World of Wood

Explore
Play
Design
Reflect

Amsterdam
Academy
of
Architecture

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About the project

In the research and design studio ‘World of wood’ from September to December 2021, we dealt with the global production chain behind wood. In other words: we challenged students to not only see this renewable and bio-based material as a raw material or construction material with which architectural and urban design issues could be solved, but as a component of a planetary system that could be improved in a considerable number of areas.

The use and the application of (more) wood could make an important contribution to the shift towards a sustainable and future-proof development of our living environment and products – and then not only as a construction material for furniture, houses and cities, but also as an alternative to glass, steel, oil, plastic and other derivatives of fossil raw materials. By increasing the use and application of wood worldwide a major step could be taken in reducing the quantity of CO2 in the atmosphere, not only because lots of carbon is released with the production of other materials (such as steel and concrete, but above all because trees and forests absorb a lot of CO2 and carbon is even stored long-term in wood.

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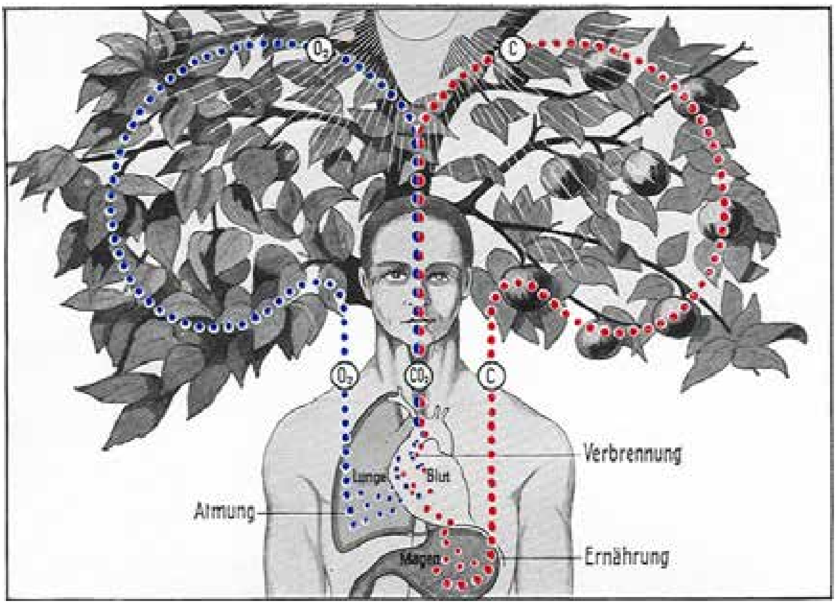

Source:
Fritz Kahn

By focusing on the entire chain with our research and design, new, but extremely relevant, questions came up for discussion, such as where wood can best be 'cultivated'. Is that local or are sustainable forms of forestry – with opportunities for nature and community – further away still conceivable? However, the processing, the logistics and the transport require attention. What is the impact of this, both in terms of energy and water consumption, and infrastructure? The obstacles and opportunities that legislation and regulations provide are also important, just like the economic, political and social circumstances. And to what extent does the reuse of wood and residual products, which arise during the processing process, bring the transition towards a circular economy closer? Finally, in which form can wood best be used to maximise CO2 reduction?

The upscaling of the wood production – via forestry or circular systems – leads in any event to new design assignments, with opportunities for biodiversity, landscape development, new living environments, alternative revenue models for farmers, recreational experience, etcetera.

The studio made one point clear in advance. If we want to utilise the many advantages that wood offers as effectively as possible, it is necessary to understand the planetary system behind this versatile material, so that the new generation of architects, urbanists and landscape architects are not only able to design sustainable and healthy homes, districts and cities (made from wood) soon, but also to make proposals to increase the sustainability of and strengthen the most crucial components in the (international) wood chain. It is only in this way that we will arrive at prudent and groundbreaking recommendations on how timber construction can truly lead to successes, and what is necessary in order to make the system behind it fair, sustainable and future-proof. On a global scale, but certainly in the case of the Netherlands too, which tasks do we need to undertake and which spatial and landscape consequences will this have?

Eric Frijters
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The MCC Carbon Clock shows how much CO2 can be released into the atmosphere to limit global warming to a maximum of 2°C, taken on the 21st of November 2021.
Source: www.mcc-berlin.net/

Lessons learned

The subject of the ‘World of wood’ studio was no easy feat. There was no assignment, no location, but there was a complicated question relating to the current system: what is the situation with the global wood chain actually and which improvements are conceivable? In order to bring this to a successful conclusion, a ‘designer’s way of thinking’ was necessary – to see correlations, make surprising connections, move through scales, use imagination. These were all aspects that needed to be manifested in this studio. And like we kept saying as lecturers: in this case, the design is, above all, a research tool – in addition to more traditional methods like literature and theoretical research – to arrive at discoveries and knowledge; an instrument to test your ideas. This also applies to writing: a useful tool to question yourself, to test, to ensure there is logic and coherence in your thinking.

In an ideal situation, the six final design proposals would have merited another two to three weeks’ time for further elaboration. However, this studio demonstrates, as mentioned already, that architecture and design are not only about results to be built, let alone iconic objects. It is about exposing abuses and offering solutions for that on the basis of the design. That is precisely why in his guest lecture the researcher Daniel Ibanez mentioned the unfathomable journey that products and materials take from source to consumer to our field of work.

In this studio, the P (research-based design/spatial design/architecture) was fully integrated with the O (research/writing). The studio had an unconventional set-up , but it was a success. Moreover, the studio was also about transcending your work, reflecting, and the ability to show and relate your findings and discoveries to a wider audience, although there is certainly still some headway to be made in these areas.

The teamwork in this group deserves some praise. The six students embraced the objective of the studio. They each followed their own path, but together arrived at a complementary package for the entire wood chain. Furthermore, grateful use was made of each other’s knowledge and findings. The film that they made as final product is a testament to that; a truly cohesive story was built.

Simply put, that cohesive story reveals three key ways in which the wood chain can be improved and made more sustainable, and the above-mentioned ambition of CO_2 reduction can be achieved as effectively as possible. That concerns the way in which we grow and manage forests, radical innovations in the transport and production system, and the way in which we use wood as carbon storage in cities. Below we will report the most important message from each student project.

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Global Tree Cover

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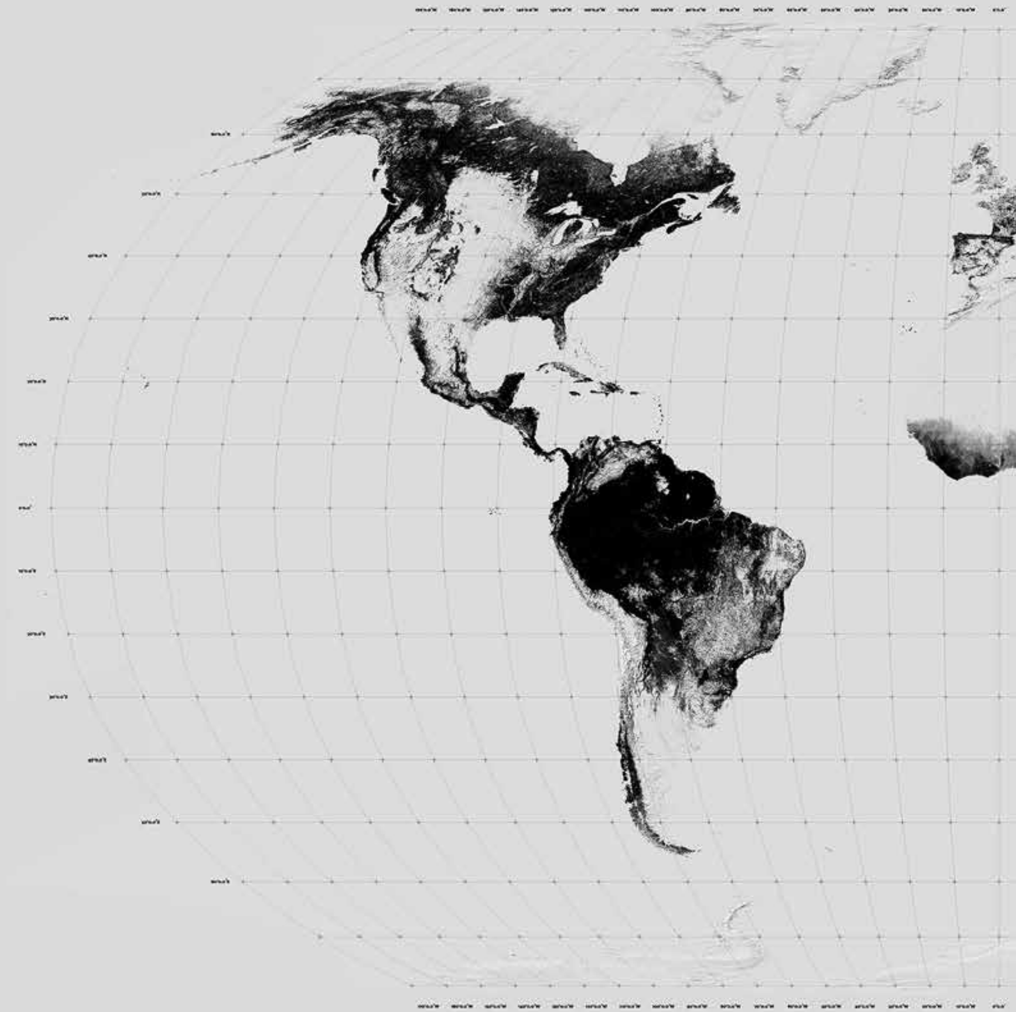

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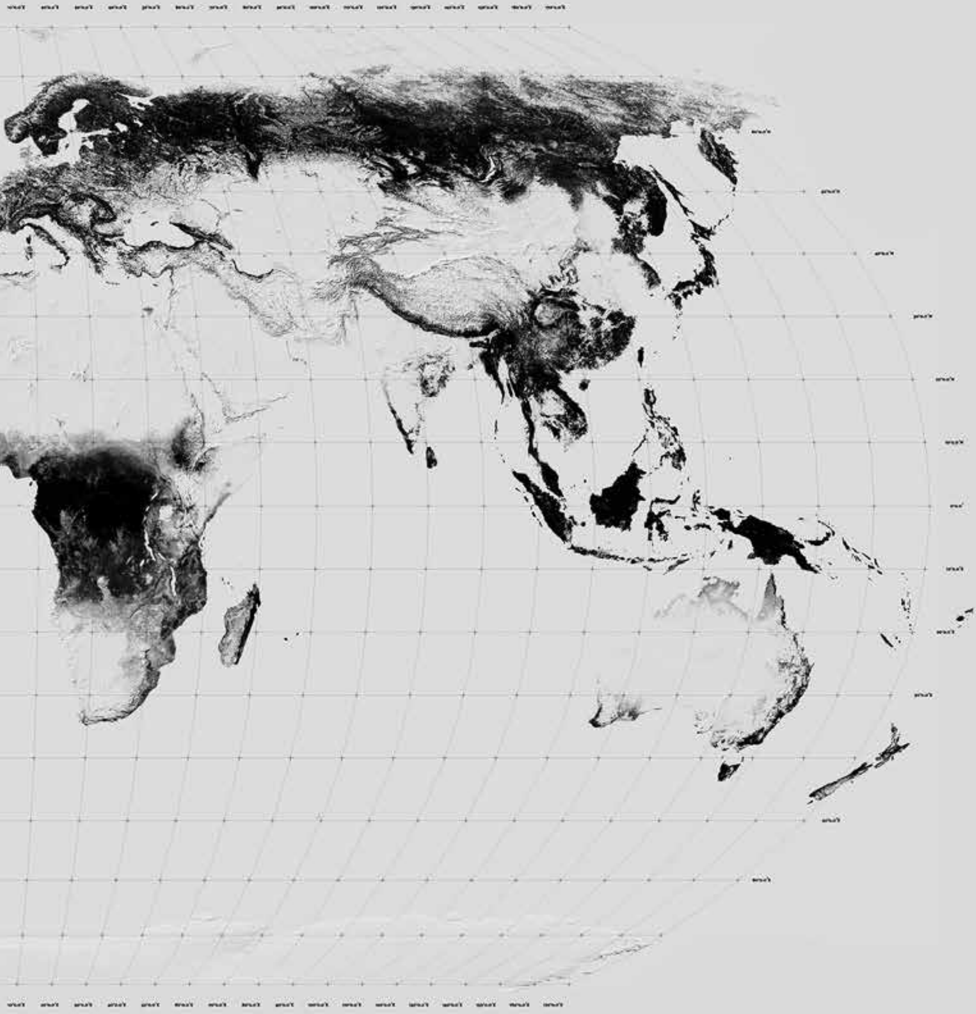
Atlas of Places



The Ultimate Forest – by Rachel Borovska
If we need more wood for the construction of our cities, it is conceivable that we will have to create more and new forests. It is wise and necessary to combine the production component plus the overlying goal of carbon storage with issues that also determine the agenda: restoration of biodiversity, climatic aspects (water distribution, heat mitigation, air quality), other forms of food products (agroforestry), and the socio-cultural significance of forests (well-being, health, traditions, recreation). In this research and design project, those extra benefits are explored. How do they relate to wood production and carbon performance and which conditions are decisive to create at least one example of 'the ultimate forest'?

A national forest strategy for the Netherlands – by Coen Pronk
The transition to build our future homes with wood is a main motor to store as much as carbon as possible. But to make this work we must meet three requirements. First, the carbon storage capacity of wood should be improved by using the many residual flows that are released during production (in TFC, for example – instead of CLT). Secondly, we need to grow the required trees and forests here in the Netherlands as much as possible. Thirdly, because this project concerns the long term (the trees we plant now can only be used after 2050), the whole building challenge needs to be broadened – besides building new houses, it will concern renovation and transformation as well.

By connecting these different aspects, a national forest strategy can be defined in which the required amount of forest – '3.5 times the Veluwe' – is placed in the different regions and landscapes of the Netherlands. One of them is a large Randstad forest that, in addition to CO_2 capture and wood production, may well serve as a landscape framework that may provide the Randstad with new impetus.

Changing the flows by local wood harbours – by Miriam Kruessel
Research of global transport flows shows that there is still a lot to be gained in this area. By experimenting with hypotheses and assumptions at different scale levels, we can conclude that although transport by water is the most promising (also in terms of CO_2-emissions), many improvements are needed and possible. Like making better use of the water network in Europe by setting up port and production locations in more places (from which a smaller hinterland can be served – in other words: shortening the distance between production site and building site, between source and consumer). The project elaborates on this for the Netherlands, and specifically for a new timber port in Nijmegen. What else can such a manufacturing site offer the city?

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Cutting the production chain: designing and building with local and unprocessed wood – by Azat Dzhunushev
Based on research, a lot of things in the wood production chain are wrong: pollution, socioeconomic problems and above all: large amounts of CO_2 emissions in every step in the wood system. To find out how to make the production chain more sustainable, clean and economically interesting, an experiment was started in the country of Kyrgizistan. The underlying principles: stop the timber import from Russia, use the forest site as a final building site as well, and above all: use unprocessed wood in building projects. Design-based research was used to explore how raw wood can be applied, especially in the construction of high-rise public buildings. Such towers may look inefficient, but the entire chain will be more sustainable and cleaner.

Storing carbon in urban wood landscapes – by Mustafa Nicanci
To compensate for the CO_2 emissions from our built environment (and future urbanisation), we should create large wood landscapes in all major cities. Design-based research was used to investigate how this could be done for Amsterdam – and what architectural expression and public significance such wooden structures (on top of the city, in the city, under the city) could have for the Dutch capital.

Beyond the wood chain: designing a natural carbon sink – by Reinier Gramsma
In addition to improving the wood and timber chain, we also need to focus on the natural carbon sinks in which wood and vegetation perform very well regarding carbon storage – in fact, if we don't do this, all those improvement proposals with regard to the wood chain will be for nothing. That ideal natural sink is the tropical peat forest (3 percent land, but one third of the storage capacity), but they are under pressure worldwide. So, it is necessary to nurture and restore these sinks, and to sharpen this call for change a natural carbon sink has been designed in the form of a new peat forest in the Siak river delta on the Indonesian island of Sumatra.

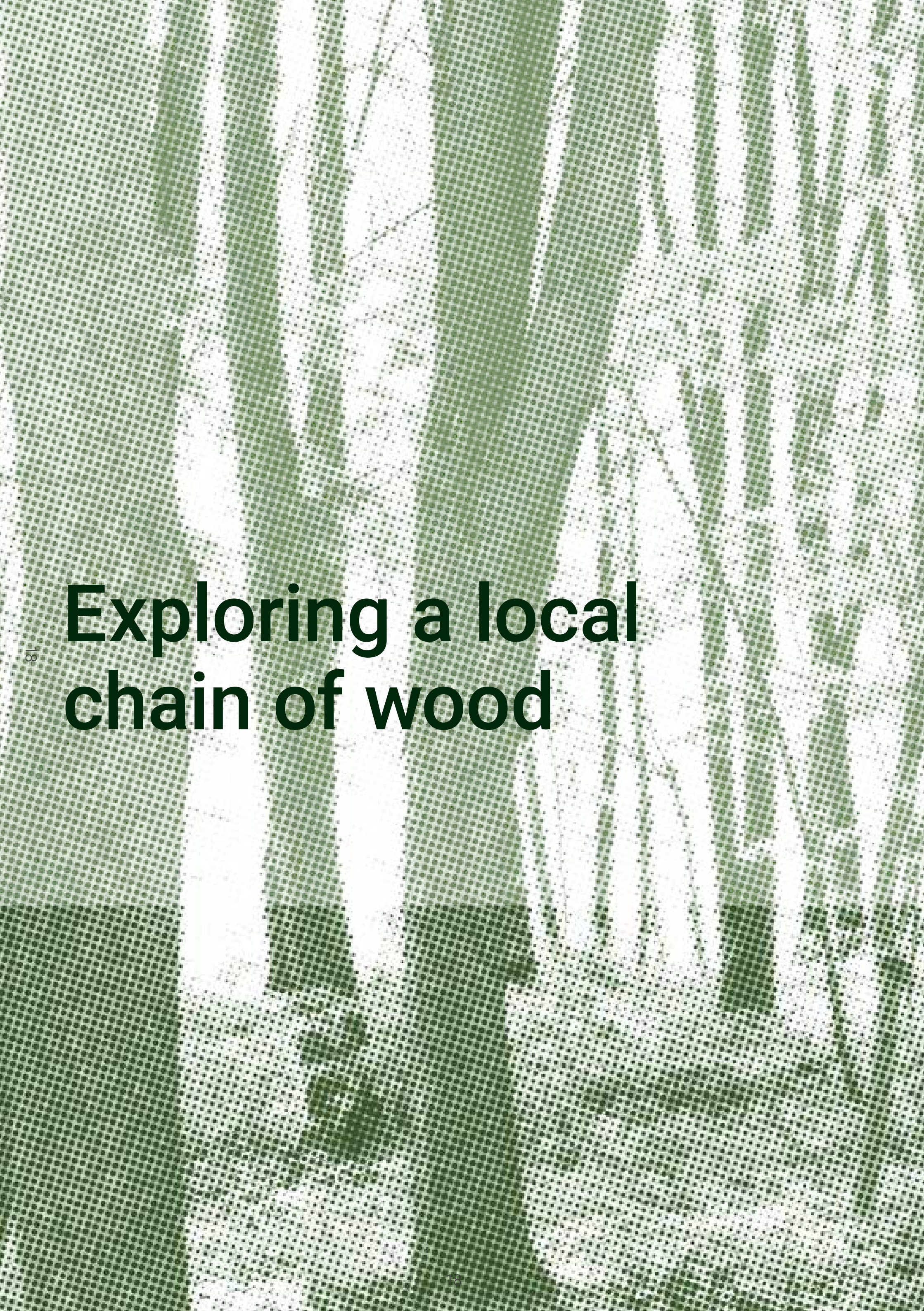
We can deduce a lot of things from the six proposals, but we will single out one of them here: this global issue can only be solved with local actions and interventions. However, we cannot simply saddle local governments, companies and organisations with those interventions and changes. Improvements in the wood chain – and striving for CO_2 reduction and carbon storage – is the responsibility of us all: of world leaders, of organisations like the EU and UN, of wood suppliers and construction companies, of us as consumers. And, of course, of the design world. As written before, it is very important that designers are aware of the journey that wood and timber have taken and that they take responsibility to improve this – restore the relationship between source and user, make the chain more transparent, sustainable, social and fair. It is up to the six students to continue propagating this message.

Exploring the global chain of wood

Documentary

This design studio is focused on the worldwide production and supply chain of wood and timber, a planetary system of flows that on a considerable number of points needs to be made more sustainable and improved. We challenged the students to research the journey that wood makes from tree to the building material, and to come up with design proposals to make this system more efficient, honest and sustainable - thinking from the ambition to make use of the ability of wood to store carbon in the largest possible way. The students made a documentary on the results of their collective research.

Link to video



Exploring a local chain of wood

Part of the search for the optimisation of the wood production chain was a visit to the Dutch cooperative Peppelhout where Job Wittens and Frans van Boeckel have developed a local production chain for poplar wood. Poplars are a characteristic feature of the cultural landscape in the Dutch province of North Brabant and are planted on a massive scale to make matches, clogs and even houses. Because it is a fast-growing tree, you can – with a bit of luck – plant and harvest a poplar tree on the same piece of land two times in your life. The poplar also plays an vital role in supporting plants and animals; research has shown that the poplar makes a unique contribution to the ecosystem.

Peppelhout demonstrate that the poplar can help us to make our economy much more sustainable, because the poplar not only grows extremely fast, but also extremely straight. The long trunks are a good alternative to wood sourced from far away, as due to new sustainability techniques, poplar can compete with harder types of wood. In addition, it offers a green alternative for the bio-based economy of the countryside.

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Composing the ultimate forest

A Forest in Layers

Rachel Borovska
Landscape architecture

If we need more wood to build our future homes and cities, it is conceivable that we will have to create more forests. But the way we do this – and the way we maintain all these forests – is very important. Many examples today show that massive planting of forests without taking care of the correct conditions, might cause extensive damages on ecosystems, loss of biodiversity and disastrous effects on landscape characteristics.

This relates to the statement that Peter Veenstra from Lola Landscape Architects made. He argues that carbon storage alone, and let alone wood production, should not be the only reason for making new forests.

Besides timber production and CO2 sequestration, forests offer other multiscalar values and benefits to ecosystems, cities and societies. These benefits are also known as 'ecosystem services' and include increasing and supporting biodiversity, heat mitigation, watershed services and improving air quality, but also food production (in terms of agroforestry), nutrient cycling and socio-cultural aspects such as well-being, health, recreation and honoring traditions.

We observe many positive climatic results, as well as those related to health and mental well-being in projects and spaces where forests have been combined with the daily rhytms of urban environments. The cooling effect of vegetation is captured vividly and calculated often for heat maps and only a couple of minutes spent outside amongst trees and plants helps us reduce stress, move more and breathe healthier air. Many cities are reliant on forests for clean water, as many animals and plants find shelter and food in these habitats. For many of us, forests around our homes are also places strongly saved in our memory. They hold cultural significance, and may define the essence of villages or regions we strongly feel with. It is the long lanes of tall trees along walking paths, the fresh smell and sound of the leaves, or the small forest route leading to another village, or the berry shrubs that your coat would always get stuck to and rip small holes on one of those daily walks.

The great significance of these ecosystems is indeed something to cherish and calls upon new ways of planning and design for more future proof visions. Combining issues, uses and goals can generate new spatial typologies and layouts for forests. In this research project the idea of 'ultimate forest' is explored. The 'ultimate forest' – where wood production, carbon storage, recreation, while maintaining high ecological values are combined. The growing need for timber is fulfilled while a healthy, well-functioning and in the long-term beneficial ecosystem is maintained.

One of the first steps of the research is examining the ultimate conditions and elements necessary for a well-functioning forest ecosystem. This is done through a multilayered approach through which all conditions that act upon each other and interact with each other are explored and categorized.

In fig.1, various layers on which forests have impacts are illustrated. At the same time, these layers are crucial for the existence of the forest and add up to its benefits. Three main categories are defined: *Natural Conditions* (i.e. all climatic aspects that act as given parameters and can't be changed) : soil, topography, heat, air temperature, water temperature, slope orientation etc., *Biotic layer* in which we define all living species, the understory and the canopy and the *Anthropocene layer* (i.e. all human interventions, in this specific case study : pathways, areas for recreational activity, interventions for production purposes i.e.harvest and maintenance). It is important to mention that these layers could be for future purposes and trials extended by much larger systems and elements depending on the scopes and goals of upcoming topics.

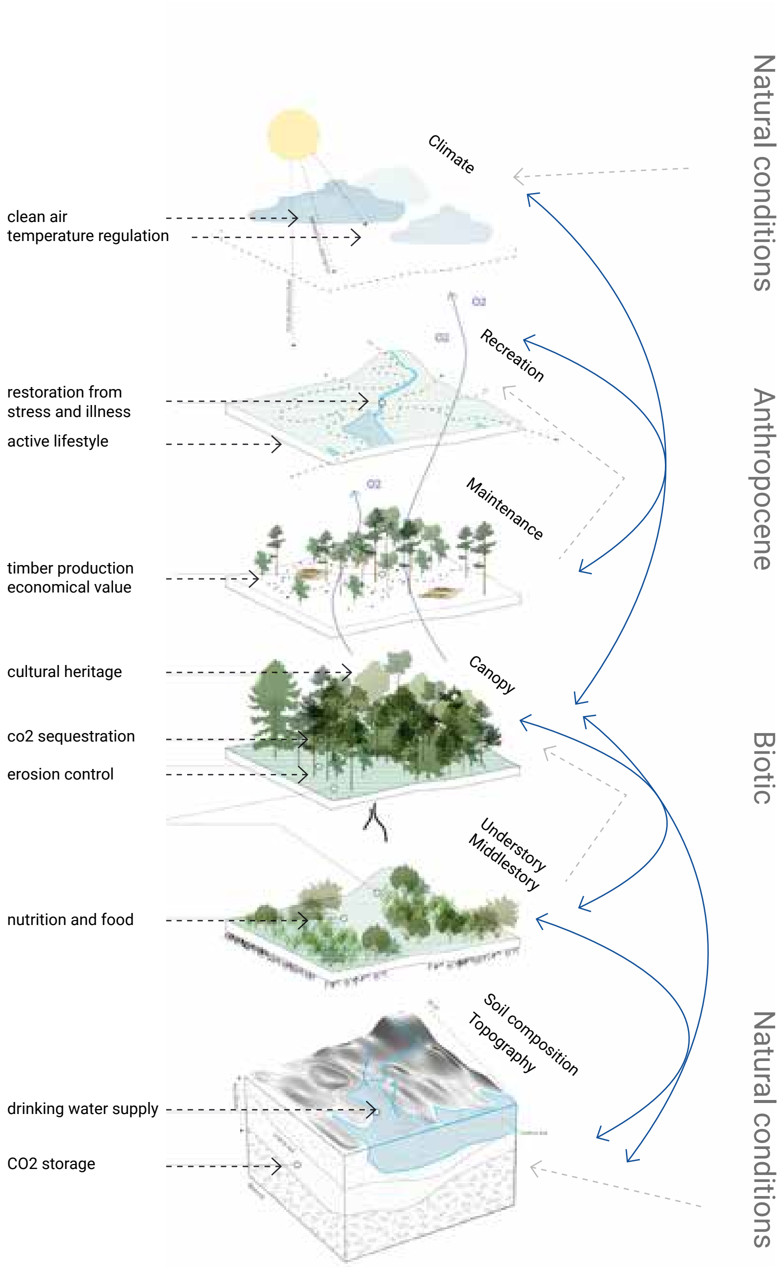
As an example of this approach: Good soil for example, makes it possible for the trees to grow faster, while the land and soil benefits from nutrients transported by the roots. The importance of roots of the understory and of the trees plays a major role in stabilizing soil and erosion control. Thus one layer benefits from the other and vice versa.

Without these layers and their interaction, it would have not been possible to research a full ecosystem of the forest and the results would potentially manifest in one-dimensional outcomes with monofuctional use which would have been contradictory to the goal of the research. In the next pages a short summary of the various conditions researched and design steps taken is show.

All in all, the idea of the 'Ultimate Forest' present in this publication suggests our approach, planting, harvesting and maintenance as well as the design of attractive spaces for recreation and leisure, should take place in a more sustainable, integrated and careful way to all aspects involved. Only then a well-functioning ecosystem can be created.

Sources

- The Forest and the City: The Cultural Landscape of Urban Woodland (Cecil C. Konijnendijk, 2008)
- Twaalf Boslessen (Simon Klingen, 2020)
- The Hidden life of Trees (Peter Wohlleben, 2015)
- Op-ed: There's more to timber building than trees (Kiel Moe, 2021)



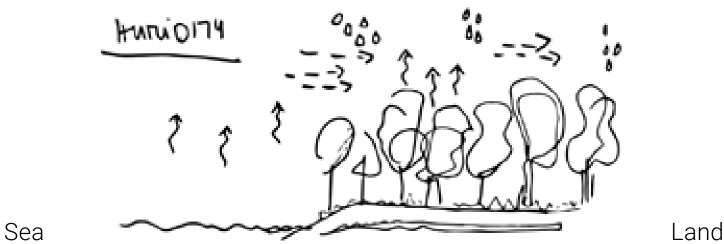
Ecosystem services in a multilayered approach

Climatic Conditions

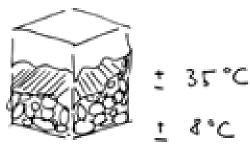
By researching the optimal conditions such as air temperature, soil temperature and topography it was possible to locate the optimal forest on an optimal location. By assessing these given parameters of climatic conditions a specific biome and condition was located for perfect growth of the ultimate forest.

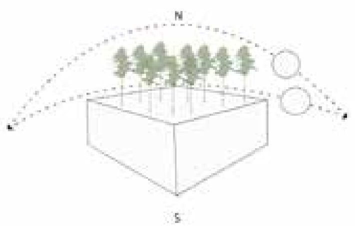
As researched in the studio by Reiner Gramsma, the Temperate Oceanic biome scored the highest on carbon values. After this biome, tropical forests took the lead.

The researched optimals were compared to the conditions of the Temperate ceanic biome. This study showed that the conditions of the biome match with the optimal conditions for forest growth. These were: location near the sea or larger water body (backed up by hypothesis of Makarieva and Gorshkov), average air temperature, average soil temperature, orientation and inclination of slope and average rainfall. A few examples are illustrated in this chapter.



Water exchange between sea and land mass, makes the climate more equable. i.e cooling the air through the day and warming through the evening.



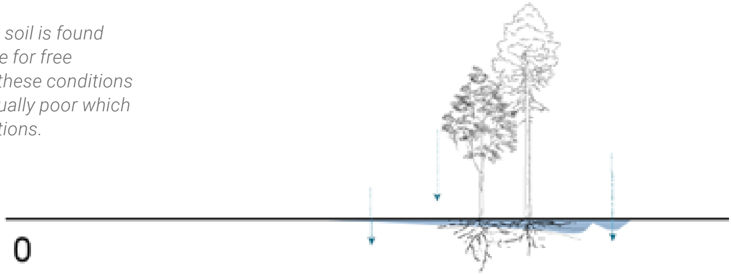


Optimal orientation of the slope is North facing. Generally the sun's rays strike the soil surface much more obliquely on north aspects. This means less heat and more vapor is produced, which is more suitable for forest vegetation.

On the South facing aspect, the air is much warmer and drier, therefore less favorable for forest vegetation.

Large shares of forests can be observed to grow on slopes between 0 to 30 degree.

On low slope grounds deep soil is found where tree roots have space for free development. However, in these conditions the drainage capacity is usually poor which might cause swampy situations.



