DYNAMIC RIVERSCAPES

A vision for inhabitable, sustainable floodplains.
The case of Huissensche Waard.

Kallirroi Taroudaki
MSc graduation thesis

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TU Delft Faculty of Architecture
Department of Urbanism - Chair of Landscape Architecture

MSc Graduation Thesis

Graduation Studio
Flowscapes

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LANDSCAPE ARCHITECTURE

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My patient supporter Giorgos, for following this journey next to me, despite the distance.

Last but not least, I would like to thank the amazing landscape family and all my greek and international friends for making these two years in Delft an incredible experience and a huge life lesson.

Floodplains, Westervoort (Source: Author)

Being a Greek student of landscape architecture in the Netherlands I was from the beginning fascinated by the Dutch landscape and the differences that it presented, compared to the type of landscapes I was used to. The surprise and excitement of the first days, though, gradually turned into questions of understanding these new areas.

This is an image that striked me the most. I was wondering why this huge piece of land is all the same - a green "carpet" of grassland and agriculture with no other functions. A vast-flat area where nobody really walks in.

During my studies at TU Delft I learned that this landscape is part of the riparian zone of the river landscape, responsible for accomodating the excess water of rivers during extreme water events. But then where is the river? To me, a river is a dynamic element, characterized by flows but this area seems very static. And why are cities turning their back to it?

Being trigured by all these questions, I decided to investigate more on the Dutch river landscape and formulate my graduation project in order to find the answers.

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01 INTRODUCTION

THE DUTCH RIVER LANDSCAPE

The Netherlands is a country with about two thirds of the total land located below sea level and thus being vulnerable to flooding. In addition, major rivers (like the Rhine and the Maas) flow through the country transporting large quantities of water, while there is also excess precipitation increasing the amount of water that needs to be drained. Because of these conditions, flood control has always been a crucial aspect of the Dutch policy and culture, in order for the land to be available and safe for habitation and production.

Water supply and distribution in the Netherlands

Water system of the Netherlands

source: http://www.chrisvankeulen.nl/ijkdoorbraak1754d.jpg

Flooding is an important issue for the dutch policy and culture, depicted in paintings, poems, songs etc.

source: http://www.chrisvankeulen.nl/;iemerswaterplaag2.jpg

source: http://rsta.royalsocietypublishing.org/content/roypta/363/1831/1271/F8.large.jpg

Water, Why

[English approximation of the lyrics of a song sung in Dutch]

For centuries a land of water,
A lowland full of rivers.
Oh banks would flood from time to time,
We took it in our stride.

But now the old dikes are giving way,
They cannot bear the load.
Buffeted by giant waves
That cannot be controlled.

And all the people rush to pack,
Stuff precious things in cases.
They have to leave their homes behind,
Their hearts are full of pain.

Not knowing what will happen, it takes so long,
It's hard to lose the place where you belong.
And how should you get through it?
Just how should you get through it?

For it may take many weeks,
Uncertain, anxious weeks
Before they can go home.
And what's waiting for them there?
Yes, what's waiting for them there?
It's a fight we have to win,
But how should we begin?
The water's at the door, it rises more and more

The water's crashing on the dikes,
There's no place left to reach them.
You can only stand and look,
As all your precious things are drowned.

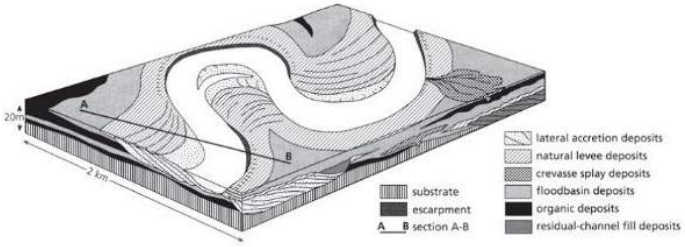
You see the pictures in your mind,
The chaos waiting at the end.
You hope the sun will start to shine,
The land light up with sunshine,
And the water will go down, go down.

And so I count the long cold days
And hope that they will end.
I feel so close to those who just don't know,
Don't know what they will see when they go home
You just count the long days
You count the long cold days
But you want it to end,
You just want it to end.

The Dutch popsinger Marco Borsato performed this song during the national fundraising campaign during the dangerously high water levels of 1993, which almost culminated in disaster.

RIVER AND FLOODPLAIN DEVELOPMENT

The river landscape was firstly formed by the natural dynamic processes and the first inhabitants were actually following the land formations, choosing the already higher grounds (levees) for their settlements, or building higher grounds (mounds) to keep their dwellings safe from water. The river was a profitable environment to settle, for transportation reasons and because of the fertile grounds that it offered.



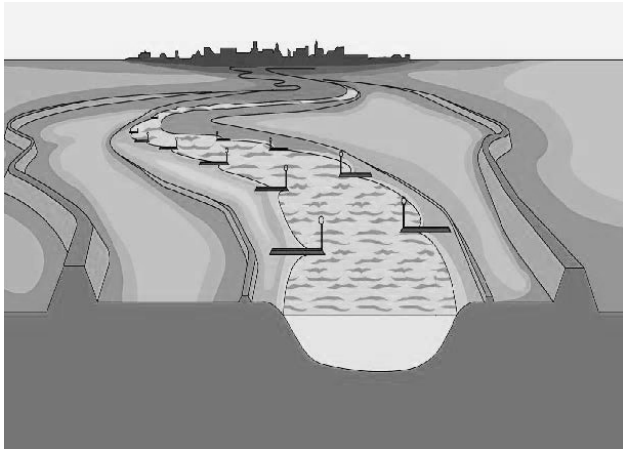
Scheme of a naturally formed river (source: Arnoldussen, S. (2008), A Living Landscape. Bronze Age settlement sites in the Dutch river area (c. 2000-800 BC), p. 34)

Later, because of population growth and the need for greater building capacity and more productive land, human interventions started to transform the river landscape, developing gradually a more concrete flood defense system that resulted in an altered river landscape of restricted space.

"From the nineteenth century onwards, complete river systems became controlled by human action in favor of economic growth". (Nijhuis and Jauslin, 2015, p.15) . The river courses were altered and less meandering, while the floodplains turned from natural areas influenced by the water flow, to large pieces of monofunctional land (with mainly or only agricultural use), as a result of an agrarian spirit that developed also during the 19th century. In addition, the dikes formed large barriers in the landscape, separating these riparian zones from the rest of the urban fabric and in most cases isolating people from the river landscape, in contrast to what was happening in the past.

Because of the limited space that the rivers were given to operate, the natural processes have also been altered (water flow, water levels etc), and they will continue to change due to the ongoing and further expected climate change conditions. A vicious circle is thus created, where the flood defense system imposed on the riverscape results in greater flooding risk, and the need for stronger defenses.

We understand that this shift in engineering the river systems and providing technical solutions for the challenge of flooding, resulted in neglecting the natural landscape and defending the natural processes.



Section of an engineered river, with summer dike, winter dike and groynes. (source: http://cfile10.uf.tistory.com/image/263E5B4F54C82AEE32DE1C)

Earliest river inhabitants on elevated former rivers channels

Forest in floodplains

10th c.

12th-13th c.

Dike construction for reclaiming land

↓

Reduced water capacity in floodplains

↓

Dikes increase in height and number

Most of the forest on floodplains was gone

16th c.

19th c.

Technological improvements, strategy resisting water

With summer dikes we have enhanced silting

Channels straightened (reduced width for shipping routes)

Pollution

Break in flood chain and species dissapeared

vicious circle

Agrarian spirit

Economic importance of area behind the dikes

1953

Severe flood in Dutch coast - 1800 people lost their lives

Delta Plan

Slower river discharge from rivers to North Sea

Accumulation of sediments-

Need for higher river dikes

More space for rivers

Focus on natural development of floodplains

Today

Timeline of river and floodplain development through the years. The river landsacpe has been transformed by a mutual relation between natural processes and human intervnetions, as response to these processes.

Recently, it has become clear that this approach of defending the water processes and perceiving water as an enemy cannot be an effective strategy anymore. Some approaches and projects developed towards the direction of giving more space to the river, like the Plan Ooievaar and the Room for the River.

Plan Ooievaar was the winning entry of the 'Eo Wijers' competition in 1985, proposing a new structure and water management strategy for the Dutch river landscape. It proposed a design strategy for the Rhine and Meuse river area on a regional scale, with new interrelations between the natural dynamics of a river system, the resulting visual expression and the land use. It was focused on nature, including river influenced woodlands (ooibos), faunal components, agricultural development, extraction of minerals etc.

In this coherent framework of self-regulating natural processes, also exceptional forms of recreation within the floodplains were made possible.

The effect of plan Ooievaar (source: De Bruin, D. et al (1987), Ooievaar. De toekomst van het rivierengebied, p. 90)

Plan Ooievaar, plan for the river area near the cities Arnhem (top right) and Nijmegen (bottom right), 1987 (source: De Bruin, D. et al (1987), Ooievaar. De toekomst van het rivierengebied, p. 24)

The Room for the River directive was passed in 1996 in response to the floods of 1993 and signaled a shift in the policy paradigm. This policy called for the integration of spatial planning and water management and recognized the need to consider ecological and social factors as well as economic factors when developing the floodplains. (Wolsink, 2006, V&W, 1996)

Major provisions in the Room for the River are the following:

1. New developments (housing, buildings, obstructing infrastructure) in the floodplains are no longer allowed; this also holds for expanding existing buildings.

2. Water embankments and the zones they are protecting will be assigned a land use. Land that is part of a winter bed will be assigned to public works. In the case of more than one land use assignment, the principal land use is to protect against high water.

3. A system of construction permits is needed for all activities that may hinder the draining of water or may cause a decrease in water storage capacity.

Room for the river project areas (source: https://drogevoeten.files.wordpress.com/2010/11/screen-shot-2010-11-05-at-5-00-55-pm.png)

Room for the River principles

Move dike inland

Deepening of river bed

Reduce height of groynes

Water storage

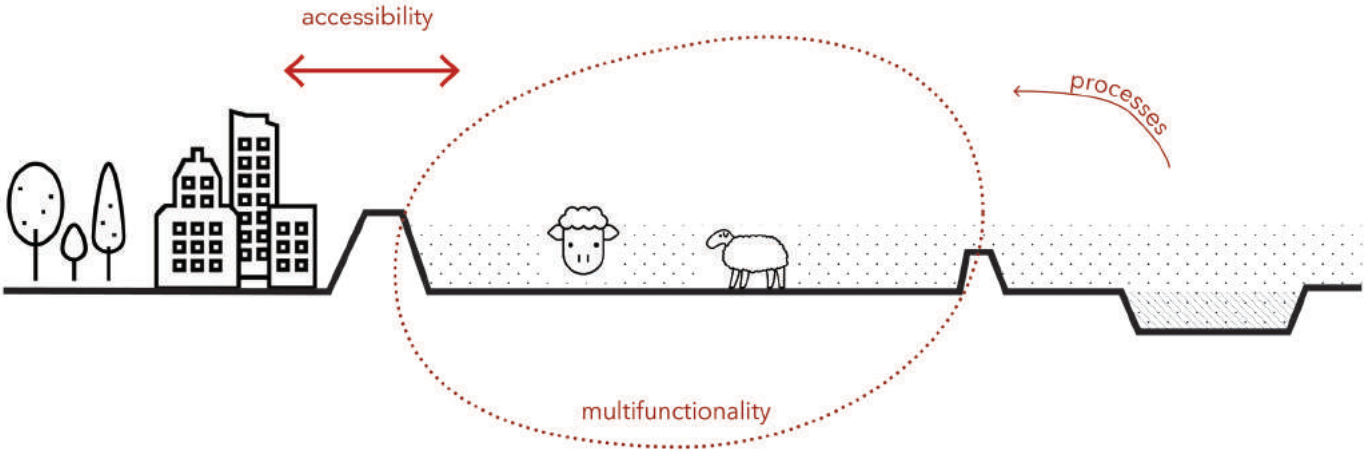
Secondary channels & green rivers

Some of the Room for the River principles, however, remain quite technical (like lowering the floodplains or moving the dikes inland) and design interventions vary from one location to the other, while as we can see it has quite a few restrictions on land use and functions.

We realize that there is already a trend in shifting the tradition of engineering the river landscape into a different way of designing the floodplains and respecting the landscape. Although some areas have already been transformed giving more space to water, the focus still remains usually on nature and recreation, while other functions, like housing, are restricted, as part of the Room for the River principles as well.

A big part of the river floodplains today are large monofunctional areas of mainly (or only) agricultural use while the dikes of the Dutch defense system form strong borders between the urban fabric and the river landscape, allowing little to no interaction between them.

Keeping in mind that with climate change the flood problem will probably become more severe in the future and floodplains should be able to accommodate more water, finding more flexible and integrative solutions for these areas is important. How can we embrace the natural processes and turn these monofunctional areas into multifunctional sustainable landscapes of combined functions that will allow people to engage more actively?



The potentials of the floodplains and the river landscape can be many. Water storage, water purification, renewable energy plants (like wind turbines) are some examples. However, these functions do not really link people to the river landscape in terms of experience. But what if people could live in such an environment? If a new, unique living environment could be created in the floodplains, taking into account the challenges of the area but also embracing its qualities? This would also be a solution for extending cities without restricting the river dynamics and engineering the landscape, as it was happening by now. Of course, talking about people, we should not forget about nature. This environment is habitat for many flora and fauna species which should be respected. Having all the aforementioned in mind, I decided that the two basic functions that I would like to address in the project are the creation of a new living environment together with the enhancement of nature.

source: goo.gl/bv0kDh

source: goo.gl/L3ZVu1

source: goo.gl/UlCmEz

The objective of this project is to use the potentials of the natural river processes (inundation, sedimentation) as a condition for the creation of a multifunctional and sustainable landscape, focusing on a new living environment in the floodplains and allowing for more interaction between the two sides of the dike.

1. What are the potentials and restrictions of the special context of the floodplains and how has the current situation been formed?

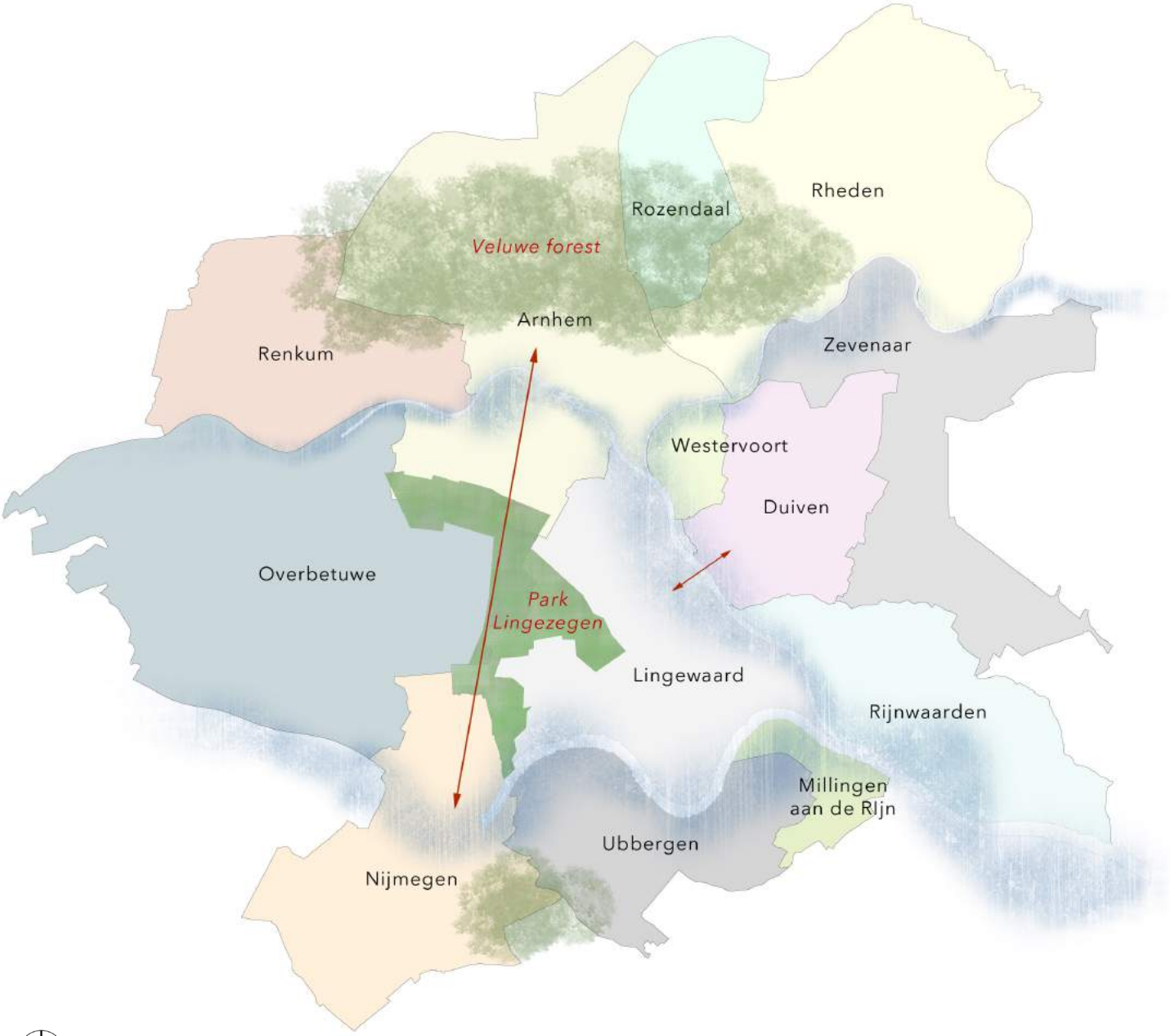
2. What kind of mechanisms can be developed to utilize the potentials of natural processes in creating conditions for other functions?

3. How can a new living environment be in balance with nature, natural processes and flooding, given the tension between processes and forms?

4. How is this interrelated mosaic beneficial in all scales, from local to regional?

Flood risk management is essential in the Netherlands and the floodplains are quite sensitive areas with several restrictions. In this graduation project I want to research how we can embrace what nature gives us instead of defending it, and turn the risk into an opportunity of being more creative in the designing of floodplains. I want to prove that the potential of the natural processes in such a special area can be a condition for a new way of thinking and living. And that the most restricted functions, like housing, can be functional if they are designed in a sustainable way, taking advantage of the conditions of the landscape or even creating conditions themselves to benefit the landscape. This way, the experience of the riverscape by people can be achieved in multiple levels, not only recreational but also practical. A landscape architect can think through all scales and create spaces beneficial both for people and nature. In this project, through research by design a new multifunctional and sustainable landscape in the floodplains will be explored and proposed.

02 PROJECT AREA


Rheden
Rozendaal
Veluwe forest
Arnhem
Renkum
Zevenaar
Westervoort
Duiven
Overbetuwe
Park
Lingezegen
Lingewaard
Rijnwaarden
Millingen
aan de Rijn
Ubbergen
Nijmegen

Selection

To explore my research objective I chose *Huissensche Waard* as a test case, the floodplains of the Pannerdensh canal and the Nedderijn, in Arnhem-Nijmegen region.

The area is situated at the entrance of the Rhine river in the Netherlands, where the river splits into the Waal and the Pannerdensch kanaal, and from there it continues as the Nederrijn and the Ijssel. As an upstream location for the Dutch riverscape, it is quite important and projects have already been realized in the floodplains, for example the Stadsblokken-Meinerswijk park and the Gelderse Poort area. Because of the growing urbanization in Arnhem extending till Arnhem South, there has been the need to connect the two big cities -Arnhem and Nijmegen- instead of leaving them operate as two different poles. Although for the specific location there are plans for sand extraction in in the near future that will allow more space for the water as well, nowadays it remains a missing "link" in terms of ecology but also in its relation to the cities and villages, some of them with historical importance.

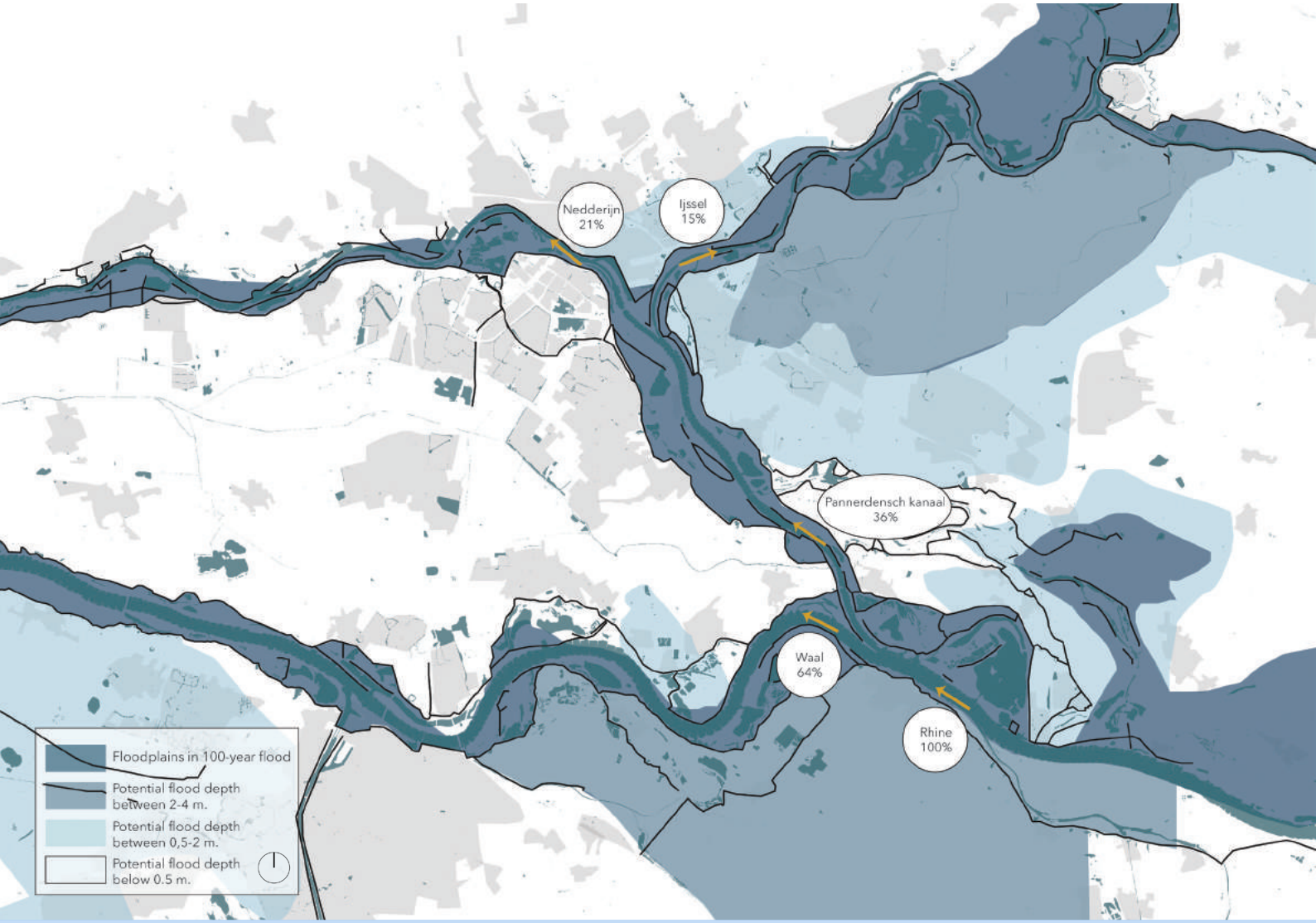
This area, therefore, combines natural and cultural layers and the project can be an opportunity not only to investigate the design of more integrative floodplains but also to become a reference point for the area, in relation to the surrounding cities, villages and already implemented projects.

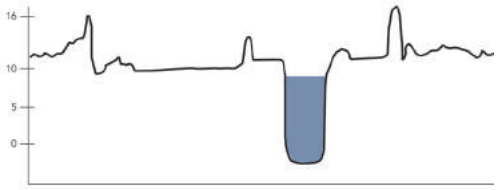
Analysis

To get an understanting of the area I started with literature review and desk study. Firstly, I worked on the regional scale, focusing on five different layers: Natural processes (water, sedimentation), the palimpsest of the landscape (history and culture), land use, connectivity-accessibility and nature. Then I zoomed in to my specific intervention area, where I also dig deeper into more spatial and social characteristics.

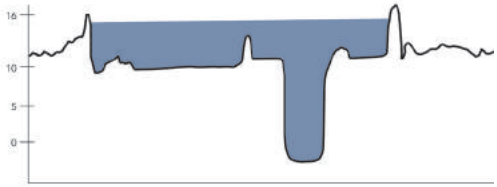
FLOODING AND WATER DISTRIBUTION

The most crucial aspect in the area is the water distribution. The riparian zones are by definition floodable areas that need to accomodate the excess water that does not fit in the main river channel during peak water events, in order to keep the areas behind the dikes protected. In this specific location, the Pannerdensch kanaal takes up about 1/3 of the water that comes from the Rhine, while 2/3 flow to the Waal. The project area has an average water level of about 8.5 +NAP, while the maximum water level is 14.73 m +NAP, which means that the whole area of the floodplains can be flooded.



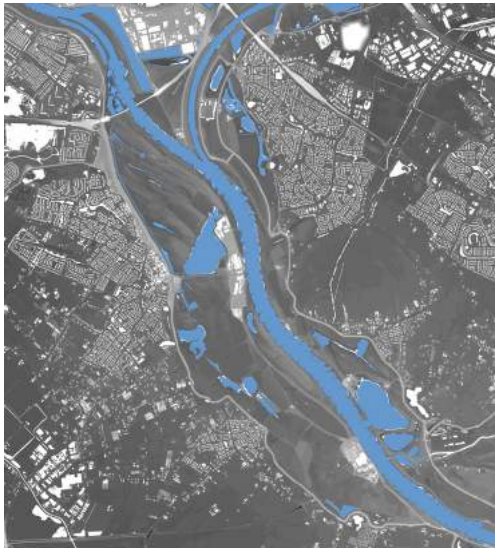


Average water level 8.5 +NAP

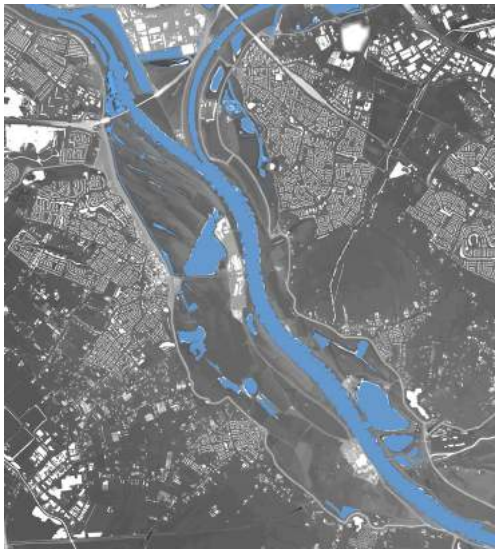


Maximum water level 14.73 +NAP

SPATIAL FLOODING DISTRIBUTION

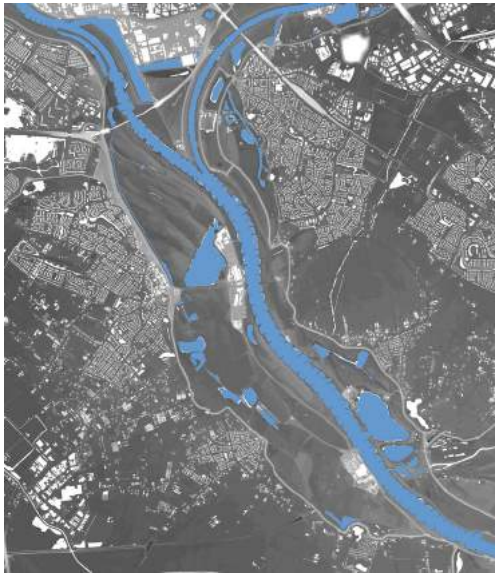


+8.11 NAP

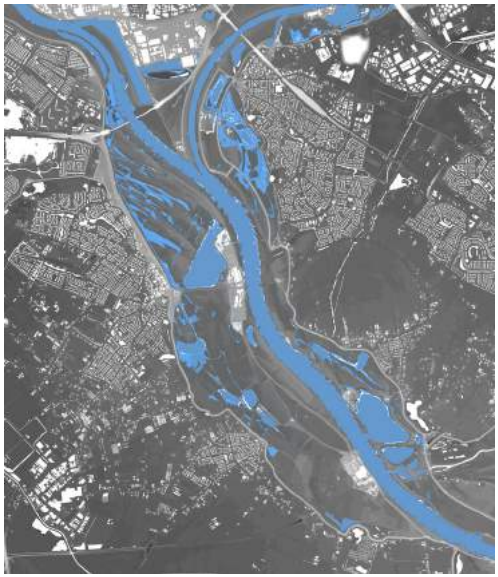


+9.50 NAP

+11.27 NAP

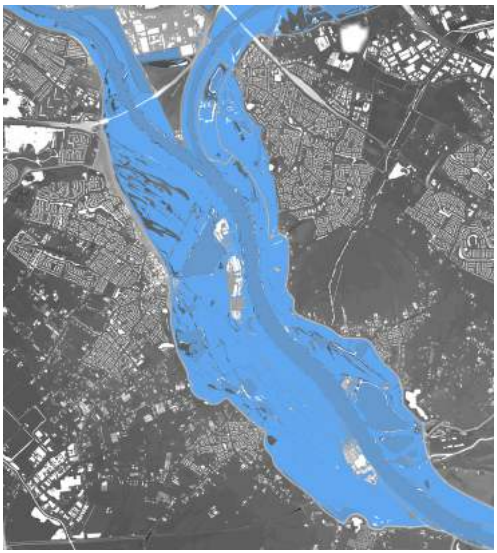


90%



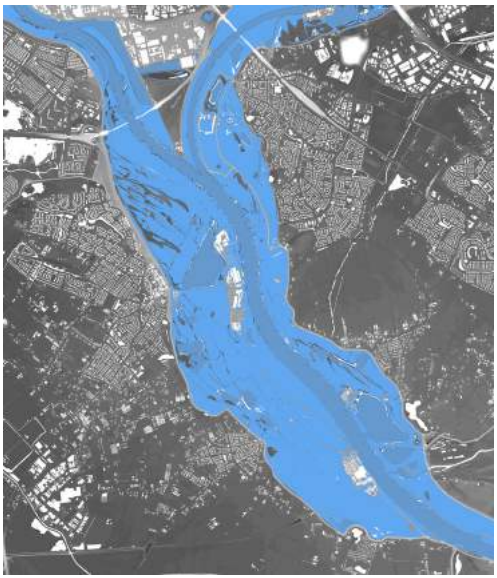
50%

10%



+13.91 NAP

Current situation
with summer dike +13 NAP



Extreme situation
without summer dike

1%

% of time in a year

The frequency of flooding and the spatial water distribution is also interesting. Because of the high summer dike (13 m +NAP) only a small part of the riparian zone is frequently innundated, while the rest of the area has lost its dynamics and is only flooded in excess water events, that refer to 1% of time through a year.

