Nature inclusive Agriculture

Re-activating the fringes in the province of South Holland

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Content

Abstract

The province of South Holland is one of the biggest drivers of the Dutch economy with almost a quarter of the gross national product earned in this region. The agrifood sector is the largest contributor with an annual turnover of about € 5.5 billion. About half of the surface of the province is dedicated to this sector, entailing many jobs and steering innovation worldwide. In line with the ambitious target of the Dutch government the province aims to be fully circular in 2050. This means the agrifood sector is facing an enormous transition.

However, the sector faces several major socio-spatial and environmental challenges. The current monoculture food landscapes contribute to 20% of GHG emissions, consumes 67% of fresh water, and results in subsidence, salination and lack of biodiversity. Additionally, with the challenge to build 230.000 houses and the space needed for energy transition and nature, the pressure on space increases. The distribution of these negative externalities results in socio-spatial inequality, placing a burden on mainly lower income communities, including a lower socio-economic position for farmers. Nature-inclusive agriculture has the potential to tackle these issues as an overarching framework. How can the agrifood sector in the Province of South Holland transition to a nature inclusive circular system?

This project aims to have a 100% nature-inclusive agrifood sector in 2050. To reach this goal, this project starts by further investigating the current linear system and its environmental social and spatial issues. It can be concluded that the socio-spatial challenges are most present in the fringes within the province. Hence, a regional vision and strategy are proposed that transform the linear-manufacture-waste model into a circular and nature-inclusive agrifood sector, through re-activation of the fringes in the province. The fringes offer a high potential for implementation of a variety of nature-inclusive and circular functions, that can be established through stakeholder engagement, co-creation and participation of local residents. Part of the strategy are 3 fringe typologies, that can be expanded throughout the region. As a result, the agrifood landscapes become more nature-inclusive and resilient, with a shorter and more just food chain, whilst simultaneously providing equitable access to healthy and accessible food.

This report is interesting for governance parties or businesses in the agrifood sector that aim to transition to a circular economy. It could also be valuable for knowledge or educational institutions related to agriculture, food, nature-inclusive or transition methods, and regional spatial planning.

Key words: Circular Economy, Nature Inclusive Agriculture, agrifood sector, fringes, socio-spatial justice

1

Introduction

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Context Province of South Holland

The agrifood sector
This project is focused on the province of South Holland, which has a leading role in the global food production and innovation. Around 50% of the land is dedicated to agriculture, producing six million tons of products with a value of € 5.5 billion annually. The sector also brings about 16,500 businesses and 103,000 jobs in 2016 (Drift Metabolic, 2018). With different types of agriculture and the presence of Greenports, the region is an important driver for both prosperity and innovation. The low altitude is also characteristic for the landscape of South Holland. Most of the land consists of polders that lie up to 8m below sea level, shaping the green and blue structures in the region. However, a vast amount of negative environmental issues are related to the agrifood sector in the province (Qu & Balz, 2021).

Urbanization in de Randstad
South Holland also has the largest population density and built-up area of all dutch provinces (CBS, 2019). It contains a large part of the Randstad and has over 3.7 million inhabitants on roughly 3,400 km2 (CBS, 2020). The amount of inhabitants will grow even more in the near future: the estimation is that around 230,000 new homes need to be built within the territory of the Province until 2030 (Provincie Zuid Holland, 2020). The territory encompasses the large cities of Rotterdam and The Hague, several medium-sized urban cores, and numerous smaller cities and villages. The bigger cities collaborate in the polycentric urban region de Randstad (Lambregts, 2009).

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Relation with port of rotterdam and makersindustry
The port of Rotterdam is located in the province and is one of the world's largest ports. It is currently specialised in distribution, storage, and processing of mostly fossil raw materials, including a fossil fuel-based energy system using mainly coal, oil and natural gas (Port of Rotterdam, 2019).

The port is also strategically located in relation to the Dutch Greenports. The Greenports conduct a series of activities in the field of cultivation, trade, logistics, supply and knowledge development within horticulture. Greenport Westland is located near the Port of Rotterdam and represents about 60% of the total Dutch horticultural sector. It contributes to the Dutch economy with its export through the port region (Port of Rotterdam, n.d.).

In the (near) future the port authorities aims to become a 'waste-to-value port', concerning the treatment and distribution of bio-based materials, reculing, and digitalisation of logistic services. In addition, they envision a transition towards a renewable energy system, drawing on for example solar energy or biomass sources. Also carbon capturing and storage is part of this ambition. Sustainable energy (Port of Rotterdam, 2019). The port area therefore offers opportunities to enhance the transition towards a circular economy by use of renewable energy and at the same time contributing to closing material cycles.

Aside from these relatively larger industrial or productive areas the province is also home to a wide range of small and medium-sized businesses specialized in niche-markets: the makers industries. These businesses have potential to trigger transition within the province, because they carefully deal with scarce materials resources (Qu & Balz, 2021).

To conclude, the province offers a great amount of knowledge, innovation and prosperous industrial, peri-urban and highly developed urban areas. Much of the land is created in a way that it is both productive and profitable, contributing to the economic position of the South of Holland and agrifood sector in particular. All these great developments also come with an environmental and socio-spatial burden. The people and the environment are not profiting from what could potentially be a healthy and productive environment for all: this needs to change.

Brief & scope

Brief
The studio this year is prepared in collaboration with the Province of South Holland. The goal of the province is to have a fully circular economy in 2050, which is in line with the ambition of the Dutch National Government (Ministerie van I&M, 2016). The assignment of this quarter is to develop a regional spatial vision and strategy supporting this transition. On the regional scale global economic power and its influence on social, cultural and environmental development is best recognizable. Through regional design spatial developments can be steered into the right (circular) direction.

The studio edition of this year, builds upon expertises acquired during the Horizon 2020 research project Resource Management in Peri-urban Areas: Going Beyond Urban Metabolism (REPAiR), which is funded by the European Union under the Horizon 2020 framework, and investigations by PortCityFutures, an initiative of the Leiden-Delft-Erasmus (LDE) collaboration between universities in the South of Holland (Qu & Balz, 2021).

Scope
The large amount of negative environmental en socio-spatial impact of the current linear agrifood system is critical, despite its efficiency. Awareness about the footprint of our food is lacking, and the connection between peri-urban land and cities seems to be an unexplored potential for addressing this deconnectivity. This project aims to refocus the current linear agrifood chain towards a more integrated, collaborative, and circular system. The focus is on the food producing landscapes of the agrifood sector and its relation with the cities: through reactivating the fringes in the South of Holland. Nature inclusive agriculture is applied as an overarching framework. It both decreases the environmental and socio-spatial related issues in the region, and at the same time it increases the quality of the (living) environments near the fringes and the quality of soil and food and its economy. It enables the transition towards a circular economy through co-creation and knowledge as the main driver of change. A spatial vision and strategy were developed to guide the transition. The strategy is a combination of top down and bottom up actions that are either general of location specific. A key location where re-activation of the fringe is proposed, is in Rotterdam around the neighborhood IJsselmonde. This key model can be translated to other locations depending on the type of fringe: primary city fringe, peri-urban fringe or production fringe. The nature inclusive re-activation of fringes can then be expanded to more locations in the South of Holland, resulting in a more circular system and a just nature inclusive environment.

Problem field

The agri- food sector in South Holland accounts for **48% of landmass**, contributes to **20% of GHG emissions**, consumes **67% of fresh water**, while employing approximately **10% of its labor force.** Next to that South Holland faces several challenges like: the need to build **230.000 houses, inequality, subsidence** and the **lack of biodiversity**. The demand on space is enormous.

Research question: *How can the agrifood sector in the Province of South Holland transition to a nature inclusive circular system?*

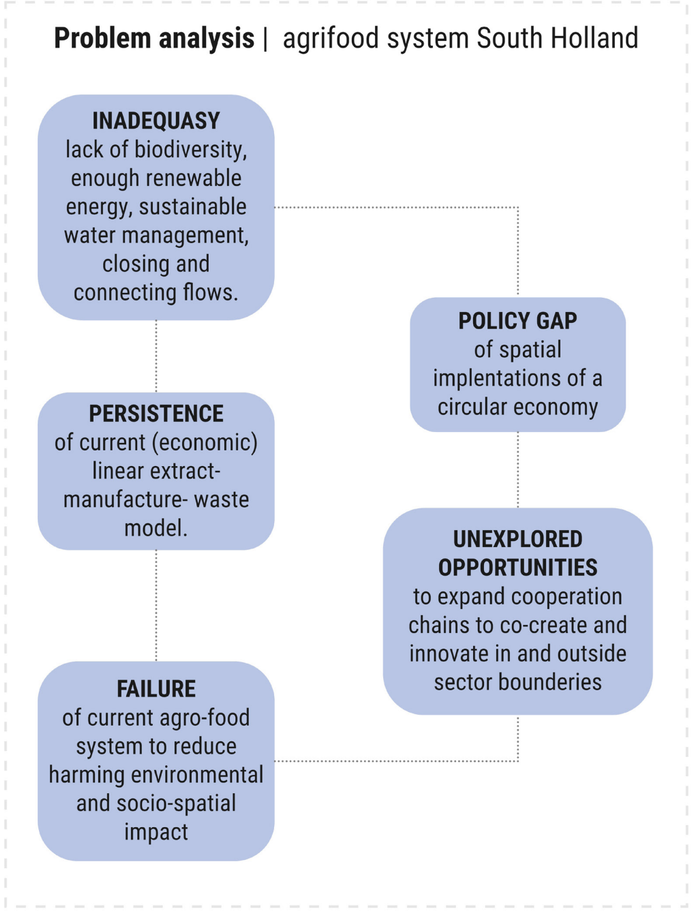
The Province of South Holland has to deal with various major obstacles in order to achieve an 100% circular economy in 2050. First of all, the persistence of the linear extract-manufacture-waste model is a problem in itself standing in the way of change. This current model is strongly embedded into the current socio-economic system. Its environmental externalities are also more fundamental and complex. This calls for more profound changes in the economy in order to create a sustainable long-term situation, in other words: a transition. A sustainable and circular economy requires a structural redesign of the foundations of our industrial, social, political and financial system (Drift Metabolic, 2018).

The agrifood sector is under pressure both economically and ecologically. The entire agrifood chain, from production to consumption, causes serious ecological disruptions, and is currently inadequate to provide sustainable solutions for these problems. The sector contributes to 20% of greenhouse gas emissions, with an annual emission of 4.7 Mton CO2. In terms of energy consumption in the chain, the greenhouse horticulture is by far the biggest consumer: it uses 48 petajoules of natural gas, equal to the energy consumption of more than 1.2 million households. The sector also uses extreme amounts of water: all production activities require 1.3 billion litres of water each year (Drift metabolic, 2018). The water system is under pressure from subsidence and run-off of nutrients. About three quarters of the province is susceptible to subsidence (Province of South Holland, n.d.). Also salinisation is becoming a major problem due to the combination of land subsidence and rising sea levels (van Dam, Pols, & Elzenga, 2019). Besides this, also poor air quality, lack of biodiversity and a decent income for farmers require a different approach (Provincie Zuid-Holland, 2016; Drift Metabolic, 2018). Lastly, the current linear system is not able to close and connect material flows in order to increase circularity.

In addition, climate adaptation and the energy transition, together with future spatial demands of urbanisation, nature and agriculture, results in pressure on space (van Dam, Tisma & Diederiks, 2019).
There is also socio-spatial injustice as a result of uneven distribution of quality of space and food. This means all together that the agrifood sector in the province faces both environmental issues, societal problems and pressure on space (further analyzed in the next chapter). The current agro-food sector is therefore failing to reduce its harmful impact on the environment and society.

Although the province has set out policies and goals to tackle these problems through a transition into a circular economy, these policies contain slim to non spatial interventions, resulting in a policy gap. This report will therefore propose spatial interventions connected to this transition.

Lastly, there are already many circular and sustainable initiatives present in the province: circularity seems to be a trend (Ellen MacArthur Foundation, 2015). Many local pioneers, farmers and (local) businesses are eager to embrace change or implement new ideas. However, regional and local coordination is needed to steer this transition. This currently shows in unexplored opportunities to expand cooperation chains to co-create and innovate both within and outside the agrifood sector.



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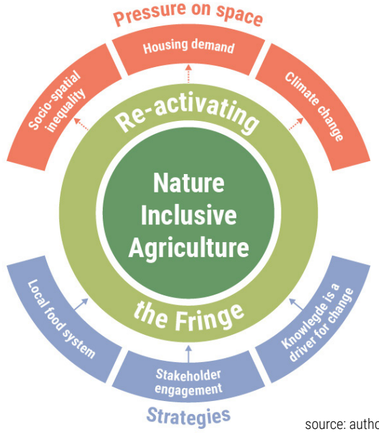
Conceptual framework



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In this conceptual framework the concepts and theories used in the research are defined. Their connections to each other are visualized in the diagram and explained below. The foundation of this project is mainly based on 3 core concepts or theories: Nature Inclusive Agriculture, Territories in Between or "Fringes", and Socio-spatial justice.

As shown in previous sections the project goal is to shape the transition in the agrifood sector from the linear extract-manufacture-waste model towards a circular agrifood system that is 100% nature inclusive. Nature-inclusive agriculture is an overarching framework for this project. In order to provide a solution for the pressure on space, while at the same time transitioning the agrifood sector towards a circular approach, the existing space must be used in a smarter and more integrated way. The fringes, or "Territories in between" are the backbone for providing integrated solutions for the urgent socio-spatial and environmental issues. Several strategies are used in order to re-activate the fringes in the South of Holland, creating stronger and resilient connections between the peri-urban and urban areas. A local food system is the result of small-scale co-creation and stakeholder engagement, combined with a more top-down approach (see chapter 4). Knowledge is on all scales the driver for change towards a nature-inclusive and just future in the South of Holland.

Nature Inclusive Agriculture

Wageningen University & Research has conducted many series of research about the potentials of Nature-Inclusive Agriculture . WUR (2019) describes the definition of Nature inclusive agriculture (NIA) as follows: ""Nature inclusive farming is a form of circular agriculture that utilises and protects the biodiversity on and around the farm. It produces food within the boundaries of nature, the environment and the living space." This shows that biodiversity is at the basis of a resilient agrifood system. The term 'biodiversity' refers to all the variety that exists within species, between species and between the ecosystems of which they are part (CLO, 2017; Bélanger & Pilling, 2019). Bélanger & Pilling (2019) state that "nature-based" solutions involving Biodiversity for Food and Agriculture (BFA) can in an environmental friendly way offer a variety of ecosystem services, addressing the various major challenges that the agrifood sector is facing. Adapting to future challenges and therefore diverse production environments require genetic diversity and diversification. This means using multiple species or crops in one plot or integrating different agricultural functions - such as arable farming, livestock farming, forests and aquatic resources –, while at the same time conserving and managing the diversity in the landscape. In short, by implementing this, the environment becomes more resilient to shocks and stresses related to climate change. These challenges differ based on the local conditions and vary from subsidence, to lack of biodiversity, salination and pollution, and so on. This is further described in chapter 2: Environmental Issues. Ecosystem services are described as structures, processes and functions in and around production in the agrifood systems and ecosystems, giving a range of benefits to humans. The ecosystem services include the crops and livestock by farmers, the trees, aquatic species, and the animals and micro-organisms that underpin the production (Bélanger & Pilling, 2019). They help in the control of natural pests and diseases, pollination, water supply and purification, natural soil fertility, a good soil structure, and habitat functions (Van Doorn et al., 2016), enhancing the resilience of our food system (WUR, 2021). Biodiversity is thus indispensable to both food security and sustainable development, and the supply of several vital ecosystem services. It can even increase the food production (Bélanger & Pilling, 2019). The importance of biodiversity to food security and nutrition, livelihood and sustainable development has gradually become more apparent over the past decades, acquiring greater recognition on (inter)national agendas. It is therefore also integrated in the SDG's (Sustainable Development Goals) of the UN. For example, number 2 'Zero hunger', number 14 'Life below water', and 15 'Life on land' are specifically related to these issues.

Erisman et al. from the Louis Bolk Instituut and Wagingen University and Research (2017) state that nature-inclusive agriculture is a form of sustainable and circular agriculture, since it strives to closing cycles towards zero emissions. It allows for raw materials to be used more efficient while reducing the impact of the agricultural business on its environment. Healthy soil is the basis for NIA and this type of agriculture is therefore in principle soil specific. There are many agroecological nature-inclusive systems that take the soil as their starting point. Examples are permaculture, food forests and community supported agriculture, that also take into account the social aspects within the food chain. Many of these NIA types use multiple layers in vegetation procuring different products at the same time. They are able to close mineral cycles, use permanent vegetation, supply nutrients and capture carbon (Erisman et al., 2017)

The transition to nature-inclusive agriculture and the associated aim of closing material cycles could mean having more diverse mixed farms where for example arable farming and dairy farms are mixed in combination with ecosystem services. When this is properly implemented, these farms will have a more resilient (eco)system)diversity, make more efficient use of natural resources, and in addition, have the opportunity to close cycles through the use of resources from their own farm or local region (Erisman et al., 2017). According to Bélanger and Pilling (2019) key priorities for enhancing biodiversity in food and agriculture (therefore nature-inclusive) are: 1) "improving knowledge of how existing practices and new approaches can best be combined to promote outcomes that increase productivity in a sustainable way" ; 2) "identifying means of adapting sustainable management methods to local agroecological and socio-economic conditions; and 3) "developing appropriate policy and outreach measures for scaling-up interventions".

In these findings the importance and meaning of NIA is articulated. Nature-inclusive agriculture is used in this project as an overarching framework providing many solutions to several pressing socio-economic and environmental issues. NIA could well be implemented in the fringes in the South of Holland, steering the re-activation of these fringes. The relation between agriculture and the fringe is explained in the next section below.

Territories in Between

Characteristics of TiB

The surface of the province of South Holland is almost half covered with land-use dedicated to the agrifood sector, which could basically be described as rural land. That would mean the other half is dedicated to other types of land-use: mainly urban areas, industrial zones, natural areas and infrastructural zones. In spatial planning there is indeed a tendency to divide the territory into urban and rural zones. However, there is a wide range of in-between-areas that can be distinguished within the landscape. There are many terms for these types of territories discussed by multiple authors. Pirro & Anguelovski (2017) use the term "fringe". This term is adapted in this report. They describe the fringe as an often forgotten space "waiting for something better". Wandl (2019) describes these as 'territories-in-between'. Wandl sets out three main characteristics of the TiB's. First of all, Territories-in-between form a complex and interlocking system of built and open spaces. Also, their existence is highly impacted by the role of infrastructure as a connecting and separating element at different scales. Lastly, they often exhibit a complex mix of land cover (Wandl et al, 2014).

Potentials of Open Space in fringes

Open spaces are simply described as places not covered by buildings. According to Wandl, Rooij & Rocco (2014) the planning open spaces is crucial for sustainable spatial development, because planning approaches as for example landscape urbanism or green infrastructure and ecosystem services all look at the relation between built and unbuilt from an open space perspective. Some of the open spaces in fringes, or Territories-in-Between are changing rapidly in terms of functions. However, the authors address that open spaces should not only include functions, but rather spatial structures and processes. The types of open spaces can differ from 'grey open spaces' that are mostly sealed impermeable paved surfaces, or 'green open spaces' that are unsealed permeable surfaces. Urban grey and green spaces

in TiB must supply crucial ecosystem services, since due to urbanization more and more rural or 'natural' areas are lost (Wandl, Rooij & Rocco, 2014). Open space in TiB can contribute to both the problems and potential solutions for the pressing environmental issues. However, the different functions provided by these 'ecosystem services' have direct or indirect impact on humans. Therefore, it is important to simultaneously consider the needs and preferences of local residents and society, through taking into account cultural needs (Lovell & Taylor, 2013; Bélanger & Pilling, 2019). This can be done by encouraging recreational activities, to incorporate aesthetic preferences of nearby communities, to educate people about nature, and to preserve historic landscape features (Lovell & Taylor, 2013).

The role of green spaces in fringes

Lovell and Taylor (2013) address the role of green spaces as key spatial structures of urban ecosystem services, since they are crucial for the conservation of biodiversity, the protection of water sources, and the improvement of microclimates. Green spaces also play a critical role in partly supplying fresh food consumed by urban residents. Wandl (2017) mentions this, and further discusses the importance of specifically green spaces in TiB. Apart from ecosystem services, green spaces provide large amounts of benefits for human well-being. However, the influence that green space can potentially have on both biodiversity and human well-being largely depends on mainly two indicators. Firstly, the quality of ecosystems and their richness of habitats and species are directly linked to the mosaic of patches in that specific area. The spatial structure of this mosaic of patches is the result of patch size together with landscape fragmentation by infrastructure. Large and un-fragmented areas - where vegetation cover and diversity play are role - are especially crucial for biodiversity and health of plant and animal species. Often, eco-corridors for animals in TiB are positioned along infrastructures and rivers, that are simultaneously acting as barriers. Secondly, the accessibility of green spaces also determines the health benefits. It is important to realize who and what communities can reach and profit from green spaces in TiB. This is relevant, since green spaces offer potential for development of educational aesthetic and cultural values, as well as contribute to human interaction (Wandl, 2017).

Wandl (2017) also states there are significant amounts of garden areas, small public green spaces and agricultural land present in these areas. TiB or fringes therefore offers high potential for (urban) agriculture and production of local (organic) food, possibly with the option to grown food for yourself. Providing food on the local scale would reduce food miles in the agri-food chain and would stimulate local people to engage so they can express themselves creatively and be more self-sufficient. This can result in more engaging and open communities (Pirro & Anguelovski, 2017), and would provide healthy and affordable food. Then again, the use of these agricultural functions depends on the accessibility of the area and whether local producer-consumer contact is possible (Wandl, 2017). These informal environmental and agricultural activities can help cities to reach their sustainability goals. Sustainability here is a result of creative active processes and locally embedded knowledge. However, rational planners do not often take these informal environmental and agricultural activities into consideration (Pirro & Anguelovski, 2017).

The role of infrastructure and mixed-use in fringes

Cities are known to influence the complex systems that are present in their hinterlands: peri-urban or rural areas (Buxton & Butt, 2020). Fast population growth and rapid urbanization are pressing issues that our cities and surrounding land are facing nowadays, and even more so in the near future. This has already led to an increase in demand for urban land in terms of housing plots and various other land uses, affecting rural-urban fringes (Thuo, 2013). Pirro and Anguelovski (2017) even state that fringes are often seen as residual spaces that are tamed by the city. Food producers in peri-urban areas are in this way dependent on consumers in cities and are hereby threatened by the expansion of the urban economy.

The South of Holland can be seen as a metropolitan region, including urbanized areas, agricultural land, open spaces and highly dense residential areas, connected through a complex regional or even national and global infrastructure network. As said before, the presence of infrastructure in fringes acts as a barrier in the territory, often fragmenting the landscape into patches. Especially regional and global transport infrastructure, such as railways, motorways or even airports, are characteristic for Territories-in between. The result is a high accessibility to these areas. This also explains why often functions such as waste and sewage treatment plants or power plants (Wandl et al., 2014) and shopping malls or distribution centers are located in TiB (Wandl, 2020). According to Wandl et al. (2014) in the South of Holland the presence of logistics centers and their related infrastructures is especially important. This relates for example to the port of Rotterdam and glasshouse areas such as Westland.

The previous sections show that fringes or TiB have much to offer in terms of different functions and relating structures and processes. Wandl, Rooij & Rocco (2014) state that TiB have a potential for multifunctionality, which is crucial for sustainable development in these areas. The amount of mix-use present can be characterized by permeability, grain size, centrality and accessibility and connectivity of the are in TiB. In short, mixed-use is a result of systemic qualities of a location. Mixed-use areas can achieve a more sustainable spatial development. However, this requires coordination through different scales for planning and design (Wandl & Hausleitner, 2021).

