IIIEE Theses 2018:15

Green is the new Grey: Implementation of Nature-Based Solutions in urban areas

Exploring potential impacts, up-scaling and knowledge transfer

Frida Hansson

Supervisors

Kes McCormick

Björn Wickenberg

Thesis for the fulfilment of the
Master of Science in Environmental Management and Policy
Lund, Sweden, September 2018

iiiee
THE INTERNATIONAL INSTITUTE FOR
INDUSTRIAL ENVIRONMENTAL ECONOMICS

© You may use the contents of the IIIEE publications for informational purposes only. You may not copy, lend, hire, transmit or redistribute these materials for commercial purposes or for compensation of any kind without written permission from IIIEE. When using IIIEE material you must include the following copyright notice: 'Copyright © Frida Hansson, IIIEE, Lund University. All rights reserved' in any copy that you make in a clearly visible position. You may not modify the materials without the permission of the author.

Published in 2015 by IIIEE, Lund University, P.O. Box 196, S-221 00 LUND, Sweden,
Tel: +46 – 46 222 02 00, Fax: +46 – 46 222 02 10, e-mail: iiiee@iiiee.lu.se.

ISSN 1401-9191

Acknowledgements

So, by writing this section of the thesis my time at the EMP program and IIIEE has soon come to an end. It has been two challenging years bringing with them new experiences, friendships and insights into my own capabilities.

In the year of 2018 Sweden experienced the hottest summer in many years, water scarcity and wild fires served as reminders of the occurring climate change. As such, this paper along with the increasing quantity of research in the environmental disciplines are more important than ever as there are still those who doubt climate change. We still have a long way to go before we will have achieved sustainable living for everyone and everywhere, but I am convinced we can do it! However, we need more research to tackle sustainability challenges, and every single paper written serves as a contribution bringing us steadily closer to making it happen. I hope my thesis will be meaningful to you who read it, and that you may share and transfer this knowledge to those around you as well as to future contacts. Thank you for your interest and help!

This said I would like to thank my two supervisors Kes McCormick and Björn Wickenberg who have supported me throughout the thesis, especially in the beginning, helping me set the scope of the project as well as formulating research questions.

I would also like to express my gratitude to all the interviewees who openly shared their experiences and opinions, without you and your expertise this thesis would not have been possible. Some of you allowed me to follow up and ask additional questions several times and kindly allocated more time than have been asked or expected; thank you so much for this!

Lastly, I would like to thank the staff at the IIIEE institute and send the biggest hug to batch 23 which truly made my onsite year in Lund an unforgettable experience. Seldom you get as much support as you have given me, and I am so grateful for all the knowledge I have gained from you and promise that I will bring it with me into my next adventure.

Abstract

Nature-Based Solutions (NBS) is an emerging concept which has the potential to address several sustainability challenges. In this multiple case study research on three NBS projects in Gothenburg (Sweden) the projects objectives and evaluated impacts are studied to provide insights into how NBS interventions are implemented in urban contexts. In addition, barriers and drivers for up-scaling are identified and the influential factors for knowledge transfer are assessed. Information for this research was collected by conducting interviews with people involved in the three projects and the municipality of Gothenburg. Research questions were answered by applying cross-case analysis and two analytical frameworks, one derived from papers on influential variables of NBS pathways and one on how to facilitate effective knowledge transfer. The findings show that the NBS concept is not applied in the city and it is only in the last decade that other related concepts have started being integrated into development projects. Today the impacts of NBS interventions are usually assessed qualitatively and as such higher priority could be given to the maintenance and quantitative evaluations of projects. To enable up-scaling of NBS in the city, the local knowledge base and cooperation between the different departments in the municipality could be improved as well as increased focus on transferring gained knowledge from the NBS projects. Through stronger collaboration between all stakeholders involved, including citizens, together with adaptive governance, the city can use NBS interventions as a strategy to tackle prominent challenges in synergy with fast urban development.

Keywords: sustainable urban planning, nature-based solutions, knowledge transfer, green and blue infrastructure

Executive Summary

Problem definition and research questions: With an increasing percentage of people living in urban areas there is a higher need to address challenges experienced in cities such as a declining biodiversity, degradation, food scarcity and climate change. As the efforts of ensuring sustainable urban development and provision of ecosystem services have increased, Nature-Based Solutions (NBS) has become a concept to address multiple sustainability challenges by using nature. NBS has lately received more attention and is today a more frequently used concept in city planning and in mitigation and adaptation to climate change.

As an emerging concept, there is quite an extensive need for more research. Since the concept is not clearly defined it is difficult to assess the impacts of NBS interventions. More research is needed on identifying barriers and drivers for up-scaling NBS interventions as well as for enhancing knowledge transfer between projects.

This thesis focuses on the implementation of NBS interventions in three projects undertaken in Gothenburg, Sweden, by asking three main research questions;

- What are the objectives and evaluated economic, societal and environmental impacts of NBS projects in Gothenburg?
- What drivers and barriers are experienced in up-scaling of NBS?
- How is knowledge transfer facilitated between NBS projects?

Methodology: This thesis is structured as an exploratory embedded multiple case study. Research questions were formulated after a literature review of existing definitions of the concept and knowledge gaps in the field. Then 16 interviews were carried out, 12 were semi-structured and conducted either in person or over the phone. The remaining 4 interviews were unstructured and conducted over the phone, except for one where answers were given by email. Interviewees were mostly persons involved in the projects or employees at the different departments in the municipality. Information about Gothenburg and the different NBS projects was sourced online. Moreover, statistical data on NBS interventions in Europe, Sweden and Gothenburg were derived from a database created by the NATURVATION project.

The first research question is answered by cross-case analysis of the three different NBS project objectives and evaluated impacts. The second research question is answered by applying two analytical frameworks. One is adopted from two different papers by the NATURVATION project, where the same factors are identified to work either as barriers, drivers or both in up-scaling of NBS interventions. Knowledge transfer between NBS projects is explored by using an integrative framework and the theory of knowledge transfer. In the framework, four categories are recognised to influence effective knowledge transfer. These include- organisational culture, support structures, knowledge recipient and type of knowledge.

Key Findings: NBS has been found to not be a greatly used concept in the city of Gothenburg, where the municipality is mainly using related concepts such as ecosystem services, to enable sustainable urban planning and green elements in the city. Implementation of NBS such as green roofs and rain gardens did not start until quite recently and since NBS interventions have not been previously used and prioritised in the city planning the local knowledge base is lacking, but it is about to improve. Consequently, all three projects studied were pilot studies with an aim of generating learnings and knowledge meant to be used in future NBS projects, thusly stimulating the upscaling process of NBS.

Gothenburg has undertaken one of the largest development projects in all the Nordic countries, project River City. Consequently, the municipality has a great opportunity to increase greenery in the city provided they can successfully integrate NBS with the traditional urban planning, ensuring the involved stakeholders prioritise these solutions in the development projects. Today NBS interventions are already defined in an early planning stage yet they are easily lost throughout the project and need reinforcement at each stage of planning, implementation, maintenance and evaluation. The city has local legislation and strategic plans, which emphasise and support the implementation of NBS. The NBS interventions in the city implemented so far tackle the effects of climate change such as heavy rain falls. Solutions used in water management and sustainable urban drainage systems are therefore the most common NBS interventions in the city.

The objectives of NBS interventions have often been unspecified. This increases the risk of impacts assessments not being undertaken. With vague objectives, without addressing one or several challenges, there will be an increased risk of not knowing which assessments, and consequently which indicators, ought to be used when evaluating impacts. From visual qualitative evaluation, all three NBS projects provided more greenery in the city, and two have undergone quantitative assessments. However, an improvement on assessments of societal and economic impacts is needed. Today they are rarely undertaken unless there are significantly negative outcomes of a project such as in the case of Kvillebäcken where the problem with gentrification received considerable attention.

The same factors can work as drivers and barriers for upscaling NBS. In Gothenburg the institutional setup of the municipality has worked both as a barrier and driver. The organisational group formed to work with NBS projects is diverse and many different departments are involved, from the City Planning Authority to the Park and Landscape Administrator. This horizontal structure ensures knowledge transfer and collaboration between actors which are an important criterion for the implementation of NBS interventions. Yet a "silos mentality" has been discovered within different departments within the municipality. All the different departments have their priorities and some projects have lacked a project director with the overarching responsibility and a supporting structure to enable cross-functional collaboration. Key persons have been identified as important drivers of NBS interventions while mentality and cognitive factors have proven to be either strong barriers or drivers for NBS.

