*Master of Science Thesis in the Master's Programmes Design and Construction Project Management & Design for Sustainable Development*

# INTEGRATING A GREENHOUSE IN AN URBAN AREA

*Exploring how Urban Industrial Vertical Agriculture can be Integrated in Göteborg, Sweden*

Department of Civil and Environmental Engineering
Division of Construction Management
Department of Architecture
CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden 2012
Master's Thesis 2011:145

LINA AHLSTRÖM
MOSTAFA ZAHRA

MASTER'S THESIS 2011:145

# Integrating a Greenhouse in an Urban Area

Exploring how Urban Industrial Vertical Agriculture can be Integrated in Göteborg, Sweden
*Master of Science Thesis in the Master's Programmes Design and Construction Project Management & Design for Sustainable Development*

LINA AHLSTRÖM
MOSTAFA ZAHRA

Department of Civil and Environmental Engineering
Division of Construction Management

Department of Architecture

CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden 2012

Integrating a Greenhouse in an Urban Area
Exploring how Urban Industrial Vertical Agriculture can be Integrated in Göteborg, Sweden
*Master of Science Thesis in the Master's Programmes Design and Construction Project Management & Design for Sustainable Development*


Examensarbete / Institutionen för Bygg- och miljöteknik & Institutionen för Arkitektur
Chalmers tekniska högskola 2011:145

Department of Civil and Environmental Engineering
Division of Construction Management
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

Department of Architecture

Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

Cover:
Close up on a Plantagon Greenhouse conceptual design made by SWECO. Source: Plantagon International AB

Name of the printers / Department of Civil and Environmental Engineering Göteborg, Sweden 2012

Integrating a Greenhouse in an Urban Area
Exploring how Urban Industrial Vertical Agriculture can be Integrated in Göteborg, Sweden
*Master of Science Thesis in the Master's Programmes Design and Construction Project Management & Design for Sustainable Development*

LINA AHLSTRÖM
*Master's Programme Design for Sustainable Development*
Department of Architecture

MOSTAFA ZAHRA
*Master's Programme Design and Construction Project Management*
Department of Civil and Environmental Engineering
Division of Construction Management

Chalmers University of Technology

# ABSTRACT

As of today, food is produced outside the cities and transported over the globe, producing enormous amounts of greenhouse gases, in to the cities. Moreover, by 2030, 4.9 billion of the expected 8.2 billion people on earth will live in urban areas. The population growth means that cities will grow fast, and careful planning is needed. Vertical farming is a concept of growing crops in skyscrapers, on sloping surfaces or in other ways maximizing the use of land by having a vertical design. Plantagon International AB is a Swedish company that has developed greenhouses that could change the way we produce and distribute food. The idea is to build enormous greenhouses for Urban Industrial Vertical Agriculture. However, urban industrial vertical agriculture is a fairly new concept and little studies have been done regarding the issue of integrating it in urban contexts. This master's thesis researches and analyses the opportunities and consequences of integrating an industrial greenhouse in an existing urban environment. Through case studies in Göteborg and system dynamics, the fundamental variables and criteria have been identified and explored. We found that our system dynamics is largely focusing on the variables *Interest for greenhouse*, *Identity* and *Attraction*. But when observing the system in a holistic perspective and when the subsystems are added to our system dynamics the periphery of the system is triggered and variables that not directly affect our district have thus come to play a more significant role. We found that building a Plantagon greenhouse is not a single purpose action. To integrate the greenhouse and encourage the local market, a cooperation or collaboration with local farmers should be established as well as close connection to public transport is essential. In the future, it may be necessary to develop greenhouses in smaller scale so its integration in inner city districts becomes possible.

Key words: Urban Agriculture, Urban Industrial Vertical Agriculture, Urban Development, Integration, System Dynamics, Göteborg

Integration av ett växthus i stadsmiljö
Undersökning av hur ett urbant vertikalt industriellt växthus kan integreras i Göteborg
*Examensarbete vid mastersprogrammen Design and Construction Project Management & Design for Sustainable Development*

LINA AHLSTRÖM
*Design for Sustainable Development*
Institutionen för Arkitektur

MOSTAFA ZAHRA
*Design and Construction Project Management*
Institutionen för Bygg- och miljöteknik
Avdelningen för Construction Management

Chalmers tekniska högskola

# SAMMANFATTNING

Idag produceras livsmedel utanför städerna och transporteras långa sträckor i världen som resulterar i att stora mängder växthusgaser frigörs i atmosfären. Till år 2030 har det uppskattats att jordens befolkning uppgår till 8,9 miljarder människor, varav 4,9 miljarder lever i storstäder. Befolkningstillväxten innebär att städer kommer växa i en oerhörd takt vilket kräver noggrann planering. Vertikalt jordbruk är ett koncept som innebär att man odlar grödor i skyskrapor, på lutande ytor eller på annat sätt som maximerar nyttjandet av mark genom vertikal design. Plantagon International AB är ett svenskt företag som har utvecklat växthus som kan komma att ändra tillvägagångssättet för hur vi producerar och distribuerar mat. Idén är att bygga enorma växthus för urban industriellt vertikalt jordbruk. Urbant industriellt vertikalt jordbruk är dock ett relativt nytt begrepp och få studier har tidigare gjorts inom området att integrerar det i stadssammanhang. Det här examensarbetet kommer att studera och analysera möjligheterna och konsekvenserna med att integrerar ett industriellt växthus i en befintlig stadsmiljö. Genom fallstudier i Göteborg och systemdynamik har de grundläggande variablerna och kriterierna identifierats och utforskats. Vi fann att mycket fokus i vår systemdynamik låg i och omkring variablerna *Intresse för växthus*, *Identitet* samt *Attraktion*. När vi fortsättningsvis studerade systemet ur ett holistiskt perspektiv och när undersystem adderades till vår systemdynamik så aktiverades de periferierna delarna av systemet och variabler som indirekt berör vårt stadsområde fick så småningom en större märkbar roll. Vi konstaterade att ett växthus i sig inte är en åtgärd. För att integrera växthuset och främja den lokala marknaden krävs att ett samarbete med lokala producenter etableras, samtidigt som tillgången till kollektivtrafik har en elementär betydelse. I framtiden är det dock nödvändigt att utveckla skalan växthusen är byggda i för att möjliggöra integrering i tomma innerstadsområden, då den tillgängliga ytan hos den här typen av platser är begränsad.

Nyckelord: Urbant jordbruk, Urbant industriellt vertikalt jordbruk, stadsutveckling, integration, systemdynamik, Göteborg

# CONTENTS

# PREFACE

This master's thesis has been carried out at the divisions of Architecture and Construction Management at Chalmers University of Technology from August 2011 to January 2012.

We would like to thank our supervisor Sigrid Laurel Östlund for all the tutoring, and support throughout this project. We greatly value all the time you have spent guiding us and whish you good luck with your continued work at Chalmers.

This thesis has been conducted in collaboration with Plantagon International AB in Stockholm. We would like to thank the staff members at Plantagon International AB and especially acknowledge Leif Sieurin, our supervisor at the company, for supporting us with information and help along the project.

A special thank to Patrik Wallman for taking your time to help us develop the System Dynamics and the feedback we received on it. Your enthusiasm and experience really motivated us and without your help this project would not have been carried out this well.

Finally, gratitude is shown to our examiners, Inger Lise Syversen and Göran Lindahl, for feedback and guidance along the project.

Göteborg, January 2012

Lina Ahlström Mostafa Zahra

# 1 INTRODUCTION

Today over half of the world's population live in urban areas, and the number is steadily increasing. By 2030 4.9 billion of the expected 8.2 billion people on earth will live in urban areas (United Nations Human Settlements Programme, 2011). The population growth means that cities will grow fast, and careful planning is needed. The quality of life in a city depends on how it is build; infrastructure, industries, social and cultural activities and access to services. Fortunately, the city is a set of opportunities, because of its concentration of people and infrastructure it is a place to implement change.

As of today, food is produced outside the cities and transported over the globe, producing enormous amounts of greenhouse gases (GHGs), in to the cities. Globally, transportation is responsible for about 23% of total energy-related GHG emissions, and 13% of global GHG emissions (United Nations Human Settlements Programme, 2011). With most of the population on earth living in cities, transport of food from rural to urban areas will increase. By growing food inside cities, we can reduce transportation and protect unexploited land from being used as agriculture land.

The industrialized world's economic wealth is, in resource terms, mainly based on imports and not exports (Ebbersten, 2005). For example, London has a surface of 160,000 hectares, but to supply the people living in the city with food requires a nearly 50 times as big area, around 8.4 million hectares, and most of this farmland is of course not located in Britain (Girardet, 2005).

Vertical farming is a concept of growing crops in skyscrapers, on sloping surfaces or in other ways maximizing the use of land by having a vertical design. Moreover, vertical farming is a way to feed and engage communities simultaneously as long distance transportation of food is decreased resulting in reduced greenhouse emissions.

Plantagon International AB (Plantagon) is a Swedish company that has developed Plantagon greenhouses, further on only called greenhouses, that could change the way we produce and distribute food. The idea is to build enormous greenhouses for Urban Industrial Vertical Agriculture (UIVA). However, the most important characteristic of urban agriculture is not the location, but the way it integrates with the urban economic, social and ecological system. Urban agriculture uses urban resources such as land, labour, urban organic wastes, and water, it produces for urban citizens, is thoroughly induced by urban conditions.

This report will try to explore which variables that are required of a city to integrate a greenhouse in an existing urban environment and how these variables interact with each other. It will also discuss the need of industrial vertical agriculture in Göteborg. Since industrial vertical agriculture is a fairly new concept, little research has been done within the field. Due to limited previous research, the report is generally based on qualitative assessments of the authors, thus calling for further attention.

# 1.1 PURPOSE

The purpose of this master's thesis is to research and analyse the opportunities and consequences of integrating an industrial greenhouse in an existing urban environment. Case studies are executed within the city of Göteborg in Sweden, although, since the city structure is similar to many other cities in Europe the result can be projected on them as well. According to Nationalencyklopedin, the Swedish National Encyclopaedia, integration is *"the process that leads to unification of separate units"*. The term can be applied on this question at issue, where a new element, the greenhouse, is to be introduced in an existing city district. The greenhouse must be synchronized with city functions, i.e. transport, energy systems, waste management, communications and the inhabitants' movement, in order to be integrated in the city.

The following questions have been explored and used to guide our research:

- Is industrial greenhouses a sustainable way of developing urban areas?
- What need is there for urban agriculture?
- What is sustainable integration for a Plantagon greenhouse in an urban context?
- How will the neighbourhood develop if a greenhouse is implemented there and what consequences will it have for the city?

The aim is to study the opportunities and consequences of integrating an industrial greenhouse in an urban area.

# 1.2 DELIMINATIONS

The guiding questions will be approached from a city planning and project development perspective. An evaluating system will be developed in order to explore the issue of integrating a greenhouse in an urban environment. However, in this thesis the main focus will be on the physical and social requirements of integrating a greenhouse in an urban environment, hence no design and technical calculations will be made, since it does not fit our purpose.

In the theoretical frame of reference the concept of sustainable development will be managed. The definition of sustainable development treats the issues of social, environmental and economical sustainability. However, this thesis does not examine economical and financing aspects, due to the need of limiting the extent.

The case studies of the thesis are geographically located in Göteborg to facilitate the research process. The city is chosen because it posses several city area types which can be found in larger metropolitans, since the results of the thesis is to be projected in a European context. Moreover, because of the authors' closeness and their local knowledge of the city, the city becomes a natural choice for the studies.

The Plantagon greenhouse is designed in several sizes, although the one concerned in the case studies requires a space of approximately 1 600 $m^2$. This report addresses single standing greenhouses, although, Plantagon is also designing building integrated solutions and retrofitting greenhouses. Because of the limit in time, these concepts will not be further discussed.

# 1.3 PLANTAGON INTERNATIONAL AB

Plantagon International AB (Plantagon) is a Swedish company that has developed greenhouses that could change the way we produce and distribute food. Plantagon's idea is greenhouses for Urban Industrial Vertical Agriculture (UIVA). It allows production of local food in urban environments, cutting costs and environmental damage by eliminating transportation and deliver products directly to consumers.

## 1.3.1 THE COMPANY

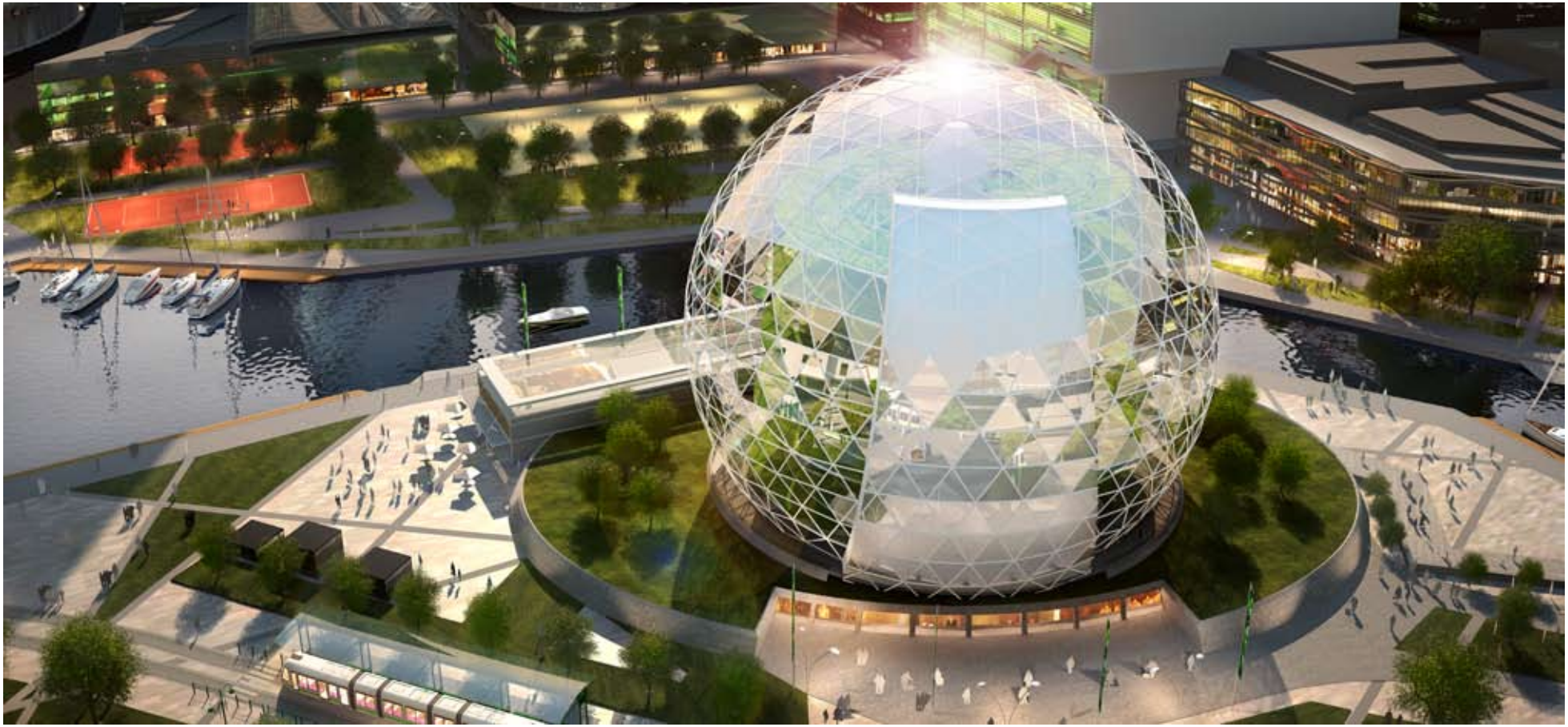
The CEO Hans Hassle and the North American tribe Onondaga Nations founded Plantagon International AB in 2008. The Onondaga Nations owns 85% of the company, and SWECORP Citizenship Stockholm AB owns the remaining 15%. Plantagon has a strong Corporate Social Responsibility (CSR) focus, and by combining a profit driven organization, Plantagon International AB, and a non-profit driven association, Plantagon Non-Profit Association, Plantagon has created a new company structure, the Companization. The Companization means the company will have no control over the non-profit organization, while the organization itself may select 50% of the company's board, resulting in a hybrid of social responsibility goals and financial goals. Plantagon is hoping that the greenhouses will function as a catalyzing project, to promote CSR and sustainability in the world[1].

## 1.3.2 THE GREENHOUSES

The idea of the Plantagon greenhouse is to vertically grow crops in an urban environment. The crops are mechanically moving along a vertical structure, starting as seeds or small plants from the top, when moved along the entire formation the plant is ready for harvest. Preferably, the greenhouse should be integrated with the city infrastructure; carbon dioxide would be delivered from a biogas plant, and excess heating from district heating distribution net would heat the greenhouse. The production is industrial and in no greater need of human contact, although operators will be necessary to control the climate, lighting and irrigation ensuring good climate for the vegetables. Development and design of the greenhouse is being made by SWECO, and a prototype is to be built in Linköping with start of construction in 2012. The prototype will be of a size of 40 m height and a 10 000 $m^2$ footprint, producing lettuce. According to Plantagon, the greenhouse will produce about 3 000 lettuces a day, and be productive 365 days a year.

Plantagon does not want to compete with local farmers but rather be a supplement and support the local market. The products should keep a market price, hence the profit should come from the reduced transportation costs (Plantagon, 2011). The vertical design maximizes the use of land, an important factor in the more denser world we are approaching. Growing vertically in an industrial environment can be several times more effective than growing on flat land, whilst the handling costs and transportation cost will be cut dramatically (Sieurin, 2011). This would lower the pressure on infrastructure and improve the local environ-

1. Leif Sieurin (CTO, Plantagon International AB) Interviewed by the authors 15 September 2011.



*Conceptual Design of Plantagon greenhouse.*
*Source: Plantagon International AB*

*Conceptual Design of Plantagon greenhouse.*
*Source: Plantagon International AB*

ment inside cities. The greenhouse is of a spectacular design and will probably be seen as a landmark and a statement wherever it is build. Plantagon's main market is in the fast growing countries like China and India, where population density and urban sprawl is a growing problem.

The greenhouse construction treated in this project have a footprint of 1 600 $m^2$, where the cultivation part's footprint is about 400 $m^2$. Moreover, the cultivation area is approximately 4000 $m^2$, the greenhouse process area within the construction is less than 1 600 $m^2$ and office space for other programmes and business amount to 2 400 $m^2$. The greenhouse will thus have space for other programmes and businesses than only cultivation. Finally, a grocery store selling the crops will be located on groundlevel[2].

## 1.4 OUTLINE OF THE REPORT

Chapter 1 frameworks the introduction with purpose, delimitations and a presentation of the case and the company.

Chapter 2 presents the method used in the thesis. The research process, as well as how the study has been conducted is described. The theory of SWOT analysis, Multi-Criteria Decision Analysis and System Dynamics will also be presented in this chapter.

Chapter 3 and 4 explain the background to the subject of the thesis. These chapters describe the state of the world, the theory of sustainable development and the development of urban agriculture.

Chapter 5 and 6 present the outcome of the case studies, Multi-Criteria Decision Analysis and System Dynamics.

Chapter 7, a proposal through the outcomes in chapter 5 and 6 are presented in text and illustrations. The proposal illustrates how an area can be changed when integrating a greenhouse.

Finally, Chapter 8 discusses the findings and chapter 9 presents the conclusion of the thesis.

2. Leif Sieurin (CTO, Plantagon International AB) Interviewed by the authors 1 November 2011.

# 2 METHOD

In this chapter methods and methodological approach of the thesis are introduced.

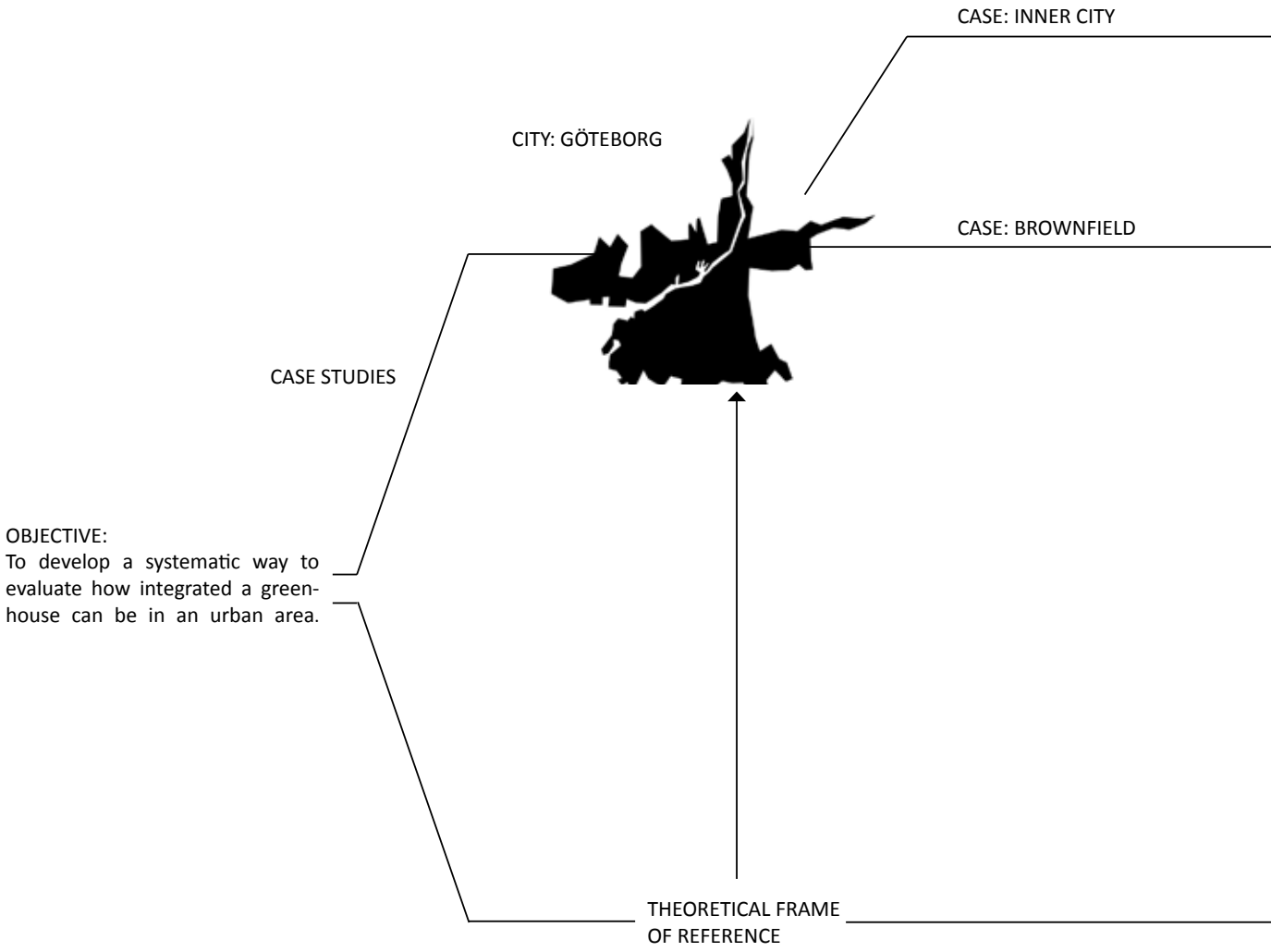
# 2.1 RESEARCH PROCESS

To answer the guiding questions an objective is determined. Furthermore, a research process is established to explore the objective. Two approaches, theoretical frame of references and case studies, are carried out to embrace a holistic view. The two methods have a qualitative approach since qualitative approaches are preferred in situations that require a deeper understanding of social phenomena. Additionally, qualitative research is appropriate since it is seen as a good method to find out what someone knows about a specific issue. Along the process, the two methods interchange information to finally converge, in a critical part of the process, to develop a system of evaluation. The system of evaluation consists of a multi-criteria decision analysis, system dynamics and qualitative judgements. Finally discussion of the findings will be made.

1. DETERMINE OBJECTIVE

2. WHAT TYPE OF CITY ARE WE MANAGING?

3. IDENTIFY THE OPTION AREAS.



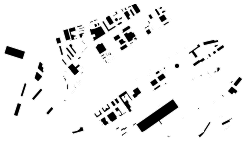
4. EXPLORE THE IDENTIFIED AREAS AND PROCESS THEM.

5. DEVELOP A SYSTEM FOR EVALUATING THE AREAS.

6. DISCUSSION OF THE RESULTS

7. WHAT CAN BE DEVELOPED FURTHER?

SKANSTORGET



GULLBERGSVASS

PRINCIPLES FOR SUSTAINABLE URBAN DEVELOPMENT

SYSTEM OF EVALUATION
-MCDA
-SWOT
-SYSTEM DYNAMICS

FINDINGS

CASE RESULTS

FINDINGS

ANALYSIS AND DISCUSSION

CONCLUSION

## 2.2 CASE STUDIES

A case study is not a method, but a research strategy, which in detail investigates an area with the aim to provide an analysis of a phenomenon in a real life context, which highlights the theoretical issue being studied (Hartley, 2004). The phenomenon is of interest because the aim is to understand how behaviour and processes are influenced by, and influence context. Case studies are a key method to understand the addressed issue. According to Yin (1994), multiple methods are a part of the definitions of case study research. Instead of examine a limited number of variables, case study methods involve an in-depth, often over a long time period, examination of a single instance or event: a case. Case studies consists of a mix of qualitative and quantitative evidence, since there will always be too many variables for the number of observations made (Hartely, 2004), no standard approach or survey design is adequate.

Different methods, such as direct observation, field studies, interviews, and documentary analysis have been in combination. Hence, case studies are flexible and adaptable to the issue at question. The result of the case study could be a deeper understanding of sequence of events and what might be important to do further research on.

Yin (1994) recommended the use of case-study protocol as part of a carefully designed research project that would include the following sections:

- Overview of the project
  (project objectives and case study issues)
- Field procedures
  (credentials and access to sites)
- Questions
  (specific questions that the investigator must keep in mind during data collection)
- Guide for the report
  (outline, format for the narrative)

(Yin, 1994, p. 64)

## 2.3 THEORETICAL FRAME OF REFERENCE

In this chapter, the frame of reference used to examine and analyze the findings is presented. The theory of Multi-Criteria Decision Analysis, SWOT analysis and System Dynamics is presented.

### 2.3.1 MULTI-CRITERIA DECISION ANALYSIS

Multi-criteria decision analysis (MCDA) is a form of multi-criteria analysis (MCA) that has found many applications in both public and private sector organizations. MCA is a structured approach used to determine the preferences between alternative options, where the options purpose is to complete several objectives. The objectives are specified and corresponding attributes identified. The measurements of the indicators are often based on the quantitative analysis, through scoring, ranking and weighting, of qualitative impact categories and criteria. However, the measurements do not need to be in monetary terms. MCA provides the technique for comparing and ranking different outcomes where environmental and social indicators can be developed side by side with economic costs and benefits. (United Nations Framework Convention on Climate (UNFCCC), 2011)

MCDA is both an approach and a set of techniques that provides a general ordering of the alternative options identified, from the most preferred to the least preferred option. The options differ in the extent to which they achieve several objectives, which means that no single option will be evidently best in achieving all the objectives. Furthermore, some conflicts may usually occur among the objectives, for example options that are more beneficial tend typically to be more costly. (Communities and Local Government, 2011)

MCDA is an approach that looks at complex problems characterised by any mixture of monetary and non-monetary objectives (Communities and Local Government, 2011). MCDA breaks the problem into more manageable fragments to allow a coherent overall picture to decision makers. Its purpose is to support thinking and decision-making, but not to take the decision (Communities and Local Government, 2011). MCDA measures the extent to which options achieve objectives and it also provides different ways of weighting the objectives and reassembling the pieces (Communities and Local Government, 2011). Furthermore, according to United Nations Framework Convention on Climate Change, MCDA is a tool particularly appropriate to use in cases where *"a single-criterion approach, such as cost-benefit analysis, falls short, especially where significant environmental and social impacts cannot be assigned monetary values"* (UNFCCC, 2011).

