Urban Gardening & Sustainable Consumption

Loudden, The Stockholm Royal Seaport

Course: GE7015 Environmental Management in Planning

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Foreword

This report is the result of a project work within the course Environmental Management in Planning at Stockholm University. The course is a mandatory part of the multidisciplinary Master programme Environmental Management and Physical Planning at the Department of Physical Geography and includes both Swedish and international students. The course comprises ten weeks of study (15EHTC), of which the project part covers five weeks. The aim is to give the students an opportunity to apply their acquired knowledge on environmental management in planning on a realistic and relevant case. This time we have chosen to study the Stockholm Royal Seaport (SRS) and its surroundings. The different project groups have focused on remediation and implementation of urban gardening in Loudden (the last area to be developed in SRS), retrofitting of neighbouring residential areas as well as The Royal National City Park as a green resource for SRS.

The students alone are responsible for the results and conclusions of this report and it cannot be regarded as the position of Stockholm University. The project supervisor has been Nadja Stadlinger from the Department of Physical Geography. We want to thank all those who have been helpful in providing the students with information and materials as well as having taken time for interviews. Without your help this project could not have been realised.

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Abstract

This project will focus on Loudden which is located in the Southern part of the Royal Seaport, Stockholm. The area is approximately 4.3km^2 and the majority of the land is currently being used for a biogas plant and a petroleum import depot. To date, limited plans have been made for the development of the area but it is known that approximately 4000 apartments, along with offices, shops and schools will be included. As such, Loudden has provided this project with an opportunity to research and present some suggestions as to how it should be developed.

Amongst the global community increasing population pressures, along with concerns over climate change have begun to be noticed and discussed, particularly their impacts on food security. Although food security is not an imminent threat within Stockholm or Sweden, this project has been approached from a food security perspective in order to highlight the need to prepare for the worst, as well as encourage Stockholm to utilise the opportunity to put its pioneering nature, in regards to sustainability, to use.

As such, this project will look at how urban gardening tools can be used within Loudden to increase sustainable consumption practices. The final outcome, of which, will be a map with suggestions as to what could be included in the area in order to maximise the environmental and social benefits. A range of urban gardening techniques have been included in the suggested plans including: forest gardens, community gardens and green rooftops in order to maximise the benefits for the residents. The methods used in this project include: a causal loop diagram, an ecosystem services matrix, informal interviews, a cost analysis and the green space factor index. The findings from each method have been triangulated to provide a rich discussion.

Keywords: Urban gardening, Food Security, Urbanisation, Climate Change, CLD, Green Space Factor, Ecosystem Services

Sammanfattning

Fokus för detta projekt är Loudden, som ligger i den södra delen av Norra Djurgårdsstaden i Stockholm. Området är cirka 4.3km^2 och i dagsläget så används området för ett biogasverk och en depå för oljeimport. Planer för exploateringen i området har påbörjats, och området planeras för att rymma runt 4000 lägenheter samt kontor, affärer och en skola.
Eftersom planerna för Loudden fortfarande är under utveckling så har det blivit en möjlighet för detta projekt att undersöka och framlägga förslag för hur området skulle kunna exploateras.

Globala svårigheter såsom en ökande befolkning tillsammans med oro för klimatförändringar har i allt större omfattning uppmärksammats och debatteras, framförallt i relation till påverkan på tillgång till mat. Trots att frågan om matsäkerhet inte är ett överhängande hot varken i Stockholm eller i Sverige så har detta projekt tagit avstamp från ett sådant perspektiv i syfte att belysa behovet av att förbereda för ett framtida värsta scenario, samt att uppmana Stockholm stad att använda möjligheten att återigen vara pionjärer i frågor om hållbarhet.

Detta projekt kommer att undersöka hur stadsodling (*urban gardening)* kan användas i de nya planerna för Loudden för att öka tillämpningen av hållbar konsumtion. En karta med förslag på vad som kan inkluderas i området för att maximera miljömässiga- och sociala fördelar presenteras. En mängd olika urbana odlingstekniker har inkluderats i den föreslagna planen; skogsträdgårdar (*forest gardens*), gemensamma odlingslotter (*community gardens*) och gröna tak (*green rooftops*) i avsikt att förstärka nyttan och förmånerna för de boende i området.
Metoder som har använts är: Causal loop diagram, matris på ekosystemtjänster, informella intervjuer, kostnadsanalys och grönytefaktor-index. Rönen från varje metod har analyserats och undersökts i relation till varandra för att få till en berikande diskussion.

Nyckelord: Urban gardening, Urbanisation, Food security, Climate change, CLD, Green Space Factor, Ecosystem Services

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1. Introduction

The project will focus on Loudden, located in the Southern part of the Royal Seaport. The area is approximately 4.3 km^2 and currently consists of a biogas plant and a petroleum/container import depot. The plan is for Loudden to be developed into a residential area with approximately 4000 apartments, as well as offices, shops, preschools, school, sports area, parks and market areas, the area is planned to be finished in 2030 (Stockholms stad 2016, Stockholms stad 2017b). This report will seek to show how urban gardening can be implemented in the plans for the area, how urban gardening can be used as a tool for a more sustainable city, as well as to understand the role of urban gardening in encouraging the residents of the Royal Seaport, both directly and indirectly, to engage in sustainable consumption practices.

Approximately, 55% of the world's population live in urban areas. This is expected to increase to 68% by 2050. Although, 90% of the predicted urbanisation will take place in Asia and Africa, Europe will still be impacted and should also make preparations for the future (United Nations 2014). Within Sweden, the population of Stockholm is predicted to increase by almost 30% by 2050, bringing the total population to approximately 3.4 million inhabitants (Stockholms Stad 2018). As such, the city will face new challenges in relation to the stresses of urbanisation and climate change. Within city planning, focus must therefore be placed on providing the fundamental necessities for the city residents.

Stockholms stad (2018) noted that:

> *Society needs to become more robust when it comes to the supply of many basic goods. Long-term spatial planning is an important instrument in Stockholm's work on civil contingencies planning and managing extraordinary events. This work is closely linked to planning transport, adapting to climate change and utilities infrastructure. Urbanisation will make infrastructure (försörjning in the original text) increasingly important in the cities*.

As it is important to gain an understanding as to the possible wider implications of Stockholm Royal Seaport, a food security perspective will be used to frame the project. Other challenges such as increasing urbanisation and climate change will also be considered in their relation to food insecurity.

The final outcome of this project will be a suggestion of which types of urban gardening we think can be implemented in the area of Loudden, along with the suggestions there will be a map that shows the implementation of the urban gardening in Loudden. Our suggestions are based on previous literature on the subject, interviews, and the already built areas of Stockholm Royal Seaport. Several methods have been used to gain an understanding of urban gardening and to justify our choices: a causal loop diagram, an ecosystem services matrix, informal interviews, a cost analysis and the green space factor index.

2. Background

This section will provide an overview of the definitions which have been used to define and structure this project. The aim is to place this project within some of the main global issues in order to highlight how Stockholm fits within a global context.

2.1 Food Security and Climate Change

The flexibility of the concept of food security is reflected in the continuous evolution of its definition (FAO 2006). The term was first used in the mid-1970s, when the World Food Conference (1974) defined food security in terms of food supply: "*Availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices*". During the 1980s, more focus was placed on providing access. The FAO (1983) defined food security as: "*Ensuring that all people at all times have both physical and economic access to the basic food that they need.*" The World Bank's report on Poverty and Hunger (1996) further influenced the definition of food security by highlighting the need for a multi-layered approach. The report particularly focused on the distinguishing between chronic food insecurity and transitory food insecurity. The now widely accepted World Food Summit (1996) definition reinforces the multidimensional nature of food security and includes food access, availability, food use and stability. Over the last 30 years, the concept of food security has also started to include social, political, ethical and human rights dimensions and as such, the world has begun to understand that food insecurity is the result of a combination of complex factors unique to each time and place (FAO 2006). This project will discuss and evaluate the sustainable tools and practices which could be used within the Royal Seaport to address our current concerns over food security.

Developing countries tend to be viewed as more at risk of food insecurity due poor infrastructure and low-income populations. However, as the challenges of climate change and urbanisation continue to grow developed countries such as Sweden also need to be prepared. Concerns have been raised over whether Sweden would be able to produce enough food in the event of a crisis as 42% of Sweden's total food and beverage supply was imported in 2018 (Lantbrukarnas Riksförbund 2018). With a population of 960,031, Stockholm is particularly vulnerable to any drastic changes due to the majority of its' people relying on store bought food (FAO 2019). As such, more projects need to focus on tackling urban food security within Sweden. Suggestions have been made that Sweden should invest in more detailed maps of where their food is sourced from, who grows it, where it goes and, who consumes it (Porter et al 2013). With this in mind Stockholm Royal Seaport provides an opportunity to utilise Stockholms pioneering nature for testing out the sustainable practices in order to move towards eventually achieving food security on a local, national and global scale.

Climate change, caused by anthropogenic activities, refers to the changing weather patterns, rising sea levels, more frequent extreme conditions, and increasing greenhouse gas emissions seen over the last 50 years (United Nations 2019). Recognition of the potential risks for

both human societies and natural systems amongst Governments has grown over the last two decades. As a result, climate change adaptation and mitigation plans have become more and more central to the decision processes in both the public and private sectors (National Academy of Sciences 2010). Focus is often placed on the developing world when it comes to concerns over climate change. However, developed countries such as Sweden also need to be prepared to deal with the effects.

Since the 1960's Sweden has had a reputation as an environmental pioneer. In 1967, it became the first country to establish an environmental protection agency and it has since supported and designed several environmental initiatives such as the international climate change treaty Kyoto Protocol (1998 and 2002) and the Stockholm Convention (2001). As such, Sweden has been at the forefront of this movement and should continue to do so.

Projects such as Stockholm Royal Seaport provide opportunities for the country to continue setting the standards for sustainability, as well as helping the country deal with its own climate change concerns. and create a secure food future for the coming generations.

2.2 Sustainable Solutions

The growing threat of food insecurity due to urbanisation and climate change has brought about a discussion as to the possible solutions. Stockholm Royal Seaport, and in particular the area of Loudden provide an opportunity to test possible methods of dealing with food insecurity and promoting sustainable consumption. Urban gardening is one of the many possible tools which could be used to achieve the four dimensions of food security: availability, access, utilisation, and stability.

The concept of sustainability was first defined in the Brundtland commission report (1987) as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" The multi-faceted nature of the concept has, however, resulted in many different interpretations. There has been continuous discussion and critique as how to define it, along with whose needs should be taken into account (Metzger & Rader Olsson 2013). Previously, the concept focused on issues related to poverty, economic growth, and environmental degradation. However, as the global understanding of sustainability has progressed, and concerns over climate change and rising populations have grown, focus has shifted towards the ecological aspects of sustainability.

In our case, the concept of sustainability should be seen as a solution for the addressing climate change and rapid urbanisation stresses on food security. Our understanding of sustainability is based on the three widely acknowledged dimensions: ecological, social and economic. Although most approaches consider the three dimensions to be equally important, many still regard them as separate. These differences in interpretation and operationalisation have made the concept difficult to understand and use.

2.2.1 Urban Agriculture and Urban Gardening

Urban agriculture, or urban farming, can be defined as "*the cultivation of food within metropolitan cores as opposed to that in more peri-urban and rural areas*" (Horst et al 2017).

Urban agriculture is strongly connected with issues of food security and food justice and is getting more recognition as a strategy for combating these issues, alongside with environmental issues of e.g. climate change. The aim is to get people in the community engaged in taking care of urban gardens and urban farms by collectively taking the responsibility for their organization and design (Bonow & Nordmark 2018).