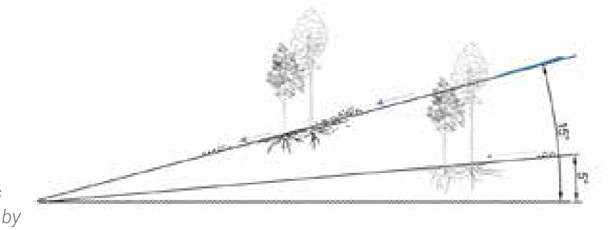
Species tolerating shallow soils are: Spruce, pine, birch...

Species demanding moderate depth: willows, alder, horse chestnut

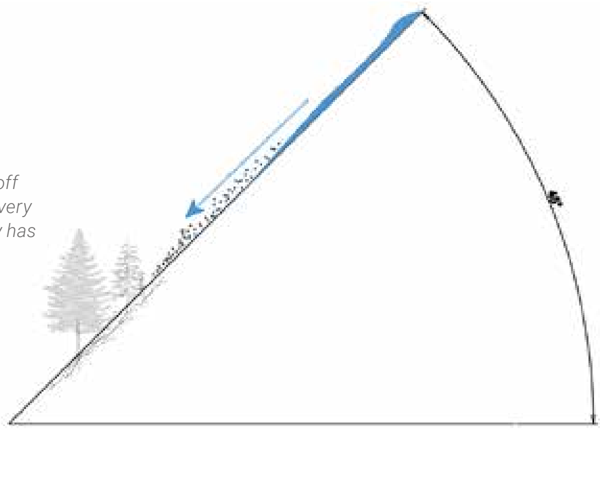
White poplar is an example of greater depth demand.

Silver fir, sweet chestnut and oaks demand soils with greatest depth.

The lower lands of the slopes have more fertile soil in comparison to soil in the higher altitudes. The reason is that soil is deposited in the lower lands transported by water.

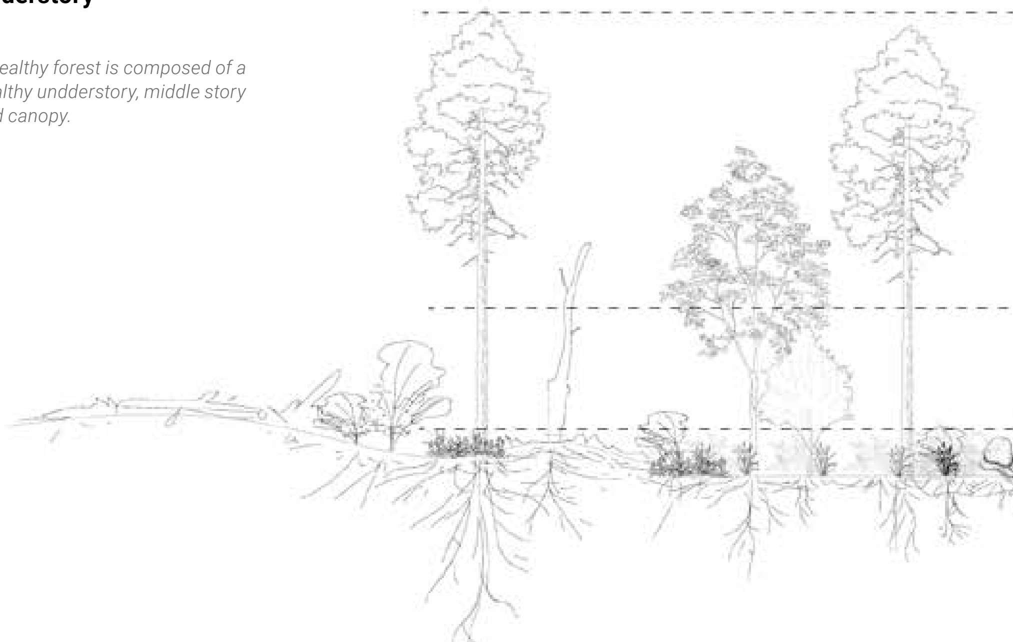


The higher the slope, more surface runoff and erosion. A gradient of above 45° is very negative for forest growth and it usually has little or no forest growth.

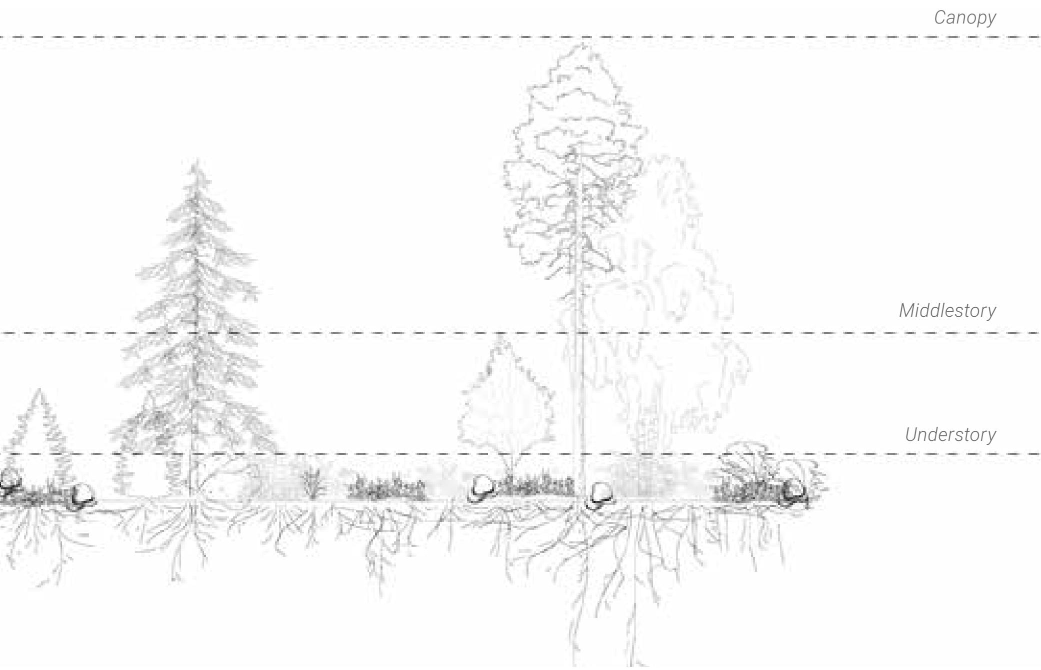


Understory

A healthy forest is composed of a healthy undderstory, middle story and canopy.



The understory serves as an important shelter and cover for animals, as well as a nutritous food soource. Different berries and nuts are favoured by various species such as squirrels, elk, hummingbirds and many more.



In deciduous forests at the areas where there is not enough light mostly leaf litter is explored. These are non-living components. Very little shrubs, or understory spieces cover this ground.

This means, the area of the forest is blocked by tree canopies, not letting enough light pass through for vegetation to grow. Dead wood, twigs and bark is also a part of the non-living components feeding important nutrition to the soil. Enhancing growth.

Snow cover can be also considered as another non-living component on the soil surface, that, in moderate conditions can act as a cover for the understory. Deep snow can maintain moisture by transpiration. Many small trees, shrubs and plants can survive through winter due to its cover. In more open spaces, where enough light passess through, ferns and mosses, shrubs, fungi and lichens appear, creating an all connected understory system.

The symbiosis between funghi and plants is considered as one of the most widespread and ecologically important relationships on earth. Parent trees (i.e ones that protect smaller ones use this system to exchange sugar through their root systems to feed seedlings. They have the ability to warn each other and protect each other from insect infestations. In case of a disease, trees use this network to give away their valuable nutrients.

Canopy

CROWN

photosynthesis O2 release

CO2 absorption

evaporation

STEM

material transportation

production

ROOT SYSTEM

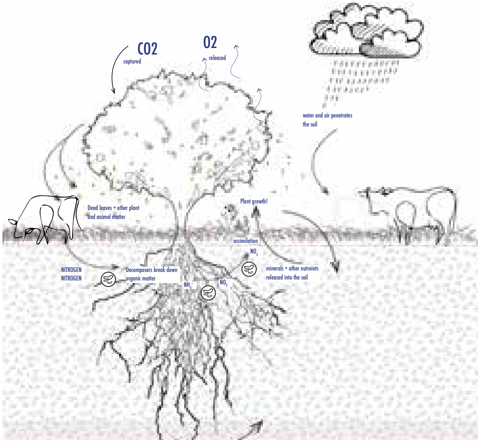
aeriation

anchor

nutrient exchange

CO2 storage

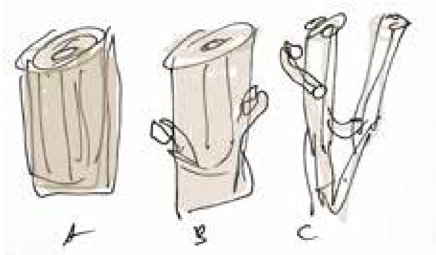
water collection



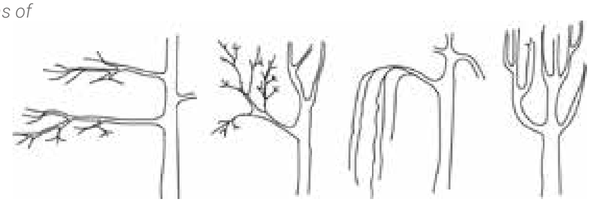
Roots improve energy flow and nutrient circulation as the main functions of the ecosystem.

In the ultimate forest, various species and crown types are planted. These have different effects on shadow casting, evaporation and biodiversity.

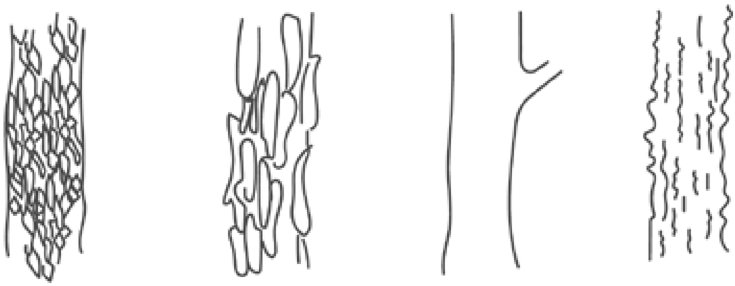
Tree stems
Tree stems are good indicators for valuable timber. Type A is a smooth stem, without knots, which is the most favourable for furniture and product making.
Type B is a stems with knots, this type might be sold as cheaper timber, as it becomes more difficult to create smooth cuts.
Type C is a multistem tree which can be considered as the natural type. It is not so well used for timber production, however has higher values in biodiversity since it's foliage is larger.

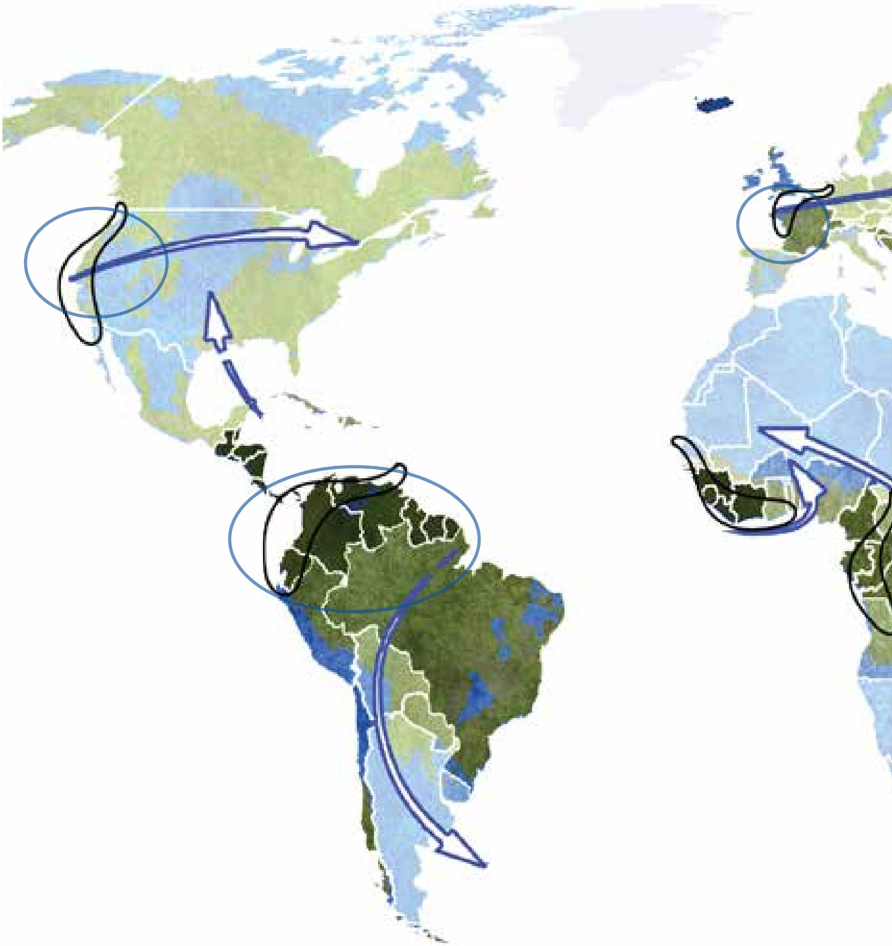


Branching types
Branching as in type A is effective in preventing water runoff down the tree trunk, rather spreading it through the lengths of branches.

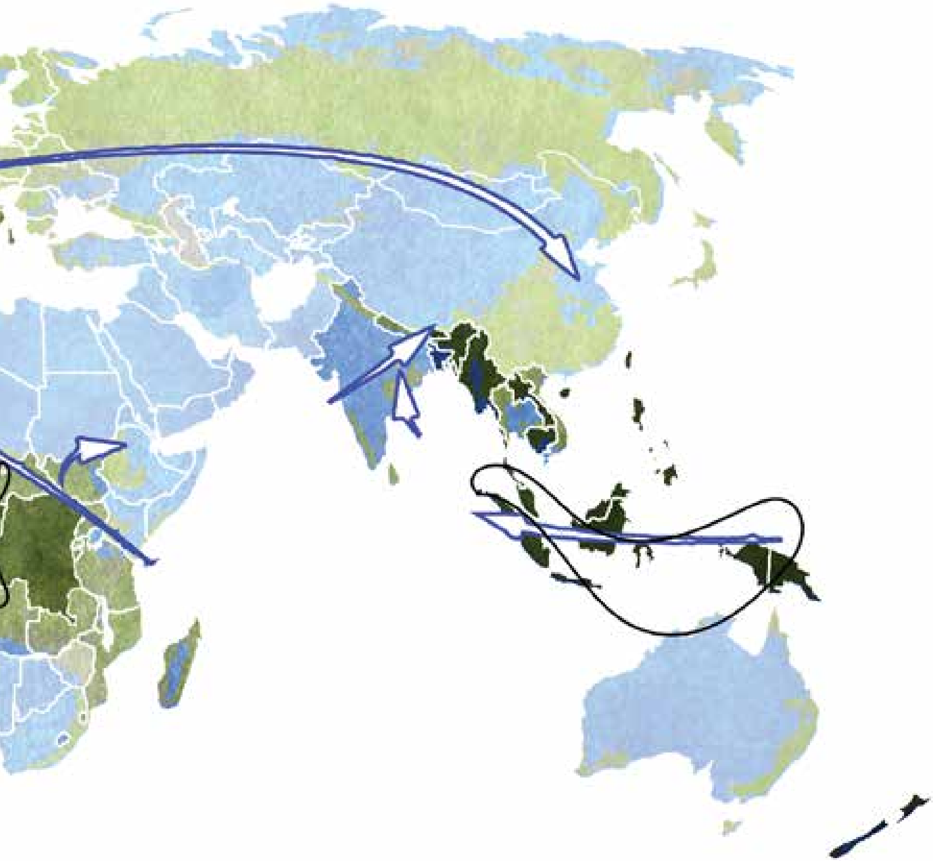


Bark types
Rough barks, type A, B or D have a better capacity to hold and slow water running down the trunk. Preventing erosion at the base of the tree.





Potential locations of Ultimate forest. Combined map of Annual Rainfall, Forest Cover and Makarieva and Gorshkov's Flying rivers.



Models of the Ultimate Forest

The design phase started with a code combined of a set of parameters in Grasshopper (a coding software). The visuals of this research are to be seen on the next pages of this publication. This engine assessed the most efficient models or outcomes for carbon sequestration of a 1ha large forested area. The carbon sequestering calculations have been done by gathering information of the width, density and lenght of the tree trunk, width of the canopy density and the tree's age. All these parameters have been 'fictional', due to the duration of the study and since there was no existing forest to have this data measured from. The selection of tree species resulted from the research on natural conditions. Species occuring at Temperate Oceanic biome have been selected for this model.

The second category of parameters was based on the canopy growth of sun loving and shadow loving species. This rule avoided overlapping canopies on sun loving species, however allowed shadow loving canopies to overlap a lot more. The overlaps were also estimated by the height of each tree, where for e.g. small growth could not overlap tall growth. The understory specie had defined percentagesm or sensitivities towards light. Categories from shadow loving had values of 100% tolerance of shade, half shadow 50% tolerance of shade and sun loving 5-0% tolerance of shade. These criteria positioned the understory at various locations, either under dense growth or more at the edges and openings.

While the engine has been tested on the absorption of carbon sequestration only, the next step would be to apply the same engine to calculate the most efficient model for timber production and harvest. For these studies, further research and collaboration with coding would have been necessary. In the preferred situation, the comparison of the two models would follow.

In the following section, an overview of the design of the forest is shortly summarized. The logic of open spaces, adding recreational pathways through andd and zoning

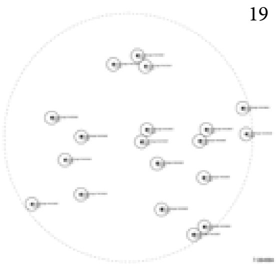
Conclusion
While the term ‘ultimate’ forest might suggest total perfection, the opposite might be true. The meaning of ‘ultimate’ in this research project aims to take our attention from identifying or seeing our forests as carbon absorbers or timber production machines only. This, as mentioned before, would only lead to monofunctional and monocultural forests, stripped off from all the other potential benefits, values and advantages forests can offer.

The same applies to forests and the importance of seeing them as layers interacting with each other – which reach underground (soils), on the ground (understories, middle stories and canopies) but also above the grounds (climate). Through these layers we can learn about what are the specific characteristic of each place or biome, observe what works and what does not and apply this knowledge to create designs that are site specific, local and remain true to their identity. In this way, instead of damaging ecosystems they become strengthened.
Even though this research focuses on ‘ultimate forests’ located in their ‘ultimate conditions’, such as the Temperate Oceanic biome, it does not mean this is the only correct answer. We should be aware that there are many ultimate forests that have many different appearances, can occur or grow in many other locations, with many different conditions and functions. The ultimate forest can be a new plantation for reforestation, an existing all aged forest under threat, a forest planted to restore exhausted soils, a preventive area protecting riverbanks or even a pioneer project willing to experiment with new methods for timber harvesting.

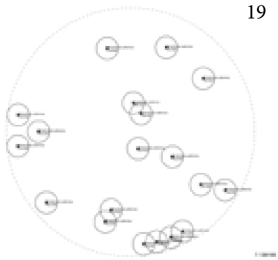
We should see the ultimate forest as a living entity with it’s own pace. We could take lessons from theories of Heidegger, Graham Harman or Timothy Morton to adapt a way of looking at ecosystems, empathize and respect them for their own needs and character. Consider them equally conscious as human beings. Notice, that they take their time to regenerate, to grow, change, decay and live again and then we can start to collaborate with them. Then resilient, adaptive spaces are created for humans as well as animals to live in, to enjoy and to fulfill needs and desires.

At last, I hope this attempt to understand and compose the ultimate forest can be beneficial and opens a worldwide conversation between foresters, planners, politicians, wood and timber companies, policy makers, landscape architects, environmentalists, and nature conversationists. Since this research is only at its birth and tackles only a few principles of a well-functioning ecosystem only more layers, more stories and more strategies could help this project become stronger and richer.

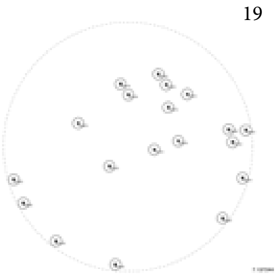
Planting the ultimate forest



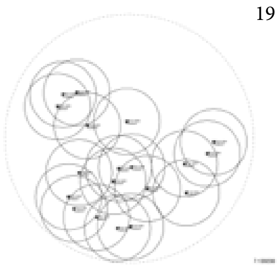
Pseudotsuga



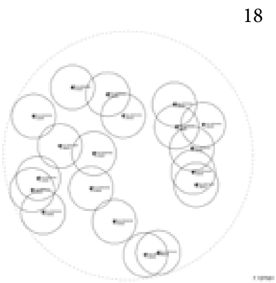
Umbellularia



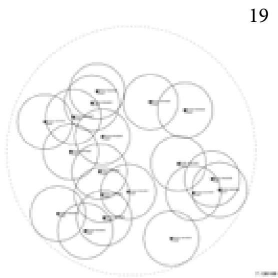
Tsuga heterophylla



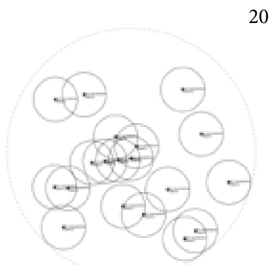
Alnus rubra



Picea sitchensis



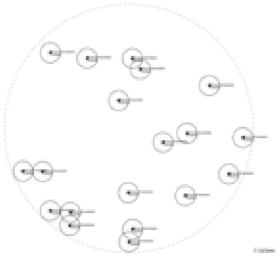
Arbutus menziesii



Acer macrophyllum

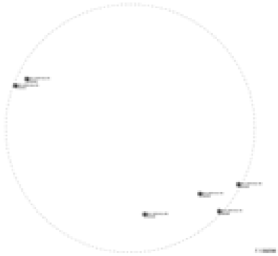
Species of the ultimate forest are selected through the research on the most favourable growing conditions. In this case, most of the species can be found growing in the Temperate Oceanic biome. Their capacity to absorb carbon and their speed of growth in combination with the conditions they thrive in, reaches a very high value, making them the 'superspecies' of carbon sequestration on a global scale.

19



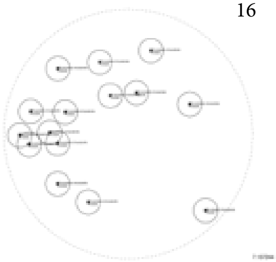
Quercus

6



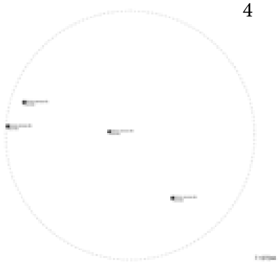
Aralia californica

16



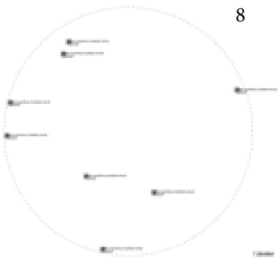
Chrysolepsis chrysophylla

4



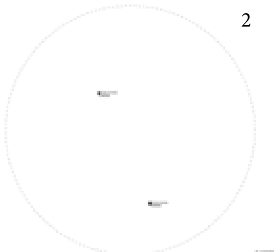
Mahonia nervosa

8



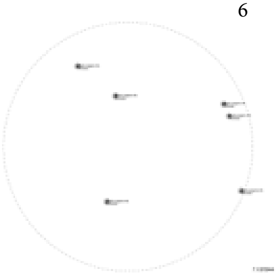
Rubus parviflorus

2



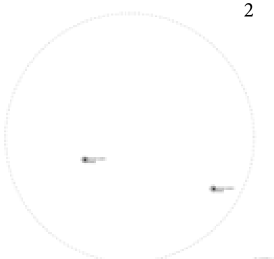
Corylus cornuta

6



Oxalis oregana

2

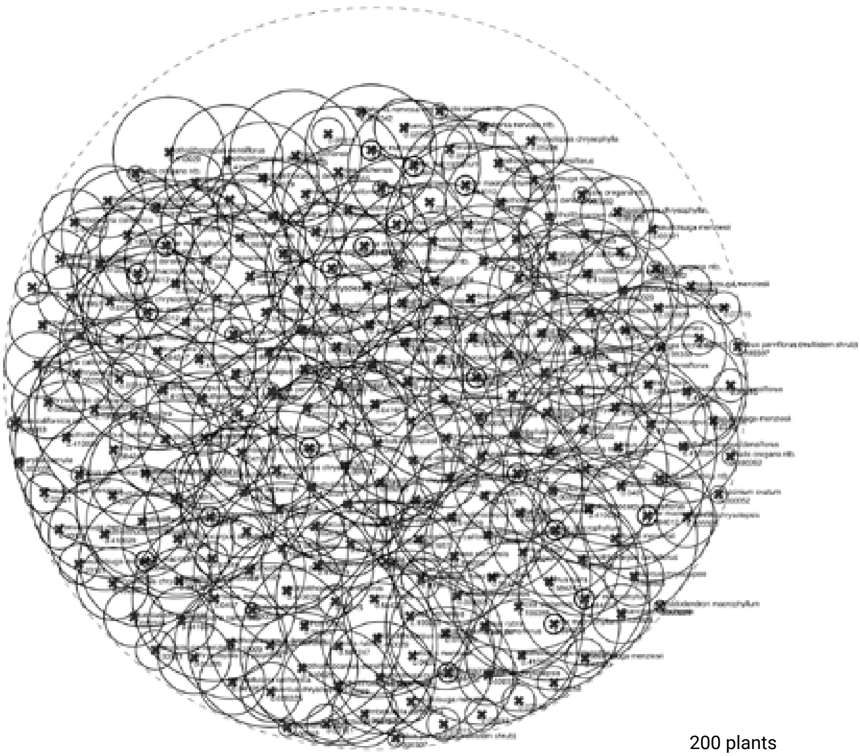


Vaccinium ovatum

The software has compared 50 000 options of a carbon sequestring forest. The final output from calculated 200 plants/trees in one hectare with a capacity to absorb 13.5 t of CO2 per year.

The use of parametric design on the organization of forest was used as a supporting tool. The outcomes are strictly computational and should not be taken as an ultimate equation. While looking at the model, the monofunctionality of this example is very aparent.

Trying to design a forest through a code serving only one goal (CO2 absorption in this case) is compareable to focusing on forests as monocultures serving purely as CO2 sponges. In this way, the model completely lacks spatial organization.



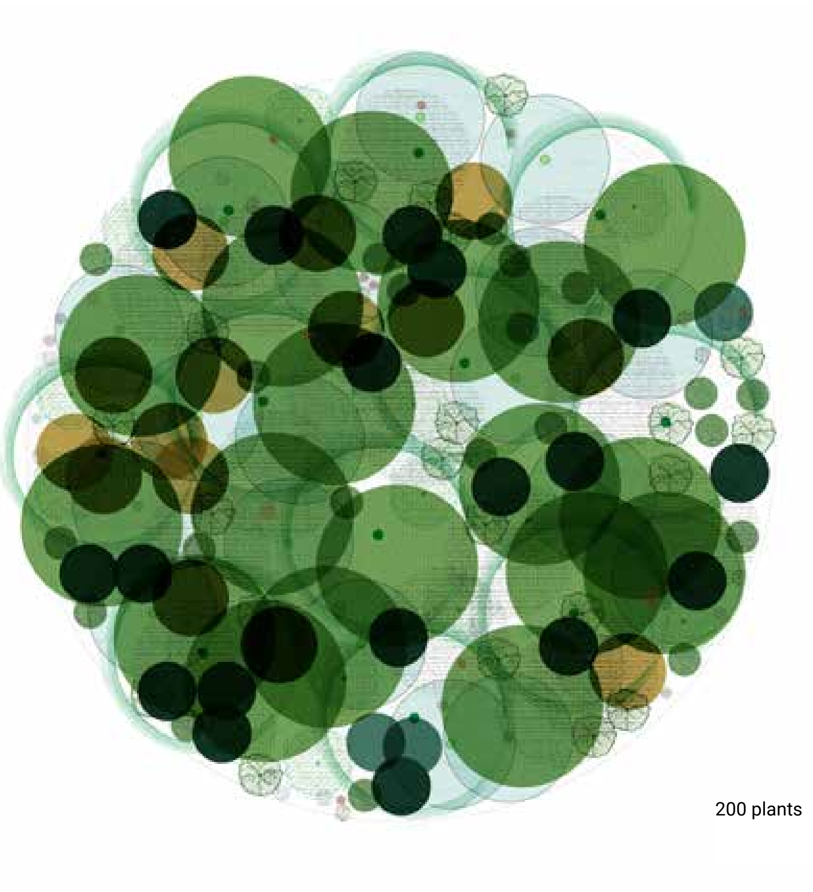
200 plants

Ultimate carbon sequestring forest model

Through the hand of the designer, the model is taken through a first organizing process. Species are equally spreaded within the boundaries of 1hectare of an area. A more clearer visual differentiation is apparent.

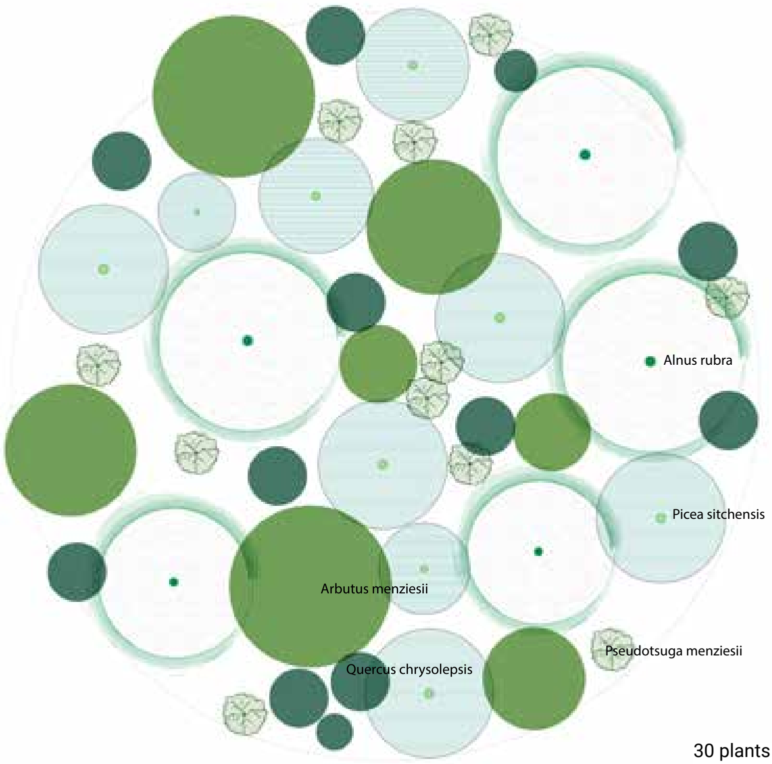
Several incosistencies in the model are observed: Sun loving species tend to overlap each other oor grow through each others trunks. The density of the forest is too high, therefore also not applicable for production or recreation purposes.

In reality, vegetation would not be able to grow in this manner, therefore further modifications needed to be done.

