DYNAMIC PRODUCTION FORESTS

PLANTING NEW FORESTS ON OLD AGRICULTURAL LAND IN THE NETHERLANDS

Woodn't you like to grow a house?



Yael Hagar von Mengden

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COLOFON

Dynamic Production Forests

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Woodn't you like to grow a house?

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ACKNOWLEDGMENT

With this graduation project, not only my master's comes to an end, but also my time in Delft. This year I cycled a lot from Rotterdam to the Faculty of Architecture and every time I entered the campus, a melancholic feeling came over me. Seeing all the places I have fond memories of, I can only conclude that I had such a joyful, learning and loving time here.

Nevertheless, I also realised during my bike rides that everyone around me got a lot younger, so I think it is time to move on to a new phase.

This graduation year has been challenging for me and I've run into myself quite a few times. But, as we say in Dutch: *"Het resultaat mag er zijn!"* and this thesis is the product of being immersed in the world of forestry and wood one year long – alone ánd together with Mathilde.

Thank you Gerdy for all the freedom you gave me to shape this project the way I wanted. You knew how to guide me forward at times when I didn't knew how to proceed, while at the same time challenging me to be critical, making the story stronger.

Thank you Alex for the constructive guidance that gave me the right focus after tutoring. I learned a lot from the way you looked at the project as a whole: from forest to material to building.

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Thank you to all my parents for being there for me. I always feel very loved and supported by you all.

Thank you to my graduation buddies, Lisa and Floor. I am glad we went through this together and I can't imagine what it would have been without you.

Thank you to my friends, Soete, Rosa, Brizia, Bas, Sam, Mara, Valerie, Sebastiaan and Jasper for the support and nice distractions.

And of course thank you Mathilde. I am so proud of us for going all-in together on this project. It was a great learning adventure with discussions during tandem rides, excursions to Hattem, heartbreaks, beers, outfit coordinations, some tears but most of all: lots of laughter.

ABSTRACT

Currently, the building industry is complicit in resource depletion, excessive CO2 emissions (38% globally (UN Environment Programme, 2020)) and the nitrogen crisis. This contributes to negative changes on a global scale, such as climate change and biodiversity loss.

Using wood as a dominant building material would have a positive effect on these problems. The Netherlands used to produce wood on a large scale, but a shift in the functions that forests had to accommodate caused production to become secondary.

Currently, there is no circular system in the Netherlands in which landscapes produce materials that can be used in the common building industry on a local scale.

The main goal for this project is to show a future in which the production of wood and the forests that go with it play a central role in our day to day landscapes. This will be done by answering the research question: "How can a sustainable and multifunctional production forest be designed in the Netherlands?"

The current nitrogen crisis and the expected buy-out of farmers who run intensive cattle farms around Natura 2000 areas, will be used as a starting point for the design location.

The outcome shows three types of production forests that differ in accommodating five aspects that are valued in forests: production, recreation, biodiversity, climate resilience and experience of landscape. This way a new idea can be formed on how forests can be productive, while also providing space for animals and humans in the Netherlands. The design is tested on sand soil in Hattem, but could be applied to any agricultural land.

The discussion elaborates on the reason why production forests are not planted on a large scale to provide a circular material producing system. Taking into account: the current relationship between humans and materials, the difficulty of circular thinking due to the complexity of current systems, the long-term thinking that has disappeared in our culture and the unpredictability of the future due to rapid global changes.

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1. INTRODUCING DYNAMIC PRODUCTION FORESTS

1.1 PERSONAL MOTIVATION
1.2 PROBLEM FIELD
1.3 PROBLEM STATEMENT
1.4 RESEARCH OBJECTIVE AND QUESTIONS
1.5 LOCATION

Photo: Louis Fraanje

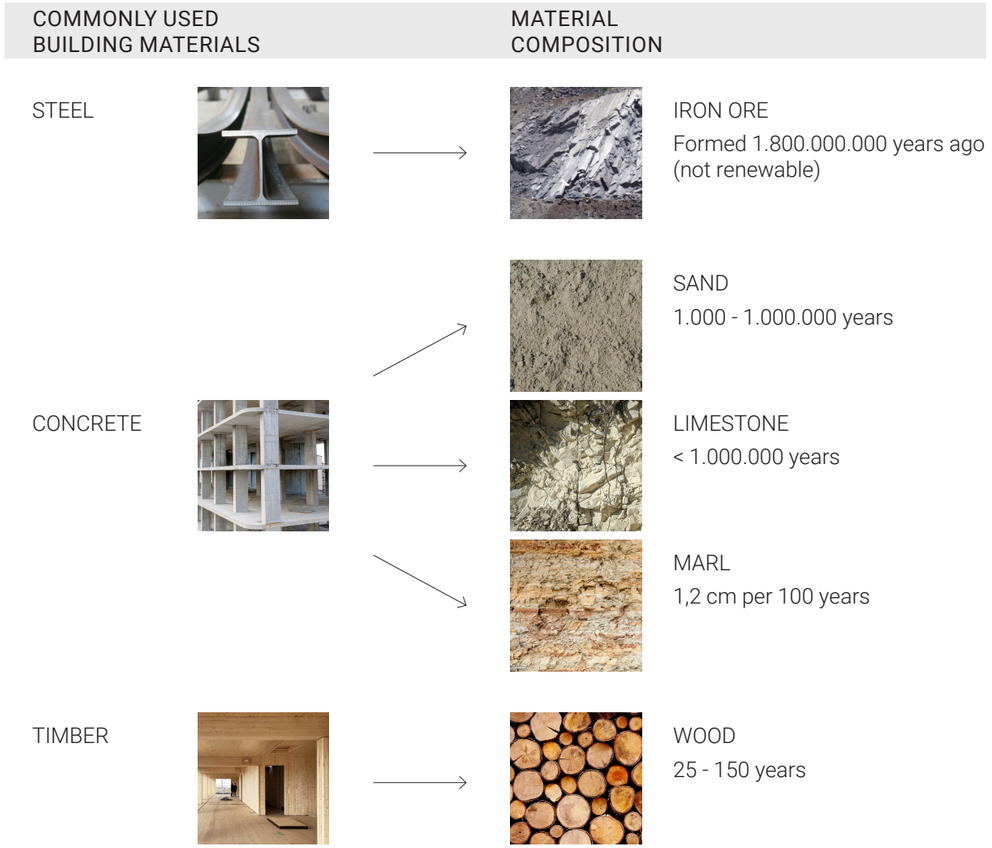


Figure 2. Growth time of the most commonly used building materials (created by author)

1.1 PERSONAL MOTIVATION

My fascination for forests and wood as a renewable material in building constructions, started after watching the documentary Anthropocene: The Human Epoch in 2019 (figure 1). This documentary is about the current geological era we are living in: the Anthropocene. This era is characterised by human activity being the dominant influence on climate and the environment. I saw this documentary at the Architecture Film Festival Rotterdam and afterwards I felt disappointed in the way we care for the earth. Back then I was still studding the bachelor Bouwkunde and I realised that I would later end up working in a highly polluting industry.

Watching this documentary was therefore the starting point of this graduation project, because it made me think critically about our relationship as designers & builders and the materials that we use to build our designs, and how these materials are extracted.

I started thinking about how long it would take for materials to grow back. I never thought about materials that way, but I realised that every natural material has a growing time (figure 2). I imagined buying a forest and trying to set up a cycle which would result in a balance between growth and harvesting. But not just for wood, I thought the same concept could also be applied to stone. For example, how long would you have to wait to harvest 1m3 of limestone? As this became quite complex, I decided to explore this concept first for wood and that was the starting point of this project. I started talking to people about the idea and one day with Mathilde. She was already excited about building with wood and was interested in seeing if we could set up this plan together. We made some rough calculations on how many trees we would need to grow for one house per month and started to search for forests to buy and manages ourselves in the Netherlands. Unfortunately, this all turned out to be more difficult than we thought due to regulations (and more expensive), but the plan was born to graduate on this together.



Figure 1. Poster documentary (The Anthropocene Project, 2021)

Lignite extraction



Deforestation



Emissions from steelworks



Saw mills for wood production



Figure 3. The effects of resource extraction and processing of materials on the environment (The Anthropocene Project, 2021)

1.2 PROBLEM FIELD

Currently, the building industry is complicit in resource depletion, the excessive CO_2 emissions (38% globally (UN Environment Programme, 2020)) and the nitrogen crisis. This contributes to negative changes on a global scale, such as climate change and biodiversity loss (figure 3).

Using wood as a dominant building material would have a positive effect on these problems. Firstly, because wood is a fast-growing renewable material that can be used to set up a sustainable production chain. Within 60-70 years, an average tree can grow into a high-quality building material, which is only at the end of its life after a second or even third use and then can be used for biomass, a renewable energy source (Lugt, 2021). Secondly, because forests capture CO_2 and they could be designed to be used as a buffer to protect vulnerable nature areas from depositing nitrogen (College van Rijksadviseurs, 2020). And finally, forests have a positive effect on the environment by providing a place for people and animals to make use of them. Of all recreational activities, visiting a forest is in second place after visiting family. This makes the forest one of the highest valued landscapes (Rijksdienst voor het Cultureel Erfgoed & Staatsbosbeheer, 2021).

The Netherlands used to produce wood on a large scale, but a shift in the functions that forests had to accommodate caused production to become secondary. In the Netherlands, timber still gets produced. In 2020 around 800.000 m^3 wood was harvested from Dutch forests, but not for the purpose of being used in construction (Stichting Probos, 2020). There is currently no sustainable chain from forest to average building, while there is a lot potential in the Netherlands and a large housing demand.

This, combined with the current nitrogen crisis and the expected buy-out of farmers who run intensive cattle farms around Natura 2000 areas, provide an opportunity to explore how sustainable and multifunctional production forests can be created on old agricultural land.

Based on the numbers of Agrarische Feiten En Cijfers, the average size of a dairy farm is 59,4 ha (2022). If we assume that the 500-600 largest nitrogen emitters were bought out, around the 30.000-35.600 hectares of land would become vacant to develop into these new production forests.

The link between the built environment and the forest is central to this; can development of housing go hand in hand with development of nature? And what could such a material-producing landscape look like?
At the same time, this design challenge offers an opportunity to redefine the relationship between humans and nature; can a landscape be created where people are part of nature, rather than being separate form it? For this, the idea of humans moving from the Anthropocene towards the Symbioscene, combined with Lovelock's Gaia Theory, are used as framework for this graduation project.

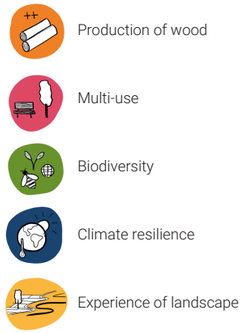
The main goal for this project is to show a future image in which the production of wood and the forests that go with that play a central role in our day to day landscapes.

1.3 PROBLEM STATEMENT

The current and future problems of production forests can be divided into three challenges:
1. In order to make the building industry more sustainable by the usage of wood as dominant building material, more production forests are needed in the Netherlands.

2. The old model for production forests, monocultural forests, are not sustainable to look at as inspiration for new production forests. This because they have been proven not to be future proof due to being vulnerable for climate change, failing in accommodating biodiversity and over time decreasing the quality of soil, making the land nutrient-poor.

3. The demand for recreation in forests or even liveable space is increasing, this puts pressure on the functions a forests needs to accommodate. Also the wish for restoring or reintroducing cultural historic forest elements (NL: kleine landschapselementen) is increasing, as part of our cultural heritage.



1.4 RESEARCH OBJECTIVE AND QUESTIONS

This leads to the following research question for this graduation project (figure 4):
How can a sustainable and multifunctional production forest be designed in the Netherlands?

To be answered through the following sub-questions:
1. What is a production forest?
2. What design elements can lead to a sustainable forest and how do they work?
3. What functions can take place in a forest and what spatial requirements do they need?

To explore how production forests work in the Netherlands, this study looks at the management of current production forests, including the extraction of timber therefrom, but does not include the milling or processing of timber (Western Bay of Plenty District Council, 2009).

To explore what elements can be used to make a forest sustainable, the aim is to design a biodiverse and climate resilient forest.

To find out in what ways a forest can be multifunctional, the different ways it's used by people are considered, along with the experience of the landscape.



Figure 4. Research question explained (created by author)









Figure 5, 6, 7, 8. Current forest area, current Natura 200 area, location Hattem within NL, Hattem (WEnR, Natura 2000, 2018, Google Earth, Google Earth)

1.5 LOCATION

In order to give a spatial answer to this research question, a test location has been chosen. To decide on this location, a number of requirements were set:
First, the new desired production forest should start from an existing forest (figure 5). Just as cities grow from a city core, this should be similar for forests; in order to prevent fragmentation, which has a negative impact on the health and resilience of a forest and on biodiversity.
Secondly, creating a new forest generates opportunities to respond to current events, like the nitrogen crisis that is putting pressure on our Natura 2000 areas. This event forms the opportunity to redesign current agricultural land that is located too close or in Natura 2000 areas, since these farmers will get bought out resulting in vacant land (figure 6). The ambition for this vacant land is that it will contribute positively to the protection of the neighbouring Natura 2000 land. New forests can be an answer to this, being created as a buffer, therefore the location for this project will on (old) agricultural land next to a Natura 2000 area (College van Rijksadviseurs, 2020).
Thirdly, the area should be close to a municipality that has ambition to grow. This, because this project also wants to show an option of how people can live in or closely to a material producing landscape, like a production forest.

On all sites meeting these requirements, the research question that stands central in this graduation plan, could be expressed/shown.

For this graduation project the municipality of Hattem has been chosen, in the province of Gelderland (figure 7 & 8). Besides the requirements above, Hattem has an interesting landscape to offer to show the opportunities of this project, namely:
- A variety of soil (sand, clay/silt and peat), allowing a wide range of trees and therefore forests to be explored.
- A big altitude difference (35 meters), from the highest point of the moraine on which the Veluwe is situated to the lowest point of the river IJssel.
- The combination of soil and altitude difference create four divers landscapes; river, polder, city and forest.
- There is a rich history with old structures and elements of wood plantations and of a bocage landscape (NL: coulisselandschap), resulting in interesting starting points for a design.



2. TOWARDS A LANDSCAPE APPROACH

2.1 THEORY
2.2 METHOD

Photo: Roman Skrypnyk

2.1 THEORY

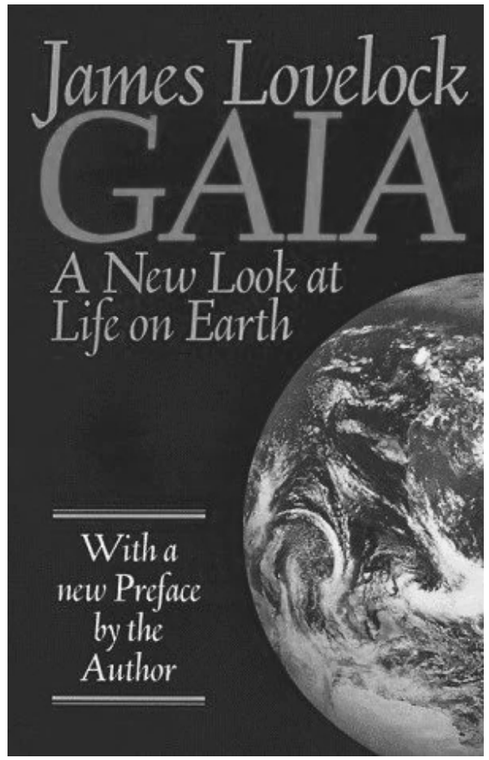


Figure 9. Book: A New Look at Life on Earth (J. Lovelock, 1979)

This project is embedded in the worldview that we will shift in the coming years from an Anthropocentric lifestyle towards a Symbiotic life: the Symbiocene. An era in which humans, nature and technology together create a new balance (Welkom in Het Symbioceen, 2022). A view that already longer exists within the Gaia theory by James Lovelock.

The Gaia theory states that the earth functions as one big system, in which there is a interaction between the biotic and abiotic, resulting in a dynamic balance. This balance is created by a self-regulating feedback mechanism in which all organisms are involved (Brouwers et al., 2020).

James Lovelock (1919 – 2022), a British scientist and inventor with a background in chemistry, is the proposer of the Gaia theory or Gaia hypothesis. He developed this hypothesis into a theory over time, which started in 1969 when he worked for NASA. He stated that it is possible to detect, based on the composition of an atmosphere, whether there is life on that planet (Giffin & Lovelock, 1969). This, because oxygen, which is very reactive, and methane cannot coexist without reacting with each other over time, the same for nitrogen. From this he concluded that if these substances are present together, they must be replenished from below by organisms, such as plants.

This idea of a self-regulating balance formed the basis for the Gaia hypothesis. In this, he states that life creates liveable conditions for itself, for example in the composition of the atmosphere, as well as temperature (Lovelock, 1972b). However, this was criticized because it gives the impression that Earth is doing this "consciously" for herself. The name for the Gaia hypothesis didn't work for this either, because it evokes the image of a mother earth that cares.

After this, Lovelock continued to develop his hypothesis and built his idea into a theory in which he stated that there is an interaction between abiotic and biotic factors on earth, in which the living and lifeless interact and provide a dynamic balance (Lovelock, 1983). This underlined this theory with a computer model called Daisy world. This model existed of a sun that became warmer over time – just like our sun, and an earth, spinning around this sun. On this earth two species of daisy had been sown; white and black daisies. In the beginning the black daisies had an advantage, since they absorbed the warmth of the sun, making it warmer than it actually was. The sun kept becoming warmer and also the white daisies started to bloom. Because they were white, they had a dampening effect on the temperature which had a positive effect on the black daisies. Similar to what we now know how the ice caps also have a cooling effect for our earth. However, this was a new way of thinking at the time; that naturally self-regulating systems with feedback loops are everywhere, and not for example only in our bodies, but also on the planet.

What appeals to me about the Gaia theory is the way it approaches the world as a whole, without hierarchy among organisms, or even between the biotic and abiotic. This means that humans are also just a part of this. Despite what people like to think, in Lovelock's Gaia theory, we are not at the centre, but instead participate in the bigger picture.

Together with the idea of going to the Symbiocene, it forms the background in which the scene of my graduation is set.

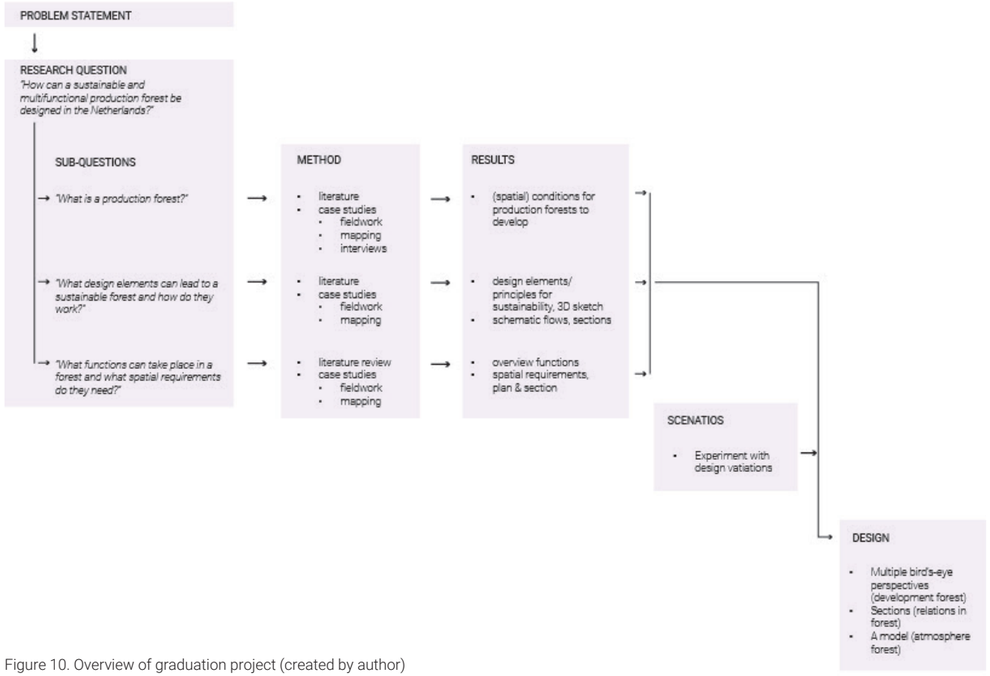


Figure 10. Overview of graduation project (created by author)



Figure 11. Exploration of different types of production forests (created by author)

2.2 METHOD

In order to give an answer to the research questions, the following method will be followed (figure 10).

