BSc Thesis Landscape Architecture

DESIGNING THE TRANSITION TOWARDS CIRCULAR AGRICULTURE FOR ETTEN-LEUR

The Netherlands, the sustainable producer for the world

“THE ONLY WAY TO PREDICT THE FUTURE IS TO DESIGN IT”

Richard Buckminster Fuller

VINCENTKLAASKATE

WAGENINGEN UR

Colophon

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02.07.2021

Cover image: (Skafar, 2019)

Content

Abstract

Studies have determined that our current linear food production system is failing to support the growing world population as well as it's detrimental for the physical environment and even leads to strained profitability for farmers in some cases. To prevent losses in environment as well as in resources a circular production system is proposed and will be tested for the agriculture sector. However, in designing for circular agriculture the spatial quality of the landscape shouldn't be forgotten as this is increasingly valued in western societies. This research investigates six design guidelines for three archetypes of circular agriculture based on spatial landscape conditions and criteria for spatial quality. Through a regional and detailed design as well as an assessment matrix all 6 guidelines have been proven significant and valuable for the area. The design guidelines have been devided over the different archetypes, nature based (3), technology land based (2) and technology non-land based (1).

Introduction

Our current linear food production system is failing and will continue to fail in the future to support the growing world population. In addition the linear system based on the take-make-dispose flow is detrimental for the physical environment and can even lead to strained profitability for farmers. One of the proposed solutions to this problem is a circular system which is based on waste reduction, respect towards the socio-economic as well as the physical environment and resource conscious business conduct (Sariatli, 2017). In this research the agriculture sector of this system will be discussed. The Dutch government has already anticipated the transition towards circular agriculture with a national vision in 2018. The main issues defined in this vision are soil depletion, water pollution, the depletion of raw materials, the decline in biodiversity and emission of greenhouse gasses (Schouten, 2018). The test area for this research will be around the municipality of Etten-Leur, the land outside the city borders is dominantly used for intensive agriculture and thus forms a fitting test area. In addition the province of Brabant in which Etten-Leur is located falls behind on the general innovative trend in the Netherlands (Venema et al., 2019). Thus, it might even be more interesting to prove the benefits of circular agriculture for this area.

The area of Etten-Leur is located in the western part of Brabant, in the north it's bordered by the Mark river. The ground mostly consists of peat and clay soils but at the city borders there are also some sand soils (Noord-Brabant, 2021). The area is slightly elevated towards the south with a height difference of approximately 10 meters (AHN, 2021). The rural area is dominated by agricultural grasslands, corn fields, wheat fields and other crops. Next to agricultural production the area is home to more than 120 ha of natural grasslands (Noord-Brabant, 2021).

NATURE BASED			TECHNOLOGY LAND BASED				TECHNOLOGY NON-LAND BASED	
Small scale mixed farming			Cropping		Livestock farming		Food cluster or Agropark	
Agroforestry	Mixture of crops and livestock	Extensive livestock farming	Precision cropping	Intensive cropping with capturing, processing and exporting waste streams	Intensive dairy farming with processing manure beyond what is legally required and use local waste as feed (partly)	Indoor livestock in association with intensive feed production	Focus on technological innovation	Focus on closing regional cycles

Table 1: Archetypes as defined by Camara de Assis, created based on (Camara de Assis, 2021)

Research aim

The objective of this research is to provide and test design guidelines for the transition towards circular agriculture in Etten-Leur based on physical conditions and criteria for spatial quality. These guidelines will be defined based on a literature study towards preferred pvhysical conditions combined with the criteria for spatial quality for each archetype. These criteria are predefined by a study towards criteria for spatial quality in agricultural landscapes (Bakx, 2021). The archetypes are predefined as well in table 1 based on a research towards circular agriculture archetypes (Camara de Assis, 2021).

This research mainly focuses on *what are design guidelines for different archetypes in circular agriculture based on the criteria for spatial quality.* To come to a fitting conclusion the topic is separated into four sub questions which build on each other.

The first sub question (SQ) investigates *which sets of landscape conditions are preferred to support the different archetypes.* To answer this question the landscape conditions are based on the layer approach and thus defined as the substratum layer (1), networks layer (2) and occupation layer (3) (van Schaick & Klaasen, 2011). The first layer focuses on biophysical conditions for which this research uses soil, climate and terrain as they're the most detrimental factors for agriculture as stated by the JRC of the EU (Orshoven et al., 2012). The second layer focuses on networks which comes down to infrastructure for import and export agricultural resources and products.
The third layer focusses on occupation which in this research will be narrowed down to current land use. The second sub question focuses on *which archetype allocation is preferred based on sets of landscape conditions that are present in the area of Etten-Leur.* The same landscape conditions used in sub question one will also be used for sub question two. The third sub question combines the first two sub questions with the criteria for spatial quality as it investigates *which design guidelines contribute to the spatial quality of the archetypes in Etten-Leur.* In the research through design process used to answer this question the criteria for spatial quality will be used to evaluate the design of agroparks on a detailed scale.

Criteria to evaluate spatial quality									
Experiential	Openness	Regional character	Naturalness	Visual Heterogeneity	Coherence	Historicity	Cues of care	Seasonality	Multi-sensory
Economic	Profitability	Local economy	Recreational facilities						
Ecological	Abiotic	Biodiversity							
Long-term	Circularity	Flexibility							

Table 2: Criteria for sptial quality as defined by Bakx, created based on (Bakx, 2021)

Method

To answer SQ1 and SQ2 a literature study will be conducted, this should result in a linkage between archetypes and preferred spatial conditions. Combined with a landscape analysis several sets of landscape conditions that are present in the area of Etten-Leur will be defined. Following the research through design (RTD) framework which builds on the results of the first two sub questions the third SRQ will be answered. The model shown in figure 1 builds on using specialist knowledge, in this case landscape conditions combined with agricultural suitability, to create generally applicable design guidelines (Lenzholzer, Duchhart, & Koh, 2013). Following this study assumptions can be made about the applicability and validity of the design guidelines for the area of Etten-Leur. Actual empirical evidence for the design guidelines can only arise over time by systematic evaluations of the designed landscape.

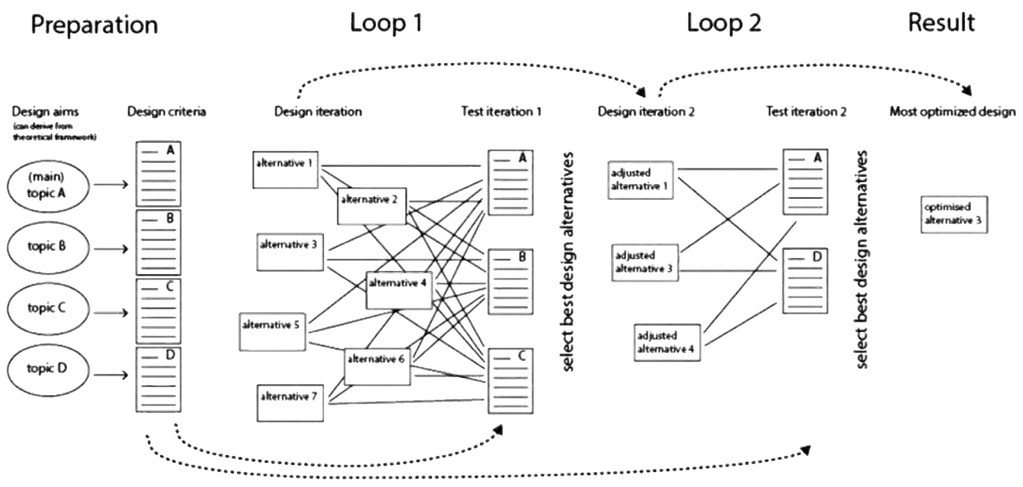


Figure 1: Research through design framework (Lenzholzer, 2021)

Research model

Figure 2 shows the proposed research model, first following a chronological order from left to right which later transforms in a dynamic proses of using new found results to alter previously made designs.

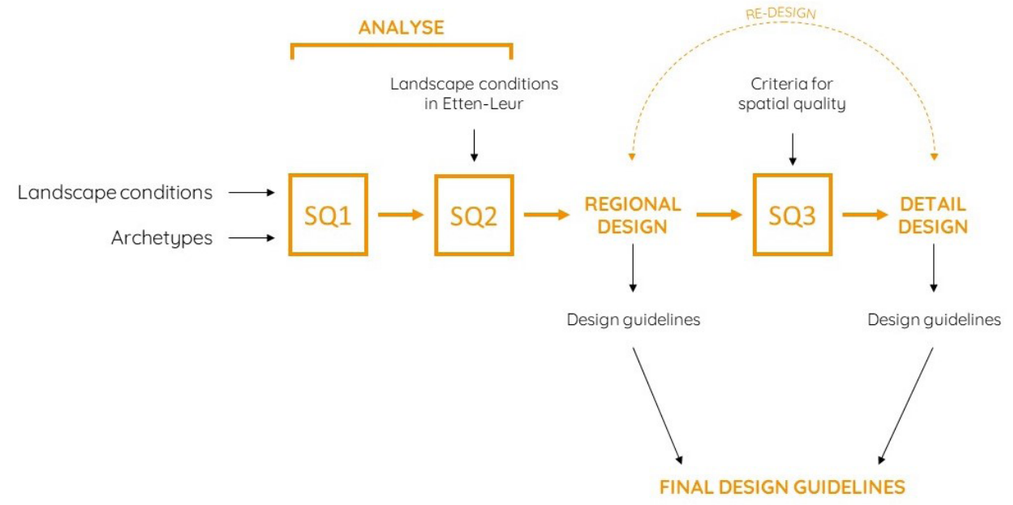


Figure 2: Research model which shows the combination of the several sub questions in this research

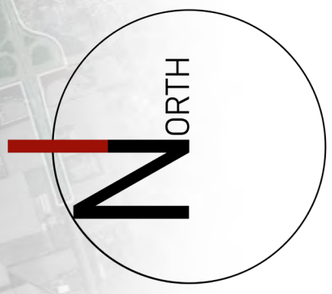
Challenges & objectives

A major challenge for this research will be to present design guidelines as a supportive tool for designers as well as for the farmer or users. Studies have determined that, especially in Brabant, the proposed system of innovation and sustainable circular implementations is often seen as a threat by its users. This research hopes to convince the users of the promising future of a circular agricultural system but understands the often emotionally driven objections and barriers.

In this thesis I would like to develop my academic skills in writing, analyzing literature and designing. I would like to focus on producing a rational and academically sound design based on a wide range of literature, maybe in a sense even proof that design should be a literature supported process when practiced at an academic level. Further challenges lay in planning and overview as I had some trouble with this in studio Regional Design.