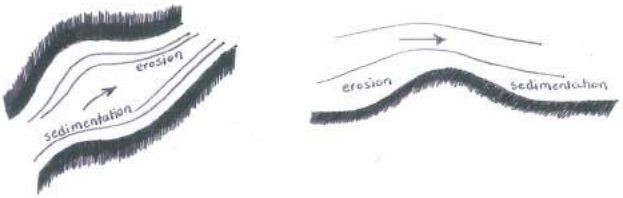
By testing the situation if there was no summer dike, we can see that the area would be much more frequently flooded, giving space for better water distrubution and differnt kinds of nature.

Enhancing river dynamics, therefore, is an aspect to consider in this area.

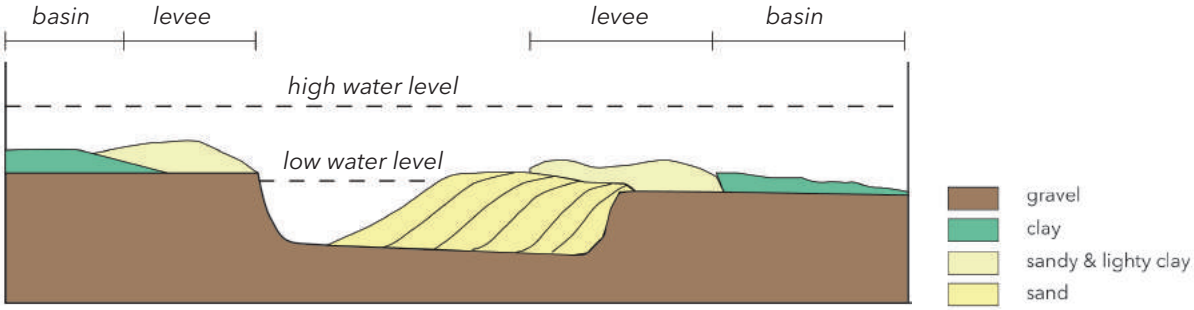
SEDIMENTATION

Another important river process is sedimentation. Rhine annually carries 500.000 m3 of sand and gravel and 2,5 million tones of sludge. In the upstream river system there is no sedimentation of sludge in the main channel but during high water sediments are deposited on the floodplains. Anually, 8% of silt entering the Netherlands at Lobith is captured by the floodplains (around 200.000 tones).

Topography of the landscape plays an important role in the allocation of sediments. Without summer quays, there is 2-3 times more sedimentation at summer wharf. Without embankments, there is also deposition of sand at the interface between channel and river. As for inundation frequency, the higher it is, the higher the sedimentation also gets.

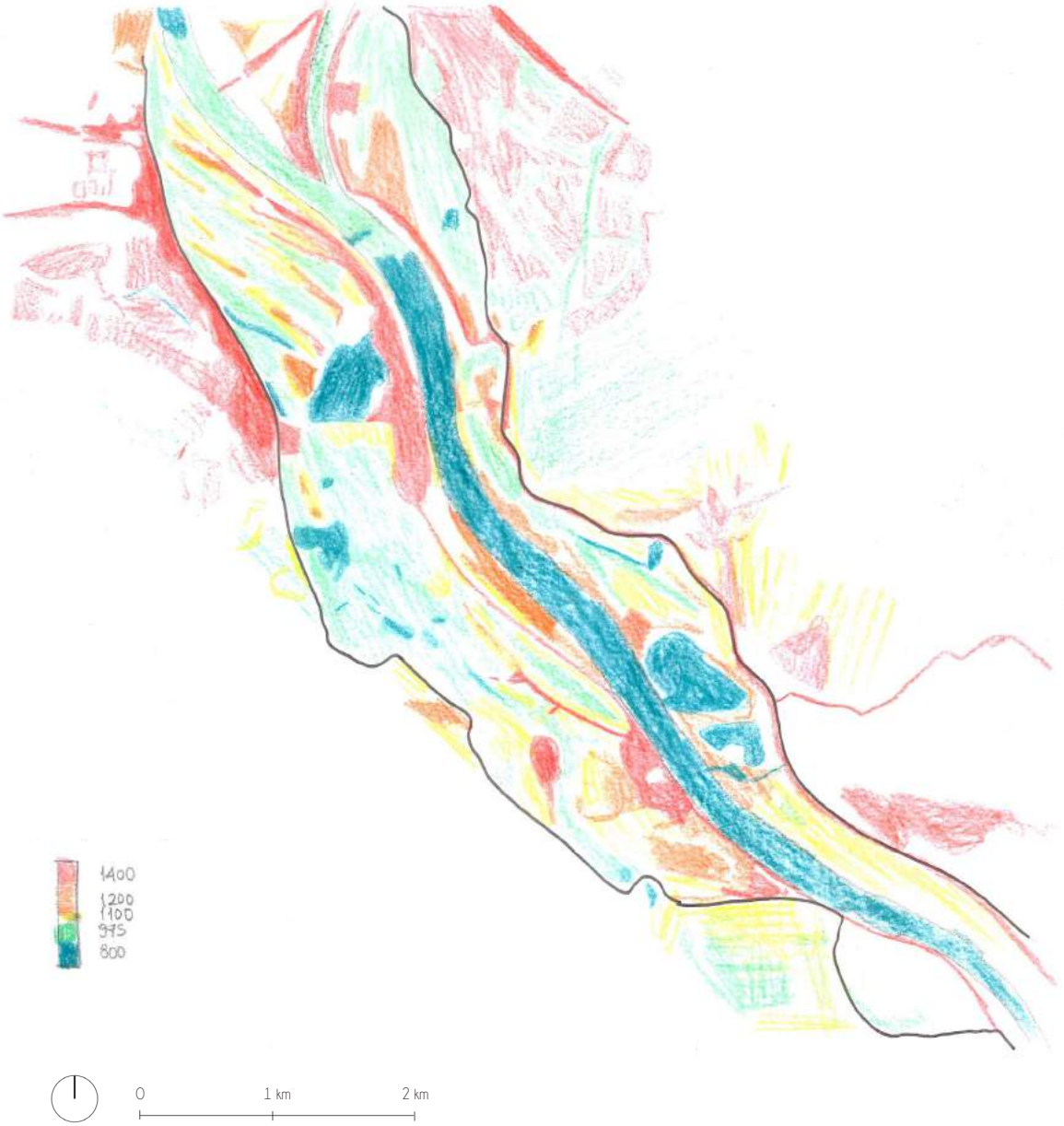


Erosion and sedimentation processes in a river stream



Sediment deposition in a typical river section.

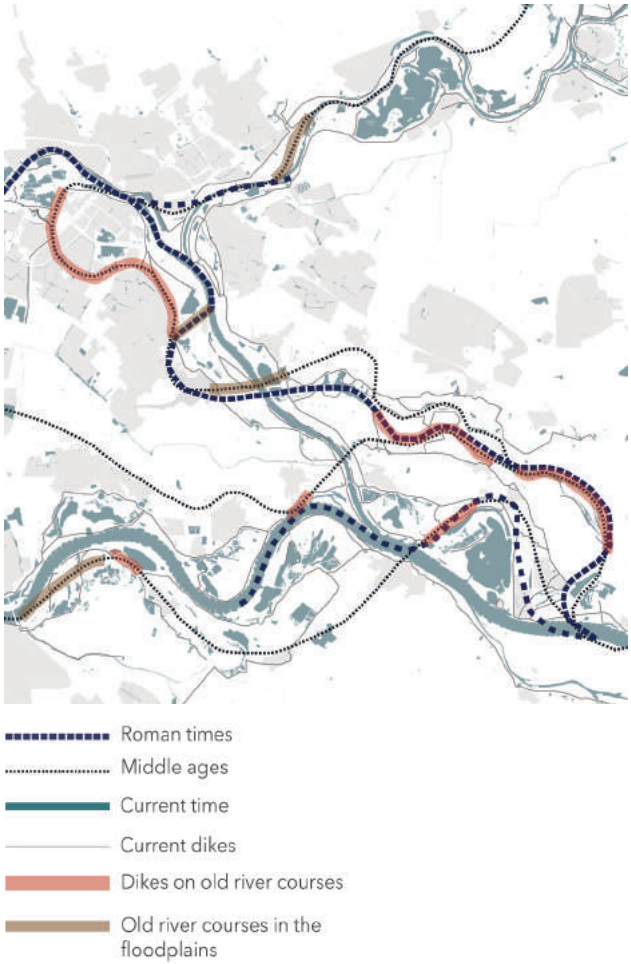
It is believed that in the long term, maintenance of the sediments will be very important since they gather after every flood circle and gradually highten the level of the floodplains, which is not beneficial in terms of river management. Looking at the height map of the project area, we can see that sedimentation occurs basically in the area outside the summer dike, raising a part of the floodplains at a bigger height, while the rest of the area is not involved in the process. So there could be an opportunity to allow sedimentation to occur more freely and use the material to create something new in the area itself, enhancing the identity of the place.


1400
1200
1100
975
800
0
1 km
2 km

PALIMSEST - HISTORICAL AND CULTURAL LAYERS

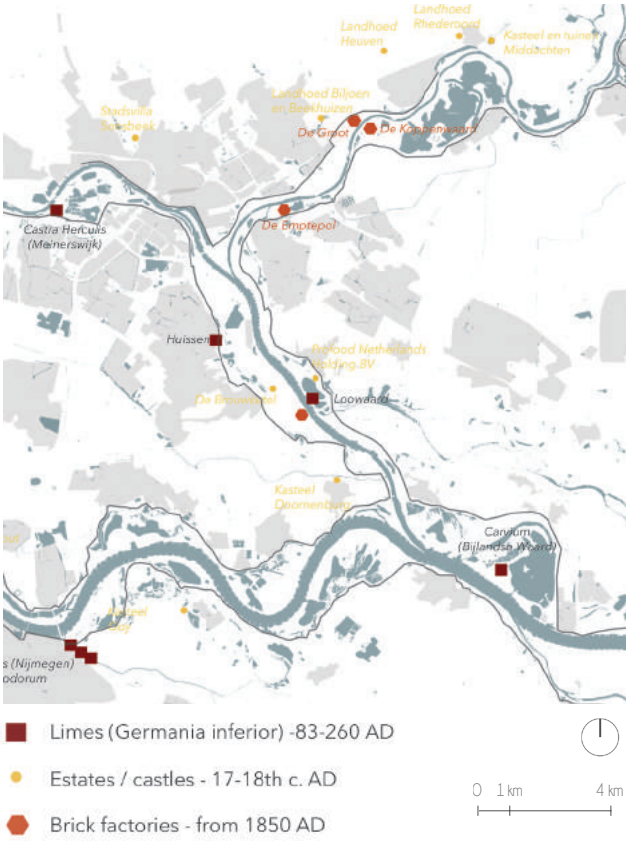
As was described in the introduction section, most river courses have been altered through the years and this is also the case in the project area. The Pannerdensch kanaal was constructed between 1701-1709 in order to control the water flow from the Rhine to the Ijssel and Nedderijn, due to silting problems in former courses. If we look at the river courses from different periods we realize that the area was much more meandering and dynamic.

Old river courses



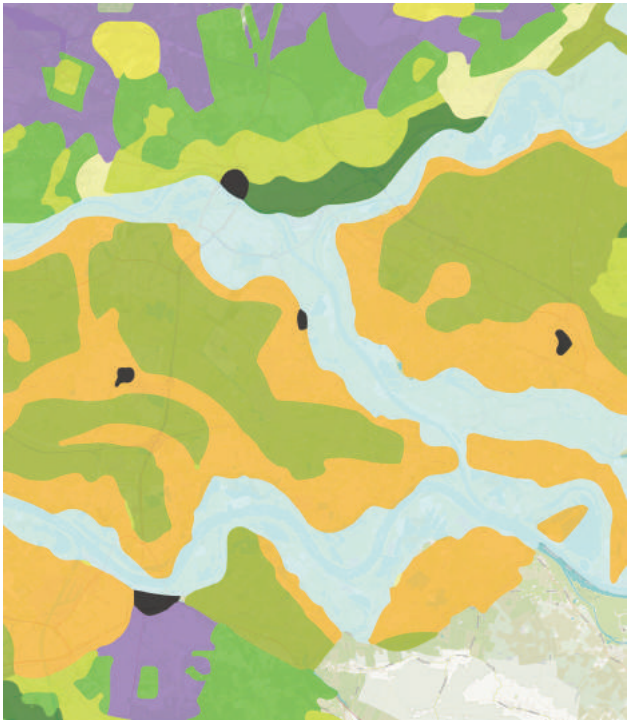
Some of the current dikes are situated almost on top of old river courses. In the area the historical and cultural layer is also quite interesting. There are several elements, like the Limes (borders of the Roman Emperor), the Brick factories, making bricks from the very suitable riverine clay, and the Estates, which all had close relation to the river landscape and the floodplains, and some of them still exist as part of the area's identity.

Historical-cultural elements

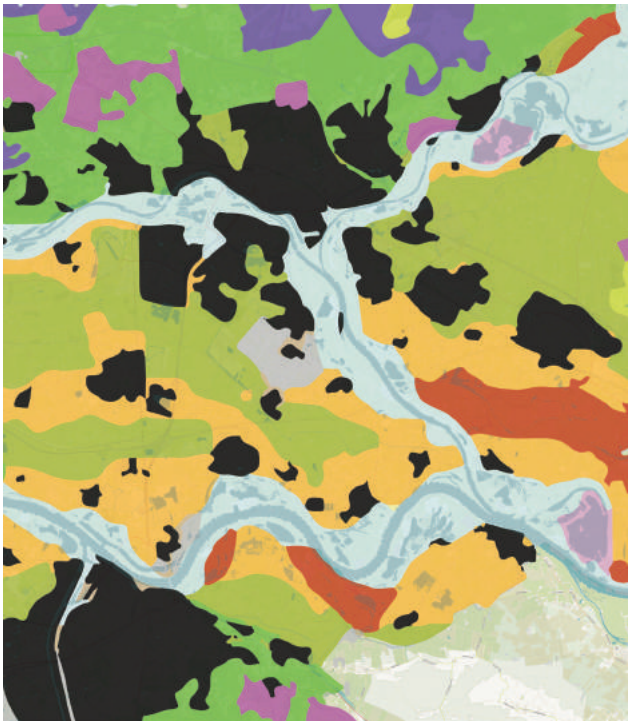


The altering of the river in some cases was also caused by the extension of cities to the floodplains. There has been a dramatic change in the land use from 1850 till today, especially due to the excess urbanization of the South part of Arnhem. We see that the extension of the city occupied part of the riparian zone, creating a bottleneck to the Nedderrijn river and deteriorating the flooding issue. Since the growing population and the need for more housing areas will be possibly an issue in the future, taking advantage of the large space of the riparian zones but in a sustainable way that will be in balance and in dialogue with the river processes can be an important solution.

1850



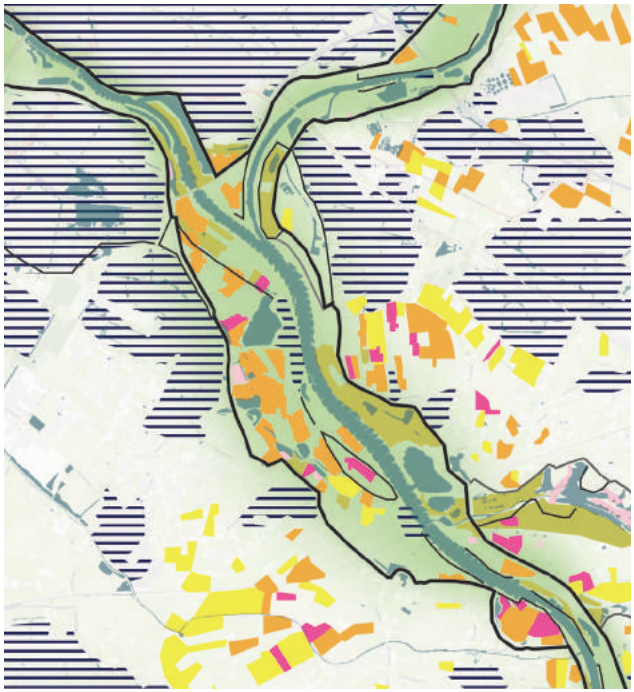
2015



LAND USE AND SOIL QUALITY OF THE FLOODPLAINS

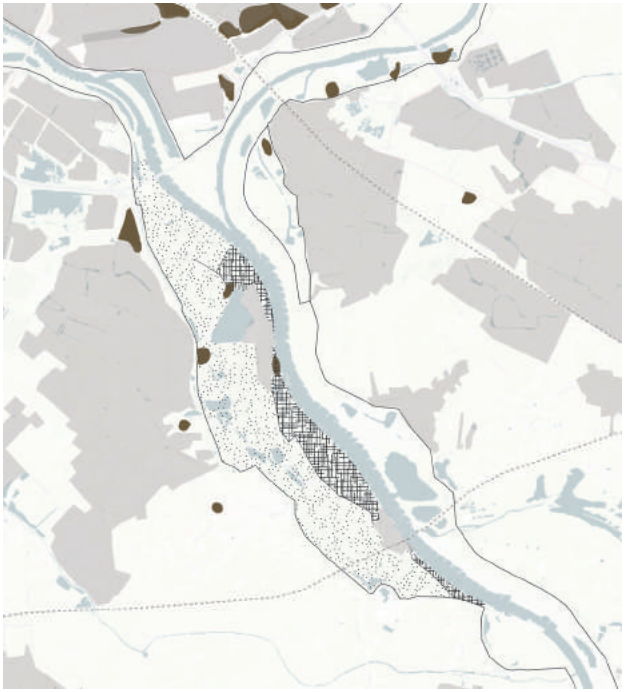
Looking closely at the land use inside the floodplains, we can see that the riparian zone Huissensche Waard remains quite monofunctional. The main use is agriculture, with different types of crops (mostly corn) being cultivated. The cultivation has also to do with the fertility of the soil, due to the proximity to water and inundation frequency. The rest of the area is a vast grassland for animal grazing. In the area there are also two industrial grounds. The caused soil pollution, however, is moderate and only encountered in a small part outside the summer dike. The rest of the area is characterized by clean soil, suitable for crops and for the use of clay.

Floodplain land use



urban development
corn
cereals
other agricultural crops
other swamp vegetation
natural grassland

Soil quality

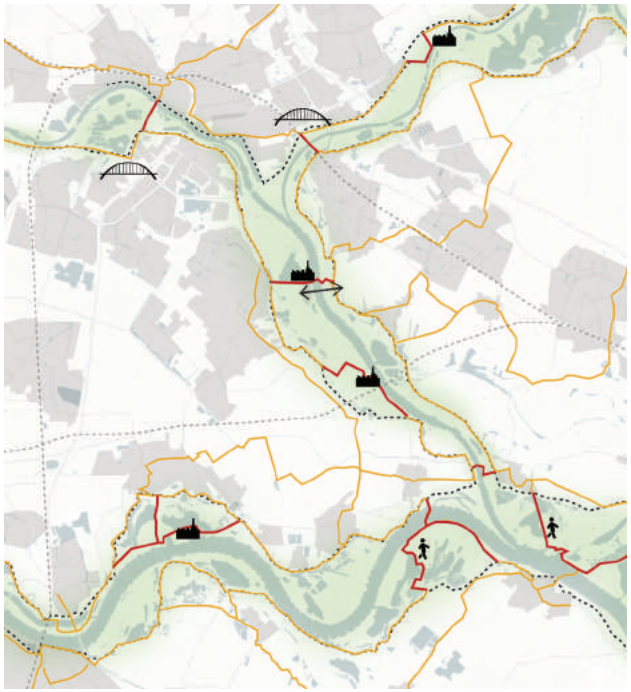


clean soil to light polluted
moderately to heavy polluted soil
former landfills

0 1 km 3 km

The relationship between dry and wet land is quite poor. Connections refer both to physical and visual relations. As for accessibility, in the floodplains there are only a few hard paved roads, usually when there is an industry or building that needs to be reached. There are also a few bike paths and footpaths but not really operating as a network. In addition, views from the dike (which is the border between the dry and wet land) are usually restricted and the river is not even visible, either because of the long distance or because of some obstacles in the way. Therefore, we realize that the floodplains are quite isolated, confirming the problem statement.

Physical connections



bike path routes
bike path on floodplains

Visual relations

river visible from dike
river invisible from dike

0 1 km 4 km

building

vegetation

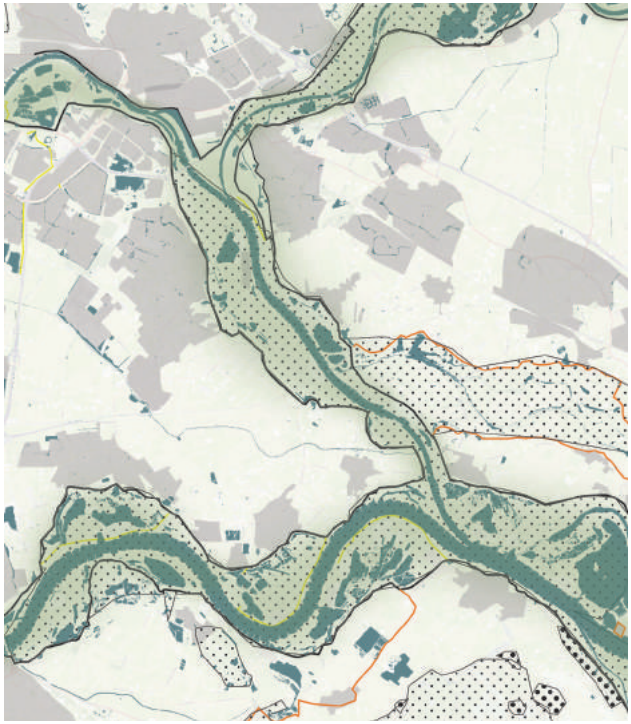
distance

source of pictures: Google Street View

NATURA 2000

Last but not least, the area is also part of Natura 2000, in the categories of "Habitats Directive Sites" and "Birds Directive Sites". The ecological value, though, is quite low, apart from some parts on the regional scale whose value is higher, mainly because of projects developed with a natural focus, like the Gelderse Poort. A few fauna species can be found in the area while more are missing and would need to return in order to restore the ecological corridor of the Rhine branches.

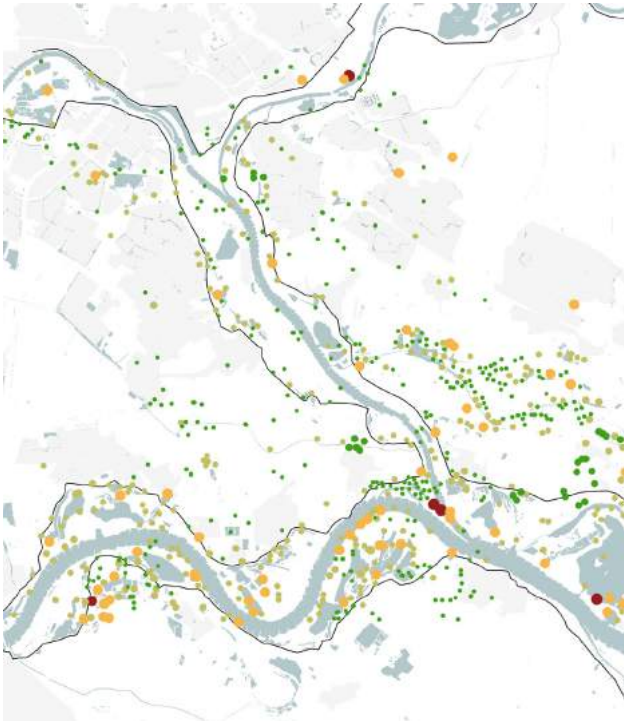
Natura 2000



Protected landscape areas

Habitat/species management area

Flora value



very high
high
medium
low

0 1km 5km


source: goo.gl/Yow2eq


source: goo.gl/sPjVpj


source: author


source: author

Flora and fauna species in the project area

Flora

31 plant species in the "Standard list" of flora monitoring river area
- wilde marjolein (Origanum vulgare)

Reed beds

Elzenbroekbossen

Fauna

Breeding birds (grasslands important rest areas for migrating birds)

Gray goose (Branta canadensis)

Beaver

Steltlopers, Kievit, Grutto

Das

Bat (Chiroptera)

Waterspitsmuis

6 species of amphibians
- Kamsalamander (Triturus cristatus)

Protected fish species
- Bittervoorn (Rhodeus amarus)
- Kleine modderkruiper (Cobitis taenia)

missing species

CONCLUSION

Taking the analysis of the five previous layers into account, we can conclude that the area has been transformed a lot through the years and by these transformations it has lost its dynamics. However, there are some historical-cultural elements as reminders of its identity. The area is part of the Natura 2000, but there is a part in Pannerdensch kanaal and the Nederrijn that is of limited value and can be considered as a missing link between North and South. Furthermore, there are several small cities and villages with limited relation and accessibility to the floodplains. In this context, the Huissensche Waard, is a riparian zone with a lot of potential to improve on a local scale, in the frame of the general research question of this project.

Taking a closer look at the area and its surroundings, we see that it is neighbouring with the cities of Huissen and Angeren on the west, and Westervoort on the east side. There is a dike separating the Northern and the Southest part of the floodplains, which is also the access road to the big concrete and asphalt industry, located at the junction between the two parts. This industry is an important economic driver and so as a function it is not removed from the floodplains.

17,615 inhabitants

- urban environment behind the dike
- agriculture inside
- stronger contrast between two sides

2851 inhabitants

- agricultural environment behind the dike
- natural / cultural values inside


Immerloo park
ditch
openness
distance
HUISSEN
North part
South part
Zwanewater
Loveer industry
Grote Bloem
lake network
restricted space
ANGEREN
Brouwketel
Stenfabriek
Huissensewaard
0
0,5 km
1 km

The **northern part** neighbouring with Huissen has a bigger contrast between the two sides of the dike. Huissen is a city of about 18000 inhabitants, with quite an urban edge. From the dike, which is also the main access road, the city seems quite dense, while the floodplains very open and without any striking element, apart from a ditch very close to the dike.

The only part where the city extends into the floodplains is an existing mound at the border of the city, between the north and south part. This mound includes a supermarket and several houses, however as a facade from the city to the floodplains it is poorly developed, although it could be a nice point of connection.

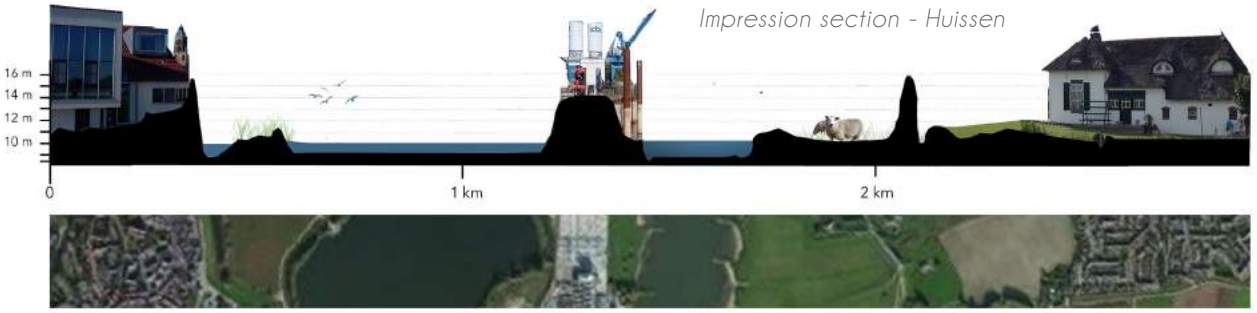
Inside the floodplains, the northern part is quite problematique in the sense that it has a lot of fences and unclear borders, there are no elements of importance and it does not remind at all of a river landsacpe.

The skyline from the dike to the river side is also scattered, with different elements (houses, trees, bridge) forming a confusing picture.

city of Huissen and church

ditch in the floodplains

borders



Impression section - Huissen

The **south part** has a better transition between the two sides of the dike. Angeren is an agricultural village with many farmhouses and a more 'natural' image. The view of the floodplains from the road gives the impression of a natural area, since there is a system of lakes very close to the dike, (like the Grote Bloem), which were naturally formed through the years. Some of them are also situated on the inland part (for example the Vlote bloem), reminding of the changing river courses and being part of the identity of the place.

The meandering shape of the dike close to Angeren also relates to the previous years. Due to construction difficulties and failures at earlier times, the dike was breaking and rebuilt several times. For this reason, the function of the greenhouses has thrived in Angeren at this point, since people were using the fertile material collected after the dike breaks. As a symbolism, we can see that having a common function between the inside and outside area can be a way of reconnecting the two sides.

In the south part there are also two cultural elements, the brick factory "Steenfabriek Huissenswaard" as well as the Brouwketel, which was a stopping points from travellers from Huissen to the fortress Schenkenshans in the south in earlier years. These two buildings are also a part of the area's identity.


Grote Bloem


Steenfabriek Huissenswaard


the Brouwketel

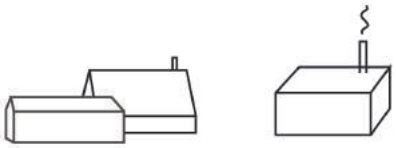

the dike - road

Impression section - Angeren

READING THE LANDSCAPE

Having analyzed the area on its processes and spatial/social characteristics, we can see that there are some elements of importance in terms of identity or value, and some that do not comply with the image of a dynamic river landsacpe and could potentially be changed or improved.

