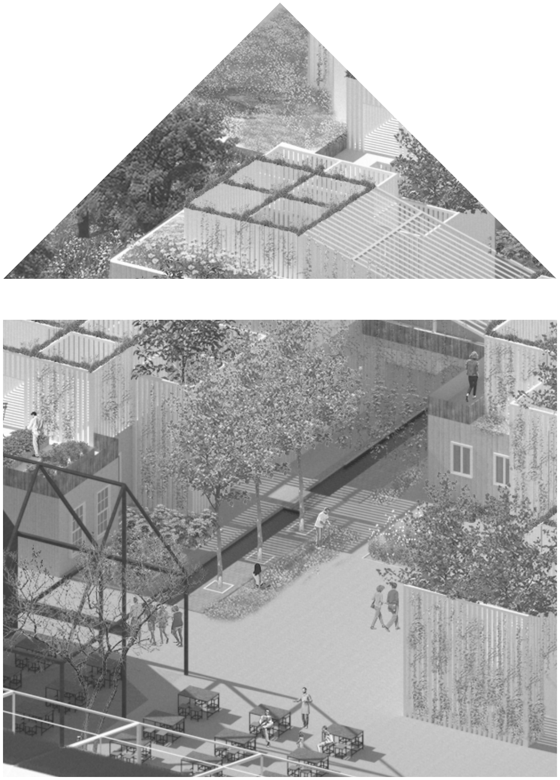

URBAN FOODPRINT

EXPLORING A DESIGN THAT MERGES URBAN LANDSCAPE AND LOCAL FOOD PRODUCTION

Urban foodprint - exploring a design that merges urban landscape and local food production

Master thesis booklet
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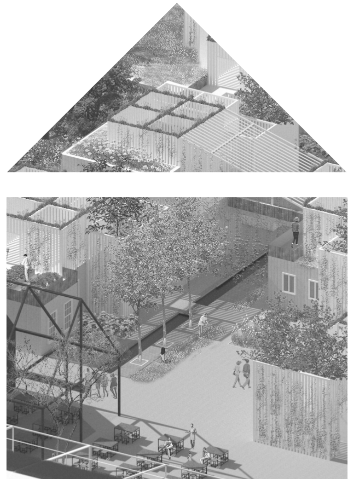

URBAN FOODPRINT

exploring a design that
merges urban landscape and
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CONTENT

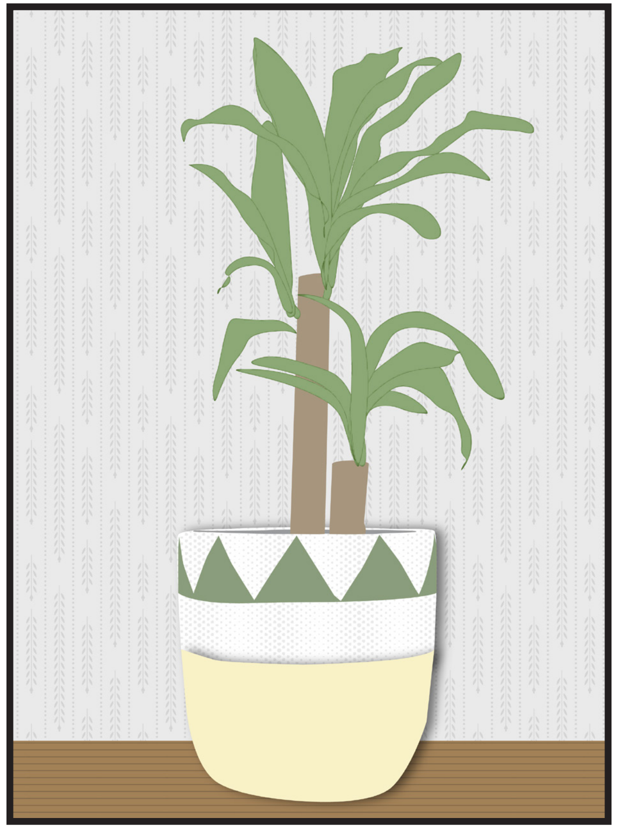
ABSTRACT

Globally, there is an intensification of agriculture that puts high pressure on local eco-systems. Soil degradation and deforestation are some effects that in the long-term perspectives cause agricultural degradation. Still, UN projects that we would need to increase our food production by 70 per cent to supply our growing population with food.

Currently, we are facing intense urbanisation and in 2050 two-thirds of the total population are projected to live in cities. As the major part of the labour will live in urban agglomerations it leads to the question of the possibilities to produce food in cities. Urban farming and locally produced food have recently been an upcoming trend, if the food production is moved to cities there will be less pressure on eco-systems in the rural landscape. Implemented in certain ways it can enhance bio-diversity and add green values to cities. However, arguments against, points out that many of the urban centres suffer from bad soil quality that can interfere with the quality of food. Adding a spatial perspective of food production increase the surface beyond visible territories and due to the conflict of activities, it might not even be possible to implement space demanding fields of agriculture in urban agglomerations.

If agriculture is supposed to be an integral part of the urban landscape there will need to be further studies regarding spatial dimensions and issues that can interfere with the quality of food. Applied in a physical environment, this project will explore the possibilities to implement food production in urban environments. It will experiment on density related to certain diets and if an adaptation of the landscape can create profitable circumstances enhancing self-sufficient lifestyles. It will also explore what qualities are brought to cities when agriculture is implemented in urban environments.

INTRODUCTION



THE PLANT IN A POT

This thesis will investigate how the design of buildings and urban landscapes can be shaped in correlation with sustainable food production and will investigate questions such as if we can design an environment that enhances more locally produced food. Apart from the production of food itself, what are the spatial qualities that a concept for urban farming can bring to cities?

Today we are dealing with a global food consumption that not only harms our health but also the biodiversity in several areas of the globe and soon we will need to make an action to prevent further damages. Example of ways of how to deal with this is to globally enhance less resource-demanding diets, explore technological solutions, find ways to make the farmland more productive or find more space to grow, preferably closer to where people live. Today it is not uncommon to look at the city as separated from the farmland, the city is where most people live and the farmland is a productive landscape to be viewed at from outside. But the truth is that people in the cities are very dependent on what happens in the farmland and the bigger the gap between cities and farmland the more sensitive the system can be for changes, unfruitful circumstances in an agricultural landscape can increase the price of food in faraway cities.

With this said, it should not be underestimated how much space is required to supply cities with food. Looking at the technology that we have today, many cities are spatially not made to be self-sufficient, to be able to survive they need land outside the borders to feed their population. Using the cities as the only source of producing food would not be enough.

The project will have its focal point in Refshaleoen, Copenhagen, located in Öresundsregion, the region that includes east Denmark and southern Sweden. The region is an area with, in general, high-quality soil used for agricultural landscape, but it is also an attractive, densely inhabited area with an increasing population which makes the question of space interesting, is it justified to let the cities grow on high-quality soil and could there be other solutions where the city can grow in combination with the agricultural landscape? As the focal point is within the Öresundsregion, the project will emerge in a Nordic context, though as inspirational sources the project will also look at other densely populated regions in the world that embraced urban farming.

To understand how to develop a city in combination with an agricultural context it would be a start to investigate the footprint of our food production and research on the relation of spatial dimensions. Further, crucial factors for growth such as sun access, water treatment, sheltering and soil quality would be important to study. Developed into a strategy, this can then be used as the base for further development of self-sufficient cities.

Even though there are strategies for growing more locally, there is the psychological aspect, which brings us to the question of how far people are willing to go to produce their food? Can the design be shaped in a way to make growing food convenient for people with already strong-rooted lifestyles? Just because it is potentially possible to farm the land, does not necessarily mean that someone will farm it.

I like to compare the human population with a plant in a pot, the earth as the pot and the food we produce as the soil and water that supplies the plant with fuel. In the beginning, the plant is small, it thrives and flourishes in the environment rich in energy. The plant grows bigger, and sooner or later the fuel from the rich soil runs low and will not be able to supply with the right amount of energy. The plant does not lie it tells us when something is wrong, normally, watering the plant adds nutrients, the soil can be renewed and changing the pot can create more space. The human population are still more complex and difficult to grasp but looking at it as a plant it does not lie either and we need to find solutions to make the environment pleasant enough for the plant to survive.

In 2020 we had a population of 7.8 billion and the estimated amount of our total population in 2050 is 9.7 billion. In the meantime we are facing a bigger movement towards urban centres around the globe, we have 33 megacities (a city with a population bigger than ten million), in 2030 there are 43 megacities projected and in 2050 two-thirds of the people in the world will be living in cities. To be able to feed our growing and urbanising population UN projects that we would need to increase our food production by 70 per cent in 2050. The population is not only growing, but the economic situation is also improving in many emerging countries which can lead to food consumption that is characterized by greater demand for meat, fish and dairy products and other resource-intensive items (FAO 2009: 1; FAO 2018: 12; Pezzini 2012; UN 2019).

There is a correlation between the increase of income and overconsumption of food, where economic growth in many countries has been associated with significant changes to average diets that stimulates an inflated demand caused by over-consumption. In developed countries this has already happened, from 1936 to 2006 in the US, the portion size and calorie counts have increased by 50 per cent and in 2016 there was 72 per cent overconsumption of protein in Europe and 80 per cent in North America. It is the animal-based protein, the most space requiring protein source, that has been increasing the most.

Between 1961 and 2009 the global average per person availability of animal-based protein increased by 59 per cent, while that of plant-based protein increased by 14 per cent. Although animal-based food consumption may be peaking in developed countries where it is already high, it is projected to rise in developing countries, especially in emerging economies and in urban areas. The estimated total consumption of animal-based food is expected to rise by nearly 80 per cent between 2006 and 2050 (Nevius 2016; Ranganathan 2016). In the time as this is written, the food industry has been even more actualised due to the coronavirus, the pandemic has caused several lock-downs and economical crisis amongst many countries. A majority of experts argues that the virus was spread from animals to humans, because of the relatively short time since the outbreak it is difficult to argue, some says that it was due to poorly managed animal keeping. Diseases that are spread from animals to humans is nothing new and there is an obvious risk for this to happen again. In light of the pandemic, it is arguable to eat less food that is based on meat as it is both a health risk and is causing a resource-demanding consumption.

AGRICULTURAL INTENSIFICATION AND DEGRADATION

At the same time as we have a growing population with an increased resource-demanding consumption the total amount of arable land is decreasing. The main reason for this is because of the degradation of soil quality due to erosion and climate change, around three million hectares of agricultural land are lost each year because of erosion, which is when soil components move from one location to another by wind or water. In the EU, 13 countries have declared that they are affected by desertification, due to climate change, declines in soil moisture have increased the need for irrigation and lead to smaller yields, changes in seasonal temperatures can shift the annual cycles of plants and animals resulting in lower yields as the vegetation blossoms before their pollinators have hatched. Erosion is a natural process but can be prevented by using cover crops. For agriculture, plants such as clover grown in between harvest and sowing could increase soil quality and avoid erosion, healthy ecosystems with restored soils can keep the carbon underground and by this act as a defence against climate change. Restoring currently degraded soils can remove up to 63 tonnes of carbon, a small but important share of global greenhouse gas emissions, the restored soil can also capture moisture underground and slowly release the water during dryer seasons making it more resilient to temperature changes (Cunningham 2013; European environment agency 2019).

Four million hectares are lost every year when agricultural land is converted and used for the built environment such as highways, housing, factories and other urban needs, our population is increasing and we still need to find more space to produce food. There has been an intense development where people and organisations around the globe are looking into solutions of how to solve feeding our growing population. Even though the total population has doubled in the same amount of time and the total arable land has decreased by more than half, the food production has increased during the last 50 years and enabled a reduction in malnutrition rates. This is mainly due to high-efficiency production, although the intensification of food production has a backside, in conjunction with the population growth farming practices have evolved to produce more food to feed the larger population by the usage of chemical fertilizers, irrigation systems, pesticides and mechanized technologies. Increased intensive farming has put pressure on local ecosystems, reduction in biodiversity and due to the machinery required, intensive farming is also considered as a major contributor to climate change.

The forests host 80 per cent of the world's terrestrial biodiversity and are a major provider of various vital components of functioning earth, not the least cutting atmospheric carbon dioxide. Planting more trees around the globe would buy us more time to deal with global warming. In the meantime industrial agriculture is the most significant driver of deforestation, in tropical and subtropical countries, it accounts for 80 per cent of deforestation from 2000-2010. Globally, almost 50 per cent of the land that is suitable for vegetation, such as forest, have been converted to agricultural land. One example of this is the deforestation of Amazon rainforest which not only have negative effects on global warming but will also mean the loss of sensitive and unique ecosystems. A major reason for this is the import of soy and beef products to other parts of the world such as the EU.

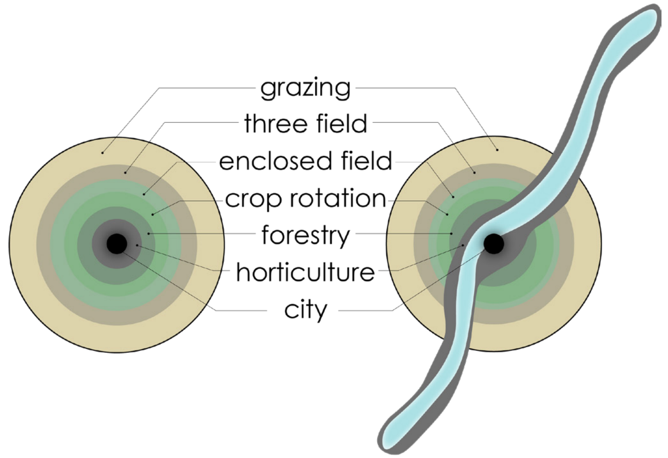
Looking at effects brought by the coronavirus there is an obvious risk that might as well apply to any other potentially upcoming crisis leading to lock-down. As a first effect of the virus many shelves in groceries, usually filled with goods, became empty as people started to hoard food. In many countries, hoard food was never a recommendation, but it tells something about the human flock behaviour in desperate times if every country starts to use aggressive trade restrictions to secure strategical food stocks there is a risk of inflation. Food prices are difficult to project but according to FAO (2015: 2-3), food prices are already expected to rise due to climate change and countries that are most exposed to inflation are the ones where import is a big part of the food supply or have a low valued currency. In some cases amongst poor urban households, 60 to 80 per cent of the total income are spent on food, this increases the vulnerability to global food price inflations and tells something about the dependency on our complex system of food production. Another point is the question if it is justified to keep on destroying 50 million old ecosystems to feed someone else on the other side of the globe, cutting down the forest for agriculture is only a short time solution and a risk for creating a vicious circle as it is proved to have negative effects on climate change and with higher temperatures comes a risk of decline in arable land.

There are unconventional methods to agricultural systems where the local ecosystems in forests are embraced to become highly productive, rather than being destroyed. Syntropic agriculture is a method developed in Brazil that uses patterns of the rainforests and imitates the diversity of the natural ecosystem to stimulate productivity and in the meantime improve soil quality and the balance of biodiversity. Biodiversity has an important role when it comes to food production, in human history about 7000 plant species have been cultivated for food, their wild relatives hold a cache of genetic diversity that may be important as drought or disease threaten monoculture crops. Today about 75 per cent of our food supply comes from 12 plant species and these could not work without hundreds of thousands of lesser-known species, a wide range of wildlife makes agriculture possible.

As a result of improved biodiversity, food production does not necessarily have to mean the elimination of the local ecosystem, one strategy would be to create a model of agroforestry by using trees as an important part. When 10 per cent of the agricultural land is covered by trees it is defined as agroforestry which means that it would not be a substitute and a reason to rearrange an already existing forest, but it might be reconsidered when developing new areas for food production and that trees can be used in a wider range compared to conventional agriculture. Apart from the positive effects such as cleaning carbon dioxide from the atmosphere, there are several benefits when trees are included. They can contribute to higher yields, provide a habitat for multiple species and continually enrich the soil with organic matter such as fallen leaves. To get the highest effect all the layers of the forest should be used including tall trees, small trees, shrubs, herbs and ground covers. Agroforestry can be implemented in the rural landscape as well as in the urban landscape such as gardens, parks and other green areas (Agroforestry network and vi-skogen 2018: 4; European commission 2019; Global forest atlas 2020; Leahy 2019; Mclendon 2019). It is a possibility to use farming as a way to both embrace biodiversity and to help to prevent climate change and by this stabilise and enhance the productivity. There is a necessity to take care of the arable land that is declining but as there is ongoing urbanisation, much of the labour to accomplish this is moving towards the cities. This leads to the idea of enabling food production closer to the cities.

CITIES AND FOOD PRODUCTION

Carolyn Steel, an architect and writer of the book Hungry cities, argues that city and country have been locked together in an uneasy symbiotic clinch for 10 000 years. As the cities have relied on the countryside to feed them, the countryside has obliged. Some small cities existed before the invention of agriculture but it was not until the discovery of agriculture that the era of cities really took off and flourished (Steel 2009: 7). Most of the pre-industrial cities were developed as an integral part of the supplying system. These cities usually had cultivated land inside or adjacent to the borders and historically arable belts were normally no longer than the distance a horse-drawn cart could cover in a day. Von Thünen who presented the theory of the isolated state developed a land-use model for pre-industrial cities giving a belt of potential agriculture land of approximately 20 miles in radius. If the city had access to a waterway of any kind it could expand its arable belt to include the accessible areas connected to this making it possible for the city to grow (Delshammar et.al. 2012: 4; Stenholm 2014: 24-25).



Von Thünen model Model modified by a river

Feeding the cities has been one of the greatest forces of shaping civilisations, Steel argues that in order to understand a city properly they need to be studied through food and not as isolated islands. The cities grew dependently on agricultural yields and they still are (Steel 2009: 10). The difference might be that the fields and vineyards of ancient city-states were considered just as important as their streets and buildings and rural citizens enjoyed the same rights as their urban counterparts.

Today many people move to cities because they hope to achieve and do things that they don't believe that they could do or achieve in the countryside. As cities grew, it not only absorbed the resources of the nearby villages and countryside. An example of this is the Roman empire that became highly driven to expand in order to feed its capital (Steel 2009: 16-17; Stenholm 2014: 37-38, 83). The continuous expansion, the dependence on distance trade and military might eventually cause the fall of the Empire. There are a variety of different reasons for the fall of civilisations but five commons are presented below, in no particular order:

- Environmental damage, such as deforestation and soil erosion.
- Adverse climate change.
- Dependence upon long-distance trade for life-essential resources, followed by the loss of these trading partners.
- Increasing levels of internal and external violence, such as war or invasion.
- The way society chooses to respond to its environmental problems.

Today economic power and resource demands on one continent often lead to a decrease in resources on other continents. An effect of this is explained before when the need for meat in Europe leads to deforestation in South America. Looking at the historical reasons for a collapse, there is currently some factors to be aware of such as climate change, deforestation and soil erosion as well as dependence on long-distance trade. In the meantime, we see a movement of global power balance from the western world, and people in Europe are becoming increasingly aware of this international and intercontinental struggle for resources (Stenholm 2014: 39, 49-50). It is important to consider how society responds to its environmental problems, environmental-friendly technological improvements and changes to less resource-demanding consumption are some methods that are already improving and movements towards a more self-sufficient society is another trend.

SPATIAL REQUIREMENTS

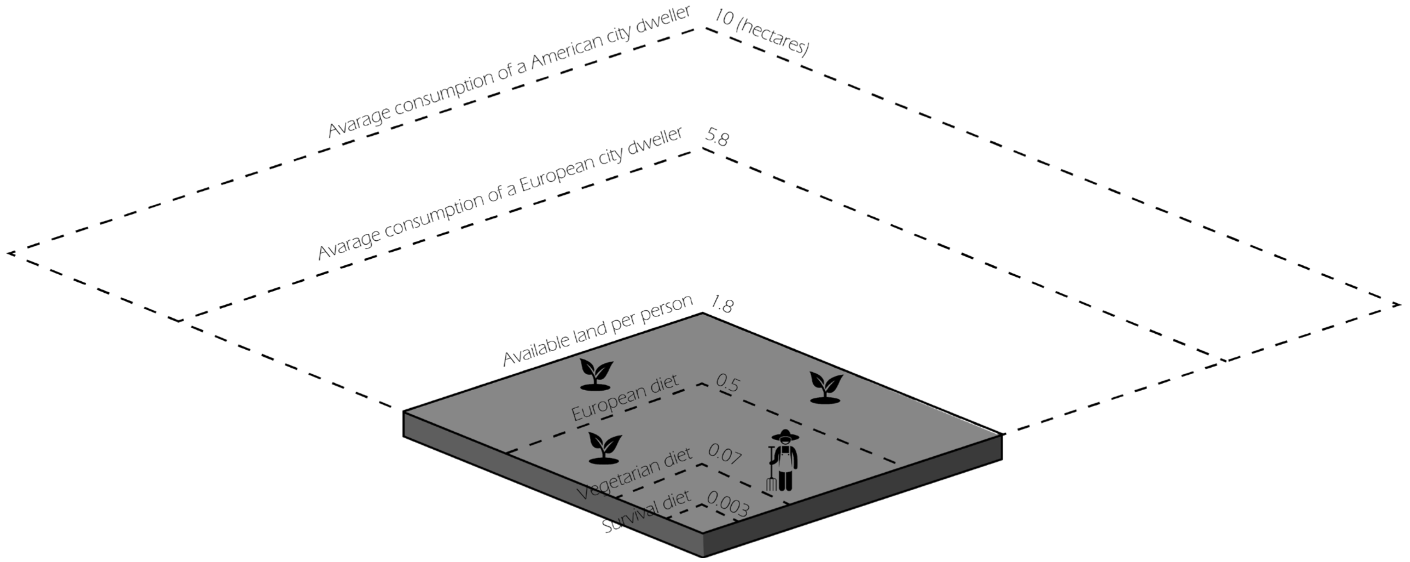
Doing spatial studies is a great start when trying to understand our total agricultural footprint, studying how much space is required to be able to supply the whole population with food and thus our possibilities to become self-sufficient. We are limited to one pile of earth with a total landmass of 150 million square kilometres, a landmass with resources that has to be shared amongst our total population of 7.8 billion and if we put the numbers together and add the variable of everyone having a conventional European diet, requiring 0.5 hectares per person (Stenholm 2014: 86), we would need a third of the total landmass for farmland. This gives a hint of how much space that is required to be able to supply us with food, but as it probably would not be possible to grow food on the top of Mount Everest or in the middle of Sahara desert it would be more reasonable to look at the total arable land in use which according to FAO was 10.8 million square kilometres in 1999. With the estimated amount of our total population in 2050, assuming that the total arable land in use would not change significantly and that everyone is using the conventional European diet then we would need all the arable land in use multiply 4.5 to be able to supply our population with food.

Looking at this perspective we would need a less resource-demanding diet to be able to share the global food resources amongst the total population. As an example, with a vegetarian diet requiring 0.07 hectares per person, we would need 67 per cent of the total arable land and in theory, a person could survive on only 0.003 hectares, 30 square meters, of land which would then only require 2 per cent of the total arable land. Looking at these numbers seems hopeful but even if there are arguments for that, changing diets on a global scale is not an easy task and may not be needed to this extreme extent. But using these numbers is a way to understand how to develop cities in order for the people to have the possibility to become self-sufficient. Using London as an example, with a conventional European diet the city would require an area that is more than the whole surface of Denmark to feed its population. With a vegetarian diet, the city would need five times of its own area to be able to feed the population, and in theory, with the minimum required space, the city would need less than half its own area, making use of the parks, gardens and roofscape to supply inhabitants with food.