The knowledge transfer from prior NBS projects to new projects is insufficient due to the organisational groups which are made up by a vast range of stakeholders where the collaboration tends to be temporary. Once a project is completed there is a high risk of gained knowledge and experience being lost. However, knowledge transfer can be facilitated if evaluations of projects and gained knowledge are included in the project's budget and if tacit knowledge is transferred face-to-face, for example during workshops, meetings and guided tours. Other factors facilitating knowledge transfer is an open organisational culture and if there are key persons working as knowledge brokers who prioritise experimentation and learning. Moreover, the organisational structure should be horizontal to enable collaboration between the different stakeholders as this can strengthen mutual trust.

Conclusions: The urban development in Gothenburg is fast, and adaptive governance and flexible urban planning are required to implement the NBS interventions which provide several co-benefits. At present the city prioritises the implementation of NBS interventions more than maintenance and evaluation. Moreover, as the city is currently lacking local

expertise in use and implementation of NBS, knowledge transfer should be highly prioritised to ensure an increase uptake of NBS in the city. Recommendations are as follows:

- **Improvement of knowledge transfer and knowledge base:** The knowledge base and experience of how to use and integrate NBS interventions and on what benefits they can provide could be strengthened in the city. In each phase of the project process it can be beneficial to have an organisational culture which is open to learning and changing practices so as to include NBS interventions and identify ways of transferring knowledge.
- **Organisational improvements:** Silos-thinking is a critical problem which prevents the implementation of NBS. To enable a break up of "silos-mentality" NBS projects need committed and dedicated persons from each department in the project group. A dual ownership of projects between top management and dedicated project leaders with a budget stream allocated only to NBS projects would motivate the departments to prioritise cross-functional collaborations. In addition, evaluation of learnings and knowledge transfer could be planned at an early stage and have an allocated part of the project's budget.
- **Flexible projects with clear objectives:** It is important to undertake a complex balancing act between clear project objectives and flexibility. Changes occur fast, and because the contexts and the environment in which the projects are undertaken are not permanent the project themselves should be adapted and constantly questioned.

It has been identified that more research is needed on how to undertake impact assessments of NBS interventions with greater focus on economic and societal benefits. Moreover, there is a need to increase focus on the significance of different barriers and drivers and how the influences of those vary according to geographical contexts. This is necessary so that policymakers will know what and how to prioritise. Lastly, more research is needed concerning how tacit knowledge can be retained and transferred. Today tacit knowledge is mainly transferred interpersonally. However, careful documentation would greatly facilitate knowledge transfer whilst also rendering it more efficient.

Table of Contents

List of Figures

List of Tables

Abbreviations

BI- Blue Infrastructure

CWA- Circular and Water Administration

DSC- Delegation of Sustainable Cities

EbA- Ecosystem based adaptation/mitigation

EC- European Commission

ES- Ecosystem Services

GI- Green Infrastructure

IUCN- International Union of Nature Conservation

NBIS- Nature Based Innovation Systems

NBS- Nature-Based Solutions

NC- Natural Capital

PBOs- project- based organisations

PLA- Park and Landscape Administration

RBG- Region Business Gothenburg

R&I- Research and Innovation

SDGs- Sustainable Development Goals

SGBC- Sweden Green Building Council

TIS- Technological Innovation Systems

WRA- Water and Recycling Administration

1 Introduction

Today, more than half of the world's population lives in urban areas and the number is expected to increase to 65% by 2050 (Frantzeskaki & Kabisch, 2016). The trend of urbanisation poses challenges to prepare the cities for an increasing number of people while the efforts in improving and enabling sustainable urban development simultaneously must be strengthened (Haase et al., 2017). As more people move into cities, space is needed to provide housing and infrastructure, thus conflicting with the need for green and blue spaces, such as parks, rivers and trees. Today cities are already challenged with issues such as a declining biodiversity, pollution, degradation of resources, food scarcity, poverty and the need for improved health and wellbeing. These problems are likely to become even more severe as the cities grow denser with fewer green elements (European Commission, 2015; Hanson et al., 2017). Additionally climate change is having a substantial impact on human society with significant effects foreseen to be experienced in urban areas (Frantzeskaki & Kabisch 2016). As a reaction to those threats, "nature" has become increasingly acknowledged for its multifunctionality in addressing such challenges. There is an enhancing focus on how to achieve sustainable development in cities by the use of nature, focusing on the triple bottom line - economic, societal and environmental sustainability (Faivre et al., 2017).

The significance of securing and enable a sustainable environment has gained more importance over time (Nesshöver et al., 2017). The United Nation defined terms such as "sustainable development" in the late 1980's, "biodiversity" became a concept in conservation biology, and ecosystem services (ES) got attention in the late 1990's and is today a highly recognised, universal concept. In the last 20 years there has been a great variety of concepts used when managing natural resources and a greater focus has been directed towards how nature can bring value to humans (Eggermont et al., 2015; Nesshöver et al., 2017). The awareness and knowledge base concerning our dependence on resources and ecological provisioning[1] are becoming larger and more comprehensive (Millennium Ecosystem Assessment (MEA), 2005). Amongst different business communities today we see a heightened awareness of how to sustainably manage ecosystems as well as how to secure a long time supply of resources (European Commission, 2015). Moreover, there is increasing engagement from citizens and smaller communities, who want to re-introduce nature into urban areas.

One of the fast-emerging concepts used in this context is Nature-Based Solutions (NBS) which goes beyond traditional conservation biology and ecosystem management[2] (Cohen-Shacham et al., 2016). NBS not only focuses on how nature and ES can be beneficial to the society but also on how they can respond to several acute challenges, such as climate change, in the longer term (Eggermont et al., 2015). Conventionally grey infrastructure has been used in the organisation of cities to tackle one or several specific problems without necessarily providing additional benefits of environmental and societal character. NBS has the potential to provide multiple benefits and thusly solving several problems faced in cities (Hanson et al., 2017).

[1] One specific category of ecosystem services, "that describe the material or energy output of ecosystems. They include food, water and other resources." (The economics of Ecosystems & Biodiversity, n.d)

[2] Ecosystem management "is managing areas at various scales in such a way that ecological services and biological resources are conserved while appropriate human uses are sustained." (Brussard, et al., 1998)

One definition of NBS is formulated by International Union of Conservation of Nature (IUCN), *"Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits."* (Cohen-Shacham, 2016, p.5). Another commonly used definition is from the European Commission (EC) *"….aim to help societies address a variety of environmental societal and economic challenges in a sustainable way. They are actions which are inspired by, supported by, or copied from nature"* (European Commission et al., 2015, p.5).

NBS has the possibility to provide multifunctional benefits in terms of economic, environmental and societal. Examples of NBS in practice are the uses of greenspaces like parks and green roofs in cities (European Commission, 2015) (see Figure 1-1). They lower energy and resource consumption as they reduce temperatures, providing more comfortable living conditions in cities. Green areas also work in water retention and as such have the potential to replace traditional technology used in water management. Additionally, they act as carbon sinks and are used as mitigation strategies tackling climate change. (European Commission, 2015). Besides, they have an aesthetic value and carry importance on tourism and it is proven that living close to green areas has a positive effect on health and people's wellbeing (European Commission, 2015). Moreover, NBS interventions require high stakeholder involvement and expertise from many fields in both the design and implementation. The concept is therefore highly important in innovation-development and in stimulating new jobs and economies (Raymond et al., 2017).

Figure 1-1. Potential environmental, societal and economic benefits provided by NBS. In this case, the NBS is a green roof placed in an urban context.

Source: Inspired by Faivre et al. (2017)

As a relatively new concept emerging from nature conservation and environmental science in the late 2000s, NBS has so far no universal meaning (Kabisch et al., 2016; Cohen-Shacham et al., 2016). Despite this, NBS has in recent years received more attention both from policymakers as well as from scientists and how it can be used in mitigation and adaptation to climate change and in policy strategies of city planning (Raymond et al., 2017). The concept

has remained a grey area in many sources as a clear definition of the concept is mostly not stated. Only recently have scientific reports and articles started addressing NBS and more specifically how it can be applied in urban areas and to city planning (Potchin et al., 2015; Kabisch et al., 2016).

The EC is currently working with the EU Research and Innovation policy agenda on Nature-based Solutions and Re-Naturing of cities. This project is funded and implemented through Horizon 2020, the largest EU program for Research and Innovation (European Commission, n.d a; European Commission, n.d b). In one of the multiannual programs "Climate action, environment, resource efficiency and raw material, work program 2018-2020, the EC emphasizes and strengthens both the knowledge base on NBS and improves the up-scaling and replication of implementation of such solutions (European Commission, 2015).