[+]



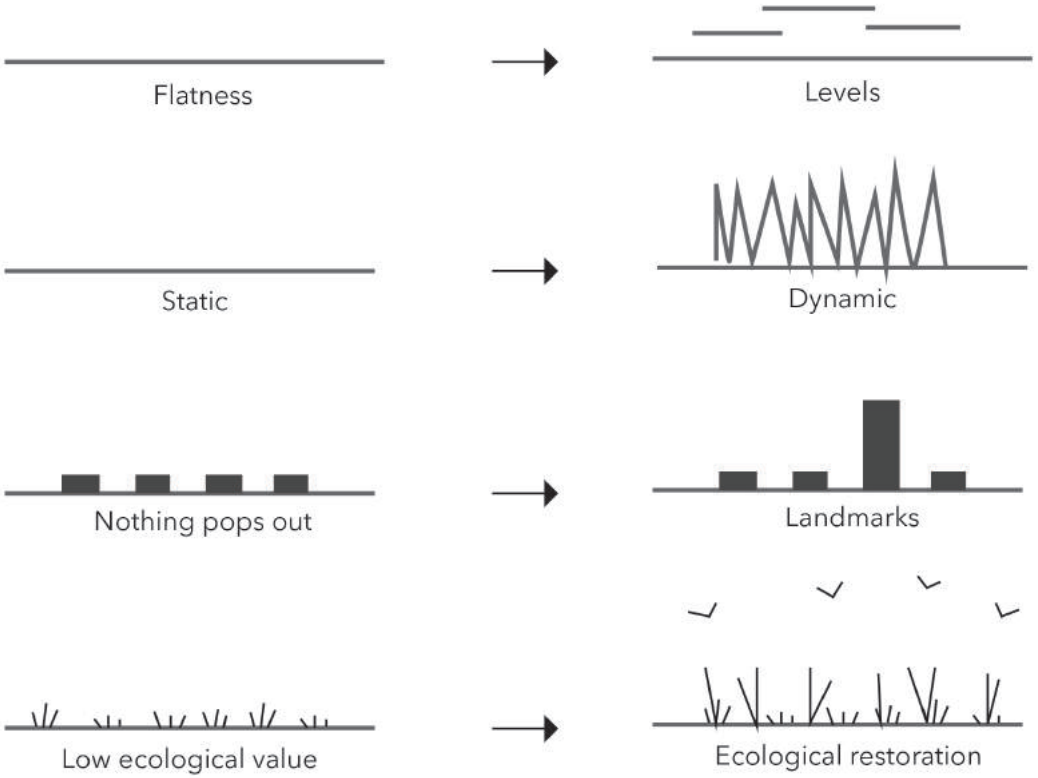
Cultural elements

Water elements

Soil quality - suitable for crops

Temporary water levels

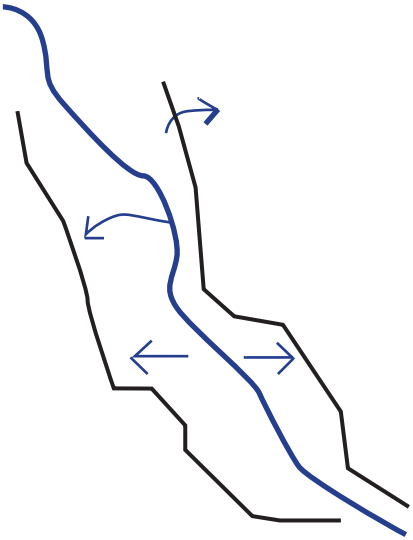
[-]


Flatness
Levels
Static
Dynamic
Nothing pops out
Landmarks
Low ecological value
Ecological restoration

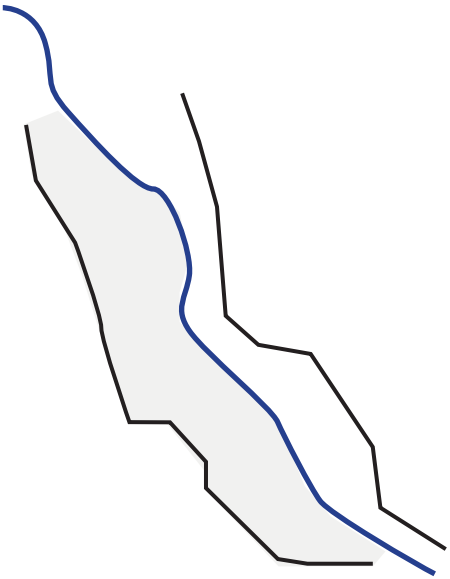
03 STUDY OF PRINCIPLES & PRECEDENTS

MAIN ISSUES

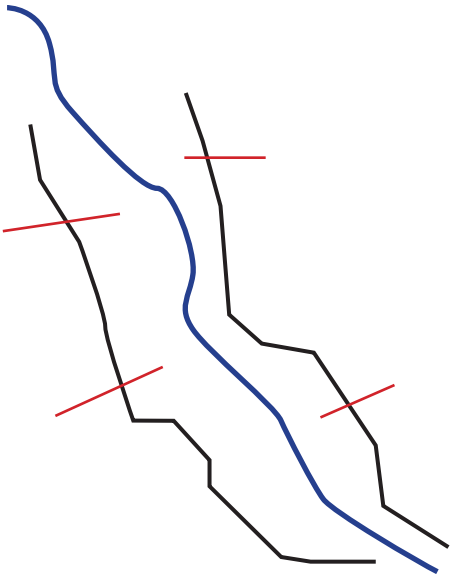
From the problem statement and research objective of this project, three main issues emerge that will be addressed in the design. First of all the ongoing natural processsses and how to provide more space for water and enhance river dynamics in order to embrace the natural processes. Secondly, the current monofunctionality of the floodplains that this project seeks to change into a more integrative approach, focusing on a new living environment in the floodplains in balance with nature. The third main issue is the pour relationship between the 'dry' and the 'wet' land caused by the existence of the dike. To approach these issues, I derived principles through literature review, design research and precedent's study, which will be presented in this chapter.



1. River management- offer more space for water and enhance dynamics

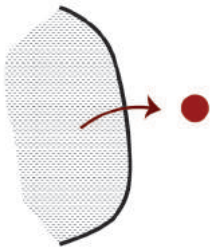


2. Monofunctionality of floodplains - how to impose a living environment?

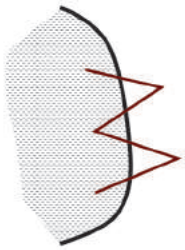


3. Dike border between floodplains and urban fabric - enhance connection

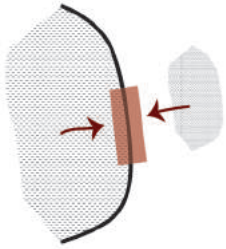
Firstly, I defined principles by which the connection between the two sides of the dike could be achieved. This connection can be physical, visual, but also mental, in terms of relation with land, ownership and management/maintenance of the area. For the objective of this project, all of these principles could be combined. However, having in mind the fact that the city is now turning its back to the riparian zone, creating a practical relation that will allow people to gradually engage and discover the area while feeling connected to it, would be the most efficient option. Because of the soil fertility and the current agricultural use, giving people a community space they can utilize, like a community garden and public space, could be a successful first step towards the desired connection.



Function in floodplains refering to urban fabric

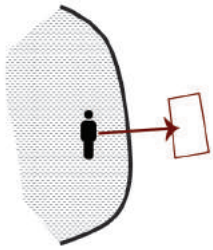


Enhance accessibility



Make dike the connection (buffer zone) with functions refering to both sides

Visual relation (landmarks)

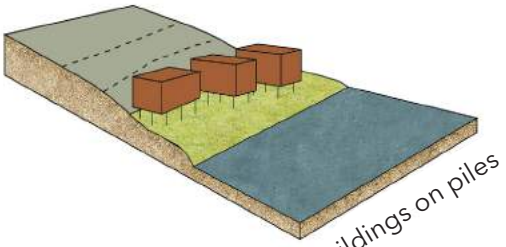


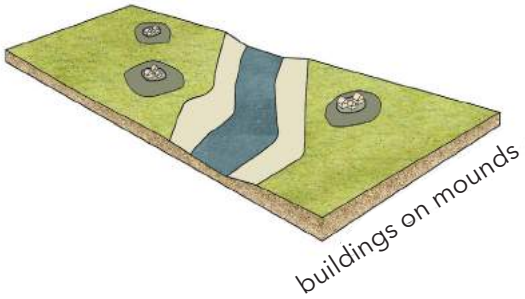
Relation through land ownership, maintenance or responsibility

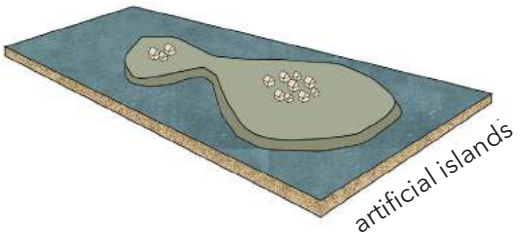
CURRENT BUILDING TECHNIQUE PRINCIPLES ON FLOODABLE AREAS

As for the new living enviornment creation, there are some existing building principles on floodable areas that have to do with safety but also with water flow disturbance. In the project area, building on piles could be possible but the height difference between the floodplain level and the maximum level that water can reach is 5 meters, which requires specific building techniques and also would not probably provide the best spatial result. On the other hand, building on mounds can be more efficient and has the advantage that the material can be provided by the area itself, because of the abundance of clay and the gained sedimentation after flooding.

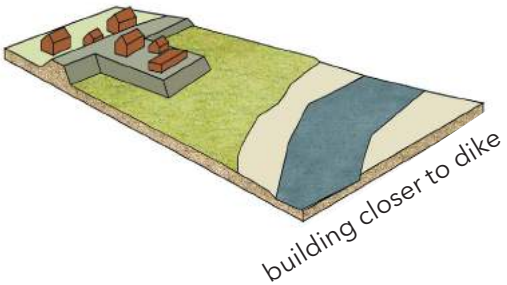
For building safely on the floodplains

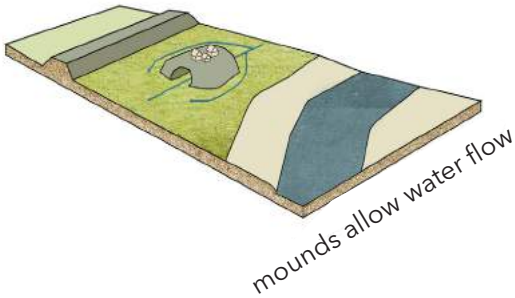






For not disturbing water flow

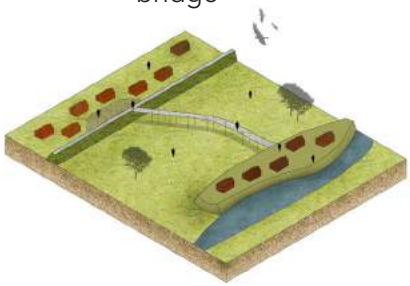




Apart from the general building techniques, there are also different typologies that emerge, not only on building types but also on ways of connection and accessibility as well as on arrangement (how to create a community). Regarding transportation, bridges have the disadvantage that they form obstacles in the landscape and are superimposed. On the other hand, using boats when the area is flooded and regular access paths on ground level the rest of the time is a solution that can adjust to the changing conditions and reflects more a dynamic landscape.

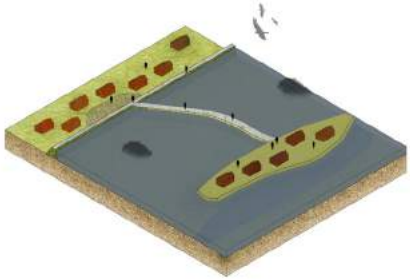
Connection typologies

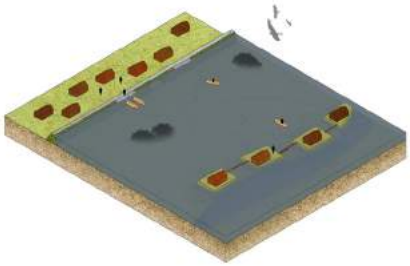
bridge



regular paths and boats

regular situation





flooded situation

Another method to derive principles was to look at precedent studies and projects with relation to my project's objective. The first refers to two approaches for the floodplains (Plan Ooievaar and Living Waters). Although the examples focus on nature, their main ideas could be translated in a different case.

The second precedent example are the Chinampas in Mexico, which deal with land reclamation and dealing with excess water conditions. The main points of these precedents are presented briefly in the following pages:

1. Plan Ooievaar & Levende Rivieren (The Netherlands)

Plaam Ooievar, as described before, was a design strategy for the Rhine and Meuse river area. It provides:

1. Principles on management of rivers, nature and agriculture
2. New interaction between natural dynamics of river system, land use and resulting visual expression.

Levende Rivieren (Living Waters) was a strategy for the Geldersepoort area, inspired by Plan Ooievaar.
Main ideas:

1. Perspective on natural development and recreation
2. Proposed solution focuses on digging secondary channels

Principles

- Control flooding to the desired areas by soil extraction
- Use clay as raw material for brick manufacturing
- Creation of marshy sites
- Flood forest can thrive back in river environments
- Natural water purification by secondary channels

Plan Ooievaar (source: De Bruin, D. et al (1987), Ooievaar. De toekomst van het rivierengebied, p. 24)

The Gelderse Poort area (Source: Google maps)

Biking in the floodplains (Source:https://www.deltatalent.nl/sites/default/files/nieuws/P1180211.jpg)

2. Chinampas (Mexico)

The chinampas were a type of raised-bed hydrological agriculture on the shallow lake beds in the valley of Mexico. They formed artificial islands (floating gardens) created by building up extensions of soil into bodies of water.

Source: https://goo.gl/1KyzyG

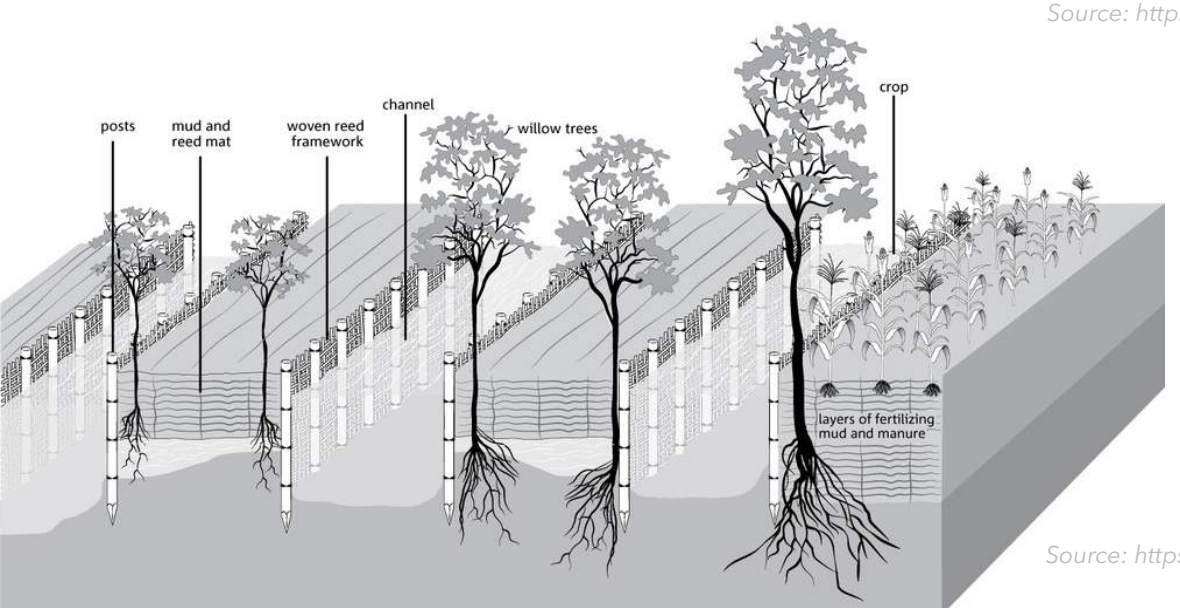
Technique:

1. Stake out lake bed
2. Fence rectangle with wattle
3. Layer fenced-off area with mud, lake sediment and decaying vegetation
4. Willow or other trees planted around to secure the chinampa and keep the nutrients (clean soil)
5. Channles for canoe access.

Source: https://goo.gl/33cjY6

Principles

- Surpass the restriction of water conditions by building on it
- Use materials from the area
- Use of natural elements (trees) to stabilize the soil
- Transportation/connections with boats through channels



Source: https://goo.gl/O3uLMz

04 METHODOLOGICAL FRAMEWORK

After defining the first principles on the three main issues of the project, it was important to develop a methodology that would merge these layers together. The objective of this methodology is to provide principles of understanding and mechanisms of designing, towards an integral design of the river floodplains, where a new living environment will operate together with nature and natural processes.

1. The context and the challenge - landscape as a process

The main challenge of the floodplain areas (or riparian zones) is their unique characteristics that result from their definition. The floodplains of a river are the areas where water overflows when its discharge capacity is high and water cannot be stored in the main channel. This gives the area a temporal dimension, since the water levels are variable and cover a different part of the area each time. Because of the water flow and velocity, sediments are also deposited on the floodplains (mostly sand and clay), gradually changing the terrain. This means that the floodplains are not a landscape of a given 'form' or 'image' but they are constantly changing environments with unexpected characteristics occuring over time. We could say that they are transforming surfaces with uncertainty being part of their uniqueness.

So what kind of landscape are actually these areas? There have been many understandings and discourses concerning the term 'landscape'. For Gruen, the landscape is the environment in which nature is predominant, but not in the form of an untouched wilderness but ''those regions where human occupation has shaped the land and its natural processes in an intimate and reciprocal way". (Corner, 2006, p. 26). This definition of Gruen comes closer to the idea of landscape as a pictorial image, a representation of nature. However, according to Hough (1984), this kind of landscape as an object can lead to wrong priorities in the design, since it does not come in line with the dynamics of natural processes that exist.

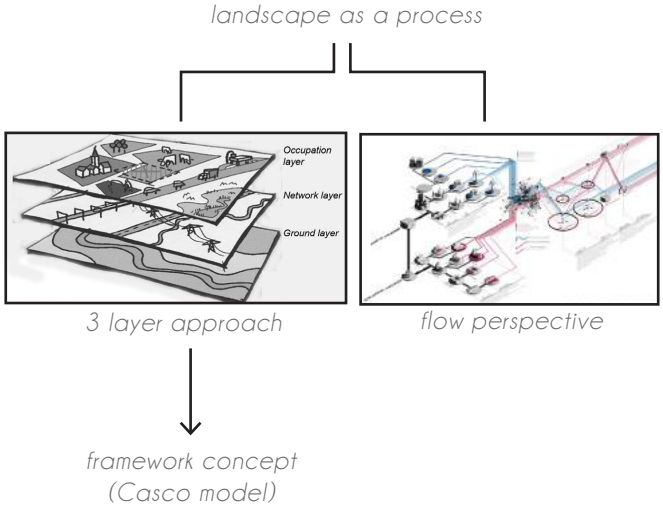
Given the uncertainty and temporal dimension of the floodplains as described before, we understand that to come up with a strategy or a design for such an area, a landscape architect cannot consider the landscape as an object with a static form, because he would then neglect part of the inherent characteristics of the area, which are the dynamic conditions that shape it. It is then important to understand landscape as process, as a planar piece of land where natural forces and processes take place and create a setting of dynamic interrelationships. Then the landscape can be perceived as "a functioning matrix or connective tissue that organizes not only objects and spaces but also the dynamic processes and events that move through them". (Wall, 1999, no pagination)

The processes, however, do not need to be only natural. By understanding landscape as a process, we also interpret landscape as infrastructure, "as an operative field that defines and sustains the urban development and ecological and economic processes are employed as formative design tools." (Nijhuis and Jauslin, 2015, p.20)

This perspective is important in understanding how the floodplains can be more than part of the flood defense system. They can be infrastructure, providing space for other functions and promoting interaction between processes and objects. "Planning and design operations should focus on the interaction between landscape processes and formal-aesthetic aspects and facilitate a multitude of relationships between natural and human systems" (Nijhuis and Jauslin, 2015, p.22)

2. Related existing theories and methods

Several approaches and methods have been developed through the years to understand landscape as a process, and in some cases provide design principles on finding the right balance between processes and forms. Two of these approaches relevant for this project are the 3-layer approach, later translated into the Casco Concept, and the flow perspective, which is also part of the Flowscapes graduation studio.



2.1 The 3-layer approach and the Casco Concept.

The 3-layer approach has been developed in the Netherlands since the 1970s, inspired by Ian McHarg's book "Design with nature". McHarg used in his book the overlay mapping as a tool of inductive reasoning. (Conan, 2000). He overlayed different factors and revealed spatial patterns of suitabilities for diverse land uses, focusing both on natural and artificial characteristics of the area. Having done that as individual transparent maps, he then superimposed the maps over each other to construct the necessary suitability maps for each land use. (Conan, 2000). However, we could say that this method of McHarg combined different layers of information that were known from the past and present but was not really taking into account the uncertainty of the future. This was elaborated on the 3-layer approach.

This approach describes the landscape as a complex system of a-biotic, biotic and anthropogenic factors (Meyer and Nijhuis, 2013). The three layers of the approach include the substratum, the networks and the occupation, tighed together with a time-relationship, since each layer is transformed in a different pace than the others (with substratum having the slowest pace and occupation the fastest). The re-arrangement of these layers in order from bottom to top based on their time-relationship can set priorities and conditions for spatial plans (Chung, 2014). However, it is considered that it remains somehow vague how to translate this approach into a real design.

The 3-layer approach was further embodied in the Framework Model (Casco Concept), "for conducting the complex interrelationship between nature and human landscape." (Chung, 2014, p. 72)

"The framework concept is based on the paradox of time and uncertainty. Change and uncertainty are both fundamental in natural and cultural systems. The landscape is no different- change is fundamental- and uncertainty is a 'given'. This is the paradox of time in landscape architecture and planning." (Ahern,1999, p.185)

In this model, the landscape layers or functions are characterised as "low dynamic" and "high dynamic". For example, key ecological processes, like groundwater recharge, require a level of stability to function. On the contrary, other processes who

can be influenced by social or economic factors, require flexibility because they contain a level of uncertainty. The framework model combines the two, by providing a longterm stability for the low dynamic processes and allowing more flexibility for land use change in the other areas. (Ahern,1999). The landscape planning issue is how to create ecologically sound landscapes with possibilities for the development of conflicting types of land use. (van Buuren and Kerkstra, 1993)

One of the first projects in which the the Casco Concept was implemented is the Plan Ooievaar, which was described in the introduction and the precedent analysis. The use of this concept in the Dutch river floodplains led to the formation of a coherent framework of self-regulating natural processes, which also made exceptional forms of recreation possible within the floodplains.

2.2 The flow perspective

The flow perspective gives special attention to the space of flows, as opposed to the space of places. The space of flows can be defined as "the formal expression of structures for the (1) provision of food, energy, and fresh water; (2) support for transportation, production, nutrient cycling; (3) social services such as recreation, health, arts; and (4) regulation of climate, floods and waste water." (Nijhuis & Jauslin, 2015, p.23)

Shifting attention to the space of flows gives landscape architecture and other design disciplines the potential to gain operative force in territorial transformation processes (Nijhuis & Jauslin, 2015). Understanding landscape as a space of flows and movement can facilitate the relationship between natural and human systems, between the processes and the built environment. These landscapes, or flowscapes, are then becoming operative structures that create conditions for future development and aim towards sustainability.

Here the concept of the longue durée is crucial: perceiving landscape as a long-term structure, which is changing rather slowly. (Nijhuis & Jauslin, 2015). Landscape is not understood as a stable structure but rather as a system of dynamic actions, containing a network of interrelations between space and processes.

3. Towards a methodology for an integral design of multifunctional river floodplains

The aforementioned theories and approaches are closely related to the objective of creating a system of interrelated natural and 'stable' structures in the dynamic context of the floodplains. They present the landscape as consisting of different layers or elements, with relationships between them both in space and through time.

The first step then is to define the layers that will constitute the new desired multifunctional landscape. For this project, these layers are the natural river processes (separated into water and sedimentation), nature and a new living environment (urban development). For the layers to be combined and operate sustainably, it is important that they are not superimposed but they should utilize the potentials of what the landscape itself can provide and also understand how one layer can positively influence the other. This is translated in two scales; the larger one, concerning how to allocate the functions in the area, and the smaller one of how the functions will actually operate.

3.1 The potentials and needs of each layer

a. River processes

Water (inundation, water level fluctuations)

Water in the floodplains has a temporal character. Depending on the river discharge, the precipitation, the terrain of the floodplains and other factors, the area can flood at different parts, at different times and for variable duration. The abundance of fresh water can have a great potential. Fresh water is valuable for human life and ecology and thus, the fresh water that flows in the floodplains could be stored and then used for example as drinking water ,after the necessary purification techniques. There is also the potential of influencing which areas will be inundated, by controlling the flooding (for example through digging layers of the clay).

Furthermore, the changing in water levels can provide flexibility in the stable structures (for instance floating houses that move as the water levels change).

Sedimentation

The second important river process is sedimentation. Sediments (mostly sand and clay) are deposited on the floodplains after every flood circle, gradually heightening the level of the terrain. These sediments provide an abundance of raw material through time, that can be used for example for brick manufacturing, or for creating higher grounds that can host other functions safely.

There is also the possibility of controlling where the sediments will be gathered, by using natural or man-made sediment catchers and/or altering the terrain of the floodplains.

b. Nature

Ecological restoration in the floodplains is a subject that has been researched lately. It is believed that flood forests can thrive back in the riparian zones and offer possibilities for different species to return to the river landscape (this is part of the plan Ooievaar's approach). In addition, by having areas with different water depth (seepage lakes, deeper lakes etc) there can be room for a variety of plant and animal species to develop. Nature will of course need a degree of maintenance, which can also be done by man or by nature itself (for example grazing by herbivores).

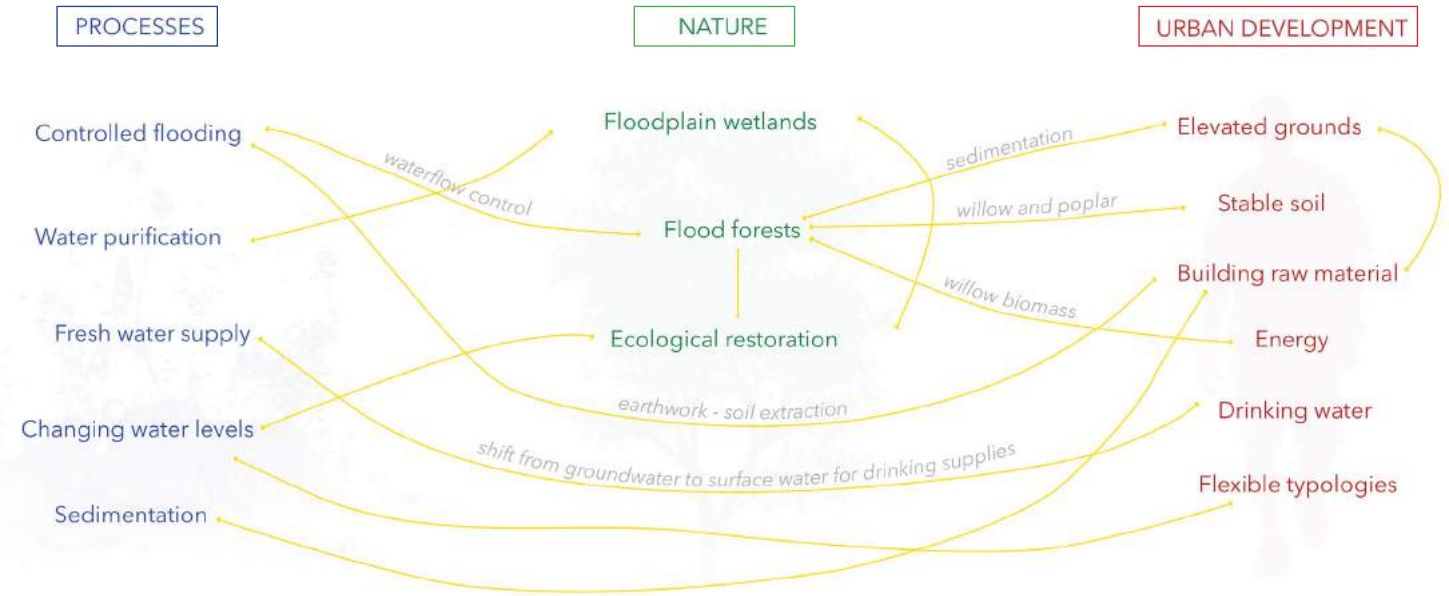
c. Urban development

Urban development is a function that might seem conflicting with the two previous layers. For a new living environment, there is of course the need for higher grounds, so that settlements and structures are safe in this context, but also for infrastructure, energy, drinking water and so on. Landscape as a process and as infrastructure, can provide these necessities so that the urban development will operate sustainably, without deteriorating the environment but by working with it.

3.2 Basic principles

After having defined the potentials and necessities for each one of the three main layers, it is important to reveal the interrelations among them. The diagram illustrates the main layers and their relationships. It is clear that all the layers are linked and each one can provide conditions or influence other functions and processes. For example, a flood forest is beneficial for ecological restoration but it can also control the river flooding. Because of the resistance caused to the water flow by the trees, it is recommended to compensate by digging other parts of the floodplains. The material extracted can be used as raw material or to elevate grounds relevant for urban development. In addition, the trees (for example willows) can be a great source of energy, through biomass, but they also contribute to soil stabilization and purification.

Having these interrelations in mind, we can derive basic principles, both for the larger scale (the floodplains in total) and for the smaller scale (the sustainable operation of the new living environment in the floodplains, by embracing and utilizing what nature and natural processes can provide, without deteriorating the landscape and environmental conditions.)