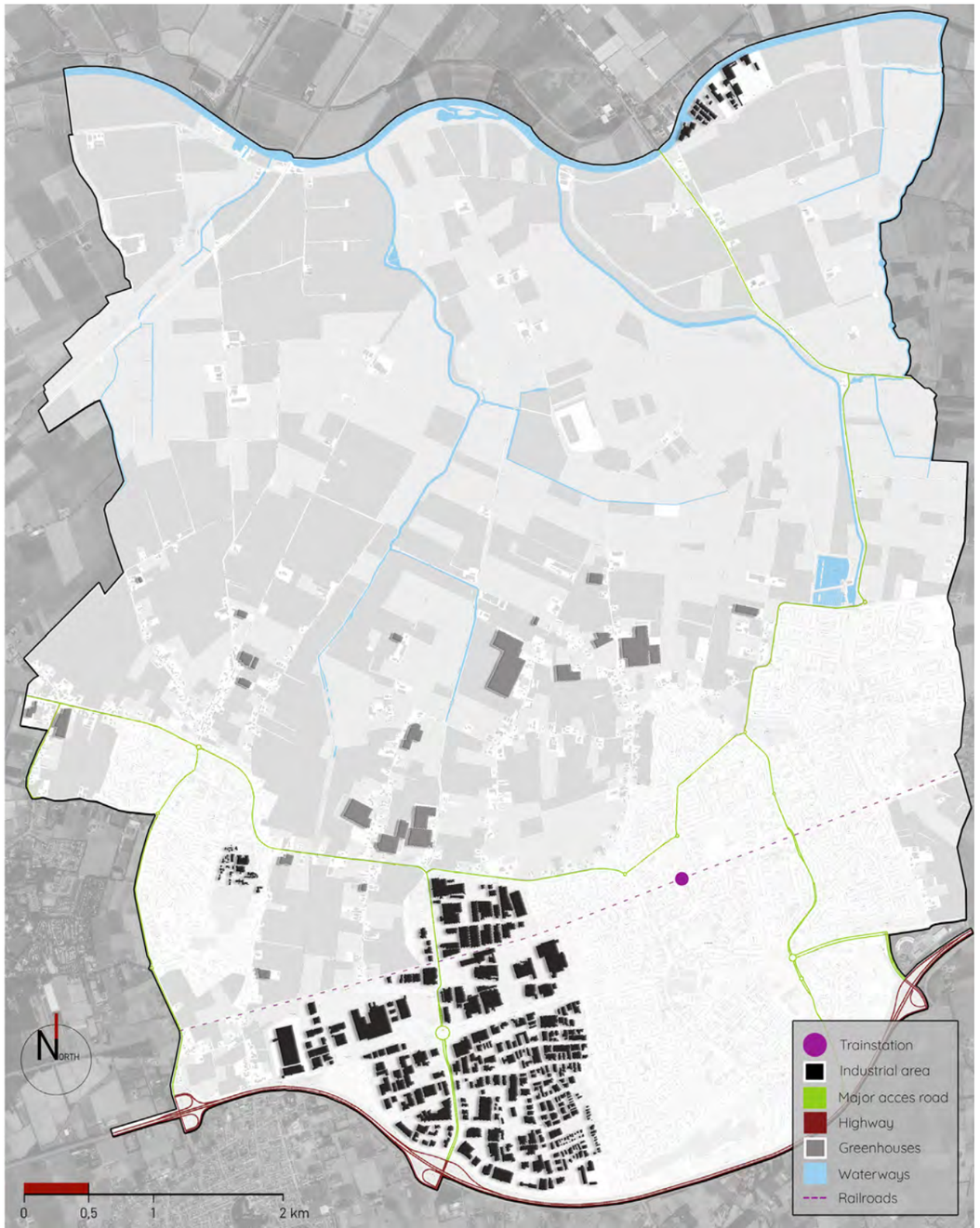
Area

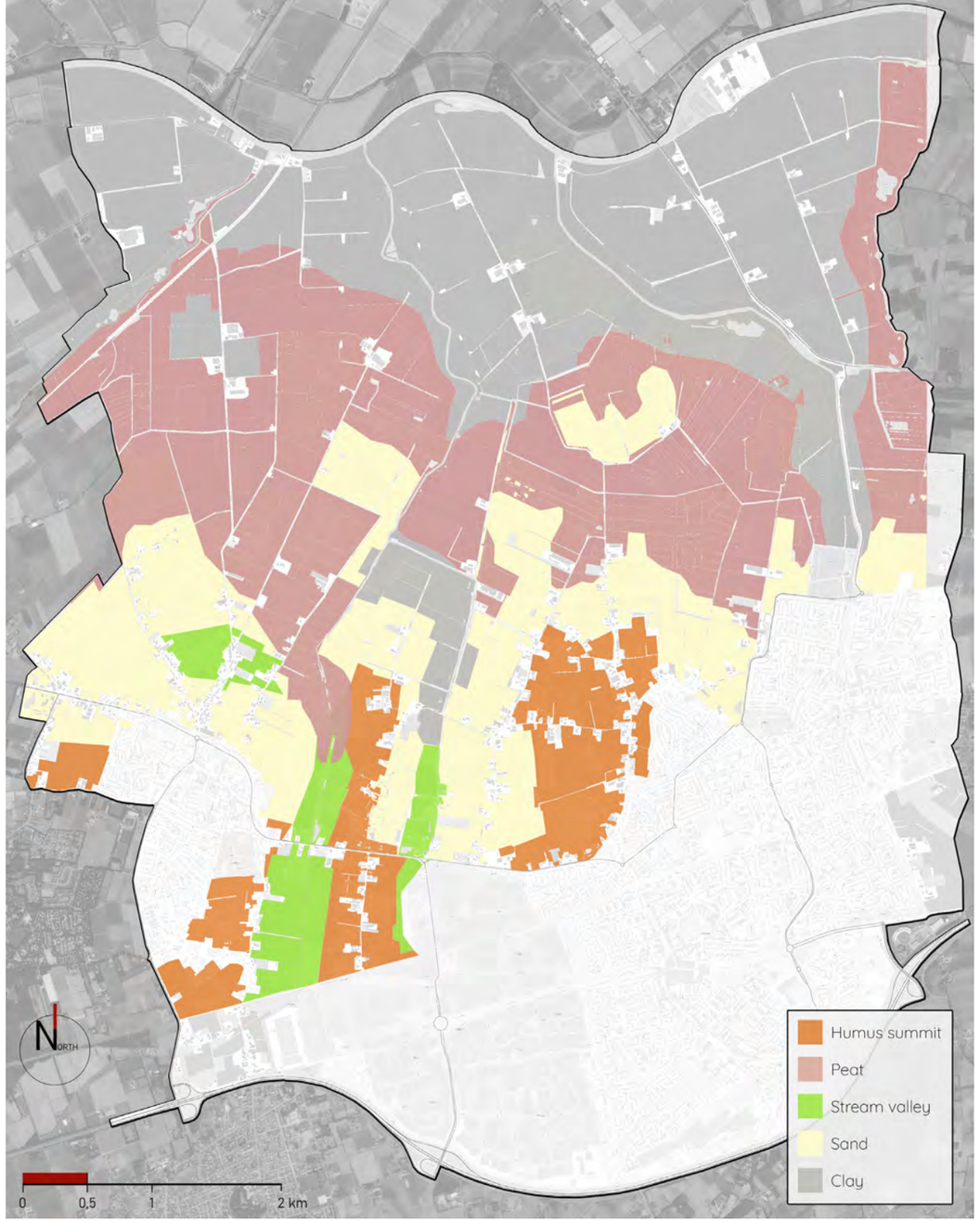
The research area is located in the municipality of Etten-Leur and the municipality of Hoeven. Next to the Mark river the area knows some minor streams which all flow from south to north and end up in the Mark. In the northern part of the area the landscape is experienced as fairly open due to long stretching crop fields or grasslands. The horizon is marked by some rows of wind turbines. Closer to the urban sites of Etten-Leur and Hoeven there are big areas that are covered with greenhouses, although these areas cover quite some hectares they're merely experienced when visiting the area. This is mostly due to green barriers and tree hedges which surround the greenhouses. Except for the main accesa roads the area is characterized by narrow roads of asphalt or Flemish bricks. Most of the farms that are still in use are modern farms which give the landscape a industrial look. Most old-looking farms are used for living. Tree hedges in different densities accentuate the lines in the landscape as well as the dyke of the river Mark.



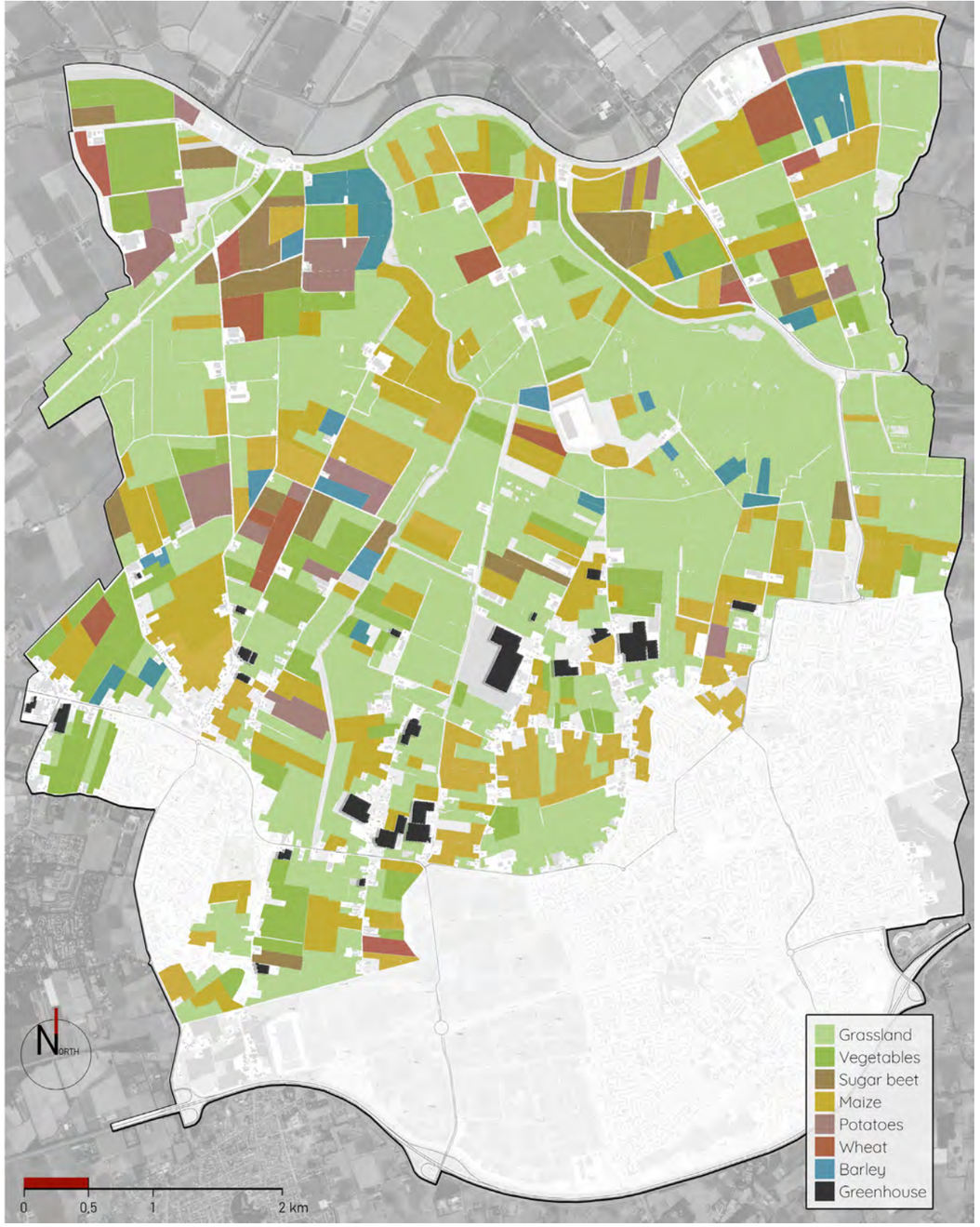
Analysis

Networks: The river Mark in the North could be used as a distribution channel for agriculture products as Etten-Leur has small harbor with the possibility to grow. The industrial area in the North also has some docking possibilities. The city borders are accompanied with major acces roads but they don't lead in to the center of the rural area. In the south the A58 presents a direct connection to several major cities like Breda, Antwerpen and Rotterdam. The greenhouses found in this area are mostly located close to the urban areas. Industrial areas are found close to the highway and accesroads.