The performance matrix is a standard feature of multi-criteria analysis. It is a consequence table in which each row describes an option and each column describes the performance of the option against each of the identified criterion (Figure 2.1). When assessing the individual performance, it is usually done numerical, but it can also be expressed as bullet point or colour coding. (Communities and Local Government, 2011)

The performance matrix is often the final product of the basic form of an MCA. It allows decision makers to assess the extent to which their objectives are met by the entries in the matrix. However, such intuitive processing of the data can be speedy and effective, but according to the Department for Communities and Local Government in London *"it may also lead to the use of unjustified assumptions, causing incorrect ranking of options"* (Communities and Local Government, 2011).

| CRITERIA | Attitude greenhouse | Attitudes locally produced food | Attraction | Density of people | Flow of people | Sun insolation | Heating/Cooling | Electricity | Fresh water | Grey water sanitation |
|---|---|---|---|---|---|---|---|---|---|---|
| PRIORITY | 40 | 15 | 40 | 90 | 85 | 50 | 80 | 80 | 10 | 10 |
| SKANSTORGET | 100 | 100 | 100 | 100 | 100 | 30 | 68 | 91 | 100 | 0 |
| GULLBERGSVASS | 100 | 100 | 40 | 25 | 0 | 100 | 68 | 91 | 100 | 0 |

Figure 2.1 *Extract from MCDA table*

Multi-criteria analysis is described as a step-by-step process resulting in a performance matrix. Moreover, a MCA normally involves eight steps and it can sometimes be necessary to double back, re-visit earlier steps and revise them. The MCA is also assumed to be implemented by a small team with a general knowledge of the area in which they are working. The team's role is to *"provide advice on appropriate courses of actions to senior staff or to politicians"*. Finally, it is worth noticing that the purpose of MCA is not restricted to just find one single most suitable option. The step-by-step process is particularly helpful when the purpose is to short-list a set of options for more detailed investigation or if the aim is to categorize options in a transparent and justifiable way. (Communities and Local Government, 2011)

## 2.3.2 SWOT

SWOT is an acronym of the words Strengths, Weaknesses, Opportunities and Threats and is a method often used as a planning tool. The analysis is a structured way to get an overview over the current situation and what needs to be developed in an organization or business (Thompson et al., 2010). The SWOT is often illustrated in an a 2x2 matrix, (Figure 2.2). Strengths and weaknesses are seen as internal factors that the organization can affect it self. Opportunities and threats, however, are external factors that the organization cannot influence. After completing a SWOT, weak spots can be identified, or opportunities can be exploited.

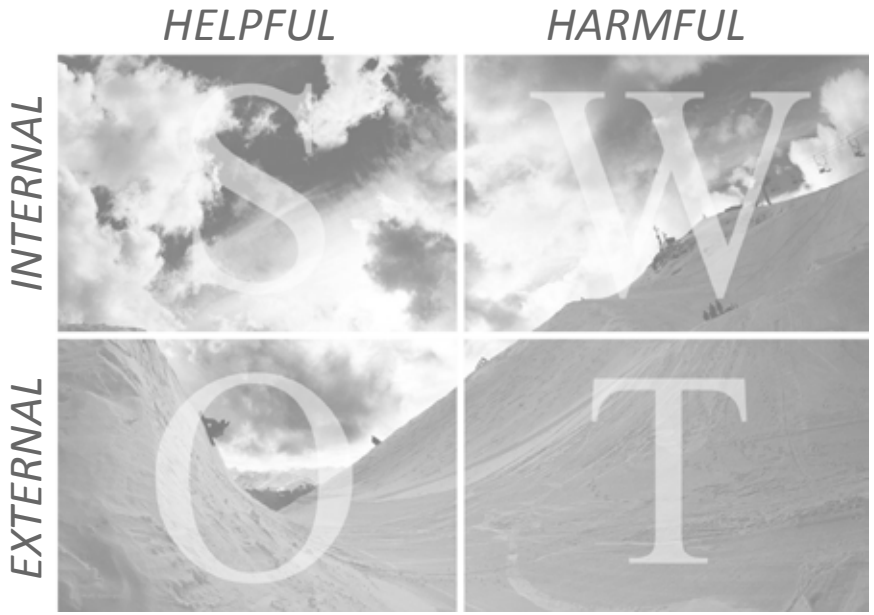



Figure 2.2 *SWOT matrix*

## 2.3.3 SYSTEM DYNAMICS

System dynamics is an approach that helps us to understand complex social, managerial, economic and ecological systems over time[3]. It can be applied to any dynamic systems characterized by interdependence, mutual interaction, information feedback, and circular causality (System Dynamics Society, 2011). Professor Jay W. Forrester of the Massachusetts Institute of Technology originally developed the approach during the mid-1950s to help corporate managers improve their understanding of industrial processes. Lately, system dynamics is being used throughout the public and private sector for policy analysis and design.

The system dynamic approach usually involves (System Dynamics Society, 2011):

- Defining problems dynamically, in terms of graphs over time
- Striving for a behavioural view of the significant dynamics of a system, an internal focus on the characteristics of a system that generate or strengthen the perceived problem
- Thinking of all concepts in the real system as continuous quantities interconnected in informative feedback loops
- Developing understandings and applicable strategy visions from the resulting model
- Implementing changes resulting from model-based understandings and insights

System dynamics deals with casual loop diagrams (CLDs), which are a kind of system thinking tool. These diagrams consist of arrows that connect variables, things that change over time, in a way showing how one variable affects another (The System Thinker, 2011).

Furthermore, system dynamics manage the feedback concept, which is the heart of the approach (System Dynamics Society, 2011). Diagrams of loops of information feedback and circular correlation are used for conceptualizing the structure of a complex system and for communicating model-based insights (System Dynamics Society, 2011). When the arrows come together in CLDs, they form a loop that is labelled with an “R” or a “B” (The System Thinker, 2011). If the tendency in the loop is to reinforce the initial action, then the loop is called reinforcing (R) (The System Thinker, 2011). And accordingly, if the tendency is to oppose the initial action, the loop is called a balancing (B) feedback loop.

To completely understand the system dynamics, its behaviour over time is studied. The System Archetypes are tools for gaining insight into patterns of behaviour and the understanding of the underlying structure of the system being studied. However, managers must consider that the archetypes are generic in their nature. The archetypes can be applied in two ways - diagnostically and prospectively. (Braun, 2002)

When archetypes are applied diagnostically, they help managers to distinguish patterns of organizational behaviour that are already present. When managers have formulated the means to accomplish their organizational expirations, archetypes are used prospectively for planning. The archetypes are then used to test if policies and structures that mangers have taken into consideration may alter the structure in such manner as to produce the archetypal behaviour. If this might be the case, then managers can take corrective action before changes are adopted and embedded in the structure. (Braun, 2002)

3. Patrik Wallman (Researcher, Swedish Metrological and Hydrological Institute) Interviewed by the authors 31 October 2011.

# 3

# BACKGROUND THEORY

This chapter describe a set of ideas, conditions and assumptions as of philosophical principle that determine how the state of the world, sustainable development and urban agriculture is approached, perceived and understood. The chapter will also explain the definitions of locally produced food and corporate social responsibility.

# 3.1 STATE OF THE WORLD

Most of the globe is covered by water, 71% to be precise, 5% of these are biologically productive sea space. Additionally, 21 % of the globe is biologically productive land, adding up to a total of 26%, or 13.4 billion global hectares, biological productive land and sea space (Figure 3.2) (Amend et al, 2010). The growth of the human species and the technological development has transformed the land surface through cropping, forestry, and urbanization. For example, 10-15% of Earth's land is covered by row-crop land or by urban-industrial areas; additionally 6-8% has been converted to pastureland. The majority of Earth's vegetated surface consists of woodland that has been harvested; graze land (sometimes degraded), semiarid ecosystems, and grassland. Estimates of the proportion of land transformed by humans fall in the range of 39-50% (Lubchenco, J, 2008).

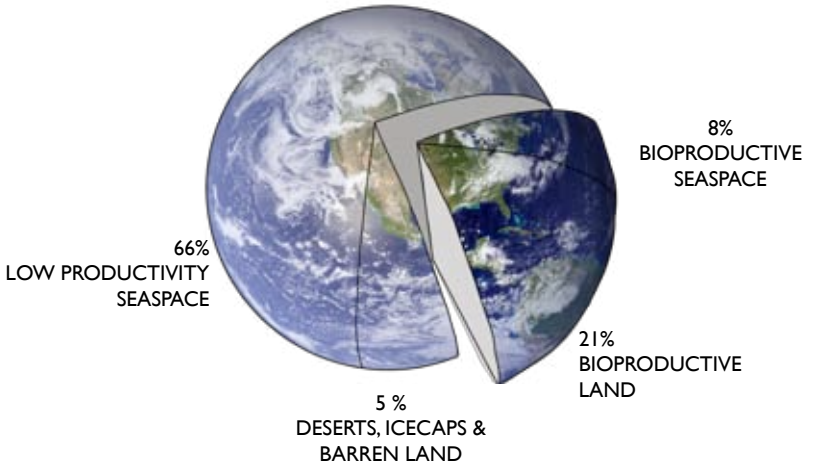



Figure 3.1: *26% of the globe is bioproductive land and seaspace.*

Today over half of the world's population live in urban areas, and the number is steadily increasing. By 2030 4.9 billion of the expected 8.2 billion people on earth will live in urban areas (United Nations Human Settlements Programme, 2011). The population growth means that cities will grow fast, and careful planning is needed. The quality of life in a city depends on how it is build; infrastructure, industries, social and cultural activities and access to services. Fortunately, the city is a set of opportunities, because of its concentration of people and infrastructure it is a place to implement change.

Along with the population growth, the food issue grows. Today nearly 1 billion people go hungry every day. Changes in climate are expected to put an additional 49 million people at risk of hunger by the year 2020 (International Fund for Agricultural Development (IFAD) n.d.). The number of undernourished people in the world in 2010 is estimated to 925 million people (Food and Agriculture Organization of the United Nations (FAO), 2010) (Figure 3.2). This is a decline from 2009, however, more people are hungry in 2010 than before the food and economic crises of 2008-2009 (Figure 3.3). The largest decline was in Asia where 80 million fewer people go hungry. In sub-Saharan Africa 12 million less people are undernourished. However, the proportion of undernourished people is the highest, with 30%, in sub-Saharan Africa (Amend et al, 2010).

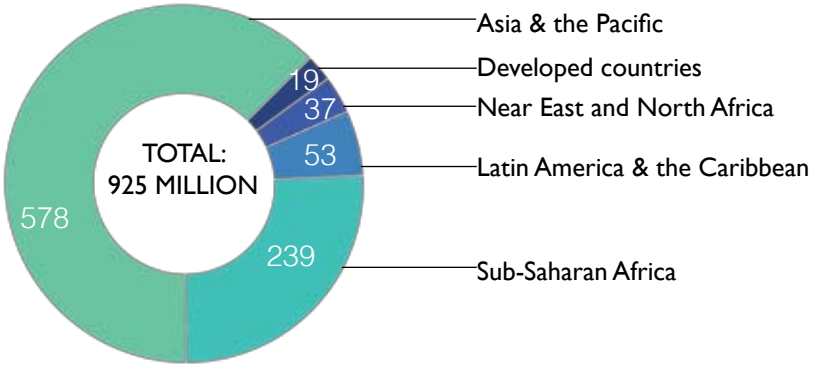



Figure 3.2: *Undernurishment in 2010 by region (Millions) Statistics from FAO (2011)*

Paradoxically, the world produces enough food to feed everyone. World agriculture produces 17 percent more calories per person today than it did 30 years ago, despite a 70 per cent population increase (FAO 2002). This is enough to provide everyone in the world with almost 3,000 kilocalories (kcal) per person per day (Lappé & Moore Lappé 2004). The question is then; why do people go hungry? The root of the problem is the uneven distribution of resources, both globally but also within countries and regions. The principal problem is that many people in the world do not have land to grow, or income to purchase, enough food. This

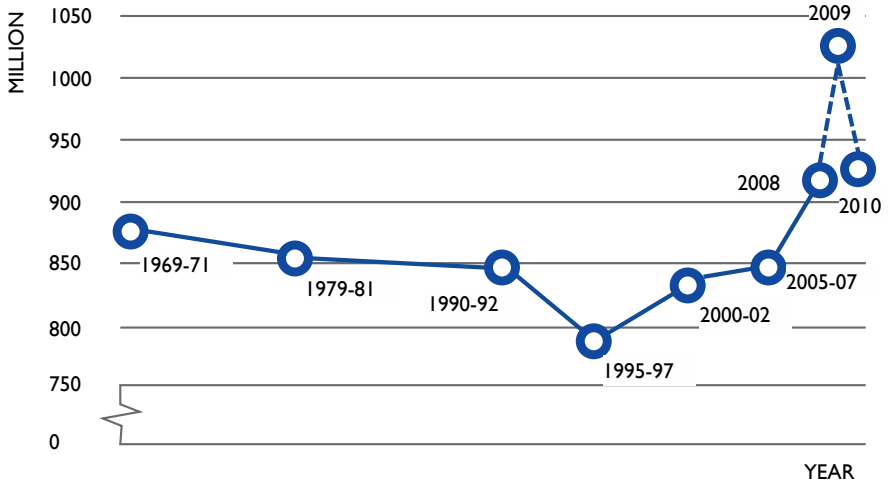



Figure 3.3: *Number of undernourished people in the word. Statistics from FAO (2011)*

is a question of democracy; laws, tariff systems and multinational companies are controlling the global trade of food. Ensuring food security has to go beyond short-term responses like emergency food aid and address the democratic issue, to enable a long-term solution to ensue the right to food.

According to the World Trade Organisation (2000), WTO, food security is:

*The physical availability of food, the stability of supply, but also the economic access to the product. All that entails the necessary resources to purchase food, produce it locally or both.*

FAO (2010) also writes:

*The use of a varied set of food assistance tools, complemented by innovations in how food is procured, will serve as a strong basis for food security in the longer term.*

Finally, in today's society, food is produced outside the cities and transported over the globe, producing enormous amounts of greenhouse gases (GHGs), in to the cities. Globally, transportation is responsible for about 23% of total energy-related GHG emissions, and 13% of global GHG emissions (United Nations Human Settlements Programme, 2011). With most of the population on earth living in cities, transport of food from rural to urban areas will increase. By growing food inside cities, we can reduce transportation and protect unexploited land from being used as agriculture land. Hence, there is a great need to develop ways to reduce greenhouse gas emissions and reduce the vulnerability to climate change impacts.

## 3.1.1 EUROPEAN CONTEXT

Over the last 50 years agriculture has become even more capital intensive. New technology and energy sources have made it possible to develop highly technological agricultural systems and has also enabled the emergence of million people cities. Future production of food must be done in much the same cropland, which is already exploited. Fact is, nearly all of the increase in production from croplands the last 60 years is due to increased yield per hectare, not expansion in cropland (Ebbersten, 2005). Hence, new techniques for growing food need to be developed.

The industrialized world's economic wealth is, in resource terms, mainly based on imports and not exports (Ebbersten, 2005). For example, London has a surface of 160,000 hectares, but to supply the people living in the city with food requires a nearly 50 times as big area, around 8.4 million hectares. Most of this farmland is of course not located in Britain, but in the rest of Europe, the USA, Canada, Brazil, Thailand or New Zeeland (Girardet, 2005). This is not a unique situation; most of the developed countries are dependent on food import. Thus, the question of food security in developed countries is a political issue. In a long-term perspective, the developed countries parasitism on developing countries is not sustainable, thus, a lifestyle change is needed to achieve an equitable distribution of resources.

Trends among developing countries and especially Europe are that the demand for organic food increases, with health considerations and food safety ranked first among the buying motives. Also environmental protection and quality of the products are central reasons for buying organic food. The share of cereals and potato products is declining, while that of meat, dairy products and oil crops is rising (WHO, 2011). According to the Swedish Food Federation the Swedish food industry, in a European context, is in a stage of change. Some identified trends are:

- Food additives are being reduced

• From price pressure to quality awareness

• More healthy products in pipe-line

• Largest investment ever in innovation

• A co-ordinated approach to R&D

• Strong growth of small and locally oriented producers

(Dreber, 2011)

Hence, consumers in western countries are getting more aware of what they eat and are familiar with the concept of diets. How this public awareness affect Plantagon's business is hard to interpret. It is possible to assume that some resistance towards the production process will be met, since no vegetables will be cultivated in soil. On the other hand, Plantagon will not have any need to spray their plants with pesticides, as the greenhouse is completely separated from contamination.

# 3.2 DEFINING LOCALLY PRODUCED FOOD

Definitions of locally produced food related to geographical distance between production and sales vary by regions, companies, consumers and local food market. According to Hand and Martinez (2010), several definitions use political boundaries or geographical distance to identify local products, while others focus on how food is produced and distributed. However, Martinez et al. (2010) mean that there is *"no consensus on a definition in terms of the distance between production and consumption"*. This statement seems to be agreed with by authorities and organizations in Sweden. According to the Swedish National Food Agency, Livsmedelsverket, (2010), defining the term "locally produced" is challenging and there is significant confusion on how to manage it. Furthermore, few actors try to define the term, yet those who do, seem to have a roughly common definition that locally produced food refer to *"groceries that have been produced close to the consumer"* (Livsmedelsverket, 2010). The Swedish National Food Agency's analysis says that any precise borders concerning distances between producer and consumers, amount of the raw material that originates from the region or company size do not exist (Livsmedelsverket, 2010). In the end, it is up to the consumer to estimate whether a grocery is locally produced or not based on the values the individual consumer himself or herself add to the concept of locally produced food.

One example that illustrates the difficulty in identifying a single geographic definition of "local" is the definition adopted by the U.S. Congress in the Food, Conservation, and Energy Act of 2008. The definition says that a "locally produced agricultural food product" is, *"any agricultural food product that is raised, produced, and distributed in (1) the locality or region in which the final product is marketed, so that the total distance the product is transported is less than 400 miles from the origin of the product, or (2) the State in which the product is produced"*. According to Hand and Martinez (2010), this definition is not sustainable. In a country like the U.S where some counties in the west are larger than some states in the East, the concept of "local" must accommodate a wide range of perspectives and definitions.

The non-profit organization Bondens Egen Marknad have for their purpose defined locally produced food as "*grocery that is produced within a radius of 250 km from the market*". One of the organization's rules states that the farmer personally must cultivate everything that sells on the market. Even the head ingredients in processing food, e.g. jam and sausage, must originate from the farmers farm.

Recent market research shows on the question "What distance between a producer and a grocery store is acceptable for a specific grocery to be called locally produced?" that 18% of the respondents answered maximum 50 km, 30% answered 100 km and 27% answered 200 km (Jordbruksverket, 2010). Moreover, a consumer survey by Coop (2009) shows that a great majority (78%) define food from the region as locally produced food. However, the survey does not consider defining what the term region includes. 47% of the respondents say that food within the municipality is locally produced; meanwhile 45% of the respondents say that food within Sweden should be classified as locally produced (Coop, 2009).

In a project conducted by LivsmedelSverige[4], an agreement together with the industry is determined on the definition of locally produced food. Until now the essential definition of "local food" or "locally produced food" is that:

> *"…The food is produced and consumed locally, where locally means within a distance of 250 km."*
>
> – Ingela Hallberg, SLU (2011)

This definition can shade off in at least three different ways:

1. Commodity (primary) production, where the processing and selling of food is within 250 km.

2. Commodity production and selling is within 250 km, where the processing is on other location (outside the 250 km limit).

3. Commodity production is outside the 250 km limit, where the processing and selling of food is within 250 km.
   a. Raw materials with only Swedish origin
   b. Raw materials from all over the world

For European conditions, the definition adopted by the U.S. Congress is not satisfactory. As mentioned earlier in the text, some counties are bigger than some states and some states in the U.S. are actually much bigger than some countries in Europe, which will make the definition considering political boundaries ambiguous and irrelevant. LivsmedelSverige's project in finding a common definition is still running and not fully developed. However, the strength with their definition is the focus on determining the origin of the commodity production, the processing and where the food is sold. Furthermore, managing the origin of raw materials from international exporters has not yet been considered in the other examples apart from LivsmedelSverige. With Sweden's membership in the European Union with policies that ensure free movement of people, goods, services and capital, this aspect becomes fundamental. However, for this report, the definition of locally produced food will not consider political boundaries since the greenhouse's purpose is to distribute food only within a close by distance with sustainable transportation means (Leif, 2010). Further on, locally produced food will in this report be defined as **food produced within a radius of 100 km**, according to how the majority of the respondents answered in the market research presented in Jordbruksverket's, the Swedish Board of Agriculture's, report; Hållbar konsumtion av jordbruksvaror (2010).

4. Ingela Hallberg (Head of Unit, SLU) Interviewed by the authors 13 October 2011.

## 3.3 CORPORATE SOCIAL RESPONSIBILITY

Business and companies are the main source of innovation, solutions and financing for the growth required. They play a central role in the future climate regime, thus this requires accelerated innovation, collaboration and implementation of sustainable solutions. Furthermore, World Business Council for Sustainable Development advocate increased collaboration across business sectors and between, business, government, academia and civil society. (Innovating for Green Growth, 2010)

Increasing urbanization will lead to rapid energy and infrastructure growth. This will offer huge opportunities for business to invest; however it also challenges companies to consider the climate change. In their report Innovating for green growth the World Business Council for Sustainable Development writes, "*Businesses understand that an unsustainable world is not a good place for doing business*". Therefore, business as a committed solution provider that meets future energy and climate challenges is essential to meet the dilemmas that come with increasing urbanization.

Corporate Social Responsibility (CSR) has been adopted as a formal policy goal by governments and businesses. Organizations that commit to CSR usually implement sustainable development goals that consider economic, social and environmental impacts in the way they operate. Clegg et al. (2008) writes, "*In order for companies to do well, financially, they musty be good, ethically, by acting virtuously*". However, cynics might say that adopting CSR is just a matter of share-

holder value for business to appear to be concerned about sustainable development issues. This usually leads to a critique that CSR should be often seen as a tool of corporate greenwash, a device employed by organizations to legitimize the corporate form (Clegg et al, 2008) and claim to be "green" through advertising and marketing than actually implementing business practices that minimize environmental impact (Greenwashing index, 2011). On the other hand, CSR can operate as civil regulations, which limit the range of acceptable behaviours for organizations and also establish new responsibilities. Hence, the condition is that civil society organizations or other independent external auditors monitor CSR (Clegg et al, 2008).

## 3.4 SUSTAINABLE DEVELOPMENT

In their report Planera för verksamheter (2010), a guidance on how to work with the industry for increased employment opportunities, the municipality of Göteborg writes *"The spaces, land and physical conditions in the city shall be utilized in a manner that develop the business and also strengthen the city towards a social, economic and environmentally sustainable development"* (Göteborg Stad – Planera för verksamheter, 2010). According to the GH Brundtland report Our common future (Brundtland, 1987), sustainable development is "*the development that meets the need of the present without challenging future generations to meet their needs*". However, a more recent definition of sustainable development addresses the linkages among Economic, Social and Environmental Sustainability (Swanson, 2004). The definition explains sustainable development as *"the society's development that creates the possibility for achieving overall wellbeing for the present and the future generations through combining environmental, economic, and social aims of the society without exceeding the allowable limits of the effect on the environment"* (Ciegis et al., 2009).

The dimensions have been drawn in a variety of ways, where two of them have been mainly used. The weak sustainability model (Figure 3.4) considers the three dimensions (circles) overlapping each other, however each one has its own distinct driving forces and objectives (Cheng and Hu 2010). The economic reflects on improving human welfare, primarily through maximising the flow of income and consumption that could that could be generated by at least maintaining the stock of assets (Ciegis et al., 2009). The environmental focuses on the stability of biological and physical systems. According to Common and Perrings (1992) it is described as ability to regenerate, vitality and organization's versatility, dynamics, and hierarchy. Furthermore, according to Ciegis et al. (2009), the significance of preserving biological variety is emphasized in order to maintain balanced nature, elasticity of ecosystems at a global level and their ability to adapt to changes in biosphere, as well as ability to protect future possibilities. It is also worth to discern that biological variety cannot be replaced by anything else (Ciegis et al, 2009). The social development emphasizes *"the interface between development and dominating social norms and strives to maintain the stability of social systems"* (Ciesgis et al, 2009), i.e. the enrichment of human relationships. It also strives to reduce vulnerability and preserve the health of social and cultural systems, and their ability to resist shocks (Chambers, 1989; Bohle et al., 1994; Ribot et al., 1996). However, Cheng and Hu (2010) mean that the main criticism of this model is that it assumes that natural capital can be expressed in monetary terms and is substitutable. On the other hand, strong sustainability (Figure 3.5) recognizes that human society and economic activity are totally constrained by the natural systems of our planet (Cheng and Hu, 2010). Strong sustainability is further explained as the environment and natural resources forming the all-embracing foundation for society and its institutions, with the economy as one division of society (SWEDESD, 2011). Hence, the approach fails to tackle the conflict between social, economic and environmental sustainability (Cheng and Hu, 2010).

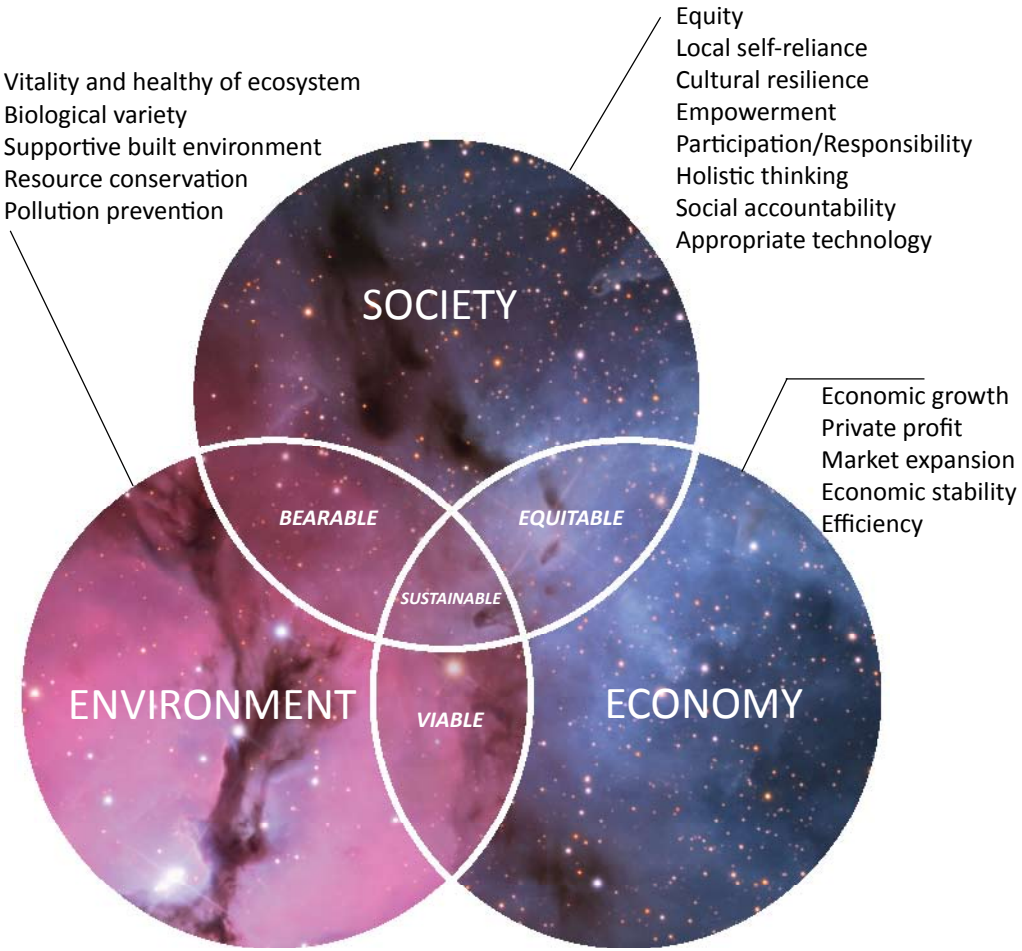



Figure 3.4: *Weak sustainability*

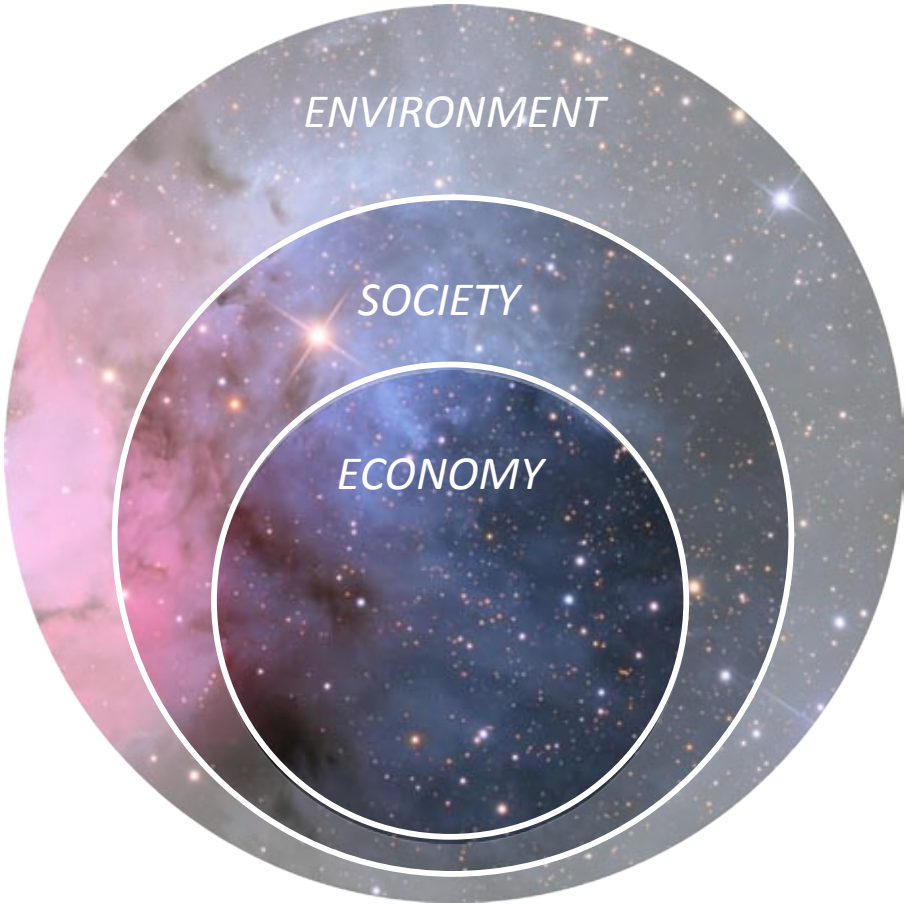



Figure 3.5: *Strong sustainability*

## 3.4.1 SUSTAINABLE URBAN DEVELOPMENT

Global climate change and global settlement patterns of sprawl is two major challenges cities have to deal with. According to Ewing (1994; 1997), there are five significant characteristics of urban sprawl: (1) a scattered and discontinuous pattern of development, which is inefficient from the perspective of infrastructure and public service supplies; (2) development of residential areas with low densities, resulting in single private dwelling units and the absence of public spaces; (3) commercial strip development, shopping and businesses emerging along the big traffic routes; (4) segregation of land uses, the separation of urban functions from each other; and (5) low accessibility and high dependency on private vehicles, a cause from the isolation residential areas have from the commercial and industrial districts. Furthermore, cities are major consumers and goods and services are continuously distributed from them. As a result, resources from the surrounding region on which they depend on tend to be drained (Cheng and Hu, 2010). However, Cheng and Hu (2010) writes:

> "*The question whether cities can truly become sustainable is debatable, but this does not prevent steps being taken towards sustainability by various types of communities*".