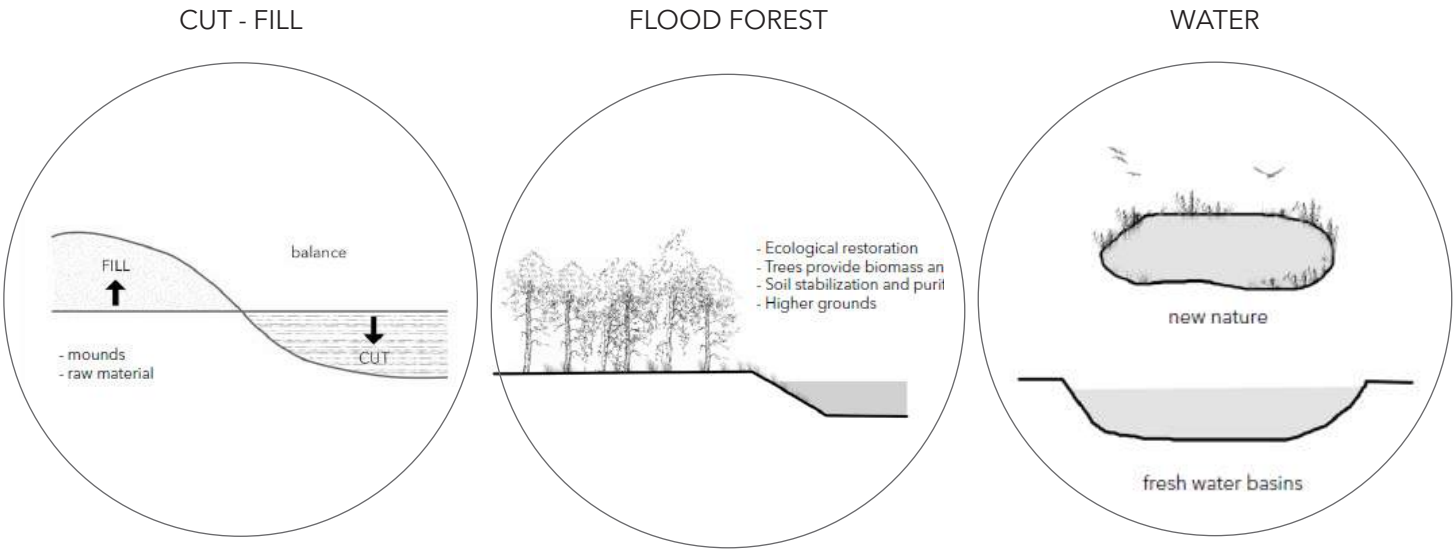
Interrelations between the basic layers.

A. Large scale principles

a. The cut-fill principle, meaning that everything that is taken from the area (like the excavated material) can be given back to create something new. This is based on a recycling concept of using what the area can provide, enhancing also the identity of the place.

b. The flood forest development, which is a connecting element of all layers, since it has benefits for all of them, as explained in paragraph 3.2.

c. New functions of water and water elements. Lakes and channels can be an organizing spatial tool, assigned with functions related to the storage and purification of fresh water, or the development of new nature. This way the flooding can be a potential rather than a threat for the area.



Schematic representation of large scale principles

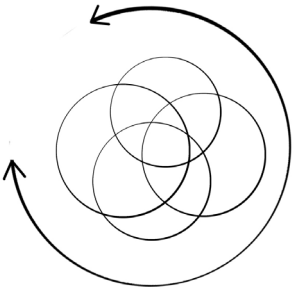
B. Small scale principles

The small scale principles refer to the sustainable operation of the living environment in the floodplains, by profiting from nature and natural processes and not conflicting with the landscape. Basic principles are the following:

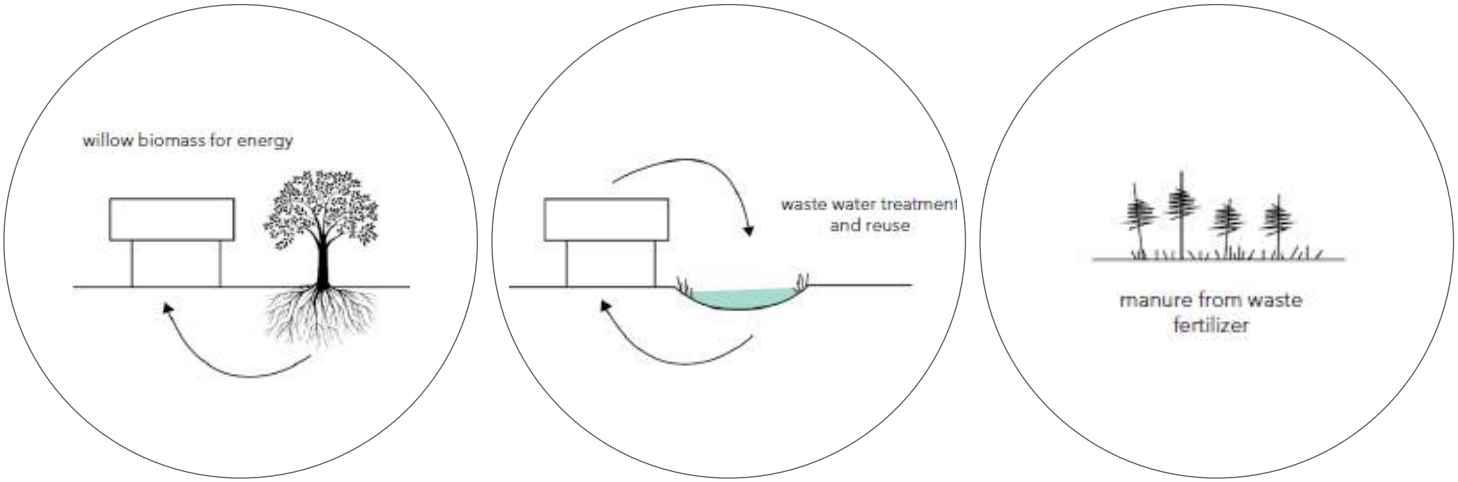
a. Use willow biomass as energy source and wood from trees for heating.

b. Create a closed-circle of waste water treatment (purification) and re-use for the building functions.

c. Use manure from waste as fertilizer.



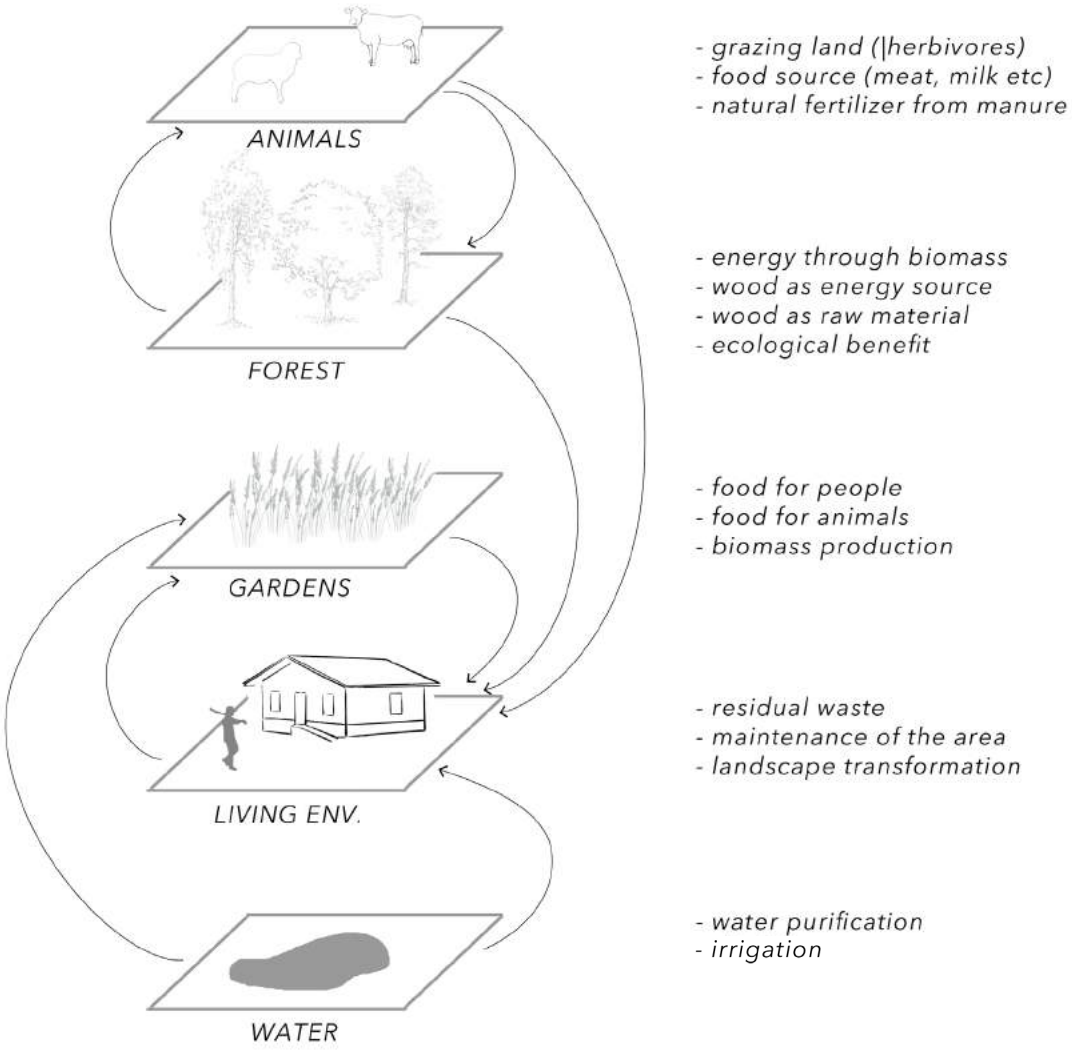
circular process



Schematic representation of small scale principles

Sustainable living

The small scale principles point towards the direction of a sustainable way of living, where the houses do not put a negative impact on the landscape but they are self-sustained through a circular process. This way, the landscape can provide sources but also remains respected.



3.3 Mechanisms for principles' application

The large scale principles refer to the whole project area and provide ways by which the different functions can develop in an interrelated way. To apply these principles spatially it is necessary to develop some mechanisms by which the area will be transformed through time. The following mechanisms can be described as tools or strategies necessary both for the development of the basic layers (natural processes, urban development, nature) and for their mutual existence.

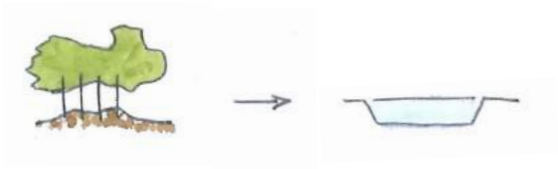
1

The "cut" and the "fill" locations can be in close distances, for direct material transportation.

2

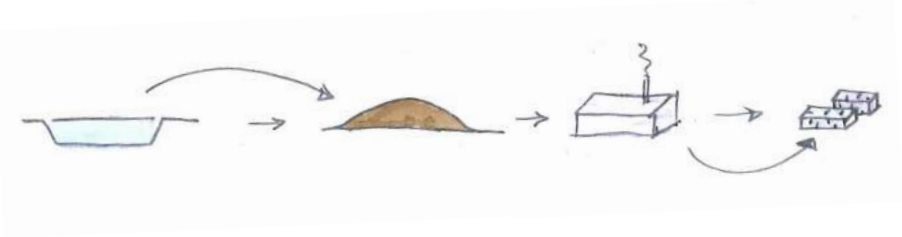
The development of flood forest creates conditions for housing through the gain of sediments and higher grounds.

3



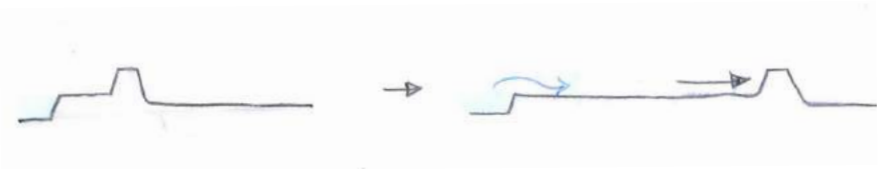
Water elements should be dug for compensation of the water flow resistance caused by the developed flood forest.

4

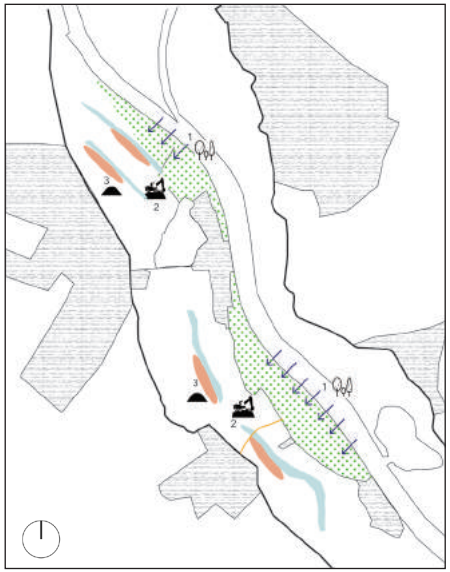


Local clay can be used for building but also as raw material for brick production.

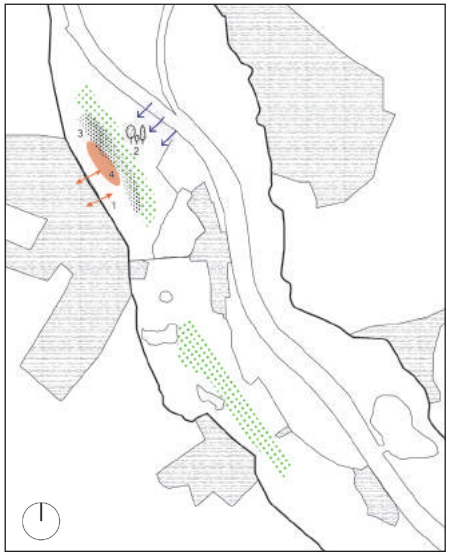
5



Natural processes can be facilitated by enhancing river dynamics, for example through moving the summer dike or imposing barriers.



Example of principles' application through the mechanisms - cut and fill locations



Example of principles' application through the mechanisms - gain of sediments through the flood forest

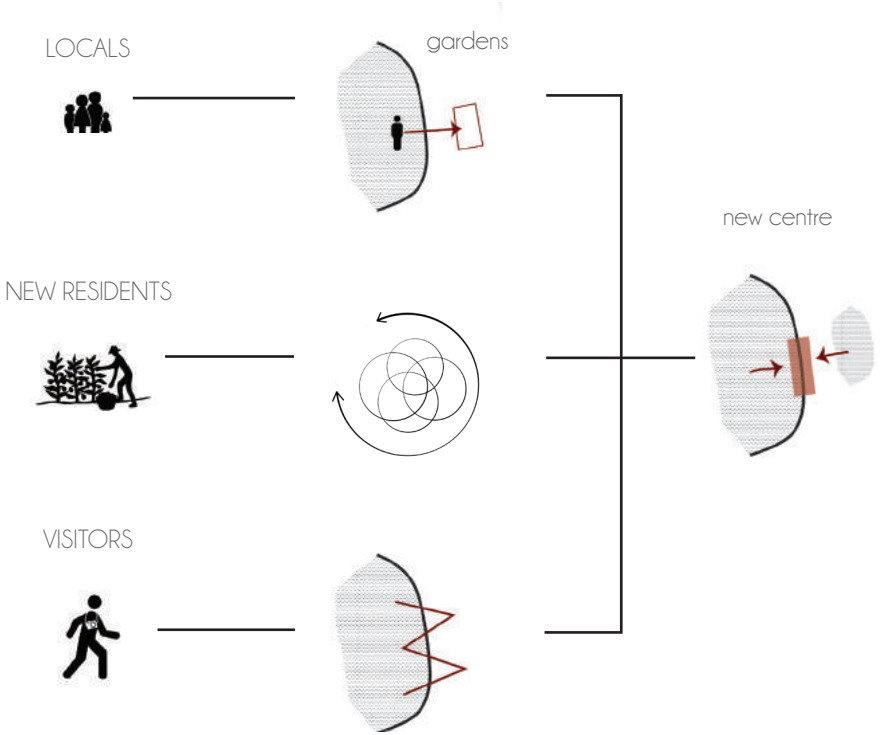
4. Conclusion

This chapter described a methodology aiming at providing principles for designing multifunctional river floodplains, integrating urban and natural development, through embracing the natural river processes.

The perception of landscape as a process and as infrastructure and the notion of interrelating diverse layers to derive principles for their integration can be successful in achieving this goal, given that in the context of the floodplains there is tension between stable and dynamic elements, between processes and forms and thus considering each layer separately will make it hard to achieve a sustainable relation among them.

This graduation will be based on this methodology and test through research by design how the principles can be applied in the design of the Huissenche Waard. Rendering the question from general to more local, the specific spatial and social characteristics of the area will also take part in the design. This will be elaborated in the next chapters.

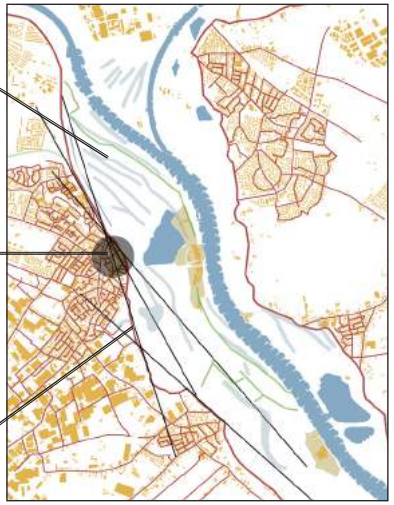
05 THE VISION FOR THE AREA

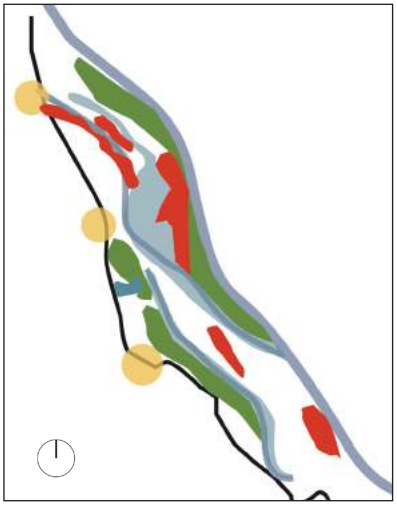


curves - underlying water layers from geo-morphology map

junction point - location for the new centre

lines of infrastructure (roads, dikes)





spatial vision for an integrative landscape

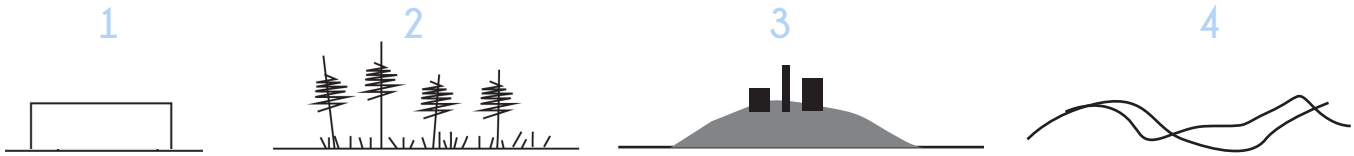
Having defined a methodology to apply the integration of diverse functions spatially, it is important to define which will be the main functions and how they will benefit the area also on a local level. The vision for the area includes three main user groups. First of all, the inhabitants of the surrounding cities, in the frame of enhancing the connection between the cities and the floodplains. As was discussed in the principles of connection, allowing people to have a relation with the land of the floodplains could be the first step. Envisioning a sustainable landscape with respect to localities, the idea is to allow people from Huissen to reclaim part of the floodplains and create community/allotment gardens on the border of the city, extending the urban fabric to the riparian zone. This way, they will have their own space in the riparian zone and a new facade will be created that will let them make the first step towards the 'wet' land.

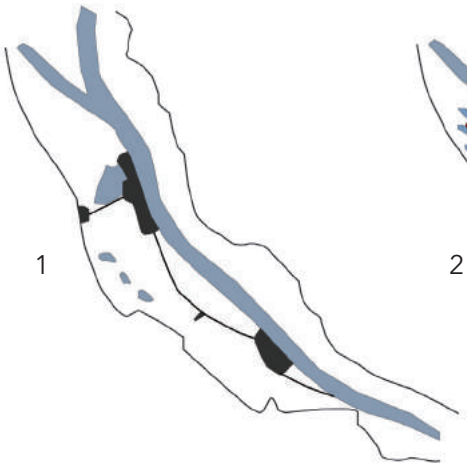
The second user group are the new floodplain inhabitants. To avoid creating a gated community, these people should not be isolated but have access to facilities and also communitcation with the city. The community gardens can be a place where the two user groups can meet, and even exchange products on a temporary level, promoting the local products and identity of place.

The last user group, the visitors of the area, should also be included in the experience. Creating a new welcoming centre that will allow them to know the area and interact with the locals is also imporant. In this centre there will be workshops where visitors can learn how to create their own bricks using local clay, and feel more connected to the area during their learning process. For this centre the most suitable location is the already existing mound with the Albert Heijn supermarket on the junction between north and south part. This location close to the city centre of Huissen, will allow visitors not only to engage in the floodplains, but also visit the village which will give a boost to its economy and make it more visible than it is now, as the back of Arnhem.

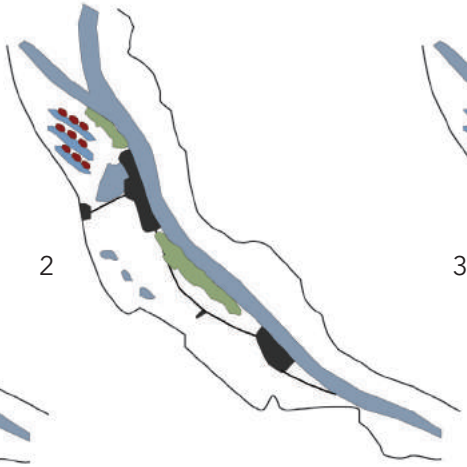
The goal is to transform the area through the use of the natural processes, based on the previously described mechanisms. Restoring the river dynamics and allowing more space for the processes to take place will transform the current image of the landscape into an integrative and diverse mosaic of interrelated functions.

Based on all the aforementioned, there are four main elements for the new vision. With each one as a starting point, I created four different storylines of how the area would be gradually transformed in steps, using the mechanisms of the methodology through a research by design approach.

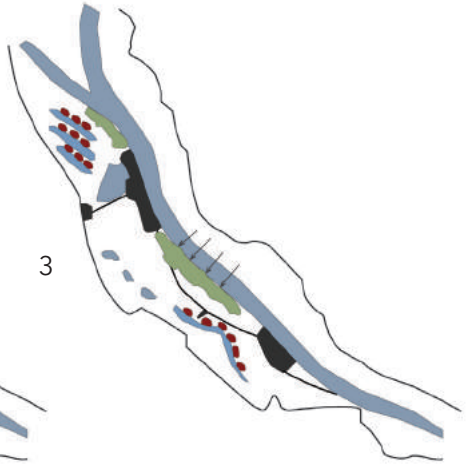




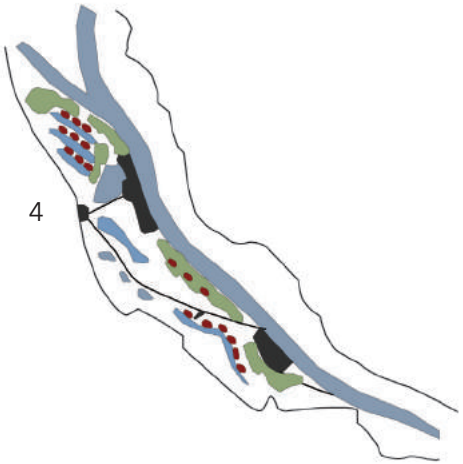
current situation



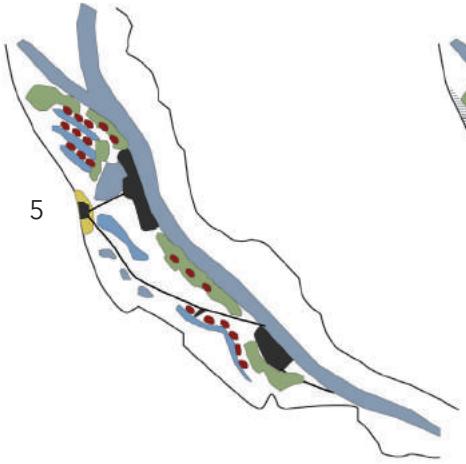
first houses through cut and fill principle - channels dug based on geomorphology patterns



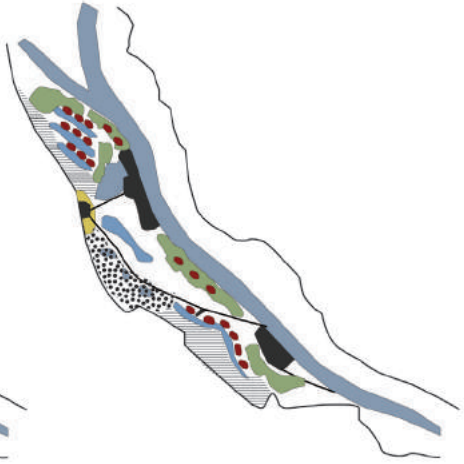
flood forest in the inundated parts - dig more channels for compensation



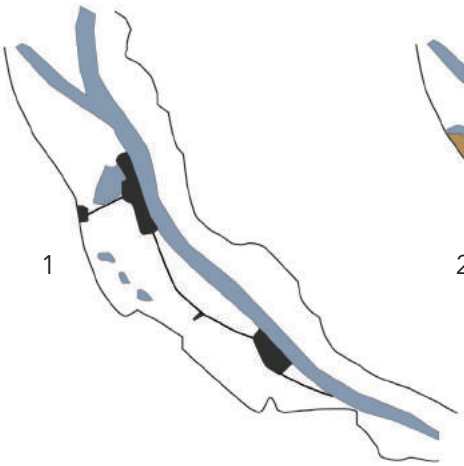
new mounds through cut-fill mechanism - move summer dike for more space for water



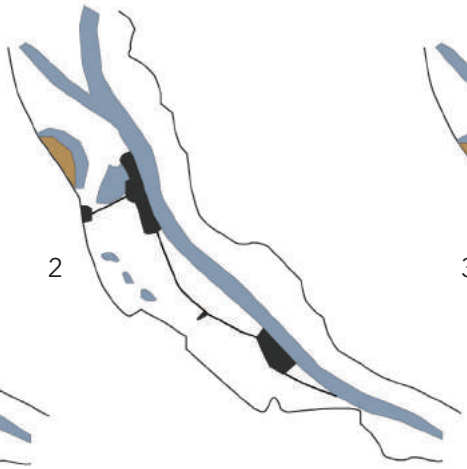
creation of new centre through gained material



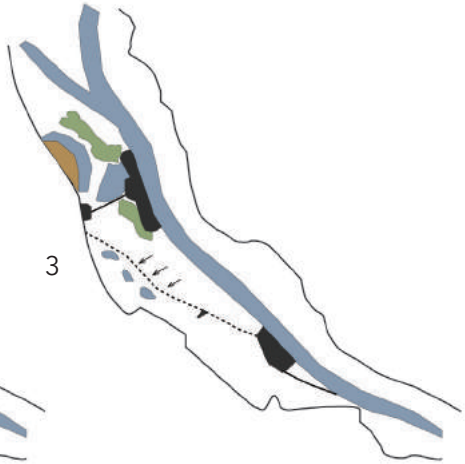
areas after interventions



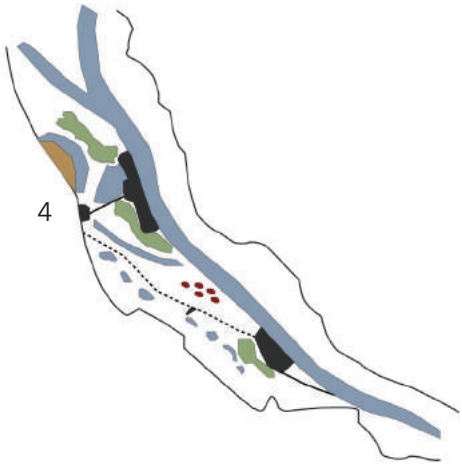
current situation



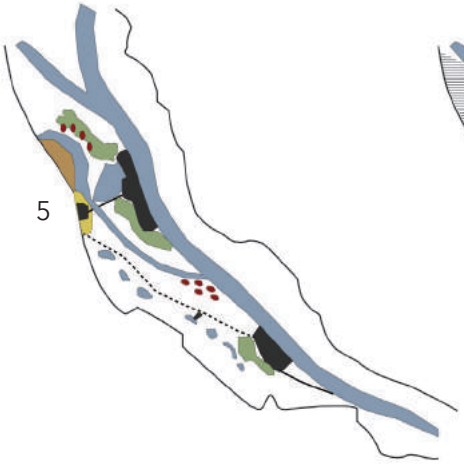
dig lake to get material to create the gardens (cut-fill mechanism)



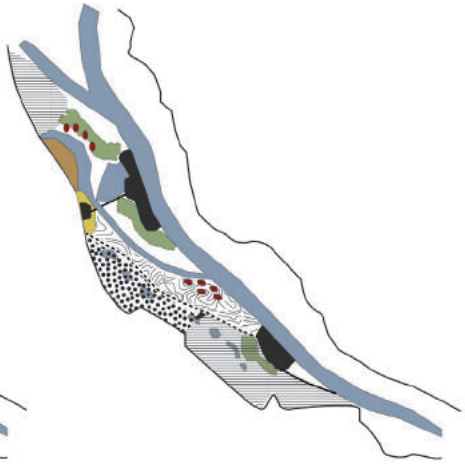
flood forest as a curtain - move summer dike for more space for water



dig extra channel and lakes (compensation mechanism) - living mounds increase water dynamics

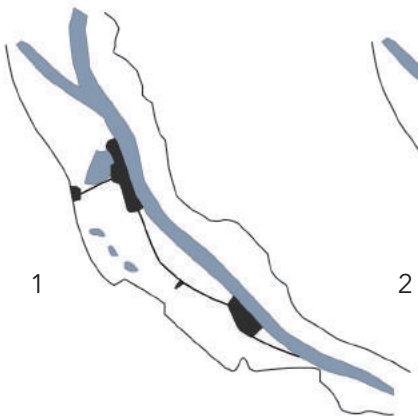


connect channel with lake and river and create new centre through dug material - sedimentation in forest - new mounds