Socio-spatial justice

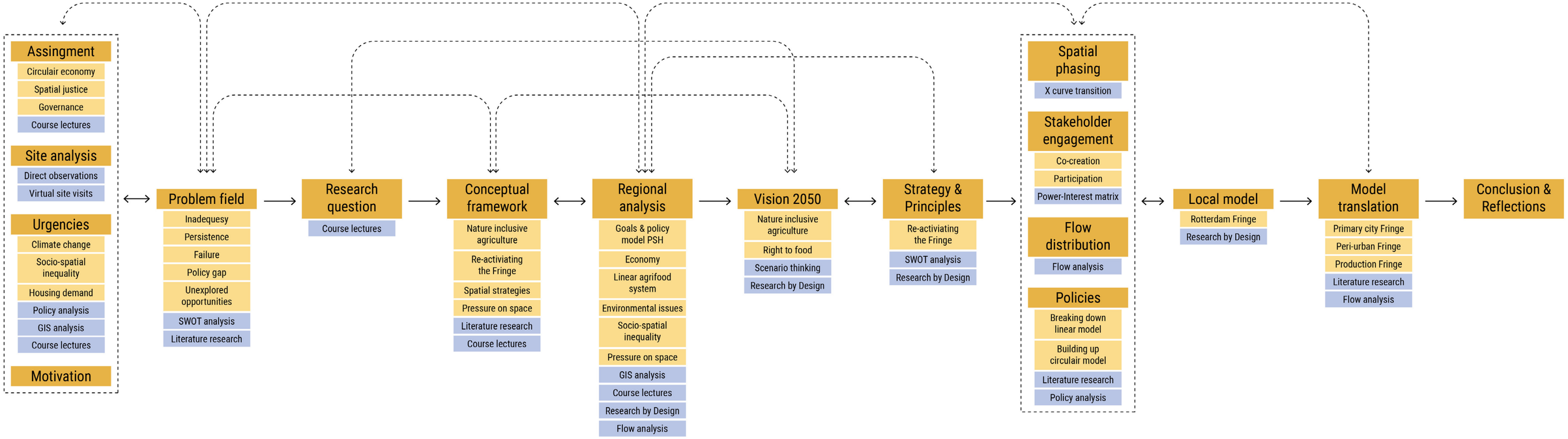
Most people in the 21st century inhabit cities (Gross, 2016). There seems to be an increase in people wanting to live in cities to seek a better life (Rocco, 2021b). However, inhabitants are not necessarily offered the same opportunities within cities. Resources, allocation of public goods and services are in many cases not fairly distributed and shared. Spatial dimensions of distribution of burdens and benefits seems to be especially relevant. Social justice is in that sense connected to geography in the way cities are planned, managed, and designed, hence, the term 'spatial justice' (Rocco, 2021b), or socio-spatial justice. Socio-spatial justice is strongly related to human actions and economic incentives (Gonzalez-Val & Pueyo, 2009). Social justice is, according to Rocco (2021b), one of the greatest challenges of our time. Socio-spatial fragmentation can be the result of socio-spatial inequalities. An increase in inequality and lack of access to public goods are a threat to the social, economic and environmental aspects that contribute to sustainability of our cities (Dillard, Dujon, & King, 2009; Larsen, 2012; Rocco, 2021b). According to Campbel (2013) planning and design must engage with both sustainability and social justice. They together combat the negative consequences of this "uneven development". This includes the uneven distribution of economic resources and environmental habitats, resources, land-use or relating hazards (Campbel, 2013). Access to educational, economic and environmental opportunities is crucial for spatial justice (Johnson & Kossykh, 2008). Especially in a world of growing inequality, scarce resources and climate change, the need for true democratic spaces is increasing. This includes participation of (civil) society on the distribution of burdens and benefits.

In terms of agricultural land, the land is most of the time allocated to the farmer. However, the landscape itself can be seen as a public good. Agriculture is directly linked to broader social issues at different scale levels, such as the relationship with consumers, food awareness, health and biodiversity (Van Dam, Pols & Elzenga, 2019). This is of great importance, since especially food awareness and "healthy eating" are receiving more attention in today's society. The transition of the agrifood sector should therefore be placed in a broad social context, so people can have access to healthy and locally produced food. With the landscape as a public good, local residents should be able to have access to a healthy and safe living environment that is sustainable in the long term. This is especially important for the experience of qualitative agricultural landscapes that can contribute to the well-being of people living nearby (Provincie Zuid Holland, 2020b). These findings are important in order to transition towards a nature-inclusive and just agrifood sector, and are used in this project.

Conclusion

The above findings show the potential of both green and grey open spaces in fringes and the importance of including ecosystem services and qualitative mixed-use areas both for the environment (biodiversity) and the people using the space. The presence of agriculture and its potential for local community-based food production and well-being can be well combined with nature-inclusive agriculture concepts, which is in turn highly beneficial for providing ecosystem services. (Bio)diversity is key in these findings. The fair distribution of public goods and resources, and the geographical access to healthy living environment and food is very important to take into account. Socio-spatial justice is therefore an underlying value in this project. The main theories or concepts from this conceptual framework are contributing to the design of the regional vision and strategy for the South of Holland, that focusses on re-activation of the fringes.

Methodology framework



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2

The South Holland Agrifood system

Global economy perspective
The linear system
Environmental issues
Socio-spatial issues
Pressure on space
Synthesis: re-activating the fringe

Global economy perspective

The South Holland agrifood sector is active in a globalized world in which economic development is achieved by joining intense competition for investment. Since the 1980s, the importance of the region has increased due to technological change (internet), increasing free market ideology and increasing corporations which manifest cross borders (UN). This change has led to high levels of welfare for some metropolitan areas (Qu & Balz, 2021).

This is also applicable to the Province of South Holland, with the Port of Rotterdam as an important location for in- and export. The agrifood sector produces about six million tons of products, which has an annual value of in total €5.5 billion. It offers 103.000 people a job and entails in total around 16.500 companies. This all makes the sector an important driver for innovation & prosperity (Drift metabolic, 2018).

The Netherlands exported a total of 95.6 billion euros worth of agricultural goods in 2020, even with a slight increase of 1.0% compared to 2019 (Rijksoverheid, 2021). This contributes to great economic prosperity, but also comes with a big environmental burden. There is an enormous mismatch between the import and export of food products and its own consumption in South Holland, which results in many transportation flows around the world. For example: there are more meat products imported than consumed in the province, the sector even exports 75% of its production, mainly to Germany & Italy. Moreover the province imports fruits and vegetables whereas it produces enough to feed its own population. The same accounts for dairy products (FutureFood Zuid-Holland, 2019). Because of this, the landscapes are being strongly depleted, especially since they are also serving other regions of the world. If this continues the way it does now, even more energy and raw materials are needed, and landscapes become more and more industrialized and depleted. The environmental impact is already visible around us and even contributes to climate change worldwide.

The agrifood system has to be reconstructed in order to decrease the footprint of the Netherlands as a whole, and especially the South of Holland as important as an indispensable link in the current agrifood chain. The link with the global food chain should be severely minimized, and the agrifood sector has to serve more local and contextualized regions. A shift is needed in the economy of the Province of South Holland, becoming less dependent on the Port of Rotterdam and its export, in order to be able to transition towards a circular food production system in 2050.

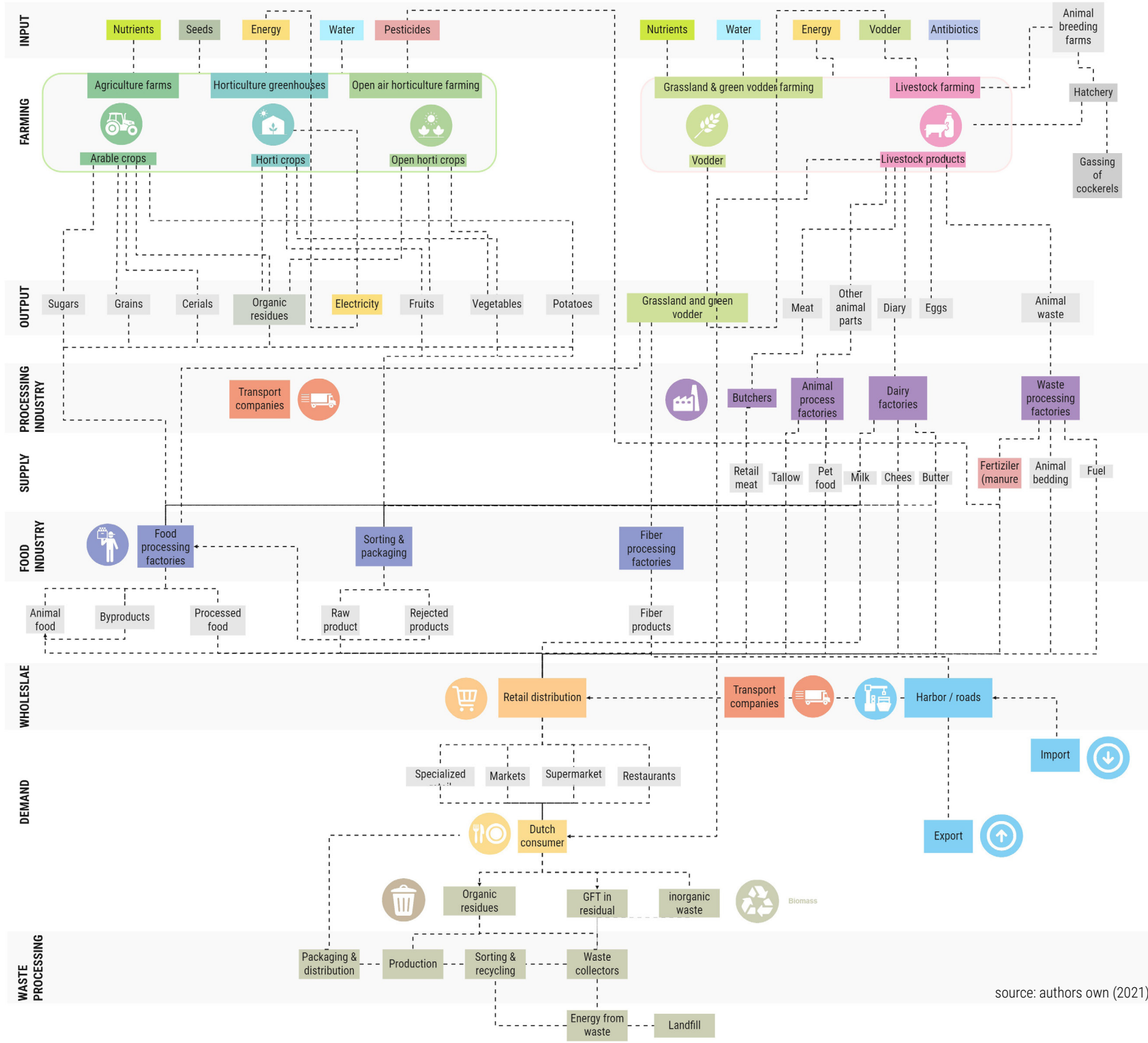
The linear system

The current agrifood system consists of a linear extract-manufacture-waste model. The supply chain is based on different actors who all aim to gain the greatest economic benefit. This results in supply chain parties using raw materials at their disposal, processing these at the lowest costs and with the highest yield, and then sells the product to a consumer, who leaves behind a lot of waste (Ellen MacArthur Foundation, 2013). The current food system relies on large chains that serve larger global demands and supplies. Most of the time these resources are not extracted and produced in a sustainable manner (Ministerie Landbouw, Natuur en Voedselkwaliteit, 2018).

As can be seen in the material flow analysis in figure …, the agrifood sector is a complex system with multiple different actors. In short, the linear chain can be conceptualized as follows: Inputs - Production - Processing & packaging - Wholesale - Consumption - Waste. Agriculture (production) takes up about 48% of the province. There are types of agriculture distinguished in the flow analysis. They all need a lot of input resources. The largest inputs are water, food, fodder and energy. In terms of fodder, 1,27 million cattle fodder required for livestock farming in the province. A significant part of this comes from outside of the province, partly even from outside the EU (Drift Metabolic, 2018).

In terms of outputs, the goal is ofcourse the different agricultural products that are for a large part exported to other countries through the port of Rotterdam. About 18% of the output is produced by greenhouses, contributing to this amount. Another important output is the waste stream of manure: in total 3.8 million tonnes. This contains nitrate, phosphate, and potassium. The manure is partly used as local fertilisation. However, the province has to deal with large amounts of manure surpluses due to the scale of livestock farming in the region. Other byproducts are organic residues of crops, such as straw, leaves or pulp. Part of this can be used as fodder, or can be processed into other products. Household waste streams also result in 460 kilotonnes of biomass, 280 of which is house residual waste.

Given that the province aims to achieve a circular and biobased agrifood sector, it is important to consider the benefits and burdens of the current production system (types of agriculture), the current consumption and diet, and the waste streams. This should be taken into account in order to set up the vision and strategy towards a circular and nature inclusive agrifood sector.



source: authors own (2021)

Types of food & energy production

Arable crop farming
The largest part of the production landscape surface is dedicated to arable crop farming: around 36.000 ha. In particular in the south of the Province there are concentrations with arable farming. However, compared to the rest of the Netherlands, the arable type of land is relatively small: 6% of the Dutch arable land is in the Province of South Holland. About 35% of the 1.3Mton production consists of potatoes to consume, followed by sugar beet (30%) and maize (15%).The residual flows mainly consist of manure and organic plant residues (Royal Haskoning, 2017).

Greenhouse horticulture
The greenhouse horticulture sector has a strong presence in the province. Westland and Boskoop are two of the six Dutch Greenports located here, mostly devoted to floricultural crops (53%) and greenhouse vegetables (44%). The economic value of the sector is around €2 billion, of which approximately €1.4 billion is for cut flowers and pot plants and €0.6 billion for greenhouse vegetables (Royal Haskoning, 2017). As mentioned before, the horticulture sector generates the highest yields and cash flows in relative terms (Drift Metabolic, 2018).

Open horticulture
Within the open land horticulture sector different clusters can be distinguished: from flower bulbs growing in the Duin-en Bollenstreek, to tree nursery in Boskoop and surroundings, to finally the cultivation of horticultural vegetables in the south of South Holland. The surface covers in total around 7327 ha with a value of € 300 million euros. Especially the flower bulb sectors with tulips as main products have an international leading position. The main downside of this, besides its environmental impact due to transportation, is the over 80.000 tonnes of plant waste that is released during production, processing and trading of the bulbs (Royal Haskoning, 2017).

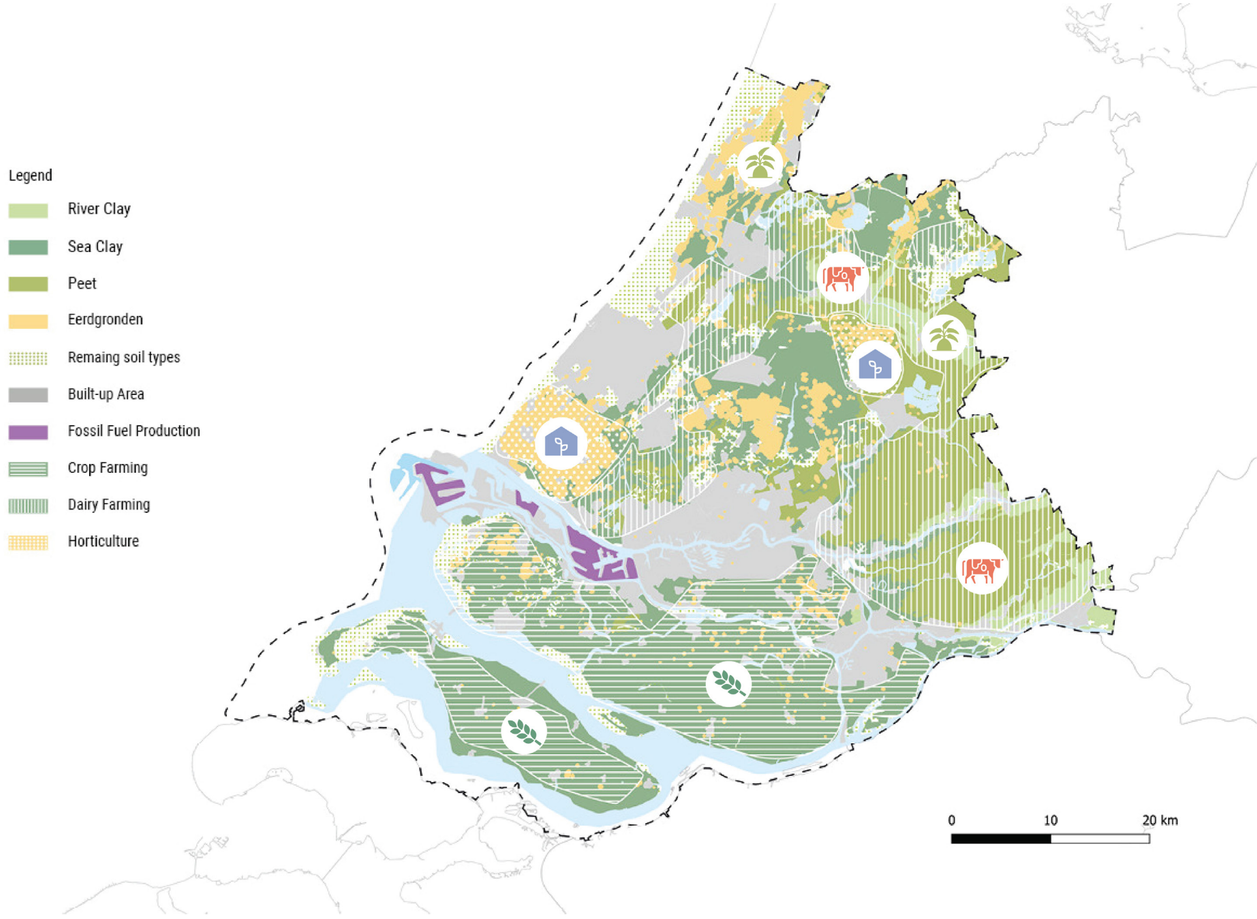
Livestock farming
The livestock farming sectors includes both dairy and meat production. Approximately 1 million animals are kept in livestock farms, in need of food, water, antibiotics and sufficient living space. In terms of fodder these animals require 1.3 megatons of fodder each year, which is partly imported and partly produced regionally (see grassland and green fodder farming in figure … (Drift Metabolic, 2018). Milk is produced on a large scale in the province. In total, about 800 million litres of milk are produced yearly, resulting in 3.7 megatons of manure being released. There are a total of six dairy factories in the South of Holland, with large customers such as Friesland Campina as front runner.

Arable crop farming
Surface: 36.138 ha
Value: € 0,1 billion
Production: 1,3 Mton
Residual flows: 0,3 Mton

Greenhouse horticulture
Surface: 4.762 ha
Value: € 2 billion
Production: 1 Mton
Residual flows: 0,2 Mton

Open horticulture
Surface: 7.327 ha
Value: € 0,3 billion
Production: 0,3 Mton
Residual flows: 0,1 Mton

Livestock
Companies: 2.027
Value: € 0,4 billion
Production: 0,8 Mton
Residual flows: 3,7 Mton



source: Authors own, 2021 - based on 1) Verkenning Circulaire Economie Provincie Zuid-Holland (2017); 2) Drift Metabolic

Consumption & diet

In the Netherlands, every person consumes on average about 3,1 kg of food per day (RIVM, 2021). For the province of South Holland about 1.3 million tonnes of food are needed to feed the 1.6 million households. Based on the national average, the common diet consists of one-third cereal products and potatoes, one-third fruits and vegetables, and one-third animal products and other products such as nuts and mushrooms (Drift Metabolic, 2018).

The table below shows a selection of certain kinds of food. The conclusion that can be made according to these facts is that inequality exists in food consumption. For example higher educated people are eating more vegetables and fruits than lower educated people. Moreover meat consumption is higher at lower educated people. Next to that, 50% of consumed meat is processed. Therefore higher educated people are consuming a more healthy diet (RIVM, 2021).

Dutch consumption (gr/day)

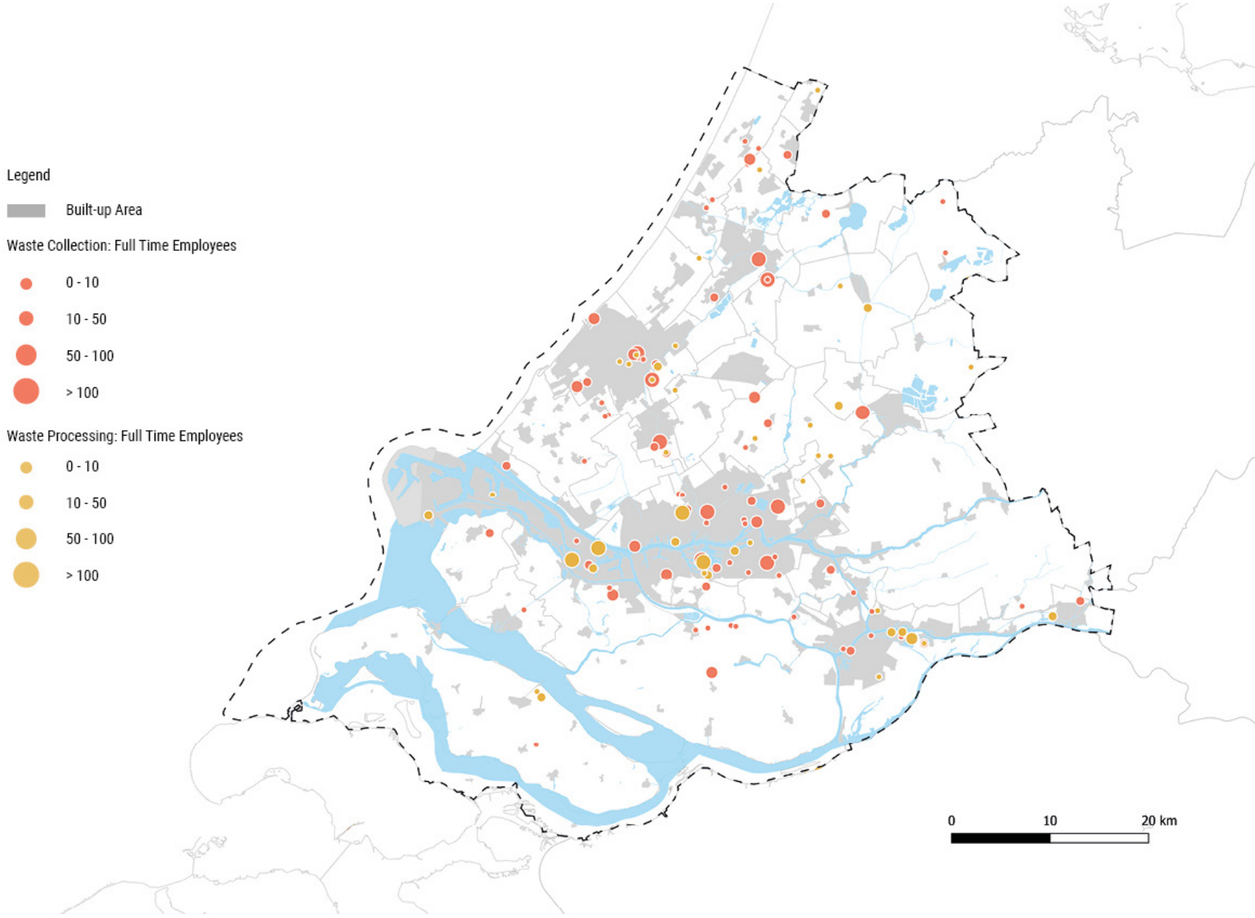
	Dutch average	Lower educated adults	Lower educated children	Higher educated adults	Higher educated children
Meat	98	108	89	96	66
Vegetables	131	131	85	172	73
Fruits	130	119	98	163	133
Grains	194	186	162	212	172
Alcoholic drinks	139	152	-	172	-

source: RIVM (2021)

Waste processing

More than 5% of the annual average dutch food consumption is inevitable waste, like peels of fruits. However, about 13% of useful food is also wasted (Drift Metabolic, 2018). In 2020 the province of South Holland had to deal with a total of 202.000 tonnes of organic waste from households. An amount of 1703 kilotons of household waste had to be processed (CBS, 2020).