If by urban sustainability we mean towns and cities that nourish themselves without any harmful impact on ecological systems then the sustainable urban neighbourhood is an impossible goal. Rudlin and Falk (2009) write that the last human settlement to be sustainable according to above, in Europe at least, was probably the small medieval town dependent on its surrounding area. Therefore, a truly sustainable city may be impossible if not new eco-cities are built[5]. However, the planning of new human settlements has an essential role to play in increasing sustainability of human activities and it is the management responsibility to ensure that unsustainable impacts on the natural systems are minimized (Rudlin and Falk, 2009).

It is estimated that the city of London, a resource-hungry metropolis, with a population of 8 million (2009) annually consumes more than a billion tones of water, 20 million tones of fuel oil, 2.3 million tones of food, about 8 million tones of building materials and 1.2 million tones of metals (Rudlin and Falk, 2009). As a consequence of this, London produces 8.2 million tones inert waste, 2.4 million tones of household waste and 7.5 million tones of sewage sludge. To add, it also releases 60 million tones of $CO^2$, 400 000 tones of sulphur dioxide and 280 000 tones of nitrogen oxide to the atmosphere (Rudlin and Falk, 2009). However, Rudlin and Falk (2009) ask the question: If London did not exist, where would its eight million people live and would they consume any less resources or produce any less pollution? The answer is debateable, but it is inevitably that if these people and thousands of companies located in the city were spread out in low-density societies their environmental impact would be much greater. The cost of transporting goods over wider areas would be significantly higher and public transport would become less viable for people.

## 3.4.2 NEW URBANISM

A counter reaction to urban sprawl and global climate change is the movement of the new urbanism. Since human interventions in the built environment tend to have a long life cycle and long-term impacts, it is fundamental to identify long life and durability rather than transience (Council of the New Urbanism, 2011). Furthermore, new urbanism advocates that investing in human settlements should reduce future economic impacts of climate change and that truly design must be rooted in and evolve from adoptions to local climate, human culture and urban patterns. The Congress for the New Urbanism who promotes and works for walkable, mixed-use neighborhood development, sustainable communities and healthier living conditions has developed the Charter of the New Urbanism. It provides a powerful and long-term set of principles for creating more sustainable neighbourhoods, buildings and regions (Council of the New Urbanism, 2011).

5. Prashant Brahmbhatt (Vice President, Plantagon International AB) Interviewed by the authors 15 September 2011.

# 4 URBAN AGRICULTURE

*“The most striking feature of urban agriculture, which distinguishes it from rural agriculture, is that it is integrated into the urban economic and ecological system: urban agriculture is embedded in -and interacting with- the urban ecosystem.”*

-Resource Centres on Urban Agriculture and Food Security

The global food market today is fragile. Demographic growth and lack of investments in agriculture make many countries dependent on the international food market. This creates a heavy burden on both the exporting and the importing countries, especially since the food price often is linked with the price of oil (Gronewold, 2011). Further on, climate change and instability of the weather is a threat to the agricultural production. Many cities are at risk of becoming disaster traps, due to the effects of sea level rise, floods and hurricanes or through food supply problems caused by drought, hailstorms or frost that affect agricultural production in their hinterlands. Indirect effects of climate change include the possibility of increased migration from rural areas (Dubbeling et.al, 2011). The urban expansion and the food supply issue have major consequences for urban food security. According to Argenti (2000), the challenge in food security lies in facilitating consumer access to food and ensuring the quality of it.

There are several different definitions of urban agriculture; a frequently used definition is the one by The Food and Agriculture Organization of the United Nations (FAO):

> "*An industry that produces, processes and markets food and fuel, largely in response to the daily demand of consumers within a town, city, or metropolis, on land and water dispersed throughout the urban and peri-urban area, applying intensive production methods, using and reusing natural resources and urban wastes to yield a diversity of crops and livestock*."

The most important characteristic of urban agriculture is not the location, but the way it integrates with the urban economic, social and ecological system. Urban agriculture uses urban resources such as land, labour, urban organic wastes, and water, it produces for urban citizens, is thoroughly induced by urban conditions; policies, competition for land, urban markets and prices, and impacts the food security, poverty, ecological and health aspect of the urban system (Danso et. al, 2007)

Growing food in cities is nothing new, the Hanging gardens in Babylon is an early example of urban agriculture. Also the South American Maya and Inca Indians had sophisticated agricultural systems in their cities. Urban and peri-urban farming was the norm before long-distance transport became an option (Girardet, 2005). In many parts of the world urban agriculture is essential to survival. Urban poor are often hungrier and at greater disadvantage than their rural counterparts because they have to purchase most of their food. For poor people, growing their own food is an important factor to reduce hunger, ensure nutrient food and save money. 15-20% of the world's food estimates to be grown in urban areas (The Worldwatch Institute, 2011). In Western cities urban agriculture is often absent, although, during World War II, many urban spaces in Western world countries were transformed in to agricultural areas (Gorgolewski et. al, 2011). However, quickly after the war this concept of food production was phased out as agribusiness and commercial food systems took over the food production, food production was not considered a valid use of land in the urban context; however it is slowly starting to reclaim its former rights and starts to be recognised as a sustainable element of the city development.

Urban agriculture has some advantages over rural farming, including proximity to the market and low transportation costs. Another advantage is the access to nutritious food, as the urban population grows the need for fresh and healthy food increases. Even so, as cities and the population grow, agricultural land is likely to loose the competition between demands of land to housing, industry and infrastructure (Argenti, 2000). Consequently, to feed the ever-growing cities, more food will have to be imported and produced in areas that are presently used for agriculture, or on new land. However, Cuba is a current example of how a country can be self sufficient on food and not dependent on long transports.

EXAMPLES OF URBAN AGRICULTURE:

*Hanging gardens of Babyon*
*Source; www.famousbuildings.net*

*Peruvian Inca farming*
*Photo: Private*

*World War II Victory garden*
*Source; http://dancollier.org*

*Gerilla gardening in central London*
*Source; http://livegreentwincities.com/*

*Kiberia slum farming*
*Source; http://chikainkenya.wordpress.com*

*Urban agriculture in front of San Fransisco city hall*
*Source; http://civileats.com*

Urban and Peri-Urban Agriculture is increasingly being recognized as an important strategy to tackle climate change. The World Meteorological Organization (WMO) has suggested that urban and indoor farming are necessary responses to on-going climate change and as ways to build more resilient cities (WMO, 2007). There are the characteristic policy perspectives on urban agriculture, each related with different types of urban agriculture (Figure 4.1) (Danso et al, 2007):

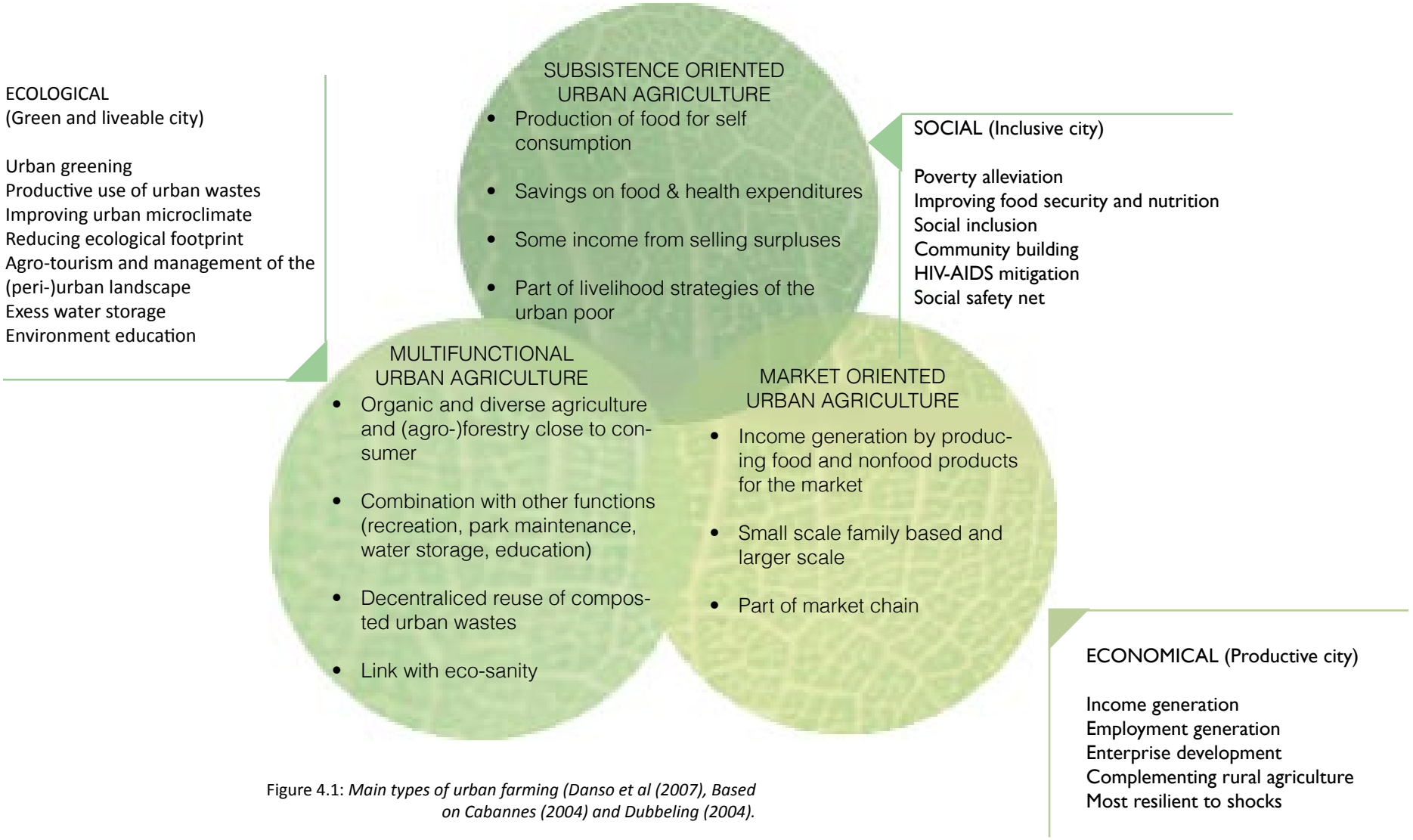



Figure 4.1: *Main types of urban farming (Danso et al (2007), Based on Cabannes (2004) and Dubbeling (2004).*

- Social perspective-home gardening, community gardening, institutional gardening, micro scale open field farming. These systems function with a low level of investment and show little direct profitability, but have important social impacts such as improved food security, social inclusion and community development.

- Economic perspective –small-scale family businesses, large scale farms run by private investors or producer associations. The activities produce both food and non-food products and have a commercial interest. Problems with contaminated soil tend to be high, and there is a health risk from use of contaminated water.

- Ecological perspective – integrated waste management systems, parks, nature reserves, types of urban agriculture that has multifunctional character. These systems combine urban agriculture with the city's environmental management.

These perspectives are most likely to be mixed and adapted to the needs in the city. Because of the multidisciplinary nature of urban agriculture, policy planning should involve different disciplines, such as waste management, health planning, community development, parks and nature management (Danso et al, 2007)

Another important factor of urban agriculture is the location. Western cities have zones with very significant characteristics, hence, these offers different opportunities for urban agriculture and food supply (Gorgolewski et. al, 2011);

- City centres often have a high density due to high cost of land; building integrated production could provide food for the residents in these areas.

- Traditional urban residential areas with moderate density often have small yards and public green areas, raised-bed gardening and rooftop gardening as well as farmer's markets could be implemented here.

- Former industrial areas, especially those in a transition stage, are especially good for greenhouses, raised-bed gardening, roof top gardening and small agricultural businesses.

- Older suburbs usually have large public lots, which could be used for agriculture, also growing in front, and backyards are possible.

- Newly designed, lower density suburbs have a moderate amount of land to cultivate, also front and back yards of private homes could be used for growing.

- Commercial areas in the outskirt of the city often have large parking lots that could be used for horticulture.

- Peri-urban agriculture land could be used for extensive food production; additionally it could provide educational and recreational opportunities.

- Infrastructure –wasteland connected to railways, power line corridors and highways could be used for integration production of food.

- Wastes from the city, such as solid waste, wastewater and stormwater can be treated and reused as nutrient sources.

- Empty lots pending for development could provide a temporary lot for food activities.

# 4.1 URBAN AGRICULTURE HELPS CITIES TO BECOME MORE RESILIENT

Maxwell et al. (2008) state that:

> *"Urban and peri-urban areas are similarly impacted, as natural causes can lead to increased, temporarily or sustained, higher food prices, food shortages, epidemics, and sudden settlement of those displaced by the shock".*

The same regions will repeatedly be affected, due to natural causes of food crises and that they often are cyclical (Dubbeling et al. 2011). However, Reid and Sattertwhaite (2007) mean that the attention of adapting urban areas has been vastly insufficient and suggest that if risk reduction and adaption efforts are incorporated into city investments and developments plans, the lower the unit cost will be. Urban and indoor farming is suggested by the World Meteorological Organization to be a required response to ongoing climate change (Dubbeling et al. 2011). Dubbeling et al. (2011) present a list of how urban agriculture has high potential of improving urban environment (UN-HABITAT 2009) and how it helps cities to become more resilient by:

REDUCING THE VULNERABILITY OF MOST VULNERABLE URBAN GROUPS AND STRENGTHENING COMMUNITY BASED ADAPTIVE MANAGEMENT THROUGH:

Diversifying urban food sources, enhancing access of the urban poor to nutritious food, reducing dependency on imported foods and decreasing vulnerability to periods of low food supply from the rural areas during floods, droughts or other disasters

Diversifying income opportunities of the urban poor and functioning as a safety net in times of economic crisis

Being a source of innovation and learning about new strategies/technologies for high land and water efficient food production.

MAINTAINING GREEN OPEN SPACES AND ENHANCING VEGETATION COVER IN THE CITY WITH IMPORTANT ADAPTIVE (AND SOME MITIGATION) BENEFITS INCLUDING:

Reduced heat island effect by providing shade and enhanced evapotranspiration, more cooling, less smog

Reduced impacts related to high rainfall (by storing excess water), increased water interception and infiltration in green open spaces and keeping flood zones free from construction, reduction of rapid storm water runoff and less floods downstream and more replenishment of ground water

Improved water quality through natural cleaning in low-lying agricultural areas, e.g. natural or constructed wetlands, aquaculture in maturation ponds, etc.

$CO_2$ and dust capture

Prevention of landslides by (agro-)forestry on steep slopes and preventing building on such sites

Conservation of biodiversity, protecting a wider base of plant (and animal) genetic diversity

SAFELY REUSING WASTEWATER AND COMPOSTED ORGANIC WASTE:

Adapting to drought by facilitating year-round production, safely using waste water flow and nutrients in water and organic waste

Reducing competition for fresh water between agriculture, domestic and industrial uses

Lowering the depletion of certain minerals, e.g. phosphorus, by making productive use of the nutrients in wastewater and organic wastes

Reducing landfill volumes and thus methane emission

REDUCING THEIR ENERGY USE AND GREEN HOUSE GAS EMISSIONS BY PRODUCING FRESH FOOD CLOSE TO THE CITY:

Using less energy in transport, cooling, storage, processing and packaging and enabling synergic and cyclical processes between urban domestic and industrial sectors and agriculture (e.g., use of excess heat, cooling water or $CO^2$ from industry in green houses)

Reducing the ecological footprint of the city via the energy and water needed to produce and transport the food consumed by it

(Dubbeling 2011)

However, Urban Industrial Vertical Agriculture may not have the opportunities to help cities become resilient according to all statements mentioned above. To strictly prohibit a contaminated environment, Plantagon's greenhouses will be operated in closed systems[6]. Access into Plantagon's industrial greenhouses will therefore be highly constrained for people living in the city[6]. Nevertheless, the company has a policy to be transparent and desire the city to have benefit from their business[6]. However, Plantagon will be a source of innovation and learning about new strategies and technologies, they will help to capture $CO^2$ and reduce the ecological footprint of the city via the energy and water needed to produce and transport the food consumed by it.

Plantagon's business entity, the Companization, renders possibility for the urban inhabitants to be engaged in the company. The urban public living in the area where the greenhouse is sited can become members in the Plantagon Non Profit Association for a small fee. The non-profit organization will obtain 10% of the stock in Plantagon International AB and then share 50% of the power and responsibility to appoint 50% of Plantagon International AB's board members. This will give the public the opportunity to influence the company into doing good business by being active members or support the non-profit association[6]. Thus, this requires that the society are involved in Plantagon's business model.

6. Leif Sieurin (CTO, Plantagon International AB) Interviewed by the authors 15 September 2011.

# 4.2 URBAN INDUSTRIAL VERTICAL AGRICULTURE

Vertical farming is a concept of growing crops in skyscrapers, on sloping surfaces or in other ways maximizing the use of land by having a vertical design. The pioneer of vertical farming, Dickson Despommier, a Columbia University professor, started to investigate the possibility to grow food in high-rise buildings in order to meet the future shortage of cropland and horizontal surfaces (Gorgolewski et. al, 2011). According to Despommier (n.d.), the all-season crop production enlarges the production on a surface by 4-6 times, or more depending on the crop, compared to outdoor farming. Furthermore, the crop is protected from weather related failure such as drought, floods and pests. If grown in a protected environment no pesticides will be necessary, additionally, a black and grey water treatment plant could be integrated in the design, to use the natural fertilizers and return fresh water. Additionally, for urban industrial vertical agriculture to function ideally it should be cheap to build, durable and safe to operate and independent of economic subsidies and outside support (Despommier, n.d.)

Nevertheless, there are critics of vertical farming, the most significant critique is the need of lighting, because of the vertical structure sunlight is reduced and artificial lighting will be necessary, resulting in a high energy use giving the crop a high energy input per calorie. Furthermore, critics claim industrial urban agriculture will remove agriculture even further from the natural system, being dependent on fossil fuel, industrial mechanisms and fertilizers (Gorgolewski et. al, 2011).

## 4.2.1 WHY URBAN INDUSTRIAL AGRICULTURE

*"When speaking with Chinese authorities, they talk about building new cities and not to expand the existing ones."*

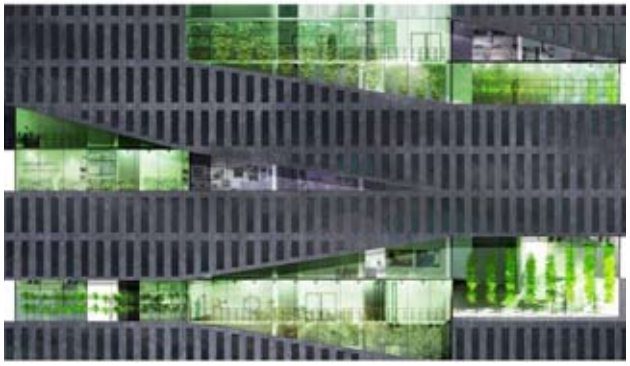
-Leif, Plantagon

300 million Chinese people are expected to move from the countryside and into cities over the next two decades (Cheng 2009), necessitating the building of over 150 new cities by 2030 and 600 new ones by 2050[6]. There is no doubt that the per capita ecological footprint, which measures the resource consumption and waste assimilation requirements of a defined population or economy in terms of

## EXAMPLES OF URBAN AGRICULTURAL PROJECTS:

*Public Farm 1. Images: Mikkel Bøgh*


*Secret garden. Source: www.cityfarmer.info*



*The Living Tower. Source; www.verticalfarm.com*

### PUBLIC FARM 1

Public Farm 1 is an installation made by WORK Architecture Company in the summer of 2008. It is a sculptural invention within the dense urban setting of Long Island City, New York, showing the possibilities unused space in cities has. In the end of the harvest season the exhibition was composted, reused and recycled.

### LEADENHALL STREET CITY FARM

The Leadenhall Street City Farm is a proposal from 2009 where a construction site in London pending for financing temporary is used for agriculture and recreation. Shops would sell the crops grown in the garden, a restaurant would cook the fresh food, and the people in the surrounding are could walk in the garden. Already existing infrastructural and the use of existing or cheap materials would make it a low-cost project. Mitchell Taylor Workshop developed the project, although it was never realized.

### THE LIVING TOWER

The tower is a proposal by SOA architects meant to show that skyscrapers can be used for far more than just residences and office space while still retaining a design that is both provocative and aesthetically stimulating. The tower has an advanced agricultural system to minimize ecological footprint from farming. The tower is producing electricity through turbines and photovoltaic cells. It has a rainwater filtration system and is ventilated through natural ventilation in order to minimize mechanical use.

a corresponding productive land area (Wackernagel, 1996), will increase radically once the huge flow of inhabitants from the countryside urbanize the cities. Further example is the city of Mumbai, which increases with approximately one million inhabitants a year. These streams of people tend to build their settlements on existing farmland, pushing out the agriculture more far away from the city core resulting into urban sprawling[7]. The New York City Peak Oil Meetup Group, dedicated to informing, educating and activating those interested in the topic of Oil Depletion, writes:

> *"Those who prefer the city life must learn how to make their buildings more energy efficient, work to provide for low energy transportation systems, support and perhaps operate local businesses, and use all available space for the local production of food."*
>
> – Peak Oil New York City (2011)

In addition, The Congress for the New Urbanism, who promotes walkable, mixed-use neighbourhood, development, sustainable communities and healthier living conditions, writes in their Canons of Sustainable Architecture and Urbanism that (CNU 2011):

> *"Prime and unique farmland shall be protected and conserved. In locations with little or declining growth, additional agriculture, parklands and habitat restoration shall be promoted on already urbanized or underutilized land".*
>
> – The Congress for the New Urbanism (2011)

Holistic solutions must address poverty, health and underdevelopment as well ecology and the environment (CNU 2011). Thus, a holistic approach is fundamental towards a sustainable development (Göteborgs Stad 2010). Urban policies must therefore incorporate food security considerations and focus more on building cities that are more resilient to on-going climate change and crises. With China's significant economic development, urban lands increasingly expand. As an example, the Chinese government has set up a compensation system to meet the land demand during industrial and urban growth while maintaining enough agricultural land for food self-sufficiency. The system requires that "*the request of cultivated land must be compensated by land users reclaiming the same acreage of agricultural land*" (Cheng 2009). However, the vision of Dongtan eco-city on the wetland outside of Shanghai had failed to be in compliance with the country's land use policies. The case of Dontang eco-city was that the land the city was built on where intended for compensating the agricultural land lost to urbanization in Shanghai (Cheng and Hu 2009). The primary usage for the land should have been for agricultural production instead of urban development. Cheng and Hu (2009) writes, *"even with the best outcome of ecological design, the overall impact of Dongtan on the surrounding environment will surely be greater than if it had been left untouched"*, e.g. local ecological systems are expected to be under stress. To avoid future vulnerability of local ecosystems and maintain the protection of prime and unique farmland, governments and municipalities must strictly address land conservation policies and not neglect them. If possible, new development shall be situated on underutilized, poorly designed or already developed land (CNU 2011).

Finally, many cities are highly exposed of becoming disaster traps, due to increasing sea levels, flooding scenarios (low-elevation coastal zones represent 2% of the world's land mass and hold 10% of its total population) and harsh food supply problems caused by changing rainfall patterns or frosts that affect agricultural production (Dubbeling et al. 2011). Undoubtedly, cities are suffering great impacts and therefore play a crucial role in finding appropriate solutions (Dubbeling et al. 2011). According to UN-HABITAT, urban agriculture has been recognized as having great potential for improving the urban environment and urban adaption to climate change (UN-HABITAT 2009).

7. Leif Sieurin (CTO, Plantagon International AB) Interviewed by the authors 15 September 2011.

# 5 CASE

Case studies have been executed within the city of Göteborg to achieve roughly reality-based results. Different area types have been identified in the city and two of them have been chosen for further case exploration.

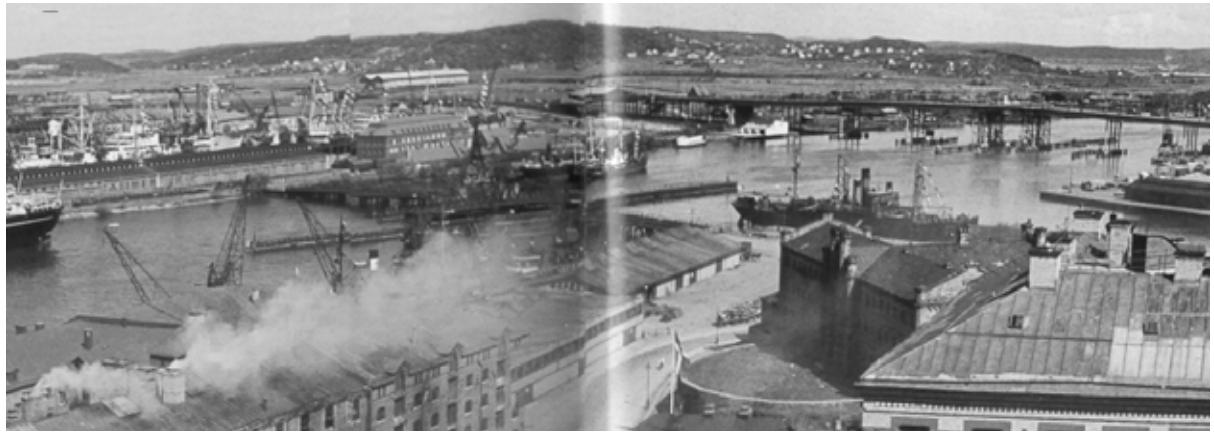
# 5.1 GÖTEBORG

In the late 19th century Göteborg starts to industrialize from being a city known for merchant shipping. Agricultural land and single family housing around the harbour also characterized the city[8]. In the middle of the 20th century, a large-scale industry was established along the harbour. Distinguish for the period is also the huge development of residential outside the city centre. Later on around the 1960's, residential was developed to be located near public transport[8]. Big external commercial sites like Backa was also introduced and the large-scale industries were of great importance for the city and Sweden[8]. Today, the Göteborg region has 1.4 million inhabitants and the city is the second largest in Sweden, while it also has the largest port in Scandinavia[9].

