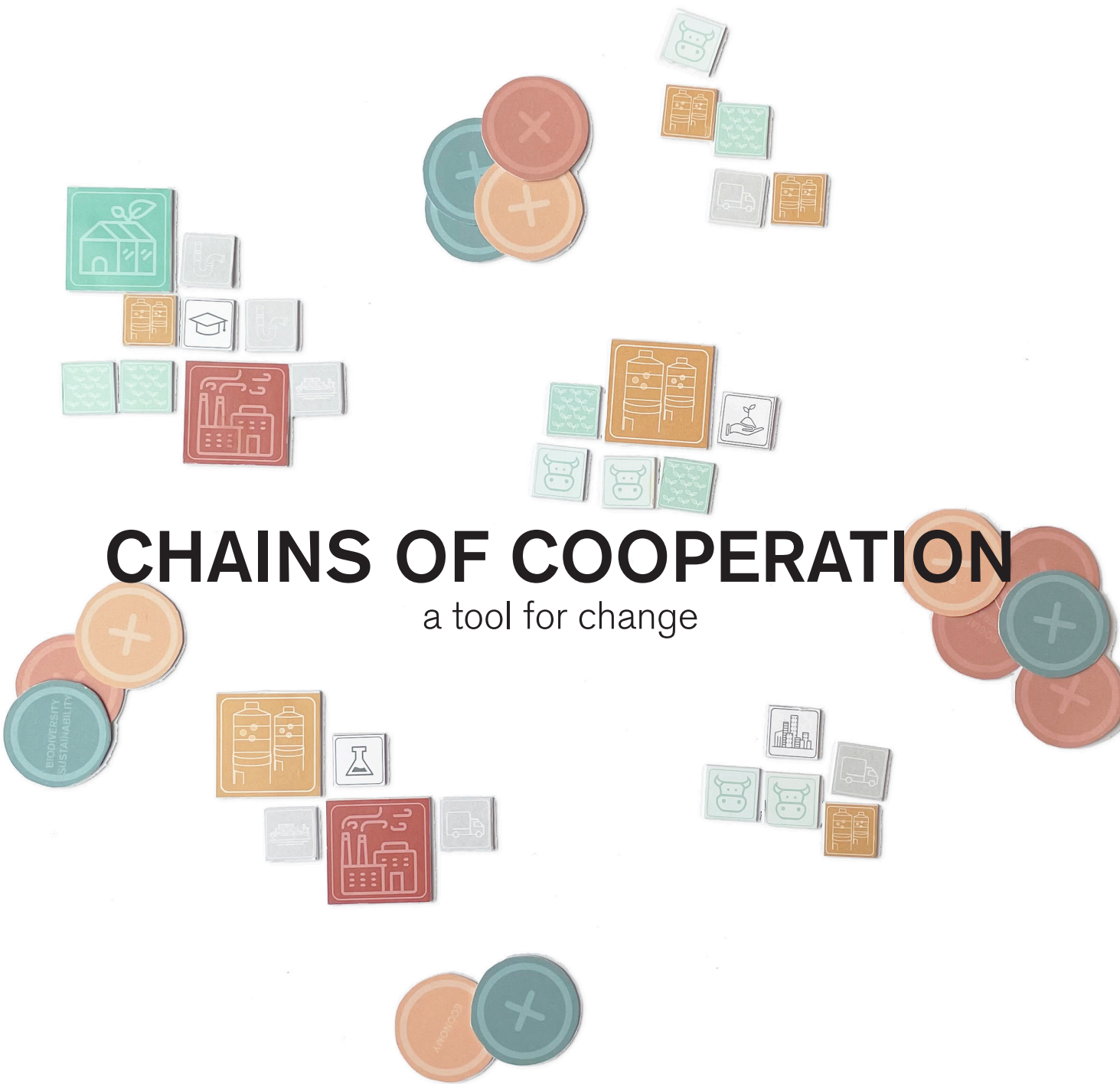




CHAINS OF COOPERATION

a tool for change

colophon

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AR2U088 Research and Design Methodology for Urbanism

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Chains of Cooperations is a regional project for the Province of South Holland that was fully design through a game. It depicts cooperation as a way to stimulate a circular economy in which waste is transformed into value.

introduction

introduction to bio-based economy

abstract

table of content

In this chapter we will give a short introduction about the content of this report.

We first introduce the definition of bio-based economy. Secondly, the abstract summarizes our project and research. Lastly, the content of the whole report.

The bio-based economy was the starting point of the project and determined the direction we took for our research. A bio-based economy is a complex concept that is now upcoming and will be important in the future. It is, therefore, essential that we define our understanding of a bio-based economy.

introduction to bio-based economy

It is a common goal of the Province of South Holland and the Port of Rotterdam to strive towards a transition for a circular economy. A circular economy is an economy which emphasizes the environmentally and economically sustainable ways of using natural capital and resources (& Metabolic, 2018). Therefore, the Port of Rotterdam has recently developed several visions that have the ambition to change their economy implementing more 'waste to value' technologies and, consequently, becoming a more sustainable greenport'. (Port of Rotterdam, 2019b).

The ambition on becoming a greenport comes after several years of the Port of Rotterdam decaying on the ranking of best ports in the world, and function as a counter response to becoming a port pioneer on sustainability and clean energy and again standing off next to the big Asian ports (Gemeente Rotterdam, Provincie Zuid-Holland, Port of Rotterdam, Rijksoverheid & Deltalinqs, 2019). Within the ambition to transit to a circular economy, the use of biomass and organic materials have big potential to contribute to becoming a circular port and the to create a bio-based economy in the Province of South Holland.

A bio-based economy is an economy that uses organic waste from the agriculture and food industry for non-food applications. Organic waste serves as a resource that is later used as biomass for green refineries (Vermeulen & van der Waal, 2015). Nevertheless, the growing biomass still does not compete with

food production as the waste that arises during the food production is the biggest target source of waste up until now. The biomass from this type of waste can be processed into green materials, chemicals, transport fuels and energy (electricity and heat). (Rijkdienst voor Ondernemend Nederland, 2021).

Within the potentials regarding bio-based economy, the agri-waste in the province showed itself as a promising asset. The Province of South Holland is known for a big agricultural sector which covers half of its surface and produces millions of products for the food industry. Glasshouses and food production from the province are the biggest exporters and producers in Europe. Therefore, the agricultural sector provides a substantial amount of organic waste during the production of food, plants and breeding of livestock. The port itself also provides food-waste, paper, pulp and wood waste. And, as before mentioned, in a bio-based economy, all these bio-materials can be used to produce bio-energy and bio-chemicals (van Barneveld et al., 2019).

In this report we will take a close look at the combination of the agriculture, glasshouses and the port in the whole Province of South Holland, depicting our vision on potentials and possibilities of interventions.



Figure 1: Abstract visualization of opportunities for bio-based economy in South Holland

abstract

The province of South Holland is a region in the Netherlands that can be characterized by its flourishing economy. The place where the vein of the river Maas stretches out over land and the Port of Rotterdam has settled in as a strategic trade-point. Moreover, the abundant agricultural sector in Westland holds accountable for not only multiple glasshouses, but also many livestock farms in the province.

When it comes to social inclusion in this big trade-port frame, the disconnection between the workers of the port to the chain of trade they are involved in is clearly noticeable. At the same time, farmers have no relation to the port industries and chains of distribution and cooperation.

This said, the vision strives to transform the linear, incoherent and patchy economy into a bio-based economy, truly rooted on circular and cooperative hallmarks. Enclosed within is a strategy that embeds entirely the waste-chains that can be found in both the Port and the agricultural sector and have currently been underused.

The idea of generating bio-energy from processed waste flows from glasshouses and farmers ensures that the production runs on bio-based means. To completely close the cycle, the vision enhances the port provision of CO₂ through pipelines underground to the glasshouses in the Westland, as it further supports cultivation of crops and helps to reduce unsustainable energy consumption.

New cycles based on waste, unveil new landscape demands in the Province of South Holland, in which waste streams can be treated, traded and re-used for new purposes. These are zones with high potential to become spots for the exchange of knowledge from both parties (Port and agricultural sector) on how to strive and cooperate in the transition towards a circular and cooperative economy, in the near future.

Keywords: **bio-based; waste-to-value; circular economy; cooperation; waste chains; CO₂ trades.**

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the port of rotterdam

bigger picture of the Port

visit to the Port

analysis

This chapter describes the current situation of the Port of Rotterdam. Analyzing it on a macro lens, we take into consideration its position on a global configuration.

On the other side, the site visit allows an empirical approach and highlights important impressions and insights as it deepens the analysis on the relations and connections that the port has with its surrounding.

The Port of Rotterdam is the biggest port in Europe (Port of Rotterdam et al., 2021) and provides international connections with not only Europe but the whole world. Its connections and importance created an important scene for development, in the distribution and logistics sector and for energy production (Port of Rotterdam et al., 2021).

In this chapter, we are going to describe its main characteristics and functions, analyze the connections created throughout time and name specific reasons and features that make the Port of Rotterdam so different from others.

Going further than the numbers and comparisons, we believe that the spatial configuration created also plays an important role in the operationalization of the Port. The findings that arose from the site visit portray many of the issues that the Port is facing. It depicts mainly how its performance can result in undesired spatial configurations that create barriers of interaction, ignoring important potentials of cooperation in between sectors.

By the end of this chapter, the main information that leads to our approach is set. The first impressions and analysis have a key function on the definition of our values, our understanding of potentials and weaknesses of the area.

bigger picture of the port

The Province of South Holland, located in the south of the Netherlands, has always had a strategic position. Its main asset is, without doubt, its delta.

The delta of the Maas River for long represented not only the main waterway, that provided the area with traditional fishing and transport potentials; but was also an enormous good for agriculture, fertilizing the land in its surroundings. Hence, the economic potential of the area is highly connected to the Maas river and its multiple features and provisions. (Provincie Zuid Holland, 2021).

Nowadays these qualities represent an economic importance that sustains the whole province. It developed in two main sectors: the port and its industries and agriculture. And by analyzing both of them, we are able to understand the intersections and influences on one another.

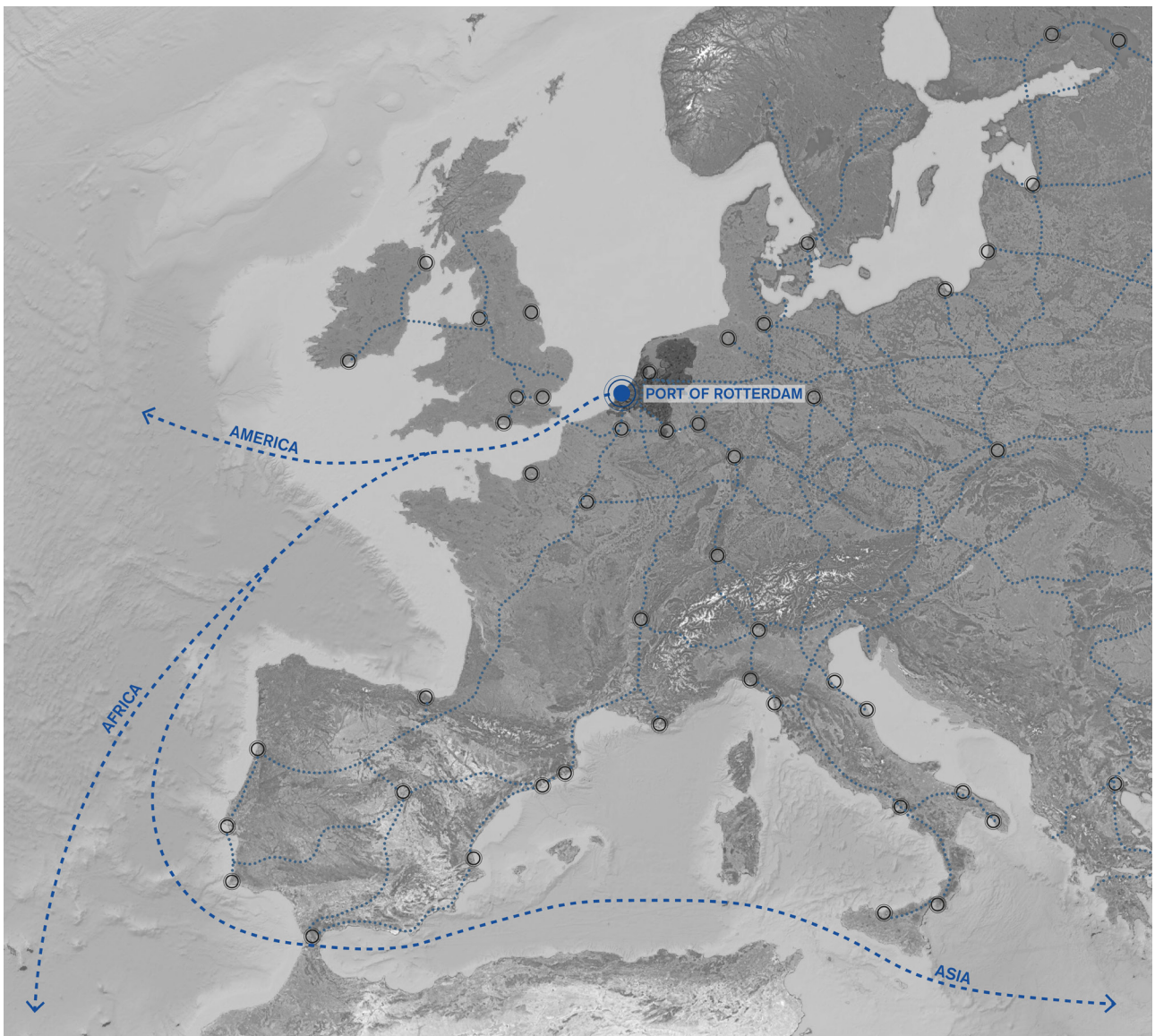


Figure 2: A global perspective of the Port of Rotterdam. Source: Google Earth (2022), Union Internationale des Chemins de fer (UIC) (2021)

The port and its industries:

Different from other ports in Europe, the Port of Rotterdam shares intermodal connections and strategic location. It is easily accessible from the North Sea and it is the delta of the Rhine river - one of the major European rivers, which classify it as an important shipping route in Europe (Provincie Zuid Holland, 2021),

Other physical characteristics of the Port of Rotterdam concern its depth and large surface area, which together make the port a leader on logistics, load and safety.

The province was highly developing thanks to its great network. The possibility of connecting to other countries - not to say continents - was much related to its large network of roads, railways and waterways.

The agricultural sector:

Another important economic sector of the region is the Westland that is considered one of the biggest horticultures of the world. Its large production is also distributed through the port and shipped to other countries (Provincie Zuid Holland, 2021).

The cooperation of both sectors can reach an important role when it comes to sustainable resources. Recently, CO₂ pipelines were implemented as a solution to the industrial emissions to collaborate with the biggest cluster of glasshouses in the world. (OCAP, powered by Linde, n.d.)

outgoing

EUROPE

47,2 Mio. Ton

AFRICA

3,2 Mio. Ton

AMERICA

12,9 Mio. Ton

ASIA

24,1 Mio. Ton

OCEANIA

0,8 Mio. Ton

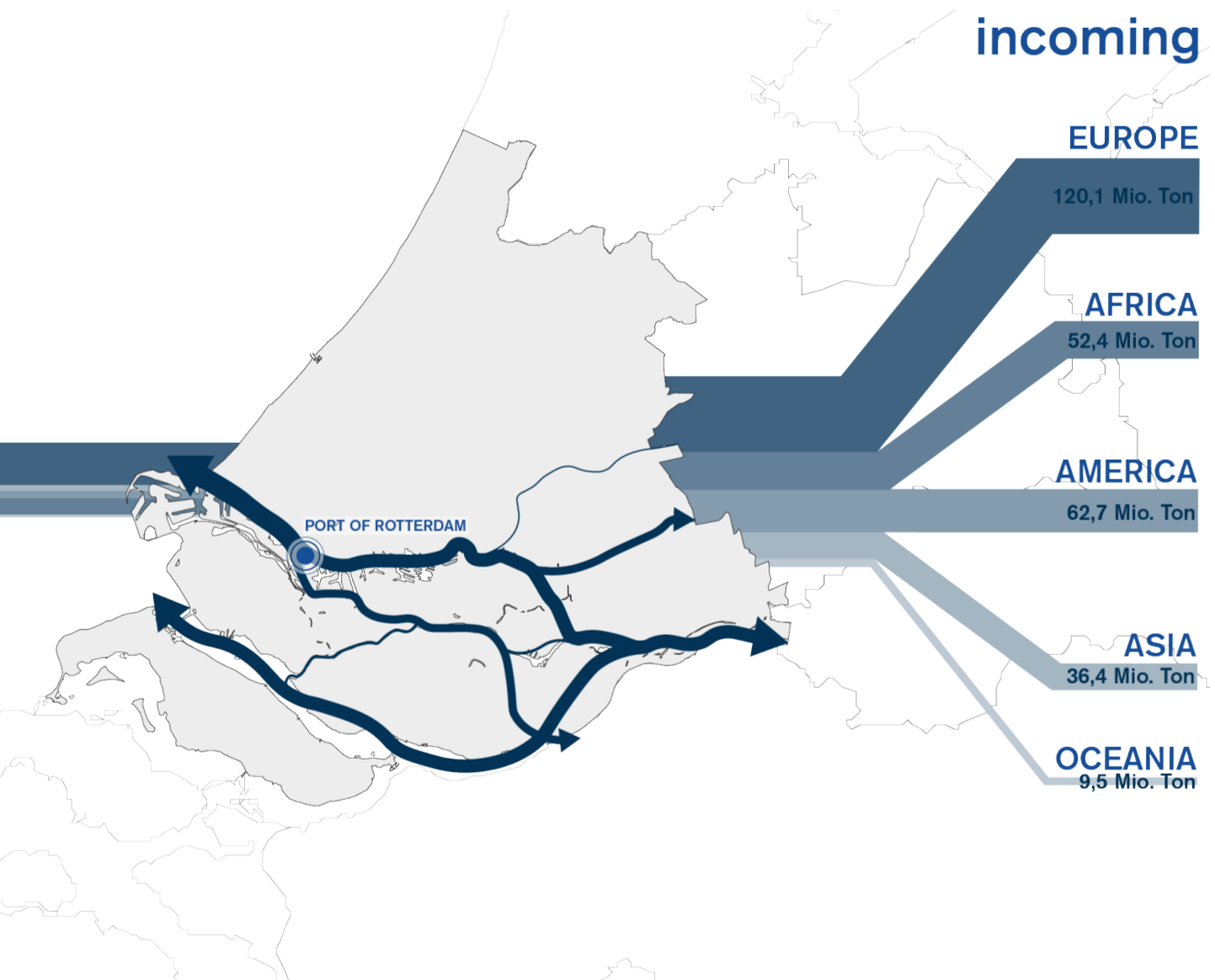


Figure 3: The Province of South Holland and the great value of the port on a bigger scale. Based on: Port of Rotterdam (2019)

visit to the port

The Port of Rotterdam consists in 40 km of length. It stretches through the whole municipality of Rotterdam, crossing the most dense and urban areas until the vacant land and semi rural areas.

These multiple arrangements and combinations in between port - industrial, urban - residential and rural - ecological functions create interesting threshold characteristics that are spatially translated into complex spaces. They merge different characteristics when it comes to function, ecology, location, accessibility.

In another perspective, to visit the port is also an experience of being immersed in the large scale where the body has less importance than the machine. Ships, containers, cranes are typical “users” of the space and it is hard to perceive how humans display a part in this configuration. The search for a social interaction was our angle to approach this area: as we tried to understand how this operationalization of the port finally creates spaces and creates social relations.

The following pages illustrate specific areas that depict this complexity. The lack of bodies is a sign for what we would later understand as a black box. The lack of consciousness on the labour, interest on social connections throughout the 40km-facilities easily justified the understanding that the port is an entity that not only wants, but also tries to stay distant and hermetic from the city, the civilians but also, the land.



Figure 4: Port of Rotterdam, seen from Pernis



Figure 5: Pernis: the neighbourhood in between the big industries of the Port



Figure 6: The Makers District and its abandoned facilities are now on the same neighbourhood as new residential urban areas



It is not hard to notice the disconnection of the port with the surrounding areas. Even though its proximity, the accessibility and interactions are badly performed.

When experiencing the port from the water, the distances appear to be shortened, highlighting the connectivity that the water provides in the province. It is intriguing to think how the great network of infrastructure, nevertheless does not provide the same effect. In the opposite way, it works as a social barrier.

The harsh borders between industry and cities create a sense of no interaction, that is different from what experienced in the old harbour areas. Any initiative of combining the city and the port seems to have failed in the innovative and inclusive aspect - as we experienced in Pernis.

The final impressions of the site visit defined what we would dig into on the following steps. The analysis and confirmations of the impressions help us map the current situation of the port in the many tangible and intangible aspects.



Figure 7: The Port of Rotterdam: maritime view



Figure 8: Vokpark: the bio-based distribution center, located in the middle of the Port of Rotterdam

analysis

The following pages aim to easily illustrate the current situation observed during the site visit. It highlights spatially the different impressions previously experienced on site.

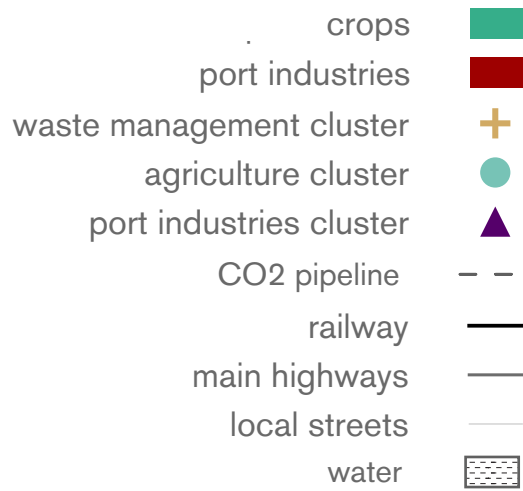
The mapping makes it possible to identify more characteristics of the land use, the clusters of each sector and the system of operations that is now ongoing.

These three analysis focus on detailing the main characteristics of the sectors, in order to reach more substantial insights on their interrelations.

The land use and productive land analysis illustrate the area and length of surface occupied by each sector. When compared, it is possible to create relations of influence, importance and spatial needs. Their locations also highlight the possible connections (or disconnections), proximity to other urban areas.

By analyzing the clusters and its locations, it is possible to identify areas already settled, its possible interactions and its density.

Finally, the system analysis enables a clear understanding of these relations while also spatializing in a diagrammatic way.



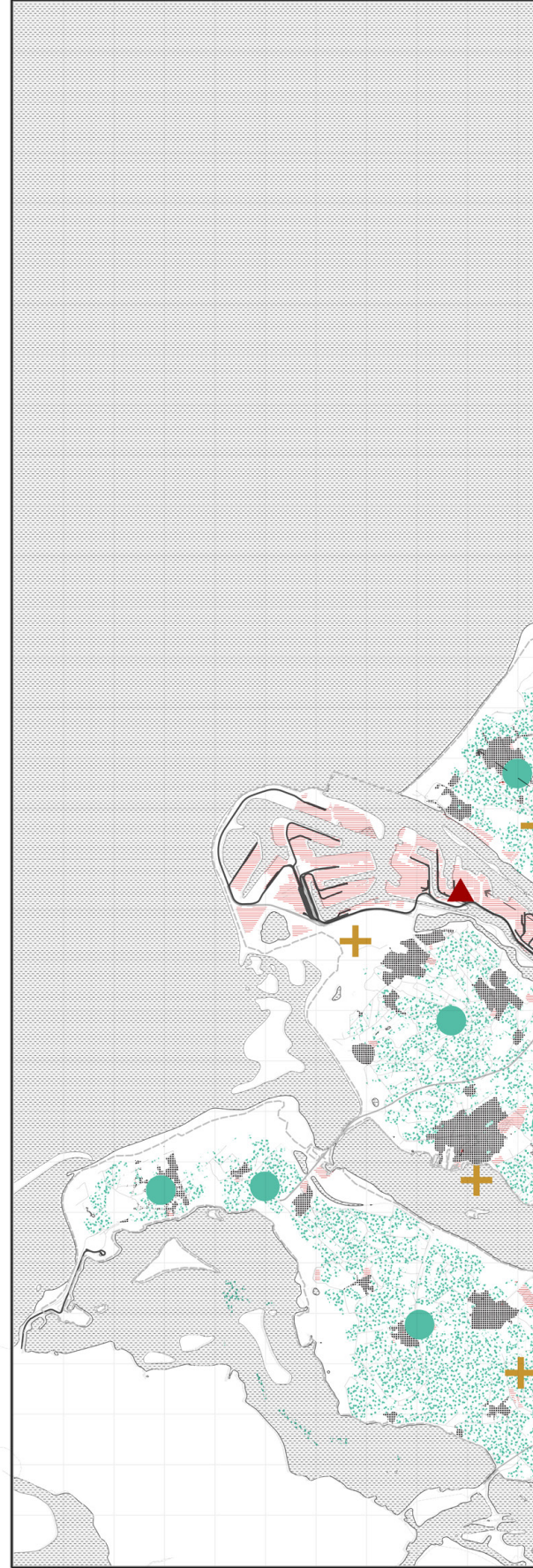
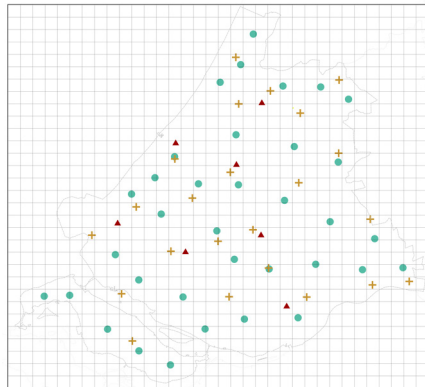
INFRASTRUCTURE