The map on the right shows the size and location of waste collection and processing companies, with the size based on the amount of full-time employees. The map shows most waste collecting and processing facilities are located within or on the edges (in fringes) of the larger cities. Most of the time these facilities are located along the regional road network. A few are also present in the Port of Rotterdam. In the linear model waste is harmful to the environment and does no justice to the value of food and its producers (Ministerie Landbouw, Natuur en Voedselkwaliteit, 2018). With the aim for a circular economy in mind, the organic waste streams from both production processes and households offer opportunities for reintroduction of organic materials into another cycle. The 'end-of-life' concept should be replaced with waste-to-value principles, where elimination of waste is the highest goal. This goes far beyond disposal and even recycling, where large amounts of embedded energy and labour are lost (Ellen MacArthur Foundation, 2013).



source: Lisa data, edited by authors(2021)

Environmental issues

The environmental impact of monoculture
Since the 1960s, mechanisation, and use of large quantities of artificial fertiliser and pesticides have led to an increase in scale, changing the agriculture into monocultural landscapes. This means growing just a single crop, plant, or livestock species, variety, or breed in a field or farming system at a time. This led to an enormous increase in food production yield (Erisman et al., 2017). However, the negative consequences of this scale increase and disconnected production systems have increasingly become apparent. The sector really is under great environmental pressure (Erisman et al., 2017; Drift Metabolic, 2018).

Climate change
The map of the Netherlands below shows that the South of Holland with the Port of Rotterdam is the biggest polluter of the Netherlands in terms of greenhouse gas emissions (CO_2, methane, nitrous oxide). The chain has an annual emission of 4.7 Mton CO_2-eq. Greenhouse horticulture emits 73% of direct emissions in South Holland's agriculture, through gas burning (Drift Metabolic, 2018).

Fossil fuel industry
The use of fossil fuels also impacts the environment contributing to climate change. In particular greenhouse horticulture in the province uses a considerable amount of raw materials and fossil fuels (Drift Metabolic, 2018). The port of Rotterdam plays a significant role in the fossil fuel industry, housing a few gas and coal power plants. The contribution of this to climate change is visible in the small map of the Netherlands below. The port area therefore needs to gradually change towards renewable energy production.

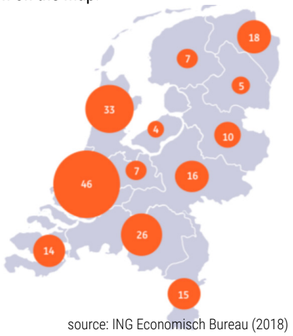
Lack of biodiversity
The replacement of small-scale extensive agriculture with monoculture also caused the disappearance of habitats for animals and insects: edges and overhangs with nectar plants, host plants, food, shelters and nesting places. The result is the reproduction of animals - and therefore the many characteristic animal species of the agricultural habitat - have strongly decreased. Since 1990, 26 of the 47 most important species have declined significantly. This is especially true for breeding birds and butterflies (CLO, 2021). This trend is strongly visible in the Fauna figure below.

The resilience of crops in monoculture is primarily maintained by the use of pesticides. Also nutrient leakage from manure threatens biodiversity. Of all pesticides in the Netherlands approximately half (55%) are highly toxic to humans, bees, insects, soil and (drinking) water (Drift Metabolic, 2018). This directly reduces natural enemies of pests such as spiders, parasitic wasps and predatory beetles, which in turn has influence on other animals and insects in the natural food chain (WUR, n.d.-a)

Water salination & eutrophication
The agriculture sector is dependent on the use of groundwater. In North and South Holland, farmers are especially short of fresh water during dry periods. Old seawater rises from deep groundwater layers and the soil salinity increases. Within agriculture, flower bulbs and cut flowers are the most sensitive crops to salinization. Crop damage can already occur at relatively low chloride levels in the soil (de Boer & Radersma, 2011). The amount of subsidence in the province can be seen on the map.

Type of agriculture	Soil type	Environmental issues
Crop farming	River/sea clay	water eutrophication, nutrient leakage, loss of biodiversity, use of pesticides, fossil fuels, food waste
Livestock farming	Peat	water eutrophication, nutrient leakage, loss of biodiversity, use of pesticides & fossil fuels, land subsidence, heating from stalls, food waste
Horticulture	Eerdgronden	light pollution, salination, fossil fuels, monoculture, CO_2, water deficit, food waste

source: authors own (2021)

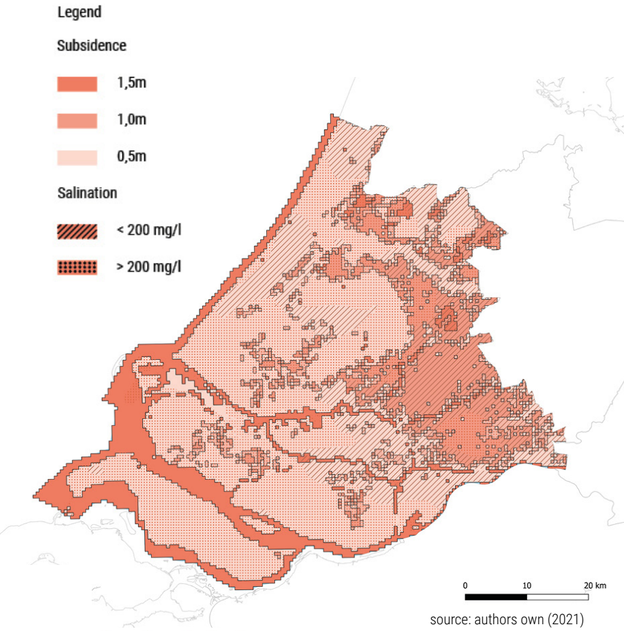


source: ING Economisch Bureau (2018)
edited by authors (2021)

Water eutrophication: In the South of Holland the food production requires a significant supply of nutrients in the form of artificial fertiliser. Some of the nitrogen and phosphate from the artificial fertiliser ends up in the groundwater and surface water. Agriculture is therefore the primary source of nutrient run-off and thus water eutrophication (Drift Metabolic, 2018). Most instances of exceedance of standards are found in ditches near tree nurseries, flower bulbs, fruit growing and greenhouse horticulture (WUR, 2019).

Soil depletion and subsidence:
The monoculture is depleting the soil and is reaching its limits. Heavy machinery makes the quality of the soil even worse, spoiling the soil structure (Erisman et al., 2017).
Peatlands are made suitable for grazing through groundwater drainage. The contact of the peat with the air causes oxidation releasing CO_2. The constant need for groundwater drainage leads to subsidence. In South Holland, the oxidation of peat lands results in almost one megaton of CO_2 per year (Drift Metabolic, 2018; Provincie Zuid-Holland, n.d.). As can be seen on the map on the right, subsidence is indeed a big environmental burden in the province.
With the current way of farming in a linear system and on monoculture landscapes another problem is the manure surpluses. This imbalance has a negative impact on the environment as well (Drift Metabolic, 2018). Therefore closing the nutrient cycles is a crucial step towards a circular nature-inclusive agrifood sector.

source: Authors own (2021)



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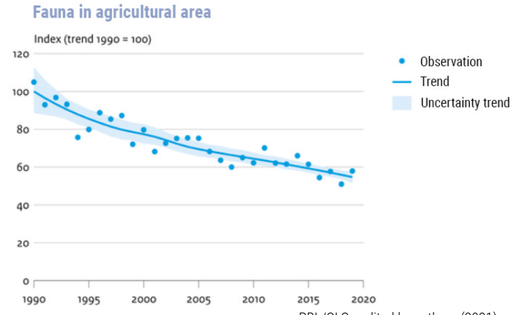


source: PBL/CLO - edited by authors (2021)

Socio-spatial issues

To visualize the socio-spatial inequality in the province South Holland we mapped several key demographic minorities. The demographic groups we show are neighborhoods in which certain demographic variables are at their highest percentage.

Low incomes:
Neighborhoods with low incomes often have little access to affordable and awareness about healthy food.

Elderly:
The elderly demographic experiences a lot of loneliness, and benefit from access to healthy food.

Single households:
Single households also experience loneliness more than others.

Non-western background:
Healthy food isn't accessible for a lot of the non-western immigrants. Awareness about local production is often not present.

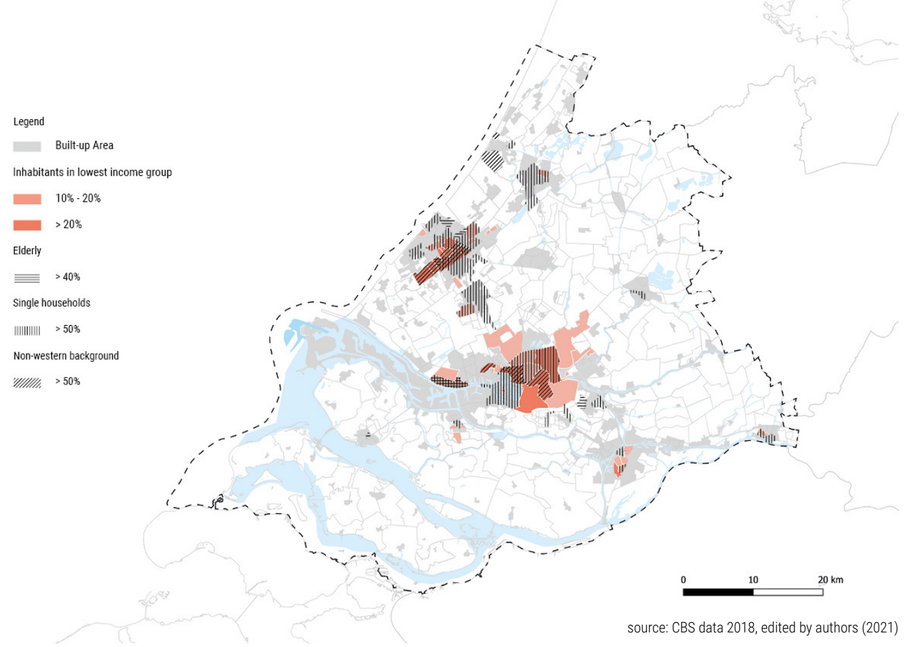
These minorities are target groups we want to focus on when planning nature inclusive fringes. The map shows that a lot of these target groups are located on the outer edges of the cities in South Holland. In a lot of these cases, they are examples of socio-spatial injustice. Their spatial situation, on the edges, has great influence on the social justice present (or missing) in these neighborhoods.

Another form of spatial (in)justice is the inadequate capacity of green areas, especially for urban citizens. Obviously, neighborhoods located in the center of big cities have the least access to open green spaces. A lot of the current residential areas do not have enough access to nature. Some of the outer edge neighborhoods, discussed previously, have higher access to such green space. Lately, a lot of people searching for a new home are looking more to move out of the (centers of the) cities and find something with more open space. This is increasing their value, and influences the rents, and therefore the population within the neighborhoods. "Current planning for urban regeneration and the creation of new high-quality recreational public green spaces sometimes results in projects that reinforce the paradox of green gentrification." (Silva et al, 2018)

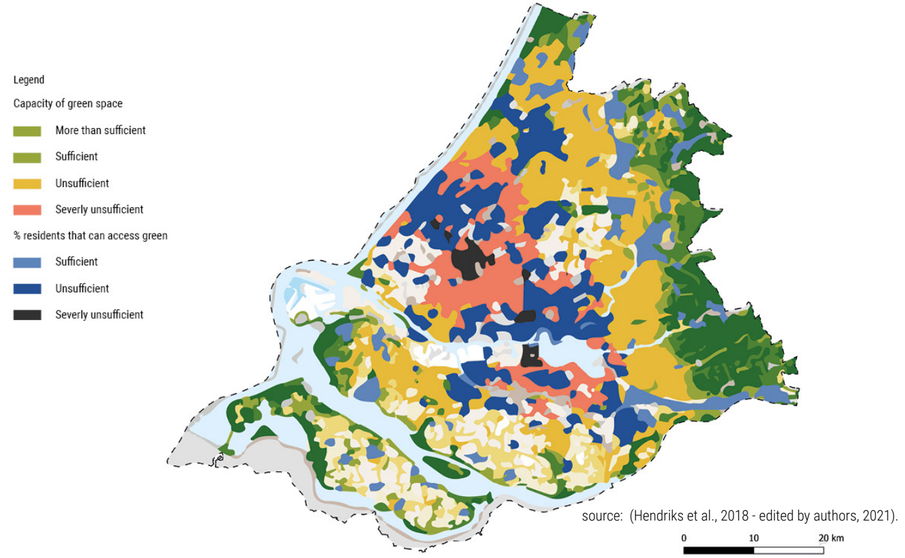
The map shows the demand from residents in the province of Zuid-Holland for green space for cycling in their area and the supply of such space. It shows whether supply meets this demand or not, so in fact this map also indicates the mismatch between supply and demand.

It shows that residents with a shortage of green spaces for bicycles mainly live in the big cities. It is also striking that the availability of green space for Delft residents is highly insufficient, whereas there is green space in the area. The fact that Delft is wedged between Rotterdam and The Hague also plays a role, as a result of which many residents from these towns move to the surrounding green spaces, which results in high recreational pressure. (Hendriks et al,, 2018)

source: ANP



source: CBS data 2018, edited by authors (2021)



source: (Hendriks et al., 2018 - edited by authors, 2021).

Pressure on space

In the following decades, the population of cities will increase. This is only an addition to the housing shortage that is already present in South Holland. “the Province of South Holland estimates that 230,000 of these new homes will need to be built within its territory.” (Balz & Lu, 2021). Next to this, the province is also planning on keeping this spatial urgency within the borders of the existing cities. This may cause a lot of conflicts about land-use and exploitation. New housing within the borders of the cities is also often not affordable for lower income groups. The current high demand and plans to keep the construction within the cities will create strong financial incentives for developers. This will result in a very little amount of affordable housing in the cities.

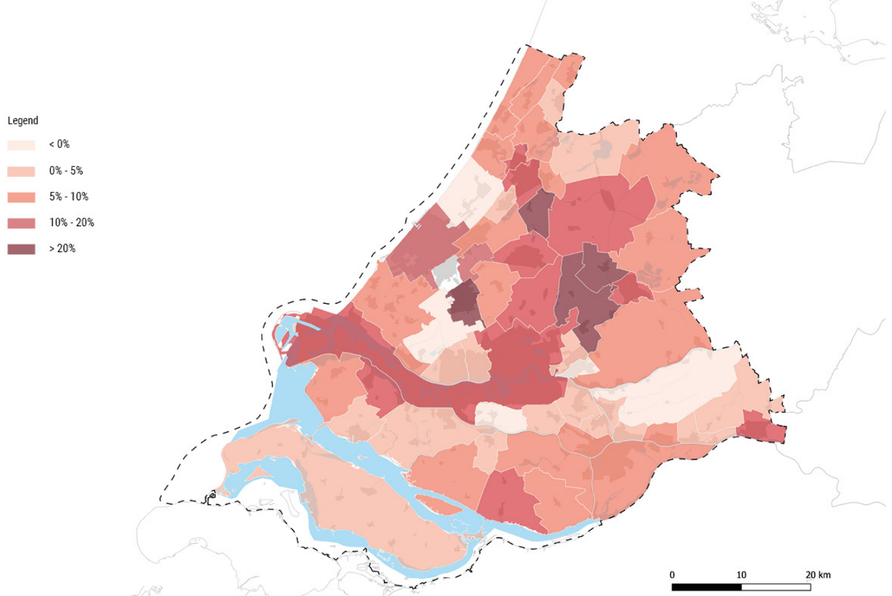
But housing is not the only thing taking up space in the province. There should also be enough space kept available for the transition to renewable energy. This cannot be done at a singular location in the province. On different scales, space for the energy transition should be available.

Furthermore, a competition between urban and rural development is going on. Currently, 48% of provincial land surface is agrifood sector while contributing to less than 5% of the Dutch economy (Drift Metabolic, 2018). The expansion of especially greenhouse horticulture is colliding with the borders of several cities. The housing stress which these cities are facing further emphasizes the need to develop highly efficient and agricultural methods that are sustainable and less demanding of space.

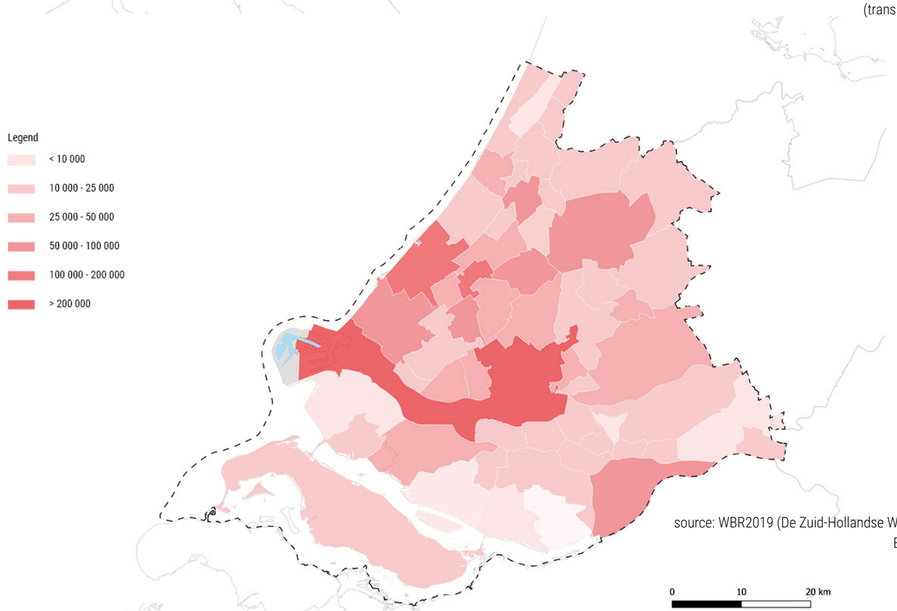
The extent of the new space claims on the landscape can only be indicated approximately. After all, there are several alternatives for accommodating these claims (e.g., urban densification, offshore wind energy production). These alternatives are subject to political decision-making, in which not only costs and benefits are considered, but public support is also considered. However, the consequences of these alternatives for the existing landscape are not always included in the decision-making process.New claims on space, such as for energy and climate adaptation, but also for urbanization and nature, require new considerations and choices at various levels of government about fitting in with the landscape and combining it with existing land-use functions. These considerations may differ per landscape and therefore per region. Municipalities, regions, provinces, and the State are faced with a common task to think about a sustainable spatial fitting-in of these space claims, considering the existing qualities of the present landscape or striving for new qualities of the envisaged landscape. (van Dam, Tisma & Diederiks, 2019)

Depending on the choices the province makes, the development of South Holland can vary greatly. If the province gives living and working all the space it needs, the green character of this densely populated region will further diminish everywhere. In the scenarios where great importance is attached to the protection of nature, landscape, and water, it appears that the province is too small to meet all space claims. (van Dam, Pols & Elzenga, 2019)

Overall, there is an enormous pressure on space. The province does not want to expand its borders; therefore, tactical land-use changes should be made. The edges of the cities, often deprived by other circumstances, are ideal locations to tackle the housing shortage, address socio-spatial inequalities and bring agriculture and the city closer together at the same time.



source: PBL/CBS regionale bevolkings- en huishoudensprognose 2019
(translated by authors, 2021)



source: WBR2019 (De Zuid-Hollandse Woningbehoefteraming),
Edited by authors, 2021

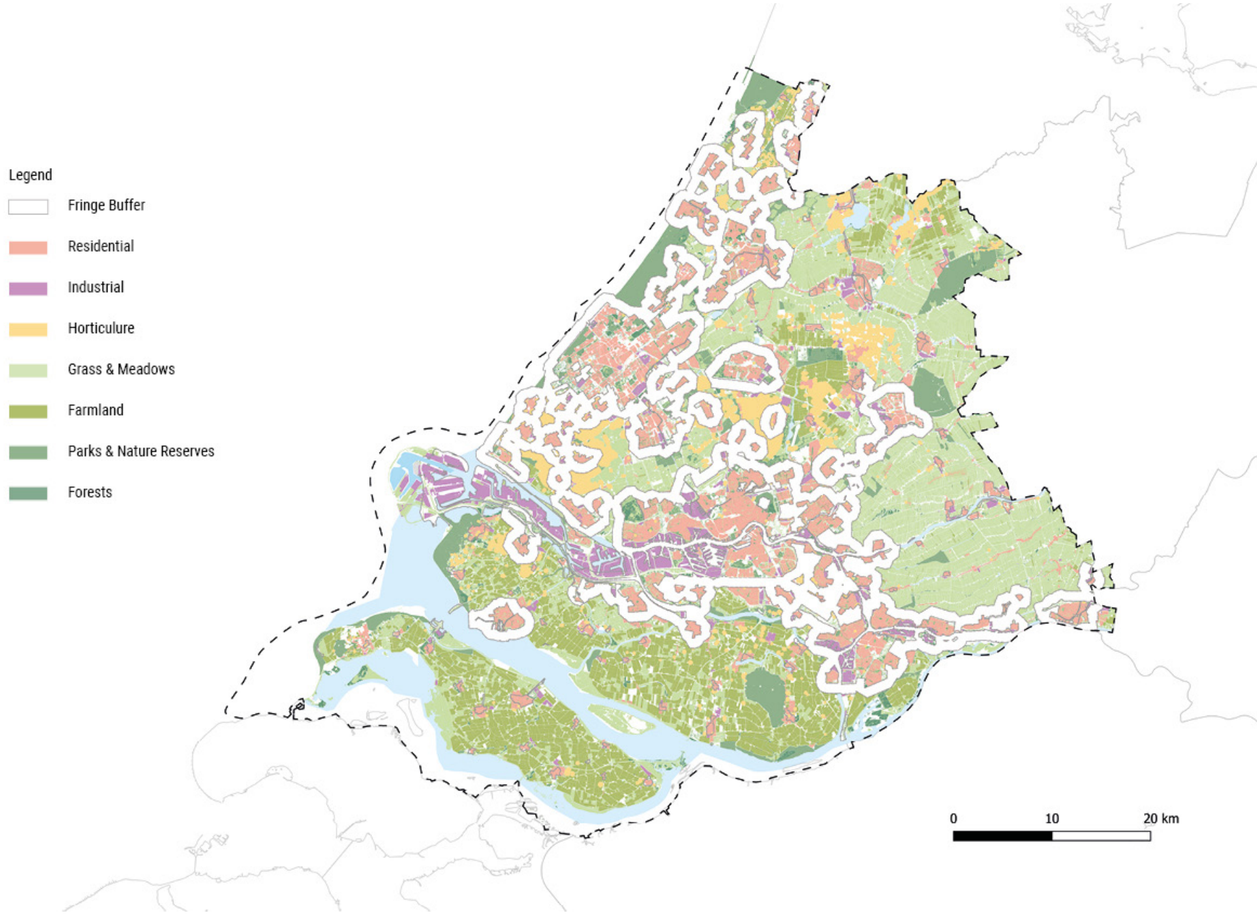
Synthesis: re-activating the fringe

The previous analysis of several subjects relevant in South Holland have revealed different urgencies. Monoculture, the lack of biodiversity, the current linear system, environmental pressure, socio-spatial inequality, the housing shortage. They are all highly in need of synchronized change, these urgencies should be faced simultaneously and should not be seen and treated as separate problems. Nature inclusive agriculture in the fringe could function as a catalyst for other essential change.