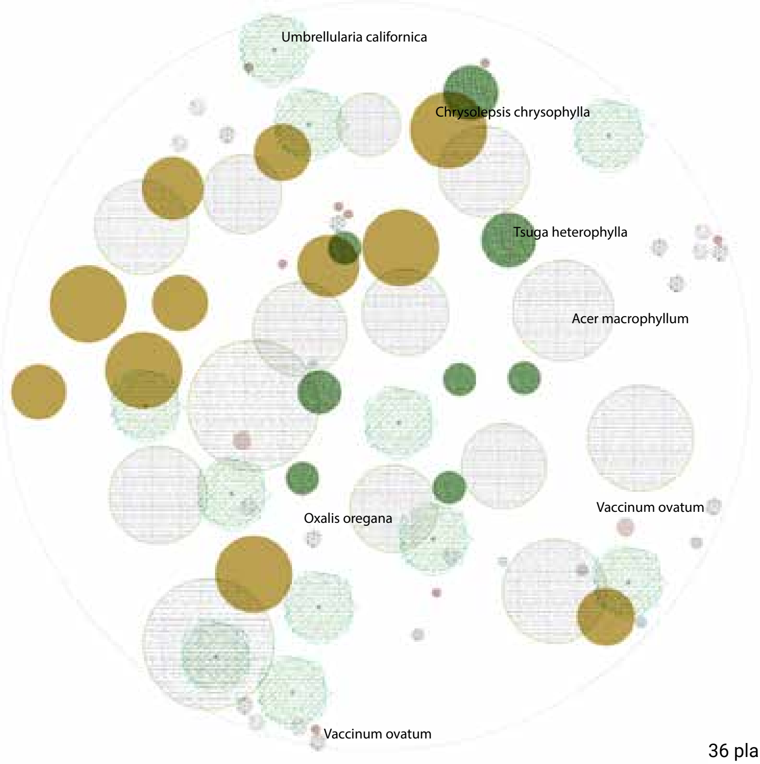


Trial 1

Sun loving and shadow loving species are separated from each other. Overlaps are mostly encouraged for shadow loving species and avoided for the pioneer species.



Sun loving species

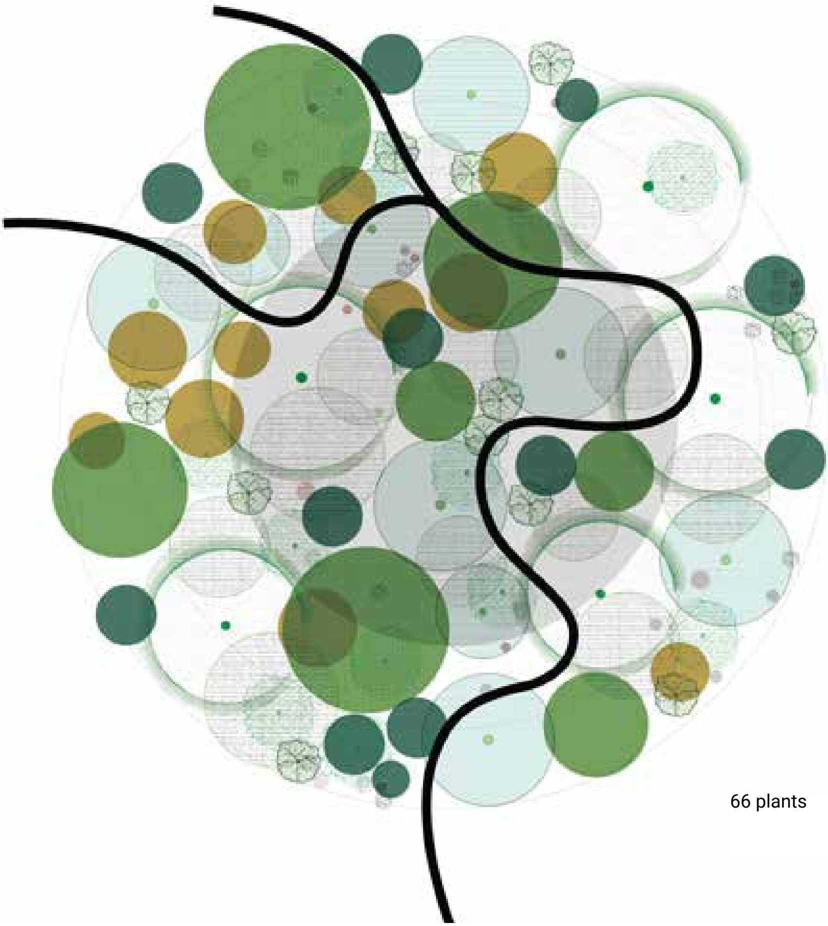


36 plants

Shadow loving species

A path of 1.5m width is included into the planting scheme defining more necessity for open spaces. The density of the plants, both canopy and understory in this model resembles more a park rather than a forest. Therefore, another step for densifying the planting scheme is necessary.

By adding zoning to this scheme, a clearer hierarchy of spaces can be introduced.

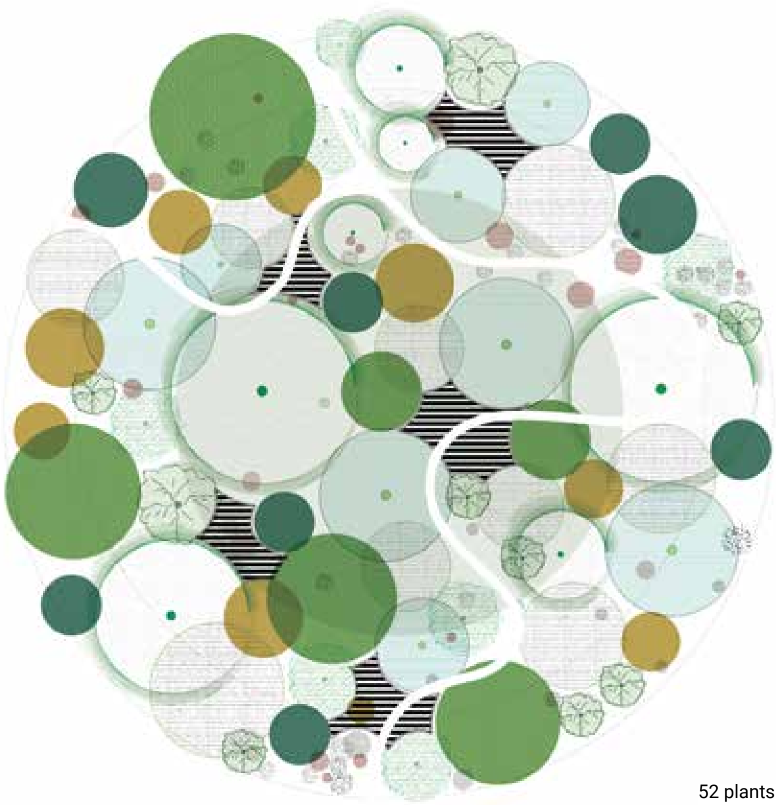


66 plants

Trial 2

The recreational path is now marked clearer by understory at its edges. Density is decreasing even more as more open spaces are added for both recreational and also ecological purposes. Open spaces in the forest are not only esential for providing light and comfort, but also to allow birds to hunt prey living in the lower parts of the forest.

Larger trees are placed around the path and entrances of the scheme as landmarks and wayfinding items. Further densification is necessary.

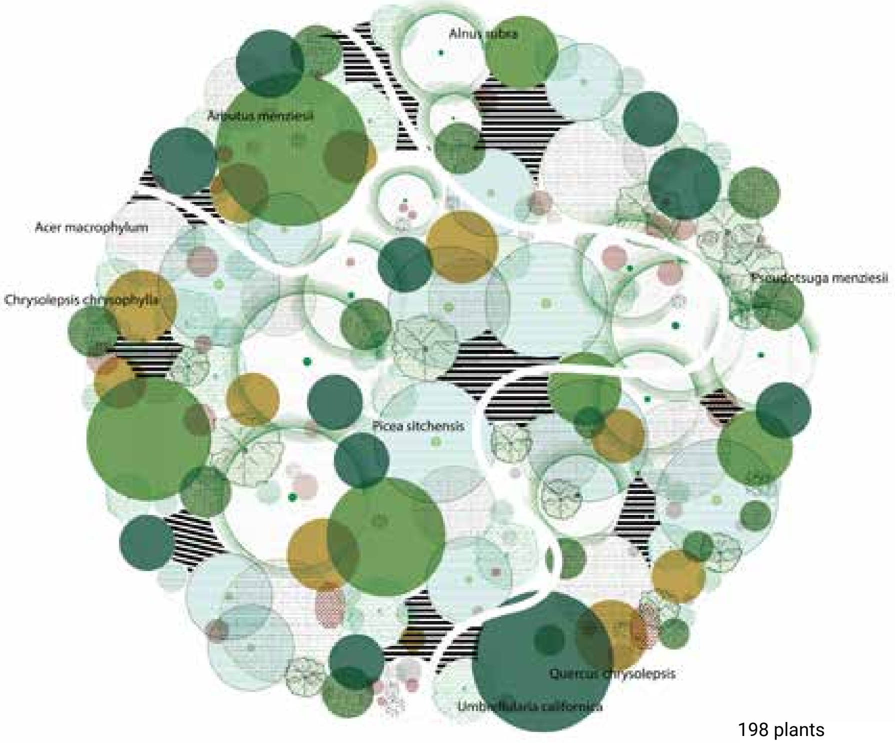


52 plants

Trial 3

The final set up of the forest has a clear hierarchy of open spaces mostly positioned at the edges of the forest, allowing the core grow denser. In this sense the core of the forest is the richest, most biodiverse and dense area, while the edges serve as more open - prioritized for production and recreation. The entrances at the edges are marked with special trees such as the Umbrellularia or Arbutus menziesii.

In reality, the edges of the forest would also serve as connections and corridors for animals to move through.



198 plants
equal to ca. 13tons
of CO2

The ultimate forest model

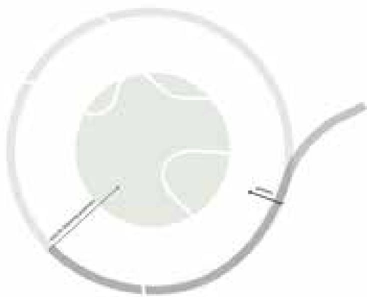
Some trees are kept as landmarks, orientation points for aesthetic reasons.

Thinning is essential for having valuable timber for wood prodction

Diverse planting, different ages, different heights, different years.

Open spaces. Examining the density of the forest and simultaneously creating open spaces in the canopy for more growth, ecological purposes and comfort of pathways.

Maintenance zoning or harvesting zoning defines the frequency and priorities of harvesting.
The edges are primary harvesting locations with most frequent interventions, while the core is a secondary priority, leaving it grow denser. It's possible to access the core more often for thinning purposes.



Principles for the ultimate forest

A circular perpetuum mobile.

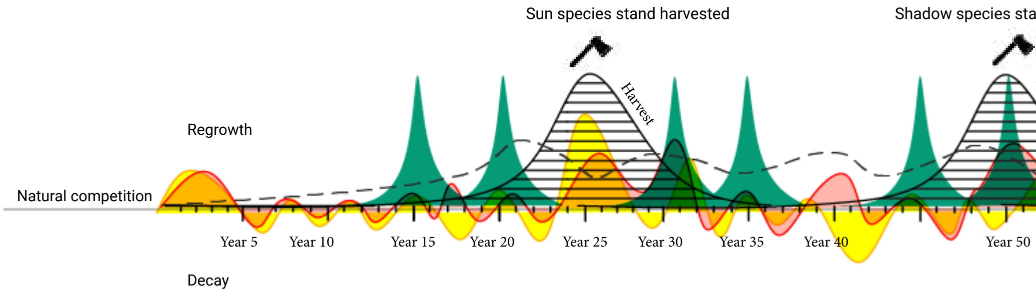
The timeline of the ultimate forest model is a perfect symbiosis and a careful choreography of processes occuring within. In this example, we begin with a new plantation. The natural competition of sun loving and shadow loving species is encouraged and has to be observed over time in order to select future species for harvest and species for wayfinding purposes.

Human intervetions such as thinning and harvest are an important part of this cycle. By thinning, important ecological and recreational spaces are created in the forest, selected trees are encouraged to grow bigger and become valuable.

Harvest and cut expands the programme of the forest - part production forest, part recreation forest, part habitat.

Harvest occurs every 25-30 years with selected species ready to be cut. The forest in this way also gives space for other species to grow and therefore changes its character....Every 30 years, the experience of walking through this area brings a different atmosphere.

Ideally, this timeline model represents a constant regenerative process, growth and constant maintenance of spaces, thus the levels of CO2 keep steadily fluctuating instead of intesely peaking and dropping.

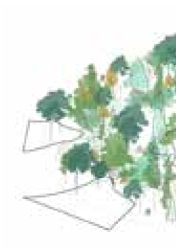


Year 1

Sun loving species are planted first, in a diverse planting scheme.

Year 8 - 10

Seeds of the sun loving species are carried through by wind and pollinators, while some grow taller, there are new species popping up. Including shadow loving ones.



Every 5-10 year

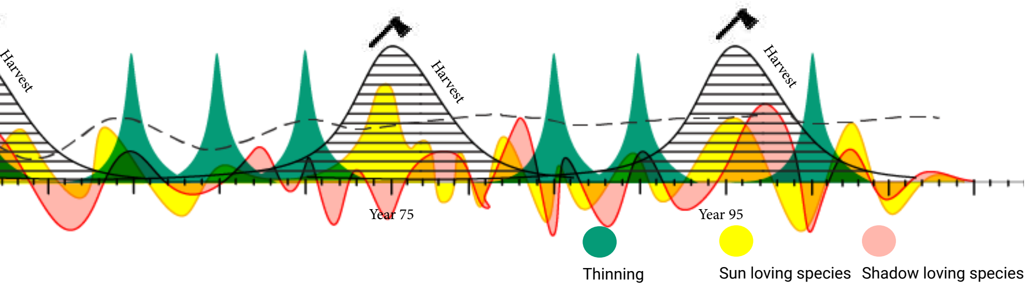
Checking the de
creating open s
for more growt
purposes.

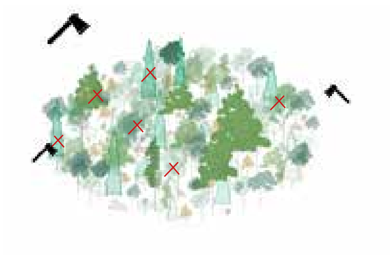
Regrow

Ultimate forest succession and production timeline nd harvested

Sun species stand harvested

Shadow species stand harvested





s thinning

ensity of the forest
paces in the canopy
n, and recreational

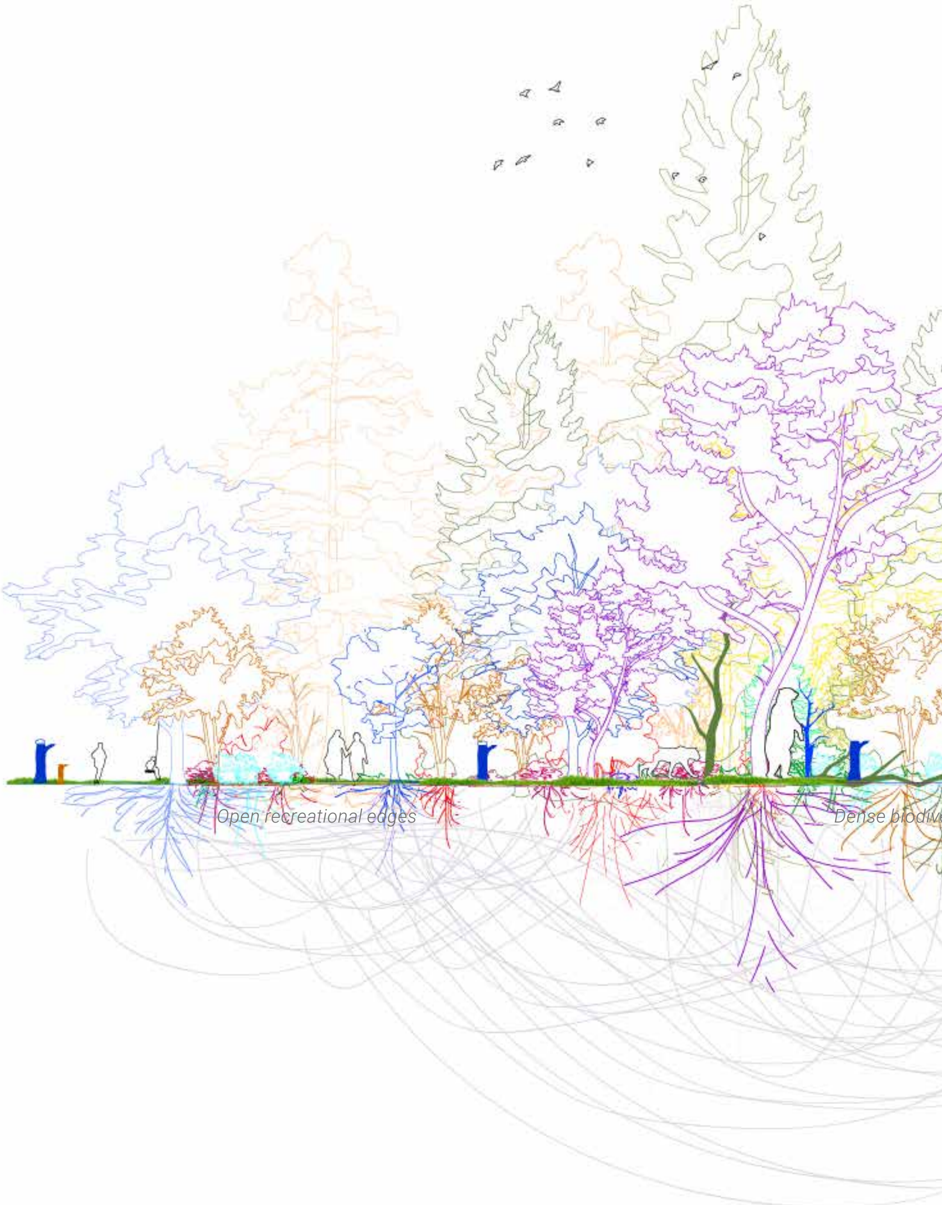
Year 10-15

Natural competition takes over, where trees create their own spaces. some species die, dry out or simply don’t have enough light and space to grow taller.

Year 25- 30

Harvest time. Mainly done in the outter edges.

Harvest



Section of the ultimate forest model


erse cores
Open ecological edges

Waste is more
A national forest strategy for the Netherlands

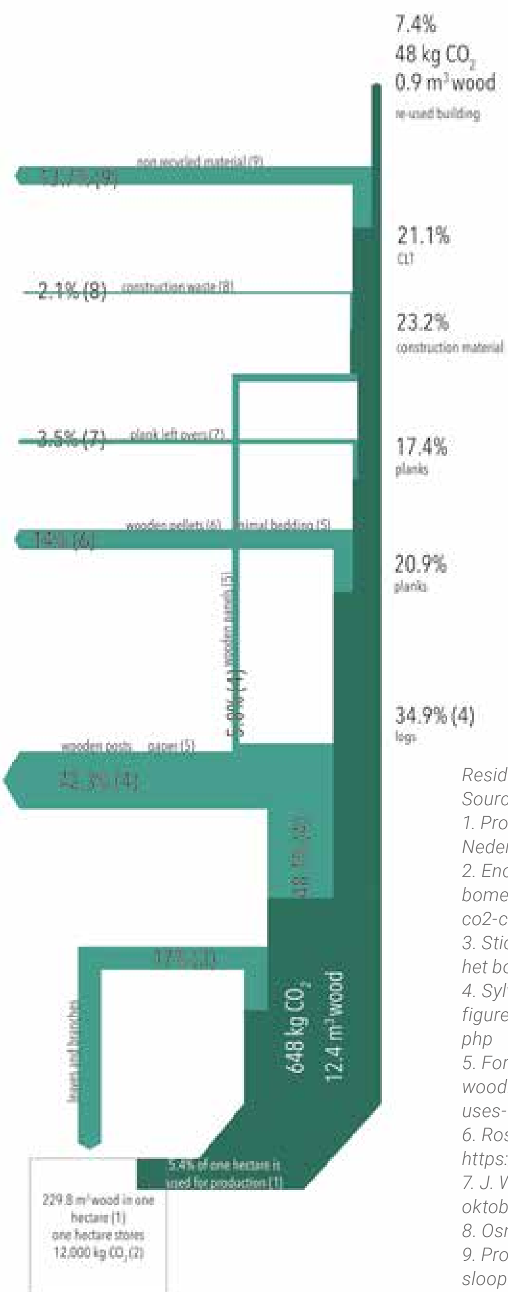
Coen Pronk
Landscape architecture

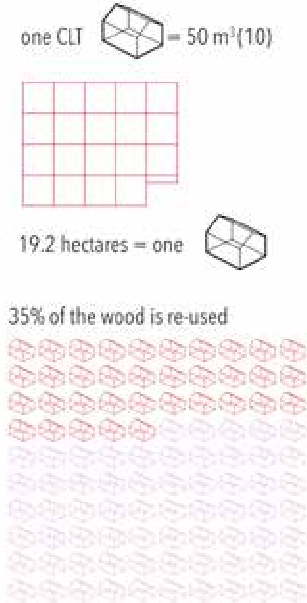
Today, building with wood, especially CLT (Cross Laminated Timber), is seen as an important solution to solve the worldwide CO2 problem. Trees capture and store carbon dioxide while they grow, and the production process of wood and timber is less polluting than building in concrete or brick. However, research shows that during this production process a huge amount of wood is lost – to make one cubic meter of CLT three cubic meters ends up as waste [1] - [10]. These residual products often end up in an incinerator or rot away, releasing the stored carbon dioxide again. This makes the storage of carbon in wooden buildings a lot less efficient, or meaningful than thought.

Three points
Due to these losses of stored carbon in the production of wood, because of burning or decaying residual products, the idea of using wood as solution for storing carbon will be at risk. At least if we continue in this current system, where of the 12,000 kilogram stored carbon in one hectare of forest only 137 kilogram gets stored in construction wood. Three things need to changed fundamentally to make sure the storing of carbon is most optimal in our future cities and buildings. At first all the residual flows need to get a destination. This is where timber frame construction (TFC) can provide a solution. In contrast to CLT it does not use large slabs of wood, but uses large beams to make a sturdy frame. Where only the best quality wood can be used with CLT, TFC offers many more options. By using the best wood for just the frame, less wood is needed for the framework of the building [11]. In addition, the residual wood materials can be used as a finish in the form of plate material, insulation material or as woodwork on the outside. Not only can more houses be put into use from the end product, the finishing of the houses can also be done with the same wood. As a result, much more wood and therefore more CO2 is stored in an TFC home.

Secondly we need to take a wider look onto the building tasks we set up for the future. We now mainly see the goal of building one million houses before 2030 while this is hard to reach. Also the trees that are planted now could be harvested at least after twenty to thirty years, so we need to rearrange the use and destinations of the timber. The construction of one million houses will be spread out over more years and will be added with renovations, transformations and public facilities to store carbon also in the future.

Thirdly we need to plant these trees close to the locations where the wood is needed to reduce the emissions from the transport. We need to find space for forest in the Netherlands.

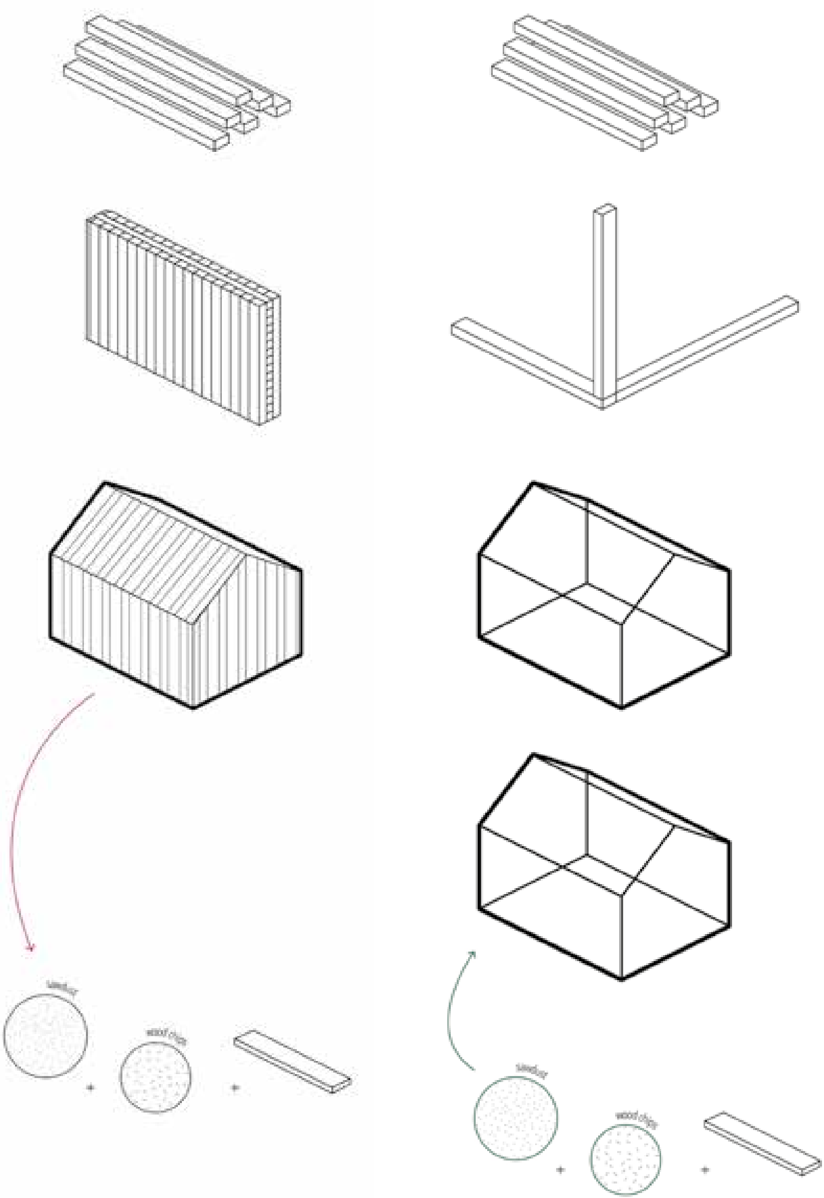




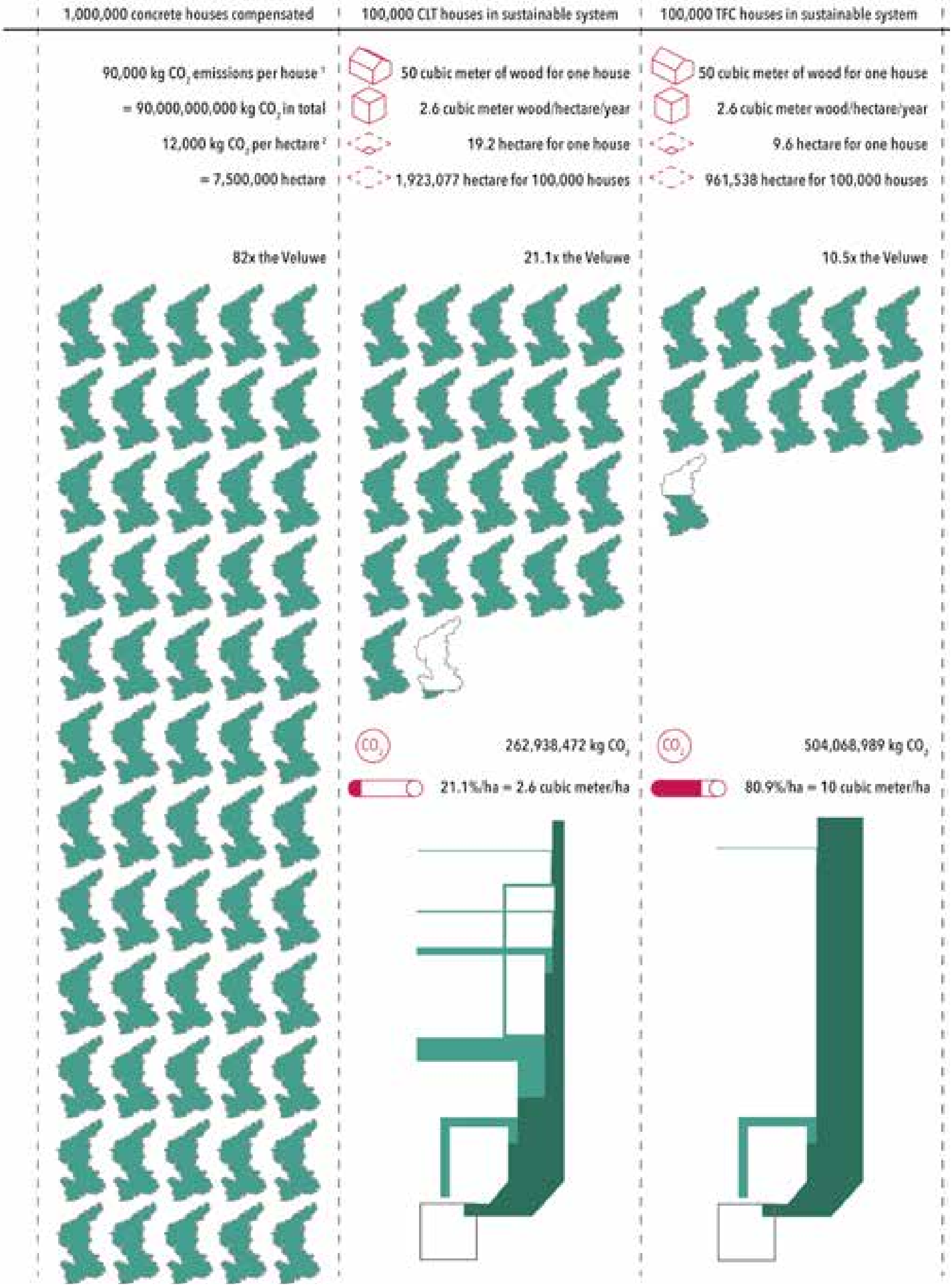
Residual flows of the production of timber.
Sources:
1. Probos (2014). Kerngegevens bos en hout in Nederland.
2. Encon. (n.d.). Berekening CO2 compensatie bomen.https://www.encon.be/nl-BE/berekening-co2-compensatie-bomen
3. Stichting bos en hout (1995). Door de bomen het bos zien.
4. Sylva Foundation (n.d.). OneOak facts and figures.https://sylva.org.uk/oneoak/tree_facts.php
5. Forestry England (n.d.). Timber and the uses of wood. https://www.forestryengland.uk/timber-uses-of-wood
6. Rostan (n.d.). Scheitholz fordert Nutzer. https://www.rostan.de/heizung/holz-und-pellets/
7. J. Wittens, personal communication, 2021, oktober 8
8. Osmani, M. (2011). Waste.
9. Probos (2013). Inzetten op hergebruik van sloophout.
10. Studio Marco Vermeulen (n.d.). Bouwen met bomen. https://marcovermeulen.eu/nl/projecten/bouwen+met+bomen/

Cross Laminated Timber

Timber Frame Construction



Advantages TFC and amount of houses from the same amount of wood.
Source: Platform Architecten (september 23, 2020). CLT weg ermee!? https://duurzame-architect.com/clt-weg-ermee/



Comparison of different types of forest mangement and construction types next to the amount of forest we need to compensate the carbon from 1,000,000 concrete houses.
1. Climate Cleanup (n.d.). Modle. https://climatecleanup.org/co2open/modle/
2. Encon. (n.d.). Berekening CO2 compensatie bomen. https://www.encon.be/nl-BE/berekening-co2-compensatie-bomen

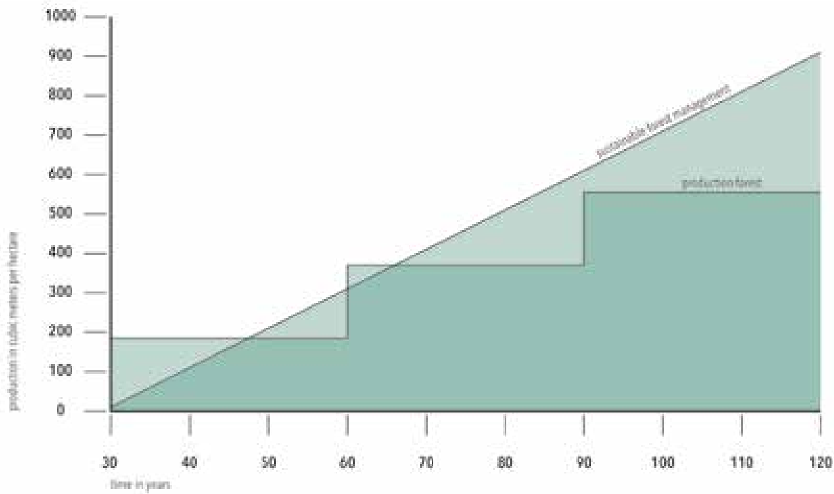

100,000 TFC houses in production forest
6,000 CLT houses in sustainable system
6,000 TFC houses in sustainable system
25 cubic meter of wood for one house
1.6 cubic meter wood/hectare/year
15.6 hectare for one house
1,560,000 hectare for 100,000 houses
25 cubic meter of wood for one house
2.6 cubic meter wood/hectare/year
19.2 hectare for one house
115,385 hectare for 6,000 houses
25 cubic meter of wood for one house
2.6 cubic meter wood/hectare/year
9.6 hectare for one house
57,692 hectare for 6,000 houses
17x the Veluwe
1.3x the Veluwe
0.6x the Veluwe
CO2
505,625,000 kg CO2
80.9%/ha = 6.2 cubic meter/ha
CO2
15,776,360 kg CO2
21.1%/ha = 2.6 cubic meter/ha
CO2
30,243,993 kg CO2
80.9%/ha = 10 cubic meter/ha

How much do we need?