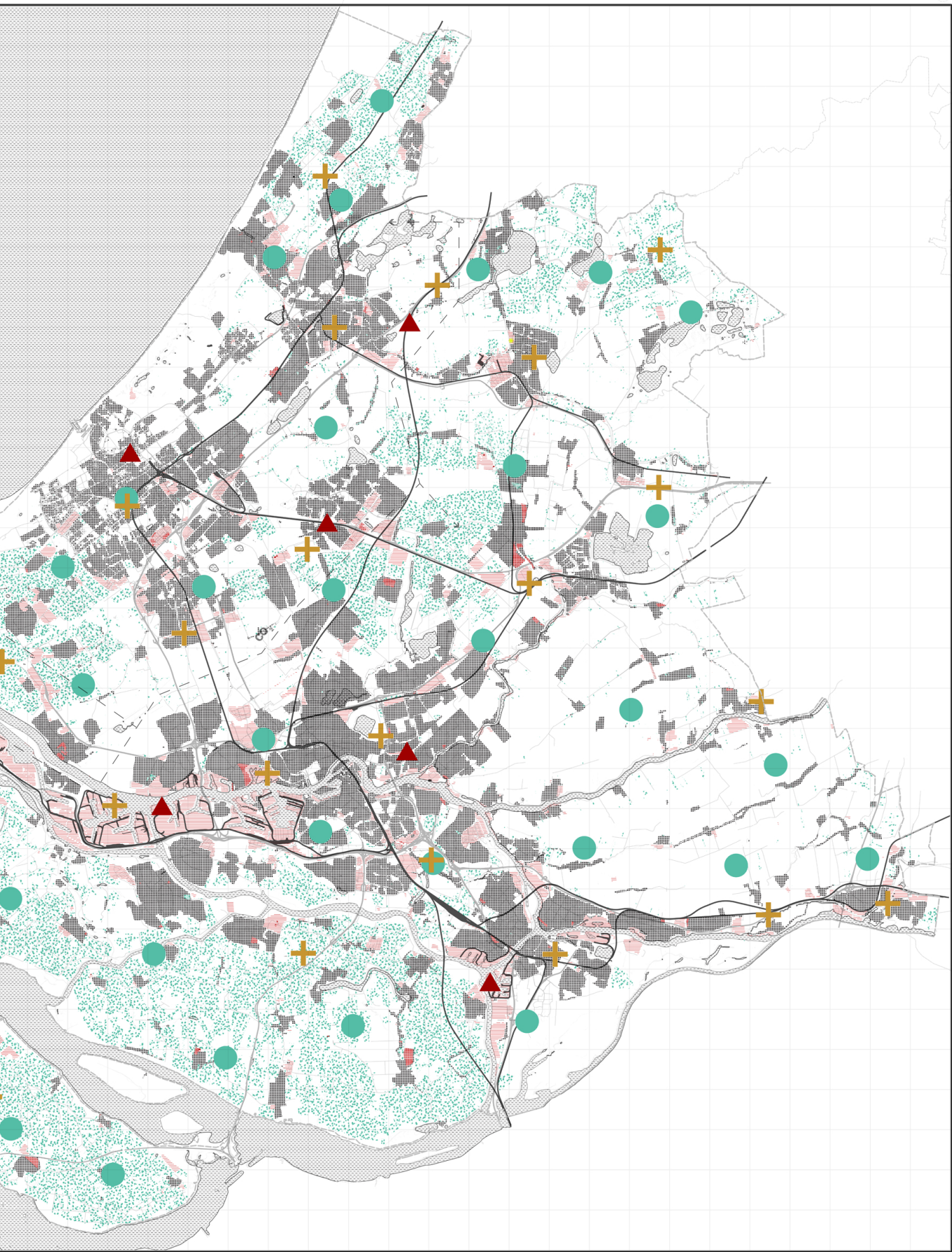


LANDUSE

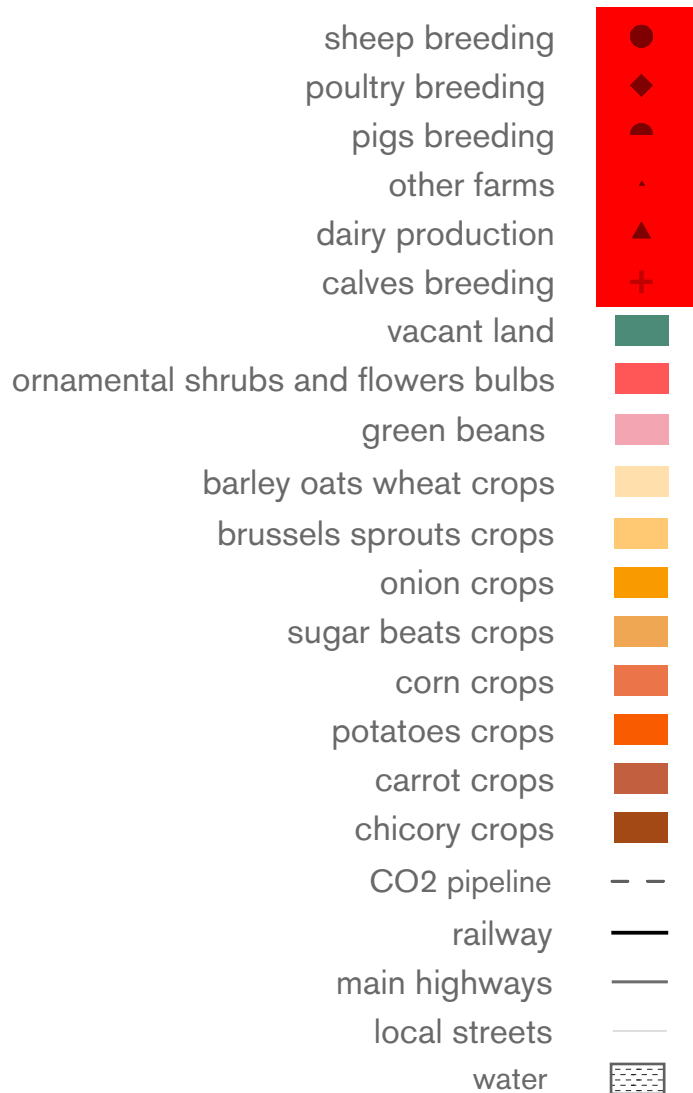


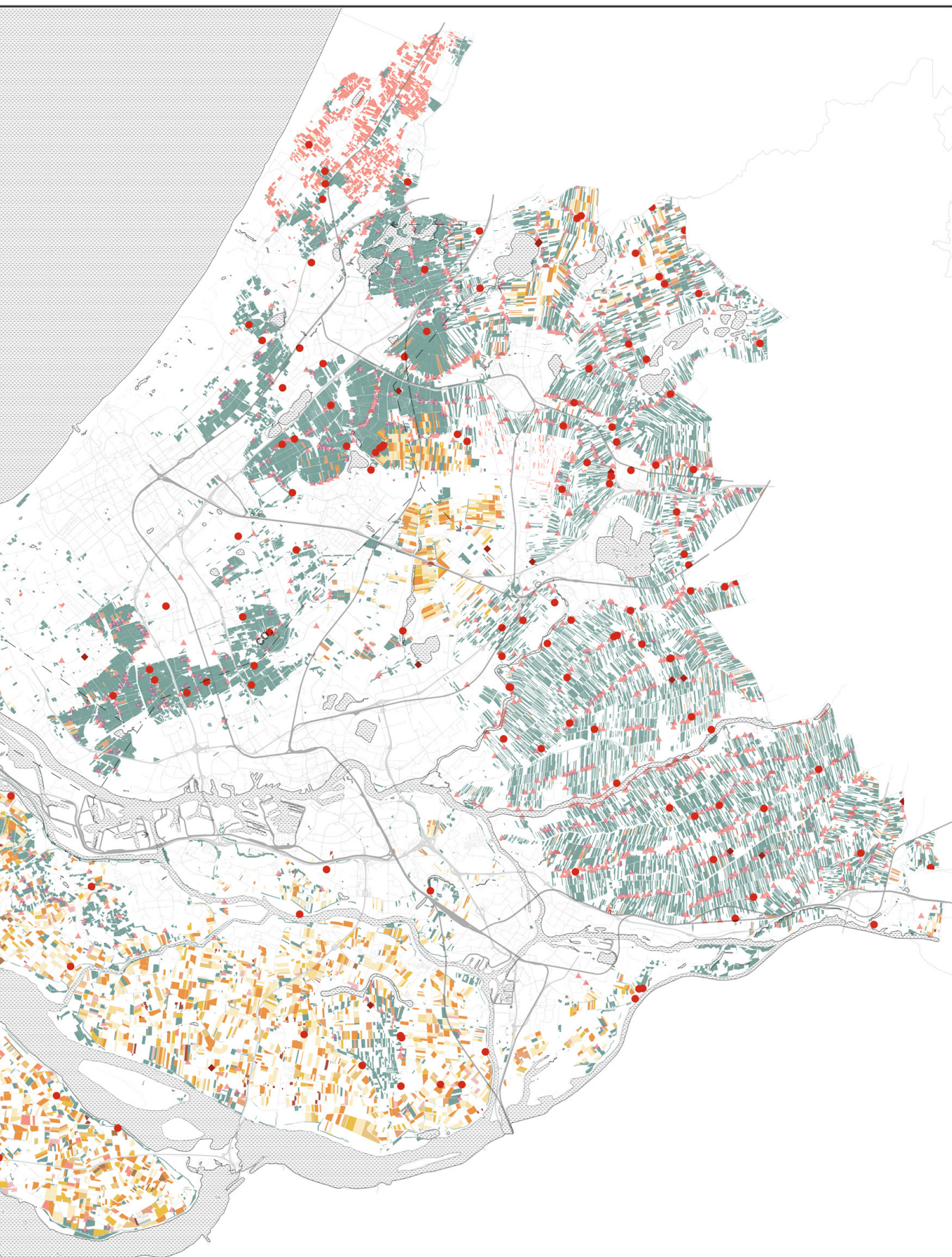
CLUSTERS





Based on: Open Street Map (2022), PDOK (2022), LISA (2022), Ocap (2014)

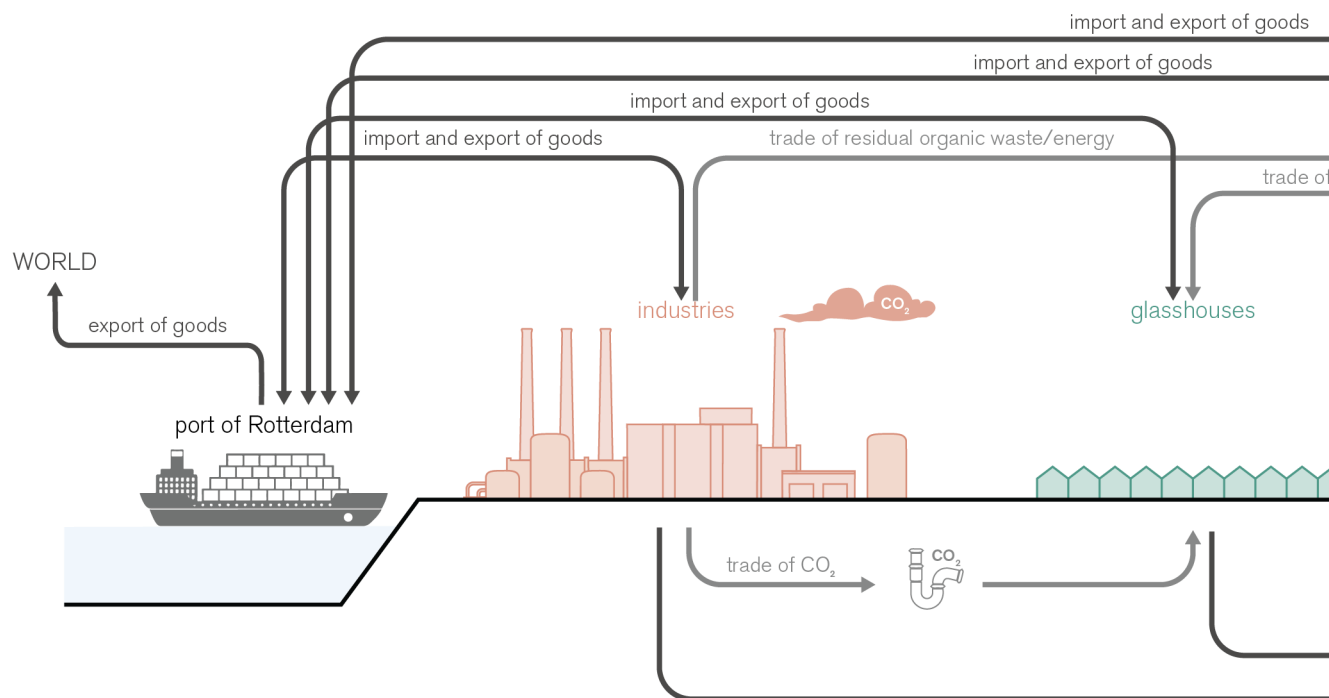


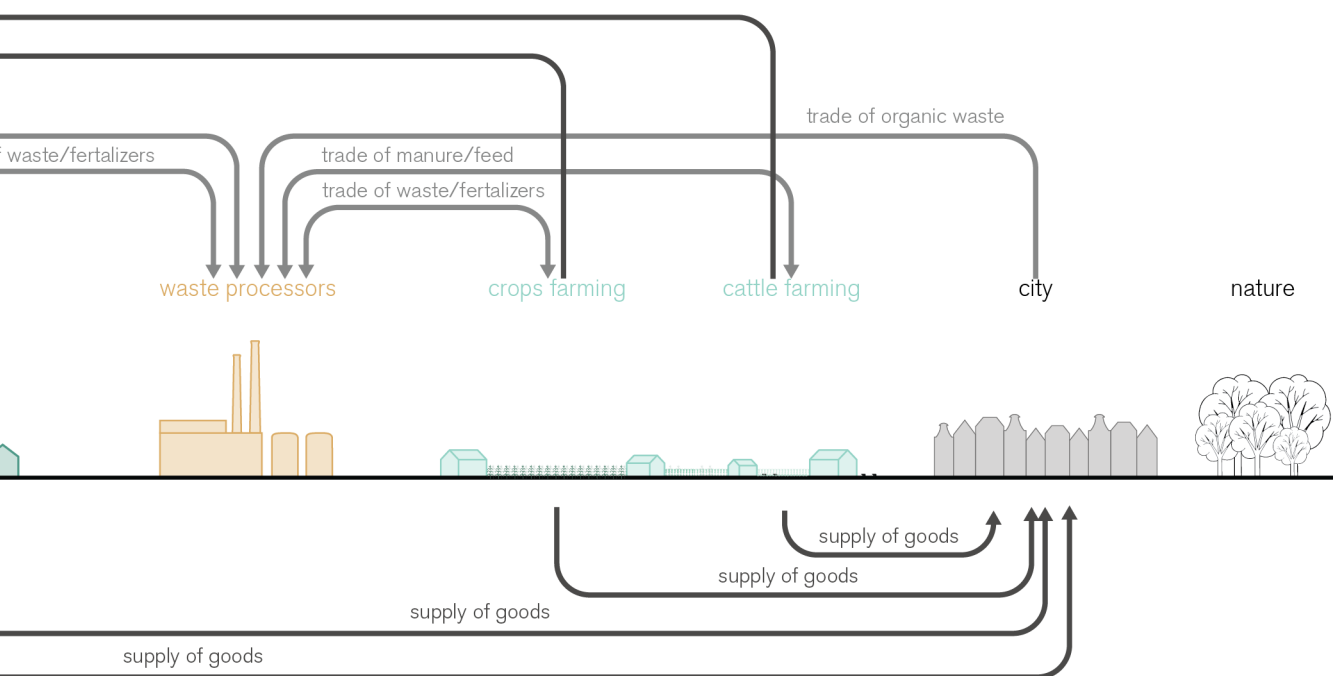


Based on: Open Street Map (2022), PDOK (2022), Ocap (2014)



EXISTING SCENARIO





problem statement

problem statement

introduction to waste to value

waste to value in South Holland

research question

conceptual framework

In this chapter we will introduce the problem statement of the research. Focusing on the Port of Rotterdam and a bio-based economy, we went into the direction of a waste-to-value economy and want to find out how the port and the Province of South Holland process their waste.

The definition of a waste-to-value economy will be explained in general and later we will take a close look at how a waste-to-value economy works in the province. This will result in our research question and our conceptual framework in which we explain fundamentally the concept of the project.

There are three main issues that play a big role in our project; the first one is the amount of CO₂ emission from the port; secondly, the lack of reutilization of biomass and third issue is the lack of cooperation between the companies and industries in the port itself and the between the port and the agricultural sector of the province.

With a clear problem statement we dove into the definition of a waste-to-value economy to understand the concept and propose possibilities that would help the Province of South Holland solve its problems.

A waste-to-value economy relies on the possibility of producing a constant amount of waste while managing its treatment into specific facilities that would convert it into different products with greater value. The Port of Rotterdam and the Province of South Holland produce a lot of waste and also need a lot of energy. Hence, there is a possibility for the region and the port to become a waste-to-value region. Nevertheless, it still needs to adapt its operationalization in order to make it possible. Currently, the province still faces fragmentations, not only related to its spatialization but also on their lack of social and intangible relations. A more circular and bio-based economy is necessary to create a resilient province that is able to feed and replenish itself.

This resulted in the research question “How can the agricultural waste management help to plan a more coherent and connected

region that stimulates actors from port and agriculture to cooperate?”

We established a conceptual framework to visualize our concept: connecting the waste chain and the CO₂ chain, as tools for implementing a greater reconnection of the province. The waste chain relates to the agricultural sector and the CO₂ chain relates to the port industries' emissions, our biggest actors in the province. In sum, we state that our goal is to combine the two chains from both sectors conducting the province to a more circular economy and better cooperation between the actors. Thus, it results in a waste-to-value province.

problem statement

The province of South Holland, as all the regions with a prosperous economy based on maritime trading and agricultural production, has a big amount of waste and CO₂ emissions produced daily. (T&E study of CO₂ emissions in European seaports, n.d.)

As discussed before, the Port of Rotterdam plays a fundamental role in the province but also in the whole Netherlands. It does not only deal with a big part of the exports and imports but it is also an important oil processor hub (Oil Refineries, n.d.). The industries of the port emit CO₂ that causes air pollution, leading to climate change.

Another weak point of the province is the lack of reutilization of biomass and raw materials (Drift Metabolic, 2018): huge amounts of waste are produced daily due to the heavy agricultural production but - rather than being used as resources for the province - they are seen as residues to be eliminated by exporting.

Both CO₂ and waste are therefore local issues for the Province of South Holland, which could become a global concern.

As shown in the image on the right, the main activities of the province (agriculture and industries) are clustered in some areas and, instead of communicating and cooperating with each other, they create barriers and harsh limits that disrupt interrelations.

The fact that CO₂ emissions and waste have

effects that have a greater scale and that are both tangible and intangible on a local spatial configuration, makes us want to rethink the current scenario and respond to these problems.

Following the logic of these two main issues, it is easy to conclude that the chains of waste and CO₂ are not used to their full potential. Both topics share a possibility of configuring the space in the region in a better and more efficient way.

industrial	waste	7,5 MT	per month
agricultural		4,9 MT	
industrial	CO₂	2,2 MT	per month
agricultural		3,5 MT	

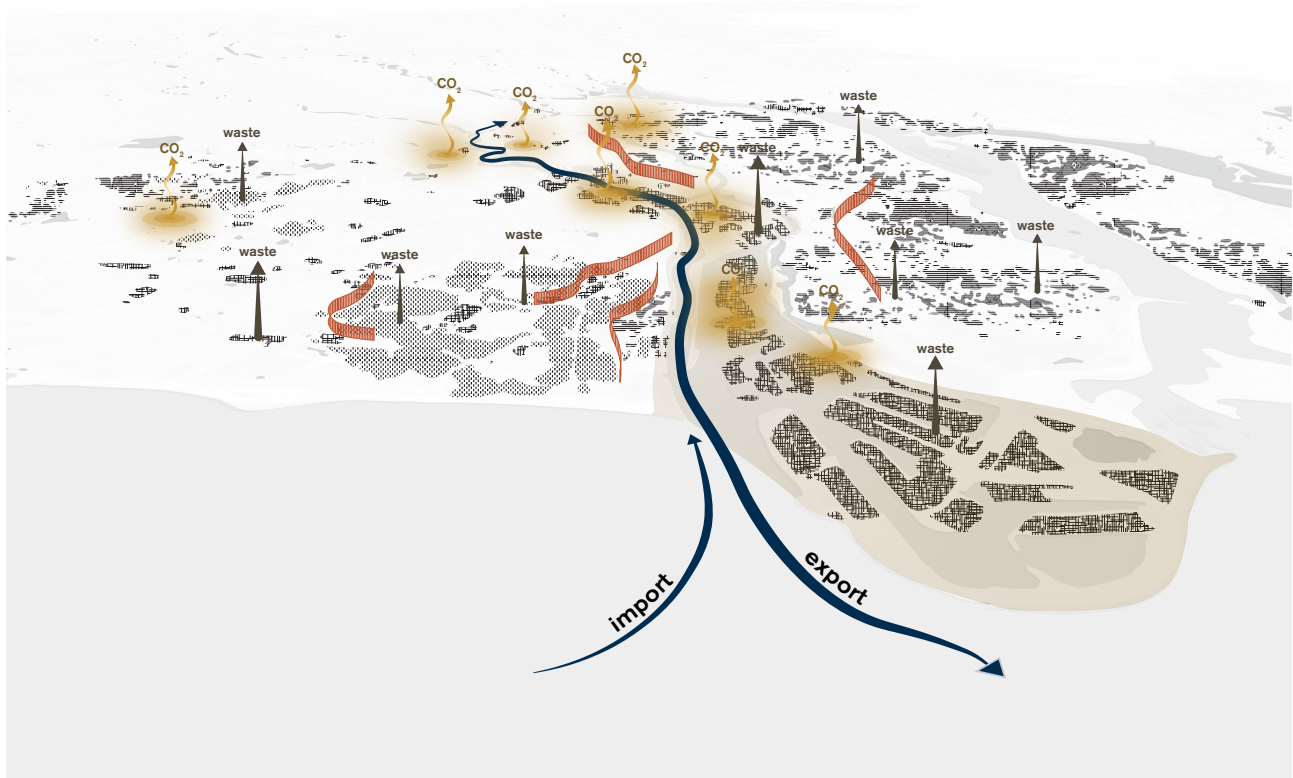


Figure 9: Visualization of clusters, emissions and waste production in South Holland. Based on: Open Street Map (2022), PDOK (2022)

introduction to waste to value

The waste-to-value approach is a circular process that aims at extracting the maximum value from the waste streams, in order to give it to other consumers and, therefore, decrease the amount of unusable waste.

This approach is generally interesting because of the increase in energy demand and product supply as well as food production. The waste-to-value approach displays a broad concept that can be applied at different scales, with different types of waste and with different outcomes.

In order to analyze and understand the scale of the waste chain and its possible applications, it is necessary to distinguish the spatial facilities that are involved in the different stages of the process. The image on the left illustrates the main typologies: industries, waste processors, livestock farmings, glass-houses, crops farming, neighborhoods and natural reserves.

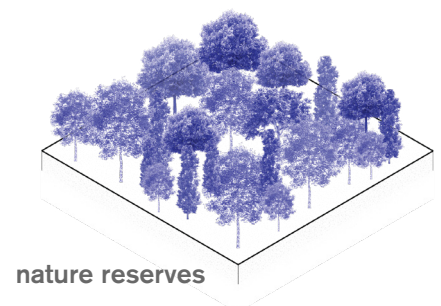
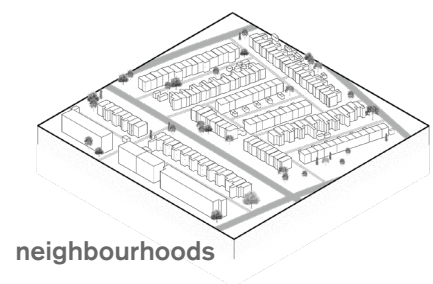
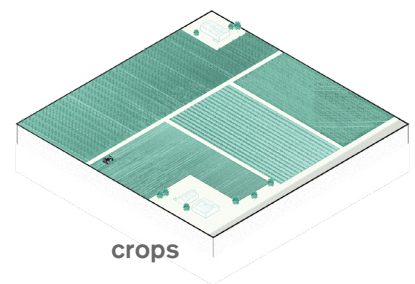
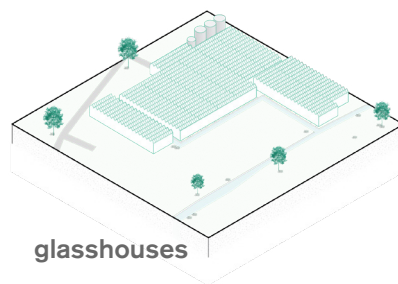
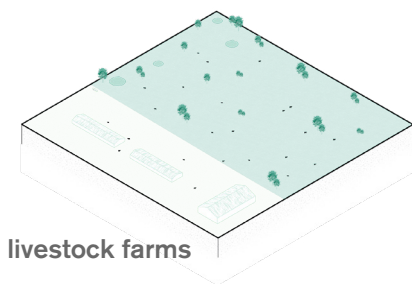
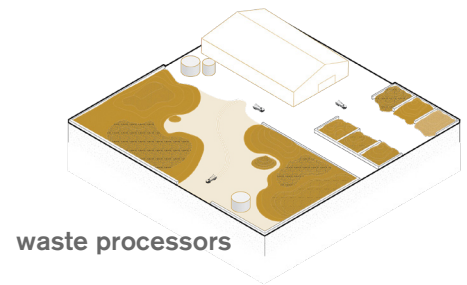
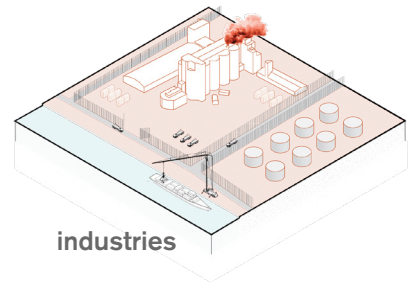


Figure 10: Main land uses typologies within the waste chain

When the metabolic process of the waste treatment is taken into account, it is also possible to separate the facilities by proximity and interdependency, as shown in the image on the right. With these combinations of different facilities, a most efficient configuration can be arranged to eventually reach the balance in the waste-to-value economy.

The main actors in these circular and interlocking loops are the waste processors: they are specialized in working the different types of waste, extracting products that can be reused.

The waste-to-value does not only apply to the waste chain but could also apply to the CO₂ chain and connecting the industries of the port - CO₂ suppliers - with the glasshouses, which have an increased amount of CO₂ demand to grow crops.

In the small loop the organic waste treatment works to produce animal feed or bio-oil from the agricultural waste. Besides, the manure is processed to create fertilizers to replenish the soil. This loop depicts the possibility of farmers to be either the providers and the consumers. It also enhances the possibility for these small businesses to cooperate and collect more and more diverse waste that could be processed and transformed into different products.

The second loop involves the organic waste treatment of materials from the port, which are produced in a bigger scale at a constant

flow, that can be recycled and reused by the port and other actors.

The third loop shows the waste-to-energy approach at its finest application: the chemical treatment is applied on a bigger scale and involves the outcome of pre-treated waste and chemical processes that turn them into fuel and energy for industries.

The most important aspect of the waste-to-value approach is the interlocking dynamics of the loops. Taking into consideration the highly interdependency of loops and their requirements of resources, one can conclude that it is unlikely to reach an efficient and meaningful outcome if the loops do not cooperate.

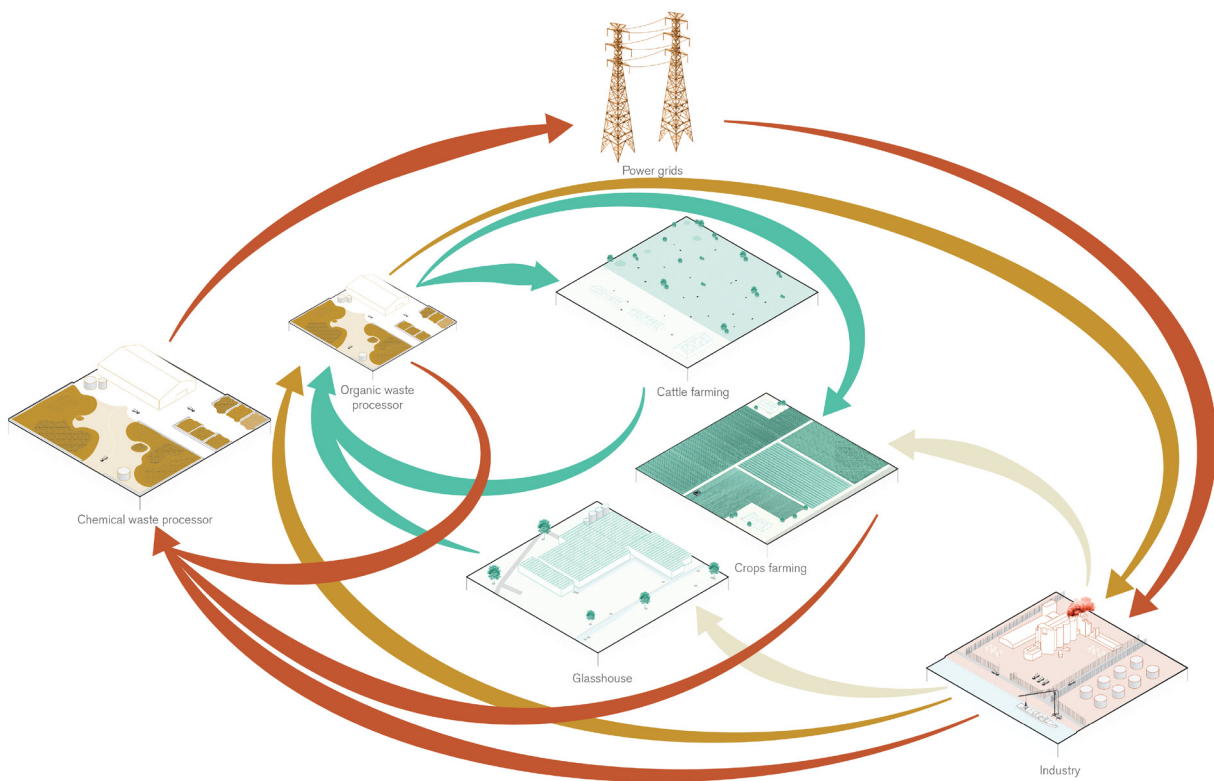


Figure 11: Visualization of the small, medium and big loops inside the waste and CO₂ chain in a circular bio-based economy

waste to value in South Holland

It is especially interesting to analyze the possibility of the waste-to-value approach in the Province of South Holland. The province, being the biggest exporter of horticulture in Europe, relies heavily on the agriculture sector, which leads to a constant waste production. In the current report from FUSIONS, an European project that works on the reduction of food waste, estimates that 30% of the total food production is lost before it reaches the market (Stenmarck et al., 2017).

Furthermore, because of its placement as the biggest port in Europe, the province has high emissions of CO₂ and high energy demand - which also comes from its industries and the necessity of heating due to the cold temperatures (International Energy Agency, 2020). At this moment, the energy produced from renewable source is just a small percentage of the total final energy consumption but an increasing generation from renewables is expected to shift the Netherlands from its historic status as a net importer to a net exporter of electricity in the next few years (International Energy Agency, 2020).

Taking this energy transition into consideration, the potential of the Province of South Holland to become a waste-to-value province becomes more clear. The constant production and the demand of goods on a large scale makes the process possible, but also requires relations among facilities. As stated before, the quantities of emissions and waste production in South Holland are shocking;

and, for this reason, an implementation of the waste-to-value economy could be a solution to multiple issues.

Despite the huge potential for energy production and sustainable waste management - the province still faces many gaps when analyzing the metabolic process and the facilities now in use. In the current situation, the loops that represent the metabolic process of waste treatment are neither efficient nor fully address the income and outcome of resources.