The method for this graduation plan will be a combination of different research methods and techniques:

- To get a general idea of the historical context, a timeline is constructed to understand and describe forestation in the Netherlands through time, based on literature research and using the landscape biography method.
- To get a general idea of current ideas for future forest development in the Netherlands, visions and strategies have been reviewed.
- Three case study forests, chosen based on soil types (sand, clay and peat), will get analysed through mapping, fieldwork and interviews, supported by literature.
- These forests will get analysed on five different aspects, being: production, multi-use, biodiversity, climate resilience and experience of landscape (figure 11).
- From these analyses, an overview of design elements will be created, along with a radar charts to be able to compare and score the three forests on the five analysed aspects.
- Also the design location, Hattem, will get analysed by mapping and later fieldwork.
- Later, when starting the design, strategies will be formed by different balances between the aspects named above. One of these strategies will form the basis for the final design.

On the way to answering the research question, the trade-off between the five aspects: production, multi-use, biodiversity, climate resilience and experience of landscape will get explored.







3. UNDERSTANDING THE DUTCH FOREST

3.1 CURRENT STATE
3.2 NATURAL VS PLANTED FORESTS
3.3 HISTORY OF THE DUTCH FORESTS
3.4 PERSPECTIVES ON THE MANAGEMENT
3.5 CHALLENGES AND OPPORTUNITIES FOR DUTCH FORESTS

Photo: Ben Bender

3.1 CURRENT STATE

Looking at the current Dutch forests, we see the result of our planting and management strategies of the last 125 years, since at least 90% of our forests were planted during this period (Schelhaas et al., 2014). We have around 363.800 hectares of forest in the Netherlands, which is almost 11% of our total land surface (Oppervlakte Bos in Nederland, 1970-2021 | Compendium Voor De Leefomgeving, 2023). 28,8% of this forest lays in the province of Gerderland (Schelhaas et al., 2014).

26,4% of this forest is owned by Staatsbosbeheer, 17,8% private, 14,2% by municipalities and 11,6% by nature protective organisations (Schelhaas et al., 2014).
Momentarily the forest area still consists of more coniferous species (47,9%) then deciduous species (44,7%) (figure 12), but this is shifting slowly over time (Schelhaas et al., 2014). The dominant tree species are: Scots pine (29.9%), Native oak (17.2%), Birch (6.6%), Douglas fir (5.1%), Japanese larch (4.9%), Beech (4.1%) (Schelhaas et al., 2014).

In order to understand how we got to this forest in the Netherlands, first the natural succession of forests will get explained, followed by an overview of the history of Dutch forests and management perspectives, to conclude with the current challenges the Dutch forests will face in the coming decades.



Figure 12. Division of trees in the Dutch forest (Schelhaas et al., 2014)

3.2 NATURAL VS PLANTED FORESTS

In order to understand how forests can be created and rejuvenate, this chapter will explain:

- Forest succession, the natural way of how forests grow;
- how natural forests in the Netherlands would look;
- and how humans intervene in the process of the start of a forest.

Forest succession
Ecological, or in this case, forest succession (figure 13) is the process by which the mix of species and habitats in an area changes over time. Gradually, these communities replace each other until a "climax forest", a mature forest, is reached, or until a disturbance, such as a fire, occurs (Forest Succession, 2001).

Primary succession is when at the starting point of a succussion there was no plant life present in the landscape. Over time pioneer species, will be replaced by intermediate species and finally climax species, resulting in the soil becoming nutrient-richer over time.
Secondary succession has a different starting point, namely the result of a disturbance, like the landscape after a wildfire.

In the process of forest succession there is no humans interference.

Natural forests in the Netherlands
If there would be no human interference in the Dutch landscape and full ecological succession took place, almost the entire country would be forested. Based on the soil types, different forests would climax (figure 14).

Although this map did not take climate change and the effect of this on Dutch forests into account, it shows a totally different landscape if humans would not intervene in ecological succession.

Looking at this map, it shows the potential of forests in the Netherlands together with a picture of what the Netherlands probably have looked like before people intervened in natural processes.

Humans intervention
Unfortunately, in the Netherlands we no longer have forests that were established without human interference but through succession, old-growth forests. The last old-growth forest was cut down in 1871, the Beekberger forest, to be transformed into agricultural land (Natuurmonumenten, 2022). This means that all our forests in the Netherlands are originally planted by humans.

By now, rejuvenation took place, and within the Dutch forests are trees that have grown naturally again, via seeds from the planted trees. However, still a lot trees and forests get planted, resulting in artificial rejuvenation. Allowing more control over the speed of forest growth and the type of trees that will form our woodland.

In conclusion, the Netherlands has a lot potential for different types of forests, due to our divers landscape. To allow forests to grow naturally, via ecological succession, it will take a long time. In order to speed up this process or control the outcome of tree species within the forest, human interventions can take place. This is also in line with Dutch tradition, as all forests were planted in the Netherlands.

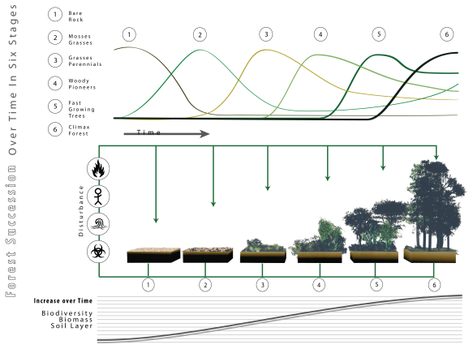


Figure 13. Succession (Forest Succession Depicted Over Time, 2011)

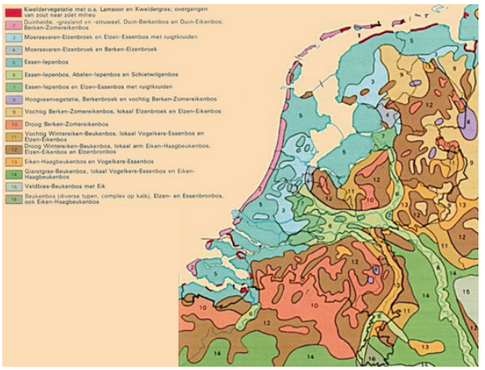

Figure 14. Potential natural vegetations in NL (S. Jansen, 2022)



Figure 15. Impression of the Dutch landscape during the time of the hunters and gatherers (created by author)

3.3 HISTORY OF THE DUTCH FORESTS

To understand how our current forests were formed, this chapter describes the stages that our woodland area has gone through in general terms over time. Also the relationship between humans and forests, and the interaction will be discussed.

From balance to regression

In the time of the hunters and gatherers, people lived in the gradient areas in the landscape from high to low lands, close to water. The landscape must have been similar to the Biesbosch, how we know it today, and the forests consisted of birch and pine (Visser, 2022). Figure 15 gives an impression of how the landscape could have looked and been used. A canoe was found from this time, a hollowed-out trunk from the Scots pine, that was used to paddle through the creeks and streams. During this time, the landscape was guiding for where people started their settlements.

From the Neolithic Revolution humans started to shape their environment in order to make space for arable fields; forests were cleared and due to agriculture the soil became nutrient poorer. This mainly happened on higher grounds. On the lower grounds swamp forests and peat bogs stayed uninhabited.

Entering the Roman era, most of the West of the Netherlands was still uninhabitable, consisting of marshland. The areas next to the rivers in the East and South of the Netherlands were densely populated and forest disappeared on a large scale due to human influences. This resulted in a half-open landscape. An impression of this changing landscape can be found at figure 16.

Start of the cultural landscape

In the Early Middle Ages the population density declined, resulting in reduction of human activity



Figure 16. Impression of the Dutch landscape during the age of the romans (created by author)

on the landscape, allowing rejuvenation to occur in almost all forests.
At the Veluwe iron mining from charcoal took place, which led to local deforestation. In its place came drifting sands and heathland.
This was also the first time regulations came into management and use, from land lords, who had made reclaimed lands part of “wildernisrecht”. A right that provided a ruler to lay claim to land without an owner, often undeveloped, untouched land (NL: onontgonnen) (Ensie, 2016).

In the High Middle Ages (approx. 11th-13th Century), the population began to increase again and reclamations started to happen over the whole of the Netherlands. Agricultural land in sandy areas quickly became exhausted. To maintain fertility, strooisel en plaggen (= the upper layer soil with vegetation and animal manure) were extracted from forests and spread over the land. In addition, cattle grazed through the forest, eating tree seeds. As a result, little rejuvenation took place. Despite attempts to regulate this through wildlife barriers (NL: wildwallen), it was unsuccessful (Rijksdienst voor het Cultureel Erfgoed & Staatsbosbeheer, 2021).

From first production forests to Staatsbosbeheer

During the 16th and 17th century, lots of forests were planted on estates for production. The Mastbos is an example of this and was the first coniferous forest planted in the Netherlands. The name “mast” refers to the use of the trees; they were used for the construction of ship masts.
Also for recreational hunting, forests were plated. During this era there was an increase of forests (Rijksdienst voor het Cultureel Erfgoed & Staatsbosbeheer, 2021).
From the 1850s, thanks to the knowledge of forestry and the invention of fertilizers, the forest

cover began to increase. Those who owned uncultivated land (NL: woeste gronden) often chose forest planting from a financial standpoint. Besides financial benefits, forest planting was also a way to prevent sand drifts, which had caused many problems due to earlier deforestation, like on the Veluwe.
The timber proceeds went, among other things, to construction and paper production but mainly to the mines in Limburg (figure 17). The pinewood was used to support the mine corridors (NL: stuthout). Because the wood first cracks before it breaks, it also had a warning function.

Where first forest planting was mainly for the nobility and wealthy industries, in the late 19th century the government got involved and in 1899 Staatsbosbeheer was established.
From then on, not only reclamation for forest plantation was supported by the government, but mainly reclamation for agricultural land.

The effects of agricultural intensification
The idea grew that the use of agricultural land could be done more efficiently, leading to the Ruilverkaverlingswet in 1924. This of course focused on restructuring agricultural land, but at the same time a lot of new forest was planted. The “overhoekjes”, small areas of land that remained as leftover areas in the newly designed subdivision plan, were planted with forest. At the same time, as part of the Ruilverkavelingswet, Staatsbosbeheer made sure that the new landscape and green structures preserved the essence of the landscape. However, during this period, many cultural-historical landscape elements disappeared, such as elements used to demarcate parcels of land.

Different wishes and priorities
After the war, came the desire for recreational areas. For this, forests proved to be very suitable, like the Amsterdamse Bos, which was specially constructed for recreational purposes. Forests were also planted as buffer areas between cities. This increased the proportion of forests in the Netherlands.

In 1992 the Natura 2000 areas were established with the main objective of protecting specific flora and fauna to preserve biodiversity on a European scale (Natura 2000, 2018). Within Natura 2000 sites, guidelines have been drawn up for both the protection of species and areas in order to protect the conservation of wild birds and natural habitats and of wild fauna and flora. protected areas for specific (habitats of) (bird) species.



Figure 17. Photos of stuthout for mines (Mijnhout | Sleutel Spoor, n.d.)

As mentioned in the previous chapter, by 1850 there was enough knowledge about forestry to set this up on a large scale. Over time different concepts of management have been developed, focussed on desired aspects the forest should fulfil. Below, these are shortly described through time. An overview can be found in figure 21. To keep it relevant for this graduation, only forest management forms for high forest are described.

Production-focussed (<1950)
Out of efficiency and the need for high production, forests were planted at one go and later cut at the same time; clearcutting (NL: kaalslag). This resulted in even-aged monocultures, making the forest vulnerable to disease, storms and forest fires, as can be seen in figure 18.



Figure 18. Traditional monocultures
(Productiebos in Oerlesche En Zandoerlese Bossen, 2018)

Multifunctional (’60)
As prosperity increased, forests were considered more and more as recreational and natural areas. From this followed multifunctional forest management, where the goal was to allow different functions to coexist in a forest. This resulted in zoning within the forest with parts of older forests, mixing of tree species and smaller interventions. However, timber production remained an important focus within forest management. Nowadays, 2/3 of the Staatsbosbeheer forests are managed this way, with single-tree selection.

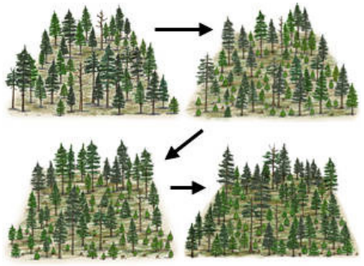


Figure 19. Single-tree selection cutting over time
(Forest Practices Branch, 1999)

Nature-focussed (’72/’73)
During the storms in 1972 and 1973 a lot damage had been done to the forests, which led to discussions about clearcutting and the current monocultural forests in the Netherlands, planted around 1900 for wood production. A more natural forest management was advocated. Nature values were becoming more important in forest management, for example by aging trees, more mixed forests, dead wood, clearings in the forest, natural rejuvenation, attention to the shrub and herb layer, use of indigenous tree and shrub species.

Pro Silva (’89)
Pro Silva management takes this further and focusses on low-risk, ecologically and economically healthy forests. It aims at preserving or restoring ecosystems, protecting soil and forest climate, producing timber and providing recreation, nature

experience and other cultural services. It aims to create mixed forests with a lot of structural variation and uses single-tree selection.

Integrated (‘90)
Integrated forest management seeks to integrate the functions of timber production and nature management in the same piece of forest, with a preference for spontaneous processes. Recreation can take place within this forest as well. Integrated forest management seeks to produce quality timber, a diverse and open forest structure, and a mixture of tree species and ages. The intended forest consists partly of native tree species and there is a substantial share of dead wood. Rejuvenation is done selectively and mostly on a small scale by group selection cutting (figure 20) (NL: groepenkap) or shelterwood cutting (NL: schermkap), depending on the desired light or shadow tree species.

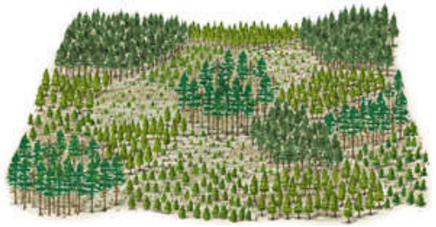


Figure 20. Spatial consequences of group selection cutting over time (Forest Practices Branch, 1999)

Ecosystem (‘90<)
This form of management aims to maintain a diverse, stable and resilient ecosystem, with optimal and sustainable function fulfilment, without choosing specific forest functions in advance. The management is intensive and uses singe-tree selection, based on ecological knowledge.

Biodiversity (<‘00)
In 1/3 of the forests in the Netherlands, managed by Staatsbosbeheer, biodiversity conservation is the main goal in “nature forests” (NL: natuurbossen). Examples of management measures aimed at increasing biodiversity include deadwood creation, making forest edges, clearing, creating vertical layers and wildlife management. Many of these forests in Europe are part of the Natura 2000 network and have forest management focused on biodiversity. The idea is to form a desired habitat within these forests that regulates itself. Intervention is therefore there is none or minimal.

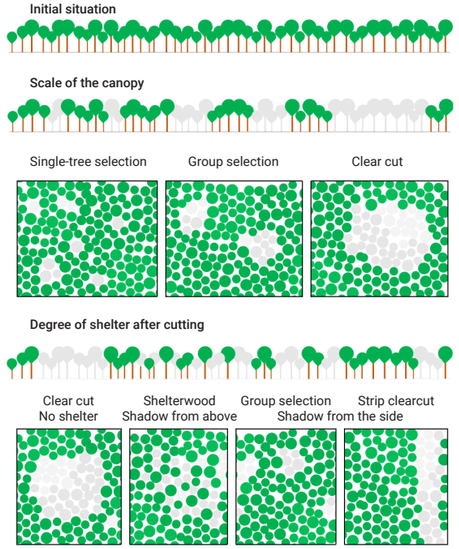


Figure 21. Different cutting methods (Den Ouden & Mohren, 2020)

3.5 CHALLENGES AND OPPORTUNITIES FOR DUTCH FORESTS

Looking at the historical development of forests and management perspectives, a couple challenges and opportunities can be formulated:

- There is currently still a lot monocultured forest in the Netherlands which consists largely of coniferous trees making them vulnerable for the consequences of climate change. These forests need to be transformed to multicultural forests. Here lies an opportunity, since space must be made for deciduous trees, so many conifers will be cut down that can be used in the building industry.
- Forests in the Netherlands are fragmented and under pressure do to space scarcity. This means that new forests should be planted smart, creating new connections and corridors at the same time to enlarge habitats for biodiversity goals. Small landscape elements can play an important role here.
- A lot trees and plants that are currently present in the Dutch forests are not indigenous and some are even invasive, like the Japanese knotweed (Reynoutria japonica), causing a lot disturbance or even damage within ecosystems. This shows the importance of using trees that are indigenous. By using indigenous trees, the tree will fit within current ecosystems and forest animals can use them as a food source. In addition, they will fit better into our climate, even though it is changing. Finally, indigenous trees also have cultural-historical value compared to exotics, they have been part of the Dutch landscape for centuries.
- Climate change is a threat to tree species like the Norway spruce, Beech and Larch. Actively discouraging these trees would be good (especially if they are exotics) or looking for alternative seeds that are more resistant to the future Dutch climate – today’s Mediterranean climate.

Besides these challenges and opportunities, our demands and desires for forests have changed over time, requiring a forest to fulfil more functions than just timber production, like figure 22 shows. Together this results in an interesting design challenge.

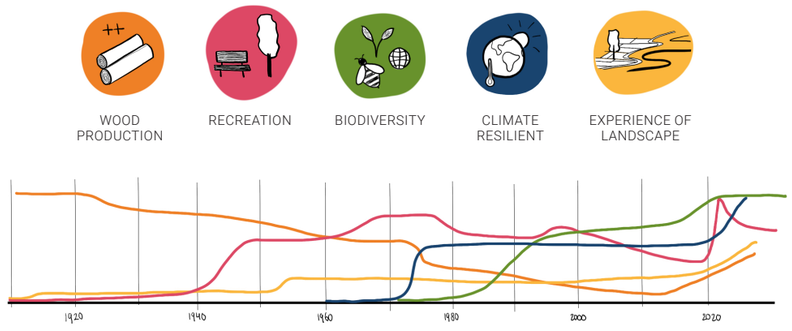


Figure 22. Shift of what aspects are important within a forest (created by author)



4. HATTEM AS LIVING LAB

4.1 INTRODUCING HATTEM
4.2 CHARACTER HATTEM
4.3 HATTEM ACCORDING TO THE ASPECTS

Photo: Google Earth

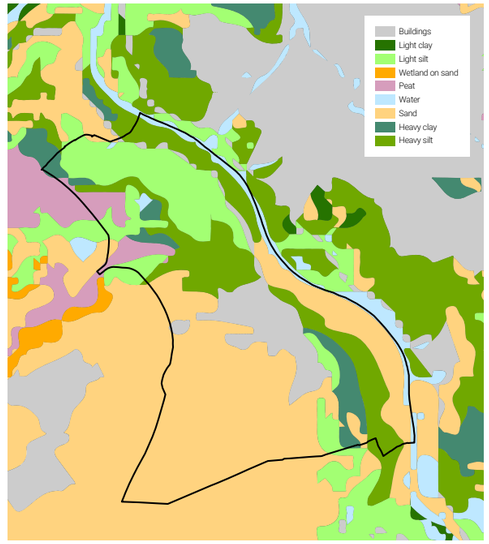


Figure 23. Soil types in Hattem (Atlas Leefomgeving, 2018)

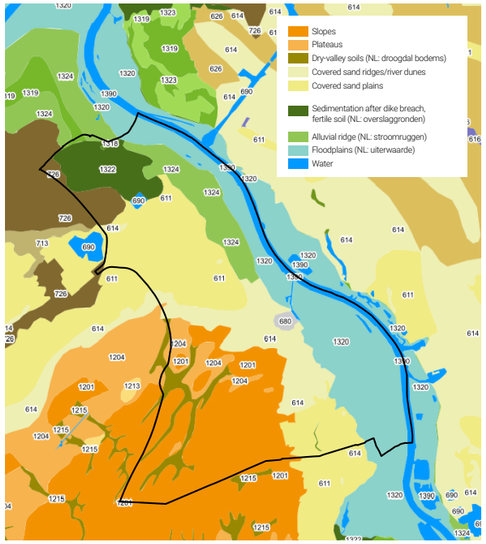


Figure 24. Geomorphological map Hattem (Atlas Leefomgeving, 2018)



Figure 25. Different landscapes in Hattem, together with section (created by author)

4.1 INTRODUCING HATTEM

Divers landscape

Looking at the identity of Hattem, due to the soil types and the geomorphology underneath Hattem (figure 23 and 24), 4 landscape types can be recognized (figure 25):

- First, the river landscape; this is expressed by the IJssel and its floodplains.
- Secondly, the urban landscape; the old city centre of Hattem and its expansion. Hattem is a Hanzestad and became famous for its bricks, made from clay from the Ijssel – so Hattem already has this relationship of producing materials from its landscape.
- Thirdly, the polder landscape; characterized by open fields of grass and rectilinear ditches. The dyke is a clear mark of where the floodplains end and the polder starts.
- And finally, the forest, the Veluwe, which is situated a lot higher than the rest of Hattem, because it grows on top of a moraine.