A lot of the previous analysis has, in some way, been related to the fringes of the cities. The problem is that the potential of the fringe is underestimated, and they are generally overlooked. But these fringes are situated in varying locations with diverse characteristics. These characteristics are often approximately described by the land use they are surrounded by, but especially the land use that takes place within the fringes. The fringes are generated by buffering a 1000-meter zone around the (urban) built-up areas in South Holland. The land use around the fringes has been mapped to give a first insight into what types of fringes there could be. Distinctions have been made between residential areas, industrial areas, horticulture, grass (& meadows), farmland, parks (& nature reserves) and forests. The differing types of land use come with their own advantages and disadvantages. Combinations of these functions within the fringe could increase its value.

Goals for energy transition, agriculture, urbanization, climate adaptation and biodiversity require interventions that can often be combined well at the fringe level. Combining functions leads to multiple use of space and thus to space savings and can lead to a landscape that is considered more beautiful. The national program 'Ruimte voor de Rivier' (Room for the River) has proven that this is possible: it combines national water safety objectives with objectives for nature, landscape, and recreation. Stimulating multiple use of space and combining functions can be done by imposing requirements on the area design of the intended layout of the area. (Bouwman, Kuiper & Tijbosch, 2006)

The task of urbanization is complicated. Not only must space be found for new residential areas, workplaces and infrastructure - preferably within the contours of the existing city, but the search will also have to be linked to the tasks of climate adaptation and the promotion of a healthy and pleasant living environment. A lot of these problems meet in the fringes. Making the city climate proof and keeping it liveable and attractive requires more space for water and greenery in and around the city. Preservation, restoration and development of nature and biodiversity can be linked to urban development and climate adaptation. The challenge of urbanization thus implies more compact construction and densification of existing cities as well as the creation of new functional and physical green-blue links between the city, urban periphery, surrounding areas, the natural network, and the water system. (Van Dam, Pols & Elzenga, 2019)



source: OpenStreetMap & Wageningen Environmental Research, Edited by authors, 2021

3

Vision

Guiding principles & SDG’s
Nature Inclusive Agriculture
Fringes
Knowledge exchange
Co-creation & participation

Guiding principles & SDG's

source: authors own (2021)

Adressed Sustainable Development Goals (SDG's)
source: United Nations, edited by authors (2021)

The vision shows a clear and coherent overview of all the different espects that are being taken into account. Moreover the vision goals are based upon the Sustainable Development Goals (SDG) defined by the United Nations (UN). We'll adress how and which SDG's are translated to the vision goals we defined for a nature inclusive agrifood sector.

The first vision goal which focusses on closing material flows relates to SDG 12 about responsible consumption & production and SDG 17 about strong partnerships. To ensure that waste flows are changed to interesting resources, strong partnerships are neccessary.

The second vision goals which focusses on sustainable energy relates to SDG 7 about affordable and clean energy, SDG 12 mainly to change from fossil fuels to renewable energy sources and SDG 13 to combat climate change. The use of fossil fuels does not happen anymore in the future agrifood sector.

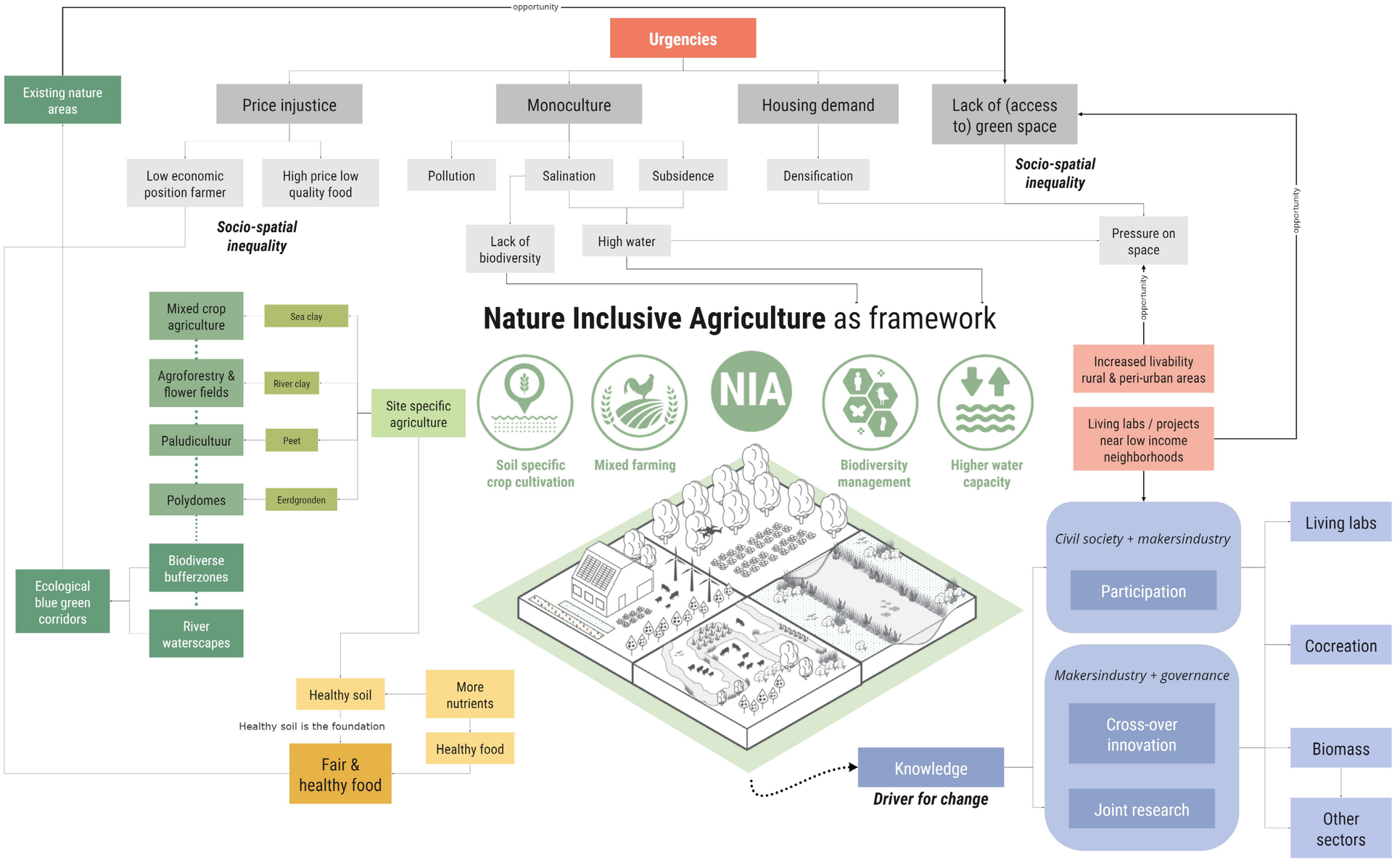
The third vision goal which focusses on resilient water management relates to SDG 13 to combat climate change, SDG 6 & SDG 14 to stop and prevent water quality pollution, inparticulair caused land-based activities such as the Port of Rotterdam and the many livestock farms.

The fourth vision goal which focusses on nature inclusivity relates to SDG 3 to stop illnesses from polluted area's, SDG 11 to also improve nature inclusivity in the future development of cities, SDG 13 to combat climate change, SDG 14 to increase the life below waterlevels and SDG 15 to stop the decline in biodiversity.

The fifth vision goal which focusses on accessible & tangible knowledge relates to SDG 4 about equal opportunities to education, SDG 8 about sustainable economic growth and SDG 10 to reduce inequality.

The sixth vision goal which focusses on an active civil society relates to SDG 5 to reduce gender inequality and SDG 16 to promote inclusive societies

The seventh vision goal which focuses on affordable food relates to SDG 2 about affordable and healthy food, SDG 8 about sustainable economic growth, SDG 10 to reduce inequality and SDG 12 about responsible consumption & production.



source: authors own (2021)

What is Nature Inclusive Agriculture?

Nature Inclusive Agriculture (NIA) as part of the conceptual framework has been explained in the 1st chapter of this report. In this project NIA is an overarching framework providing many solutions to several pressing socio-economic and environmental issues. According to Wageningen University & Research (2019) the definition of Nature inclusive farming is as follows: ""Nature inclusive farming is a form of circular agriculture that utilises and protects the biodiversity on and around the farm. It produces food within the boundaries of nature, the environment and the living space."

Biodiversity management

At the basis of a resilient agrifood system is biodiversity. Biodiversity refers to all the variety of life within species, between species and between the ecosystems to which they belong (CLO, 2017). It is essential for the management of an agricultural business. Applied on multiple scales it provides a wide variety of ecosystem services, such as the control of natural pests and diseases, pollination, water supply and purification, natural soil fertility, a good soil structure, and habitat functions (Van Doorn et al., 2016), enhancing the resilience of our food system (WUR, 2021). For nature-inclusive agriculture, it is important that there is a link between agricultural biodiversity (agrobiodiversity) and natural values, such as landscape and specific target species (Erisman et al., 2017). This means increasing biodiversity in the farmland enhances the perception and attractiveness of the agricultural landscape and also gives the farmer more appreciation from his surroundings (WUR, 2019). The application of the nature-inclusive agriculture system, as is explained in the coming sections, creates favourable conditions for farmland birds. With less use of crop protection chemicals and more diverse crops, the position of the bee - the bee populations are currently in danger - will be strengthened. This is of great importance since bees are indispensable for pollination of food crops.

source: WUR (2019)

Healthy soil-water system

A healthy, naturally functioning soil-water system is the basis for nature-inclusive agriculture and in the end obtaining healthy products. Organic matter in the soil provides nutrients for crops, retains and supplies sufficient water (sponge effect), and gives the soil a rich soil life. A healthy soil is also able to capture carbon in the ground (Erisman et al., 2017; WUR, 2019). In order to compensate for the natural decomposition of organic matter, other natural fertilizers can be used to enhance soil capacity and health, such as solid manure, crop residues and compost (WUR, 2019).

In addition, it is important to use lighter machinery to ensure a minimum tillage of the surface. In this way organic matter is broken down less quickly and the soil structure keeps intact. Therefore the soil has a better capacity to regulate the moisture balance and to ensure enough supply of oxygen. Crops then develop a better root system, absorbing more water and nutrients (WUR, 2019). However, without a good water system, a balanced agro biodiverse ecosystem cannot be achieved. Sufficient and clean water should at all times be ensured. Ground water storage, dynamic (ground)water level management, including customised irrigation, is key. The extreme environmental effects of climate change and its damaging effect on crops, such as drought or heavy rainfalls, can resiliently be managed with this water system. It also prevents surface run-off of valuable nutrients. The capacity for a higher groundwater level is especially important for the peat meadows to prevent peat oxidation and subsidence (WUR, 2019). In addition to this water system, a wider cultivation plan with mixed crops also enhances the quality of the soil-water system, as is discussed in the next paragraph. To conclude, in line with our vision goals: In 2050 nature inclusivity strengthens local biodiversity, soil health and livability. The water management system is resilient to climate change and usage is minimized or even refused.

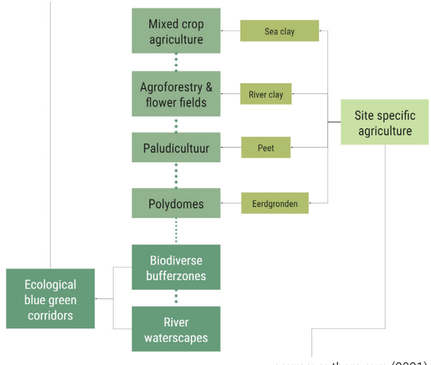
Soil based farming

Soil specific mixed crop cultivation

Nature-inclusive agriculture is based on a greater variety of crops and animals, and promotes land-use that is adapted to the natural conditions. The South of Holland has a few characteristic soil types, each resulting in specific environmental issues that have to be tackled. Therefore this project promotes to implement NIA that is specific to the natural conditions. A wider cultivation plan is crucial for all types. Below the four most common types in the province are discussed.

Sea clay: mixed-crop agriculture

By far the largest part of the soil in the province consists of sea clay. These soils are very fertile. They are currently intensively used, especially for arable farming. In order to change this landscape the implementation of smart combinations of different crops one field (mixed or in strips) is essential. There is also room for diverse arable field edges, winter food plots and natural meadows to calm the soil and increase biodiversity. This way nutrients are better used and crops catch more light, and useful organisms get more space and suppress harmful organisms. More diversity in crops literally leads to more diversity in organisms (biodiversity). The use of artificial fertilisers and crop protection products decreases. There is more space for nature in the landscape, due to strips of land along ditches and waterways and overhangs, and has great potential for meandering pathways for cyclists and pedestrians (WUR, 2019).



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River clay: agroforestry and flower fields

River clay can mostly be found around the meandering rivers in the South of Holland. It is a diverse landscape, since it is common to cultivate trees and fruits on river banks and floodplains. The lower wetter clay grounds are mostly used for livestock farming as well as sometimes for arable farming. The key to incorporate more nature-inclusive agriculture in these areas in the province lies in the development of more diverse and robust systems based on agroforestry and flower fields. Then again a mix of diverse crops is crucial. In this case, a mix of fruit or nut trees is beneficial. The cultivation plan can also include trees and woody plants that can offer year-round shelter for animals. Overhangs and strips along the orchard can be used for herb- and flower vegetation to attract insects. This way of farming can also well be combined with stray chickens that help eat weeds and harmful insects, fallen fruits or leaves and keep the grass short (WUR, 2019). Cows that can be used for both dairy and meat can graze on the herb-rich meadows along the river-bank areas. The grazing of this natural fodder is beneficial for the health of the cattle. Beside this, the income of the farmer becomes more stable due to the cultivation of both agroforestry, herb-rich meadow, and dairy and milk production (WUR, 2019).

In recent years, more space for the river and nature has already been created on the floodplains. Various forms of nature-inclusive livestock farming can already be found (WUR, 2019). This can be a trigger to enhance the nature inclusive agriculture for site specific farming in these areas in the near future.

Peet: paludicultuur

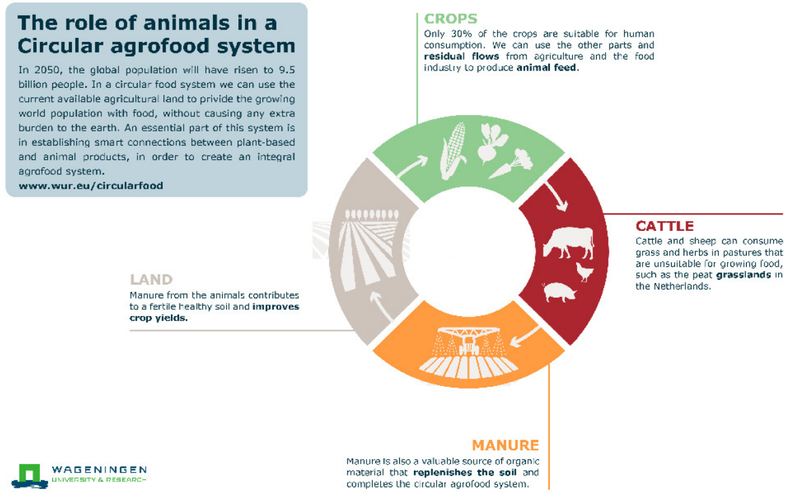
The peat meadows in the province are characterised by often parallel parcelling of land separated by wide ditches. The land is currently often used as grazing land for the livestock sector. This soil type also deals with specific environmental pressures, such as subsidence and the release of greenhouse gases through oxidation. To transition this landscape into nature inclusive agriculture that is suitable for peat meadows, it is important to implement integrated water management combined with adapted grassland. Higher

groundwater levels are reached through (temporary) technical support such as underwater drainage. In places where the soil becomes too wet, the farmer can switch to wet crop cultivation. This is called 'paludicultuur'. The banks of ditches have potential to be designed and managed in a nature-friendly way, offering nest and breeding places for meadow birds (WUR, 2019).

Eerdgronden: polydomes

The so-called Eerdgronden in the South of Holland are mainly used for the greenhouse horticulture sector in Westland and Boskoop. These areas are characterized by dense built-up areas of glasshouses with small ditches in between, alternating with small sized urban cores. The amount of paved areas results in a low infiltration level of the ground. In addition, the greenhouses need enormous amounts of water (Drift Metabolic, 2018), resulting in low groundwater levels and the dehydration of the soil.

Polydomes are a nature-inclusive alternative for the current typical greenhouses. In a polydome the cultivation methods are based on polycultures. This means that there are different crop types present in one greenhouse. The waste from one crop can be food for other crops, based on the waste-to-value principle (source). The crops can be combined with mushrooms and if possible also fish and chickens. The mushrooms produce CO2 and heat contributing to the growth of greenhouse crops. The excrements of fish and chickens can be used as manure. The combination of fish farming with vegetable or herb farming is called Aquaponics. Micro-organisms can convert the fish excrements into nutrients for the plants. In turn, the plants purify the water for the fish (Smits & Linderhof, 2015).



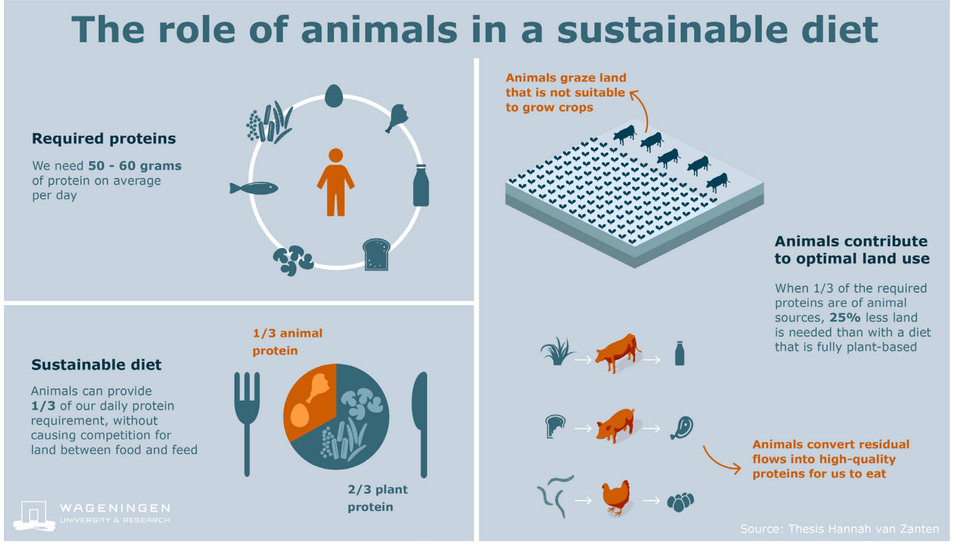
source: WUR (z.d.)

Ecological blue green corridors

The previous sections show that a nature-inclusive landscape will be much more diverse. In addition to the redevelopment of soil specific agricultural areas, the new landscape offers great opportunities to connect nature-inclusive farmlands with existing natural areas. Connecting zones with for example Natuur Netwerk Nederland (NNN) could enhance landscape quality and biodiversity (Erisman et al., 2017). The Province of South Holland has a unique delta landscape that offers large scale green-blue structures, most of it part of NNN. Examples are the coastal landscape with dunes, and several National Parks within the region with protected landscapes. These areas are attractive for recreation and sporting activities, and could be part green-blue structures that are connected with the NIA farmlands. These structures could even be linked on a small-scale inside and around cities (Provincie Zuid Holland, 2018).

Diet and healthy food

In order to decrease the environmental burden on our planet, it is important to balance and establish connections between plant-based and animal products. Animals have the ability to convert residual flows that people cannot digest into protein-rich food. According to research conducted by Wageningen University & Research (n.d.) the most sustainable diet in a circular agrofood system contains about 20 grams of animal protein per day. This is in line with the NIA system, where in most areas diverse crops are combined with animals. In the left image from WUR the role of animals in a Circular agrofood system is visible. The right image from WUR shows that 25% less land is needed than with a diet that is fully plant-based.



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Vision statement

In 2050 the agrifood sector is **100% nature inclusive.** The current linear extract-manufacture-waste model has been transitioned into an **integrated, collaborative, and circular agrifood system**. The fringes between cities and peri-urban areas are re-activated with knowledge as main driver of change. Everyone has a **right to healthy and accessible food.**

Our vision statement is that: In 2050 the energy demand is supplied by 100% renewable energy. In the transition, alternative non-fossil fuel energy sources are needed.

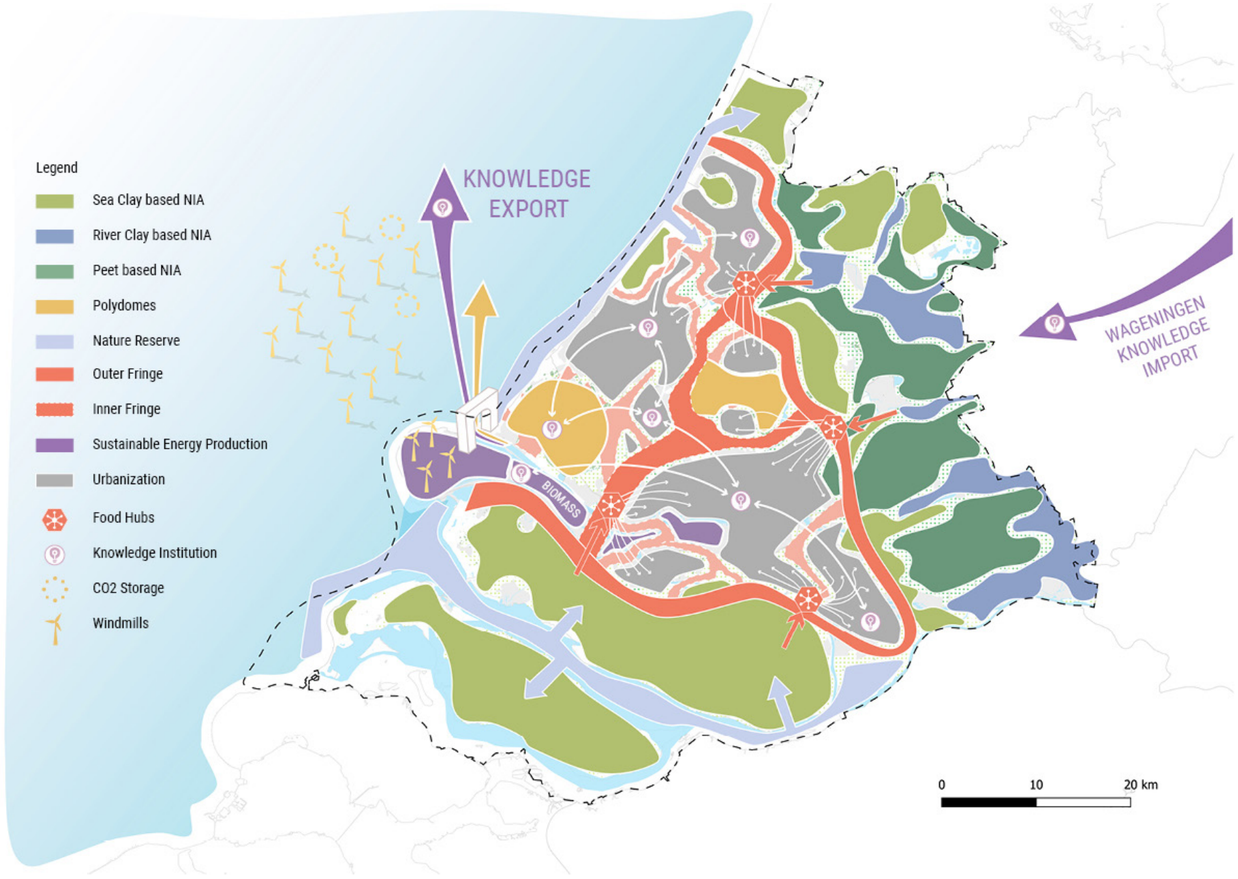
We based our vision on several urgencies which we see as the most significant ones. The agrifood sector in South Holland accounts for 48% of landmass, contributes to 20% of GHG emissions, consumes 67% of fresh water, while employing approximately 10% of its labor force. Besides this, South Holland faces several challenges: the need to build 240.000 houses, inequality, subsidence, and the lack of biodiversity. The demand on space is enormous and the monoculture landscapes needs to change dramatically. Nature inclusive agriculture that is site specific has a great number of benefits to its socio-economic environment: the agrifood sector becomes more resilient, the soil healthier, the peri-urban and rural areas will be more accessible and attractive, and the food chains will be shortened, more local and more just.