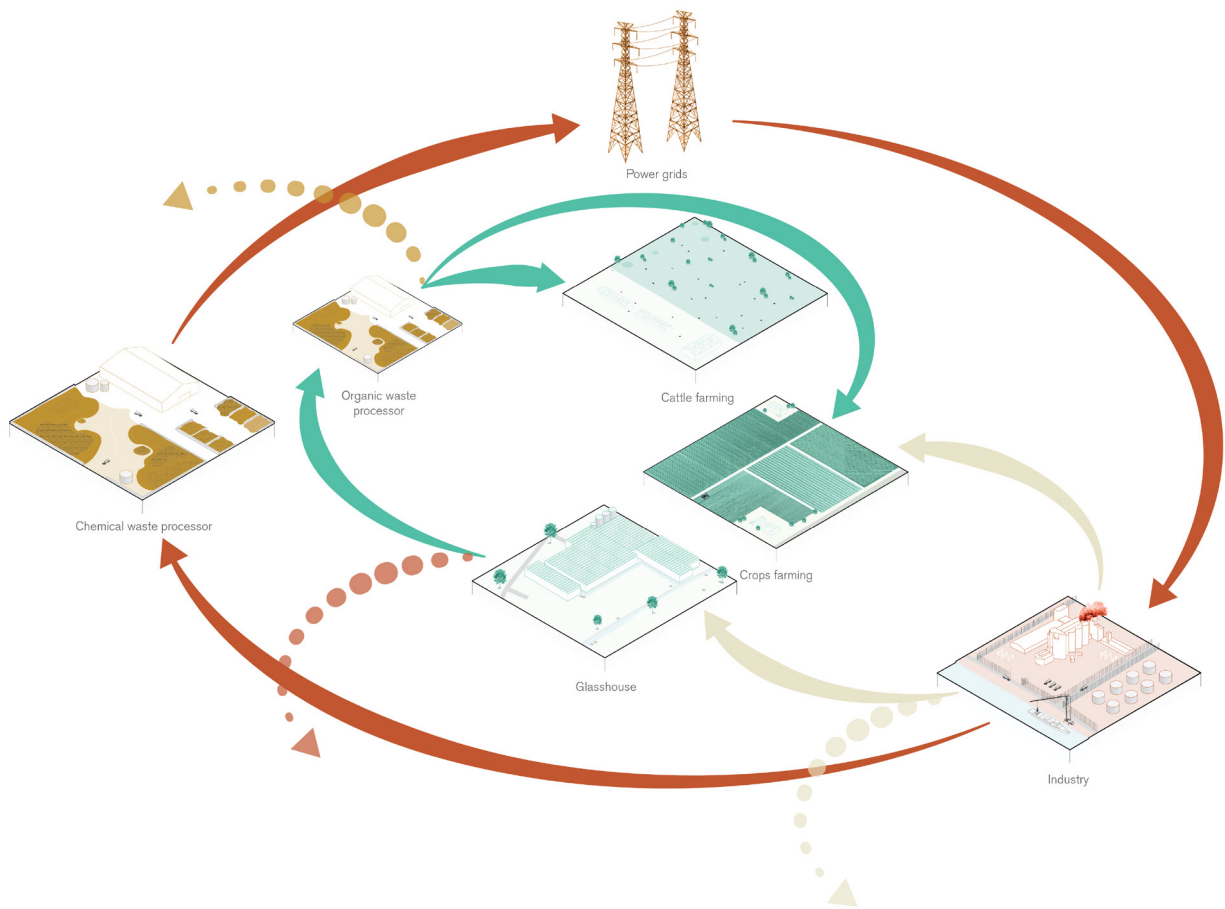


Figure 12: Visualization of the small, medium and big loops in the economy of South Holland

As shown in the diagram, much of the waste produced in the province is either unutilized or shipped out of the country, which makes the heavy local production become a global issue.

In the case of the Province of South Holland, the clustered sectors and the disconnection are key factors to explain the reason why the waste chain and the CO₂ chain do not cooperate and therefore none of them is used to its full potential. The question that now arises is: how can these two chains cooperate to accomplish a waste-to-value economy? In the following analysis we will depict the overall situation of the province and introduce a new possibility to improve the current flow of waste and CO₂.

paper, pulp and wood
biomass
mixed



wast
7

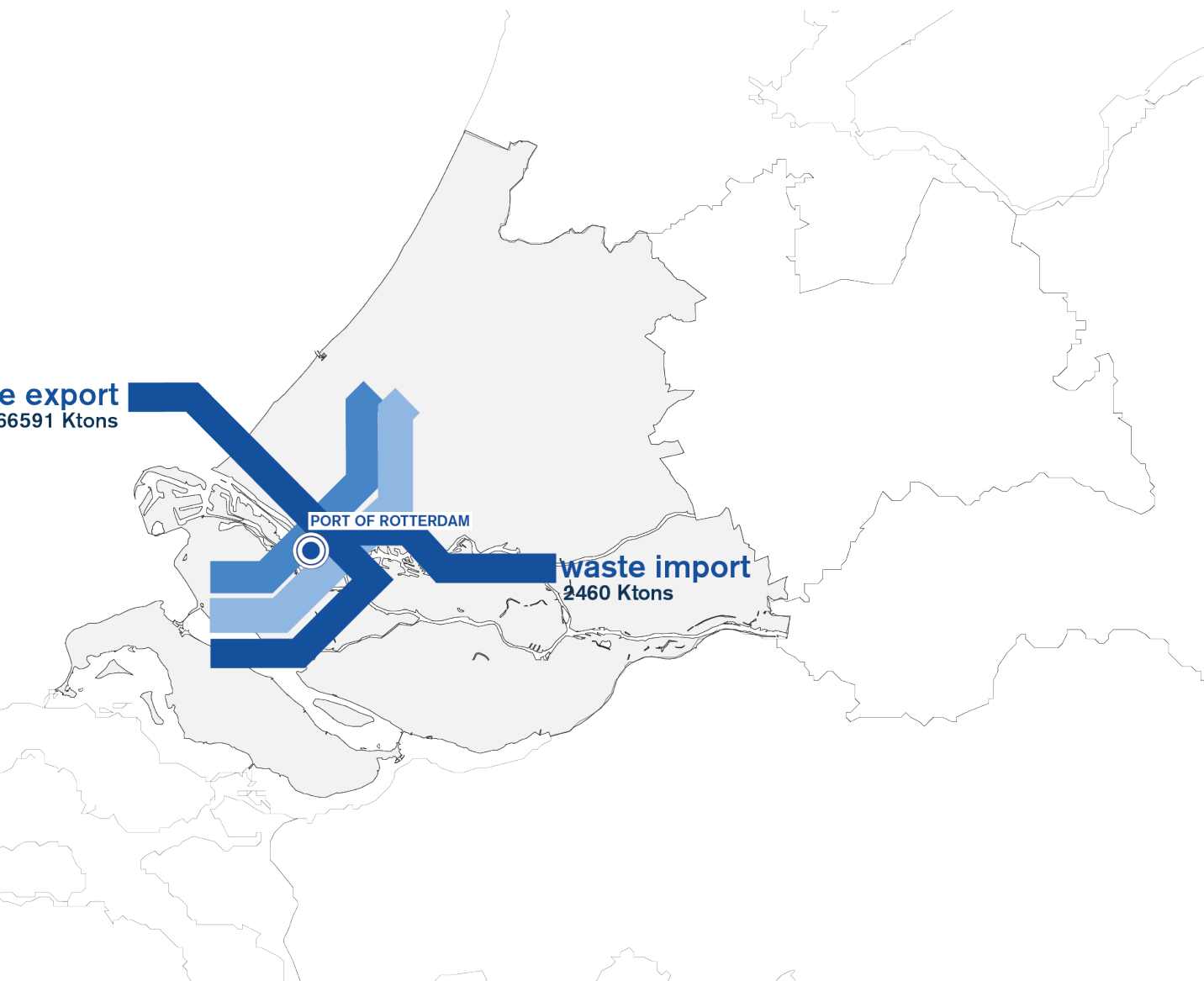


Figure 13: Flows of waste import and export at the Province of South Holland. Based on: Drift Metabolic (2018)

Taking into consideration the previous explanations, regarding the interlocking, efficiency and concentration of facilities and their trade of resources, it is necessary to emphasize that there is a spatial logic behind the performance and efficiency of the process. This overarching argument of the proximity of the loops, can also be translated into the idea of cooperations between the actors, which could mitigate the fragmentation in the region.

The map illustrates the numerous loops distributed through the province. Although their positioning, as illustrated on the map, the Province of South Holland still faces challenges on creating articulations in between loops, rather, each loop is either independent - and, therefore, not collaborating fully in the waste chain - or incapable of transforming or trading the waste-to-value.

Based on the idea that proximity creates connections, the map highlights the means of how the loops could work in the project. It illustrates a visualization of their possible interlocking dynamics. For a waste-to-value approach to be implemented we need to guarantee that there are specific combinations that together reach an interesting trading system. The spatial arrangement needed would create a more heterogeneous disposition of facilities that would promote interaction and exchange of resources at different scales.

Furthermore, this intertwining of land uses and facilities provide products, services, information and profit that would help the manufacturing and technology development, as well as, an economic growth. A more circular and bio-based economy is necessary to create a resilient province that is able to feed and replenish itself.



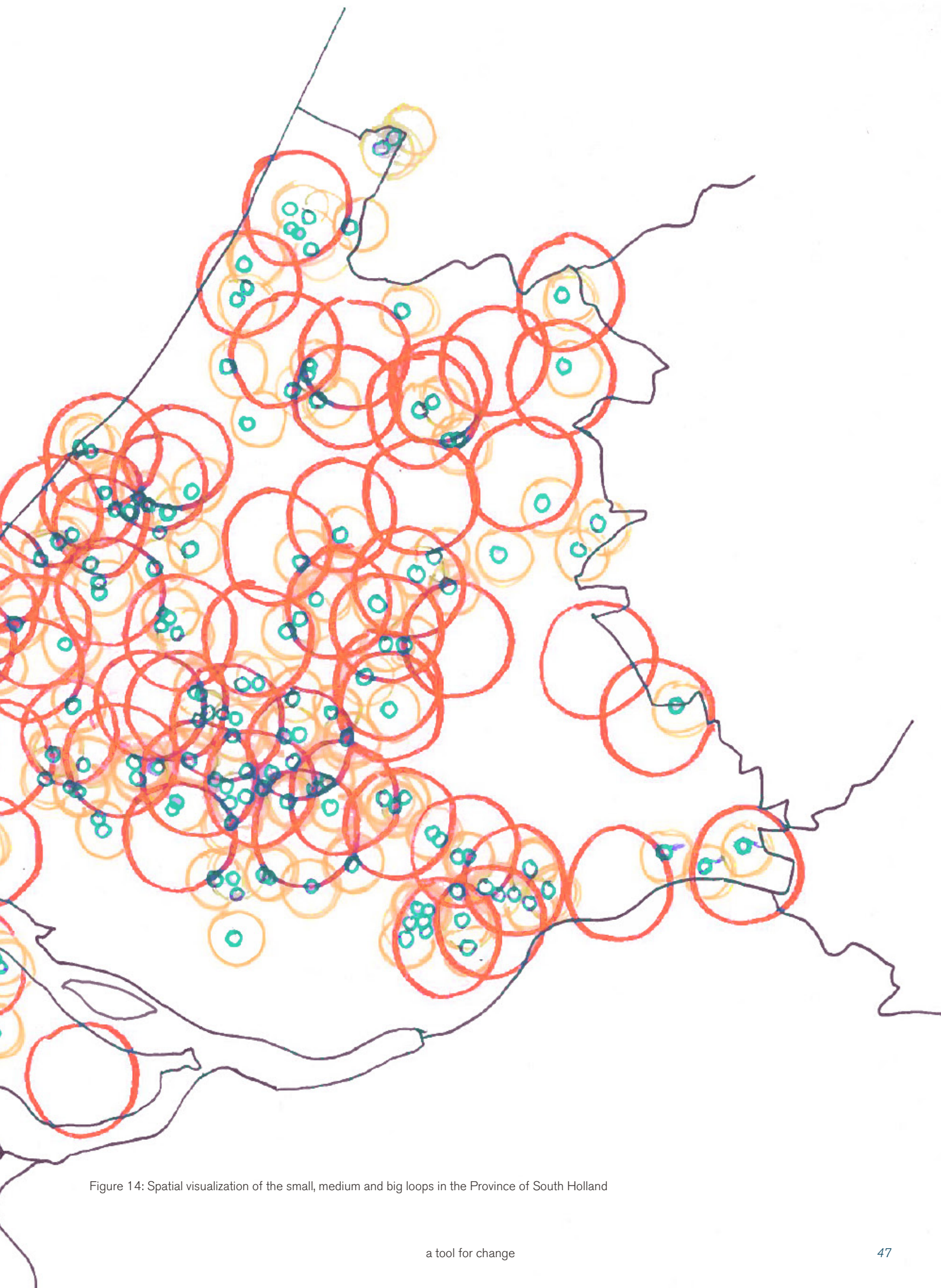
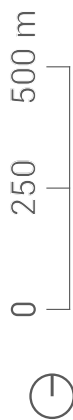


Figure 14: Spatial visualization of the small, medium and big loops in the Province of South Holland

SATELLITE: IMAGES OF THE LOOPS



LARGE LOOP



MEDIUM LOOP



SMALL LOOP





Figure 15: Satellite images of one system of small, medium and big loops in the Province of South Holland (52°01'57.5"N 4°30'06.8"E)
Source: Google Earth (2022)



+ SMALL LOOP





Figure 16: The small loop: farmland in South Holland. Author:

SMALL LOOP





Figure 17: Glasshouses close to Zoetmeer

MEDIUM LOOP





Figure 18: Waste processor facility close to Zoetmeer

BIG LOOP





Figure 19: The Port of Rotterdam and its facilities and transportations

**HOW CAN AGRICULTURE
MANAGEMENT HELP
COHERENT AND CO
THAT STIMULATES A
AND AGRICULTURE '**

research question

**AGRICULTURAL WASTE
TO PLAN A MORE
CONNECTED REGION
ACTORS FROM PORT
TO COOPERATE?**

conceptual framework

The bases of the Chains of Cooperation project are the waste chain and the CO₂ chain; while the waste chain relates more to the agricultural sector, the CO₂ chains relates to the port. The possibilities of combining both chains are explained in the previous chapters. This synergy is reasoned by the existing demand and supply of a waste-to-value economy, which is highly interdependent. Furthermore, the relevance of the port in relation to both sectors and, hence, both chains, depicts an magnitude of this framework.

On one side, CO₂ is produced from the port in excess and could be injected into glasshouses for crops production. On the other side, agricultural waste could supply resources for energy production that eventually could fuel the port.

Following this logic, Chains of Cooperation is a project that does not only aim at closing the chains of waste and CO₂ by combining them, but also about creating better cooperation between the actors, focusing on the creation of a more resilient and robust province.

The circularity presented in the framework is essential to reduce and prevent the primary use of raw materials while strengthening the flow of resources. This idea also relates to spatial and social justice: as explained previously, closing the chains of waste and CO₂ would diminish the fragmentation in the province and make it more heterogeneous in the disposition of facilities. This would

promote accessibility at different scales and the cooperation among the stakeholders, which would give the possibility to engage in a bigger flow of resources and knowledge.

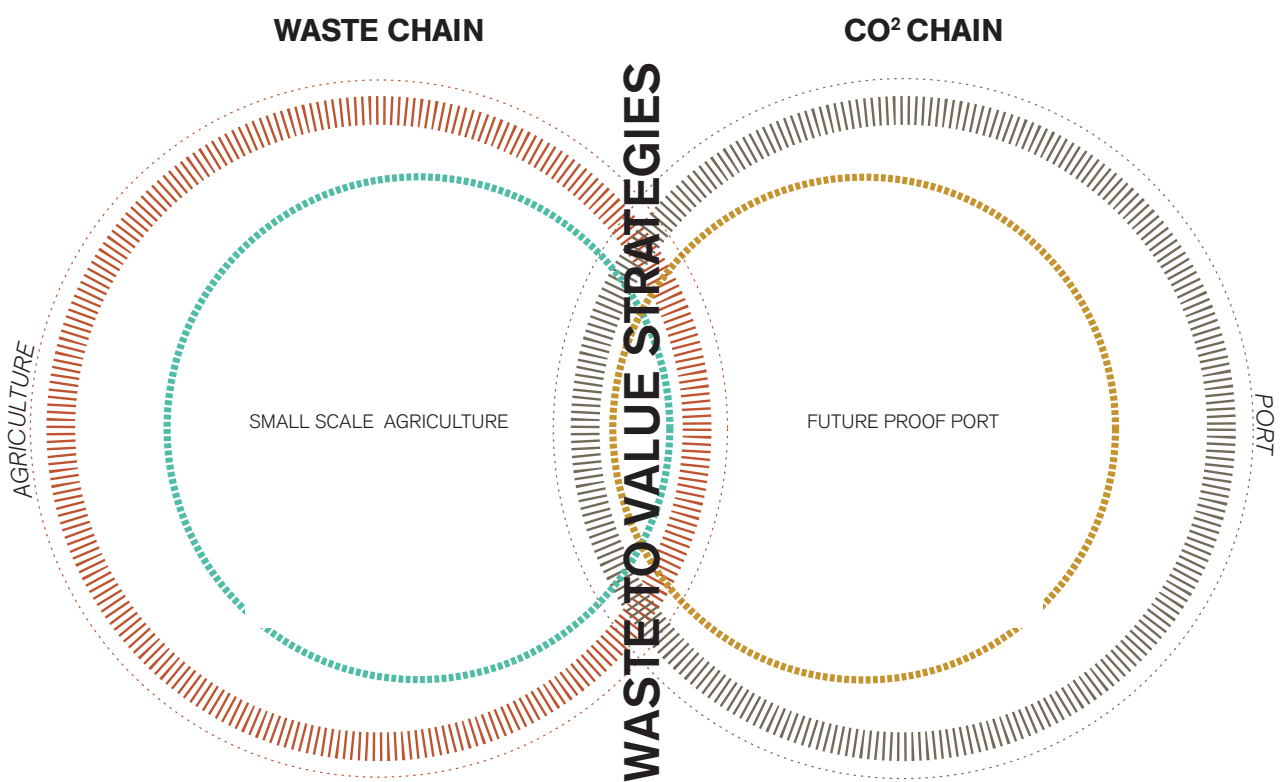


Figure 20: Conceptual framework

The Sustainable Development Goals (SDG), created by the United Nations, have the purpose to promote wealth and prosperity while also protecting the planet, strengthening the idea that it is impossible to achieve one without considering the other (United Nations, 2021).

The SDG and the relations suggested among environment, society and economy were fundamental to form a vision and strategy that would create a more sustainable and circular economy.

The Chains of Cooperation represents a responsible attitude towards consumption and production (goal 12) because it aims at monitoring waste streams in the province and making the waste chain and CO₂ chain as continuous as possible. By doing this, cooperation and partnerships between industries in the port and the agricultural sector in the province will be created (goal 17).

Another positive outcome of the project would be the production of affordable and clean energy: the province will be able to provide the port, agricultural sector and other industries bio-based energy and resources (goal 7). The whole transition to waste-to-value approach can also contribute to climate change (goal 13), because the production in the province will be less harmful to the environment and decrease the CO₂ emission.

Another point that is tackled in the project is the quality education (goal 4). If education

on waste treatment and recycling is provided for the farmers and workers and education on new technologies for big industries and companies is being fomented, the transition to a circular bio-based economy will be smoother. Innovation and infrastructure are an important starting point to reach responsible consumption, production and cooperation.

When focusing on a conscious consumption and production and on an increase of cooperation a more sustainable planet - for economy, society and environment - can be created (goal 9). Some of these goals explained above, also relate to the European Green Deal, which aims on improving well-being by having no net emissions of greenhouse gasses by 2050, making Europe climate-neutral and protecting the natural habitat for the people, the planet and the economy (European Commission, 2019).

MAIN GOALS



LATERAL GOALS



Figure 21: Selected goals for the project: the Sustainable Development Goals from The United Nations. Based on: United Nations (2022)

methodology

introduction to spatial arrangement

technical approach

methodology

The following chapter explains our methodology. To begin with, we explain our technical approach, which is essential to the understanding of the later on methodology. The methodology works based on a distance - land use nexus and in order for it to work, a model logic was set to carry out the GIS analysis. The overlap of maps gave all the necessary information for the analysis. This resulted in three variables that conduced the project into a more abstract, while complex understanding of the area.

The mapping techniques will illustrate the range of the loops, the density of clusters and the existing connections. The reasoning behind the methodology and its means to it are described in the following pages and lead us to the formulation of the vision, in the coming chapter.

N

E

N E X

U

S

The project makes the assumption that there is a spatial logic, related to a distance - land use nexus.

U S

technical approach

The approach to this project is theoretical and relies on an assumption: there is a spatial logic behind the loops and it is related to the distance within facilities of each loop.

In the image on the right, all the elements of the technical approach are shown.

The chains of CO₂ and waste appear to be interlocking and they indeed are, as a consequence of the possible collaboration between the actors of these two chains (explained in the previous chapter “problem statement”).

Inside these chains we have the loops, which are based on an assumption: as explained in the “approach on Waste to Value” sub-chapter, the main actors of these interlocking loops are the waste processors and therefore they are the center of each loop.

We have the small (500 m radius), medium (2 km radius) and big loops (4 km radius). The radius, that we are calling distances, of these loops are being calculated taking into consideration the average distance between the waste processors and other facilities.

Starting from the concept of distances, a grid was created to translate the average distance (500m, 2km, 4km) into an abstract map which contains spatial information. In fact, for each single part of the grid, we applied different variables (such as information based on function, dimension and distances) to better describe how the loops work and identify the problem in their spatial arrangements.

For this reason, the project is not only about closing loops and making the economy more bio-based and circular, but it is also about re-designing and spatializing new arrangements in order to make the loops more efficient and inclusive.

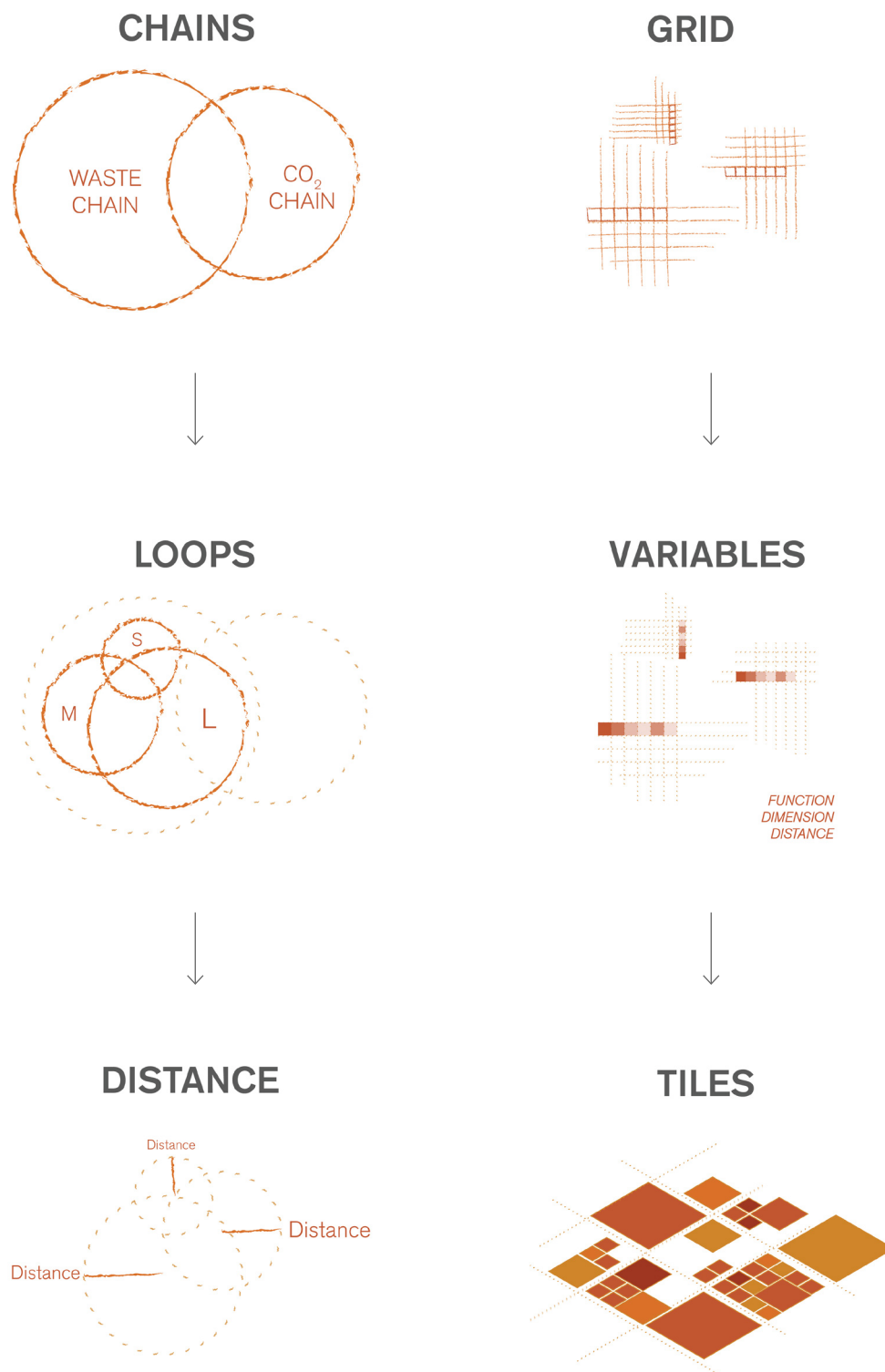


Figure 22: Translating concepts into spatial visualization. Visualization of the technical approach

methodology

We, therefore, created a methodology that works based on a distance-land use nexus. In order for the methodology to work, a model logic was set to carry out the GIS analysis.

In the previous sub-chapter, “technical approach”, the translations from chains to loops and from loops to distance have been explained. Through the GIS it was possible to analyze geographic information in a specific and accurate manner, and create maps with different variables. The overlap of these maps would give all the necessary information for our analysis in a readable and clear way.

The three variables, shown in the image on the right, are: functions, dimensions and distance. When analyzing the functions, we produced a map with different textures that classify the different land-uses: agriculture (crops farming, animal farmings and glassshouses), waste processors and industries. The next variable is dimensions: the grid divides the space in different areas and makes it easy to determine the presence of clusters. The last variable is distance: the shading of the colors show the closeness of facilities to the waste processors and therefore their potential.

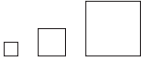
VARIABLES	1	2	3			
FUNCTION	AGRICULTURE	WASTE	INDUSTRY	→	texture	
DIMENSION	10.000m ²	50.000m ²	500.000m ²	→	size	
DISTANCE	0,5 km	2 km	4 km	→	colour	

Figure 23: Table of variables and its visual translation into mapping

A

B

S

T

R

A

C

T

I

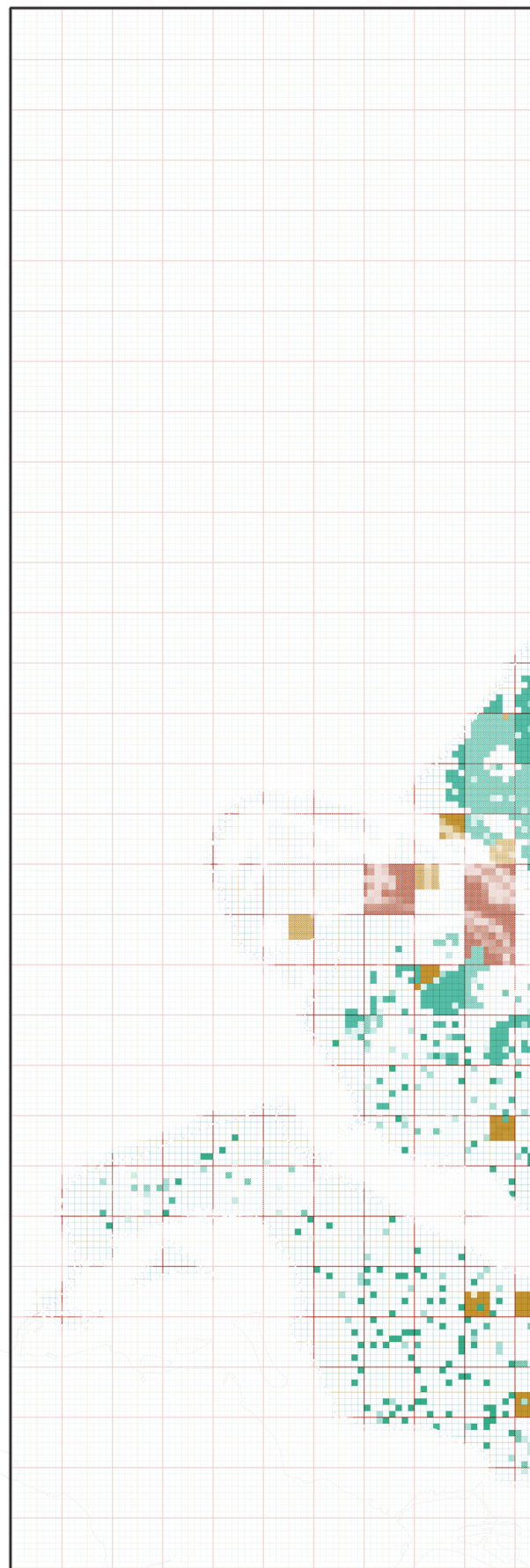
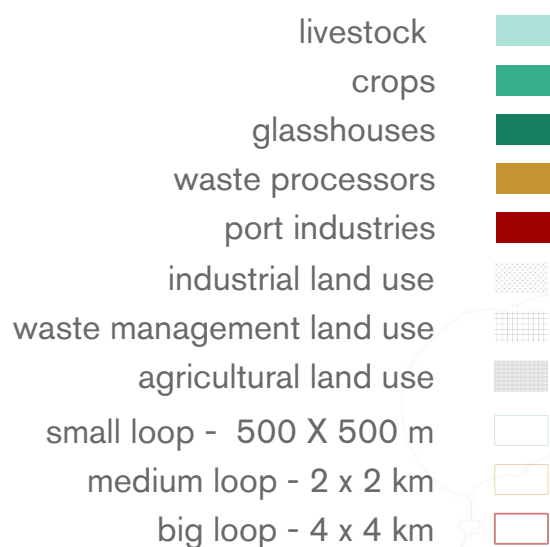
O

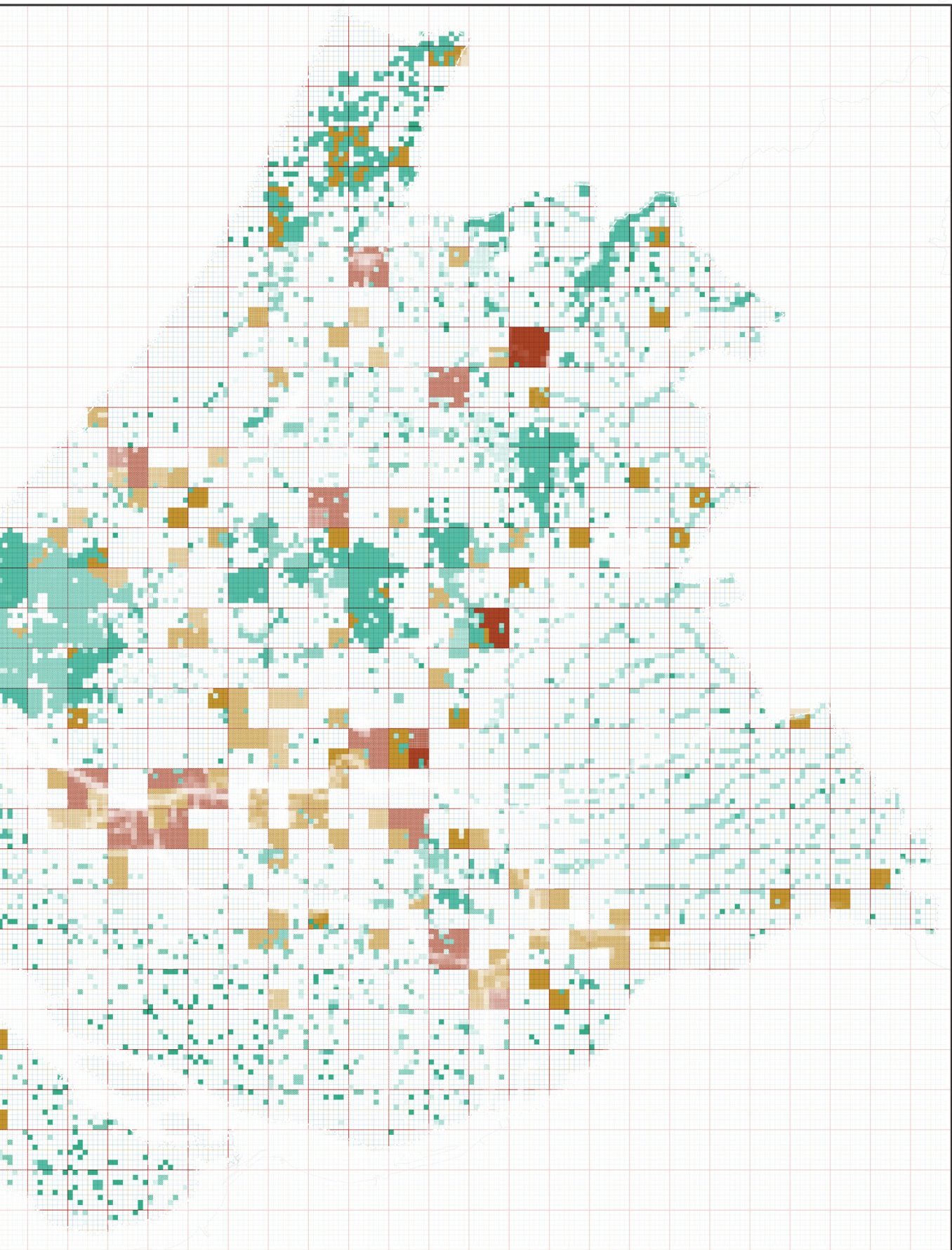
N

There is a need for abstraction, in order to interpret the multiple variables and complexities of classifications.