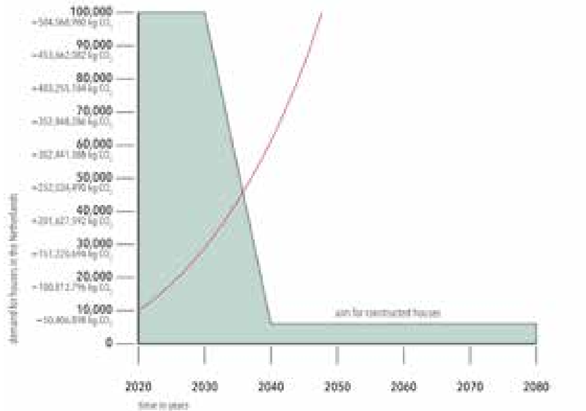
In the Netherlands we need to plant 2.6 times the Veluwe, but where does this number come from? First we take into account that we use TFC for construction instead of CLT. Due to the fact that constructions will be made out of TFC, there is less wood needed. In fact, if CLT is used for construction we need twice as much wood - and therefore forest - as we do with TFC. But we also store more carbon in timber frame constructions due to the more effective use of the wood.

Besides that we use sustainable forest management in the new planted forests. Due to this kind of management we can achieve a higher production over the years, the forest will never be cleared or show gaps and the biodiversity keeps contained. A sustainable maintained forest can provide 2.6 cubic meters per hectare per year, while a cleared forest can only provide 1.6 cubic meters per hectare per year. We will need to plant an amount of forest that can provide enough timber per year using this sustainable system.

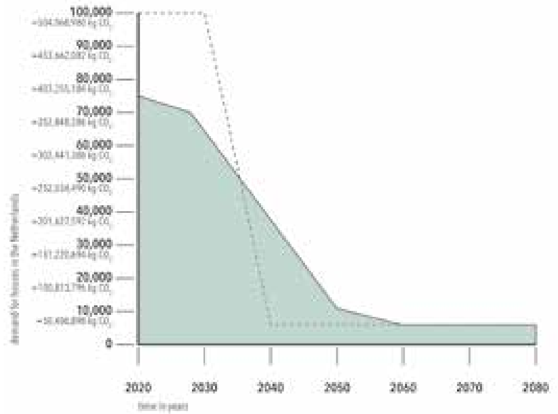
The final factor is time. The forest can be used after twenty to thirty years, so that means that we need to estimate the amount that is needed then. Estimations of the Centraal Bureau voor Statistieken (CBS) in the Netherlands calculate that we need about 6,000 houses on a yearly base [12]. These houses will roughly be needed in the Randstad and the bigger cities around it. By the time the forest is fully grown, a wave of renovations and refurbishments will arrive. Together with the building of neighbourhood facilities, which are not included in the housing numbers, we need 616,512 cubic meters per year, which comes down to 237,120 hectares or 2.6 times the Veluwe. On a yearly base we store over 128.5 million kg of carbon dioxide!



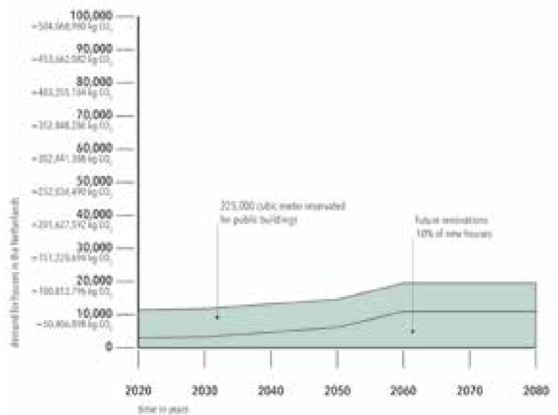
Comparison of the yield of sustainable forest management next to production forest.Source: Probos (2014). Kerngegevens bos en hout in Nederland.



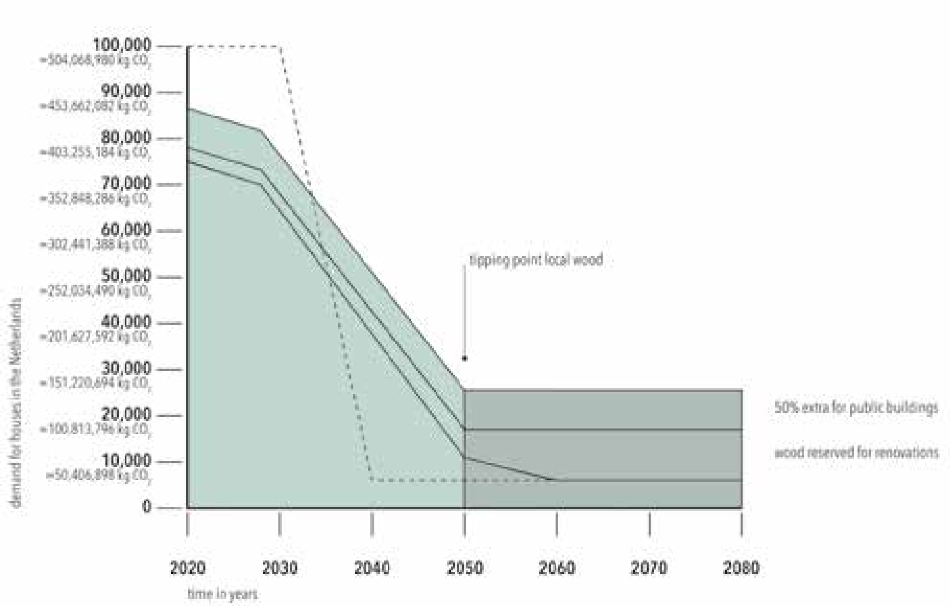
Source: Architectuur en Stedebouw (februari 17, 2021). Nieuw woonakkoord pleit voor 100.000 woningen per jaar.



Source: CBS (oktober 8, 2019). Prognose 2019-2050: woningbouwveronderstellingen.

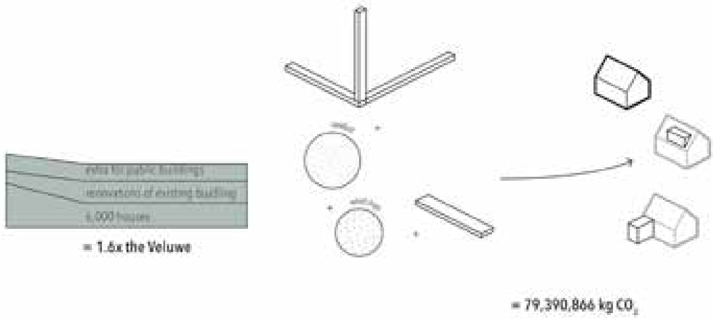


Wood for renovations and public buildings.

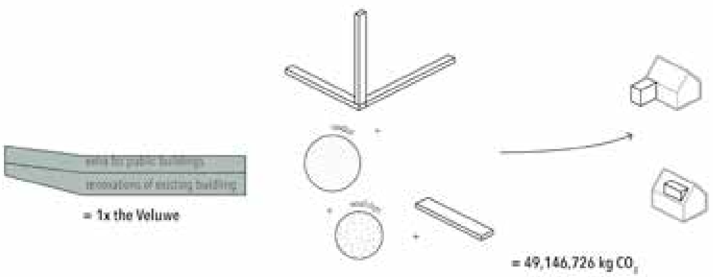


Combined housing and renovations.

Randstad



Rural landscape

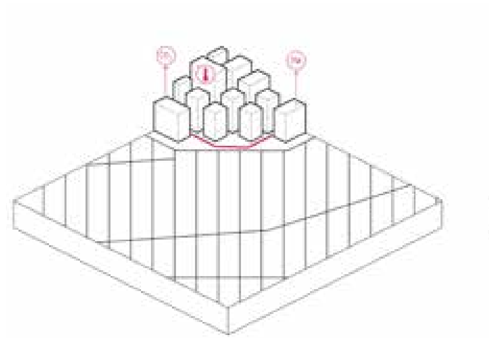


Amount of forest for the Randstad and the rural landscape, plus the amount of carbon stored in the timber from the production.

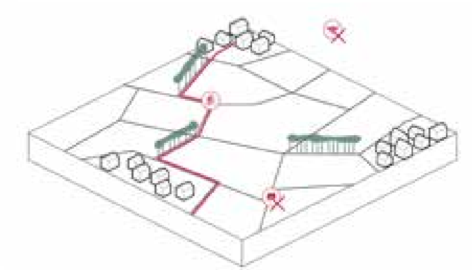
2.6 times the Veluwe on scale.

Randstad

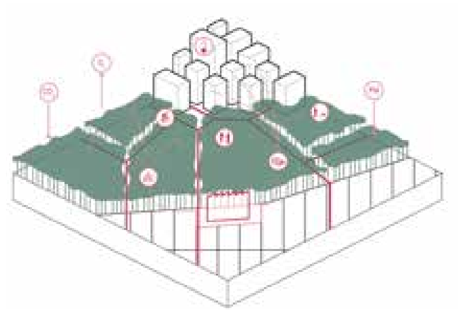
Sand landscape



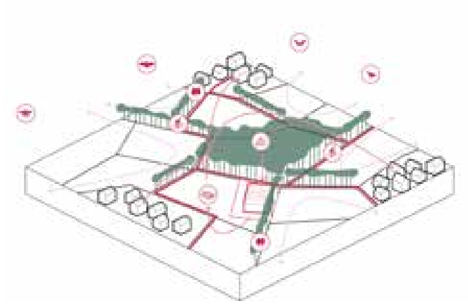
Now



Now



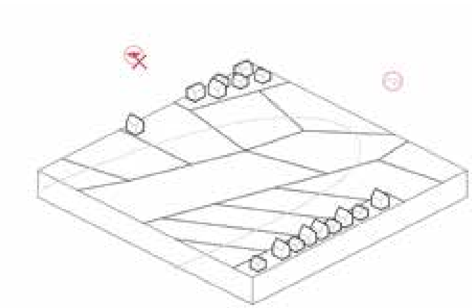
Future



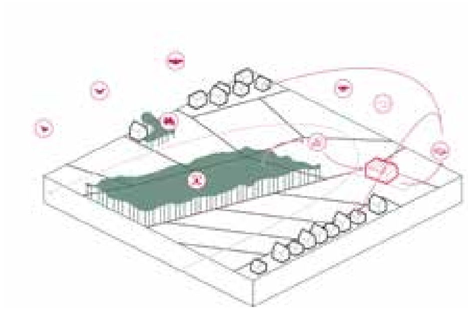
Future

Developments of the forests and green structures in different landscape types.

Clay landscape

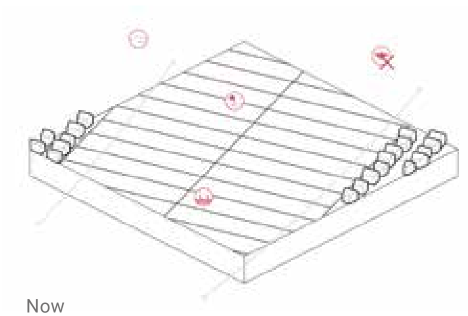


Now



Future

Peat landscape



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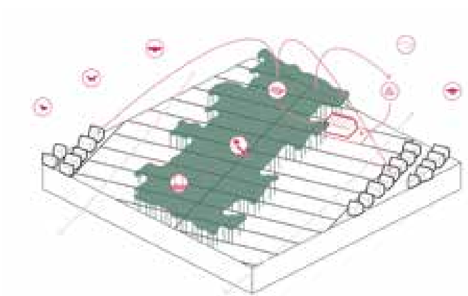

Future

Find space
But a new question arises, where to plant all these forests? Here we start with a separation between the Randstad and the rural landscape. In the rural landscape few new homes are needed, in fact, these regions are aging and in need of renovations and facilities. Therefore a total amount of one time the Veluwe is needed in these regions. The landscape could be organised in three major types: the sand, clay and peat landscapes, with each their own characteristics. With small forest interventions the landscapes could be preserved and strengthened, open landscapes remain open with clusters of forest and closed landscapes will regain green structures.

As said before the housing is mainly needed in the Randstad and neighbouring cities, but also renovations and facilities will be needed here. If we calculate the amount that is needed here we need 1.6 times the Veluwe in and around the Randstad. This is a great opportunity to create a large green structure throughout the Randstad. This is not only the place with the most residents, it is also the most polluted area. With planting a lot of forest in and around the area the air gets purified and healthy places will be created outside the cities. Actually a large park arises that binds together the different cities in the Randstad, green corridors will connect the cities. Within the forest there is place for sports and activities. In thirty years a forest has grown where timber is growing, where carbon is stored, where the air is purified and where residents could relax and enjoy.

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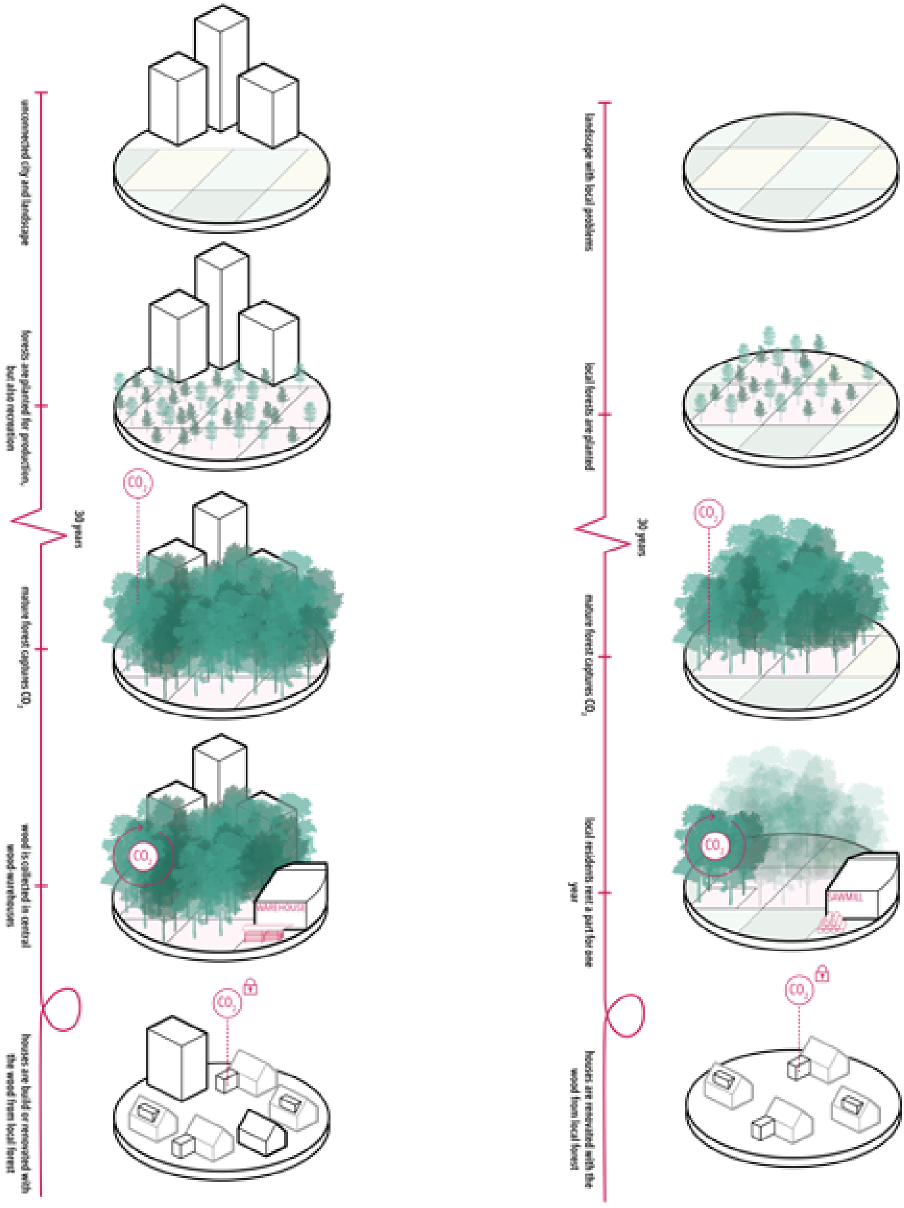
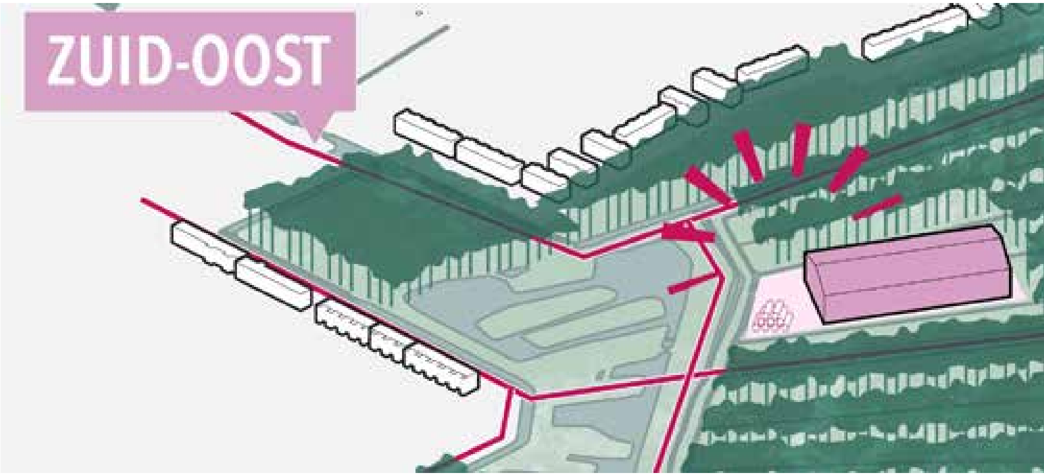
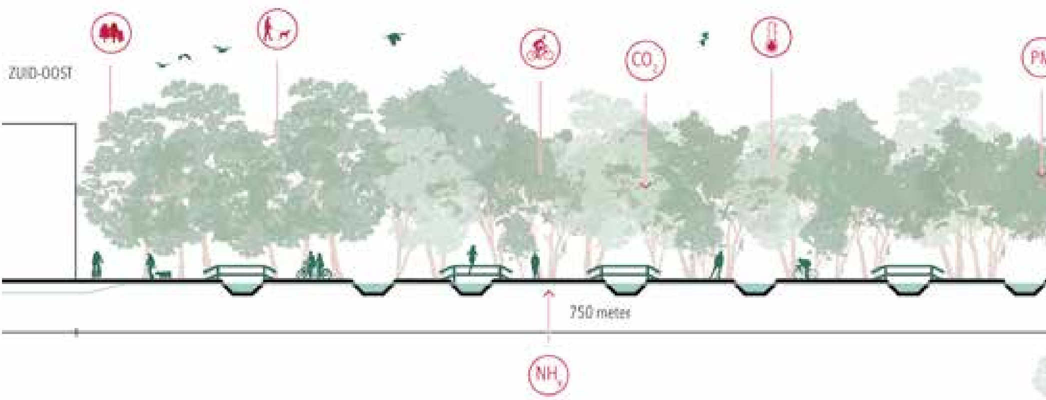


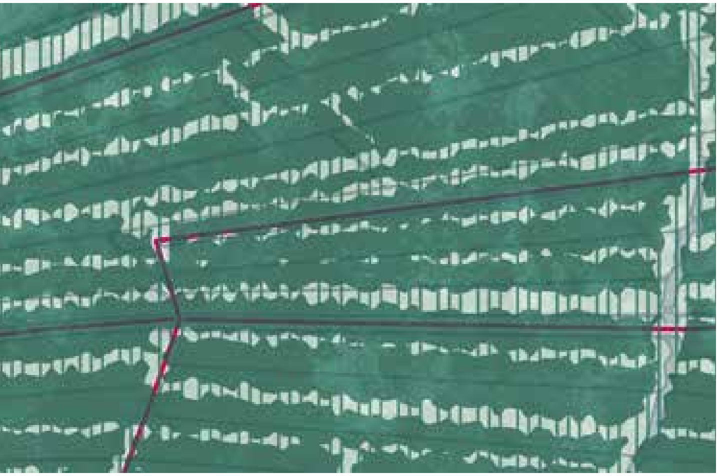
Development of the city forest and rural forest with the distributing buildings over time.

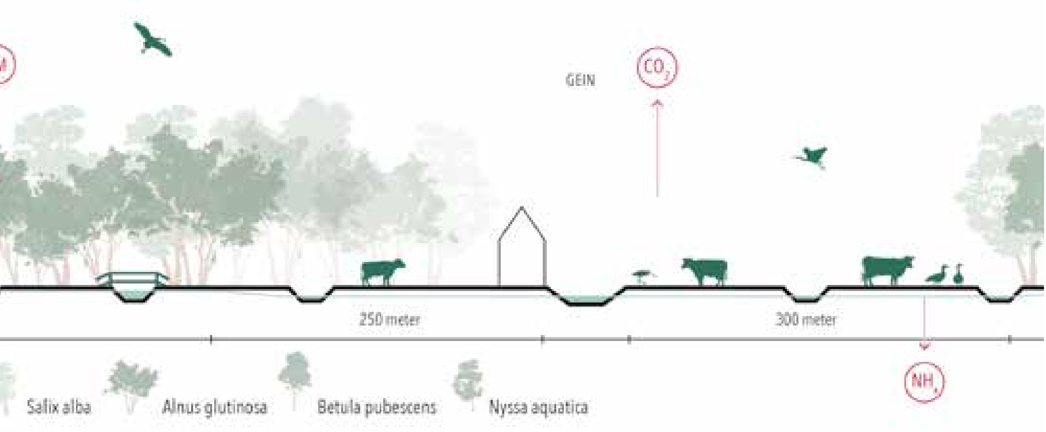
Randstad



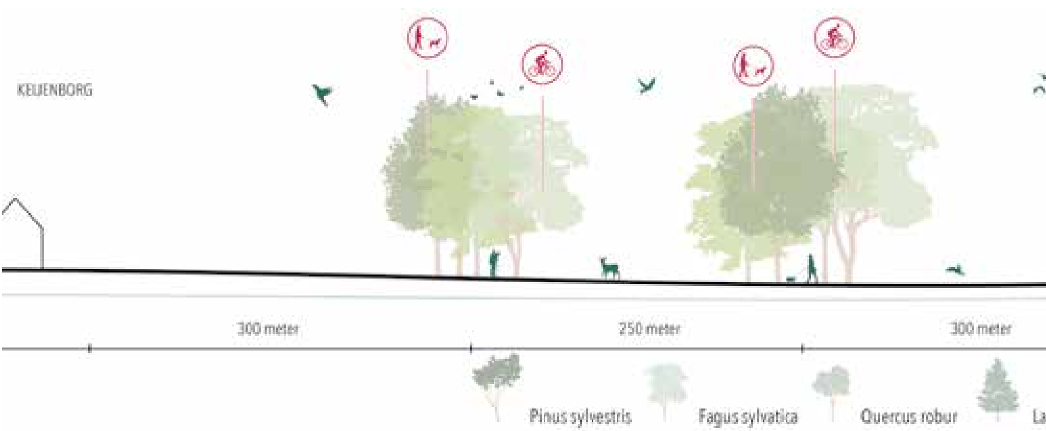


Forest landing in the outskirts of the citiy.

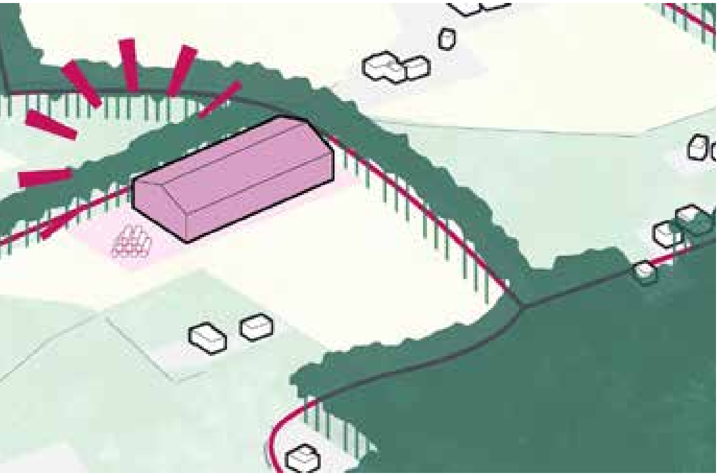


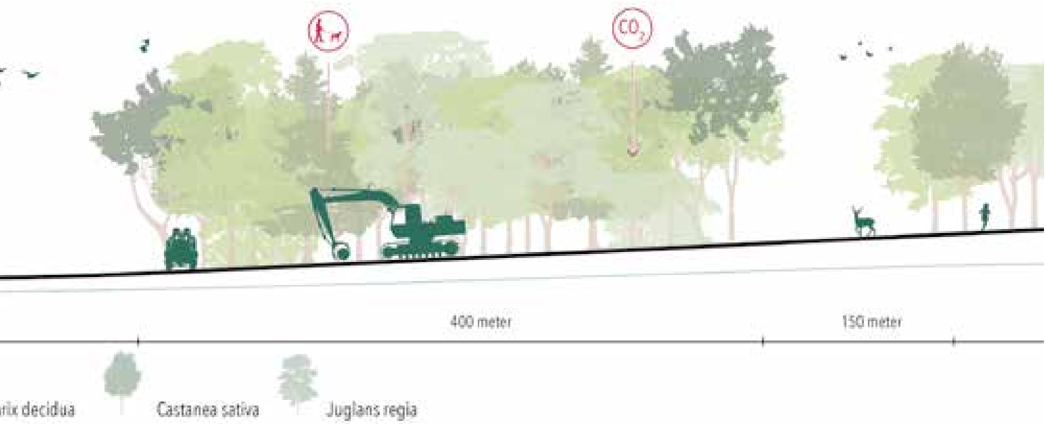

GEIN
CO_2
250 meter
300 meter
NH
Salix alba
Alnus glutinosa
Betula pubescens
Nyssa aquatica

Sand landscape

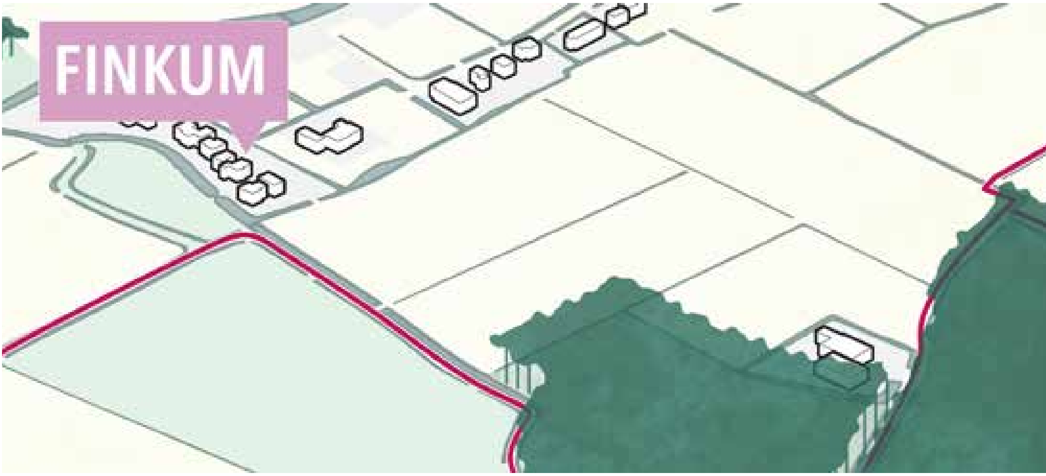


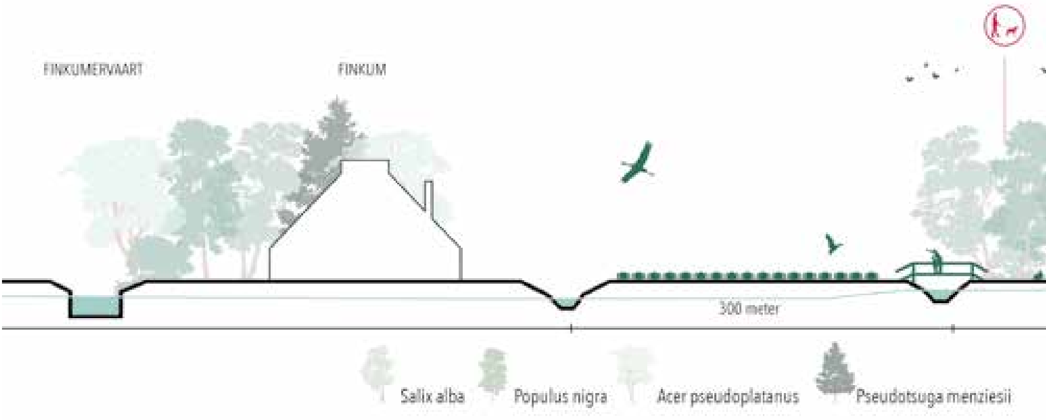
Green structures and forest in the sand landscape - re-connecting the existing structures.