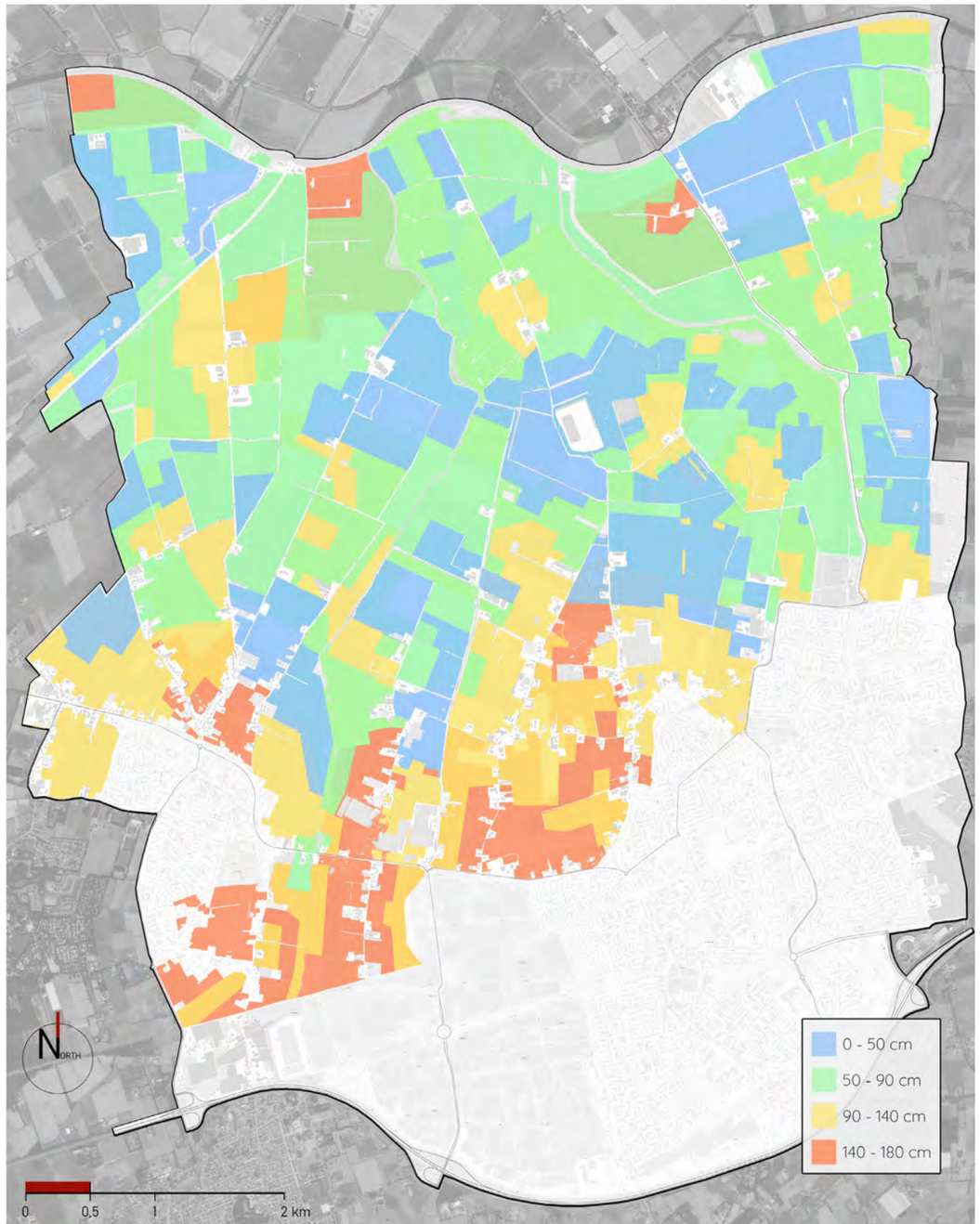


Soil: The area dominantly consists of clay, peat and sandy soils. The clay soils are found closest to the river Mark as the river deposited the clay particles over time. The middle of the area is dominated by peat soils which have arosen over time due to high groundwaterlevels. And close to the urban areas on the more elevated parts of the area we find the sandgrounds. In the Southern part of the area some old stream valleys determine a nutrient rich top layer for the parcels close to these old streams. Humus rich top layers can also be found most likely due to consistent agricultural use of the land. In agricultural terms the sandy soils are the least valueable as they contain much less nutrients than the other soil types (Noord-Brabant, 2021).



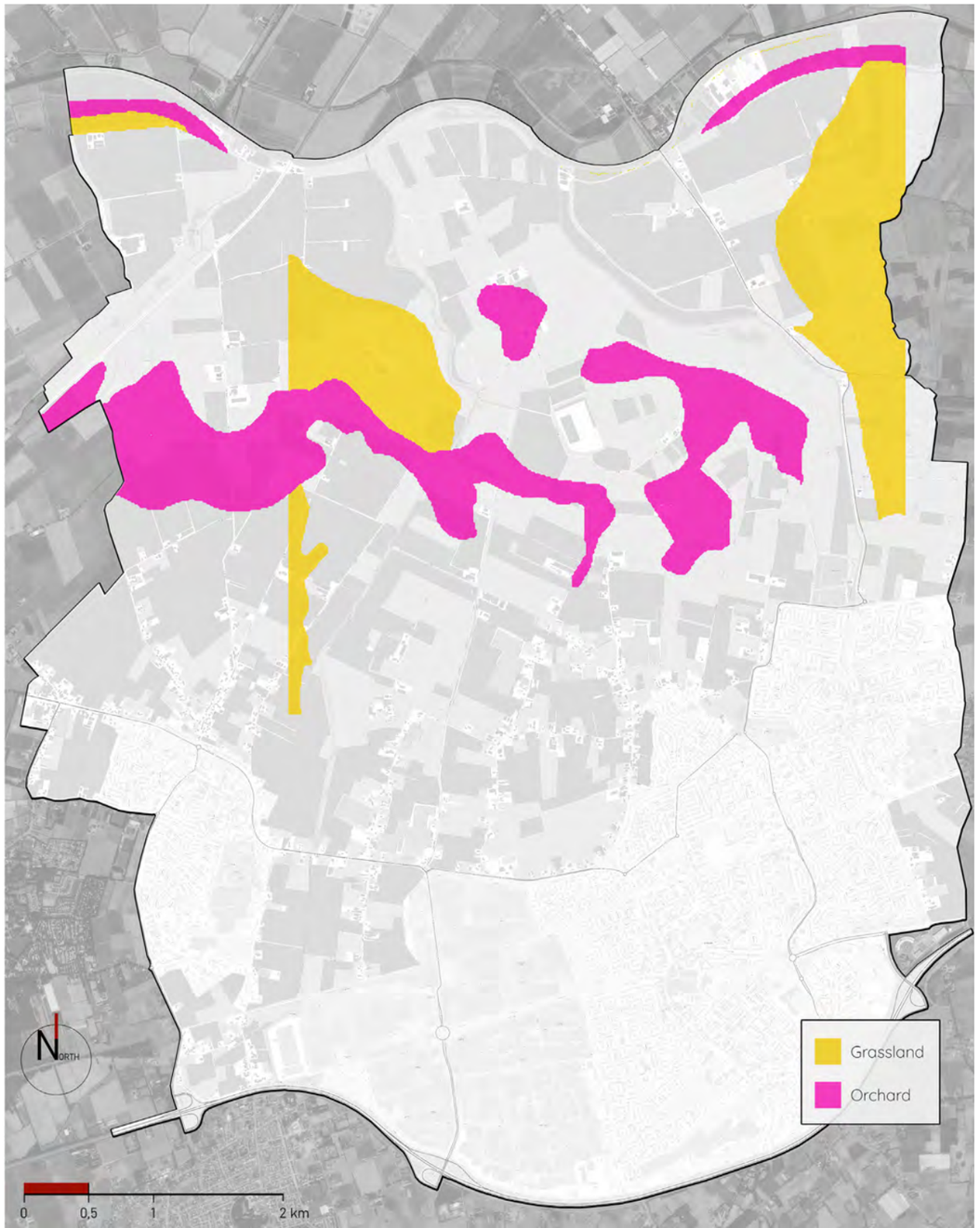
Land use: Most of the parcels in the area are used for grassland varying from intensive to extensive use as well as some natural grasslands. Maize and vegetable production also take up a lot of space in this area, note that this maize is produced for animal feeds and not for human consumption. Although vegetable production in this area takes up over 100 hectares most of the vegetables produced in this area come from the greenhouses close to the urban areas. Less commonly produced in this area are sugar beets, wheat and barley (Onesoil, 2018). Most of the agricultural land use in this area is highly intensified, there's just one farmer in the area which runs an extensive dairy farm called Hillekens hoeve.

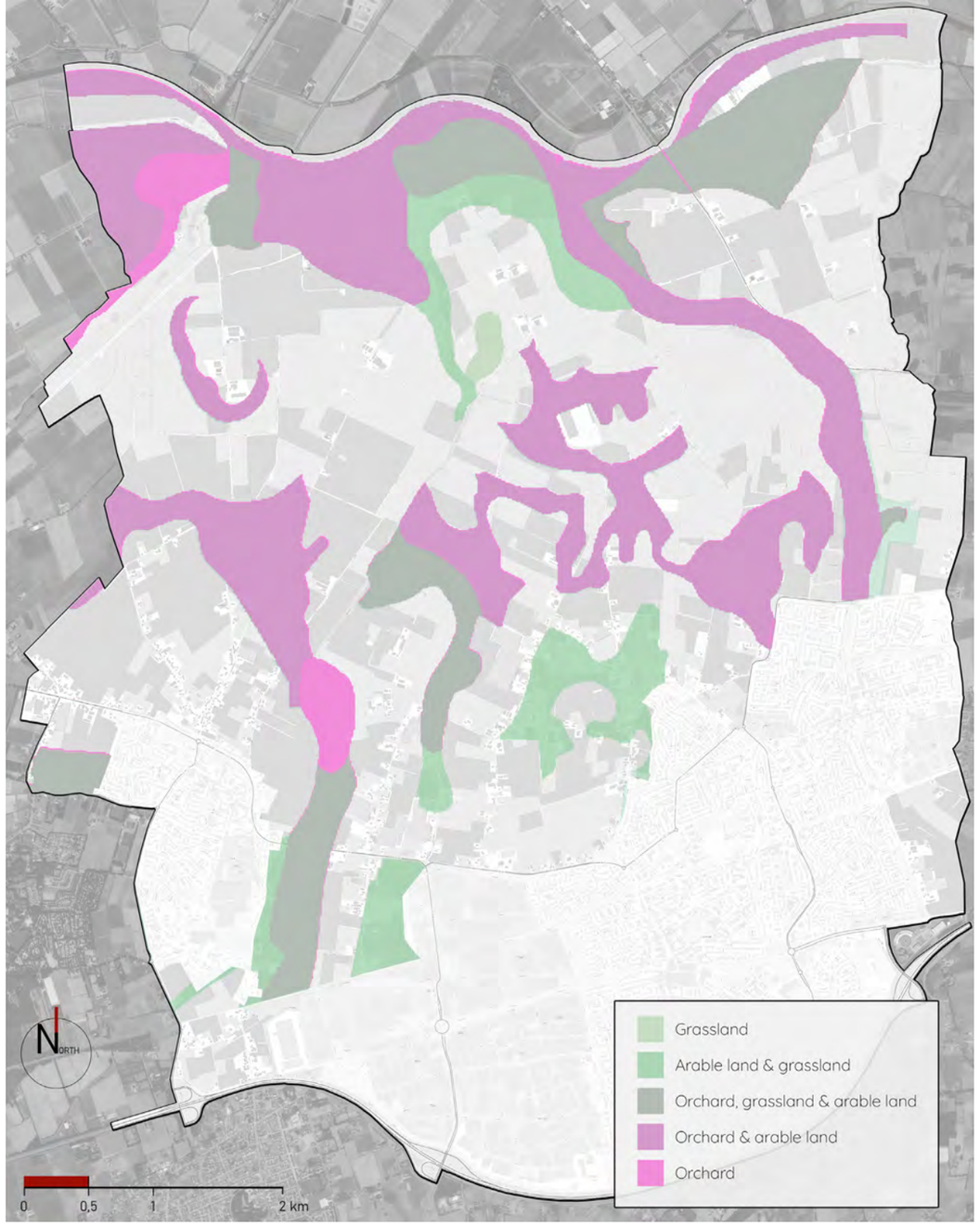
Groundwater level: Most of the area has a fairly wet top layer which explains the dominant use of grasslands. Closer to the urban areas the landscape is slightly elevated which causes the groundwater level to drop rapidly and create a drier top layer. Some minor areas are an exception to this rule as streams cross through the landscape and add to the capillary rise of the groundwater level in those areas (Noord-Brabant, 2021). The wet top layers are mostly accompanied with a nutrient rich peat or clay ground which offers favourable agricultural lands. The more dry areas are some times accompanied with a sandy soil resulting in unfavourable agrvicultural lands and sometimes by soils with a humus rich summit which offers favourable conditions for less water dependent crops.