VARIABLES ON A MAP

The result of this analysis with GIS is a map rich with information that illustrates the range of each loop, the density of clusters and connections.





Based on: Open Street Map (2022), PDOK (2022), LISA (2022)

vision

potential areas

aspects of development

In this chapter the process of formulating the vision and the vision itself is explained.

Initially, the analysis of the GIS data was essential to understand where there were potential areas for our approach.

While analyzing three themes that are associated with each potential area were formulated. This is specifically important to explain possibilities of closing the loops and improving the cooperation. Thereafter, we explain the aspects for the development of each of the areas previously highlighted. Finally, we illustrate our vision in an interpretative image.

The vision statement contains our main vision for the Province of South Holland. The vision for South Holland in 2070 is to have a bio-based circular economy that is based on the restructure of the current waste stream. In which companies situated in the port would operate in cooperation with the glasshouses and farmers of the agricultural sector in the Westland. This would help reduce unsustainable energy consumption and also tackle a transition to a greener and more energy clean port.

To formulate and visualize our vision, we first analyzed the results from the methodology. This led to a clear visualization of density and concentration of processors, industrial and agricultural land. In order to restructure the current waste stream, we need to close the loops and, therefore, be aware of the already existing structures and facilities. The assumption that there is a spatial logic and a relation to the land use-distance nexus helps to understand which areas need to be improved, clustered or stimulated to cooperate in multiple loops. Each of the so called 'potential areas' were assigned a specific theme that is related to their location in the province and to the facilities and to their potential on performing as hubs for the province. They could provide educational and trading services, infrastructure and technology services and the social and trading services. The idea of implementing different objectives for each hub not only is related to the potential of each area, but also relates with the provisional service that could be afforded

in order to reach an overall balanced scenario when the vision is concluded.

As previously stated, when providing education, knowledge, infrastructure and trading spaces, it is possible to improve alliances and influence social life, ecological protection and boost a profitable economy.

In 2070, Zuid Holland will have a **bio-based**, circular economy, based on the restructure of the current waste-stream. In which companies situated in the port would function in **cooperation** with the glasshouses and farmers of the agricultural sector in the Westland. This would help **reduce unsustainable energy consumption** and also tackle a transition to a greener and more energy clean port, which completely aligns with the port vision and aim.

With this as a main target, other lateral effects are created: as a proper consideration of the balance in between productive land and natural reserves, as well as facilitating the exchanges of resources between companies within the cooperation.

vision statement

Apart from that, the social aspect of unveiling the blackbox and **creating a more transparent process**, that not only encourages an innovative atmosphere for exchange of knowledge, but also brings the cycles closer spatially.

This will be achieved by introducing a spatial and metabolic structure that connects small to big scale companies in regard to their production and will **rearrange** and coordinate the waste streams and redirect them into waste-to-energy facilities. This would close waste chains on three different scales and process the Province's waste into reusable materials and energy, valuable to the Port.

potential areas

As a result of our methodology and its translation to the GIS mapping, we tried to understand how the region could improve its potential areas, in order to become coherent, connected and cooperative following our vision for the region of South Holland.

The map depicts the functions, densities and distances of the loops and translates this to a more abstract and simplistic way to understand the potential and weaknesses in the region clearly.

By analyzing the map we highlighted areas that have an already dense organization with processors, industrial and agricultural. In order to close the loop we need to be aware of the already existing facilities that can contribute to closing the loops. We highlighted the areas where there are a combination of loops relating to each other. Some areas display the 3 loops already united or highly concentrated. Other areas only present 2 loops, in these areas there is distance between the loops. The assumption that there is a spatial logic, and the relation to the land use-distance nexus helps us understand which areas need to be improved, clustered or stimulated to cooperate in multiple loops.

In the following paragraphs and on the map, we will explain potential areas in which there is need or a latent feature to become more expressive centres on the vision to become a waste-to-value economy.

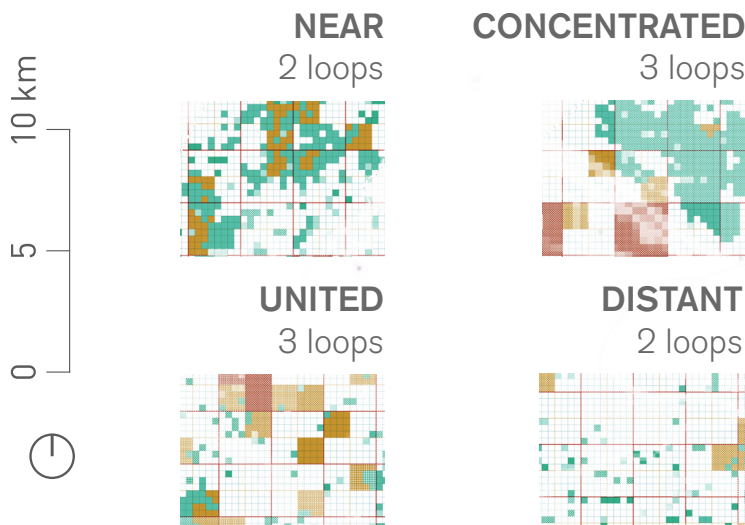
POTENTIAL AREAS

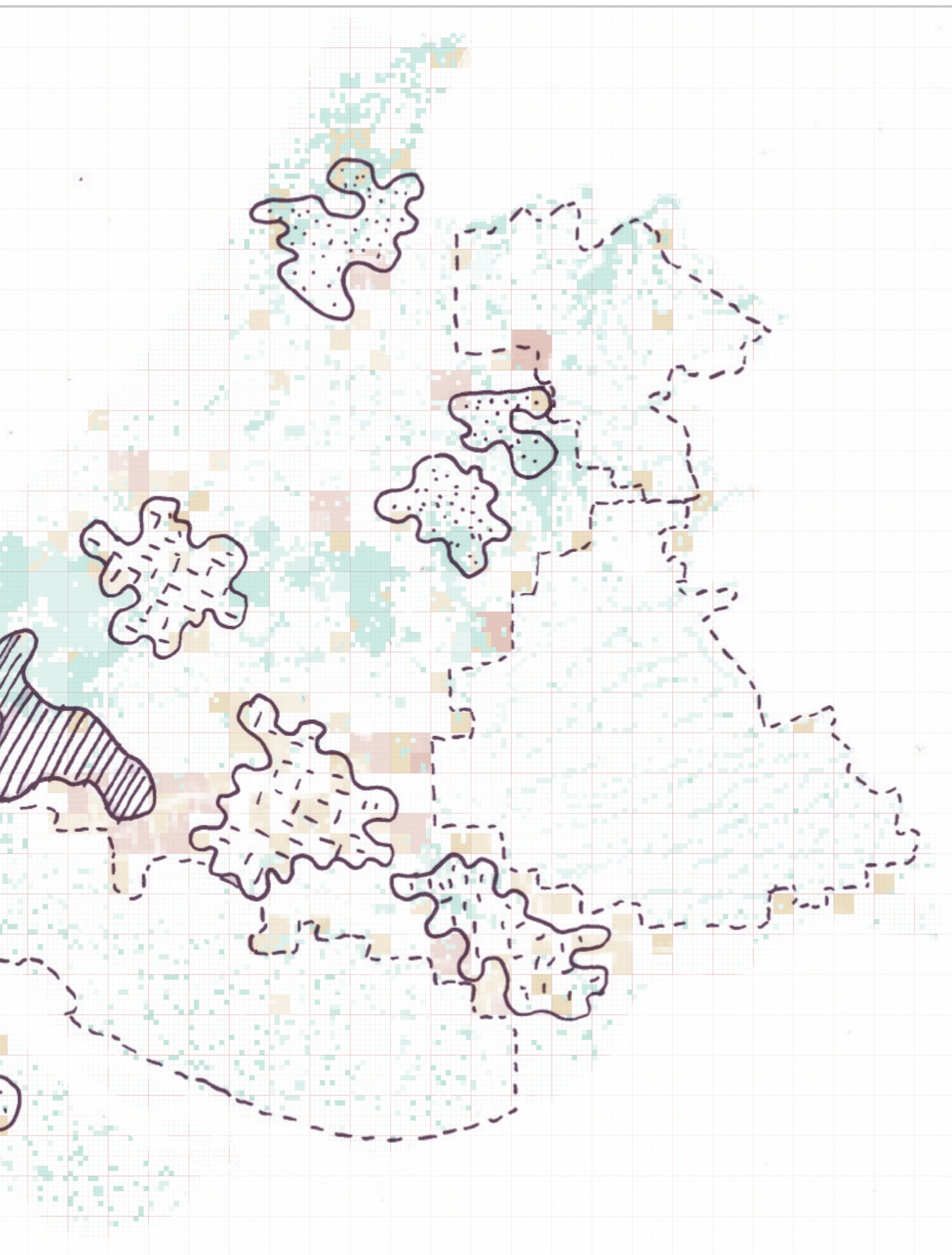
As we can see in the map the area around the port is a dense area where industry and waste processors are really close to each other. The area around the port therefore already has a lot of potential to use the waste chains efficiently and close them. This is a big potential for the project.

Because the port is already a dense area with a lot of potential for cooperation between industries, processors and agriculture this can function as a starting point for innovation and new technologies in the region of South Holland. The other clusters of processors and industries can expand and innovate to stimulate new innovation in the surrounding area and work as example hubs and connecting hubs within the region.

In the north of the region there are a few areas where there is more concentration of processors. This could be future areas of expansion and development, taking into account the existing initiatives and the possibility of developing new centres that are independent of the Port of Rotterdam stream of exchange.

The area's more on the edges of the region South Holland are less dense and lack the availability of processors. In this area there can be a potential to make better use of the organic waste streams from agriculture. A strategic spot can help to stimulate the corporation for the companies to close the loops, creating a network of smaller cooperatives that are supported by a waste processor centre.





Based on: Open Street Map (2022), PDOK (2022), LISA (2022)

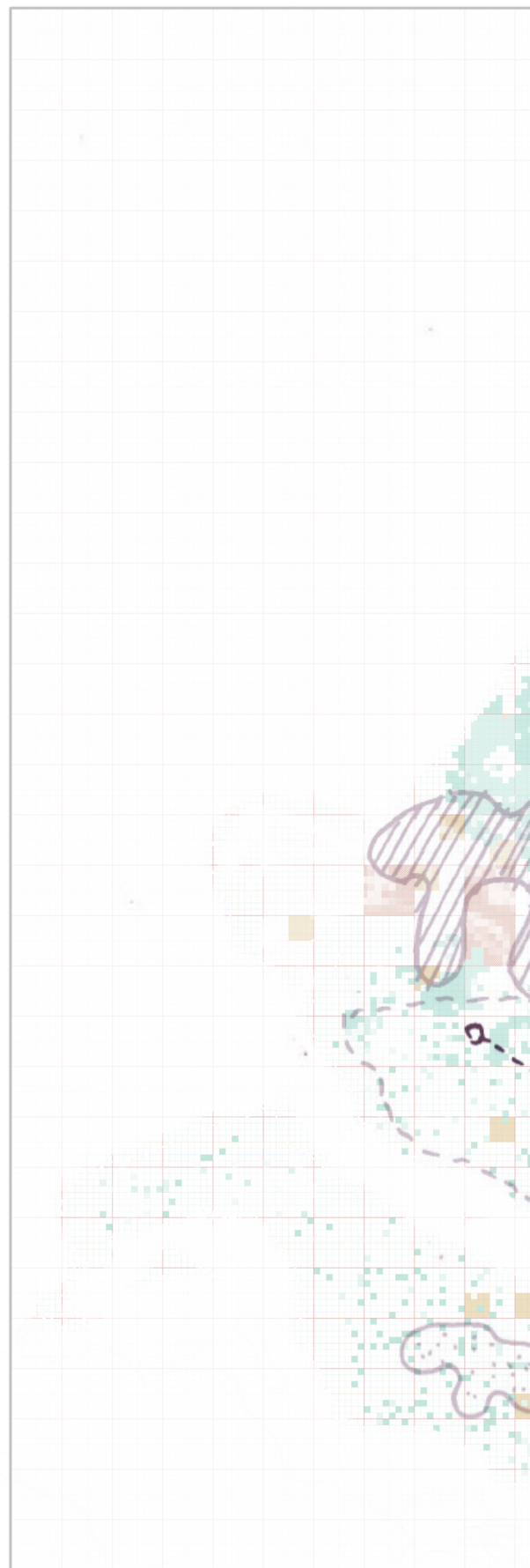


+ POTENTIAL HUBS

While analyzing the potential areas, different kinds of themes were able to be assigned to each area. Educational and trading hubs, infrastructure and technology hubs and the social and trading hubs. The idea of implementing different objectives for each hub or centre not only is related to the potential of each area, but also relates with the provisional service that could be afforded in order to reach an overall balanced scenario when the vision is concluded. This refers to themes such as social, ecology and economy, the main aspects to be developed in a sustainable and circular vision (Yolles, 2018). In this sense, to provide education, knowledge, but also infrastructure and trading spaces we aim to improve alliances that have effects on the social life, ecological protection and still boost an effective economy.



- social and trading hub I
- educational and trading hub II
- infrastructure and technology hub III

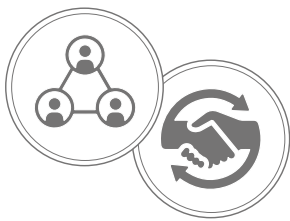




Based on: Open Street Map (2022), PDOK (2022), LISA (2022)

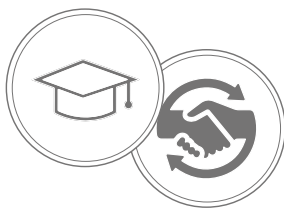


aspects of development



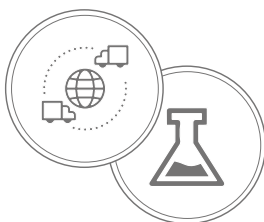
I. social and trading hub

The social and trading hub is related to the social theme. This hub focuses mostly on the cooperation between companies from the agriculture and the industries of the port.



II. education and trade hub

The educational and trading hub are related to the sustainability and biodiversity theme. In this hubs there will be a focus on education in new sustainable farming techniques and a trade hub for organic waste.



III. infrastructure and technology hub

This hub is related to the economy theme. This hub strives to work efficiently with transport and will be a center for new technologies to improve the transport, industries and processors.

In the following paragraphs, we deepen the idea of the three themes to be prospered by our vision and will further explain the outcome of each of them.

There are three themes that play an important role in our vision. The first theme is the social theme where we focus on cooperation. For that, we believe that implementing educational and social hubs (in the areas with potential to this implementation) will play a role as meeting and trading centers in order for farmers and industrial industries to be innovative and cooperative. Moreover, a development in the province, also means the growth of the population and relocation close to its facilities. Therefore, new residential and social areas are needed. The goal for the social theme is that farmers and the port are completely connected regarding the waste processing industry, not only productionwise, but also occupying same spaces and having similar social providences

The second theme is the sustainability and biodiversity theme. This theme is not related to a specific hub as it is mostly an overall approach of the circular economy and how important it is for climate change and for societal changes related to the culture of food consumption. The protection of natural areas will be important because these natural areas are important assets to deal with climate change. Another important topic is the production of monocultures by the farmers ; in this case, we aim on stimulating them to create a more diverse selection of

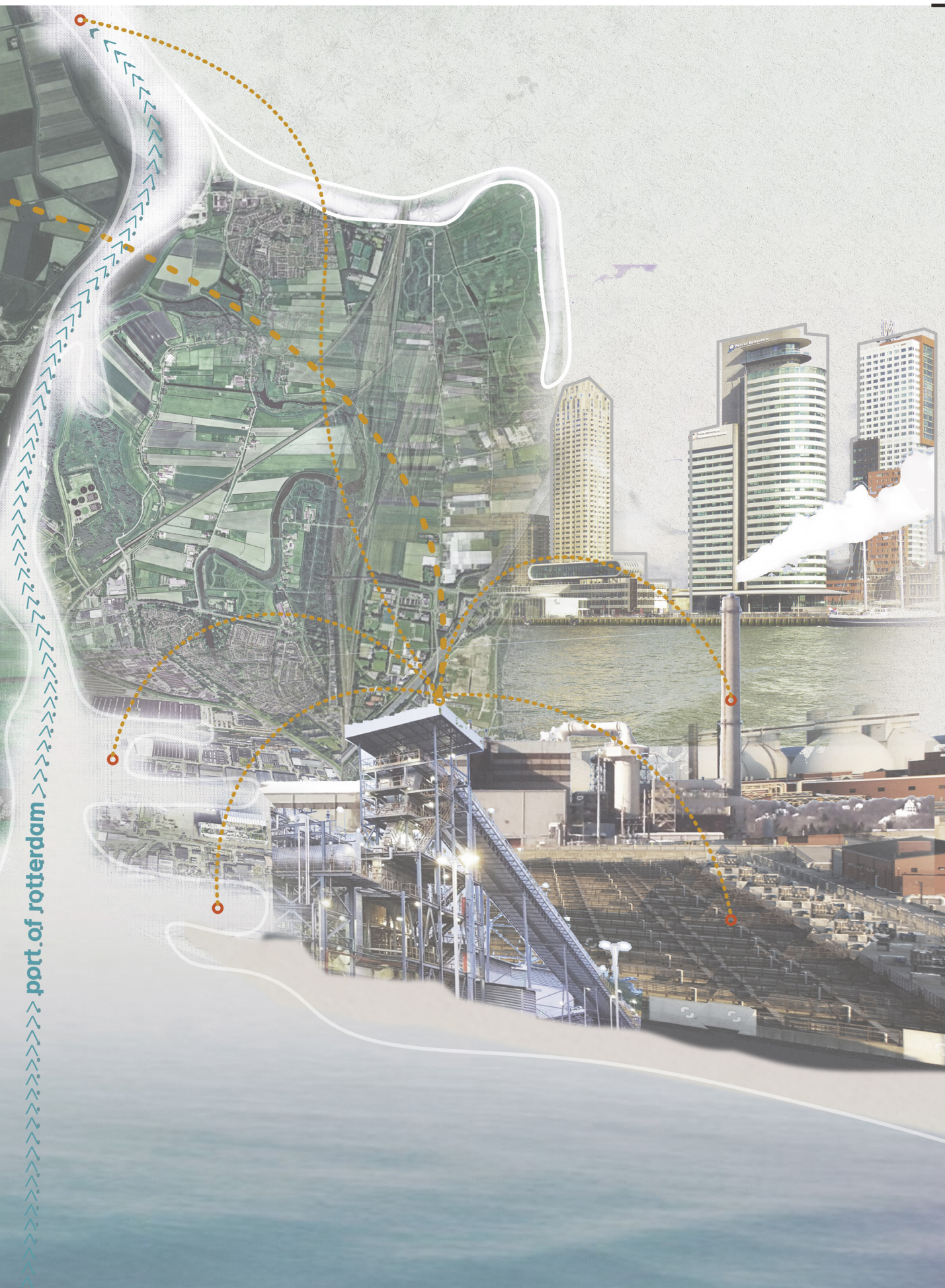
crops, improve the biodiversity but also the variation of organic-waste and needs. In this same logic of dietary change, the livestock sector has a lot of transmissions and does not contribute that much to the bio-based economy.

The third theme is the economy theme. This theme is highly related to the technological hubs that not only provide job opportunities, but also increase the expertise in the waste research field. We believe that by adding new techniques the process facilities will be optimized and new sustainable waste processing will grow and create more opportunities for efficient waste treatment flows.

The idea of having an intense investment on technological development is substantial to the goal of implementing an economy that is effective and profits over an sustainable process of energy production and waste management. Therefore, more and more, fossil fuel based industries are eliminated from the market (following the current trends and aligning to the existing vision of the Port of Rotterdam to become a greenport. (van Barneveld et al., 2019).)

VISION





strategy | a game

strategy | the game

stakeholders | the players

land uses | the tiles

policies | the rules

tool | the board

phasing | the game rounds

decision making | the evaluation

optimal combination

results

Our strategy is set up as a game. In our proposal, we use the game as a tool for planning. In this way, it is easier to understand (by abstraction) complex aspects that were relevant for the strategy and influence on the vision to be reached.

For this chapter, we firstly explain the game and then, in sequence, we explain how we translate real spatialization and policies into rules of the game: describing the stakeholders (players), land uses (tiles), policies (rules) and the tool (board).

After this, the phasing of our vision (rounds of play) is described and the criteria for the decision making (evaluation points) of the project are specified.

Altogether, the conclusion of this chapter depicts the results of the game and the interpretations on how each spatial combination reached by the game relates to possible planning tools of master plans.

In the previous chapter, a design vision for the regional scale of the South of Holland was created. The vision was intended to create a more overall sustainable future for all actors coming from the Port of Rotterdam and the agricultural sector in the province.

The end vision creates a closed and coherent system in the whole province in which all sectors are stimulated to cooperate. By using a theoretical approach highly grounded on the distances and connections between facilities, the vision developed into a spatial logic where different configurations of functions should be made and rearranged, in order to achieve circularity.

This idea will be further discussed in the following chapter, with the introduction of a new tool to support the decision making and the planning process. The interventions that need to be implemented in the province will be elaborated through a game, in which we stretch the possibilities of spatial interventions and are able to speculate and analyze new placements by engaging with the stakeholders and creating abstract rules that translate the real life situations. A method of evaluation is the key asset to fully comprehend the outcomes and the development of the area.



GAME AS A TOOL

A pixelated map of a city area, likely a coastal region, rendered in a grid-based, low-resolution style. The map features various colored blocks representing different land uses or zones: teal for water bodies, orange and yellow for urban or commercial areas, and brown for parks or undeveloped land. Several small icons are scattered across the map, including a house, a school, a factory, and a shopping cart. The map is overlaid on a white background with a faint grid.

L FOR PLANNING

strategy | the game

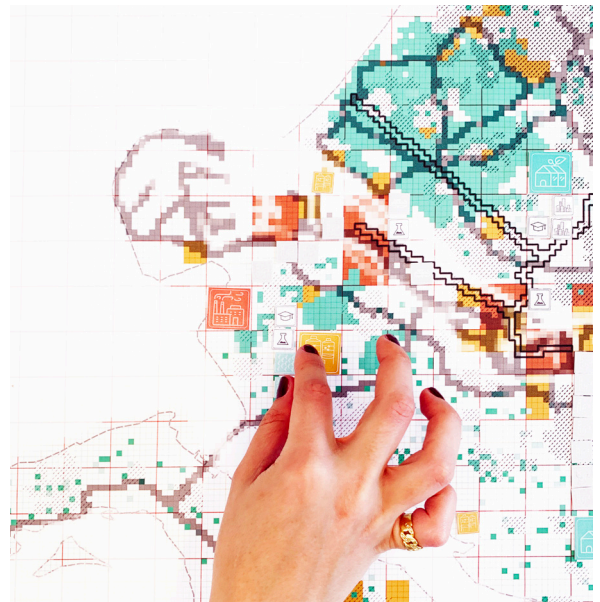
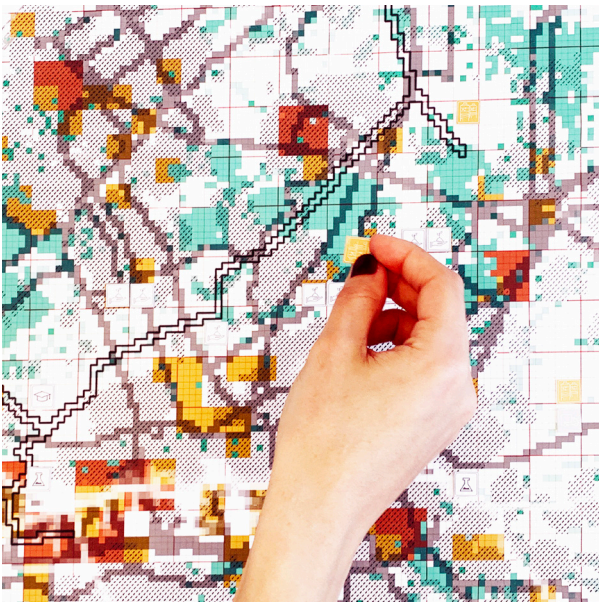
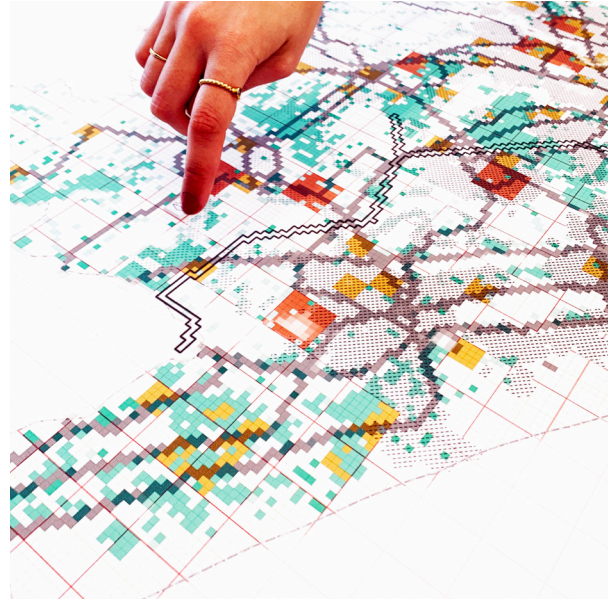
Following up on the methodological approach towards the waste and CO₂ chains in the province, the method to eventually establish a development strategy was done through a game. The game is not centered around competition between stakeholders, but is rather directed to stimulate cooperation and to be a tool for negotiation between them. The desired victories are reached when a balance of organization of spatial elements is created, which best supports all the closed cycles of waste and CO₂ trading and has facilitated some central hubs with the highest activity on the social, economic and sustainable level.