The EC funded program has enabled many new research projects in Europe, for example NATURVATION (Nature Urban Innovation). NATURVATION is a four-year project where 14 European institutions seek to reach a better understanding of the true potential of NBS interventions and how they can be used for urban sustainability (Naturvation, 2017a). Despite an increased interest in NBS there is a gap between the theoretical benefits and possibilities of using NBS in urban planning, uptake and implementation of NBS. NATURVATION aims to address this problem. Another of EU-project is Urban Nature. This five-year project is funded by the Swedish Research Council for Environment Agricultural Science and Spatial Planning (FORMAS) (Lund University, 2018). The aim of the project is "to investigate the ability of NBS to simultaneously meet different urban challenges such as climate change and public well-being". This by conducting case studies in four Swedish cities- Malmö, Gothenburg, Helsingborg and Ystad.

1.1 Problem definition

As an emerging concept there is quite an extensive need for more research in several areas relating to NBS (see section 2.3 Knowledge gaps and current research projects). Despite a good understanding of the importance of natural systems and how these are comprised in NBS it is uncertain how to translate this knowledge into practice. Furthermore, the embedding of the concept into the existing policy mixes has proven to be difficult and problematic (Nesshöver et al., 2017). Likewise, there is a lack of knowledge transferred in the other direction - from practice to research and academia and how to retain knowledge learned in the implementation of NBS (Bulkeley, 2017). This makes it difficult to find specific frameworks and practices in how to implement and up-scale the use of NBS. Knowledge sharing and collaboration between different stakeholders such as municipalities, universities, communities and sectors, together with a greater number of examples of NBS implementation processes in different contexts seem vital to recognise the potential of NBS interventions and to ensure their true value is captured and understood.

Moreover the knowledge gaps concerning the assessment of NBS are significant in aspects of social, economic and environmental impacts (Frantzeskaki & Kabisch, 2016; Hanson et al., 2017). To give an example, it is often difficult to prove and assess how much a green park increases biodiversity or has an impact on people's wellbeing in the city where it is implemented. There is extensive on-going research related to co-benefits and impacts provided by NBS (Hanson et al., 2017; Raymond et al., 2017) however there is still a need to assess NBS impacts over a range of different challenges (Raymond et al., 2017). Societal impacts especially have been identified to need more empirical evidence, and how the implementation of NBS engages and involves citizens and communities.

Firstly, to provide empirical evidence of implementation of NBS interventions will enable an understanding of how NBS is used in practice and how it can be integrated into current policies and decision making, as well as contributing to research on how to enable implementation and assessment of impacts. Secondly, since the EC's objective is to increase diffusion and uptake of NBS interventions it is necessary to understand what significant factors are enabling their implementation and what potentially hinders their uptake. Answering these would consequently give support to stakeholders involved in the planning, implementation, maintenance and evaluation of NBS and contribute to research regarding what factors influence the implementation of NBS.

To summarize this section, one can conclude that;

- NBS is an emerging concept with the potential to address several challenges faced in urban areas, such as climate change. However, it is still in the process of being better understood by academics, policymakers and practitioners.
- There are many examples of different geographical contexts of implemented NBS interventions, yet no systematised or broader up-scaling are taking place (i.e. implementation is still performed on basis of individual projects).
- As such, the evidence-base on the social, economic and environmental impacts of NBS has to be strengthened and other related knowledge gaps need further exploration before its potential can be unleashed.

By addressing the above-mentioned knowledge gaps, this thesis aims to feed into two NBS-research projects, NATURVATION (European level) and Urban Nature (Sweden), by studying the implementations of three NBS projects in the second largest city in Sweden, Gothenburg.

1.2 Research questions

The overall purpose of this thesis is to investigate and analyse the implementation of NBS in urban areas in Gothenburg.

This thesis has three main research questions;

- What are the objectives and evaluated economic, societal and environmental impacts of NBS projects in Gothenburg?
- What drivers and barriers are experienced in up-scaling of NBS?
- How is knowledge transfer facilitated between NBS projects?

Firstly, the thesis will examine the implementation of NBS by looking at three examples of NBS in detail in the city of Gothenburg (Sweden). This will be through the examination of the objectives of these projects, evaluated impacts as well as the stakeholders involved in the implementation thusly enabling the projects.

Secondly, the drivers and barriers for up-scaling NBS interventions will be studied. Thirdly, it will be explored how new learnings and knowledge (potentially different than traditional practices) are retained and transferred between NBS projects.

Knowing that NBS is highly context-specific, and this is seen as one of the challenges in replicating NBS, this study will demonstrate the potential benefits of using locals' knowledge and successful examples of NBS together in order to create new ways of working, which enables implementation of NBS in more cities.

1.3 Scope

There have been several studies evaluating cities' integration and use of NBS in city planning, stating the importance of adaptation of NBS and how solutions vary from case to case (Kabisch et al., 2017; Eggermont et al., 2015). The geographical boundaries of this thesis are set through the selection of studying three NBS carried out in the second largest city in Sweden, Gothenburg. The rationale of selecting Gothenburg as context and the three projects as objects of study is presented in the methodology under the section called 3.2 Case selection process. Gothenburg is a city actively working to address sustainability challenges and has in recent years increased its efforts towards urban sustainability planning, currently undertaking one of the largest urban development projects in all the Nordic countries (Göteborgs Stad, 2012).

The three NBS projects can be seen as having temporal boundaries in that they have set start dates and specified end dates. Given by the aim of the thesis, only NBS intervention which were completed (Kvillebäcken being in its end phase) were selected as study objects. However, since the impacts sometimes need more time to be provided in NBS intervention the temporal boundaries for the three projects are in this thesis from start date up to today, when this study was carried out. The three NBS projects are presented in Figure 1-2.

Figure 1-2. The three NBS projects, being objects of study in this thesis. The first project is on a city scale where NBS interventions were used in the transformation of a district in the centre of Gothenburg, project Kvillebäcken. The second NBS project consists of the implementation of rain gardens in conjunction with construction of parking lots, project Kviberg. The third project is the implementation of a green facade by the property company Vasakronan.

Source: Kvillebäcken by author 2 September 2018, Rain gardens (Kviberg) by Tobias Hagman 3 July 2018 and Green facade (Vasakronan) by author 6 July 2018.

There are several definitions of NBS as a concept (this is presented in depth in the section called 2.1.1 Exploring the merging definitions of NBS) making it necessary to define the conceptual boundary of the study. The broader definition proposed by the EC is applied throughout the thesis, which is also the definition used in the two NBS projects this thesis aims to contribute to. Yet for the interviews with stakeholders other overlapping concepts with NBS were used since the concept itself is not well known in the city. Common concepts such as ecosystem services, green and blue areas, and green areas/elements were used as synonyms in the interviews as well as in sourcing data used in the Literature review and in the Description and Analysis section.

1.4 Limitations

Throughout the thesis several different limitations were identified which to a certain extent have influenced the study. Firstly, case study research approach has both weaknesses and strengths. The approach is a suitable research method when the object of the study and its units of analysis are clearly defined. However, when the object of study is a project this is rarely the case. In this thesis the boundaries for each project were set from when the project started up to current date, summer 2018. This boundary setting was needed since several impacts are potentially not provided by the NBS intervention until a period after the completion. Consequently, it is difficult to estimate the appropriate point in time to carry out a study addressing impacts and impact assessments of NBS interventions. If this study would have been undertaken in a few years, the study might have generated different results. Yet this is a fundamental component of case study research. The study is undertaken in a changing context and can consequently only consider what is known by the time it is carried out.

Secondly, the case study research requires a critical eye as different sources, such as published material and interviews, can be contradicting. Furthermore, contrasting to quantitative data collection, qualitative research poses the risk of reflecting only a few persons' opinions about a given situation. Even if the interviewees represent a variety of expertise and knowledge they are still just representing a few peoples' perceptions. Consequently, findings can vary depending on who was interviewed and therefore it is important to select interviewees wisely and always try to think critically if the person could be biased. It is important to highlight that there is a risk the people interviewed represent a homogeneous group where people with high engagement in environmental work is overrepresented. Since NBS requires expertise and participants who traditionally do not necessarily work in the sustainability and environmental discourse they should also be represented in the study.

Thirdly, statistical data only publicly available online was used from the Atlas by NATURVATION (Naturvation, 2017b). The report Almassy et al. (2018) presents how the data was gathered, methodology and rationale for identifying and selecting cases. Yet, being a project undertaken by several people, there is a high likelihood that the material was sourced in different ways depending on the person sourcing the information. For example, the method of searching for cases as well as time spent can differ among researchers. Moreover, some of the published material was not in accordance with reality (only noticeable for the three cases which were studied in detail). Therefore, there is a high risk that the quantitative database is not always comprehensive and, in some cases, not updated. Preferably more time should have been allocated on gathering and analysing the data. To give an example: in the database project Kvillebäcken was identified to only have two domains of NBS interventions while in real life all six most common domains were present in the project. This highlights the importance of combining quantitative- and qualitative methods to get a comprehensive and reliable understanding of NBS implementation.