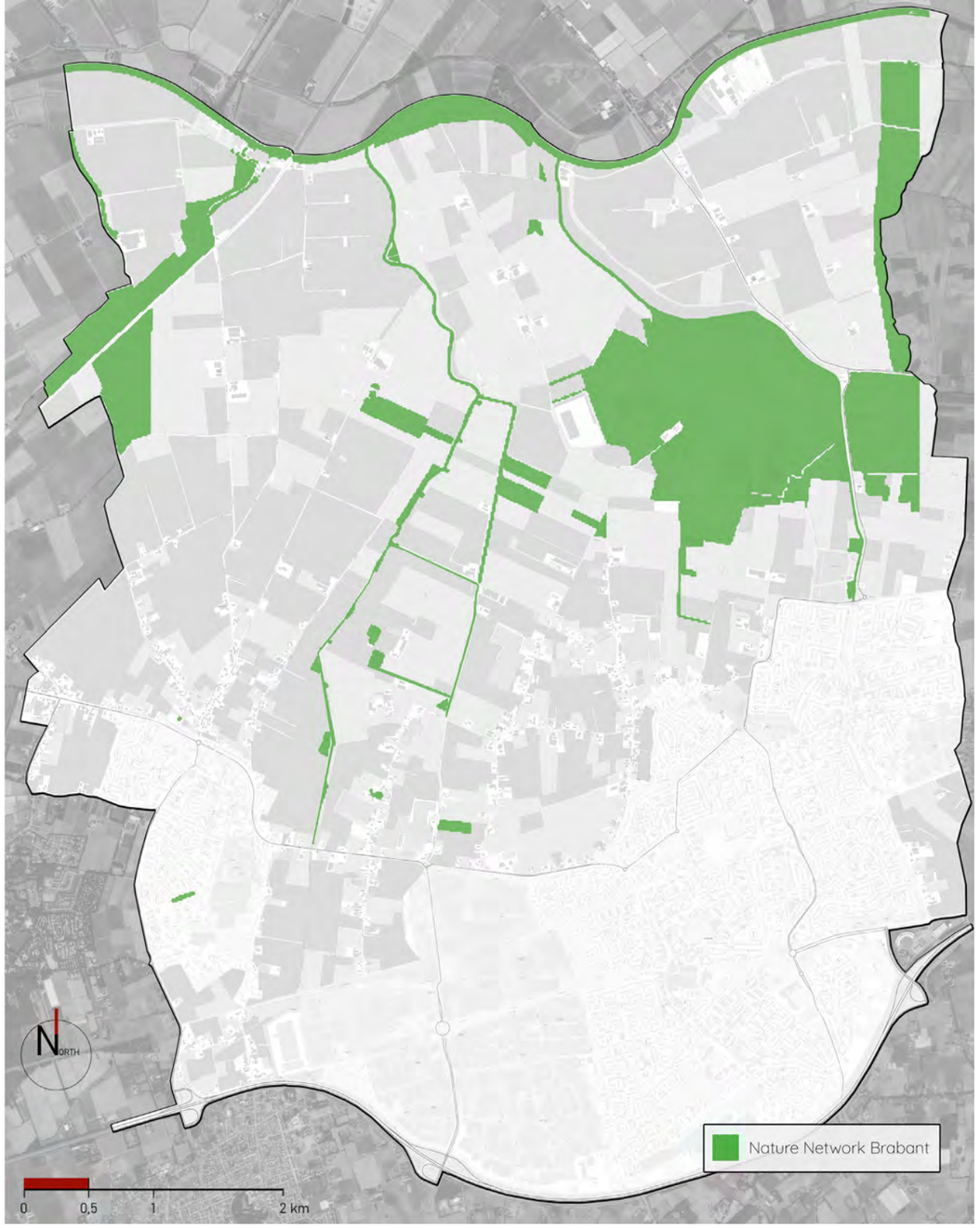


Unpreferred land use: Grasslands and orchards are the two types of land use that can't be implemented anywhere as there're certain risk areas. These risk areas are mostly determined by risks of flooding, risks of drought, unproductive soil types and the ability to use machinery (Noord-Brabant, 2021).

Preferred land use: In this area the best agricultural lands can be found close to the dominant waterways, the parcels often combine a nutrient rich soil type with a medium groundwater level. Although a major part of this area is suitable for orchards there aren't many. This might be due to a high overlap in suitable parcels for arable land and orchards (Noord-Brabant, 2021).







Nature network Brabant (NNB): several parts of this area are marked within the NNB, generally the NNB follows the waterways in the area. In addition there are several nature areas which are combined with this water network (Noord-Brabant, 2021). In the western part of the area there is a small forest like area called Hoevense Beemden which has a high value for local hikers. In the eastern part of the area there is a major natural grassland called the Kelsdonk which is home to the Laarzenpad which is a valuable hikers track. In addition to these bigger structures there are also some minor nature parcels which vary from being owned by Staatsbosbeheer to some privately owned parcels (Verhulst, 2021).

Concept

The agricultural export of the Netherlands is a big factor in its economy, annually exported agricultural products turn over more than 95 billion euros. In addition to this the Netherlands is also one of the main leaders in the transition towards sustainable agriculture (Jukema, Ramaekers, & Berkhout, 2021). The Netherlands is able to be the second largest exporter of agricultural products due to highly intensified production systems. However, as stated in the introduction these can be detrimental towards the physical landscape. A study towards sustainable agriculture in development countries has determined that sustainable agriculture, in which the physical environment is well taken care of, often fail in the development countries. Mostly due to a lack of knowledge, money and national acceptance of a 'sustainable view' (Regmi, 2000).

As these limiting factors are not or at least less limiting in the Netherlands this research stands for the Netherlands as the sustainable producer for the world. For this plan it means that the agricultural production of this area shouldn't decrease while transitioning towards a more circular system. It even embraces the thought of possibly increasing the agricultural production with the help of technological innovation. To make this possible without further burdening our physical environment a more circular system should be i1mplemented to reduce waste streams, counter the depletion of our valuable soil and the pollution of our waters. This transition will have a huge impact on a lot of farms that are producing in a traditional way in the area. Therefore, it's even more important that the agricultural production does not decrease as this cuts directly in the income of the local farmer.

Next to this functional use of the rural landscape this research also emphasises on the experiental quality of the landscape. In most Western societies this has become a more and more important topic in evaluating landscapes and landscape designs due to the impact on recreational value (Goossen, 2000). This is why the recreational value of the area should be preserved while transitioning towards being the sustainable producer of the world. A with coming trend on this subject is the increasingly adopted mindset of people in western societies to know where and how there food is produced (Cairns, 2018). The design for this area will help users to know where and how their food is made.

Landscape conditions

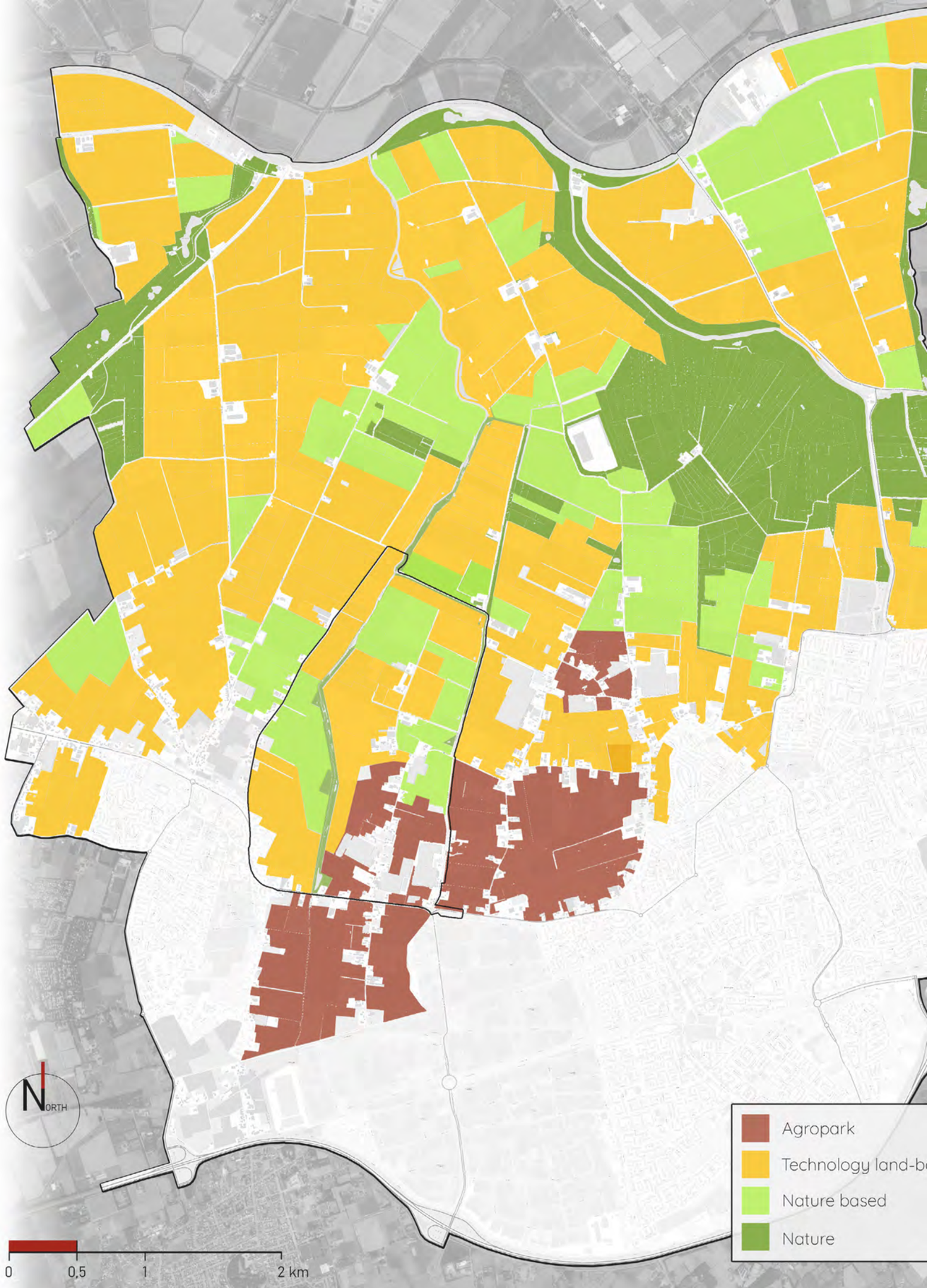
To answer the first SQ the archetypes will be slightly redefined to the concept of this research. As This research strives to find an optimal land use allocation for food production all valuable parcels for arable land will be allocated to the technology land-based archetype to reach maximum production capacity. All less valuable arable land will be allocated to the nature based archetype to improve the sustainable usage of the land building on nature recovery zones for the area. Lastly all unvaluable land will be allocated to the Technology non land-based archetype as its productivity is undependent of the soil due to closed systems production. To clarify, the valuability of the land is based on soil type, groundwater level, current networks and current land use. The first step in this allocation process is based on soil type and groundwater level and is shown in table 3.

	Clay	Peat	Stream valley	Humus summit	Sand	
0 - 50 cm	Grassland Agroforestry (wet)	Grassland	Grassland Vegetables	Grassland Vegetables	Grassland	Nature based
50 - 90 cm	Orchard Maize Potatoes	Vegetables Maize Potatoes	Vegetables Maize Potatoes	Vegetables Maize Potatoes	Maize Turnip	Technology land-based
90 - 140 cm	Vegetables Wheat Barley Rye Sugar beets Maize	Vegetables Maize Potatoes	Vegetables Maize Potatoes	Vegetables Maize Potatoes	Maize Turnip	Technology land-based
140 - 180 cm	Agropark Sugar beets Wheat Barley Rye	Agropark Sugar beets Wheat Barley Rye	Agropark Sugar beets Wheat Barley Rye	Agropark Sugar beets Wheat Barley Rye	Agropark Wheat Barley Rye	Technology non land-based

Table 3: Assesment matrix to determine which land use and archetype are preferred based on soil and groundwater level., based on data from: (Veer, 2006)(Hellegers, 2001)