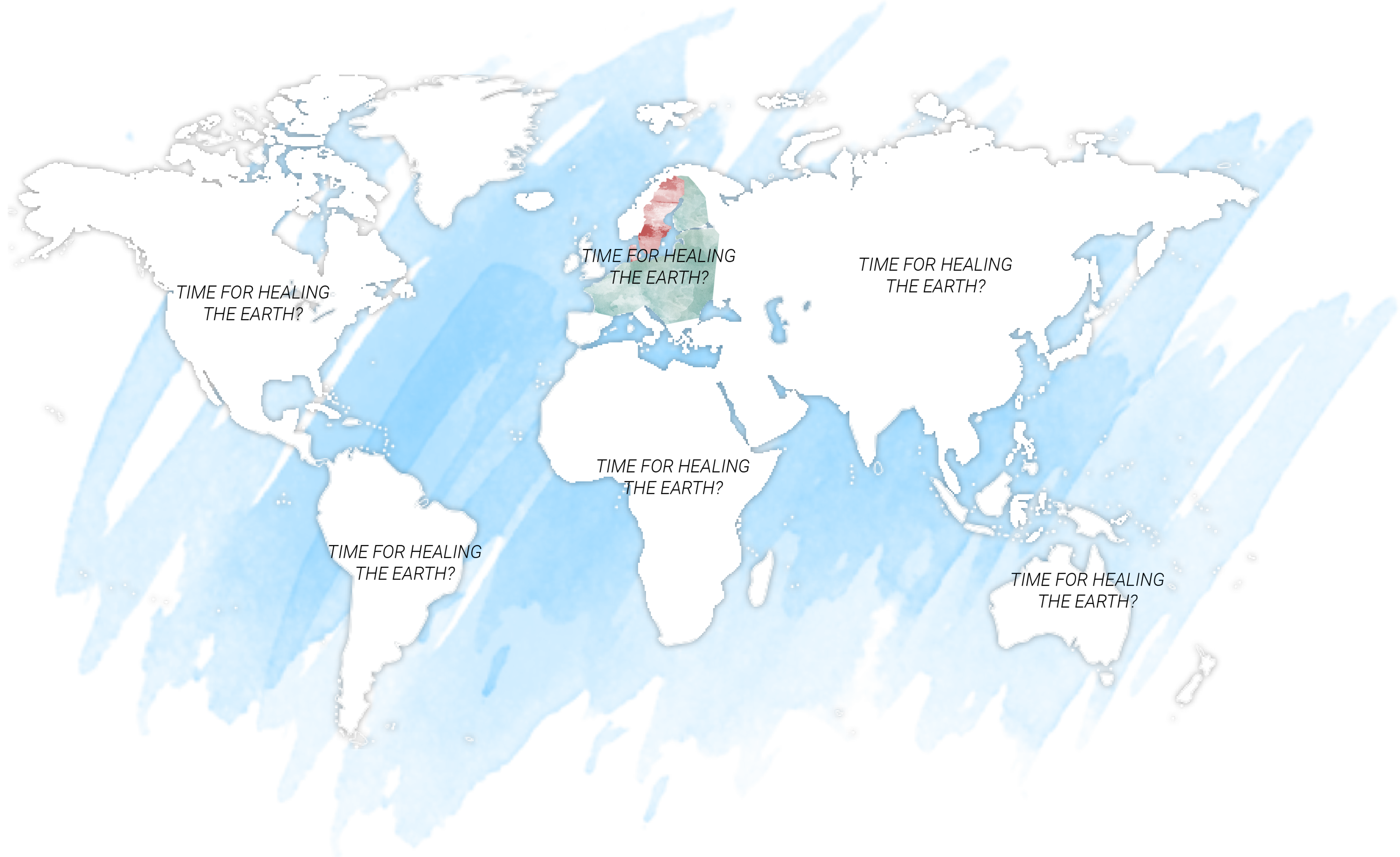
Getting back to the bigger perspective again, and imagine the global built-up areas, such as cities, town villages and human infrastructure, approximately 1.5 million square kilometres (Ritchie 2018), being used for farming. With a conventional European diet, this area could feed up to three per cent of our total population. Using the vegetarian diet as a variable then we could feed up to 27 per cent of our total population and using the minimum diet instead, we would increase to feed even more than the total population. The numbers tell about a conceivable outcome of changing a diet, but it also gives us a clue about the possibilities to grow food in cities. A city usually consists of several amounts of activities that compete with space, some spaces can be combined with food production such as lawns, balconies, rooftops. Then some spaces are obviously more difficult to combine with permanent farming, such as highways or sport facilities.

DEFINING DENSITY AND LOCAL BOUNDARIES

A visit to the exhibition Agricultura e arquitectura: Do lado do campo in Lisbon was made at the beginning of January 2020 as an inspirational source for this project. The exhibition reflected on the critical environmental situation the world is facing, with a focus on strengthening the relationship between agriculture and architecture. Looking at concepts such as agroecology and permaculture the exhibition explored ways of how to redefine maintenance of living territories. The exhibition explored current events such as the growing urbanization, changing diets and lifestyles, exacerbated by climate change. Further, the importance to reconsider the interaction between the city and its surroundings, the countryside, not as two antagonistic realities, but according to a complementarity



SPATIAL REQUIREMENTS DEPENDENT ON SPECIFIC DIETS AND CONSUMPTIONS.



Spatial concept where the green area is the space needed to be able to feed the population in the red area with a vegetarian diet and a density of 150 persons per hectare.

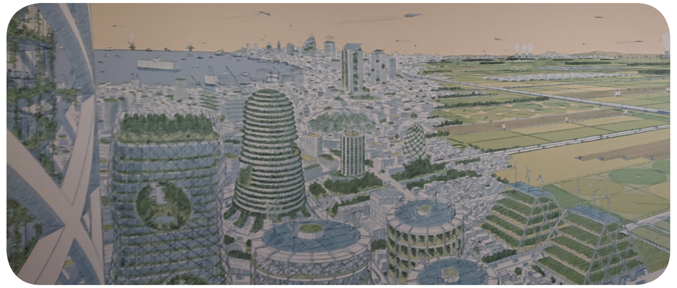
dynamic, where the greatest potential for transformation can lie and face today's planetary challenges.

For this project, the visit to the exhibition initiated an idea about how different implementation changes the outcome depending on local circumstances, density and planning type. Four of these implementation types were explained and illustrated as imagined outcomes. First is *Incorporation* which is the highly capitalistic metropolis that absorbs agriculture, second is *Infiltration* where agriculture and horticulture invade the city, third is *Negotiation* that allows agriculture to become an integral component of urban extensions, *Secession* where every house is seen as the component self-sufficient and supported by the area that surrounds it. With this in mind, it is of interest to study how pro-active planning can shape the spatial conditions, by imagining a certain life-style the planner is allowed to define a path towards a desired outcome.

Fundamental historical shifts regarding food production in relation to urban settlements and the influence from different front figures were frequently mentioned in a timeline. It started with the Neolithic revolution where agriculture and architecture enter the scene as two complementary poles of an autocatalytic process by which societies start to coevolve with their ecosystems. Through different target points, the timeline stretches towards the Great acceleration after World War II where globalization, technologic progress and fossil fuel enabled a spectacular population growth but also impoverishment of non-renewable resources. The great acceleration has put us in an unsustainable situation, criticized by many. One of these who were pointed out, Vandana Shiva, a physician, philosopher and eco-feminist expressed the important step to move from a centralized, chemical monoculture and long-distance transportation towards direct consumer-producer links bypassing the exploitative middlemen, including giant corporations.

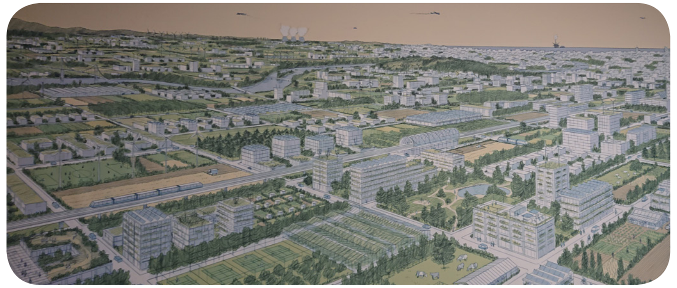
By imagining this as a future system it is interesting to study what it means when implemented in spatial planning. It is not only a question of how different a city would be, one that is dependent on the local situation and another one that is dependent on far away food production. The relation between primary living area (space where people live) and secondary living area (the space needed to supply the primary living area with food) brings us closer to the idea of density and distance. What happens to the distances in an urban settlement when local food production is an integral part depends on how it is implemented and what defines local. Looking at the imaginative outcomes of the four examples *Incorporation*, *infiltration*, *negotiation* and *secession* it is possible to find a division between a highly dense alternative, *incorporation*, that incorporates agriculture to the urban environment with vertical gardens but would mostly be dependent on the agriculture that surrounds it. Conceptually, the city as a compound primary living area with a distance to the agriculture that supports it. Compared to *secession*, a low dense alternative where the households are spread, every single one seen as a component with direct access to the secondary living area that surrounds them and consequently the alternative with the closest connection between primary and secondary living area.

This becomes important when discussing local and brings us to the question of how we define the boundaries of local. Attempts to articulate what counts as local have only recently emerged and there is yet no clear definition of local food. The two main approaches to local food are local by proximity, everything within a certain physical distance, or local by relationship, the ability to have direct contact with the food producer. It is possible to define the proximity of local food by looking at access to population-dense areas where transactions between food producers, retailers or consumers occur more frequently. As urban centres allow for more retail outlets, such as restaurants and grocery stores, local can be kept within a shorter distance compared to less densely populated areas such as rural settings. The interest in local food may also differ as it is more common for



Incorporation. Agricultura e arquitectura: Do lado do campo (Marot 2019).

Infiltration. Agricultura e arquitectura: Do lado do campo (Marot 2019).



Negotiation. Agricultura e arquitectura: Do lado do campo (Marot 2019).

Secession. Agricultura e arquitectura: Do lado do campo (Marot 2019).

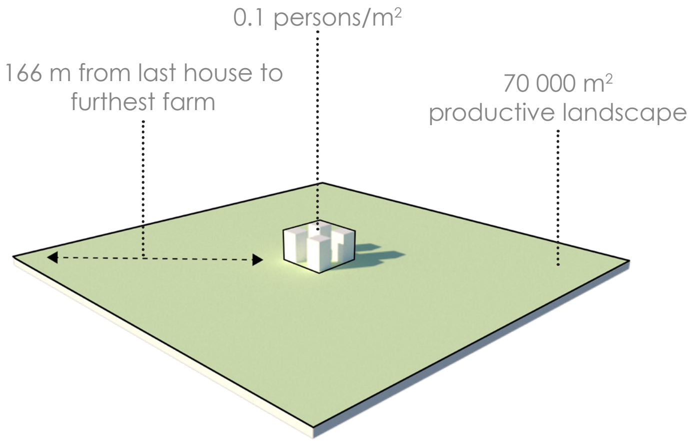
urban consumers to see local food in a more individualized light (having local food for their own benefit), while rural consumers see local food as a possibility for community building (Trivette 2015: 475-477).

Dense environments are considered positive as they generate intense social links and sustainable use of resources, shortened distances enables a walkable environment that also improves physical and mental health. Although, when self-sustainability is reflected in urban centres, it is considered to be impossible as people seek their own personal best and care little for the common good of the community. Arguments against large and dense cities point at these as capitalistic hubs perceived successful within a shorter time-frame but in a longer perspective degradation and depletion of limited resources will lead to the collapse of the city. A low dense scenario where every community or family is self-sufficient and takes care of the common or private land adjacent to the house supports an adjustment of close connected urban behaviour of consuming from elsewhere, and a change from urbanisation, where people move from city to low dense communities in the countryside (Stenholm 2014: 47, 50, 83-84).

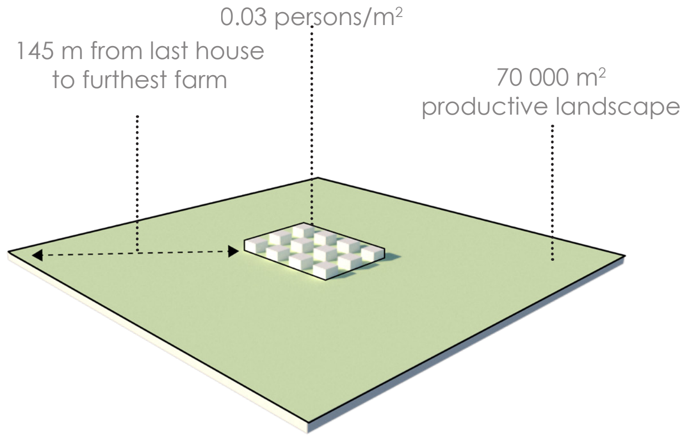
Understanding local in terms of proximity suggests that shorter distances mean more local, the most local would in this case be where a household has direct physical access to where the food is produced. In a perspective of local by relationship, the most local would be when the food production avoids any bypassing, the household is in this case producing all their own food. Due to the space required to produce food it becomes problematic to keep this certain local appearance in dense areas, this because the less dense a primary living zone is, the closer the local can become. This makes the implementation of agriculture a balance of distance between food production and consumer that still keeps a certain desirable density.

This is explained in the figures to the right that explores three different types of settlement: urban centre, suburban neighbourhood and rural single houses, each alternative inhabited by 100 persons. The experiment is based on a vegetarian diet which means that 70 000 m2 is needed to supply the people with food. All the space on the ground and the rooftops are used for food production, every building complex has an equal length and width of 10 metres, in the first scenario the buildings are all separated 10 metres apart. They differ in height which is a common variable affecting the density, the space required for building and the space between these is set as size boundaries and together with the population decides the density. The longest distance between household and farm is in all cases of scenario one 187 meters. As illustrated, the less dense example has the least potential people with this distance and is the one that provides the shortest distance between the last house and furthest food production. From this, the volumes can be rearranged differently to minimize the distances but the result will have similar results. Though, this only applies if the rooftops are productive as well, in other cases the productive landscape will have to expand depending on how much ground space the buildings require. The experiment also assumes that the rooftops are equally effective as on the ground which in reality is not always the case.

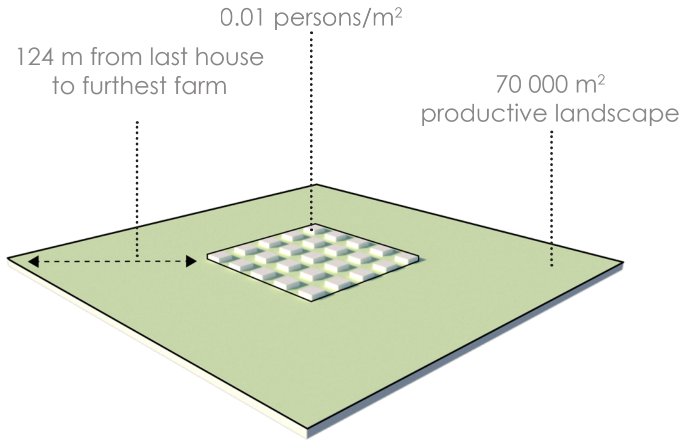
It is a matter of perspective when it comes to the discussion of local food, there are examples using a guideline of 100 miles as a boundary for local (Trivette 2015: 476), which compared to the urban centre is much more generous and rather a regional perspective. In reality, it will probably depend on local interests and economical factors to define a common idea of what boundaries are in terms



Urban centre agglomerated: This alternative is based on four building complex, six floor in height, each an agglomeration of 25 people. Calculating the built environment and the total space between these, this alternative has a density of 0.1 persons per m^2 , the highest density of all alternatives. Except any vertical distance the longest distance from last house to food production is 166 metres.

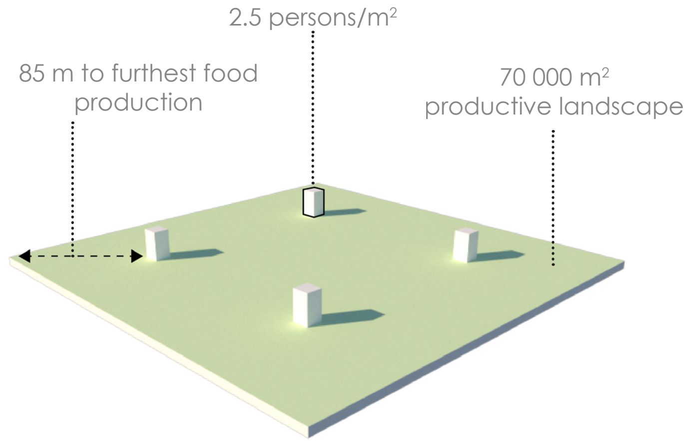


Suburban neighbourhood agglomerated: This alternative is based on 12 building complex, two floor in height, each inhabited by 8 persons. The alternative has a density of 0.03 persons per m^2 and the furthest distance from last house to food production is 145 m.

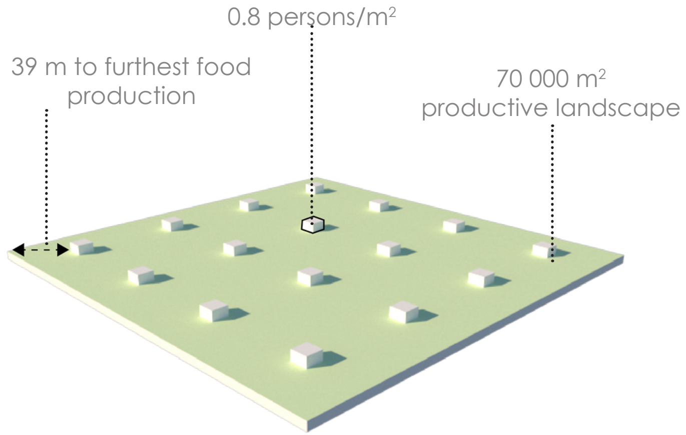


Rural single houses agglomerated: This alternative is based on 25 building complex, one floor in height, each inhabited by 4 persons. It is the alternative with lowest density and the shortest distance between last house and furthest food production.

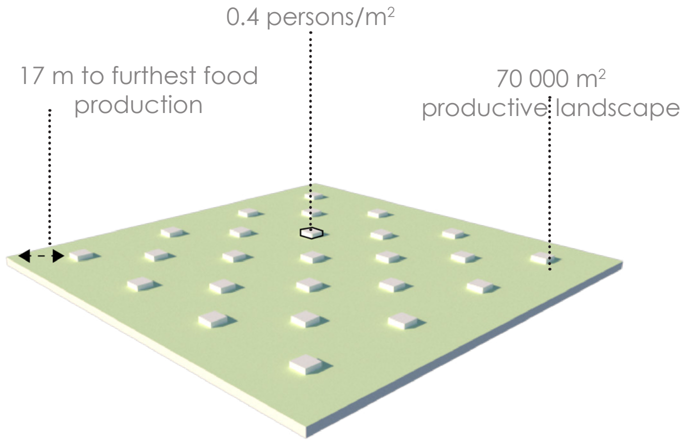
SCENARIO ONE



Urban centre spread: This alternative is based on four building complex, six floor in height, each an agglomeration of 25 people, the highest density of all alternatives. Except any vertical distance the longest distance to food production is 85 metres.



Suburban neighbourhood spread: This alternative is based on 12 building complex, two floor in height, each inhabited by 8 persons. The furthest distance to food production is 39 m.

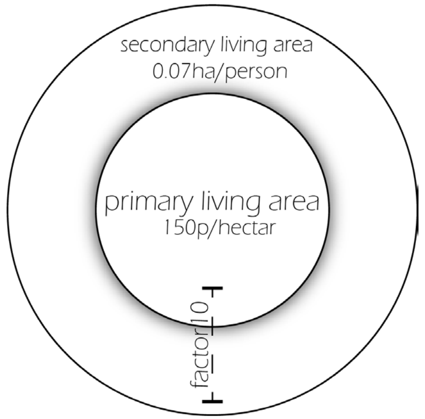


Rural single houses spread: This alternative is based on 25 building complex, one floor in height, each inhabited by 4 persons. It is the alternative with lowest density and the shortest distance to furthest food production.

SCENARIO TWO

of local food production, although this adds a design aspect to the discussion. Local offers a direction towards sustainable solutions but it should not be assumed that local is inherently justified as sustainable. Adding a spatial perspective of food production increase the surface beyond visible territories and due to the conflict of activities, it might not even be possible to implement space demanding fields of agriculture in urban agglomerations. Because of soil quality and less exploited sites, the countryside is on many occasions considered the best option for agriculture. Despite this, pioneers for vertical gardens argues that vertical farms could increase the total yield. The concept is to create a year-round crop production in a closed system that eliminates agricultural runoffs, affected by external natural processes (Despommier 2015). As it is based on vertical development the space for growing can increase drastically compared if only the ground was used. Vertical farms seem to solve many problems but there are arguments pointing that it requires large financial investments and that the total economic profit, therefore, can be questioned. In environments where water is a scarce resource, vertical gardening as a closed system might be effective but looking at the technology we have today, skyscrapers that supply whole cities remains a utopia. However the concept leads to a field of research were horticulture, molecular biology, technology and architecture can merge (Delshammar et.al. 2012: 9-11).

Spatial opportunities will be on the agenda in many dense urban centres around the world when implementing local food production. Even though density differs between urban settlements it is possible to set a guideline to understand a spatial dimension that is required to feed the population. For example, by imagining a density of 150 people per hectare as the primary living area and a secondary living area that is based on a vegetarian diet, it creates a correlation of factor ten. For every space required in the primary living zone, there will be ten more of the second living area. These calculations can be used for urban designers to pro-actively plan according to an imagined lifestyle and diet type.



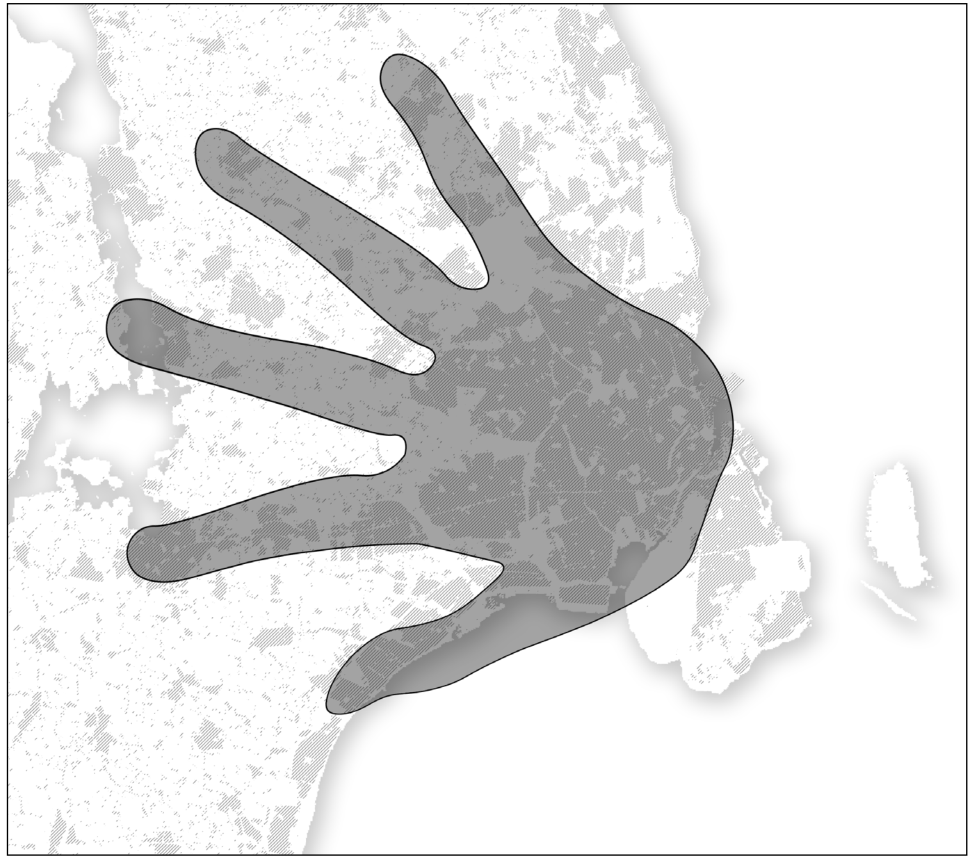
EXAMPLES OF DENSITY AND SOCIAL STRUCTURES

As mentioned, it is common that urban centres come with a mentality that embraces local food for individual benefits rather than community building. However, in practice, this idea is not entirely applicable, to further investigate extreme scenarios of density and social structures in relation to urban farming, a study trip to Rio de Janeiro was made in February 2020. An organisation called Favela orgánica, initiated by Regina Tchelly, became successful and known in both Brazil and internationally by encouraging the creation of community gardens and reuse of healthy food. A visit to the favela Babilônia - Chapeu Mangueira, where the organisation first established, was made where Tchelly gave her point to urban farming. From Tchelly's experience growing more locally and organic makes people eat more healthy food, eat more environmentally friendly, become more aware of the food chain and recycle more. Using empty spaces and the community, the residents from the favela cooperate to maintain the gardens. One example is a healing garden that encourages people to eat healthy herbs such as Pimenta (good against issues related to the heart), Basil (ease acne, insect bites and skin inflammations) and Pereskia (prevents against inflammations, skin problems, treats wounds and are based on 25 per cent protein). By writing the information on the facade and using colourful architecture creates attention towards surrounding gardens. The municipality of Rio de Janeiro has initiated a series of micro-scale urban agricultural projects which have made different neighbourhoods in the city come together to cooperate. At a community level, these gardens reinforce community solidarity and a sense of collectivity in otherwise conflicted areas. Many of the projects are developed in extremely dense areas such as the favelas with, on some occasions, have more than 60 000 people per square kilometre. These heavily dense areas appear to lack the necessary space for urban farming, however with an idea that any sunny surface fit the needs for a planting area the implementation has been improvised to small scale backyards, patios or favela rooftop terraces, laje's, that is flat and receive sun (Torres 2017).