Development Hattem

Briefly, how the area has been shaped through time:

The highest point in Hattem is the Veluwe, that consists of moraines, which were formed about 150.000 years ago during the second-to-last ice age, resulting in the current height difference. During the Holocene our climate became warmer causing the area to become forested.

The IJssel is the youngest river in the Netherlands and the lowest point in Hattem. It was formed as a result of a breakthrough of two creek systems early in the 4th century. Due to the combination of these special developments in the landscape, 't Algemene Veen (a natural kolk, formed by a river break through a sand ridge) and the Wiessenbergse Kolk (a lower ago area between the moraine and the embankment of the IJssel) were created.

The area has been inhabited since the Middle Ages. After the first dike was built around the village of Hattem, the digging of drains and connecting roads began in the late 14th century. Hattem became known in the Hanseatic period for its bricks, which were extracted from the IJssel clay. So producing materials from its landscape is not new to Hattem!

Hattem has two estates in its municipality, of which Landgoed Molecaten is the largest and where a lot of coniferous forest has been planted. Probably partly to prevent sand drift, but also certainly for production purposes – which they still do.

In between the Veluwe and the IJssel, a cultivated polder can be found, where farmers began to live from about 1800.

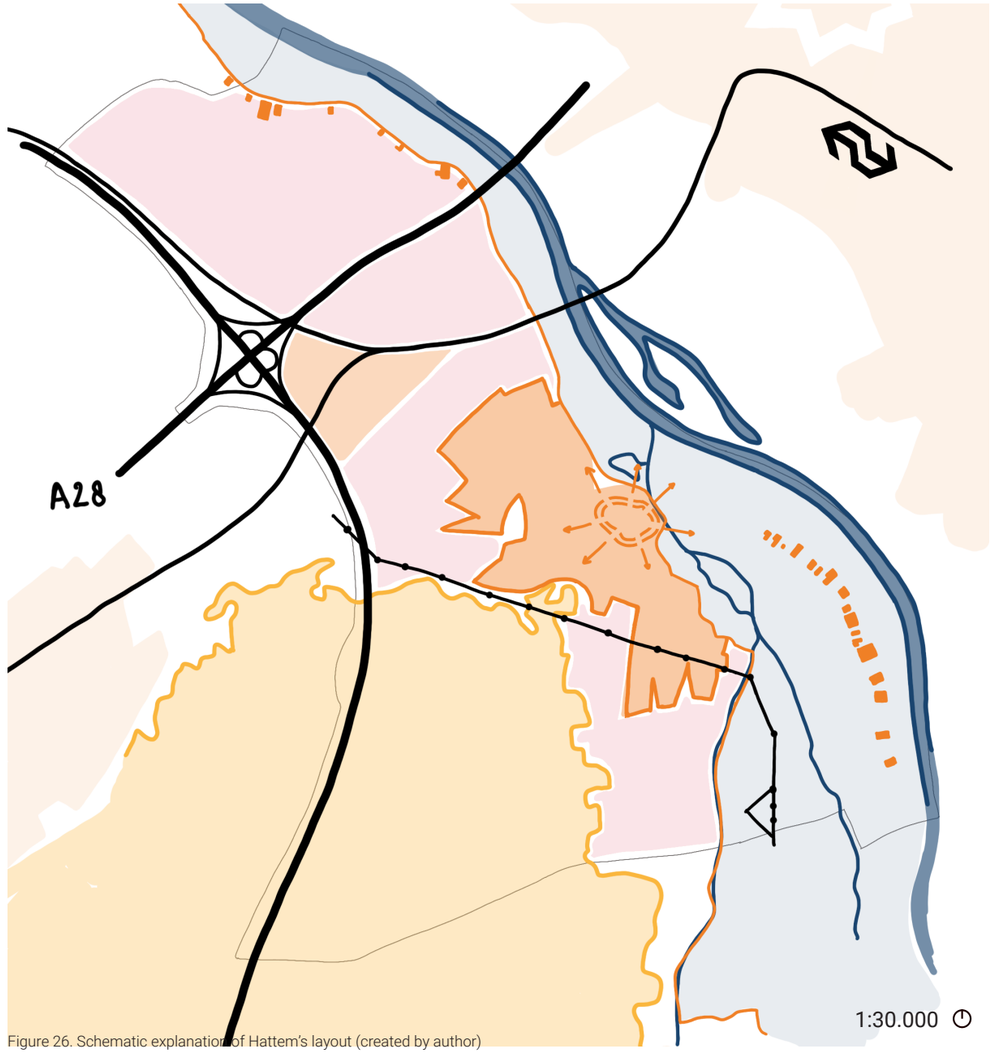


Figure 26. Schematic explanation of Hattem's layout (created by author)

FOREST
URBAN AREAS
DYKE
POLDER
FLOODPLAINS
RIVER
INFRASTRUCTURE

4.2 CHARACTER HATTEM

Many different characters can be found in Hattem, partly because of the diverse landscape, but also because of human interventions, such as infrastructure. A schematic overview of the layout of Hattem is shown in figure 26.

The character of Hattem can be drawn in the following features:

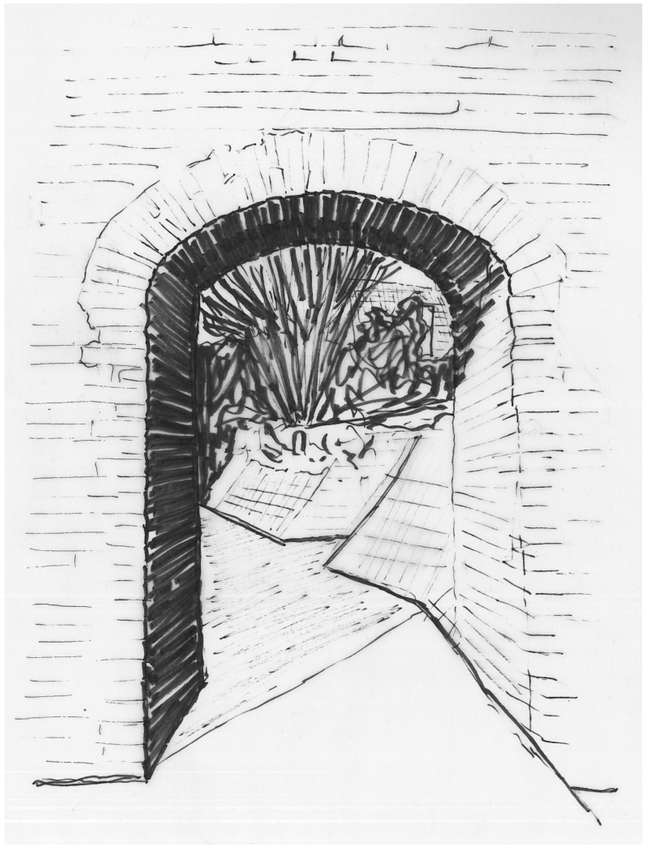
- A panoramic view, everywhere the polder landscape occurs up to large elevations or buildings, panoramic views can be seen. Figure 27 illustrates this.
- Elevation of Hattem city and the Veluwe, both are higher than the rest of the landscape, making them recognizable landmarks within Hattem. The drawings in figure 28 show this.
- There are many sightlines "doorkijkjes", see figure 29, within the town of Hattem. They keep the view exciting and inward, while also providing vistas outward to the landscape.
- The rectilinear infrastructure is dominant within the landscape of Hattem, resulting in harsh lines cutting through the landscape. Figure 30 shows examples of these elements.
- The transition between the different landscapes is hard, forming a clear contrast between open and closed. In the drawings of figure 31 this contrast is shown.
- Hattem is an area with many recreation possibilities like walking and cycling routes, figure 32 illustrates this.



Figure 27. Panoramic view (created by author)



Figure 28. Elevation (created by author)



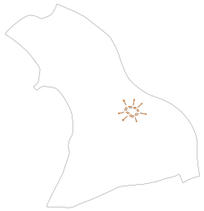
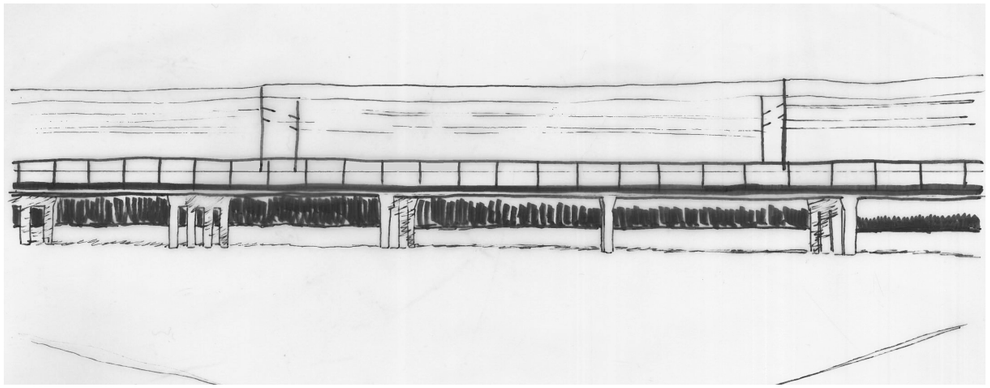


Figure 29. "Doorkijkjes" (created by author)





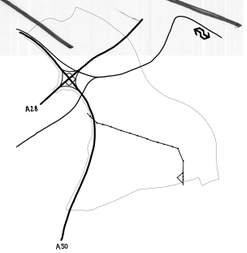


Figure 30. Rectilinear infrastructure (created by author)





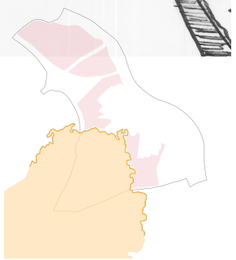
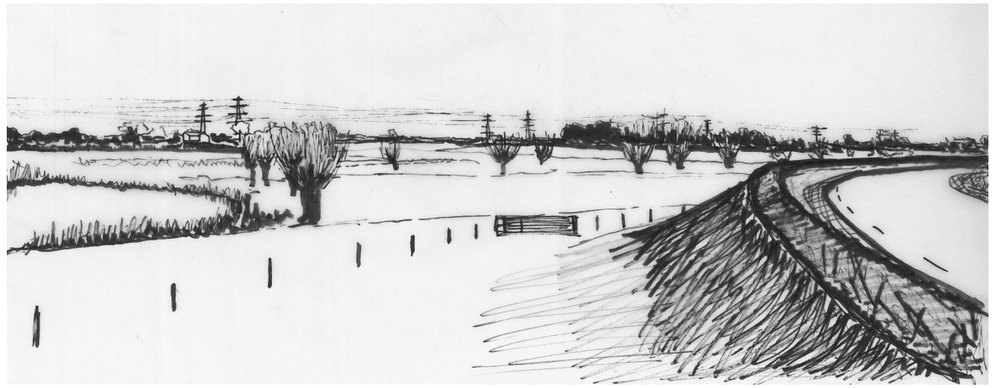
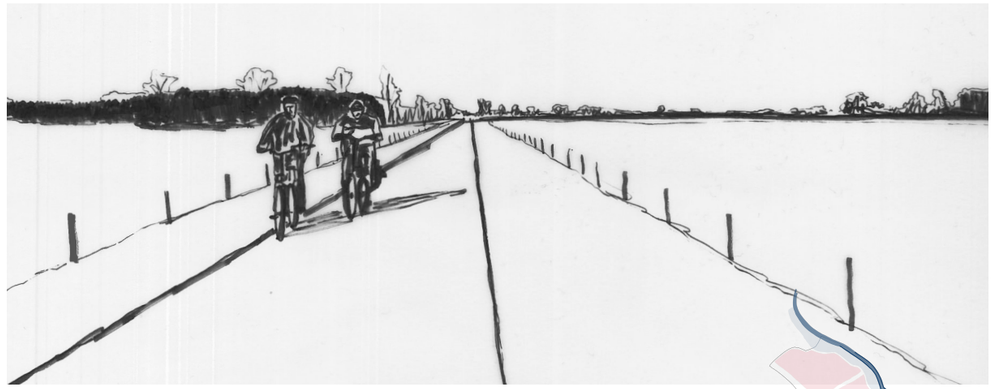


Figure 31. Harsh transition (created by author)





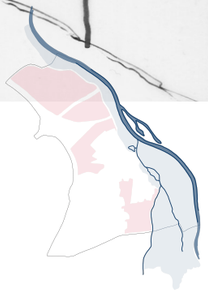


Figure 32. Recreation (created by author)

4.3 HATTEM ACCORDING TO THE ASPECTS

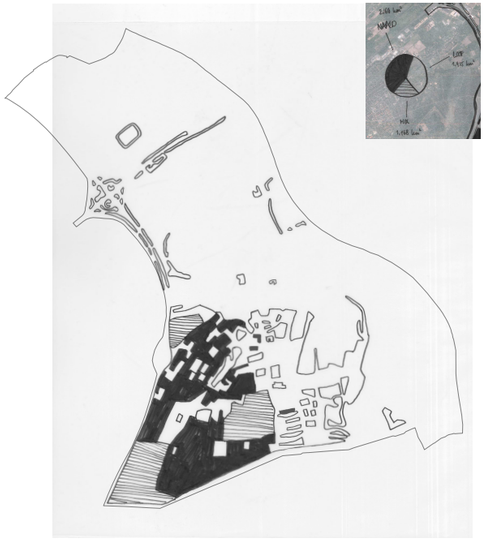


Figure 33. Ratio of different forest types (created by author)

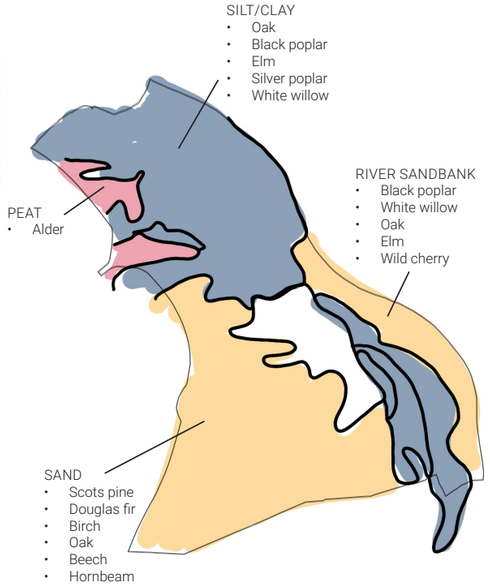


Figure 34. Soil types in combination with trees (created by author)

PRODUCTION

Currently, the ratio of different forest types in Hattem is distributed as follows:

- ca. 41.2% is coniferous forest
- ca. 36.5% is deciduous forest and
- ca. 22.3% is mixed forest (figure 33).

Much of this coniferous forest falls under Landgoed Molecaten where the forests are still managed for wood production. However, over time, these forests will need to become more diverse to remain healthy, especially the old plantations that are still a monoculture.

In order to select trees for the design, an overview of trees and their qualities for the forest as well as for construction, has been made, together with Mathilde (figure 35, next page).

Based on the different soil types that can be found in Hattem, a pallet of trees has been formed for their production quality, see figure 34. Not all trees are the best to use for construction, some trees are selected because they grow fast in open fields to establish as soon as possible a forest climate, like the Birch or White willow. This way, they can protect the final wood producing trees that will profit from the climate created for them to grow in.

On sand the following trees will be used:

- Scots pine *(Pinus sylvestris)*
- Douglas fir *(Pseudotsuga menziesii)*
- Birch *(Betula pendula)*
- Oak *(Quercus robur)*
- Beech *(Fagus sylvatica)*
- Hornbeam *(Carpinus betulus)*

On silt/clay the following trees will be used:

- Oak *(Quercus robur)*
- Black poplar *(Populus nigra)*
- White elm *(Ulmus laevis)*
- Silver poplar *(Populus alba)*
- White willow *(Salix alba)*

Looking at the time it takes trees to grow to felling size it is noticeable that trees on sandy soil generally grow slower than those on clay (figure 36).

If generalised, four categories can be distinguished in terms of growth rate:
150 years, 75 years, 50 years and 25 years.

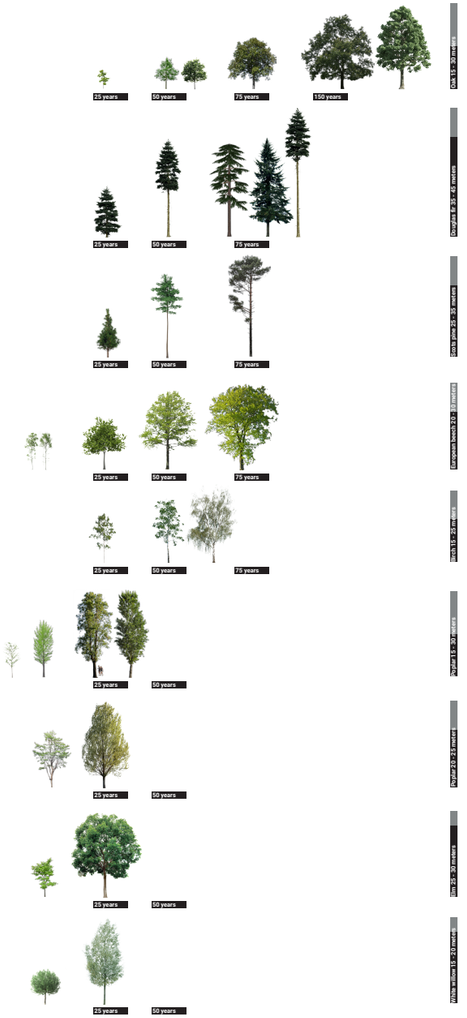


Figure 36. Overview of the growing time of trees (created by author)

Roots	Soil	Shadow/light	Growing site	Indigenous	Pioneer tree	Height	Tree type	Target diameter (minimum)	Growth rate	Latin name	Tree species	Tree photo
Lateral	All types of soil (loess, silt, peat, heavy clay, light clay, sand, loam)	Sunny to semi-shaded sites	Deciduous forests, hillside forests, calcareous forests, wooded banks, hedges, shrublands, along roads and stream banks.	x		15-20m	Deciduous tree/ hardwood	45 dbh	Medium	*Carpinus betulus*	European hornbeam	
Lateral	Loess, silt, light clay, sand, loam	Sunny sites	Dune forests, riparian forests along large rivers, forest edges, shrublands and roadsides.	x	x	15-20m	Deciduous tree/ hardwood	50 dbh	Fast (15-25 years) Annual growth: 15m3/ha	*Populus alba*	Silver poplar	
Heart	Loess, silt, heavy clay, light clay, sand, loam	Sunny to semi-shaded sites	Along roads, along ditches in meadows, along rivers, wet marshes, pocket forests, willows and wet forest edges.	x	x	15-25m	Deciduous tree/ hardwood	100 dbh	Fast (25 years)	*Salix alba*	White willow	
Tap	Loess, heavy clay, light clay, loam	Sunny to semi-shaded sites	Deciduous forests, dune forests and scrubland.	x		Max 40m	Deciduous tree/ hardwood	60 dbh	Medium (60 years) Annual growth: 8,4m3/ha	*Fraxinus excelsior*	European ash	
Tap	Loess, silt, light clay, sand, loam	Sunny	Coniferous forests.			25-45m	Coniferious tree/softwood	50 dbh	Fast (40 years) Annual growth: 10,5m3/ha	*Larix decidua*	European larch	
Lateral	All types of soil (loess, silt, peat, heavy clay, light clay, sand, loam)	Sunny, open places	Forest edges, shrublands, wooded banks, pioneer on logging plains, clearings in forests, dunes, roadsides and along railroad tracks.	x	x	20 - 30m	Deciduous tree/ hardwood	50 dbh	Fast (15-25 years) Annual growth: 15m3/ha	*Populus nigra*	Black poplar	
Lateral	Loess, heavy clay, light clay, loam	Semi-shaded to shaded sites	Coniferous forests.			Max 45m	Coniferious tree/softwood	50 dbh	Medium-fast (40-60 years)	*Picea abies*	European spruce	
Heart	Loess, silt, light clay, sand, loam	Sunny to semi-shaded sites	Along streams and rivers, deciduous forests, ravine forests, hedgerows and along hollow roads and open field.	x		25-35m	Deciduous tree/ hardwood	45-60 dbh	Fast (25 years)	*Ulmus laevis*	White elm	
						30-45m	Deciduous tree/ hardwood	60 dbh	Medium	*Abies alba*	Silver fir	
						15-25m	Deciduous tree/ hardwood	40-60 dbh	Medium (60 years) Annual growth: 14-17 m3/ha	*Castanea sativa*	Sweet chestnut	
						25-30m	Deciduous tree/ hardwood	?	Fast (40 years) Annual growth: 9,4m3/ha	*Robinia pseudoacacia*	Black locust	