Under the umbrella concept of urban agriculture is a great diversity of farming systems, the list includes rooftop gardens, allotment gardens, private gardens, urban orchards, community gardens, peri-urban agriculture (Lin et al 2017) but also guerrilla gardening spots (Bonow & Nordmark 2018).
Depending on factors such as management, type of food, production scale, service provision and land tenure the different types of urban gardening sorts under the previous mentioned categories of farming systems. But as many of those are not strictly set under one system they can often be found under more than one of these categories (Lin et al 2017).

Rooftop Gardens

Rooftop gardens are vegetation established on the roof of a building (figure 1). The vegetation can be of any kind and for the purpose of decoration or agriculture (Lin et al 2017). Which plants that can be grown in rooftop gardens depends on the depth of the available soil, and the possible depth of the soil depends on the structure of the building, since deeper soil means a bigger weight for the roof to carry. Rooftop gardens can have the soil directly on the surface of the roofs or make use of planting boxes, pots and greenhouses.

Figure 1. Example of rooftop garden in Durban, South Africa (World Economic Forum, 2019)

Community Gardens

Eigenbrod & Gruda (2015) defines community gardening as a collective cultivation of plants by various people on a shared area. Community gardens can range from close-knit groups with mutual activities to more loosely organized groups that only share the facilities (figure 2). The cultivation of the land can also be done on individual plots or on a collective base (Eigenbrod & Gruda 2015). The aforementioned rooftop gardens can be seen as a community garden, other possible places are the courtyards between the houses, school gardens/playgrounds, open space such as a park or a marketplace. Depending on the location and place of the garden the planting can be done directly in the ground or in gardening boxes, green houses, pots etc. The use of the gardening boxes/greenhouses opens up the possibility to cultivate vegetables in areas otherwise deemed not suitable, for example in cemented areas. The soil in Loudden is of poor quality and will be remediated/partly replaced (Stockholm stad 2017a), it's important that the remediation of the soil used for the crop cultivation has been adapted for this purpose. Community gardens can be supported through non-governmental organizations, municipalities, private sponsors or donors (Eigenbrod & Gruda 2015).

Figure 2. Example of a community garden in Dover, England (Diversity in Steam, 2018)

Forest Gardens

Forest gardens is part of the agroforestry concept. The main focus is using a diversity of perennial plants instead of monoculture of annual plants to make it a food system that is more similar to a natural forest ecosystem (figure 3). A forest garden is built up in seven different layers; first the canopy layer, second smaller trees, third bush layer, fourth climbing species, fifth herbs and higher ground plants, sixth ground layer and last subsoil layer likes root vegetables. When creating

a forest garden, it is important to take into consideration the existing site condition, desirable ecosystem components, ecosystems pattern and management activities. The purpose is to get a desirable ecosystem and food system that has self-renewing fertility, minimal herbivory, healthy plants, sustainable water demand, minimal competition, directed succession and an over yielding polyculture. The outcome will be high and diverse yields, high self-maintenance to a minimal cost and a healthy/strong ecosystem (Jacke & Toensmeier 2005) Forest gardens can be seen as a multifunctional tool for cities.

Figure 3. Example of forest garden in London Glades, England (dogwooddays, 2019)

2.2.2 Benefits and Challenges of Urban Gardening

Modern cities are facing many challenges as the increased urbanization leads to densification of the cities, which will amplify the competition of the use of urban land, alongside with climate changes and issues of sustainable food production and food security. It is essential to point out that these challenges differ in developed countries and developing countries and that the objectives of urban agriculture are of different character in various parts of the world. In developed countries urban gardening has a focus on sustainability, whereas in developing countries the issue is more about food security (Taylor & Lovell 2013). Urban Gardening generates many different benefits to the city but also brings with it some problems.

Benefits

Food security and health benefits

Urban gardening can be used for both edible and non-edible plants. Urban gardening of edible plants can improve all factors of food security; availability of food, access to food, and quality of food (Eigenbrod & Gruda 2015; Lin et al 2017). Both edible and non-edible plants can also provide therapeutic health benefits through their aesthetics, emotional connections to the plants as well as the social relationships and the learning that can be found in a community garden (Hale et al 2010)

Self-sufficiency and decreased transportation

More locally grown food means the area will be more self-sufficient which leads to a decrease in food transportation to the area. It is also a way for the community to take control over the resources of the area and get involved in the use of resources (Taylor & Lovell 2013). Decreased transportation means a decrease in pollution, in the form of noise and pollution. Of course the decrease in pollutions are also a health benefit for the people living in the area.

Social resilience and learning

The community gardens can work as a meeting point for various social groups to interact and learn from each other's experience. The learning and social interaction can reproduce social-ecological knowledge, strengthen social stability and reinforce social cohesion (Taylor & Lovell 2013) as well as increase social and cultural resilience (Lin et al 2017). The community gardens can also be used as a place for learning about for example food production and environmental issues, for people who are not part of the particular garden, e.g. school classes.

Biodiversity

Green spaces in urban areas can increase the biodiversity of vegetative, arthropod and vertebrate species through the variety of types of urban agriculture. It can have the effect of positive spill over to adjacent areas (Lin et al 2017). In general, urban gardening increases the green space/green infrastructure of an urban area which in turn will increase the biodiversity. A peer review of green roofs/rooftop gardens has seen that even though it does not generate a higher biodiversity than ground level ecosystem it can support local species and aid in conservation if they are designed right. This will mostly help species like insects (bees, beetles, butterflies and spiders), birds and bats (Williams et al 2014). Forest gardens are designed in a diverse way and has biodiversity as a key function in their planning stages and has the possibility to have higher biodiversity than other man made ecosystems (Jacke & Toensmeier 2005).

Ecosystem services

Ecosystem service (ESS) is a concept of what the ecological system can provide to humans. There are several ways urban gardens can enhance ESS depending on urban gardens strategies. Some of those strategies to enhance ESS and biodiversity is increasing the vegetative complexity, flora diversity, have a prolonged season, support belowground biodiversity, facilitate drainage, reduce urban heat island, support native flora, 3D structure, increased genetic diversity, vegetation cover, wildlife habitat and dense tree structure (Lin et al 2015). ESS are often divided in four subsections; supporting, regulating, provisional and recreational.

Two main supporting ESS that urban garden can increase is biodiversity and habitat creation (Lovell & Taylor 2013). Biodiversity is fundamental for ESS, thus the key is to take a close look at how to compose the structure and diversity of animal and plants. It may be significant to even plan for the peri-urban areas in order to achieve success (Lin et al 2017). An urban garden can assist in many different regulating services like air purification, soil fertility, pollination and global/ local climate regulation (Lovell & Taylor 2013). The main provisional service is food supply, but it can also assist in the production of medicinal/aromatic plants or energy depending on what urban garden technique is used (Lovell & Taylor 2013). There is also a number of recreational services an urban garden provides such as health benefits, depending on how it is used. This shows that urban gardening can assist in direct wellbeing for humans in producing food and raw material among other things. But maybe more important may be the indirect benefits with the supporting, regulating and recreational

services. Some of those benefits is that urban garden can encourage a healthy life-style and reduce stress levels that would create less need for hospitals (Lovell & Taylor 2013). With the ability of regulating local climate, it can also reduce the cost of infrastructure maintenance.

In our chosen urban agriculture techniques (rooftop gardens, community gardens and forest gardens) you can find many attributes that enhances biodiversity and ESS. Among the enhancing qualities are vegetative complexity, flora diversity, a prolonged season, support belowground biodiversity, facilitate drainage, reduce urban heat island, native flora, 3D structure, vegetation cover, wildlife habitat and dense tree structure. This since we have a forest garden that is a multilayer food system with many perennial plants like trees and different depth in rooftop gardens that makes it possible to grow a wide variation of flora.

Challenges

Maintenance and organisation

All forms of urban gardening needs to be taken care of, since it is a big challenge to make them sustainable and self-sufficient. Bonow & Nordmark (2017) researched community garden projects in Stockholm and conclude that for the garden to function you need firm leadership, good structure in how the work should be divided between the members, as well as a clear goal with the project. Long term vision and engagement is vital if the gardening is to become sustainable (Bonow & Nordmark 2017).

Polluted ground

The urban environment can be highly polluted and the ground may not be suitable for gardening or farming (Eigenbrod & Gruda 2014). As we mentioned above the soil in Loudden is contaminated due to the industries on the site. While the contaminated soil is deemed to be good enough for some buildings and will be remediated it might not be possible to use all of the soil for urban gardening. The gardening will then have to utilize soil coming from another place and tools such as gardening boxes instead of being planted directly into the ground (Stockholm stad 2017a).

There is also the possibility that urban gardening itself will be a source of pollution, if pesticides and fertilizers are used. To combat this, it is important to make sure that the processes and methods of agriculture are organic and environmentally friendly (Eigenbrod & Gruda 2014). This partners with the above problems of maintenance and organisation, to make sure everyone follows the same rules and do not pollute the ground. A working organisation that both informs and controls is probably needed.

Weight carrying capacity of buildings

Building a garden on top of a roof means adding extra weight to that roof. The weight put on the roof from a rooftop garden can be substantial and needs to be calculated correctly and built with the weight in mind. The weight from the rooftop gardens does not only extend to the actual soil, but also the vegetation, the people working the garden, recreational areas for the workers, pathways, possible greenhouses, the gear needed for the gardening (which might include

heavy machinery from time to time) and the extra weight and stresses that comes from wind, rain and snow (Vinnova 2017).

Accessibility and equity

In already built areas the placing of new green areas can lead to a gentrification of the area and force low-income residents to move away (Wolch et al 2014). Since Loudden at the moment is a container terminal as well as an oil harbour and not a residential area (Stockholms stad 2017b), the risk of forcing low-income residents away should be minimal. However, the implementation of urban gardens in the area could make the area more desirable and in turn more expensive (Wolch et al 2014) and therefore only be possible for a select few to buy and live there. The placing of the gardens can have an effect on who will have access to,and be able to participate in the gardens. Public-access community gardens (PAC-gardens) are community gardens that are open for anyone at all times (Bendt et al. 2013). Planting boxes in open spaces such as parks and markets should be able to function as PAC-gardens, and be open to all in order to see, learn and take part. The rooftop gardens and courtyard gardens however might not have this openness for all, since the rooftops and courtyards often might not be accessible to people not living in the building.

Invasive species

Bringing in new species to an area increases the risk of new species spread to the surrounding ecosystem and negatively affecting native species and ESS (Lovell & Taylor 2013). Therefore, considerations have to be taken when planting species, and knowledge about species and the risk of the species being invasive needs to be taken into account.

2.2.3 Urban Gardening within Europe

Rooftop Gardens in Copenhagen, Denmark

Copenhagen has adopted a “green roof policy” that ensures that all new buildings with roof slopes of less than 30 degrees must be covered with vegetation (Scandinavia Standard 2017). This has led to green roofs being mandated in most new local plans in the City of Copenhagen, and more than 40 green roofs already exist. A total of 200.000 square meters of green roofs is to be installed based on the approved new local plans (Københavns kommune 2012). Green roofs do not equal urban gardens but the policy opens up for the possibility of urban gardening on the roofs of buildings. Two examples of urban rooftop gardening in Copenhagen is ØsterGRO, which is located on the roof of an old car-auction house and DYRK Nørrebro which is located on the roof of Blågård school. ØsterGRO started in 2014 and is a 600 square meter organic rooftop garden, with 110 tonnes of soil spread on the roof. The focus for ØsterGROs planting is edible plants such as organic vegetables, herbs and edible flowers. On top of the roofs there also exist a greenhouse, henhouse and three bee-hives. DYRK Nørrebro is smaller in size than ØsterGRO and utilizes planting boxes. Both DYRK Nørrebro and ØsterGRO functions thanks to the work of the members and volunteers but the area is open for others to see, learn and even get a taste of the food grown there (Scandinavia Standard 2017). While these two examples show us that rooftop gardens are possible to implement in an urban area in order to produce food, it still only exist on a small scale when you take into account the size of the city as a whole. Furthermore, the green roof policy is a green roof policy and not a rooftop garden policy. To fully implement rooftop gardens in a bigger

scale so that it could truly make a difference, similar policies and decisions may need to be made but concerning rooftop gardens.