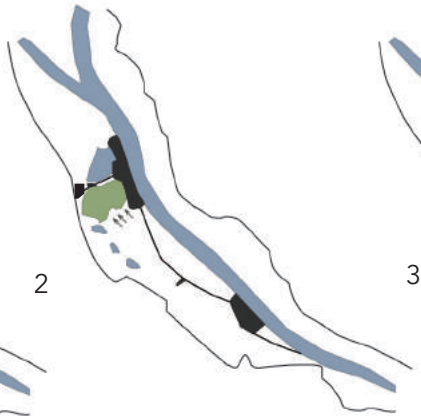
areas after interventions

STORYLINE 3 - Create new centre on the existing mound



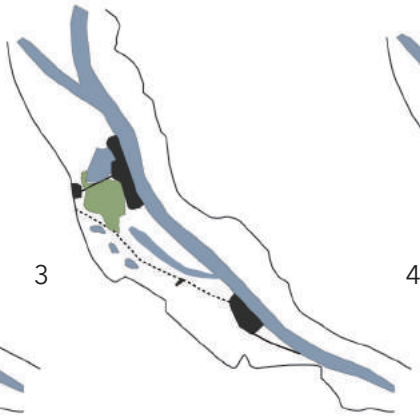
1

current situation



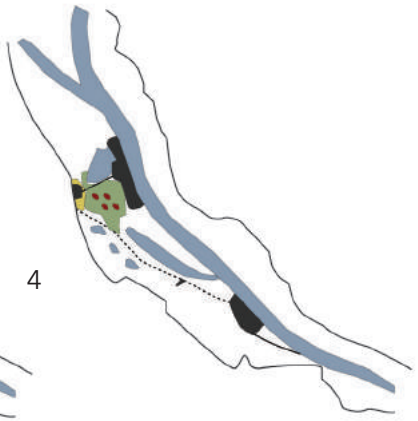
2

forest close to mound to get material through sedimentation



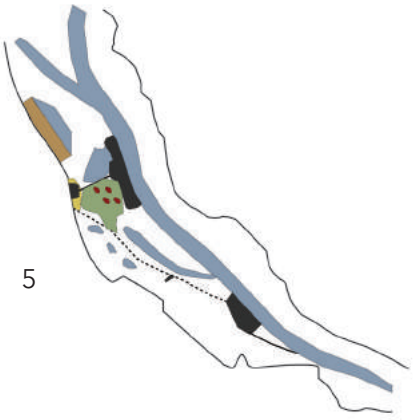
3

relocate summer dike to increase dynamics and activate processes



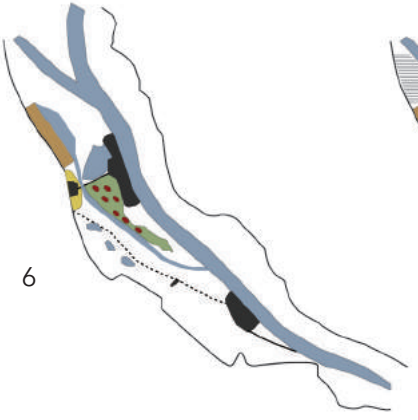
4

creation of new centre and first living mounds in the forest



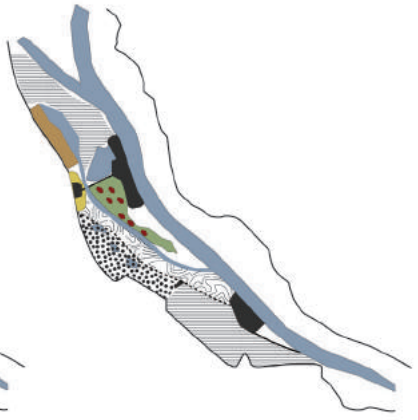
5

creation of gardens through cut-fill mechanism

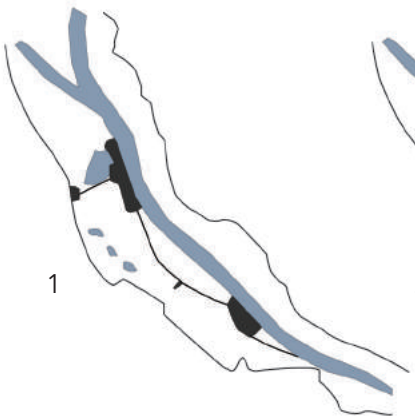


6

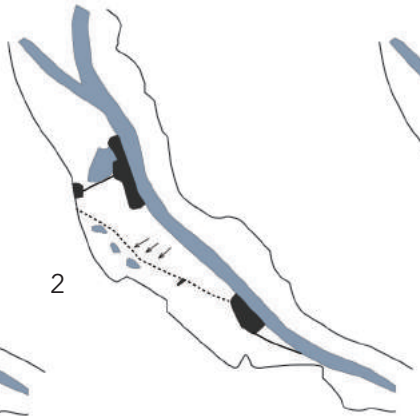
extension of flood forest and more living mounds



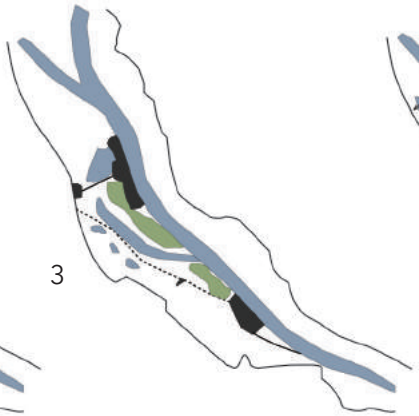
areas after interventions



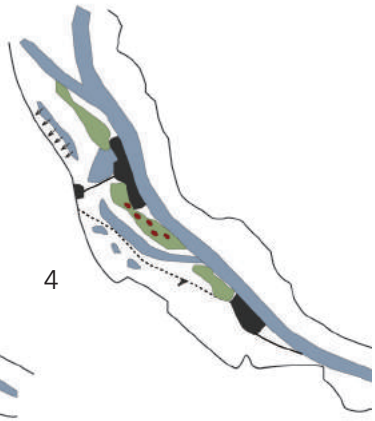
current situation



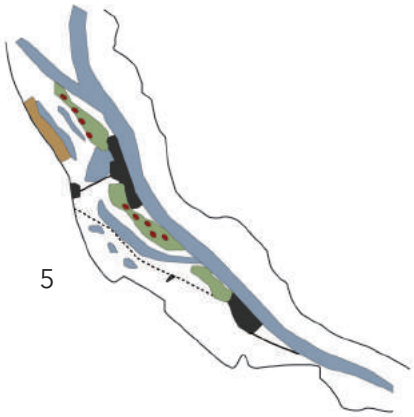
relocate summer dike to give more space for water



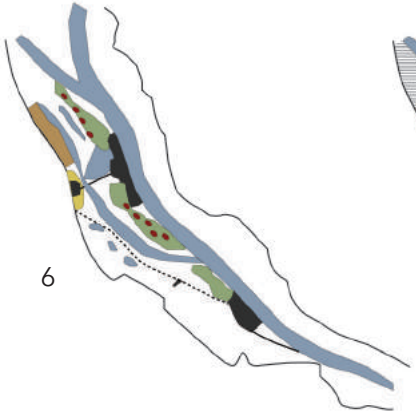
develop flood forest and dig channels for compensation



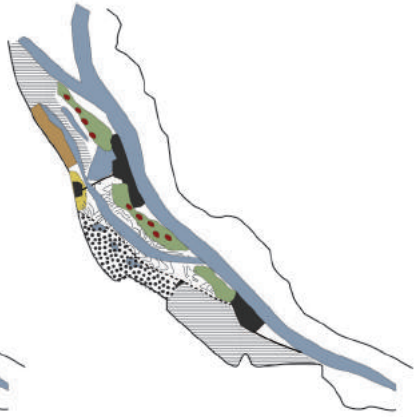
first living mounds in forest through the gained sediments



creation of gardens through cut-fill mechanism and more mounds in north forest



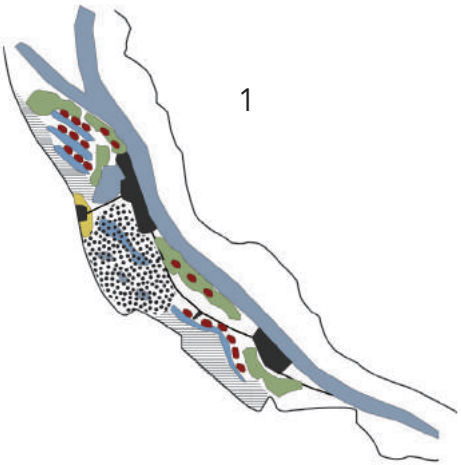
connect channels and create new centre on existing mound with the excavated material

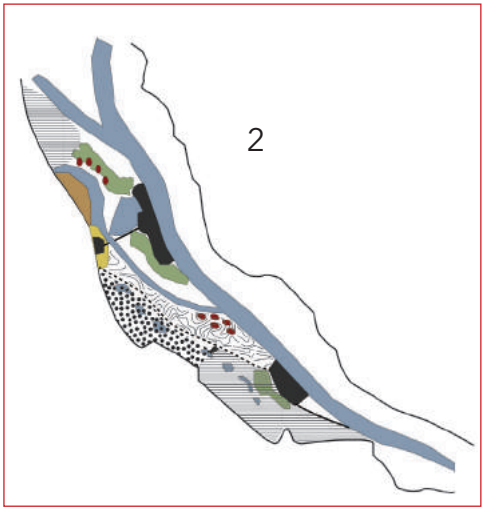


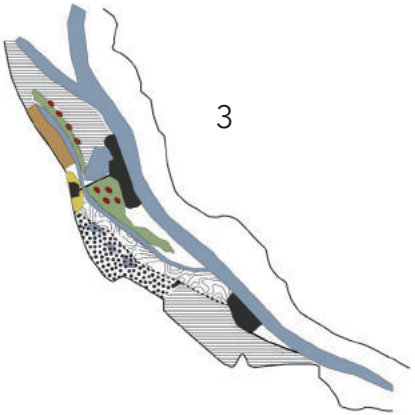
areas after interventions

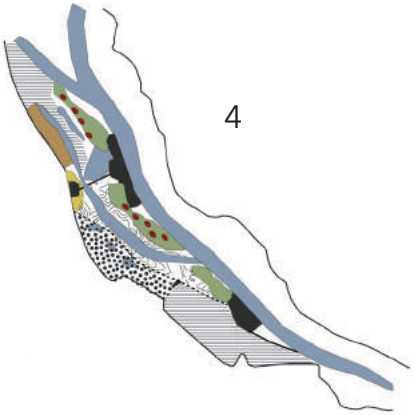
COMPARISON OF THE FOUR OUTCOMES

By comparing the different outcomes it is clear that the first one has the most striking differences, while the other three present a quite similar result in terms of created spaces and areas. Also, in the first one, important parts of the story, like the community gardens do not directly emerge. This is because thinking in the first place how to impose the living mounds leaves out several aspects of the process. Thinking that the project will be developed through the years and the connection between city and riparian zone is important as a first step in the time scale to transform this landscape and make people part of the changes, I chose to elaborate on the second storyline of the research by design trials, which starts from the creation of the gardens.









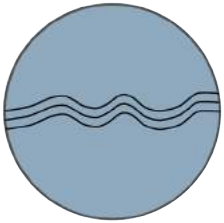
By now it has been clear that a main aspect of the project is to embrace the natural processes and make them part of the design decisions, allowing space for flexibility and uncertainty. The described mechanisms of the methodology provide tools to work with the potentials of natural processes. However, thinking in more local terms, there are several funcions as part of the vision that will be more fixed and whose location and design emerge from other socio-spatial characteristics. This difference between fixed and changeable elements is the biggest challenge while designing in such dynamic environments. There is a tension between processes and forms and they can both provide incentives for design.

On one hand, the natural procedures should be taken into account and in some cases are the driving forces of design decisions. For example, knowing the maximum water level in flooding situations can give a 'rule' in determining the height of structures, so that they are safe. Or the way the water flows can determine the placement of elements in the landscape. So the natural processes can create conditions for the architectonic decisions.

On the other hand, designers always have their own perception, principles and concepts while creating spaces. Decisions (for instance, where to place a meeting point for people, or where to direct the views) can be taken according to social, experiential or even environmental aspects, and then conditions are also created through the designer's intervnetions.

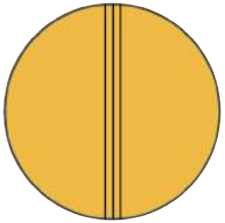
In this project, these two approaches are binded together. Landscape is perceived as a process that creates conditions but also it is perceived as an element with shape, form and qualities. For this reason, sometimes the natural processes lead the design through their conditions, other times forms and shapes are imposed to the landsacpe because of architectonic or social-oriented decisions and also create conditions.

In the next pages, the process of the plan development will be described in steps and the following icons are used to indicate in which cases a decision comes mainly from a process-oriented perception of the landscape or from a more architectonic-oriented approach based on other factors.



Process-oriented decision

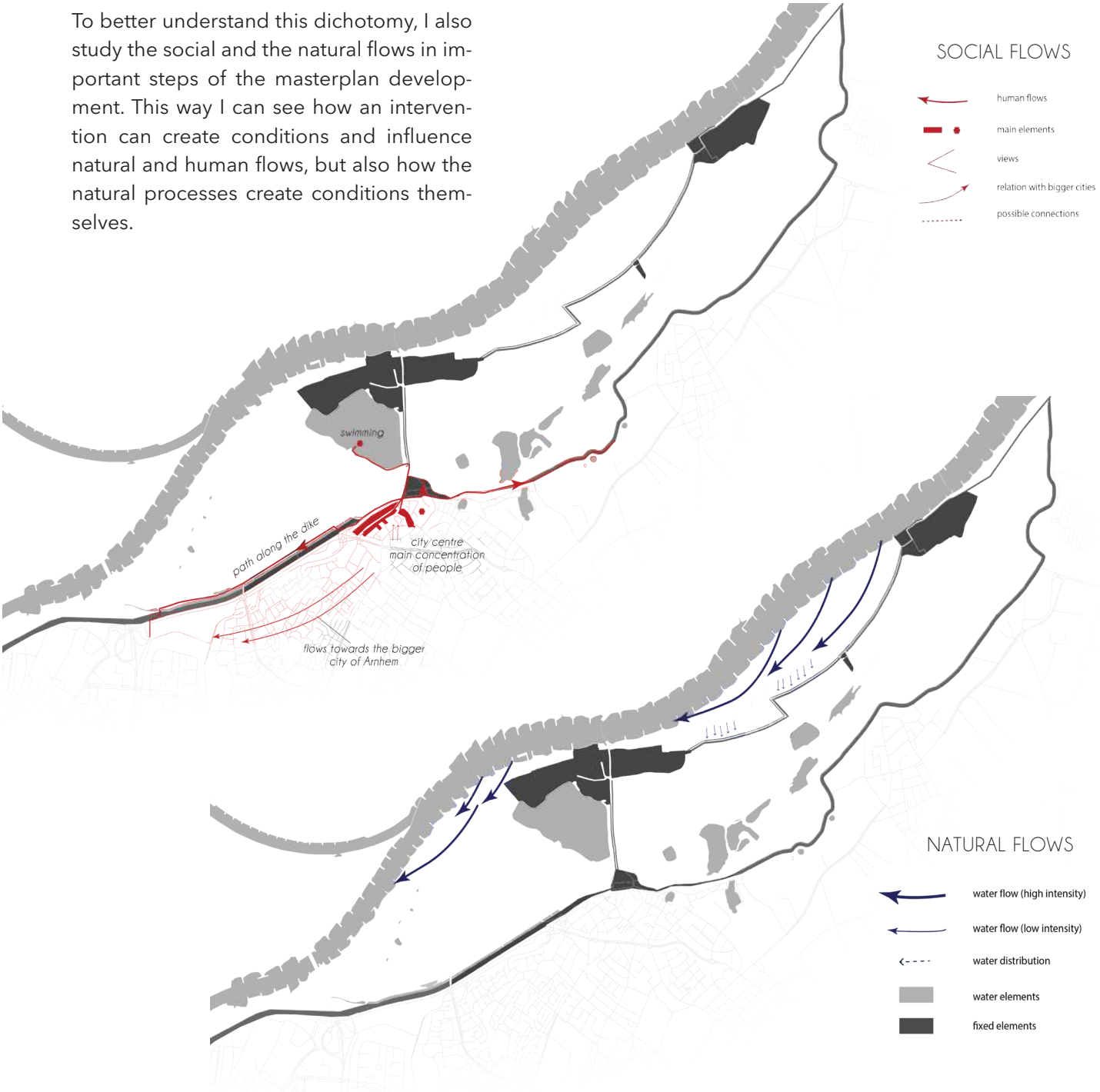
VS



Architectonic-oriented decision

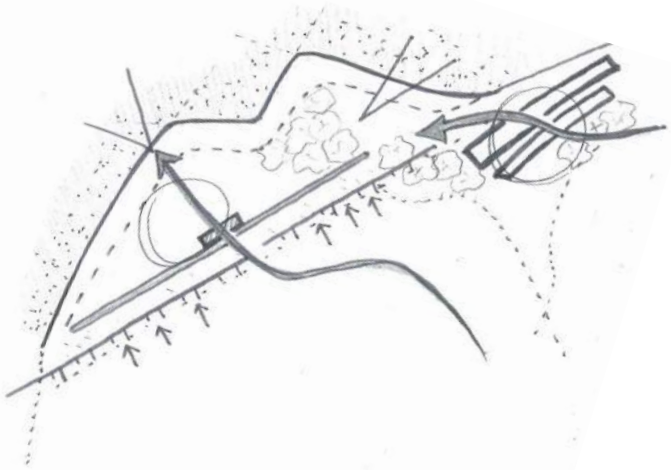

0
0.5 km
1 km

To better understand this dichotomy, I also study the social and the natural flows in important steps of the masterplan development. This way I can see how an intervention can create conditions and influence natural and human flows, but also how the natural processes create conditions themselves.

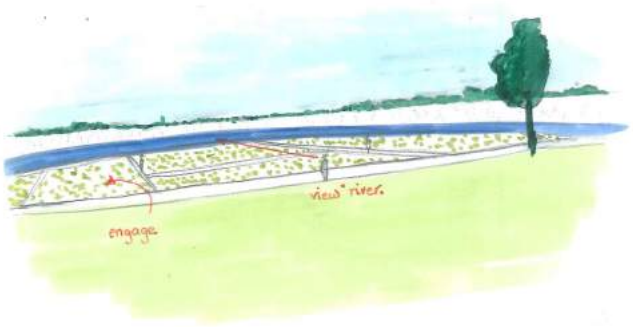


STEP 1 - year 0

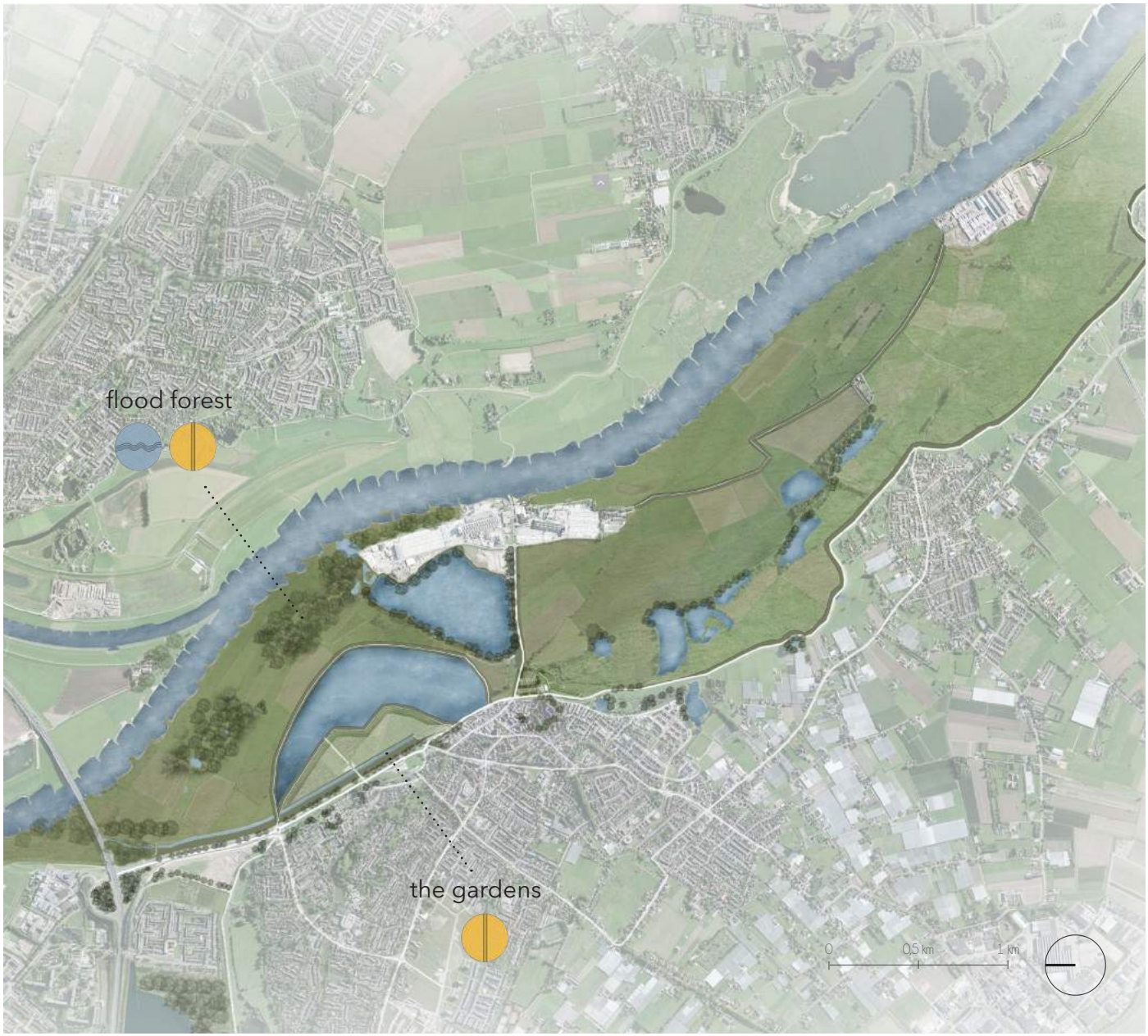
The first step of the new vision is to create the Huissen gardens, an extension of the city into the floodplains, with a function that engages people to the landscape of the "wet side". The shape was decided to feel as an embrace of the city towards the landscape, extending the most prominent city roads but also keeping some of the existing agricultural pattern lines of the floodplains. The amount of soil needed to create these elevated gardens was calculated so based on the cut-fill principle, a part of the floodplains around the gardens will be excavated and a lake will be created, that will also shorten the distance from the city to water.



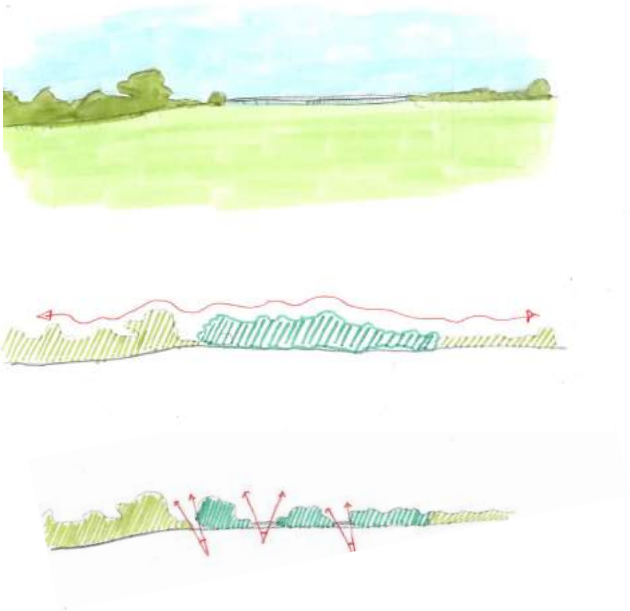
conceptual scheme



the gardens as an extension of the city in the landscape (concept collage)

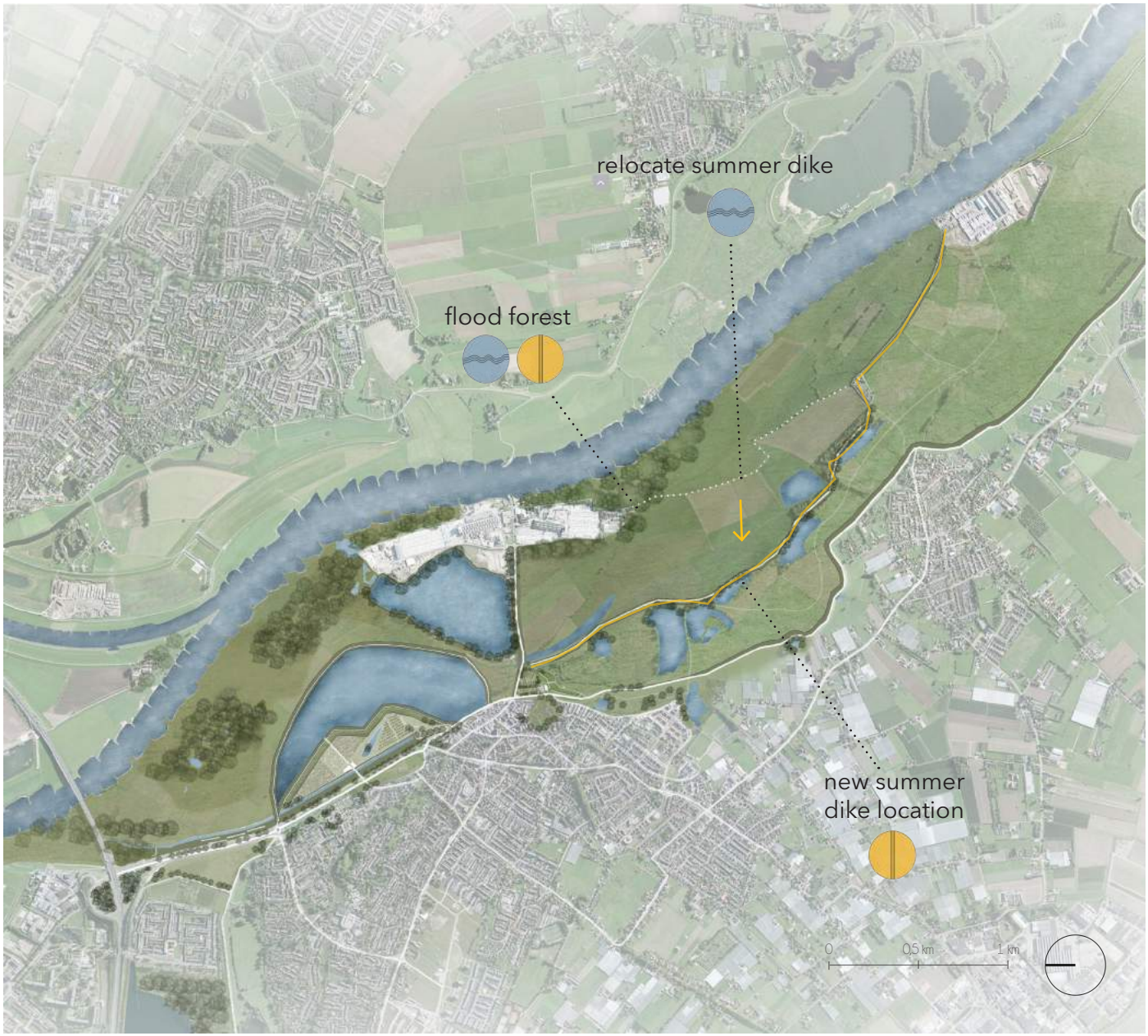

flood forest
the gardens
0
0.5 km
1 km

Since the gardens will be the new 'facade' of the city, the views towards the landscape are important. Now, there is not a clear horizon line but there are several scattered elements constituting the skyline. Planting a group of trees (willow, poplar) as a curtain will smooth the focal point from the garden to the other side, and by allowing openings at specific points, the view can be directed. The flood forest in this location can serve for this purpose. Because of its proximity to the river, it will also be more frequently inundated and thus the processes of the forest (water flow control, sedimentation) can be more direct.



forest as a curtain

directed view points through vegetation

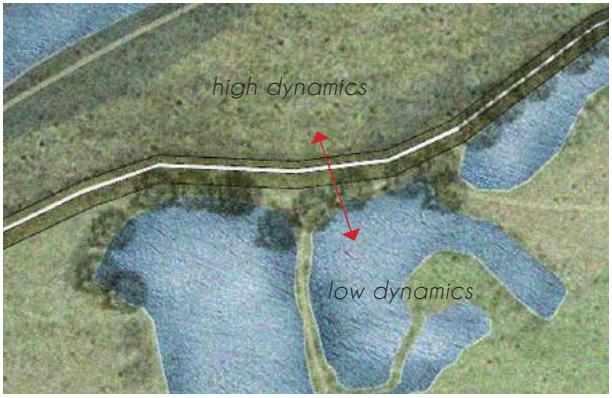

relocate summer dike
flood forest
new summer
dike location
0
0.5 km
1 km

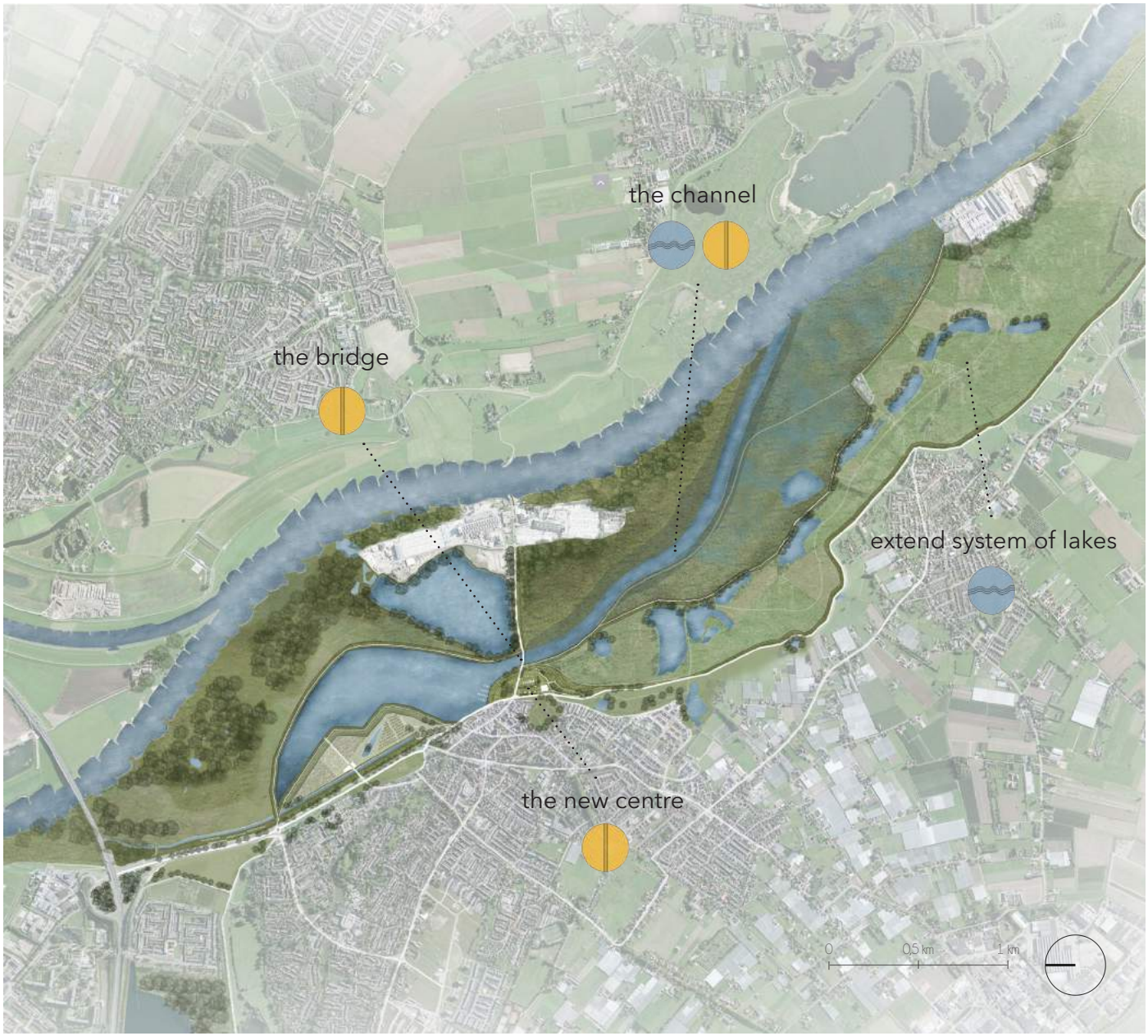
To increase the water dynamics in the area, the summer dike will be moved more inland, in order to allow more space for the water to flow. This way, new types of nature will also become possible, like river wetlands and more spontaneous species of flora and fauna, adjusting to the water conditions. An important part of nature in the area, though, are the system of lakes (described in the project area analysis chapter). The new location of the summer dike was decided to emphasize the contrast between the new high-dynamic and the existing low-dynamic nature, so it follows the line of lakes and trees that already exists.