*The Harbour Frihamnen 1957*
*Source: Private*

*The Harbour Frihamnen 2009*
*Source: Private*

*Göteborg Inner City 1870*
*Source: Private*



*View from Kvarnberget towards Hisingen (Hising Island) 1945*
*Source: Private*

8. Maritime Museum and Aquarium, Göteborg. Lecture 15 November 2010.

9. Kerster Gibson (Urban Planner,City Planning Office Göteborg) Interviewed by the authors 9 November 2011.

## 5.1.1 GÖTEBORG AS RESEARCH EXAMPLE

There exist around 70 metropolitan regions in Western Europe that are bigger than the Göteborg region. In a European perspective Göteborg is categorized as a modern industrial city, which is characterized by a large amount of employed in manufacturing, a strong base in the service and financial sector, a BRP (the regions correspondence to GNP) higher than the average, high employment rate, large amount of students and educated inhabitants (Samhällsutvecklingen, 2011). According to World Economic Forum, Sweden is the most competitive economy in the EU and is also considered to be more competitive than the East Asian economies and the U.S (World Economic Forum, 2010). This is very positive for Göteborg whose industry is very export concentrated and stands for a large amount of Sweden's total export. Additionally, Sweden strikes number one in EU on the area of sustainable development (World Economic Forum, 2010). To maintain its leading position and to be an example for other countries, Sweden and Göteborg must challenge themselves and continuously improve for sustainability.

Göteborg sees a shift towards sales of services and tourism. Therefore, it becomes essential for the city to market them and an urban greenhouse project is a method to proclaim the seriousness of that. Much is done in the public building for energy efficient purposes, however a greenhouse for Göteborg would have a symbolic value rather than a step for decreasing the stress on the environment and the protection of unique farmland. However, Göteborg does not have shortage of farmland. Furthermore, Göteborg is in a need of actions that promote the city's attractiveness[10]. Today, Göteborg has developed a profile towards a food city and has received great attention in international prestigious travel magazines like the Condé Nast Traveller. The closeness of sea and forest provides access to fine ingredients, and the city has five restaurants with stars in Guide Michelin (Göteborg & co, 2011). Additionally, there is a close collaboration with Göteborg's Restaurant Association with purpose to develop Göteborg's position as a food city (Göteborg & co, 2011). Therefore, a greenhouse with commercial functions, providing food facilities, can be a new line in developing the city's profile.

Plantagon says that since the development is continuously leading us forward, the limits of where to build and operate a greenhouse will be changed[11]. Cities of Stockholm's, Göteborg's and Malmö's sizes can today be considered as interesting to implement greenhouses in. However, the need of Plantagon's greenhouses should be less significant in sparsely populated areas with great distances and relative big agrarian areas. But with great distances comes the issue of transporting goods into the cities. In the visionary project Göteborg 2050 the issue of developing a long-term sustainable transport system is discussed (Göteborg 2050, 2011). The long-term sustainable system includes:

- ***Proximity to grocery store and service results in shorter travel dis tances for pedestrians and cyclists.*** *The structure of transport and settlement is built around local public squares within and between densely built-up areas. The public squares shall provide service of all kind and grocery stores.*

  (Göteborg 2050, 2011)

An urban greenhouse in inhabited areas will provide short distances for pedestrians and cyclists to grocery stores and other services.

- ***Less and more loaded cargos transport our goods and materials.*** *Local production and recycling will be promoted, simultaneously as cargos by sea and railways will be more usual.*

  (Göteborg 2050, 2011)

An urban greenhouse provides the city with locally produced food and in exchange, the city provides it with nutrients from organic waste.

- ***More solar energy.*** *The increased global warming has been taken seriously and all energy sources are renewable.*

  (Göteborg 2050, 2011)

Plantagon's greenhouses are designed to take maximum advantage of solar energy. Additionally, energy for warming and cooling can be acquired by excess heating from nearby industry and businesses.

Thus, urban agriculture is a sustainable action when issues like shortening travel distances and increasing the use of solar energy is discussed. Furthermore, urban greenhouses have the potential to facilitate the reaching of the municipality's vision since their aim is to be integrated in existing neighbourhoods and offer grocery services, i.e. locally produced food, to the inhabitants.

Moreover, gentrification refers to the process when wealthier people acquire or rent property in low income and working class communities, resulting in increased property values and changes in the district's character and culture. A consequence of gentrification is that the average income increases and average family size decreases in the community (POV, 2011). Generally this often leads

10. Göran Lindahl (Associate Professor, Construction Management, Chalmers University of Technology) Interviewed by the authors 27 October 2011.

11. Leif Sieurin (CTO, Plantagon International AB) Interviewed by the authors 1 November 2011.

to native residents being displaced from the neighbourhood, since they are being unable to pay increased rents, house prices, and property taxes. The term is often used negatively, but the effects of gentrification are complex and contradictory (POV, 2011). On the other hand, a greenhouse project in less wealthier or abandoned areas could rather change the character of the area and increase the flows of human movements within it, if it is used in an appropriate way. The greenhouse will have 2400 $m^2$ of office space, excluding the 4000 $m^2$ used for cultivation. The office space can be programmed to complement the existing programmes according to the present condition of the area the greenhouse will be sited in.

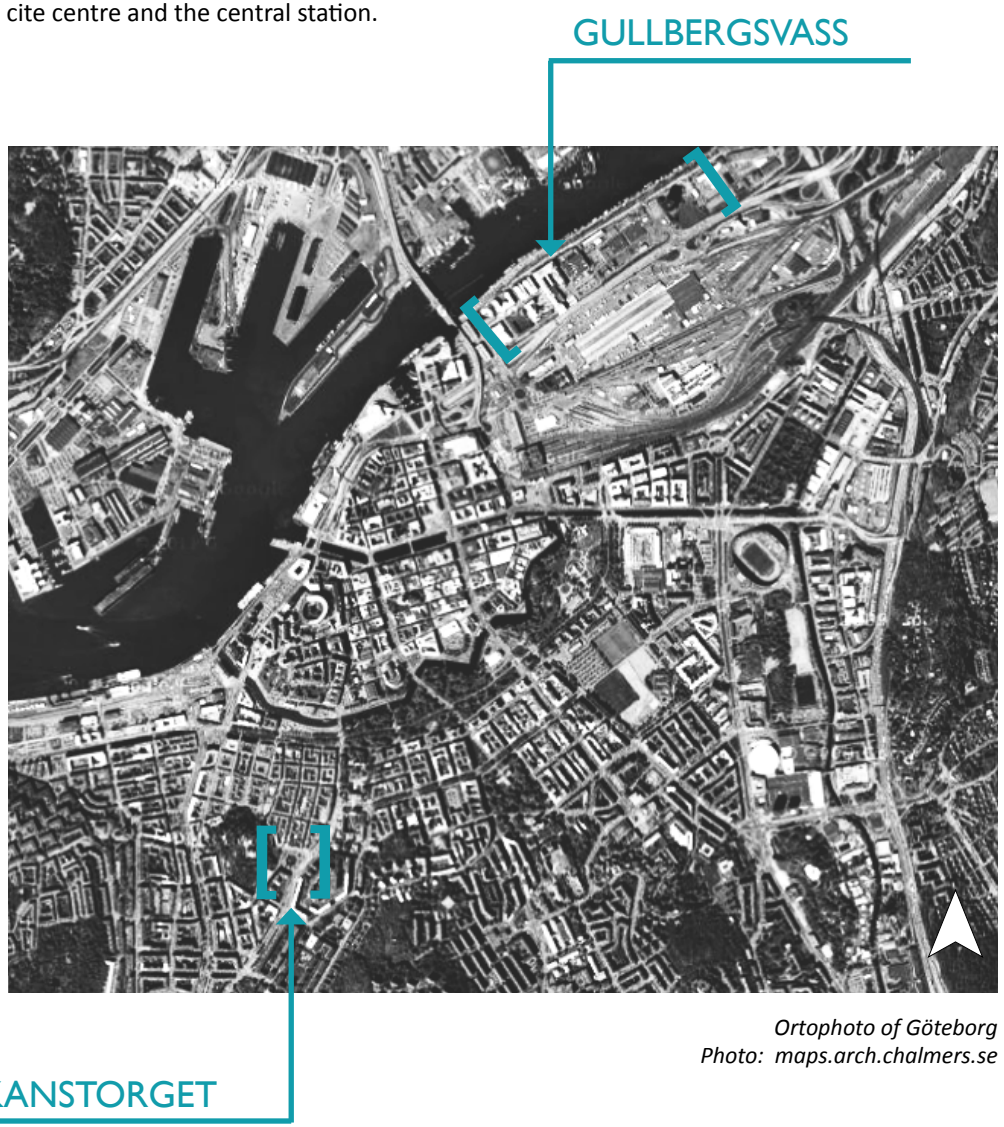
The following SWOT illustrates the strengths, weaknesses, opportunities and threats when integrating a greenhouse in Göteborg (Table 5.1). Strength and Weaknesses are the internal factors, thus within the City of Göteborg. Opportunities and threats are the external factors, the world at large.

| | HELPFUL | HARMFUL |
|---|---|---|
| EXTERNAL INTERNAL | • Sales of services and tourism<br>• Need of actions that promote the city's attractiveness<br>• Has a vision for long long-term sustainable transport system<br>• Plans to use more solar energy<br>• To educate the inhabitants<br>• Landmark and new public space<br>• Develop brownfield land<br>• Promote Sustainable Göteborg | • Expensive land in the city centre<br>• The municipality have plans for many central areas<br>• Long lead time<br>• Unsure market in short term perspective<br>• Not in need for more agrarian areas<br>• Sparsely populated region |
| | • The concept can be projected to foreign cities<br>• Strengthen the city's position as a food city<br>• Decrease the risk for gentrification if used in appropriate manner<br>• Reduce import of food from other countries | • The Swedish market is not big enough - risk that food will be transported<br>• Great challenge to develop old cities<br>• Abnormal structure of the building could disturb the city skyline<br>• Increase the risk for gentrification if not used in appropriate manner |

*Table 5.1 SWOT -integrating a greenhouse in Göteborg*

## 5.1.2 PRESENTATION OF CASES

To proceed the project, two case sites where chosen for further investigation. The first site, Skanstorget, is located in the city centre with a clear mixed city structure. The other site, Gullbergsvass, is a brownfield not far away from the cite centre and the central station.

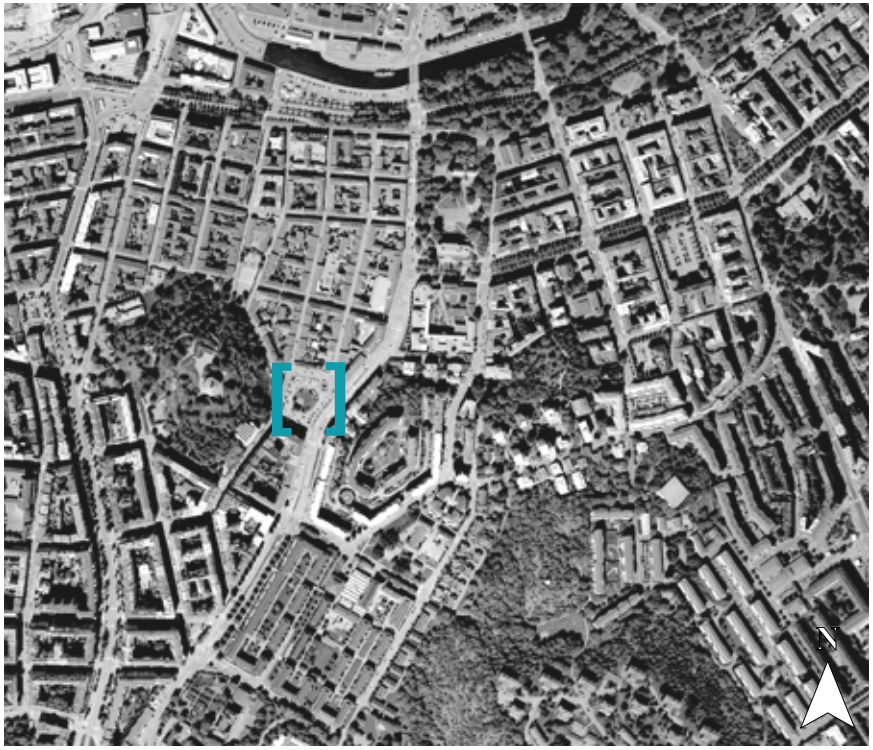



*Ortophoto of Göteborg*
*Photo: maps.arch.chalmers.se*

# 5.2 CASE SKANSTORGET

Skanstorget is located strategically between Haga, Linnéstaden and Vasastaden in central Göteborg. The area is a typical city environment where housing, businesses and schools co-exist. No industry is located here, however a few major parks can be found nearby. The area has high rents, attracting middle class to upper class citizens. Since most services can be found here, the need of a car is not prioritized among the inhabitants. Furthermore, many university buildings are located here, and with that come a high flow of students.

The mix of activities and services attracts tourists and people from all over the city to come here. Many public transport lines pass through the area, making it easy to access.



*Ortophoto of Skanstorget*
*Photo: maps.arch.chalmers.se*

## HISTORY

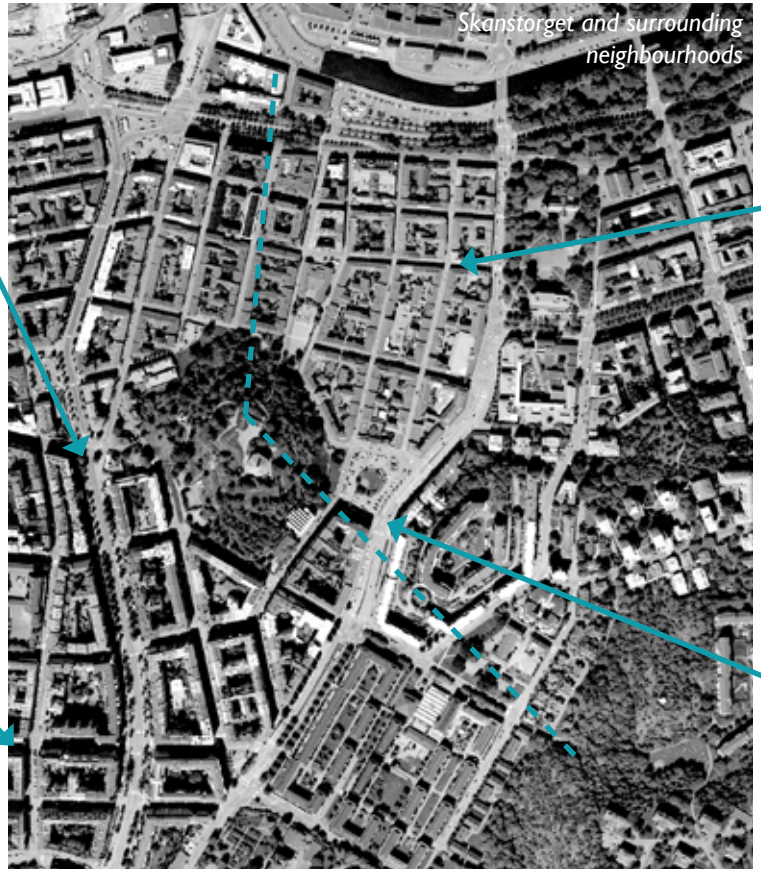
Skanstorget was built in 1896 and three years later the indoor market hall, called "Spottkoppen" (the Spittoon) was built on the spot. The square got its name from the defence building, Skansen Kronan, situated on the mountain.

*View of Skanstorget with the indoor market. In the background Skansen Kronan, 1910.*
*Photo: http://www.tidsbilder.se/content/view/19/32/*

*View of Skanstorget and Skansenkrona from Övre Husargatan, 2011.*
*Photo: Private*

*Panorama of Skanstorget and Göteborg city. View from Skansberget.*

*Linnégatan*



*Skanstorget and surrounding neighbourhoods*

*Haga Nygata*


*Eco-grocery store in Linnéstaden*

*Övre Husargatan viewed from Skanstorget.*

*Photos: Private*

# PROGRAMMES IN THE AREA


HOUSING

OFFICE

CULTURE

EDUCATION

COMMERCIAL

GREEN

URBAN AGRICULTURE

URBAN METABOLISM

INDUSTRY

PUBLIC TRANSPORT NODE

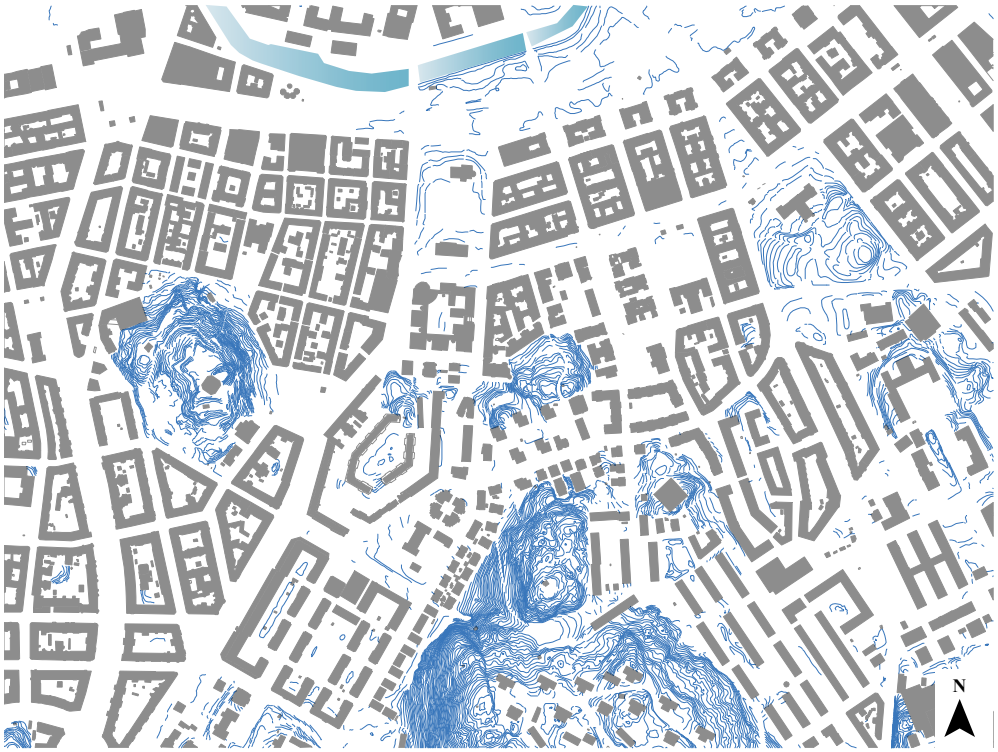
## LANDMARKS AND ROADS


Linnégatan is connected by two main nodes, Järntorget in the north and Linnéplatsen in the south. Skanstorget is situated along Övre Husargatan, below Skansberget. On top of the mountain Skansberget the former defence building Skansen Krona is situated. Nya Allén and Vasa Allén connects the area to the city centre. Haga Nygata is, together with Linnégatan, the busiest shopping streets in the area.

## TRANSPORTATION


Övre Husargatan, Linnégatan and Haga Nygata is the main streets for transportation by motorized vehicles. However, Haga Nygata is reserved for pedestrians and cyclists and the other streets are well suited for pedestrians and cyclists. There are several entrances to the area from both outside the city, from across the river and from the city centre.

## TOPOGRAPHY




Distinguishing for Skanstorget is that the location is on a part in Göteborg where the ground consists of crystalline rock. The neighbourhood is mountainous and on each side of Skanstorget two of Göteborg's higher ground levels are to be found. Few places in the city centre have such high-rise building as the neighbourhood around Skanstorget, much thanks to the solid ground. Moreover, the area is not at risk of becoming flooded.[12]

## BARRIERS


Övre Husargatan, Linnégatan and Skansberget are the main barriers in the area. Although Skanstorget is easy to access from all directions. Overall the area is easy to access and to move around in. Other barriers is the large street Parkgatan and Nya Allén in the north.

12. Claes Alén (Assistant Professor,Geology and Geotechnics, Chalmers University of Technology) Interviewed by the authors 24 October 2011.

# ANALYSIS OF THE AREAS


## SKANSTORGET

Skanstorget is a small green space surrounded by parking lots. In the corner you can find a small fast food service. Moreover, the space is surrounded by housing and Göteborgs Universitet. Övre Husargatan, a main street, passes here with high density of cars and bicycles during the day. To the west of Skanstorget lies a big hill with a former defence building, Skansen Krona, on its top. The hill is mainly used for recreation and is an important landmark for the city of Göteborg.

## LINNÉ

Parade street with restaurants, bars, cafés and cinema. Characteristic high-rise buildings for housing with 4-8 floors. On the ground level you can find commercial activities. The street is trafficked by trams, busses, bicycles and cars. The end of the street, Linneplatsen, is a big traffic node, where the highway traffic from the suburban areas enters the city. The street is very crowded during day and is also a part of the city nightlife. Moreover, the biggest recreation area, Slottsskogen, in Gothenburg is located nearby Linneplatsen. To the west of the street, the topography is hilly.

## HAGA

Mostly old wooden houses in 2-4 stories, new houses in wood or stone. Functions like café, hairdresser, stores in the ground floor, housing on two upper floors. Haga Nygata's picturesque character is a tourist attraction. A pedestrian and bicycle friendly neighbourhood with little vehicle traffic. Haga is very flat. Daycares and elementary schools is located in the area. Smaller grocery stores are also located here.

## ANNEDAL

A district located on a slope towards Övre Husargatan and Skanstorget. Mostly housing and a few commercial activities. In the area you can find several Göteborg University buildings and Campus Linné, daycares and elementary schools. A tram passes thru the area.

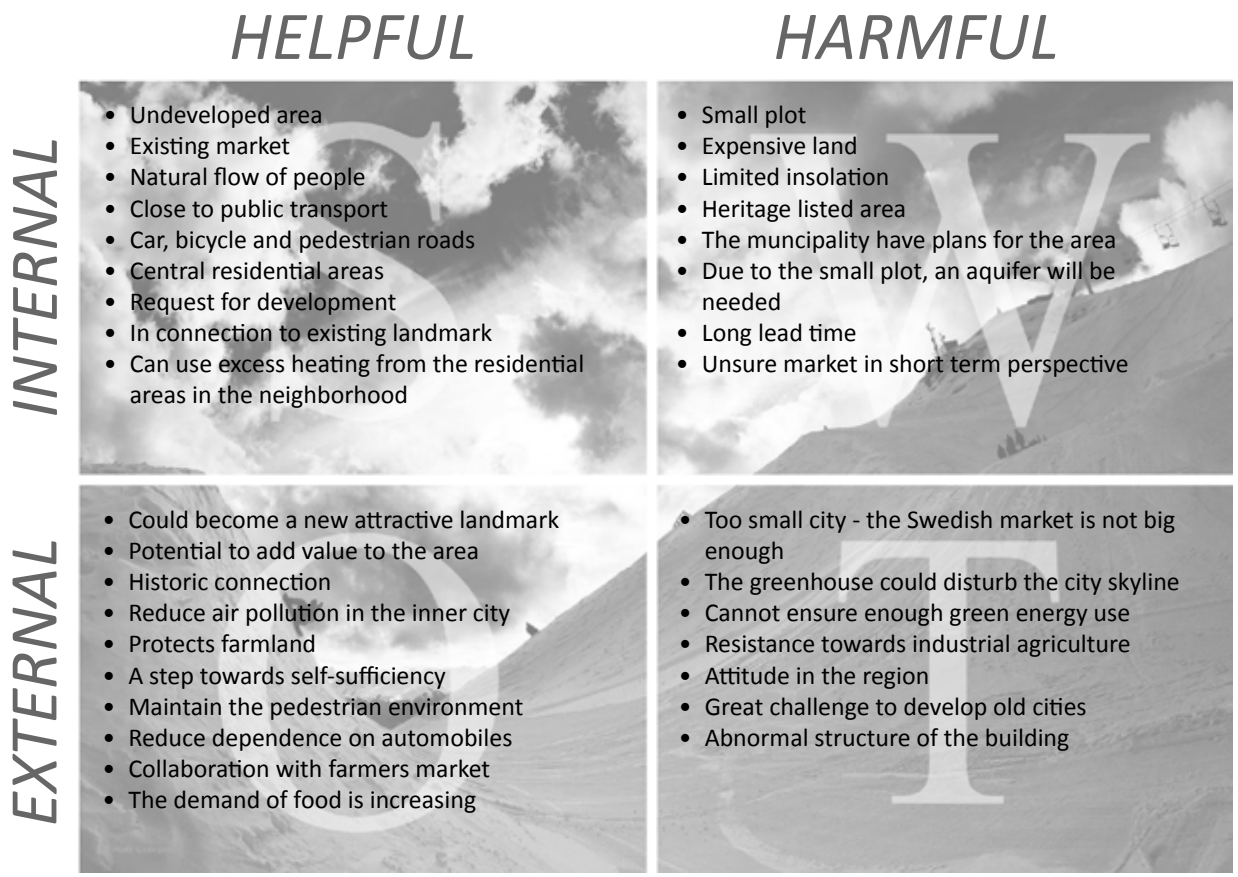
## VASA

Is a typical "mixed city" with a grid street plan. Housing facilities are located among commercial activities, offices, restaurants and bars. Trams, cars, bicycles and pedestrian occupy the main street along the alley.

## JÄRNTORGET AND NYA ALLÉN

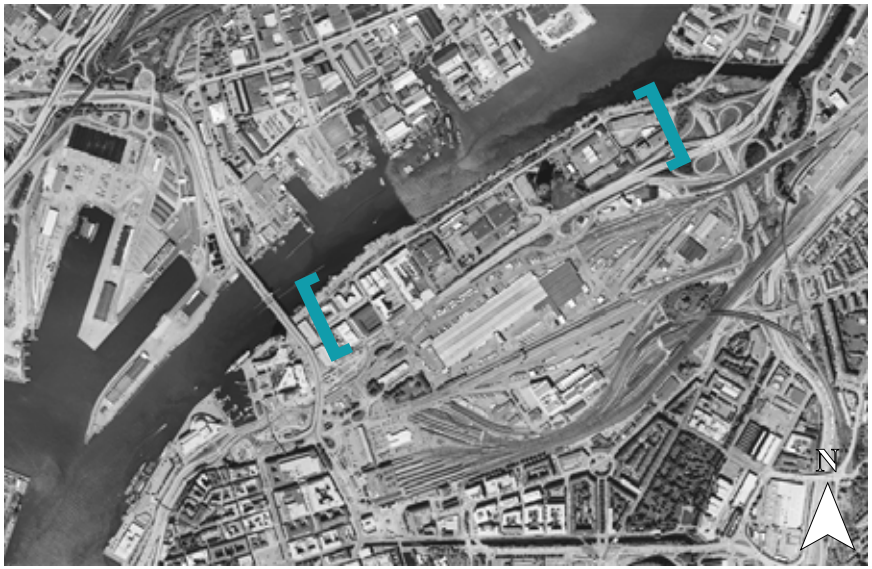
Järntorget is a square northwest of Skanstorget where trams, busses to the city's periphery and also boat traffic operate. Around the square you can also find cultural activities and municipality services. The square is surrounded by bars and shopping. Nya Allén passes through Järntorget and is a main street crossing central Gothenburg. Other major roads connect to Nya Allén.

SWOT ANALYSIS OF SKANSTORGET



# 5.3 CASE GULLBERGSVASS

Gullbergsvass is a dilapidated industrial area; despite its close connection to the city centre it is not a part of the city life. Along the quay, Drömmarnas Kaj, house-boats are mixed with old rusty boats and junk. Some industries occupy the area that mostly consists of low industrial buildings.