As food prices in Rio de Janeiro can differ as much as 17 per cent in a month, urban farms can reduce vulnerability and offers economic stability for low-income earners. Though, due to insecurity and risk of violence, it is not an easy task to implement urban farms in the favelas of Rio de Janeiro. In the Rocinha favela there have been several tryouts, the project *Rocinha Mais Verde* in the area Valão was showcased at the 2012 United Nations Rio+20 Summit on Sustainable Development as an outstanding example of sustainable design but because of security constraints, it has not been possible to develop other projects in the Valão. Another project in Rocinha, in the area Cachopa, Estrada da Gávea, opened up interactions between neighbours that initially were strangers from one another. Exchange of materials, ideas and emotions evolved into a social practice that laid out a groundwork for fostering solidarity. This created willingness for neighbours taking the risk to help each other and develop informal forms of public responsibility. On steep slopes of Tijuca favela, the *Hortas Cariocas* program established food gardens that helped to improve socio-economic development, poverty alleviation, food and nutrition security, and the mitigation of erosion and pollution. Many of the urban farming projects in the favelas in Rio de Janeiro proves that they initially or at some point can gather groups and develop a community spirit, but in areas facing violence it can not be seen as a single solution solving issues regarding insecurities (Rekow 2015: 3; Rekow 2016: 58, 60-61). According to Tchelly it is important with a combination of top-down policy and bottom-up initiatives to maintain the urban farms. Increase of awareness, anti-corruption and access to money (even small amounts) are crucial for the maintenance. The examples from Rio de Janeiro shows that it is spatially possible to implement urban farming in extremely dense urban environments, these can increase economic profit and if well maintained enhance the community spirit. Even if a city can not become totally self-sufficient, urban farming can add several qualities worth considering in urban developments. Studying regional and local circumstances is important to further investigate the implementation of local food production.

The terrace at Favela orgánica, Babilônia - Chapeu Mangueira, Rio de Janeiro.

REGIONAL PERSPECTIVE



The hand is the city, the cells are the people, the cells needs nutrients to sustain and the people need food to survive.

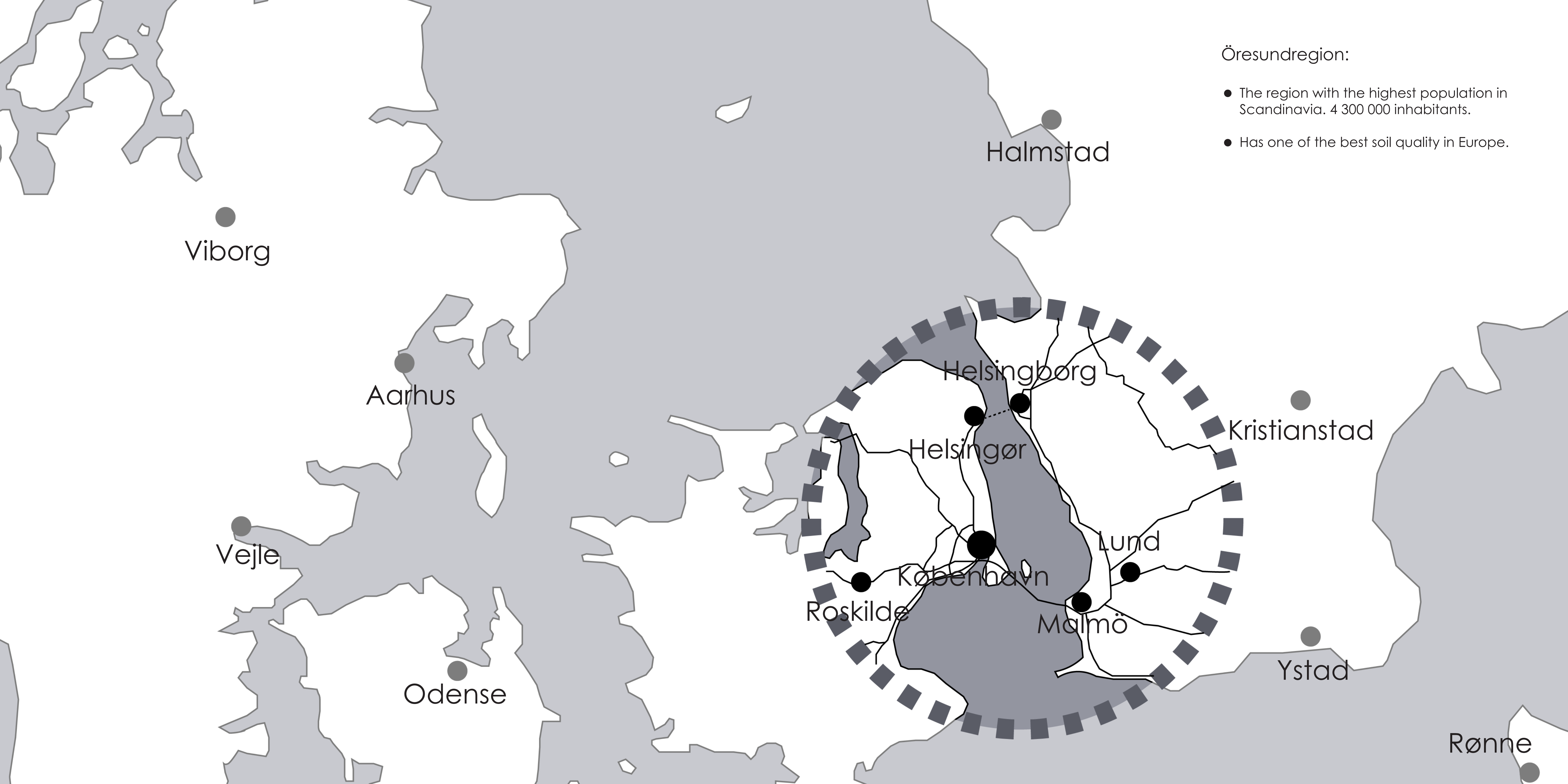
The project site is situated in Copenhagen, in the Öresundregion, a lucrative area that merges east part of Denmark and southern part of Sweden. The region has a population of 4.3 million which make it the biggest metropolitan area and one of the densest areas in the Nordic region. Because of the high soil quality, flat landscape and fruitful climate conditions, large areas in this region is made for agriculture. In the meantime there is a growing population, during the latest ten years there has been a growth of 300 000 inhabitants, this puts pressure on the local food production, a conflict that is visible in some cities. One of these is Lund, together with Helsingborg the most growing city in the region latest year (Øresundsinstitutet 2020). The municipality explains that they want to let the city grow within the city borders as this is where there is the best access to workplaces and public transports, but to manage this the large demand for housing cannot only be met by building on non-agricultural land. This resulted in the principles that the builders need to compensate by enabling for growing in yards, balconies, facades and roofs (Lunds kommun 2020). However, some land is of high-quality soil and therefore the compensation will probably not create equally good circumstances for growing.

Copenhagen, the largest city in the region and densest urban centre in the Nordic countries, is commonly known as the vibrant bike-friendly city that during the latest years have scored within the top 10 of the happiest cities in the world. Much of the urban form is based on the five finger plan from 1947 which allows green wedges to stretch far in the city. This provides closeness for inhabitants to enjoy green fields, parks and agriculture and could very well be one reason why people living in Copenhagen are feeling so happy. Social interaction, access to workplace and leisure are all important qualities that usually can be found in urban centres, although proximity to rural landscapes provides unique qualities that enable an easy escape from the busy streets, qualities which should be considered when developing further. With this in mind, it is interesting to look at a fusion embracing these qualities in urban landscapes. In 2018 there was 31.91 m^2 green area per inhabitant in Copenhagen, 15.5m^2 parks, 6.22 m^2 forests and woodlands, 1.77 m^2 maintained grass, 1.68 m^2 dedicated to golf courses, 0.68 m^2 nature reserves and 0.57m^2 public gardens (Statista 2018), these statistics are not considering the allotment gardens that are spread out in the city.

CLIMATE FRIENDLY CITY

There is a mission of becoming the first carbon-neutral city in 2025 and as a part of this process, the City Hall has approved to plant 100 000 new trees, in this way objects that might be more commonly seen in the rural landscape are becoming a stronger part of the urban fabric (Lauritsen 2015). There are many positive aspects of this such as reduce of carbon emissions, increasing biodiversity, enhance the quality of life and depending on which trees, be a part of the local food production. Imagine if all the trees that are planted were apple trees, one semi-dwarf apple tree could produce ten bushels of apples which is estimated to supply two people, this means that 200 000 inhabitants would be able to feast on locally produced apples. If all the trees were walnut trees instead it could be possible to produce more than 2700 tons of walnuts a year (Wallin 2019), this would provide five walnuts every day for every inhabitant. Due to the sensitivity of large scale monoculture tree plantation and the lack of biodiversity, it would be more reasonable to plant many kinds of different species and there are several of them that are edible. This gives an idea of including food production in the strategies for Copenhagen adding yet another quality and as locally produced food reduces transportation it can assist the mission of becoming the first carbon-neutral city as well.

Looking at the strategic document Copenhagen Carbon Neutral by 2025 the CO^2 reductions are based on five themes, the biggest reduction should regard the energy production, following green mobility, energy consumption, new initiatives and lastly city administrations (Baykal, Jensen n.d: 13). Further looking at the document there are



Öresundregion:

- The region with the highest population in Scandinavia. 4 300 000 inhabitants.
- Has one of the best soil quality in Europe.

no direct aspects related to agriculture, urban farming and food production. When it comes to handling the climate change, the focus tends to be on clean energy solutions as it counts for the majority of greenhouse gas emissions, in the meantime the global food system is responsible for 26 % (Ritchie 2019), a large contributor to the global greenhouse gas emissions.

FOOD CULTURE AND URBAN OPPORTUNITIES

Today the inhabitants of Copenhagen enjoy a large number of luxury restaurants. The city had 18 restaurants with Michelin stars in 2014, 15 more since the city was mentioned in the guide main cities of Europe in 1983 and, in total, Denmark hold 35 Michelin stars in 2020, more than any other Nordic country. The epicentre of Danish gastronomy is based in Copenhagen and the cuisine is still rooted in the farmer's tradition, potatoes, rye bread and salted meat are still at the centre of most meals. Danish chefs and food production have recently gained international fame and the restaurant Noma in Copenhagen has been selected as the world's best restaurant four times in a row. The meatpacking district (Kødbyen) is one famous area known for its creative cluster with galleries, nightlife and restaurants. It was once an industrial part of the town that has become fashionable and popular and alongside the creative business cluster, the restaurants and nightclubs, it is still possible to find food companies with an industrial vibe (Danish agriculture and food council 2014: 36, Martinez 2015).

There have been progressive visions related to organic consumption where the city of Copenhagen wants to become one of the cleanest capitals in the world. In 2015, 20 per cent of the total food consumption should be organic food and the food consumed by municipal institutions should be 90 per cent organic food (City of Copenhagen 2007: 17). Organic production have been a priority by the national government for over 25 years. Denmark was the first country in the world to introduce organic legislation which means that organic farmers need to comply with organic regulation but also other rules pertaining to the environment, nature, animal welfare, traceability, hygiene and food safety in food production. The city of Copenhagen have developed a program that enables organic food in public food services without increasing the cost of meal. A conversion process during ten years, with a cost of 7.1 million €, launched a permanent structure, the Københavns Madhus (Copenhagen House of Food), that now provides a higher quality of service without increasing food budget. Less meat, greens in season, awarness of expenses, diverse food and use of the whole product are some of the principles for the public meal system. Today Denmark has the largest market share for organic food compared to any other country in the world and according to the Danish agriculture and food council, a new era has been ushered by a new movement called the New Nordic cuisine that promotes natural, locally sourced and seasonal raw materials in an innovative and creative way (Danish agriculture & food council n.d.: 14, 23, 29; Martinez 2015).

Denmark has a long tradition of exporting food, every year Danish farmers produce an amount of food sufficient to supply 15 million people per year, three times the Danish population. However, urban agriculture is still in infancy. There is an insecurity about the relevance of urban farms beacause of the low potential regard to food quantities and the level of pollution that will interfere with the quality of food. According to a standard law called the Jordforureningsloven, or Soil Contamination Act (§8 and §72b), all soil in Copenhagen is contaminated to a certain degree and urban agriculture must apply the Act by e.g. cleaning the soil (Martinez 2015). Looking at the map on page 29 more than half of the existing cultivation plots are within contaminated zones. If Copenhagen wants to, not only become one of the cleanest capitals in the world but also embrace organic, local and healthy produced food there is a need to develop a strategy that handles contaminated soil on a city level. Today there are already two bigger areas with contaminated soil that are dealt with by bigger companies.

Øresundsparken and Østre Gasværk are analysed and followed up every year with samples of water to understand the amount of contamination. There are several grades of contamination, the light contaminated soil are common in urban areas and accumulates over many years. It comes normally from cars, heating for buildings together with smoke and dust emissions from industries. In these cases, it should be avoided to grow vegetables that are closely attached to the ground such as strawberries and carrots. The heavily contaminated soil can be found on properties that have previously housed landfills, petrol stations or dry cleaners. On properties such as these, the contamination stems from substances that have seeped out from e.g. leaky drums, tanks and sewer systems. In these cases raised beds that are not attached to the ground, rooftop or balcony gardening is a necessity to grow food.

However, a positive role of urban agriculture is foreseen, as a catalyst of social integration and environmental education, the interest in eating locally produced food is instantly increasing and so does the concept for urban farming. Apart from the cultivation plots that already exists, there are some projects in Copenhagen where urban farming have been implemented and combined with existing buildings such as rooftop gardening. In Østerbro there is the ØsterGro project which is a 600 m² rooftop garden, it is organized five floors above an old car auction. In Nørrebro, DYRK Nørrebro works with expanding vegetable gardens to enhance new urban communities. Copenhagen municipality explains Nørrebro as one of the disadvantaged areas in the city and DYRK Nørrebro sees that implementing urban farming is a great opportunity to turn a former conflicted image of Nørrebro into a positive collective spirit. Nørrebro is also known for its multi-ethnic society, inhabited by people from all parts of the world and implementing urban farming can strengthen the community spirit by letting people meet through organized farming days (Copenhagen municipality 2012: 14-15, DYRK Nørrebro 2011, Københavner grøn n.d., Martinez 2015). Studying the maps built environment (page 33), green structure (page 34), blue structure (page 35) it becomes clear that the further in towards the city core the less there is green structure. Although, there are empty unused spaces such as roofs, mowed yards and parking lots that can be used for urban farming and the canals can be used for aquaculture facilities. In some areas it is also possible to create multifunctional activities, parks and public gardens can be developed with edible plants. The project investigates urban extensions where there are possibilities to invite food production and bridging architecture with agriculture. At the beginning of the project, some certain bigger areas in Copenhagen where studied, the design result does not consider these but the studies can be used as a base for future development.

POTENTIAL SITES

First, Kloverparken is an area just south of Refshaleøen and has a size of almost 900 000 m², the ground mostly consists of mowed grass which does not enhance biodiversity. It is used for sports activities such as football but as it is such a big area in a central location it can be considered to rearrange the space towards multifunctional activities. Kloverparken is also close to some disadvantaged areas and as mentioned in the project of Nørrebro, urban farming can be used as a meeting point where organizations strengthen the community spirit. It is also next to already existing cultivation plots and therefore urban farming in this area would go well in its urban context. If the whole space were used for farming it could feed up to 3000 people, it is one of the few bigger green spaces left in Copenhagen inner city and as it is close to the water it has a great potential to be combined with aquaculture facilities. Next area to mention is Valby industrikvarter. It is known as one of the greenest districts of Copenhagen and it is also close to disadvantaged areas of the city. The location is close to the border of the rural landscape and it would be interesting to study the possibility to create a built environment that is enhancing rural and urban qualities. The area is 240 000 m² and would feed up to 800 inhabitants, there are already plans for this space and urban farming is not a bigger part of it. Amager fælled is another area where the urban landscape meets the rural. It is characterized as a green area with good qualities for recreation and some of it is nature reserves. It is a large area stretching from the south towards the centre and by some of the edges, there are housing and offices being developed. As it is a well-used area for relaxation and recreation it is arguable to not be developed with large scale farming. Though, adding edible plants it is interesting to study the relationship between recreation and public farming and why this in combination can become a strong factor to keep the green structure instead of nudging on the edges with built structure. The total size that is within the borders of Copenhagen is 9 000 000 m², although not all the size would be suitable for farming the total area could feed up to 30 000 inhabitants of Copenhagen. Ørestad is another area that is close to Amager fælled, it is an area where the city almost meets the rural landscape and is also close to the metro. Parts of it is already planned and is promoted as a development project with environmentally friendly buildings, therefore, incorporation of urban farming could go well-aligned with the project. The area that has not yet been built is 186 000 m² and would feed up to 620 inhabitants. Lastly to mention is Godsbaneterreannet, the most central location of the ones mentioned and a very important one as it is supposed to work as a base for maintaining the metro. It is promoted as an area with high architectural standards and it would be interesting and bold to incorporate food production in facades, rooftops and balconies and thoughts of resiliency in this central district. It is 730 000 m² and would feed up to 2300 people. All of these areas are large scale development projects but urban farming can be smaller initiatives as well, in existing private gardens, parking lots, roofs, alongside streets etc. The city could benefit from the growing interest in eating local and organic food, aligned with bottom-up initiatives it is possible to develop strategies for food production. Continuing with Refshaleøen, the choosen site for this project, the area is characterized as a rather empty industrial space by the water and it is being used for activities such as restaurants, festivals, concerts and street food markets. In a bigger perspective, this can be seen as the first point for a concept of local food production that nourishes the five finger plan of Copenhagen. Refshaleøen is an old industrial area, close to the centre of Copenhagen and it has a good starting point by the water that can be used for aquaculture facilities and as well assist cleaning substances that comes from agriculture. The peninsula has made itself known for being a playground for entrepreneurs and food clustering, there is the street food festival and already a high percentage of restaurants, it is possible to embrace the already existing food culture aligned with the trend of local and organic food production. In the outpost of the peninsula, there is a water management plant that is connected to many parts of Copenhagen. As there are phosphorus and other substances that come from this, that can be used to fertilize farms, there is an opportunity to create a closed loop that connects it to urban farms in Refshaleøen but also the rest of the city.

According to the plans of Copenhagen, Refshaleøen is described as a perspective area which means that it is possible to be developed earliest in 2031 (Copenhagen municipality 2019: 58-59). If the area is supposed to be developed with housings, the upcoming years can be used for purifying the soil, this is even more important if it should be used for growing food. Deeper and local analyses would be of interest to understand the character of the soil and the level of contamination. In some cases where the soil is too heavily contaminated, it might have to be handled in certain labs. While purifying it, those areas can then be switched with other soil for example redundant soil that would come from the digging of the future extension to the metro. When the heavily contaminated soil is handled it can then be used for adding soil on rooftops to extend the possible space to grow. Meanwhile a closed-loop system from the wastewater management plant, buildings for restaurants, market halls, aquaculture facilities and other similar facilities that do not need contact with the contaminated soil can be developed to introduce food systems in the peninsula.

Implementing urban farming in a broader context.

Built environment.

Green structure.

Blue structure.

SITE SPECIFIC ANALYSIS

Secure the city with agriculture and food, not fortifications.
History, present and future of Refshaleøen.

Refshaleøen is originally an island located in the northern part of Amager and gained its name from where the district of Christianshavn is located today, Refshalen. It is an area of approximately 1.1 km^2 and straight-line it is 1.5 km from the inner city, 1.2 km from Christianshavn and 0.9 km from the closest cultivation plots, from the centre, it is possible to get there in ten to twenty minutes by bus, ferries or bike.

HISTORICAL SHIFTS - CURRENT SITUATION - FUTURE VISIONS

During the late 1600-century, the development of Christianshavn was initiated by king Christian, a new city-project in Copenhagen, with its new arrangements of fortifications and ramparts the district was supposed to create a better defence-line from hostile attacks. As the most northern position of Christianshavn, Refshaleøen functioned together with St. Ann's Fortress as the guarding outpost to the entrance of the harbour. Refshaleøen kept its position as an important defence outpost, during the 1800-century when a new sea fortress called Lynetten was built, the island developed as a military base until late 1900-century where it changed to become an important area for industries. A part of the iron industry and shipbuilding company Burmeister and Wain was moved to Refshaleøen 1872 and it was during this time where the island increased in size with landfill. At the beginning of 2000-century, the company started with diesel fuel which increased production and in 1930 it was the biggest workplace in Denmark with over 8000 employees. But due to increased rivalry from companies abroad, parts of the Burmeister and Wain was sold and in 1996 it went bankrupt. Even though many of the buildings for production have been demolished there are still signs from the company where enormous halls have been kept for other purposes such as concerts. Other examples of functional changes are the old sea fortress, Lynetten, that in the late 2000-century was rearranged into northern Europe biggest wastewater management plant. Today the plant takes care of the sewage from more than 500 000 people and produces more than 25 000 metric ton per year (Hovedstadshistorie (A) n.d.; Hovedstadshistorie (B) n.d.; Hovedstadshistorie (C) n.d.). Nowadays Refshaleøen has several kinds of activities and apart from the wastewater management plant, the main activities are food businesses, summer festivals and moorings. Organizers for the peninsula promote it as an urban playground for co-creation, innovation, food and creativity, and not at least the place with the largest street food market in the Nordic region. There are at least 20 active restaurants located in the area and the food industry has already a big impact on the area, many of the restaurant facilities embrace local food production and promotes the idea of eating crops from their own farming. With famous restaurants as Amass, the organic-vegan based meal kit company Simple feast and the biggest street food market in the Nordic countries (Reffen (B) n.d.), Refshaleøen is already established as a food cluster business district which makes it suitable for a development aligned with the productivity of food.

A vision described by the organizers of Refshaleøen is to develop a local food scene in correlation with the climate, environment and human. There is, for example, the idea of developing the first street food market with self-produced organic ingredients and, for this purpose, there is already a greater import from the organic farm Juliangaard in the northern part of Zealand (Reffen (A) n.d.). As people get more aware of climate change and healthy food diets, the intake of organic and locally produced food has become an increasing trend over the world. If local food production is developed in Refshaleøen companies and restaurants can benefit from the proximity as they can embrace this trend and market themselves as climate-friendly companies with close location to the farm. This could attract culinary tourists and strengthen the economic situation but also, as mentioned, in the long-term reduce carbon emissions and increase access to healthy and fresh food. The peninsula has been an area in constant change, the functions have changed from being a military base and boat-industries to what it is today a foothold for food and creativity. It is possible to rearrange old functions in coordination with the different situation of

today. If it was important in the 1600-century to defend the city with fortifications it is obvious that this is not needed any longer, instead, there are other obstacles to be aware of. Implementation of sustainable food systems and increase in food security is one of these and it is essential to implement strategical visions of how to deal with an upcoming global food situation. For this project Refshaleøen is suggested to be rearranged from a historical appearance as an old guarding outpost translated into a local self-sufficient climate district. These ideas are nothing new, real estate companies want to make Refshaleøen the next version of Samsø which is already a project recognized as a climate-neutral island (Reffen (B) N.d. , Ugenserhverv 2013).

LOCAL CIRCUMSTANCES

Reduction of carbon emission and increase of profitability are related when it comes to shortening the supply chain, as the supply chain includes fewer intermediaries the carbon footprint can reduce when excluding e.g. carbon emissions coming from packaging (usually with plastic boxes), storage in refrigerators and transportation. In the meantime, direct sales create outstanding economic profitability through income optimization as the farms get rid of price markups by intermediaries (Hu et. al. 2019: 622). It is arguable to minimize the distance within the food production, both the supply chain but also the physical distance and as clustering of restaurants and food stalls is already well established in Refshaleøen there are possibilities to use this arrangement as a stimulus to introduce the whole food system within a local distance. In the theory of clustering, there is an optimistic idea that, regarding related businesses which are spatially concentrated at a local level, can develop exclusive corporations due to geographical proximity. Geographical and cultural proximity gives access to closer relations and sharing of knowledge of favourable information, this in contrast to businesses with longer distances (Porter, M. E. 1998: 78, 90). Eventually, this can both bring economical prosperity and direct the development of Refshaleøen towards an environmental friendly settlement. Studying the soil quality in Refshaleøen it contains contamination from the larger industries that were in use during the 1900th and 2000th century, disposing of petroleum products such as machine oil, asphalt, lead, tar or certain agricultural chemicals can pose problems. If there is supposed to be farm facilities it will be a necessity to heal and restore the peninsula from contamination. To reclaim soil quality, phytoremediation plants can be used as a first step to handle issues with contamination. Using green plants to decontaminate soil is a progressive and sustainable process, greatly reducing the need for heavy machinery or additional contaminants. This can in its turn create a more safe and pleasant area for people living and working there and can embrace biodiversity that in a future perspective is crucial for the prosperity of agriculture. Phytoremediation plants avoid further chemicals and contamination to be used and establish greenery, biodiversity, healthy soil and beautifying the area. As the contaminated elements in the soil have been removed the plants should be harvested and the heavy metals can be extracted and reused. The soil quality should be studied in detail, in some zones where the contamination is higher, it might be a necessity to assist by purifying the soil in labs.

