: mountains rarely go bankrupt, rivers seldom change their political opinion radically and the subsurface does not often migrate for economic reasons, but actors frequently do. Placing this critique into a wider context, however, it can be argued that the criteria of "(most) efficient allocation" is very context-sensitive of our current socio-economical system. Maybe, this criteria changes sooner than the stakeholder constellation.

INDIVIDUAL REFLECTION

WOUTER NOUWENS

ON RESEARCH AND DESIGN IN A GROUP PROJECT

What is the relationship between research and design in your group project?

Within the group, the relationship between research and design often became a complex one. During the analysis section, the focus lay almost entirely on research, design here was merely done through rough sketching of maps or ideas that helped us understand the research more. It was more during the vision making that research and design started becoming linked. Principles and concepts that were discovered during the analysis, were placed in spatial contexts to see how they would look. This was done in diagrammatic sections but also through quick collages in both bird's eye view and ground level. Using design in this stage also helped with filling gaps in the research. Finding out that one concept did not work in a collage or was not fully clear yet led to further research. This interplay of research and design was further expanded in the making of the vision map and panel diagram. Data used in the research of point polluters was refined further to find places with higher concentration of industries and solitary ones. Using this information, an abstraction of industrial points became a layer of the vision map. The same manner of research was used for subsequent layers. During the strategy phase, the relationship between research and design was reversed. Sketching and ideation through diagrams led to some concepts of spatial interventions. While these were interesting, some research was needed. In summary, the relationship between research and design in our group was at often times a very strict hierarchy where results from research led to a design, but other times, design helped find gaps within research.

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REVIVING

Regenerative decontamination design for industries in the N.W.E DELTA region

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