Figure 35. Overview trees (created by author and M. Siderius)

Strength	Durability (heartwood)	Laminated	Solid	Other	Remarks	Sight	Smell	Touch (effusivity relative to palm)	Wood photo
?	V	x		Floor tiles	Untreated not suitable as construction wood, decays too quickly in moist air	White, silverish, with little difference between heartwood and sapwood	-	42%	
D35, D40	V	x	x	Threshold, stairs, floor	Very good to glue. Expands a lot in contact with water. Not to be used outdoors.	Heartwood whitish to light brown. Steamed is pink to light red.	-	41%	
D40	V	x (CLT in development)	x	Roof, doors, staircases, floor	Heavy, hard but excellent to work with. Highly underrated in construction, grows fast, is hard and has beautiful markings.	Very broad sapwood, contrasting with the brownish heartwood. White to creamy white color. Uniform texture. Light yellow exposed to daylight Nice grain with beautiful markings.	-	39%	
C14, C18, C24, C30. Similar in properties to pine but heavier, harder and stronger.	II-III: One of the most durable coniferious tree species in Europe. Larch sapwood is less susceptible to blue mold than spruce sapwood and much less so than pine sapwood. Can be used outdoors untreated.	x	x	Frames, façade, interior, staircases and rooftrusses, foundation pole	Larch wood ranks above pine in utility value, but below that of larch, Douglas fir and pinus. Takes twice as long to dry as pine. Does not work, warps fairly quickly.	Sapwood: dirty white. Heartwood: yellowish brown to reddish brown. discolored over time.	Contains a large amount of resin, pronounced resin smell.	32%	
C14, C18, C24, C30. Less resilient and tough than spruce and pine and therefore less suitable for long joists.	III: Sapwood very nondurable.	x	x	Frames, door, floors, interior, fences	Disadvantage compared to silver fir and spruce is the strong perspiration of resin. Easy to process.	Fresh heartwood: light brown. Sapwood: white to white-yellow. Clear difference between light-colored earlywood and thinner-colored latewood. Becomes darker over time.	High resin content creates a pleasant resin smell. Disappears over time but when old wood is reworked it smells like new again.	32%	
C22. In terms of mechanical properties as strong as a spruce.	V: For indoor use it is durable but outdoors it does not last long.	x	x	Floor	Dries relatively quickly. Wear-resistant and difficult to ignite. Strange that poplar wood is hardly used in construction in NL.	Practically colourless.	Odorless, resinless.	29%	
C14, C18, C24, C30	IV: Unlike other woods, spruce sapwood is considered equivalent (in durability and other properties) to heartwood for most applications after drying. Not to be used outdoors untreated.	x	x	Frames, doors, staircases, floors, interior, furniture, foundation pole, façade	Easy to process	Almost white to pale yellow-brown. Freshly sawn almost white. Yellow-brown due to exposure to light and air. 5-6cm of sapwood.	Resinous but lacking the distinctive resin smell found in pine.	32%	
C14, C18, C24, C30	III: Can be used outdoors untreated.	x	x	Frames, façade, interior, foundation pole	Fir is known for laying down a consistently high proportion of strong, dense summerwood, which is what makes it such a good structural timber.	Heartwood is light red, to brownish red. Sapwood is light yellow. Yearrings are well defined. 1-2 cm of sapwood.	Relatively resinous.	32%	
D18/D24/D30	II-III: Keeps well when dry or continuously in water.	x (CLT in development)	x	Frames, doors, floor	Steaming reduces shrinking and swelling. Wood works in one direction, can cause cracks	When fresh: yellowish white, later yellowish red. Steamed pink to pale red. In contact with steel blue/black due to the reaction of tannic acids with the metal which will corrode.	Odorless	41%	
Elm is barely inferior to oak in quality as construction or work wood.	IV	?	x	Door, staircase, furniture		Relatively high percentage of sapwood, color light yellow. Heartwood color light brown to dull dark brown, sometimes with a greenish sheen.	Said to release unpleasant odor during processing.	-	
C14, C18, C24, C30	IV: Little resistance to insect attacks. Susceptable to blue mold.	x	x	Frames, door, staircases		Yellow to greyish white. Contains many knots and coarse yearrings.	Little resin, no characteristic odor.	32%	
D24	II: High tannic acid content accelerates corrosion of metals but allows untreated outdoor application.	x (CLT in development)	x	Frame, Door, furniture, façade, roof, floor	Easier to process than oak	Light brown to dark brown. Resembles oak, but slightly lighter, with beautifull grain. Little sapwood.	-	-	
D30	II: Known as one of the most durable woods in Europe.	x	x	Frames, door, staircases, façade		Color of the heartwood is light yellow-green to brown-green, turning golden brown after exposure to light. In sharp contrast with with the 10-20 mm wide gray-yellow sapwood.	-	52%	

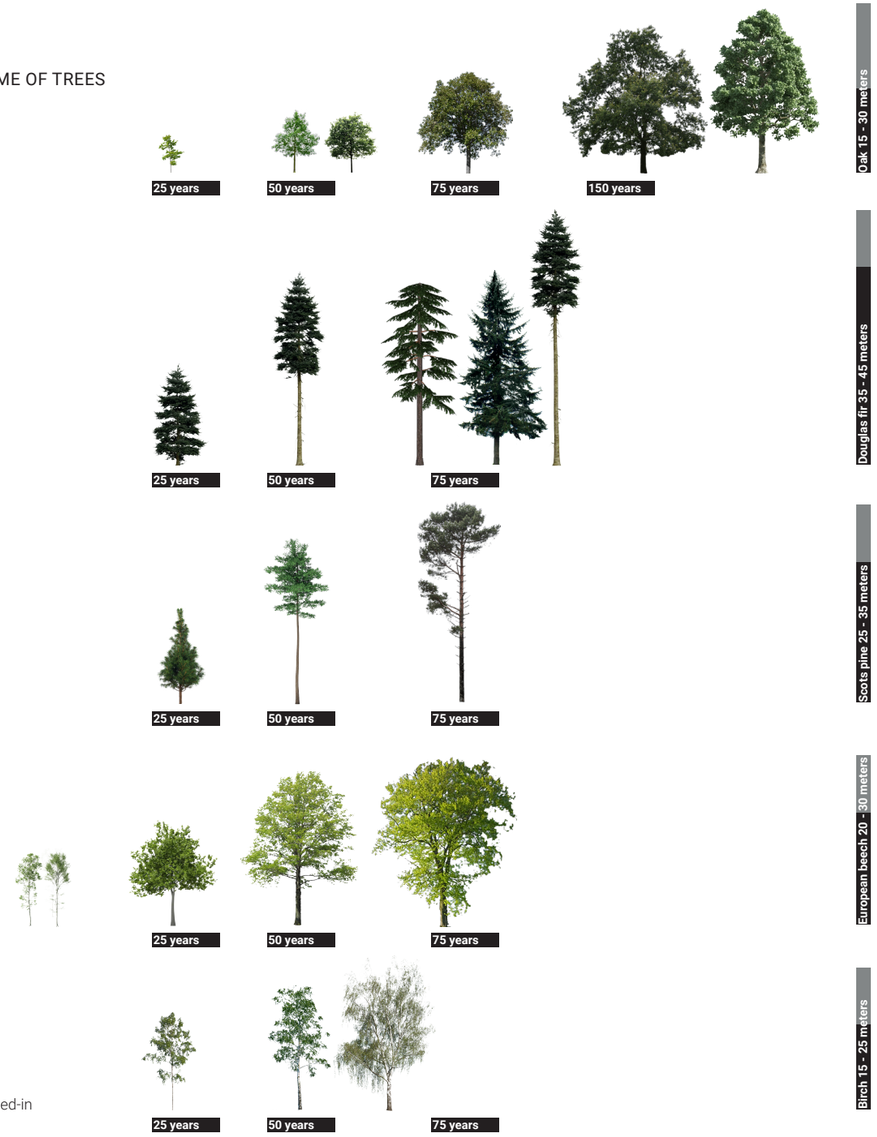
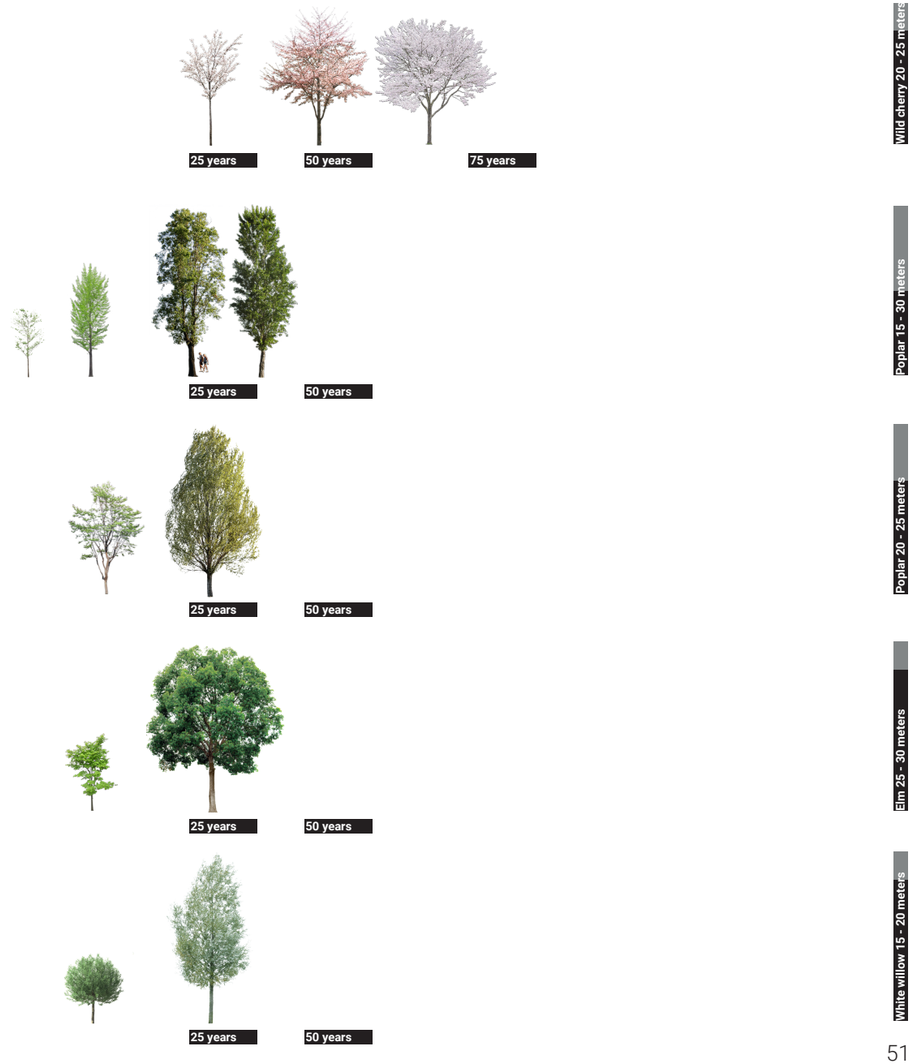


Figure 36. Zoomed-in



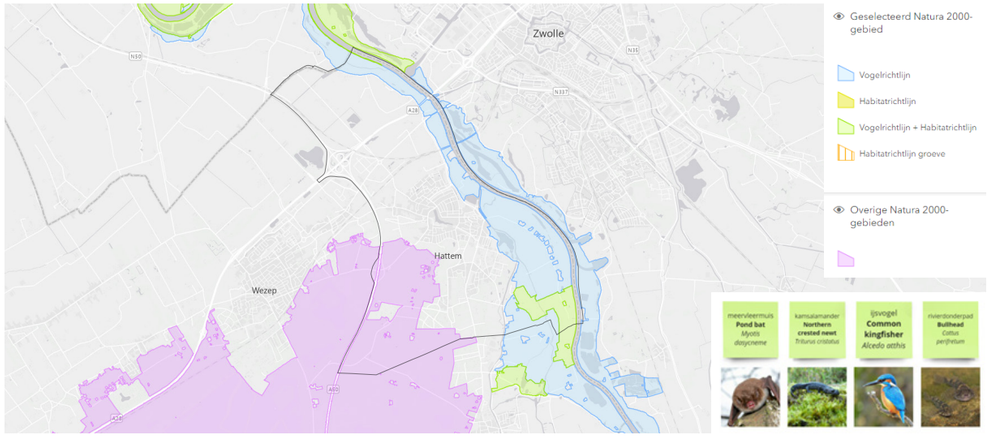


Figure 37. The Natura 2000 areas in Hattem and the aspired animals (Natura 2000, 2018)

BIODIVERSITY

Biodiversity is the diversity of life you can find in one area – from animals to plants, fungi, and microorganisms that together form our natural world. These different species and organisms work together in ecosystems to maintain balance and support life. Biodiversity supports everything in nature that we need to survive: food, clean water, medicines and materials (What Is Biodiversity and Why Is It Under Threat?, 2019). Biodiversity gets therefore often used as an indicator to determine whether an area is healthy.

In order to provide space for biodiversity in the design of new production forests, the first step is to determine which flora and fauna can be found in forests in the Netherlands and what kind of habitat requirements they have. Next the current Natura 2000 areas and the ambitions for these areas in Hattem will be analysed to see which animals are intended to be accommodated in this area and whether the new forest can contribute to achieving this.

Natura 2000 areas

Natura 2000 is a European network of nature protection areas, in which specific flora and fauna are protected to preserve biodiversity (Natura 2000, 2018). Within Natura 2000 sites, guidelines have been drawn up for both the protection of species and areas in order to protect the conservation of wild birds and natural habitats and of wild fauna and flora. protected areas for specific (habitats of) (bird) species.

In Hattem, two Natura 2000 areas are present: the Uiterwaarden IJssel (38) and the Veluwe (57), see figure 37. These areas both have ambitions/goals for habitat-specific animal species and (breeding)



Figure 38. Elements that the Pond bat needs in its habitat (collage created by author)

birds. For a couple species, like the Common kingfisher *(Alcedo atthis)*, Bullhead *(Cottus perifretum)*, Pond bat *(Myotis dasycneme)* and Northern crested newt *(Triturus cristatus)* there is an overlapping ambition to accommodate these species in both areas.

Currently, there is little to no exchange between these two Natura 2000 areas due to barriers in the form of infrastructure and buildings. By creating eco-corridors in the form of new green structures or strengthening current ones, it will have a positive effect on the biodiversity. This, because it will result in a larger habitat for the current species living there, more access to food and shelters and exchange in population (Wat Is Ontsnippering?, 2021).

Besides the positive effects listed above of an eco-corridor between the two current Natura 2000 areas, there is also an additional opportunity in Hattem. Since Hattem is a transition zone between forest, meadow and wetland, a connection between these areas will be attractive for “gradient” animals. Such as the roe deer, badgers, wild boar, hedgehogs, bats, frogs and salamanders (Ministerie van Infrastructuur en Waterstaat, 2022).

For the following species, there is the ambition to accommodate them both in the Uiterwaarden IJssel and in the Veluwe:

- The Common kingfisher *(Alcedo atthis)*,
- Bullhead *(Cottus perifretum)*,
- Pond bat *(Myotis dasycneme)* and
- Northern crested newt *(Triturus cristatus)*.

The four animals that could benefit from an eco-corridor to connect the two Natura 2000 areas.

From these animals, especially the Pond bat and Northern crested newt are interesting to look into deeper since these animals need landscape elements and trees in their habitat which this project could respond to.

Pond bat

The Pond bat needs landscape elements such as hedges, wooded banks, lanes and gardens to navigate and as flight routes. They can also make use of these landscape elements as shelter during wind. The edges of forests or groups of trees become also important then. The Pond bat also prefers to visit river-conducting forests (ooibossen) to hunt. There are not many of these in the Netherlands because a different landscape design is often chosen at the edges of rivers, namely floodplains. An overview of what the Pond bat needs can be found in figure 38.

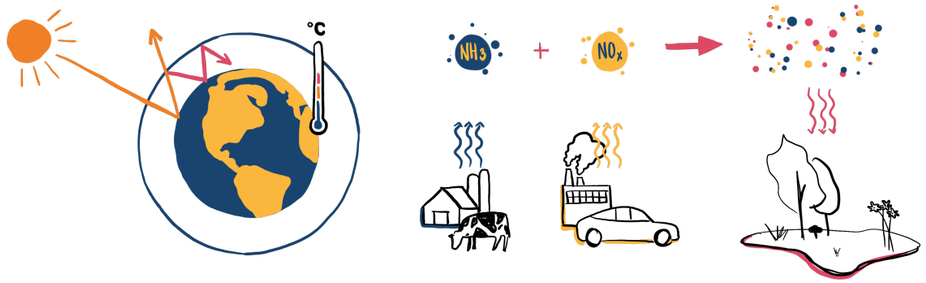


Figure 39. The mechanism of the greenhouse effect and nitrogen deposition (created by author)

CLIMATE RESILIENCE

Excessive use of fossil fuels, large-scale deforestation and livestock farming are affecting the earth's climate and temperature. Due to large emissions of greenhouse gases in our atmosphere, the earth is heating up resulting in climate change (Causes of Climate Change, 2016), see figure 39. The consequences of climate change is something we are increasingly noticing nowadays and what we need to make ourselves more resilient to. According to the KNMI, written in Klimaatsignaal'21, we will face the effects of sea level rise, fluctuations in river water levels, drought and downpours with extreme winds more and more (KNMI, 2021). To respond to this, (new) forests should become climate resilient to cope with future changes due to climate change.

Looking at the expected effects of climate change in relation to the design challenge of planting new production forest in the context of Hattem, the following challenges need to be considered:

- Drought, especially on the higher sandy soils of the Veluwe;
- downpours, mainly in the polder area, in between the Veluwe and the IJssel;
- wind, to which forests can be vulnerable;
- and the fluctuations of the river water levels, to which the IJssel is subject.

Drought

Not enough water

Due to prolonged drought in spring and summer, forests struggle to get enough water. Especially on sandy grounds, where trees get their water from groundwater and therefore rely on rainwater.

A forest consisting of trees with roots that root close to the surface (lateral roots), will face more difficulty with getting enough water then trees with roots that root deeper into the ground (tap or heart roots), see figure 40. An example of a tree with lateral roots that cannot cope with the consequences of climate change, is the Norwegian spruce *(Picea abies)*. This tree species has been experiencing mass extinction across western Europe in the last few years (NOS, 2022). One solution to this, is to stop planting these types of trees on sandy soils. But looking into the future, these type of trees should not be planted in the Netherlands at all, due to our becoming drier climate.

Another solution, is to strive for mixed forests with a range of different tree species and therefore different roots. This is because all roots are connected by a system of mycelium, so with less deep roots can profit from their neighbour-tree with deeper roots.

The forest manager of the Speulder- en Sprielderbos explained during my visit to this forest that research had shown that the same wood species in monotone sections did worse than diverse wood species in mixed sections. This was because each wood species works to a certain depth to where it roots: its own "working area". What happens then is that a neighbour brings up water from deeper and the higher-lying roots benefit from this (personal communication, January 3rd 2023).

Fire risk

Due to the many planted conifer trees in the Netherlands, especially on sandy grounds, there is a high risk for wildfire during dry periods. This is because conifers contain more oil and resin in their branches then deciduous trees and they grow more closely to each other, which makes easy for a fire to spread (Government Alberta, 2012).