School gardens in Amsterdam, Netherlands

A School garden refers to a garden located in proximity to a school so that the students can be actively involved in the care and maintenance of the garden. Fourteen school gardens currently exist in the city of Amsterdam (City of Amsterdam 2019). School gardens can give many contributions to different areas. For example, the use of the school gardens as a learning tool where the school gardens give an opportunity for a more varied and hands-on learning experience for the pupils (CSGN). While the educational purpose of the school gardens is the main focus their food growing attributes should not be forgotten. The school gardens give the opportunity of more locally grown food which gives basic food security for the school/area and gives the opportunity of better food in the sense of nutrition and diet (FAO 2010). School gardens therefore gives all the benefits of other community gardens with the extra benefit of a better educational tool for the pupils. The problem in Stockholm is that the schoolyards gets smaller and smaller, while at the same time the access to nature gets farther and farther away (SCB 2018). While the declining access to nature gives even more validity to the use of school gardens, the decreasing size of the schoolyards is a problem, since urban gardening may use up a big part of the space in an already to small schoolyard, giving the pupils no place to play and have fun.

Forest gardens in Dartington, England

In Dartington, England, one can find one of the oldest forest garden in Europe. The garden is 25 years old and 2 acres large. This forest garden function as a research tool and showcase on how a forest garden can function and has around 500 different species with edible parts. It is run by an agroforestry research trust where Martin Crawford is the main developer and is seen as one of the pioneers for forest garden techniques (agroforestry.co.uk 2019).

2.3 Stockholm Royal Seaport

2.3.1 Sustainability in Sweden

Focusing on Sweden, Stockholm prides itself on being at the forefront of sustainable city planning. A combination of history, politics and geographical characteristics helped Stockholm become one of the leading sustainable cities in the world (Metzger & Rader Olsson 2013). Its position as an environmental pioneer was further strengthened when the city was awarded the “Green Capital Award” in 2009. This profile has since been used for marketing the city as “green” to a worldwide audience (Metzger & Rader Olsson 2013).

In Sweden the city planning is performed and executed by the municipalities. The Stockholm City Plan work as guidance and aid in decision on how to regulate and use the land and water in Stockholm (Stockholm stad 2018). The Stockholm region has a vision: “Vision 2040” of a “*cohesive, climate-smart and economically and*

democratically sustainable city" with emphasis on social cohesion (Stockholm stad 2018).

The Stockholm city plan has four goals of city planning and development: a growing city, a cohesive city, good public spaces, and climate smart and resilient city (Stockholms stad, s.6). Stockholm is becoming more segregated physically as well as socio-economically and the Stockholm City Plan aims to use the planning of the city to promote venues where people from different backgrounds can meet (Stockholm stad 2018).

Global warming will be mitigated by planning for multifunctional use of space, water use, energy efficiency and toward public transportation and to become a fossil fuel free city by the year 2040. As climate will change, the city needs to be able to adapt and planning should work towards decreasing climate impact and in general to be proactive.

Today the city has a connected network of parks, green corridors, green walks and natural spaces, that is seen as one of Stockholms unique features which should be developed further as the city expands and gets denser. The ambition of the city is to improve the access to green areas and to include ESS in the infrastructure (Stockholm stad 2018). By planning for offices in an urban environment, that is mixed used and high density, Stockholm will become a city that attracts people and businesses (Stockholm stad 2018).

In the plan for Stockholm Royal Seaport the sustainability objectives have been concretized as five strategies for sustainable city development: vibrant city (*levande stad)*, participation and consultation (*engagemang och inflytande*), accessibility and proximity (*tillgängligt och nära*), resource efficiency and climate responsibility (*resurshushållning och klimatansvar*) and "let nature do the work" (*låt naturen göra jobbet*) (Stockholms stad 2016).

The Stockholm Royal Seaport is one of the main entry points to Stockholm due to its number of ports and location. The area is 236 hectares in size, which is roughly half the size of Södermalm. It consists of the sub areas Hjorthagen, Värtahamnen, Frihamnen and Loudden. The area stretches from Hjorthagen in the north to Loudden in the south (Stockholm stad 2016; Stockholm stad 2017b).

As of 2012, Stockholm Royal Seaport is being transformed into a new city district which is scheduled to be completed in 2030. At least 12 000 housing units are planned to be built, mostly in Hjorthagen and Loudden, along with 35 000 new workplaces and 600 000 m^2 of commercial floor space (Stockholm stad 2016).

The developmental goal of the Stockholm Royal Seaport is to meet the growing demand of housing areas and workplaces and it is also supposed to be the leading example in the development of sustainable city districts of the next generation. This will be accomplished through transforming areas that were previously used by industries into an attractive and dynamic city district (Stockholm stad 2017b).

2.3.2 Urban gardening in the Stockholm Royal Seaport

According to the Sustainability report for the year 2017 Stockholm Royal Seaport has only 90 urban gardening planting boxes available for the residents of the area. However, it does exist 13,500 square meters of green roofs, although no information is given how much, if any, is used for gardening as a whole or food production specifically. In the Sustainable urban development programme for Stockholm Royal Seaport (Stockholm stad 2016) it says that the area "*...is to include possibilities for gardening…*" and mentions roof terraces as a possible place for it.

2.3.3 Loudden

The focus of this report is the area of Loudden in Stockholm Royal Seaport and how urban gardening could be utilized in the planning and building process. Loudden is located in the southern part of Stockholm Royal Seaport and is adjacent to the National City Park. The area has previously been used as a location for large-scale industry and infrastructure, including concrete works, a container harbour and oil tanks (Figure 4). The critical infrastructure and supply systems of Stockholm are situated in this area and are visible due to their scale and accessibility. The objects, as well as the areas, in Loudden create physical and mental barriers. Some of the buildings in Loudden are significantly large in size and vary in age (Stockholm stad 2016; Stockholm stad 2017b).

The ports close to Loudden are of importance to Stockholm from an economic standpoint. They play a major role in increasing the sustainability of Stockholm as a whole, through the sustainable mode of transport that is shipping. Furthermore, Loudden is where the Stockholm Stock Exchange is located, along with several hotels and art galleries (Stockholm stad 2016).

Figure 4. Loudden (Google, 2019a)

3. Research Aim

Having framed the need for urban gardening within the main global concerns the aim of this project is to highlight how Stockholm stad could utilize its pioneering nature, in regards to sustainability, to develop Loudden using urban gardening as a tool for increasing sustainable consumption practices with Stockholm Royal Seaport.

3.1 Research Questions

How can urban gardening tools be used, within Loudden, to increase sustainable consumption practices within the Stockholm Royal Seaport?

1. What is the relationship between urban gardening and the ecological, social and sustainable consumption systems?
2. How can urban gardening be used to improve Loudden in comparison to the previous projects in Stockholm Royal Seaport?
3. How can the selected urban gardening tools be practically implemented within Loudden?

4. Methodology

4.1 Causal Loop Diagrams

A causal loop diagram (CLD) is a diagram which is used to visually portray reality. It shows how the variables of a system are interrelated through casualties and how the variables within the system affect one another. The CLD has nodes, in the shape of variables, with connecting arrows to link the variables with each other which describe the causal relationship between the variables of the system. The links can be either positive (+) or negative (-). A positive link between two variables means that the change occurs in the same direction; the increase or decrease of one variable means that the other one will follow the same pattern. A negative link means that the change occurs in the opposite direction; the increase of one variable results in a decrease of the other, or vice versa (Sverdrup et al., 2018).

If there are multiple links in between several variables which all have the same change (+ or -) then the loop can be described as a ‘reinforcing loop’. If all the arrows in a loop have a (+) change then they can be considered ‘Positively reinforcing’, meaning that an increase in any variable will subsequently increase all other variables in that loop, and if (-) then they are considered ‘Negatively reinforcing’. This loops will carry the label of ‘R’ at the centre (Sverdrup et al., 2018).

A causality in a CLD can be delayed, which is indicated by two crossing lines on the arrow. The delays are relative to the time scale of the CLD.

If a delay is present, the signal sent through the system will be received at the other end of the arrow at a later time.

The links in the CLD do not explicitly show the magnitude or significance of each link. The CLD only qualitatively describes how the variables affect each other (Sverdrup et al., 2018).

In this report, a CLD is used to visualize the potential effects that urban gardening has on the environment and ecology in the area, the social aspect of the process and how sustainable consumption can be improved by it and therefore answer research question one.

The following question will be answered by the CLD: What is the relationship between urban gardening and the ecological, social and sustainable consumption systems?

The spatial boundaries of the CLD is approximately 3 km^2, which the size of Loudden. The time scale of the CLD is 10 years, working from an annual time step. Different aspects will have varying timescales in that the growth of crops will happen once a year but the social effects may take a few years to change. This is reflected by delay arrows in the CLD.

4.2 Ecosystem Services Matrix

An ecosystem services matrix is a visual tool used to showcase a preview of the potential ESS provided from certain natural environments (flat green areas, forest gardens, street trees, etc.), and green structures (green rooftops and planting boxes) within a plan or programme area (Boverket, 2019).

The matrix itself is a table that includes the relevant ESS which are divided into provisioning, regulating, habitat and cultural services. The columns list the natural environments that are included in the plan. A checkmark indicates that a specific ESS is provided.
In an article by Camps-Calvet (2016), a number of ESS from urban gardens are mentioned. The ecosystems services matrix, and its ESS, in this report is based upon these findings. The ten different natural environments and green structures along the columns are based upon the project area and our proposed plan for it.

The matrix was filled by using the results from Camps-Calvet (2016) and personal expert opinion.

4.3 Interviews

First hand data was gathered for the project through ten informal interviews (appendix 1). The interviews were carried out with randomly selected residents living in the Northern part of Stockholm Royal Seaport between 11am and 2pm on the 1st of March 2019. The questionnaire consisted of 10 main questions and three sub-questions. The first six questions were answered by giving a number between 1-10, where 1 represent the lowest grading and 10 represent the highest grading. The three sub-questions provided alternatives to choose from.

Alongside this, an interview (appendix 2) was also conducted with Camila Edvinsson, the Information Officer at Stockholm Royal Seaport Information Center on the 6th of March between 9.30am and 12pm, to gain more insight into how certain planning/environmental theories have influenced the development of the project, as well as some more practical queries in regards to transportation, urban gardening and socio-economic issues.

4.4 Green Space Factor

Green Space Factor (GSF) is a measurement tool used by municipalities in Sweden, mainly the urban regions of Stockholm, Gothenburg and Malmö to put value on different green infrastructure. Every municipality is able to alter its GSF, for their purpose. We used Nacka municipality's version of GSF (Nacka Kommun, 2019). GSF is a tool that is continually developing so you can get different eco-efficient factor depending on what GSF is used. The Nacka municipality GSF is divided into a general section and five specialized sections; social values, storm water management, biodiversity, local climate and air purification.

For Loudden we divided the areas in different sections; apartments, green corridors, offices, school/ sports arenas, shopping mall/ square. The apartment was divided in three sections; the roads surrounding the apartments, the courtyard and the building. The areas for the apartments was taken by calculating the mean areas from two apartment blocks that had been built in the northern part of Stockholm Royal Seaport. This was completed using Google maps in order to get a map over Loudden on Google maps with areas for the different sections (apartments, offices). With those areas we were able to calculate the GSF, depending on section size and used urban garden technique. Those different sections where then colour coded in the map. The areas for the other sections were developed with guidance from Group - Remediation and Planning and made using Google maps.