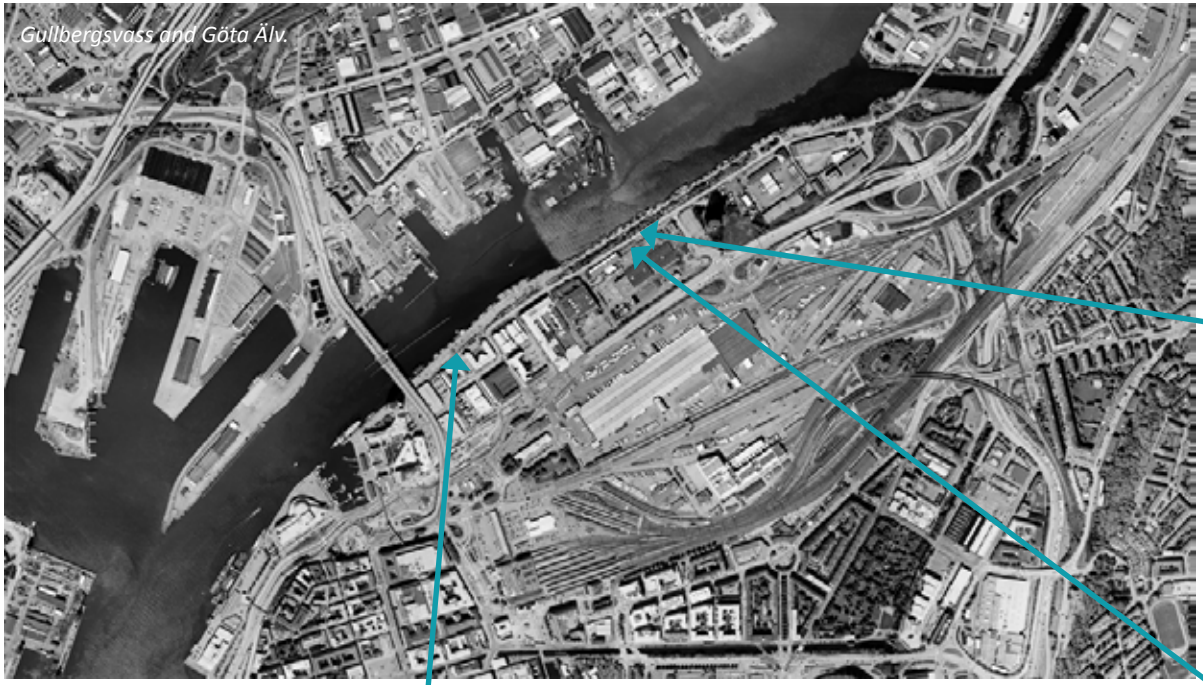

*Ortophoto of Gullbergsvass*
*Photo: maps.arch.chalmers.se*

## HISTORY

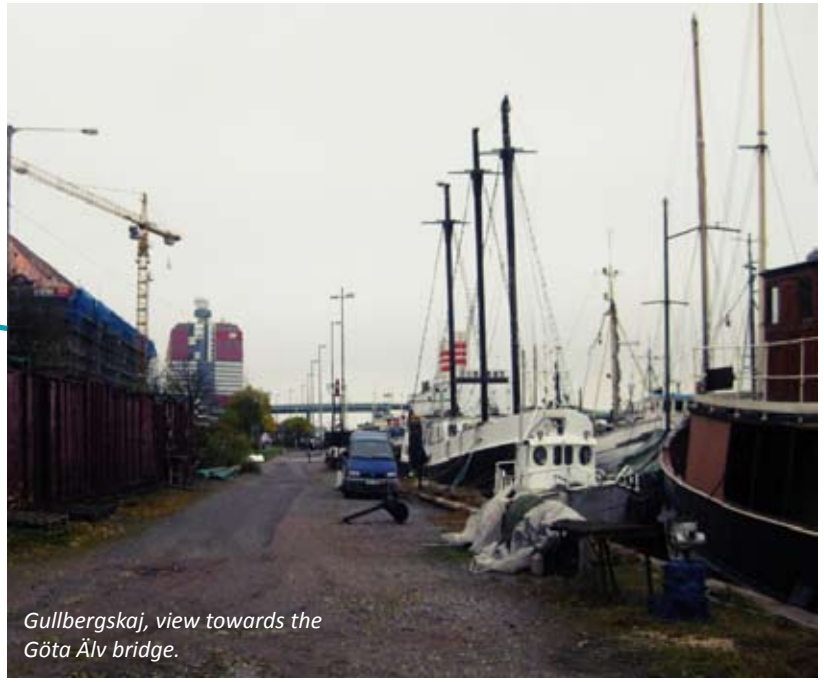
Gullbergsvass has not always been a district in Göteborg. Until the mid 1800th, the river was undeveloped and Gullbergsvass consisted of a great reed bed. As the development of Göteborg went from being a city of merchant to an industrial city, larger harbours and better connections with Sweden's midland were required. Between the years 1841 and 1844 the area was piled to reinforce the ground for further development. Finally, the area was an excellent site for location of trains and railways, and in 1855 the first state railway to Stockholm was established. (Fritz, 1996)

*Old picture of Mårten Krakowgatan with the railways.*
*Photo: http://www.tidsbilder.se/content/view/33/46/ (2011)*

*View of Gullbergsvass and Drömmarnas kaj as it looks like today.*
*Photo: Kent Hallgren, GP.se*



*Gullbergsvass and Göta Älv.*



*Gullbergskaj, view towards the Göta Älv bridge.*

*Gullbergsvass' business district.*

*Gasklockan viewed from Gullbergskaj.*

*Photos: Private*

# PROGRAMMES IN THE AREA

HOUSING

OFFICE

CULTURE

EDUCATION

COMMERCIAL

GREEN

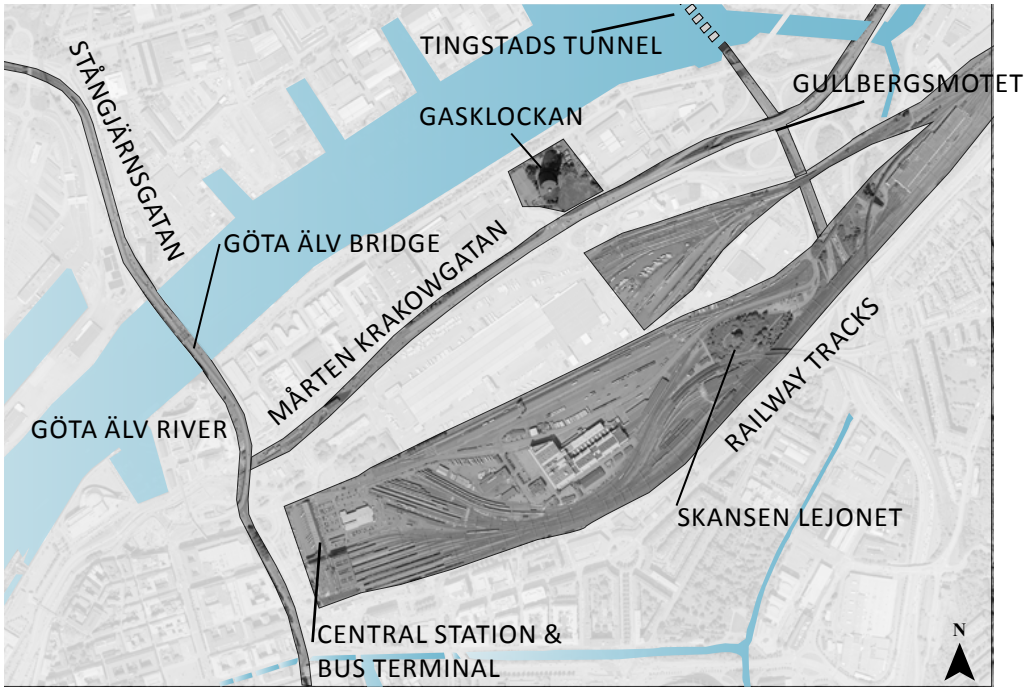
URBAN AGRICULTURE

URBAN METABOLISM

INDUSTRY

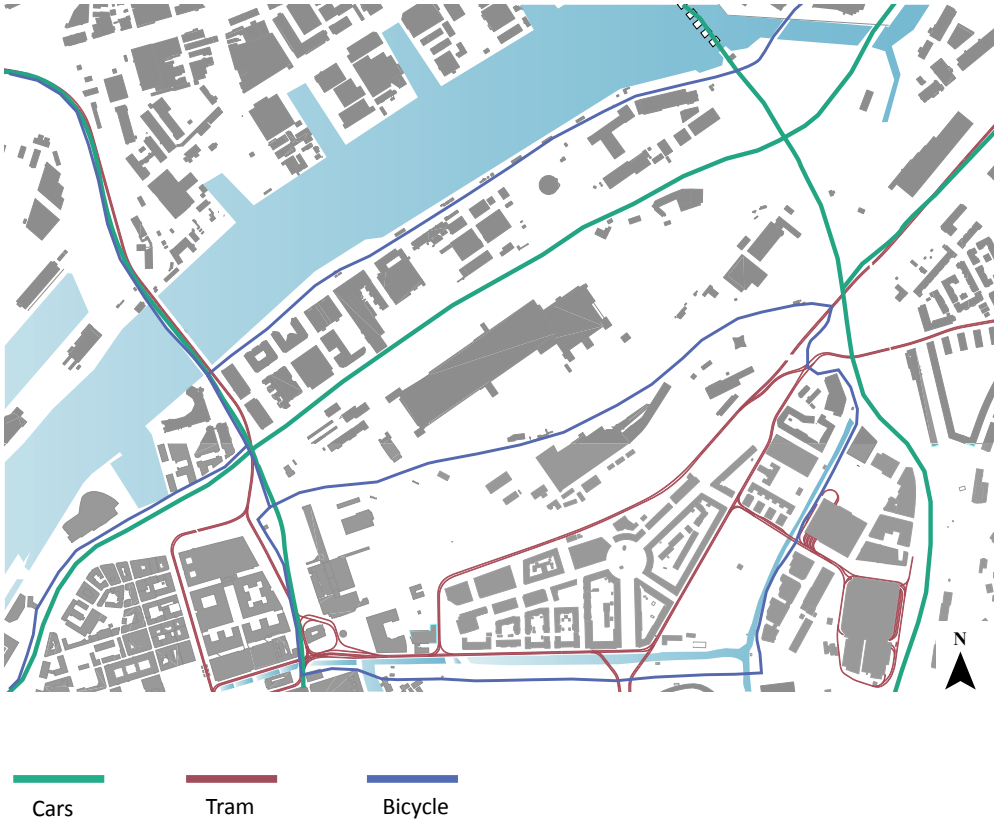
PUBLIC TRANSPORT NODE

## LANDMARKS AND ROADS




An important node is Mårten Krakowsgata meeting Göta Älvsbron, where the traffic from the north part of the city meets the south. The Gullbergsvass junction is distributing the traffic from the highway E6 and E45. By the central station all train traffic, long distance buses and local public traffic meet why this is an important traffic node. Gasklockan, the old gas-holder, and Skansen Lejonet, an old defence building, are two landmarks in the area, both being important cultural elements in the Göteborg's history. Also the central station is an important landmark.

## TRANSPORTATION

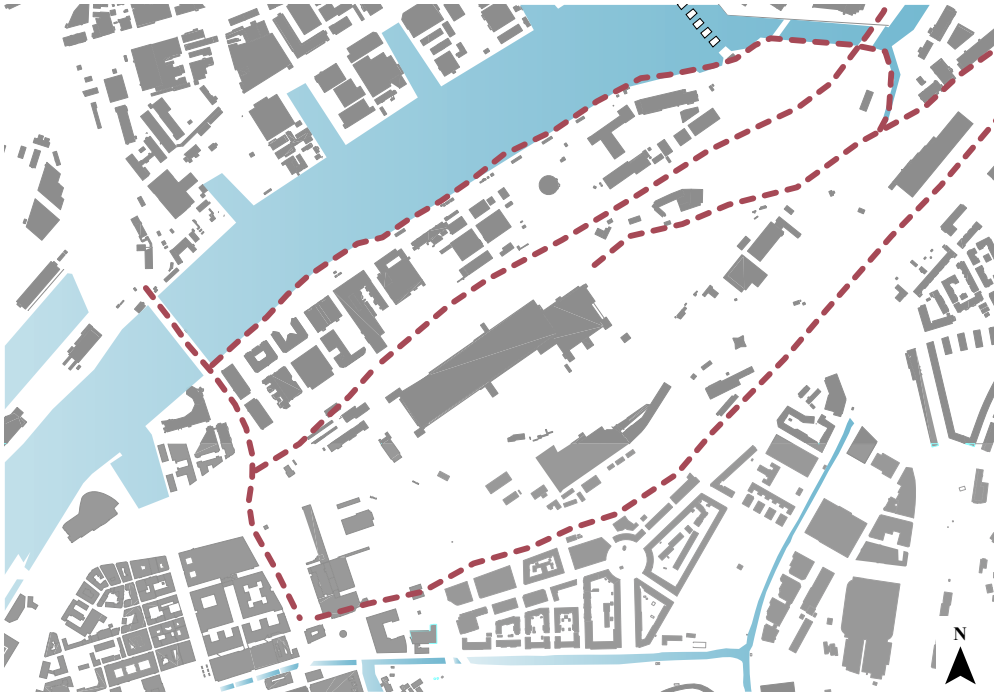



No tramline goes through the area, the closest stop is at the central station, although one bus line goes through the area. In the north east of the area the large roads E6 and E45 meet, and connects to the central station. Along the quay, Drömmarnas Kaj, there is a possibility to walk and bike, although the roads are in a poor condition. The area is overall not well suited for pedestrians and cyclists.

## TOPOGRAPHY


The ground in Gullbergsvass is piled and filled with discards and fluvial sediments and has historically been contaminated in some parts where old streams flowed. The area is flat and at great risk of being flooded in a hundred years period[13].

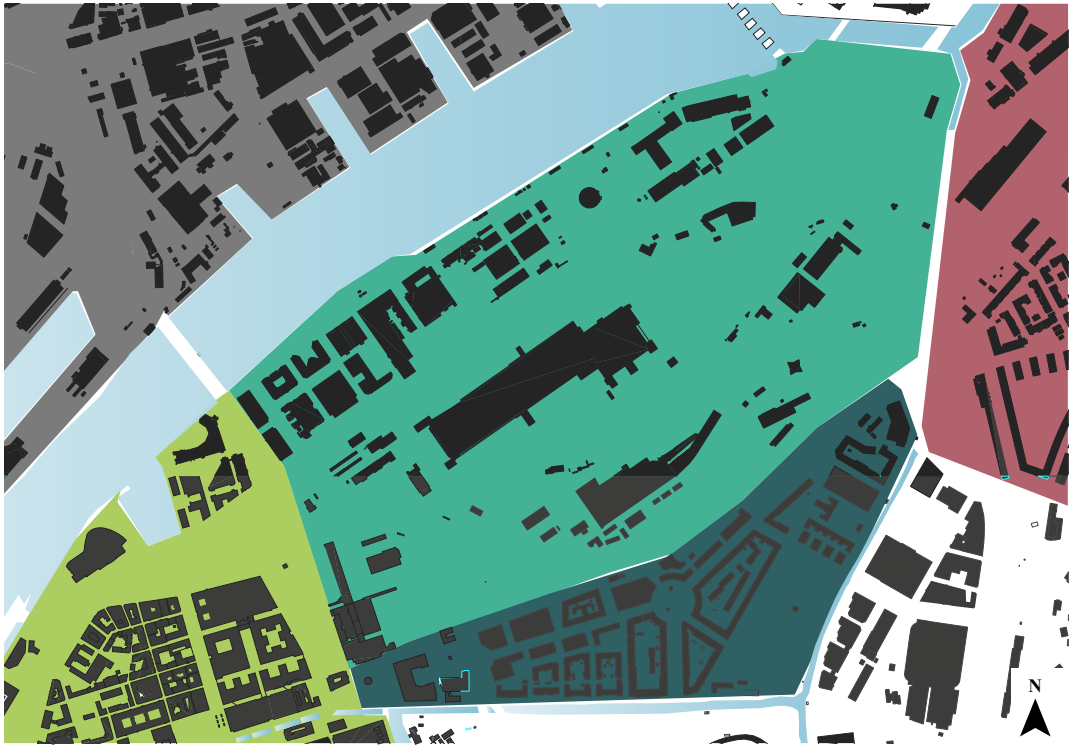
## BARRIERS




Gullbergsvass has well defines edges on all four sides, Göta Älv in the north, and roads and train tracks on the other three sides. The train station and the tracks are isolating the area towards the city and the city life.

13. Claes Alén (Assistant Professor,Geology and Geotechnics, Chalmers University of Technology) Interviewed by the authors 24 October 2011.

# ANALYSIS OF THE AREAS




## GULLBERGSVASS

Is a former industrial harbour with little activities. It is located close to the city centre, but is not a part of the city life as few people passes through the area. The area has mostly low industrial buildings, although the old gasholder is a prominent landmark of the city. The river Göta Älv and the smaller river Säveån define the area in the north and the east. In the south the railway restricts the connection to the close by area Stampen.

## INNERSTADEN

The most central area of Gothenburg holding residential buildings, several large shopping malls, restaurants, hotels, museums, bars, opera house and a small marina. The area is trafficked all hours a day and all public transportation means passes through here.

## STAMPEN

Stampen holds housing, offices and some commercial activities. Göteborg's Centralstation is located between Gullbergsvass and Stampen, having several large service buildings and railway tracks crossing the area. Stampen has some green areas such as Skansen Lejonet, an old defence building, lies on top of a hill close to the railway, and two cemeteries.

## OLSKROKEN

Consists of both industries, closely connected to Gullbersvass, and housing and some commercial activities in the connection to Stampen.

## RINGÖN

A large industrial area on he island Hisingen. It is a standard industrial area with low buildings and cranes. It is closely connected to the city and is a part of the plans for extending the city centre and connect Hisingen to the mainland.

SWOT ANALYSIS OF GULLBERGSVASS

| | HELPFUL | HARMFUL |
|---|---|---|
| INTERNAL | • Underdeveloped and unused area<br>• Potential to use existing buildings<br>• Not disturbing for the neighbourhood<br>• Storage spaces<br>• Strategically situated with the waterfront in<br>• the north<br>• Close to several residential areas<br>• Gasklockan - an existing landmark<br>• Large open spaces<br>• Political support for change | • Underdeveloped public transport<br>• The area is torn down<br>• The bridge, river, train tracks and highway creates barriers surrounding the area<br>• Not bicycle and pedestrian friendly<br>• Contaminated ground<br>• Bad soil condition<br>• Noise pollution along the E6 and Mårten Krakowleden<br>• Unsafe environment |
| EXTERNAL | • Existing foundations<br>• Need for activity<br>• Developing the port and Södra Älvstranden<br>• Adding value and a new identity to the area<br>• Potential to develop the public transportation to the area<br>• Investments in the area promotes further development of Älvstaden<br>• Node for train, roads and commercial?<br>• National interests in the area | • Risk for flooding scenarios<br>• The diversity of business in the area is poor<br>• No activity during evenings and nights<br>• High cost for new development and infrastructure |

# 5.4 VALUE TREE

Integrating a greenhouse in a specific area must have certain affect and demand on the neighbourhood it will be sited in. To evaluate which these criteria are, a top-down approach to structure a value tree was implemented resulting in a matrix where the site is scored against each criterion. According to the MCDA, the process can be made step by step as below (Communities and Local Government, 2011).

## ESTABLISH THE CONTEXT

Only limited data were available about the sites, more for some sites, less for others. After all, the aim of the MCDA is to recommend a short list of sites that would then be the subject for data gathering. Key players and stakeholders were identified to supply information and judgements. The key players are Plantagon, Göteborg municipality and consultants within different fields.

## IDENTIFY THE OPTIONS

Several areas of different types in Göteborg were identified so a distinction could be perceived in an eventual result. The areas were reduced to only consider three option sites: inner city, brownfield and peri-urban. Later on, the limited time of the project required us to eliminate one of our option sites - peri-urban – to not be further studied.

## IDENTIFY THE OBJECTIVES AND CRITERIA

When integrating a greenhouse in an existing urban area economic and social factors, along with environmental and technical matters should be taken into account. All possible factors should be taken into account when constructing a value tree (Communities and Local Government, 2011). To ensure that no key factors is forgotten, stakeholders were first identified to comprise: politicians, share owners in Plantagon, local residents, investors, local authorities, customers, owners and competitors. However, since the aim of MCDA is to determine a short list of sites and due to the short time of the project, the involvement of key players and stakeholders becomes limited. Discussion about which factors that should be taken into account in evaluating the sites and the objectives that should be met by a site when integrating a greenhouse enabled the construction of a value tree. The higher-level objective included:

- Cost
- Adapt to city structure
- Impact on environment
- Social development

Each of these was later broken down into lower-level objectives, and finally into performance criteria or state variables (Figure 5.1). Yet, the existence of the lower-level objectives Cost and Water is possible to assume here[14], but their significance is too extensive to be studied further at this conceptual level. In the case of Plantagon, visionary companies follow a cluster of objectives, of which making money is only one – and not necessarily the primary one. Yes, they seek profits, but they are equally guided by a core ideology – core values and sense of purpose beyond just making money (Communities and Local Government, 2011).

14. Patrik Wallman (Researcher, Swedish Metrological and Hydrological Institute) Interviewed by the authors 31 October 2011.

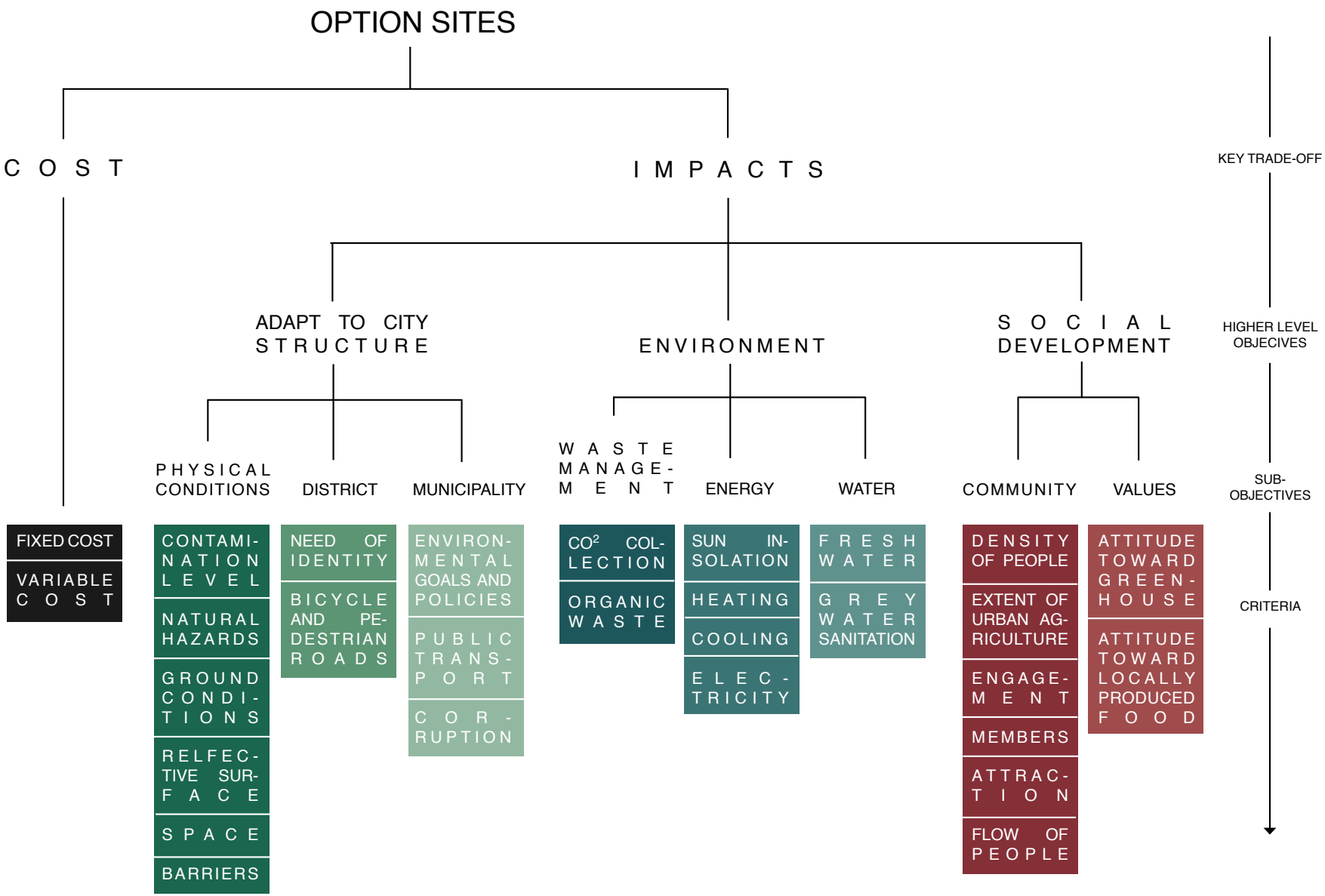



Figure 5.1: *Identified performance criteria for each subobjective*

## SCORING THE OPTIONS ON THE CRITERIA

The following steps will help us to construct our matrix.

Several methods can be used to obtain preference scores. Mostly, relative preference scales were used, these are simply scales anchored at their ends by the most and least preferred options on a criterion. The most preferred option is assigned a preference score of 100, and the least preferred a score of 0, much like the Celsius scale of temperature (Figure 5.2). (Communities and Local Government, 2011)

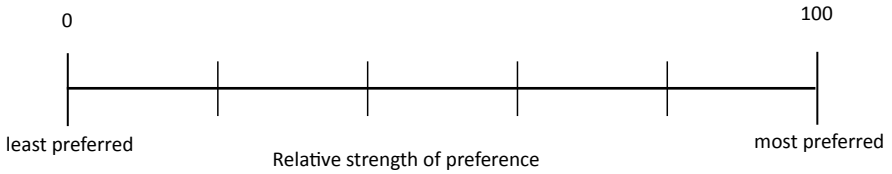



Figure 5.2: *Relative strength of preference*

Numerical scales for the assessment of criteria have been used in some cases. For example, access to a facility might be recorded in terms to the nearest public transport, where the natural scale of measurement, distance, associates a low number with a good performance. The value functions used is then assumed to be linear (Figure 5.3).

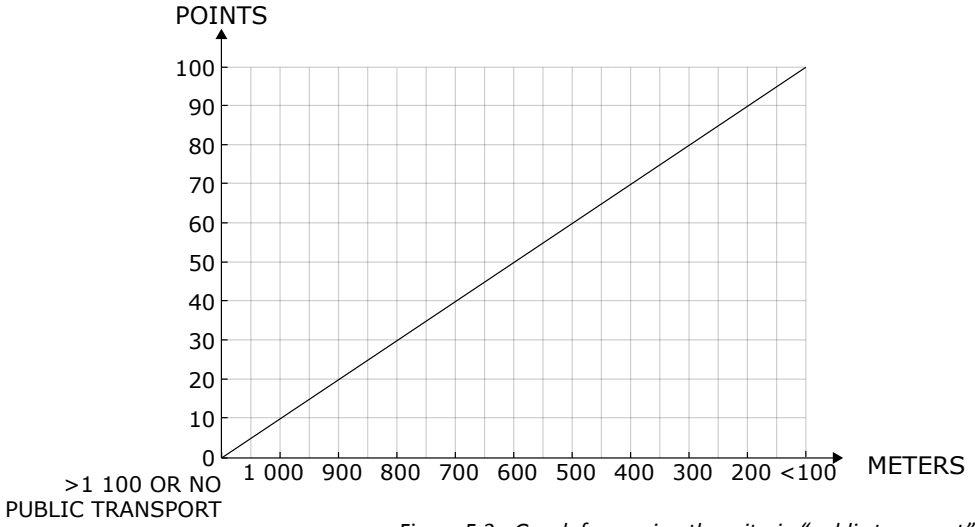



Figure 5.3: *Graph for scoring the criteria "public transport"*

Another approach used when scoring the options on the criteria is direct rating on a range between 0-100. This is used when a scale of measurement for the criterion does not exist, or where there is neither the time nor the resources to undertake the measurement. Direct rating is a very qualitative approach of assessing and is simply done through the own judgements of an expert. The use of direct rating judgements in MCDA can cause some problems of consistency in some circumstances where the assessing is to be done by different people (Communities and Local Government, 2011).