The food chain is significantly shorter because the fringes (Territories in Between) are the backbone for locating regional food hubs and waste sorting facilities, and to enable a smooth transition from urban to rural areas. This way the current linear extract-manufacture-waste model is transitioned into an integrated, collaborative, and circular agrifood system. This change can only happen with bottom-up innovation, where knowledge is the main driver for transition. Joint research in the makers-industry and local initiatives, such as co-creation farms or local participation projects, enable both small scale change and awareness amongst stakeholders. Social justice is reached through a better economic position of farmers and more just food-chain with fairer pricing: everyone has a right to healthy and accessible food, when we transition towards a 100% nature inclusive agrifood sector in 2050.

The vision map shows where we want to locate different types of agriculture. Our vision is to link the type of agriculture to the soil on which it takes place and therefore facilitate 'soil-based nature inclusive agriculture'. The map also gives a rough estimate of the overall locations of fringes, and the urbanization within them. The knowledge network is also shown, which appears as connections between relevant knowledge institutions and the import of knowledge from the Wageningen University. The other arrow, going out of the province, shows the focus on knowledge export rather than other contemporary export flows.

The current and future wind energy production is shown in our vision map. Additionally, to join the vision of the port towards their transition towards renewable energy, we propose the creation of a biomass hub where currently most of the fossil fuel production is situated. Also, we propose the continuation and expansion of C02 capturing and storage projects.

Lastly, several tactically located food hubs within the fringes are proposed. The locations we propose are close to different types of infrastructure and focus their distribution of certain specific urban areas. The food hubs are further explained in the circular flows section.



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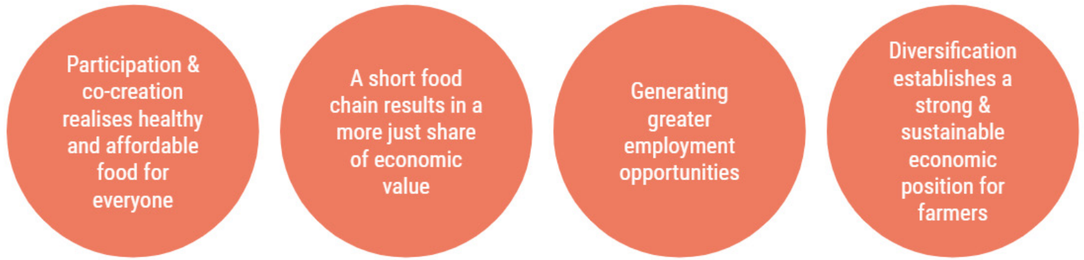
Re-activating the fringe

The fringes are the spatial focal point of our vision. Therefore, the reactivation of those fringes is essential. With reactivation we mean to use the spatial values that the fringe has. The fringes should function as valuable connections between the urban and rural areas instead of as blockages. The link between built and open spaces can be of great value for urban residents. Ultimately, their usage of these fringe areas in various ways is the reactivation. The planning of this usage, and therefore what kind of specific activities take place in the fringes are of utmost importance. The fringe areas share common denominators but are spatially, functionally, and demographically diverse. Appropriate spatial planning for these locations should be formulated very precisely and needs to be built on a careful analysis of the characteristics in the specific fringe. (Wandl, 2014)

Farmers, or agricultural businesses, are a vital part of the businesses that should be present in these fringes. Bringing the urban and rural areas together in the fringe also means that the distance between the consumer/citizen and the farmer shortens. There is currently more of a division between them then a connection. This is because of urbanization, a reduction of the agricultural working population and a great pressure that has been put on the living environment because of cost reductions and production increases in the agricultural industry. This division has caused the citizens to know rather little to nothing about the origins of their food, and the farmers to feel undervalued and not appreciated for their essential contribution to cities (Ministry of Agriculture, Nature and Food Quality, 2018). Caring for nature goes hand in hand with caring for the landscape. A healthy living environment for all is attractive for living, working and recreation in the area. The landscape is made accessible to local residents and recreationists by means of cycle paths and walkways, nature trails and clog paths.

For productive land usage in the fringes, but also to facilitate activities for residents in the fringes (next to public parks), productive and participatory (agricultural) businesses should be present. Depending on certain criteria, such businesses do sometimes settle in fringes. Their presence in fringes is of great value for local residents. The residents not only benefit from the green open spaces that nature inclusive agriculture brings, but also from the direct connection to healthy food. The amount of food that can be produced is obviously only for a small percentage of cities. We would like to locate and connect this fringe agriculture to neighborhoods with currently less access to healthy and affordable food.



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Circular material flows

The Province of Zuid-Holland therefore has major ambitions to accelerate the transition to a circular economy in South Holland. For example, it is a co-signatory of the Agreement on Raw Materials, supports various networks in the region around circularity, and has recently launched the 'ACCEZ' transition campus for cooperation between the government, business, and science. However, the province does not have a specific policy and implementation program to achieve its objectives regarding the transition to a circular economy. (Drift, 2018)

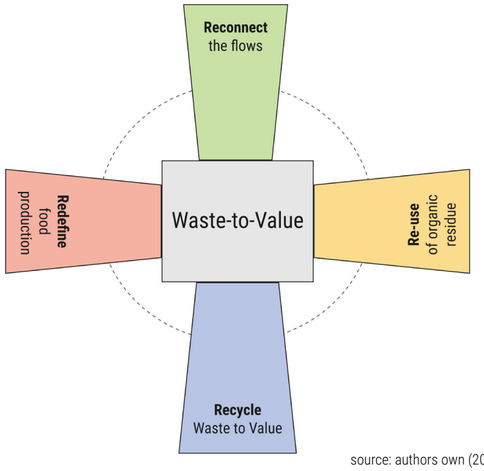
Our vision states that in 2050 food is healthy and affordable. Producers enjoy a valued and resilient business model; the production chains are short and material flows are closed with possible participation of other sectors. To achieve this, things need to change. Instead of constantly reducing the cost of products, we need to focus on constantly reducing the use of raw materials through a more efficient use within cycles.

This shift is possible. It requires us to change the current system by working towards circular agriculture as the ecologically and economically vital, prevalent production method. This production method must be based on the economic strength of collaboration between parties in the agricultural sector and on support and trust from civil society organizations. Food safety naturally remains the key priority. The current supply chain – with a beginning, an end, and leaks within the chain – needs to be transformed into a system with minimal unnecessary losses. This will make farming, horticulture, and fisheries part of a circular food system. (Ministerie Landbouw, Natuur en Voedselkwaliteit, 2018)

Transitioning into a complete circular economy is a very complex challenge, we cannot consider all aspects. Agriculture plays an essential part role in the transition towards the circular economy. *"The soil forms the basis for circular agriculture. Soil management is a reciprocal process: human activity removes minerals and water from the soil for production and feeds the soil with organic materials, water and nutrients to maintain growing power."* (Ministerie Landbouw, Natuur en Voedselkwaliteit, 2018)

We focus on circular material flows in agriculture and what it could contribute to the circular economy. A waste to value system could help with this transition. In order for an efficient waste to value system to work, food production should be redefined, flows should be reconnected, organic residue should be re-used, and waste should be recycled.

The flow diagram visualizes a nature inclusive circular model and what connections should/could be made between sectors. It introduces the food and biomass hub as essentials parts of the model. The food hubs functions as distribution location that shorten the step between the farmer and consumer. The farm to plate concept can be reinforced by them. The biomass hub can be ad additional part of the waste to value process by processing waste flows that were previously linear. Their processed waste can subsequently be brought back to various other sectors for differing purposes. This is still in development so their collaboration with the knowledge sector is also of importance. The section shows how these flows would spatially look like.



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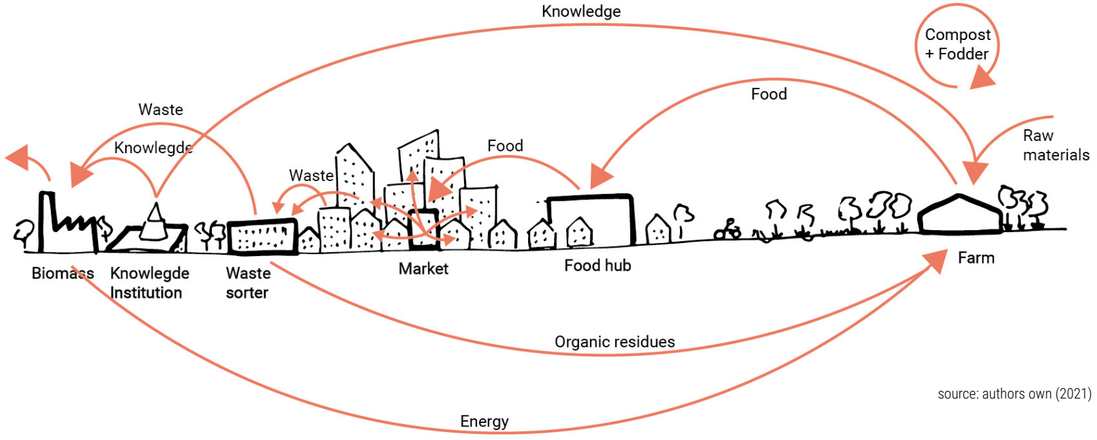

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Knowledge exchange

Knowledge as driver of change

Knowledge, innovation and social embedding are crucial in order to change the agrifood sector towards a circular and nature-inclusive system. The innovative businesses of the local Makers Industry are the pioneers of this transition, testing, developing and implementing new circular techniques (Provincie Zuid Holland, 2019 - samen versnellen). Within the agrifood sector there is already a lot of experience with efficient and technologically advanced production methods. Well-developed entrepreneurship, highly valued research and education institutions, and a strong willingness to work together offer great opportunities to steer the necessary change (Ministerie Landbouw, Natuur en Voedselkwaliteit, 2018). Knowledge is therefore the driver for change in this vision. Thus: in 2050 knowledge is accessible & tangible and drives national and global innovation.

Knowledge export

The province of South Holland already helds a prestigious position in agrifood around the world (Drift Metabolic, 2018). The province also has two important horticulture areas, part of the Dutch Greenports: Westland and Boskoop. Various companies and organisations work together here to develop innovation concepts that guarantee the security of food, sustainable energy and effective water management (Westlandhortibusiness, n.d.). However, as discussed in the chapter 'Environmental Issues', the agrifood sector also has a negative impact on the environment. Therefore in this project's vision knowledge will be the main export products. This will give other farmers around the world an opportunity to implement this knowledge themselves in that specific environment. This allows them a better economic position through generating more income (Bélanger & Pilling, 2019). In addition, this indirectly results in the Netherlands decreasing the environmental impact of the agrifood sector around the world.

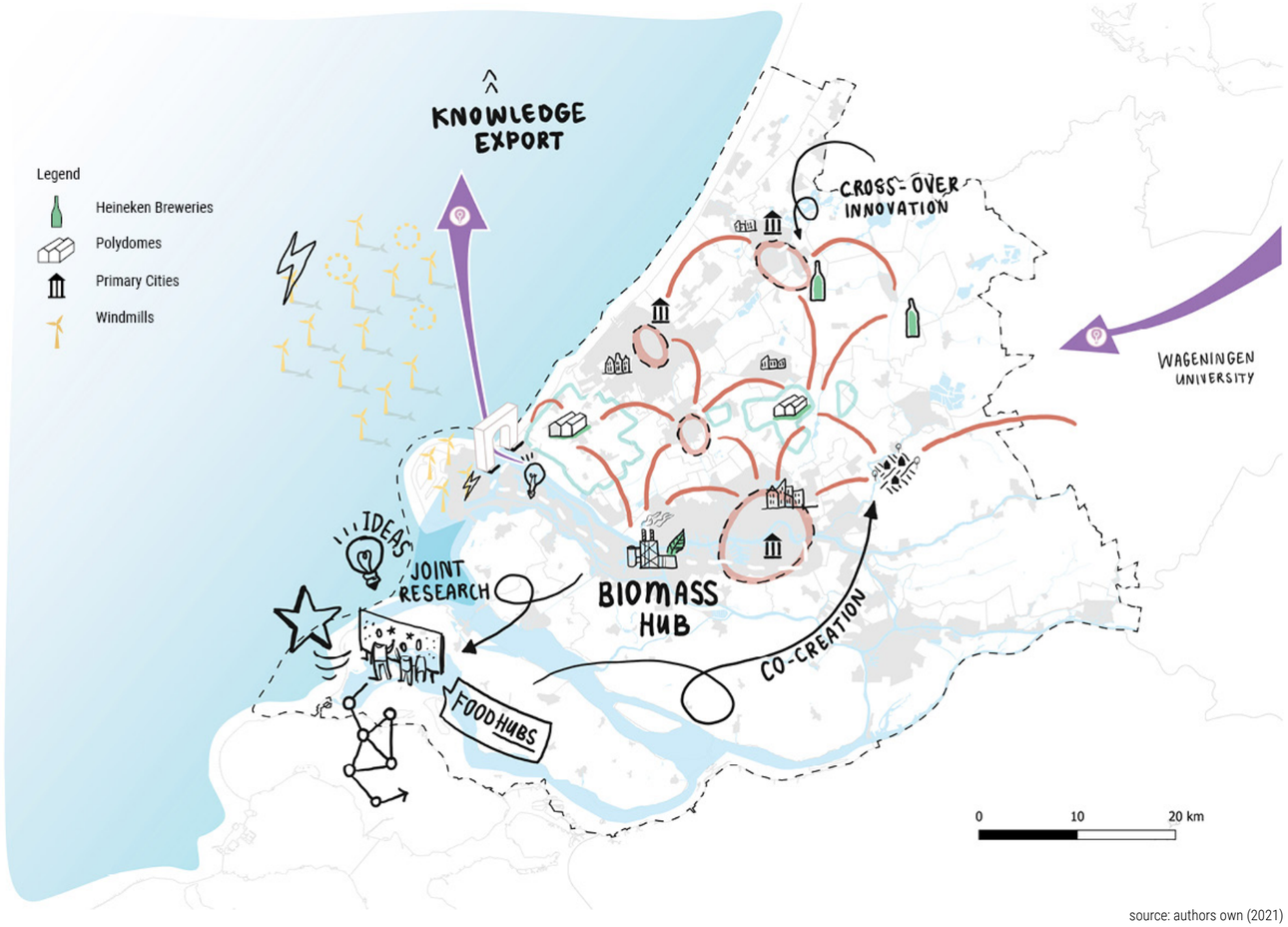
Cross-over innovation & joint research

Knowledge networks

In order to stimulate new chain cooperation and innovation within different (overlapping) sectors, it is crucial to build upon existing knowledge networks and to stimulate new knowledge transfer. The Province of South Holland set out a few actions in their report 'Circulair Samen Versnellen' to boost existing new networks and chain cooperations. As part of this they also aim to connect different stakeholders, such as environmental services, water boards, municipalities, the business community, knowledge institutions and social partners (Provincie Zuid Holland, 2019). Besides this, there are already numerous fast-growing partnerships in the agrifood sector working towards a more sustainable and circular sector (Ministerie Landbouw, Natuur en Voedselkwaliteit, 2018). This project therefore aims to link innovation and knowledge from different sectors resulting in cross-over innovation and joint research, based on these knowledge networks.

The role of knowledge institutions and educational institutions

Part of these knowledge networks are also often knowledge and educational institutions. As can be seen on the map on the right, the South of Holland contains numerous high qualitative knowledge institutions, such as the Technical University in Delft, the Erasmus University in Rotterdam, and the University of Leiden. Additionally, the region offers numerous colleges and numerous smaller schools. Some of them are even specialized in sustainability or agriculture, or in (social) justice (Den Haag-Leiden). Wageningen University & Research is not situated in the province itself, but offers a great amount of leading research and education about climate change, biodiversity, feeding the world, circular economy and healthy food & living (WUR, n.d.-b). These knowledge institutions already work together with other organisations and entrepreneurs in the province to generate new ideas and spread knowledge resulting in cross-over research. However, this knowledge is not always tangible or practical for farmers. Research from Louis Bolk Instituut in cooperation with Wageningen University & Research (2017) demonstrates that for farmers working with biodiversity in nature-inclusive agriculture requires different knowledge, techniques and monitoring from the company. Experience in practice is key to require this knowledge. So-called 'pioneering companies' are essential in demonstrating which approaches are effective. This reveals the importance of tangible knowledge in the transition towards a nature-inclusive food system (Erisman et al., 2017). Nature-inclusive Living Labs in strategic locations can help farmers and local residents to share this type of knowledge (see Rotterdam Fringe, chapter 4).



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Co-creation & participation

The role of civil society

In our vision, civil society plays an active role by co-creation and participation in 2050. For agricultural innovations to respond better to local challenges, co-creation through participatory processes is very important (FAO, n.d.). As mentioned before, knowledge should be accessible and tangible in order to achieve this. First of all, stimulating awareness about food production and waste is important when trying to let civil society participate in the transition. In addition, social values, culture and food traditions are context-specific (Bélanger & Pilling, 2019). Therefore civil society has an important role in steering change into the right direction. Citizens are in this way part of civil society via formal and informal institutions, where they associate around common objectives. When civil society engages the process of change can incorporate possible downsides, ethical issues and social implications (Rocco, 2021a). Social justice in that sense can then better be achieved through interaction with each other.

Relation with the fringe

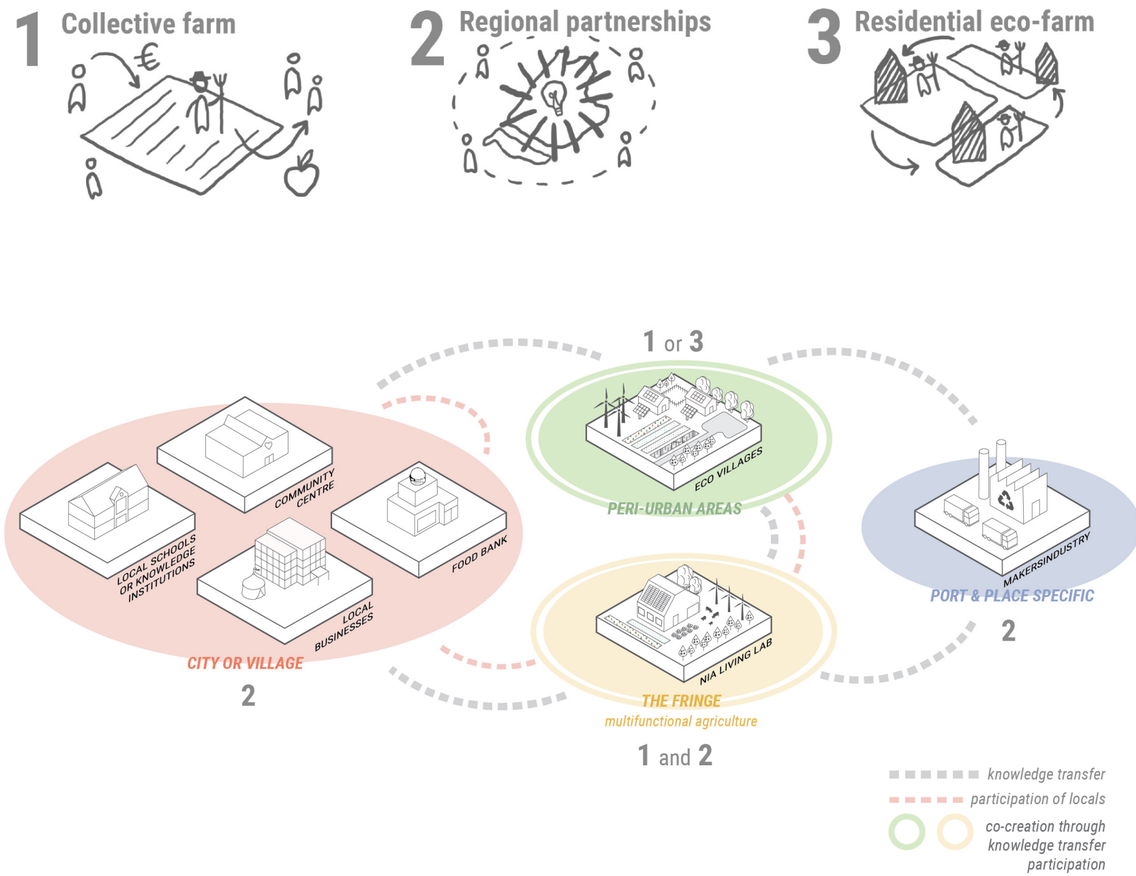
In our vision the fringes are re-activated through implementation of nature-inclusive agriculture to create a healthy environment for local residents, to enhance food awareness and to localize food flows. As can be seen on the image on the right, the fringe plays a key role in co-creating through knowledge transfer and participation. Depending on the type of fringe (see chapter 4), this area between peri-urban land and city houses a variety of functions that are closely interrelated with city function, peri-urban and port areas. Between all 4 areas in the image knowledge transfer is possible and even more so needed to embed change. Participation of local residents takes place on several levels. For example local residents participate in the agrifood sector through bringing food to the food bank or hosting food awareness events in the community centre. This allows for a growing responsibility and awareness over food and health in neighborhoods where this is desired. Residents can also participate in different farming concepts, or civil society can participate in regional partnerships, as explained in the next paragraph.

Three typical applications of co-creation or participation concepts within farms

A collective farm: There are already several collective farms emerging around the country. Local residents can become a member through paying a one-time fee or monthly contribution to the farm. In return they receive fresh healthy vegetables, dairy or meat. In this way, the farmer can be employed fulltime and can be motivated to transition towards nature inclusive farming methods with an income promise. Members are not required to help on the farm. However, helping and organizing events can become part of the community that emerges from the collective (Wijnants, 2021). These types of farms are perfect to locate within the fringe to steer transition towards nature-inclusive farming on larger scales.

Residential eco farm: this idea is based on the development of 'Oosterwold' in Southern Flevoland as mentioned in the research of Wijnants (2021) about the Future of Countryside Living. In this specific project agriculture is combined with nature-inclusive living in peri-urban areas. In Oosterwolde future residents can to a certain extent freely built their own home and living environment, including the construction of public space. However, every plot has to have a surface that is for 59% dedicated to agriculture, and 13% for public green space with 2% water elements. This leaves 18% for the homes and 8% for paved surfaces. In terms of housing needs in the province, densification will mostly take place around city edges. However, these types of residential eco farm locations have potential in the peri-urban areas of the province. Especially since there seems to be a trend due to covid-19 for people to move into more natural rural areas (Wijnants, 2021).

Regional partnerships: according to Wijnants (2021) the third important factor in order to achieve these kinds of collective or residential farms is regional partnerships. Creating partnerships on a regional level can enable the transition. This is also true for the implementation of NIA in general, as discussed in the previous chapter about knowledge. Involving different stakeholders and stimulating engagement is key in this process.



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Strategy

Guiding principles

For the strategy a few guiding principles are proposed, that are based on the values and goals that were proposed in the Vision.

Organic waste to value: as discussed in the Vision, a key element of the circular economy and in nature-inclusive agriculture is the re-introducing waste into the cycle as a new resource. This is possible through the knowledge economy, and directly related to the values of material circularity, and indirectly to renewable energy, since this is part of a circular economy.

Local agrifood network: this is a result of nature-inclusive agriculture, combining material circularity, biodiversity, the use of renewable energy for local production, climate adaptation and a resilient business model for local farmers.

Accessible & tangible knowledge: this guiding principle is of course directly related to the knowledge economy. As described in previous chapters, the need for accessible & tangible knowledge is of great importance in order to transition to a nature-inclusive circular agrifood sector.

Accessible & healthy living environments: access to green and healthy environments is very important to take into account, as described in the conceptual framework. It is directly related to the presence of ecosystem services, such as the values biodiversity and climate adaptation. Access to a healthy living environment as a public good is part of socio(-spatial) justice, as described in the conceptual framework.