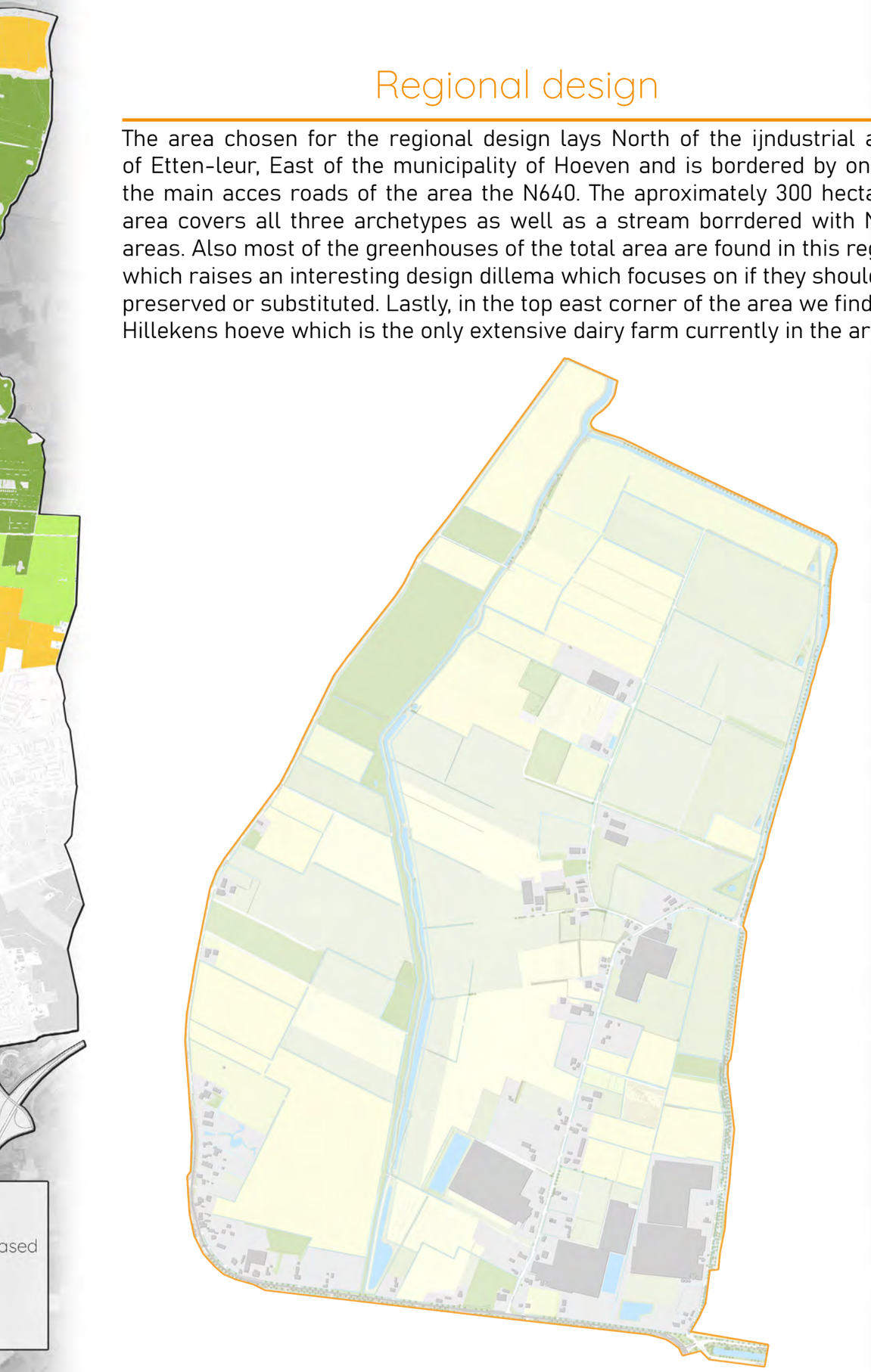
Regional allocation

The second SQ is answered by the allocation map on the right, this map is a result from combining table 3 with the landscape analysis of the area. Following the layer approach table 3 focusses on the substratum layer. The networks layer has been taken into account for allocating the agroparks as export routes are most important for them due to their high productivity. The parcels allocated for agroparks are therefore all unvalueable agricultural lands close to major acces roads. The occupation layer mostly determined the preservation of the current nature network as all parcels that currently fall under the NNB should not be altered. The precise design for the allocated areas will be explored further in a smaller scale regional plan as wel as a detailed design which will both be tested against the criteria for spatial quality.



Regional design

The area chosen for the regional design lays North of the ijndustrial area of Etten-leur, East of the municipality of Hoeven and is bordered by one of the main acces roads of the area the N640. The aproximately 300 hectares area covers all three archetypes as well as a stream borrdered with NNB areas. Also most of the greenhouses of the total area are found in this region which raises an interesting design dillema which focuses on if they should be preserved or substituted. Lastly, in the top east corner of the area we find the Hillekens hoeve which is the only extensive dairy farm currently in the area.



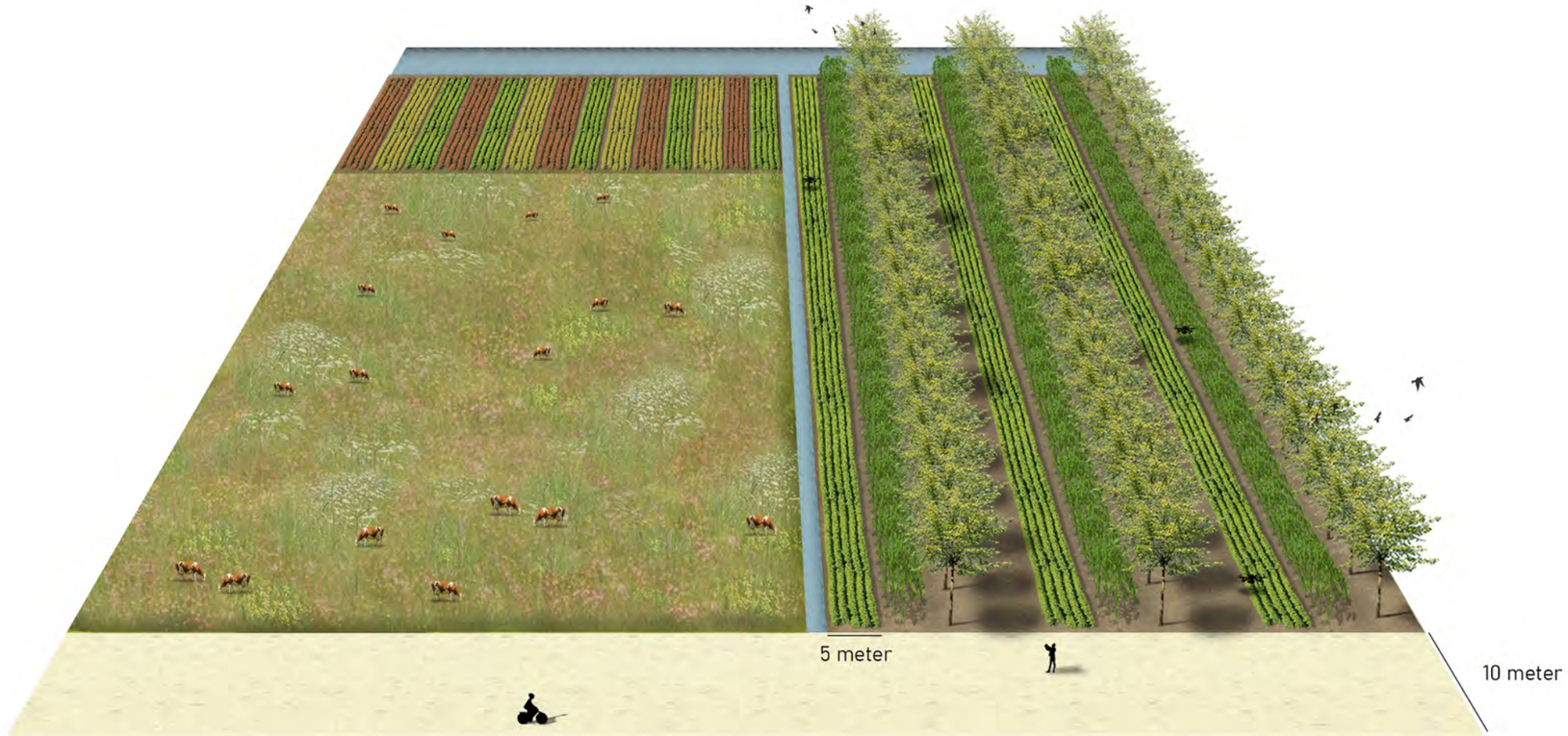
This design uses five different land uses, dry stroke agriculture, wet stroke agriculture, extensive dairy production, aquaculture and agroparks. The current area is home to over 12 hectares of greenhouses which should be replaced with agroparks in combination with extensive dairy production to boost productivity and experiential comfort as well as reducing the stress on the landscape. Greenhouses are accompanied by large water reservoirs to supply the system of water, these can be transformed in a multi-purpose reservoir by building aquaculture ponds in the reservoir. Agroparks use less water due to closed system production and thus the reservoirs can remain at a certain water level which is suitable for aquaculture. In addition the feces of certain fish species can add valuable nutrients for crops to the water.

The extensive dairy production uses natural looking grasslands filled with flower and herb species which give a diverse natural look to the landscape. This creates a contrast with the modern-looking 4 floors high agroparks, a campus-like area focused on agricultural production should be created. The buildings and existing lines in the landscape, often ditches, are accentuated by new tree hedges. These create more diversity in the landscape, smoothen the transition between grassland and agropark as well as offering shade and shelter to cattle. Close to the existing farms the are small parcels with maize or turnip production which provide the dairy farm with extra animal feed for the winter.

The stroke agriculture in this design is divided in two types based on ground water level. The dry type includes a combination of maize, wheat, barley, rye and sugar beets. The wet type includes a combination of vegetables, potatoes, fruit trees and nut trees. The strokes are designed horizontally in the ground plan creating East-West structures in the landscape. This is important as the natural riverbed of the stream in the center of the plan remains visible from the roads and paths in the area. Next to this the crops need to be placed from South to North based on maximum height, this will be further explained in section B-B".

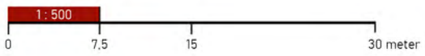
Small parcels of forest-like areas area added close to the stream at the edges of the grassland parcels. The stream and riverbed connect these parcels creating a network between new habitats and niches for different species. The tree hedges should also give the landscape a more closed look making it more attractive for meadow birds as they often only nestle in grassland areas which are sheltered.

The design know two agropark locations, one in the bottom east corner and on in the bottom center. They're connected with an interrupted avenue of trees which accompanies the bike/footpath. In the eastern agropark these trees are already present but in the western park they will need to be planted.



To make sure the natural environment of the stream invisible to the area's users the stroke agriculture is designed in strokes from east to west. However this creates a difficulty regarding crop production as the sun is dominantly shining from the South the design makes sure that the higher the vegetation gets the more north it's placed. After the highest line of vegetation, which are often fruit trees, a small path is designed for operational use and machinery. This path also takes up the area covered in the shadows of the highest vegetation line.

The bike/footpath that runs through the area is 10 meters wide and facilitates for an easy and peaceful use. The user receives the time to observe the landscape and see the technological innovations used in stroke agriculture.



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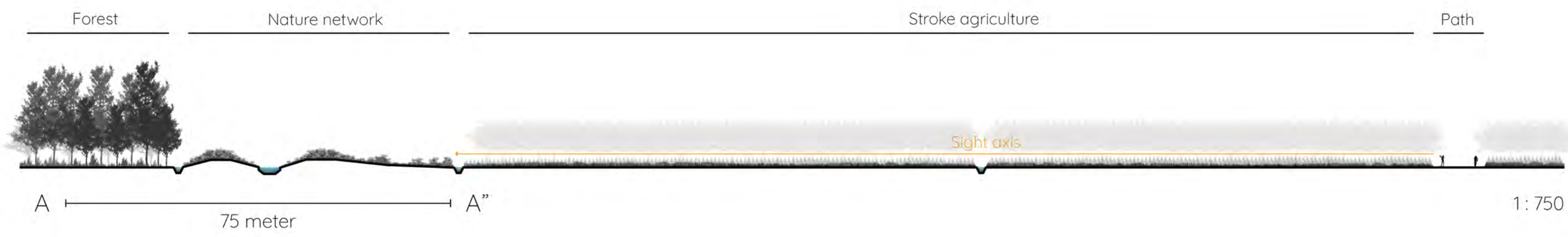


Detailed design

The agropark contains nine 4-storey buildings of which eight rectangular buildings and one circular. The rectangular ones should be production focused with some degree of retail or service and the circular building should be focused on retail, service and agro-tourism. The 4th floor of each building could be designed as the current greenhouses in the area to compensate for the loss of these facilities. However, further research needs to be done to determine if this is preferred over adding another vertical farming layer to the buildings. The buildings should contain a closed system production area for several crops, a visible from the outside processing and packaging area as well as a distribution area for export. The buildings are designed to have a long side towards the paths and roads in the area, this is meant to create a big surface to make the complete process visible through glass from the outside. The distribution areas are smaller sides at the back of these buildings subtracted from the users view.