4.5 Cost Analysis

A cost analysis will provide a breakdown of the additional costs involved in the implementation and maintenance of the suggested urban gardening methods. The analysis excludes the infrastructure costs which would have occurred regardless such as: the apartment buildings, offices, school and shopping centre with suitable roofs for green rooftops, roads and pavements. Labour costs for implementation have also been excluded as these costs are included in the general labour costs for the project.

4.6 Plan for Loudden

As a point of conclusion to the report a map of Loudden has been produced. The purpose of the map is to provide an example of how all the ideals could be practically implemented in the area. Although the plan is not architecturally accurate it does provide an idea as to how the area can be utilized in order to achieve the maximum GSF score. The map could also be viewed as an example of an 'ideal' plan which includes all of the benefits and facilities of urban gardening.

The map has been developed as a result of the discussions held within the group which aimed to make sure that every element was included and it was constructed using a combination of google maps and an illustrator programme.

5. Results

5.1 Causal Loop Diagrams

The variables in the CLD (figure 5) are split up into four different sections; social, ecological, water management and sustainable consumption, all stemming from the physical system created by urban gardens. The purpose of this CLD is answer part of our research question in that how can urban gardening affect the aspects listed previously and weather the greater effect will be positive or negative.

Socially speaking more *planting* increases the *recreational opportunity* for citizens, which then increases *human health* through psychological and physical factors. *Recreational opportunity* also increases the amount of *social activities*, which then increases the *social interaction* and *social security*. Furthermore, if *social interaction* is higher, then the *social activities* will increase as well, creating a reinforcing loop. The increase in *social interaction* causes an increase in both *human health* and *community quality*, as well as an increase in *social security*. An increase in *social security* leads to an increase in *community quality*, which is also increased if *aesthetics* of the area goes up from the construction of *urban gardens*. An increase in *community quality* will in turn cause an increase in the *popularity of the area*. An increase in the popularity will cause an increase in the *cost of living*, due to the higher desire to reside in the area. A higher *cost of living* leads to a decrease of the *social diversity* in the area.

There are two main delays within the social system, these are created by varying time scales of change. For example, *growth* will occur on a yearly or seasonal basis provided that *planting* and *water for growing* are both regular. But in terms of *community quality* and *popularity of the area*, these will develop on a decennial time period. Therefore, multiple growing periods will begin and end before *community quality* and *popularity of the area* has visibly been affected and thus creates delays in the system.

Ecologically, the increase in *soil* will lead to an increase in the *available habitat for fauna* and the *available habitat for flora*, both will cause *biodiversity* to increase, relative to an undeveloped urban environment. More *biodiversity* leads to more *pollination*, and more *pollination* will increase the amount of *crops*. An increase in *pollination* will also lead to more *biodiversity*, creating a reinforcing loop.

For water management, the construction of urban gardens obviously creates opportunity for *planting* of plants which in turn increases the amount of *growth* for the area. As *growth* increases, so does the capacity of *stormwater management*, as more plants will increase the uptake and particular plants such as wetland reeds have been proven to have a delaying function after sudden events of excess water (storms, floods, etc.). As well as actual growth *stormwater management* can also

be created by the construction of channels or drainage integrated into the physical design of the garden. This channelization can be combined into a *water storage* system with tanks etc. Therefore, more *storm water management* leads to more water in the water tanks, which leads to an increase in the *water storage*. This water could be repurposed for *water for growing*, if properly managed, and therefore more *growth* can also occur. The *water storage* is also filled by *rainwater*, and *rainwater* will also allow for more *water for growing* through direct rainfall. This creates a reinforcing loop behavior pattern (described in methodology). Additionally, if there is more sunlight, there will be more growth in combination with water and soil.

In terms of sustainable consumption, as the *growth* of edible *crops* continues and develops in urban gardens, the amount of *locally grown foods* will be higher. This leads to a decrease in the *local transportation of foods* and the *international import of foods*. A decrease in these two variables leads to a decrease in CO_2 *emissions* and an increase in *food security*.

The CLD has some major leverage points in *planting* and *growth*. These are the points at which maximum effect is caused if the variable is changed. Once *urban gardens* are constructed, planting must continue on a regular (annual) basis so that the social benefits can remain and develop. If *planting* was to stop or reduce, *recreational opportunity* is directly reduced which then has a knock on effect to the whole social system. *Planting* also directly feeds *growth* which is the main ambition of urban gardening itself to generate *crops* through *growth*. Meaning if *planting* is not done correctly at the right seasonal time then its *growth* will be affected. Both these points are fundamental to the system, if one would change the magnitude of them then the whole system would be affected in some way.

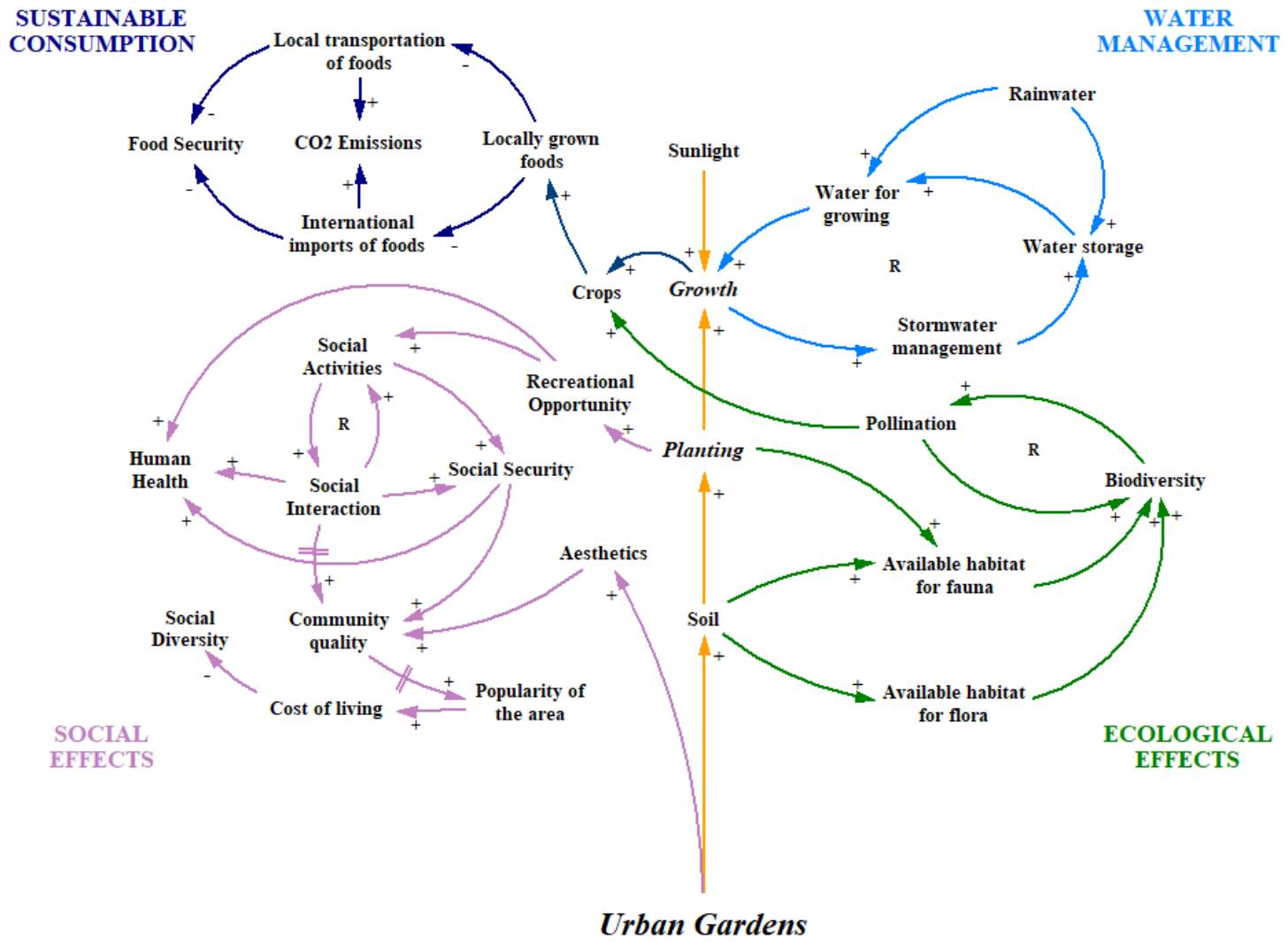

Figure 5. A CLD showing the causal links between the different variables of the ecological, social and sustainable consumption systems.

5.2 Ecosystem Services Matrix

The seven natural environments (NE) and the three green structures (GS) that are included in our proposed plan could potentially provide a total of 22 ESS, including three provisional, five regulating, two habitat and 12 cultural services (table 1). Most of the ESS are self-explanatory, but biophilia is one that needs explanation. Camps-Calvet (2016) defines biophilia as the feeling of satisfaction from growing plants.

Many of the natural environments and green structures are able to provide almost all of these ESS, as can be seen in the matrix. Furthermore, the matrix shows which natural environments and green structures that are most valuable when looking at a specific ESS. The bottom row of the matrix shows the number of ESS provided by certain natural environments or green structures while the column to the right shows how many natural environments or green structures are able to provide a certain ESS.

Table 1. The ecosystem services matrix showing the ESS provided by certain natural environments and green structures, indicated by checkmarks. The ESS are divided into provisioning (blue), regulating (yellow), habitat (green) and cultural services (purple).

	Flat green area (NE)	Grove (NE)	Forest garden (NE)	Street trees (NE)	Shrubbery (NE)	Flowerbed (NE)	Ruderal vegetation (NE)	Green roofs (GS)	Planting boxes (GS)	Green corridors (GS)	Number of NE/GS for ESS
Food supply		✓	✓	✓	✓			✓	✓	✓	7
Medicinal resources & aromatic plants		✓	✓		✓	✓	✓	✓	✓	✓	8
Energy		✓	✓		✓		✓	✓		✓	6
Air purification	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Local climate regulation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Global climate regulation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Maintenance of soil fertility	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Pollination	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Biodiversity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Habitat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Social cohesion & integration	✓	✓	✓	✓	✓	✓		✓	✓	✓	9
Placemaking			✓			✓		✓	✓		4
Political fulfillment	✓	✓	✓	✓	✓	✓		✓	✓	✓	9
Biophilia			✓			✓		✓	✓		4
Quality of Food		✓	✓	✓	✓			✓	✓	✓	7
Aesthetic information	✓	✓	✓	✓	✓	✓		✓	✓	✓	9
Nature & spiritual experiences	✓	✓	✓	✓	✓	✓		✓	✓	✓	9
Relax & stress reduction	✓	✓	✓	✓	✓	✓		✓	✓	✓	9
Entertainment & leisure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Exercise & physical recreation	✓	✓	✓				✓			✓	5
Learning & education	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Maintenance of cultural heritage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Number of ESS provided by NE/GS	16	20	22	17	19	18	13	21	20	20	

5.3 Interviews

5.3.1 Residents interviews

This section will highlight the main topics discussed and the findings from the interviews which were used to guide the final suggestions for the map of Loudden.

In total, 10 individuals were interviewed, five female and five male, ranging from 25 to 70 years of age and they have been living there for one to seven years (table 2).

Sustainability

The participants which had moved into Stockholm Royal Seaport at the beginning (5-6 years ago) had not been heavily influenced by concerns with sustainability. Those which had recently moved into Stockholm Royal Seaport (within the last 1-2 years) noted, however, that sustainability had had a strong impact on their decision to move there. The main sustainability factors mentioned were waste disposal, energy efficiency and access to nature.