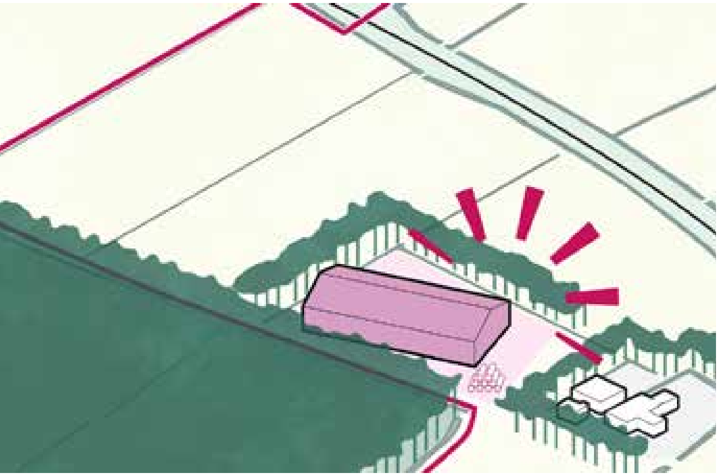

CO_2
400 meter
150 meter
rix decidua
Castanea sativa
Juglans regia

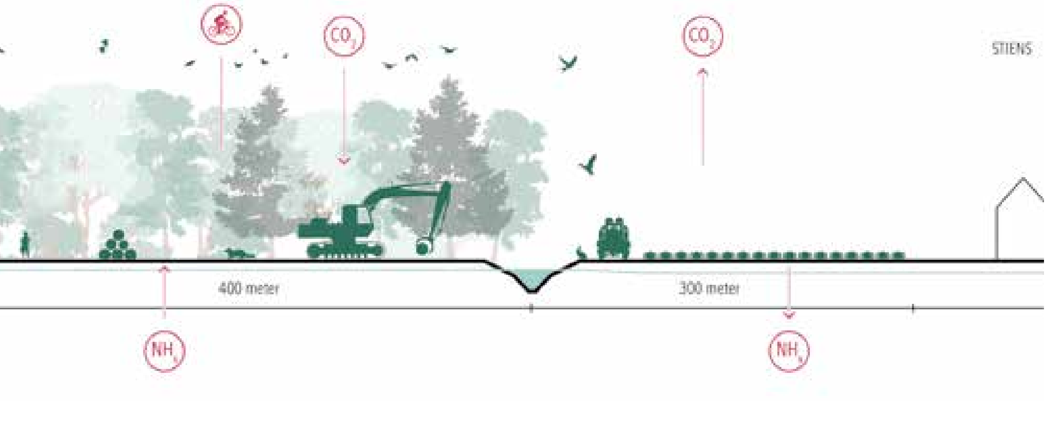
Clay landscape



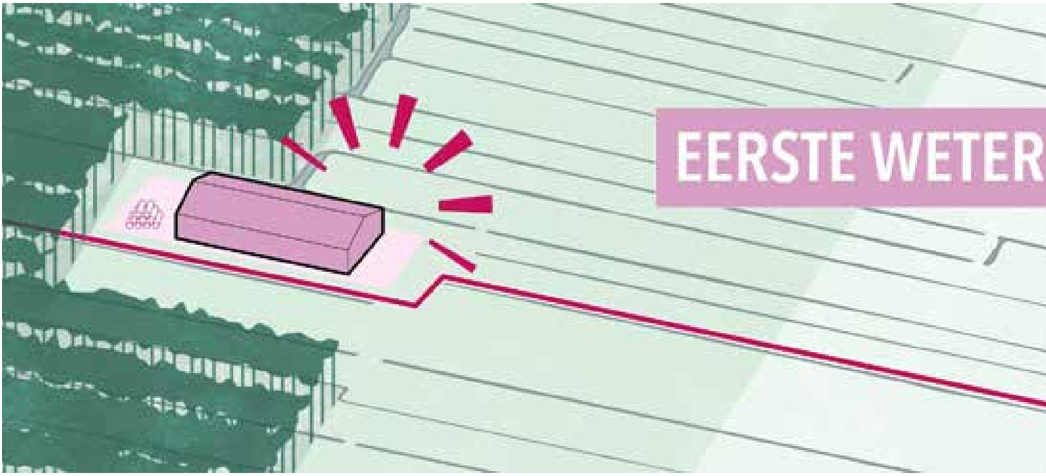


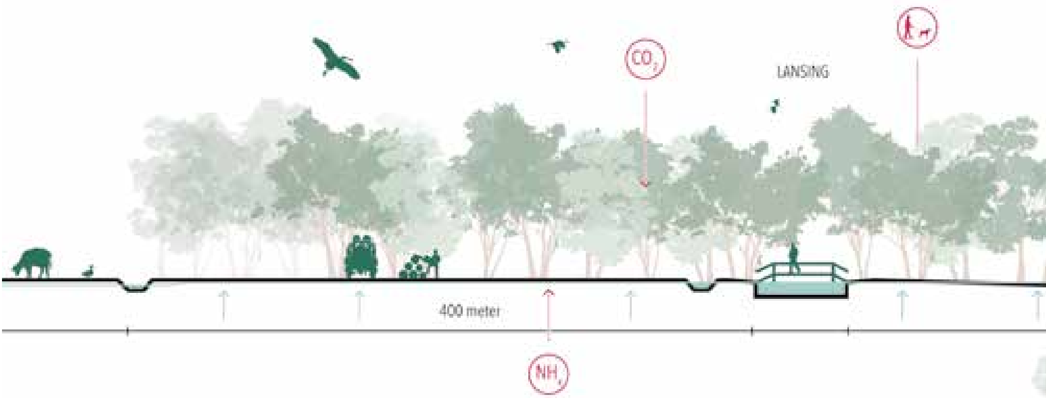
Forest clusters keep the landscape open. Other structures cover sheds and buildings.



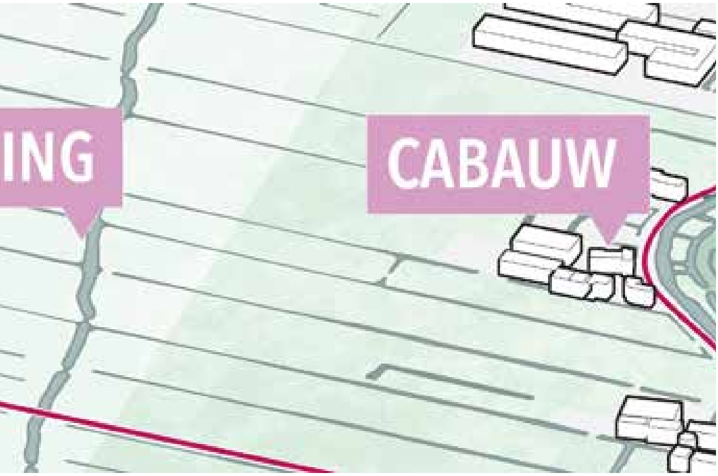

CO2
CO2
STIENS
400 meter
300 meter
NH3
NH3

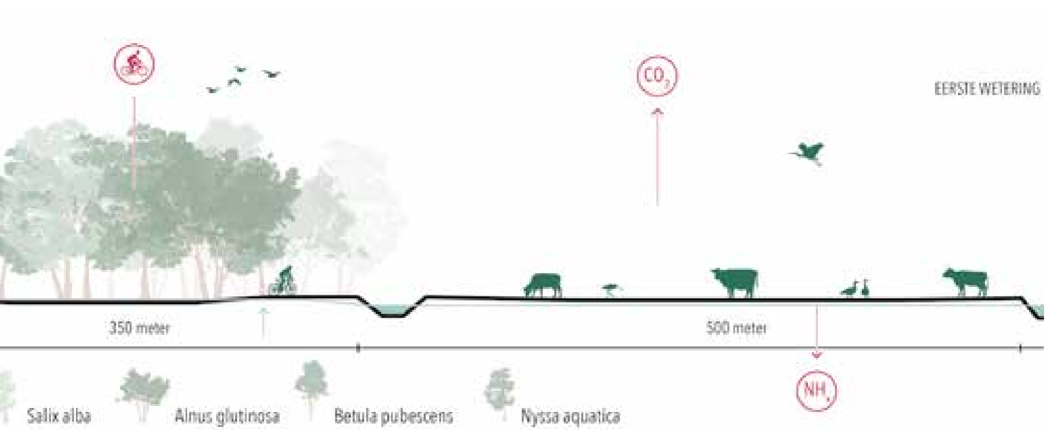
Peat landscape





Open peat landscapes are preserved. Forests are located at the back of the typical long and narrow plots.


ING
CABAUW


EERSTE WETERING
350 meter
500 meter
Salix alba
Alnus glutinosa
Betula pubescens
Nyssa aquatica

Forest in and around the Randstad. A place for activities and providing a healthy environment for the residents.

Project

Global wood flows
A closer look on the footprint of a local production network

Miriam Krüssel
Architecture

Wood is often considered as a ‚holy' construction material, as the future of the building and architecture industry - as it is way more sustainable than steel and concrete. But looking closer at the production chain of wood and timber, it seems, that the beneficial characteristics are very relative. Especially the main reason to use more wood - to absorb CO2 in forests and to store carbon in wooden buildings - are overshadowed by the emission of CO2 during the chain of forestry, transportation and production. Long distances between the harvesting of trees, the production of timber and building sites are quite normal. An example is the common shipping route of wood logs harvested in Europe, transported to China and then shipped back to Europe again to be sold as building material.

Like architect and researcher Daniel Ibanez states, the long distances strongly disturbs the relationship between the final product and its users. The process behind a consumed material - from tree to timber - happens upscaled and up regulated - far away and fast consumed. The material wood looses its sustainability due to the long and partly unreasonable transportation routes by truck, train and ship. These are heavily influenced by trade and the associated money flows. With the aim of the Parisian climate agreement this wood flows should be influenced by an ecological position instead of economy and politics. In contrast to road and rail transport, which are visible in our everyday life, the maritime shipping - responsible for a large part of the global wood flows - often takes place out of sight on the sea. Nevertheless, in comparison to road and rail transportation, shipping causes way less CO2 emission. The use of local resources and the abandonment of long transportation routes, especially long distance maritime shipping is a commonly spread answer to lower the CO2 emission. This might work for smaller scaled projects, but it becomes difficult to cover the huge global demand of hardwood of high quality. The consequences of a restricted transport could be an isolation of single countries, as well as an excess or a shortage of wood. As a restriction of transportation would therefore cause a lot of new problems, the solution concentrates on an improvement of the existing transportation methods. The aim is to shorten the unreasonable flows from forest to society by using the most sustainable transportation method - maritime shipping.

Zooming in on the European wood flows, some fascinating discoveries can be made. The export and import of wood products have started to overlap. Europe has a high forest density, especially in the less dense populated areas in northern and middle Europe. At the moment, trade within Europe happens mainly via truck. A dense road network has been created for this. To create an equally dense network for maritime shipping, it is combined with the continental river network. The biggest harbors of Europe take part as distributors, as there are always located in dense populated areas - and therefore close to future building sites. They are responsible for reloading the industrial roundwood from big bulk vessels on to smaller barges. The continental speculation shows, that a distance of 250 km from coastline and river network, supplies the whole continent with wood products, while a network of 150 km distance only leaves small gaps. Throughout the continent a network of production sites - wood harbors - are created close to the rivers. This way, the road transport is reduced to a minimum, as it is only needed for the final transportation step, from production site to building site.

The Netherlands is a country that isn‘t able to supply itself with the necessary amount of wood. Especially with the aim of building one million houses in the upcoming years, a lot of additional building material is needed. As the Netherlands is located in a delta, with a long coastline, big rivers and one of the biggest ports in Europe, there is already a high-volume maritime transport network existing. The regional speculation makes clear that even a 50 km distance would be enough to supply nearly every area with wood. This distance can easily be covered by electric trucks, which deliver the pre-produced wood directly to the building site within 45 to 60 minutes of driving. To create this dense network, six production areas are needed throughout the Netherlands. The biggest one is located in the harbor of Rotterdam, as the global wood import arrives here. It is the main distributor of wood logs to the other locations as it supplies Nijmegen, Zwolle, Alkmaar and Harlingen. An exception in the supply chain is Groningen, which is supplied by the Ems-Canal. Groningen also shows how important it is, to expand the network European wide, to ensure a functional network which is defined by short distances and sustainability. The production site in Rotterdam is defined by a special position in the wood production network, as it is responsible as a distributor for the other production locations in the Netherlands. Estimated 12 million tons of wood are for the production site itself, while 37,4 million tons are reloaded and transported to the other sites.

Zwolle and Groningen both offer small harbors in their industrial areas close to the city center. In Groningen an existing building material and timber trade is expanded to a production site that is able to supply the city of Groningen and the surrounding network with wood products, to full fill the aim of 65.000 new wooden houses. To reach Zwolle’s ambitious demands of building 80.000 new houses for the city alone, existing industry at the harbor is changed into a sustainable wood production with an area of 140.000 square meter While this production sites are located close to the city, their functional integration into existing industrial areas won’t necessary bring them closer to the society.

The production site in Nijmegen therefore creates a contrast, as it is located on the most present location of the city - the island next to the Waal. The aim is to make it a visible part of the city. The different water levels on the islands are also a reference to the climate change and rising water levels, as it changes the surroundings of the site everyday. Independent from the production chain an education center is located, facing the city, to bring society and production closer together by inviting the people to events, school trips and more. Due to the rising water it is part of the island most of the time, but during the maximum water level it appears to float in the river.

The visitor can watch the production site from three different points of view: first from the city itself, where he can get a first impression of the busy machines and the unloading of ships - second from the bridge, where he gets an overview of the whole production chain happening in one place - and lastly from the site itself, where he can get a closer look on the individual processes and also go inside the sawmill buildings.

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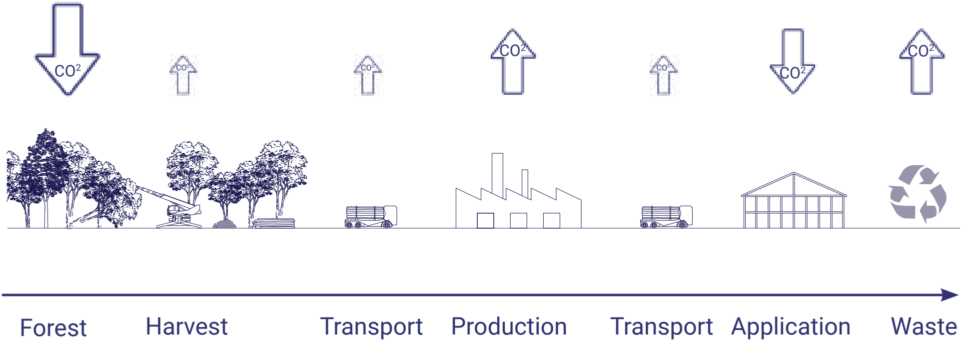
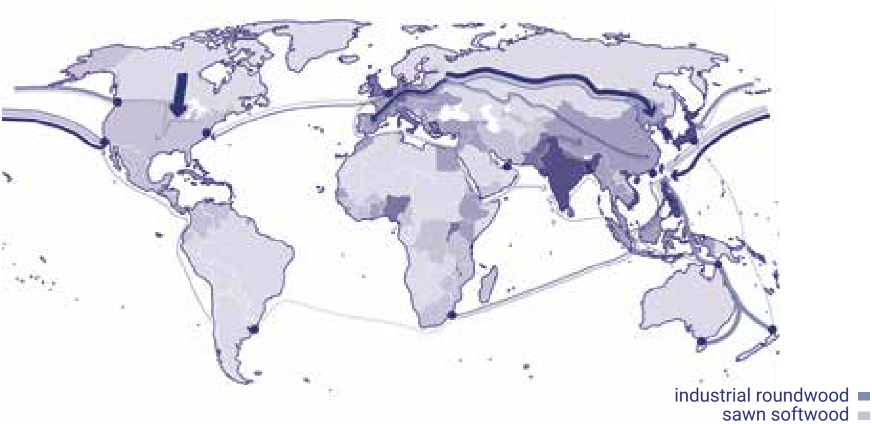
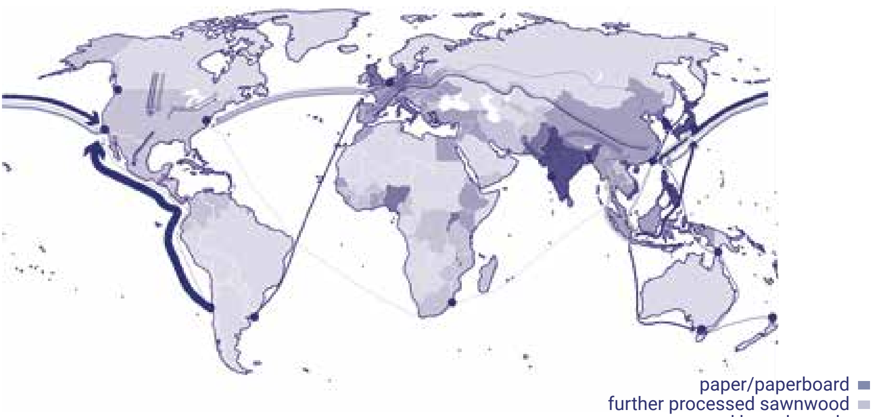


Production chain

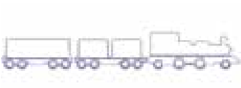




Flows of roundwood and sawnwood
UNECE/FAO Forest Products Annual Market Review, 2020-2021

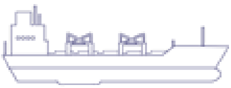
truck
80 g of CO2 per tkm
industrial roundwood and
further processed products

autonomous electric
logging trucks
loads 16 t of wood
testing phase since
2018, Sweden



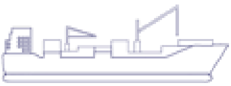
train
81 g of CO2 per tkm
industrial roundwood and
further processed products

not used as much
not enough capacity
rail transport is only
responsible for 0.4% of
CO2 emission



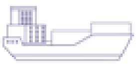
bulk vessel
2.5 g of CO2 per tkm
industrial roundwood
max. 400.000 DWT

2007 practice of lowe-
ring speed - to reduce
the CO2 emission
reason: fuel prices and
financial crisis

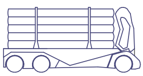


container vessel
12.5 g of CO2 per tkm
further processed products
around 20.000 TEU

today: with a
combination of wind
energy and fuel
Maersk Pelican ships:
combination of wind
energy and fuel - redu-
cing the Co2 emission
up to 8.2%



short sea vessel
15,8 g of CO2 per tkm
short distances near coasts
min. 24.000 DWT



electric trucks
industrial roundwood and
further processed products

autonomous
electric trucks
loading up to 40 t of
wood

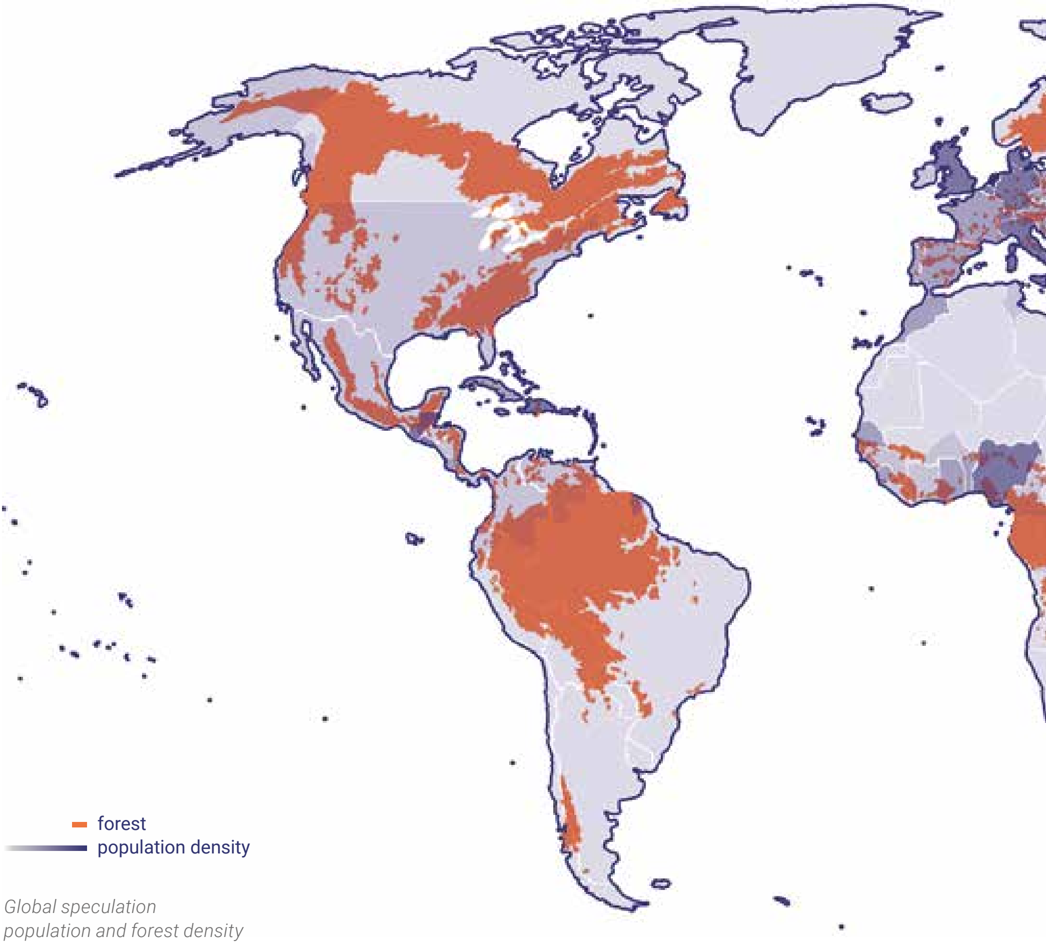
ships with windenergy
80 g of CO2 per tkm
industrial roundwood and
further processed products

Oceanbird: reduces
the CO2 emission up
to 90% - rotor sails
decreases the space

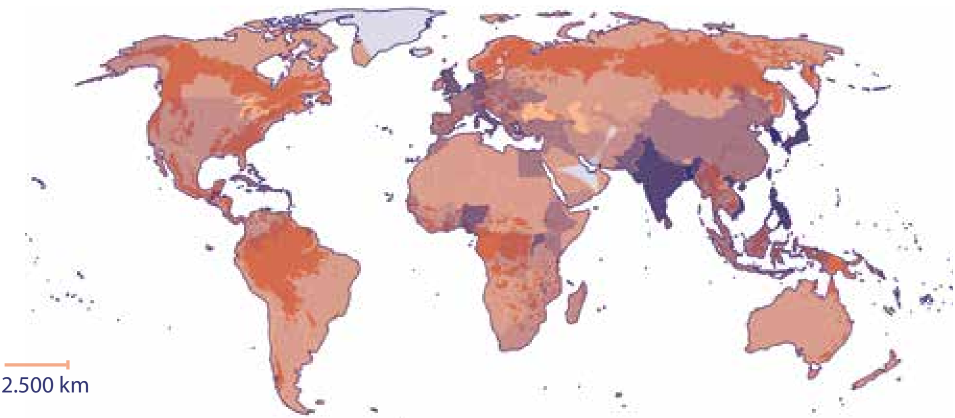
Transportation methods and sustainable developments

Disconnected relationship forest, production and user

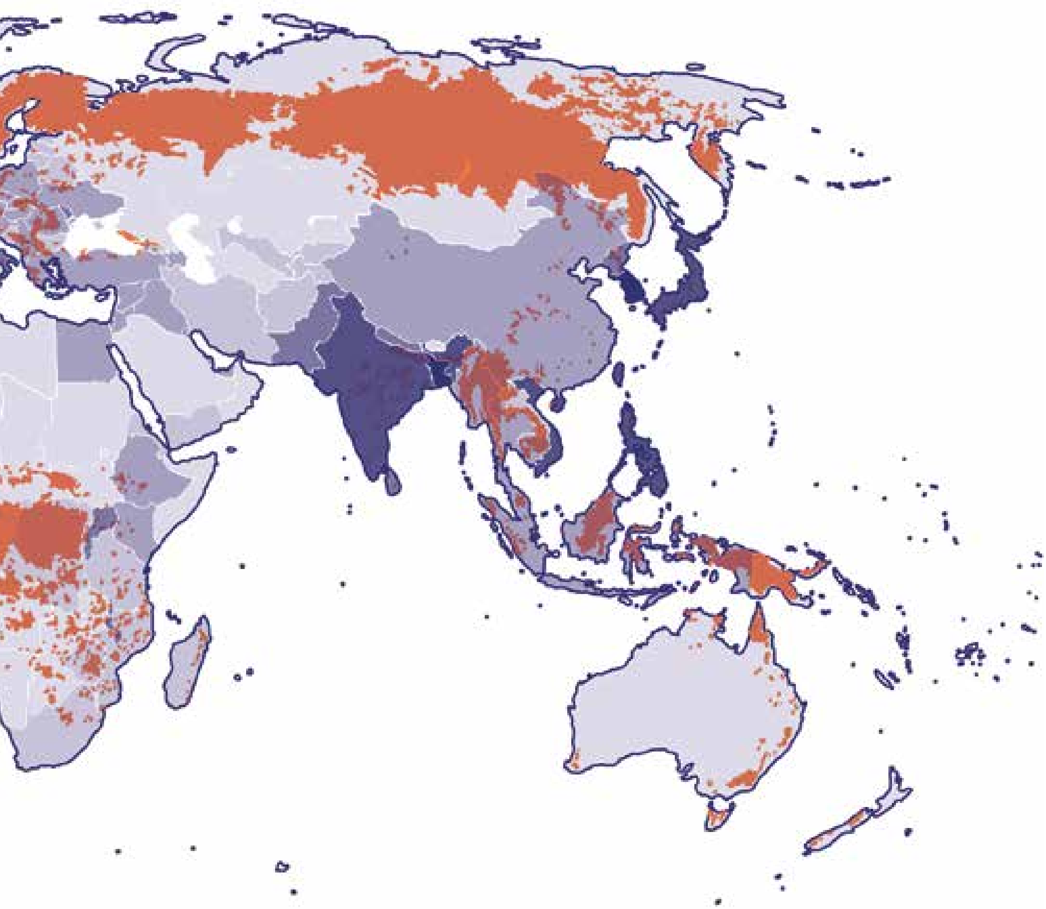
World

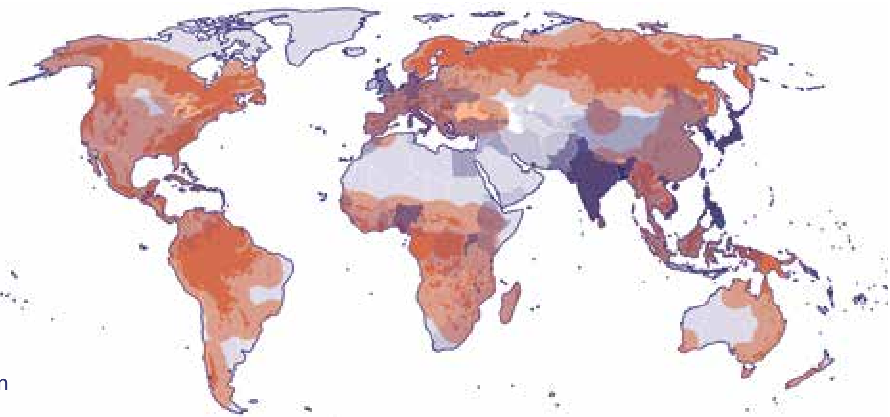


Global speculation
population and forest density



Global speculation
short distances - 2.500 km

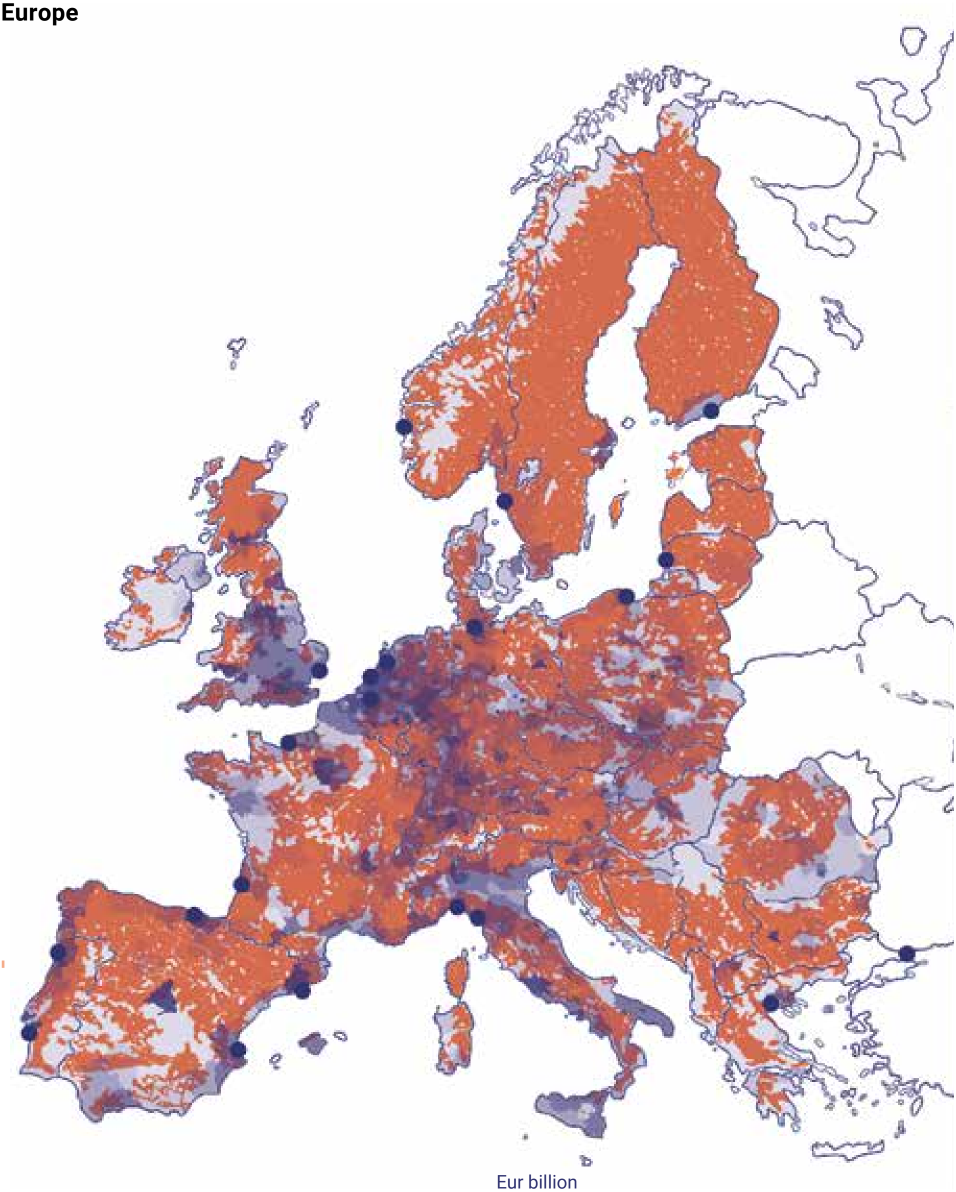




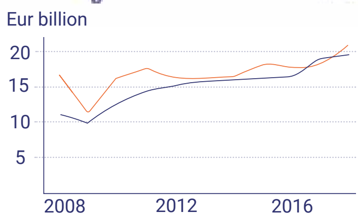
500 km

Global speculation
short distances - 500 km

Europe



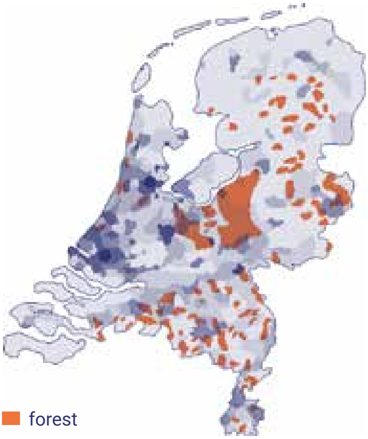
Continental
europes forests, population and demand