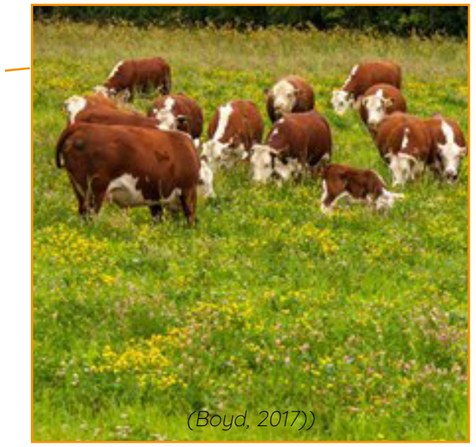
Many of the tree hedges in the design are already in place and almost all except for one don't need to be cut down for any of the buildings. Additional tree hedges are implemented in the design to preserve the closed character of the landscape and add a bit of mystery to the park. The tree hedges smoothen the transition between the 4-story buildings and the grassland. In the center of the park an old avenue of trees is preserved the accentuate the old landscape. Next to diversification in the landscape the trees offer shade to users and cattle as well as shelter for cattle and the buildings. The private areas are secluded from the buildings by tree hedges, in most cases this was already the case but if not it has been implemented in the design to create privacy. Through the center of the park a general axis runs past all the buildings followed by a curling foot/bike path. There also runs a power line over the axis which forced the buildings to move to the outside of the area. This was also preferred as the distribution backsides of the buildings are then closest to the main access roads. The current road system that runs into the area wasn't sufficient to provide for heavyweight trucks used in agricultural export, therefore the eastern road has been widened in this design. The willows that were next to the existing road have been replanted in this design in a high density, only when surpassing a building the density is lower to give the user a good view of the process.

The rectangular water reservoirs have been given a organic form to increase the surface, stimulate a natural look and contrast with the rectangular forms of the buildings. The linear ditch that ran through the middle of the park has been redesigned to flow fluently through the landscape, it also has been widened to provide for natural riverbeds and a less steep slope. The bike/foot path runs curling through the herb-rich grasslands with a view on technological agricultural processes, grazing dairy cattle and agroforestry. The agroforestry is only found in the north east of the area due to soil limitations.

Agroforestry

(Smith, 2018))

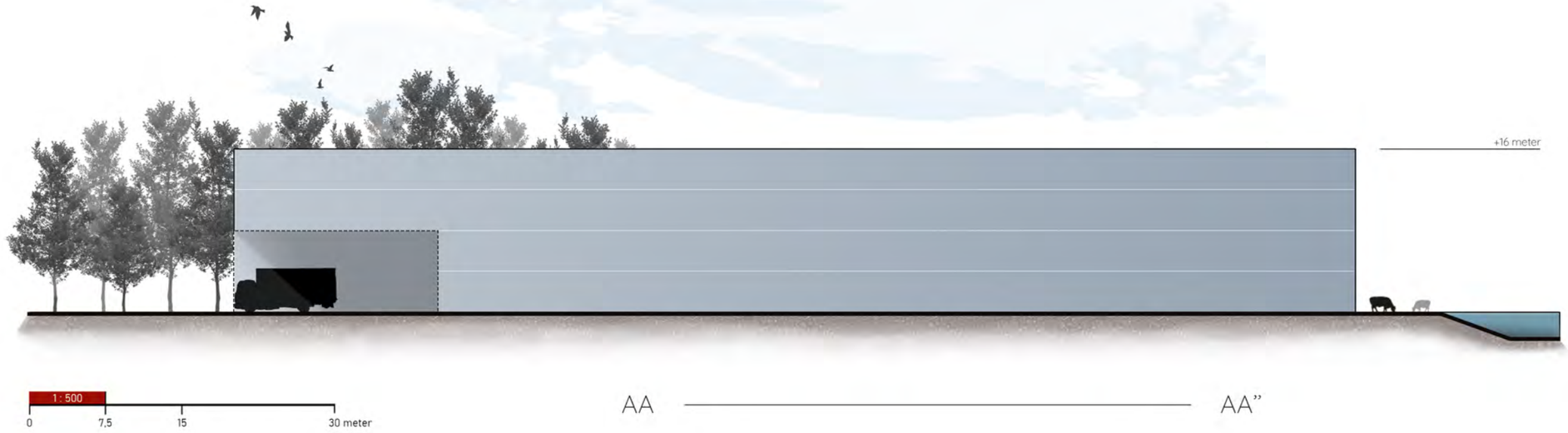
Extensive dairy



(Boyd, 2017))

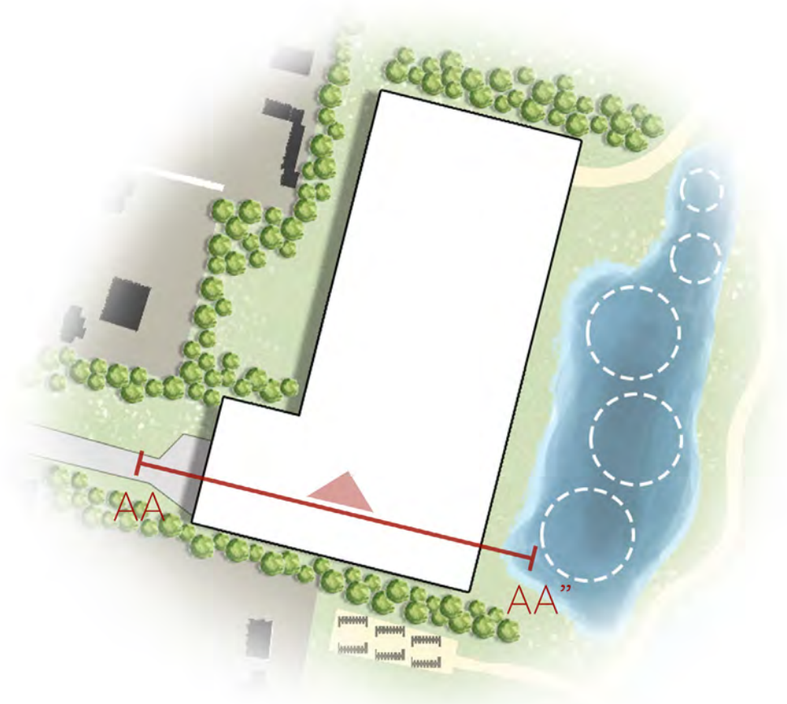
Aquaculture

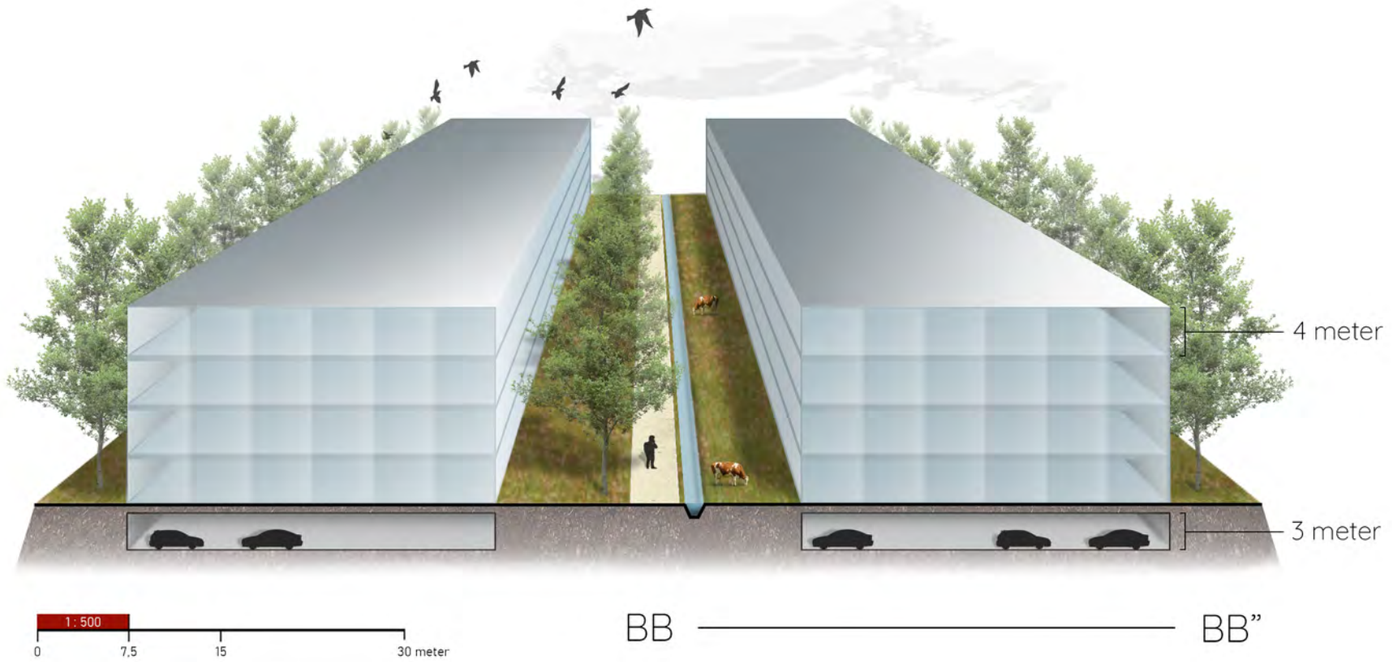
(Hegen, 2017))



As is shown in section AA-AA” the rectangular agropark buildings have a front- and backside. The back is used for all transportation including products, employees and visitors which come by car. The front is used to project the agricultural process to the outside as well as providing an entrance for employees and visitors which come by foot or bike. The front is also facing the herb-rich grasslands which reach as far as the exterior of the buildings.

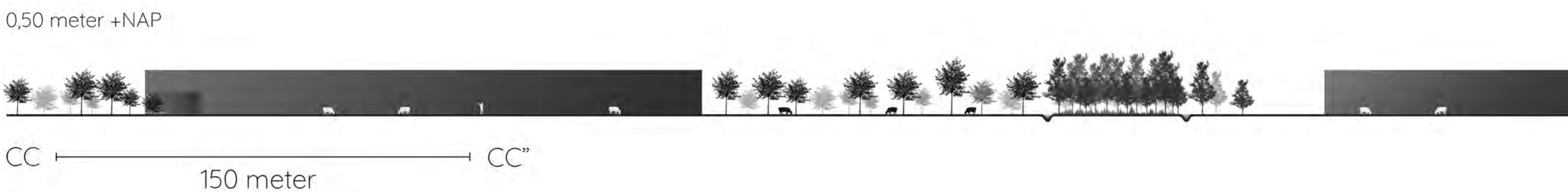
The back of the buildings are covered with tree hedges which hide the main acces point for cars and trucks. These tree hedges also make sure that the privacy of the current inhabitants of the area is preserved. The buildings knows four floors of which at least three should be used for production, processing and packaging. The ground floor can function as a retail or restaurant area, this should be accessible for the general public.