Moreover, it would have been preferable to have the same number of projects when comparing NBS interventions within the three geographical scales, Europe, Sweden and Gothenburg. Currently the conclusions drawn from the comparison between the three geographical scales must consider that there are almost 1000 interventions studied in Europe whilst only 31 are being used for statistics in Sweden and 10 total in Gothenburg. Moreover, it is important to draw attention to the fact that the statistics on Sweden and Gothenburg are also counted in the European statistics and the same is true in how Gothenburg's projects represent almost a third of the all projects in Sweden. As such, when comparing the geographical scales, they have several NBS projects in common, and the same projects are "counted" several times. For example, projects undertaken in Gothenburg are counted three times, on all the geographical scales.

1.5 Ethical considerations

Much consideration was given to the requests and respect of the interviewees. Before any interview was conducted permission to record was given by the interviewee. In addition, all the interviewees were asked whether they would prefer to stay anonymous in the written report or if their name could be used. Consequently, some of the persons which are referenced are not named. By the time the thesis started to be finalised, the persons directly cited in the study were emailed their citation to get approval. Only approved citations were used in the text.

1.6 Audience

This study intends to serve a broad audience; to anyone interested in NBS. However, it will primarily be useful for research regarding the implementation and up-scaling of NBS interventions. It will also serve the two larger projects NATURVATION and Urban Nature as well as the city of Gothenburg and stakeholders involved in the three different NBS projects examined. Hopefully, the thesis will help to get a clearer picture of how the design and implementation of NBS in practice serve governments, agencies and stakeholders involved with the process.

1.7 Disposition

The outline of the thesis is as follows;

Chapter 1, presents an overview of the problem addressed, the purpose of the study, research questions, scope and limitations. Lastly the ethical considerations are presented, and the audience of the paper.

Chapter 2, the literature review presents existing definitions of NBS and its relation to other concepts used in ecosystem management, followed by weaknesses of the concept, current research on the concept and current knowledge gaps, collaborative structures in the use of NBS and lastly knowledge transfer theory and how it can be used in the field of NBS.

Chapter 3, outlines the methodology. It presents the multiple case study approach and how the three cases were selected. It gives more detailed information on how interviews were conducted, and a presentation of the analytical frameworks used.

Chapter 4, presents the description and analysis. Firstly, the statistical data derived from the database by NATURVATION, secondly the background information about the city of Gothenburg and thirdly the presentation of each NBS project. Each project presentation is divided into the units of analysis, defined as; objectives, drivers, implementation, barriers and obstacles, impact amassment, new practices and learnings.

Chapter 5, the discussion links the thesis research questions to the description and analysis. Through a cross-case analysis, the different NBS project objectives and evaluated impacts are compared. Then drivers and barriers for up-scaling NBS are identified by applying an analytical framework and lastly the facilitation of knowledge transfer is studied by applying an integrative framework together with knowledge transfer theory.

Chapter 6, presents the main conclusions of the thesis, explains how the work contributes to the existing literature on the topic, and then provides recommendations to the municipality and for research in the field.

2 Literature review

This literature review consists of background information on the definition of NBS and potential weaknesses of the concept. This is followed by a presentation of current knowledge gaps and research on the topic, which focuses on efforts by the EC. Collaborative relationships in the use of NBS is then presented and lastly a section on knowledge transfer, meant to strengthen the theory behind knowledge transfer between NBS projects. The rationale of the literature review is further presented in the methodology.

2.1 Definition of NBS

As a concept without a universal definition, this section presents existing definitions of NBS and how the concept relates to other concepts used in ecosystem management. Moreover, different categorisations of NBS are explored.

2.1.1 Exploring the emerging definitions of NBS

NBS is an emerging concept which has gained increased recognition in recent years (Eggermont et al., 2015; Nesshöver et al., 2017). Commonly technological approaches are put forward as means for tackling different environmental problems. However, nowadays an alternative field is given more and more attention where nature is seen as providing possible solutions to many environmental challenges (Nesshöver et al., 2017). NBS uses comprehensive approaches of socio-ecological systems- complex, self-organising systems with high mutability- aiming to sustain and increase the recognition and value of ecosystem services (ES). The idea behind NBS is to use nature to deal with societal and environmental problems, making use of the multiple benefits nature serves to humans.

In late 2000 NBS acquired more advocates when new solutions for climate change adaptation and mitigation were sought. Subsequently the concept was brought forward by the International Union of Nature Conservation (IUCN) (Cohen-Shacham et al., 2016). After this the concept has become broader, and is today promoted by EC, as a concept that also addresses societal challenges. NBS is perceived to be overlapping and complementary to many other concepts, such as ES and Green/Blue infrastructure (GI/BI) (Eggermont et al., 2015; Cohen-Shacham et al., 2016; Nesshöver et al., 2017). However, it brings new elements in that it focuses on the long-term benefits of the solutions rather than the short-term ones which helps support the transition forwards more sustainable urban planning (Faivre, et al., 2017).

The concept is today used inconsistently, and it has a conceptual flexibility that might increase the risk of the term being misused by people managing natural resources (Cohen-Shacham et al., 2016; Kabisch et al., 2016; Nesshöver et al., 2017). As such, efforts have been made to delineate the definition in order to establish it among policymakers and city planners.

Potschin et al. (2015) points out the risk with unspecified concepts and the importance of consistency when using them to bring meaning. However, the authors also argue that an open and flexible definition might encourage a broad variety of stakeholders to get involved in the use and design of NBS. Looking at NBS used in practice, local expertise (from a range of stakeholders) is of essence to get a successful implementation.

Potschin et al. (2015) further highlights how the EU's Horizon Research Programme has several definitions and addresses how NBS is used in industrial design and biomimicry[3] where designers and researchers learn from nature rather than finding solutions and strategies based on nature. The authors identify three components, which can be included in a definition just by unpacking its different elements;

1. Nature: Is in the report defined as biodiversity in aggregated- and individual form (ecosystems vs species).
2. Nature-based: They refer to as ecosystem approaches, biomimicry and utilisation of components of biodiversity.
3. Solutions: There must be some kind of problem to be solved.

In this literature review, four papers were used to explore the definition of the concept of NBS (see Figure 2-1). There are several different versions of the definition given by the EC, thus this definition is one out of several. There are other sources addressing definitions of NBS and what they consider are important elements, however they all mainly refer to those

The European Commission: "…aim to help societies address a variety of environmental, societal and economic challenges in a sustainable way. They are actions which are inspired by, supported by, or copied from nature". (European Commission, 2015, p.5)

IUCN: "Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al., 2016, p.5)

Maes & Jacobs: "any transition to a use of ecosystem services with decreased input of non-renewable natural capital and increased investments in renewable natural processes" (Maes & Jacobs, 2015)

BiodivERsA: "NBS refers to the use of nature in tackling challenges such as climate change, food scarcity, water resources, or disaster risk management, encompassing a wider definition of how to conserve and use biodiversity in a sustainable manner. By going beyond the threshold of traditional biodiversity conservation principles, this concept intends to additionally integrate societal factors such as poverty alleviation, socio-economic development and efficient governance principles" (Balian et al., 2014, p.5)

Figure 2-1. The four existing definitions, 1) European Commission 2) IUCN 3) Maes & Jacobs 4) BiodivERsA.

[3] "Biomimicry is an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies. The core idea is that nature has already solved many of the problems we are grappling with." Biomimicry Institute (n.d).

four definitions.

Source: Author's own elaboration

The EC has as previously mentioned integrated the concept in a new programme within Horizon 2020. The concept stated by IUCN promotes nature as a provider of solutions to climate adaptation and mitigation challenges. BiodivERsA is a network researching biodiversity and ES in Europe and is funded by the EU's Horizon 2020 Framework Programme for Research and Innovation (biodiversa, 2018). The definition appears in the Strategic Foresight Workshop (Balian et al., 2014). The last definition is established by two authors involved in NBS research and the article looks at and refers to the European Commission and Horizon 2020.

Even if the four definitions have several similarities they also entail clear differences. All four definitions highlight how NBS uses nature and/or ES. Three of the definitions state how NBS is used to tackle societal challenges (Maes & Jacob's definition is an exception, since their definition does not state that NBS is used in response to challenges, however it is implicitly stated when they describe NBS in their paper).