When more material is needed to build the dike, small channels can be dug, based on the cut-fill mechanism. Then it is also possible to develop a flood forest in the high dynamic area, since there will be compensation for the water flow resistance through the digging. The flood forest in that location can operate as a "green wall" hiding the industry and taking care of the soil.

better flow of water with dike relocation

dike between two natures emphasizing the contrast



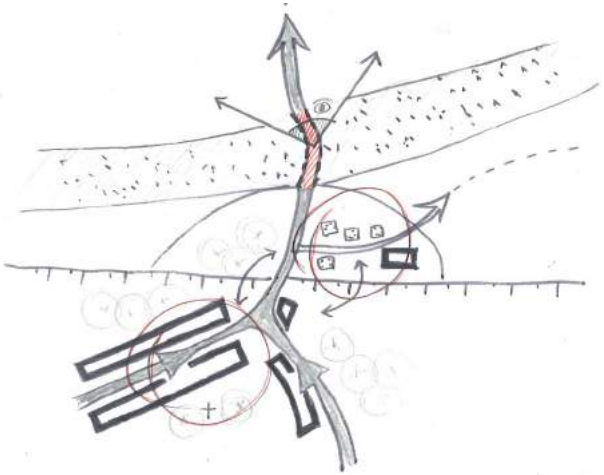

the channel
the bridge
extend system of lakes
the new centre
0
0.5 km
1 km

To emphasize the integrative character of the area, the small channels will be connected with the lake on the north part, creating a secondary channel that will also enhance natural diversity.

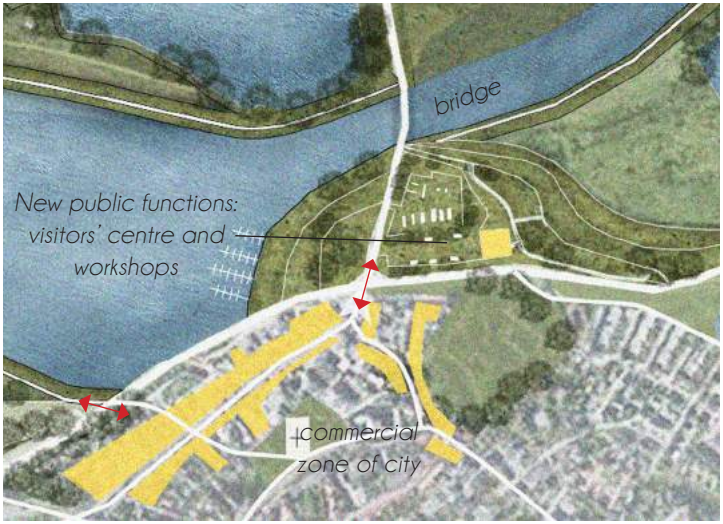
The dike that leads from the city to the industry is now a separating element. To achieve the integration, part of it will be turned into a bridge, to allow water to flow beneath and express the united landscape. At that area, where there is already the existing mound, a new centre for the area will be created. The supermarket (Albert Heijn) can be transformed into an urban observatory, while a visitor centre and a workshop area will be added, to welcome visitors and allow them to interact with local materials, be informed but also educated on the water issues. For instance, a workshop could teach visitors to create their own bricks from local clay and then use it to create a brick path in the area.

Furthermore, the forest will start to grow and create a 'forest island' between the industrial area and the new channel.

current situation *the new centre* *bridge as connection element*

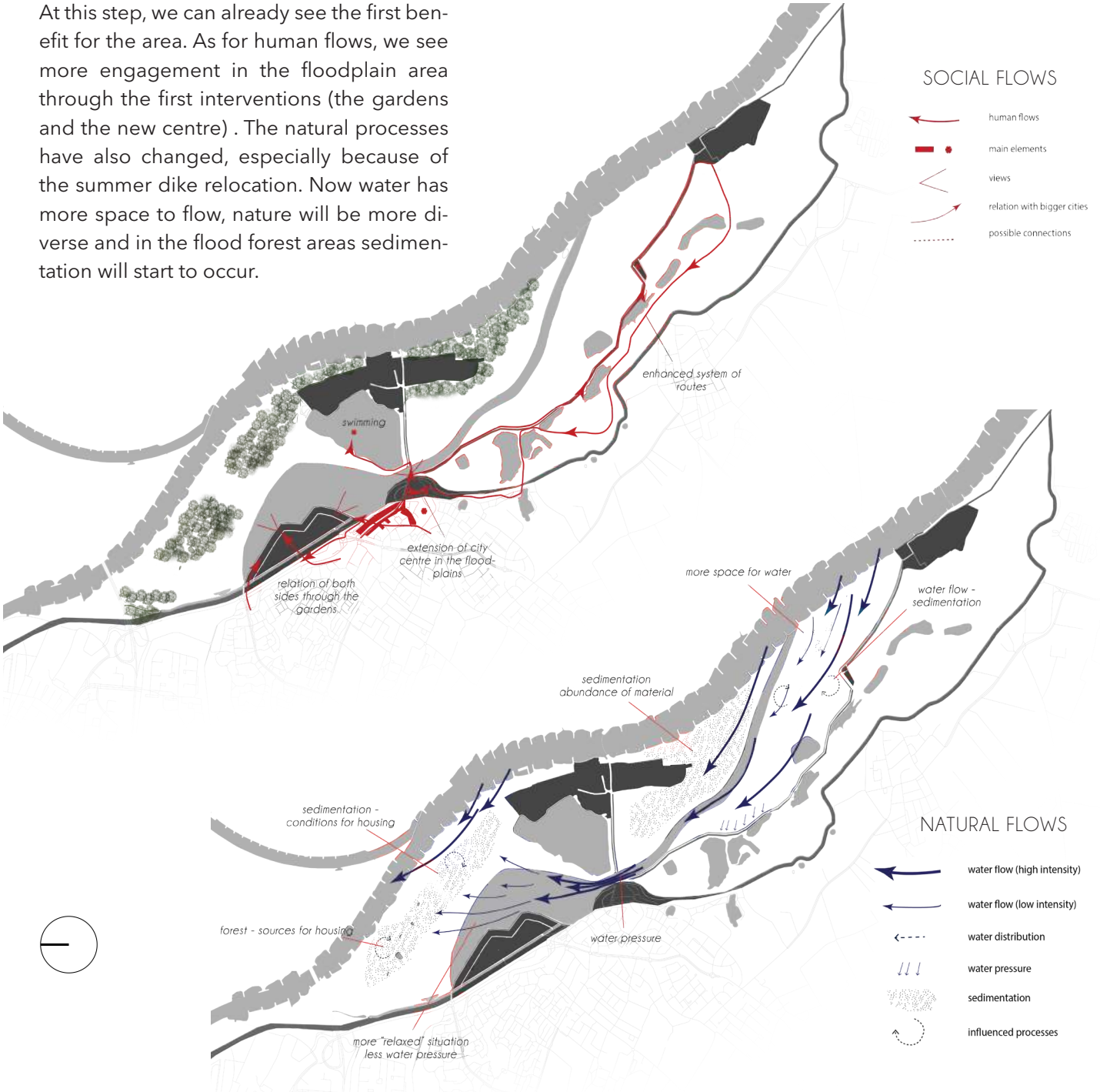


conceptual scheme



STEP 4 - Social and natural flows

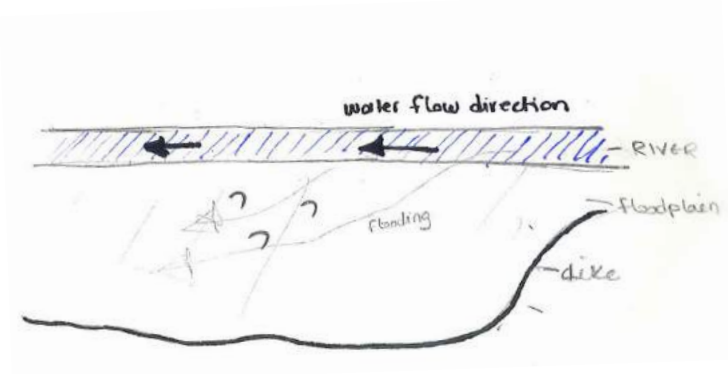
At this step, we can already see the first benefit for the area. As for human flows, we see more engagement in the floodplain area through the first interventions (the gardens and the new centre) . The natural processes have also changed, especially because of the summer dike relocation. Now water has more space to flow, nature will be more diverse and in the flood forest areas sedimentation will start to occur.

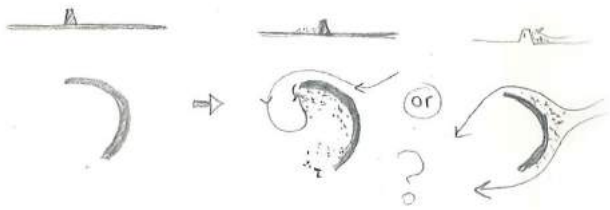


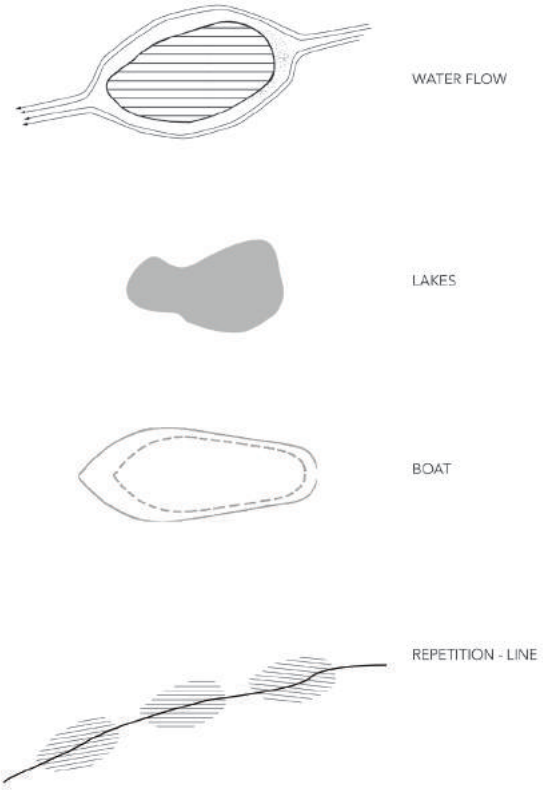
With these transformations and created conditions the new living environment can graduallystart to develop. In this step the natural processes play the major role. Based on the study of natural flows, I tried to understand what the landscape can provide for the houses but also what the houses could give to the landscape.

On one hand, the flood forest gathers sediments and creates higher grounds which are more suitable for habitation. Also, the forest can give necessary resources for energy and for building material. On the other hand, placing an element or unit in the landscape will diverse water flow. The creation of the living mounds can then be an opportunity to further increase the area's dynamics by influencing the water flow and sedimentation. By placing barrier walls, the water flow can already start to divert but also gather more sediments during the flashing out of water after inundation in the specific locations. So the mounds can gradually start to form with the water processes.

The shape of the mounds was decided first of all to better respond to the water flow and secondly as a symbolism, reminding of the system of lakes that already exists but also ressembling a boat when the area is flooded.

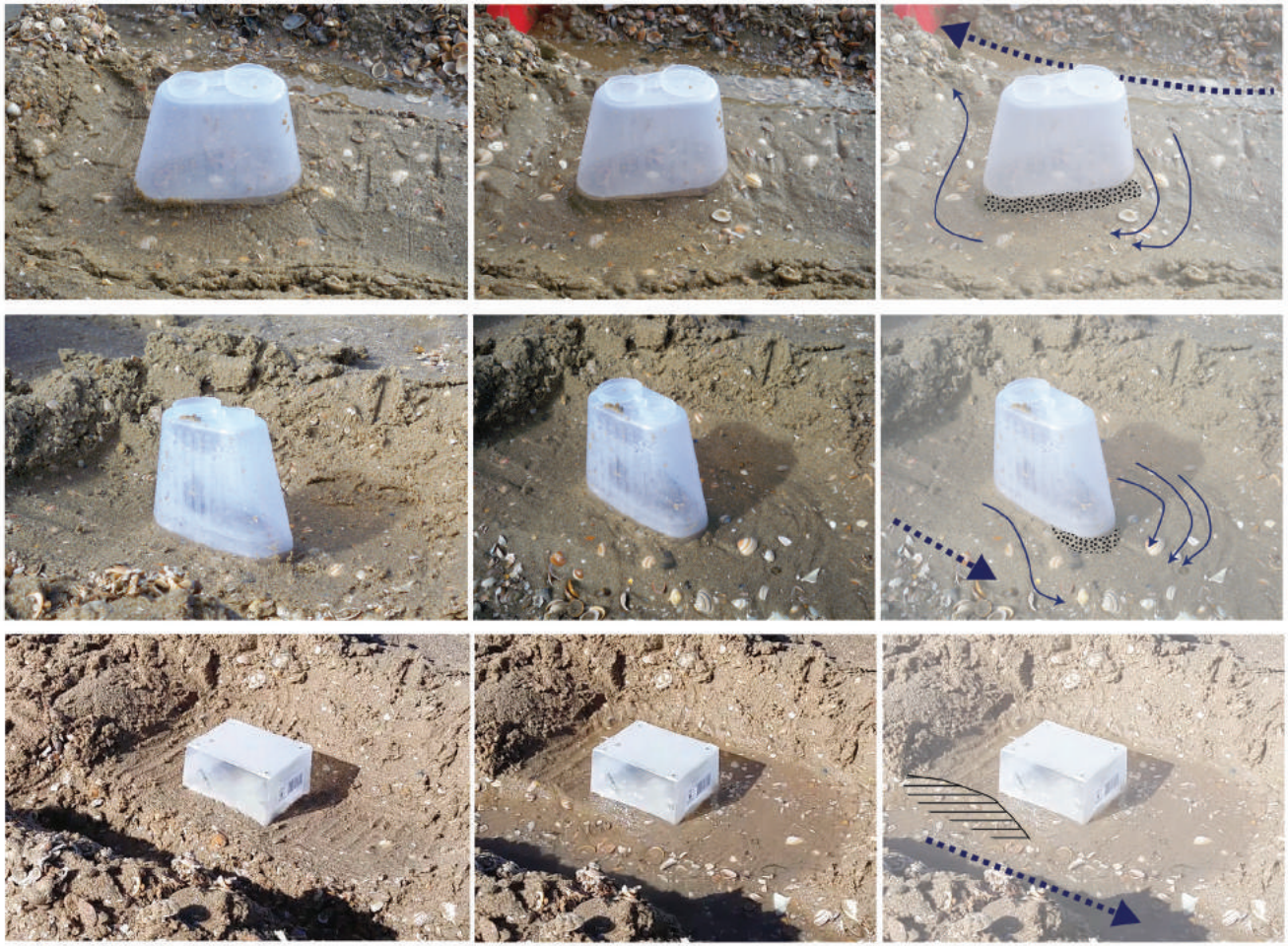






WATER FLOW EXPERIMENT

The chosen shape was tested in a real-time experiment in Scheveningen beach, by creating a system that ressembles the river and the floodplains. The oval shape was compared to a box shape, and the results showed that the oval shape facilitates the water flow around the element, and also has more effect on the area around it in terms of movement of sediments. On the contrary, the box shape didn't have so clear results.



SETTING

The chosen location for the experiment was Scheveningen beach in Den Haag, because of the abundance of available materials (sand, water, shells...) that would be needed. A structure was constructed to ressemble the river and the floodplains but not in scale, rather in a more abstract way.

ELEMENTS


round shape structure


box shape structure

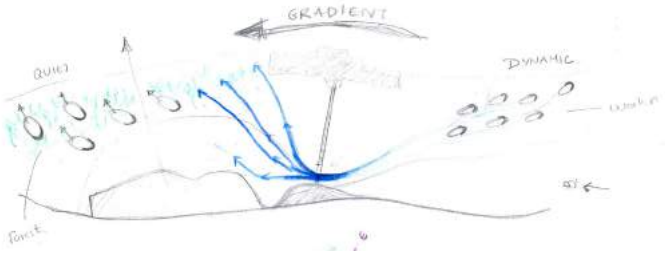

shells to stabilize sand

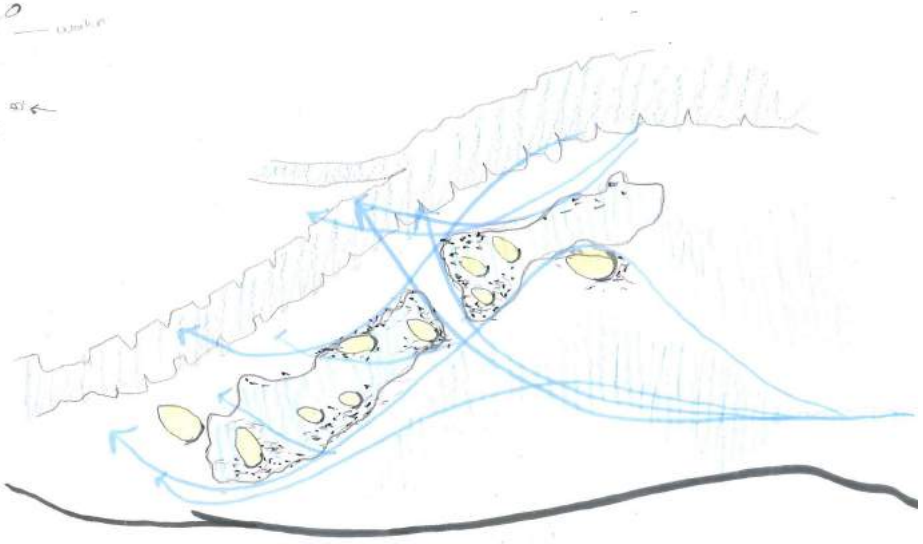

bucket to pour water

QUESTION
How is water flow affecting and transforming the floodplain terrain after a flood? How do structures of different shapes and placement influnece this landsacpe transformation?

METHOD
I used 2 plastic elements of different shape, one box and one more rounded to represent possible floodplain structures that would block water flow. To make sand more stabile and avoid erosion as I pour water, I used shells to make it more stable. To represent water flow I poured water with the help of a bucket. I let the floodplains flood and then gradually the water was gone, as it happens in reality.

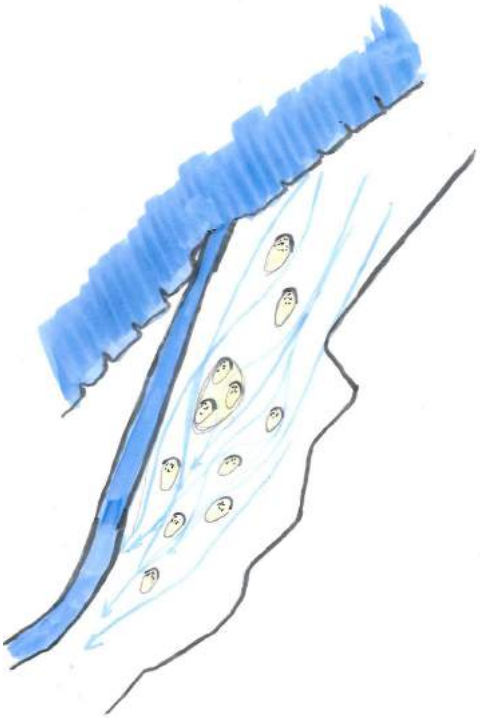
Based on the described study of natural processes and suitable locations, two mound 'typologies' arise in terms of creation and relation to the landscape. The mounds in the forest will be created by people with the sediments gained by the trees and clay from the area. So the size was decided to be easy to organize as a community. Also, it is important to take into account that sediment gain occurs through time and not all mounds will be raised at once. This was another reason to choose for a smaller size capable of hosting a number of families and not a village mound, that would constantly need to change through expansion.

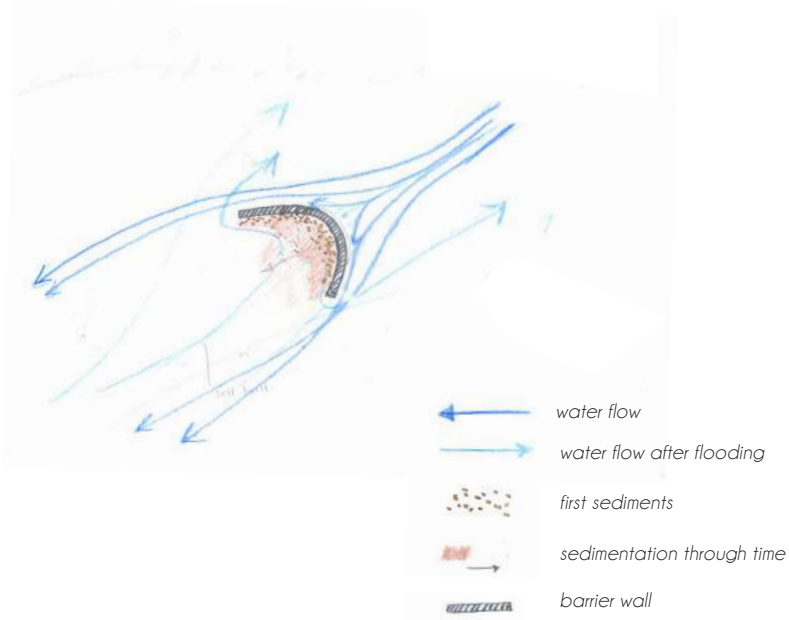




Research by design sketches on water flow and mound positioning

The second typology is the mounds that influence water flow and are situated on the south part of the floodplains, close to the new channel. These mounds will start to develop by placing the barrier walls in the first place, that will affect water flow and will initiate sedimentation in the specific locations, gradually raising the ground of the mounds. The rest of the desired shape and height will be finished by people themselves. In both cases, the location and orientation of mounds came through research by design sketches, based on an estimation of the processes.



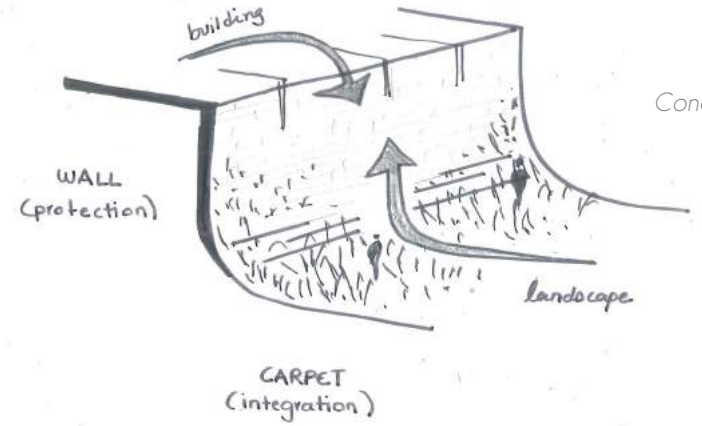


THE BARRIER WALL

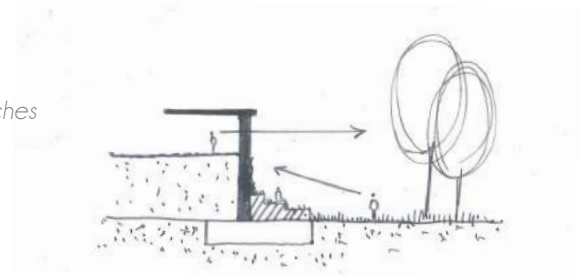
The barrier wall is the starting point of the second mound typology, but will also be essential for the forest mounds. Although in that case it will not initiate the creation of the mound, it is needed in order to keep the mound stable and safe from the pressure caused by the water during flooding events. In both cases, the wall will be a multiplied, visible element so it can be seen as a landmark in the landscape.

The wall will express its role as a protection element that should be firm and stable, but also will be integrated in the landscape, allowing nature to develop in it (bird nests, spontaneous vegetation) and people to approach it. The concept is that the ground 'carpet' will continue up to the wall, but also the buildings of the mound will be related from roof to wall. (This will be elaborated in the next chapter).

the wall as a landmark in the landscape



Concept sketches

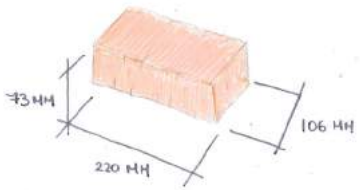


protection but also integration
private vs accessible

spontaneous vegetation
(source: goo.gl/Xf2nAX)

bird nests
(source: goo.gl/Xf2nAX)

materiality - local brick



public furniture structure

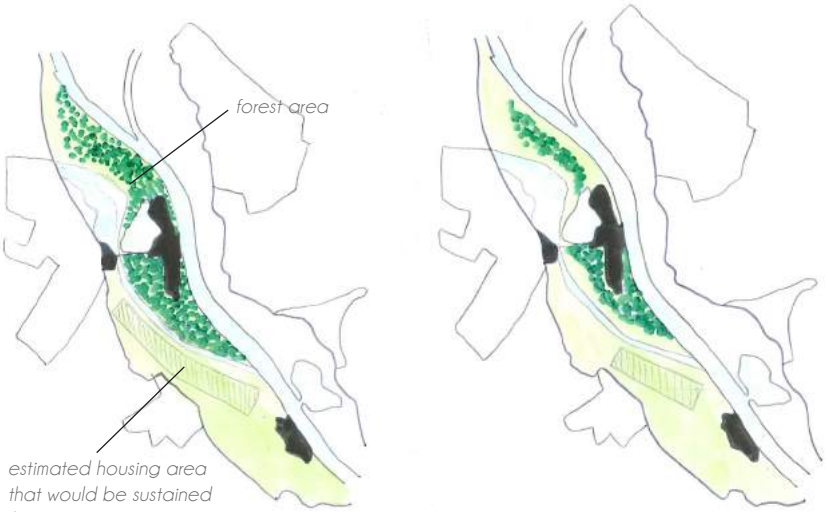
supportive element for wall construction

HOW MANY HOUSES?

The process of the living units will be created gradually through the years (so not all mounds will be built at the same time). However, a maximum capacity of the area should be estimated. Based on the sustainability principle of these housing units, the most important elements to consider are the biomass energy coming from the trees, the food and the water consumption. The last two can be dealt with in a local level, on each mound. So for the whole area the most crucial thing to consider in terms of capacity is the biomass.

By calculating the average consumption per family and the area of forest that is related to it, a maximum housing capacity of 613 houses was estimated that could be sustained if we utilized the maximum capacity of forest in the area. However, relating this to the water flow, these numbers would cause a problem in the area in terms of water management because both the forest and the mounds would form obstacles, impeding water flow. Based on forest area proposed by the plan, the number of houses that can be sustained is 265, which is more acceptable in terms of water flow. In the current plan, around 100 houses are proposed, which would practically be tested and if more capacity was possible, the process would continue through time.