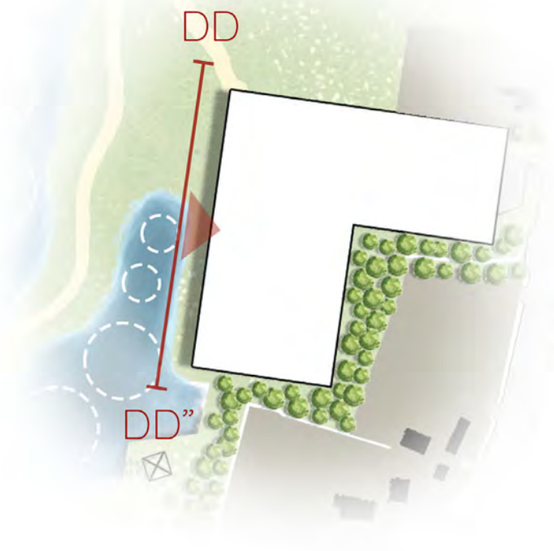




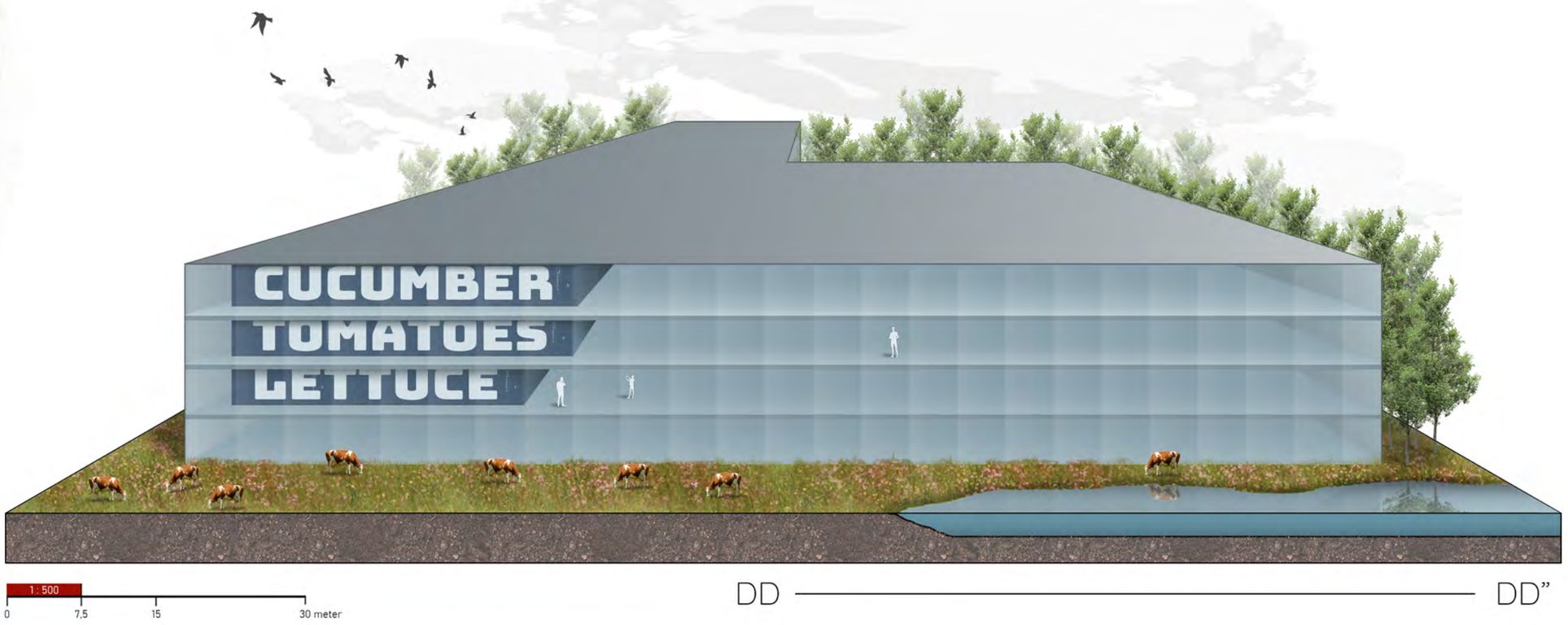
The two buildings in the BB-BB” impression are placed along a existing avenue of trees which continues into the landscape. This avenue is repeated in the regional design to create a passage towards the other agropark. The agropark buildings are facilitated with a sub-ground level parking space for employees and visitors. The ditch follows the tree line and accentuates lines of the old landscape.

The CC-CC” section is a section of the entire park from north to south, this section clarifies the implementation of the long stretched buildings in between the tree hedges or agroforestry. It also shows that the herds of dairy cattle can be found at any moment in the park as the herd is free to move wherever it wants to go. Therefore, the entrances and exits of the park should have animal grids. Limits for the herd within the park should be managed using natural borders such as waterways or thorn bushes.





The DD-DD” impression visualizes the use of glass to give the user of the area an idea of the agricultural process. On the left we see the vertical farming facilities accentuated with crop names. On the right there's free space for processing and packaging machinery. The entire process should be visible for the users of the area. The natural grasslands, dairy cattle and multipurpose pond on the front create a contrast between the natural and the modern industrial.



Design guidelines

From the regional and detailed design six consistent design guidelines (DG) can be determined. (1) Placing additional tree hedges throughout the grasslands following lines of the old landscape. (2) Turning the monoculture grasslands into herb-rich grasslands filled with wild flowers. (3) Building geometrically shaped transparent agropark buildings which show agricultural processes. (4) Transforming old greenhouse water reservoirs into natural looking multi-purpose ponds. (5) Designing curling paths and waterways through a generally geometric landscape. (6) Turning monoculture agricultural fields into stroke agriculture of which the direction is based on view axis.

Diagram 1: Lines in the current landscape (left), tree hedges to accentuate these lines in the design (right)

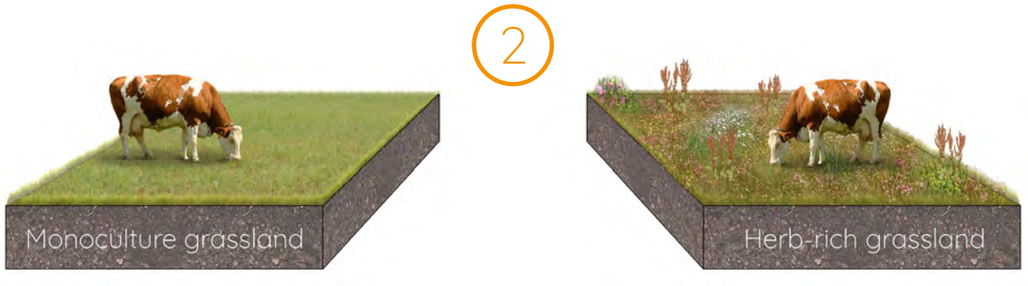


Diagram 2: Transition from monoculture grassland to herb-rich grassland

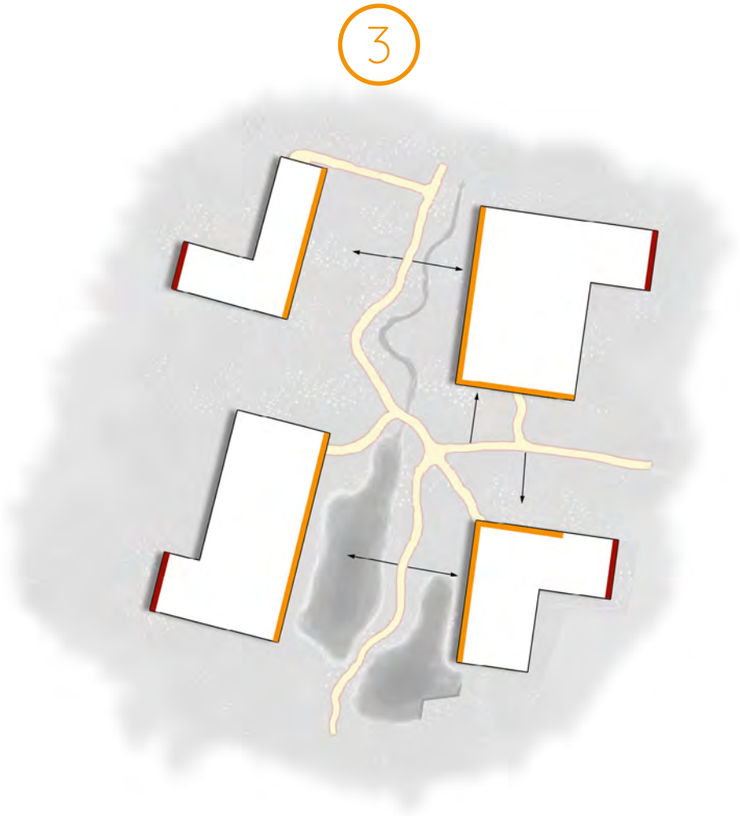


Diagram 3: Straight glass walls along the long side of the building making the agricultural process visible

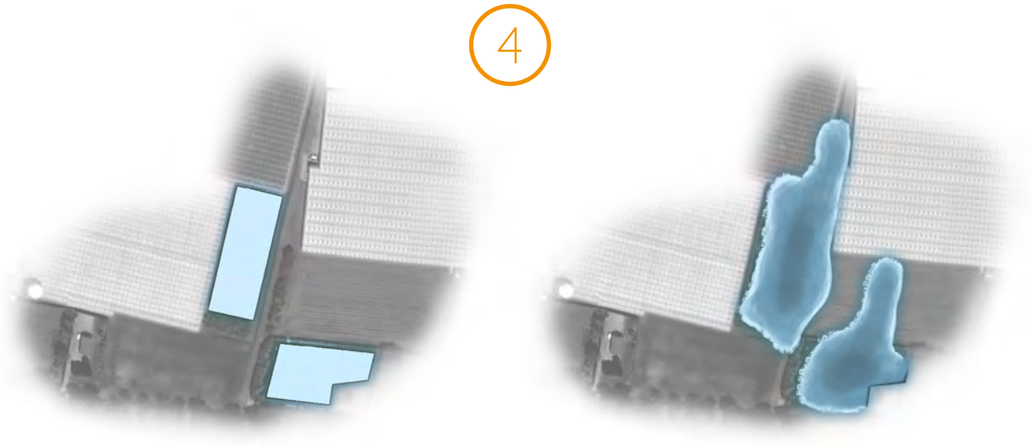


Diagram 4: Current water reservoirs for greenhouses (left) and natural multi-purpose reservoirs (right)

5

Diagram 5: Curling paths and waterways contrasting with geometric lines in the design

6

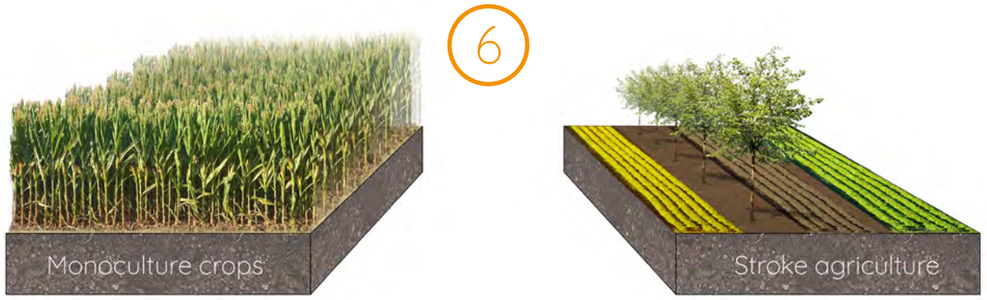


Diagram 6: Transition from monoculture crops (left) to stroke agriculture (right)

In order to test this design on spatial quality the DG's are evaluated with the criteria for spatial quality. To do this consistently a matrix, which is shown in table 4, has been made in which the DG's are scored on a 32-point scale. Every DG can score 0 (no impact), 1 (small impact) or 2 (big impact) per criteria. In this research a 'impact' will be seen as a positive effect on the criteria, a big impact (score = 2) on openness or profitability will represent more openness and higher profitability. Following this definition a DG with a higher score on the 32-point scale will be assumed to have a better impact than those with a lower score.

Experiential						
Criteria	DG1	DG2	DG3	DG4	DG5	DG6
Openness	0	2	0	2	1	2
Regional character	2	2	2	1	1	2
Naturalness	2	2	0	2	2	1
Visual heterogeneity	2	2	2	2	2	2
Historicity	2	1	0	1	0	0
Coherence	2	2	1	1	1	2
Cues of care	0	1	2	2	1	2
Seasonality	1	2	1	0	0	2
Multi-sensory	0	2	0	1	1	1
Economic						
	DG1	DG2	DG3	DG4	DG5	DG6
Profitability	0	0	2	2	0	2
Local economy	0	1	2	1	0	2
Recreational facilities	2	2	2	2	2	2
Long-term						
	DG1	DG2	DG3	DG4	DG5	DG6
Circularity	1	2	2	2	0	2
Flexibility	1	2	0	1	1	2
Ecological						
	DG1	DG2	DG3	DG4	DG5	DG6
Abiotic	2	2	2	1	1	2
Biodiversity	2	2	0	1	1	2
Total score	19	27	18	22	14	28

Table 4: Assesment matrix for design guidelines based on the criteria for spatial quality

Based on this matrix especially DG2 and DG6 score well, both being changes in agricultural land use and thus having an effect on almost all criteria. As this this design is mainly focusses on diversification, coherence and heterogeneity these are the criteria on which all DG's score quite high. As in some areas the spatial quality is dependent on multiple DG's the total score of an area might be higher.

DG1: *Placing additional tree hedges throughout the grasslands following lines of the old landscape.* This DG scores high in the experiential assessment as the new tree hedges have a high impact on the diversity and naturalness of the landscape. Due to the smoothening of the transition between grassland and agropark it also adds to the coherence and heterogeneity. The base on old landscape lines as well as tree hedges which are currently in the area add to the historicity and regional character. In an economic view the tree hedges don't have any added value except for recreational as they do add to the overall experience of the landscape for users. Ecologically the tree hedges are very valuable as they function as small nature parcels with a high biodiversity also providing for a nature recovery zone in this circular system.