Looking at the soil type the majority is clay soil. Clay soil binds water and nutrients better than sandy environments, it, therefore, retains moisture further into dry periods and retains heat for a longer period of the year, food production is therefore positively affected as the harvest period can be extended longer in autumn. On the other hand, it becomes more problematic during rainier periods when clay soil has a higher risk of getting flooded. This can lead to that the roots of the plants drowns and dies because of lack of oxygen. It is possible to let parts of the soil be drained and by using the landscape lead the water to certain parts, these parts are then filled with water and are therefore not used for cultivation. However, the newly formed ponds or streams have other good functions as they create environments that can increase the biodiversity and extend the harvest period further when the heat is stored and reflected on the surrounding vegetation, some vegetation that thrives in ponds can also help clean the soil. Covering the clay soil with compost material that has a structure such as sticks is also a way of how to handle the water flow and covered with permeable organic material, it will be excellent for cultivation. There are large parts of hard surfaces that create barriers between green and blue areas. Major parts of the peninsula are filled land and the site contains large undefined empty spaces. Some of them are a legacy from the industrial period that today are used for festivals and can fit larger crowds, although, the most time of the year these are unused areas. It is a possibility to heal the empty spaces with green links that connect the green spaces and embrace biodiversity. This can give positive effects on food production as it attracts pollinators. Further, this can be organized aligned with an increased blue structure inviting a harmony between green and blue structure.

SPATIAL ANALYSIS

Refshaleøen will be a large development project, a spatial experiment shows that the site would fit the inner city of Copenhagen, the old town in Stockholm and Champ de Mars in Paris altogether. Imagining the area being developed with the same density as the rest of Copenhagen (4 550 inhabitants per km2) then the project would be planned to inhabit a bit more than 5 000 people. Although in a long term perspective the demand for housings might require higher density. The development project in Nordhavn, north of Refshaleøen, that covers about 2 km^2 is planned to inhabit 40 000 residents, a density more than four times the rest of Copenhagen. In light of local food production, there are difficulties with this higher density looking at the space that is required for certain diets.

Some areas in Refshaleøen such as the water management plant will not be suitable for farming but can support the production in other ways, therefore the whole peninsula will not be used for agriculture. Many of the areas that are potential for urban farming will be distributed to be used for restaurants and food business districts which will also affect the assumed possible total population. Though, imagining the whole surface of Refshaleøen being used for agriculture and the space that is required for certain diets gives us a clue of the possibilities of local food production and possible population related to that.

- Conventional European diet: 220 inhabitants
- Vegetarian diet: 1 570 inhabitants.
- Survival diet: 36 670 inhabitants.

The idea for this project is to enhance local food production, allowing a variety of diets rather than planning for a single certain one. Applying a minimum space requiring diet would allow a population similar to the project planned in Nordhavn, though, this project will keep a limit that enables a mix between European, vegetarian and survival diets. A lower density will enable closer connections to the landscape, the proximity will support a spatial relation that can break barriers related to physical and perceived distance. This will also allow for greener, calmer and healthier environments. The project will not close the possibilities of future population growth if that is required and if so it is recommended to keep 36 670 inhabitants as a maximum. This will enable flexibility towards unpredicted changes, changes that can be related to diets where we eat less meat, technological improvements that make the productivity of agriculture more efficient or higher expected population growth. A possible scenario will also be where the food production not only supports the population on site but also to other parts of Copenhagen. It is possible to direct the development of Refshaleøen towards an outcome that is successful in long-term frames. The project will not support a certain diet but develop a fundament that invites urban lifestyles based on recycling and local consumption. This can enable a settlement that in a longer perspective will avoid a point of degradation and depletion due to limited resources.

Refshaleøen. Size 1.1 km².

Indre by in Copenhagen with Strøget as a central core. Size 0.5 km²

Champ de Mars in Paris with the Eiffel tower to the west. Size 0.28 km².

Gamla stan (old town) in Stockholm. Size 0.36 km².

1 Top: clay, glacial till.
Bottom: postglacial lime (material).

2 Top: clay, glacial till.
Bottom: postglacial lime (material).

3 Top: sand. Bottom: mud.

4 Top: postglacial saltwater gravel.
Bottom: lime (material)

- Clay soil binds water and nutrients better than sandy environments.
- Clay soil becomes more problematic during rainier periods when muddy soil easily becomes water-filled.
- Possibility to have parts of the soil drained and lead the water to certain areas and thereby creating waterways such as ponds or streams.
- Water can be used as a thermal mass, increase biodiversity but also to clean harmfull substances (with reed beds, marshland and/or wetland).

1 A water management plant that is connected to large parts of the sewage system of Copenhagen.

2 A former industrial complex now used as an arena for culture and entertainment activities. Hosted Eurovision song contest 2014.

3 Open area for festivals. The place hosts the biggest rock and metal festival in Denmark.

4 The place for the biggest street food market in the Nordic region.

5 Hallen i skoven, an old hangar construction that is turned into a platform for the cultural scene.

6 A windmill company, building windmills for Denmark, Sweden and England.

7 Facilities for bars and an urban beach.

8 Amass, a restaurant awarded with a Michelin star.

9 Teaterøen, an open platform for Danish and international performing arts.

10 Boat facilities.

- Alchemist
- Amass
- Banana club Copenhagen
- Baobab
- Broaden and build
- Corner Tortilleria
- Grab'n go burgers
- Kristinedal
- La Banchina
- Lille bakery Simple feast
- Malawa truck
- Mikkeler Baghaven
- Panelværkstedet
- Pizza bus
- Reffen
- Reffen Bar
- Restaurant Lynetten
- Street polenta
- S'more bread
- Tropical shave ice

1. This is where you are entering the area (looking backwards) walking from the built environment just south of it. To the right in the picture, there is a trench filled with water. A legacy from the old fortress.

2. This is the entrance to the area (looking forward). Entering from this way there is a bigger meadow, to the right is the sea and the coastline is covered by smaller trees and bushes. The flooded muddy ground gives a clue about the soil type which in this case is mostly clay soil.

3. In this picture, we are standing in the middle of the meadow and facing the largest and most iconic building on the peninsula, an old industrial building from B&W. It is now used for cultural activities such as music competitions.

4. Walking further we can notice the artificial ski slope Copenhill on the mainland. Although it is not located on the peninsula it is 124 meters tall and has a visual impact.

5. Surrounded by a fence and parking there is a green area situated in the south. The reason for the fencing does not show clearly. Although a reflection is that it is a contaminated zone.

6. In this picture, we come closer to the iconic building from B&W. We realize the big scales, in this case, a large hard surface used for a driving school.

7. In comparison to the big scale, there are several smaller buildings as well. The road in this part is lined with trees.

8. The trees edging the road in the previous picture connects to a larger forest. The forest is fenced and from this side, it is difficult to access.

9. This is the corner of the wastewater treatment plant. On the horizon, we can spot several big wind turbines.

10. Visually this road appears almost endless. The hard surface gets flooded in the rain as the drainage capacity is saturated. Looking to the left we can spot the B&W facility, the majority hidden by a hill.

11. Here we can see some of the containers that are located in the area. Studying the asphalt we can spot grass, slightly coming up from the ground and defying the hard surface.

12. Here we can spot a lunch restaurant, one of the restaurants in the area that already has raised beds with vegetables, providing fresh and locally produced food.

13. Looking at this view, we realize the wide and undefined spaces. There is no greenery and the area appears to be mostly made for vehicles.

14. This picture shows the urban farming belonging to the restaurant Amass. It is just by the restaurant and the costumers can see the farming from the window.

15. Urban rigger is a project from the architecture company BIG. It is a floating student accommodation with a structure based on containers.

16. This view shows the sharp edges of the hard surface of the coastline. The peninsula is surrounded by water but these sharp edges does not give an impression of an environment invites the water.

17. Small scale building alongside the water. Adjacent to this there is a restaurant with a sauna for winter bathing.

18. In this picture we spot the B&W facilities to the right in comparison to the container accommodations to the left. The scale difference becomes clearer.

19. In front, we see an office building. As the parking is filled with bikes we can assume that biking here is a popular way of transportation.

20. In this picture, we stand on the left side of the entrance and the water is located to the left of the picture. There is one restaurant with a sauna and possibilities for swimming. The area is mostly occupied by parking.

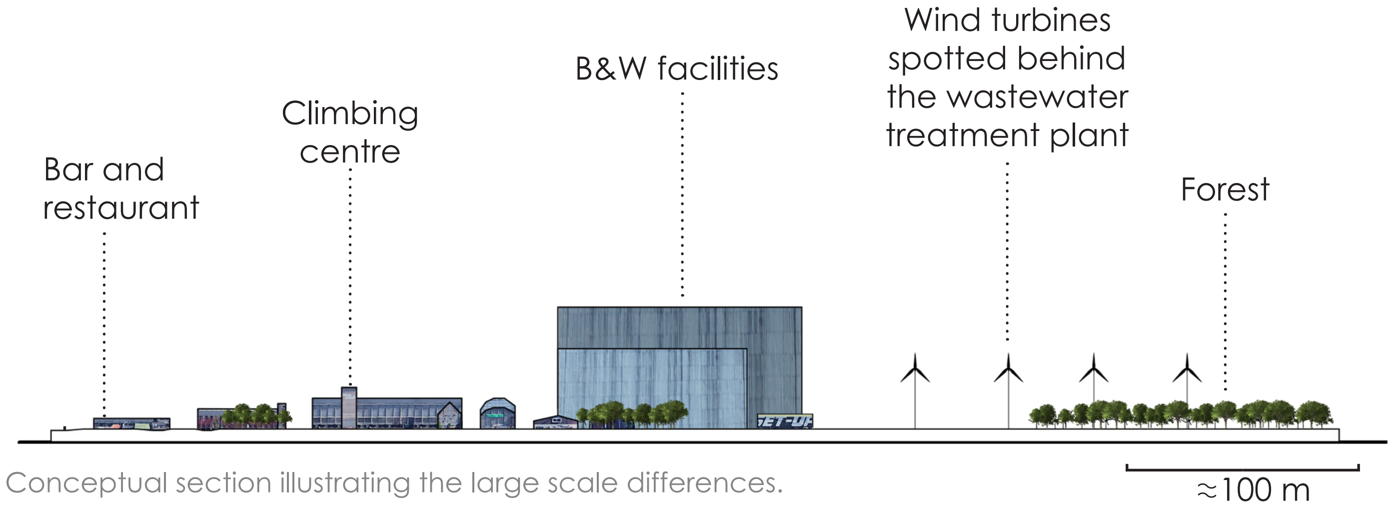
GENERAL REFLECTIONS ON SITE:

Visually noticeable were the large scale undefined spaces. During the visit, these were mainly unused, but for cars, the bus or some few people walking. A reason for this might be that the climate did not invite for a walk and there were no specific events that were going on. Visiting the site during summer, at the same time as a festival, street food market or another event it would probably be more crowded and the large scale environment would feel more relatable. Although the weather gave an honest picture of the common daily life and gave a hint of the areas that suffer from flooding.

It is fairly easy to get there by bus, although as I wanted to understand the feeling of getting there seeing the view from a human perspective I took the metro from Kastrup to Christianshavn and walked from there. Getting there from Christianshavn I passed by green areas and cultivation plots, closely located from the peninsula. A reflection I had while getting there is that these already established farms can appear as a link between a possible food cluster in Refsaleoen towards restaurant districts in the centre of Copenhagen.

Studying the area from distance (e.g. analysing maps) it is difficult to grasp the spatial circumstances, this becomes clearer when getting there. There are long empty roads, unpleasant to walk through, mainly made for motor vehicles but possible to get around by bike. The large B&W facilities and the small hubs and containers define an interesting identity of the site, the different scales are challenging when looking at the taller industrial buildings compared to the small huts facilitated by restaurants. To consider is a development that either enhance the big scale differences or link them by for example middle-scale developments. Many of the existing buildings are still functional, although there are large empty areas, the existing structure can be adapted to frame and heal large undefined public spaces.

Getting to the city centre by bus goes rather quick but there is only one bus station on the peninsula, situated in the centre slightly to the south. To enhance alternative transport it will be important to develop more stations for public transport.



Conceptual section illustrating the large scale differences.

CONCEPTUAL IDEAS DERIVED FROM THE ANALYSIS:

- Green links can be developed to heal large empty spaces. The green structure should be designed in a way that embraces agriculture such as considering diversity aspects and fruitful micro-climate.

- Inviting blue structure can help to deal with drainage, clean substances from agriculture, act as thermal mass and increase biodiversity. Aquaculture facilities can be developed to embrace local food production.

- Well used nodes can be further developed as central hubs, this would apply to the location for the street food market, the wastewater treatment plant, the B&W facility and the bus station. Currently, the main spine with most intense movements stretches from the entrance in the centre, slightly to the west, towards the water treatment plant, this can be taken into consideration for the future development of activities.

Potential development of green links.

Potential blue structure.

Nodes and social connections.

STRATEGIES

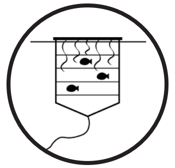
Embracing creativity, reuse and food culture as the identity of Refshaleøen.

The strategical plans from Copenhagen municipality show that Refshaleøen should be seen as a future project not arranged in 10 years from now. As lot of the area is filled land it will be a process to improve the soil to the extent that it is possible to grow high quality food. At a first stage of landscaping it will be important to secure the ground from any unwanted substances, phytoremediation plants will not only heal the soil but also beautify the area. Wide fields of sunflowers and hidden lush spots can attract local tourists where they will find a green oasis close to the city and find time for leisure and relaxation. Vegetation such as comfrey and clover fields that adds nutrition to the soil and preparatory species such as larch will help to stabilize the ground and prepare it for farming purposes. To prevent roots from drowning in flooded clay soil, blue structure such as ponds and streams can be established by leading the water to desired spots. Reed plants in the water bodies helps to clean unwanted substances and cattails can secure exposed water edges against erosion. It will be important to develop high biodiverse landscapes and heal large hardsurfaced areas with green links, a wide range of species should be concidered, different sizes of trees, bushes and ground vegetation will create a diverse environment for different animals. In many areas, a landscape that is close to syntropic agriculture will be a vision to reach for. Vegetation that attracts pollinators can be crucial and an early establishment of a fruitful base for high biodiversity will enhance the future development of a productive agricultural landscape. Examples of landscapes as well as suitable edible plants, phytoremediation plants, biodiverse enhancing plants and soil adapted plants are proposed on page 60 - 67. Though, important is to reach for diversity, these should therefore be seen as an inspirational source rather than a definite framework, there are also other factors that enhance the quality, fallen branches and leaves can e.g. serve as important objects embracing biodiversity.

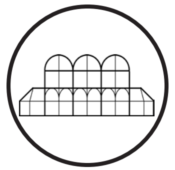
Once the soil is restored from unwanted substances the phytoremediation plants should be harvested, heavy metals that are cleaned from the ground can then be reused in certain labs in e.g. electronic devices. In 10 years from now, conceivably even earlier than that, it is possible to develop the area with housings and agricultural landscapes. A diverse mix of agricultural types such as open fields, hugelkultur, food forests, syntropic forests, water facilities, terraced gardens etc. will create a strong fundament that is flexible towards unpredicted changes.

Each household should have direct access to outdoor spaces where the ground is prepared as either a private or common farm, every household will have the possibility to become self-sufficient. The landscape will be merged with the building typologies in a way that decrease physical and perceived barriers. Restaurants are encouraged to use the surroundings for farms to supply the costumers with local food. Restaurants and events, such as concerts and street food markets will gain economic profit from the increase of tourists. In the time when the soil is not totally restored, restaurants can establish greenhouses on the roofs or similar farming facilities that are not directly attached to the contaminated areas. This will strengthen the identity as the new food hub with local food and create a trademark that can establish interests amongst local communities and people who are interested in food.

Food production as a system includes many components and for this project, there are 21 different kind of urban food facilities proposed. They are chosen to serve the food business industry, tourism and people who want to become self-sufficient on food and each one is interlinked to enhance recycling. Different kinds of farms concidered are aquaculture facilities, common yard farming, food forest, greenhouse farming, rooftop farming, private yard farming, shipping container farming, terraced farming and vertical farming. Different type of food leisure activities is the botanical garden, edible park, food market, restaurant district, street farming, torvehal. Different type of purification facilities is compost facilities, reed beds, wastewater management and wetlands. Other facilities are food storage and pollinator street.



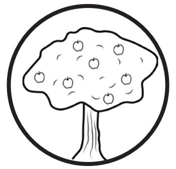
Aquaculture facilities. Water-based facilities such as algae, fish and oyster production, developed by the coastline or in watercourses.



Botanical garden. The botanical garden is made for leisure, research and enables access to food from different climates.

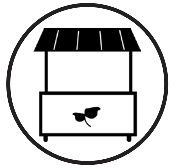
Common yard farming. This is a form of shared farming typically seen in courtyards where people grow together in local communities.

Compost facilities. These can be smaller and bigger facilities recycling organic matter reused in farming.



Edible park. These are parks made for leisure but where edible plants are the majority of the vegetation.

Food forest. These are forests developed as e.g. syntropic agriculture with a focus on production and increase of biodiversity.



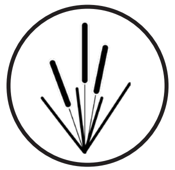
Food market. A meeting place where people can get inspired by local and international food, it can attract people living in the proximity and tourists from other parts of the world.

Food storage. A facility that can store over left food to be used later.

Green house farming. Facilities with glass facades both smaller and bigger scales, the warmer climate prolong the harvest season.

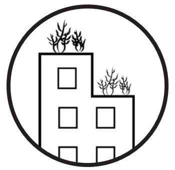
Pollinator street. These are streets that provide shelter and green links between the different farms.

Private yard farming. These are private farm used for people living in the area.

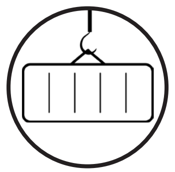


Reed bed. These are vegetation growing in water which naturally purifies the water. They can be planted in streams to clean the water before getting out into the sea.

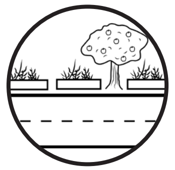
Restaurant district. These are areas with a higher amount of restaurants. Some are already established on the site.



Rooftop farming. Farming on the rooftop of the buildings.



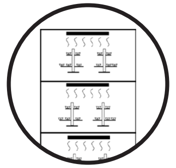
Shipping container farming system. A system based on the reuse of existing containers in the area.



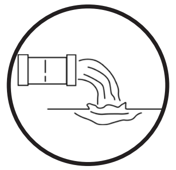
Street farming. Growing food is socially transmitted, growing by the streets can enhance this.

Terraced farming. This kind of farming is based on the concept of giving access to people living on higher floors.

Torvehal. A place for charcuterie and delicacy. A Danish word for a market hall.



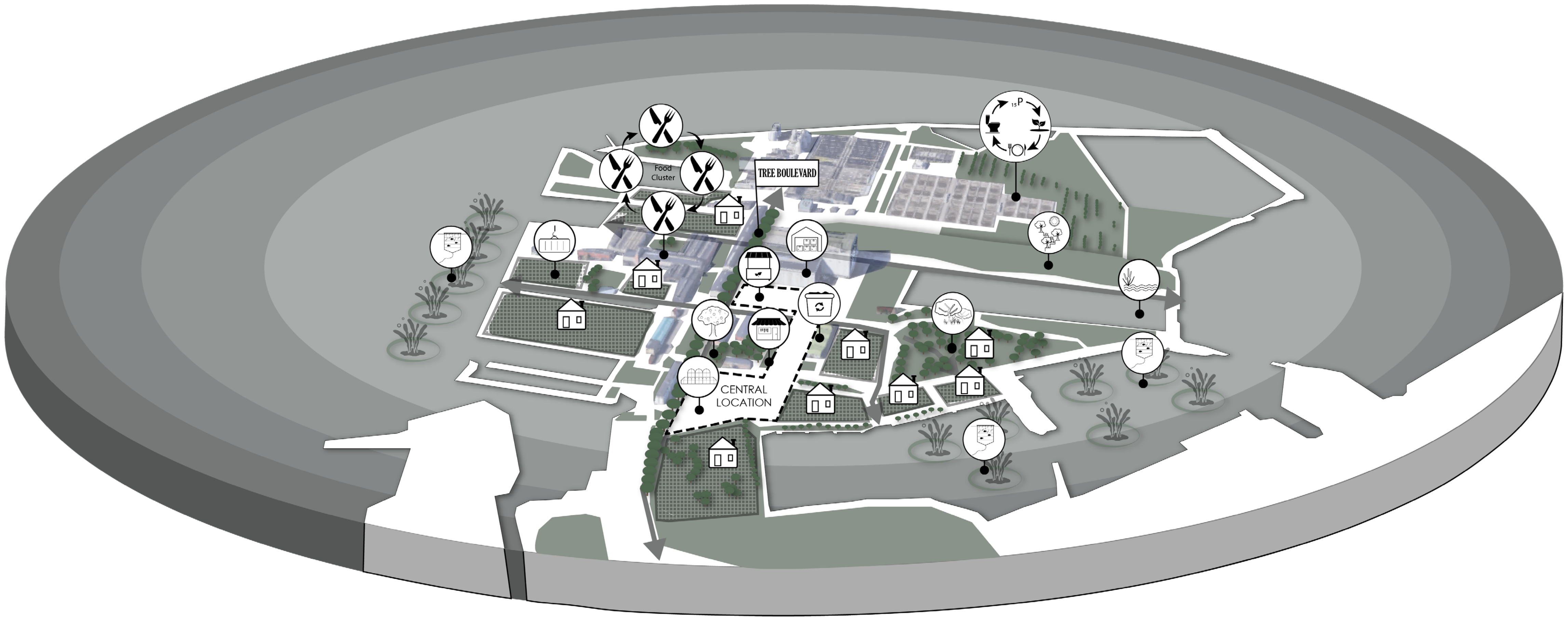
Vertical farm. Farming that grows vertically and thereby increase the spaces to grow food.



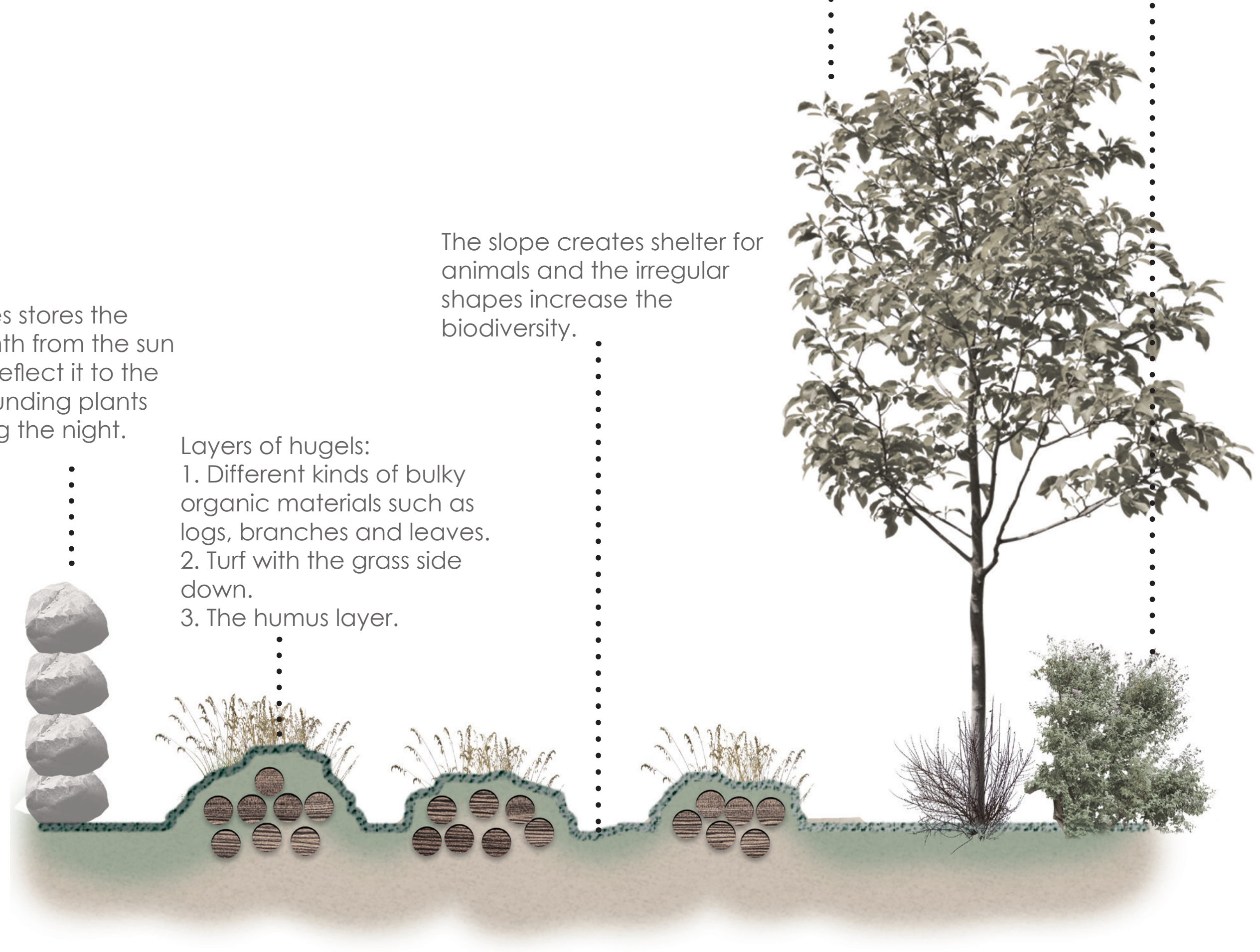
Waste water management. A purification facility cleaning the water before getting out to the sea. Some substances can be gathered and used for agricultural purposes.