IUCN's definition introduces the idea of using NBS as mitigation and adaptation solutions to tackle problems such as climate change and future food scarcity. IUCN's definition moreover implies to view solutions as both natural systems (without human intervention) and solutions with engineering interventions. The EC's definition is the broadest, and defines NBS as all actions supported, inspired and copied from nature. The EU definition so forth incorporates biomimicry, industrial design and innovation as a part of their definition of NBS. Innovation is something which is further addressed in the definition by Maes and Jacobs (2015) who emphasise that NBS can be used as a transition to the use of ES. The definition by BiodivERsA is clearly distinguishing NBS from earlier concepts used in conservation and environmental protection and stresses the importance of conserving natural systems to later use them in provision of goods.

2.1.2 Understanding the relationships between NBS and ecosystem management

Many sources of literature describe how NBS is highly supported and interrelated to other concepts used in ecosystem and environmental management, highlighting that NBS is one of many concepts in the field (Faivre et al., 2017; Kabisch et al., 2016; Nesshöver et al., 2017). Here is given descriptions of some of the most frequently used concepts in relation to NBS, the potential overlaps and complementation.

Ecosystems Services (ES): NBS's in relation to ES is highlighted in many of the literatures addressing conceptualisation of NBS. In Chaudhary et al. (2015) it is explained how the ES, as a concept, emerged from the increased concern about degradation and depletion of earth's resources. Today it is widely used in policymaking to evaluate and protect the environment. The highly cited article by Costanza et al. (1997) provides a foundation on how to define the value of ES. In the article it is concluded how ES has greatly contribute to welfare. The authors estimate the approximate value of all ES by looking at the cost of replacing current systems, such as how much does it cost to replace all the services we get from trees estimating values like clean air, oxygen etc. Their conclusion is that ES is irreplaceable and future scarcity

of many resources will generate major challenges. According to MEA (2005) ES can be defined as "the benefits people obtain from ecosystem services". These benefits include provisioning services (food, timber etc), regulating services (services affecting flooding, climate change etc), supporting services (carbon cycle, soil formation etc) and cultural services (aspirational and educational etc). ES relation to NBS is today seen, for example in urban planning where ES needs to be operationalised through other concepts such as NBS or Green infrastructure (Kabisch et al., 2016).

Green/Blue infrastructure (GI/BI): According to EC (2014) GI/BI is "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services" In practice this can result in green spaces (or blue if they are water ecosystems) such as trees, parks etc are incorporated into the traditional infrastructure in cities. GI and BI can provide multiple benefits such as protecting biodiversity, increase air quality and work for disaster risk reduction (European Commission, 2014). According to Nesshöver et al. (2017) the two concepts, NBS and GI/BI, are similar and can sometimes be used as synonyms, even if there is a difference in "infrastructure" and "solution." According to Kabisch et al. (2016) GI is the concept that is mostly used in urban planning to integrate and use NBS and ES in cities.

Natural capital (NC): Can be defined as "The world's stock of natural assets which includes geology, soil, air, water and all living things" (World Forum on Natural Capital, n.d). However, there are many different definitions with different scopes. NC helps understand the role of nature in meeting the need of humans and societies and can therefore be used to favour the implementation of NBS (Nesshöver et al., 2017).

Ecosystem based adaptation/mitigation (EbA): Can be defined as "The adaptation policies and measures that take into account the role of ecosystem services in reducing the vulnerability of society to climate change, in a multi-sectoral and multi-scale approach" (Nesshöver et al 2017, p. 1219). EbA should be a part of NBS to secure the solution is "climate change adapted" (Kabisch et al., 2016).

2.1.3 Drawing the line for what is NBS

As an umbrella concept, NBS has in its definitions challenges regarding where to draw the line as to what can be considered natural and nature (Nesshöver et al., 2017). Some of the solutions might include significant involvement of human intervention, such as biomimicry, which refers to technology and solutions only inspired by nature without necessarily using nature.

Several reports have categorised different NBS depending on 1) the involvement of engineering and 2) to what degree the maximisation of delivery of key services can be achieved by an NBS (Cohen-Shacham et al., 2016; Eggermont et al., 2015; Balian et al., 2014). This results in ***three types*** of NBS (see Table 2-1). As the level of engineering used in the intervention increases, the maximisation of the delivery of key services increases. However, if the number of services and stakeholder groups targeted by the NBS is higher, the maximization of delivery of key services decreases (table 2-1, the case for type 1, with low human intervention).

Table 2-1. The three different types of NBS.

Type	Description

1	This group includes NBS with no or minimal engineering intervention in ecosystems. An example is the protection of mangroves, which give values and ES just by their existence. They act as carbon sinks, as important aquatic habitat and as a storm barriers and sediment trap.
2	This type of NBS involves engineering. Management is used to accomplish and gain more of selected ES than would have been obtained with only protection of ecosystems. It can be innovative planning of how to obtain several benefits from a specific forest or a piece of land. This type is linked and associated with concepts such as evolutionary- oriented forestry, agro-ecology etc.
3	In this category NBS is on the spectrum of what can be seen as artificial ecosystems (changed and adapted so they enhance desired services and characteristics), used for example in blue-and green infrastructure. These are used as solutions in heavily polluted areas where a maximization of key ES is of importance such as improving air quality or mitigating temperature rises in cities.

Source: Author's own elaboration

2.2 Weaknesses of NBS concepts

Even if NBS is advocated predominantly as solutions which brings multiple benefits they can bring several so-called ecosystem disservices (Haase et al., 2017; Kabisch et al., 2016). These are ecosystem functions which can be recognized as negative and unwanted. For example, it is possible that a higher number of green areas such as parks increase the number of mosquitoes in urban areas, which increase the risk of infectious diseases and generate more pollen, causing problems for those who are allergic. In Nesshöver et al. (2017) it is questioned if there is a way to include every possible pros and cons when using NBS. NBS interventions bring multiple impacts and because of this there exist trade-offs. Moreover, in Balian et al. (2014) they argue how few 100%-win situations exist and how most situations will have implications. Consequently, it is important to clearly decide which services should be prioritised to ensure the NBS intervention will result in greater benefits than potential side effects or unwanted impacts. Since NBS are living systems it is difficult to find "simple" and clear solutions.

Many studies show how green areas and nature have positive effects on people's health (Amoly et al., 2014; European Commission, 2015; Krekel et al., 2016), and therefore it is important to use NBS in such a way that it becomes inclusive and available to all social groups (Kabisch et al., 2017). The implementation or restoration of green spaces can increase the risk of higher rents due to improved attractiveness of the area which in turn causes some social groups being displaced and subsequently excluded from enjoying the benefits provided by NBS. This problem has been experienced in different cities and are referred to as environmental or ecological gentrification (Haffner, 2015; Kabisch et al., 2017). To prevent this, it is important to develop new modes of governance.

The additional costs which might be associated with the use of NBS are something which can be described as a weakness of NBS. Nesshöver et al. (2017) describe how it is important to keep moderate expectation on NBS as the projects tend to be expensive and laborious. However, Nesshöver et al. (2017) argue that it depends on whether the implementers consider the feasibility in short- or long-terms and what actual services and functions are given by the solution.

As mentioned NBS can bring multiple benefits and be used to tackle challenges and promote nature. However, according to Nesshöver et al. (2017) the concept entails the risk of overselling nature. NBS should not be perceived as a completely substitutable solution of

many other traditional approaches but should in many cases be combined with traditional solutions – so called hybrid solutions (Cohen-Shacham et al. 2016).

Another potential drawback with NBS is the time-frame in which the benefits can be perceived. Since the solution is based on nature and natural processes, the short-term benefits can be lower compared to other conventional technologies (Balian et al., 2014). Some benefits might not be provided until after a longer period of time. This can be a significant aspect causing replacement of NBS where there are time constraints and where improvements are urgent.

2.3 Knowledge gaps and current research projects

The EC has made a new Research and Innovation (R&I) policy to enable more research around NBS and its possible use (Faivre et al., 2017). Previous concepts address many of the more short-term gains and have tackled problems more from a distinct perspective and through the lens of one particular field. EC believes that NBS will be a platform for new innovative structures and approaches, important in the transition from a resource intensive society to a sustainable and resource efficient one. EC has emphasized the societal benefits of NBS and highlights how impacts from NBS interventions can fulfil several Sustainable Development Goals (SDGs) (Faivre et al., 2017). For example, SDG 3 (good health and well-being) can be achieved by increasing green areas in the city. Likewise, NBS can contribute to achieving SDG 11 (sustainable cities and communities) as well as SDG 6 about sanitation and clean water.