DG2: *Turning the monoculture grasslands into herb-rich grasslands filled with wild flowers.* This DG scores vey well overall as it impacts almost every feature of a landscape. The variety in vegetation through the sowing of different herbs, grasses and wild flowers adds to all the assessments criteria. It adds to biodiversity, diversity, seasonality and coherence. The extensive dairy production is linked to the historicity, the regional character and to the long-term aspects of the landscape. The only part on which this DG scores low is economically due to the extensification. However this is compensated by the combination with the highly productive agroparks.

DG3: *Building geometrically shaped transparent agropark buildings which show agricultural processes.* This DG scores rather low on the experiential assessment but compensates with big economic and circularity impacts. On the experiential assessment the agroparks mostly lack on historicity, naturalness and openness. This is mostly due to the modern innovative approach to agroparks, in this design this will be compensated by the combination with extensive grassland. However the buildings do add to visual heterogeneity and cues of care. Economically this DG scores very well due to it's high productivity as well as the ability for users to observe and buy the locally produced food. In abiotic terms this DG also scores high as it reliefs other areas from intensive production and so contributes to the preservation of the landscape.

DG4: *Transforming old greenhouse water reservoirs into natural looking multi-purpose ponds.* This DG scores high overall as it makes use of an existing landcape ellements and aims to transform it in a better fitting element with multiple purposes. Experiential this DG is an improvement as it stimulates, naturalness, heterogeneity and cues of care. Economically it also scores high due to the multi-use as reservoir and as aquaculture pond. The natural form and less steep slopes contribute apart from the experiential assessment to the ecological assessment as well. In a circular perspective this DG is a leading example due to multifunctionality and waste-stream usage.

DG5: *Designing curling paths and waterways through a generally geometric landscape.* This DG scores the lowest of all which is most likely caused by the small size of the intervention. It has relatively no impact on the economic assessment as well as on the long-term assessment. However, it does contribute to the experiential assessment and scores high on naturalness, and heterogeneity. The widened streams also contribute to the ecological assessment as new habitats are created in the natural riverbeds which help to capture washout nutrients from the agricultural landscape.

DG6: *Turning monoculture agricultural fields into stroke agriculture of which the direction is based on view axis.* This DG scores highest overall and has just like DG2 a very high impact on all assessments as it transforms the total land use. The cultivation of multiple different crops adds to the heterogeneity, coherence, seasonality, cues of care and openness. The base on view axis towards natural features in the landscape adds to this experience. In the economic assessment this land use should become very profitable as it builds on the newest innovations and technology, it also provides for the local production of multiple crops. The diversity in crops adds to both ecological features as well as the circularity of the system.

Overall all DG contribute to an improvement in spatial quality based on the assessment matrix. DG2 and DG6 the most as they are the interventions with the largest scale. However this research realizes that spatial quality is experienced by its users through an area and not one specific DG. DG1, 2, 3, 4, and 5 are present in the designed agropark landscape shown in the detailed design. In the agropark as a whole the DG's compensate for each other on the criteria that they lack. As mentioned the economical infeasibility of the extensive grasslands is compensate by the agropark buildings and in turn the experiential lack of these buildings is compensated by the herb-rich grasslands. DG6 originates from the regional design and already scores very high, this could be even higher when explored with a detailed design but this research chose to focus on the agroparks.

In terms of archetypes the DG's can be divided. DG1, 2 and 5 are linked to extensive dairy production and so they represent the nature based archetype. DG4 and 6 are driven by technology but are land dependent and thus represent the technology land-based archetype. Lastly the third DG solely focuses on the design of agroparks and so represents the technology non-land based archetype.

Discussion

This chapter aims to explain and clarify assumptions and possible flaws in this research. To validate the overall validity of this research these assumptions should be checked with further research.

First of all the design guidelines are scored based on the criteria for spatial quality from Bakx. The matrix used in this research states that if a design guideline has a impact on a criteria this is assumed to be a positive impact. For example, the design guideline leads to an increase in openness and this is seen as a positive impact on the landscape. However, this doesn't have to be the case as dominantly open landscapes with little diversity can also be experienced as boring. An element in the matrix which reduces this subjectivity is the use of multiple criteria to score the design guidelines. Still this research believes that it's crucial that a designer only uses the matrix as a tool and not as a strict law on how to design a landscape.

Secondly, this research assumes that all greenhouse owners in the area have the financial capability as well as incentive to tear down their current operations and invest in expensive new agroparks. Ofcourse this research thinks authorities should have an important say in this and so also collectively finance this investment. Still the current parcel owners have to be onboard and willing to contribute to this radical change. This research believes that these currently technology based farmers (greenhouse owners) can be convinced with arguments based on increased production, use of innovative technologies and more efficient use of resources. This research also believes that it's very important to offer current owners the opportunity to acquire a meaningful function within the new agropark sector. The new design practically asks the current owners to share their land with a collective based on an idea which thrives on the 'greater good'. To convince farmers of this ideology has been an issue in the Netherlands for decades. This research does believe that the implementation of extensive agriculture and intensive technology based agriculture in these agroparks provides for a more widened compensation offer for current farmers as it gives them the opportunity to choose for themselves which sector to continue in.

Thirdly, this research assumes that implementing aquaculture in the water reservoirs of the agroparks doesn't lead to any complications such as water pollution with infections or bacteria. It might occur that certain fish species used in aquaculture carry unwanted bacteria for certain crops, this would pollute the water reservoir and make it unusable for crop production. The other side of this effect is that certain fish species might add to the water quality by adding nutrients through feces. To determine which fish species is the most beneficial further resource needs to be done towards nutrient and bacteria excretion in aquaculture ponds.

Fourthly, this design primarily makes use of tree hedges to smoothen the transition between the agropark buildings and herb-rich grassland. The buildings are 16 meters high and thus quite large tree hedges are needed to provide for this transition. As several tree hedges need to be planted upon executing the design it might take several years, maybe decades, for the area to appear as formulated in the design. It's also important that the tree hedges are filled with three species which acquire a height of 15 - 20 meters. As tree hedges are generally a artificial nature based implementation they consist of multiple species dependent on the area. This design doesn't define specific species which might lead to the planting of trees which will remain too small to facilitate for the transition.

Lastly, the design guidelines have been graded by a singular researcher/designer which creates the possibility of the assessment being biased. Although the researcher has attempted to remain objective on this matter it remains difficult as no concrete values have been added to the criteria for spatial quality. For example the openness of an assessed area hasn't been linked to a certain limit of square meters open ground but more towards the professional perception the designer/researcher has of the area. In order to tackle this validity problem it would be wise to have multiple professional designers asses the design using the assessment matrix. An average assessment could be derived from this process leading to a higher validity based on multiple professionals.

Conclusion

To investigate what design guidelines are for different archetypes in circular agriculture this research determined what preferred landscape conditions are per archetype, which landscape conditions are present in the area and which design guidelines contribute to the spatial quality of the designed archetypes. This research also determined that designs for sustainable circular agriculture should not limit the potential production capacity. The Netherlands is a country in which sustainable agriculture has the potential to grow and so provide for countries less applicable for sustainable agriculture while preventing damage to the physical landscape.

The first sub question concluded that the wet and sandy soils in this area should be used for the nature based archetypes as the production potential of this parcels are already low. The layer approach determined that extensive dairy production on herb-rich grasslands is most suitable for this area. The most valuable soils with good access to groundwater and nutrient rich top soils are most suitable for the technology land based archetype with stroke production of vegetables, potatoes, fruit trees and nut trees. The valuable soils with lesser access to groundwater but with a nutrient rich top soil are most suitable for the technology land-based archetype with stroke production of maize, wheat, barley, rye and sugar beets. Unvaluable soils with minimal nutrients and almost no acces to groundwater shouldn't be used for land-based agriculture production and are suitable for agroparks due to their independence of soil type. However, they are located based on the networks and occupation layer as infrastructure and transition costs are highly relevant for this technology non-land based archetype.

The second sub question determined that the area can provide for all three main archetypes based on a landscape analysis through use of the layer approach. An allocation per parcel shown on page 10 is the result of this landscape analysis combined with the results of SQ1. This allocation divides the tree archetypes to the preferred landscape conditions as well as preserving the current nature network. The agropark and technology land based allocation is further divided on a smaller scale to allocate dry stroke agriculture, wet stroke agriculture, agroforestry, agropark buildings and grasslands.

The third subquestion has derived six design guidelines for different archetypes from the regional and detailed design.

1. *Placing additional tree hedges throughout the grasslands following lines of the old landscape.*
2. *Turning the monoculture grasslands into herb-rich grasslands filled with wild flowers.*
3. *Building geometrically shaped transparent agropark buildings which show agricultural processes.*
4. *Transforming old greenhouse water reservoirs into natural looking multi-purpose ponds.*
5. *Designing curling paths and waterways through a generally geometric landscape.*
6. *Turning monoculture agricultural fields into stroke agriculture of which the direction is based on view axis.*

The second and sixth DG have the most impact on the spatial quality of the landscape, they're also generally applicable. The fourth DG also has a high impact and also presents itself as typical DG for circular systems. The others score a bit lower but still have a significant impact on the spatial quality of the area. DG1, 4 and 5 are very specific towards the landscape of Etten-leur and so less applicable in general, this could be changed with minor adjustments to the guidelines based on the landscape that is designed.

Based on the assessment for spatial quality all proposed design guidelines are deemed applicable and valuable for the area of Etten-Leur. For this area the first, second and fifth design guideline are proposed for nature based circular agriculture in Etten-Leur. The fourth and sixth design guideline are proposed for technology focused land-based circular agriculture in Etten-Leur. Lastly the third design guideline is proposed for technology focused non land-based circular agriculture in Etten-Leur.

Reflection

This chapter reveals some insight in obstacles this thesis and its researcher faced during an intensive eight-week period in which this thesis was established. This might help to clarify the structure of thesis as well as create a list of learning points for the research himself. The researcher thinks that this thesis shows skills of adaptation, lay-out, visualization, structure based work and research-based design. The main learning points are focused on writing, literature study and preparatory thesis structure.

This thesis might appear as 'short' as it uses 26 pages out of the 30 pages limit. The researcher thinks that this mostly lacks on textual contents based on additional literature study to explain design choices. In his opinion the thesis process has been focused on designing for a little too long resulting in time management issues for the writing of the actual thesis. Therefore, he is satisfied with the final design and results but thinks the explanation and argumentation of the design could have been specified. The researcher has started his writing effort rather late in the process resulting in additional time loss to re-discovering his design choices and arguments. For future research this could be tackled by alternating between designing and writing. When a design choice is made the researcher should aim to immediately write down this design choice and create an written-out argument for it, this will definitely reduce the amount of time loss and increase the amount of textual completeness. This would have automatically resulted in a thesis backed with more literature due to increased literature study towards these design choices. Although the researcher thinks the amount of references in this thesis is rather low he doesn't think the results are affected by this. The necessary literature used in the analysis was found and thus creates a solid base for the design. However, this based could have been expanded to create a more solid argument for the radical transition in land use.

Additional to obstacles in writing the content of this thesis the researcher also experienced unforeseen difficulties in determining a fitting proposal. The original structure was based on an analysis, a regional design and a detailed design. However, when the thesis developed the researcher discussed with his peer to specify on the agropark archetype. They concluded that there were several interesting design problems which could be solved if the focus was shifted towards the details of an agropark. This resulted in a new structure based on new research questions, this focused on an analysis which would lead to a regional allocation, a smaller scale regional design and a detailed design focusing on agroparks. Although the research understands that this process is part of a thesis and doesn't have to be particularly bad it did lead to additional work as well as doing several steps twice.

To end on a positive note the researcher did somewhat surprise himself with the capability of digitally visualizing his design, in his opinion this thesis truly shows the visual skills gained over the bachelor period. This shows itself in use of lighting, use of scale, use of texture and use of perspective. The researcher is also satisfied towards a more minimal approach towards sections and general lay-out. 'less is more' actually creates a lot of tranquility in the representation of the design.

A final note towards the peer of the researcher. During the process the researcher experienced a pleasant relation with his peer, varying between a professional as well as friendly relation. Communication and feedback was clear, accesdsible and direct which worked very well for this thesis.

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