Green space

All of the participants noted that the green space within Stockholm Royal Seaport was very important to them, and they perceived the area to be very green already. Most noted that they used the space for recreation and sports.

Urban gardening

Over half of the participants noted that they thought increased urban gardening opportunities could positively affect Stockholm Royal Seaport. They listed social inclusion, physical health, mental health, access to local food, access to healthy food, education and aesthetics as the positive impacts of urban gardening. They also said that they thought there were not any negative aspects.

When asked if they would like to be actively involved in the garden opportunities their answers varied. All of the participants thought that having access to rooftop urban gardening and gardening boxes would be positive for the area, however, some noted that due to their busy lifestyles it would be difficult for them to be fully involved. It was found that those which wanted more opportunities tended to be female.

In regards to maintenance, the participants were asked whether they would be willing to work with Stockholm stad and/or their neighbours. The majority gave a positive response and noted that they would be willing too if they were involved in the urban gardening projects. They gave different reasons saying that it would connect the neighbours and make the area more up to date and give it quality.

Loudden

The residents were asked if they had any concerns about the development of Stockholm Royal Seaport. The majority said no, however a few made comments about the issues with transportation

during the early stages of the development of Stockholm Royal Seaport and hoped that this would not be a problem again.

When asked if the residents had heard about the progressing development of Loudden the answers were mixed. Half stated that they had not received any information and the other half said they were well informed. Further discussion with the participants showed that those who felt they had enough information had sought it out for themselves.

Table 2. List of interview participants.

Participant	Gender	Age	Year moved in
1	Female	35	-
2	Female	60	2012
3	Female	40	2018
4	Female	60	-
5	Male	45	2016
6	Male	65	2014
7	Male	55	2013
8	Female	25	2018
9	Male	70	2013
10	Female	65	2018

5.3.2 Interview with Camilla Edvinsson

Addressing global concerns

Concerns over food or water security had not influenced the development of Stockholm Royal Seaport. Neither had other global frameworks such as the Paris Agreement (2016) and the Sustainable Development Goals (2015) despite mitigation of the effects of climate change being the main focus.

Environmental and Social Sustainability

Sustainability has been addressed through five main strategies within Stockholm Royal Seaport. These strategies have been equally considered throughout the process but the various phases have had different focuses depending on the area and those involved. Environmental sustainability was noted to have provided the overarching framework for the development of the area.

Social sustainability was noted to have been taken more into account during the early stages of the development where citizens were invited to the presentations to discuss the planning proposals. Interviews were also conducted in order to collect more information from people living in the adjacent areas. The main issue encountered here was that the same people tended to show up, and it is difficult to reach out to the wider public. Other social sustainability efforts have included taking on long-term unemployed workers to help with the project in order to give them the opportunity to get back into the job market.

As for the residents, Camilla noted that Stockholm Royal Seaport residents were “nudged” towards sustainable practices. For example: the heating in the apartment building hallways is purposely turned down so that people feel their homes are warmer and do not feel the need to turn the heating up. Camilla also pointed out that if they were allowed they would be able to measure the amount and type of rubbish thrown away by each household.

Urban gardening

Currently the planting boxes in the Northern part of Stockholm Royal Seaport seem to be regarded as more of a social activity by the residents rather than a method of dealing with food insecurity. The development plans for Loudden focus more on energy, waste disposal, transport and street design than the implementation of different urban gardening options. Competition for green spaces are hard, and in order to get the green space approved architects and developers have to highlight the multifunctional qualities of the green areas.

Maintenance

For the first two years the developers are responsible for the maintenance of the green spaces between and within the buildings. Following this, the responsibility then falls to Stockholm stad and the residents. To date, Stockholm Royal Seaport had not yet figured out a complete plan for encouraging residents to maintain and look after green areas. As it is now the green spaces may require lower maintenance for it to work in the future.

Green space factor

The application of the green space factor (GSF) index has changed from being voluntary during the first two phases of Stockholm Royal Seaport to mandatory. To date, the developers have managed to reach the target of 0.6 but there are further goals to increase the GSF to 1.0 in future stages of the Royal Seaport development. To achieve this cooperation is needed between the developers.

Transport

Car use is still high within Stockholm Royal Seaport. This could be addressed by raising the fees for the parking spaces and encouraging residents to use public transport. A car-free zone would not be possible, however, some vehicle space is still needed for delivery trucks and the emergency services.

Gentrification

Stockholm Royal Seaport, due to its high property costs, has attracted those with a higher socioeconomic status. As such, concerns over socio-economic barriers have been raised. Gentrification, and the pricing out of lower income brackets is a concern in Stockholm and efforts have been made to keep prices level and rents low in some area. There are plans for a new school and Kulturskolan in Stockholm Royal Seaport and Camilla thinks this will help make the area more diversified.

5.4 Green Space Factor

When it comes to the apartment blocks, 22 in total, we decided to have 70 % green roofs and of these 30 % was with the soil depth of 400 mm and 70 % with the soil depth of 200 mm. In the courtyards forest gardens were planned for with a > 800mm plant depth. In every courtyard, the plan included 3 large tree, 6 medium trees, 9 bushes and 6 climbing plants. For the roads 20 % were planned for forest gardens of similar structure as for the courtyards but with a lower number of species. The total areas for the apartment blocks became 22.19 hectare out of which 4.44 ha were roads, 5.1 ha courtyards and 12.65 building (roofs).

For the nature areas 60 % was planned for forest gardens, 10 % for dams, 20 % for green areas and 10 % for communications (gravel roads). The total area for the nature with this composition became 6.54 ha. Beside this 4.95 ha were planned for a nature area along the coast where no urban garden was planned. In the forest garden we estimate that it will fit 101 large trees, 202 smaller trees, 303 bushes and 202 climbing plants. The nature areas were planned so they had connection with existing paths from the Royal National City Park through green wedges into Loudden to get a good connectivity for biodiversity. Since a forest garden should try to resemble an ecosystem, different efforts has been put in to assist biodiversity.

The offices had a total area of 3.41 ha and for these 80 % was planned for green roofs with a depth of 400 mm. School and sport arena had a total area of 1.95 ha and of these 65 % was planned for green roofs. The

square and shopping mall had a total area of 2.47 ha and of these 70 % was planned for green roofs. We also see possibilities to put greenhouses among these green roofs. For the school/sport arena and shopping mall/square green roofs was decided to have 30 % cover with the soil depth of 400 mm and 70 % with the soil depth of 200 mm.

With the help of mentioned urban garden techniques that this project has focused on for Loudden, a GSF close to 1 (0,99) would be achieved (Table 3). This is around 65 % more than what the recently built areas in Stockholm Royal Seaport that have a GSF of 0.6. As for the balance account the urban garden techniques reach 100 % for the local climate and air purification and overall high numbers in social and biodiversity and good numbers for stormwater. Worth mentioning is that the seaside park was not used for urban gardens and therefore only calculated in the GSF when it comes to social values and surrounding area for Loudden, that is an area of 4.92 hectare.

Table 3. Estimated GSF with green roof and forest garden techniques

Loudden - Green Space Factor				
Project: Urban Garden Crew				
Space			Total Space (m^2)	Eco-Efficient Space
Overall				185273
Social				111006
Stormwater				59128
Biodiversity				39761
Local Climate				15612
Air Purification				17408
Total sum (eco-efficient space)				428188
Whole space			434000	
Accomplished Factor				0,99
Balance	**Maximum**	**Achieved**	**%**	
Social	16	12	75%	
Stormwater	8	5	63%	
Biodiversity	15	12	80%	
Local climate	6	6	100%	
Air Purification	5	5	100%	

5.5 Cost Analysis

The cost analysis (Table 4) has been constructed with the aim of providing an understanding of the implementation and maintenance costs of the suggested urban gardening plans for Loudden. The costing of the forest garden (trees, shrubs and climbing plants) were taken from a recent pricing sheet which we had access too through one of our group members who has their own company developing forest gardens. The assumption that the trees native to Sweden would be brought as saplings, whereas the non-native and fruit trees would be brought at between 1-2 years came about through further research on forest garden construction.

Our costing assumption for the community gardens (planting boxes) were made through comparisons of typical costs for boxes similar to those already being used in Stockholm Royal Seaport. Our assumptions for the costing of the green rooftop implementation are based on the numbers given in a report produced by the Environmental Protection Agency (2001). The numbers were originally in USD and based on the US market prices in 2001. As such, they should be viewed as an indicator of costs. Different prices were awarded to the two types of green roofs: extensive and intensive. Extensive green roofs refer to simpler, lighter weight systems with 200mm soil depth that tend to be suitable for small, less intensive plant types. Intensive refers to green roof systems with 400mm soil depth which could handle conventional garden structures with large trees and shrubs. The cost, therefore, varies due to the different components involved such as: the growing medium, type of roofing membrane, and drainage system chosen (Environmental Protection Agency 2001).

Extra water tanks have also been included within the costs as they will provide extra water for the plants when water resources are low. The cost assumptions came from market research on hardware store websites such as Jula.

Maintenance costs include 23 resident gardeners and 2 Stockholm stad gardeners. Their salaries have been based on a recent report by the Statistiska Centralbyrån (2017). In order to encourage the community aspect of urban gardening one resident gardener from each apartment building will be paid to manage the green rooftops. Tasks would include: planting, watering and weeding as well as monitoring those using the rooftop to make sure they throw away rubbish.

Table 4. Cost Analysis of Urban Gardening Suggestions

Loudden - Urban Gardening Costs			
	Cost	**Amount**	**Total Cost**
Forest Garden Implementation (excluding value-added tax)			
Trees native to Sweden (sapling)	30 SEK	300	9,000 SEK
Trees non-native to Sweden (1-2 year old)	350 SEK	130	45,500 SEK
Fruit Trees native to Sweden (2 year old)	250 SEK	215	53,750 SEK
Shrubs	30 SEK	3000	90,000 SEK
Climbing Plants	100 SEK	130	13,200 SEK
Forest Garden Components Total			**211,450 SEK**
Forest Garden Maintenance			
Resident Gardener (Annual) + Training	25,000 SEK	1	**25,000 SEK**
Community Garden Implementation			
Apartment Planting Box	300 SEK	150	45,000 SEK
School Garden Planting Box	300 SEK	50	15,000 SEK
Community Garden Components Total			**60,000 SEK**
Green Rooftop Implementation (excluding value-added tax)			
Extensive Green Rooftops - Apartments (200mm Soil)	100 SEK per Sqft	6.2 ha	66,736,200 SEK
Intensive Green Rooftops - Apartments (400mm Soil)	250 SEK per Sqft	2.65 ha	71,310,750 SEK
Intensive Green Rooftops - Offices (400mm Soil)	250 SEK per Sqft	2.73 ha	73,463,500 SEK
Extensive Green Rooftops - Shopping Center (200mm Soil)	100 SEK per Sqft	1.2 ha	12,916,700 SEK
Intensive Green Rooftops - Shopping Center (400mm Soil)	250 SEK per Sqft	0.5 ha	13,454,750 SEK
Extensive Green Rooftops - School (200mm Soil)	100 SEK per Sqft	0.82 ha	8,826,400 SEK
Intensive Green Rooftops - School (400mm Soil)	250 SEK per Sqft	0.35 ha	9,418,250 SEK
200L Water Tanks for Apartments	300 SEK	66	19,800 SEK
200L Water Tanks for Offices	300 SEK	10	3,000 SEK
200L Water Tanks for Shopping Center	300 SEK	5	1,500 SEK
200L Water Tanks for School	300 SEK	5	1,500 SEK
Green Rooftop Components Total			**256,152,350 SEK**
Green Rooftop Maintenance			
Resident Gardeners (Annual) + Training	10,000 SEK	22	**220,000 SEK**
Stockholm City Maintenance			
Stockholm City Gardeners (April - September)	153,000 SEK	2	**306,000 SEK**
Implementation of Urban Gardening			**256,423,800 SEK**
Annual Maintenance			**551,000 SEK**

5.6 Loudden Plan

Today almost all of Loudden is empty of green area (Figure 4) so all vegetation is new to get the results for GSF values. A new plan for Loudden was created, in conjunction with group - Remediation suggestions, showcasing potential construction with urban gardening and sustainable consumption in mind (Figure 6).