Wetland farm. A farm facility that both purify the water, provides habitat for animals and provides food.

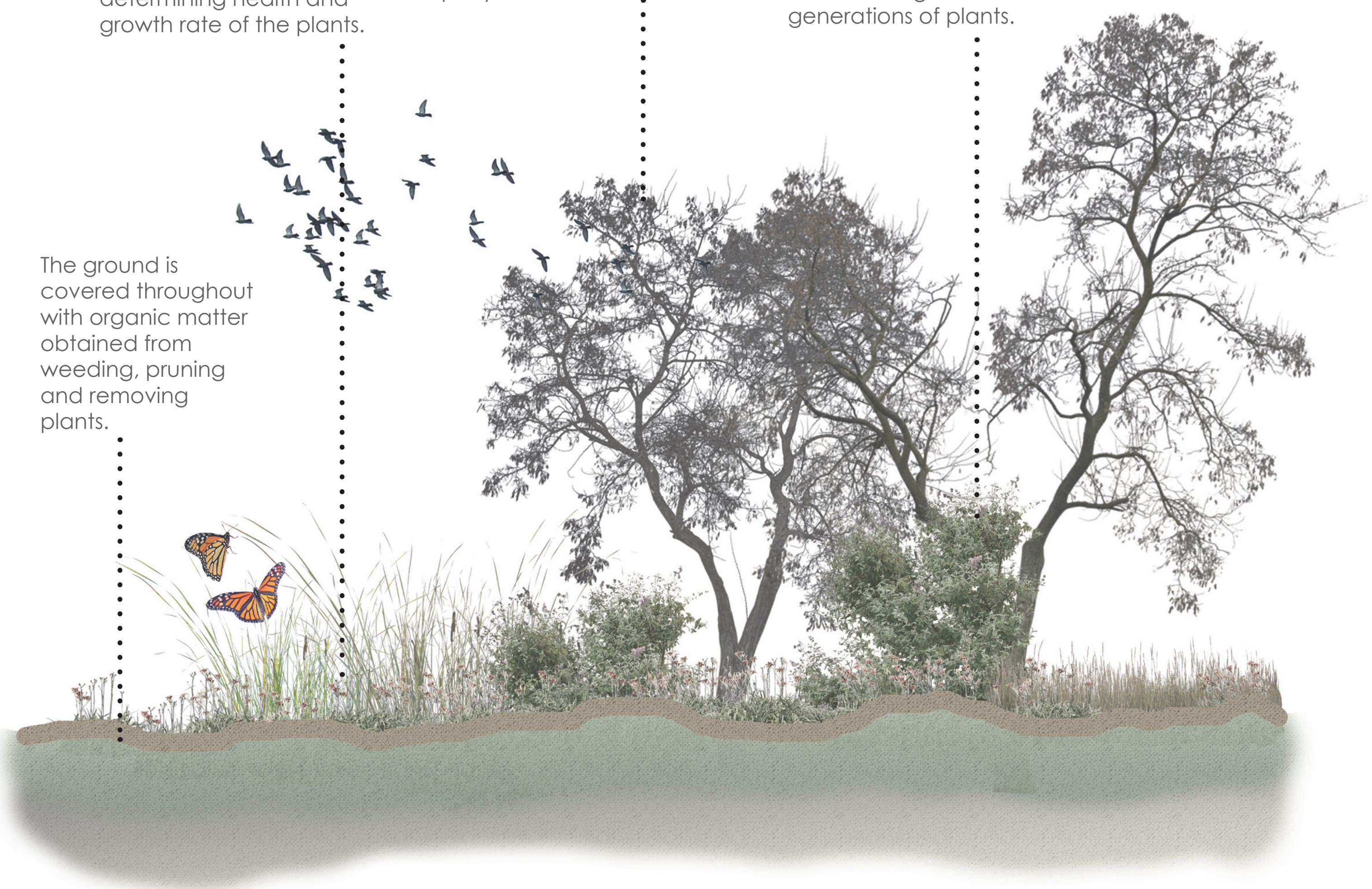
This axonometric view shows how the food facilities, housings, green and blue structure are located in the area. They are distributed to enhance existing social structures and the conceptual ideas of green and blue structure described on page 53.



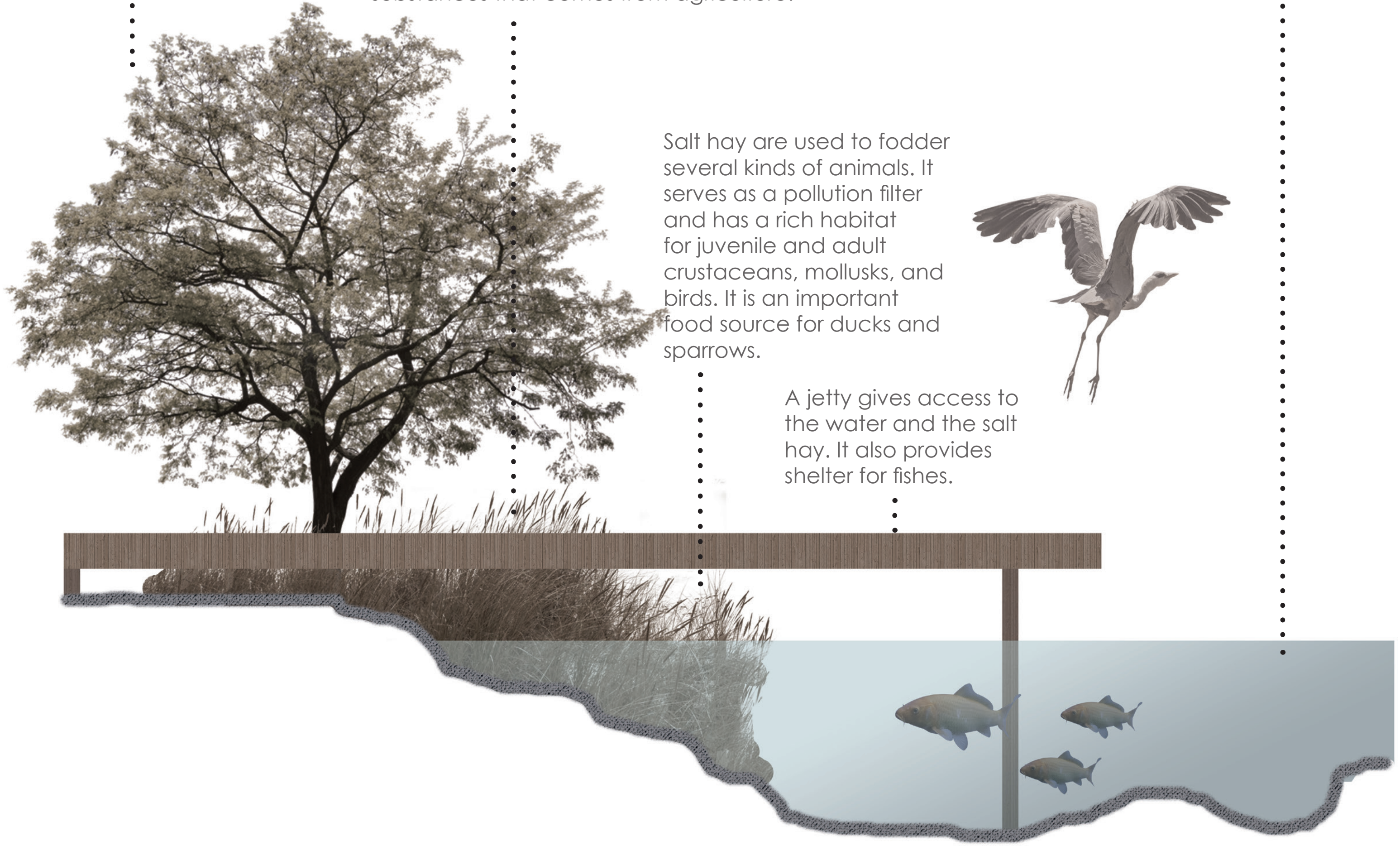
strategical axonometric view



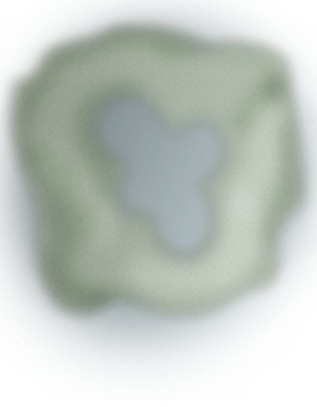
• With hugelkultur old logs are reused as structural base for the hugels, this can supply with nutrients for 20 years, captures water and generate heat. Hugels can by this become self-fertilizing with a minimum irrigation. The slope creates more surface to grow and the irregular shaped environment increases biodiversity.

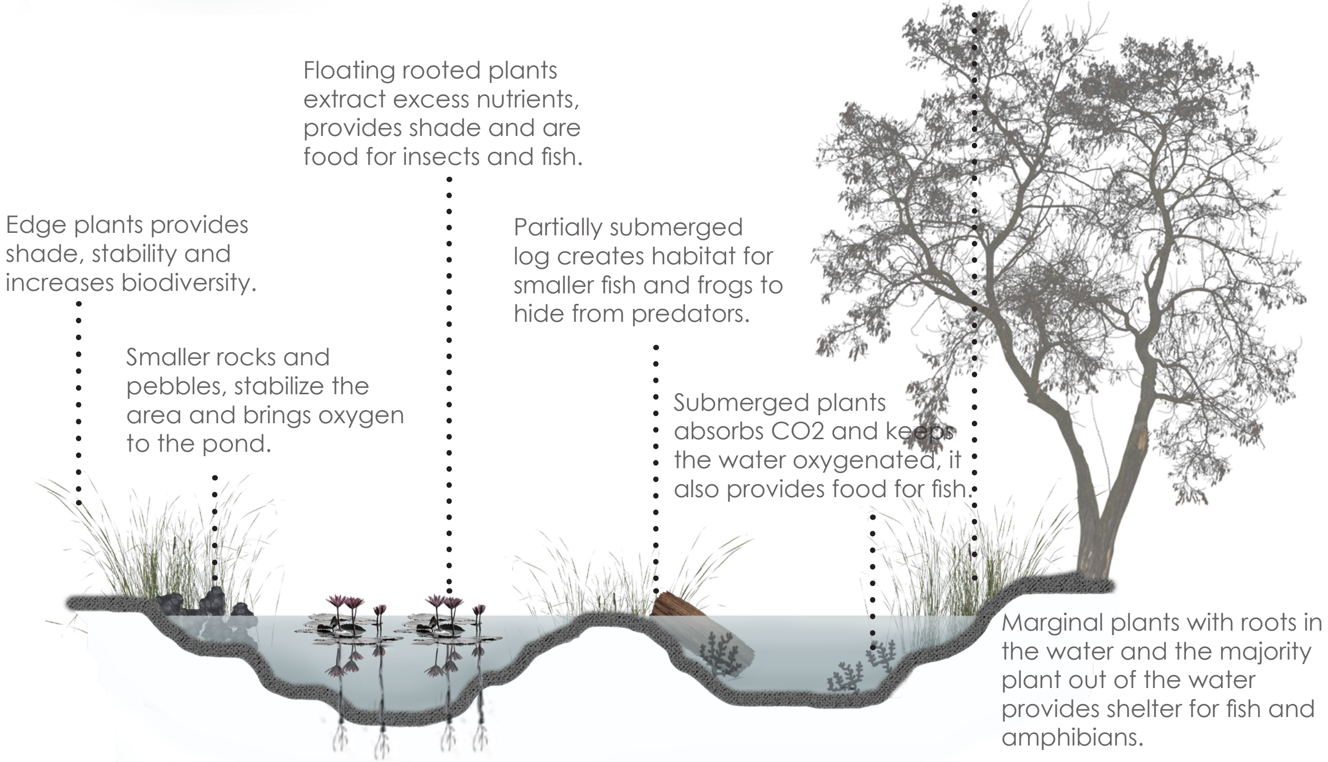


• Syntropic agriculture follows the law of negative entropy and is about understanding natural processes and use them to create a functional landscape with high efficiency in food production. It is a way to handle production in harmony with local eco-systems and can thereby increase soil quality and biodiversity. It is a process-based agriculture, rather than input-based. In that way, the harvest is seen as a side effect of ecosystem regeneration.



• Water edges in the landscape can have an important role in agriculture. The project can be edged by salt marshes and in certain parts enlosed with wetland parks.





• Ponds acts as a thermal mass which can both store and reflect heat from sun. Water bodies can therefore increase the temperature and humidity to the surrounding plants. As it gets warmer it can create a frost free zone and thereby extend the planting season.

Populus
Some carcinogen substances is easily absorbed by poplar tree roots. They can also degrade petroleum hydrocarbons.

Willow
The willow roots have the capability of absorbing cadmium, zink, copper and accumulating heavy metals in sites polluted with diesel fuel.

Trees

Reed plants
Has the ability to extract heavy metals of waterways through the roots, stem and leaves.

Spartina
Grass plant that thrives on salt marshes and that are able to inhabit Lead, Zink and Copper.

Aquatic plants

Black mustard
Highest ability to accumulate heavy metals in above-ground parts.

Hydrangeas
Specialized in drawing up aluminium out of the soil.

Rapeseed
Effective in the uptake of Copper, Cadmium, Lead, and Zink.

Sunflower
Responsive to high concentrations of Lead and Cadmium from contaminated soils.

Ground vegetation

PHYTOREMEDIATION PLANTS

European Larch
Thrives in colder climates such as Scandinavia. It fits well in clay soil and commonly used in agroforestry. It is a preparatory specie as it has strong roots and grows quick.

Hawthorn
The Hawthorn is from the rose family and is bush or tree-shaped. They fit very well in clay soil and they can become an important shelter for birds, mammals and insects.

Trees

Cattail
The cattails reduce the force of small waves and winds and thereby protects the banks of water bodies from erosion.

Marram grass
Grows close to the coastline or sand environments. They have deep roots and helps to protect from erosion and blowouts.

Aquatic plants

Clover
Clovers are multi-functional vegetation its roots increase soil friability (crumbly texture) improves the soil health and attracts beneficial insects.

Comfrey
Comfrey contains high amounts of nitrogen, phosphorus and potassium. Due to the high fertile leaves they sometimes even get compared to manure.

Field peas
These are nitrogen-fixing plants that add fertility to the soil. They are winter annual which helps to keep the garden occupied in the colder months.

Oats
Planted together with the field peas they support and puts nitrogen as well as organic matter on top of the soil.

Ground vegetation

SOIL ADAPTED PLANTS

Beech
The beech trees are commonly found in the forests of Denmark. It provides important food for wintering birds.

Oak
Can be up to 30 meters tall and provides shelter for animals. In some studies, they are shown to provide about 300 different insect species scattered over individual oak trees.

Trees

Iris
Iris is a flower that can be found in wet areas such as ponds. It can provide shelter for organisms and animals living in the water.

Water lily
These grows with the roots in the bottom, provide shelter for fishes but the flower also attracts insects such as flies and beetles.

Aquatic plants

Borage
The Borage is very fruitful for bees as they provide ample sweet nectar and has an attractive star-shaped flower.

Crocus
Crocus is a great source for early pollinators as it is one of the first flowers to bloom in spring.

Daisy
Daisy flowers can come in many different colours and attracts prime bee and butterflies.

Nepeta
A low maintenance perennial that is attractive to many insects.

Ground vegetation

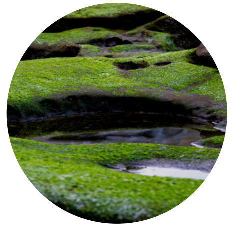
BIODIVERSITY ENHANCING PLANTS

Apple
Apple trees are a popular fruit that can be used for puree, cream, cider, wine, vinegar, fruit and pastries. It blooms in May to June and fruits can be harvested in autumn.

Walnut
The walnut tree has a large crown and can be up to 30 meters tall. The fruit is rich in fat, protein and iron and considered to be healthy for blood sugar levels.

Trees

Carrageen moss
A red algae that grow in the water of Öresund. It is rich in iodine, minerals and vitamins. Its jelly consistency can be used for making desserts.



Chlorella
This green algae is rich in protein and chlorophyll it also contains several healthy minerals.

Aquatic plants

Broccoli
Thrives during summer in the Nordic region. Rich in antioxidants, vitamin C and calcium.

Kale
Kale is one of the healthiest vegetables. It consists of a high amount of flavonoids and calcium. It can withstand cold environments.

Peas
Peas can thrive in colder climates and are rich in protein. It contains antioxidants, fibres and many minerals.

Spinach
Spinach can grow in a winter climate and is rich in iron, calcium, magnesium and vitamin A.

Ground vegetation

EDIBLE PLANTS

1. Current.

2. Adding phytoremediation plants and eventually establish farming facilities that are not in direct contact with the soil.

3. Adding water elements for drainage and establish restaurant facilities.

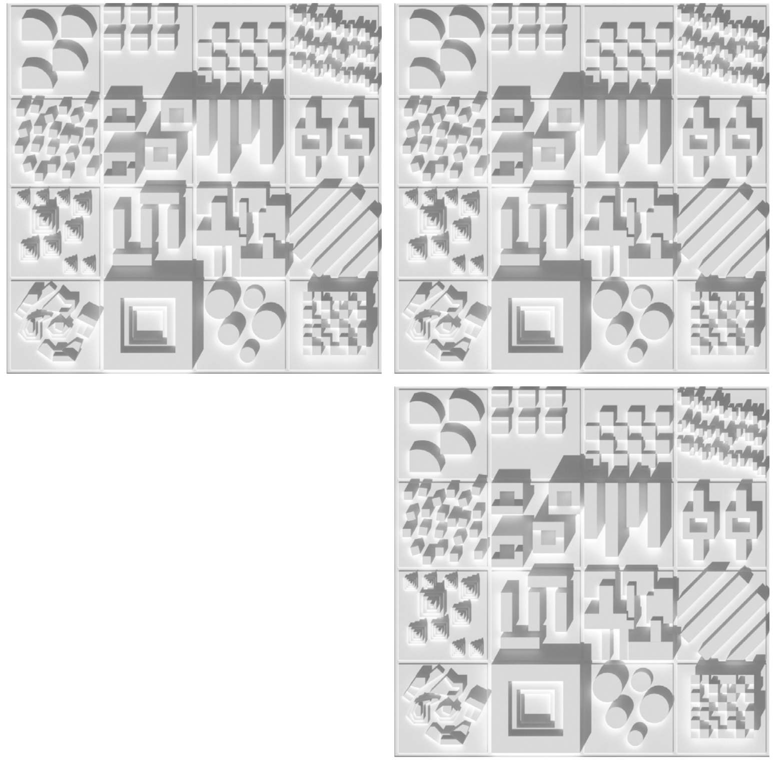
4. After 5+ years the area would be restored and ready to be inhabited.

1. Current.

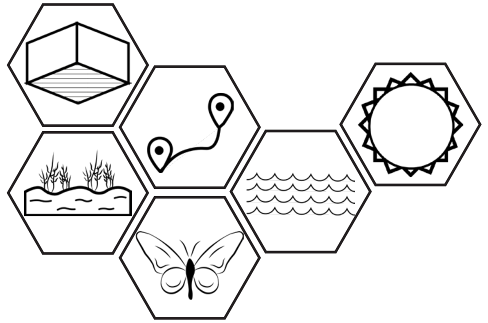
2. Rapeseed fields purifying the soil and greenhouses on top of existing structure enabling for farming.

1. Current.

2. Creating soft shapes towards the water. In the future, the beach can be used to gather algae for fertilization.



The project propose six major factors to set a framework with guidelines shaping the design of the urban environment: space, distance, soil quality, climate, pollinator flow and water treatment. These will direct the development towards a self-sufficient settlement supporting consumption based on local food production and recycling.



SPACE: As the project is based on a European context it can be argued that a European diet would set the spatial limits for the design. For this project, the idea is to spatially enable self-sufficiency on local food production rather than being bound to a special diet. Therefore the minimum survival diet of 0.003 hectares is set up as a base for developing the whole area. This will secure self-sufficiency but does not mean that some development can still enable spatial dimensions that relate to diets such as vegetarian or conventional European. In general, the spatial guideline is to keep a balance between certain proximity that enables a closer connection to the landscape and a density that allows enough space to grow. The combination of calmer landscapes and well-defined spaces can create safer environments that invite people to grow food and develop a sense of public responsibility.

DISTANCE: Minimizing physical distance and the supply chain can decrease greenhouse gas emissions. If the crops from the farm are sold directly to consumers in the local market the carbon footprint gets lower, this is partly due to transportation and unnecessary stages such as the use of plastic commonly needed for packaging and the energy consumption that comes from storage in refrigerators and freezers. Spatially this can result in a model of clustering. Geographical and cultural proximity will give access to closer relations and sharing of knowledge of favourable information and strengthen the interaction between consumer and producer (Grollmus-Venegas, Pérez-Neira 2018: 67; Hu et. al. 2019: 620; Porter, M. E. 1998: 78, 90). Concentrating facilities and housings within a certain distance will therefore both improve the economy and decrease the effect on climate change.

Physical proximity and perceived distance are also important to consider to create a stronger relationship with the landscape. With a closer distance to the farm, it is more likely that people are willing to grow food. This does not only come to horizontal distance but also vertical. Verticality has a big effect on the perceived idea of distance, even though there is a direct physical correlation between a building and farmland it is more likely that someone living on floor one to three will use the ground floor than someone living on floor four to seven. To minimize barriers, all households should have direct access to private or common gardens (rooftop, balconies and facades included). Further, a guideline is to provide access to the total area needed to be self-sufficient with a minimum vertical distance of three floors.

SOIL QUALITY: Soil is one of the fundamental components of life on earth, although because of unsustainable actions soil is polluted and there are some potential risks of using cities for growing food. Toxic trace elements and organic pollutants is usually a problem in urban areas and it would therefore be important to investigate the current situation of soil contamination. Using phytoremediation plants is a progressive and long-term solution that greatly reduces the need for heavy machinery or additional chemicals and contaminants. To boost the effectiveness, fungus such as mycorrhizae greatly improves the cleaning process as it grows into the roots of the plants and allows better access to needed nutrients from the soil to their plant partner. In situ remediation involves using soil amendments and establishing plant growth encouraging phytostabilization. This is considered to be the most cost-effective and prevents the contamination from spreading to other areas via erosion, leaching, or food chain (Lal and Stewart 2018: 175, 186; Nilsson 2016; Stone 2019).

Several plants can be used as a tool to further improve soil quality. Using plants that add nutrients such as nitrogen, phosphorus and plants with e.g. strong roots that can prevent erosion will help to stabilize the soil. When implementing plants it is important to look at those that are suitable for the local climate and use them as a base for a diverse green landscape. This will create a strong fundament for agricultural purposes.

CLIMATE: In a Nordic climate, sun access can be crucial as the sun hours are lower during the winter. Open courtyards with lower buildings toward the south can be one solution to this as it allows better sun access to the courtyards. Protection from strong wind can be added with shelters such as pergolas. These pergolas allow greenery to climb up on the roofs and thereby create a green flow towards the rooftop gardens or terraces. Keeping sensitive vegetation closer to buildings can be useful as the building reflect warmth during colder seasons and provides shelter. Adding greenhouses is a recommendation as they give possibilities to grow food during longer times of the year and allows for a larger variety of vegetation.

Creating a positive climate for growth is also about how the environment is shaped where some vegetation benefit from each other. Trees provide shelter for smaller bushes and fallen organic matter lets trapped carbon go back to the soil. Further, as water bodies act as a thermal mass it is a great tool for prolonging harvest season. A natural succession enables a positive micro-climate and embraces biodiversity.

WATER TREATMENT: The plants need water to survive but in events that are too intense there is a risk of flooding which can cause drowning of the roots. Canals, streams, ponds, rain gardens, wetland, salt marshes and lakes are some water bodies that can balance the access to water. Water can act as a natural filter in wastewater management, fertilize the soil and provide drinking water for stock. Further, a big part of the food consumption is based on habitats that come from water such as fish, algae and seafood. Certain water-based vegetation like reed beds works as a natural way of how to treat contaminated water. The reeds provide the habitat for microbes to thrive amongst the plant roots and the pollutants are by this decomposed by the actions of bacteria and other microbes living within the soil. This can be an important brick in cleaning substances that comes from agriculture.