As an emerging research field NBS provides many opportunities for future research (Cohen-Shacham et al., 2016; Faivre et al., 2017), and several of these knowledge gaps are addressed in the literature (see Table 2-2).

Table 2-2. Current knowledge gaps which are highlighted in papers.

Knowledge gaps	Nesshöver et al. (2017)	Raymond et al. (2017)	Cohen-Shacham et al. (2016)	Faivre et al. (2017)	Kabisch et al. (2016)	Balian et al. (2014)
Delineation of the concept	x		x			x
Translate the knowledge into action (operationalisation) (mainstreaming)	x	x	x	x		
Distinguish NBS from grey solutions		x				
The effectiveness of NBS (environmental, societal and economic)		x		x	x	x
Barriers, opportunities and drivers for NBS					x	x
Trade-offs and synergies between services		x				x
Evaluation of stakeholder involvement and communication (How to involve actors and the public)	x	x				x
Temporal and spatial scales		x			x	x
Governance and management of NBS						x
Political and social resistance to changes from using NBS						x

Source: Author's own elaboration inspired by Udomcharoenchaikit (2016)

The need of **delineation of the concept** is commonly discussed (Cohen- Schacham et al., 2016; Nesshöver et al., 2017). Kabisch et al. (2016) arranged a workshop focused on NBS with participants from different relevant fields. Knowledge gaps in the current understanding and use of NBS were discussed at the workshop, which resulted in a categorisation of the gaps and four identified categories for future research; i) **effectiveness of NBS** ii) **NBS and society relation** iii) the **implementation of NBS** and iv) the **design of NBS**. These are all rather broad categories and Kabisch et al. (2016) specify research gaps within the categories. As an example, in the category called NBS and society relation, they formulate specific knowledge gaps such as on **stakeholder involvement**, **trade-offs** in the use of NBS and on how to communicate the negative and positive impacts.

One commonly addressed problem in regard to NBS is the **lack of assessment and evaluation** of the impacts (Balian et al., 2014; Kabisch et al., 2016; Raymond et al., 2017). The actual provision of environmental impacts is an area which should be further studied by studying existing examples of NBS interventions (Faivre et al., 2017; Nesshöver et al., 2017). Evaluation of different ecological services, using models and indicators, is an on-going field where it is necessary to map different examples of NBS in diverse contexts to truly see the variety of potential impacts (Hanson et al., 2017). Having a comprehensive evidence base would enable development of assessments which in turn could include the different ecological impacts provided by NBS.

Economic evaluation is an aspect of NBS which should be further studied since there is a discrepancy between the costs of NBS and the value of multiple benefits (Bockarjova & Botzen, 2017). Problems and uncertainties in this matter are the **time-scale** of NBS and difficulties in measuring and capturing the monetary value of some benefits, such as mitigation of climate change and increased wellbeing (Balian et al., 2014; Bockarjova & Botzen 2017; Raymond et al., 2017). Enabling a complete assessment of cost and benefits for NBS-projects is critical when designing policies for sustainable city development. Moreover, it is vital in convincing investors and **policy-makers about the benefits** provided by **NBS contra grey investment**.

Social and cultural impacts of NBS is highlighted as a field where more research is necessary (Maia da Rocha et al., 2017; Raymond et al., 2017; Balian et al., 2014). NBS have the possibility to give several benefits, such as increased wellbeing and recreation opportunities. However, like both economic and ecological evaluation the social and cultural impacts are very context specific. This is the reason why we need more studies on how to measure the social and cultural value of NBS worldwide, and among different social, cultural, gender and age groups.

As previously mentioned there is a need of understanding how to practically integrate NBS interventions into existing policy decision processes. Here NBS has both supporters and opponents who might be **reluctant to use NBS** as an alternative to traditional methods (Balian et al., 2014).

Currently, the EC is constructing a roadmap of their R&I agenda with multiple on-going sub-projects, meant to answer some of the research gaps (Faivre et al., 2017). Building up an evidence base for NBS is a task within EC's agenda. The first real impact- evaluation framework was developed by an expert working group in the interface of science-policy-society called Knowledge and Learning Mechanism on Biodiversity & Ecosystem Services ***(EKLIPSE)*** (Faivre et al., 2017; Raymond et al., 2017). EKLIPSE specifies actions and suggests indicators, which can be used to address 10 different challenges.

Two out of several projects increasing the evidence base on NBS are ***NATURVATION*** and ***Nature4Cities***, which are mainly working with finding new business and governance models and economic-impact assessments (Faivre et al., 2017; Naturvation, 2017; Nature4Cities, n.d). These two projects will be complemented with a framework for insurance value of ES by the ***NAIAD*** project (NAIAD, n.d; Nature4Cities, n.d).

NBS and innovation are particularly addressed in other four actions/projects funded by the EC's Horizon 2020 Innovation and Action programme. ***Connecting nature*** is a project which accumulates evidence on NBS (Connecting Nature, n.d). In this project a community of cities, where peer to peer learning is a key element, allows NBS to be innovative. ***Grow Green*** focuses on climate and water resilience and aims to show good examples of NBS, thus increasing the awareness and the replication of NBS projects (GrowGreen, n.d). ***URBAN GreenUP*** uses a methodology to demonstrate the value and effectiveness of NBS in three countries, as a first step. In the second step additional partner countries will try to implement NBS in their cities by using knowledge gained from replicating the URBAN GreenUP strategy (URBAN GreenUP, n.d). Likewise, the project called ***UNaLab*** aims to first develop a framework, which can be used for upscaling NBS, where mainly three cities are involved with demonstrations. In the second step the framework is meant to be used in in seven so called "replication cities" (UNaLab, n.d).

Another project worth mentioning is the Green Infrastructure and Urban Biodiversity for Sustainable Urban Development and the Green Economy (***Green Surge),*** which recently released a handbook for policymakers and city planners providing good examples of urban GI planning (Green Surge, 2014). The project called Operationalisation of Natural Capital and Ecosystem Services ***(Openess)***, has through case studies shown how GI can be integrated in urban planning. Operational Potential of Ecosystem Research Applications (***OPERAs)*** demonstrated how NBS can be combined with already existing and traditional solutions (Faivre et al., 2017).

2.4 Collaborative relationships and governance in the use of NBS

As an umbrella concept NBS is, as previously mentioned, connected and overlapping with already existing concepts used in urban governance. There are useful practices and knowledge sources to be found with policymakers, urban planners, researchers and citizens which should be explored when starting NBS projects (Kabisch et al., 2016). NBS has the strength of making use of already existing knowledge which is used separately whilst held by different actors. By enabling new forms of partnerships and collaboration arrangements it is possible to generate innovative ways to work towards achieving urban sustainability.

By using a multisectoral approach NBS can enable mainstreaming of environmental thinking and targets into sectors which traditionally do not consider sustainability important (Nesshöver, 2017). There are clear challenges that must be addressed when applying multi-sectoral approaches. However, the EC believes that NBS can generate new platforms and networks where stakeholders together can share experiences as well as conflicts and disagreements. By improving the transdisciplinary collaboration (e.g large variety of people and knowledge base), there is a greater chance of "outside the box-thinking" and that new solutions are developed (Nesshöver et al 2017; Faivre et al 2017). Hereby NBS can stimulate new jobs and also green economies on smaller and larger scales (Raymond et al., 2017). It is implied within the EC's R&I Policy and research that NBS will turn complex problems in cities into opportunities for innovation whilst simultaneously providing cost-effective solutions to several problems.

2.5 Knowledge transfer and organisational learning for NBS

The importance of knowledge and knowledge transfer have gained more recognition in recent years (Ajith Kumar & Ganesh, 2009). As knowledge economies emerge it becomes increasingly important with good knowledge transfer within and between organisations. Today organisational learning is seen as an essential strategy for companies and organisations to gain competitive advantages (Esterby-Smith et al., 2008). Knowledge transfer can be seen when one source of information, Agent A (a person, group or organisation) transfers knowledge to the recipient of Agent B, which in turn can be an individual, group or organisation (Ajith Kumar & Ganesh, 2009; Szulanski, 1996). Knowledge management "is a complete and organisationally specified process of acquiring, organising and communicating both tacit and explicit knowledge so others can use that knowledge and become more effective and productive" (Wiewiora et al., 2009). Explicit knowledge is the dimension of knowledge which is more easily transferred from one person to another, often in the form of numbers and data which can be easily documented. Tacit knowledge is in contrast more difficult to transfer since it is knowledge retained in the mind of people and requires observation and experience by an individual (Ajith Kumar & Ganesh, 2009). Knowledge transfer is an important part of knowledge management and is the step during which knowledge is relocated to other units where it can be used (Wiewiora et al., 2009).