Forest gardens and garden pathways has the goal to work as green corridors from the Royal National City Park both for wildlife and humans since it now exists manmade pathway. Office areas should work as sound barriers from the harbour. A school, sports centre and shopping mall are adjacent to green areas for added recreational values. It is also possible to implement a school garden as part of the school. Courtyards in the residential areas are put there as an example and should be focused on giving maximum sunlight and connectivity for humans and wildlife. Ponds within the green corridors are planned for existing wildlife and ESS, it is also important to increase the GSF. We see that the seaside park has a more aesthetic value than to be used for urban gardens. Rooftop gardens are planned for most of the buildings mentioned in the GSF results as a multifunctional tool, for example for food production, biodiversity and recreation.

Figure 6. Suggested layout for Loudden, including forest gardens, courtyard areas, garden pathways etc., with mentioned urban garden techniques (Google, 2019b).

6. Discussion

This section will look to discuss the results and provide an answer to the main research question: “How can urban gardening tools be used, within Loudden, to increase sustainable consumption practices within the Stockholm Royal Seaport?”

The main aim of this report was to provide a map with suggestions as to how Loudden could be structured to include a range of different urban gardening techniques focused on consumption. After having identified that food and water security concerns have not had a strong impact on the development of Stockholm Royal Seaport so far, during the interview with Camilla Edvinsson, it was decided that our project should be approached from a food security perspective in order to place Stockholm Royal Seaport within a global context.

The interviews, with both the residents and Camilla Edvinsson, brought to our attention that most, if not all, of the residents of Stockholm Royal Seaport fit within a higher socio-economic bracket. Food insecurity is, therefore not a big issue as most can freely and easily buy their food from supermarkets and other shops. As such, this project has not been approached with the aim of making residents of Stockholm Royal Seaport completely self-sufficient. It has, instead, been constructed with the aim of convincing Stockholm Royal Seaport, and Stockholm in general, to use their pioneering nature to implement a consumption focused gardening system in an urban setting which could then be used to encourage further use of urban gardening techniques around Stockholm, Sweden, and even the rest of the world.

The CLD (figure 5) provided a general overview of the four main systems operating within Loudden. It is not a perfect representation of reality as it is unable to explicitly show the significance or magnitude of each link. However, it is still able to provide a clear visualization of the potential benefits of urban gardening.

The CLD highlighted that *planting* and *growth* are the cornerstone variables of the urban garden system. *Planting* provides discernible benefits to the social system associated with urban gardening as the act of *planting* itself increases *recreational opportunities* and *social activities*, creating a higher *community quality*. Alongside this, urban gardening was also found to provide physical, psychological and social benefits. This finding was supported by the results gained from the resident interviews who noted the main reasons for urban gardening to be social interaction with neighbours, followed by mental and physical health, access to local and healthy food.

Growth is the main factor in the *food security* of Loudden. If *growth* is reduced, the *local transportation of food* and the *international imports of food* will increase, resulting in less sustainable practices. As such, a key conclusion drawn from the CLD was that urban gardening has the potential to provide one of the most effective solutions to food security issues in the modern world. Stockholm accounts for approximately one ninth of Sweden’s population and although food security has not been

a big issue so far, threats of climate change and a volatile world have made preparations a more pressing concern.

Expanding on the CLD, the ecosystem services matrix (table 1) shows that ESS will benefit highly from urban gardening, particularly regulating and habitat services. These services are enhanced in every criterion by urban gardens. Regulating services will, of course, always be enhanced by the addition of more vegetation because it raises the capacity of regulating effects (*air purification, soil fertility*). This is the same for habitat services, by physically increasing the space available for fauna and wild flora biodiversity also has the capability to increase. Both provisioning and cultural services are fulfilled in the majority, however there are a few major gaps under certain criteria. From a provisional standpoint flat green areas, street trees and flowerbeds have minimal benefit. Cultural services are benefited across the board, except for ruderal vegetation which does not fulfil eight of the cultural services, this is essentially because areas with ruderal vegetation are unkept or undeveloped and have not been designed for human usage.

The green space factor provided further insight into how urban gardening could help improve Loudden. Currently, Stockholm Royal Seaport follows the Stockholm standard of 0.6. However, as noted by Camilla Edvinsson there have been suggestions to set the target higher. With this in mind, the suggested plan for Loudden aimed to get as close to 1.0 as possible. The final calculated GSF was 0.99. As mentioned previously Stockholm Royal Seaport has the potential to reshape how urban gardening fits into the realm of sustainable practices, and by setting the bar high, Loudden can be used as the example for others.

The alternative plan for Loudden (table 3) demonstrates how the GSF could add value to the general area. The main benefits are the large sections of green corridors suggested for within Loudden which would assist with the biodiversity and ESS of northern Djurgården. This is of major importance to Djurgården's biodiversity since it is currently surrounded by water/urban structures. Looking closer that the GSF, though, it becomes clear that there is more focus on recreational ESS than on regulating and supporting ESS and provisional ESS. Even though a high number is achieved in the eco-efficient value with the help of urban garden techniques this could be a disadvantage for urban gardens since urban gardens are mainly a provisional ESS.

The structure of this GSF came from the Nacka municipality. However, some alterations were made to fit the needs of this particular project. The ability to change and adapt this tool highlighted to us the risks associated with it. Each project or municipality is easily able to change the different factors making comparisons difficult between both different projects, and also past and future projects which may have had different focuses. As such, it is believed that the GSF tool should not be used alone, but rather in conjunction with other tools as has been done in this project. The interview with Camilla Edvinsson further highlighted that Stockholm Royal Seaport does not use international methods to measure their sustainability making international comparison also challenging. This can create a problem if they want Stockholm Royal Seaport to act as an international pioneer in sustainability as currently the measurement tools are not universal. The introduction of different urban gardening techniques also brings to our

attention the need to have a consistent measurement scheme in order to help others apply the knowledge to their own projects.

Alongside the different measurement tools used the general practicalities involved with the suggested plan also need to be considered. The challenges identified are mainly on an organisational and economical level. As pointed out by Camilla Edvinsson, in order to sustainability implement and maintain the different urban gardening methods more thought will need to be given over who takes responsibility. The developers are in charge of the maintenance for green spaces for the first two years after the apartment have been built, but a clear plan has yet to be made for what to do after this. It has been suggested that as a part of the community garden idea residents will be required to contribute to the maintenance, however this will require training programs to make sure it is done correctly. It was also found, during the resident interviews, that despite liking the idea of urban gardening many noted themselves to be too busy to commit to it full-time. These challenges, however, can be seen opportunities for Stockholm Royal Seaport to demonstrate how mind-sets can be shifted and changed. Camilla Edvinsson noted that simple techniques are already being used by Stockholm Royal Seaport to push residents towards more sustainable practices. Being involved in urban gardening activities could become a norm in Loudden in the long-term if implemented correctly.

Economic concerns are often huge barriers to the implementation of new and innovative ideas. A cost analysis was produced in order to gain a further understanding of the costs of the different urban gardening techniques. It indicated that total implementation cost for the forest, community and rooftop gardens, using our assumptions, is 256,423,800 SEK, and the total annual maintenance cost is 551,000 SEK. Although a large investment is needed for the initial set up, in the long-run the maintenance costs are fairly low. A cost-benefit analysis could be completed in future studies to gain a fuller understanding of the long-term benefits of urban gardening from an economic perspective.

It should be noted though that at the moment, there is an issue with soil contamination from the biogas plant and a petroleum/container import depot currently located in Loudden. These costs assume that the infrastructure (buildings, roads, pavements and the ground soil) is suitable for urban gardening to be implemented. As such, when looking at the project as a whole there would be additional costs to those represented in this report.

7. Conclusion

As a final conclusion, rather than attempting to address a lack of access to or availability of food this project has focused on creating and setting a new standard for the inclusion of urban gardening within city planning. To date, large scale urban gardening methods have been more theoretical than practical. As such, the urban gardening techniques suggested in this project could mark a new beginning in the development of urban planning as they provide a multifunctional tool for tackling the problems related to climate change and rapid urbanisation.

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Appendix 1 – Interviews

Stockholm City Council has designed Stockholm Royal Seaport with the aim of it becoming a model for urban sustainable development. We are looking at the role of urban gardening within the area of Loudden. We are looking to find out more about what the residents of Stockholm Royal Seaport know about the development of the project and what they think could be improved.

Resident Interviews

Question 1: To what extent did concerns over sustainability play a part in your decision to move to the Stockholm Royal Seaport?

Most of the participants gave an answer for about 3 to 6, with two answers at 1 and 10. The reasons mentioned when asked this question participants was access to nature, energy efficiency and the waste disposal system.
(Answers: 9, 7, 7, 6, 5, 5, 3, 3, 3, 1)

Question 2: How important is green space in your lifestyle?

When asked if greens space was important the answers was unanimously high in number, from 7 to 10 where only one of the participants choose 7.
(Answer: 10, 10, 10,10, 9, 9, 8, 8, 8, 7)

Question 3: How green do you perceive the area to be?

We asked how green they perceive the area to be and out of the 10 residents we interviewed 7 of them noted that they perceive the area as very green, giving a 9 or above. The other three gave slightly lower scores of 6, 7 and 8.
Answers: (10, 10, 10, 10, 9, 9, 9, 8, 7, 6)

Question 3b: How do you use the green space? (Recreation, Sport, Gardening, Edible Gardening)

When asked what they use the space for they all answered recreation, with one person also noting that they use it for sport. No particular trends were noted between the age or gender of the participant and their scores for these question. One person did not answer this question.
(Answers: Recreation IX, Sport I)

Question 4: Would you like more urban gardening opportunities in your living area?

When asked whether they would like more urban gardening opportunities in the area out of the 10 participants, 3 gave a score of 9, one of 8, 7 and 6, and 4 gave a score of 5 or below. As a

general trend it was noted that those giving the higher scores were female. It is more difficult to see a trend in regards to age, however, those giving the lower scores were all above 45.
(Answers: 9, 9, 9, 8, 7, 6, 5, 5, 2, 2)

Question 5: Would you be willing to work with neighbours/Stockholm stad to maintain the garden areas?

When asked if they would want to collaborate with Stockholm city and/or neighbours to keep the garden areas, the participants answers ranges from 2-10. Note that eight of the ten residents answer 5-10, and only two answers below that, and none answered 1 on the scale.
(Answers: 10, 9, 8, 8, 7, 7, 5, 5, 3, 2)

Question 6: How positively do you think urban gardening affects your neighbourhood?

All of the participants answered the question on to which extent they thought urban gardening had a positive affect in their area, with a number between 7-10. Four people answered 9. Two people answered 10. So all of the participants thought that urban gardening would affect their neighbourhood in a positive way, and more than half of the participants thought that it would affect in a very positive way.
(Answers: 10, 10, 9, 9, 9, 9, 8, 8, 7, 7)

Question 6b: In what way? (Social Inclusion, Mental Health, Physical Health, Local, Healthy food, Education, Aesthetics)

It was possible to choose more than one alternative to the question in what way the neighbourhood would be positively affected by urban gardening. Three of the participants did not answer this question. Two participants answered that all of the mentioned alternatives would be positively influenced by the urban gardening in the neighbourhood.