Co-creation & participation: this guiding principle is based on the knowledge economy, since co-creation and participation is only possible with enough valuable high level and practical knowledge. Participation directly has a link to social justice, since it addresses the engagement of (local) stakeholders in order to assure the fair distribution of burdens and benefits.

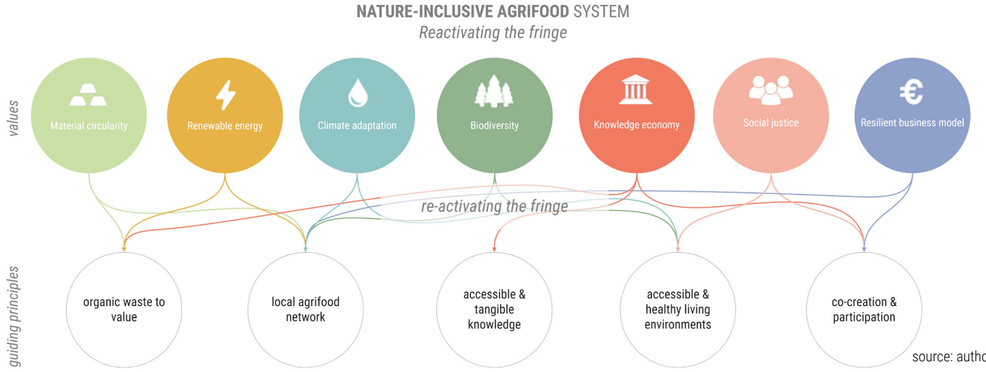
Regional strategy

As touched upon in previous paragraphs, the nature inclusive agriculture that we propose is based on the soil on which it should take place. The regional strategy map shows the types of agriculture according to their corresponding soil type. A distinction is made between; agroforestry and flower fields (based on river clay), wet crop farming (based on peet), mixed crop farming (based on sea clay), polydomes (based on eerdgronden) and mixed types of farming on the remaining soil types. Also, paludi culture is suggested in several places where agriculture takes place in the proximity of rivers or bodies of water.

In the fringes a distinction is made between agriculture, polydomes, densification and green connections. This 'zoning' is mainly based on the current land usage in the fringe. The (demographic) context of the fringe areas is also considered. Meadows, grass fields and current farmlands are proposed to become nature inclusive agriculture areas in the fringe. The polydomes are proposed on the locations where current horticulture is situated. The densification is proposed in areas that are already residential, or in areas that are currently industrial and should be transformed. The placement of the green connection's deviates somewhat from the other fringe functions. Every park that lies in the fringe is proposed to be (part of) a green connection. In some areas we propose additional green connections to ensure the stronger link between the rural and urban areas surrounding the fringes. Also, green fingers are proposed to further extend the green areas into the city.

To sustainably facilitate the energy demand, wind energy production and a biomass hub in the Port of Rotterdam are necessary. The biomass hub will replace the biggest fossil fuel production and become the focal point of sustainable innovation. The location within the port is currently wasted on fossil fuel production. It could be used far more effectively when also using its proximity to Rotterdam to manage the flows coming out of there.

We suggest food hubs in four different fringes in the province of South Holland. The locatiosn are chosen based on their surrounding infrastructure, specified demographic target groups, and potential land use transformations, adapatations or densification surrounding them.



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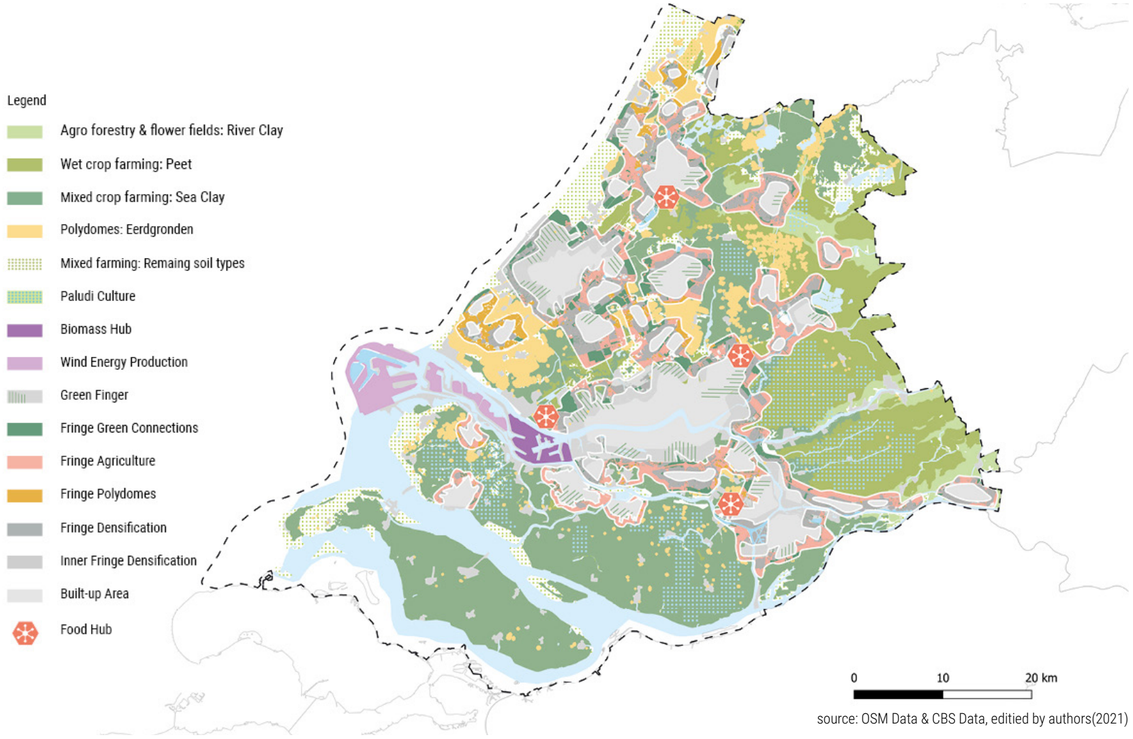

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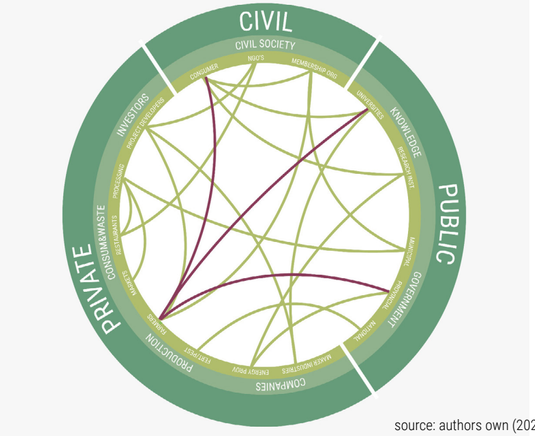
Stakeholder analysis

"The thousands of entrepreneurs in farming, horticulture and fisheries who work hard to bring us our food often do this under difficult economic circumstances. Individual producers tend to have a weak position regarding their large buyers. They incur many risks, ranging from uncertain weather and animal and plant diseases to a volatile market. Farmers, growers, and fishermen are hard-working entrepreneurs, and they deserve a solid and stable position in the supply chain. They should have a good income and the prospect of being able to pass their business on to the next generation. Consumers who know where their food comes from, and therefore have respect for producer and product, can contribute to this process. This will help to reduce waste and to achieve a fairer price for the producers. Short supply chains bring farmers and citizens closer together. A healthy living environment in which farmers and citizens happily coexist remains an important issue as well. Nature is of value to us all, and to agriculture in particular. It can no longer be that nature and agriculture are seen as opposites and that agriculture puts pressure on biodiversity. Nature and agriculture belong together, and this relationship must become stronger and more organic than is currently the case. Agriculture holds an important key to further improvement of natural value in the Netherlands, but the sector can only achieve this if the entire system and all its participants, from farmer to citizen, cooperate." (Ministry of Agriculture, 2018, p.16)

The regional strategy we propose entails that the amount of power or interest of several stakeholders will change. The power-interest matrix shows five movements of stakeholders within the grid. The stakeholders are divided in categories. Our strategy increases the interest of two stakeholders within the business category. The port of Rotterdam and green ports are key players in the transition towards a circular economy. They already have a lot of power but their interest in the transition should be greater as well. In the consumption sector the wholesale traders lose power and waste processors gain interest. To raise awareness, NGO's and activist groups gain power.

But most importantly, in the production category, the farmers should gain power. We want to return power(interest) to the farmer by reducing the number of steps in the value chain of their products. A wider cultivation is typical for NIA. In the long run this is economically beneficial for farmers, since a field



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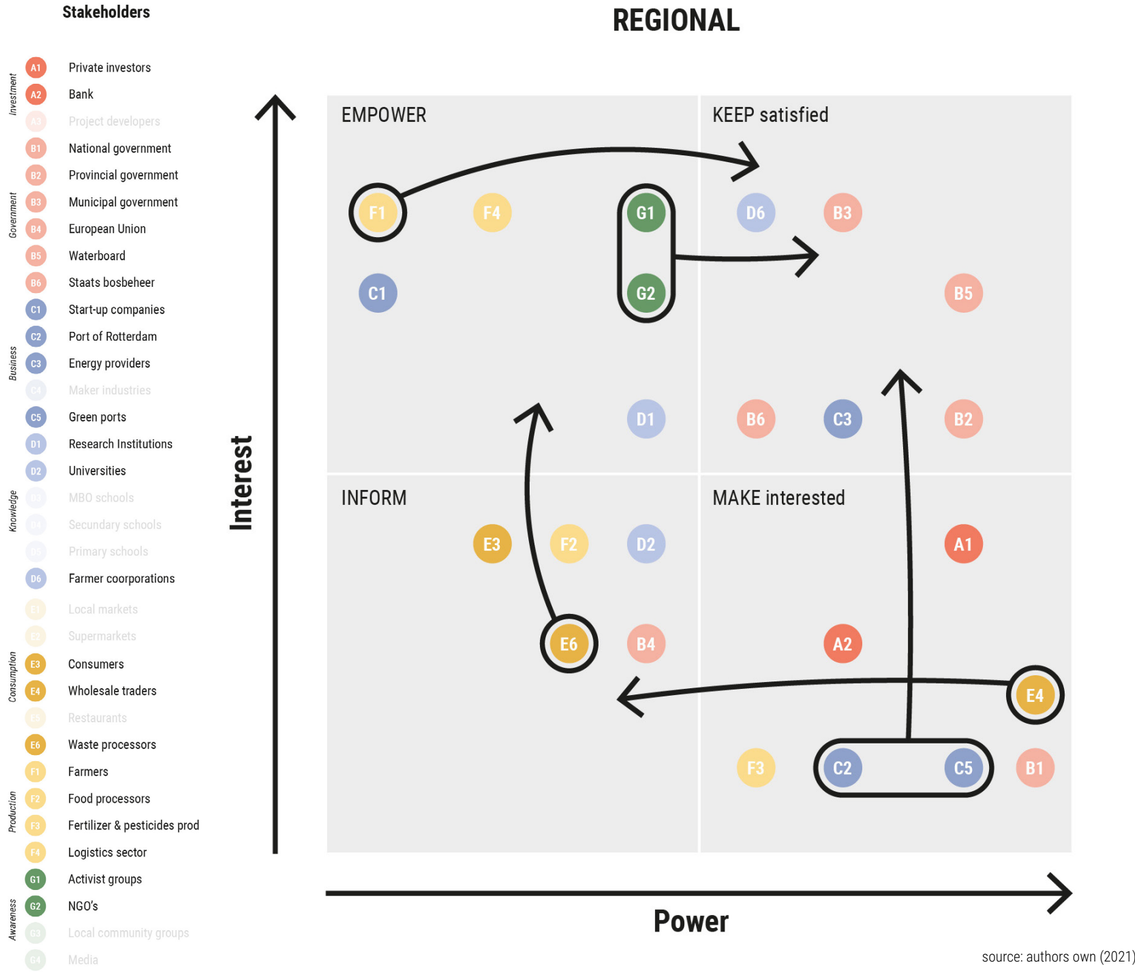
can over time, once the natural conditions are partly restored, achieve the same yield. Besides this, less use of pesticides and artificial fertilizer, and a more dominant position in the food chain, increases the economic position of the farmer.

Necessary connections between stakeholders are shown in the stakeholder synergy diagram. The emphasis lies on three key connections between farmers and different stakeholders. Firstly, to connect the farmers to the customers, inhabitants of cities will be able to directly buy from farms in the fringes of their city. This will enable farmers to increase their profit and allows city residents to access open green spaces, possible agri-tourism, and access to fresh food. Secondly, education on multiple levels is linked to farmers to increase awareness and participation of schools not related to agriculture. Higher education related to agriculture is linked to the farmers as well to increase awareness of the farmers about sustainable innovation. Finally, the regional governance is also linked to the farmers to ensure the implementation of policies that enable nature inclusive farming.



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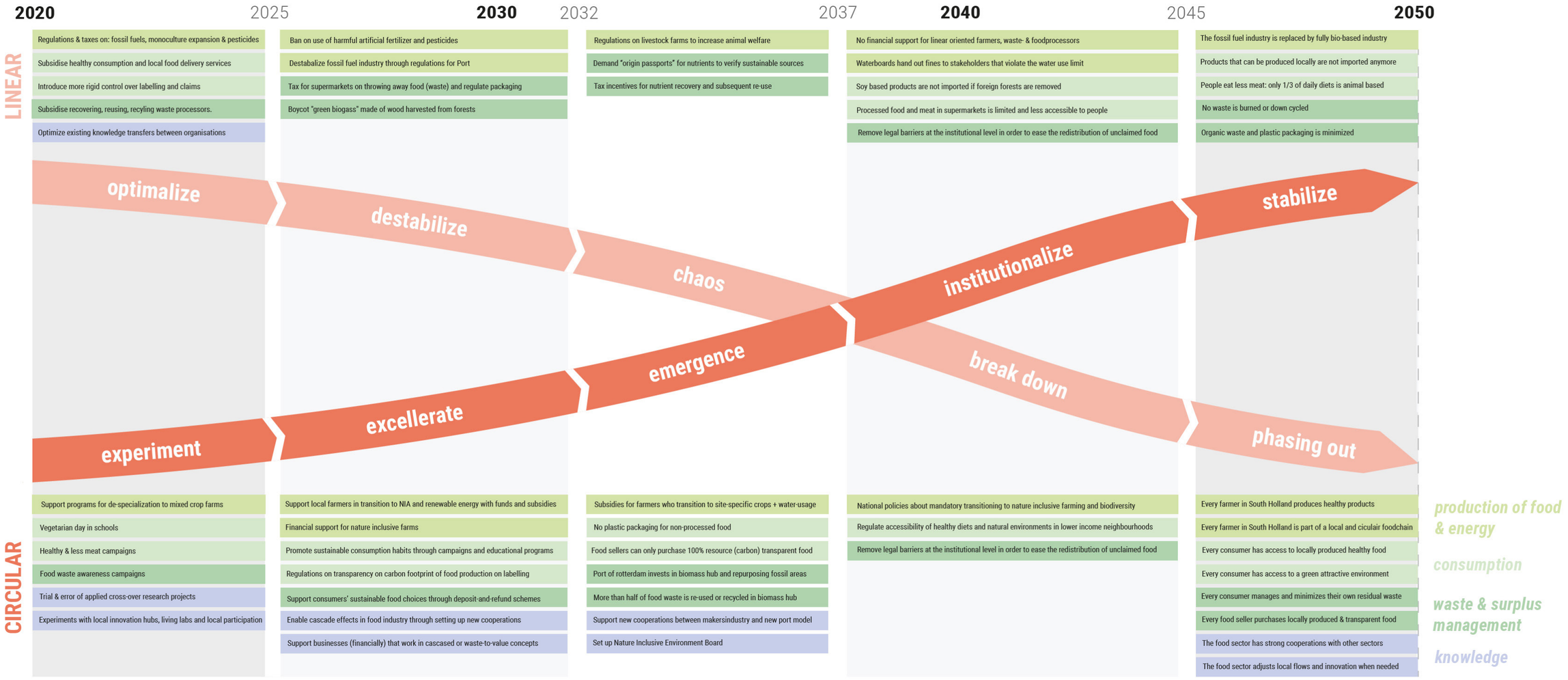
Phasing *X-curve transition model*



source: authors own, based on Drift Metabolic X-curve(2021)

Policies

The transition towards a circular and nature-inclusive agrifood sector is far-reaching. It requires many stakeholders to accept major challenges. However, the process of change is already visible in many places. There are pioneers to be found in different industries and scales, serving as pioneers and inspiration to others (Ministerie Landbouw, Natuur en Voedselkwaliteit, 2018).

The diagram that is presented above is based on the X-curve model from Drift Metabolic (2018). Transition is about both the building of new habits and structures, and about breaking down old ones. These dynamics are mapped in the x-curve. This model combines different phases that happen simultaneously. The theories of Drift Metabolic (2018) and Jurgilevich et al. (2016) about transition towards a circular economy in the food system are used below and in the diagram to explain the regional strategy.

The first phase is optimize & experiment. The linear system is in a well-functioning state and optimizing is mainly aimed at improving and innovating what already exists. At the same time, more and more people are coming forward that are experimenting with radical different visions, structures and practices (Drift Metabolic, 2018).
In terms of optimisation, the strategy proposes in this phase among other things the optimizing of knowledge networks; subsidise healthy habits and recycling or re-valuing of waste; and more control over labeling, use of fossil fuels, pesticides and monocultural production. In terms of experiments, campaigns are introduced concerning healthy diets with less meat; de-specialization of production methods to more mixed-use is promoted; and simultaneously with optimizing existing knowledge networks, cross-over projects and experiments with local agricultural or innovation projects can be implemented.

The second phase is destabilize & excellerate. Dominant systems within the linear agrifood chain begin to come to a halt. The current ways of working are broadly questioned in relation to sustainability, creating initial crises. At the same time, these crises offer a broader scope for the acceleration of new alternatives. More and more people and companies are switching to a more circular model. However, resistance to these alternatives is also growing.

In the strategy for this project, this phase starts with the ban on pesticides, while also setting up regulations for the Port of Rotterdam to destabilize the fossil fuel industry. In addition, there are taxes for supermarkets and a ban on burning of wood as so-called “green” energy production, that uses fresh trees from other countries. Excelleration is reached through financially supporting the transition towards nature-inclusive ways of farming; regulations on transparency for food packing; the support of consumers’ food choices and their diet; and supporting new businesses and cooperations to stimulate cascade effects.

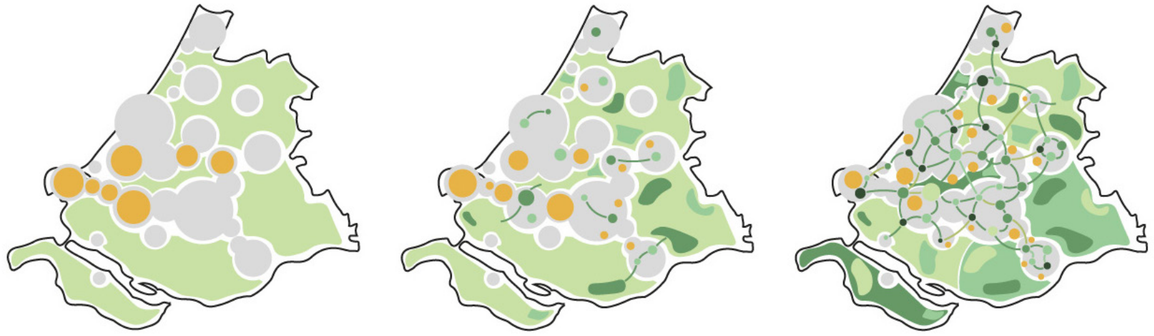
The third phase is chaos & emergence. The dominant structures now really start to crumble. The new solutions and alternatives are already present, but now become apparent to the outside world. The direction of change becomes clearer, while at the same time the resistance to the destruction of the linear system hardens.
In this phase the strategy proposes a few policies and guidelines that further break down the old model, including for example the demand for so-called “origin-passports” for nutrients. At the same time, a lot of new policies and actions are proposed: subsidies for farmers that want to transition to NIA; financial instruments for the port to expand the biomass industry; and. amongst other things, a Nature Inclusive Environment Board will be set up to involve stakeholders in the transition.

The fourth phase is institutionalize & break down. The two lines in the model now cross eachter, and change is now irreversible. New rules, structures and power relationships are formed. The linear system crumbles even further, resulting in the disappearance of certain connections, routines, professions and patterns. A new stability of the alternative circular system gradually emerges.
In this phase the strategy helps in breaking down the old model, in terms of a.o.: removal of legal barriers at the institutional level to ease distribution of unclaimed food; regulating accessibility and healthy environments for lower income neighborhoods. This in turn, is possible since the above actions have already contributed to the re-activation of fringes on smaller scales (see strategy: fringe models); it is mandatory for farmers to include nature-inclusive farming methods. Institutionalizing is possible through a.o.: financial consequences for violating actors; regulations for supermarkets in terms of processed food and meat; legal barriers for sustainable food and production initiatives are removed.

The fifth phase is stabilize & phasing out. The circular system is becoming the new established order. The old system is phasing out, cleaning up the remains, and accepting losses. In this phase the strategy needs its final instruments. The fringe is re-activated and the region has transitioned as a whole, resulting in a nature-inclusive circular agrifood system that uses waste-to-value principles, with closed material cycles, a better economic position for farmers, and healthy and accessible food and living environments for all.