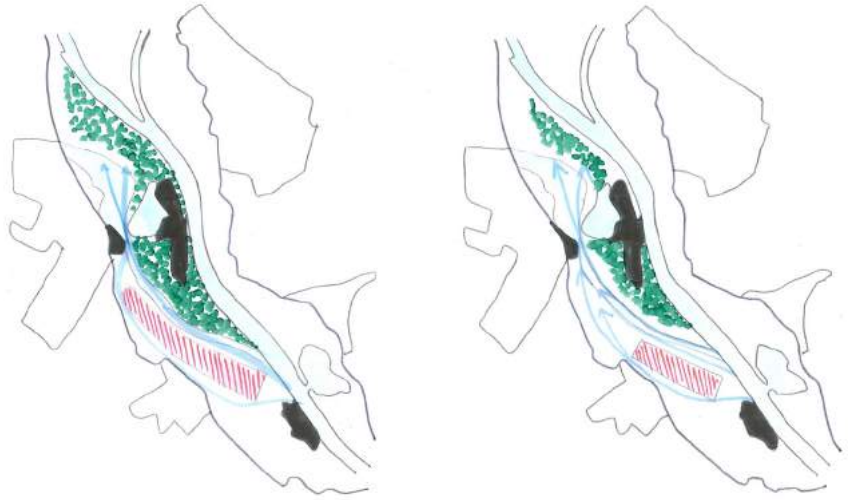
1. Forest and schematic area of houses that it relates to.



extreme situation

current plan

2. Water flow related to the estimated schematic housing area.



Biomass

Average need per year for a small house (100 m2) = **8430 kWh**

For having wood pellets as a fuel, it is estimated that the provided energy is **4800 kWh / tonne**

A working forest, can annualy provide **2 tons per acre**

Which means that one family in a small house would need 8430 kWh /4800 kWh/t = **1,76 tons of wood**

3561,36 m2/house

Food production

An average family of 4 needs about **200 m2** of garden to sustain itself

Succession planting is also a good solution to save place. A combination of different edible seeds can be planted, according to their compatibility.

If there are also **animals**, there should be place for chicken, goats etc.

To be **self sustained**, the animals also need to be fed.

200 m2 / family of 4

Water

Each person is estimated to spend about **80-100 gallons** of water per day.

This number includes water for taking a shower, flushing toilet, washing hands, having a dish-washer etc.

For a **family of 4**, it is estimated that this number is about **200-400 gallons per day** (or 0,757 m3)

200-400 gallons per day /family of 4

STEP 5 - masterplan year 15

Taking into account the previous research, calculations and research by design experiments, the plan can be expressed spatially. The first step would be to place the barrier walls in the river area, but also some of the forest mounds could start to be built. At this point the area would alreary operate as a multifunctional, sustainable landscape, embracing the river processes and enhancing its local identity.

In addition, differnt user groups can interact through the more stable (new centre, gardens) and the more dynamic elements. The existing cultural and historical elements of the area will be part of this experience. For example, the Brouwketel can operate as a cafe-stopping point for visitors, while the brick factory can be the one that produces the materials from the local resources. Nature will also improve, by having different kinds of areas: riparian forest, wetlands, channels, lakes, seepage ponds, agriculture. Diverse species will then be attracted and the ecological diversity will increase, respecting the fact that the area is part of the Natura 2000.

The plan is a combination of static and dynamic elements, of processes and forms. In the first steps of the most fixed functions, the decisions are more architectonic-oriented while in the stages of the mound creation, the process leads more the design through the created conditions.


ANGEREN
HUISSEN
0
0,5 km
1 km

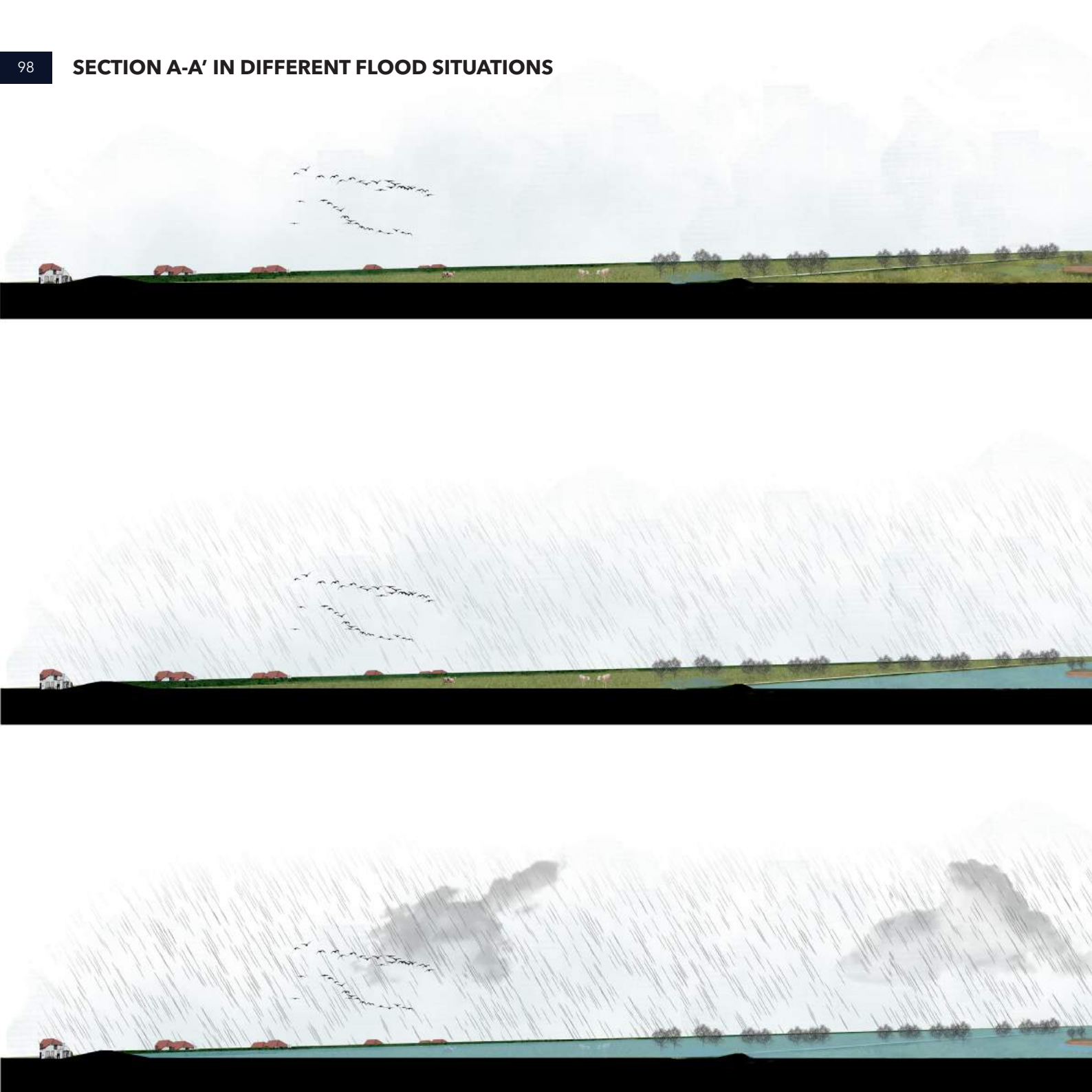
STEP 6 - masterplan year 25+

Through the years and as more sediments will be gathered with flooding events, the fixed elements will stay the same but the mounds and forest will alter and expand. This plan depicts an image of the area in the longer term.

the plan in different flood situations


A'
A
ANGEREN
HUISSEN
0
0,5 km
1 km

SECTION A-A' IN DIFFERENT FLOOD SITUATIONS



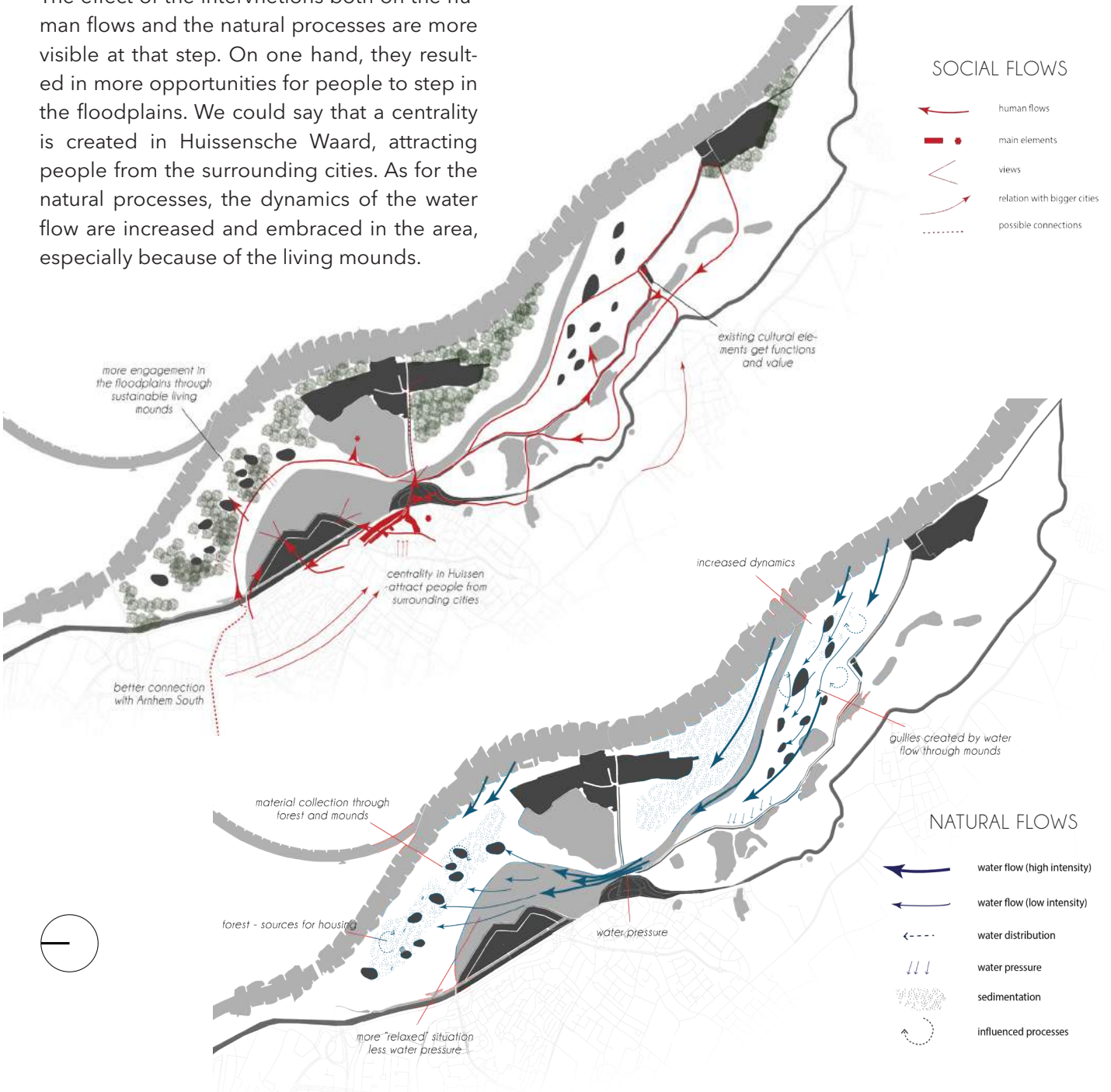

8.5 +NAP


12 +NAP


14.73 +NAP

STEP 6- Social and natural flows

The effect of the intervnetions both on the human flows and the natural processes are more visible at that step. On one hand, they resulted in more opportunities for people to step in the floodplains. We could say that a centrality is created in Huissensche Waard, attracting people from the surrounding cities. As for the natural processes, the dynamics of the water flow are increased and embraced in the area, especially because of the living mounds.



Northern part of the floodplains - intermediate scale

ADDED VALUE TO THE AREA - NATURE

More specifically, the plan is developed in layers of nature, elements and flows of people and water, that together create the new multifunctional, dynamic river landscape through the described approach of working with processes and more architectonic interventions. Different areas of nature create a mosaic in the landscape, and attract a variety of species. In the parts that are frequently flooded, spontaneous vegetation and aquatic species can appear, while in the flood forest beaver and singing birds will find a friendly environment to settle. The already existing system of lakes is also extended and expressed more in the new plan, as an important natural area.

riparian forest

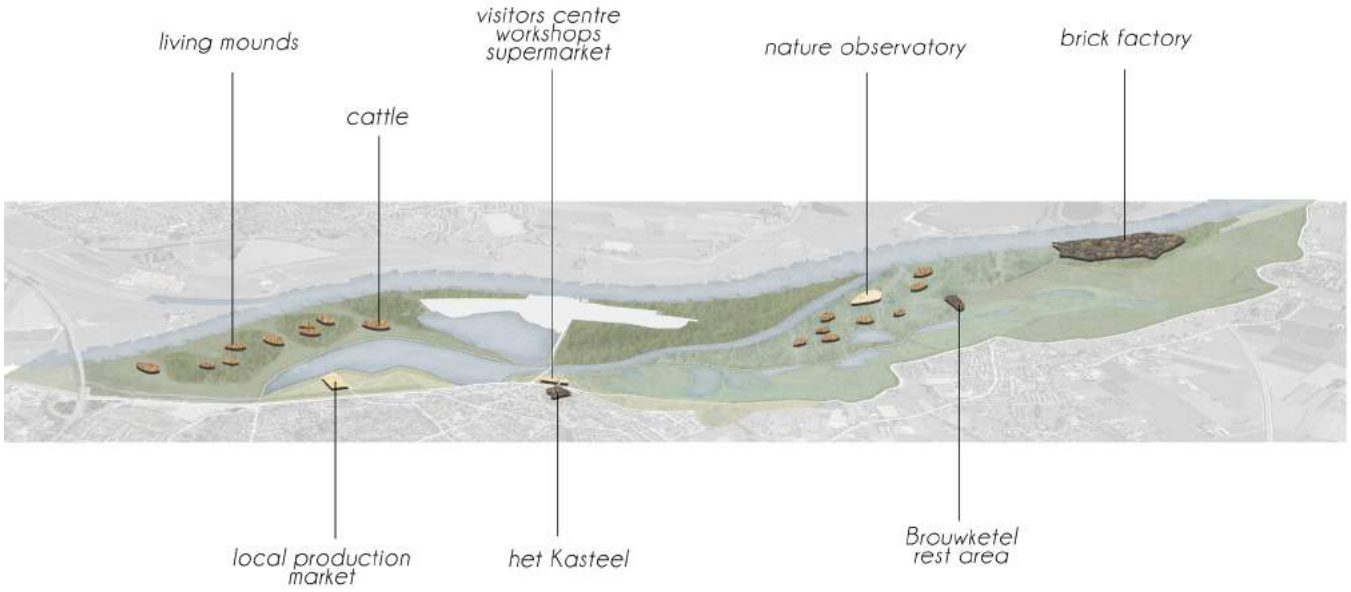
high dynamic-
spontaneous nature

"urban" nature

low dynamic nature

agriculture

As for the imposed structures, existing cultural elements (like the Brouwketel and the brick factory) will be bined with the added functions (the new centre, the market of the gardens, etc) and create a strong identity for this place, that is based on its inherent qualities and characteristics but also allows space for flexibility. The new functions as well as the created living mounds also relate to existing parts of the inland side (the village church, the old castle etc), so that apart from giving new meaning to the floodplains they will enhance the relation between the two sides and attract more people to Huissen and Angeren.



ACCESSIBILITY

RESIDENTS

access roads to houses

boat routes

VISITORS

5 km route

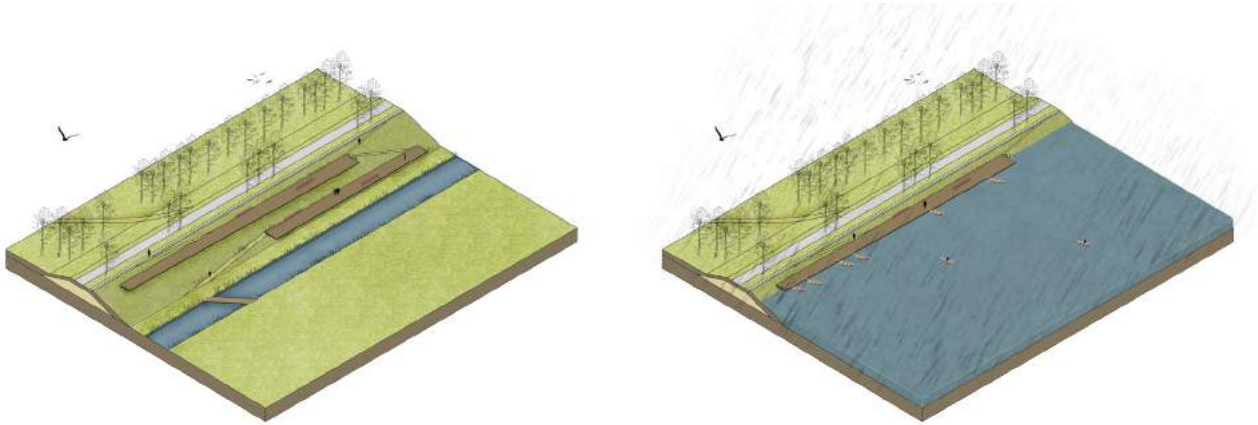
10 km route

other public route

Accessibility is important both for the people who will live in the floodplains (the new residents) but also for the visitors and the local inhabitants of the surrounding cities and villages.

Because of the temporary water conditions and the water level fluctuations in the floodplains, differnt means of transportation are needed. When the area is dry, usual bike and foot paths can be the main access roads for all people. When the area is flooded, residents can use boats to reach the mounds. Parkings for cars will exist in different places close to the dike, to minimize the walking distance. Boats will be parked in platforms on the dike designed in different levels, which can operate as public space in dry situations. This way, the dike also gets a multifunctional character, both practical and social.

For the visitors, a 5km and a 10km route are designed, passing through all the important elements of the area (the new centre, the mounds, the Brouwketel, the brick factory etc) and also through the different areas of nature, the more static and the more dynamic. This way visitors can experience the diversity of the area and appreciate the landscape. Through different water events, the experience also changes. The summer dikes can be accessible until water exceeds 13 +NAP, which means that in some situations people can walk around the water.



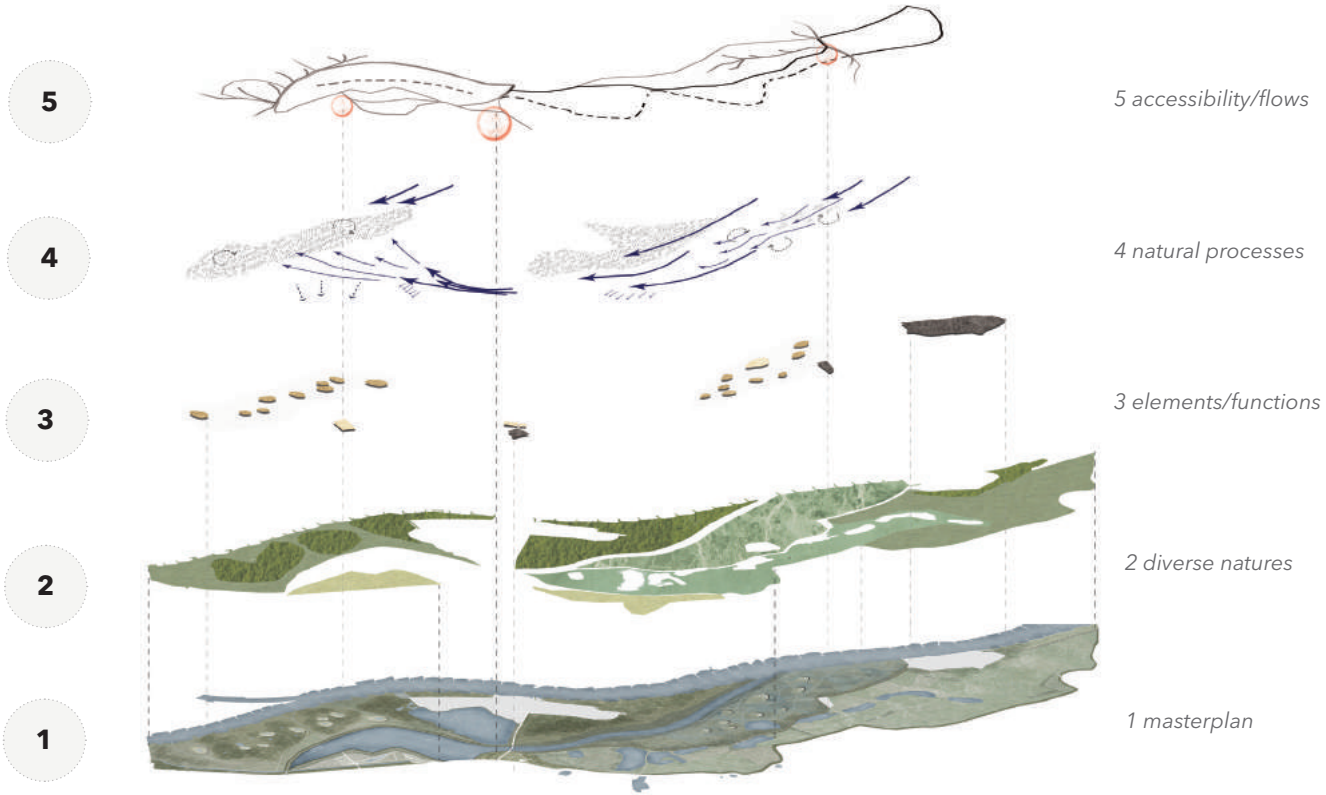
The dike will become more multifunctional, with platforms that serve both as public space but also as places for boat parking in the extreme water events.

BENEFIT ON LOCAL AND REGIONAL SCALE

Apart from the benefits on the local scale, the project also has an impact on the regional scale (area of effect). Until now, Arnhem and Nijmegen are the two big cities-poles, while the surrounding smaller cities and villages, like Huissen, Angeren etc, are situated 'at the back' of the big cities, with nothing helping them pop out and develop economically.

The park Lingezegen designed to link these two poles, operates on the inland area but is not extending till the river. In addition, in the north part there is now the Stadsblokken-Mijnerswijk park, the 'back garden of Arnhem' as it is called, and also the Gelderse Poort area on the south, that can be seen as important zones of ecology, recreation and attraction.

The new design of Huissensche Waard can be an addition to this system of reference and connection points, enhancing the relationship among the smaller cities but also between the smaller cities

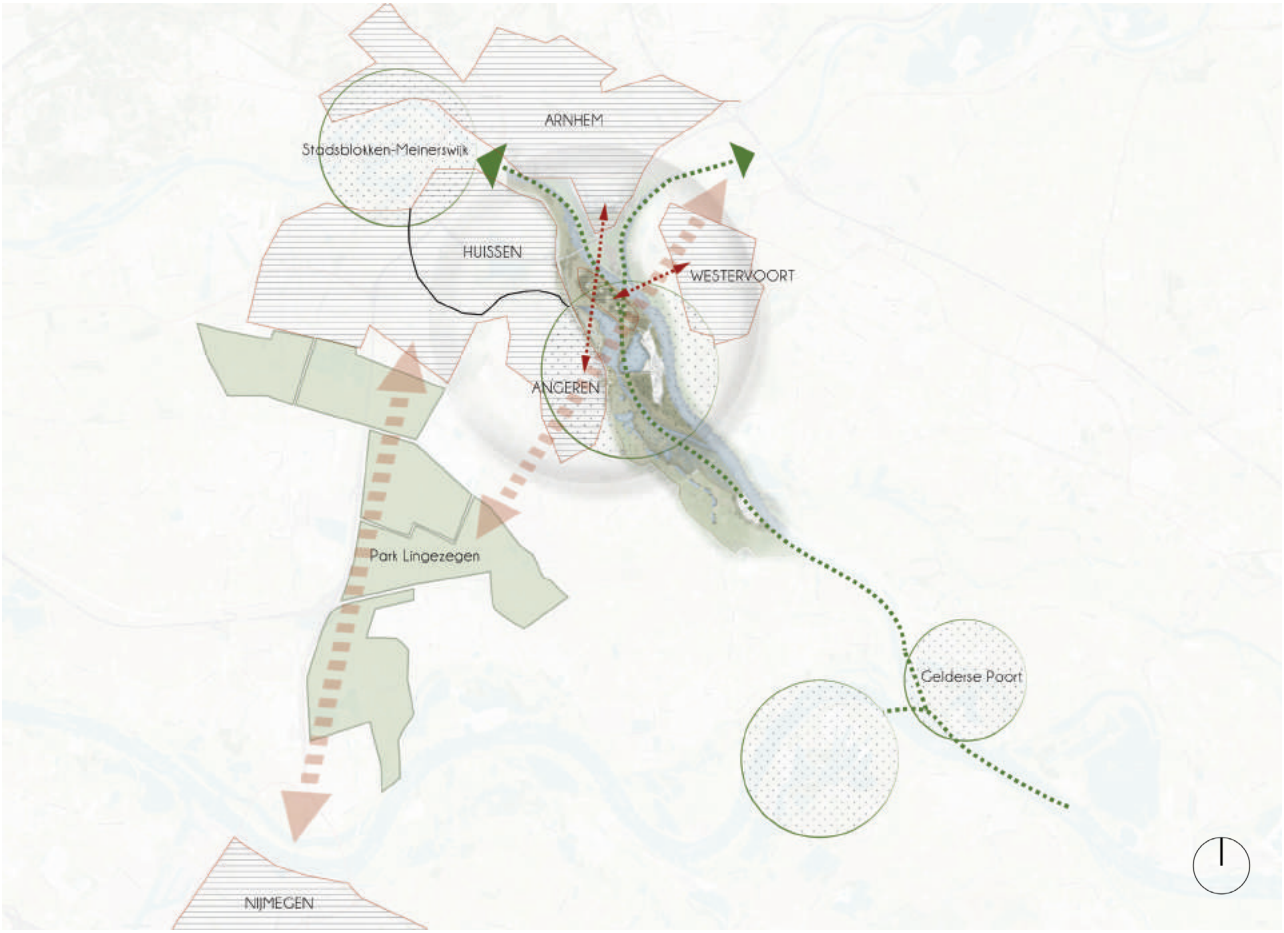


Masterplan in layers

and Arnhem. By attracting people away from the big centres, the economy of the smaller cities will increase and they will become more recognizable and competitive.

Furthermore, there is the possibility that part of the living mounds will operate as short-stay holiday houses for eco-tourists who want to experience living in this environment for a short period of time. This way, the appreciation of nature also raises, together with the economy, and the respect of people for natural environments, as well as the awarness towards flooding and its risks.

Last but not least, enhancing the quality and diversity of nature through the diverse areas will be an opportunity to restore the missing ecological link between north and south of the project area. So the benefit is not only socio-economical, but also environmental.



The effect of the proposal on regional scale

06 DESIGN PRINCIPLES & APPLICATION

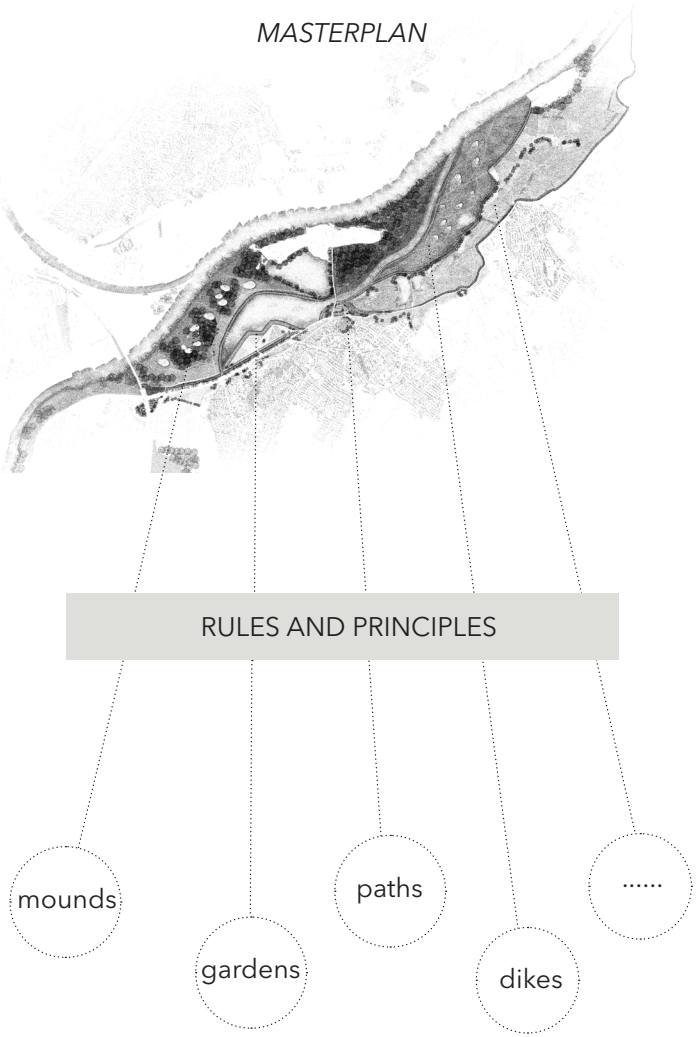
THE NEED TO DEFINE DESIGN RULES AND PRINCIPLES

The project deals with a large riparian zone and the masterplan, as described, will be realized step by step in a large timescale. This means that different designers and offices would probably realize different parts, but also that unexpected events could arise. The individual design projects should allow for change and flexibility, in case that future needs, potentials and tools change, but also they should express the general concept so that there is coherency in the design.

As said, some of the design decisions emerged from a study on the processes, and some by more architectonical choices. In some cases, rules are essential to be followed for safety reasons (for example the height of the mounds) but in other cases it's a matter of the desired expressed quality of the interventions (for instance materiality).

For this reason, it is important to provide some design rules and principles to make sure that the interventions are safe and also bear the desired qualities, even if they are different ways to design each individual element.

In this chapter I present the main parts of the design (mounds, gardens, dikes, paths) firstly by explaining the general principles and rules and then giving design examples that express them.



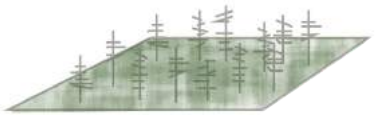
For the design of the mounds a standard housing typology of 100 m2 was considered, that is able to host diverse user groups. As already said, the mounds will be organized as small communities. Through the research by design experiments with sizes and placement of mounds, a shape of around 80-130 m is able to host around 8-10 houses. However, there can be flexibility in this.

As for the elements of the mound, based on the sustainability principle, each house should be able to produce their own food, and also all the houses should have a cirulatory system of grey and black water treatment and reuse. The common water element will have bigger capacity thatn the calculated daily use of the houses, to be able to store water in a longer period of time and give time for the purification process, but also to store excess rainwater without overflowing.

As for materiality, local materials should be used for the creation of the mound, like brick, wood, clay or straw bales, that are easy for people to build but also enhance the place's identity.