Four people thought that social cohesion would gain from urban gardening. Mental health, physical health, access to local food and education got three answers as to be positively affected, whereas only two participants thought that education was seen to have a positive affect. All the six females answered this question, and only one (out of four) male participants.
(Answers: Social inclusion IV, Mental health III, Physical health III, Access to local food III, Healthy food III, Education III, Aesthetics II)

Question 7: Do you think having access to urban gardening through options such as green rooftops and plant boxes would improve the area? If so, in what way?

All of the participants thought that urban gardening would be positive for the area, one said that it connects the neighbours, while another emphasized that it adds some quality to the area and gives it a modern feeling. One woman states that the area is more green than other areas in Stockholm, and the plants and trees are all native and are well designed for the area.

Question 8: Could there be any negative effects with urban gardening?

None of the participant expressed that urban gardening could have a negative effect, when asked this question.

Question 9: Do you have any concerns about the development of the area as it continues? Adequate transportation, services?

We then asked whether they had any concerns about the development of the area most people said no. However, a few noted that transportation had been a concern in the past. When people started moving into the area 5 - 6 years ago there was no bus links to the city centre. The participants noted that as the area grows and more people move in sufficient transportation could be a problem again. Overall though, the participants noted that they thought more people moving in would have a positive effect.

Question 10: What have you heard about the development of the southern part of the Stockholm Royal Seaport? Do you receive updates on the project?

When we asked the participants whether they had heard anything about the development of Loudden there were mixed answers. Over half noted that they had not received any information about the development of the area. Those who said they had noted it was because they have actively sought out information through internet searches, brochures and newspapers. One person said that the main reason they had spent time researching this was because they had a keen interest in city planning generally.

Interview with Camilla Edvinsson

In the background to our report we need to create a clear framework for the project. We, therefore, need to include a discussion as to the most important/influential concepts guiding the development of Stockholm Royal Seaport Project in general, and also in relation to our topic: urban gardening.

1. In the report "Sustainable Urban Development Programme for Stockholm Royal Seaport" (2017) five strategies for making Stockholm Royal Seaport a model for urban sustainable development are noted: vibrant city, accessibility and proximity, resource efficiency and climate responsibility, let nature to the work and participation and consultation. Are all of these five areas being equally considered? Or are certain factors being focused on more than others? If so, why?

When asked about whether the five strategies for urban sustainable development are equally considered Camilla answers that they were. The various phases have different focus in the strategies. Mission for the whole project of Stockholm Royal Seaport is first and foremost environmental sustainability. Social sustainability is mostly accounted for in the beginning of the project, with presentation of the project to the public where they can participate. Interviews

have also been carried out to get a sense of the attitudes of residents from nearby areas towards the development of Stockholm Royal Seaport, and these opinions have been collected.

The five approaches are specifically designed for Stockholm and Stockholm Royal Seaport. Each area (energy, transports, climate, waste, water etc.) have a group of experts that meets regularly. Sustainability has through these five strategies been more understandable and useful in the planning process. Neither the Sustainable Development Goals from UN nor Agenda 21 has been part of the process in defining sustainability in Stockholm Royal Seaport.

There is more of a focus on environmental sustainability than on social sustainability. However, Camilla points out that they do employ people to work at the site as a part of a program to get people that has been unemployed for a long time, to get back into work.

Working with sustainability takes time, Camilla says they take baby steps. For instance, in the first two phases the implementation of green roofs was voluntary, whereas in phase three green roof became mandatory. But it is going in the right direction; 2009 was it decided that Stockholm Royal Seaport was the only ecological area in Stockholm.

Currently there are 150 people working on the project part-time, and 30 people working full time. 55 developers are involved in the project.

The people moving in to the area are mostly middle/upper class that want to still retain the connections to the city, while at the same time getting more for their money. However, by planning for a new school and Kulturskolan the area will be more diversified as people not living in the area will go there.

2. Has it been any focus on environmental psychology in developing Stockholm Royal Seaport?

It has not been a focus on that concept, but they do consider green space as a wellness factor. They actively try to push people towards a more energy efficient lifestyle.

This can be that they lower the temperature in the building hallways both for the purpose of saving energy but also to make the residents in the building to get a feeling of being warmer when they step into their own apartments.

3. Stockholm is known as a pioneer in the area of urban sustainability and its aim to tackle many of the issues associated with it. How does Stockholm Royal Seaport project fit into the wider global concerns such as: food security, water security and climate change?

The issue of food security and water security is not really talked about, or used to frame the project. Focus is more on climate change and how to mitigate those effects. The green roofs are mainly used as storm water, 60% of storm water is taken care of, therefore, need the green roof to achieve this.

Boxes for urban gardening are more of a social project, a meeting point for people and a hobby for those interested in gardening.

The GSF must be carried out by the developers, and in order to make this work the developers need to cooperate.

4. Has the "GSF" model been used in the project as a measurement tool? If the model has been used, has the GSI increased from building stages 1 to 4? By how much? / Is that progress planned to continue/increase through whole Norra Djurgårdsstaden? How many stages are there in the development of Norra Djurgårdsstaden in total?

GSF is an index they work with in the development of Stockholm Royal Seaport. It will be evaluated if GSF is the measurement to use. In the first phases it was voluntary, now it is compulsory. In the planning it has not been a focus to use GSF on urban gardening, but maybe this could be something to take into account.

Now the requirements for the GSF is 0,6 for the area, which was easily reached by the developers in phase 3.

Since it was easy for the developers to reach the goal of 0,6 it could be useful to change this GSF to 1,0 in the future stages, to highlight the sustainability of Stockholm Royal Seaport. Still working to understand how the GSF works, would like to change some factors in the index first before making the threshold higher.

Every phase has/will have 1,000 apartments in order to test and develop sustainability ideas. In total for the whole area it is planned for 12,000-14,000 apartments.

5. What other methods and/or tools will be used to measure the impact of the project? How has/will the issue of maintenance of these urban garden areas be addressed in Norra Djurgårdsstaden? How will residents be incentivised to contribute/maintain communal garden areas?

The developers are contracted to measure the effects of the green spaces for two years after the project is finished. After that time, it is up to the associations that take over the building to continue with the measurements. Camilla says that there is a need to increase interest in the follow up. There may be need for low-maintenance greens space in order to make the future maintenance work. Now everything is documented and given meaning to convince people that maintenance is needed.

6. What are the plans in regards to transportation? Would it be possible to make the area car free (private)?

A lot of the residents still use cars and park in the street where there are parking spots. Camilla noted that a higher parking fee could decrease the use of cars in the area. Some car space in the area is still needed of course, for deliveries and such.

7. What urban gardening techniques are possible to use in the area? Which factors affect this?

The offices would need to use the roofs as green space since they do not have access to courtyards. Nudging to use different gardening techniques.

8. What urban gardening methods are currently being used in the northern part of Stockholm Royal Seaport? Could more be done? What improvements could be made?

In Loudden the focus has been on transport, street design, energy, waste and disposal, rather than on urban gardening. To get more green space the landscape architect often has to fight, otherwise the space will be used for buildings. So the green space has to be presented as a multifunctional landscape that is important for the area.

9. How do nearby residents feel about the development of Loudden? Have they been contacted? The stakeholders in the project are noted to be residents, employees, developers, politicians, researchers, municipalities and authorities. Do the current residents get a say in how Loudden will be developed? Or do more influential stakeholders make the decisions?

The residents have been contacted through the normal approach in planning where the Stockholm municipality holds meetings and the residents are invited to join and discuss the plans. Their opinions on how to develop the area do not get a strong say, though. Despite trying to involve everyone there is often an issue with only a few of the same people turning up to these meetings every time. Residents in the adjacent area Gärdet has been positive about the development, as they see it as an opportunity for their area to be more connected through transportation and residential areas, especially with the waterfront.

10. How will socio-economic issues be dealt with in this project, if at all? Will certain areas of Stockholm Royal Seaport be open to everyone?

Gentrification is a problem, but it is being discussed. Things that can be done is to keep prices of the flats levelled to stop pushing poorer people out, and try to keep rents low. However, the fact is that the area is newly built and therefore more expensive and this cannot be changed.

Appendix 2 – Green Space Factor

Loudden - Green Space Factor					
Detaljplan: Loudden Projektnamn/Byggherre: Urban Garden Crew					
YTOR	BERÄKNINGS-FAKTOR	ANTAL	BERÄKNINGS-YTA (KVM)	TOTAL YTA (KVM)	EKOEFFEKTIV YTA
Bevarad naturmark	**1,5**	-		0	0
Ej underbyggd markgrönska	**1,1**	-		58860	64746
Växtbädd >800 mm djup	**0,9**	-		51040	45936
Växtbädd 600-800 mm djup	**0,4**	-		8876	3550,4
Växtbädd 200-600 mm djup	**0,1**	-		0	0
Grönt tak med > 300 mm djup växtbädd	**0,3**	-		62537	18761
Grönt tak med 110-300 mm djup växtbädd	**0,1**	-		82273	8227
Grönt tak med 50 - 110 mm djup växtbädd	**0,05**	-		0	0
Grönska på väggar	**0,4**			660	264
Grönskande balkonger	**0,3**	-		0	0
Befintliga stora träd >30 cm	**3,0**	0	**50**	0	0
Befintliga övriga träd 15-30 cm	**1,5**	0	**50**	0	0
Nya stora träd (stam >30 cm)	**2,4**	217	**25**	5425	13020
Nya mellanstora träd (stam 20-30 cm)	**1,5**	434	**25**	10850	16275
Nya små träd (stam 16-20 cm)	**1,0**	0	**25**	0	0
Buskar generellt	**0,2**	-		49578	9916
Vattenytor i dammar, bäckar och diken	**1,0**	-		3270	3270
Hårdgjorda ytor med hög genomsläpplighet - gräsarmering	**0,3**	-		0	0
Hårdgjorda ytor med hög genomsläpplighet - grus,sand mm	**0,2**	-		6540	1308
Hårdgjorda ytor med viss genomsläpplighet - plattytor med fogar	**0,05**	-		0	0
Täta ytor	**0,0**	-		0	0

KVALITÉER	BERÄKNINGS-FAKTOR	ANTAL	BERÄKNINGS -YTA (KVM)	TOTAL YTA (KVM)	EKOEFFEKTIV YTA
Sociala värden					
Gräsytor för social aktivitet	**1,2**	-		13080	15696
Odlingsytor	**0,5**	-		400	200
Tak, balkonger, terrasser och växthus för odling	**0,5**	-		108036	54018
Gemensamma takterasser	**0,2**	-		56270	11254
Synliga gröna tak	**0,05**	-		56270	2814
Blomsterprakt i fältskiktet	**0,2**	-		49578	9916
Buskar upplevelsevärden	**0,1**	-		0	0
Buskar med ätliga bär och frukter	**0,2**	-		24789	4958
Träd, upplevelsevärden	**0,4**	217	**25**	5425	2170
Fruktträd och blommande träd	**0,2**	434	**25**	10850	2170
Pergolor o.dyl.	**0,3**	-		4420	1326
Habitatstärkande åtgärder, upplevelsevärden	**0,2**	0	**5**	0	0
Utsiktsplats mot grönska	**0,5**	-		0	0
Vattenspeglar	**0,5**	-		3270	1635
Biologiskt tillgängliga vatten - upplevelsevärden	**1,0**	-		4850	4850
Fontäner o.dyl.	**0,3**	0	**25**	0	0
Dagvattenhantering					
Avvattning av dagvatten från hårdgjorda ytor till vegetationsytor, regnbäddar mm	**0,2**	-		101777	20355
Fördröjning och rening av dagvatten i vegetationsytor					
Fördröjning och rening av dagvatten i vegetationsytor, mer än 20 l/s/kvm	**0,5**	-		0	0
Fördröjning och rening av dagvatten i vegetationsytor, mer än 10-20l/s/kvm	**0,15**	-		0	0
Fördröjning och rening av dagvatten i vegetationsytor, mer än 5-10l/s/kvm	**0,1**	-		0	0
Fördröjning av dagvatten via ytvattensamlingar från hårdgjorda ytor					