Moreover, through playing the game, an experiment arises that unravels how the different stakeholders react to each other during certain drastic changes and connections or, for instance, when the government makes decisions or implements policies. Collaboration is, therefore, strongly stimulated in the game; creating a statement that the game is an interesting tool on negotiating the achievement of a desired future scenario.

The need for interaction is a reason that led to the choice of designing a game that would simplify the complex system of interaction between stakeholders, land uses, sectors and policies. We envision that the participants will be required some level of knowledge and expertise on the fields of design, planning, governance and policy making. The use of the game in real situations should be seen as a negotiation tool for experts (industry parties,

agricultural parties, municipalities).

While playing, the different experts are introduced to the rules of the game, which will be explained on the next pages of this chapter. In this way, the game requires them to put their own personal goals for development in a new perspective. Thus, the game gives them an improved insight on all the implications involved in creating a vision and strategy for a whole region. Besides, it will give them a spatial overview in an extremely quick manner on where changes in land-use can be made.



stakeholders | the players

The purpose of the game and the project aims at reaching collaboration between the port and agricultural sector. Before translating these dynamics into a game structure, all stakeholders and actors were set out as the players of the game. Those players will then build up the whole strategies, arrangements and negotiations.

To identify the stakeholders and assign them roles is also a way of identifying priorities, influences and power granted to each one of them. Hereby we will explain the stakeholder analysis as we dig deeper on understanding the common dynamic of each actor.

To begin with, when looking at actors involved, this entails not just farmers and workers involved in the industrial processes of the port and province: in order to accomplish cooperation that will eventually lead to circular waste streams, many more stakeholders will have to get on board in the development strategy. In the stakeholder analysis, an inventory of all stakeholders involved in the Province of South Holland is set out and their accompanying interests, needs and their amount of influence to enhance or oppose change, are listed.

When looking at the active stakeholders in the private sector, we identify "knowledge institutions", citizens and the government. For these stakeholders, notions like biodiversity, innovation and connectivity are of importance. The knowledge institutions mentioned include universities like the Technical University of

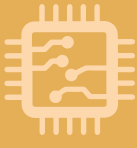
Delft, academies, and research institutes.

Involved in the production of food, goods and other products, we identify stakeholders such as: small scale farmers, big agricultural companies, and big port companies. An example of a bigger agricultural firm can be for example Royal Flora Holland, which connects multiple horticultural companies in the province (Royal FloraHolland, 2021). Big port companies involve for example Vopak, Shell (Port of Rotterdam, 2021) and many other companies related with the ship building and metal industry. These three mentioned stakeholders have a high potential to be involved in the circular trading system of CO₂ and waste. It is also relevant to mention that all these stakeholders and their sectors require a relevant amount of land of province, which is also a big issue when it comes to creation of new arrangements and disposal of new facilities.

A stakeholder involved and of importance for the vision specifically are waste processing companies in the province. These companies already exist in the current situation, but in quantities that are too little, and without the right innovations and knowledge yet to take up for all the agricultural waste that is unused nowadays in the region.

Investors are lastly stakeholders involved in the private sector of the region. If common goals and visions are aligned, their capital could have a big influence in developing and implementing the needed technologies for a

WASTE PROCESSORS



HIGH PRIORITY



138 MEDIUM TILES

YOU CAN ADD AS MANY TILE AS NEEDED

CROPS FARMING



HIGH PRIORITY



695 SMALL TILES

YOU CAN ADD AS MANY TILES AS NEEDED

LIVESTOCK FARMING



HIGH PRIORITY



1439 SMALL TILES

YOU CAN ADD 10% OF THE TILES ADDED BY THE CROPS FARMING

BIG AGRICULTURAL COMPANIES



LOW PRIORITY



3029 SMALL TILES

YOU CAN ADD 40% OF THE TILES ADDED BY THE CROPS FARMING

BIG PORT INDUSTRIES



LOW PRIORITY



19 LARGE TILES

YOU CAN ADD 10% OF THE TILES ADDED BY THE CROPS FARMING

GOVERNAMENT



**YOU CAN ADD AS MANY TILES AS YOU WANT!
AND ON THE BOARD YOU HAVE...**



22695 SMALL TILES



8389 SMALL TILES



349 SMALL TILES



5561 SMALL TILES



1501 SMALL TILES

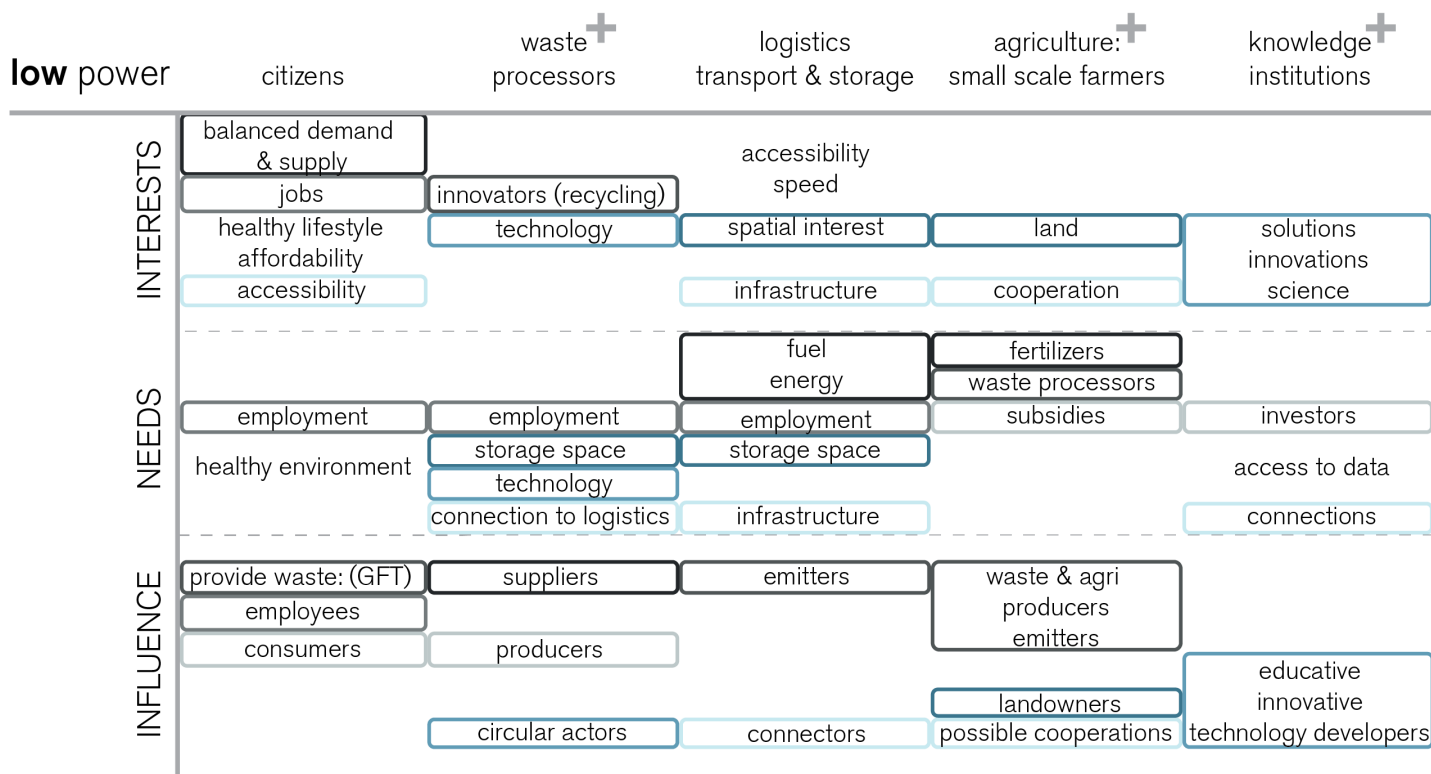


Figure 24: The stakeholder analysis: their interests, needs and influence within the Province of South Holland

waste-to-value province.

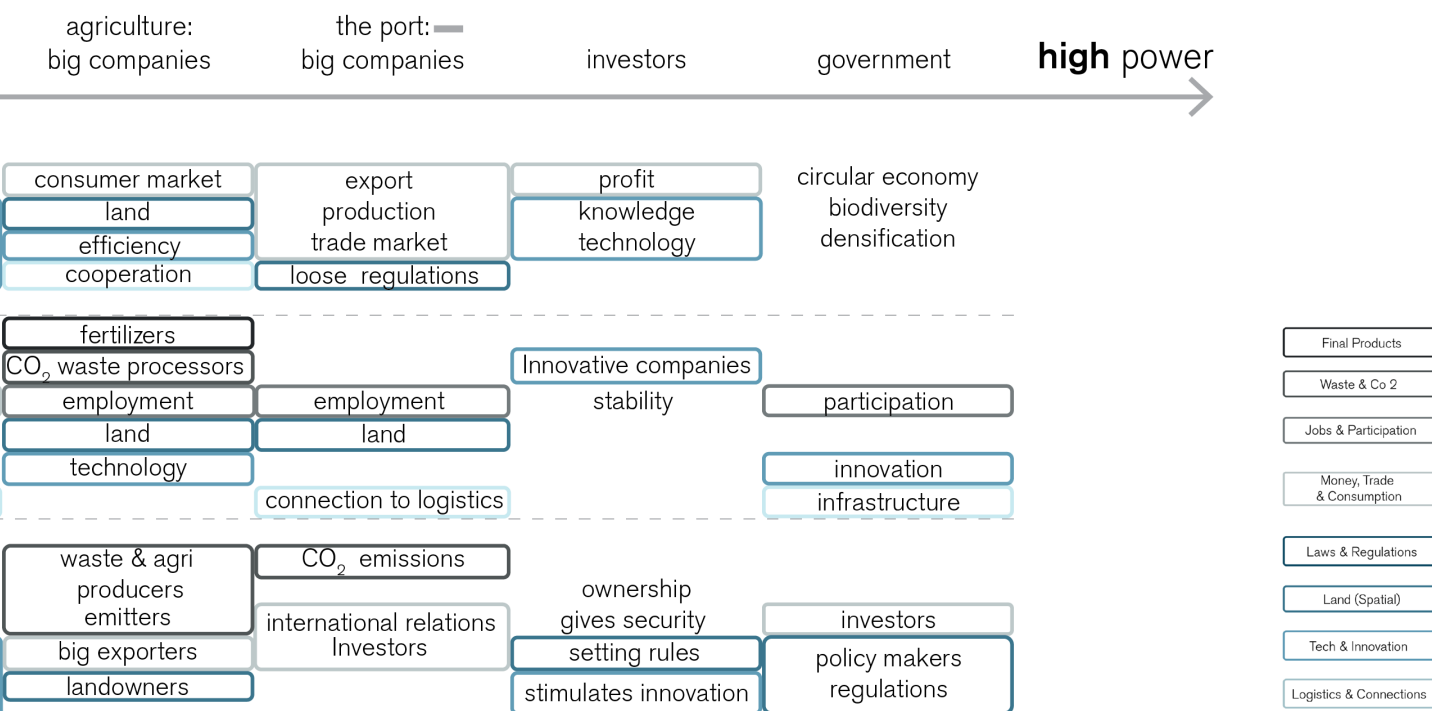
After summarizing all stakeholders, one could divide them by how influential they are in the planning process. As seen in the diagram, the government and investors have the highest power, as they are the ones that can enact laws, regulations and policies and have access to money to subsidize specific initiatives. Following up on these two stakeholders are the bigger agricultural and port companies, based on their share in different trading markets and on the capital that they have already built up. Citizens and knowledge institutions have less power, due to their lack of governmental rights, even though they have some power to lobby societies' problems. The most remarkable stakeholders with little power in the current situation are the waste-processing industries and small scale agricultural firms. These two stakeholders play a key role in the vision and are essential to the circular economy, in order to be able to create value out of waste.

Taking the influence analysis into consideration and seeking to translate that into the game and in the development strategy, these stakeholders and players will need more support and an increase of power.

Firstly, a player card is given to the government, which is in the game an overarching card that represents the citizens, knowledge centers, investors and the government itself. It includes all stakeholders that are involved with subsidies, implementation of infrastructure, social and innovation initiatives, urban residential expansion and protection of biodiversity. This player has the power to implement some facilities, further described on the pages, that are uniquely specific to this card and reflect what policies and interventions are needed to accomplish the vision.

We understand the government as a judge of the game - and also in reality - as it performs regulations and stimulations and can allow or ban some actions from other sectors. Overall, the government as a stakeholder is able to guide the course of the vision and the goals for the province.

Secondly, the waste processors stakeholders reflected in a player card, as they have an aforementioned key role in the vision. They are granted illimited actions in the game, in order to stimulate implementation of new areas of treatment and stimulate as much as



possible the metabolic process that results in a waste-to-value economy.

Following up, the role of the farmers and agricultural sector was split into three players, due to the variety of this sector, its big influence on the waste pretreatment and the different ways of food production that require and generate energy and waste differently.

In the game we can define them as: crop farmers that cultivate vegetables, fruits, feed for animals and other vegetation on land. Another player is the livestock farms, which can provide the waste processing loops with big amounts of animal-based manure. Hereby, think of livestock farms, who are engaged in, among other things, the breeding of poultry, cows or pigs. The biggest part of agriculture in the South of Holland is the greenhouse agriculture and horticulture, and, therefore, in the game it is represented by the player 'Big agricultural companies'. The glasshouses involved in this part of the agriculture demand huge amounts of energy in terms of fossil fuels (CO₂) (Gemeente Westland, 2021).

Even though all the agricultural players are representing the same sector, they have different priorities during the game. This is because they have different influences and

power, as already stated before. The small scale farmers have the high priority during the game, as a way to ensure their voice to be heard and their interests to be favored. Big agricultural companies have less priority as they are already a big influence and play a big role in the operationalization of the system.

The amount of influence displayed by the port is translated in the game as the player with less priority of playing and creating new arrangements. This is explained because of the inflexibility of the facilities involved, the amount of space and land needed to expand, but also to the unsustainable industrial process now on course. Therefore, this player is challenged to cooperate and diminish its emissions and damages, rather than expanding and reallocating.

The next pages of this chapter will go into more depth into this topic, as the game rules will be explained thoroughly.

land uses | the tiles

Following the same spatial logic used in the previous steps, the game abstracts its functions into tiles which are placed by the players.

The tiles represent different land uses that compose the current scenario of the province, when analyzed from the lenses of the metabolic process of waste-to-value.

Each tile represents a spatial facility: the agricultural sector is represented by the livestock farms, crop farms, glasshouses; the waste treatment facilities are represented by the waste processor tile and the big port industries are presented by the industries tile. Other land uses are also translated into tiles, such as: urban perimeter, nature reserves, which can be placed by the government.

As part of the vision for the coming years, new educational and knowledge centers tiles are also available to be placed by the government.

An important definition is the placement of infrastructure, because they define new possible areas of development that can take advantage of a well connected network, a pipeline or waterways that open up the connection to the port. That said, the tiles for waterways, CO₂ pipelines and highways are also offered to be placed by the government.



livestock



crops



glasshouses



waste processors



industries



urban perimeter



nature



knowledge centre



educational centre



waterways



co₂ pipelines



highways

LANDUSE

HUBS

INFRASTRUCTURE



Following the same dialectic from the methodology, the tiles can be represented in three different sizes, as they are facilities that take part on one (or more) different types of loops; hence, its distances and reach of influence are distinct from one another.

The overlapping of the analyzed functions and their distance led to a board that contains certain amount of each tile category. This initial display is related to the current scenario of the province.

DIMENSIONS OF TILES

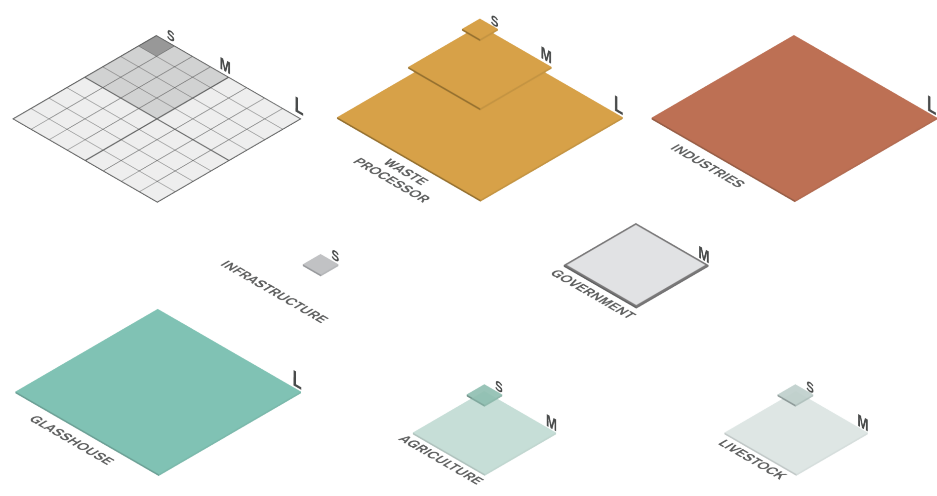


Figure 25: Each land use correspond to a specific tile size

AMOUNT OF TILES

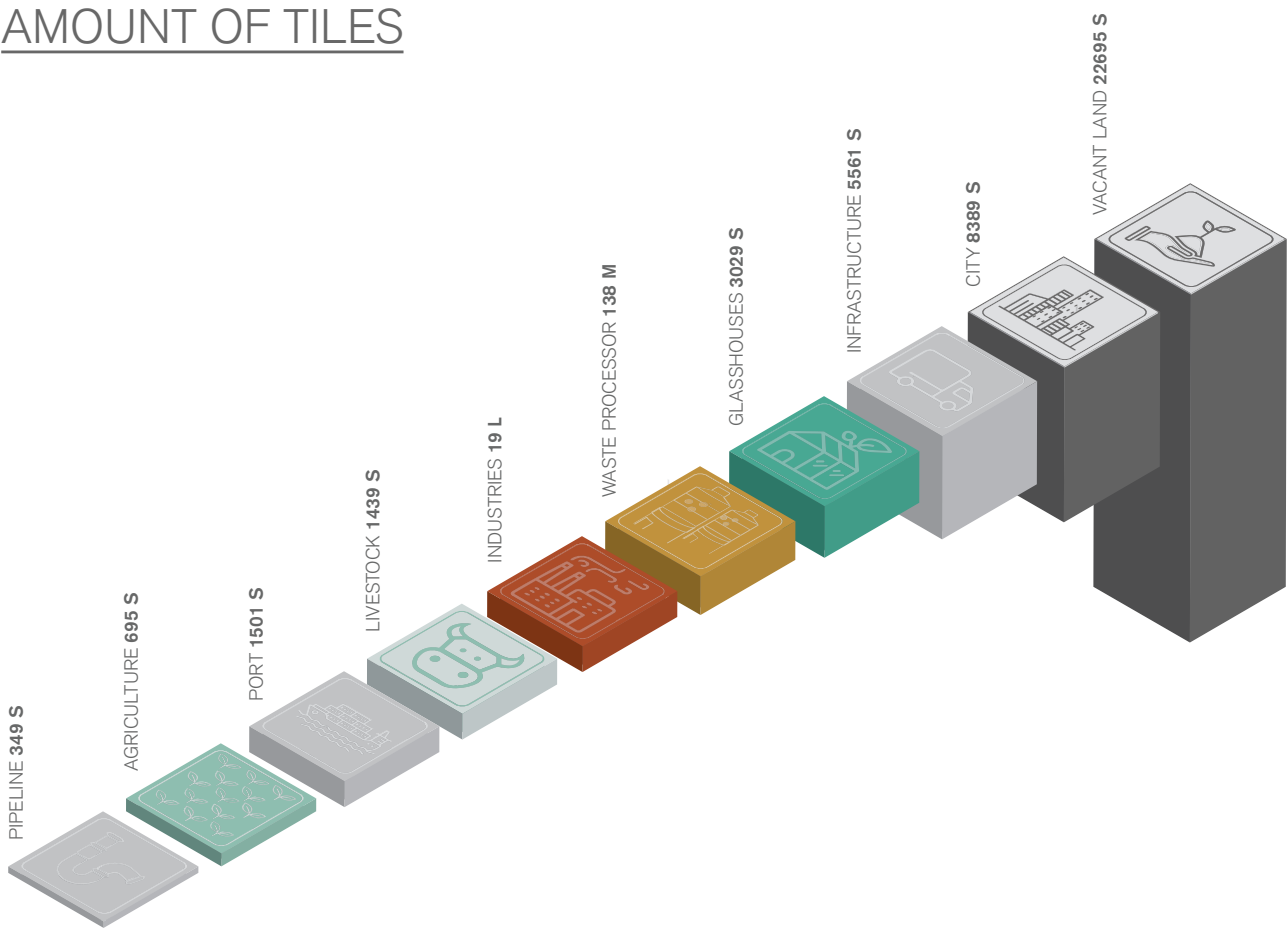


Figure 26: Amount of tiles per category on the current scenario. Based on: Open Street Map (2022), LISA (2022)

policies | the rules

The game was structured to reflect real problems and conflicts of the province; therefore, a series of rules were created not only to indicate ongoing policies, but also as a way of implementing new desired ones.

As beforehand stated, the game provides a space for experimenting with multiple arrangements of tiles (that represent land uses and facilities). To restrict certain combinations or to coordinate the number of tiles to be placed is a strategy for, in reality, control which type of land use occupations are inappropriate and undesired for the current and future scenario.

The rules structure a minimum requirement of distances from areas that are either desired not to be intervened or are areas of protection and with a consolidated land use.

Moreover, the rules use the current scenario in a critical way in order to stimulate an interesting policies, according to our vision that relates sustainability to waste-to-value economy.

The possible spatial configurations of a more circular metabolic process that connects the waste producers (agriculture and industries) and waste processors is the main goal of the game, that is further be translated into planning. As this process is highly influenced by distance and their surroundings, the first restrictions of the game are critically thought in order to prevent inappropriate combinations, setting minimal distances for

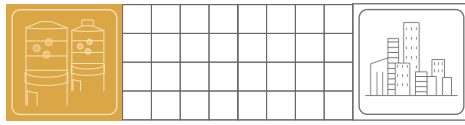
specific land uses.

New waste processors facilities and industries have to respect a specific distance from urban residential areas. Glasshouses are required to develop around CO₂ pipelines, in a strategy to stimulate placement of facilities that would easily cooperation and use the infrastructure that connects them to the industries (producers of CO₂).

Urban areas, nature reserves and recreational parks are examples of areas protected by the game, that area kept out of the game in order to maintain an equilibrium on areas that are either consolidated or have greater value of importance.

The game also controls the amount of tiles available to be placed, and this is calculated based on the ratio of capacity of waste-to-energy production (Langeveld et al., 2021) (Twence, 2022). In that sense, land uses that produce less energy with the same amount of waste production would receive less preference on placing tiles as they do not perform sustainability overall.

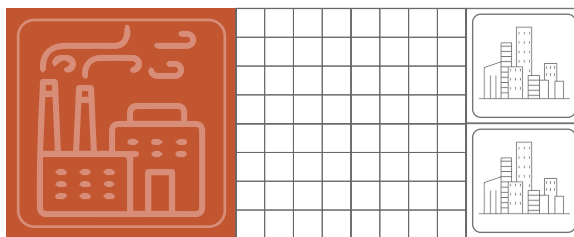
DISTANCE RULES



- Waste processors can not be 2 medium tiles close to neighborhoods.



- Glasshouse needs to be 8 small tiles close to pipes lines for CO2 transport.



- Port companies can not be 2 large tiles close to the neighborhoods.

Figure 27: Distance rules: the restriction that some land uses face when locating new areas of development

EXPANSION RULES

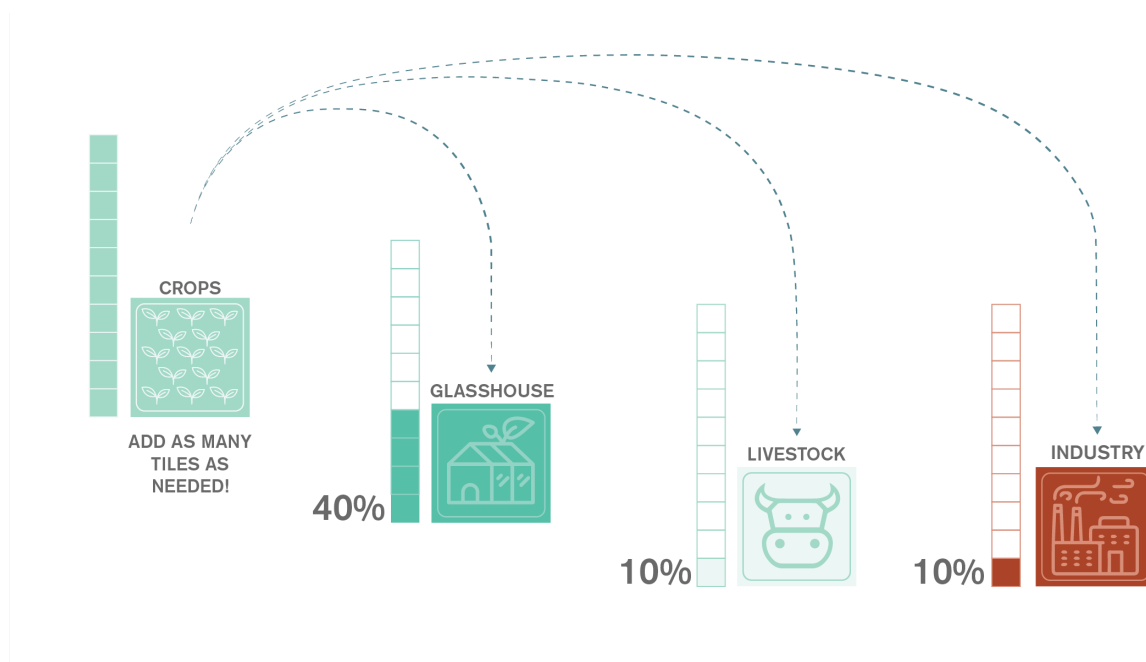


Figure 28: Additional tiles: the densification process is granted differently to each landuse

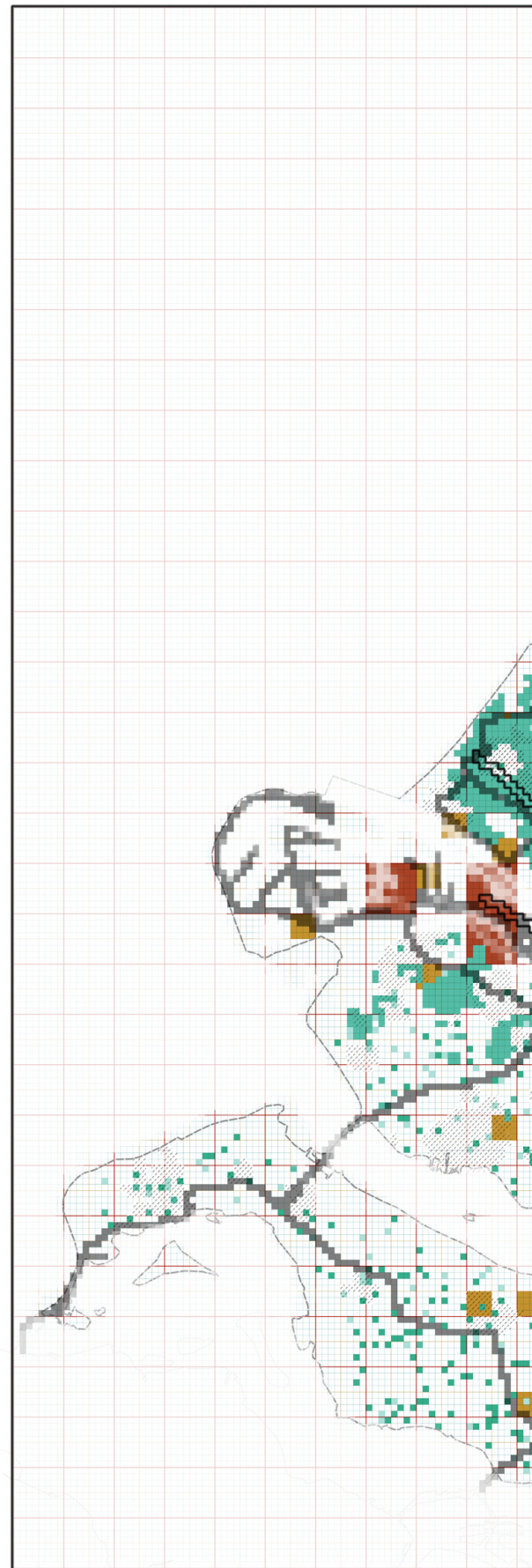
tool | the board

The board in which the game is played is a grid with different tile sizes (small, medium and big) intersected by infrastructure (small grayscale tiles). Some parts of the grid are colored in gray, in order to represent unreachable areas (for example nature reserves, cities with neighborhoods)

The board also portrays an abstraction of functions and distances in forms of tiles, as previously explained. It helps to highlight areas still not developed or with little to no interaction in between land uses.

The board provides possibilities to understand proximity to infrastructure and cities, while also highlighting concentration of land uses of the province. It supports the arguments of concentrating and intertwining functions in order to achieve the best possible performance on the circular perspective.

The possibilities of arrangement and composition of space with tiles, which are disposed of by the players, is the way the game helps in the process of planning. It highlights multiple possibilities that are later on evaluated.