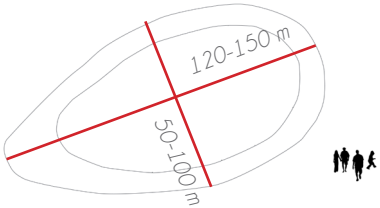
Based on the calculations presented in the previous chapter, some basic rules for the houses emerged:

5m height of mound
to keep dry at max. water levels



200 m2 garden / house

common water purification element



community of houses
size can be flexible but within limitations

material palette : local materials, identity of place
(brick, wood, clay, straw bales)

LIVING MOUNDS

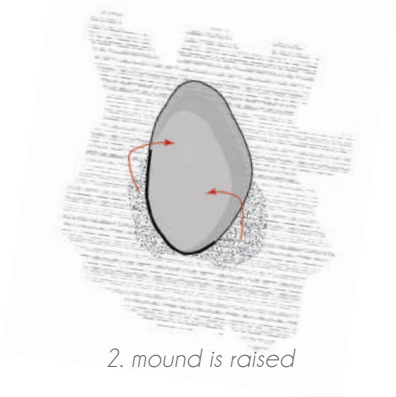
As for the principles, taking into account the process of creation and escpecially in the mounds of the forest which are related to the trees, the cutting of trees should allow open views from the mound to the river, while the barrier wall will be placed on the other side, based on the water flow and pressure study.

The houses should be related to the wall, to emphasize its integration from the ground till the buildings. However, to avoid having a very solid side, views to the forest can also be made through more transparency or openings to the wall. Also, sunlight is important to enter all houses, and common spaces should exist for all people to utilize.

In the next pages an example of the application of these rules and principles is presented.

The process

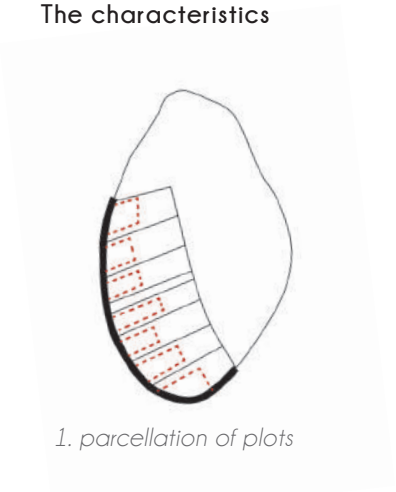
1. forest collects sediments



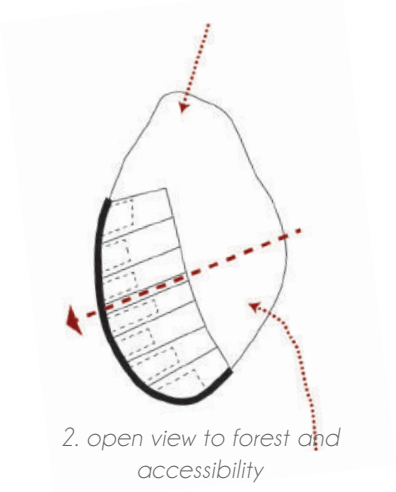
2. mound is raised

3. forest cut when resources are needed - open views to the river

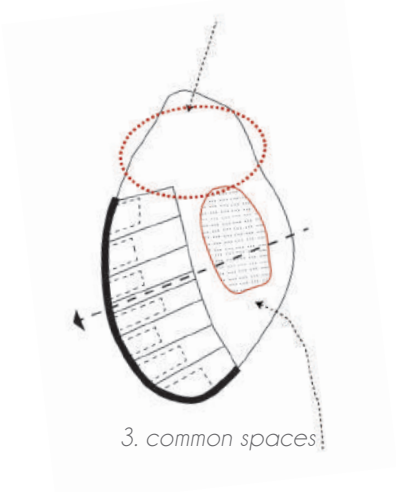
The characteristics



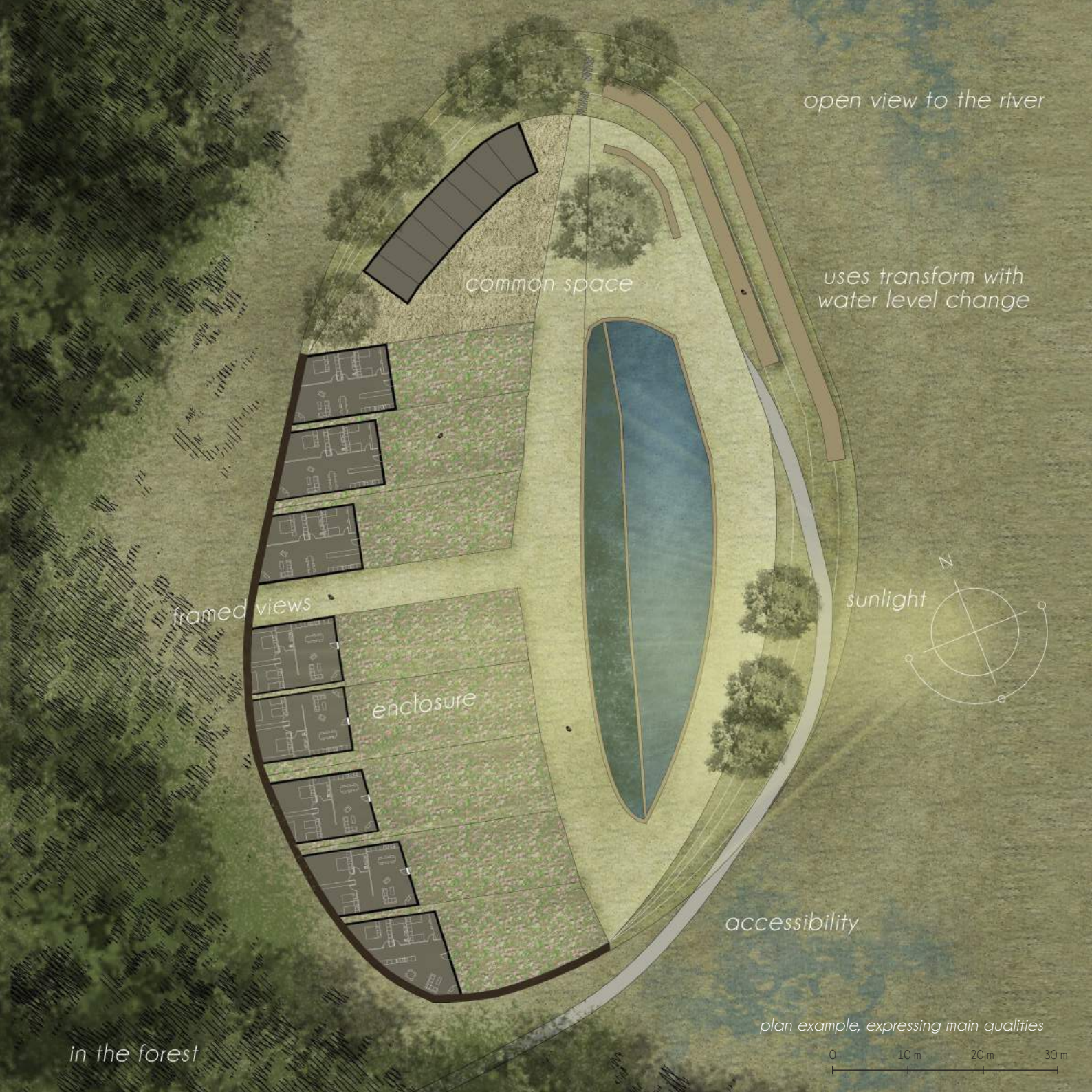
1. parcellation of plots



2. open view to forest and accessibility

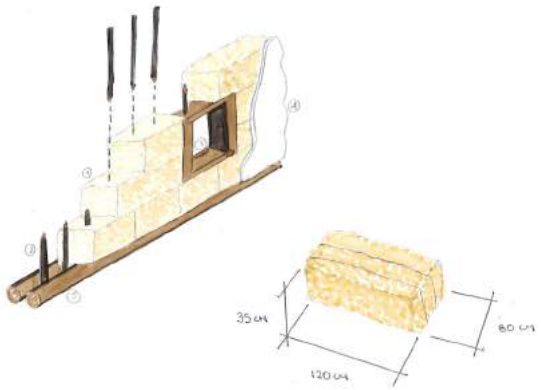


3. common spaces


open view to the river
common space
uses transform with
water level change
framed views
enclosure
sunlight
N
accessibility
in the forest
plan example, expressing main qualities
0
10 m
20 m
30 m

In this example the houses are organized in relation to the wall (attached) but oriented in a way that they have open views to the river and also sunlight based on the movement of the sun. The chosen material for the houses is straw bales covered with clay and wood for the roofs and foundations.

A water pool is created for the water purification needs but also operates as a reference element for all inhabitants of the mound. In addition, wooden platforms are designed for boat parking when the area is flooded, which can also be used as public furniture during the different seasons.



1. Straw bales
2. Wooden stakes to pin the straw bales
3. structural wooden frame for windows
4. clay layer - insulation
5. foundation of wood (self-drained)

forest side

houses built from local materials

14 m

grey & black water collection basin

reed bed purification system

clean water pond

clean water collection basin

wooden platforms

river side

27 m | *4,5 m* | *10 m*

Approaching the mound with boat on flooded situation

Facade of houses - the wall allows open views towards the forest

LANDSCAPE PRINCIPLES

For the design of the basic landscape elements (dikes, paths, bridges) the goal is to create an experience for people expressing the diversity of the new landscape areas and the contrast between the dynamic and static character. For example, in areas with more frequent water flow and unstable conditions, the paths will also be more natural. In the more static areas, paths can be fixed (for example by the use of local materials, or by poles marking the route). In the next pages, some of the main principles and examples of their application along the project area are presented.

openness

enclosure

viewpoints

facilities

diverse levels

paths

unfixed paths express the dynamic landscape

fixed paths relate to the less changing landscape

elevated paths enrich the experience from dry to wet times

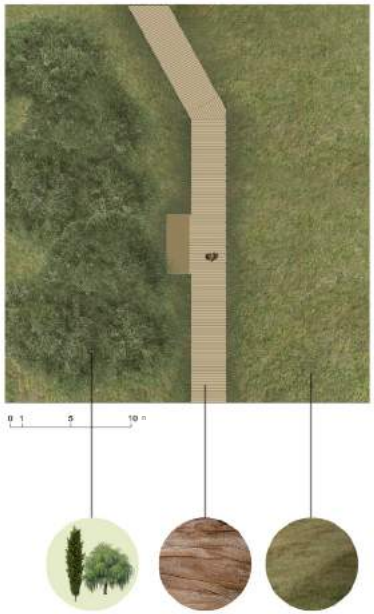
dikes

different profile to express diversity between two sides

steepness expressing inaccessibility or a dramatic impression

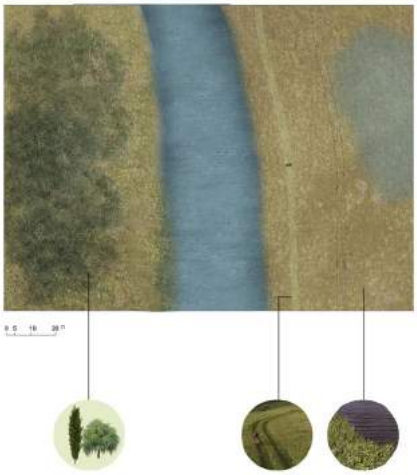
A WALK THROUGH THE AREA

...elevated path to the forest

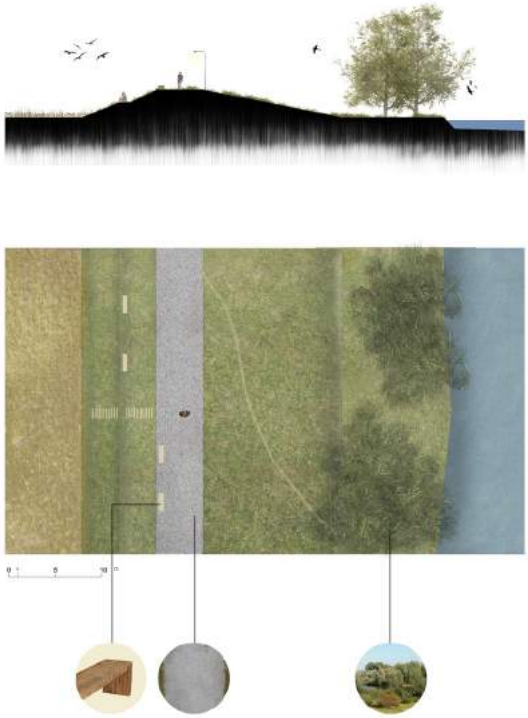


A WALK THROUGH THE AREA

...close to the river channel



...dike between two natures

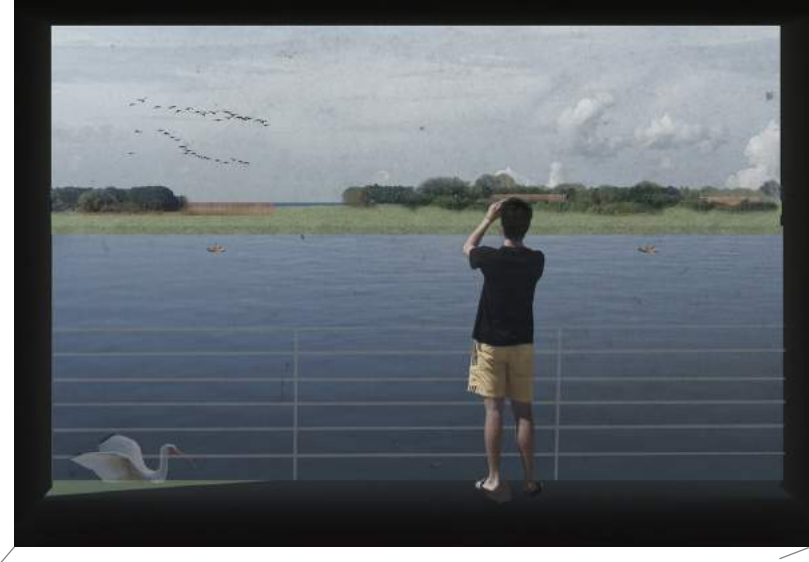


A WALK THROUGH THE AREA

...the gardens

1. vegetable gardens and sheds built with local materials

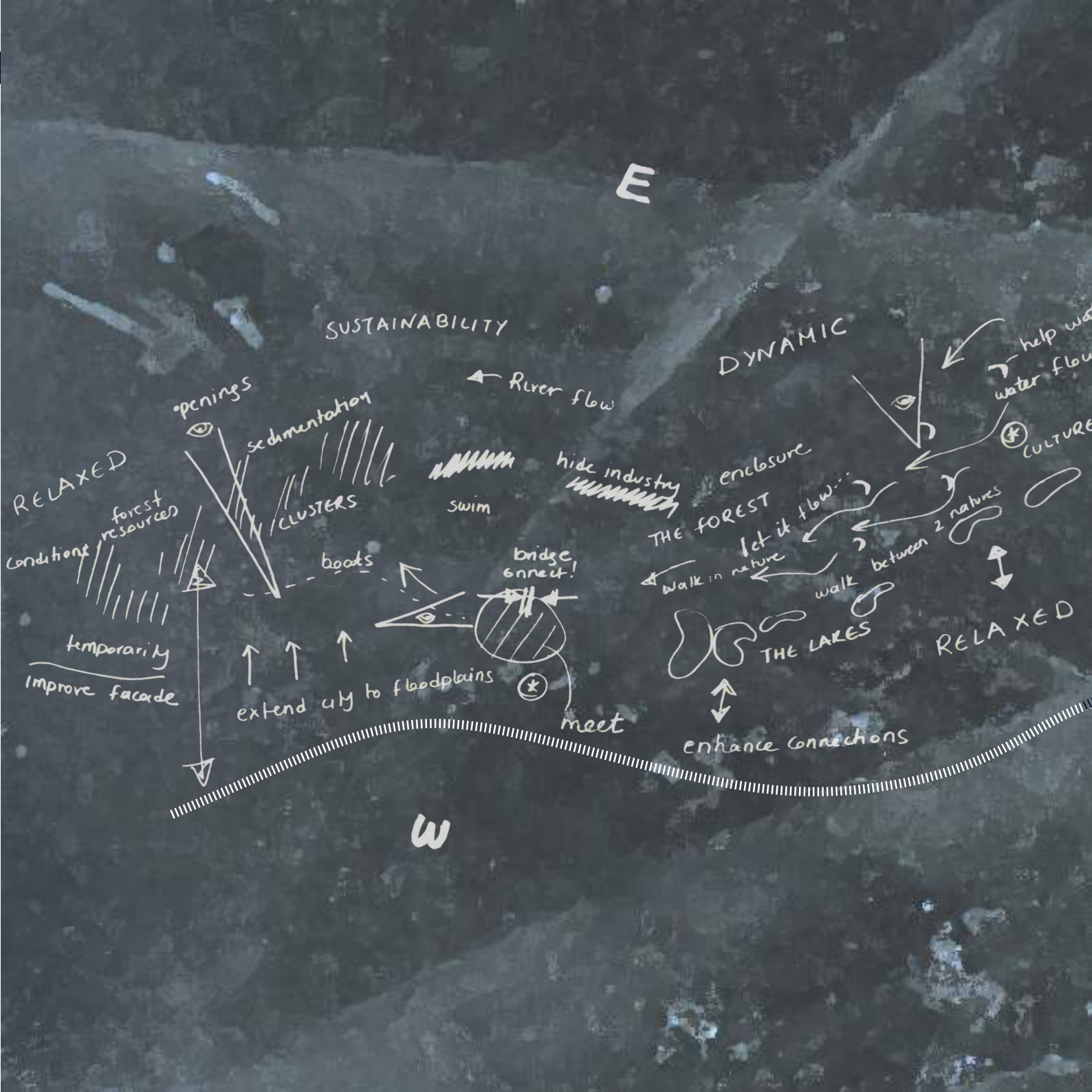
3. 'framed' view to the landscape



2. 'framed' entrance through bridge

A WALK THROUGH THE AREA

...the bridge as integration element


E
SUSTAINABILITY
DYNAMIC
openings
River flow
sedimentation
RELAXED
CLUSTERS
swim
hide industry
enclosure
THE FOREST
let it flow...
forest resources
conditions
boats
bridge connect!
walk in nature
walk between 2 natures
temporarily
improve facade
extend city to floodplains
meet
THE LAKES
RELAXED
enhance connections
W

07 REFLECTION

Relation of the project to the Flowscapes graduation studio

The 'Flowscapes' graduation studio is focusing among other aspects on landscape as infrastructure, exploring the relationships between natural and human systems and the dynamics between landscape processes and typo-morphological aspects. Having my diploma in architecture, I was always fascinated by the relationship between the urban/human and the natural environment and their co-existence both in space and time. Being a foreign student in the Netherlands, the Dutch landscape impressed me from the beginning but also raised many questions. One of those was regarding the monofunctionality of the river floodplains and their disconnection from the urban fabric. Therefore, I chose to formulate my project in this context, more specifically in part of the Rhine's river system, with the research question of how we can embrace the potentials of the natural river processes (inundation, sedimentation) as a condition for the creation of a multifunctional and sustainable landscape, focusing on a new living environment in the floodplains, in balance with nature. With this project I was aiming to address an issue that is important for the Netherlands (design of floodplains) from a perspective that has not been yet elaborated but also raises debate (building on floodplains) and get a deeper understanding of the tension between processes and forms, having in mind that working in a dynamic/changing environment requires to perceive in the first place landscape as infrastructure, but also as a flow. In this sense, the project was closely related to the framework of "Flowscapes".

Reflection on methodology and working process

The structure of the graduation studio is based both on design research and research by design. These approaches proved very helpful from the first steps of my working process, trying to formulate the project clearly and find related methods by which I could develop it. The reading of existing theories and the study of precedent projects was fruitful in deriving principles for understanding but also for designing. In addition, doing some experimental plan collages of superimposing existing landscapes on my project area and seeing how the basic functions could be combined in a united spatial result was helpful in discovering the missing links to bind these functions. Based on the notions of landscape as a process and landscape as a flow, I developed my own methodology which helped me realise that in the frame of a multifunctional landscape, the relations and interrelations between elements are crucial. Every element, whether it is 'stable' or changing, should be seen with regards to the other components, to achieve a mutual existence and a sustainable result.

More specifically, trying to incorporate a living environment in a natural, dynamic environment without superimposing it, I had to go deep in understanding the conditions that the landscape itself can provide, and how the living environment could not only pose a non-negative impact on the landscape, but even offer to it. This part for me was the hardest to grasp. At some point I was missing a link between the whole landscape and the living mounds I created. Although I was following my methodology of interrelating functions, they didn't seem connected yet. The difficulty lied also in the fact that such a step required research and understanding of the formative power of the river processes, like water flow and sedimentation not only in general but on a spatial level on this specific area, which required knowledge of other fields I was not familiar with, like hydraulics or water management. In this step, contacting people from other disciplines and asking questions and doubts was very helpful. By communicating with experts I managed to surpass that difficulty, draw my conclusions and go forward with

the design, through several research by design trials which narrowed down the possibilities. Furthermore, I conducted a real-time experiment in Scheveningen beach to test some of my design decisions for the living mounds in relation to the water flow, simulating the river landscape with sand, shells and simple materials. This engaging with nature was inspiring in thinking not only through paper but also through palpable techniques.

The dichotomy between process-oriented and architectonic-oriented design decisions

This work with the processes, though, represents one side of the coin. One of the main challenges of this project was the dichotomy between working with processes and understanding the rules, principles and conditions that they can offer for design, but also applying a personal perspective as a designer, based on more architectonic-oriented decisions and an analysis of the area itself, respecting its characteristics, locality and identity. This dichotomy represents the described tension between processes and forms that is a fact in dynamic environments. In this project, I tried to combine the two approaches. I perceived landscape as a process but also as an 'object', with specific qualities and characteristics. In the first steps of the masterplan that refer to more stable parts (for example the gardens or the new centre) where the river processes do not yet take an active part, the decisions were mostly based on social, environmental or experiential factors. These decisions also create conditions, but more on a social level and the engagement of people in the area and the human flows and concentrations. In the step of creating the living mounds, where I wanted to embrace the natural processes as part of the design, the decisions were more process-oriented, through research by design. For example, the placement of the mounds was a result of research on the possible water flow patterns and sediment disposal. In this case, a level of uncertainty is given due to the unexpected behaviour of the natural processes but the design represents a strong possibility. Other decisions, like the arrangement of paths or viewpoints and even the choice of materials and orientation, can be described as more architectonic-oriented, representing my desire as a designer to give a specific character to the area, expressing the identity and dynamics of the floodplains. Thus, I tried to bind the notions of working with processes and working with architectonic concepts into a logical and united design since during my process I realised that this was the most efficient way to utilize the full potential and quality of this area.

Reflection on the proposal

The proposed plan is comprised of different layers of water, nature and buildings, offering more space for the river, more diversity in ecosystems, and also room for people to engage. It includes these different layers in an integrative way, allowing them to co-exist and also interact. However, because of the sensitive environment of the floodplains and the multiple disciplines involved in river management, as a landscape architect I can only be part of the chain. Therefore, it would be interesting to see if my design decisions and predictions would really operate in reality the way I expect. For example, what is the exact water flow resistance caused by the flood forest and the living mounds? Is the plan posing a negative effect in terms of flooding risk or is it beneficial, by dropping the water level, taking into account that I offer more space for water but also add new elements? In river management even a few millimetres of water can make a difference, thus it would be helpful to be able to calculate the effect of my design proposals in reality.

Furthermore, in projects dealing with processes apart from the spatial outcome, the development through time is important. The design should operate at present time based on current needs, but

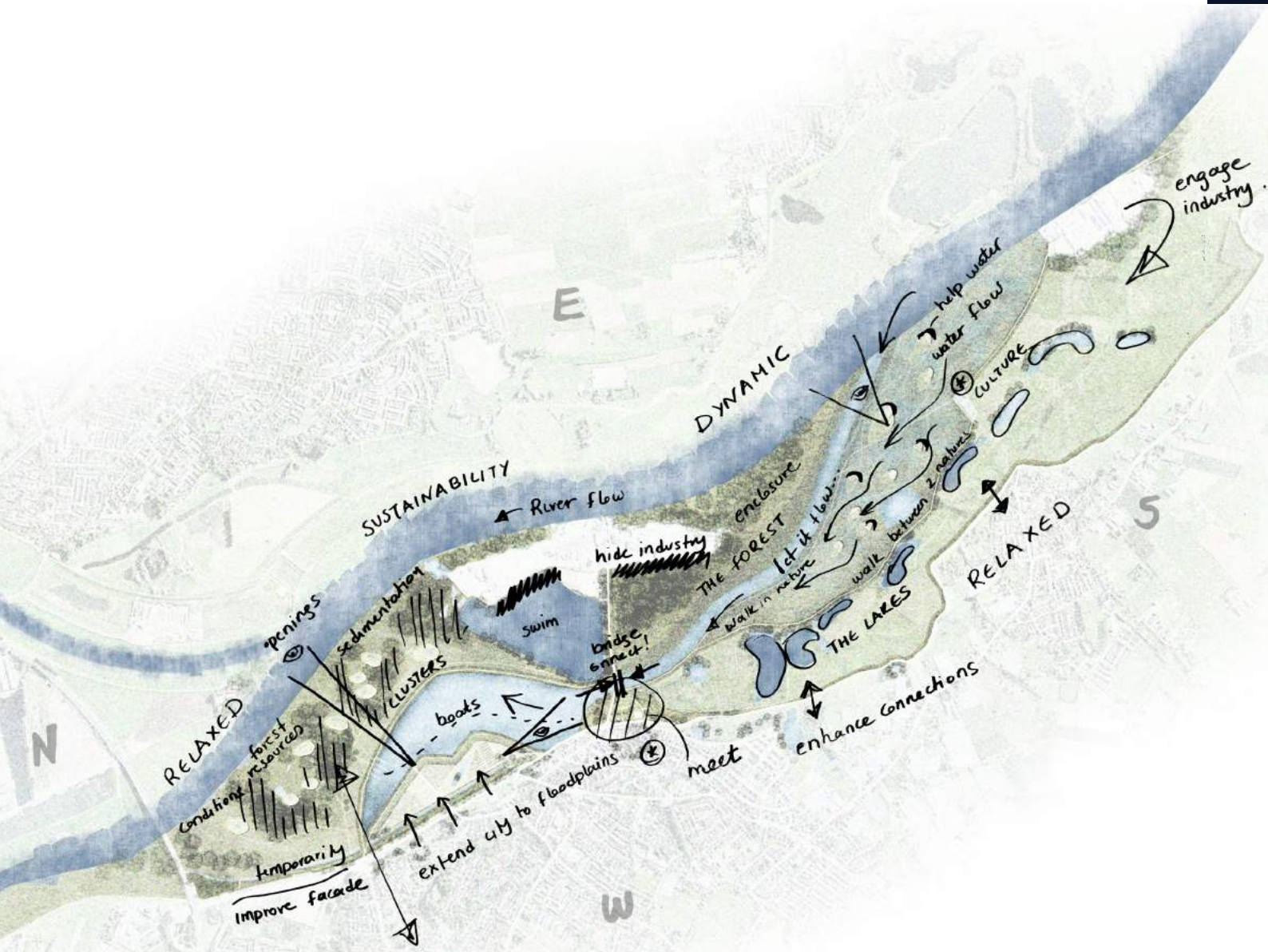
should also be flexible enough to operate in different possible situations in the future, which is also necessary due to the uncertainty given by the dynamic context. In my plan, I combine both fixed and flexible elements, that would be able to adjust to changing conditions. For example, if after the creation of the first living mounds it was found out that they do not respond as expected, then it would be possible to adjust the size, shape or even location, based however on the general design principles that bind the project together. After all, the design of a robust plan would probably (or certainly) prove ineffective. Effective will be a "a durable frame that allows for flexible infill." (Tjallingii, 2015, p 76). So the plan depicts a snapshot of the area in a specific year and time of the year, but the situation could be open for change.

Lessons learned - relevance for the landscape architecture field

Looking back at my research objective and reflecting on the end result I can see that although I started with a more general research question, the fact that I worked on a particular location and went deeper in the design of a plan for this area made the project more site-specific and local. Starting from principles on the larger scale but also going deeper in understanding the human experience and perspective in this landscape helped me to really work through the scales and that was a great lesson for my further steps as a landscape architect. In addition, this project helped me to think differently. The project's aim to propose a strategy towards an integral design of multifunctional river floodplains, incorporating a living environment in such a particular and sensitive area seemed quite controversial at the beginning, taking into account the restrictions and regulations that already exist for building on floodplains. Having in mind all the regulations seemed difficult but gave me motivation to explore more on a new way of living, who will be in line with the context of the floodplains, the possibility of flooding and the temporary conditions. If we only follow regulations, though, we will probably produce solutions that already exist. After all, the role of the landscape architect, having the privilege to work through the scales and having an overview of natural, social and environmental aspects, is that he/she can give food for thought and begin a conversation on issues that refer to a local, regional or even national level. In this case, binding the dichotomy between processes and forms and understanding the conditions that they both can create proved helpful as a method. Instead of letting processes totally guide the design, leaving out other important qualities of the site or vice versa superimposing the new functions without taking into account the created conditions of the landscape, a co-design between the natural processes and the architectonic interventions was achieved. This made the link between the dynamic environment of the floodplains and the new created functions more strong and also the relationship between the urban fabric and the floodplains more concrete.

Conclusion

To conclude, this project can be regarded as a pilot project or test case on how we can shift our thinking regarding floodplain design from a mono-functional to a multifunctional, integrative and sustainable perspective. The project proposes that, although the restrictions should exist, changing our way of thinking can really make a difference. Having in mind the fact that building on floodplains is a controversial issue that in some cases has raised protests and doubts, this project can trigger conversation regarding an important topic for the Netherlands, and allow different opinions to be heard and discussed. It might seem optimistic, but it can also be a realistic image of a possible future.



"Eventually, all things merge into one, and a river runs through it."

Norman Maclean

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DYNAMIC RIVERSCAPES

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The case of Huissensche Waard.

Kallirroi Taroudaki

TU Delft