Despite increased attention to the benefits of efficient knowledge transfer it has been difficult to put into practice (Argote et al., 2000). The problem of transferring knowledge within the organisation has been called internal stickiness by Szulanski (1996). Similarly, barriers have been identified relating to knowledge transfer in project- based organisations (PBOs). PBOs can be defined as "variety of organisational forms that involve the creation of temporary systems for the performance of project task" (Thiry & Deguire, 2007). These are organisations where the main business focus lies on the execution of projects (van Waveren et al., 2014).

The implementation of NBS can be studied as projects with start – and – end dates involving several collaborating stakeholders. Thus, when examining knowledge transfer between NBS projects it becomes relevant to study knowledge transfer in project-based organisation (PBO).

The identified difficulties of the projects' temporary natures have warranted the term "learning paradox" (Bakker et al., 2011). In one way, projects have great potential to generate knowledge because they are interdisciplinary, unique and seen as test arenas for new solutions and technology (Bakker et al., 2011; Wiewiora et al., 2009). However, because of the temporary nature of projects there is also the problem of securing sedimentation, to retain gained knowledge in the organisation/organisations after the completion of a project (Wiewiora et al., 2009). Usually, once the project is over the members of the working group move on to other projects making tacit knowledge transfer difficult which in turn can lead to a loss of knowledge and experience.

Research on project learning has shown that projects despite the uniqueness, could be valuable in other projects, for instance, preventing collaborators from making similar mistakes again (Wiewiora et al., 2009). If the gained learning, experience and knowledge are not recorded, documented, discussed or shared it will not be accessible for future projects (Izadi Moud & Abbasnejad, 2012). Functional organisations are more likely to have procedures to capture and transfer knowledge, while these procedures must be established in each new project (Waveren et al., 2015). In addition, projects suffer from strict deadlines and their focus is on producing results. Moreover, knowledge transferring and sedimentation of knowledge are rarely a part of the project's aim and is therefore not prioritised.

The works of literatures distinguish between ***inter-and intra-organisational knowledge transfer*** (Goh, 2002; Esterby-Smith et al., 2008; Szulanski, 1996). In the paper by Esterby-Smith et al. (2008), it is emphasised that knowledge transfer is a complex phenomenon. This is especially true in the case of transferring knowledge between two different organisations do to a variance in organisational culture. As can be seen in the paper by Ren et al. (2018) there is a higher probability that organisations will share knowledge if they are more similar in their operations, processes and in their use of technologies. However, there are many factors also hindering intra-organisational knowledge transfer that are important to address (Goh, 2002; Sulanski, 1996).

In literatures, there are two main mechanisms mentioned or ways in which knowledge can be transferred - ***informally*** and ***formally.*** Informally entails knowledge transfer through face-to-face communication. In contrast knowledge is formally transfer in the form of documents where the information is more structured and written down (Schindler & Eppler, 2003; Wiewiora et al., 2009). To have explicit knowledge shared through channels and documents is especially important when transferring knowledge between two project groups (Wiewiora et al., 2009). In Wiewiora et al. (2009) it is further pointed out how important it is to have a comprehensive approach to the documentation of learned lessons and that it should be integrated into the project process and included in the scope and budget of the project (Wiewiora, et al., 2009; Schindler & Eppler, 2003). If learned lessons are not included there is a high likelihood that the respective actors involved with the project do not want to prioritise or allocate money to evaluation or briefing of the project once the project is completed (Wiewiora et al., 2009). Moreover, documentation is essential as geography and distances have been argued to prevent and hinder the sharing of knowledge (Ren et al., 2018; Ajith Kumar & Ganesh, 2009). In small organisations, informal dialogues are the most common way of transferring knowledge and they take place during coffee breaks and at informal meetings (Wiewiora et al., 2009).

The ***project manager*** is highlighted as an important factor in determining whether the organisation achieves efficient knowledge transfer (Wiewiora et al., 2009; Schindler & Eppler, 2003; Izadi Moud & Abbasnejad, 2012; Goh, 2002). Knowledge transfer may be prioritised differently depending on the attitude, perception and personality of the manger. Equally is the importance of ***organisational culture*** since it has been proven that more knowledge is transferred in open environments with trusting and close relationships between employees, departments and/or organisations (Wiewiora et al., 2009; Schindler & Eppler, 2012; Goh, 2002). An additional factor determining to what extent knowledge is transferred is the ***organisational structure*** (Goh, 2002). In organisations with distinct hierarchies and "silos thinking" it is more likely that knowledge will be retained only within the department or office instead of being diffused into other departments and organisations.

In several papers it is stressed that ***technology*** has enabled more and faster knowledge transfer (Ren et al., 2018). Installing an online network for sharing experience and information can be an efficient way to increase knowledge transfer. Furthermore, technology plays a central role if knowledge has to travel long distances from source to recipient. However, as described in Goh (2002), it can be important to have a reward system for sharing information online since people tend to not voluntarily share knowledge to everyone if there is no incentive to do so.

3 Methodology

In this section the research strategy is first presented followed by an explanation of how the NBS projects were selected. Secondly, the research design is outlined together with information about methods of collecting data and finally what analytical frameworks were used.

3.1 Case study research

Case study research seeks to answer focused questions by generating in depth observations and descriptions of a specific case (or cases) over a period of time (deMarrais & Lapan, 2003). The EC's research on NBS aims to strengthen the understanding of NBS in Europe by applying this specific qualitative research method (European Commission, 2015). The highly context specific nature of NBS makes it important to study specific NBS projects to generate information important to fill in the knowledge gaps concerning NBS and their uses. According to Yin (2009) case study research allows for examination and a holistic understanding of specific real-life events and should be applied when it is necessary to ask qualitative and in depth questions to describe social phenomena.

This thesis is structured as an exploratory multiple case study research, paper looking at three NBS-projects in Gothenburg. It is exploratory since the thesis with research questions is designed to answer "what" questions, such as what are the barriers and drivers in up-scaling of NBS (Yin, 2009)? Typical for exploratory case study research is to outline only a broad research design prior to the data collection, while the definite research questions and aims are not formulated until after some initial observations (Yin, 2014). The multiple case study approach is suitable when there are strong arguments to believe that there are similar or contrasting findings between cases (Gustafsson, 2017). As such cases should be selected on the basis of either predicting similar results called literal replication, or contrasting results called theoretical replication (Yin, 2014). Some argue that multiple case studies are more reliable than single case studies since suggestions and conclusions are more grounded in empirical evidence (Zainal, 2007; Yin 2014). However, drawbacks with multiple case studies compared to single case research are the time often spent on studying each case (Gustafsson, 2017). If more cases are studied, it is more likely to provide a greater spectrum of representation of social phenomena. The downside, however, is that there will be less time available to look at the individual cases.

The so-called embedded analysis allows specific parts or aspects of the cases to be studied (Barick, 2016) In this thesis the same multiple units are studied for each of the three cases and they are derived from the research questions and the aim of this thesis. The units of analysis are; objectives of the projects, drivers, implementation, barriers and obstacles, impact assessment and lastly new practices and learnings gained from the projects. However, it can be argued that unit of analysis is first and foremost the specific implementation of NBS intervention(s) in each project, consequently making it the single unit of analysis. Due to having just the one unit of analysis the case study is called holistic and in the final comparison of the different cases this single unit is compared between the cases (Yin, 2009). Applying so called cross-case analysis or comparative case study the different cases are first compared separately and independently from each other (Verschuren & Doorewaard, 2010). Secondly, the units of analysis for each case are compared between the different cases to identify contrasts and similarities. The results from the first stage are essentially used as input for the second stage where the different cases are compared.

3.2 Case selection process

In the selection of three NBS projects there were four screening stages. In this section each stage and its selection criteria are presented (see Figure 3-1).

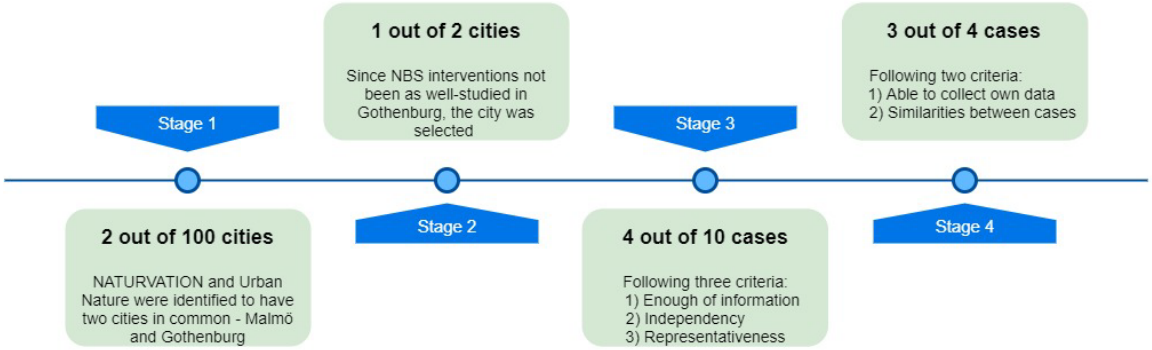


Figure 3-1. The four different screening stages in selecting the three NBS projects.