Based on: Open Street Map (2022), PDOK (2022), LISA (2022), OCap (2014)

phasing | the game rounds

A phasing strategy is extremely important when it comes to creation of long-term visions. It supports the idea of paced and constant implementing, extreme and ground breaking scenarios. In this project, to implement it in a game, 'scenario cards' were created. Each of which announces a new round and a new challenge that the game sets. These round cards refer towards the future and stimulate the players to speculate about the year 2030, 2050 and 2070. As aforementioned, the government has high priority in the game and this is why the scenario cards entail mostly policies that the players should keep in mind whenever they decide to place a certain tile on the board. Through these phasing, depicted in the game as rounds of play, the possible timeline of the vision becomes slightly apparent, besides, it tries to cautiously direct the sequence at which spatial interventions are taken. However, the results of the steps taken during the game are the results that lead to a further concrete description of a timeline and its accompanying interventions. This can be distinguished when the game is finished.

In the phasing, we portray the beginning of a energy transition based on reduction of CO₂ emissions and implementation of waste processors subsidies; counteractions to balance out the biodiversity and ensure social inclusion through areas of development; and finally, investments and rewards based on good performance areas that fully implemented a waste-to-value economy.

During the design process of creating a regional vision for the Province of South of Holland, the game was played following three different strategies. In this way it was made possible to experiment even more, to find different results that will be now evaluated, also following the evaluation points.



ROUND I : 2030

"The government is subsidizing the use of biofuel and demanding a reduction in CO₂ emissions. There is a need for cooperation between farmers and users. Waste processors facilities have priorities on expanding to help support this policy."

ROUND II : 2050

"The energy transition has developed further on but this leads to a big expansion. The government requires more social and residential areas and demands the protection of nature reserves, by stimulating the players to concentrate on the existing sprawl areas with the construction of new infrastructure networks."

ROUND III : 2070

"The government invests in the hubs to make them more efficient. Clusters with good performance receive subsidies and are awarded with new educational and knowledge centers."

decision making | the evaluation

Until now, we identified the main objective of the game, as a tool for interaction, speculation and negotiation. Sequentially, we determined the players of the game, their role on rearranging and adding new land uses to the Province of South Holland and on engaging on new collaborations. We also defined which land uses are within the metabolic process that we are spatializing, but specially we created requirements, rules and conditions for them to be arranged.

The numerous possibilities of rearrangements and new dispositions also bring up different results depending on the aspect being evaluated. For that, we create a evaluation system that analyses the social-cooperation, biodiversity-sustainability and economy. The criteria for granting points on each aspect comes from the spatial quality and the potential performance of each of the tiles crossovers.

The social-cooperation aspect reflects the intensity of cooperation in between land uses, and grounds its criteria on the ratio of waste-energy produced out of the cooperation and/or the social provisional service offered by land uses such as infrastructures, educational and knowledge centers.

The biodiversity-sustainability aspects grants points and evaluates based on the outcome of natural services provided by the combination. Possible natural services that were taken into consideration are: implementation of more biodiversity, reduction of emissions,

concentration of land uses and therefore decreasing the need of unnecessary transport.

The last aspect concerns the economical aspect, which evaluates the potential for growth, profit and efficiency. It takes into consideration the overall performance of the metabolic process.

It is important to reiterate that, as the game is spatially-oriented, the evaluation system eventually evolve to a result in which combinations that highlight the importance of clusters are granted more points. This happens because the game (and the project) makes an assumption that there is a spatial logic that is related to the proximity in between facilities. Hence, a highly convenient result is the one that brings facilities together to other facilities and also to infrastructure, optimizing their performance and closing the loop.

An interesting game plan to reach the highest "score" is to create differentiated clusters of functions are visible. Monofunctions, poor accessibility or isolation will lead to a lower score and gives the player an unpreferable outcome.

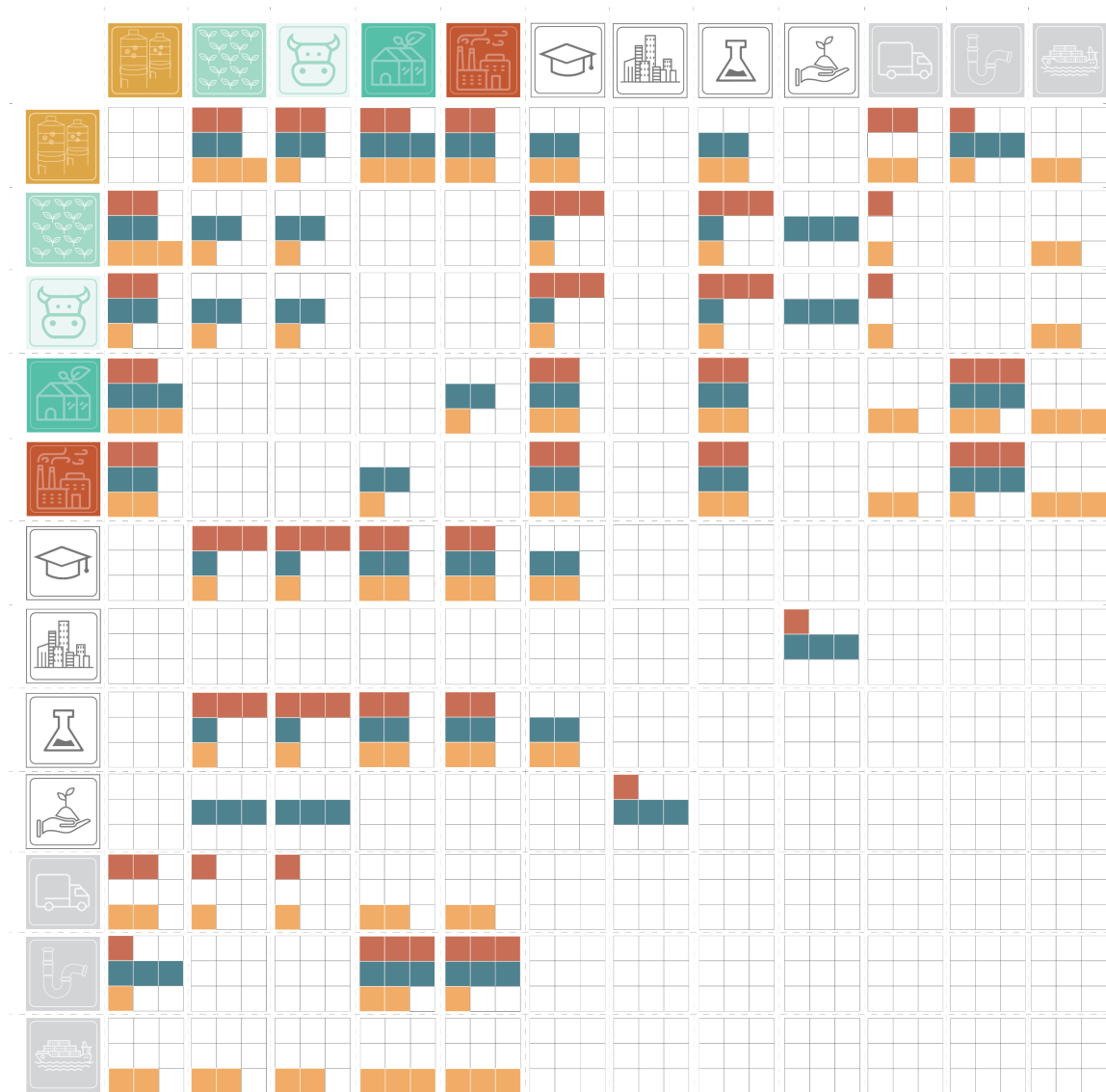


Figure 29: Evaluation system: each combination of tile represent a spatial configuration that perform socially-economically-ecologically different

optimal combination

When analyzing the combinations of the tiles (landuse) with the metabolic process described by the loops previously mentioned, it is possible to state that in the small loop the most efficient combinations are related to the land uses of crops, livestock farming and waste processors. In order to efficiently transport the waste created in the process, you need an adequate infrastructure. These are the four essentials landuses that should be neighbouring. By adding more nature reserves and livestock close to the agricultural land, more biodiversity is created.

The second loop refers to the organic materials produced by the port and the CO₂ emissions from the port industries. An interesting arrangement to close this loop is the positioning of glasshouses, industries and waste processors nearby. The industries supply CO₂ to the glasshouses and the glasshouses exchange organic waste to the processors. The combination of CO₂ pipelines, waste processors and both port industries and glasshouses close by, is the optimal solution for this loop. When adding educational and knowledge centers, this process can be improved and new technology innovations can enhance the trading and reduce emissions and waste outcomes.

The third loop regards the chemical waste processors and transformation of biomass into biofuels. For this process an efficient connection between industries and processors must take place. Good infrastructure (such as roads, railways) and innovative technology

can make this loop more efficient.

The diagram makes clear that the more that the three loops collaborate, the more efficient and successful the whole chain becomes. Moreover, by strategically placing knowledge, educational centers or nature reserves the sustainability, sociability and technologies are enriched. The diagram shows potential configurations that are important for a better performance on the game and on the project.



Figure 30: Evaluation system: best possible combination of tiles, regarding efficiency and collaboration

results | A

densification

The first strategy used while playing was 'densification'. The idea is to take into account the land-use of the province in the current situation and to leave this almost unaffected. At the same time, the players are looking for new land that is best suitable for new implementation of changes. This means mostly addition of spatial interventions to existing organization of land.

The result of playing this variation showed that the emergence of several clusters with combinations of functions were possible. However, this variation showed some difficulty to attach these clusters to the port properly sometimes, due to the proximity of cities and monocultural zones of land use that could not be altered. The biggest challenge is to place new glasshouses tiles, industry tiles and waste processor tiles. A pattern that can be seen is the scattering of medium size clusters over the hinterland.

EVALUATION:

social **106**
ecological **118**
economical **116**

- new CO₂ pipelines
- new highways
- large loop hub
- urbanized densification
- knowledge centre
- educational hub
- small loop hub
- nature





Based on: Open Street Map (2022), PDOK (2022), LISA (2022), OCap (2014)

results | B

rearrangement

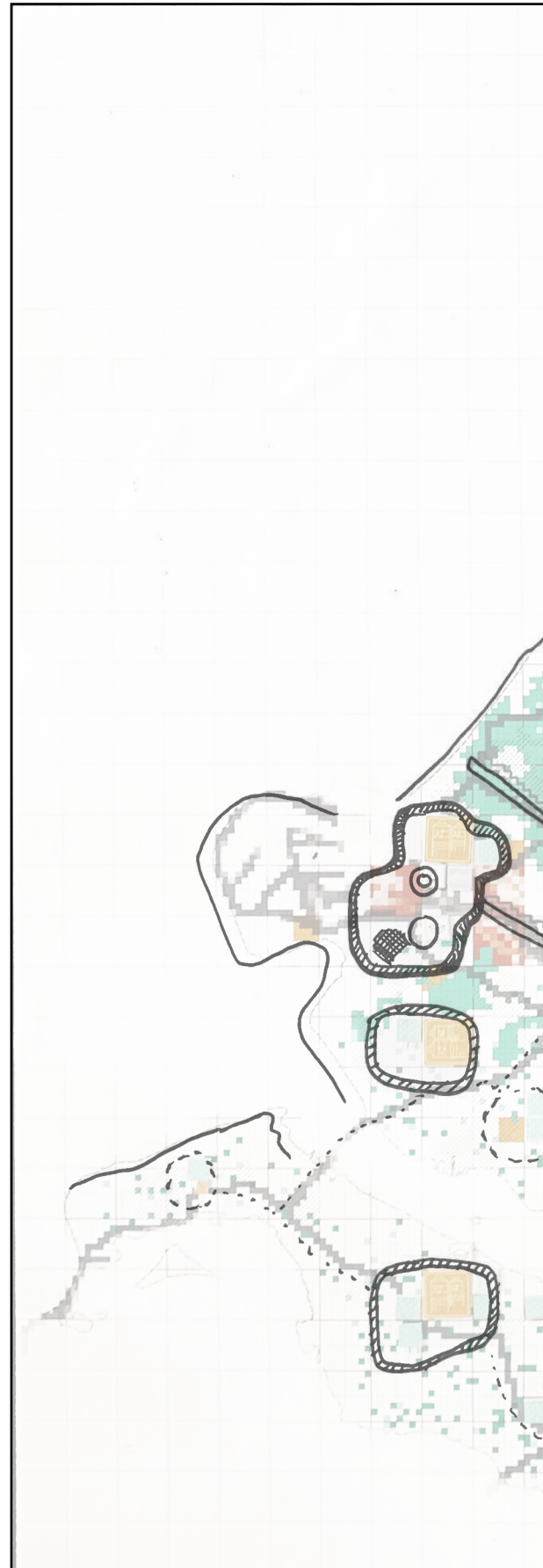
The second strategy used to play the game was 'rearrangement'. During the play of this variation, players were allowed to rethink some organization of land-use. As could be seen before, the land use of the province has a high variety of functions spread across, but sometimes the arrangement is not optimized: there is a lack of interaction between land uses. An example of rearrangement is, that in this play, when waste management facilities were dispersed in a certain area, they could be replaced with one, large, core-waste processors that could function as the starting point of a new cluster.

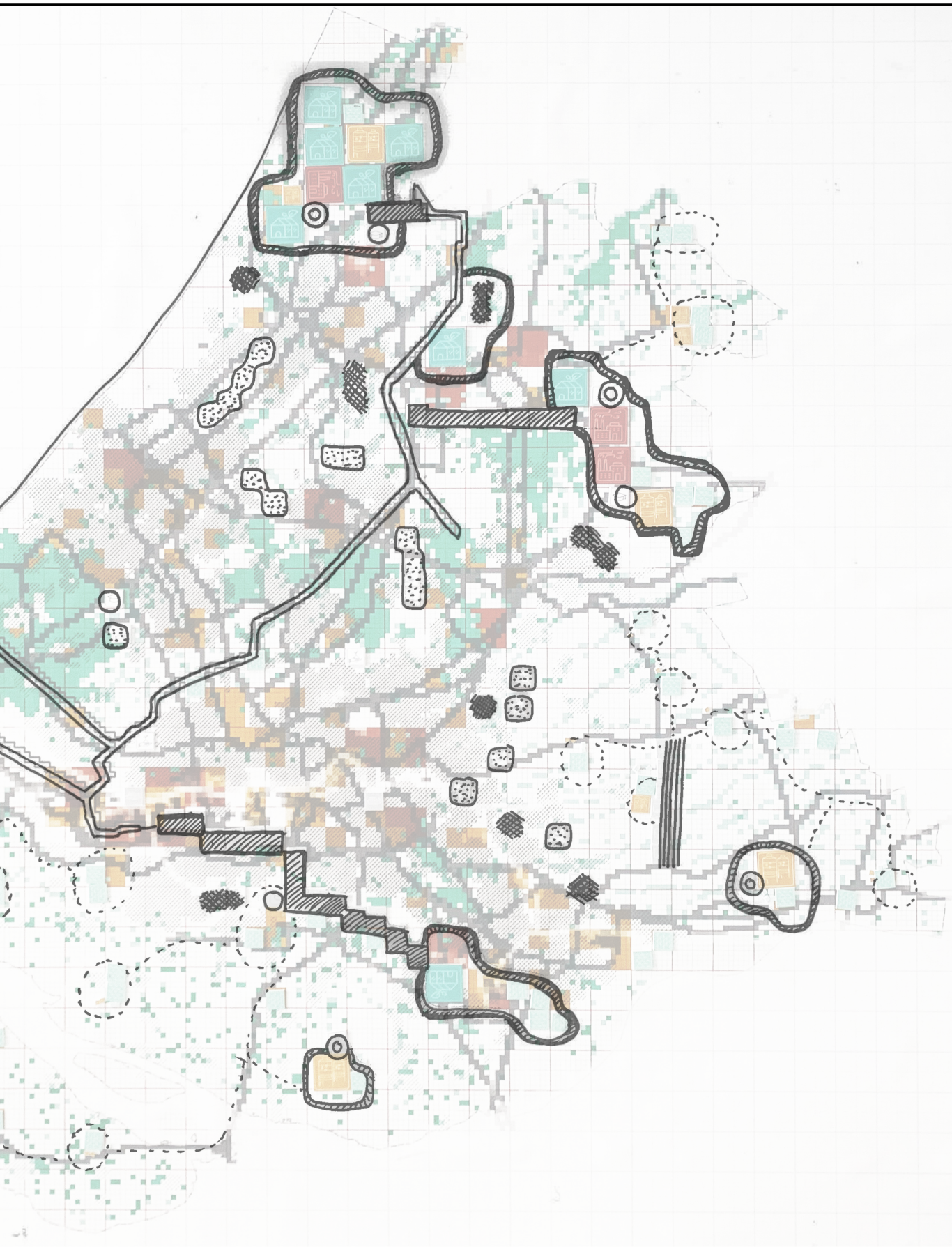
The possibility to attach more changes to the current land-use arrangement especially lead to two clusters with mostly big tiles, so big spatial interventions, in the north. In reality this can mean more varied, efficient, big hubs of waste trade and recycling will emerge here. Besides, it offered the possibility of several big waste-processing facilities to arise in the south of the province. Summarizing this variation, there was more flexibility possible during this game which made the creation of more drastic clusters possible, especially in terms of size.

EVALUATION:

social **104**
ecological **143**
economical **131**

- new CO₂ pipelines 
- new highways 
- large loop hub 
- urbanized densification 
- knowledge centre 
- educational hub 
- small loop hub 
- nature 





Based on: Open Street Map (2022), PDOK (2022), LISA (2022), OCap (2014)

results | C

hubs

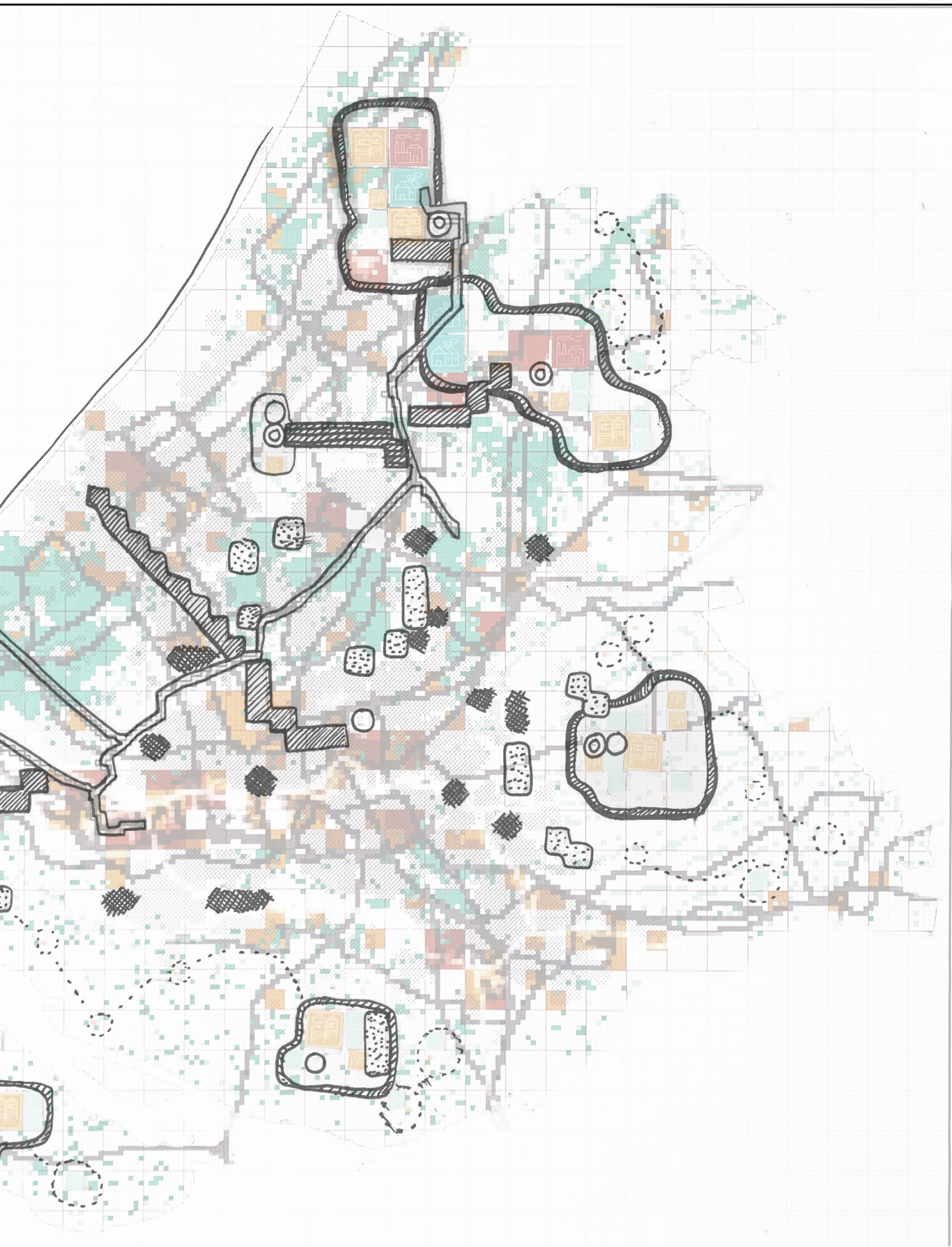
The last strategy followed during the game was the following of so-called desired 'clusters'. This game started with the accorded selection of areas where combinations of tiles should start from, choices based on identified 'hubs' that derived from the creation of the vision. So the course of this game was more directed towards specific locations. Remarkable in the result of this game, is that it shows a considerable amount of clusters with a high variety of functions within them. The rule of this variation forced the players to focus on the way the clusters were arranged, which caused the result to be more optimized than the previous variations.

EVALUATION:

social **113**
ecological **119**
economical **116**

- new CO₂ pipelines
- new highways
- large loop hub
- urbanized densification
- knowledge centre
- educational hub
- small loop hub
- nature





Based on: Open Street Map (2022), PDOK (2022), LISA (2022), OCap (2014)

outcome

game as a tool for planning

reflection on policies

strategic spots

overall sustainability

This following chapter depicts how the results of the game were later applied as a tool for planning, resulting in a strategy plan and leading up to a master plan on a regional scale. In this last phase, more detail is added to the abstract proposals that the game portrays and the province is, afterall, displayed more realistically.

To conclude this, three strategic spots are chosen of which one explains in depth how the three waste-recycling loops function together. This visualization supports the assumption that the combination of different functions related to the trade of waste and their proximity are essential for the bio-based economy to work in an optimal manner.

game as a tool for planning

As mentioned in the previous chapter, the game was played through three different strategies: densification, rearrangement and clusters. These three strategies depicted different possibilities on how the land use of the province could be divided in the future and where new facilities could be implemented in available and suitable spaces.

The game results derived from the assumption of the previously mentioned spatial logic, where, in terms of the game, proximity to other functions and infrastructure was important. As a consequence, combinations that arranged different clusters of functions, had greater value when evaluating. Monoculture, poor accessibility and isolation led to a lower efficiency, so arrangements as such were unpreferable and were evaluated as less valuable. If bearing this strategy in mind, the game can lead to evaluation scores in which social, ecological, economical are balanced.

In the following paragraphs, we will describe the analysis from the games, and outline the patterns of repetition of tile compositions. This analysis entails the unveiling of key areas in the province, in which a specific combination of tiles would take place, regardless of the strategy or the challenge to be reached.

During the "rearrangement" game, there was a small imbalance due to the creation of more drastic, bigger clusters, shifting the focus slightly away from creating cooperations between the different players.

An unbalanced resemblant was also remarkable in the considerable amount of livestock tiles in the "densification" game; where there was more attention to cooperation between crop farmers and livestock farmers. This facilitation of this cooperation is not always a good solution on the ecological level, as livestock farms at the same time emit a lot of natural gases.

Other analyses were made regarding the positioning of nature reserves and new neighbourhood areas. Moreover, the analysis made on the selection of the protective areas and also the new educational and technology centres, helped us to understand the best locations in order to reach an unfolding effect that expose optimal results.

Taking into account these lessons from the results of the game, a new combined strategy plan is made that crosses out the unpreferable outcomes and combines preferable patterns that repeated every time the game was played and were the most influential on reaching a higher score.

reflection on policies

Part of the game development involved the formulation of rules to be followed while playing. They were specifically important for the vision and strategy to work, because they would demand certain criterias and cautions while intervening in the game. These criterias were carefully selected in order to translate real life situations and obstructions.

After the evaluation and the final results of the games, some rules were perceived to be more efficient. In real life, they could be supported by the governmental policies already formulated. As previously stated, the evaluation system reflects the aspects of social-collaboration, biodiversity-sustainability and economic matters. During the game, some other rules appeared to be more consistent. The supply of new infrastructure, knowledge or technology centre facilities by the government would, in most cases, evidently push the development of collaboration among different sectors that would surround it. The connection between these centres and the different infrastructures to the businesses would, in fact, guarantee points for social-cooperation, economy and biodiversity-sustainability.

Translated into reality, this exemplifies how the governmental policies try to support small and big scale businesses in order to foster bigger changes and expansions.

A concrete example is the Rijksoverheid (Ministerie van Economische Zaken, Landbouw en Innovatie, 2022), a policy that stimulates companies that develop

innovative products through tax benefits, innovation credit and subsidies, as they generate economic growth and employment opportunities (Circular Zuid Holland, 2019).

Another initiative from the Dutch government is the “Transition to a Circular Agriculture”, in this vision and some policies are formulated to support this shift. Some of the goals involve promoting farm innovations, creating more possibilities for experimentation, rewarding sustainable farming practices, supporting short supply chains (Ministry of Agriculture, Nature and Food Quality of The Netherlands, 2019).

Agricultural sector:

In the game, small businesses are being supported by a special policy: the expansion rule, which states that crops tiles can be added as many as needed and glasshouses, livestock and industry tiles have a certain restriction. In this way, the crops farming stakeholder showed to have more chances of expanding, while glasshouses, livestock tiles had less opportunities of expansion, due to their low efficiency on a waste-to-value approach.

Therefore, some actors had more influence on the game, while others faced difficulties on expanding; and had either to avoid placement of new tiles or to concentrate in hubs, in order to be able to be nearby crucial infrastructures.

Industries:

During the game, industries do not have

big chances of expanding because of the expansion rule - which concerns their waste-to-value performance and awards them with tiles in accordance to its efficiency. Although this rule did not avoid the creation of new industrial areas, it ensured that their placement would evoke the best combination, when analysed from the perspective of the trading system that seeks to implement a circular approach.

This game rule is strictly connected to the bans and demands from the government on pushing towards a decrease of the emissions. To combat climate change, in fact, the Dutch government wants to reduce the Netherlands' greenhouse gas emissions by 49% by 2030, compared to 1990 levels, and a 95% reduction by 2050 (Climate Act, 2019).

Nature:

When playing the game, the nature reserves areas are untouchable for all the stakeholders - in order to maintain the value and equilibrium of these consolidated spaces - but their expansion is taken into consideration. The stakeholder and player "government" is responsible for arranging new "natural reserves" tiles on the board and creating more effective connections of agricultural land with biodiverse ecosystems.

These new arrangements made by the government were easy to respect by the other players, also because having natural areas next to "crops", "livestock" and "neighbourhood" tiles was providing the stakeholders with sustainability points.

These arrangements created an unfolding effect of creation of mixed-used clusters, the hubs, because there was set a new limitation areas that could be occupied by other tiles.

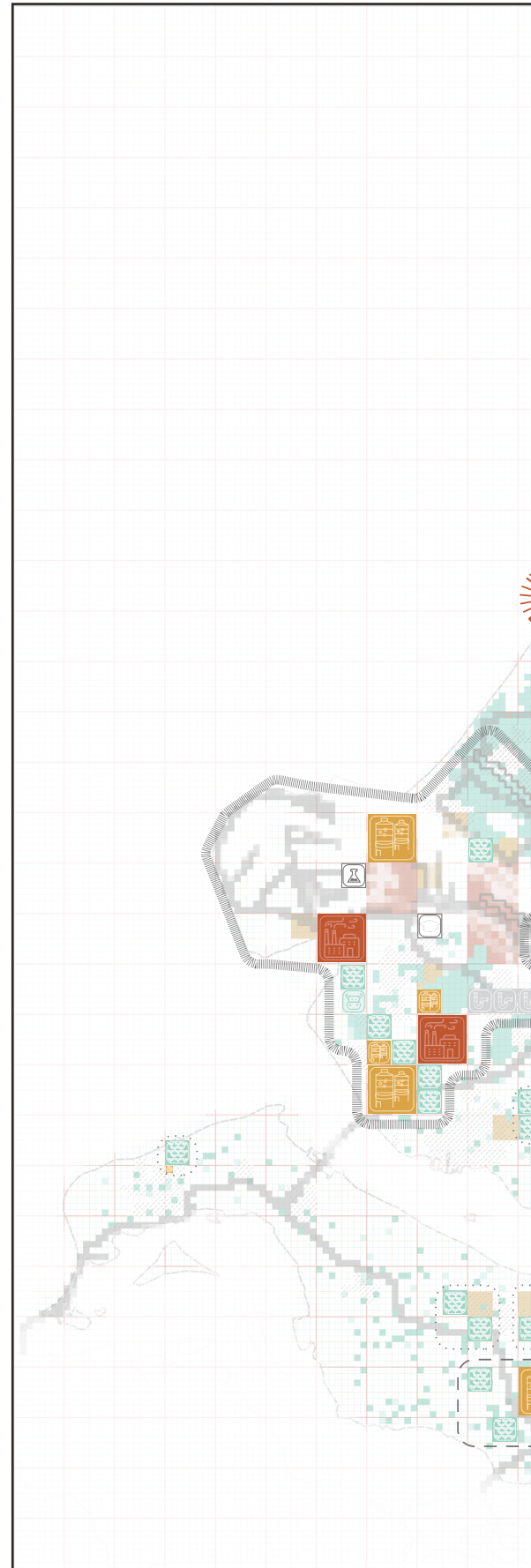
An already existing nature policy that aims at preserving and strengthening the Netherlands Natural environment and could be applied is the National Ecological Network (NEN) - or EHS, in legislation. It encompasses the national and international preservation and sustainable exploitation of biodiversity. This law is also about consolidating natural areas by linking them more effectively with each other and with surrounding farmland (Ministerie van Economische Zaken en Klimaat, 2021).