## ASSES WEIGHTS FOR EACH CRITERIA TO REFLECT ITS RELATIVE IMPORTANCE

The method of "swing weighting" to obtain weights for the criteria is used in this step. This is based on comparisons of differences: "*how does the swing from 0 to 100 on one preference scale compare to the 0 to 100 swing on another scale*" (Communities and Local Government, 2011)? When making these comparisons, it is important to take into account both the differences between the least and most preferred options, and how much that difference really matters. For example, to operate a greenhouse, you might consider the access to fresh water to be essential, thus water is fundamental for the photosynthesis. However, assume you have three different sites to choose between and all options have access to fresh water, you might not care very much about the water issue. That criterion would thereby receive a low weight because the difference between the options is small or none. But, say only one of the options have access to fresh water, you might give the criterion more weight.

With many criteria identified in the case of integrating a greenhouse in an urban area, it may be necessary to use a paired-comparison process (Communities and Local Government, 2011): compare criteria two at a time for their preference swings, always keeping the one with the biggest swing to be compared to a new criterion. Finally, the one criterion evolving from this process as showing the largest swing in preference, the criterion "space" for this case, is given a weight of 100. This criterion becomes the standard to which the other remaining criteria are compared with in a similar process together with qualitative judging.

## CALCULATE OVERALL WEIGHTED SCORES AT EACH LEVEL IN THE HIERARCHY

To calculate the overall score for each option multiply an option's score on a criterion by the importance weight of the criterion, do that for all the criteria and then sum the products. Simply, the following formula is used:

$$S_i = w_1 s_{i1} + w_2 s_{i2} + \cdots + w_n s_{in} = \sum_{j=1}^{n} w_j s_{ij}$$

The preference score for option i on criterion j is represented by $S_{ij}$, the weight for each criterion by $w_j$ and the overall score for each option $S_{ij}$. (Communities and Local Government, 2011)

## EXAMINE THE RESULT

The total scores for each option give an indication of how much better one option is over another. An MCDA can yield surprising results that need to be digested before decisions are taken (Communities and Local Government, 2011). However, our matrix is very generic in its progress and based on mostly direct rating. One should be careful when establishing temporary decision systems when dealing with unexpected results. The criteria emerged when creating the value tree in comparison with the matrix indicates which of these that is interesting to investigate further as the project proceed. The next chapter discusses the criteria that were chosen for investigation.

# 6 SYSTEM DYNAMICS

System dynamics is an approach that helps us to understand complex social, managerial, economic and ecological systems over time[15]. It can be applied to any dynamic systems characterized by interdependence, mutual interaction, information feedback, and circular causality (System Dynamics Society, 2011). Connections and relations between the identified criteria in the value tree began to emerge. As these relations were developed and discussed more, a pattern of arrows and variables was created, more variables and subsystems appeared and the first steps of the system dynamics began to visualize.

15. Patrik Wallman (Researcher, Swedish Metrological and Hydrological Institute) Interviewed by the authors 31 October 2011.

# 6.1 DEFINING OUR VARIABLES

The variables in our system have been identified and designed as the project is progressed. The main system that has been studied for the purpose of this project consists of seventeen variables presented and defined below with no particular order. Later, the system was expanded to embrace some subsystems necessary to achieve an overall picture of the purpose. The subsystems, which are very generally considered, consist of Operating Cost, Energy and Environment.

ATTRACTION
Neighbourhood regeneration creates an attraction which generates an interest for people to visit the site or area, typically for its inherent or exhibited cultural value, historical significance, natural or built beauty or amusement opportunities. Expanding the definition of attraction, a greenhouse can also, besides producing crops, educate and interact with the inhabitants.

IDENTITY
The identity is the collective aspect of the set of characteristics by which an area is definitively recognizable or known.

FLOW OF PEOPLE
Flow of people is the people passing through area and who not necessary lives in the neighbourhood. The flow can be measured in several ways, e.g. volume people that flows past a fixed point in an area over time.

GREENHOUSE
Greenhouse is the shortening for Urban Industrial Vertical Agriculture. A greenhouse is the fixed body that produce food in industrial scale for the urban inhabitants. With a high of 60 meters, a production space of 4 000 $m^2$ and its transparent façade, the building becomes a distinctive element in the area.

INTEREST FOR GREENHOUSE
The interest is the collective perception, concern and curiosity of implementing and visiting the greenhouse in the area. The interest of greenhouses is also a city's need of more agricultural land for producing nutrition to its inhabitants.

LOCALLY PRODUCED FOOD
Locally produced food does not consider political boundaries since the greenhouse's purpose is to distribute food only within the city it is sited in. Moreover, locally produced food will be defined as food produced within a radius of 100 km (see chapter 3.2).

URBAN AGRICULTURE
Urban agriculture is the practice of cultivating, processing and distributing food within a town, city, or metropolis, on land and water dispersed throughout the urban and peri-urban area, by using production methods, using and reusing natural resources and urban wastes to yield a diversity of crops.

PUBLIC AWARENESS
Public awareness relates to the attitudes, behaviours, opinions and activities that comprise the relations between the general public or lay society as a whole to sustainable development and social and ecological impacts.

ENGAGEMENT
Engagement is the public participation and concern in an issue or something and the interest for the issue's success.

CORRUPTION
Corruption is the abuse of ones position of trust for personal gaining, primarily through bribery. Corruption can also through offers, services, money, threats and compulsion for other's or personal gaining affect the outcome of a decision, contrary to applicable laws, regulations and ethics.

MEMBERS
The urban public living in the area where the greenhouse is sited can become members in the Plantagon Non Profit Association for a small fee. The non-profit organization will obtain 10% of the stock in Plantagon International AB and then share 50% of the power and responsibility to appoint 50% of Plantagon International AB's board members. This will give the public the opportunity to influence the company into doing good business by being active members or support the non-profit association.

INTEREST FOR SUSTAINABLE DEVELOPMENT
The feeling of a collective whose attention, concern, or curiosity is particularly engaged in the issue of sustainable development. Additionally, the subject in matter has an appealing traction.

ENVIRONMENTAL GOALS & POLICIES
To actively protect the environment and to develop the city towards sustainable development, goals and policies must be set. According to the goal-setting theory, goals can serve as an effective tool for making progress by ensuring that participants have a clear awareness of what they must do to achieve or help achieve an objective.

PUBLIC TRANSPORT
Public transport is a shared and sustainable passenger transportation service that is available for use by the general public. Public transport modes include buses, trams and trains, ferries and rapid transit. Moreover, bicycle pools have lately become an additional contribute to the city's public transport system.

BICYCLE AND PEDESTRIAN ROADS
The municipality shall promote pedestrian and bicycle systems to maximize access and mobility while reducing dependence on automobiles and trucks. Bicycle and pedestrian roads is a sustainable method for creating denser and environmentally friendly urban areas.

TRAFFIC
Traffic is the amount of people and distribution of goods conveyed by motor vehicles, including private transport and public transportation, in a road system within a city.

ENVIRONMENT
The natural environment is contrasted with the built environment and can be distinguished by components:

- Ecological units. Complete ecological units that function without massive human interventions, including all vegetation, microorganisms, soil, atmosphere, natural phenomena that occur within its boundaries.

- Natural resources. Universal natural resources that could be used by humans, such as air, water and climate, as well as energy, radiation, electric charge and magnetism.

- Pollution. Contaminations into the natural environment that causes in stability, disorder, harm or discomfort to the ecosystem, such as chemical substances, noise, heat or light.

OPERATING COST
The expenses that are related to the operation of a greenhouse and fall into two broad categories; fixed costs and variable costs.

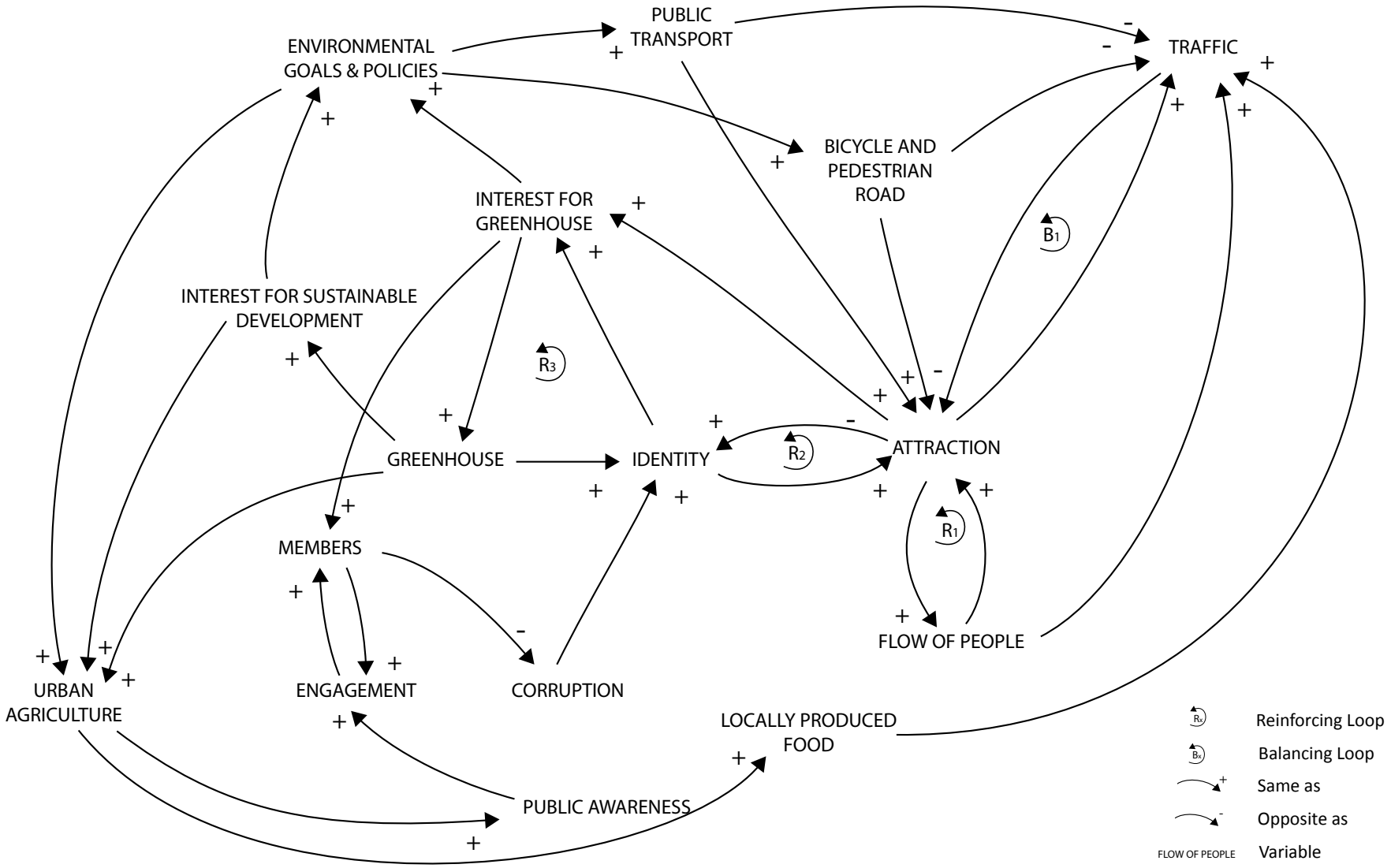
ENERGY
A system can transfer energy to another system by simply transferring matter to it. Energy in this context refers to electricity and heating produced from renewable and non-renewable energy sources. Additionally, energy is essential for running a greenhouse.

## THE SYSTEM

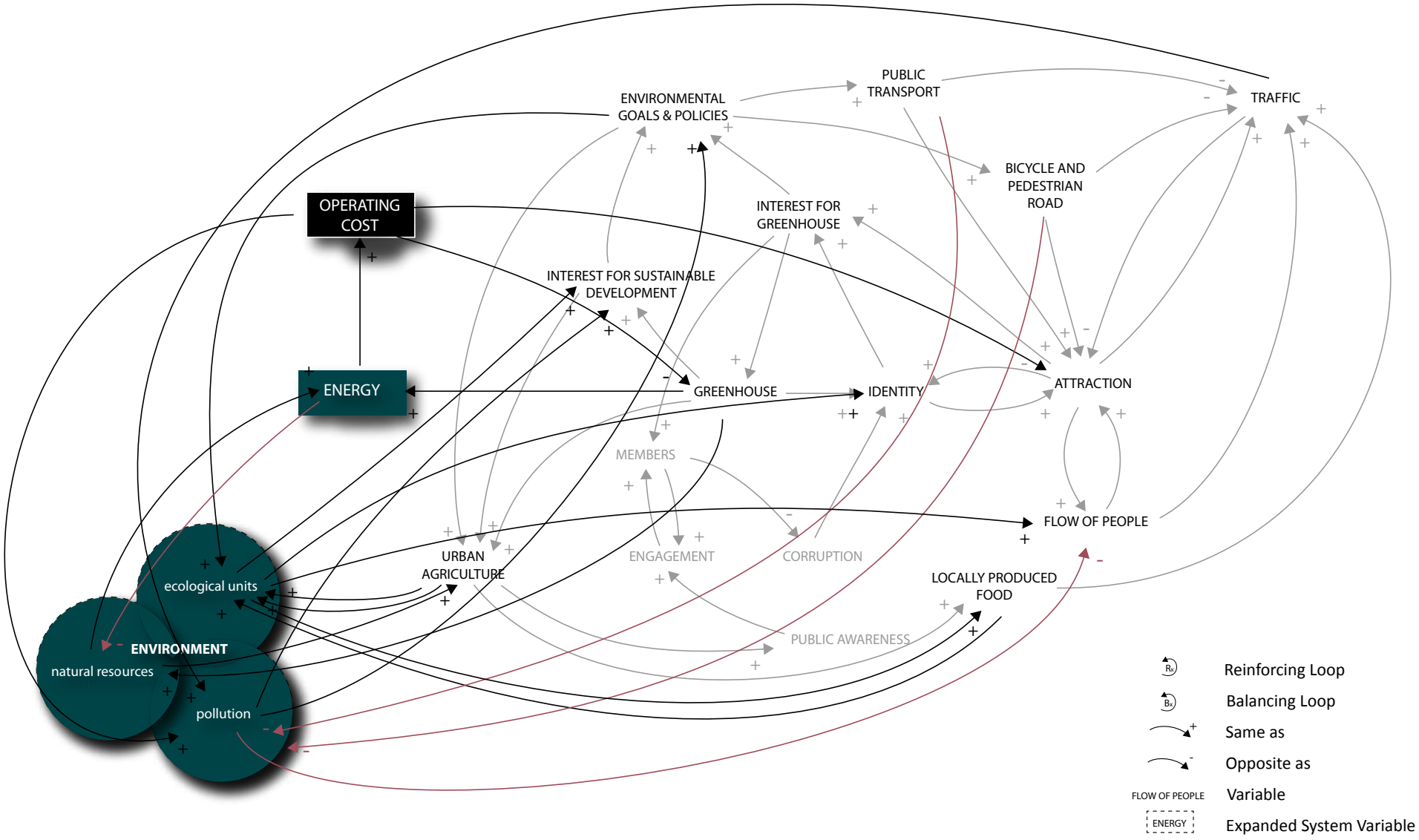
The system that will be mainly treated in the thesis is the "Inner system" consisting of variables that mostly deal with city functions and social aspects that we found essential when integrating a greenhouse in an urban area. Variables concerning locally produced food and agriculture can also be found here. It has been developed from a bottom-up approach where each single variable first is identified. The system is later expanded to also encompass the subsystems: Operating cost, Energy and Environment.

The subsystems are not studied more exhaustive in this thesis, but they have a certain impact on our inner system and must therefore be mentioned. Environment is divided in three components that overlap each other. The illustrations including the subsystem clearly show how these affect the complete inner system, whilst environment itself is affected by the other variables. This emphasis the importance of that environmental action must be embraced. On the following pages the system will be presented.

INNER SYSTEM



# EXPANDED SYSTEM



# 6.2 LOOPS

Systems thinking have two fundamental structures, reinforcing loops and balancing loops:

A reinforcing loop (Figure 6.1) is where an action produces a result, which influence more of the same action, resulting in a, generally, exponential growth or decline. When a reinforcing loop is creating a desirable result it is called a virtuous cycle, when this occurs it is important to not to ignore it but to ensure that it continues is going in the right direction.

A balancing loop (Figure 6.5) is trying to reach a desired state through some action. The desired state interacts with the current state to produce a gap. The larger the gap, the stronger the influence of the action has to be, in order to move the current state to the desired state. The loop may be delayed and result in the action eventually overshooting the goal. This would then require additional action to bring the current state back, resulting in an ever going oscillation between the two states.

## REINFORCING LOOP -$R_1$

An attractive area increases the flow of people and vice versa. In the beginning of the greenhouses lifecycle this loop (Figure 6.1) will be very important to help create an attraction. The flow of people will grow exponentially as the attraction of the area grows stronger. Eventually, as the loop slows down due to outside criteria, the flow will stop increasing and stabilize at a relatively constant number of people. Depending on outside criteria, such as traffic and identity, the loop can start spinning faster again, and change the flow of people. A continuous flow, of a minimum amount of people, is essential for the greenhouse to function as a business.

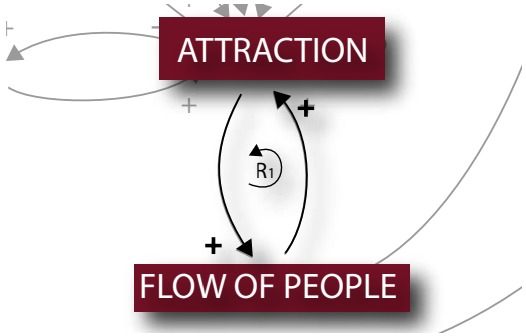



Figure 6.1: *Reinforcing loop Attraction-Flow of People*

At Skanstorget, the flow of people is already quite high, covering people from different districts in the city and from different social groups. The area is in no large need of a regeneration project, the issue in the area is rather to keep it being an attractive spot in the city, and not loose the flow and diversity it possess.

The current situation in Gullbergsvass is a low flow of people, this loop is therefor extra important for creating an attraction here. People coming to the area visit the few businesses on the site or stroll along the dockside. The flow of people is strongly dependent on a neighbourhood regeneration project creating an attraction; this is a possibility of shaping and controlling the flow to the area in a unique way.

## REINFORCING LOOP -$R_2$

A greenhouse will function as a catalyst for many processes in the area it is integrated in. A direct result of implementing it will be a change of identity. The new identity stimulates the attraction of the area, whilst the attraction of the area strengthens the identity, creating a reinforcing loop.

This loop (Figure 6.2) indicates a desirable result, a virtuous cycle. However, nothing grows forever, why it is necessary to be concerned about how to ensure a continuous development in the wanted direction, i.e. how to create a strong positive identity and an attractive area.

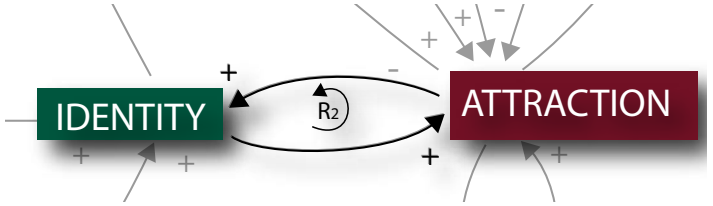



Figure 6.2: *Reinforcing loop Attraction-Identity*

The identity of Göteborg city will dramatically change if a greenhouse is built in the city. Depending on how the politicians and decision makers tackles the change, the identity of the city could be known worldwide and start a new era in Göteborgs history.

Skanstorget does not in itself possess a strong identity. Historically it was a market place and an indoor market. Today it is a parking lot and a small spot for walking the dog, although the many strong identity areas, nodes and landmarks in the surrounding area, can excuse the lack of identity on the spot. Even so, a greenhouse could strengthen the area further and make use of the unused space on one of the most attractive spots in the city.

Gullbergsvass has a strong identity but is not attractive. It is a rough area, a former industrial site with torn down buildings and little activity. By using the former identity of the area and refresh it, the heritage could be saved, whilst the value is raised. The area has many unused qualities which could benefit the identity. The identity of the whole district needs to be updated, why a continuous success by this loop is very important.

## REINFORCING LOOP -$R_3$

Without an interest for the greenhouse the implementation of a greenhouse will be delayed. The greenhouse will contribute to the identity of the area, although, the over all identity of the area has to be strong and attractive to boost the interest for the greenhouse.

In an area with a weak attraction, such as Gullbergsvass, the greenhouse will be a core function. If the area already has a strong identity, as in the Skanstorget case, the implementation of a greenhouse should not counteract, but rather merge into the culture. If the identity of the area is connected to the greenhouse, the interest for the greenhouse will increase as a direct response. This loop (Figure 6.3) should be studied by the city or region before the implementation of a greenhouse to ensure a strong identity connection to the greenhouse.

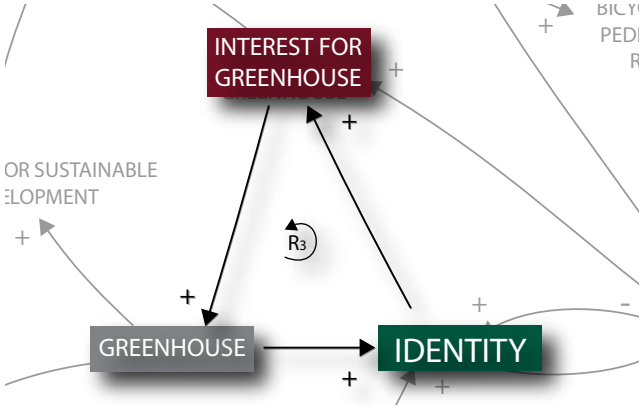



Figure 6.3: *Reinforcing loop, Interest for Greenhouse-Greenhouse-Identity*

## REINFORCING LOOP -$R_4$

This loop (Figure 6.4) describes how environmental goals could affect the development towards a sustainable development. Environmental goals and policies are important when developing a sustainable society, although, the process of implementing the ideas is slow and requires that politicians and decision makers prioritize the issue. In the long run, a change in environmental goals and policies can increase urban sustainability and benefit the global society. Global goals and agreements can support and encourage national and regional goals and policies.

Because of the bureaucracy of politics in Sweden, the implementation of environmental goals can be slow. It is very important that decision makers work towards the goal of sustainable development, although smaller organizations will probably pull the heavy load in implementing and practising sustainability.

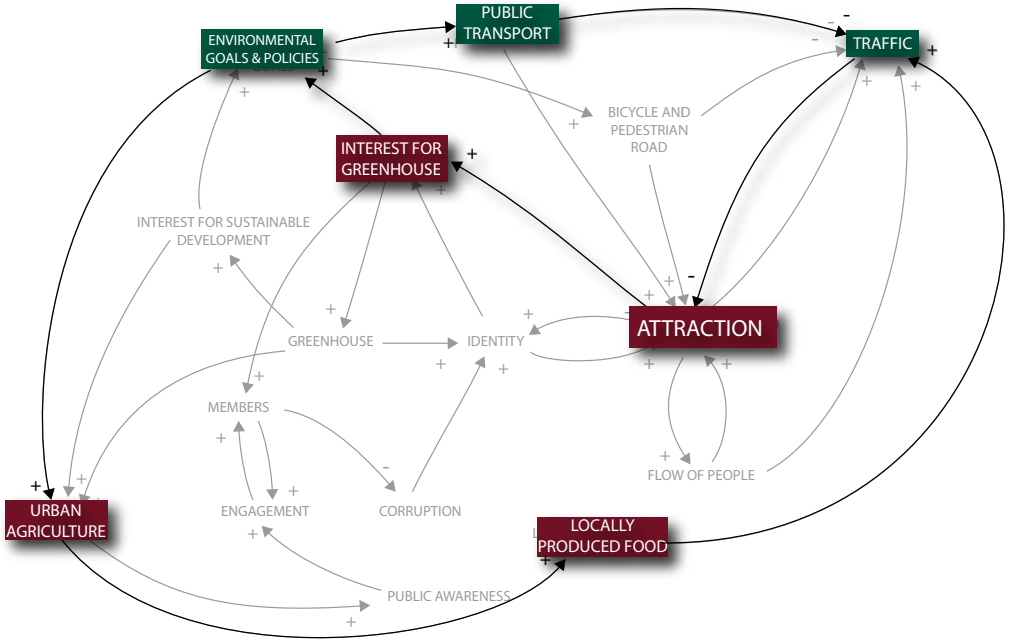



Figure 6.4: *Reinforcing loop, Environmental Goals-Public Transport-Traffic-Attraction -Interest for Greenhouse-Environmental Goals and Policies, and Environmental Goals and Policies-Urban Agriculture-Locally Produced Food-Traffic-Attraction -Interest for Greenhouse-Environmental Goals and Policies*

### BALANCING LOOP -$B_1$

Traffic and attraction are connected in a balancing loop (Figure 6.5). An attraction generates more traffic to an area; whist a largely trafficked area is less attractive leading to less traffic, which in return makes the area more attractive and so on. This loop will oscillate, however, infrastructural planning can control the size of the oscillation.

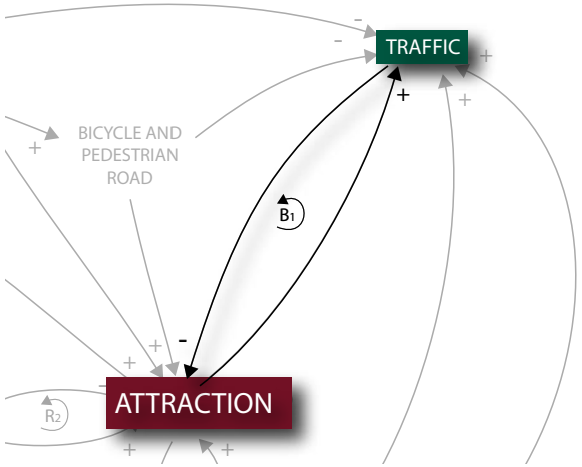



Figure 6.5: *Balancing loop Traffic-Attraction*

Analysis of the system as a whole indicates a small, fast spinning loop system in the core, and slower, large scale loops around and outside. The “core loops” spins faster and have greater effects in a short-term perspective than the slower loops. Hence, in the beginning of an implementation process focus should be on what goes on in the core of the system. It is important not to forget the slower loops, in a long term perspective these will be important to ensure a sustainable development.

## 6.3 LEVERAGE POINTS

In systems analysis, leverage points are often discussed. Leverage points are places within a complex system, an organization, a city, an economy, an ecosystem, where force can be applied. Moreover, leverage point is places where a small amount of force, the effort required, causes great changes to the system behaviour, very often predictable and favourable responses. (Meadows, 1999)
According to Senge (2006), leverage is the bottom line of system thinking. Seeing where action and changes in structures occur can lead to significant and enduring improvements. Senge (2006) continues to describe that leverage follows the principle of economy of means: *“where the best results come not from large-scale efforts but from small well-focused actions”*.

### 6.3.1 INTEREST FOR GREENHOUSE-GREENHOUSE

Small changes in the influence between the two variables “Interest for greenhouses” and “Greenhouse” result in remarkable changes in the system. Thus, the interest is a fundamental factor when implementing new concepts and assures continuous progress. With interest comes awareness and curiosity for visiting the greenhouse, which is essential for the greenhouse’s purpose – to sell locally produced food. When the inhabitant’s perception of greenhouses reaches the point that allows us to integrate them in the city, then the implementation of urban agriculture will accelerate and automatically, as a natural consequence, the production of locally produced food has started. Hence, a chain reaction is generated, activating more and more variables in our system. Our leverage point has now triggered the complete system, from infrastructure level up to a political level. Even though the direct influence between the interest for greenhouse and greenhouse is a pretty fast mechanism, many branches in the system still require some time and resulting in delay. This is because of that in the nature of political actions, processes tend do go slowly.