To prevent wildfire, a number of (spatial) interventions can be made (Cornelis, 2012):

- Fire road, a paved road that can prevent or delay fire, but can also be used as a roadway for firefighters, recreationists, forest managers. A major disadvantage of this is that it causes an interruption of nature and is expensive to construct and maintain.
- Firebreak, 10 to 15 metres wide, where vegetation is kept cut short. It limits fire spreading opportunities and increases the accessibility of the area. It does not disturb nature and increases the opportunity for development of heathland scarce grassland and provides a hunting area for the European nightjar.
- Deciduous hedgerow or woodland edge, deciduous trees are more fire-resistant. Would be suitable around buildings and vulnerable areas.
- Grazing by sheep or cattle to prevent build-up of litter. This creates less burnable material which reduces fire sensitivity. Mowing can also be done but it will cost labour hours.
- Maintain groundwater levels and possibly humidify.
- Construct lakes or ponds.
- From these suggestions, constructing firebreaks and planting deciduous hedgerows could be done easily, combined with the production ambitions, since the firebreaks could be used for the machines of the cutting of trees as well.



Figure 40. Lateral, tap and heart roots (created by author)

With the growing interest in forests, like the ambitions of the Forest Strategy illustrates, more and more attention is being given to the spatiality of forests. Under this, the (sensory) experience can be explored, but also the re-appreciation of cultural-historical “green-blue landscape elements”, which have partly disappeared in the past hundred years as a result of agricultural intensification.



Figure 41. Sightlines in Hattem (created by author)

Visual experience

Experiencing Hattem visually, it is characterised by wide views up to the edge of the city, the dyke, infrastructure or forest edge. These sightlines take place in the polder or floodplain, see figure 41.

From the city centre of Hattem, which lays higher than its surroundings, there are wide views in all directions, allowing the polder landscape, the floodplain with its river and a rooftop landscape to be seen from above. On the south-west side of Hattem, the Veluwe also lies higher, providing a softer, but also clear boundary to the wide view. Hattem is proud of this panoramic view, perhaps because the Veluwe shows the end of this wideness, like a dark backdrop in the distance.

Sound

However, the open character of the vastness also has a downside when considering noise. Because Hattem is intersected by the motorway and railway, this noise is carried far. In some places this expresses itself in constant noise from cars, while in other areas individual cars can be heard. Cars driving along the dyke are also clearly audible, leaving certain areas within Hattem enclosed on three sides by traffic noise.
Through the use of wooded banks and trees, in some places the noise of infrastructure is minimised and overruled by chirping birds. A variety of bird songs can be heard, at least five, showing that different species of birds are attracted to Hattem.
Finally, the church bells of the town of Hattem carry far across the landscape, making the town, centrally located within the municipality, widely noticeable.
The perceived sounds are visualised together in figure 42.

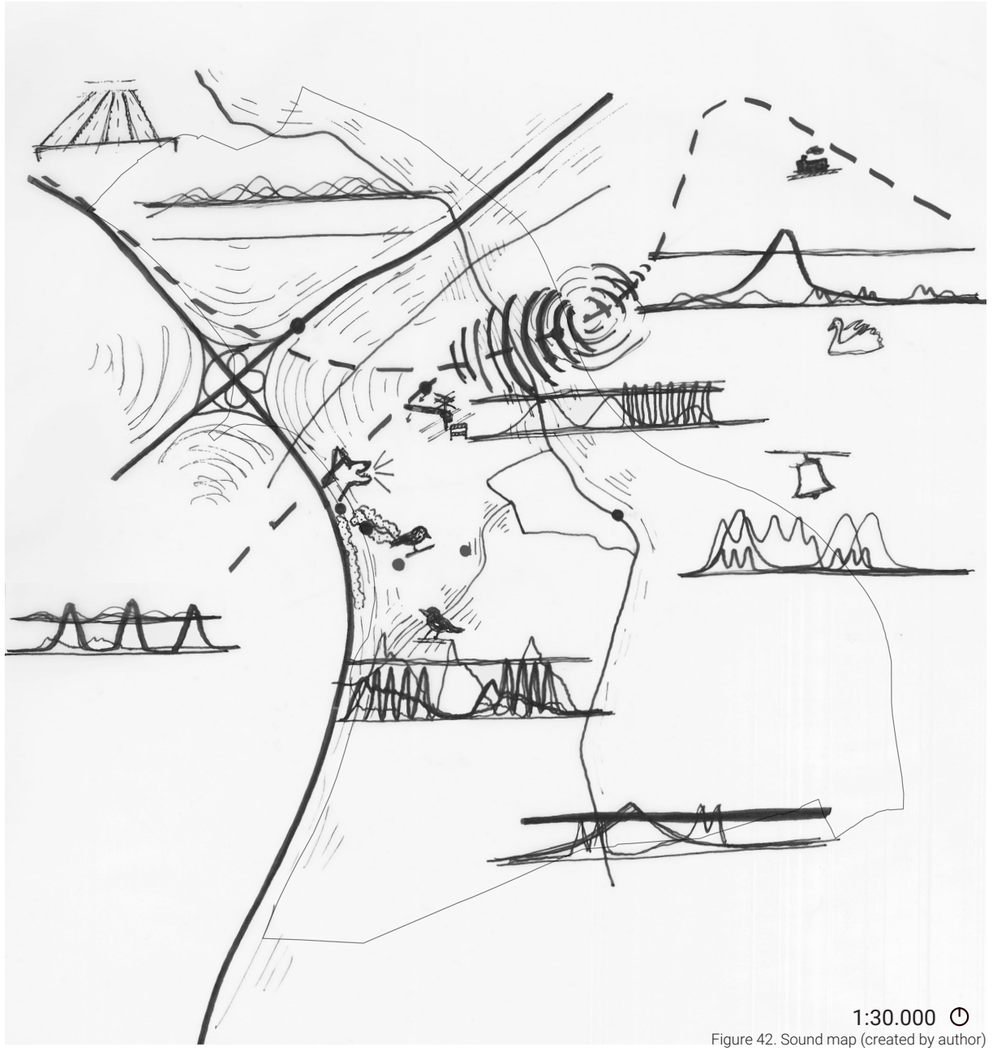


Figure 42. Sound map (created by author)



Figure 43. Landscape transformation due to agricultural intensification (Rienks et al., 2008)



Figure 44. Edges within Hattem (created by author)



Figure 45. Sightlines in Hattem (created by author)

Green-blue landscape elements

Landscape elements are the building blocks of a landscape; they are the natural corridors in the rural cultivated landscape and form the appearance of the landscape (Landschap Erfgoed Utrecht, 2021).

In the past landscape elements fulfilled multiple important functions, like separation of property and/or livestock fencing and at the same time provide wood for production, but these functions have been lost due to modern solutions. Due to the loss of its original function and intensification of agriculture with land consolidation, many old landscape elements disappeared, together with the appearance of this historical landscape, see figure 43. Which is a loss, as these landscape elements tell something about our history and old agricultural practices and land use. Besides this cultural loss, is it also a loss for biodiversity, since landscape elements serve as connection between nature areas and provide a diversity of habitats (Kleine Landschapselementen, 2017).

Hattem used to have a bocage landscape, since it is still visible on the edges of the Veluwe, see figure 44. Due to these old structures, different chambers appear, resulting in a open and closed pattern. This pattern forms interesting sightlines from the ground, making the area interesting visually, which can be seen in figure 45.

Looking more closely to what the type of landscape elements are, they can be divided in linear, point and planar elements and according to BIJ12. The following green-blue landscape elements can be divided:

- Pond and small historic water (linear and planar), (NL: poel en klein historisch water)
- wooded bank and windbreak (linear), (NL: houtwal en houtsingel)
- alder belt (linear), (NL: elzensingel)
- trimmed hedge (linear), (NL: knip- of scheerheg)
- scrub hedge (linear), (NL: struweelhaag)
- avenue (linear), (NL: laan)
- pollarded tree (linear and point), (NL: knotboom)
- standard orchard (planar), (NL: hoogstamboomgaard)
- and woodland hedge (linear) (2019). (NL: bossingel)

Within Hattem the following elements can still be found (figure 49):

- Wooded banks,
- trimmed hedges,
- scrub hedges,
- avenues, mostly Linden *(Tilia)*,
- and pollarded trees, with ditches, mostly Willows, *(Salix alba)*.

These elements help to make a transition from housing (private) to forest (figure 46) or (agricultural) land (more public) (figure 47). They can be used functional to block wind or create shadow, but also create privacy. Especially trimmed hedges are an element that almost every house has in Hattem (figure 48).



Figure 46. Wooded bank, avenue and scrub hedge (created by author)

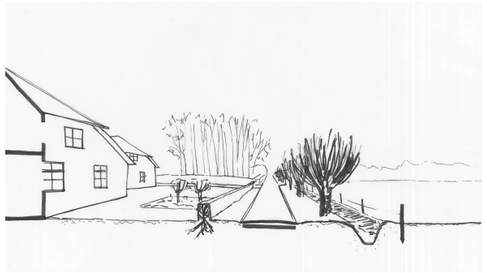


Figure 47. Trimmed hedge, pollarded trees and ditch (created by author)

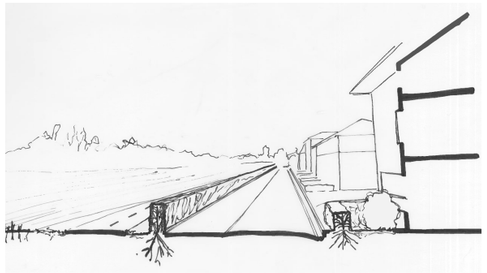


Figure 48. Trimmed hedges (created by author)

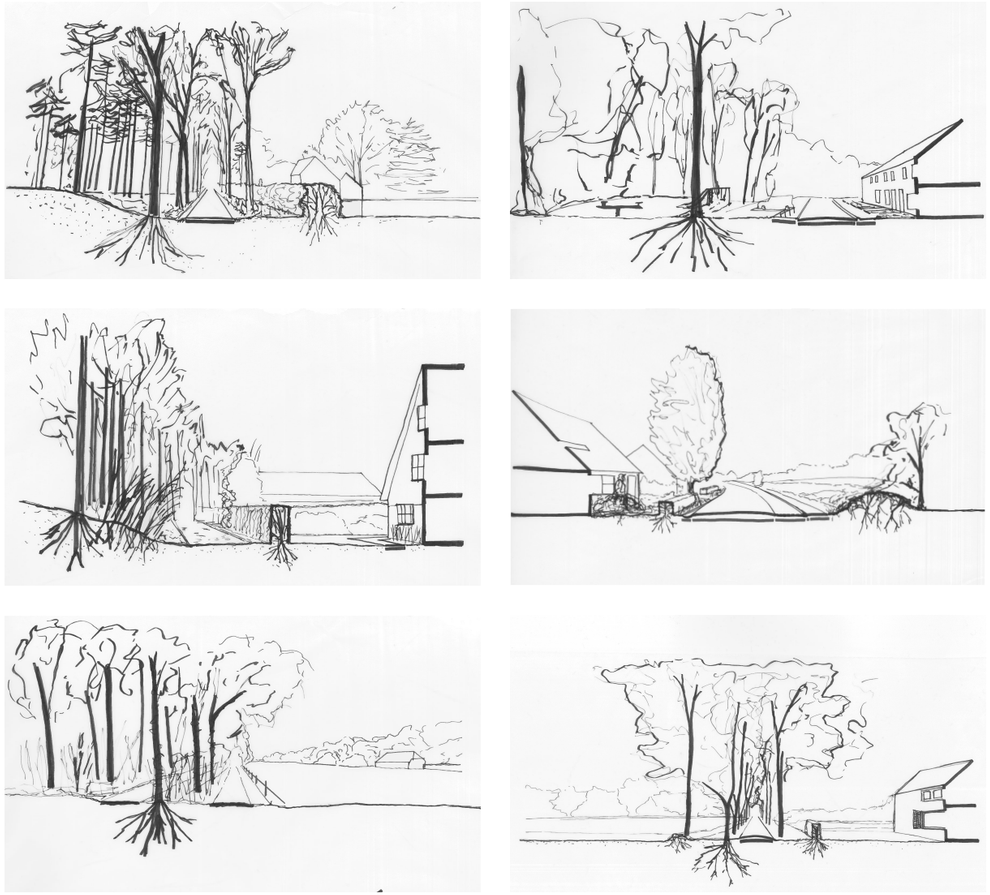


Figure 49. Overview of green-blue landscape elements in Hattem (created by author)



5. VISION & AMBITION

5.1 DEFINE A STRATEGY
5.2 SHARED AMBITION

Photo: BNNVARA

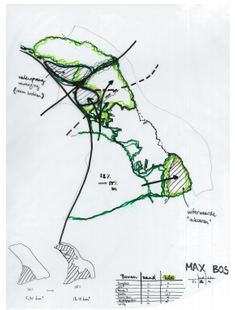
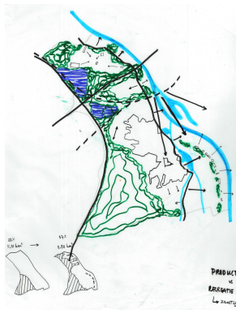
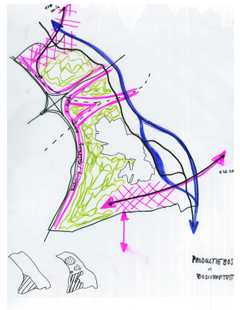
	I. MAX. PRODUCTION	II. PRODUCTION & RECREATION/EXPERIENCE	III. PRODUCTION & BIODIVERSITY/RESILIENCE
			
			
			
Yield m3/ha/year	3,19 *	1,49 - 3,03 **	1 ***
Production forest	1310 ha	680 ha	800 ha
No harvest (recreation/biodiv.)	0 ha	200 ha	500 ha
Crops	0 ha	100 ha	100 ha
Yield Hattem m3/year	4178,9 m3	1536,8 m3	800 m3
Management	Production-oriented	Multipurpose/cut-out management	Cut-out management/nature reserve
Certificate	-	FSC	PEFC
Cutting	Kaalslag, schermslag, zoomslag	Femelslag, plenterslag	Plenterslag
Trees Sand	Douglas fir, Scots pine, Larch	Scots pine, Oak, Beech, (Douglas fir)	Scots pine, Oak
Silt/clay	European spruce, Douglas fir	Oak, Black poplar, Elm, Silver poplar	Oak, Black poplar, Birch, White willow, Wild cherry, Linden

Figure 50. Three strategies for forests in Hattem (created by author)

	I. MAX. PRODUCTION	II. PRODUCTION & RECREATION/EXPERIENCE	III. PRODUCTION & BIODIVERSITY/RESILIENCE
WOOD PRODUCTION	HIGH PRODUCTION > 10 YEARS	MEDIUM PRODUCTION > 25 YEARS	SLOW PRODUCTION > 50 YEARS
RECREATION	NOT INTERESTING	VERY INTERESTING	SMALL PART VERY INTERESTING
BIODIVERSITY	VERY LOW	OKAY	HIGH
CLIMATE RESILIENT	VULNERABLE	HEALTHY	HEALTHY
EXPERIENCE OF LANDSCAPE	LOTS OF REPETITION, BUT SOMETHING ELSE	DIVERS	UNIQUE

Figure 51. Effects of different strategies (created by author)

5.1 DEFINE A STRATEGY

Leading up to the design, three strategies and the consequences of these strategies were explored:

1. What if Hattem would be planted with a maximum of production forest?
   Exploring the consequences of a highly producing landscape around the city centre of Hattem.
2. What if Hattem would plant a production forest in balance with recreation and the experience of the landscape?
   This expresses itself in preserving important sightlines and including space for recreation, while also producing wood.
3. What if Hattem would plant a production forest in balance with biodiversity and space for climate adaptation?
   Which focused on space for eco-corridors and buffers, while also harvesting wood from these forests, but on a low level.

These strategies we placed, as it were, on Hattem, resulting in interesting numbers and outcomes, see figure 50.

As the starting point for the design, the second strategy, II. Production & Recreation/Experience of landscape, was chosen because it scored best overall on the five aspects, as shown in figure 51.

*Sweden: 23.500.000 ha forest; 75.000.000m3/y wood >> 1 ha forest; 3,19m3/j wood
**numbers Staatsbosbeheer Horsterwold (4700ha; 7000m3 wood) & Speulderbos (3300ha; 10000m3 wood)
***personal assumption

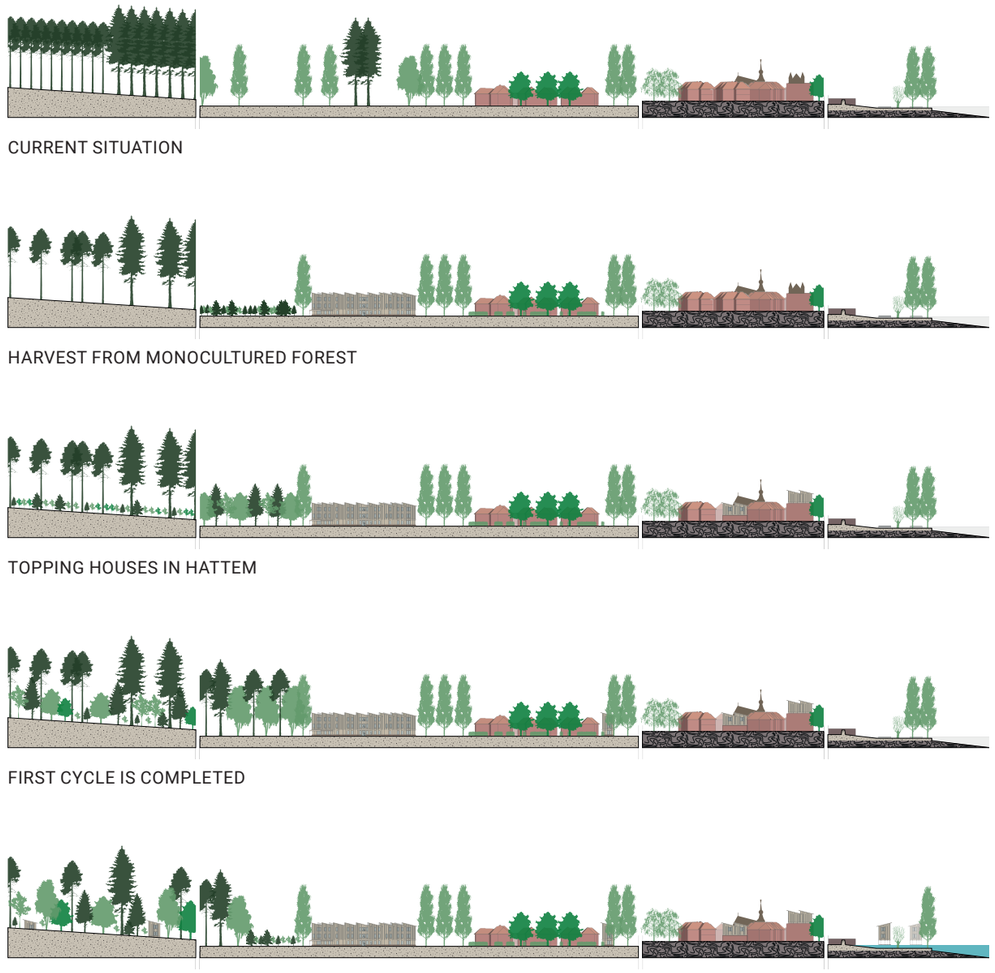


Figure 52. From current to cyclical landscape (created by author)

5.2 SHARED AMBITION

To achieve the new desired system where forest and housing grow compatible, time is needed. Only this needed time for the forest to grow is not possibe to give since there is need to build now.

In figure 52, the section schematically shows how city and forest could evolve side by side into a circular system.

In the first phase, wood can be cut from the current coniferous forests (after all, they need to become more diverse). This wood can be used to build Mathilde's first building. At the same time new forest can be planted against the current natura 2000 area.

Over the years, more trees will be able to be harvested from which new homes can be made, although it will take the first 75 years before the first planted trees are ready to build the carrying structure. So wood will have to be imported or harvested from current monocultures for the first 75 years.

Other components of the houses, such as shingles or insulation can already be harvested within 25 years, as this can be made from the residual materials cut down during maintenance.

The already used wood, which is at the end of its life cycle, for example the shingles, can go back into the forest over the years to feed the soil.

Other homes can also be made within Hattem, for example, opt-ups. Or more extreme, in the future, houses on stilts in the floodplain.

When a balanced system within the forest is achieved, there will be a consistent and predictable amount of wood to harvest annually.