Spatial change over time

The above transition is visualized in a schematic and conceptual series of three maps of the region. It is meant as a quick overview of the changes in the landscape regionally. The yellow dots represent existing sustainable initiatives that are currently operating in the linear system. These initiatives are optimized and expanded throughout the region, while at the same time new connections and initiatives take place, fringes are re-activated and the peri-urban landscapes become soil-specific and nature-inclusive. The agrifood system is local and regionally connected.



source: authors own (2021)

Local model: the Rotterdam fringe

Future of the fringe

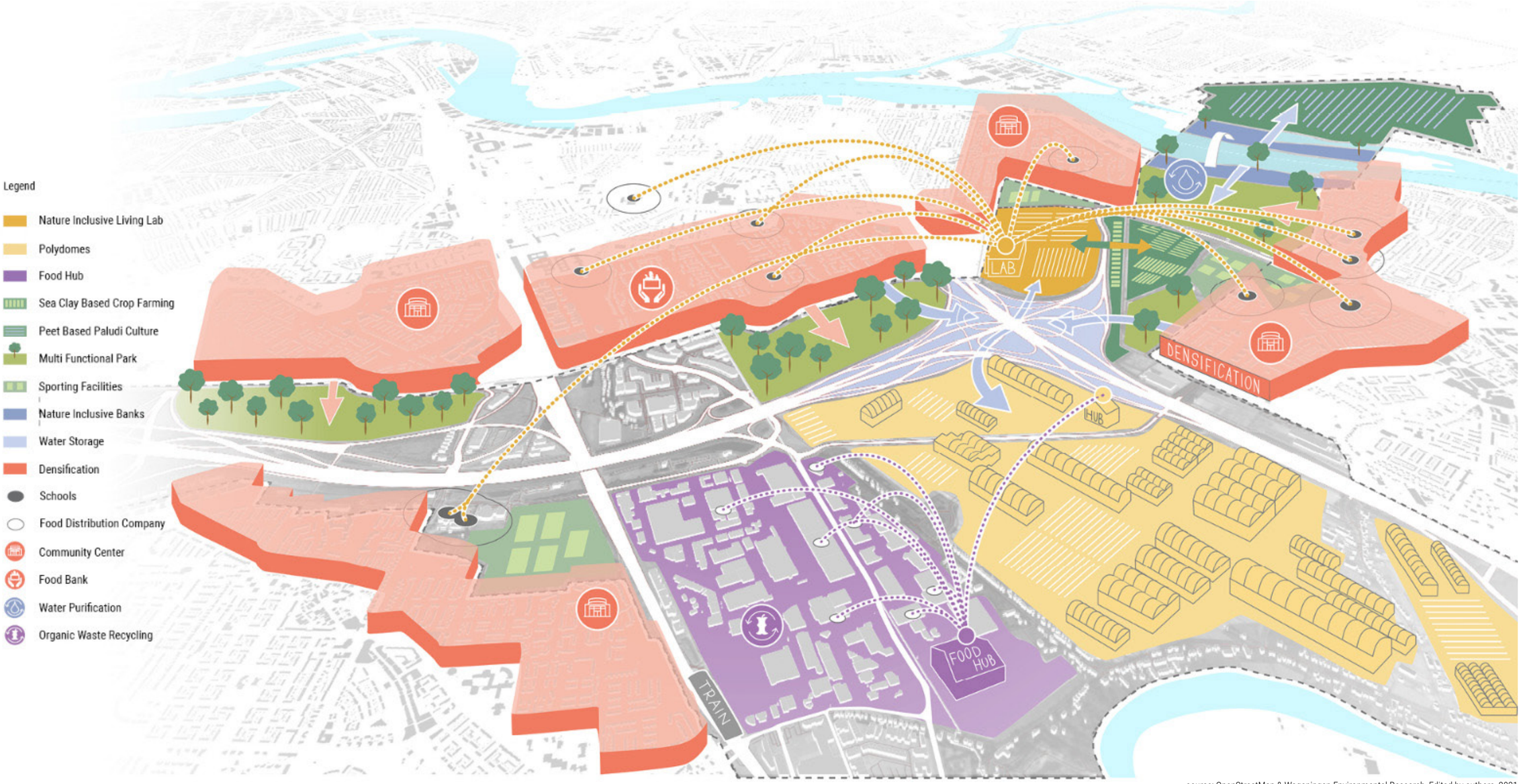
The transition to a nature-inclusive and circular agrifood sector is steered through a more top-down approach with policies and actions as discussed in the previous section. However, local small-scale interventions are also crucial in order to achieve this. Through (spatial) re-activation of the fringes in the South of Holland co-creation and participation of (local) stakeholders is stimulated and bottom-up change coming from local residents, businesses and farmers is made possible. The combination of these two types of strategy instruments complement each other and together can achieve a desirable future scenario based on a nature-inclusive agrifood sector and living environment. The key model that is proposed in this strategy is the Rotterdam fringe. In the following sections this key model is explained and visually shown in detail, showing the potential and the future of the fringe areas in the South of Holland.

Current characteristics of the Rotterdam fringe

To get a grip on what a nature inclusive future of the fringe would look like we specified a part of the fringe to test our design. We chose the south eastern fringe of Rotterdam, bordering three other municipalities. Two of them, Ridderkerk and Barendrecht are other mainly residential municipalities. However, the Krimpenerwaard is a rural municipality, where 8,000 of the total 13,000 hectares are owned or used by agriculture and horticulture. The fringe between these municipalities is an example of where a fringe currently functions more like a border than like a connection between urban and peri-urban land. In the future, active connections between these kinds of different municipalities are essential for establishing and maintaining short and sustainable food chains. To activate this fringe, several changes in land use are proposed.

The birdseye image on the previous page shows the redevelopment and re-activation of the Rotterdam fringe, near knooppunt Ridderkerk. This detailed map shows the future of this fringe. The area comes from a place with socio-spatial, environmental, and space pressure issues. First of all, the area is currently a territory in between with a very dominant presence of highways, no presence of qualitative ecosystem services and recreational green, and lack of access to these spaces from the surrounding neighborhoods. Just like other typical fringes, the area is characterized by the fragmenting role of infrastructure (Wandl et al., 2014). Here, knooppunt Ridderkerk is acting as a large barrier in the territory. The neighborhoods, especially IJsselmonde in the north, are typically lower-income neighborhoods compared to the rest of Rotterdam. They have for example a lower real estate value, the area offers a low diversity in functions apart from living, and the neighborhood has health related issues. In particular: 57% of the residents of IJsselmonde are overweight (AlleCijfers, 2016). These neighborhoods contain education on different levels, such as local schools. There are also businesses already strategically located in the fringe. On the eastern part of the junction there are two areas, ‘Cornelisland’ and ‘Dierenstein Barendrecht’ that are business areas bordering the highway. And an area that is dedicated to horticulture. The western side of the junction consists of a small fragmented park, sporting areas, several smaller businesses, and open low quality green fields.

source: authors own (2021)

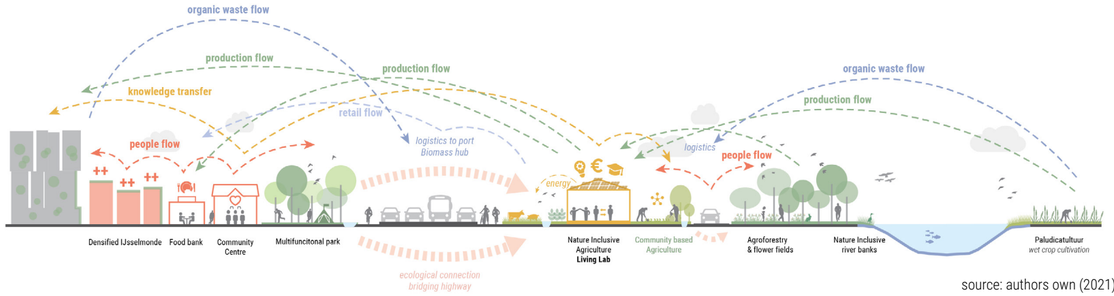


source: OpenStreetMap & Wageningen Environmental Research, Edited by authors, 2021

Fringe flows

The strategy for the Rotterdam fringe

Our strategy is to build on the current land use but integrate the surrounding neighborhoods.The birdseye perspective on the fringe provides insight to the land use transformations and links between the surrounding neighborhood, as a means of increasing the urban and peri-urban connections. In the western part of the fringe where currently open fields are located, we suggest the addition of a nature inclusive living lab (explained in the Vision chapter) and sea clay based crop farming that are linked to the park on the same side of the junction. This multifunctional park is added as a means of multifunctionality and mixed-use in the fringe, achieving a more sustainable spatial development (Wandl & Hausleitner, 2021), as discussed in the conceptual framework. The multifunctionality of agricultural and recreational functions also offer farmers a stabler and higher income. The horticulture is suggested to become nature inclusive by transforming the existing greenhouses into polydomes. A food hub in the fringe collects locally produced food from the fringe and nearby peri-urban areas, distributing this to local supermarkets and retail. Waste from production, households, retail and residual waste from the food hub is brought to the local organic waste collector, that is in turn connected in the chain with the Biomass hub in the port of Rotterdam. The nature-inclusive banks allow the water to rise further into the land, and water can be stored for the agricultural function in the fringe. In order to make sure both people and nature can benefit from the proposed ecosystem services, it is important to bridge this infrastructural barrier as much as possible. In terms of socio-spatial justice, it is therefore important that these residents can access the landscape of the fringe as a public good, in order to enjoy the value of nature and increase their wellbeing. That is why access to this area is possible through better walking and cycling paths, including the possibility of slow traffic paths and eco-corridors underneath the highways (visible in the section). The housing need in the province also puts pressure on the city of Rotterdam to build many new homes. The neighborhoods on the outer edges of the city are in need of better living environments. Since the linked area of the fringe will be more accessible and attractive, it is proposed to densify around here. This also offers the opportunity of adding new or building upon existing local neighborhoods functions, such as a community centre or food bank. These functions are crucial in order to stimulate participation of local residents in the fringe, and to achieve co-creation of initiatives in collaboration with for example local farmers or school awareness projects. This both enables the flow of people and knowledge (knowledge) transfer on a local scale. Knowledge also plays an important role as driver for change on a local and regional scale, and is present in between all four territories, as can be seen in the flow diagram.



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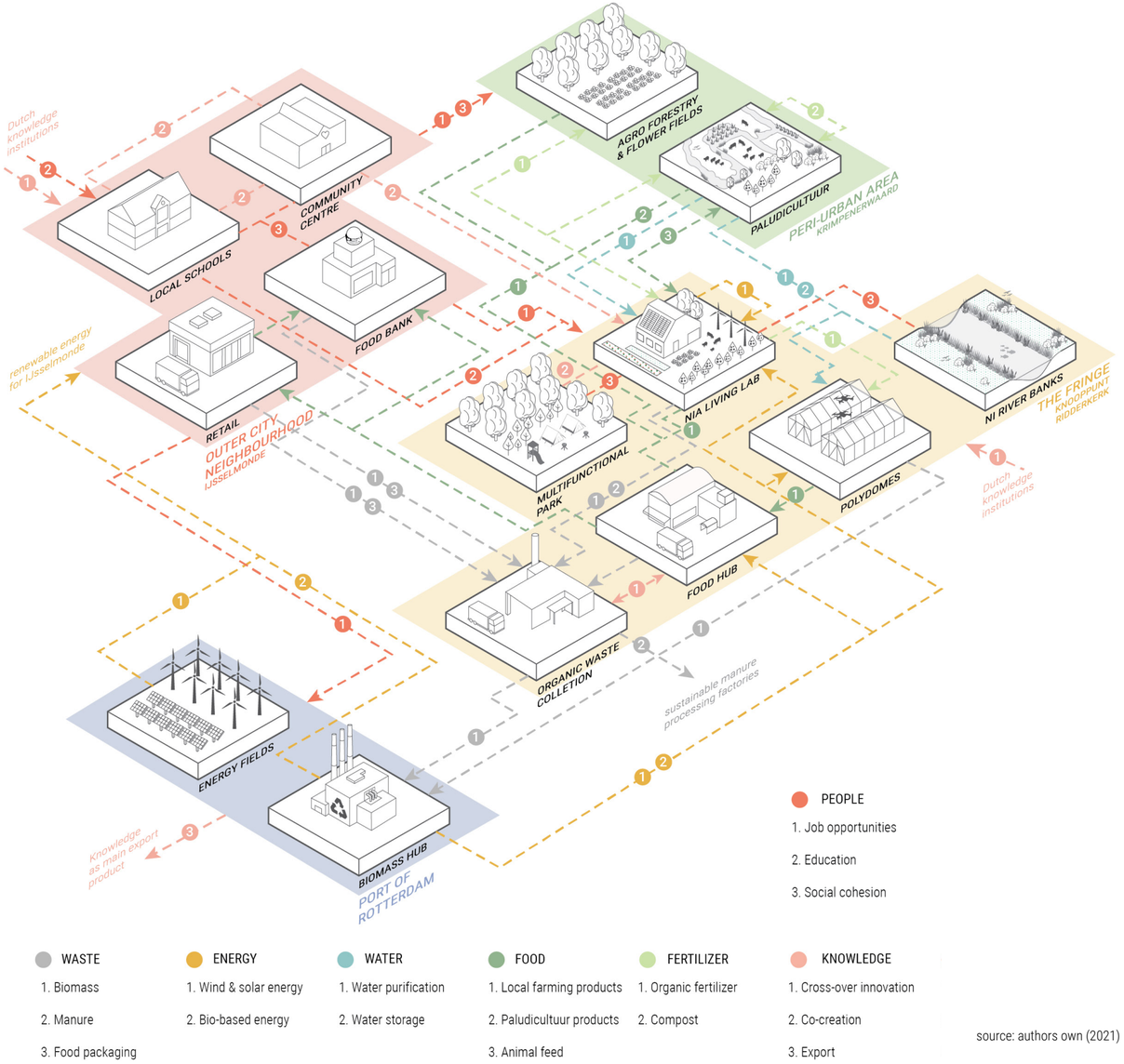

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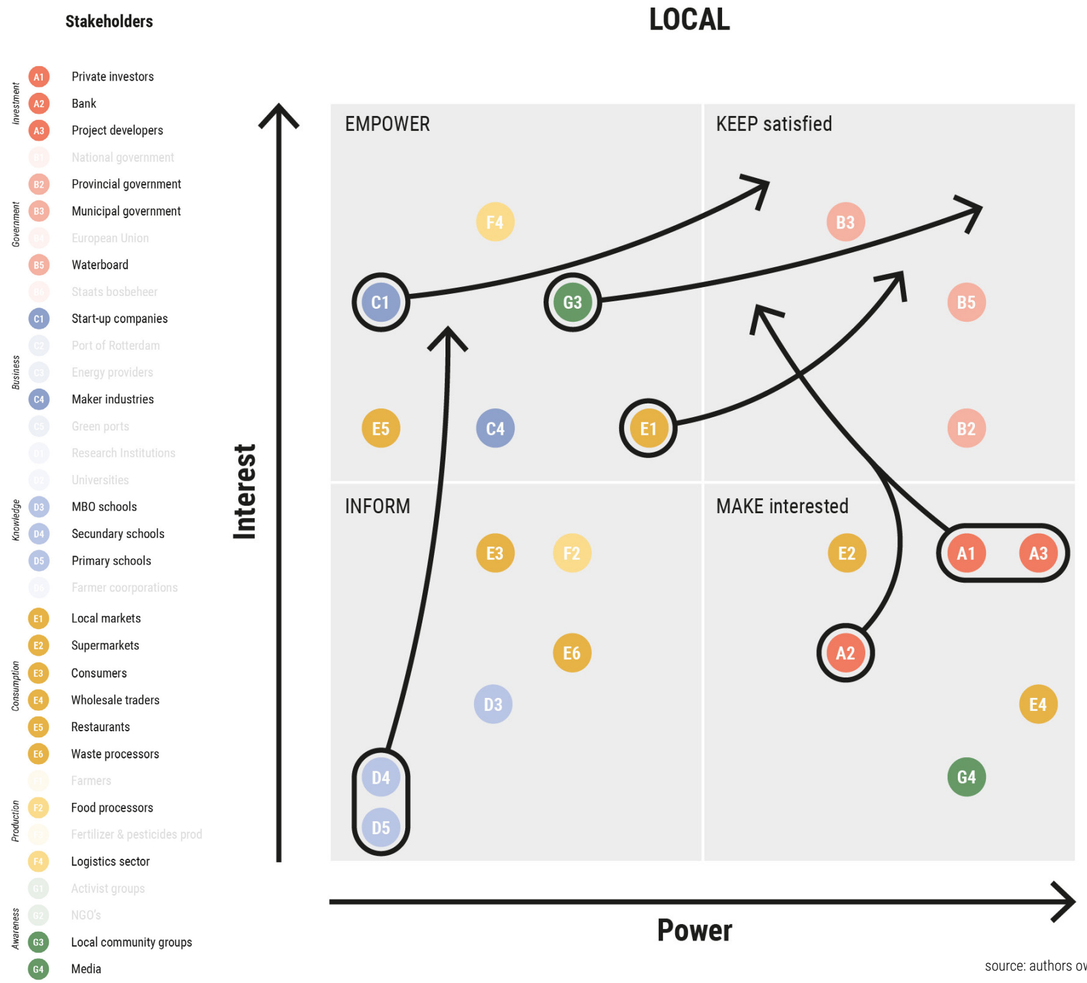
Stakeholder analysis

The amount of power and interest of local stakeholders will have to change if nature inclusive farming in the fringe wants to be realized. The changes we deem necessary are visualized in the power interest matrix. The interest of possible investors (private investors, banks, project developers) should be raised. Start-up companies should have more power and be enabled to facilitate activity within fringes. To strengthen the connection between education and (sustainable) food production, primary and secondary schools should gain interest as well. We also suggest that the amount of power and interest that local markets have should increase. The position of the farmers in this matrix is shown and discussed in the regional stakeholder analysis. Local community groups should gain power to be able to effectively connect their neighborhoods to the local markets and farmers in near nature inclusive fringes. The relation between the farmer and the citizen should be locally made accessible. A good way to achieve is by raising awareness about its benefits. An article about urban fringe farming and food resilience sums up what the benefits could be for both stakeholders in the relationship.

"Strong links between cities and local farmers can create a two-way exchange. Farmers can capture a higher share of the food retail dollar by selling direct to local consumers (through farmers markets or community-supported agriculture) or local businesses (such as cafes and restaurants). City residents benefit from access to fresh, local produce and from opportunities to participate in agri-tourism activities on nearby farms (such as pick your own produce and farm-gate bike trails). A new provenance brand could be introduced so consumers and businesses can easily recognize food from the area and support local farmers. To improve access to locally grown food and increase the resilience of food systems to climate change, we need to build mutually supportive relationships between cities and the growers on their fringes, so that farms thrive as our cities grow." (Carey et al, 2018)

By creating this opportunity to have a direct connection with farmers, consumers are given a more independent position in the food chain. But other stakeholders should be connected to the farmers as well. It is important to create certainty that these farms in the fringe will be financially sustainable for the farmers. This should be done by implementing long term policies fit for these kinds of fringe farms. Some of them should also be formulated locally, because of the varying stakeholders in the fringes. The same article suggests interesting possibilities to ensure the farmers position.

State and local governments could introduce food procurement standards so that government services, such as hospitals, prisons and "meals on wheels" programs, are encouraged to buy food from local farmers. Government food procurement standards like these are already used in other countries, such as the United States and Canada. Farmer incubators could be established to help new farmers access land and begin farming on the city fringe, mentored by experienced growers. Farmer-owned food-processing co-operatives could enable these growers to add value to their produce and take greater control of the food supply chain." (Carey et al, 2018)



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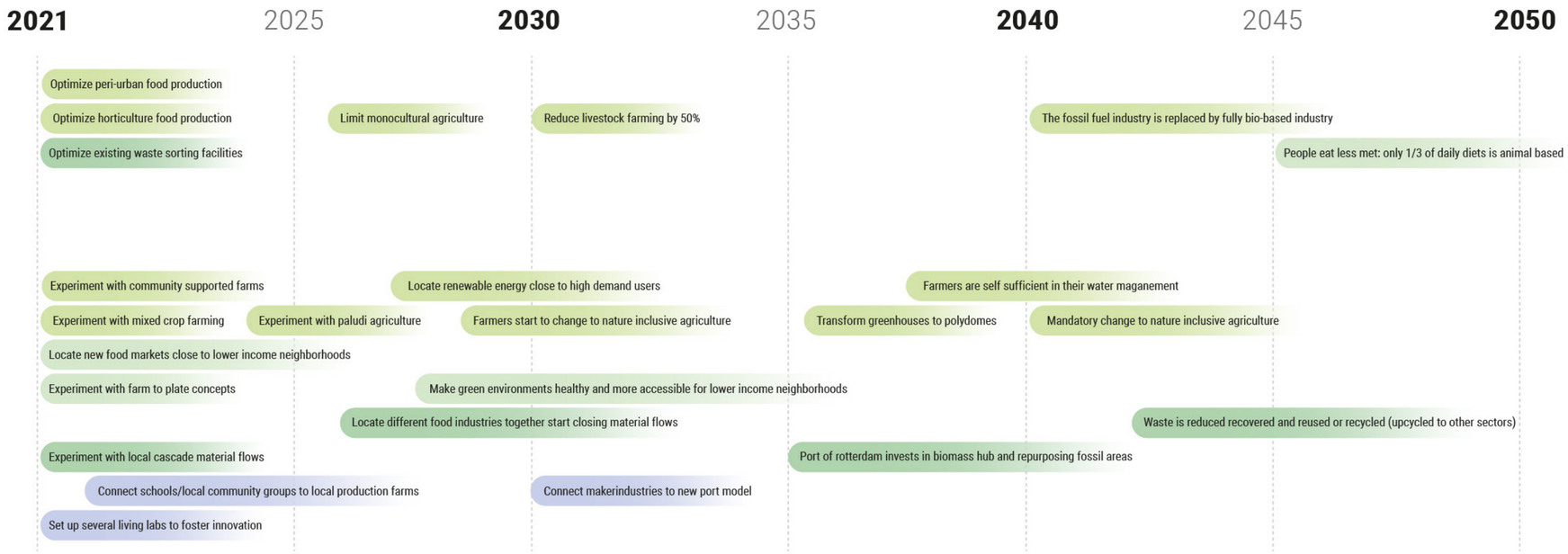
Phasing | local model

The phasing of the transition within the fringe will consist of several of actions. Some of the actions can practically start immediately. In the local phasing model, we propose actions that we think will be necessary to start nature inclusive farming in the fringes.

To begin, a lot of experimenting should take place to ensure that the innovation we propose is feasible. Nature inclusive living labs should be set up to facilitate testing grounds for ways of participation and production. Local stakeholders, such as community groups and schools, should be identified which can cooperate with and participate in these living labs. Specialized farmers should be connected to experiment with soil-based nature inclusive agriculture. This should be done while the current food production is being optimized in all sectors and being prepared to limit their monocultural production. When experimenting has delivered results and nature inclusive fringes can be set up, different food industries should be located to start closing material flows. Also, renewable energy sources should be located for the high demand users. Farmers will then be able to start their transition to nature inclusive agriculture.

After 2030, when farmers in multiple municipalities have adjusted to nature inclusive farming, it will be a great opportunity to start achieving the goal of reducing livestock farming by 50%. By then, the maker-industries in the fringes should start connecting to the port of Rotterdam. This is also when a biomass hub will be developed in the port and fossil fuel production is being repurposed. During this, the greenhouses will be transformed into polydomes.

When we start to reach and during 2040, there are several goals we want to achieve. Farmers should be self-sufficient in their water management, the fossil fuel industry is replaced by a fully bio-based industry, waste is reduced, recovered, and re-used or recycled (possible upcycling to other sectors) and that only a third of people's daily diet is animal based. To achieve these goals, we think it will be necessary to implement the policy of mandatory nature inclusive farming somewhere around 2040.



source: authors own (2021)

Model translation & expansion

General & location specific

General conditions: applicable in every fringe typologie and location

1. the fringe location should be near logistically important infrastructure to connect the fringe to the regional mobility system

2. the fringe location should be located nearby green structures to improve nature accessibility and connectivity with Nature Inclusive agriculture

3. the fringe location should be located nearby local companies (preferably related to food production, manufacturing or waste processing), or local sustainable initiatives.

4. the fringe location should be located at the level of lower income or lower socio-environmental quality neighbourhoods in the region.

5. the fringe location should be located near agricultural (peri-urban) land, preferably alongside water bodies.