### 6.3.2 INTEREST FOR GREENHOUSE TO MEMBERS AND ENGAGEMENT TO MEMBERS

A strong leverage point can be identified within and around the variable of “Members” (Figure 6.6). Members in the companization influence the organization into doing good business by supporting the non-profit association and therefore also function as a response against corruptive activity. This is vital for

the identity of Plantagon, the area our greenhouse is sited in and the reputation of the project as a whole. The construction industry is a huge and important industry for the society and corruption can quickly harm a project since it tends to loose in popularity and trust. Moreover, the investments in greenhouse projects are thought to primarily come from municipalities and public authorities and are therefore mainly financed by tax incomes. When the concurrence is eliminated as a consequence of corruptive activity, then no warranty for the best deal being done can be assured. If for example bribery, cartels or corruption have had a decisive importance when signing contract on certain conditions, it becomes impossible to see how other more beneficial arrangements would appear[16]. Finally, the taxpayers get ripped of. Additionally, media and public are constantly monitoring corruption, cartels and bribery, why the influence on the identity will be strong and effective if the use of tax money is careless.

Recruiting members in the neighbourhood is the most effective way of influencing how the business operates, why local engagement becomes a vital factor for integrating a greenhouse. A general opinion is that no one will have any objections on the idea, before it ends up on your staircase – the NIMBY ( i.e. not in my backyard) effect. Local engagement in the project will have potential to work against the NIMBY effect since the project's success is fundamental for the engaged. Additionally, if the companization does not have any members at all, the identity is at risk because the lack of influence from the non-profit association. On the other hand, more or less members does not necessary effect the identity of the project and the area it operates in. However, the main purpose of the members is still to always see to the public's benefit, ensuring ethical and justifiable decisions.

Members in the companization have great influence and can affect decisions and support with experiences without economic self-interest. Finally, members play a significant proactive role when corruption comes into play, thus it can change the whole system.

From the analysis, three significant elements of the system are acknowledged; Interest for greenhouse, Attraction and Identity. Many variables and steps in the system as long as small changes in it will have impact on these. They steer the system in the desirable direction if they are managed in the appropriate way. Even if they work impeccably at the moment or have worked before it is still important for mangers to be engaged in the process of pushing on situations to make them change or move. Lastly, a lot of inputs influence these three variables why it is important to be observant.

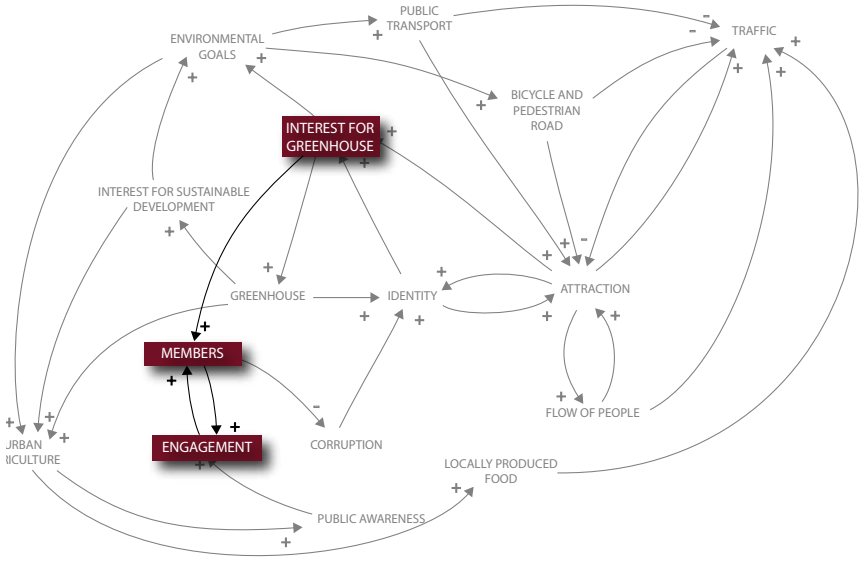



Figure 6.6: *Leverage point Interest for Greenhouse-Members-Engagement*

## 6.4 BEHAVIOUR OVER TIME

To completely understand the system dynamics, its behaviour over time is studied. The System Archetypes are tools for gaining insight into patterns of behaviour and the understanding of the underlying structure of the system being studied. However, mangers must consider that the archetypes are generic in their nature. The archetypes can be applied in two ways - diagnostically and prospectively. (Braun, 2002)

When archetypes are applied diagnostically, they help mangers to distinguish patterns of organizational behaviour that are already present. When mangers have formulated the means to accomplish their organizational expirations, archetypes are used prospectively for planning. The archetypes are then used to test if policies and structures that mangers have taken into consideration may alter the structure in such manner as to produce the archetypal behaviour. If this might be the case, then mangers can take corrective action before changes are

16. Jimmy Dominius (Press Secritary, Swedish Competition Authority) Interviewed by the authors 7 November 2011.

adopted and embedded in the structure. For the system being studied in this case, the prospective approach is considered. Finally, three distinguishing archetypes have been identified in our system: Limits to Growth, Shifting the Burden and Fixes that Fail. (Braun, 2002)

The first one, Limits to Growth (Figure 6.7), describes that "*growth cannot continue unabated in an unrestricted reinforcing dynamic"*. Simply, the lesson of Limits to Growth is that something always pushes back and there is not such thing as unlimited positive reinforcing behavior. Efforts to grow an effect are successful in initial stages, however it will meet a balancing process as the limit of that growth is approached (Braun, 2002). After implementing a greenhouse in an urban area, two reinforcing loops, i.e. *Attraction-Identity* and *Attraction-Flow of people*, will start to generate a growth in performance for the area being studied. Thus, our efforts have been successful. However according to Braun, the growth engine begins to lose its effectiveness and the rate of growth begins to stagnate. In our system, traffic influences will have great impact on the performance. As more people flow to the area as a result of implementing a greenhouse, traffic will increase and to some degree disturb the positive reinforcing behaviour of the neighbourhood regeneration. A balancing process has stopped the growth and the curve reverse.

Shifting the Burden (Figure 6.7) is the second distinguishing archetype in our system dynamics. This archetype demonstrate the tension between a) "*the attraction of devising symptomatic solutions to visible problems*", solution with short-term impact because of their ease and low cost, and b) *"the long-term impact of fundamental solutions aimed at underlying structures that are producing the pattern of behavior in the first place"*. Hence, long-term solutions demand deeper understanding of the underlying problem, take long time to formulate and test manger's patience. Meanwhile, mangers are pressured from many angles to fix problems quickly and move forward. The dynamic theory of Shifting the Burden is that once the symptomatic solution has had its effect it lessens the problem symptom and diminishes pressure, a side effect, to implement a fundamental solution (Braun, 2002).

Our system will experience tension between solutions with short-term impact and the fundamental problem. Each time an interventions is applied against a problem symptom, some temporary improvement in performance is experienced. However, the effect is only short and the reappearance in problem symptom consistently happens. When new traffic solutions are implemented and more space to built greenhouses on is available, an escalation in our graph is expected. Thus, our underlying problem is very much the slow process of environmental goals and their politics, as well as the public awareness of sustainable development. This archetype provides a starting point for identifying chains of problem symptoms and solutions that form walls between functions and divisions. Finally, Shifting the Burden also draws the attention to mangers about the gap between the pressures to perform in the short-term with the insights and long-term sustaining decisions (Braun, 2002).

The third archetype that is managed in our system is Fixes that Fail (Figure 6.8). Fixes that Fail is very similar to Shifting the Burden in that the managerial response is primarily aimed at the problem symptom rather than tackling the more complex underlying problem (Braun, 2002). Nevertheless, the difference between Fixes that Fail and Shifting the Burden is that the initial problem symptoms are worsened by the fix that is applied to them (Braun, 2002). Thus, this archetype displays a steadily worsening scenario. It can be visualized in the balancing and reinforcing loop of *Traffic-Attraction-Flow* of people in our system. Small management intervention in Traffic appears to have a beneficial effect, even as the long-term trend continues to worsen. A delay in a reinforcing loop, e.g. political and public matters in sustainable development, contributes to a gradually worsening problem symptom. This time spending process that elapses between the fix and the worsening problem symptoms frequently results in that the connection between the fix and the increasing problem symptoms is hard to identify (Braun, 2002).

After studying the Fixes that Fail archetype, much of our work and interventions appear to be concentrated to the core in the system. Accordingly, our system dynamics is largely focusing on the variables *Interest for Greenhouse, Flow of People, Identity* and *Attraction*. But when observing the system in a holistic perspective and when the subsystem Environment is added to our system dynamics the periphery of the system is triggered and variables that not directly affect our district have thus come to play a more significant role. This indicates that engagement in the periphery parts is vital to succeed with the integration of a greenhouse in an existing urban area, for much affect it in a holistic perspective.

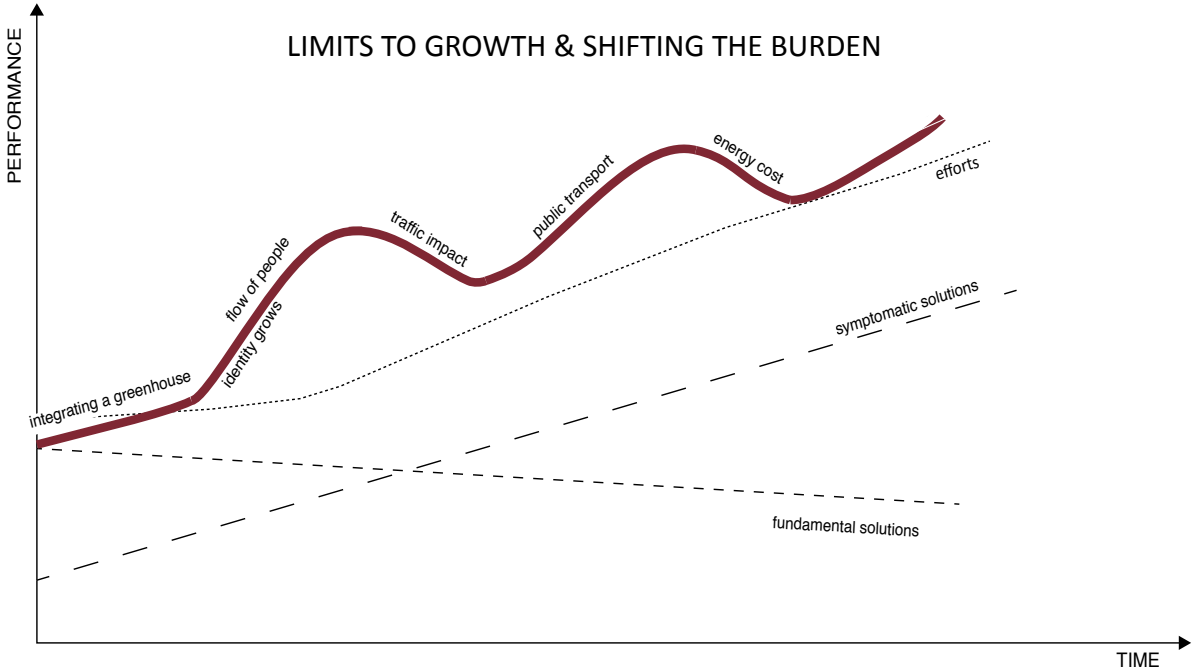



Figure 6.7: *Limits to Growth and Shifting the Burden*

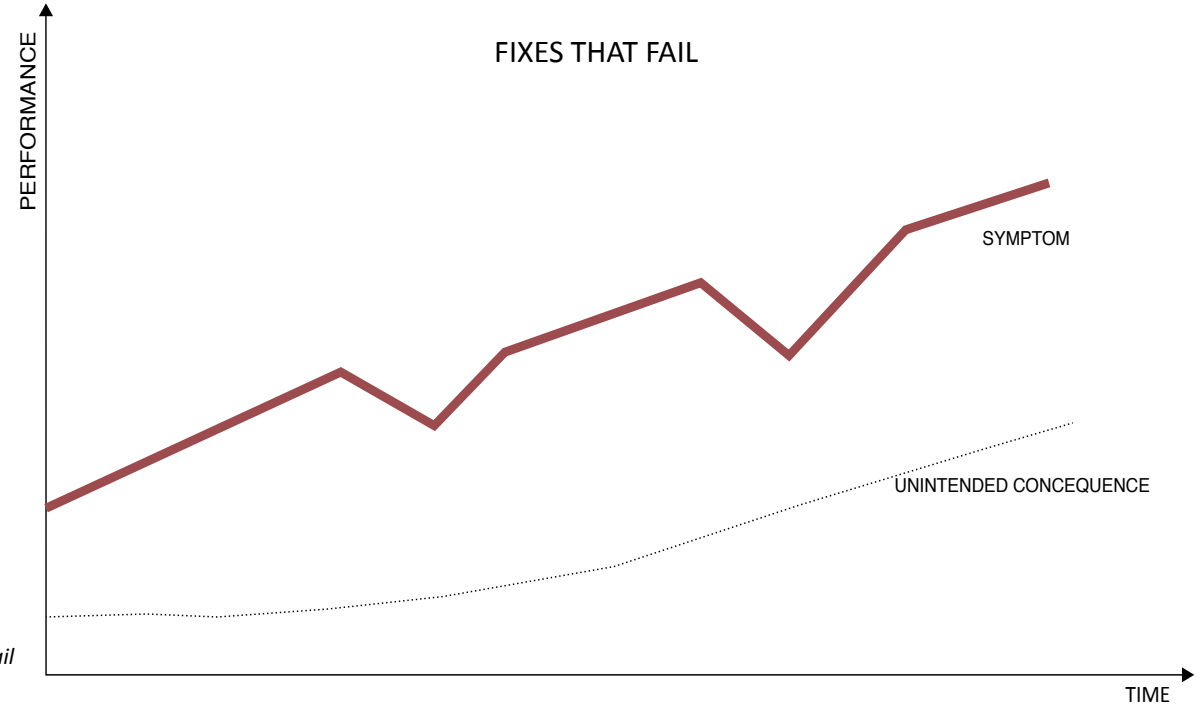



Figure 6.8: *Fixes that Fail*

# 7

# PROGRAMME PROPOSAL

The results from the research and analysis will in this chapter result in programme proposals for the chosen case areas, Skanstorget and Gullbergsvass.

# 7.1 PROPOSAL FOR SKANSTORGET

To start with, Skansstorget's plot is quite small, and may be unsuitable for a project of this size. However, in the future it may be possible to build greenhouses in smaller scale that will fit on plots of Skanstorget's size. Assuming that this will be possible, programmes that do not demand large spaces can be added in the greenhouse to integrate it with the surrounding neighbourhood. The neighbourhood has strong characteristics, making the need of increased identity not a vital issue. Furthermore, a good mixture of programmes and a high density of people and buildings make the need of new housing not of highest priority. Instead, many higher educational institutions are sited in the area, why collaboration with these is possible. Since the plot is also very central sited in the city and its closeness to the lively Linnégatan, an educational centre for all ages with restaurants and café facilities are added into the greenhouse. Given the history, a farmers market can be connected to the greenhouse since an indoor market was sited here before. The result will be a new central public space that interacts education and food. Skanstorget is a typical unused public space that can be found in many European cities.

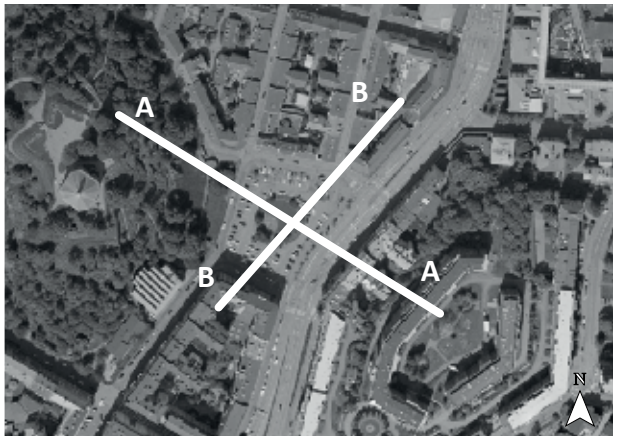
PROPOSING PROGRAMMES:

- Exhibition hall
- Education centre
- Vegetable shop
- Café/Restaurant
- Other necessary functions (toilets, reception)

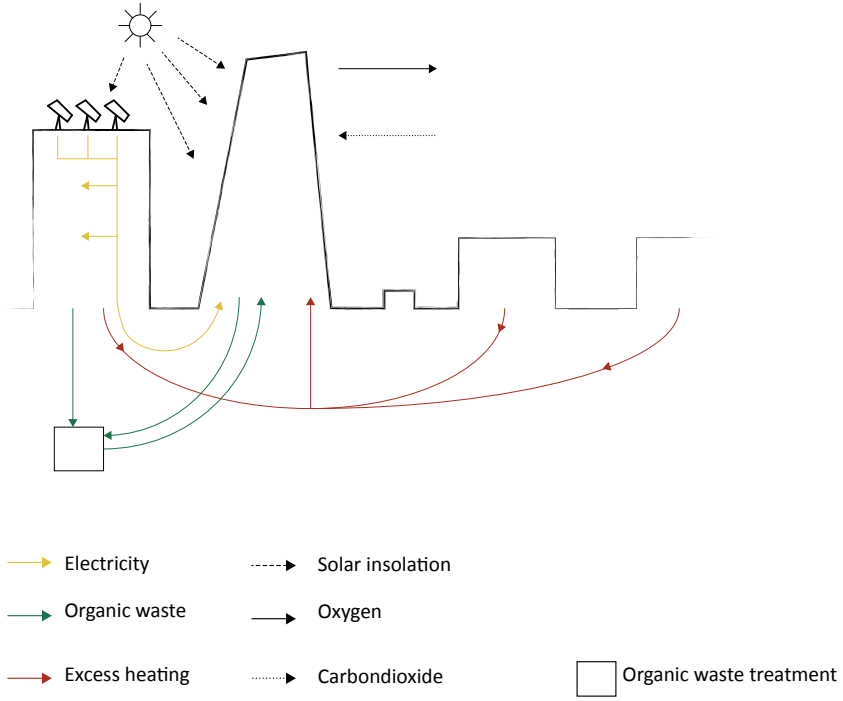
ENERGY EXCHANGE:

The illustration of section B-B illustrates the potential energy exchange when integrating a greenhouse on Skanstorget. Excess heating from close facilities and nutrients from organic waste via digesting systems will be used for operating the greenhouse. Additionally, solar panels are installed on surrounding facilities to sustainably produce electricity. Finally, the section illustrates the air exchange between the greenhouse and the city.

SECTION A-A AND B-B




POTENTIAL ENERGY EXCHANGE, SECTION B-B



PROGRAMMES TODAY

A-A

B-B

PROGRAMMES AFTER IMPLEMENTING GREENHOUSE

A-A

B-B

HOUSING

OFFICE

CULTURE

GREEN

EDUCATION

COMMERCIAL

URBAN AGRICULTURE

URBAN METABOLISM

INDUSTRY

PUBLIC TRANSPORT NODE

# 7.2 PROPOSAL FOR GULLBERGSVASS

Gullbergsvass is lacking in many of the social variables (i.e. Identity, Attraction, Flow of People) in our system dynamics and matrix. Much must be done here to increase the flow of people and density during the time after office hours. Although several major public transport junctions are located close to the area, Gullbergsvass is still difficult to reach. Hence, the area has enough space for many new programmes and more developed infrastructure. A greenhouse project in Gullbergsvass must however be a part of a greater urban regeneration project since existing businesses and city functions is not enough to generate an increased flow of people and for a greenhouse to operate its business. Even tough the area is a brownfield it still has some identity, i.e. Drömmarnas Kaj, and it is important to maintain the value adding parts of it. Gasklockan and a few industrial buildings sited here is very characteristic for Göteborg and should be emphasised. Avoiding gentrification and adding programmes that will strengthen the sustainable development of the area and sustaining characteristics features becomes essential when developing it to a new central area in Göteborg. Therefore, housing will be promoted and suggested partly in line to future flooding scenarios and the few existing boathouses.

According to the mentioned above, the area must be denser and activated during non-office hour. The greenhouse will therefore contain student housing to avoid condominiums and consequently gentrification. Moreover, the greenhouse contains a small day-care centre and a conference centre, for the western parts of Gullbergsvass is a big workplace for many people. Additionally, grocery stores selling fresh vegetables together with restaurants and cafés are to be found in it. Finally, the greenhouse will also contain education centres together with exhibition halls.

However, to few people live here, see matrix and calculations. In a long-term perspective, commercial facilities may not survive without enough customers. That is why a greenhouse project in the are should be a part of a greater urban regeneration project. However, the greenhouse could also only be used for industrial matters and distribute food (by train/boats/other sustainable solutions) to businesses. Hence, this is not Plantagon's vision and should not be the aim; they want their greenhouses to be an attraction for the people in the city.

PROPOSING PROGRAMMES IN GREENHOUSE:

- Exhibition hall
- Education centre/Science workshop
- Day-care centre
- Conference centre
- Vegetable shop
- Café/Restaurant
- Living (student housing to avoid condominiums)
- Other necessary functions (toilets, reception)

If a greenhouse should be integrated in Gullbergsvass many of the programmes and the city functions in the neighbourhood must be developed. Many barriers surround the area; new public transport stops (e.g. boat and tram stops) are therefore necessary to build over these and make the area pedestrian and bicycle friendly. To increase the opportunity for urban agriculture and to support greenhouse projects, the eastern parts of Gullbergsvass should be developed for this purpose. However, the ground is contaminated because of earlier industrial activities and is in need of sanitation. Today, some of the close industrial facilities contain smaller indoor market businesses. These businesses and facilities are developed to also contain farmers market and renewable energy sources, e.g. solar panels, are installed on their rooftops. Finally, the utilization of the river is also increased in new innovative forms: cooling system to the greenhouse and amphibian houses.

PROPOSING PROGRAMMES IN AN URBAN REGENERATION PROJECT:

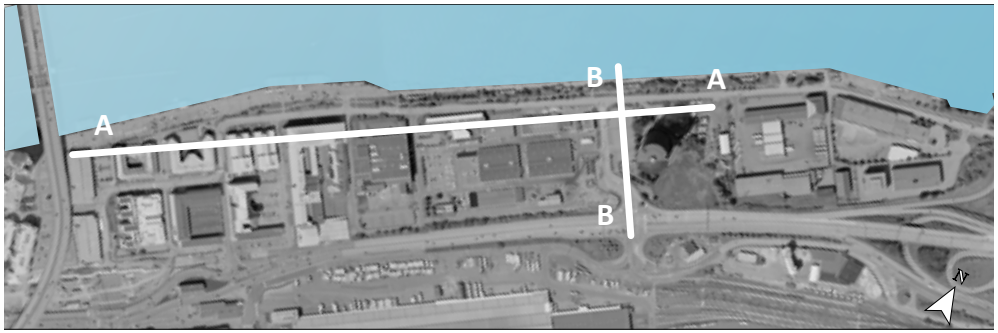
- Urban agriculture
- Farmers market
- Trams
- Public boat transport (to overcome the river/barriers)
- An easier connection to/from the central station
- Solar panels
- Remove contamination
- Amphibian houses
- Indoor market in existing industrial buildings
- Cooling system from the river

## ENERGY EXCHANGE

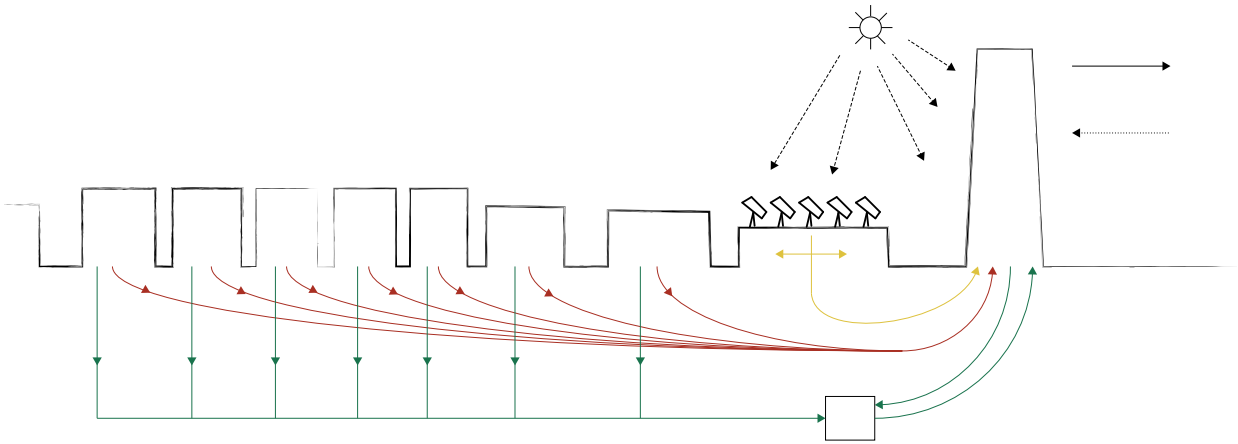
The illustration of section A-A illustrates the potential energy exchange when integrating a greenhouse in Gullbergsvass. Excess heating from close facilities and nutrients from organic waste via digesting systems will be used for operating the greenhouse. Additionally, solar panels are installed on surrounding facilities to sustainably produce electricity and deliver to the greenhouse and the surrounding buildings. Finally, the section illustrates the air exchange between the greenhouse and the city.

The illustration of section B-B illustrates the potential energy exchange and grey water recycling when integrating a greenhouse in Gullbergsvass. Cooling systems using water from the river Göta Älv will be installed to cool the greenhouse during hot days. Water recycling systems in connection to the greenhouse is also added to use grey water, e.g. rainwater, and to decrease the pressure on existing water systems.