6. DESIGN, TOWARDS A DYNAMIC LANDSCAPE

6.1 THREE TYPES OF FOREST
6.2 TYPE A: THE BUFFER FOREST
6.3 TYPE B: THE WOOD FACTORY
6.4 TYPE C: THE CLEAR-CUT FOREST
6.5 DYNAMICS AND TIME
6.6 TESTING THE DESIGN, NUMBERS OF PRODUCTION

Photo: Joost van den Broek



Figure 53. Three types of forests in a schematic section (created by author)

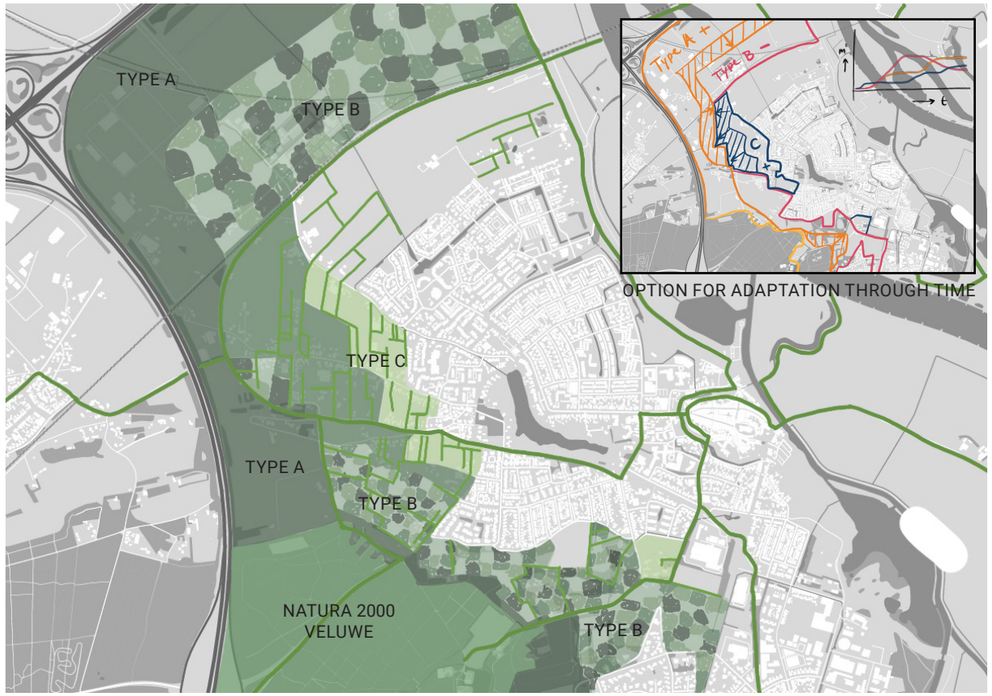


Figure 54. Possible organisation of three forest types (created by author)



Figure 55. Type A: The Buffer (created by author)

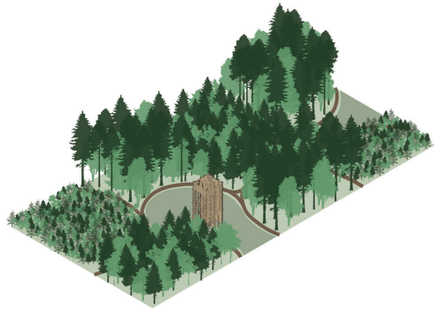


Figure 56. Type B: The Wood Factory (created by author)



Figure 57. Type C: The Clear-cut Living (created by author)

6.1 THREE TYPES OF FOREST

The design for this visionary project consists of three types of forests on sand soil, which differ in their tree species, management and structure.

From the Natura 2000 area a gradient of these different types of production forests will be introduced, see figure 53, 54 and 59 (next page) for a section, plan and birds-eye perspective.

The closest to the Natura 2000 area, a forest as a buffer can be found, type A: The Buffer (figure 55). A buffer to protect the vulnerable nature within the Natura 2000 area, but also for the people from Hattem to cancel the current noise pollution coming from the highway.

Next to it, a highly producing forest shows and confronts people with the impact of harvesting wood, type B: The Wood Factory (figure 56). This mosaic landscape will be very dynamic and changing visually a lot.

Lastly, an ecological structure, is formed, that goes all the way to the IJssel, to connect the two Natura 2000 areas (figure 58, next page). This ecological structure is combined with production forests that can be used as a placeholder for the location of new housing, type C: The Clear-cut Living (figure 57).

This design is a vision, a proposal or principle of how forests could be planted. Therefore it is not a fixed plan, but the different types of forest can change over time, if the need for wood or housing becomes different. An option for this can be seen at the top of the map in figure 54.

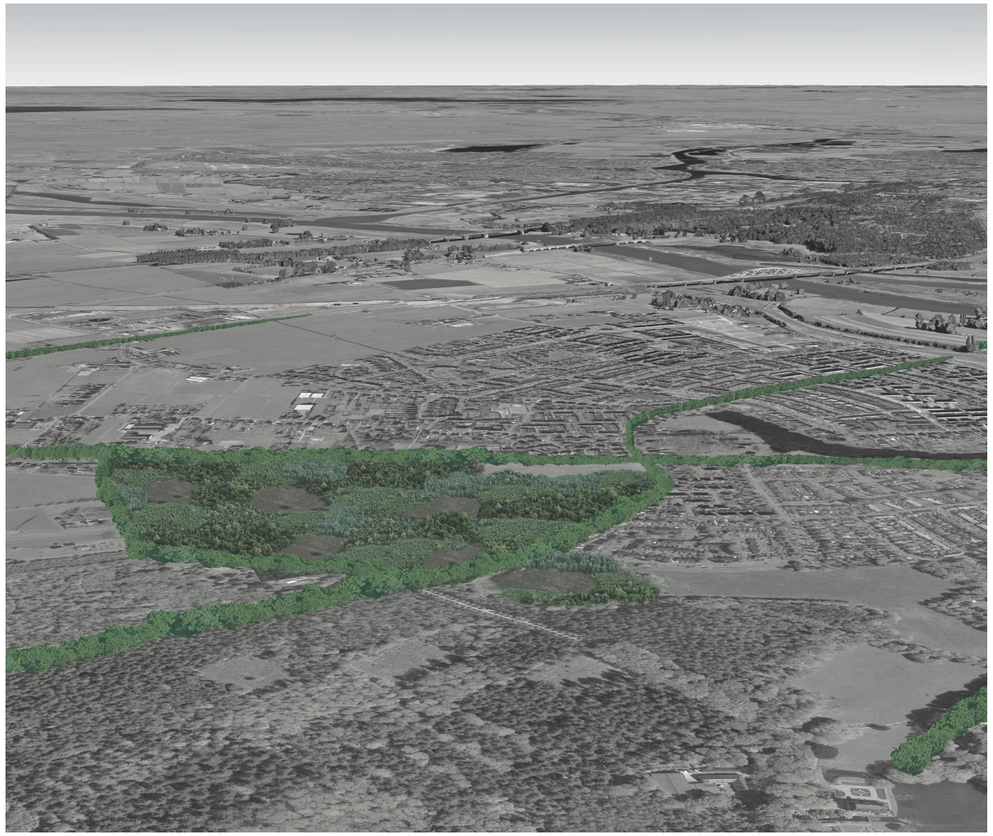


Figure 58. A birdseye perspective of the new ecological structure and Type B: The Wood Factory (created by author)

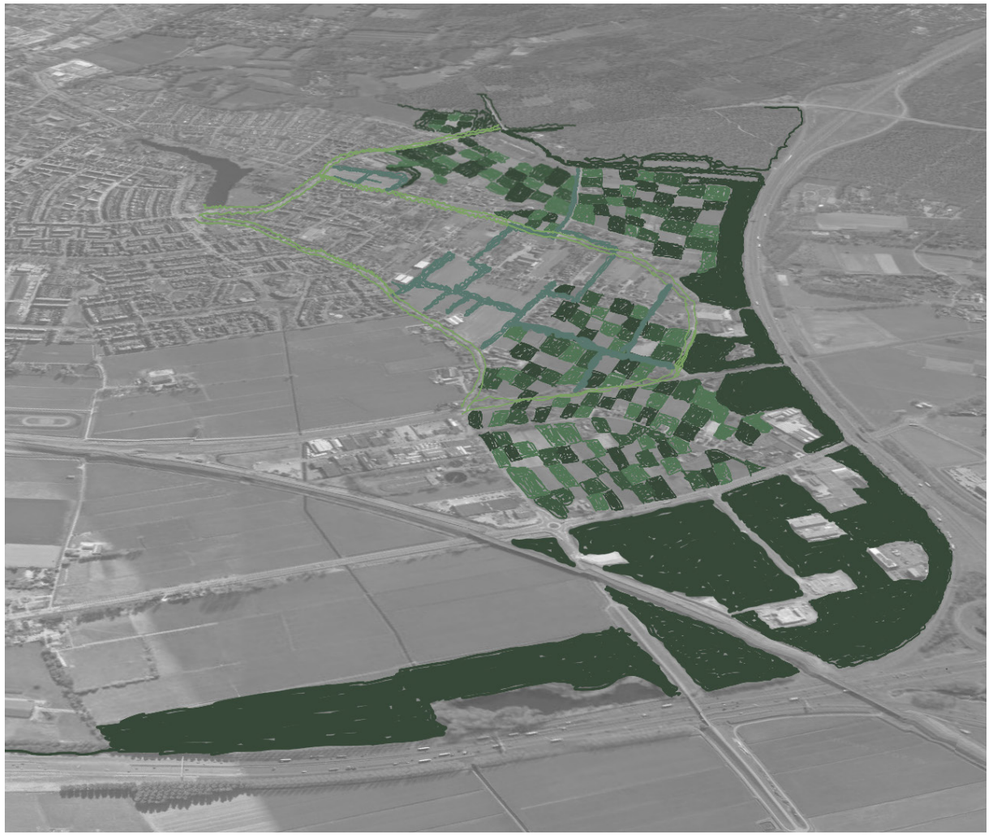


Figure 59. The transition of different types of forests (created by author)

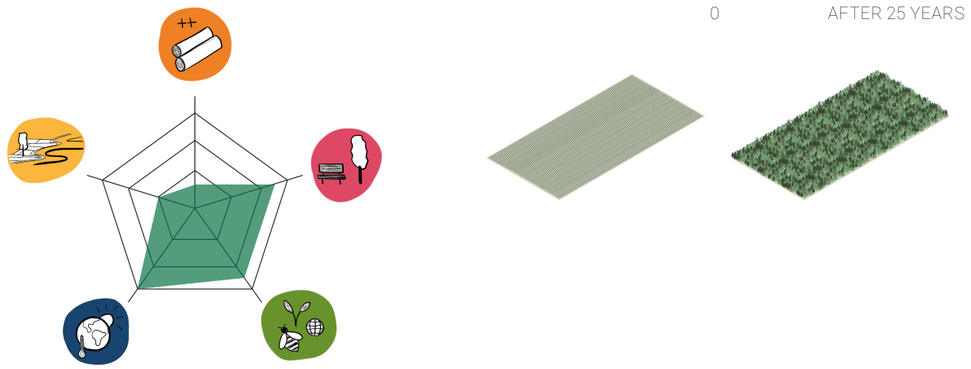


Figure 60. Balance of five aspects in the forest (created by author)



Figure 61. Type A: The Buffer (created by author)

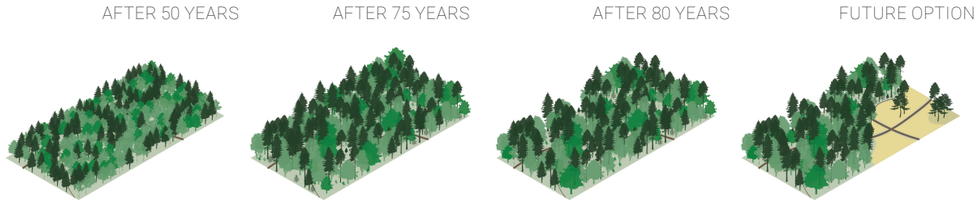


Figure 62. Development over time, 75 years till cyclic landscape (created by author)



Figure 63. The option for a new habitat (created by author)

6.2 TYPE A: THE BUFFER FOREST

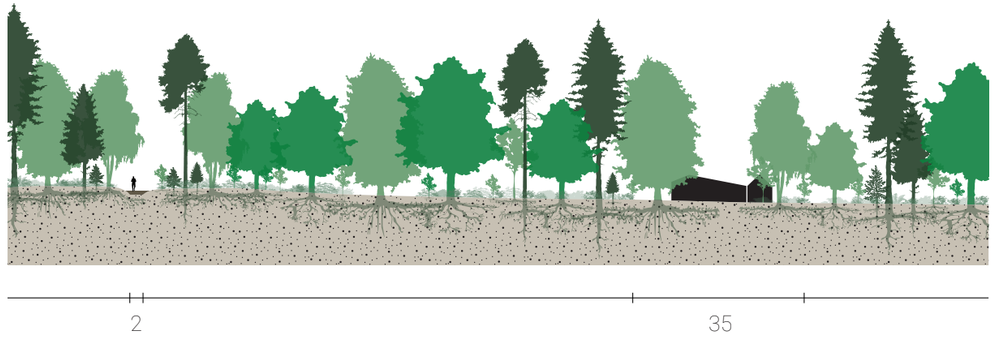
The Buffer Forest is a stable forest where the effects of production over time are difficult to spot. This is due to the use of single-tree selection management, to create space for surrounding trees or for rejuvenation, while at the same time harvesting, visible in figure 61.
This form of management results in a forest that is diverse in age and in species, since the circulation time has no effect on the harvest.

Different pathways varying in width are going through the forest making it interesting to use for hikers, cyclists and horseback riders.
In terms of biodiversity provides this type of forest a stable habitat for animals to settle in, like for the pine marten or the squirrel.
The development of the forest before one cycle has taken place is 75 years, since the most slow-growing trees have a life cycle of 75 years.
The experience of this landscape is interesting because of the diversity in tree species that can be found, together with the possibility to encounter animals.
The overall balance between the five aspects is visualised in figure 60. Type A: The Buffer Forest scores particularly high on recreational opportunities, space for biodiversity and climate resilience.

Over time, if the need for wood becomes less or there is a need to create variety in landscapes and form new habitats, this forest can be transformed into heathland and/or drifting sand, like illustrated in figure 63.

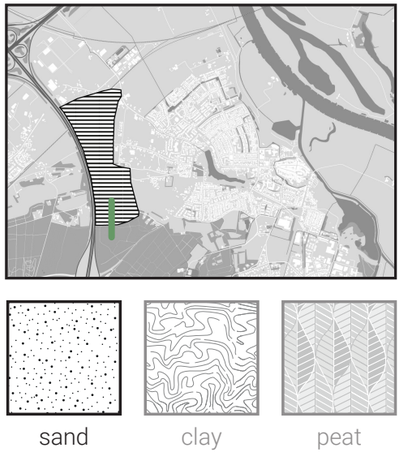


CURRENT SITUATION



FUTURE SITUATION 75 < YEARS

Figure 64. Section of current and future situation, Type A: The Buffer Forest applied (created by author)



The species used for Type A: The Buffer Forest are a mix of coniferous and deciduous trees: Oak, Scots pine, Douglas fir, Beech and Birch (figure 65).

By creating a divers forest in species, it results in a divers root system, by which trees can support each other, for example during drought or heavy winds, but also they are less vulnerable to plagues and diseases. The diverse root structure is illustrated in the section in figure 64.

This section (figure 64) shows the development overtime from a current monoculture in the Natura 2000 area that will get diversified by replacing the coniferous trees with deciduous trees. The current land for agriculture with livestock will get transformed into The Buffer Forest.

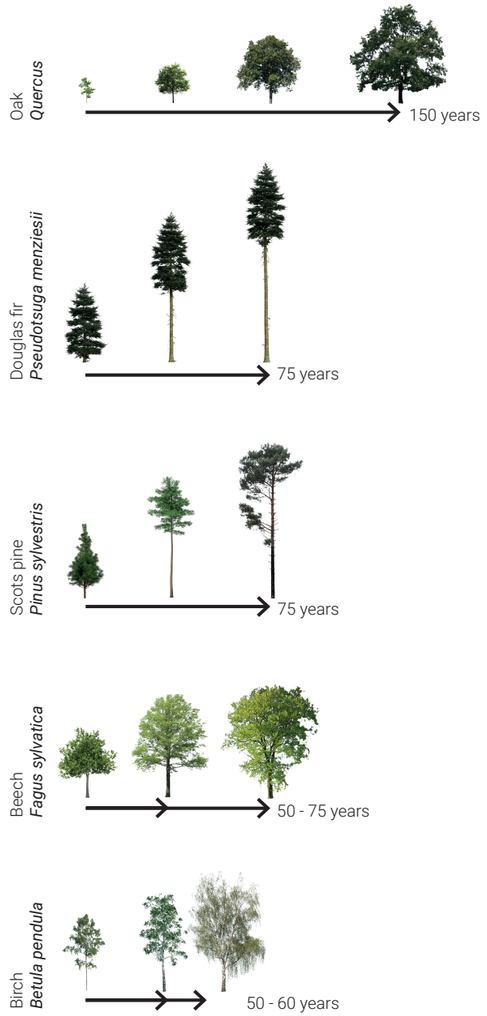


Figure 65. Selected trees and their growing time for Type A: The Buffer Forest (created by author)

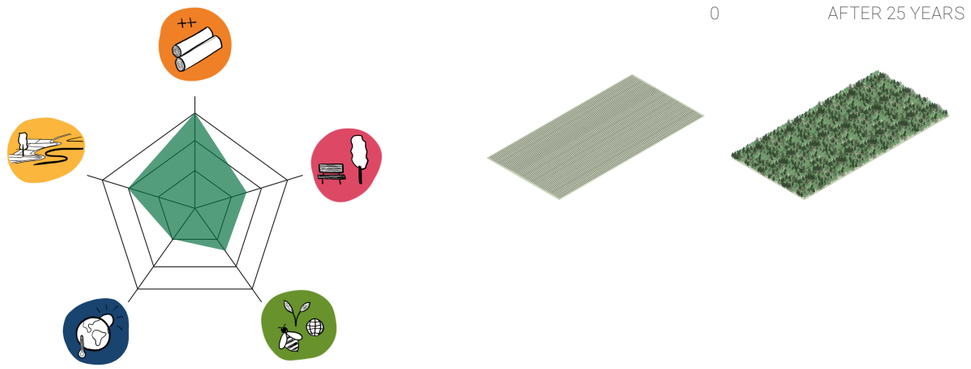


Figure 66. Balance of five aspects in the forest (created by author)

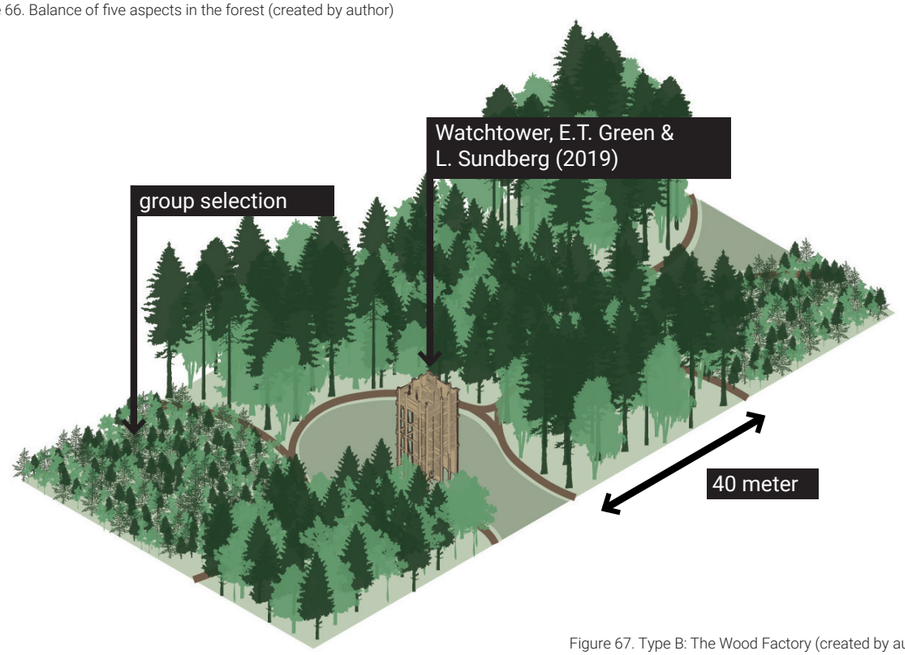


Figure 67. Type B: The Wood Factory (created by author)

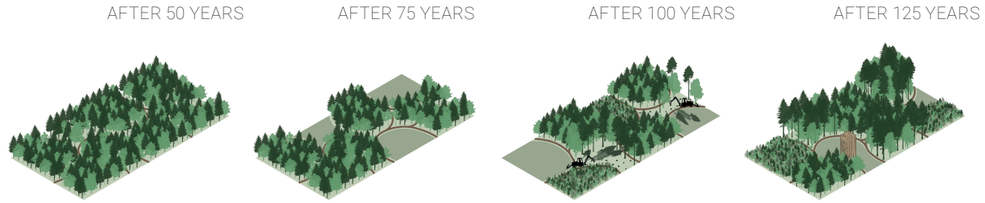


Figure 68. Development over time, 125 years till cyclic landscape (created by author)

6.3 TYPE B: THE WOOD FACTORY

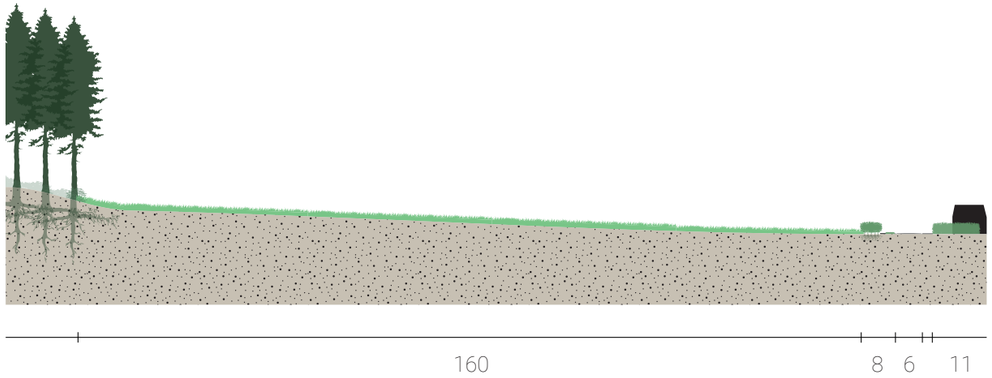
The Wood Factory is the most dynamic type of forest in its appearance and has a high level of production. This is due to the use of group selection management will take place, resulting in harvest moment every 25 years. In order to harvest a group every 25 years, the trees in one group must be even-aged. In this forest there are three ages to be found; 25, 50 and 75 years old. This management form results in a mosaic appearance in the landscape, which can be seen in figure 67.