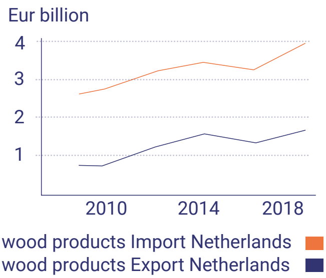


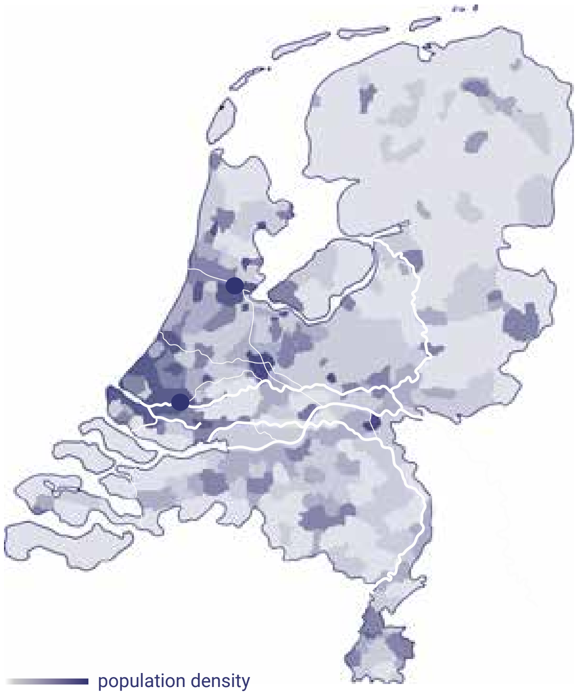
Continental speculation
250 km distance from the rivers and coastline

Continental speculation
150 km distance from the rivers and coastline

The Netherlands







Regional
Netherlands forests, population and demand

Regional speculation
50 km distance from the rivers and coastline

Regional speculation
250 km distance from the rivers and coastline

Harlingen
30.000 houses
1.200.000 t wood - 67.000 t yearly
area ca. 35.000 - 40.000 m^2

Groningen
65.000 houses
2.600.000 t wood - 145.000 t yearly
area ca. 80.000 m^2
barges up to 6000 t - 434 ships

Alkmaar
280.000 houses
11.200.000 t wood - 623.000 t yearly
area ca. 230.000 m^2
barges up to 6000 t - 1.867 ships

Zwolle
155.000 houses
6.200.000 t wood - 345.000 t yearly
area ca. 140.000 m^2
barges up to 6000 t - 1.034 ships

Rotterdam
300.000 houses
12.000.000 t wood - 667.000 t yearly
area ca. 230.000-240.000 m^2
80.000 t Panamax bulk vessel - 150 ships

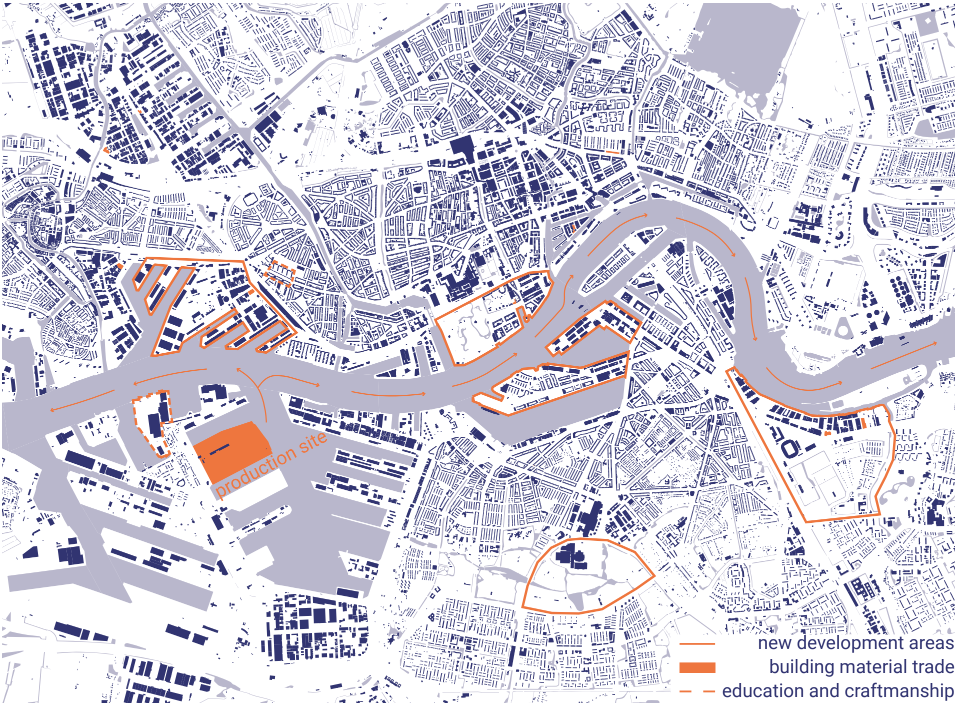
Nijmegen
170.000
6.800.000 t wood - 378.000 t yearly
area ca. 150.000 m^2
barges up to 6000 t - 1.134 ships

Regional
production network and demand

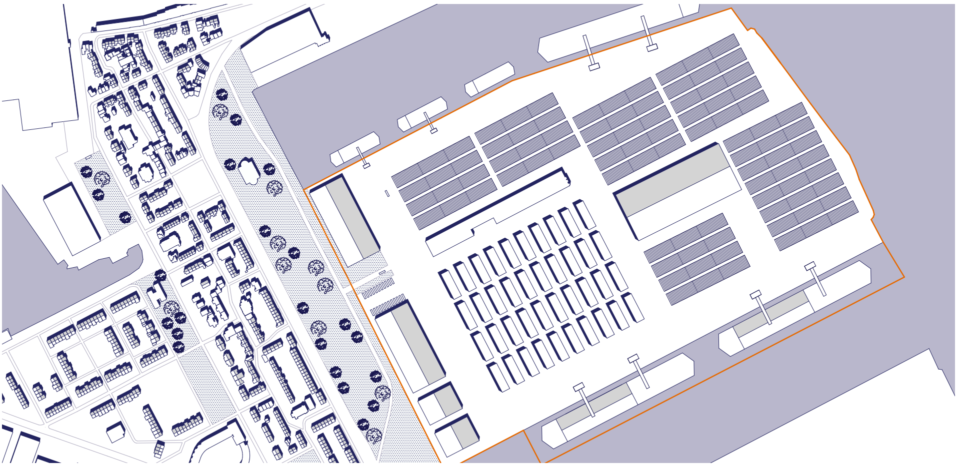
Regional speculation
production network 45 minutes driving distance

Regional speculation
production network 60 minutes driving distance

Rotterdam



City network and development



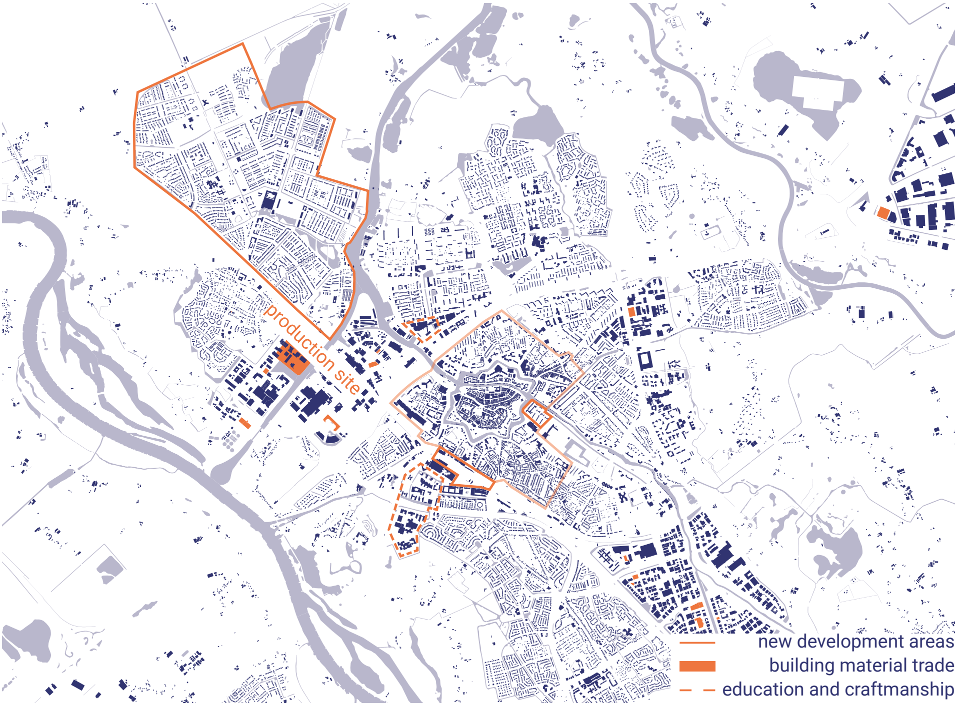
global wood deliveries → Rotterdam

12.000.000 t → production site Rotterdam → floating pre-production

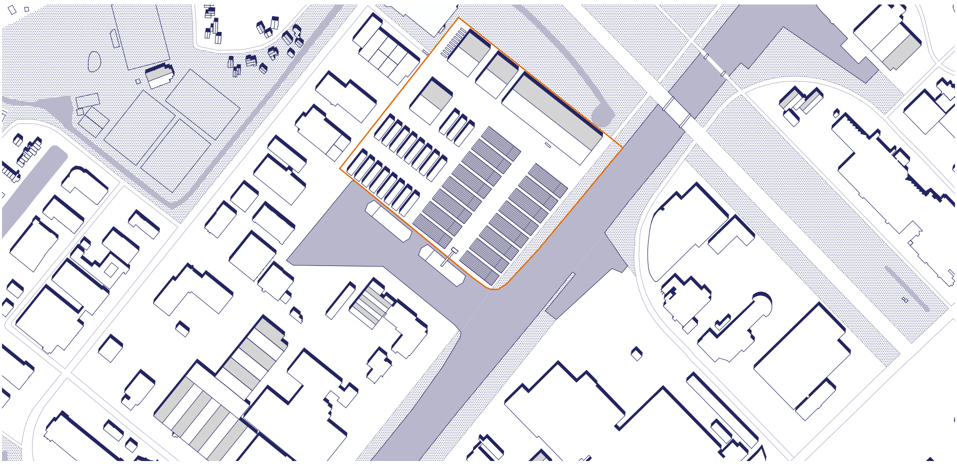
37.400.000 t → distributing to the network → production sites

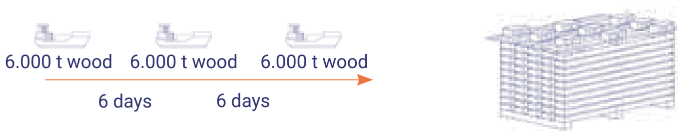
Production site

Zwolle



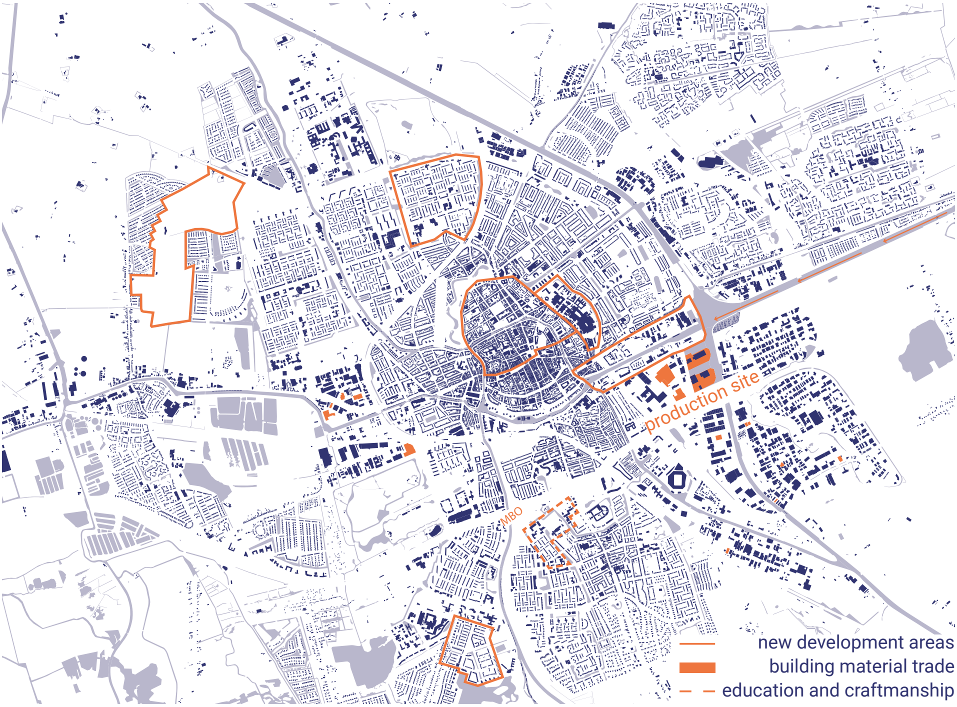
City network and development



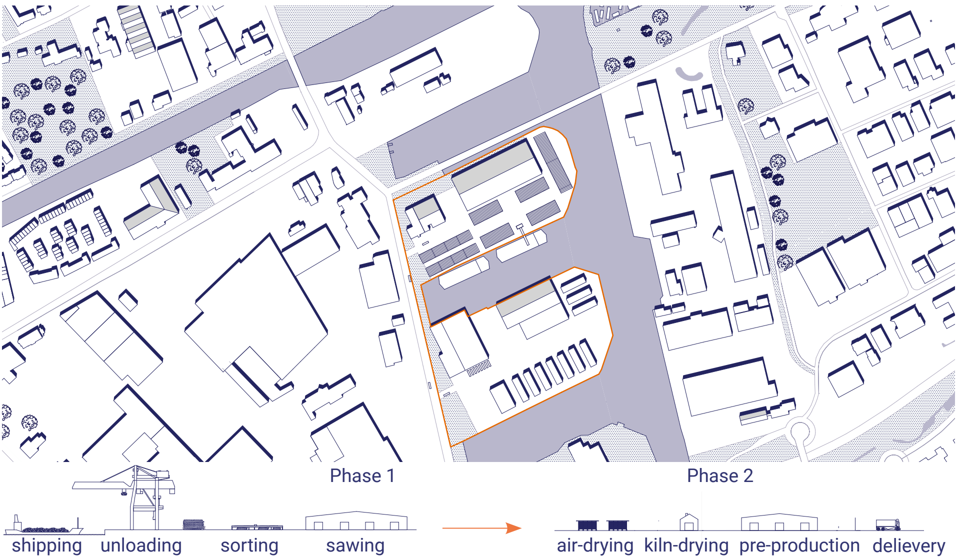


Production site

Groningen

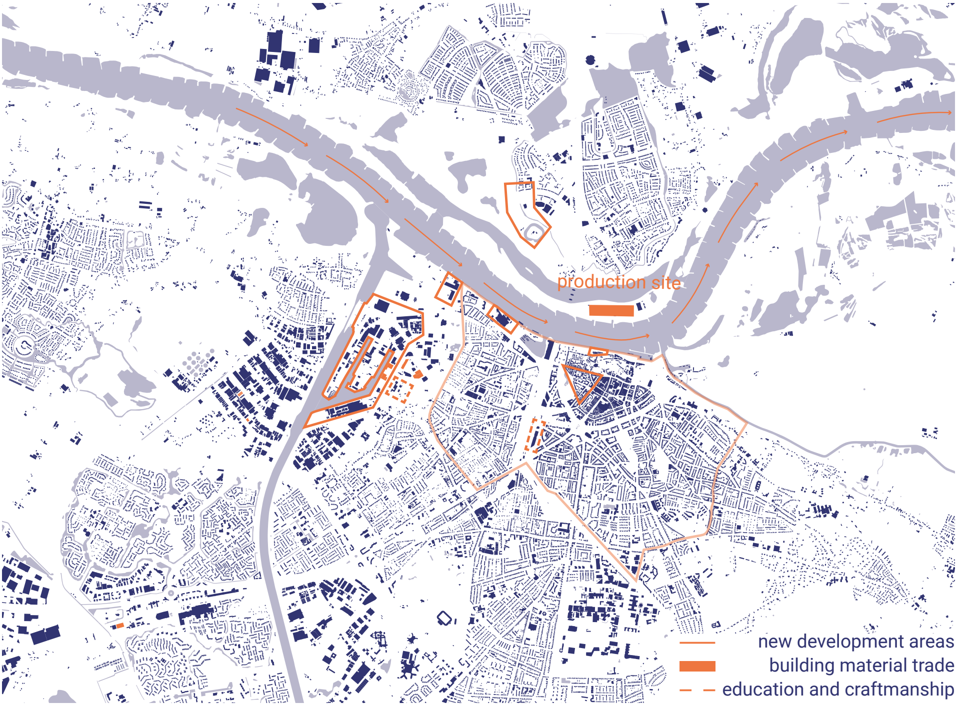


City network and development

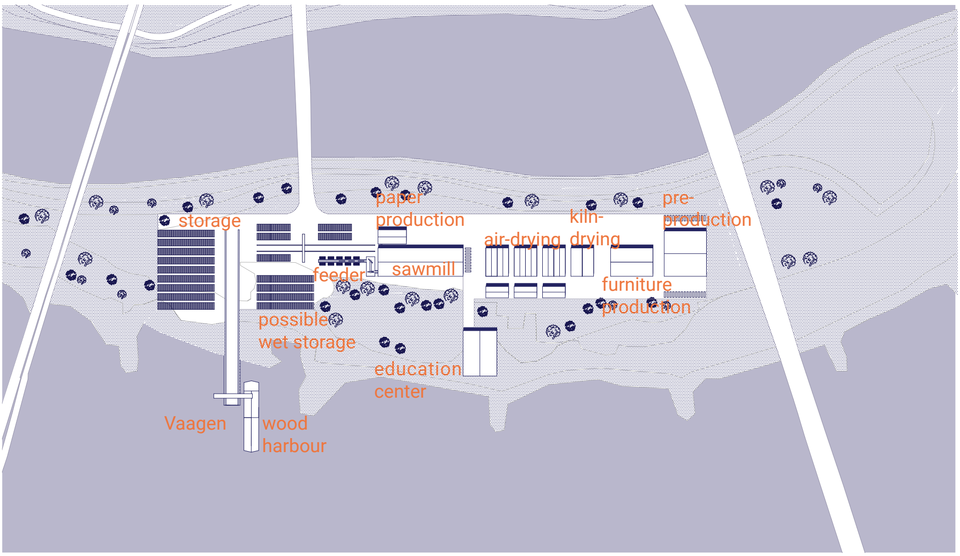


Production site

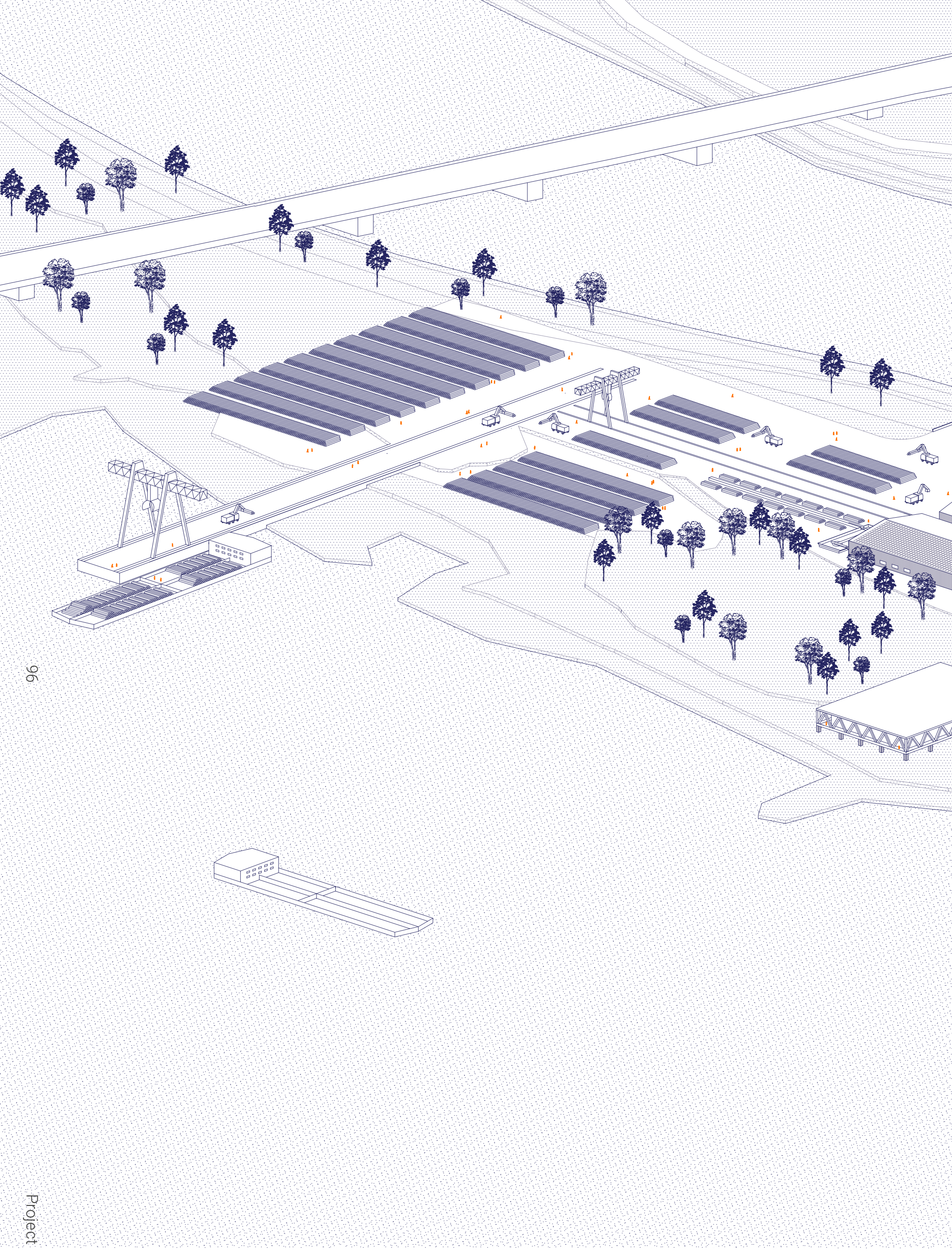
Nijmegen



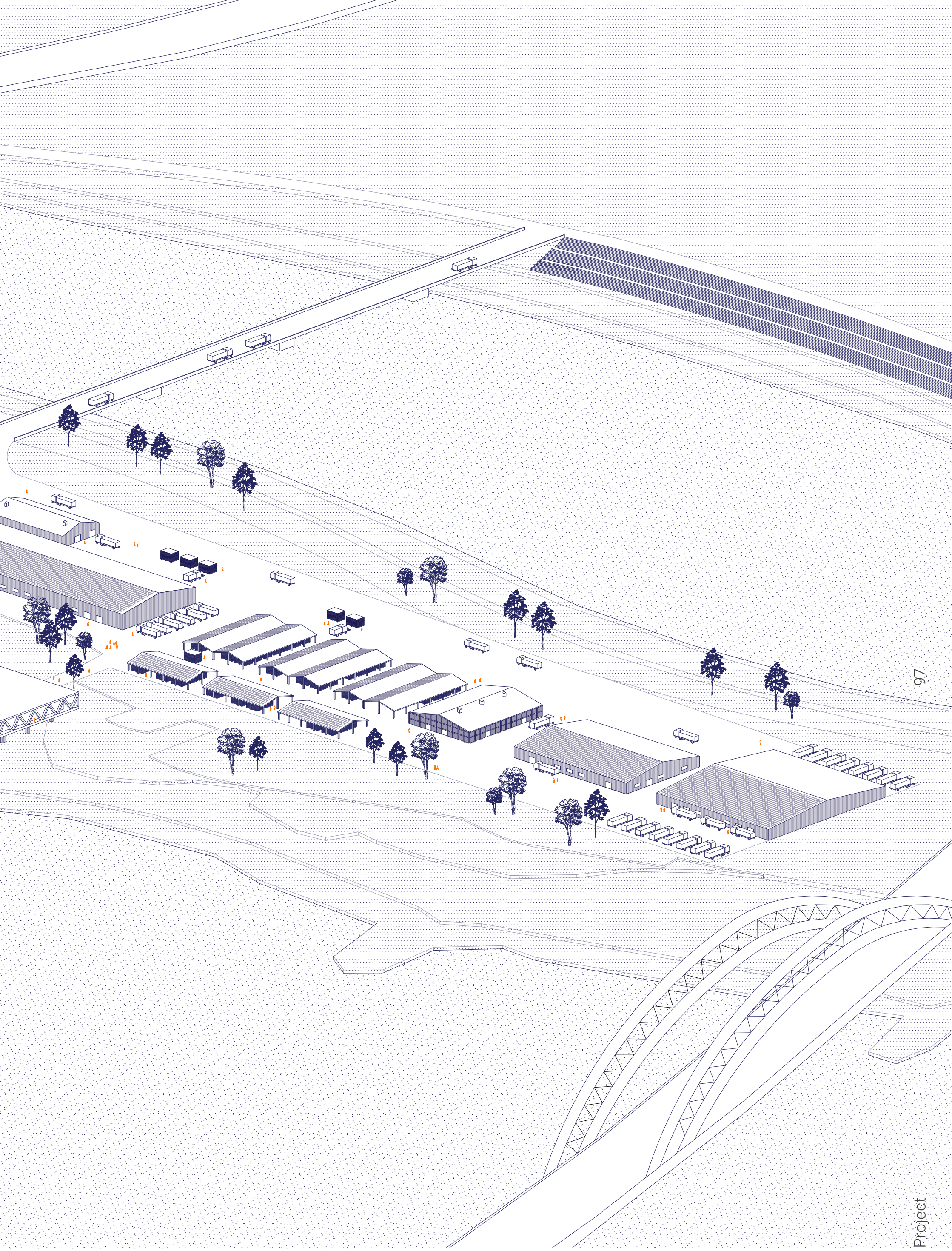
City network and development



Wood harbour



Wood harbour Nijmegen



Tower of Wood

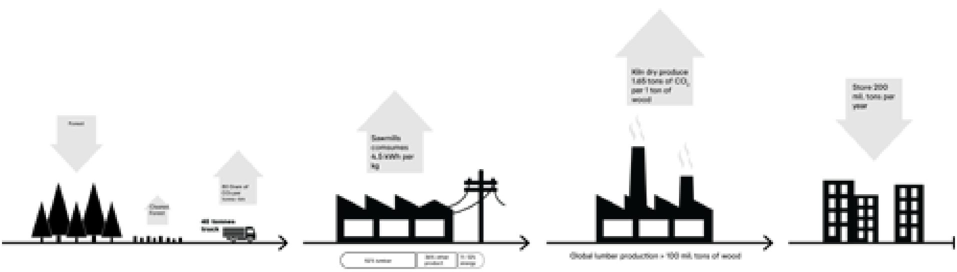
Rearranging the chain of wood production

Azat Dzhunushev
Architecture

I. Researching the chain

The beginning of my research started with understanding how wood manufacturing works. Before wood and timber appear as usable and sustainable building materials they goes through a long and interesting journey of production and logistics – from forest to our houses.

As we all know forest is a beautiful place with a lot of biodiversity, but from a functional point of view it is a biomass that annually stores 283 gigaton of CO2. The moment lumber industries start the whole process, the same forest acts as a source of carbon emission. After harvesting big amount of logs stay behind, they rot and lead to CO2-emission. In young forests another problem occurs: they need time to grow and do not compensate these emissions on early stages. Besides this, rapid harvesting would harm the soil and would decrease the effectiveness of replanting and increase degradation of land. After wood is harvested it goes to a lumber yard where it will be prepared to be shipped for manufacturing. In order to store roundwood it normally requires an area around 5000 square meters, it is 3/4 area of a football field. Then it is being loaded up to 40 tons per truck and travels a long distance to be manufactured. When the wood arrives to saw millings it is being selected for products such as lumber, raw materials (paper, boards etc.) and energy fuel (waste). Next step in processing timber is Kiln drying, which releases great amount of CO2 into the atmosphere. Globally lumber production number estimates more than 100 millions of tons of wood annually.



Existing wood chain

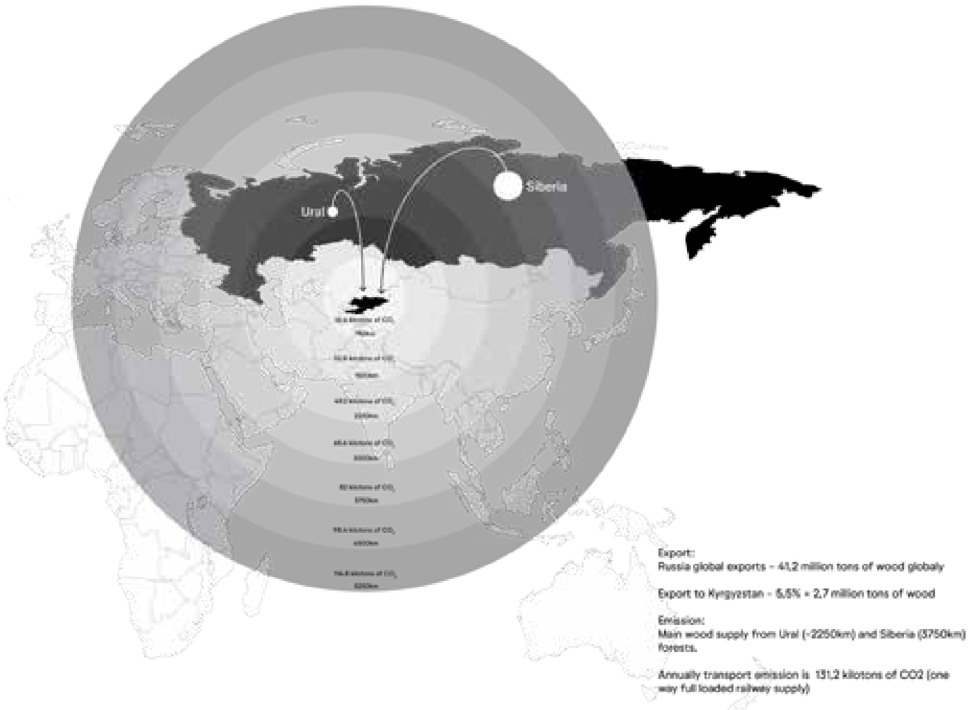


Diagram of wood import from Russia to Kyrgyzstan

II. Changing the chain

As shown the process of manufacturing wood into timber is not as sustainable as we thought. To improve these two radical interventions may be necessary. First, what if we explore the use of raw wood logs as a construction material – so polluting and CO2 emitting steps like treatment and sawing can be skipped. In the past it was quite common to use roundwood in constructions, such as bridges. Only due to its inefficiency, it was replaced by steel although wood shows a great potential in construction world. Second, what if we use a local forest – where the wood comes from – as the building site as well?

Nowadays Kyrgyzstan as a country does not produce its own wood due to the lack of local forests. All of the wood for construction material is imported from Russia. Annually 2,7 million tons of processed wood comes by trains – it travels in average 3000 km and it emits a huge amount (65,6 kilotons) of carbon. In order to stop this Kyrgyzstan should start to grow their own forests, to provide its cities with timber and to capture and store carbon.