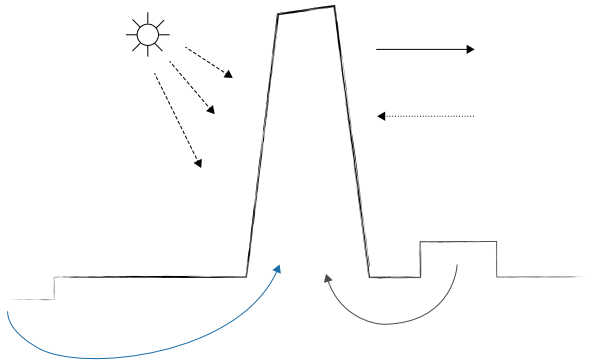
## SECTION A-A AND B-B




## POTENTIAL ENERGY EXCHANGE, SECTION A-A



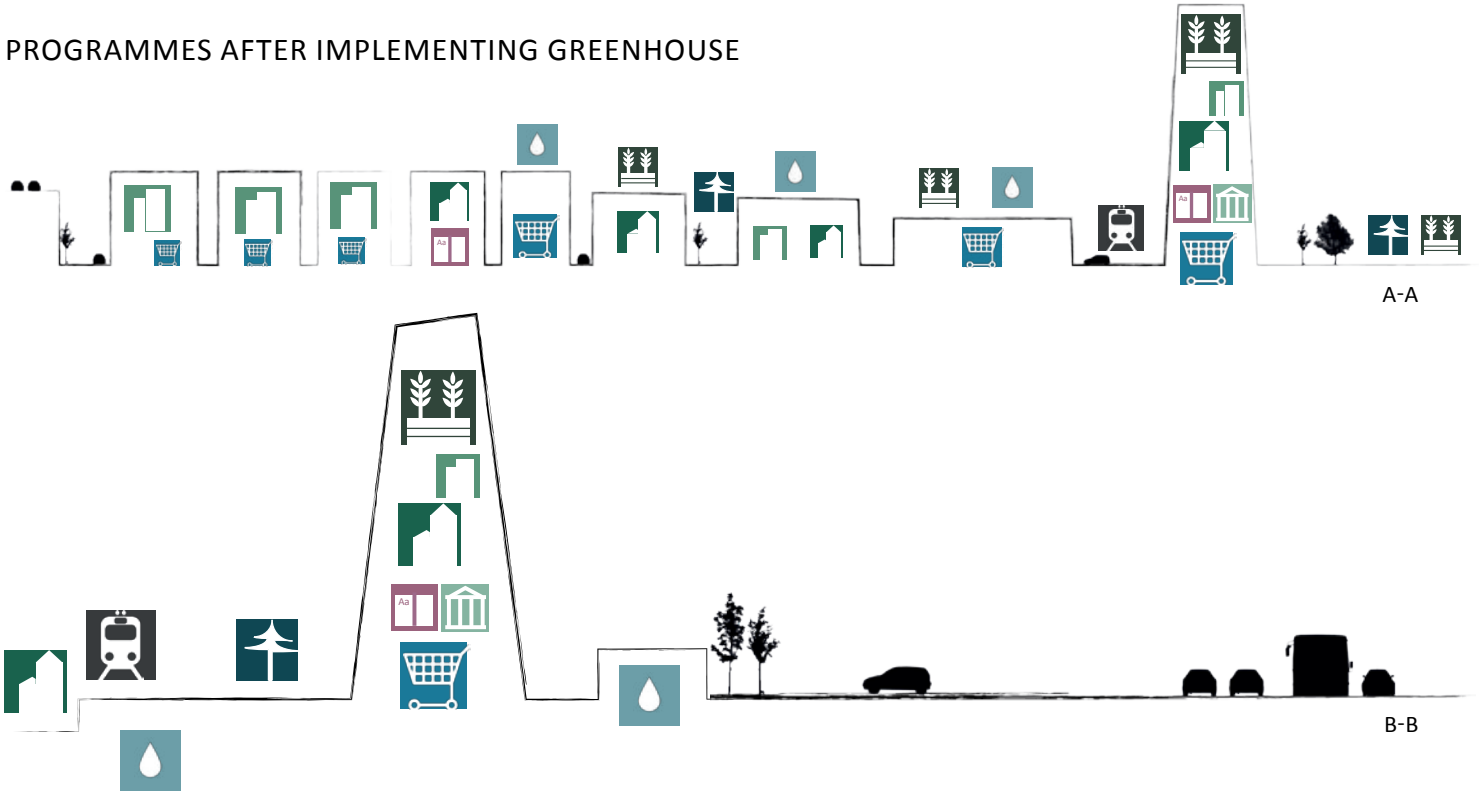
## POTENTIAL ENERGY EXCHANGE, SECTION B-B



Electricity
Organic waste
Excess heating
Solar insolation
Oxygen
Carbon dioxide
Cooling (Water)
Water recycling system
Organic waste treatment

## PROGRAMMES TODAY


## PROGRAMMES AFTER IMPLEMENTING GREENHOUSE




HOUSING

OFFICE

CULTURE

EDUCATION

COMMERCIAL

GREEN

URBAN AGRICULTURE

URBAN METABOLISM

INDUSTRY

PUBLIC TRANSPORT NODE

# 8 DISCUSSION

A city or neighbourhood is more than the sum of its parts, e.g. buildings, streets, blocks and squares. It also has a general unity and identity, which results from the design of its streets and the growing impact of its buildings. To understand this we must discuss urban design concepts such as landmarks, vistas and nodes. These are the elements that allow you to locate yourself within an urban area, provide points of orientation and store in your memory when you leave. When landmark buildings are planned, they are placed so that they can be seen from a distance along a vista and are often associated with a public space. According to the system dynamics, the neighbourhood regeneration will generate increased attraction for the area the greenhouse is sited in. However, as the behaviour over time graphs illustrate, system archetypes like "Shifting the Burden" will continuously claim its right because of the ignorance of the underlying problem. Yes, a major greenhouse project will increase the performance in the reinforcing feedback loops in the core of our system dynamics. Still, the effect will only be temporary if the fundamental solutions are continuously ignored. Moreover, the question how long a city can strengthen its attractiveness by implementing new fashions and concept is a question of time and quantity. For example, two Turning Torsos is one too much. When vertical farming is implemented in more and more cities, its value as landmark and a method of marketing a city will become less significant. It is important not to forget the real purpose of urban industrial vertical agriculture, i.e. to decrease the stress on the environment due to human activity.

Building a greenhouse in the city is a way to encourage the locally and ecologically produced food market. There is no one definition of locally produced food, confusing the consumer; hence, this is an issue that should be handled on national and regional level in countries all over the world. To enable consumers to make conscious choices when buying food, a clear definition and labelling of food should be implemented. Due to the energy and economic crisis in 2008-2010, a significant rise in food prices gave the world an indication of a future global food supply problem (Gorgolewski, 2011). Since the food price is often linked to the price of oil, one way of work-around the problem is to cut out the oil from the product chain, thus, stop transporting food long distances. This is Plantagon's strongest argument for building greenhouses in cities and one of many ways to tackle the issue. Even though the greenhouse concept is not yet finished or tested, we need to, as they say, act today only, tomorrow is too late.

One advantage with urban agriculture that is not within closed mechanic systems is that it reduce impacts related to high rainfall, increase water interception and infiltration in green open spaces, keeps flood zones free from construction and enhance replenishment of ground water (Dubbeling, 2011). These are issues many countries are dealing with at the moment, many times as a result of extreme weather due to global warming. By using rainwater as irrigation funds, the completion for fresh water between agriculture, domestic and industrial uses are reduced. Today, the Plantagon greenhouses do not have systems for grey water recycling, systems that should be integrated with the greenhouse for long term sustainable impacts. This will be especially vital in countries exposed to drought. We believe that individual buildings and complexes should produce renewable energy wherever possible to reduce reliance on costly fossil fuels and inefficient distribution systems.

The greenhouses are a way of highlighting the transportation issue, not only in the city where it is located but also globally in the world. As of today, food is produced outside the city; consequences are losses in the nutritional value, freshness and flavour reduced by pesticides, transports and processing. Reducing transportation would mean a less polluted city environment and less production of GHG's. As of today, a Plantagon greenhouse is designed to produce lettuce and leafy greens. These products will not in themselves generate a high flow of people and many times in brownfields, as in the case of Gullbergsvass, the amount of people living in the neighbourhood are to few to consume the greenhouse's production capacity. We would like to highlight the significance of the space in the greenhouse available for other purposes than cultivation, e.g. education, exhibitions and water treatment plant.

In Sweden and Göteborg, the loss of agricultural land for new development is small and availability of agrarian areas is big. Integrating urban industrial vertical agriculture in Göteborg that is located in a sparsely populated country can be understood as strange. Industrial greenhouses should rather be a source of innovation and learning about new strategies and technologies in Göteborg. Sustainable success depends on developing the thinking of policy-makers and urban agents. Plantagon wants their greenhouses to be a place for citizens to visit and with the space available for other programmes than cultivation, facilities to educate people about sustainable development and their companization can be located here. Plantagon's transparent organization culture means providing some insight into their thinking and considerations, so that those around can feel involved and empowered. It means that they transfer power to the individual through innovative human resource policies and practices, i.e. the companization. Furthermore, the construction's transparent facade gives you an insight of how the food you eat is processed. Together with pedagogical means Göteborg's inhabitants will learn about how the greenhouse's mechanical system work and how global food issues is related to their business. This increases people's awareness and engagement and can hopefully spread the word about the companiza-

tion, simultaneously as it is a new way for Göteborg to promote the city and a greenhouse could proclaim the seriousness of that.

However, urban industrial vertical agriculture shall also decrease people's transportation by car and distribution of food with unsustainable methods. If a greenhouse of this kind that is sited in urban areas cannot ensure access to it by public transportation than much of its purpose is lost. Many times, as in the case of Gullbergsvass, the people living close to this area is to few or lives too far away from it to consume the greenhouse full capacity. The greenhouse is then depended on developed infrastructure for pedestrian and bicycles and public transportation or sustainable ways of distributing the products to other businesses and regions.

In Göteborg, a greenhouse in itself, with only cultivating activities, would not be enough to be an attraction. Therefor it is important to add other functions to both the greenhouse and the surrounding neighbourhood to create a high flow of people. Moreover, the dimension of social impacts come and plays an essential role in the identity of a neighbourhood.

Today, density in urban areas is constantly discussed and has been associated with urban evils and used to justify clearance and redevelopment. In the report, "Planera för verksamheter" (2010), the municipality of Göteborg explain that the city has the lowest density of inhabitants compared to Stockholm and Malmö. Even compared with other Scandinavian metropolitans, Göteborg is sparsely populated. The municipality mean that Göteborg has potential to develop within existing built areas. However, there is a fear among some criticizers that the densification of urban areas will lead to "town cramming" and that it lowers quality of life. If town cramming means crowded streets and loss of privacy, then many of our towns and cities are crowded, and the solutions is to build more and with better design. Town cramming will only occur if we introduce new housing into cities, resulting in more traffic on streets if we do not promote walking and public transport, without rethinking the design of urban areas. As Gorgolewski et. al (2011) say, city centres often have a high density due to high cost of land, therefore building integrated production could provide food for the residents in these areas. Additionally, density is essential to the social and economic life of cities. Urban areas lacking in their development towards densification tend to loose variety and cannot sustain economic activity and shops, leading to streets with poor activity and public transport not sufficient enough to serve as an alternative to the car. We believe that regions, towns, neighbourhoods and buildings shall serve to maximise social interaction, economic and cultural activity, energy, creativity and time to contribute to a high quality of life and sustainability.

The case studies are focused in a Swedish context, where there is no shortage of agricultural land. Hence, in Sweden and other countries with the same preconditions, the main purpose of building a greenhouse is not to protect agricultural land, although in the future this might be at issue as well. On the contradictory, countries where population increases and cities grow exponentially, such as India and China, a greenhouse could save valuable agricultural land. If build on locations normally not used for agriculture, additional land would be added to the existing agricultural land of the area, hence, a greenhouse would enlarge the area dedicated for food production. Although, this is only true if no other exploiting of agricultural land is executed. A big problem is agricultural land being used for expanding cities.

There is a great potential with integrating a greenhouse on Gullbergsvass compared to Skanstorget. First of all, Gullbergsvass can provide us with the space we need to build a greenhouse on. With this space, opportunities to carefully study, manage and design programmes within the greenhouse is possible. The area is lacking activity and gives us a greater proportion to succeed with the integration. Our system dynamics shows that after implementing a greenhouse in an urban area, two reinforcing loops, i.e. *Attraction-Identity* and *Attraction-Flow of people*, will start to generate a growth in performance for the area being studied. However according to Braun (2002), the growth engine begins to lose its effectiveness and the rate of growth begins to stagnate. In our system, traffic influences will have great impact on the performance. As more people flow to the area as a result of implementing a greenhouse, traffic will increase and to some degree disturb the positive reinforcing behaviour of the neighbourhood regeneration. This outcome can be hindered when a brownfield like Gullbergsvass, which is in need for urban development and hold huge unused spaces, can be planned to also contain public transportation.

Brownfields require a well-developed public transport system so people in the city can reach the greenhouse through sustainable means. As mentioned earlier, if we cannot ensure sustainable travel, then much of the purpose, to decrease the transportation of food resulting in increased air pollution, is lost. Nevertheless, we believe that brownfields shall be redeveloped and alternative ways of producing food should be sited in these. But region must promote transit, pedestrian and bicycle systems to maximize access and mobility while reducing dependence on automobiles and trucks.

Building a Plantagon greenhouse is not a single purpose action. To integrate the greenhouse and encourage the local market a cooperation or collaboration with local farmers should be established, this could take the form of a farmers market

in connection to the greenhouse, or an interchange of products. In strive for sustainable development self-sustaining regions are the goal. Local labour and local business should dominate to local market, not only to decrease transport, but also to simulate the growth of the local economy and society. However, the complex design of the greenhouses might lead to the use of import of both labour and material for building. To ensure sustainability of the greenhouse, local resources should be used as far as possible.

Many people in the world, both in developing and developed countries, go hungry (IFAD, n.d.). Access to food is a basic function and not until this function fulfilled, further development of the society can start. The greenhouse can be a long-term solution in some ways, and a hindrance in others. Since developed countries are mostly importing, and developing countries are the main exporters of food and other goods, greenhouses implemented in developed countries could balance the resource movement. The principal problem of food security is that many people in the world do not have land to grow, or income to purchase, enough food (WTO, 2000). Using the greenhouses, developed countries themselves could produce some of the food, flowers or other farming products they normally import. This would emancipate cultivation land in developing countries that could be used for food production to be sold on the local market instead of producing products for export. Hence, transportation both globally and regionally will decrease.

The greenhouses in it self do not stimulate the job market nor the social needs in the society, two important building blocks in the striving for food security. This is negative in a democratic and social perspective, although, the Companization can empower communities if people in the region are members. Many urban agriculture projects are not just about food security but about community engagement, the projects bring people closer to each other, closer to nature and have an educative intent, at the same time as it is produces food. The Plantagon greenhouses will on one hand have a transparent organization and en educative approach, although no hands-on projects with the public will be realized in the greenhouse, and the connection to nature through growing crops will be lost. Further on, the members in the Companization will benefit from a strengthen community feeling, but the non-members will fall through the cracks.

In western countries today, the connection to food production and cultivation is somehow lost. Vegetables are bought in the store and few people cultivate their own food, or even know how to do so. Many other urban agriculture projects, such as community farming, roof top farming and guerrilla gardening, help people learn about growing and get knowledge about the natural systems, but since the greenhouses are strictly industrial with little human contact, this source of inspiration and knowledge is lost. On the other-hand the greenhouses will have educational facilities. Even so, the risk with this project is that food is getting even more mystified and distanced from people in cities. Although, since the idea of the greenhouses is to produce large quantities of food without the uncertainty of weather and climate factor, maybe the purpose, feeding the world, is greater than that people are involved in cultivating crop. In conclusion, the greenhouse concept might not develop the goals of individuals, but represent a major change for the masses.

Further on, one urban agricultural system, such as Plantagon's greenhouses, does not exclude other urban agricultural systems to establish in the city, quite opposite, it can inspire and open new doors to more urban agriculture. Since Plantagon's purpose is not to conquer out the local initiatives already existing, the implementation of a greenhouse could strengthen the preconditions of having a local market. The greenhouse can become a venue where people meet, and the investments would ensure a pleasant environment where outdoor markets with other actors on the market would complete the greenhouse.

As stated earlier in the report, the food security issue is a political issue. Plantagon is not a political company, although one could say they take a political stand introducing the Companization and the greenhouses to the world. Not unexpectedly, in 50 years or so, it might not be the greenhouses Plantagon is known for. Maybe, the most important addition to the world is the Companization and the statement of honesty itself that is the addition to the world.

To conclude the discussion, one must remember that many of the findings in our report are based on the assessments and assumptions of the authors. Specially the system dynamics, that is much dependent on the knowledge and experience the developer of it possess. The outcome can thus be different when other creates the system. We have made a generic model based on our own judgments and experiences. Finally, a critical evaluation of the methods used were made:

MULTI-CRITERIA DECISION ANALYSIS:

- The matrix is very generic in its progress
- Direct rating is a very qualitative approach of assessing
- Direct rating judgements can cause some problems of consistency in some circumstances where the assessing is to be done by different people

SWOT:

- Lack of prioritization of factors
- No suggestions for solving disagreements

SYSTEM DYNAMICS:

- Is much dependent on the knowledge and experience the developer of it possess
- The outcome may vary depending on who is creating the system
- A system dynamics diagram can become very complex with lots of variables

# 9 CONCLUSION

In the more dense society we are approaching, urban agriculture will become an important element in urban planning. Industrial Urban Agriculture is a new concept that will work as a supplement to traditional farming. However, cities in the size of Göteborg with the same characteristics are, as of today, not in a great need of greenhouse projects in the size of Plantagon's.

In the greenhouse, facilities to educate people about sustainable development and their companization can be located. Plantagon's transparent organization culture means providing some insight into their thinking and considerations, so that those around can feel involved and empowered. This increases people's awareness and engagement and can hopefully spread the word about the companization. Furthermore, since Sweden has great agrarian areas, the issue of how food is being transported within the country should be more prioritized than that of protecting agricultural land from exploitation.

Brownfields require effective public transport system so that people in the city can reach the greenhouse through sustainable means. As mentioned earlier, if we cannot ensure sustainable travel, then much of the purpose, to decrease the transportation of food resulting in increased air pollution, is lost. In the future, as the greenhouse technology is tested and developed further, perhaps smaller units that would fit on plots of Skanstorget's size and characteristics could be integrated.

The concept of Urban Industrial Vertical Agriculture is a fairly new concept and no projects have yet been built. Our studies are therefore very generic but from them we can determine that integrating greenhouses in a European context is a concept that needs to be further investigated. Although, according to our research, Plantagon's greenhouses will be a positive addition to the urban environment as well as globally. We believe that urban agriculture such as Plantagon's greenhouses can inspire and open up for new urban agricultural projects. The greenhouse can, besides from producing food, become a venue where people meet, and the investments would ensure a pleasant environment.

FUTURE STUDIES

Could temporary Plantagon greenhouse units, to be sited on empty plots in pending for redevelopment plans, be developed?

What demand is there on the flow of people in the area to assure that a greenhouse with grocery services can operate?

How will the result change if focus is put on other variables than *Interest for Greenhouse, Identity* and *Attraction*.

# REFERENCES

# BOOKS


Clegg, S., Krnberger, M. & Pitsis, T. (2008) *Managing & Organizations – An introduction to theory and practice.* London: SAGE Publications Ltd. (Second edition, p. 419-422)

Despommier, D. (2010) *The Vertical Farm.* New York: St Martin's Press. (First edition)

Fritz, M. (1996) *Göteborgs Historia – Näringsliv och samhällsutveckling, från handelsstad till industristad 1820-1920.* Stockholm: Nerenius och Santérus förlag AB

Gorgolewski, M.; Komisar, J. & Nasr, J. (2011) *Carrot city - Creating Places for Urban Agriculture.* New York. (p. 9-25, 54, 55, 100-109)

Gröndahl, Fredrik & Svanström, Magdalena. (2011) *Hållbar utveckling – en introduktion för ingenjörer och andra problemlösare.* Stockholm: Liber.

Lambertini, Anna & Leenhardt, Jacques. (2007) *Vertical Gardens –bringing the city to life.* London: Thames & Hudson. (p. 9-25, 54-55, 100-109)

Lappé, A. & Moore Lappé , F. (2004) *Diet for a Smaller Planet: Real Sources of Abundance.* Ch. 5 in the book *Feeding the Future – From Fat to Famine, How to Solve the World's Food Crisis.* Edited by Heintzman, A & Solomon, E. (2004). Toronto: Houses of Anansi press Inc.

Martinez, S. et al. (2010) *Local Food Systems: Concepts, Impacts and Issues.* ERR 97, U.S. Department of Agriculture, Economic Research Service.

Register, R. (2006) *Ecocities –Rebuilding Cities in Balance with Nature.* Gabriola Island, Canada: New Society Publishers. (Revised edition)

Rudlin, D. & Falk, N. (2009) *Sustainable Urban Neighbourhood – Building the 21st Century Home.* Oxford: Architectural Press. (Part. 3, ch. 10)

Senge, P. (2006) *The Fifth Discipline: The Art and Practice of the Learning Organization.* United States: Currency. (Second edition, ch. The Principle of Leverage)

The Wordwatch Institute. (2011) *State of the World – Innovations that Nourish the Planet.* New York: W.W. Norton & Co.

Thompson, A., Strickland, A.J., & Gamble, J. (2010) *Craftin & Executing Strategy -The Quest for Competetive Advantage -Concepts and Cases.* McGraw-Hill-

United Nations Human Settlements Programme. (2011) *Cities and Climate Change - Global Report on Human Settlements 2011.* Washington, DC: Earthscan.

Wackernagel, M. & Rees, W. (1996) *Our Ecological Footprint – Reducing Human Impact on the Earth.* Gabriola Island: New Society Publishers - The New Catalyst's (Ch. 9)

Yin, R. (2003) *Case Study Research - Design and Methods.* 3rd edition. USA: Sage Publications.


# ELECTRONIC BOOKS


Department for Communities and Local Government, London. (2011) *Multi-criteria analysis: a manual.* Wetherby: Communities and Local Government Publications. (p. 46-94)

Gorelick, Norberg-Hodge, Helena & Merrifield, Todd. (2002) *Bringing the food economy home – Local Alternatives to Global Agribusiness.* London: Zed Books.

Halweil, B., & Nierenberg, D. (2007) *State of the World: our urban future.* [Chapter 3: Farming the cities. Washington, DC: Worldwatch Institute

Hartley, Jean. (2004) *Essential Guide to Qualitative Methods in Organizational Research.* London: Sage Publications Ltd. (Second edition, ch. 26)

Moore Lappé, F. & Lappé, A. (2002) *Hope's Edge: The Next Diet for a Small Planet.* New York: Tarcher/Penguin. (Ch. 1 - Maps of the Mind)

Mougeot, Luc. (2006) *Growing Better Cities – Urban Agriculture for Sustainable Development.* Ottawa: International Development Research Centre.


# BROCHURE


Amend, T.; Barbeau, B.; Beyers, B,; Burns, S.; Eissing, S.; Fleischhauer, A.; Kus, B. and Poblete, P. (2010) *A Big Foot on a Small Planet? – Accounting with the Ecological Footprint, Succeeding in a world with growing resource constrains.* GTZ. Eschborn.

# ARTICLES AND REPORTS


Bohle, H. G., Downing, T. E., & Watts, M. J. (1994) *Climate change and social vulnerability: toward a sociology and geography of food insecurity.* Global Environmental Change. (vol. 4, issue. 1, p. 37-48)

Braun, W. (2002) *The System Archetypes.*

Carlsson, A., Palm V. & Wadeskog, A. (2006) *Energy use and CO2-emissions for consumed products and services. IPP-indicators for private and public consumption based on environmental accounts.* Sweden: Statistiska Centralbyrån.

Chambers, R. (1989) *Vulnerability, coping and policy.* IDS Bulletin. (vol. 20, issue. 2, p. 1–7)

Cheng, H. and Hu, Y. (2009) *Planning for sustainability in China's urban development: Status and challenges for Dongtan eco-city project.* Journal of Environmental Monitoring (issue. 12, p. 119-126)

Ciegis, R., Ramanauskiene, J., Martinkus, B. (2009) *The Concept of Sustainable Development and its Use for Sustainability Scenarios.* Inžinerinė ekonomika. (issue. 2, p. 28 -37)

Clarin, A., Jordbruksverket. (2010) *Hållbar konsumtion av jordbruksvaror – vad får du som konsument när du köper närproducerat?* (Report: 2010:19)

Common, M., and Perrings, C. (1992) *Towards an ecological economics of sustainability.* Ecological Economics. (Issue. 6, p. 7-34)

Food and Agriculture Organization (FAO), International Fund for Agricultural Development, World Food Program. (2002) *Reducing Poverty and Hunger, the Critical Role of Financing for Food, Agriculture, and Rural Development.* Rome. (p. 9-12)

Göteborgs Stad, Miljö. (2009) *Miljörapport 2009 -En beskrivning av miljötillståndet i Göteborg.* (Report nr. 2010:10)

Hand, M. S. and Martinez, S. (2010) *Just what does local mean?* The Magazine of Food, Farm and Resource (issue. 1st quarter 2010, 25(1))

Maxwell, D., Webb, P., Coates, J., Wirth, J. (2008) *Rethinking Food Security in Humanitarian Response*. Rome: Rethinking food security in humanitarian response international forum. (p. 16-18)

Meadows, D. H. (1999) *Leverage Points – Places to intervene in a system.* Hartland: The Sustainability Insitute.

Reid, H. E. (1994) *Characteristics, Causes, and Effects of Sprawl: A Literature Review.* Environmental and Urban Studies (Vol. 21(2), p. 1–15)

Reid, H. and Sattertwhaite, D. (2007) *Climate change and cities: why urban agendas are central to adaption and mitigation.* London: Sustainable Development Opinion, IIED.

Ribot, J. C., Najam, A., & Watson, G. (1996) *Climate variation, vulnerability and sustainable development in the semi-arid tropics.* Editors: Ribot, J. C., Magalhaes, A. R., & Pangides, S. S. Climate Variability, Climate Change and Social Vulnerability in the Semi-Arid Tropics. Cambridge.

Persson, G., Andréasson, J., Eklund, D., Hallberg, K., Nerheim, S., Sjökvist, E., Wern, L. & Åström, S. (2011) *Klimatanalys för Västa Götalands län.* (Report nr. 2011-45)

*Sieurin, E. (2011) Externa transportflöden angående ett eventuellt Plantagonväxthus i H+ området i Helsingborg -External transportation-flows surrounding a possible Plantagon green house in the H+ area in Helsingborg.* Göteborg.

Swanson, D., Pintér, L., Bregha, F., Volkery, A., Jacob, K. (2004) *National Strategies for Sustainable Development: Challenges, Approaches and Innovations in Strategic and Co-ordinated Action.* Eschborn: International Institute for Sustainable Development and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH.

World Economic Forum. (2010) *The Lissabon Review 2010 – Towards a more competitive Europe?* Geneva.

World Trade Organization (WTO). (2000) *Export Subsidies –Food Security or Food Dependency?* (p. 1)

## ELECTRONIC DOCUMENT


Argenti, Olivio. (2000) *Feeding the Cities: Food Supply and Distribution.* International Food Policy Research Institute. http://www.ifpri.org/ (2011-09-22)

Brundtland, G. H. (1987) *Our Common Future.* Oxford: Oxford University Press, for the World Commission on Environment and Development.

Csobod, É. (2011) *Food Safety.* Regional Environmental Center (REC) (2011-10-28)

Göteborgs Stad. (2010) *Planera för verksamheter.* http://www.goteborg.se (2011-10-27)

Danso, George & van Veenhuizen, René. (2007) *Profitability and sustainability of urban and peri-urban agriculture. Resource centers on urban agriculture & food security.* Rome: Ruaf foundation - Food and Agriculture Organization of the United Nations.

Dreben, A. (2009) *The Swedish food industry in a European context.* Malmö. (2011-10-28)

Dubbeling, Marielle & de Zeeuw, Henk. (2011) *Urban Agriculture and Climate Change Adaption: Ensuring Food Security Through Adaptation. Resilient Cities: Cities and adaption to climate change proceedings of the global forum 2010, Local sustainability 1.* Springer Science Business Media.

Ewing, R. (2007) *Is Los Angeles style sprawl desirable?* Chicago: American Planning Association. Journal of the American Planning Association (Vol. 63, No. 1, 1997)

Food and Agriculture Organization of the United Nations (FAO). (2010) *The State of Food Insecurity in the World - Addressing food insecurity in protracted crises.* Rome.

Schmidhuber, J. (2009) *Does the EU need a food security policy? Global Perspective Studies Unit Food and Agriculture Organization of the United Nations.* http://ec.europa.eu (2011-10-28)

The Congress for the New Urbanism CNU. (2011) *Canons of Sustainable Architecture and Urbanism.* http://www.cnu.org (2011-09-27)

The International Fund for Agricultural Development (IFAD). (no date) *Building the Resilience of Poor Rural Communities.* http://www.ifad.org/ (2011-09-21)

The World Meteorological Organization (WMO). (2011) *Urban Agriculture for Resilient Cities (green, productive and social included)*. http://ruaf.org/

United Nations Food Settlements Program (UN-HABITAT). (2009) *Report of the international tripartite conference on urbanization challenges and poverty reduction in African, Caribbean and Pacific countries.* www.unhabitat.org (2011-09-08)

United Nations Framework Convention of Climate Change, UNFCC. (2011) *Multi-Criteria Analysis (MCA).* http://unfccc.int/5440 (2011-10-24)


## WEB SITES


European Federation of Foodbanks (FEBA). (2009). http://www.eurofoodbank.eu/ (2011-10-31)

Eurostat. (2010) Population structure and ageing. http://epp.eurostat.ec.europa.eu (2011-10-27)

Greenwash Index (2011). About Greenwashing. http://www.greenwashingindex.com/ (2011-10-06)

Göteborg & co. (2011) Mat en trend i besöksnäringen. http://corporate.goteborg.com (2011-11-17)

Göteborg 2050 (2011). Hur skulle Göteborg kunna se ut om femtio år? http://www.goteborg2050.se/ (2011-10-28)

Göteborgssamhällets utveckling. (2011) Göteborgs förutsättningar. http://www.samhallsutvecklingen.se/ (28 Oct, 2011)

Peak Oil New York City. (2011) Peak Oil NYC - Urban Retrofitting. http://www.peakoilnyc.org/ (2011-10-27)

Pegasus Communication. (2011) The System Thinker. http://thesystemsthinker.com/ (2011-11-28)

Plantagon International AB. (2011) The Companization. http://plantagon.com (2011-10-29)

POV – Documenteries with a point of view. (2011) What is Gentrification? http://www.pbs.org/ (2011-10-31)

SWEDESD. (2011) Strong Sustainability. http://www.swedesd.se/ (2011-10-03)

System Dynamics Society. (2011) What is system dynamics? http://www.system-dynamics.org/ (2011-11-25)

World Health Organization (WHO) 3. Global and regional food consumption patterns and trends.
http://www.who.int/ (2011-10-27)