The urban design can be developed to gather water during extreme events and green-blue conveyance paths can lead the water through hard surfaced areas such as streets. Building typologies can be shaped in a way that leads water to certain desired points, gathered rain water from rooftops and filtered water from houses can be reused for agricultural purposes.

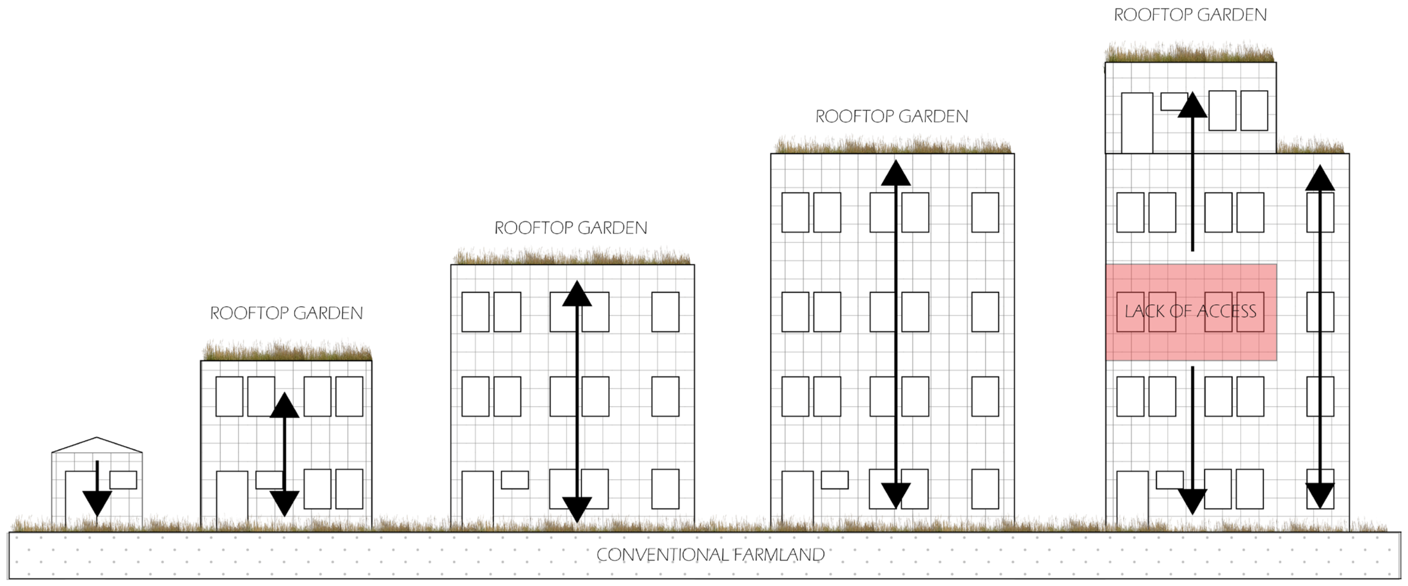
POLLINATOR FLOW: Pollinators are crucial for the prosperity of agriculture, about a third of the total food we eat is pollinated by bees. It is therefore important to make sure that the environment is developed to enhance biodiversity. Green connections between different farmlands and green fields will allow access for insects to move between larger areas. The impoverishment of habitats can be prevented by developing a wide variety of landscape with different vegetation. Keeping fallen branches on the ground can provide shelter and act as a natural habitat for many species.

Polyculture, agroforestry, hugelkultur and syntropic agriculture are all concepts that further embrace biodiversity this by enabling diverse flora and a landscape with irregular shapes. Irregular shapes can be used as inspiration both for green environments but also shaping the architecture, experimenting on both round and sharp objects. Letting greenery grow via pergolas, bushes, trees or wooden planks it is possible to connect the ground floor with higher points and thereby create a pollinator flow that stretches vertically towards gardens on rooftop and balconies. Buildings can be opened up to allow access for greenery to connect between courtyards and public farms. This will enhance the pollinator flow between larger areas.

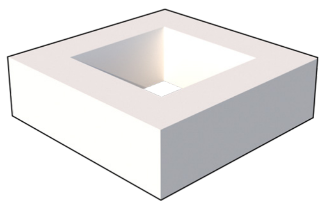
IMPLEMENTATION

These six major factors create a base for the design proposal. Applied to the overall urban structure they are supposed to direct the project shaping an environment that supports self-sufficient lifestyles. Eight different building typologies are proposed for this project. They are created with block structure, row house, modules and single villas as inspirational sources. As a base these are typologies that are commonly seen in different areas of Copenhagen. Adding new layers of function will challange existing structures and enable new variables for design. In combination with the urban landscape, they are supposed to shape well-defined spaces, ease physical and perceived barriers to farms and enhance productivity.

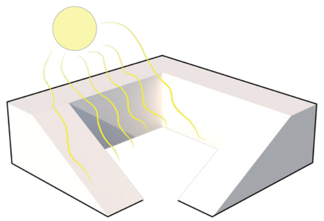
The project is not only about embracing local food but also developing pleasant environments. Establishing green and blue landscapes, high in biodiversity, will create a strong fundament for future scenarios. When people have good access to these green environments it will have positive effects on health. Further, the food business can shape a creative cluster that provides job opportunities. Events, restaurants and the local atmosphere can invite tourists, this situation will increase economic prosperity and enhance social interactions.



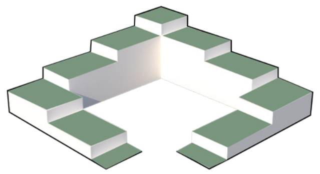
Principles of vertical access that creates stronger relationship between resident and food production.



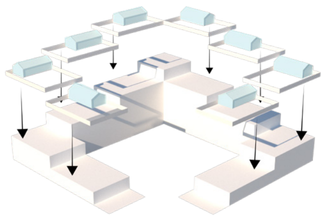
1. SOLID BLOCK STRUCTURE.



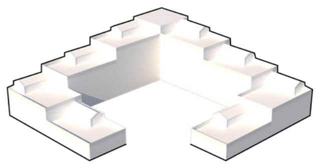
2. INCREASED SUN ACCESS.



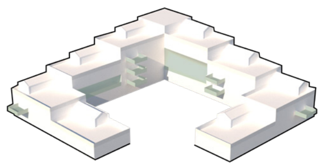
3. TERRACED SHAPING.



4. ADDING GREENHOUSES.

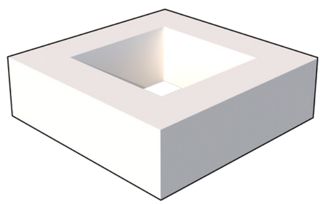


5. TERRACED GARDENS.

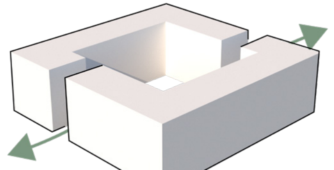


6. BALCONY EXTENSIONS.

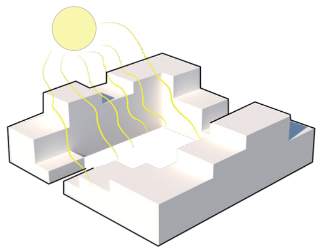
Building typology 1 - Staired block structure.



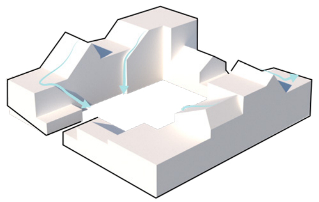
1. SOLID BLOCK STRUCTURE.



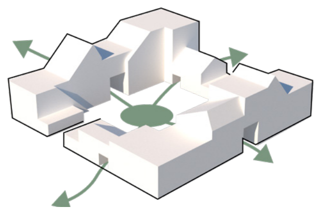
2. INREASED FLOW.



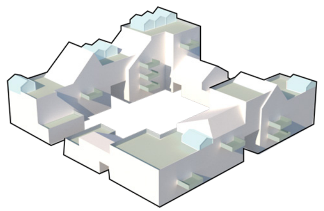
3. SUN ACCESS.



4. WATER DIRECTING DESIGN.

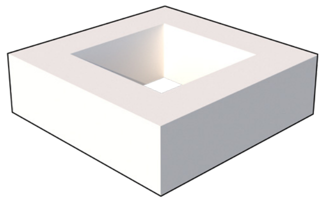


5. POLLINATOR FLOW.

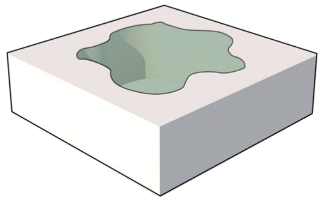


6. TERRACES AND BALCONIES.

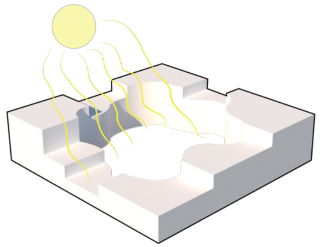
Building typology 2 - Varied block structure



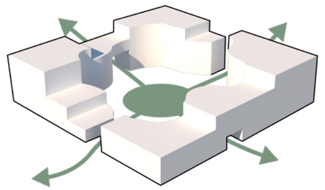
1. SOLID BLOCK STRUCTURE.



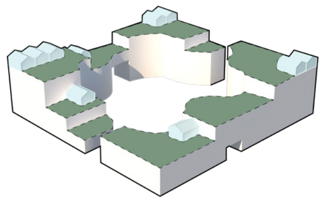
2. SMOOTH SHAPE.



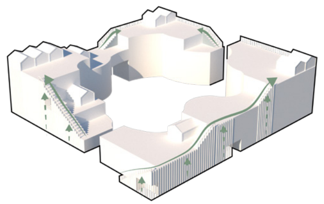
3. SUN ACCESS.



4. POLLINATOR FLOW.

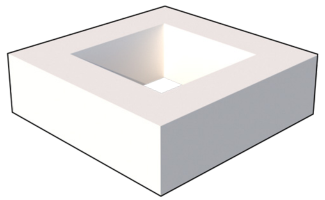


5. TERRACED GARDEN.

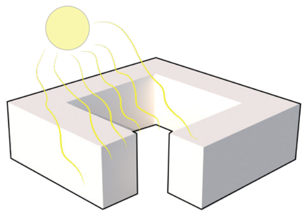


6. INCREASED FLOW.

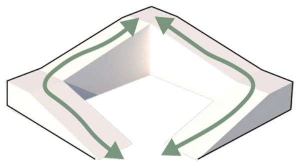
Building typology 3 - Smooth block structure.



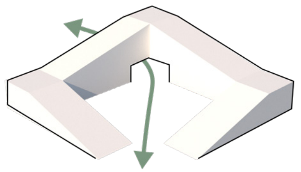
1. SOLID BLOCK STRUCTURE.



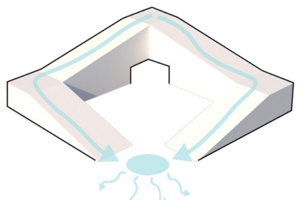
2. SUN ACCESS.



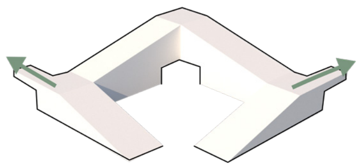
3. POLLINATOR FLOW I.



4. POLLINATOR FLOW II.

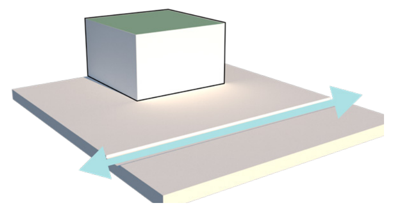


5. IMPORTANT WATER HANDLING.

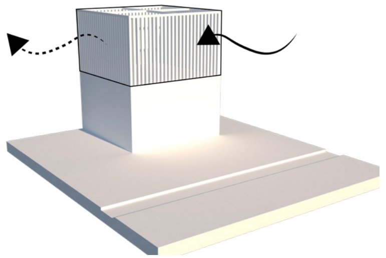


6. POLLINATOR EXTENSION.

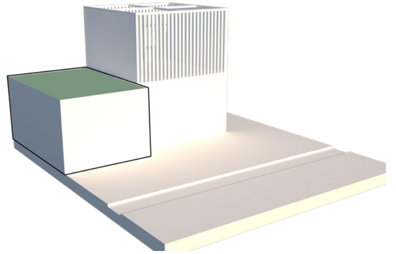
Building typology 4 - Pollinator block structure.



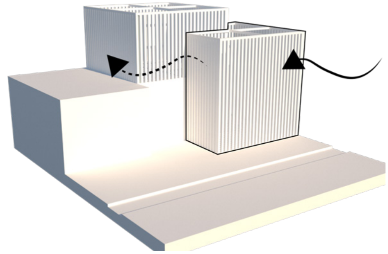
1. 30 M² AND REEDBED PURIFICATION.



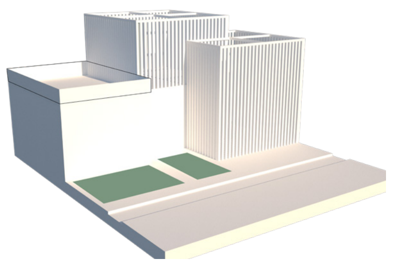
2. PROTECTION ZONE.



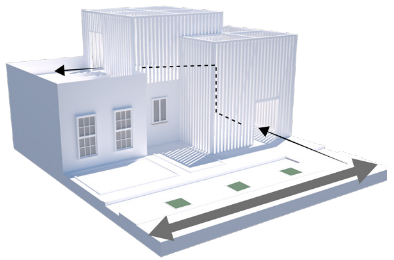
3. INREASED ROOFTOP GROWING.



4. TRANSMISSION ZONE.

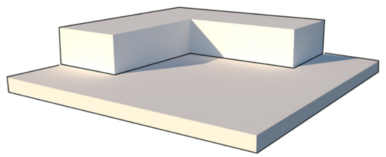


5. OUTDOOR GROWING.

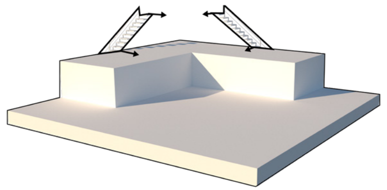


6. FINAL FLOW.

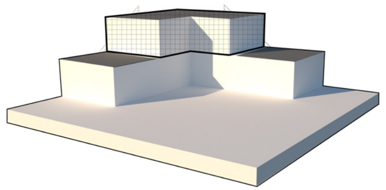
Building typology 5 - Module house type I.



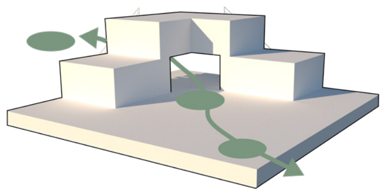
1. FIRST SHAPE.



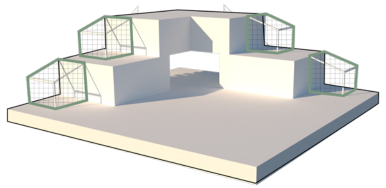
2. STAIRS.



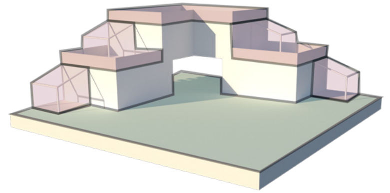
3. TERRACED SHAPE.



4. POLLINATOR FLOW.

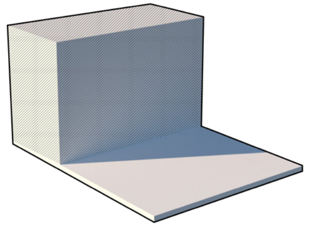


5. ADDING GREENHOUSES.

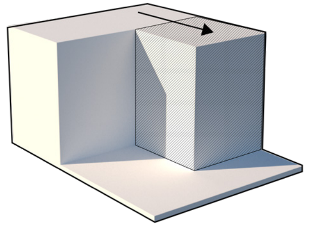


6. PRIVATE AND SHARED.

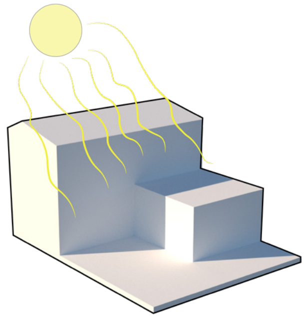
Building typology 6 - Module house type II.



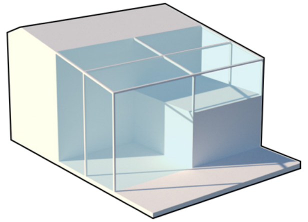
1. ROW HOUSE.



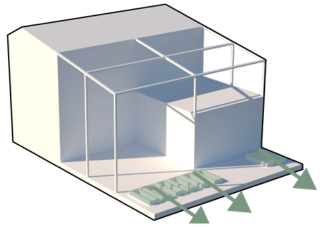
2. EXTENSION.



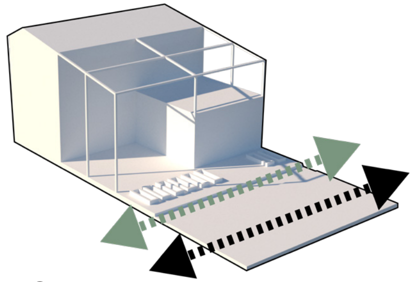
3. SUN ACCESS.



4. TROPIC GARDEN.

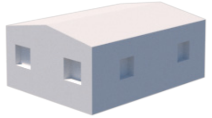


5. SOCIALLY TRANSMITTED GROWING.

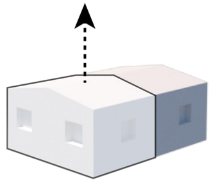


6, MOVEMENT.

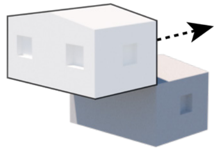
Building typology 7 -Row house with tropic extension



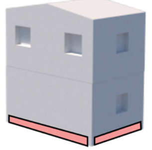
1. SINGLE HOUSE.



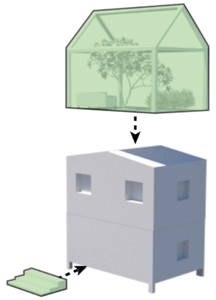
2. LESS FOOTPRINT.



3. LESS FOOTPRINT II.



4. POLLINATOR FLOW.



5. GREENHOUSE ON TOP.

6. SMALL SCALE SINGLE HOUSE.

Building typology 8 - Small scale single house

DESIGN PROPOSAL

Global studies show that the food system today is unsustainable. Although, it is possible to manipulate the physical environment and shape settlements that relate to a situation with sustainable food production. On a regional level, this project can be viewed as an experimental site that can inspire other projects of the city. If many settlements consider sustainable lifestyles there is a higher chance to face future degradation, with this in consideration, local changes will be important to handle global issues.

Global, regional and local analysis works as a fundament for the design proposal and the spatial requirements, regional interests and local qualities are important factors to consider to make the project successful. A basic intention for the design is to evolve current regional and local circumstances towards environments that enhance self-sufficiency and local food production. Adding new layers of sustainability will enhance existing qualities and develop flexibility towards future scenarios. The vision is to design urban extensions that enable healthy, inviting and prosperous situations that minimize degradation of future needs.

This chapter will show the proposed site structure, the masterplan describes how the functions are linked together with the green-, blue-, infrastructure and built environment. The high demand for local organic food directs the project towards a design that enhances certain standards of food production, landscapes are combined with a variety of vegetation that embraces the quality of agricultural purposes. Slopes, shapes and curves are considered when locating elements to make the best use of gravity, to avoid soil erosion, spare efforts, and wisely manage water storage and flows. The structure is developed from conceptual ideas shaped into concrete strategies, guidelines and frameworks and designed to enhance the visions for the project.

The project site is divided into four different areas, areas that are further described in detail, each one with certain different qualities. Proposed building typologies and landscaping are applied in the four areas and interlinked with current regional and local circumstances. The relation between buildings and landscape are experimented with to streamline possibilities of local food production. This is described through various illustrations. Map, sections, axonometric and human perspectives show how the building typologies relate to the surrounding landscape and how self-sufficiency as a design approach appears in the urban environment. Going through the four different areas the illustrations will show the different qualities related to each zone. Further, functions in the centre, including the main food market, pollinator office and the core street is illustrated with axonometric and human perspectives. Lastly, the design outcomes in numbers will show how much space can be used for different diets and how much space is dedicated to different functions.

The proposal gives an idea of how local food production spatially can appear in real environments. A dynamic vibe is expressed with the eco-friendly architecture combined with existing industrial buildings. Different sizes of buildings will rearrange the physical structure developing new forms of urban rooms where various green and blue structure embrace health and bio-diversity. The close proximity between accommodations and farm will allow access for every household to be self-sufficient on locally produced food. The project proposes a new layer to the urban fabric of Copenhagen, aiming for a high quality of life standard with both access to calm and green environments yet still a close connection to the vibrant city life in the inner Copenhagen. The project does not interfere with annually cultural events, carefully defined public rooms and low dense environments give spatial access to larger crowds if needed. Enhancing the clustering of food businesses will attract more tourists and with a creative, organic and local approach, the street food market would be able to compete with the highest rated street food markets in the world. There is an opportunity to create new standards for urban extensions and with pro-active planning, Refshaleøen can become the new self-sufficient settlement of Copenhagen.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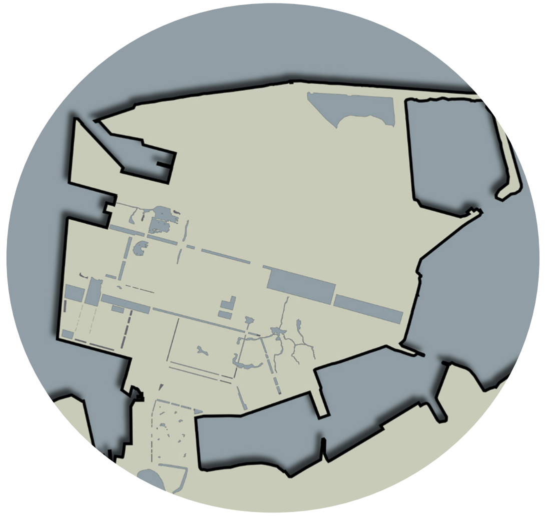
METER
MASTERPLAN

- Green structure.



- Blue structure.

Functions.

Housing.

Water cleaning plant.

Restaurants or bars.

Industries.

Leisure.

Research facilities.

Offices.

II Areas.

- Infrastructure.

E N T R A N C E

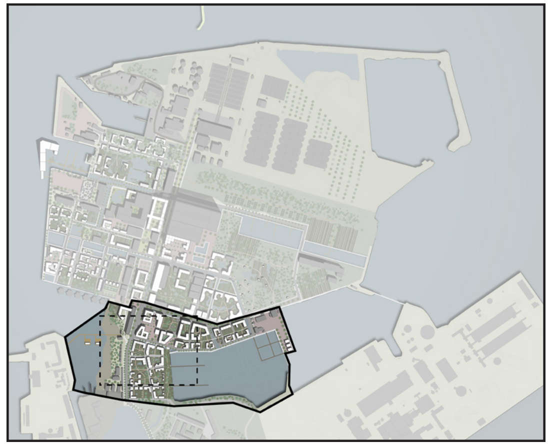
area one

This area serves as the entrance to the proposal. It is a mixed variation of terraced block structure and varied block structure. It has open courtyards and lower buildings toward the south to embrace the sunlight. In the west, there is a proposed artificial beach and to the east, the water can be accessed by docks. To the north, there is close access to the central bus station, research facilities and the botanical garden. There is an esplanade running through the area and the public landscape changes from forests, farmlands and squares.