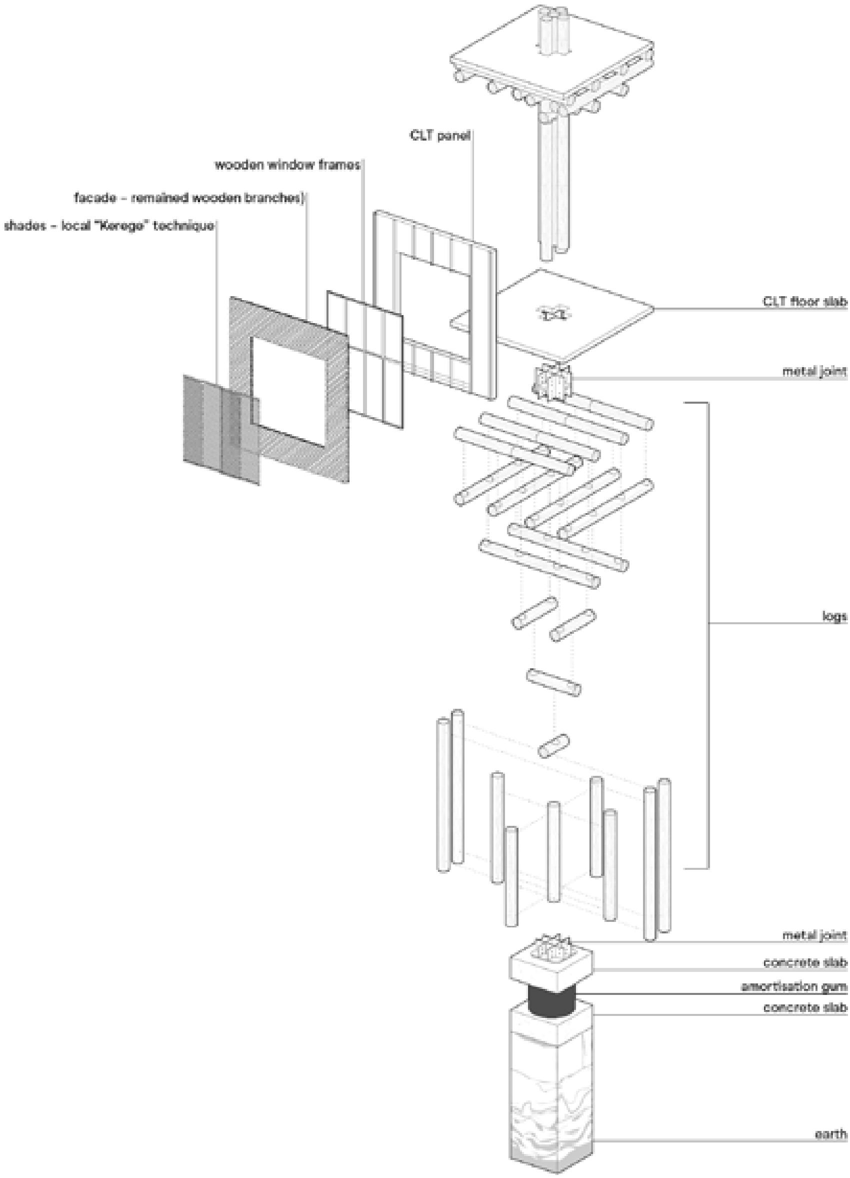
To grow 2,7 million tons of timber it requires an area of 47,5 km² that is a quarter of Bishkek. Due to its location, on the foot of the mountains it has a slope that divides whole city on uptown and downtown. People prefer to live on the uphill since the air quality is higher rather than in the down part of the city where all the pollution settles down. City expends towards the mountains and develops in parts that create empty gaps in-between the areas. That is the place where new forest might be located in order to create proposed future developments. It will not only be a forest with a biodiversity within the city but also a new public space created by temporary pavilions (by stacking wood in different ways) where the wood rests to decrease its moisture. At last it will be used as a construction building principle to design buildings. Thus, forest becomes a construction site for the future tower, using raw logs to build.

New wood chain

0.69 km² forest
(37812 m³ of wood)

From forest to construction site

Vertical carbon storage
(1725 tonnes of CO_2)



Raw wood - modular construction principle

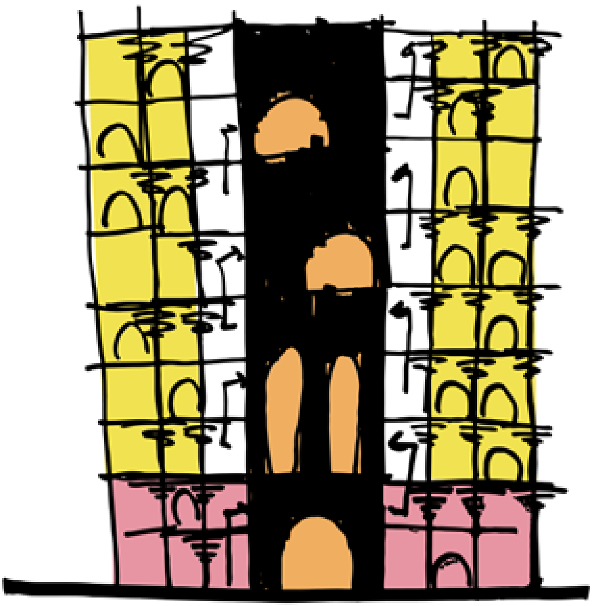
III. Design: a tower of wood

Taking into account that city expends very fast, it requires solutions to fit more and more program on a smaller footprint. Due to that I propose to build a tower that will change the local skyline, be the first skyscraper in central Asia and the largest and the tallest carbon storage in the world.

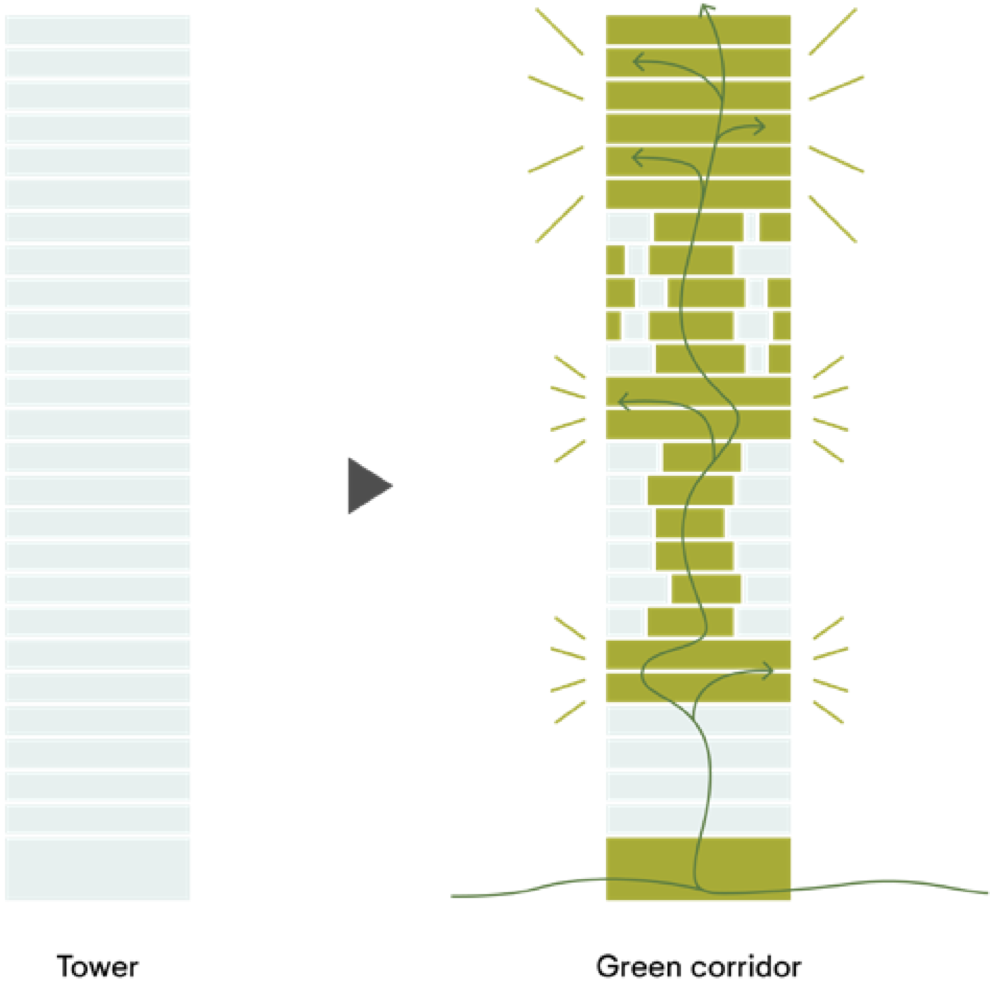
As said, this tower will be built from unprocessed, raw, round wood. For the construction – especially because Bishkek is located in a region with seismological dynamics – it is necessary to understand how many of round wooden pieces must be used and what should be the biggest span in-between them. Multiple logs are combined to create a strong column that carries the entire load from above. On the first levels columns are combined by that many of logs that almost creates dense forest underneath the tower. The higher it goes the less of wood in column. It gives more variety in the program to locate functions that don't require much of day light on the lower levels and to create more open spaces on the upper part. The design principal detail also consists of traditional horizontal stacking of round wood. It allows distributing the load equally through the whole structure. As non-supporting elements of the building, CLT slabs are used as well as panels for a facade. For an additional architectural element, shades on the facade, the traditional "kerege" technique is used, that is commonly used to make foldable structure of yurt.

The new raw wood skyscraper consists of mix used program in order to show variety in it and its potential. Open plinth represents a forest for a public use that can be transformed into spaces of many different activities and events. Administration like offices and the municipality is on the lower levels therefore making it more reachable for visitors. The tower also consists of two types of residential living. The first one is a fixed floor plan around 100 m² with a mezzanine, due to the height of construction elements. The second type is a flexible unit that dwellers can build themselves. Modular grid allows to make different variations according to everyone's personal needs. The last levels are orientated for camping and traditional yurt settlement. People might just bring their own yurt and locate it on top of the tower to enjoy the open view towards one of the highest mountain peaks in Central Asia.

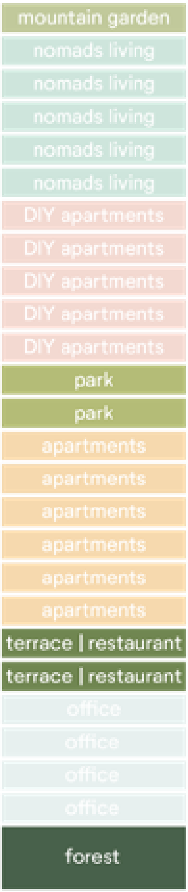
All the program is nicely merged with a green corridor. It goes up through the main core and continuous to the very top. Green spaces provide lush environment bringing more biodiversity into the project and create vertical gardens for the whole complex.



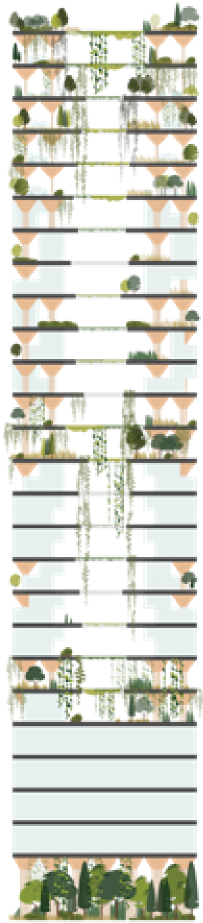
Concept sketch



Building programme and organization

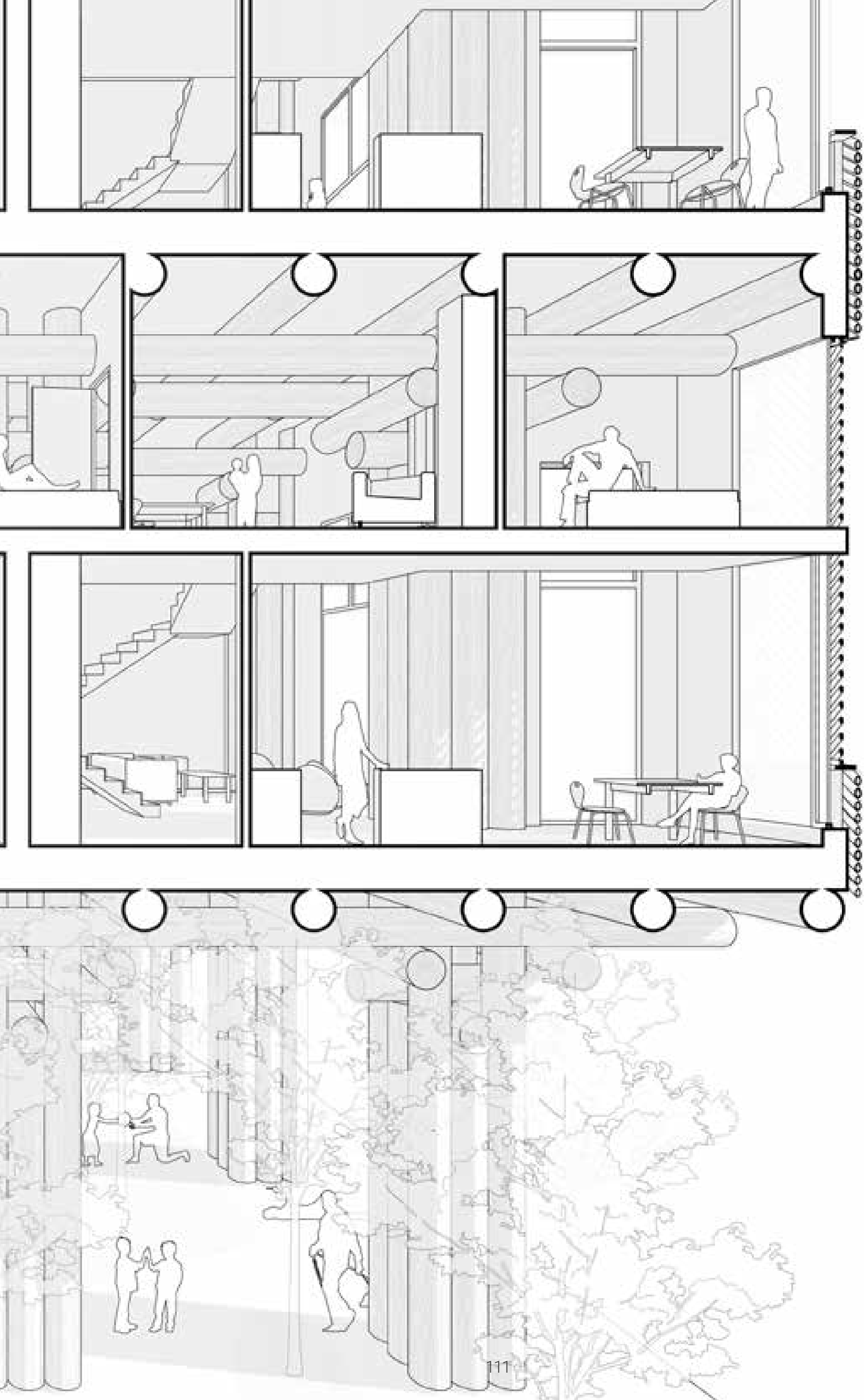


Program



Vertical forest

Section of apartments and common area



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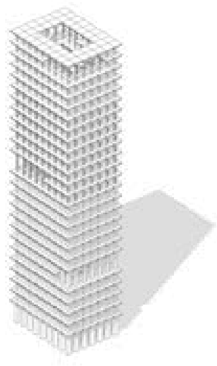

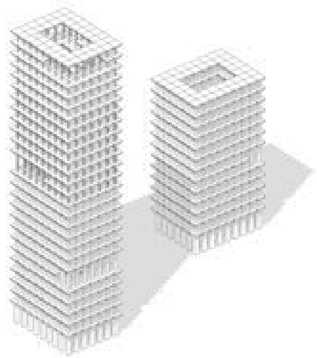

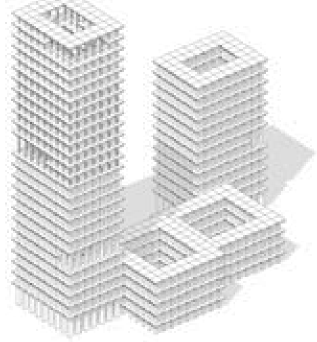

This skyscraper made of unprocessed wood is a new way of sustainable living and perceiving the city architecture. Nowadays the city spreads horizontally by single houses, the new sustainable structure allows creating more biomass that will sequester CO_2 from the atmosphere and later become a biggest carbon storage development that requires a small footprint.

Modular building system

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Wooden carbon sinks
Principles of carbon storage in Amsterdam

Mustafa Nicanci
Architecture

Wooden carbon sinks

The research I've been doing over the past few weeks has highlighted a number of issues associated with this relationship between buildings, the built environment, and the carbon cycle. Wood is a material that can be used in several ways, for example as a building material or as a storage for carbon. It has the image of being sustainable, not only in construction, but also socially. Wood can therefore link some of these underlying problems together and be one (or part of the) solution. Below I have outlined a number of problems that, at first glance, appear to be self-contained problems, but can be linked together through wood and the world behind it.

First, buildings and the construction process behind them are the largest source of carbon emissions — accounting for about 40 percent of total emissions (2030, sd). We can divide these emissions into three parts: the construction activities needed to build the buildings, building materials and getting them how and where they need to be, and the energy consumption of the buildings being built and in use. Striving to reduce emissions from any part of these three will only help reduce them partially, as the three parts are part of the same chain. The three parts thus affect each other and must be solved together. If we want to produce CO2-neutrally, we must consume CO2-neutrally, and vice versa.

Secondly, in recent years we have had an increasing problem with the housing shortage. This means that many homes will have to be built. It is expected that a city will be built every year in terms of built-up area (2030, sd). In addition, in 2040 (2030, SD) more than 60% of the current built environment will still be there. In short, the built environment is getting bigger and bigger. For comparison, it will be like adding an entire New York City to the world every month for 40 years.

Starting with the emissions from the buildings we have already built (the 60% that will remain in 2040), if we keep them at the same level, we will not reach the 1.5°C set in the Paris Agreement. If we add the emissions of the expanding cities to that, that target does not even come close. We need a radically new way of designing the city and its buildings.

As mentioned earlier, wood as a building material can be a solution. Wood contains more carbon compared to other building materials such as concrete and steel. But then Wood is simply packed in a building without any other function than just being a construction. What if we could design a wooden cube in the public space that can be used by the citizens.

To visualize the possibilities in public space, I mapped out the CO2 emissions of the metropolis of Amsterdam and converted the amount of emissions into the amount of wood. In 2021, the municipality of Amsterdam will have CO2 emissions of 4,260 kton, which is converted into the amount of wood 4,260,000 m³. This means that we can cover half of the center of Amsterdam with cubes of 1m³ wood. This would then only compensate for one year's CO2 emissions. So we have a big task ahead of us to solve.

To give the large amount of wood a place in the city, I studied a number of options. Below I have described the various options. There are various options for storing wood. To start with, we can think of wood storage in the city, in the city and under the city.

In the city, in other words, on the roofs of the existing buildings, we can top the roofs with wooden constructions. This principle is essential for a city like Amsterdam because "undeveloped land" is becoming increasingly scarce and because there are already many existing buildings that have a large roof surface. However, rules must be laid down for this in which the cityscape is safeguarded. With this principle we use the roofs and introduce more living space or other functions within the city. And it also contributes to urban densification and economies of scale.

In the city, so the public space, we can first start with, for example, replacing all benches with wooden cubes that will also function as the benches. This is a practical solution that takes up little space. If we look further into the city of Amsterdam, we see that the quay walls need maintenance. According to the municipality of Amsterdam, the quay walls will be maintained and/or replaced in the coming years. During this process we can integrate wood into the new quay walls. In addition to making the quay walls more sustainable, this can also create new public spaces. We can make a physical connection between the streets and the canals. At the moment, the spaces next to the quay walls are used as bicycle and car parking spaces and space for houseboats. By reserving space along the new quay walls, we can make wooden decking terraces in the form of a staircase. This contributes to the spatial quality of the canals of Amsterdam. These are solutions on a small scale in the city. If we think of a larger scale, we can think of wooden landscapes on the IJ canal or on the Sloterplas where a wooden landscape can be designed that can also grow over the years. The growth of the landscapes is then equal to the amount of CO2 emissions per year.

Finally, we have the principle of wood storage under the city. Underground storage can make a major contribution to CO2 emissions compensation. This is because we have a lot of space underground and because we have 400 years of experience with underground construction/foundations with wood. Amsterdam center is entirely founded with wooden foundation piles. The city of Amsterdam actually already has a large amount of CO2 underground storage. So why don't we spend our time and money developing new construction methods that allow us to foundation buildings with wooden piles and make the underground spaces of wooden structures. Sluisbuurt is a new development within the borders of Amsterdam where we can test this. We could foundation the construction area of Sluisbuurt in wooden piles with which we can compensate the emissions of the new construction on site. The underground spaces can be connected to each other, which serves as a common construction for the above-ground construction. With this we also create a new public space for residents and visitors. This principle is for compensating for new construction.

As indicated earlier, we have a major task in compensating for CO2 emissions from the cities. How will you contribute to the compensation as a professional?

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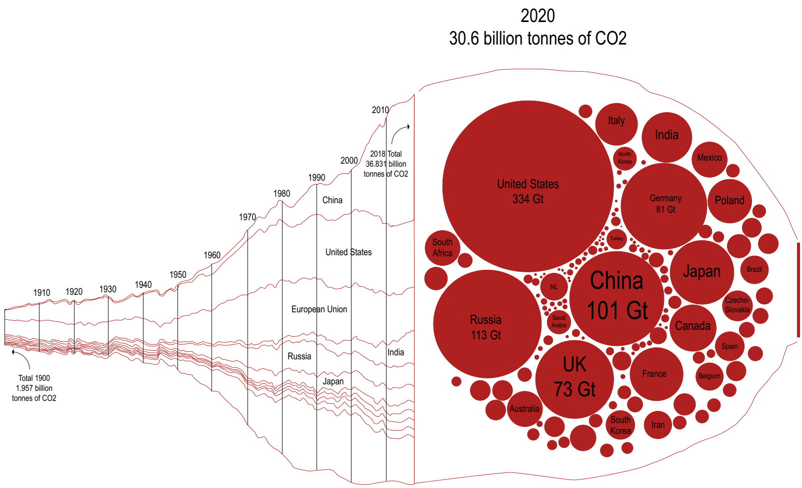
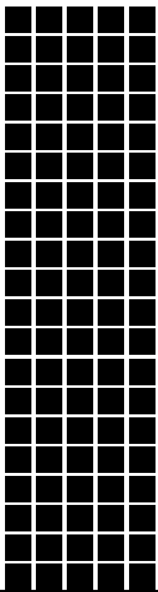


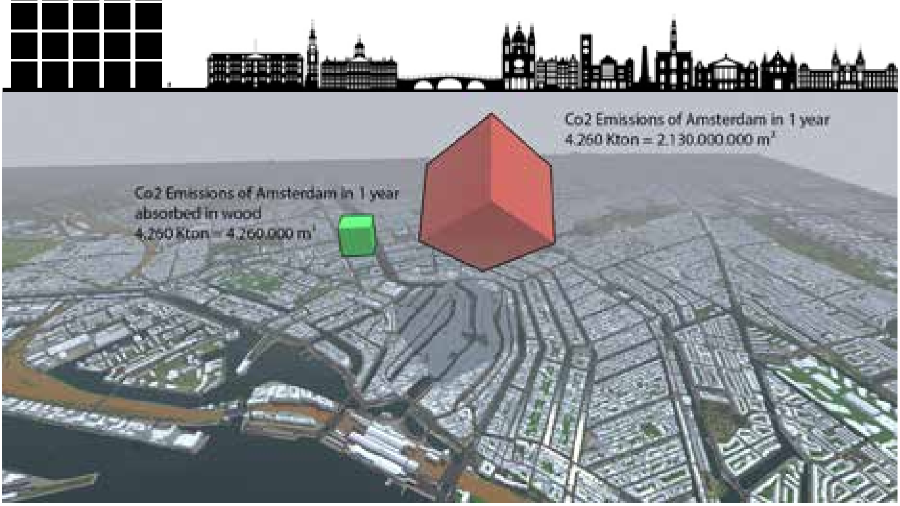
Global carbon emissions

Gemeente Amsterdam carbon emissions 2020

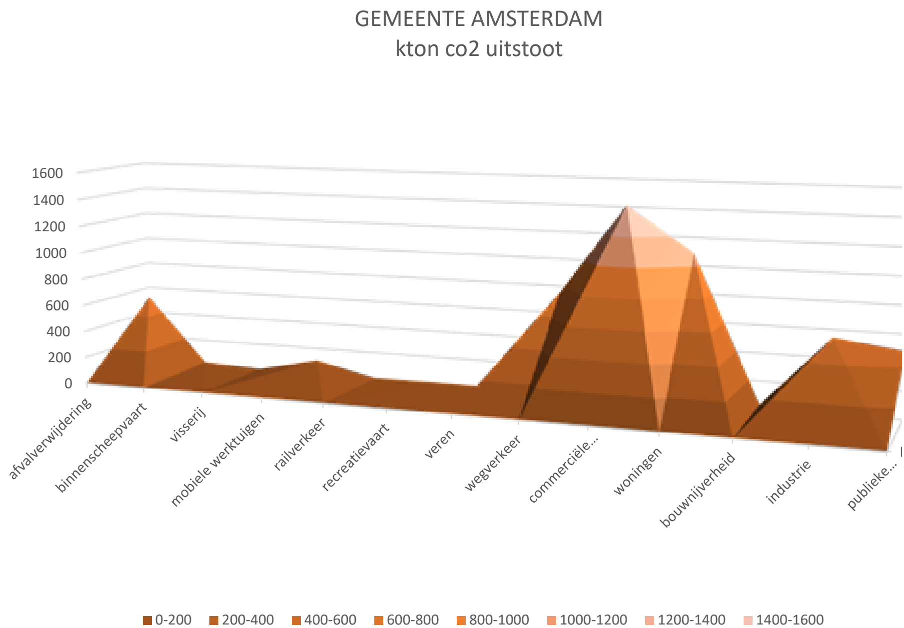
4.963 kton = 4.963.500 m³ wood



Commercial service	28,49%	=	1.414.101,15 m³
Housing	21,92%	=	1.087.999,20 m³
Road traffic	15,19%	=	753.955,65 m³
Industry	10,97%	=	544.495,95 m³
Waste incineration	10,48 %	=	520.174,80 m³
Public service	9,73%	=	482.948,55 m³
Mobile equipment	2,09%	=	103.737,15 m³
Construction industry	0,56%	=	27.795,60 m³
Inland shipping	0,39%	=	19.357,65 m³
Ferry	0,08%	=	3.970,80 m³
recreational boating	0,07%	=	3.474,45 m³
Fishing	0,02%	=	992,70 m³
Rail traffic	0,0015%	=	74,45 m³



Carbon emissions Gemeente Amsterdam 2020



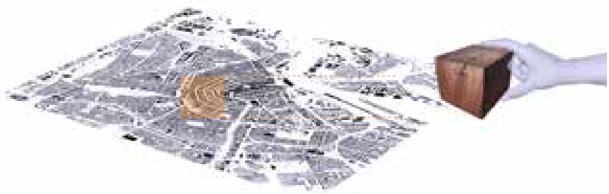
Carbon emissions Gemeente Amsterdam 2020


AMSTER


GEMEENTE AMSTERDAM CARBON EMISSIONS 2021
4.260 KTON = 4.260.000 M^3

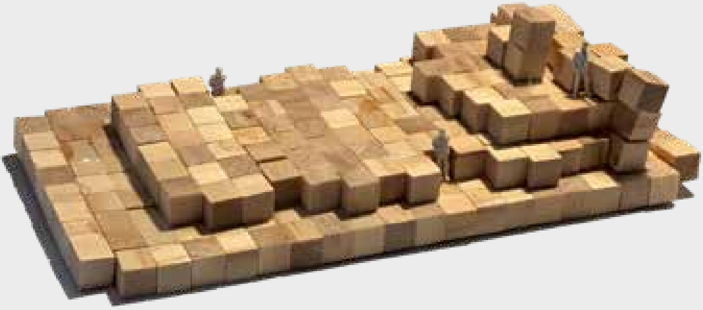
CARBON STOCK ABOVE THE CITY

CARBON STOCK IN THE CITY



CARBON STOCK BENEATH THE CITY

The three principles of stocking wood at cities



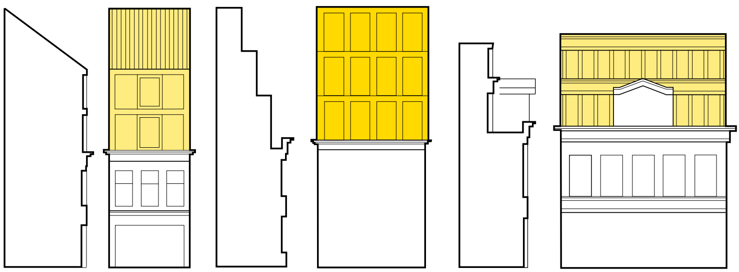
Studymodels

CARBON STOCK ABOVE THE CITY

Carbon stocking above the city

Horizontal and Vertical

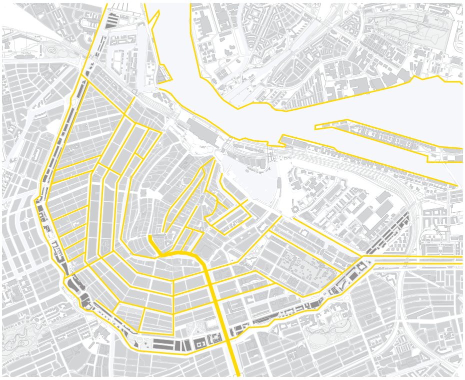
Rhythm of the facade openings and general distribution continues
Rhythm of the clear horizontal lines are emphasized in the topping



The possibilities to stock wood above the existing buildings

CARBON STOCK IN THE CITY

Carbon stocking in the city



Amsterdam Centrum canals

± 200 km quay walls

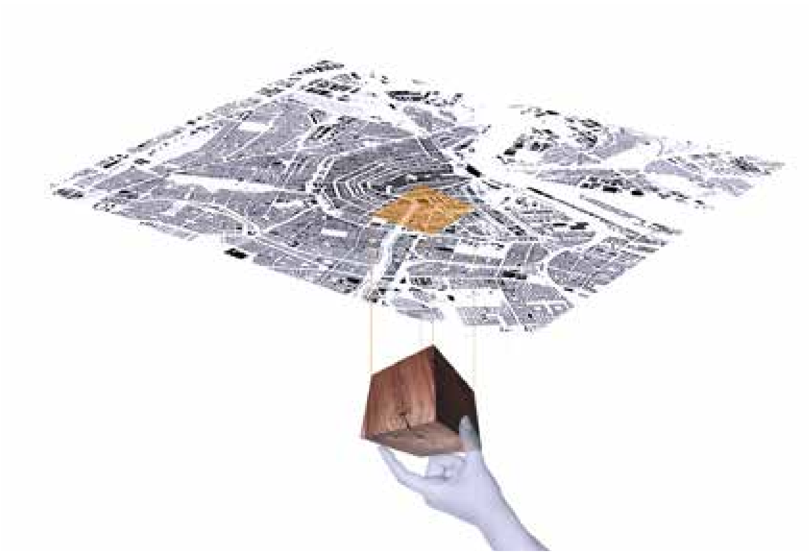
1.

2.

3.