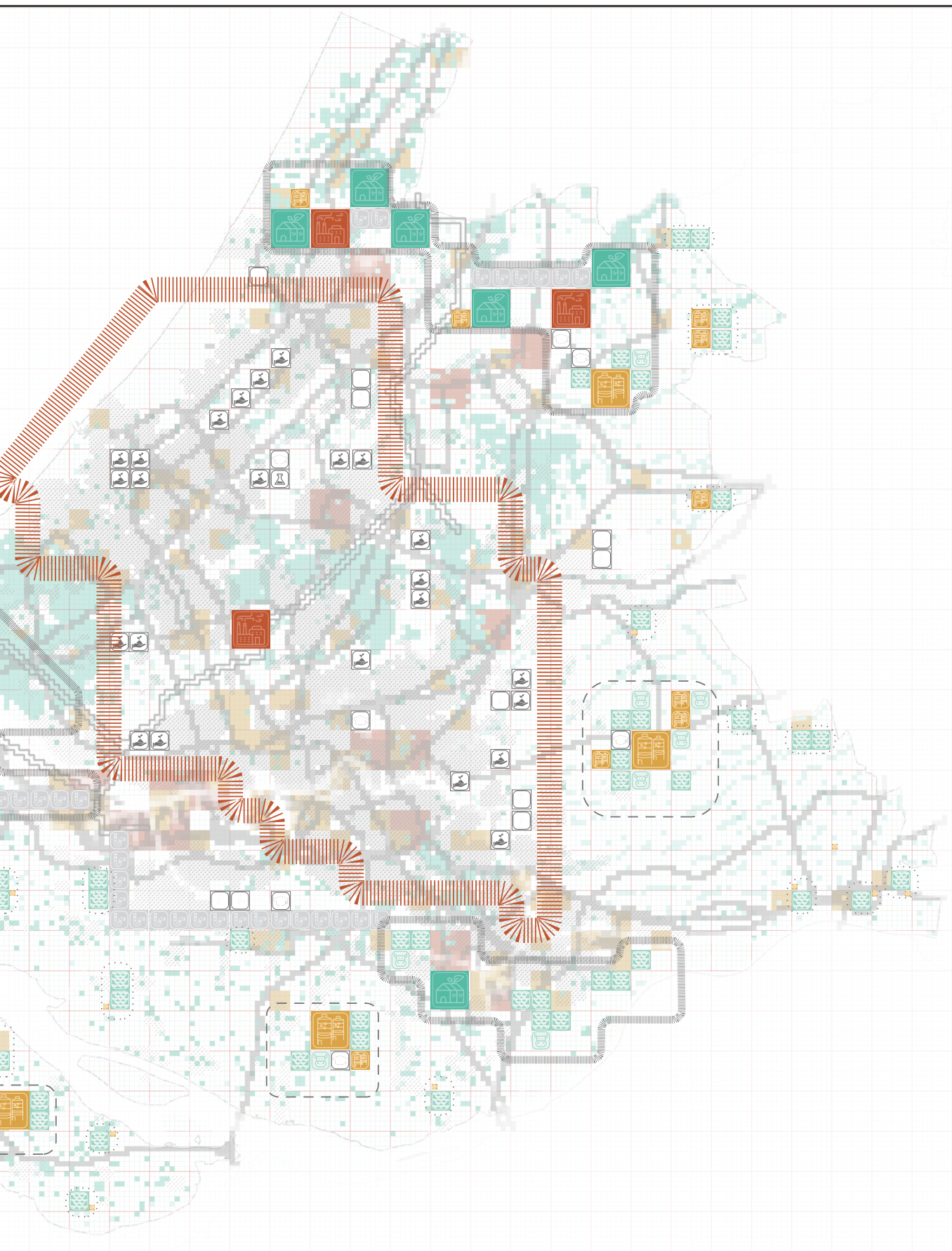
This combined strategy plan entails three new big hubs with the optimal combination of tiles reflected. The three big hubs, close to the Maasvlakte of the port, above Leiden and under Dordrecht, have mostly found their location because of the optimal ways in which functions can be combined there, as reflection of the rules of the game. They adapt to existing infrastructure, like CO₂ pipelines and roads, as well as existing facilities.

Another relevant aspect is that the areas developed reflected the ban of some protected areas: such as existing urbanized landscapes and nature reserves.

The strategy plan also portrays the most urbanized area, which coincides with the metropolitan area of Den Haag - Rotterdam, intertwined with natural reserves and recreational areas. The focus on nature protection grounds its reasoning on the potential to connect natural habitats, but also to protect the urban perimeter from industrial expansions or from new waste processing centers.

Medium sized hubs mostly illustrate how the agricultural hinterland was rearranged in a more optimal way with a tactical position of waste processing facilities, allowing for farmers to trade their agricultural waste while facilitating meeting spaces where cooperations between actors can be facilitated.

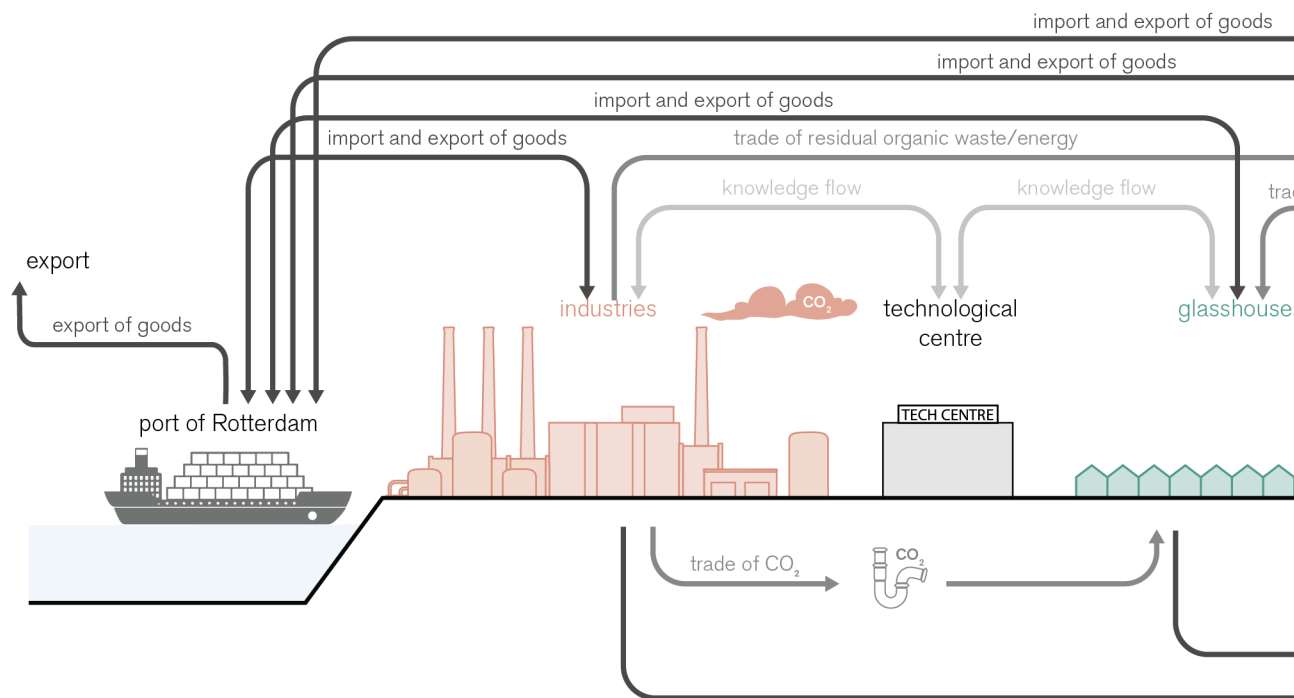


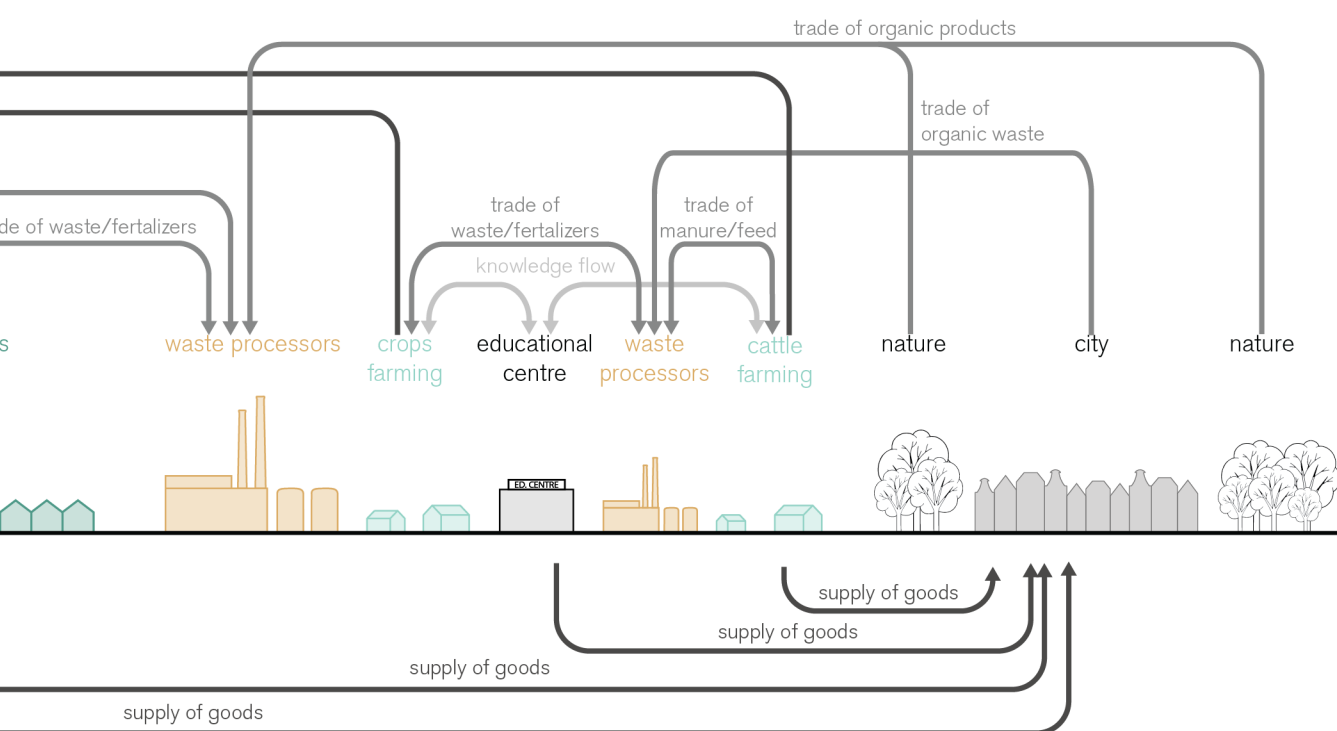


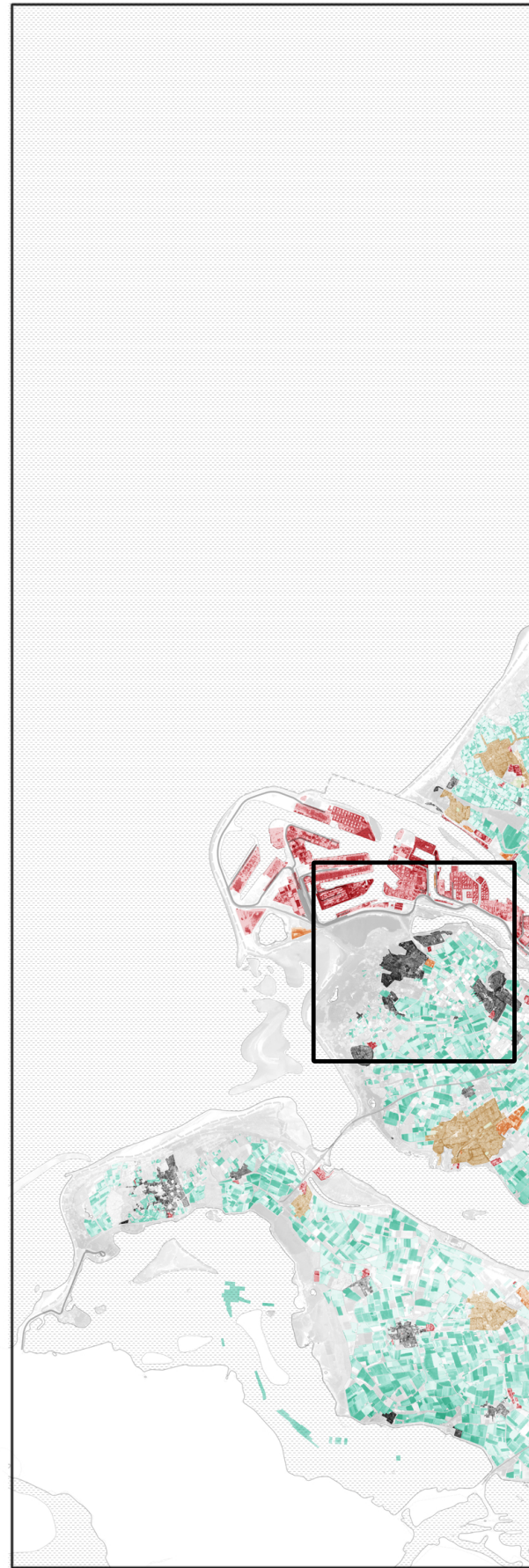
Based on: Open Street Map (2022), PDOK (2022), LISA (2022), OCap (2014)



STRATEFGY PLAN









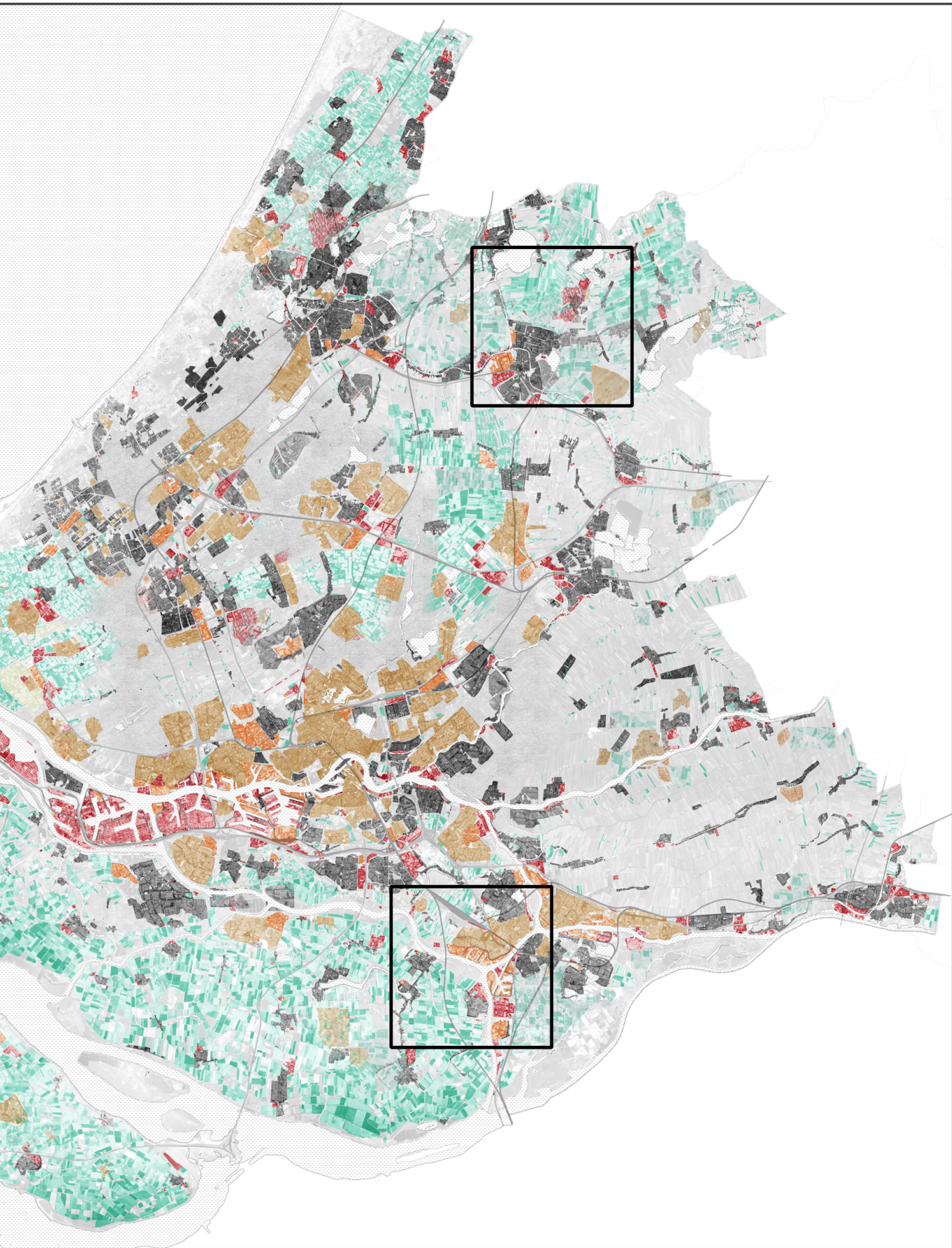
Based on: Open Street Map (2022), PDOK (2022)

+
2070



- waste processors 
- agricultural sector 
- industrial sector 
- urban areas 
- railway 
- main highways 
- local streets 
- water 





Based on: Open Street Map (2022), PDOK (2022)

strategic spots

One of the most powerful aspects of the strategy plan is the creation of three different hubs, each of them has an important position for the whole province and set a goal that implements the transition to a more circular and bio-based economy. The idea of assigning different aspects of development to each hub corresponds to its potential services and existing context. The first hub is for social and trading, the second one is for education and trading and the third one is for infrastructure and technology.

On the following maps, we highlight the zoning changes that need to be implemented in order to reach a hub in which the loops are interlocking.

- agricultural sector 
- waste processors 
- port industries 
- urban areas 
- railway 
- main highways 
- local streets 
- water 



Based on: Open Street Map (2022), PDOK (2022)



Based on: Open Street Map (2022), PDOK (2022)



Based on: Open Street Map (2022), PDOK (2022)

HUB I

The first hub spatializes new areas waste processors that would suffice the surrounding area. This area is already mainly focused on the agricultural sector. Therefore, an interesting provisional services is the one that tackles social causes and trading facilitations. Cooperation among farmers and between glasshouses and industries are required, and waste processors are carefully disposed to perform as intermediates of the cooperation.

2 km

1

0



agricultural sector



waste processors



port industries



urban areas



railway



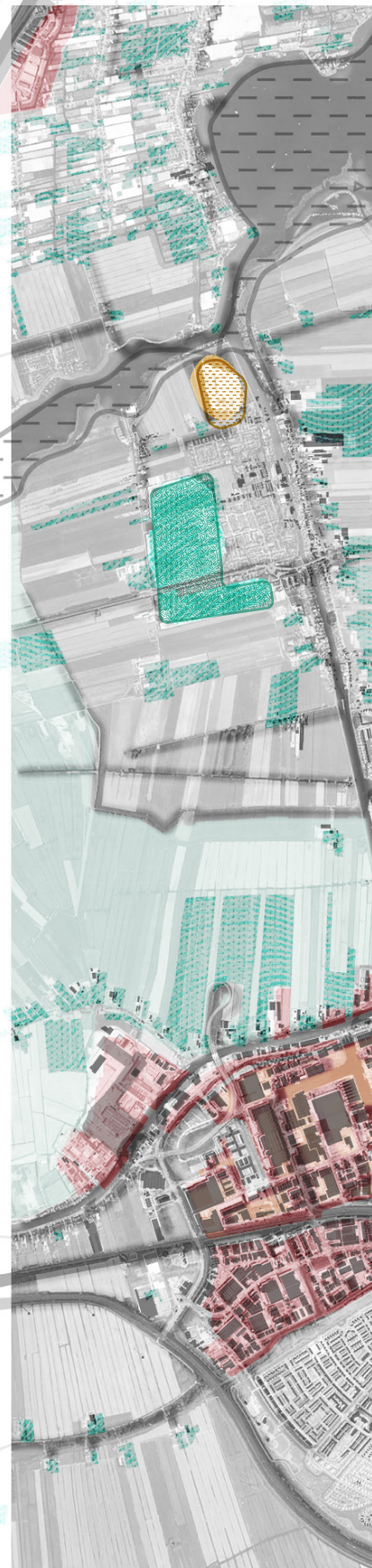
main highways



local streets



water





Based on: Open Street Map (2022), PDOK (2022)

+ HUB II

The second hub, located in the port of Rotterdam, has big potential to influence the whole Province in education and trading, as it already represents an important area with consolidated infrastructure and latent potential.

Nevertheless, there is a necessity to create more relations between glasshouses and industries, which is already feasible due to the existing CO₂ pipeline that boosts concentration on its surroundings. The existing infrastructure also provides connections throughout the province and the big amount of resources produced daily (CO₂ and waste) can be a big asset for energy production.

Moreover, the area could become an educational hub for the stakeholders, a place where to learn about waste processing and new techniques, as it is central to the whole province and surrounded by important industries and neighboring both sectors.



agricultural sector
waste processors
port industries
urban areas
railway
main highways
local streets
water





Based on: Open Street Map (2022), PDOK (2022)

+ HUB III

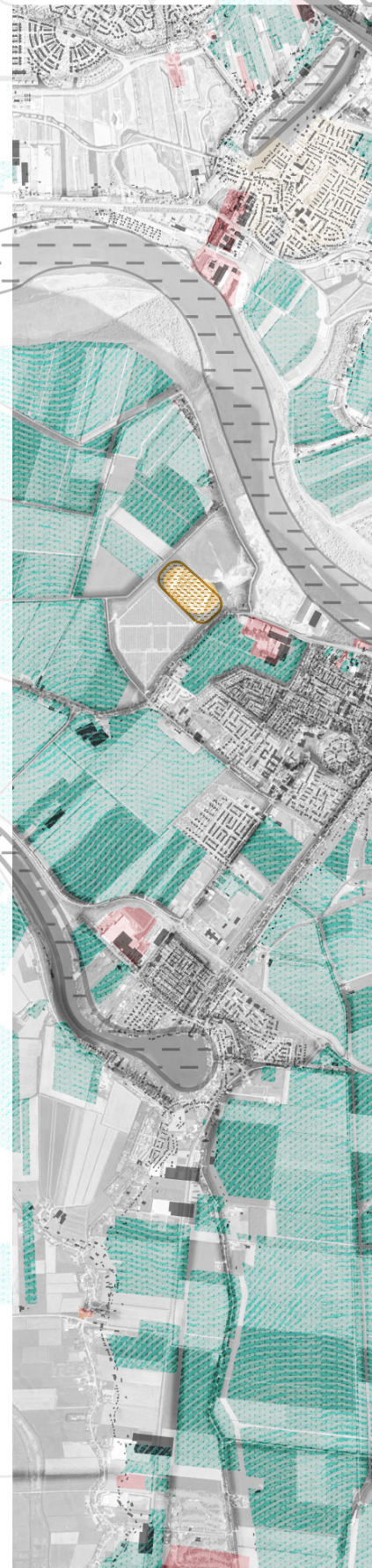
In the third hub, the infrastructure of CO₂ pipelines could be implemented in order to reach the hinterland and connect them to the port industries, facilitating the trade of CO₂.

This area already lies by the core infrastructure and the consolidated area of the port. It also has access to the Maas River, escalating its value on the overall location aspect and becoming even more relevant to transform into a central area for the province.

This hub is located at the end of the metropolitan region and the protected natural areas, previously illustrated on the strategy plan, which also displays a huge potential of connection in between the north and south of the river and the port. Technology centers could be implemented to provide the stakeholders meeting spaces where to learn about innovative techniques for waste management and sustainable crops production and animal farming.

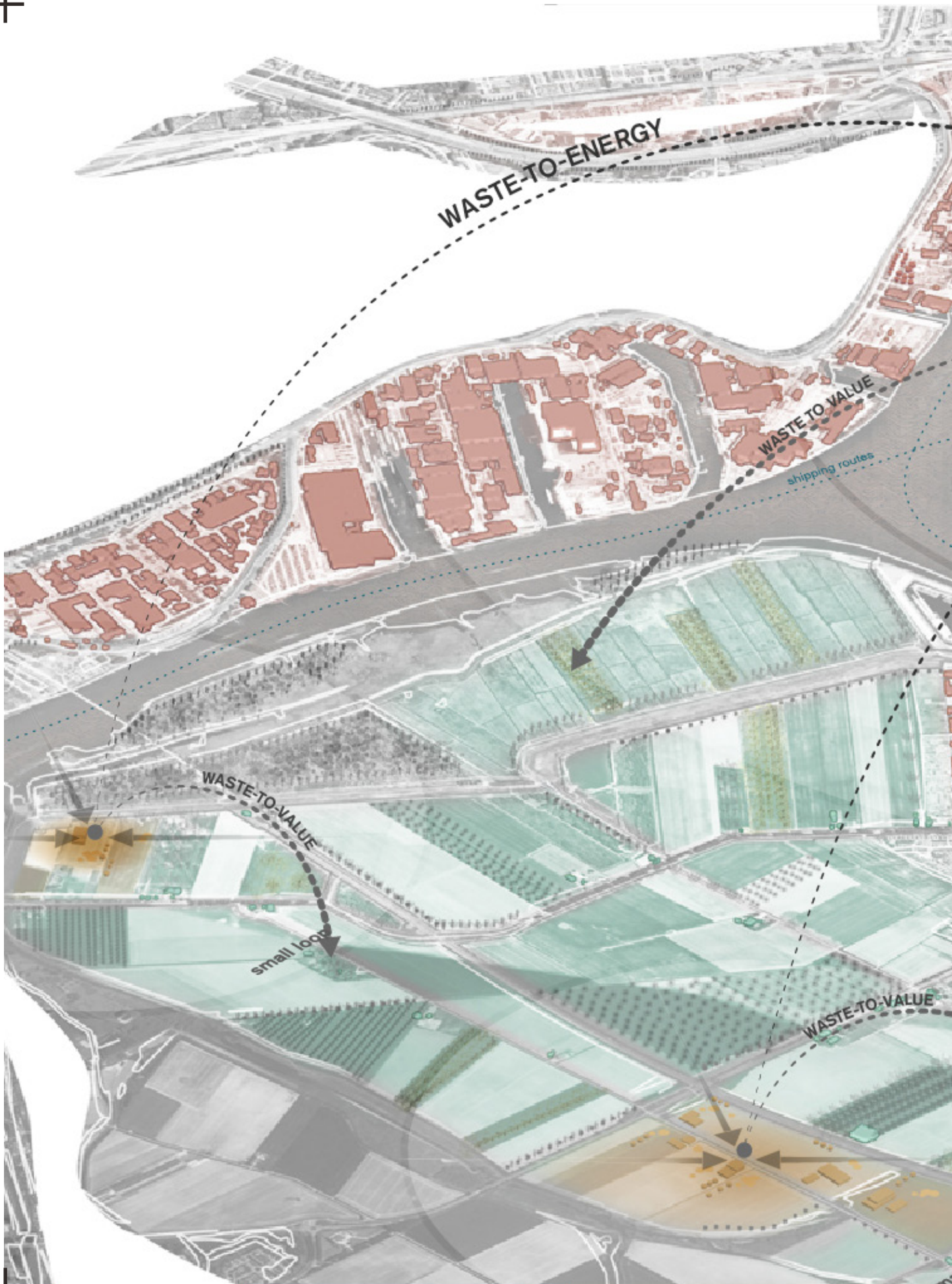


- agricultural sector
- waste processors
- port industries
- urban areas
- railway
- main highways
- local streets
- water





Based on: Open Street Map (2022), PDOK (2022)





overall sustainability

To sum, the intentions of the project are to illustrate the possibility of stimulating connections and cooperations while tackling waste and CO₂ management. Once more, when illustrating the various possibilities of the spatial logic that concerns a certain concentration of land uses in a certain distance range, we aim to highlight the unfolding effects that small scale businesses have in the bigger picture of the port and the large scale productions. This overcomes management goals, and plays a role in the creation of a bio-based province highly resilient and future proof.

As in the previous chapters the report described how the concentrations of land uses in specific areas lead to different hubs that emerged in the province, we further this reflection on social inclusion and opportunities' offer.

The inclusion of all the actors in a bigger discussion is also related to the spatial arrangement of facilities. Hence, Chains of Cooperation proposes an equitable distribution of facilities and land uses in space, not only connected to infrastructure, industries, farms and glasshouses but also to knowledge centers and innovation centers, granting access to valued resources and offering opportunities to all of them.