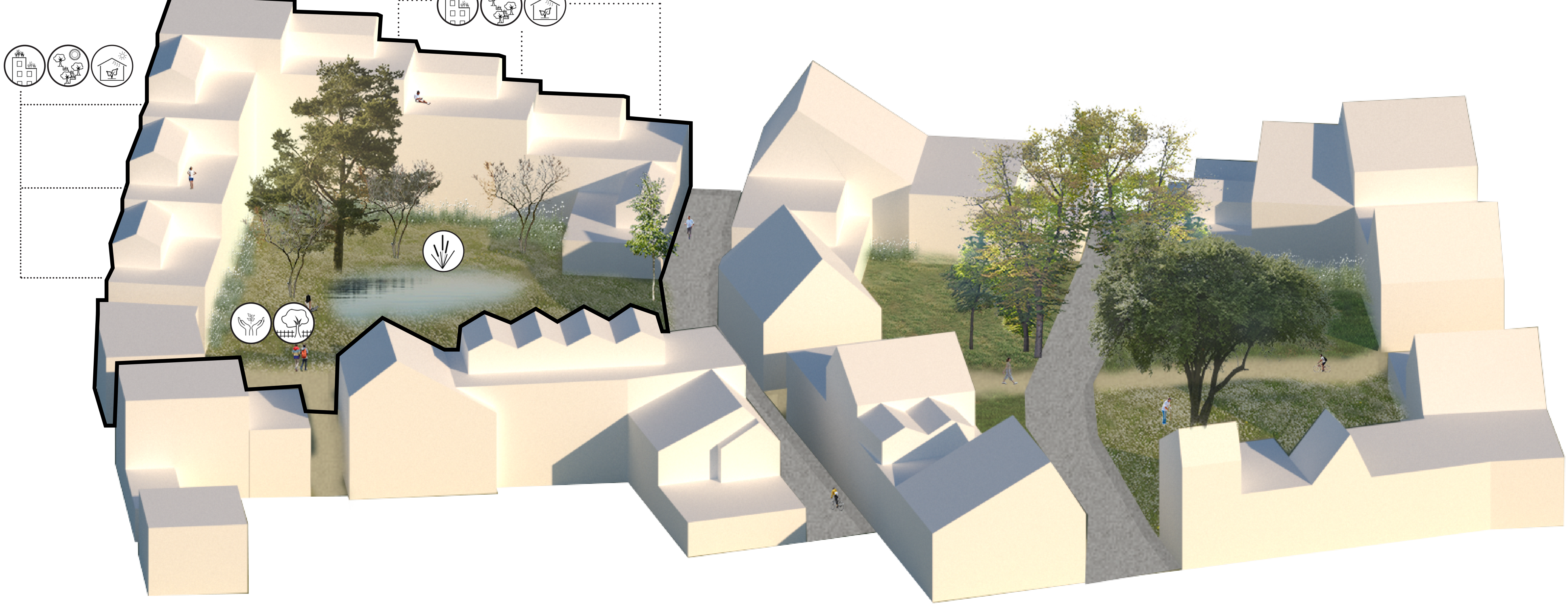
Possible amount of people 1200

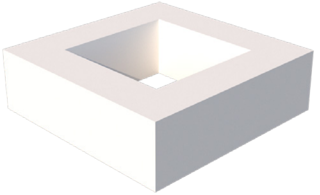
62 000 m²

Food for up to 2060 people

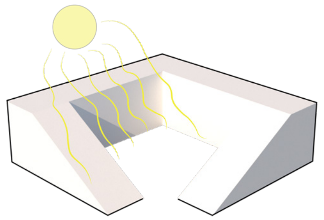


STAIRED BLOCK STRUCTURE.

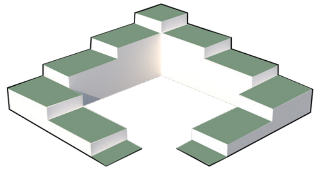




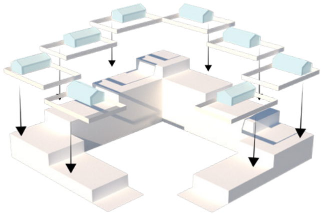
SOLID BLOCK STRUCTURE.



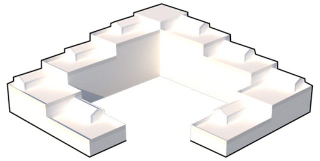
INREASED SUN ACCESS.



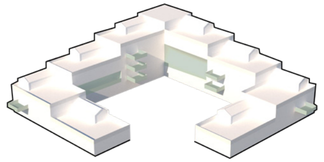
TERRASSED SHAPING.



ADDING GREENHOUSES.

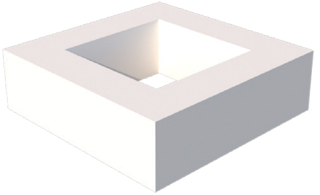


TERRACED GARDENS.

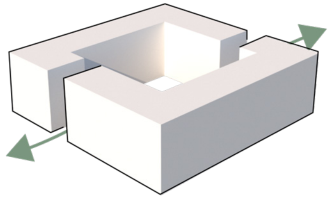


BALCONY EXTENSIONS.

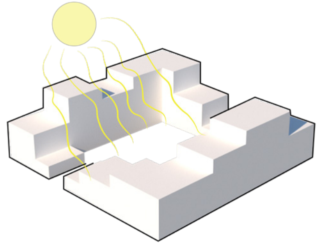
VARIED BLOCK STRUCTURE.



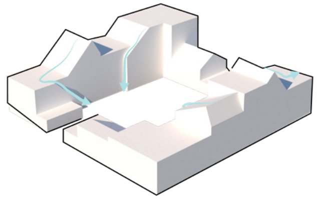
SOLID BLOCK STRUCTURE.



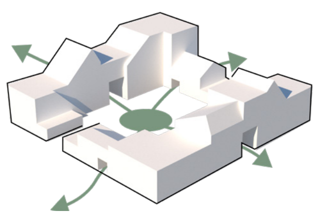
INREASED FLOW.



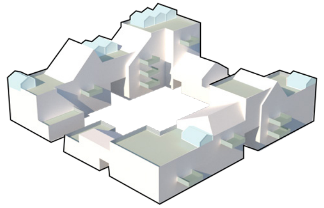
SUN ACCESS.



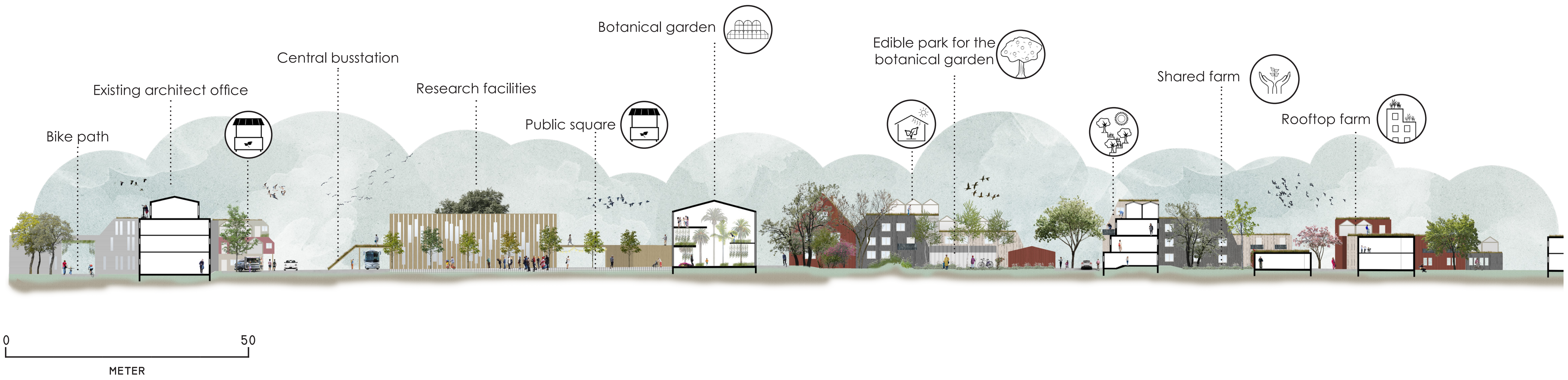
WATER DIRECTING DESIGN.



POLLINATOR FLOW.

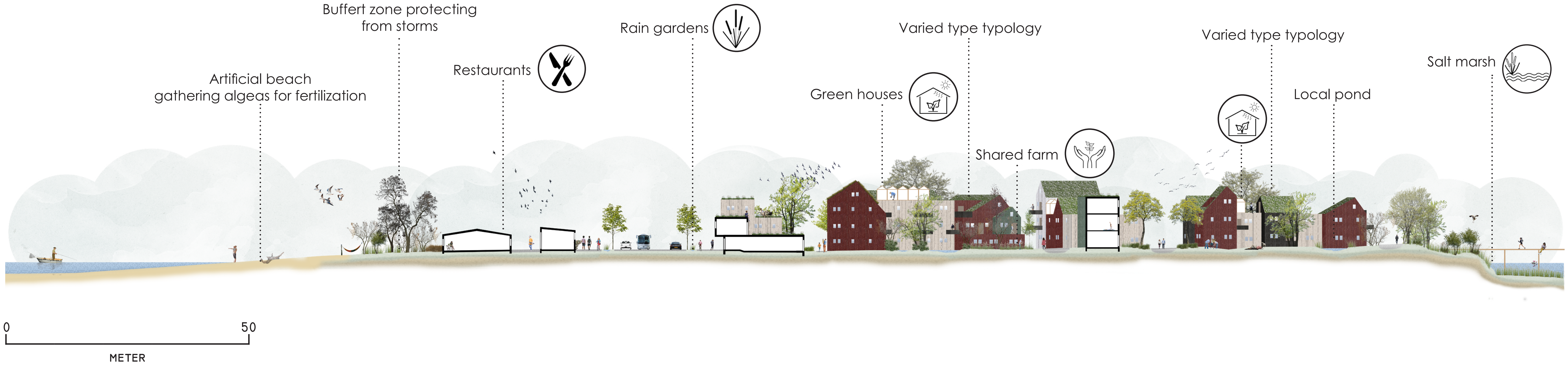


TERRACES AND BALCONIES.



Botanical garden
Edible park for the
botanical garden
Central busstation
Existing architect office
Research facilities
Shared farm
Rooftop farm
Public square
Bike path
0
50
METER

SECTION A:A


Buffert zone protecting
from storms
Rain gardens
Varied type typology
Varied type typology
Salt marsh
Artificial beach
gathering algeas for fertilization
Restaurants
Green houses
Local pond
Shared farm
0
50
METER

SECTION B:B


STREET VIEW TOWARDS RESEARCH FACILTIES

SMOOTH FOREST

area two

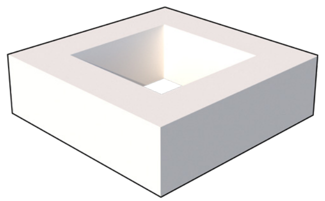
This area is located between the forest and the main market square. It includes a smooth shaped block structure that enhances the biodiversity and the small scale single houses are carefully located in the landscape to embrace the flow for pollinators. The low density enables for more than the double amount of food for the people living there. There are several ponds, small canals and small lakes with reed beds purifying the water but also beautifying the area. It is shifting from calmer in the east to busier by the central square in the west.

Possible amount of people 700

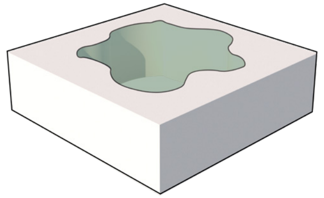
58 000 m²

Food for up to 1930 people

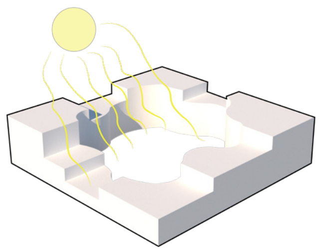
SMOOTH BLOCK STRUCTURE.



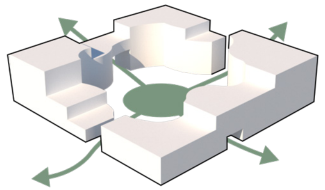
SOLID BLOCK STRUCTURE.



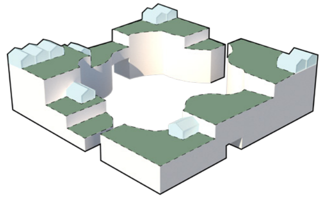
SMOOTH SHAPE.



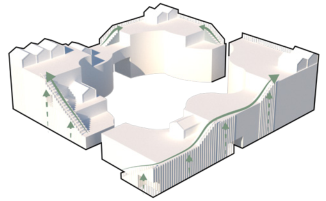
SUN ACCESS.



POLLINATOR FLOW.



TERRACED GARDEN.



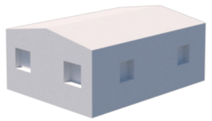
INCREASED FLOW.

Possible amount of people 1-2

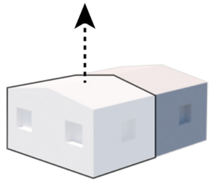
1400 m²

Food for 2 persons with vegetarian diet

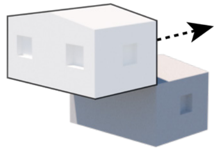
S M A L L S C A L E S I N G L E H O U S E - V A R I A T I O N I



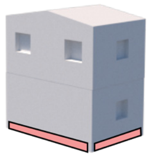
SINGLE HOUSE.



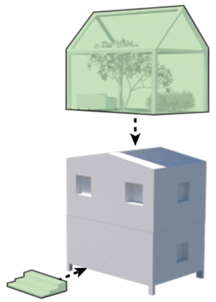
LESS FOOTPRINT.



LESS FOOTPRINT II.

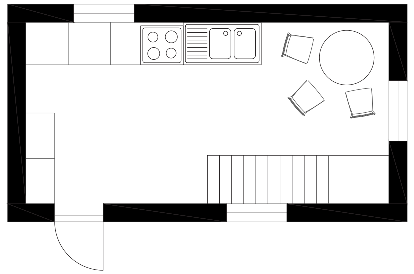


POLLINATOR FLOW.

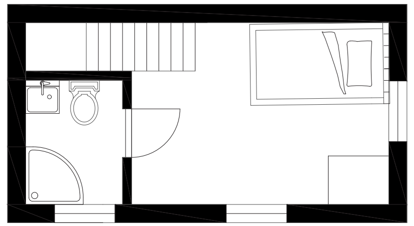


GREENHOUSE ON TOP.

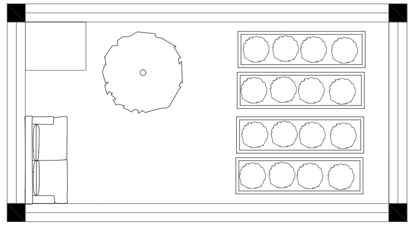
SMALL SCALE SINGLE HOUSE.



GROUND FLOOR



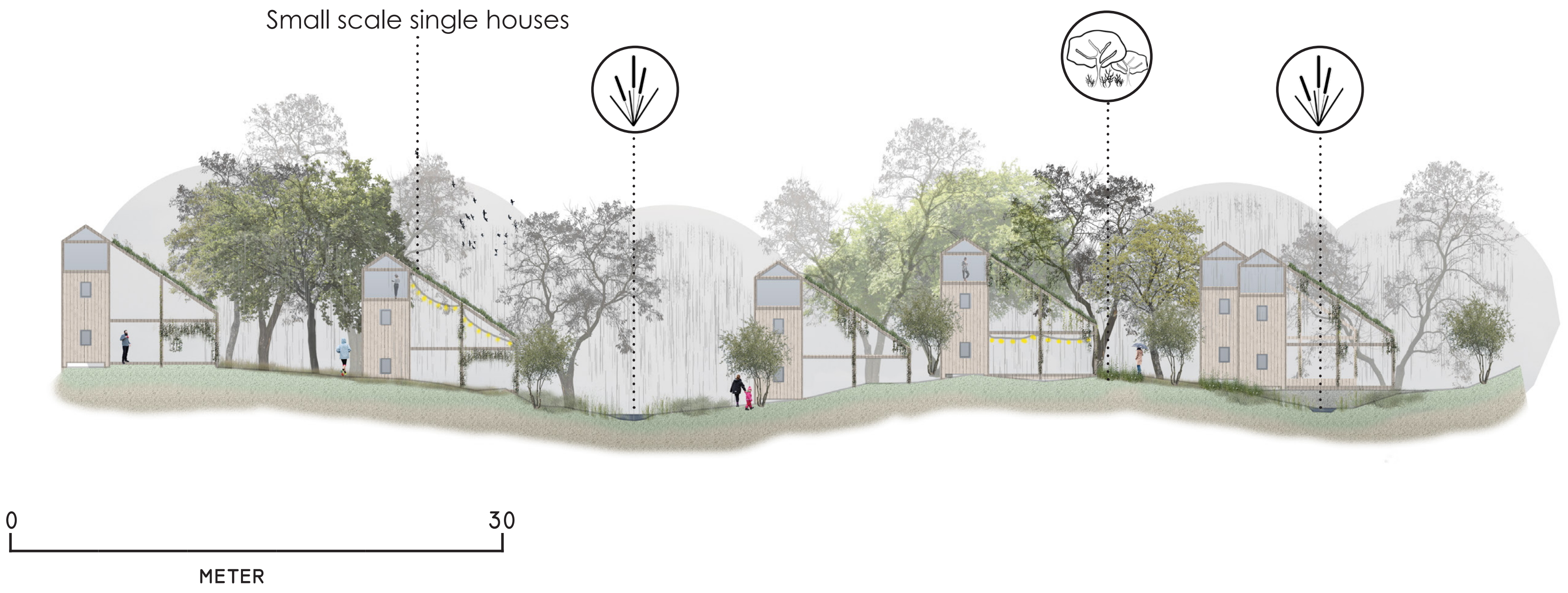
SECOND FLOOR



THIRD FLOOR

SMALL SCALE SINGLE HOUSE - VARIATION II

SECTION A:A



SECTION B:B


COURTYARD - FACILITIES

MODULE ZONE

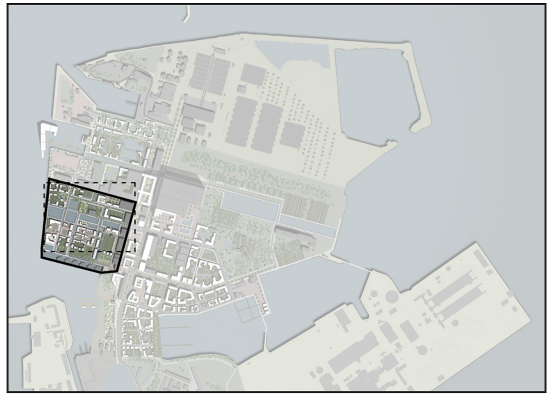
area three

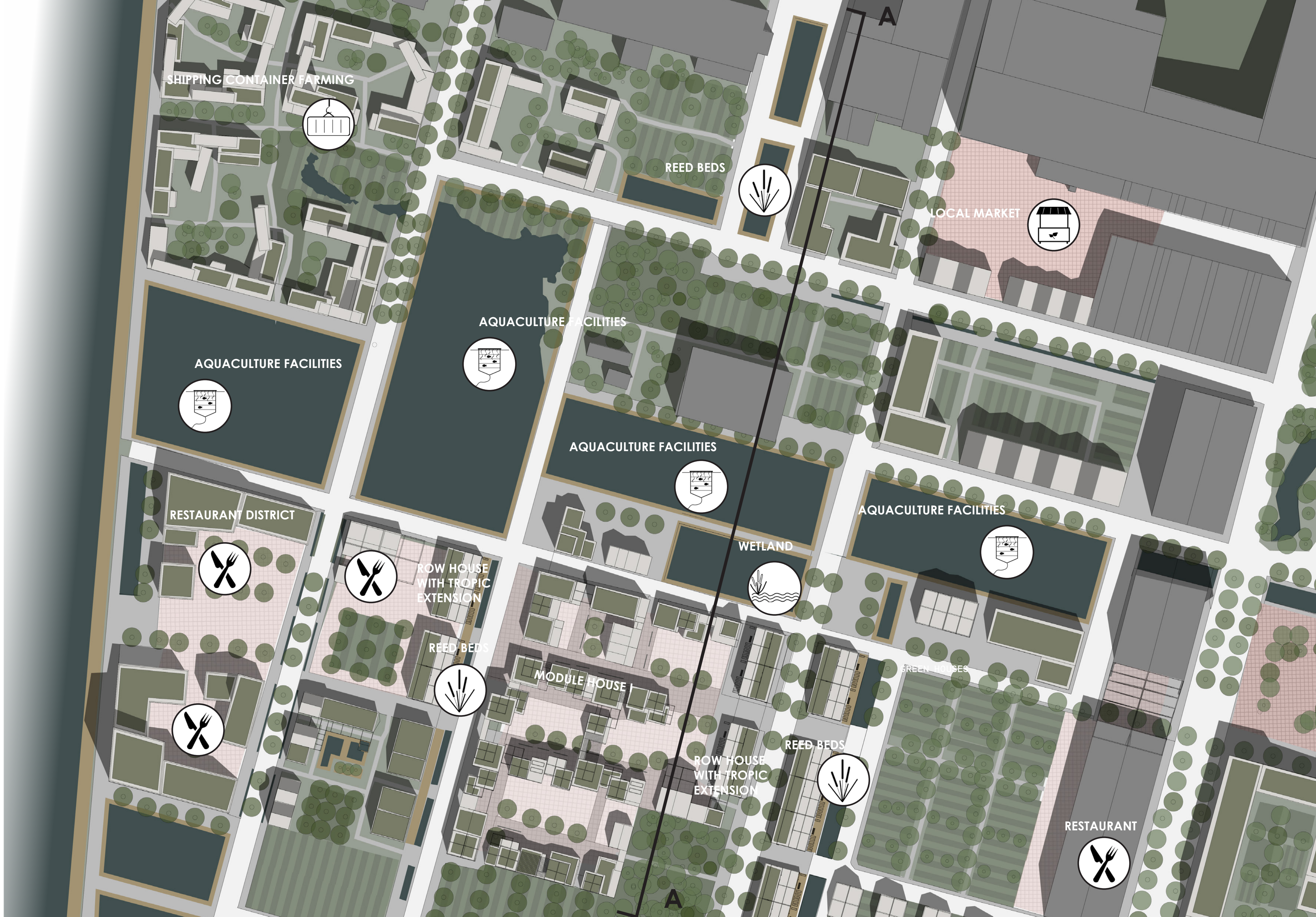
The area is mainly based on module-shaping to connect with its industrial history. It is characterized by bigger canals that are used for aquaculture facilities and purification. The area is edged by restaurants, on the south-west by the sea, to the east by the old industrial facilities and the location of the street food market is just up north. Existing containers have been rearranged creating a variety of courtyards and the interior has been changed to a closed-loop farm container system. The south is characterized by module shaped houses and row houses with tropic extension. Larger areas of farms are distributed to be used by the restaurants located in this zone.

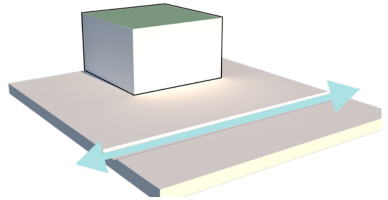
Possible amount of people 120.

50 200 m^2

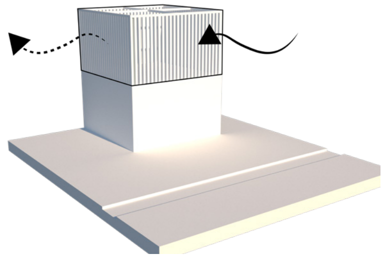
Food for up to 1675 people.



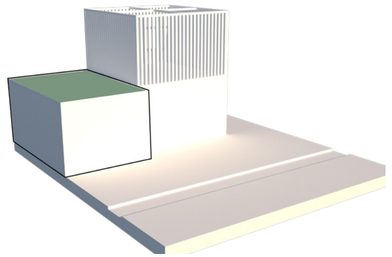




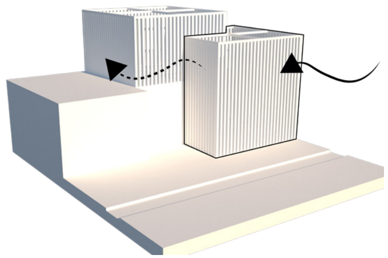
30 M AND REEDBED PURIFICATION.



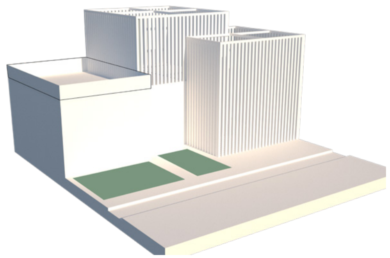
PROTECTION ZONE.



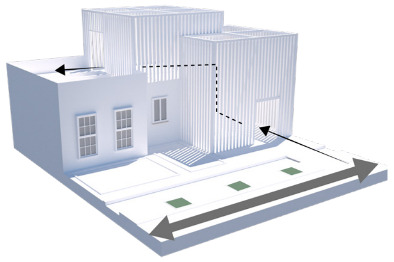
INCREASED ROOFTOP GROWING.



TRANSMISSION ZONE.



OUTDOOR GROWING.

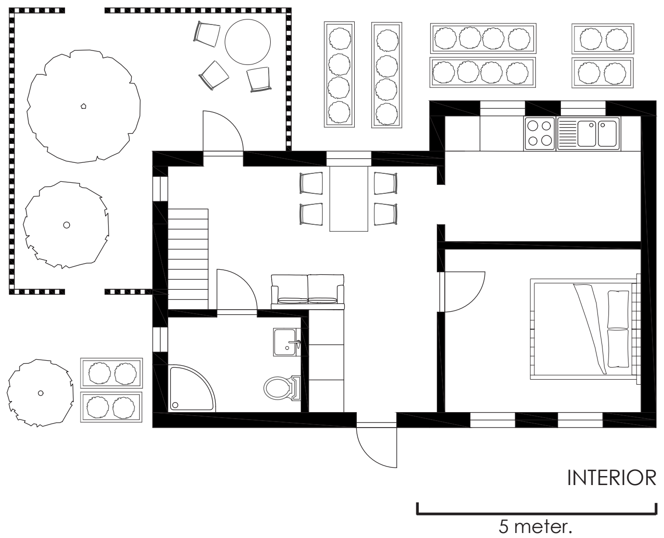


FINAL FLOW.