Primary City Fringe

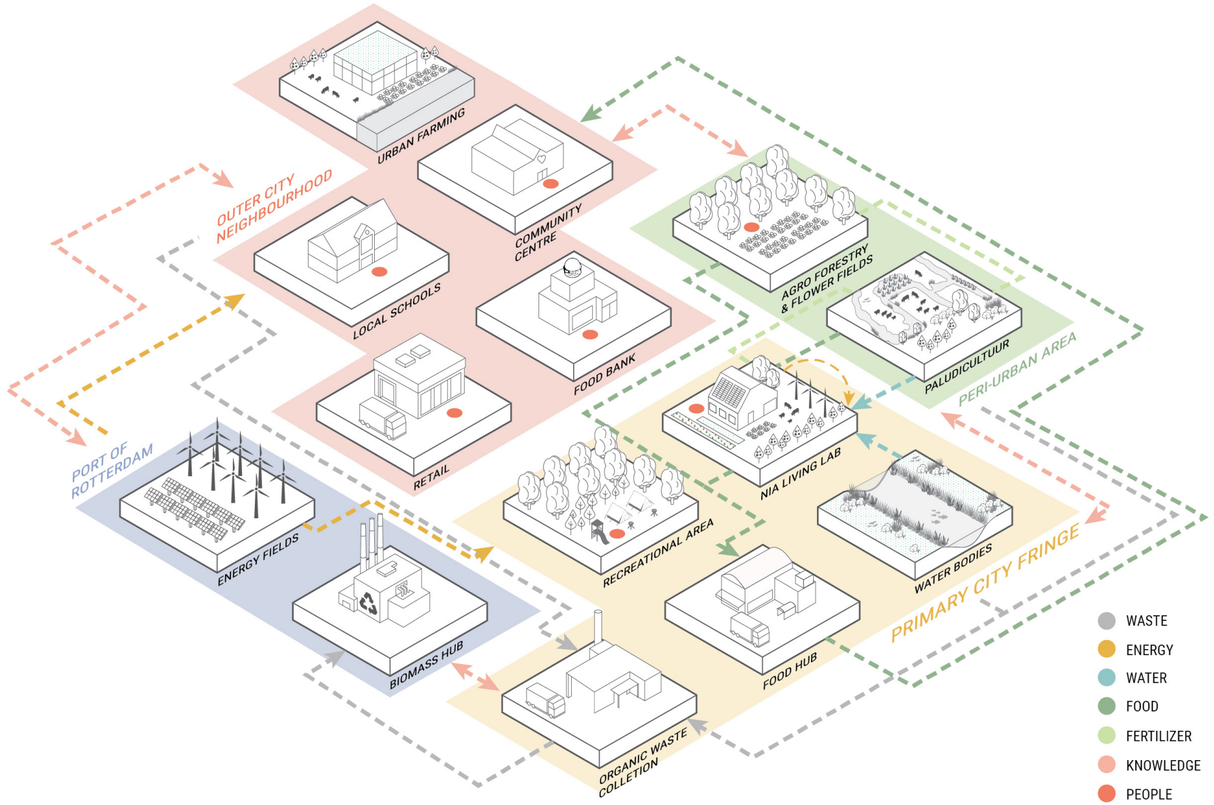
Connection with the bigger cities: the primary city fringe is characterized by its location outside the city edges of the bigger cities in South Holland. This concerns Leiden, The Hague, and Rotterdam. The key fringe model (near IJsselmonde, Rotterdam) is illustrated in the previous chapter. Since poorer neighborhoods often have the most socio-environmental injustice problems (see chapter Analysis), these neighborhoods have a relevant urgency to be changed. The social injustice offers in this case an opportunity for co-creation and participation as a means to re-activate the fringe. The connection between peri-urban hinterland and city is strengthened through reactivating the primary city fringes.

Engagement with city stakeholders: the primary city fringe is surrounded by the three biggest cities in the South of Holland. This offers an opportunity to involve various important stakeholders that are present within the city. The stakeholders (see Rotterdam Fringe chapter) can differ from production, retail, schools, community centres, food banks, or other local organisations. Involving specific local initiatives: in the primary cities there are many sustainable initiatives, such as food to waste concepts for restaurants or food banks. These stakeholders are location specific, but play an important role in awareness about the food system. This also goes for knowledge institutions that are mostly present in these larger cities. Of course knowledge exchange can take place digitally, reaching the entire region or the whole of the Netherlands, but local knowledge institutions can also help in steering change through education and cross-over innovation with nature inclusive farms (the Nature Inclusive Agriculture Living Lab).

Nature inclusive healthy environments and agriculture for the city: urban farming can take place within larger cities, connecting the city with the fringe even more. Development of green structures into the city (combined with greening of architecture) both enhances a healthy living environment and creates more awareness about the importance of green for our well being and ecosystems.

Energy: in terms of energy, the larger cities can make use of heat nets, if present, or use renewable energy produced in the port of Rotterdam. Small scale functions within the fringe or nearby peri-urban areas can also produce their own renewable energy, since they have more space available.

Primary city fringe



source: authors own (2021)

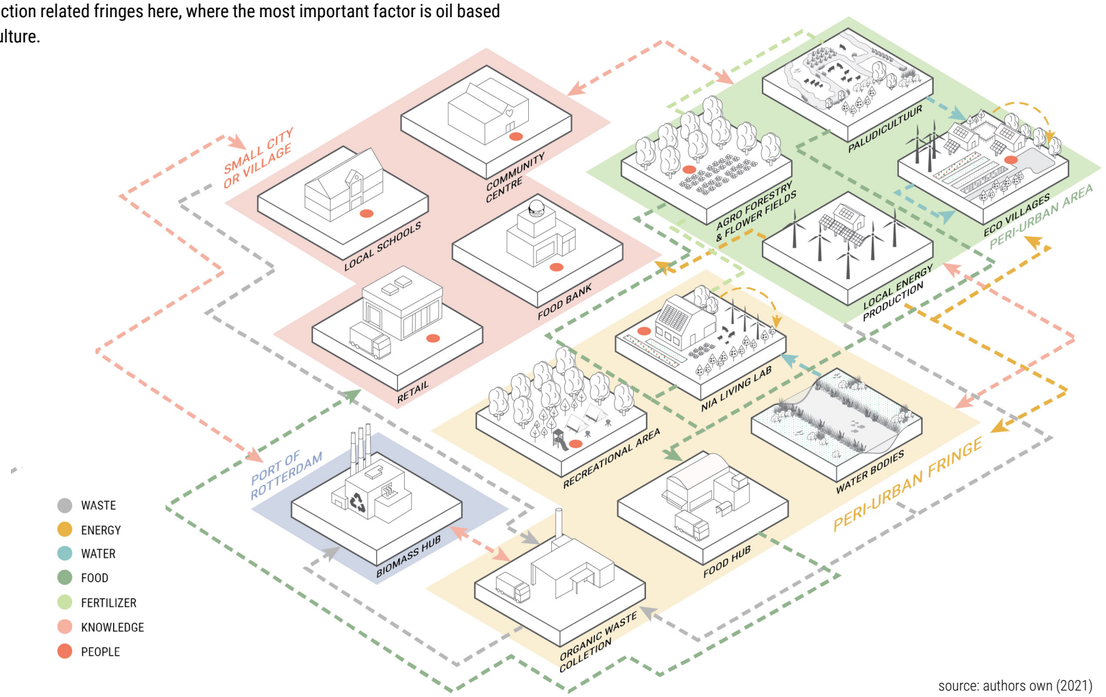
Peri-urban Fringe

Connection with secondary cities or villages: this fringe is located in peri-urban areas and is a bit smaller scaled than the ones near primary cities. It offers more opportunities for wider living concepts and open qualitative green spaces.

Engagement with local stakeholders: the engagement with local stakeholders is fairly similar to the ones in primary cities. However, this of course depends on the present public, community and food related functions within the city or village. Stakeholder engagement must be adjusted to these local circumstances.

Involving specific local initiatives: located in peri-urban areas are often larger scale sustainable initiatives, such as the factories of Heineken. These companies can steer change in these regions. This can result in more food production related fringes here, where the most important factor is oil based agriculture.

Combination with peri-urban eco villages: as mentioned before, there is a trend during covid-19 for mostly families to move to more green peri-urban areas outside of the city. The peri-urban areas next to - or even in - the fringe offer opportunities to combine farming and living in so-called ecovillages.
Local energy production: the wider landscape of peri-urban fringes offers opportunities for generating renewable energy nearby without nuisance. If we want to transition to a future circular economy that is completely reliant on renewable energy sources, the peri-urban areas have an important task to provide for this. Of course the wind energy parks on sea will also help in this transition.



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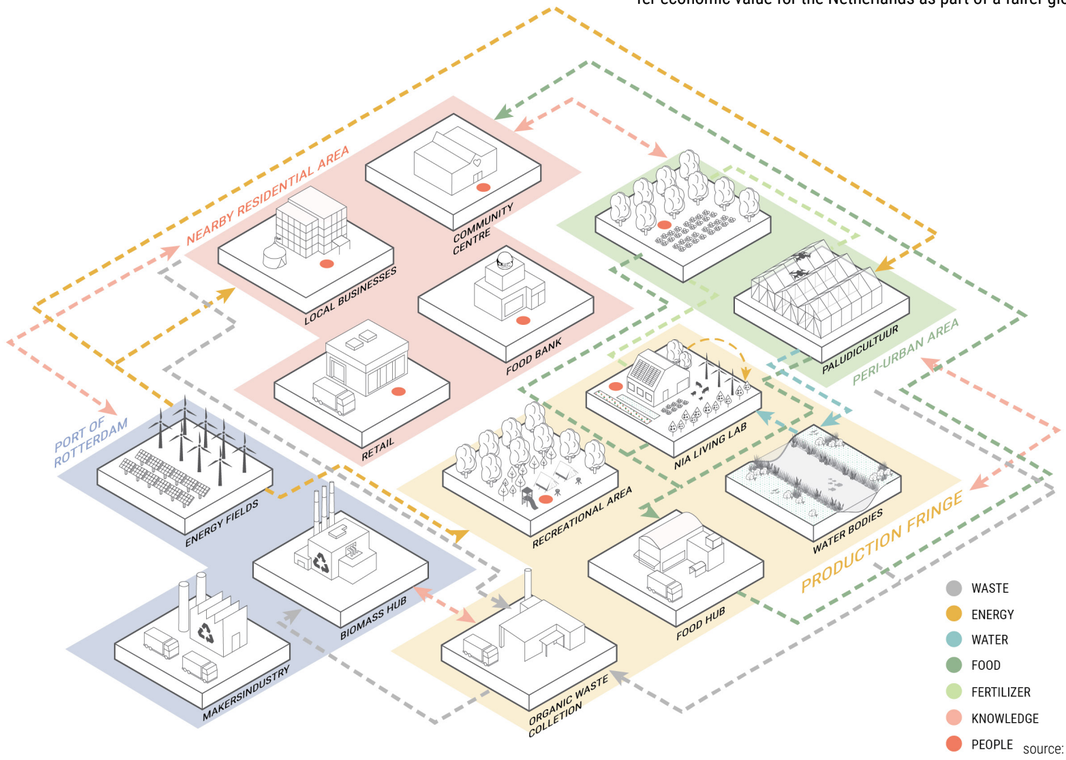
Production Fringe

Connection with main industries as priority above city connection: Important main industries in the province are Westland, Boskoop, and the Port of Rotterdam. Location of important industries in the agrifood system (production processing and waste mainly) are important here. This enables shorter material flows and productive landscapes.

Cross-over innovation and joint research with local stakeholders: shortening flows is possible in these locations when local initiatives or start-ups co-benefit from sustainable outcomes. In fact, the success of shortening material flows in the agrifood system is dependent on strong cooperation between different stakeholders and sectors. Since the production fringe is characterized by its larger scale production both alongside the port area (with different sectors and biomass hub) and the polydome horticulture areas, the main objective of these fringes is to re-activate knowledge transfer through a nature inclusive approach, resulting in strong stakeholder engagement steering a circular agrifood system.

Export of food & flowers: the production fringes are located near the highly productive polydomes, offering a large amount of healthy and diverse crops that can also partly be exported to other countries through the port. These productive landscapes therefore not just contribute to the region, but also offer economic value for the Netherlands as part of a fairer global food chain.



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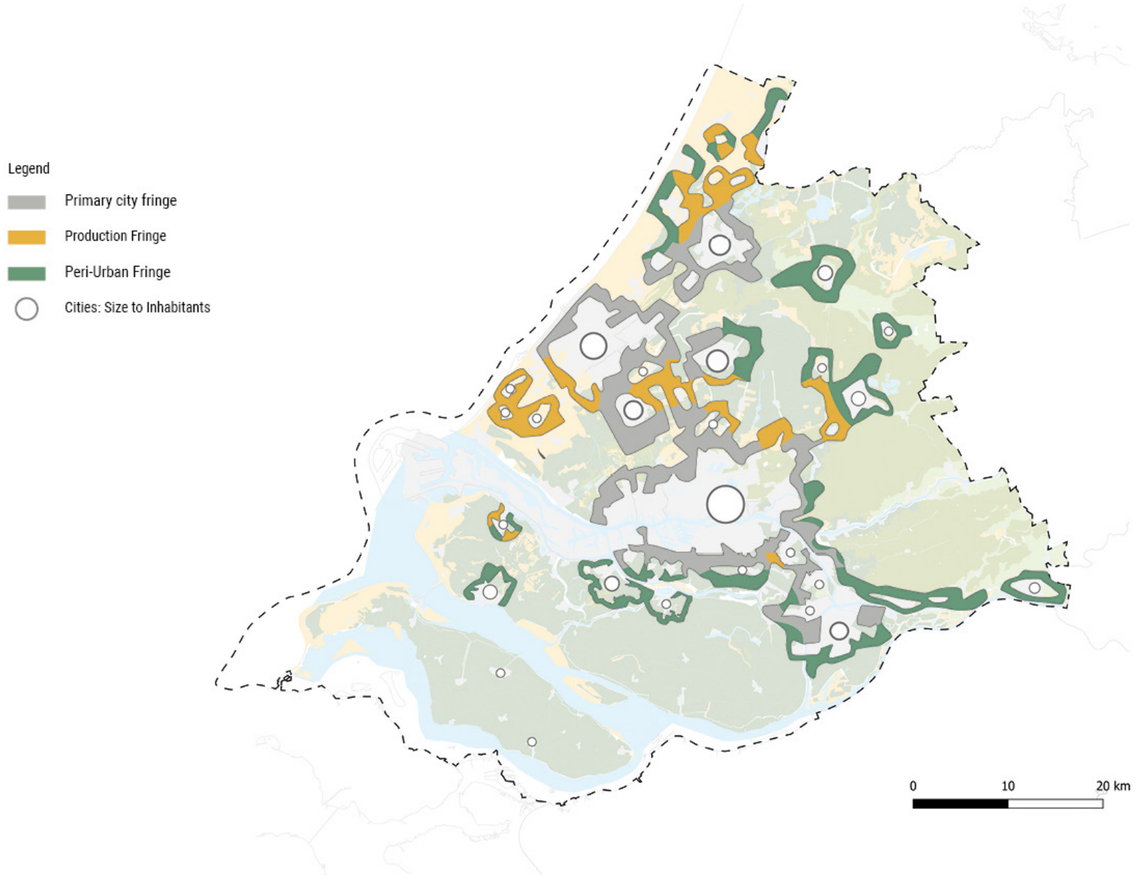
Model expansion

The previous section explained the different fringe typologies and their general and location specific characteristics. The regional strategy map already showed the future of the South of Holland, where all fringes are re-activated. The Rotterdam fringe, that is shown in detail, is the key model for this transition and shows the potential of fringe re-activation. Therefore the aim is to expand the idea of reactivation of the fringe to the other fringe typologies in the province as well. In this map, the fringes in the South of Holland are shown, and distinction is made between the three different fringe typologies. The other fringe re-development locations should be carefully picked based on the generic and specific location conditions as mentioned above. The recommendation would be to start with: i) fringes that offer the most potential to steer change (based on the conditions above) so they can indirectly help influence change within the agrifood sector, contributing to the x-curve transition; ii) fringes that are located alongside lower-income neighborhoods, or neighborhoods that deal with socio-spatial inequality as shown in the Analysis chapter; iii) fringes that differ from each other in terms of typology, meaning starting with both a primary city-fringe, peri-urban fringe and production fringe, to steer change in different spatial settings simultaneously.
The result will be that in several places over the coming years different types of fringes are re-activated, steering change bottom-up while at the same time indirectly influencing the linear system. This strategy for the re-activation of these fringes will play a large role in steering change to build up the circular model. This way in 2050 the agrifood sector in the South of Holland is 100% nature-inclusive, locally driven and circular.



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5

Conclusions

Conclusion
Recommendations

Conclusion

This report introduced nature-inclusive agriculture as an overarching framework for the future of the agrifood sector in the South of Holland. The proposed aim for this sector is to be 100% nature-inclusive in 2050, offering healthy and accessible food and living environments for all. The need for nature-inclusive agriculture was based on the analysis of the linear food system and the productive monocultural landscapes in the province, exposing the vast amount of negative environmental and socio-spatial issues currently present. In line with the goal of the province to become 100% circular in 2050, this led to the following research question: How can the agrifood sector in the Province of South Holland transition to a nature inclusive circular system?

The further investigation of the pressing problems due to the current way of working in the agrifood sector shows the importance of a highly needed shift. The South of Holland contributes to the leading role of the Dutch agrifood sector in global food production and innovation, exporting large amount of regionally produced products through the port of Rotterdam. The South of Holland together with the port area are the biggest polluters of the Netherlands in terms of greenhouse gas emissions, due to this burdening system that is reliant on the fossil fuel industry. Even though arable crop farming takes up the largest part of the productive surfaces, the Greenhouse horticulture sector contributes the most to the economic value. The complex supply chain of the linear-manufacture-waste system is based on several mostly large actors who all aim to gain the greatest economic benefit. This results in a poor economic chain position for farmers. All chain parties use raw materials at their disposal, process these at the lowest costs and with the highest yield, and then sell the product to a consumer, who leaves behind a large amount of waste. Large amounts of manure surpluses are an additional waste problem, contributing to the negative environmental impact of the sector. The productive monoculture landscapes with the extensive use of pesticides have caused the disappearance of many habits for animals and insects, resulting in a lack in biodiversity. Other pressing problems as a result of these production methods are water salination and eutrophication, and subsidence as a result of soil depletion. Spatial pressure is a result of the need to build around 230.000 houses in the province, while at the same time space is needed for the energy transition. There is a competition between urban and rural development. In addition, resources, allocation of public goods and services are in many cases not fairly distributed and shared. Even though agricultural land is often allocated to the farmer, the landscape itself can be seen as a public good. There especially exists an unfair distribution of both well produced healthy food and access to these green (agricultural) areas for lower income neighborhoods, resulting in socio-spatial injustice. Through these analyses it can be concluded that the socio-spatial challenges are most present in the fringes within the province.

In the proposed vision the fringes are therefore re-activated through implementation of nature-inclusive agriculture to create a healthy environment for local residents, to enhance food awareness and to localize food flows. Nature inclusive farming is a form of circular agriculture that utilises and protects the biodiversity on and around the farm, and it entails a healthy-soil system. It produces food within the boundaries of nature, the environment, and the living space. It can offer a variety of ecosystem services, offering solutions for the various major challenges that the agrifood sector is facing. Healthy soil is the basis for NIA, and therefore the four most common soil types in the province are translated to soil-specific nature-inclusive ways of farming: mixed crop agriculture on sea clay; agroforestry and flower fields on river clay; paludicultuur on peet; polydomes on the eerdgronden. The nature-inclusive landscapes can well be connected to existing blue green structures, contributing - if well-accessible - to the health of local communities. What also increases the health of consumers is a balanced diet, therefore the future diet consists of 1/3 animal proteins and 2/3 plant-based food. Thus, for local citizens to benefit from a healthy living environment, the fringes in between city edges and peri-urban areas should be i) accessible; ii) open for co-creation concepts and participation; iii) used in a multi-functional way contributing to attractiveness and human interaction. This is even more important, since the edges of cities offer ideal locations to tackle the housing shortage, which will result in an increase of people flows in these areas. To stimulate participation and co-creation between these local communities and businesses, tangible knowledge is essential. In fact, knowledge is the driver for change on all scales, meaning it also applies on the regional scale. The implementation of a biomass hub and renewable energy plots in the port of Rotterdam, local food hubs in the fringes, and the corresponding shortening of material flows is only possible through cross-over innovation with different sectors in the province.

In order to achieve these future ambitions for the region, a combination of more top-down regional policies and actions, and location specific spatial interventions and bottom-up initiatives within fringe areas are needed simultaneously. Therefore, a set of policies and actions are proposed on the regional scale, according to the 5 phases of the X-curve model from Drift Metabolic. This phasing focusses on both destabilizing and breaking down the linear agrifood model, while at the same time implementing actions towards the institutionalization of the new circular model. This requires key stakeholders to change their behavior and attitude, or even their position in the current agrifood chain. The port of Rotterdam and the Greenports are key pioneers in the transition towards a circular economy. Wholesale traders however, lose power, since their role in the chain will become smaller due to more local production flows. Waste processors gain interest, due to incorporation of waste-to-value principles within the chain. NGO's and activist groups gain power through for example awareness campaigns. The position of the farmer is key in the transition. Since NIA is economically beneficial in the long run, and the spatial and systematic change offers farmers opportunities to directly sell from their farms, their profit and chain position will increase. Education on multiple levels and regional governance is also linked to the farmers, offering them practical knowledge and a smooth transition towards 'new' nature-inclusive production methods.

Bottom-up change however, depends on the smaller scale spatial re-activation of the fringes in the South of Holland, that form the backbone for providing integrated solutions for the urgent socio-spatial and environmental issues. The potential of this re-activation is shown in the key model of the Rotterdam fringe. This area is an extreme example of a border between urban and peri-urban land, since it is characterized by the presence of fragmentating infrastructure. Other characteristics of this fringe – and fringes in general – are the multiple functions present, such as waste processing facilities, open spaces and productive systems. The fringes offer a high potential for implementation of a variety of nature-inclusive and circular functions, that can be established through stakeholder engagement, co-creation and participation of local residents. Key land-uses in the fringe are for example a Nature-Inclusive Living Lab, multifunctional park, and food hub, offering local flows of people, materials and knowledge. The Rotterdam fringe model exemplifies this, showing the potential for development of educational aesthetic and cultural values, as well as human interaction related to these functions. The socio-spatial inequality of the nearby densified neighborhoods can hereby decrease significantly. This key model can be translated to other locations depending on the type of fringe: primary city fringe, peri-urban fringe or production fringe. These typologies all have 5 generic conditions in common: 1) a nearby regional road network; 2) the presence of green spaces or structures; 3) presence of local companies; 4) location near lower income neighborhoods; 5) preferably the presence of agriland and waterbodies. In addition, the 3 fringe typologies all have specific characteristics that are important to take into account for the expansion of fringe re-activation. Through careful selection of other suitable fringe locations in the province and re-activating those, change can happen as a catalyst in different locations at the same time.

Through implementation of this proposed strategy the linear agrifood sector can gradually and literally make space for a nature-inclusive and circular methods. In this way, the agrifood sector in the South of Holland will be a 100% nature-inclusive, circular and locally driven in 2050. As a result, the agrifood landscapes become more biodiverse and resilient, with a shorter and more just food chain, whilst simultaneously providing equitable access to healthy and accessible food, and a healthy living environment for all.

Recommendations

Our project has shown what potential contribution nature inclusive agriculture can make to solving several problematic urgencies. These urgencies should be taken all into account when proposing solution for the transition towards a sustainable and circular economy and environment. But a lot of these urgencies are very complex and can only be examined up to a certain point. We used nature inclusive agriculture as an overarching framework in this project to make the project clear and understandable for ourselves. Spatially, we narrowed our vision down to the fringes. For the actual implementation of a nature inclusive agriculture system a lot must change. This paragraph will discuss recommendations we give for further research and possible application and the limitations they have. To categorize the recommendations will be given about the five guiding principles we have formulated in the strategy.

Local agri food network
Scaling down the current food chain will result in a lot of connections that will have to be broken. The immediate facilitation of new, local, connections is necessary for a financially feasible scenario for all stakeholders. The key stakeholders in the local agri food network we propose are the farmers. Starting their business, or transitioning into the fringes should be subsidized to enable their adjustment. We have included many stakeholders but some of them, that will be disadvantaged by the local model, are not given a sufficiently elaborated alternative. We recommend further research into a feasible transition for stakeholders that do not have enough local opportunity to transition.

Accessible & tangible knowledge
The need for accessible and tangible knowledge has been addressed. To realize this, we recommend increasing the power of institutions, agricultural businesses and initiatives that can facilitate this awareness amongst citizens.

Co-creation & participation
To incentivize co-creation and participation, general awareness about the topic should by spread regionally, awareness about where citizens can partake specifically should be spread locally. Certain demographic groups, such as lower income households and elderly, should be targeted to address inequalities.

Accessible & healthy living environments
The addition of green open spaces in the fringe by creating nature inclusive farms will significantly increase the value of the land surrounding it. Because green spaces are very scarce in city centers, a lot of people who currently live there are willing to pay just as much to live on the edge of the city and have access to green open spaces. We recommend the integration of more specialized studies into gentrification of neighborhoods on the fringe.

Organic waste to value
To transition into a circular economy, waste must be re-introduced in the material cycle. Production in the fringe should use waste as a resource when possible, and upcycled it waste to other sectors. We recommend further research into which specific sectors and stakeholders would be able to cooperate in this process

6

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