Recreation is possible in this forest, but the paths conforms to the paths used for harvesting. Due to the heaviness of the vehicles that are used during the harvest, it causes the soil to be compressed, expelling the air within it, which is unfavourable for the quality of the soil. Therefore, a 40-metre distance between roads, instead of 20-metres, is chosen for this design as this will save 20% of the soil and leaving more space for trees. A consequence of this is that the harvest is more labour intensive.
To make the forest interesing for recreation, the paths are organic shaped around a diameter of 40 metre for the vehicles. These roads, of 5 metres wide, can also be used as firebreaks, as there will be many conifers in this forest and they are more vulnerable to drought and risk of fire. At the same time they provide a new interesting area for animals to hunt, such as the nightjar.

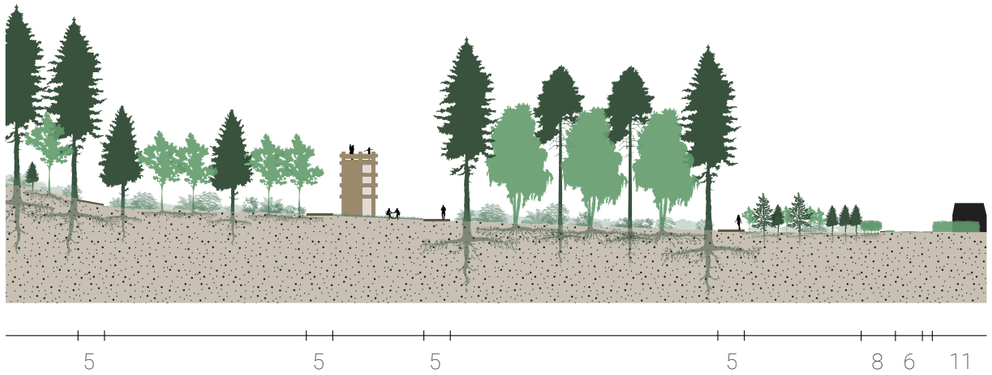
The dynamics within this forest comes with interesting opportunities. So can the just harvested area accommodate relocatable recreation, such as this circular watchtower with a coffee place (Watchtower, E.T. Green & L. Sundberg (2019).

Elements like this can facilitate a moment every 25 years to create a connection between the people of Hattem and the forest. By rebuilding the tower together, they participate in place-making in the forest, while also raising awareness on growing and harvesting of wood.

It takes 125 years for this forest to become a cyclic landscape (figure 68). It could be achieved in 75 years if a group section was planted every 25 years, but this is not desirable for the forest as it grows stronger as one forest in terms of shelter. It was also chosen to start cutting only from 50 years on. This, because it would be a waste of energy to harvest them at an age younger then 50 years.



CURRENT SITUATION



FUTURE SITUATION 125 < YEARS

Figure 69. Section of current and future situation, Type B: The Wood Factory applied (created by author)





Because the trees in one group within must be even aged, trees with the same circulation time were selected for Type B: The Wood Factory. In this case, the Scots pine, Douglas fir and Birch were selected.

Although the Birch can be ready for harvest around 50-60 years, which is faster then the Scots pine and Douglas fir who need 75 years, the diversity in trees are important to make the forest more resilient. Therefore the circulation time of the Birch gets pushed to 75 years, just like the Scots pine and Douglas fir.

The section in figure 69 shows the connection from the current forest within the Natura 2000 area to the edge of Hattem. Walking through this forest, a lot height difference between trees can be experienced, showing different ages of trees.

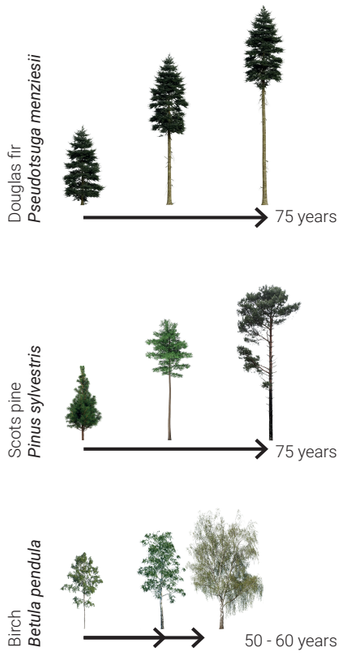


Figure 70. (created by author)



Figure 71. Impression Type B: The Wood Factory after 125 years, ready for harvest (created by author)



Figure 72. Impression Type B: The Wood Factory after 125 years, during harvest (created by author)

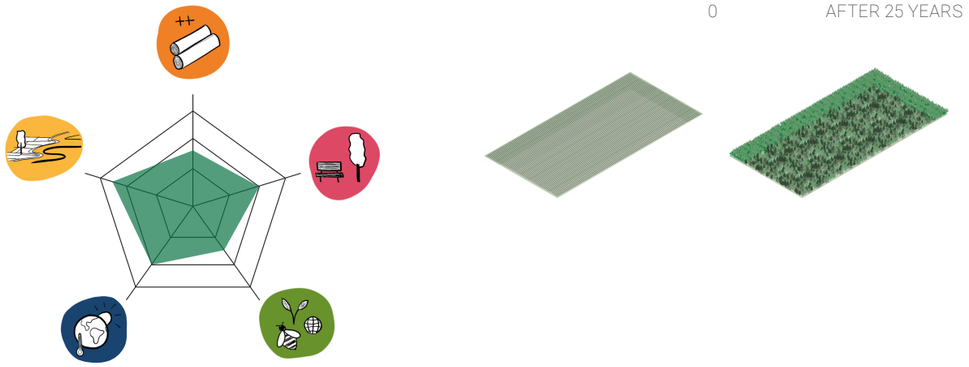


Figure 73. Balance of five aspects in the forest (created by author)

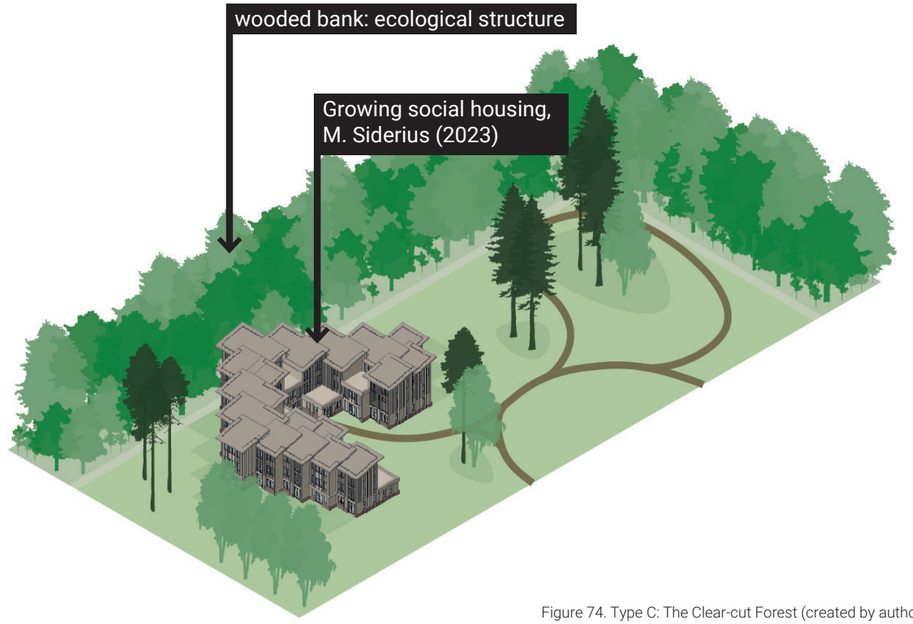


Figure 74. Type C: The Clear-cut Forest (created by author)



Figure 75. Development over time, 75 years till cyclic landscape (created by author)

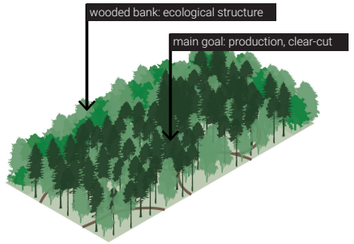


Figure 76. The Clear-cut Forest just before clear-cut (created by author)

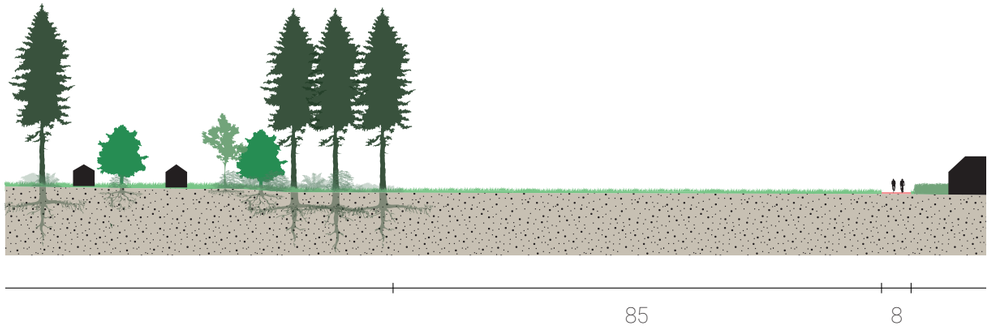
6.4 TYPE C: THE CLEAR-CUT LIVING

The Clear-cut Living forest is a combination of the other two types of forests.
It can be used as a placeholder for which housing can come into place after a clear-cut of the forest (figure 76).
An opportunity, but also a challenge with this type is that a large amount of wood is released at a once after clearcutting. This clear-cut would mean the end of the production of this forest.

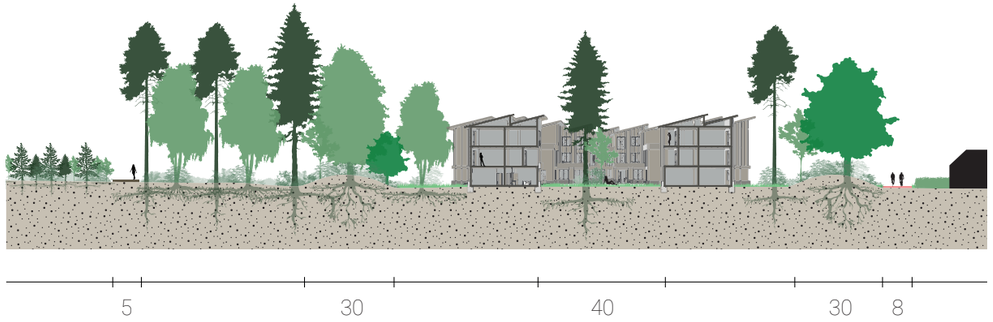
At the same time this type consists of a wooden bank as part of an ecological structure (figure 74). This provides an ecological corridor from the Natura 2000 area of the Veluwe to the IJssel. It will not be used as a place to stay for animals, but as a structure to navigate along, as bats do.

In terms of recreation and use this type of forest, it accommodates a park atmosphere, close to city.

It takes 75 years for the production part of the forest to be ready for harvest. Since this would be an one time harvest, it can also be done later. The ecological structure, the wooden banks, needs a longer time since they have Oak trees among them and they need 150 year before they have reached their potential in terms of wood production.



CURRENT SITUATION



FUTURE SITUATION 75 < YEARS

Figure 77. Section of current and future situation, Type C: The Clear-cut Forest applied (created by author)



For with highly producing part of Type C: The Clear-cut Living, the tree species will be used the same to the wood factory typology, so Douglas fir, Scots pine and Birch (figure 78).

The ecological wooded bank is managed by single-cutting. The used trees are the Oak, Beech and Hornbeam (figure 78). Trees that have the quality to form a dense hedge.

The section in figure 77 shows the relationship between the new building, Growing Social Housing (M. Siderius, 2023), and the wooden banks that are part of the ecological structure. At the same time a part of forest Type B: The Wood Factory can be seen.

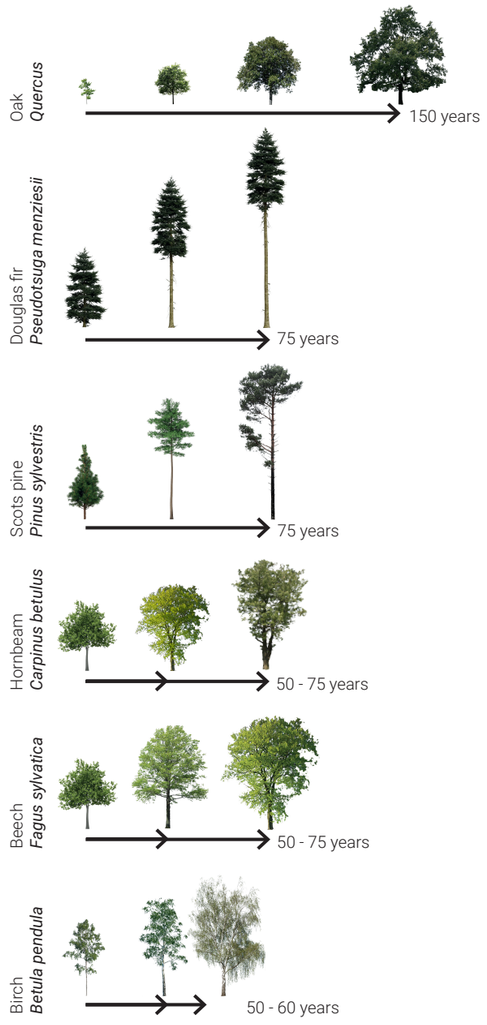


Figure 78. (created by author)

6.5 DYNAMICS AND TIME

The three different types of forests: The Buffer Forest, The Wood Factory and The Clear-cut Living all have all have a different timeline to how they develop and when they change in a cyclical landscape. Figure 79 shows an overview of this together with the relationship between the different types of forests, figure 80 and 81 perspectives.

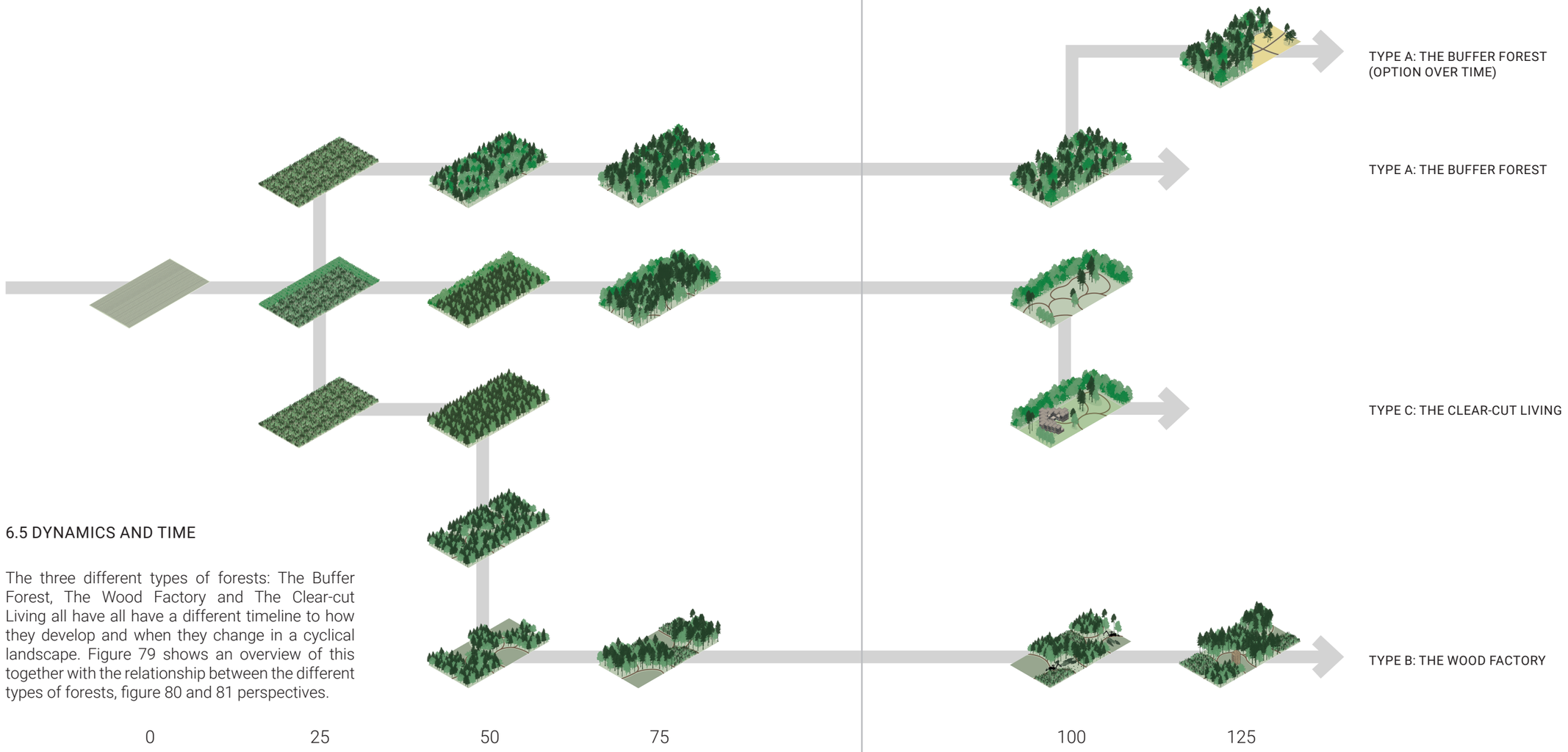
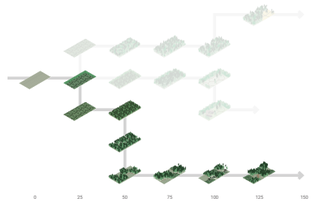


Figure 79. All the different forest types side by side through time (created by author)







CURRENT SITUATION AND MOMENT OF PLANTING



AFTER 15 YEARS

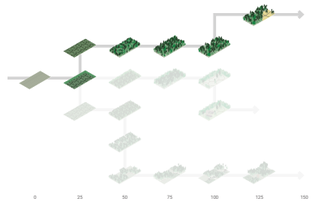
Figure 80. Perspective of Type B: The Wood Factory through time (created by author)



AFTER 125 YEARS



AFTER 125 YEARS + ONE WEEK





OPTION OVER TIME

Figure 81. Perspective of Type A: The Buffer Forest option over time if wood production is less needed (created by author)

NATURA 2000 AREA, VELUWE

NATURA 2000 AREA, IJSSEL

DESIGNED ECO-CORRIDOR

DESIGN EFFECT



6.6 TESTING THE DESIGN AND NUMBERS OF PRODUCTION

Effect design

Over time, the effect of the design will form a strong link between the current Natura 2000 areas of the Veluwe and the IJssel. This will allow exchange between the animals that have settled here as can be seen in figure 82.