Possible amount of people 2

110 m²

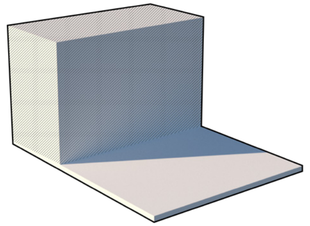
Food for up to 3 people



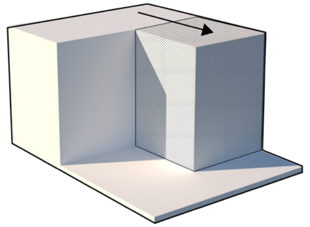
INTERIOR

MODULE HOUSE I

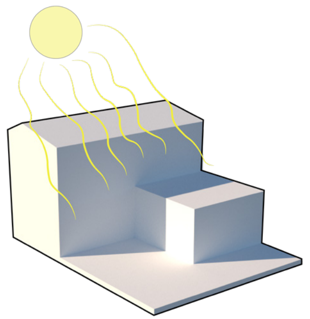
ROW HOUSE WITH TROPIC EXTENSION



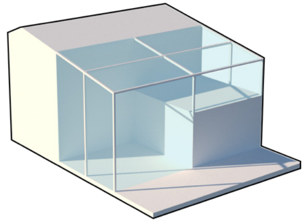
ROW HOUSE.



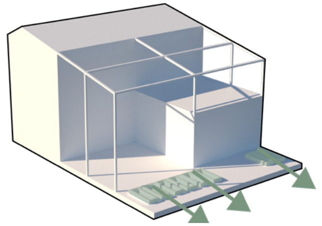
EXTENTION.



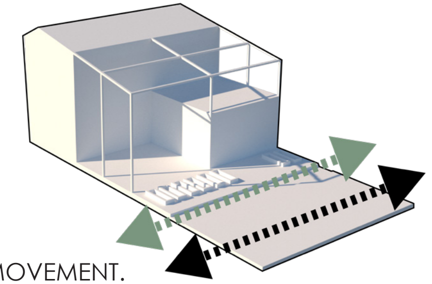
SUN ACCESS.



TROPIC GARDEN.



SOCIALLY TRANSMITTED GROWING.

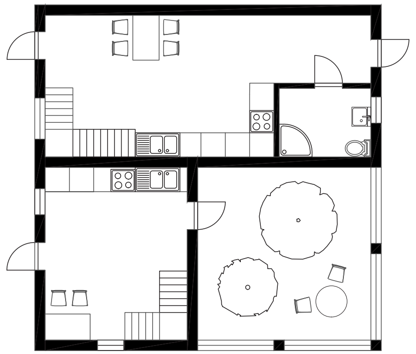


MOVEMENT.

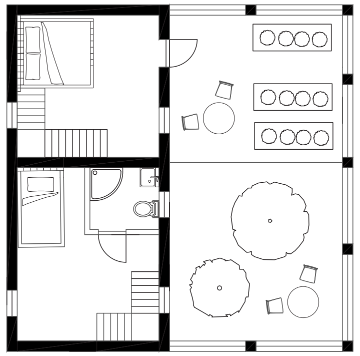
Possible amount of people 3

50 m²

Food for up to 2 people



INTERIOR PLAN GROUND FLOOR



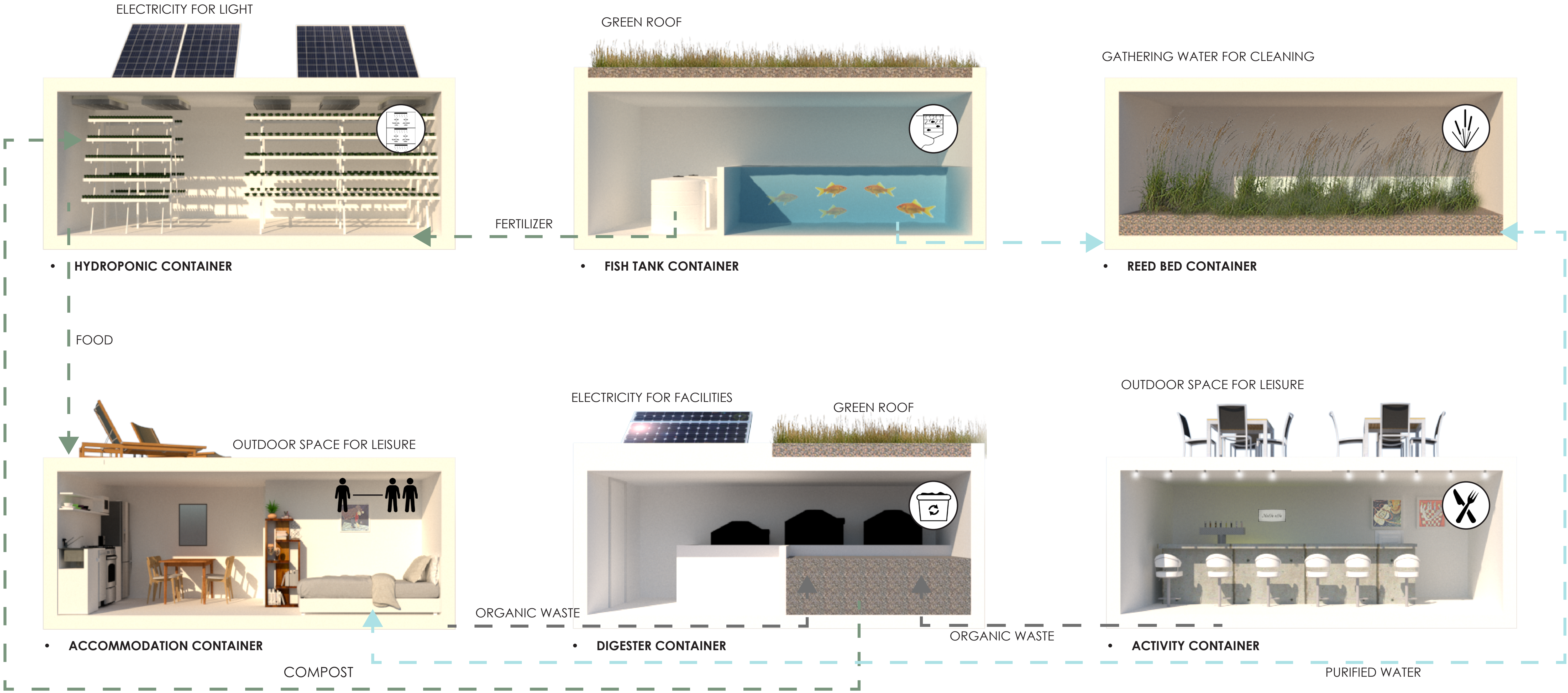
INTERIOR PLAN SECOND FLOOR

10 meter.


MODULE COURTYARD - FACILITIES

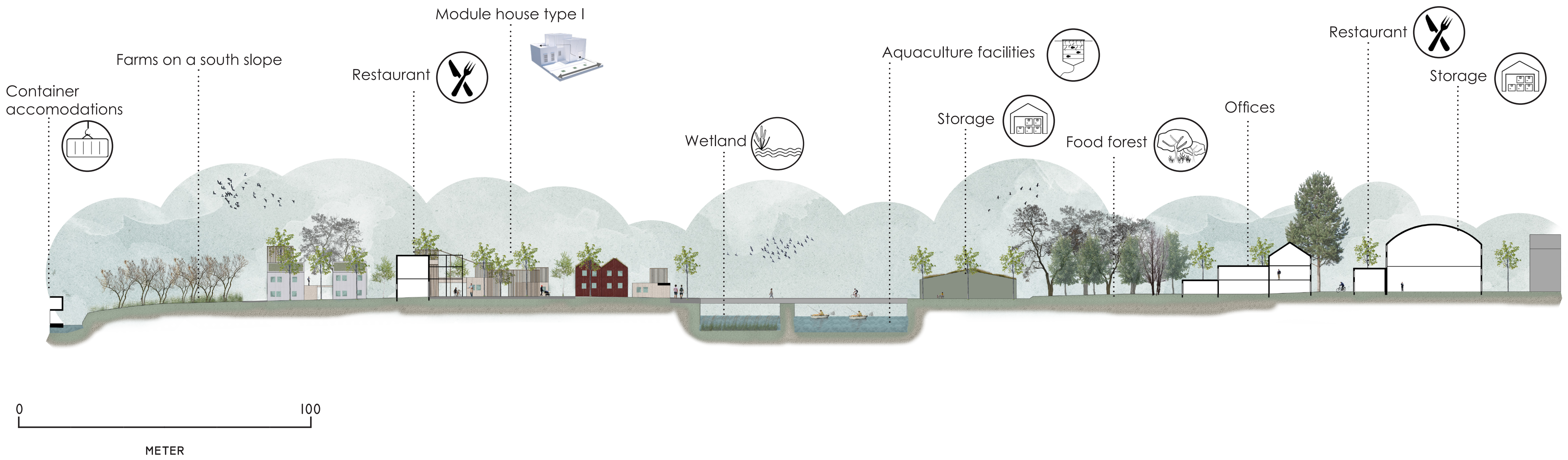

LOCAL RESTAURANT - FACILITIES


STREET VIEW- FACILITIES



S H I P P I N G   C O N T A I N E R   F A R M   S Y S T E M


BEACHSIDE
CONTAINER FARMING - FACILITIES


Container
accomodations
Farms on a south slope
Restaurant
Module house type I
Wetland
Aquaculture facilities
Storage
Food forest
Offices
Restaurant
Storage
0
100
METER

SECTION A:A

MODULE ZONE II

area four

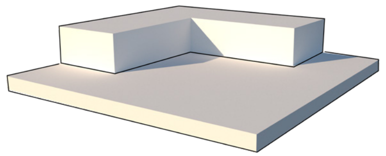
The module zone II is located north of area III and a continuation of the module typology but with a different shape. It also includes the row house typology with a tropic extension. It is the most north area for developing housing and although it is close to the street food market the area has a calm vibe and low density and it includes bigger water elements for leisure, purification and aquaculture facilities.

Possible amount of people 259

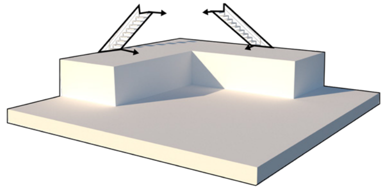
38 000 m²

Food for up to 1260 people

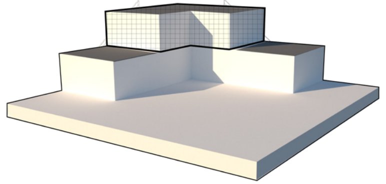
MODULE HOUSE TYPE II



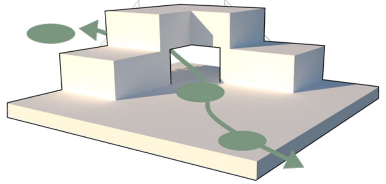
FIRST SHAPE.



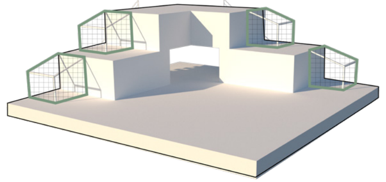
STAIRS.



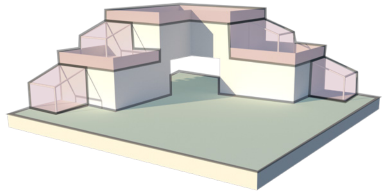
TERRASSED SHAPE.



POLLINATOR FLOW.



ADDING GREENHOUSES.



PRIVATE AND SHARED.

Possible amount of people 8

430 m²

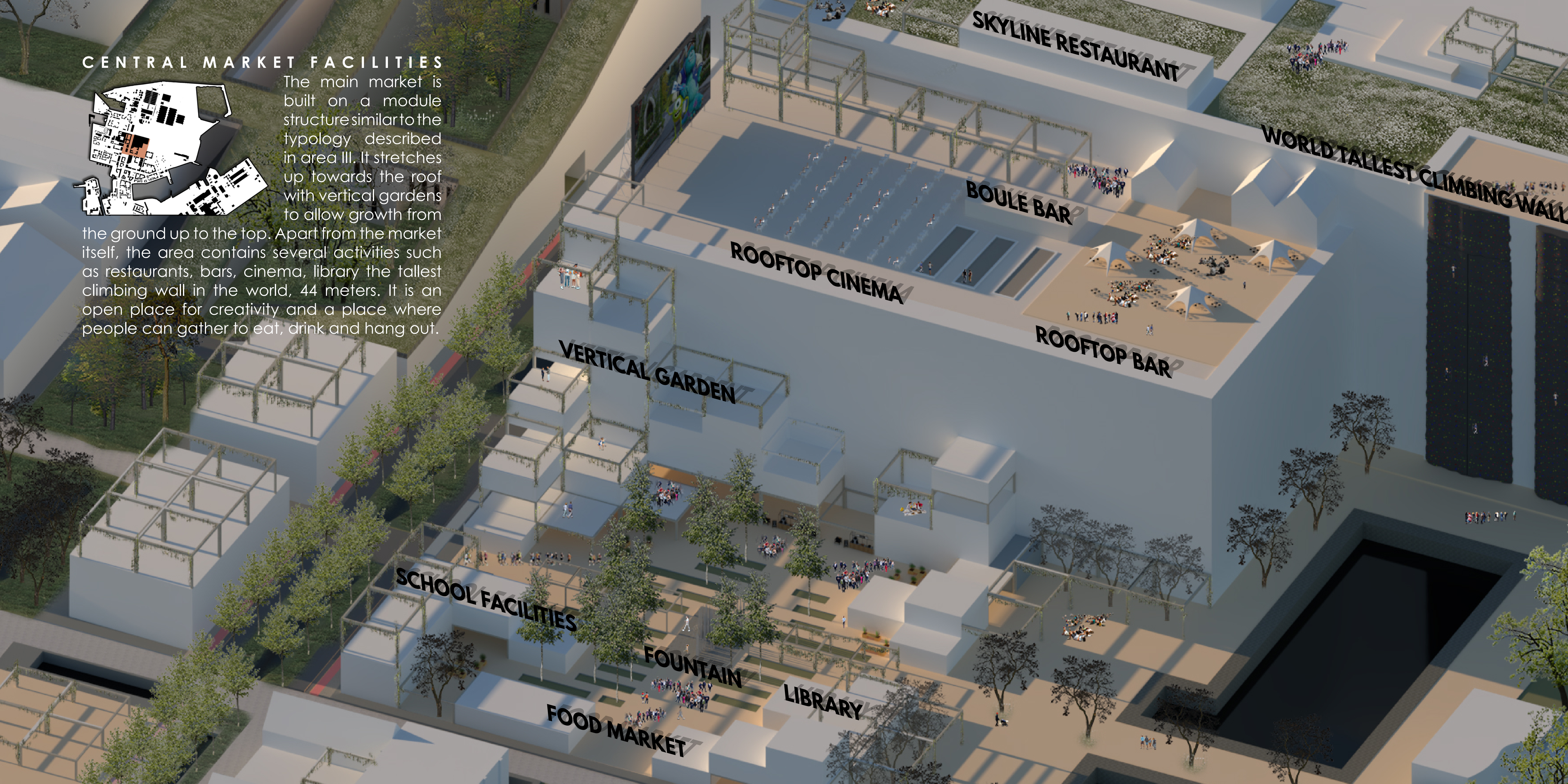
Food for up to 14 people

INTERIOR


TERRACE VIEW - FACILITIES

CENTRAL MARKET FACILITIES

The main market is built on a module structure similar to the typology described in area III. It stretches up towards the roof with vertical gardens to allow growth from the ground up to the top. Apart from the market itself, the area contains several activities such as restaurants, bars, cinema, library the tallest climbing wall in the world, 44 meters. It is an open place for creativity and a place where people can gather to eat, drink and hang out.

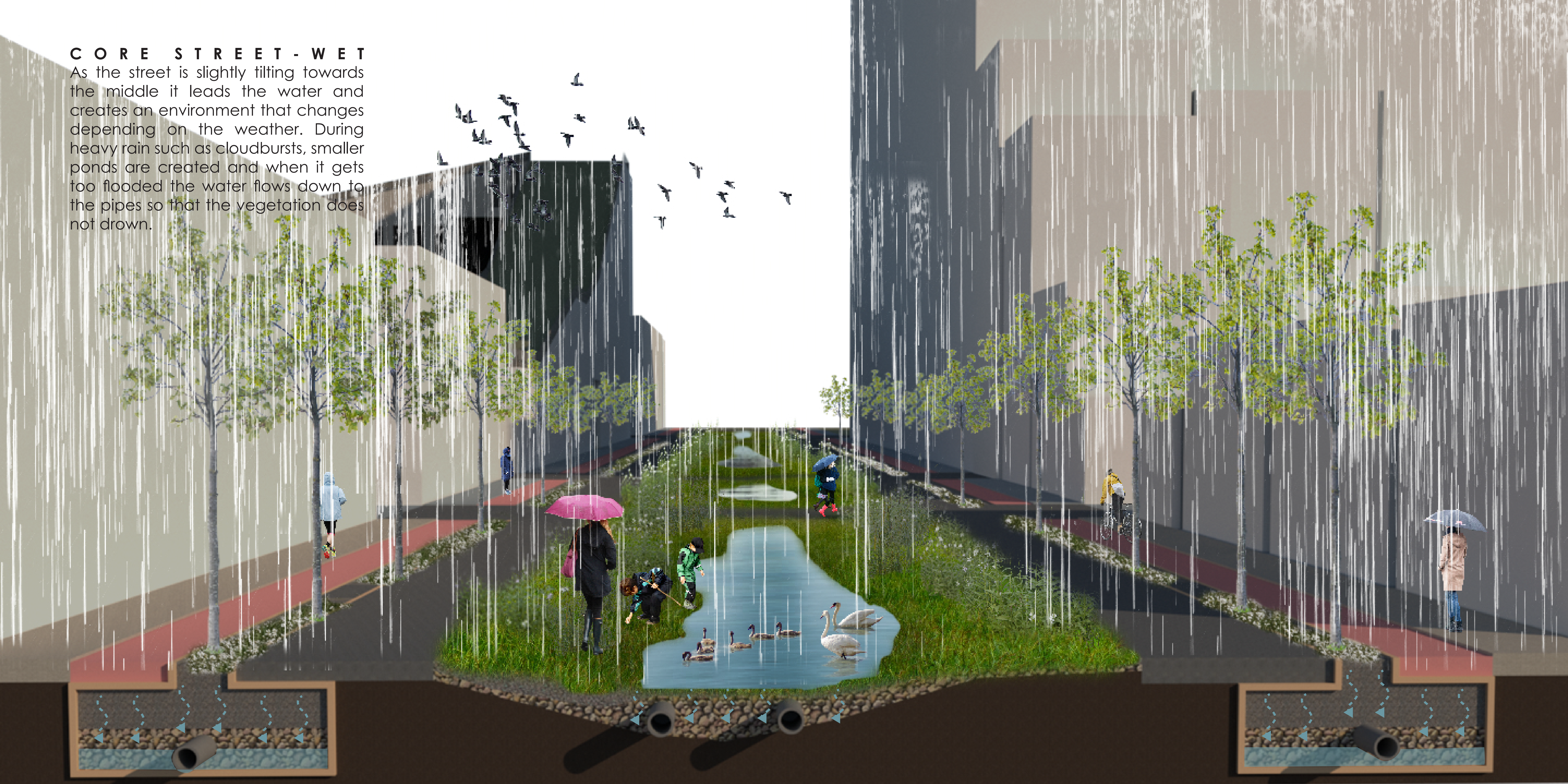


C O R E S T R E E T - D R Y

The main street stretches from the entrance towards the water treatment plant. It cut through the site and pass by several important facilities such as the existing bus station, the botanical garden, the torvehal and the central market. It is largely covered in vegetation to enable a flow for pollinators. As there might be pollution from traffic it is not suitable for growing food. Instead, the greenery is for purifying and drainage.

C O R E   S T R E E T - W E T

As the street is slightly tilting towards the middle it leads the water and creates an environment that changes depending on the weather. During heavy rain such as cloudbursts, smaller ponds are created and when it gets too flooded the water flows down to the pipes so that the vegetation does not drown.



Terraces in the facade can be shaped with a diagonal glass structure to reflect the sun. More light can extend the growing season.

THE POLLINATOR BLOCK STRUCTURE OFFICE

This office building is based on the structure of a pollinator block with a continuous flow from ground up to the top. Although the building serves as an office the roof has public access. It can be used for large scale growing of food. By the entrances to the roof, the water is handled by conveyance paths that leads it to reedbeds, streams or ponds.

Design outcomes in numbers

Total areal 1 100 000 m^2

Total area made for growing food 550 000 m^2

Developed housings for 3600 people

Vegetarian diet 758 people

Conventional European diet 110 people

Food for up to 18 400 people

50 000 m^2 waste water management plant

45 000 m^2 Reed beds and wetlands for purification

5000 m^2 Compost facilities

11 800 m^2 area for food markets

Enabling at least 40 new restaurants to be established

250 m^2 botanical garden

CONCLUSION

The initial intention for this project derives from an awareness about the global situation of food systems. The idea is that changes on a local level can create situations that withstand short and long-term perspectives. Sustainable approaches to urban design are central to the vision of the project. It is possible to shape elements of the urban environment so that it enhances urban farming, adding new layers for agricultural purposes can direct built structure and landscape in ways that add positive qualities for the urban environment and ease lifestyles that relates to self-sufficiency.

The definition of local is vague and it is therefore important to further discuss how we use the phrase concerning food consumption. By creating guidelines for spatial requirements regarding food and density it is possible to define how self-sufficient cities can be shaped. As an example, looking at local by proximity, direct physical access to the farm is far more local compared to guidelines such as 100 miles radius. What happens 100 miles away has less physical effect to a project site than farms that is located in the immediate vicinity. When local is defined it is possible to use it as a variable considered regarding density and thereby shape frameworks to develop settlements. This project proposes a situation where local is defined by direct access between a building and a productive landscape. The maximum density is defined by the area that is required to enable a minimum survival diet, but on many occasions, it will be possible to have a vegetarian diet and even a conventional European diet. However, in a global perspective this is not always a possible scenario, particularly in dense urban centres.

The spatial studies prove that food production concerning large scale urban agglomerations will require space beyond urban borders, using factor 10 as an example. Looking at the current situation (considering technology and urban growth), urban farming can not be seen as a single solution solving global issues but rather as a tool that can unburden food systems, systems that puts high pressure on climate and ecology. This will be important to consider since two-thirds of the total population in the world will live in cities in 2050 and if we want to implement sustainable approaches to new megacities.

Although, local food production offers a direction towards sustainable approaches it can not be equated with sustainable food production. There are ongoing discussions about whether it is suitable to grow food in cities or keep farming facilities in the countryside. It is therefore important to figure what qualities local food can bring to cities. Arguments against can be that a majority of urban centres suffers from bad soil quality that can interfere with the quality of food. On the other hand, implemented and maintained in certain ways it can contribute with positive aspects such as decrease of carbon emissions, enhance social security, improved blue-green values and develop an awareness that makes people eat food that is more healthy, organic and requires less footprint.

To shape the environment in the desired direction, it is possible to figure several factors that are crucial for prosperous urban agriculture. The principle is to place and shape elements so that they have the best relationship with these influences, something that is common within similar approaches to site planning, such as permaculture. Some factors, that are proposed for this project, will be applicable for other projects. Though, it will be important to study the local circumstances as different solutions will be required dependent on the local relationship with influences such as climate and soil type.

By implementing urban agriculture it is possible to develop elements that incorporate several good qualities to urban agglomerations. Studying food production related to cities is a way to develop an awareness about the great opportunities there is to shape cities that relate to short-term and long-term perspectives. Adding new layers create diverse urban landscapes and urban farming is one tool by many that can direct the global situation towards sustainable situations.

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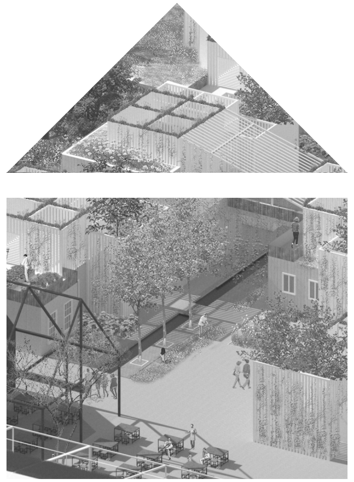

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