Fördröjning av dagvatten via ytvattensamlingar från hårdgjorda ytor, mer än 20l/s/kvm	**0,4**	-			0
Fördröjning av dagvatten via ytvattensamlingar från hårdgjorda ytor, mer än 10-20l/s/kvm	**0,1**	-		101777	10178
Fördröjning av dagvatten via ytvattensamlingar från hårdgjorda ytor, mer än 5-10l/s/kvm	**0,05**	-		0	0
Fördröjning av dagvatten i magasin					
Fördröjning av dagvatten i magasin mer än 20 l/s/kvm avvattnad yta	**0,2**	-		1558	312
Fördröjning av dagvatten i magasin mer än 10-20 l/s/kvm avvattnad yta	**0,05**	-		3270	164
Fördröjning av dagvatten i magasin mer än 5-10 l/s/kvm avvattnad yta	**0,02**	-		0	0
Minskad dagvattenavrinning med hjälp av gröna tak					
Minskad dagvattenavrinning med hjälp av gröna tak, minst 300 mm substrattjocklek	**0,1**	-		62537	6254
Minskad dagvattenavrinning med hjälp av gröna tak, 50-300 mm substrattjocklek	**0,05**	-		82273	4114
Regnbäddar och skelettjordar som omhändertar dagvatten	**2,0**	-		8876	17752
Seriekopplade dagvattensystem	**0,02**	-		0	0
Stuprör med utkastare	**0,02**	-		0	0
Biologisk mångfald					
Diversitet i fältskiktet	**0,05**	-		99156	4958
Naturligt arturval	**0,5**	-		19620	9810
Diversitet på gröna tunna sedumtak	**1,2**	-			0
Grönskande balkonger med häng- eller klätterväxter	**0,2**	-		660	132
Fjärilsrabatt	**0,2**	-		82273	16455
Bärande buskar	**0,1**	-		49578	4958
Äldre, grova träd	**0,4**	50	**25**	1250	500
Karaktärsträd	**0,1**	167	**25**	4175	418
Bärande träd	**0,05**	434	**25**	10850	543

Holkar, bikupor	**0,02**	20	**5**	500	10
Baggholkar och faunadepåer	**0,3**	42	**5**	1050	315
Habitatstärkande åtgärder för särskilt utpekade arter	**0,1**	0	**5**	0	0
Biologiskt tillgängliga permanenta vattenytor	**0,5**	-		3270	1635
Ytvattensamlingar, fuktstråk med tillfälligt vatten	**0,05**	-		0	0
Koppling till existerande grön- och blåstruktur utanför området	**0,01**	-		2840	28
Lokalklimat					
Träd placerade så att de ger lövskugga	**0,4**	167	**25**	4175	1670
Pergolor, lövgångar mm som ger lövskugga	**0,5**	-		8876	4438
Gröna tak eller flerskiktad markgrönska	**0,05**	-		144810	7241
Vattensamlingar för torrperioder	**0,5**	-		3270	1635
Uppsamling av regnvatten för bevattning	**0,05**	-		2562	128
Träd som ger vindskydd	**0,4**	50	**25**	1250	500
Luftrening					
Befintliga och nya träd	**0,1**	651	**25**	16275	1628
Vegetationsklädd mark	**0,1**	-		112236	11224
Grönska på väggar	**0,05**	-		660	33
Gröna tak	**0,02**	-		144810	2896
Trädarter som har särskilt god luftreningsförmåga	**0,3**	217	**25**	5425	1628
Total summa (eko-effektiv yta):					**428187**
Hela tomtens yta:				**427000**	
Uppnådd faktor:					**1,00**
Balansräkning:		**Max antal:**	**Uppnått antal:**	**% :**	
S = Sociala värden		**16**	**12**	**75%**	
D = Dagvattenhantering		**8**	**5**	**63%**	
B = Biologisk mångfald		**15**	**12**	**80%**	
K = Lokalklimat		**6**	**6**	**100%**	
L = Luftrening		**5**	**5**	**100%**	

YTOR	Användningsområden Loudden
Bevarad naturmark	Ej använt
Ej underbyggd mark grönska	Grön korridor
Växtbädd >800 mm djup	Innergård
Växtbädd 600-800 mm djup	20% del av väg
Växtbädd 200-600 mm djup	Ej använt
Grönt tak med > 300 mm djup växtbädd	30% av gröna tak på lägenheter, skola och köpcentrum, samt alla gröna tak på kontor
Grönt tak med 110-300 mm djup växtbädd	70% av gröna tak på lägenheter, skola och köpcentrum
Grönt tak med 50 - 110 mm djup växtbädd	Ej använt
Grönska på väggar	Alla klättrande växter i innegård som är 5 kvm/planta
Grönskande balkonger	Ej använt
Befintliga stora träd >30 cm	Ej använt
Befintliga övriga träd 15-30 cm	Ej använt
Nya stora träd (stam >30 cm)	217 st i grön korridorens skogsträdgårdar och innergårdarna skogsträdgårdar, lite tätare i grön korridor
Nya mellanstora träd (stam 20-30 cm)	434 st i grön korridorens skogsträdgårdar och innergårdarna skogsträdgårdar, lite tätare i grön korridor
Nya små träd (stam 16-20 cm)	Ej använt

Buskar generellt	Halva av skogsträdgård ytorna för innergårdar, grön korridor och väg
Vattenytor i dammar, bäckar och diken	Vatten i grön korridor
Hårdgjorda ytor med hög genomsläpplighet - gräsarmering	Ej använt
Hårdgjorda ytor med hög genomsläpplighet - grus,sand mm	I grön korridor
Hårdgjorda ytor med viss genomsläpplighet - platt ytor med fogar	Ej använt
Täta ytor	Ej använt
KVALITÉER	
Sociala värden	
Gräsytor för social aktivitet	Gräsytor i gröna korridorer
Odlingsytor	200st odlingspallar 2m^2
Tak, balkonger, terrasser och växthus för odling	Gröna tak på lägenhet, skola
Gemensamma takterrasser	Gröna tak på kontor, skola, köpcentrum
Synliga gröna tak	Gröna tak på kontor, skola, köpcentrum
Blomsterprakt i fältskiktet	25% av skogsträdgården
Buskar upplevelsevärden	Ej använt
Buskar med ätliga bär och frukter	Halva skogsträdgård ytorna för innergårdar, grön korridor och väg
Träd, upplevelsevärden	217 st i grön korridorens skogsträdgårdar och innergårdarna skogsträdgårdar, lite tätare i grön korridor

Fruktträd och blommande träd	434 st i grön korridorens skogsträdgårdar och innergårdarna skogsträdgårdar, lite tätare i grön korridor
Pergolor o.dyl.	10% av arean på skolan och köpcentrumet
Habitatstärkande åtgärder, upplevelsevärden	Ej använt
Utsiktsplats mot grönska	Ej använt
Vattenspeglar	Vatten i grön korridor
Biologiskt tillgängliga vatten - upplevelsevärden	Vatten i grön korridor
Fontäner o.dyl.	Ej använt
Dagvattenhantering	
Avvattning av dagvatten från hårdgjorda ytor till vegetationsytor, regnbäddar mm	400 mm gröna tak och skogsträdgårdar i gröna korridorer
Fördröjning och rening av dagvatten i vegetationsytor	Del av ovanstående kolumn
Fördröjning och rening av dagvatten i vegetationsytor, mer än 20 l/s/kvm	Ej använt
Fördröjning och rening av dagvatten i vegetationsytor, mer än 10-20l/s/kvm	Ej använt
Fördröjning och rening av dagvatten i vegetationsytor, mer än 5-10l/s/kvm	Ej använt
Fördröjning av dagvatten via ytvattensamlingar från hårdgjorda ytor	Ej använt
Fördröjning av dagvatten via ytvattensamlingar från hårdgjorda ytor, mer än 20l/s/kvm	Ej använt
Fördröjning av dagvatten via ytvattensamlingar från hårdgjorda ytor, mer än 10-20l/s/kvm	400 mm gröna tak och skogsträdgårdar i gröna korridorer

Fördröjning av dagvatten via ytvattensamlingar från hårdgjorda ytor, mer än 5-10l/s/kvm	Ej använt
Fördröjning av dagvatten i magasin	Ej använt
Fördröjning av dagvatten i magasin mer än 20 l/s/kvm avvattnad yta	5kvm/innergård
Fördröjning av dagvatten i magasin mer än 10-20 l/s/kvm avvattnad yta	1% till varje grönt tak och vattensamling i skogsträdgården
Fördröjning av dagvatten i magasin mer än 5-10 l/s/kvm avvattnad yta	Ej använt
Minskad dagvattenavrinning med hjälp av gröna tak	Ej använt
Minskad dagvattenavrinning med hjälp av gröna tak, minst 300 mm substrat tjocklek	30% av gröna tak på lägenheter, skola och köpcentrum, samt alla gröna tak på kontor
Minskad dagvattenavrinning med hjälp av gröna tak, 50-300 mm substrat tjocklek	70% av gröna tak på lägenheter, skola och köpcentrum
Regnbäddar och skelettjordar som omhändertar dagvatten	20% av vägnätet kring lägenheterna
Seriekopplade dagvattensystem	Ej använt
Stuprör med utkastare	Ej använt
Biologisk mångfald	
Diversitet i fältskiktet	Skogsträdgård ytorna
Naturligt arturval	50% av skogsträdgården i gröna korri
Diversitet på gröna tunna sedumtak	Ej använt
Grönskande balkonger med häng- eller klätterväxter	Alla klättrande växter i innegård som är 5 kvm/planta

Fjärilsrabatt	70% av gröna tak på lägenheter, skola och köpcentrum
Bärande buskar	Halva skogsträdgård ytorna
Äldre, grova träd	50 st i skogsträdgården
Karaktärsträd	167 st i grön korridorens skogsträdgårdar och innergårdarna skogsträdgårdar,
Bärande träd	434 st i grön korridorens skogsträdgårdar och innergårdarna skogsträdgårdar, lite tätare i grön korridor
Holkar, bikupor	20 st
Baggholkar och faunadepåer	20 st i gröna korridorer och en i varje innergård
Habitatstärkande åtgärder för särskilt utpekade arter	Ej använt
Biologiskt tillgängliga permanenta vattenytor	Vatten i grön korridor
Ytvattensamlingar, fuktstråk med tillfälligt vatten	Ej använt
Koppling till existerande grön- och blåstruktur utanför området	Gränsen till omkringliggande natur
Lokalklimat	
Träd placerade så att de ger lövskugga	117 st stora träd i grön korridorens skogsträdgårdar och innergårdarna skogsträdgårdar
Pergolor, lövgångar mm som ger lövskugga	20% av vägnätet
Gröna tak eller flerskiktad markgrönska	Alla gröna tak

Vattensamlingar för torrperioder	Vatten i grön korridor
Uppsamling av regnvatten för bevattning	5% av innergårdarna
Träd som ger vindskydd	Stora träd i de gröna korridorerna
Luftrening	
Befintliga och nya träd	217 st stora träd och 434 st mellanstora träd i grön korridorens skogsträdgårdar och innergårdarna skogsträdgårdar
Vegetationsklädd mark	80% gröna korridorerna, innergårdar och delar av vägarna
Grönska på väggar	Alla klättrande växter i innegård som är 5 kvm/planta
Gröna tak	Gröna tak
Trädarter som har särskilt god luftreningsförmåga	217 st i grön korridorens skogsträdgårdar och innergårdarna skogsträdgårdar, lite tätare i grön korridor