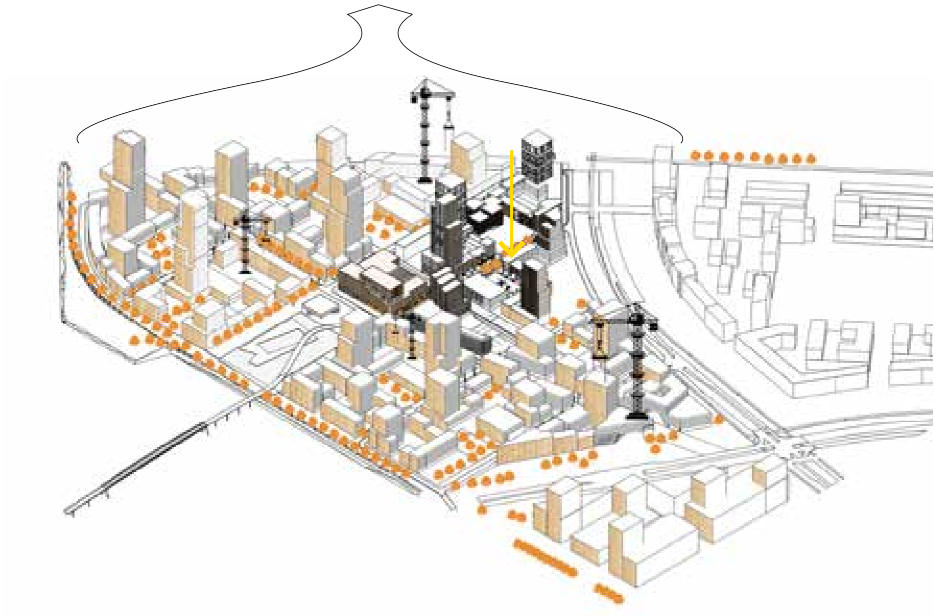
The possibilities to stock wood in the city. The quay walls of the centrum is an opportunity to stock wood

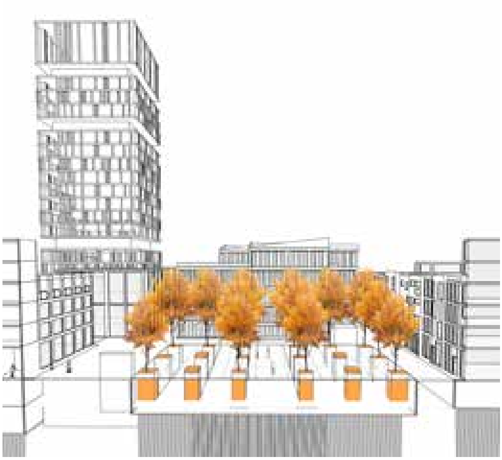
CARBON STOCK BENEATH THE CITY

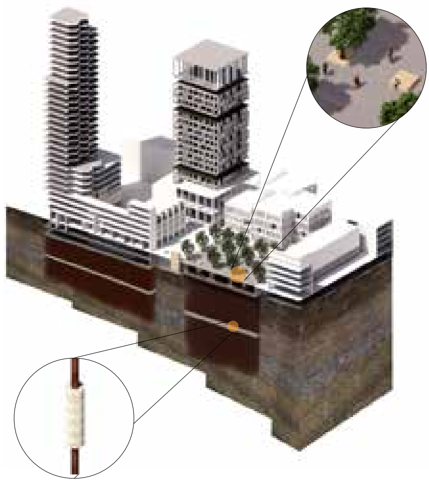


Carbon stocking beneath the city

SLUISBUURT
TOTAL AREA OF 320.000 M²







The possibilities to stock wood beneath the city. New development neighborhoods like Sluisbuurt are an opportunity to stock wood beneath the ground.

View of the square above the ground

View of the square beneath the ground. By stocking wood beneath the ground it is also possible to make public spaces

Peatland Carbon Sinks
Protecting contemporary storage

Reinier Gramsma
Landscape architecture

Introduction: Necessary, but not first
It is high time for change. Climates are on the verge of the point of no return, carbon emissions are at an all-time high level, and biodiversity is dying out by the minute. Timber has been touted as the new, green building material that we - the designers, architects, and creatives around the world - must use to design a way out of our impending doom. But on the global scale, how viable is this material really? Multiple researches have shown that an inefficient production process underlying wood and timber make it a much less sustainable material than it appears on the surface. In fact, it is a larger carbon emitter than a carbon sink.

Attempts at improving the construction world through improving the complete production chain wood are therefore commendable. However only a running battle in the long run if we do not change the entire architectural paradigm. In this manifesto I argue in favor of changing our view. We urgently need to focus on the natural carbon sinks that are at the base of carbon sequestration, the ones that really sprouted the idea of wood as a container for carbon; the forests and the peat soils around the world. Valuable, but extremely vulnerable that need to be protected, restored and expanded in light of achieving our CO2 goals.

Natural carbon sinks
Among the world's largest carbon sinks - like oceans and the atmosphere - forests and peat soils are invaluable as natural containers in storing carbon. They form an important tool in the worldwide ambition to decrease the amount of CO2 in our atmosphere. As we know, carbon can be captured in organic matter, such as trees and plant material, and in this way be stored over long periods of time. In forests this storage not only takes place above ground (in living trees and plants), it also takes place below ground in the soil. Here, the organic matter that sequestered the carbon is slowly stored away and, in some cases, even completely protected from decomposition.

A particularly beneficial combination of the potential that forests and soils offer is that of the tropical peatland forest. Carbon-rich ecosystems that cover just three percent of Earth's total land surface, but storing one-third of all carbon found in the soil. Peat soils are formed by the build-up of partially decomposed organic matter that is preserved by water-saturated anoxic conditions. These conditions keep the continual and seasonal deposits of carbon-sequestering organic material in stasis, and therefore accumulates more carbon than it emits over time, forming a net carbon sink.

Carbon sinks under threat

However, these peatland forest carbon sinks are under global threat. Due to changing land uses (forests being cleared for commodity driven agriculture) and climate change (shifting ecosystems, higher temperatures, extreme rainfall and droughts) peatlands are shifting from sink to emission. Rapid oxidation of extremely large areas of organic carbon soil are a result of these changing land uses, and becoming more common as countries such as Indonesia and Brazil clear their jungles for economic benefit.

These tropical peatlands can be found on three continents spread along the equator, each continent with its set of climate conditions and challenges due to the earlier mentioned land use changes. The Brazilian government has for instance been increasing its logging of the Amazonian rainforest in favor of plantations. Indonesia and South-East Asia have been hit by major, wide-spread fires due to El Nino - a coupled ocean-atmosphere phenomenon that causes droughts in the area, leading to large swathes of dried out peat going up in flames. Out of the three continents only the Cuvette Centrale basin in the Democratic Republic of Congo, an area the size of England, luckily has remained relatively undisturbed due to its remote location.

Time for action

In Indonesia, deforestation has led to a number of natural disasters and wildfires that have spread across the whole country, where the massive clouds of haze following these fires spread as far as neighbouring Singapore and Malaysia. Illegal forest clearing by burning set the stage for wildfires in ‘05-’06 and have since become an annually occurring phenomenon. Exacerbated by plantation drainage canals and the weather phenomenon ENSO (also known as El Niño or El Niña) these annual burns spread an uncontainable fire in the peat layer storing precious carbon. The Riau district in eastern Sumatra is currently home to the largest emissions of CO2 in Indonesia. The peatlands that accumulated here over thousands of years have been drained and burned to make space for palm oil and wood fiber plantations, paving the way for an unprecedented loss of stored carbon on the global scale.

Epilogue: A call for change in five bullets

1. Improving the wood production process is not sufficient, it is crucial to restore our natural carbon sinks
2. The most ideal natural carbon sink, in terms of carbon sequestration, is the tropical peatland forest
3. This ecosystem is under grave threat of deforestation and is disappearing in an increasingly alarming rate
4. Integrally rethinking commodity driven agricultural activity and nature restoration on a regional scale is the key
5. Importance in increasing awareness of the function of these peatlands and their cultural & socio-economic significance

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SUSTAINABILITY STARTS WITH THE SOIL

Introduction: Necessary, but not first

a manifesto by Reinier Gramsma

It is high time for change. Climates are on the verge of the point of no return, carbon emissions are at an all-time high level, and biodiversity is dying out by the minute. Timber has been touted as the new, green building material that we - the designers, architects, and creatives around the world - must use to design a way out of our impending doom. But on the global scale, how viable is this material really? Multiple researches have shown that an inefficient production process underlying wood and timber make it a much less sustainable material than it appears on the surface. In fact, it is a larger carbon emitter than a carbon sink.

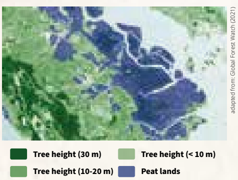
Attempts at improving the construction world through improving the complete production chain wood are therefore commendable. However only a running battle in the long run if we do not change the entire architectural paradigm. In this manifesto I argue in favor of changing our view. We urgently need to focus on the natural carbon sinks that are at the base of carbon sequestration, the ones that really sprouted the idea of wood as a container for carbon; the forests and the peat soils around the world. Valuable, but extremely vulnerable that need to be protected, restored and expanded in light of achieving our CO2 goals.

I. Natural carbon sinks

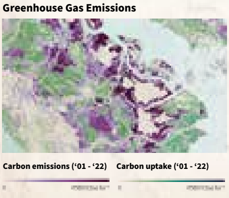
Among the world's largest carbon sinks - like oceans and the atmosphere - forests and peat soils are invaluable as natural containers in storing carbon. They form an important tool in the worldwide ambition to decrease the amount of CO2 in our atmosphere. As we know, carbon can be captured in organic matter, such as trees and plant material, and in this way be stored over long periods of time. In forests this storage not only takes place above ground (in living trees and plants), it also takes place below ground in the soil. Here, the organic matter that sequestered the carbon is slowly stored away and, in some cases, even completely protected from decomposition.

A particularly beneficial combination of the potential that forests and soils offer is that of the tropical peatland forest. Carbon-rich ecosystems that cover just three percent of Earth's total land surface, but storing one-third of all carbon found in the soil. Peat soils are formed by the build-up of partially decomposed organic matter that is preserved by water-saturated anoxic conditions. These conditions keep the continual and seasonal deposits of carbon-sequestering organic matter in stasis, and therefore accumulates more carbon than it emits over time, forming a net carbon sink.

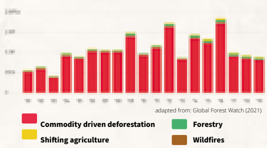
Forest and Peatlands



Greenhouse Gas Emissions



Tree Cover Loss in Indonesia (2001 to 2019)



"The Siak river system is the key to saving the Sumatran jungle and its carbon sequestering peatlands."

II. Carbon sinks under threat

However, these peatland forest carbon sinks are under global threat. Due to changing land uses (forests being cleared for commodity driven agriculture) and climate change (shifting ecosystems, higher temperatures, extreme rainfall and droughts) peatlands are shifting from sink to emission. Rapid oxidation of extremely large areas of organic carbon soil are a result of these changing land uses, and becoming more common as countries such as Indonesia and Brazil clear their jungles for economic benefit.

These tropical peatlands can be found on three continents spread along the equator, each continent with its set of climate conditions and challenges due to the earlier mentioned land use changes. The Brazilian government has for instance been increasing its logging of the Amazonian rainforest in favor of plantations. Indonesia and South-East Asia have been hit by major, wide-spread fires due to El Nino - a coupled ocean-atmosphere phenomenon that causes droughts in the area, leading to large swathes of dried out peat going up in flames. Out of the three continents only the Cuvette Centrale basin in the Democratic Republic of Congo, an area the size of England, luckily has remained relatively undisturbed due to its remote location.

III. Time for action

In Indonesia, deforestation has led to a number of natural disasters and wildfires that have spread across the whole country, where the massive clouds of haze following these fires spread as far as neighbouring Singapore and Malaysia. Illegal forest clearing by burning set the stage for wildfires in '05-'06 and have since become an annually occurring phenomenon. Exacerbated by plantation drainage canals and the weather phenomenon ENSO (also known as El Niño or El Niña) these annual burns spread an uncontainable fire in the peat layer storing precious carbon. The Riau district in eastern Sumatra is currently home to the largest emissions of CO2 in Indonesia. The peatlands that accumulated here over thousands of years have been drained and burned to make space for palm oil and wood fiber plantations, paving the way for an unprecedented loss of stored carbon on the global scale.

The Siak river system connects the city of Pekanbaru in the central Riau district of Sumatra to the ocean. It forms a natural connection of local urbanity and its economic activities to the peatland carbon sinks in the area. This major network of main river, river subsidiaries and connected drainage canals can be re-designed into a sustainable water system that not only provides much needed water for peatland restoration, but also for plantations and rice paddies. The challenge here is mitigating the dangers set out by extreme weather and water conditions caused by climate change and the influence of El Niño. Integrally rethinking land uses; economical agriculture and nature restoration, can help tackle the local problems and in turn global carbon challenges. Plantations purely meant for export can make way for rice paddie food production and peatland jungle forests, that buffer water in dry and wet times. Concluding, the Siak river system is the key to saving the Sumatran jungle and its carbon sequestering peatlands.

Epilogue: A call for change in five bullets

- Improving the wood production process is not sufficient, it is crucial to restore our natural carbon sinks
- The most ideal natural carbon sink, in terms of carbon sequestration, is the tropical peatland forest
- This ecosystem is under grave threat of deforestation and is disappearing in an increasingly alarming rate
- Integrally rethinking commodity driven agricultural activity and nature restoration on a regional scale is the key
- Importance in increasing awareness of the function of these peatlands and their cultural & socio-economic significance

Tropical and

547.8 Gigaton carbon stored

Boreal forests

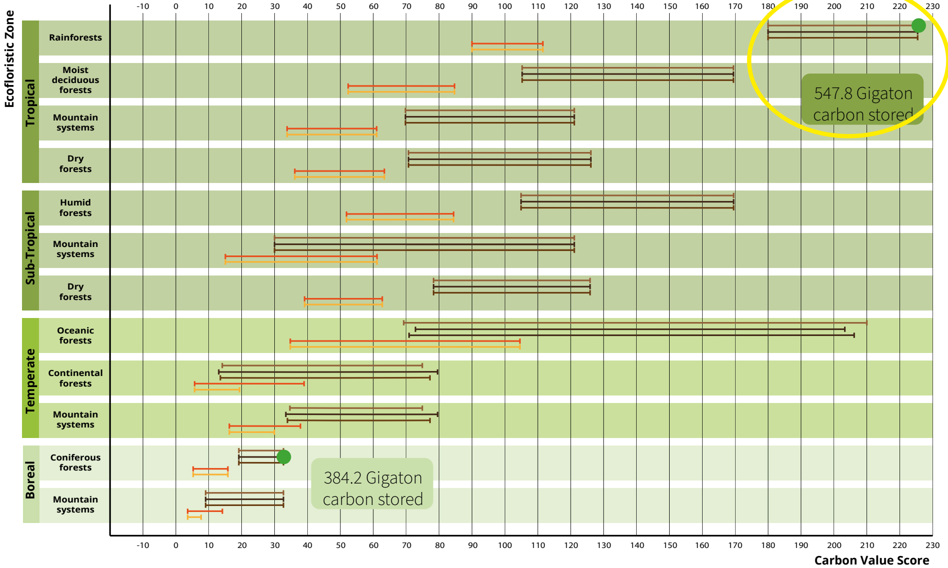
384.2 Gigaton carbon stored

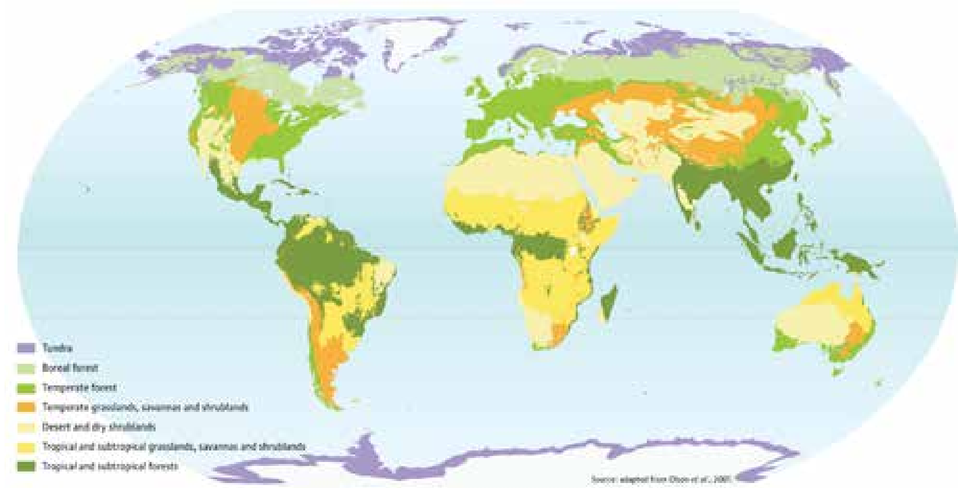
Temperate forests

314.9 Gigaton carbon stored

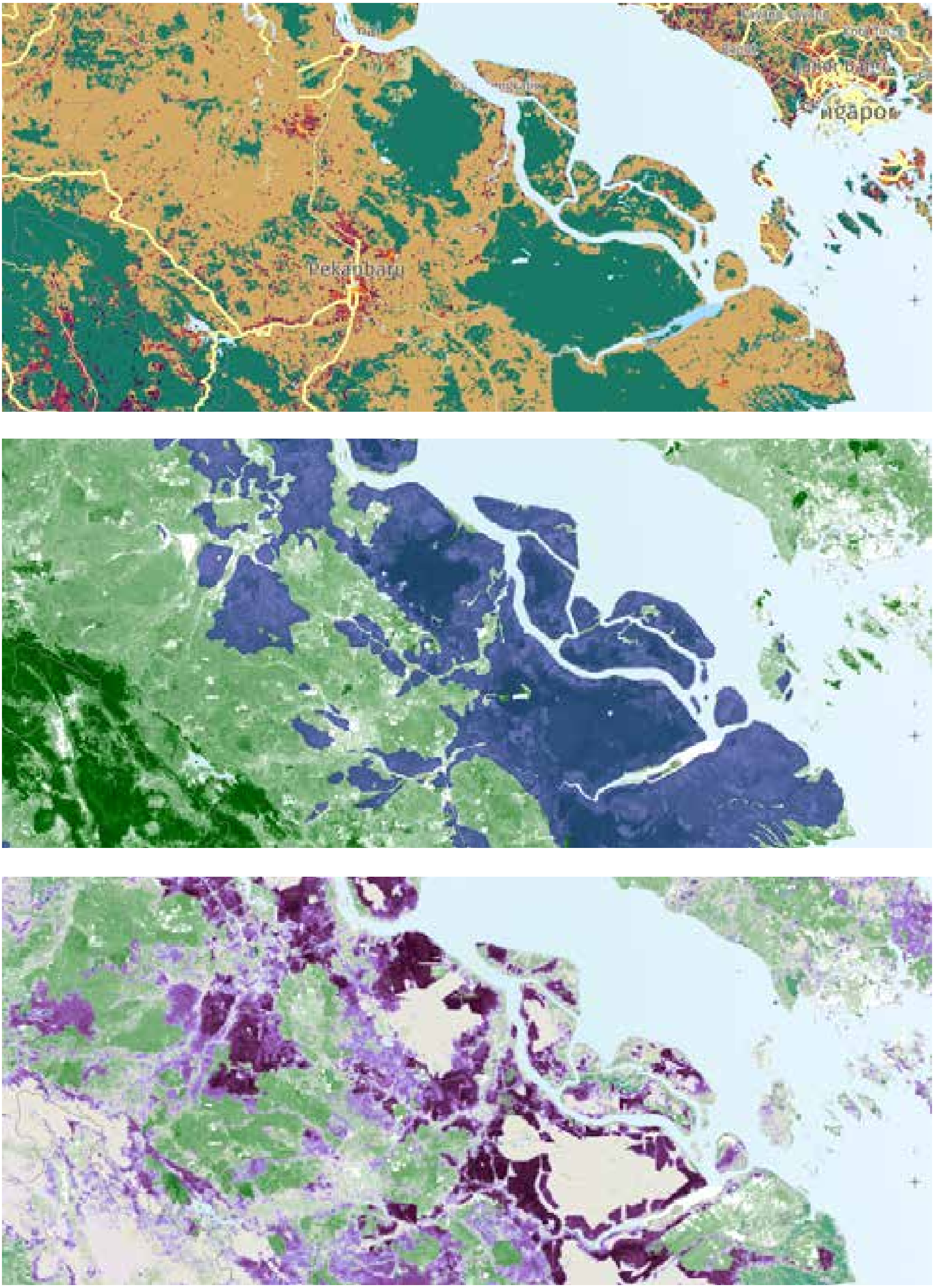
Tundra

155.4 Gigaton carbon stored

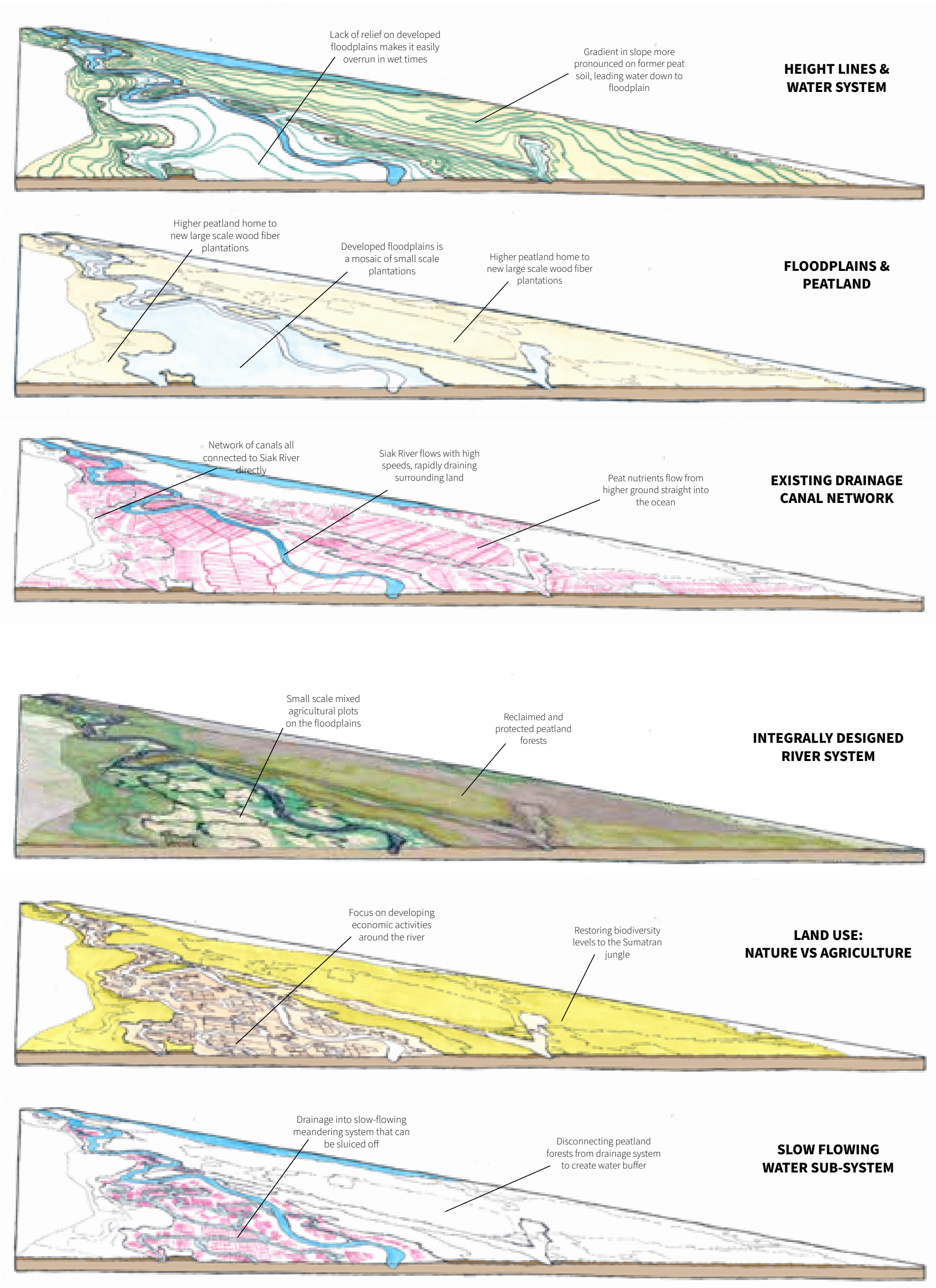




There is a range of storing capacities among the different biomes we find on earth, characterised as the carbon value score. Tropical rainforests store the most carbon and thus score the highest.



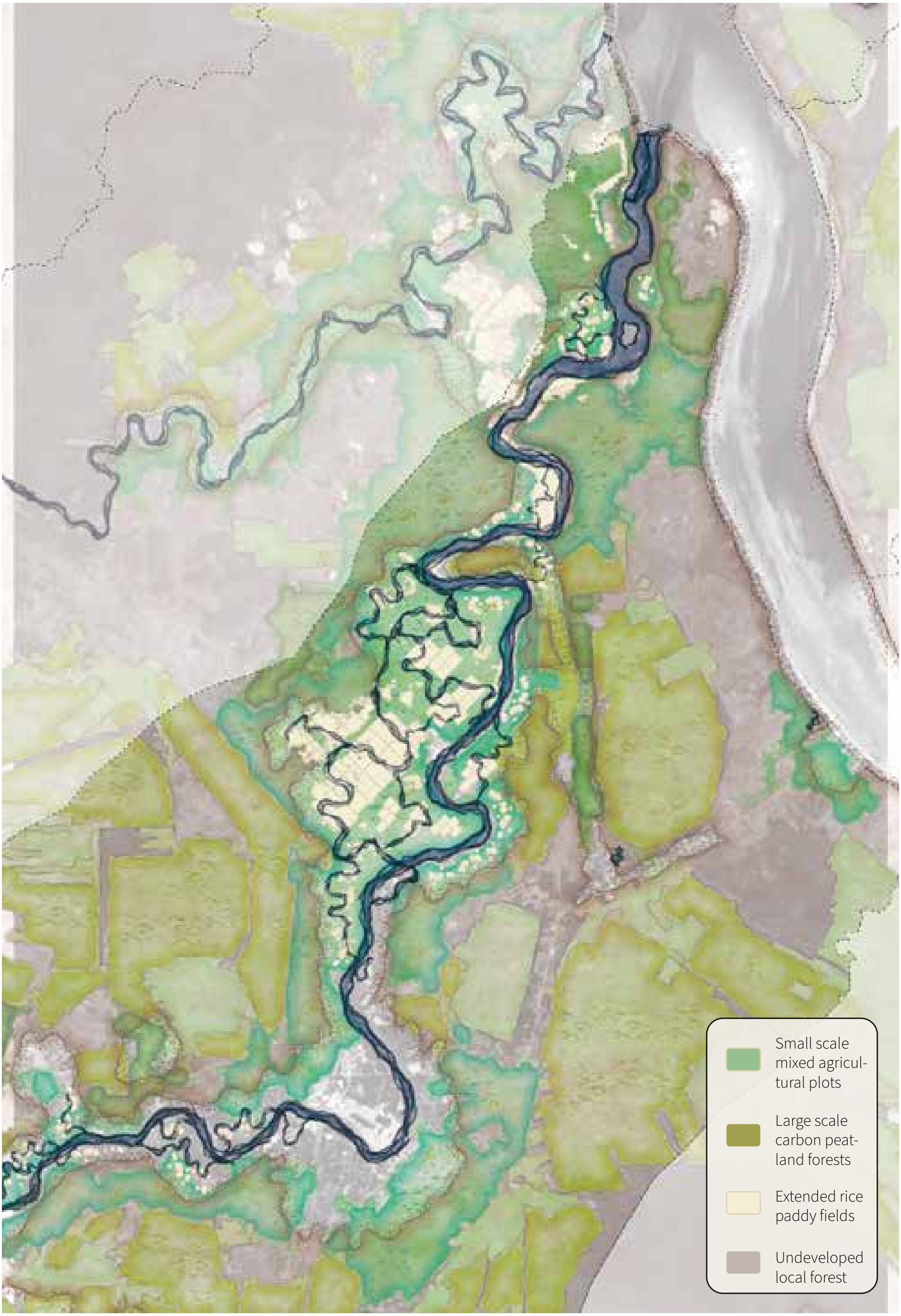
Drainage and deforestation of the peatland jungles near Pekanbaru, Indonesia has led to the emission of enormous amounts of CO2.



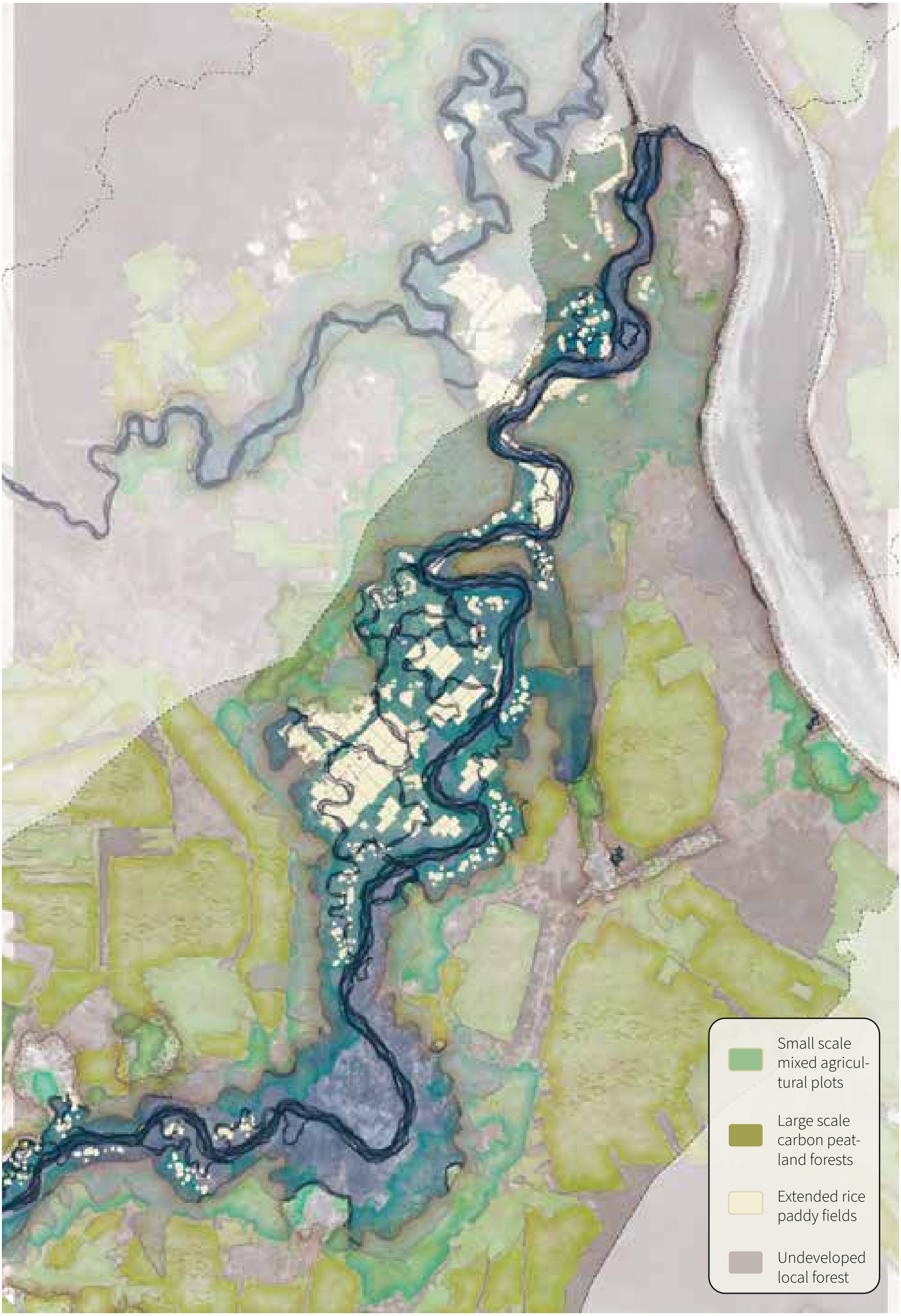
Disconnecting drainage canal networks from and integrating peatland restoration into the local Siak river system will result in a sustainable, carbon storing river delta economy.

The current situation of the Siak river delta, where small scale plantations next to the river are coupled with large scale plantations on higher peatland soils.

When El Nino occurs during monsoon season water levels raise to such an extent that flooding happens even on the higher situated areas.



Peatland jungle forests must be restored on a large scale, while water-buffering rice paddies can retain some of the economical function.



During monsoon times water can then be contained to the lowest levels of soil, while not interrupting production on the rice paddies.

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