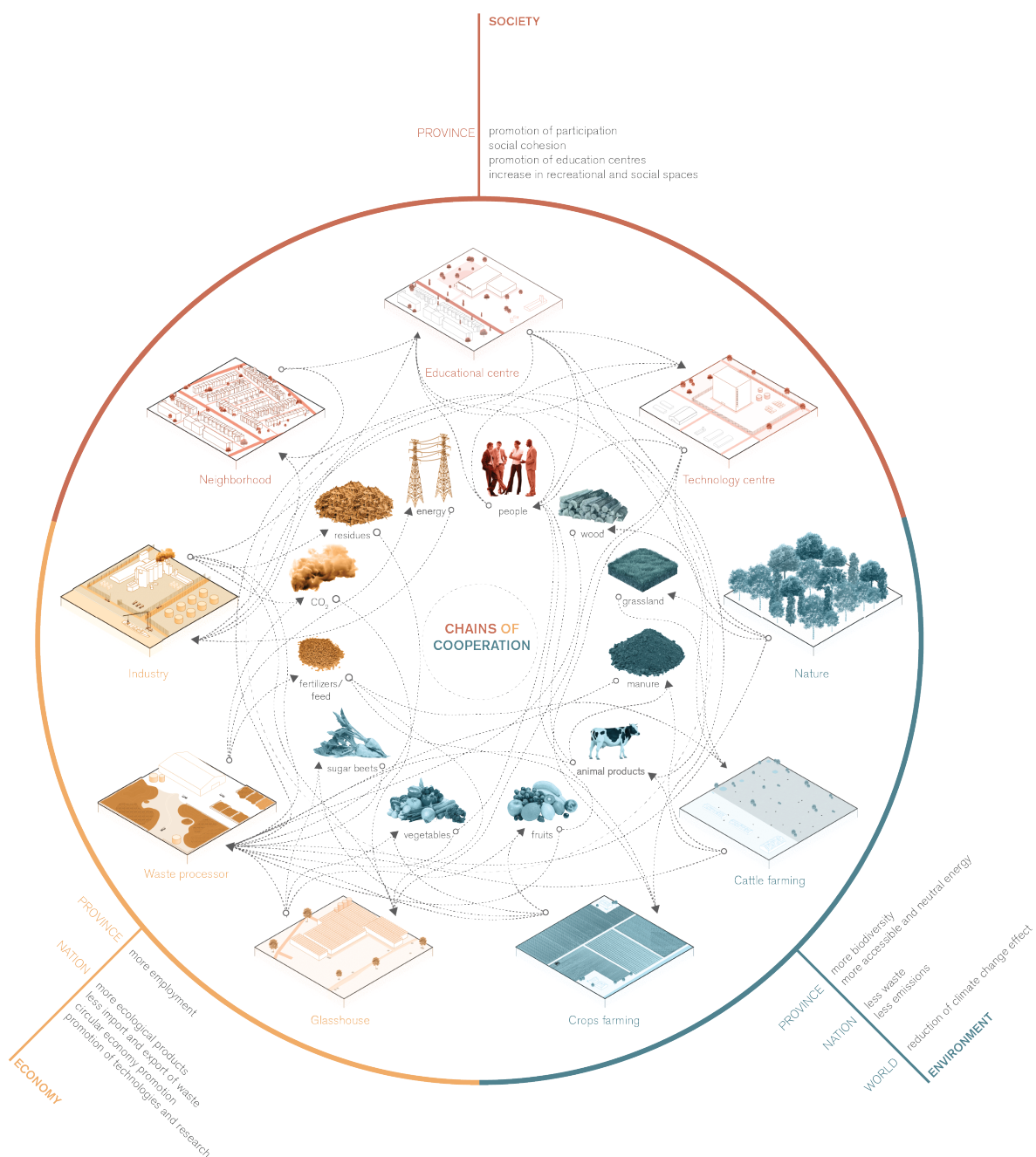


Figure 31: Visualization of the trading and cooperation systems and the resulting impacts on society, economy and environment

conclusion

our contribution

further research

This chapter highlights the overall intention of the report, shedding light to the most important topics mentioned and clearly stating the scientific contribution of the work.

It is also described possible topics to be further researched, which could enrich the relevance of the project.

How can agricultural waste management help to plan a more coherent and connected region, which stimulates actors from port and agriculture to cooperate?

The final vision in this report depicts not only the efficacy of restructuring the waste and CO₂ chains in the province - leading to a more circular and bio-based economy - but also highlights the importance of a societal contribution from all actors involved. In every circumstance where cooperations between companies - the port industries and the agricultural sector - are created, the actors are able to engage in a bigger flow of resources and knowledge.

Another important aspect outlined in this report was the circular transition of companies of the Port of Rotterdam. The project aims to illustrate the numerous possibilities of configurations that tackle this issue and promote a cooperational ambience in the province. This cooperation goes beyond management of outcome products, but creates a more resilient port and province, as it boosts collaborations by supplying needs, managing emissions and even increasing production. This interdependency in between sectors promotes a strong and solid economy for the province.

Again, it is relevant to reiterate the importance of small scale actors (present on the small loops), which could trigger small scale farmers to rethink their position as suppliers

in the food industry, taking into consideration the enormous potential of organic waste in recycling processes.

The urgency of establishing the final vision accompanied by a strategy, in which the province aims at a circular and bio-based economy, can be related to the fact that the societal threat of climate change can no longer be ignored in our current days. This is also why the Province of South Holland (2019) has signed the "National Raw Materials Agreement", that agrees on having a completely circular national economy 2050 and using 50% less primary resources in 2030. This goal corresponds to the 'European Green Deal', set up by the European Commission (2019), that strives for no net emissions of greenhouse gasses by 2050 and in which economic growth is decoupled from resource use. The project Chains of Cooperation contributes to both stated goals, by making the Province of South Holland climate neutral on the basis of cooperations between the agricultural sector and the port industries. The European Union (2020) states, within the Green Deal, how carbon sequestration can become a new solution for the climate change issues. These concepts have been translated into the presented strategy, which aims at keeping the waste and CO₂ within their chains.

our contribution

The focus of the project is specifically on the Port of Rotterdam and the Province of South Holland but the issues analyzed - CO₂ and waste chain - can also be relevant for other areas in the Netherlands as well as in the world.

The European Union (2020) also addresses the issue that the agricultural sectors are in need of a transition towards a circular and bio-based system. Within the EU, across Member States, food systems remain one of the key drivers of climate change and environmental degradation. There is an urgent need to transform the linear economy generated by irresponsible production into a more circular one, which enhances possibilities of closing the CO₂ and waste chains by diminishing the production of raw materials.

Moreover, the project relies on a theoretical assumption of a spatial logic behind waste-management and, even though the report point out an in-depth analysis on the potentials of the Province of South Holland, the concept and strategy developed are not site-specific - bringing another layer of value to the project, as it makes it possible to be replicated in similar situations world-wide.

Another relevant aspect is the creation of the game as an asset for the province. The game highlights possibilities of being used as a planning tool and promoting dialogue and negotiation between stakeholders.

further research

The game is a negotiation tool that gives insights on possible spatial arrangements of facilities and cooperations between actors. By making the game more understandable and accessible for the stakeholders, it is possible to achieve consistent and suitable insights from stakeholders, while also shifting the perspective of planning into a more collaborative manner. The game addresses real life policies and implications of actions - being, therefore, an asset to stakeholder to understand the cascading effect of their actions in a bigger picture. On the flip side, the stakeholders grant important input for the game, as it gives legitimate and palpable reactions to the planning process. Much more than achieving an outcome plan, the game facilitates education and raises awareness of crucial societal changes.

Further research can go more into depth when the changes of the food production are discussed for the coming decades. By creating a vision for the food system in the Netherlands, one could think about innovative ways to promote biodiversity in the diversification of crops, combined with a rich ecosystem that protects nature generally. Another implication of creating a more regenerative food system could be the implication of dietary changes: making the determination of the production and consumption based on the carrying capacity of our ecosystems (de Boer & de Olde, 2020).

Finally, an aspect that needs more attention and detail is the trading system of and the amounts

of waste and CO₂ and the requirements that need to be met to produce created and the needs of energy and fuel. By adding more details to this topic, the cooperation and trading system could be more clear and given more insights into to which extent the loops really operate and contribute to a more national scale. A relevant experimentation is the envisioning of a scenario in which there would be a complete extinction of fossil fuel and CO₂ emissions. This may also provide an interesting perspective to the project, by analyzing the extreme application of the waste-to-value approach.

reflection

alessandra balletta

femke snel

julia daher

wieke van ulsen

To conclude, this chapter exploits the personal reflections of the team participants, who address the relevancy of the project and ponder on the intentions, process and outcome of the project.

alessandra balletta

Nowadays everyone should be conscious of the consequences of their actions on the planet. We cannot longer be anthropocentric and self-centered, because we must be the generation of change and deal with the challenges of today: global warming, injustices and consumerism.

We need to make an urgent shift and cooperate to improve our way of living. Governments all over the world are trying to speed up this huge transition by setting goals – supported by policies - that need to be achieved in a short period of time. For instance, the province of South Holland aims at becoming fully circular by 2050 (Drift & Metabolic, 2018).

Chains of Cooperation, the regional strategy developed by me and my team during the quarter, focuses on the waste chain and CO2 chain and their interrelation in order to achieve a circular and bio-based economy in South Holland.

The project, already complex because of its large scale, includes the Port of Rotterdam, which adds up more complexity because of its cultural setup and governance pattern that can be a two-edged sword: the Province can, in fact, either embrace the change or be truly resistant to it.

During the course we had a lecture by Prof. Dr.ing. Carola Hein where she explained how important and natural it is to look at a region or a city with a port by starting from the port itself. (Hein, 2022) The harbour has a huge



power in the province, but it also comes with some weaknesses: it is a high polluted entity, whose emissions go into the cities harming the health of the citizens.

Moreover, in her lecture, Prof. Dr.ing. Carola Hein remarked the importance of identify the different components of the region and how they work together – how these form an entire ecosystem which acknowledge the importance of the port (Hein, 2022). And this is exactly what me and my group did: we looked at the region starting from the port and identified all the different spaces and how they related to the port and among themselves. By doing this we identified the main activities of the province - agricultural production and port industries - and noticed how they were clustered in some areas: instead of communicating and cooperating with each other, they create barriers and harsh limits that disrupt interrelations.

In order to spatialize this fragmentation problem, we looked at the Province as a puzzle, whose pieces needed to be re-arranged. Our focus was on understanding of how the spatial arrangements can alter the efficiency in creating more closed CO₂ and waste chains but also in the cooperation among different actors.

Chains of Cooperation, in fact, is not only about managing the waste of heavy agricultural production of the Province and CO₂ emissions from the port, but it also tackles society, stakeholders, environment, culture

and policies.

In the past I have worked on projects at regional scale, but this course helped me investigating in the challenges of bio-based, circular economy and energy transition and truly understanding the complexity of working at such a large scale.

Drift & Metabolic. (2018). Zuid-Holland Circulair. <https://www.zuidholland.nl/publish/pages/21255/hoofdrapportzuid-hollandcirculair.pdf>

Hein, C. (2022). Port Cities: Resilient Nodes on the Sea-land Continuum. [SDS and Capita Selecta lectures] retrieved from <https://brightspace.tudelft.nl/d2l/le/content/398764/viewContent/2585522/View>

femke snel

When this quarter started I was curious what this course was going to be like. I had no prior experience in regional design and big scale planning, so I was a little insecure about my skills and knowledge. Luckily, the lectures and workshops of Methodology, Capita Selecta and Spatial Development Strategies (SDS) gave me new information and methods for regional design.

The start of the course was to express your preference regarding the three themes: energy transition, circular manufacturing or a bio-based economy. The bio-based economy was a known term but an unknown concept for me. The lecture of Marloes Arkesteijn made me aware of the possibilities a bio-based economy has and the important roll it can play for the transition towards a circular economy. She told that biobased is not necessary circular (Arkesteijn, 2022). This statement caught my attention and made me decide this would be a challenge for the project and the future of biobased.

As a group, we soon found out that a biobased economy is a broad concept and has many specific directions that we could focus on. The subjects and complexity worried me and it took me a while to fully understand what directions we had to go. As a group I had the feeling that we all went through this phase and helped each other with understanding the project and the region.

The setup of the course I really enjoyed. The group work and tutoring really felt as one



big brainstorm session and the teachers felt part of the team. The group work contributed a lot to understanding the entire region and the multiple aspects that play a role by region design.

The game we designed can be used as a starting point for the stakeholders. They are challenged to cooperate and understand the different scales that play a role in the design process while seeing the bigger picture. The game was not meant to reach a specific outcome, but rather for a way to let all the stakeholders play their part and try to reach their goals by cooperating. In the end the outcome can be evaluated by the economic, social and ecological qualities of the spatial organization. In this way the stakeholders contribute to a development strategy where all interest are taken into account.

We used the game as a guide through our project. The game helped us understand all the stakeholders, land-uses, policies and how they relate and reinforce each other. The game was a way to understand the process and helped us to show all the aspects that play a role by regional design. It was a playful and abstract tool to understand the complexity of regional design. A slightly more realistic approach, by creating tiles more true to nature, could have strengthened the project even more.

The course introduced the complexity of the regional scale and regional design. This complexity first seemed difficult and, while

it is still complex, it showed me the many possibilities and solutions there are to tackle the complexity and make the vision of a circular economy and a bio-based economy possible. This course gave me the knowledge and skills to tackle complex projects like this and be optimistic about a potential sustainable and circular future.

Sources:
Arkesteijn, M (2022). Course Documents Lectures. Towards a bio-based economy . <https://brightspace.tudelft.nl/d2l/le/content/398764/viewContent/2606173/View>

The idea of working on a regional scale magnifies the complexity of any project. In the case of the Province of South Holland, there are other important aspects which make it relevant for a deep analysis: the entangled relation in between nature, the relevance of the port and the extent productive land ensures that the province is really reliable on their economical productions. Nevertheless, the current crisis related to climate change, the obsolescence of the port in the recent world rankings and the new agenda for food production consciousness put the province into a target zone and challenge it to enhance its operationalization. The need for a change is also a possibility of reaffirming itself as pioneers.

Moreover, when it comes to a chronological perspective it is also interesting to see how traditional practices shifted through the years, making it clear to describe the modernization process that takes place. Even though the technological approach on the glasshouses dynamics and the port industries logistics are portrayed as efficient, one can not certify it as the utmost situation. As paradigms change and the world demands more adaptations on the way big institutions and society behave, one has to always question itself on which future are we heading to.

Taking into consideration the richness of context described and the need to re adapt on new paradigms, the project led to an speculative lens of trying to understand and experiment actions and their possible



unfolding consequences.

With this in mind, the development of the project aimed on simplifying the complex and rich contexts in which the province currently confront. Namely, the application of a game as a tool for planning assured a just and collaborative process that creates a new collective imagination when planning the province.

The project, in my personal understanding shows its power and relevance through the possibility of opening up the responsibility of planning and creating several outcomes equally valuable. As repeatedly mentioned in the beginning of the quarter, 'the path is the goal'.

To further this thought and to illustrate the conducted approach, it is relevant to mention the tool as an interesting asset that emphasizes potentialities of the site that are, until then, unseen. One can postulate that this is crucial to regional planning, once it helps to create relations in between the scale we live in and the scale of abstraction (but complexity). The way the project was conducted evoked intuitive actions while grounding it to data and real life informations. More than an tool to be used by experts, it affords accessible insights and explanation to lay audience.

After mentioning the importance of the process to the project, it is worth reiterating the applicability and the overall outcome of the bio-based approach into the region.

It targets relevant and latent topics and it promotes thoughts that have multiples scales of application. More than that, it makes it possible to understand the deep relation of a regional planning to the local scale and its social implications.

In this sense, being able to envision an ideal scenario on a regional scale that is capable of shedding light to topics like these, while introducing innovative transitions, was for me the biggest goal.

So, to conclude, I strongly believe in the power of simplifying complex situations and understanding their consequences on real life scale. To translate an metabolic process (which is the main dynamic of Chains of Cooperation project) into the capability of communicating sectors and connecting people, goods was the means to step by step, create a new future that tackles topics as the cutting edge bio-based and the social inclusion on the port by giving power to actors that are willing to be heard.

wieke van ulsen

As we started this course as a group, we were introduced in-depth to the province of South Holland, unraveling its many variations of landscapes, with the largest Port in Europe, stretching out from Rotterdam to the North Sea as a center point of attention. But the location of the many glasshouses and agricultural land in the province also caught our eye. Both the Port and the agricultural sector in the province, are aiming at generating maximum capacity, export and production in their current state. However, this is at the expense of the limit of the Earth's resources and its biosphere. That is why an integrated approach was needed that reconnects human development with the biosphere (Rockström, 2015): achieving the circular economy. Reaching a circular economy through a bio-based lens at first seemed like a big challenge.

Early on, we started collecting information on waste flows in the province and noticed the great imbalance in waste produced from port industries and agricultural firms and waste that is actually processed and recycled. This is where missing links could be reinvented and connected. GIS-analysis that provided us the location of companies from different sectors, helped us to quickly show the spatial implications of the problem and helped us to come up with the spatial logic. This is a spatial logic where the proximity of certain functions improves the performance and efficiency of the waste-to-value processes. Our spatial vision was eventually created with a very systematic approach, breaking the region down into CO₂ and waste-recycling loops, interlocking



different sizes, distances and functions. After creation of the predominantly abstract spatial vision, we had to jump towards a development strategy. Throughout the course, all the lectures from Methodology, Capita Selecta and Spatial Development Strategies always helped me, by providing more tools and methods on how to continue with the project. The lecture of Verena Balz (2022) about creation of a development strategy showed us 'six characteristics of spatial planning strategy', including the statement of how this was a process of engaging with interests. This is where we understood that regional design needs a transdisciplinary approach and we aimed for inclusive planning with care for the interests of each participant in the region (from livestock farmer, to citizen to the Port).

We decided to come up with the game as a tool for planning. This was a very interesting approach, because during the process of designing the game, we learned a lot. It showed us how we could translate the most important policies into game-rules, which stakeholders, depicted as players could 'play' first, what were their rights and duties and how were the rounds of the game translated into a phasing. I think the game ended up to become not only a negotiation tool for experts, which is its role in this report, but it turned out to be a good tool for us personally as well: it opened up the discussion and challenged us to look at the vision and development strategy in a more comprehensible, practical and quick way.

Eventually, after playing the game, we

showed how the results could again be translated into a master plan. Lastly, I would like to state that, coming from different (educational) backgrounds, and even though the studio session sometimes lead to intense discussions, we can eventually be happy with the result of the final spatial vision and development strategy that supports a coherent and connected region where actors from the port and agricultural sector are stimulated to cooperate

Balz, V. (2012). Course Documents [Lectures of Verena Balz on Monday 14th of March]. Lecture of Verena Balz, retrieved from: <https://brightspace.tudelft.nl/d2l/le/content/398764/viewContent/2620864/View>

Johan Rockström, "Bounding the Planetary Future: Why We Need a Great Transition," Great Transition Initiative (April 2015).

glossary

In this appendix, we introduce a glossary with a selection of key definitions, which were used during the report to help explain the concepts and general ideas.

It is essential that these definitions are clear in order to understand the approach presented sufficiently. Therefore, the following page defines collected words and expressions. This can be used as a reference during reading of the report.

bio-based economy: A bio-based economy is an economy that uses organic waste from the agriculture and food industry for non-food applications. Organic waste serves as a resource that is later used as biomass for green refineries (Vermeulen & van der Waal, 2015).

waste-to-value economy: The waste-to-value approach is a circular process that aims at extracting the maximum value from the waste streams, in order to give it to other consumers and therefore decrease the amount of unusable waste. (Gemeente Rotterdam, Provincie Zuid-Holland, Port of Rotterdam, Rijksoverheid & Deltalinqs, 2019).

circular economy: A circular economy is an economic system of closed loops in which raw materials, components and products lose their value as little as possible, renewable energy sources are used and systems thinking is at the core. (Kenniskaarten - Het Groene Brein, 2019).

chains: These are the waste chain and the CO₂ chain. A chain is the total process of the waste distribution - processing and reusing.

loops: Loops are radiuses from one central point where the distance is determined by the average distance between the central point

of the subject-facility and other facilities. The central point is in this report a waste processor and the radius is based on the average distance to other facilities necessary to close the waste chain. The loops can be distinguished into small, of 500 m radius, medium, of 2 kilometers radius and big loops, of 4 kilometers radius.

distances: Are related with the radius and calculated taking into consideration the average distance between the waste processors and other facilities. We call the radiuses of the loops the distances.

variables: we have three variables in our project : function, dimension and distance. A variable is a data item that may take on more than one value during the runtime of a program. (Oxford Languages, 2021).

tiles: The tiles are elements of the game but are also abstractions of the land-uses that play a role in the project. The tiles represent realistic land-uses but are a tool to simplify these land-uses.

hubs: Hubs are areas where certain facilities are centered and placed strategically. Hubs can have their own character which is determined by the location and function of the hubs for the specific area where it is located.

references

- de Boer, I. J. M., & de Olde, E. M.** (2020). Re-rooting the Dutch food system: from more to better. Wageningen University & Research. <https://www.wur.nl/en/show-longread/Re-rooting-the-Dutch-food-system-from-more-to-better.htm>
- Drift, & Metabolic.** (2018). Zuid-Holland; Verkenning van grondstofstromen en handelingsopties voor de Provincie. <https://www.zuid-holland.nl/publish/pages/21255/hoofdrapportzuid-hollandcirculair.pdf>
- European Comission.** (2019, October 12). A European Green Deal. European Commission. Retrieved April 5, 2022, from https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
- European Union.** (2020). Farm to Fork Strategy: For a fair, healthy and environmentally-friendly food system. https://ec.europa.eu/food/document/download/472acca8-7f7b-4171-98b0-ed76720d68d3_en?filename=f2f_action-plan_2020_strategy-info_en.pdf
- FUSIONS.** (2016, March). Estimates of European food waste levels. <http://www.eu-fusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf>
- Gemeente Rotterdam, Provincie Zuid-Holland, Port of Rotterdam, Rijksoverheid & Deltalinqs.** (2019, November). Havenvisie Rotterdam.
- Gemeente Westland.** (2021, October). Visie op Westland: omgevingsvisie 2.0. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiXiruS4v32AhXQOUwKHSFgB8YQFnoECA4QAAQ&url=https%3A%2F%2Fwww.gemeentewestland.nl%2Ffileadmin%2Fdocumenten%2Fwonen_bouwen_en_verhuizen%2Fomgevingsvisie%2Fomgevingsvisie-uitvoering-2021-oktober-lowres_01.pdf&usg=AOvVaw1e1uLSN4LQukyrQLtYkM_S
- International Energy Agency.** (2020). The Netherlands 2020: Energy Policy Review. <https://www.iea.org/reports/the-netherlands-2020>
- European Comission.** (2019, October 12). A European Green Deal. European Commission. Retrieved April 5, 2022, from https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
- Kenniskaarten - Het Groene Brein.** (2019, 10 december). Circular economy: a definition and most important aspects. Retrieved at april 6th 2022, from <https://kenniskaarten.hetgroenebrein.nl/en/knowledge-map-circular-economy/what-is-the-definition-a-circular-economy/>
- Oxford Languages.** (2021, 2 december). Oxford Languages and Google - English | Oxford Languages. Retrieved at april 6th 2022, from <https://languages.oup.com/google-dictionary-en/>
- Langeveld, J. W. A., Quist-Wessel, P. M. F., Gortworst, M. J. C., & Rieks, J. E.** (2021, August). Gebruik van Houtige Biomassa voor Energie Opwekking: PBE Jaarrapportage 2020. Platform Bio Economie. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjf25iRnP_2AhUFHuwKHxegCaoQFnoECAMQAQ&url=https%3A%2F%2Fplatformbioeconomie.nl%2Fwp-content%2Fuploads%2F2020%2F09%2F21-09-2020_PBE-Jaarrapportage-2019-1.pdf&usg=AOvVaw3SuyHApUflu8Rk_ToJaN4e
- Ministry of Agriculture, Nature and Food Quality of The Netherlands.** (2019, November). Plan of action: The Dutch government's plan to support the transition to circular agriculture. Government of the Netherlands. <https://www.government.nl/binaries/government/documenten/policy-notes/2019/11/30/plan-of-action---supporting-transition-to-circular-agriculture/Plan+of+action+---supporting+transition+to+circular+ag-riculture.pdf>
- Ministerie van Algemene Zaken.** (2019, October 8). Water management in The Netherlands. Government of the Netherlands. Retrieved April 6, 2022, from <https://www.government.nl/topics/water-management/water-management-in-the-netherlands>
- Ministerie van Economische Zaken, Landbouw en Innovatie.** (2022, 2 maart). Rijksoverheid stimuleert innovatie. Ondernemen en innovatie | Rijksoverheid.nl. Retrieved april 4 2022, from <https://www.rijksoverheid.nl/onderwerpen/ondernemen-en-innovatie/rijksoverheid-stimuleert-innovatie>
- OCAP, powered by Linde.** (n.d.). OCAP wil onnodige CO2 uitstoot en aardgasverbruik voorkomen. The Linde Group. Retrieved April 5, 2022, from <https://www.ocap.nl/nl/over-ocap/index.html>
- Oxford Languages.** (2021, 2 december). Oxford Languages and Google - English | Oxford Languages. Retrieved at april 6th 2022, from <https://languages.oup.com/google-dictionary-en/>

Port of Rotterdam. (n.d.). Biobrandstoffen. Retrieved April 4, 2022, from <https://www.portofrotterdam.com/nl/vestigingen/industrie-de-haven/energie-industrie/biobased-industrie/biobrandstoffen>

Port of Rotterdam. (n.d.). Oil refineries. Retrieved April 5, 2022, from <https://www.portofrotterdam.com/en/setting/industry-port/refining-and-chemicals/oil-refineries>

Port of Rotterdam. (2021). Feiten & Cijfers. Een schat aan informatie. Make It Happen. Havenbedrijf Rotterdam N.V. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwid__WY4P32AhUkJcUKHfKMBt0QFnoECAMQA-Q&url=https%3A%2F%2Fwww.portofrotterdam.com%2Fsites%2Fdefault%2Ffiles%2F2021-05%2Ffeiten-en-cijfers-haven-rotterdam.pdf&usg=AOvVaw0bE4004lkXaViR1k8Qog-R\

Port of Rotterdam. (2022, February 7). T&E study of CO2 emissions in European seaports. Retrieved April 6, 2022, from <https://www.portofrotterdam.com/en/news-and-press-releases/te-study-of-co2-emissions-in-european-seaports#:~:text=The%20report%20states%20that%20the,million%20tonnes%20of%20CO2%20emissions>

Port of Rotterdam, Deltalinqs, Rijksoverheid, Gemeente Rotterdam, & Provincie Zuid Holland. (2021, February). Voortgangsrapportage Herijkte Havenvisie. Port of Rotterdam. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjZ3oPjy_32AhX-NyKQKHAGVC-4QFnoECA4QAQ&url=https%3A%2F%2Fwww.portofrotterdam.com%2Fsites%2Fdefault%2Ffiles%2F2021-06%2Fvoortgangsrapportage%25202020%2520havenvisie-2030.pdf&usg=AOvVaw0cB3UNwd1ftwVgiYHOrFB

Programmteam Circulair Zuid-Holland & Provincie Zuid-Holland. (2019, December). Circulair Zuid-Holland samen versnellen. Provincie Zuid-Holland.

Provincie Zuid Holland. (2021, August). Omgevingsvisie Provincie Zuid Holland. <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjOhaSNzf32AhVCs6QKHXF0AZoQFnoECAQQAQ&url=https%3A%2F%2Fwww.zuid-holland.nl%2Fpublish%2Fpages%2F28070%2Fomgevingsvisiezuid-holland.pdf&usg=AOvVaw3Qmt4RHNIZ4CiDGcFkD6FK>

Rijkdienst voor Ondernemend Nederland. (2021, November 22). Biobased Economy | RVO.nl | Rijkdienst. RVO. Retrieved April 3, 2022, from <https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/circulaire-economie/biobased-economy#>

Royal FloraHolland. (2021, December 27). Onze coöperatie. Retrieved April 5, 2022, from <https://www.royalfloraholland.com/over-ons/onze-coöperatie>

Stenmarck, Å., Jensen, C., Quested, T., Moates, G., Buksti, M., Cseh, B., ... & Redlingshofer, B. (2017). Estimates of European food waste levels. 2016. Re-trrieved from: <http://www.eufusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf>.

Twence. (2022, January 13). Mestverwaarding. Retrieved April 6, 2022, from <https://www.twence.nl/projecten/mestverwaarding>
Eerste Kamer de Staten Generaal. (2019, May 28). Klimaatwet aangenomen door Eerste Kamer. Retrieved April 6, 2022, from https://www.eerstekamer.nl/nieuws/20190528/klimaatwet_aangenomen_door_eerst

United Nations. (2021). 17 Goals to Transform Our World. Sustainable Development Goals. <https://www.un.org/sustainabledevelopment/>

van Barneveld, J., Veldboer, T., & von Daniels, C. (2019, October). Rotterdam towards a Circular Port: A deep dive into Waste-to-Value opportunities. Port of Rotterdam & Circle Economy.

van der Schans, J. W., Vader, J., Ruis, M. N. A., van Bergen, J., Kolpa, E., Aaftink, R., Janssen, B., & Boddeke, J. (2016). Ruimtelijke verdien-capaciteiten Greenport Westland-Oostland. Van Bergen Kolpa Arhitecten.

Vermeulen, M., & van der Waal, J. (2015). Biobased Backbone. Studio Marco Vermeulen. Retrieved April 3, 2022, from <https://marcovermeulen.eu/nl/projecten/biobased+backbone/>

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