Figure 82. Effect over time of the design (created by author)

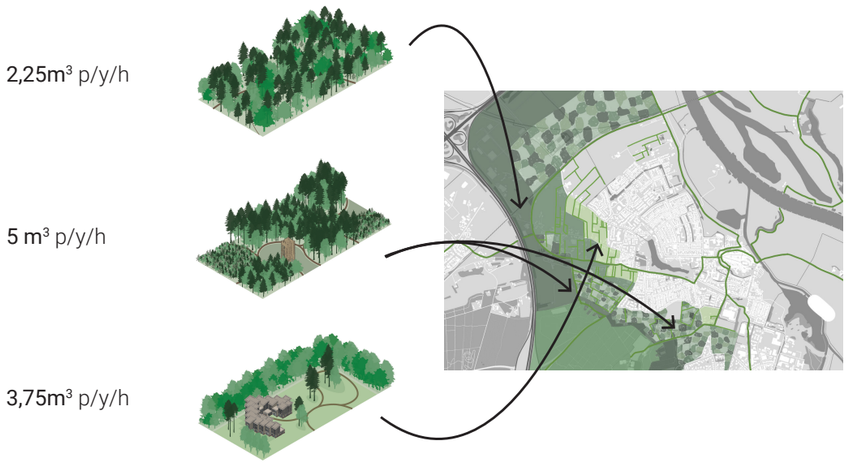


Figure 83. Different types of forest and the amount of wood they produce (m³ p/y/h) (created by author)

Numbers of production

Per type a calculation has been made of how much wood they would produce once they've reached the phase of a cyclic landscape, so the production would be predictable (figure 83):

- Type A: The Buffer Forest would produce 2,25m³ per year per hectare.
- Type B: The Wood Factory would produce 5m³ per year per hectare.
- Type C: The Clear-cut Living would produce 3,75m3 per year per hectare.

These numbers on their own don't make a lot of sense, but if we would calculate this for the whole of Hattem and use the same numbers also for the areas with silt/clay soil, Hattem would be producing on a yearly basis, from 2150 onwards, almost 1200m³ of wood. This would result in 38 houses of 3 people households.

The system

Precisely calculating the number of trees needed for a building during its lifetime is too difficult and complex. However, what might be a better way to look at it, is to make sure there is always enough forest to harvest from.

Figure 84 shows the different times of how long certain building components can last and the growth time of trees. At each point, either a used material is released to go back into the forest to enrich the soil or a tree can be cut down. The more points there are, the more regularly harvesting can take place.

Despite the fact that it takes a long time for a forest to become cyclical, it will produce wood regularly. Ditto for the building and the materials that go from there back to the forest. It's all about getting the system up and running. That needs to happen.

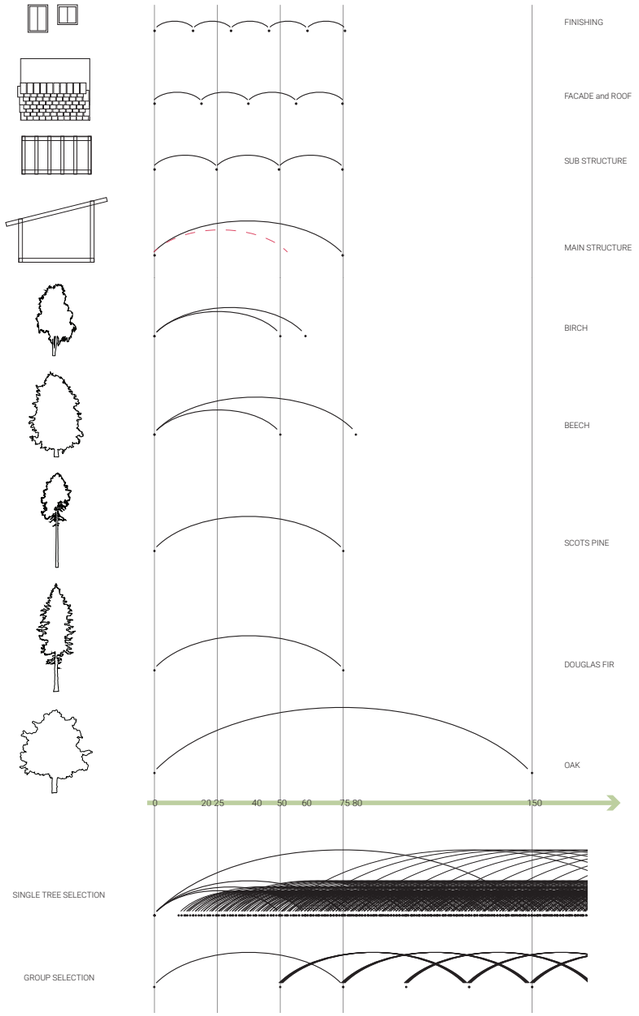


Figure 84. The time in which materials decay and trees grow (made by author and M. Siderius)



7. CONCLUSION & DISCUSSION

7.1 CONCLUSION
7.2 DISCUSSION
7.3 REFLECTION

Photo: Stichting Het Nationale Park De Hoge Veluwe

7.1 CONCLUSION

The lack of future proof production forests in the Netherlands was the starting point for this graduation project, leading to the research question *"How can a sustainable and multifunctional production forest be designed in the Netherlands?"*. The design made and explored in this thesis is an answer to this question. Combined with the research done on production forests, elements to create sustainable forests and the functions that forests can accommodate.

In the Netherlands there has been a strong culture of cultivation since the Middle Ages, when reclamation for agricultural purposes started happening on a large scale. Due to this a lot of forest disappeared and in 1871 officially the last bit of old-growth forest got lost, resulting in our current young forest landscape in the Netherlands that is completely formed by human intervention of which 90% is planted in the last 125 years.

From the 1850s, due to knowledge on forestry and the invention of fertilisers, forests got planted on a big scale for economical profits. Production forests for wood were planted with the main goal to harvest as much wood as possible, resulting in monoculture forests from coniferous tree species like the Scots pine or Douglas fir. This is the type of forest people often think about when they hear the term "production forest". However, this monocultural production forest is not a good reference for a future resilient one. Not only because of the monoculture, but also because the wishes and priorities of what a forest should accommodate–and who (humans and animals)--changed over time. Therefore the five aspects, based on current and future trends, being: production, recreation, biodiversity, climate resilience and experience of landscape, should be addressed in the forest to be designed. Since this graduation project is about production forests, production is central to the design and the other aspects form around this.

In order to get a sustainable forest, the approach towards a new design should be soil and water steering to make sure that the forest is built up from the ground in the correct landscape. Diversity in species will lead to a more healthy forest, since trees can benefit from each other's strengths, like bringing groundwater up through the root system, because some tree species root deeper than other species.

There are opportunities to connect current Natura 2000 areas by creating eco-corridors via newly planted forest. Natura 2000 ambitions and target animals can be helpful in this regard. Target animals can be used to extract design elements or principles. In the case of Hattem, the Pond bat led to the usage of hedges and wooden banks (NL: houtwallen en houtsingels) as shelters and navigational elements, which then were of service to other animals as well.

Finally, the type of seed is important to achieve a sustainable forest. To stimulate biodiversity, mostly indigenous trees are chosen for the design. The Douglas fir was excluded, due to its production qualities. However, the Douglas fir has since the end of the twentieth century the status of "exote: established". Over time nature has adapted to this tree species, making this tree nowadays interesting to animals, such as birds of prey.
For trees who have faced diseases in the past, like the Elm, or have trouble adapting to climate change, like the Beech, different types of seed can be used so that these vulnerabilities are no longer a danger. This way the species can continue to be used for its qualities. For example, the Beech should be planted with seeds from Mediterranean climate to be able to keep up with the future climate of the Netherlands.

Within forests different functions can take place; from recreation to living. Visiting a forest is in second place of favourite recreational pastimes among the Dutch, making the forest one of the highest valued landscapes. Walking and cycling are the most common activities that people like to do in forests. People are not critical about what they are looking at specifically, but need resting places or points to actively move toward, such as a watchtower.

The design adds on the current forest landscape by introducing new types of production forest, which creates a new experience to witness for visitors. It also brings back a lost cultural landscape: the bocage in combination with a new form of housing.

Many designs for production forests are possible, but this graduation project shows three types that differ in accommodating the five aspects that are valued in forests. This way a new idea can be formed on how forests can be productive, while also accommodating space for animals and humans in the Netherlands. This design is tested on sand soil in Hattem, but could be applied to any agricultural land, also loess, clay or silt soil. Peat however would be more challenging and is therefore not recommended.

Why not?
If production forests in the Netherlands can be designed and there is a need for more forests; for wood production but also for recreation, increase habitats to improve biodiversity, make climate resilient places and preserve Dutch landscapes, then why not plant more forests?

Reflecting on the conversations and discussions held this year, but also looking back at research based on literature, it seems that our current society is not set up for this way of thinking and developing landscapes. This manifests itself on four levels:

- Firstly, the relationship between humans and the materials they use in their daily lives has changed due to the growth of mass production rather than handcrafted production as a result of the industrial revolution and later globalisation, resulting in a detachment from the origin of materials. Comparable to the meat industry and the missing human relationship to the animals from which the meat comes.
- Secondly, a circular way of thinking has become very difficult because flows within a supply chain have become very long, untransparent and complex also in part due to upscaling and globalisation. Often many parties are involved in the production of one material, with different goals and interests, making it less manageable to achieve circularity (Transitioning to a Circular Economy: What Are the Challenges? - IPPI, 2023).
- Thirdly, considering the long time scale in which landscapes develop is unusual. The timespan in which landscape developments take place is one that people today are no longer confronted with.
- Braudel divided the past into three tempora: longue durée, moyenne durée and courte durée (long, medium and short). The longue durée is the time span in which geographical and climate changes take place. The moyenne durée is the period in which economic and social structures are formed. Finally, the courte durée deals with the events of relatively short duration (Hoogeveen, 2022). In our human life we have direct influence on the courte and moyenne durée, while also seeing the result. For the longue durée, the timespan in which landscapes are formed, this is different, because it is life-transcending. In the past humans were challenged to think about this time span, Cathedral thinking, as Roman Krznaric calls it, but no longer: “This is the idea of embarking on projects with very long time horizons, decades and centuries ahead, even beyond the scale of our own lifetimes. The idea relates to medieval cathedral builders who started creating cathedrals knowing they would never see the building finalised within their own lifetime.” (Roman Krznaric [Long Now Foundation], 2020).
- Finally, we are facing the consequences of global warming (the effects of a longue durée development), resulting in rapid unpredictable global changes, with many different voices and opinions on how best to approach the problem. This makes it difficult to make decisions, especially when it needs to be done on a large scale.

These four challenges could hold us back from starting projects like the one presented in this graduation plan. However, projects like this also contribute to addressing these challenges positively – because it addresses all four of them and therefore creates awareness and normalises thinking about the relationship between landscapes, materials and humans, but also thinking about circular systems, the longue durée and the importance of forests in the fight against climate change.

Discussion forest managers and ecologists
Besides the four challenges named above, there is also a debate going on within the forest-discipline, among forest managers and ecologists. There is a clear split between the opinions from these two disciplines in which direction forests in the Netherlands should go. On one side there is the opinion from forest managers to keep continuing with the (intensive) management of forests, while at the same time making them future proof; on the other side there is the opinion of the ecologists, who plead for no human intervention resulting in a forest going more towards a natural state, the end goal being “wilderness” with a self-regulating ecosystem.

In this debate I took a position from a landscape architectural perspective, in which I think we (unfortunately) cannot view our natural areas as wilderness, since it is all planted in the first place and therefore a cultural landscape. During the planting process that began after the 16th century, a lot of indigenous or modified/weak seed has been used, which lead to new forests that are not embedded in the landscapes of the Netherlands. On top of that, these forests are often monocultures, which is also not a natural state for a forest. Therefore I do not believe that these forests can form the basis of new wilderness.

Exploration what if?
Even if we decided to follow the opinions of the ecologists and let current forests in the Netherlands get wild, it would take a long time before these envisioned ecological forests would be a reality. First a lot of forests, like the nature reserve in the Speulder-Sprielderbos, would face forest disturbances, such as fire or wind. Because these forests are monocultures, they are extra vulnerable to these disturbances, making it a matter of time before they get destroyed. Normally this would mean a clean slate for succession to start over, but the soil in these places is often nutrient-poor due to the monoculture of the original forest, to the extracting of fertile soil (humus) from the Middle Ages on and the overgrazing, also during this period. Therefore the new forest would start on nutrient-poor grounds, making it harder to grow into succession – a process that already takes a long time. Which leads to impatience over the lack of space in the Netherlands. I personally do not think that people will stand by, watch a beautiful beech forest of 400 hectares get destroyed and then wait for 150 years for the return of a new vital forest. I think the Netherlands is too small for this and the pressure on space is too high (and will only get higher, given the influx of people continues to increase). It is not in our nature to wait and not intervene in these natural processes.

An example of this is the Oostvaardersplassen, a nature area of 5600 hectares in Flevoland. In this nature reserve, the desire for a balanced system, which regulates itself, is being exercised. No

human management is carried out, but grazers have been introduced to establish a natural balance. However, establishing that balance takes time and in the meantime, disbalance sometimes looks unpleasant or cruel, such as the mass deaths of grazers due to food shortages - or the lack of predators, like the wolf.

Natural wood production forests?
What if the wolf would be introduced to the Oostvaardersplassen? The wolves would eat many of the grazers, increasing the wolf population and decreasing the grazers. Eventually, a balance could emerge between the two populations. What would be the effect of less grazers on the landscape? Trees would get a chance to grow, which would create forests on Oostvaardersplassen. Since this is clay soil, development would be very quick and within 25 – 30 years trees could be harvested via single-tree cutting. This way it would be possible to grow new forests in the Netherlands via the natural way of succession. Of course circulation would be low and so would the control over tree growth, but it could be done.

Despite the fact that this scenario is one that I would find interesting, forming a natural balance, while also harvesting from it (similar to 2000 years ago), I think it is not a realistic solution for the challenges we face nowadays and we should strive towards a solution of which technology is a part, like the Symbioscene strives for.

Moving towards a new age: the Symbioscene
Our world is not comparable with the world of 2000 years ago; we live with many more people, resulting in more materials needed and therefore a higher output. This means that we do not have enough space to do it “the natural way”. We need highly producing landscapes.

In order to create these landscapes I think we should plant forests in the landscapes that the Netherlands accommodates, using the soil and water layer as a starting point, to see what kind of forest would naturally grow on this ground, striving to work with mainly indigenous trees but also seeds of trees that are adjusted to the effects of climate change to create resilient forests, since the natural way via migration of tree species will not go fast enough. This approach will ensure that the production forest is built from the ground up in a sustainable way, for our climate now, but also in 30 years.

Shift in relationship with our surroundings
Finally, I think there needs to be a change in our culture, to change our behaviour towards materials and the opinion on cutting trees. Nowadays we are far removed from the source of our materials, similar to the missing relationship betweenmeat and animals. By making the cycles of harvesting in production forests visible, the public opinion and respect towards materials could be restored, gaining an awareness of the origin of materials.

I believe this perspective/awareness is crucial for moving towards the Symbioscene. Living closely to or even in a material producing landscape can contribute to this. Like Anne Whiston Spirn mentioned in her essay The Granite Garden, there is the traditional view of city and nature as adversaries. But in reality, natural processes are the same everywhere. Plants need water, sun and CO2, wherever they grow. Not taking these natural processes into account has negatively influenced how cities are built, which results in many environmental problems cities are facing today (1984). This idea, of a continuous landscape, should become central in projects that involve our building environment, no matter the background of the discipline we’re working from.

Follow up research topics
Looking into production forests on silt/clay soil would be valuable. Thus, there would be types for production forests on the two most common soil types in the Netherlands. This would be valuable for the building industry and make an efficiency comparison possible between forests on sand soil and silt/clay soil, because of the different tree types that can be used.

Topics that are interesting to look into further could be the accommodation of livestock in the production forest. This would give an interesting alternative for farmers that are facing a buy-out. Also looking at other production materials then wood, like fruits, nuts or hemp could be valuable. The forest could provide food, clothing, insulation and medicine, making it even more relevant.

7.3 REFLECTION

The starting point was that we do not have enough forests in the Netherlands to produce wood in an efficient way to use as a building material. But there are other problems. There is not enough healthy forest in the Netherlands to accommodate our aspired biodiversity and the forests that we have currently are not climate resilient. But also, due to the growth in population and the current layout of the Netherlands, our recreational needs are not being fulfilled. And finally, over the last 100 years a lot of cultural historic forest elements disappeared due to the intensification of agriculture, resulting in land consolidation, which is now receiving a lot of attention again.

My design and the approach towards it has been around these five themes: production, biodiversity, climate resilience, recreation and experience of landscape. But they did not receive the same amount of attention in my research and in my final design. Ideally I would have done it that way, but looking back I think it was too much. During the year I found out that it took me more time to get a grip on forestry, there was a bigger gap in knowledge than I expected. Especially figuring out what the "buttons" are that you can push as a designer were a challenge. Because of this, there has been a shift during the project in which production came first and then the other aspects, while my intention was to address them all equally.

Reflecting on the methods I used, looking at the history of forests in the Netherlands worked very well. It gave me an idea and understanding of how our current forest landscape was formed. It also showed how cultivated our landscape is and made the term "nature" debatable. It formed the basis of my personal point of view towards forestry.
Learning about how forests work via analysing three different ones on different soil types was partly successful. I did learn a lot from going to the forests and got a feeling for their spatiality and how wood production gets done nowadays, but not in the way I intended and wrote about in my method. The expectation to analyse them according to the five aspects and then extracting design tools or principles was not realistic. This was because I did not have a clear method to do the analysis and it was too much to create this method myself.
Working with three strategies to make a basic design for Hattem did work well and gave me a tool to communicate with Mathilde, in the form of numbers and ambitions, but it also resulted in a starting point for a design.
Finally, I learned a lot from analysing Hattem. It is a diverse landscape, which made it a good study location because there were a lot of possibilities, but this also made it difficult because there were not that many limitations.

Generalised elements that can be taken from my project would be about the way that existing management of forests can be used as a design tool. Now they often get used only to decide the type of management for foresters, but this practical knowledge can be combined with esthetical or experiential ambitions that are interesting for a landscape architect.
Also, the way forests can grow over time into a dynamic and cyclic landscape can be used as inspiration or basis for others.

(Ethical) questions that can be raised would concern whether we should intervene this much in our "nature", or for whom it is to decide when a tree is ready to be harvested. I feel, based on the news, that the common public opinion is against the idea of cutting a tree once it is "grown up". I think this is partly because there is a distance between the space we live in, our urbanised areas and the areas we call "nature" that we like to visit to recreate. These places do not overlap. As a result, nature has acquired a holy status where we feel that we have to protect it and not destroy it by harvesting trees.

At the same time I think that we lost the relationship between our materials and the source of these materials. Therefore we don't see how much wood and therefore trees we use in our day to day life; paper, furniture, packaging, energy – the list goes on, all traceable to trees. Just as we have lost the relationship between animals and the meat we eat. By no longer being confronted with the source of materials, there is less understanding of the harvesting process.
Finally, we are no longer used to thinking about long processes of which we will not see the result in our own lives. This ability has gone lost, but used to be very common, like the "cathedral building" idea. This also contributes to the idea that trees should be protected, because it takes a long time before they will regrow.

Personally, I feel that the Netherlands is so cultivated that we have to manage and cut trees to keep our forests healthy. We almost owe it to the current forests, otherwise they would not survive over time due to climate change. Also ,if a forest can provide materials, without compromising too much on biodiversity and recreation, I think it is justified to harvest wood if it results in a more sustainable building industry.

In fact, I believe that by making wood harvesting part of our daily lives again, an awareness can be created among people about origin and material use, which can lead to a more sustainable life – a start for a new era: the Symbiocene.

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