Source: Author's own elaboration

Stage 1: This thesis aims to contribute to two projects, NATURVATION and Urban Nature, and therefore only cities within these two projects' scopes were considered; Malmö and Gothenburg.

Stage 2: Malmö, the third largest city in Sweden, has gone through an extensive transformation in recent years. The city went from being a shipbuilding industry to internationally acclaimed as a frontrunner in sustainable development (Rolfsdotter-Jansson n.d; Sánchez Gómez, 2017; Alane Barton, 2016). Consequently, the city has already had some of its greatest NBS projects well-studied. An example of a district is Augustenborg, were GI and BI and other related NBS concepts were used in adaptation to the negative effects of urbanisation such as flooding (Keesstra et al., 2018; Alane Barton, 2016; Sánchez Gómez, 2017). The district has been well-monitored, studied and evaluated in several reports since its completion 15 years ago. Thus, Malmö being a very famous and well-studied city related to NBS, Gothenburg was selected as study subject for this thesis. The city of Gothenburg has in accordance to Malmö famous examples of urban sustainability and is recognised to undertake currently one of the largest urban developments in Scandinavia (Göteborgs Stad, 2012).

Stage 3: Three NBS projects in Gothenburg were selected from the NATURVATION Atlas (Naturvation, n.d b). The three projects serve as cases in this thesis and represent three out of ten NBS projects in Gothenburg and three out of 1000 projects on European level. How the 1000 NBS interventions were identified is presented in the NATURVATION report, Almassy et al., (2018).

Of the ten possible projects in Gothenburg three projects were determined to give enough robustness in the recognition of similar or contradicting patterns between the cases (Gustafsson, 2017). As mentioned, the number of cases shall be large enough to secure a valid base for generalisation of findings but still allow time to study each case in detail (Gustafsson, 2017). Selecting a few cases as representatives of a broader population is challenging and by no means an easy task (Seawritgh & Gerring, 2008). There has over time been developed and suggested a variety of case-selection typologies, applicable in different scenarios (Gerring and Cojocaru 2015). However, some factors are important to include in the selection of cases irrespectively of which topology is used in the selection process. Firstly, there shall be enough

information available to study each case in detail. Case study research is undertaken to extend the existing knowledge and go beyond more quantitative data. Consequently, this factor should be an overarching criterion. Secondly, in studies where the different cases are compared through a cross-case analysis, selected cases should be independent from each other. However, as this study aims to examine the diffusion of knowledge and knowledge transfer between projects, there might be an interaction between the different cases. Thirdly the representativeness should guide the decision of which cases are selected, and as mentioned there are different typologies used to decide what is a representative case.

The third criterion, concerns representatives, and is in the thesis defined as completed projects. The projects had to be completed in order to evaluate the impacts, and if/how the learnings from those NBS interventions have been used to enable new interventions. In addition, it was beneficial to select cases which were completed several years back. The time perspective would increase both the likelihood of undertaken evaluations of the projects as well as benefits provided by the NBS. NBS projects are categorised in the Atlas as either completed, ongoing, in a planning stage or envisioned. Of the ten NBS projects identified in Gothenburg were only four cases completed and therefore suitable for this study.

Project rain gardens in Kviberg started in 2015 and took approximately one year to complete and project Vasakronan began and was completed within the same year, 2015. The planning stage of Kvillebäcken started around 2004/2006, but the actual construction did not start until 2011. Initially, the intention was to complete the project by 2018, but today it is considered to not be fully finalised until 2019. Consequently, this case is not completed by the time of this study. However, the project was accepted as a completed project in this thesis based on some factors identified in the screening process. Firstly, most of the construction is completed, and many residential houses have been inhabited for a while. Secondly, the interviewees talked about Kvillebäcken as a project undertaken in the past. Thirdly, in the screening process, some evaluation reports were identified and additionally several academic reports of project impacts, which give strong arguments to consider the project as completed. This said it should be highlighted that evaluation does not have to take place at the end of a project but can happen in earlier stages.

However, a fourth case which started year 2013 and was on-going until 2015 was found in addition to the selected cases. It also fulfilled the two other criteria; enough information was available on the case and it was not connected to the other three cases. Consequently, a fourth screening stage was necessary to identify three suitable cases.

Stage 4: In the last selection step, selection of the three cases depended on two factors 1) if people who had been involved in the project were possible to reach 2) and if the case was stated as unique and as the first of its kind. Following the previous overarching criteria concerning the importance of finding enough information, the first factor emphasises how it is preferable to get first-hand information, through interviews, in each case. In the fourth case, it was not possible to get information directly from people involved in the project, a reason to exclude it. Moreover, the excluded case was not explicitly stated as the first project of its kind, like the other three cases. Since one unit of analysis is *new practices and learnings* gained in the projects it was relevant to select the three cases expressed as unique, following the replication logic of selecting cases with similar predicted results (Yin, 2009). To enable this judgement the outcome of the four NBS projects were studied before making a definite decision.

3.3 Research design

The research strategy was previously presented as a case study research. A strategy relying on several sources of evidence automatically pre-decides some factors in the research material process. Qualitative interviews are together with pre-existing sources the main research material. Information related to each project and the city of Gothenburg was obtained from several different published sources as well as from interviews. Information about NBS in Europe, Sweden and Gothenburg was mainly obtained from the ATLAS by NATURVATION (Naturvation, 2017b).

The first research question was analysed using a common analysis method in multiple case studies called cross-case analysis (described in the section called 3.1 Case study research). To analyse the second and third research question two analytical frameworks were used. The analytical frameworks are presented under the heading called 3.4 Analytical frameworks (see Table 3-1).

Table 3-1. Research Design

Research question	RQ1: What are the objectives and evaluated economic, societal and environmental impacts of NBS projects in Gothenburg?	RQ2: What drivers and barriers are experienced in up-scaling of NBS?	RQ3: How is knowledge transfer facilitated between projects?
Literature review	**Sources:** articles, reports and websites **Keywords:** Nature-based solutions, innovation and nature-based solutions, implementation of nature-based solutions, nature based-solution and learning, green and blue infrastructure, ecosystem services, urban sustainable development, knowledge transfer, knowledge transfer between projects, knowledge transfer between organisations, project-based learning, knowledge management, temporary organisations		
Interviews	Individuals involved in the three projects, policymakers from different departments in the municipality, researcher and architect		
Literature for Description and Analysis	**Sources:** reports, books, documents, articles, blogs, websites and NATURVATION's database **Keywords*:** Gothenburg and environment, Gothenburg and environmental legislation, Gothenburg environmental challenges, Gothenburg + history + environment, Vision River City, Gothenburg + segregation, densification in cities + Sweden, kvillebäcken, case kvillebäcken, evaluation of kvillebäcken, gentrification + kvillebäcken, environment + kvillebäcken, rain gardens in kviberg, vasakronan + green facade		
Analytical method or framework	Empirical findings from the two case units of analysis called *Objective* and *Impact assessment,* together with statistics from NATURVATION Atlas will be synthesised to answer the research question, conducting a cross-case analysis of the three NBS projects.	Empirical findings will be analysed by using the factors identified in the two papers by Raven et al, (n.d) and van der Jagt et al. (2017), innovation pathways of NBS.	Empirical findings will be analysed by using the integrative framework by Goh (2002), together with knowledge transfer theory.

* Most of the keywords were searched in Swedish

Source: Author's own elaboration inspired by Udomcharoenchaikit (2016)

3.3.1 Literature Review

The literature review was carried out using electronic or printed sources such as articles, reports and websites. Specific terms and keywords (see Table 3-1) were searched using *Google Scholar* as well as *Lub Search*, to find existing literature on the concept of NBS and current research in the field. In addition, other concepts, identified as having strong and overlapping connection to NBS were searched online such as ES and GI/BI. Many times, relevant sources were found in the biography of already viewed papers, following the so-called snowball principle. Since a thesis paper is carried out through an iterative process, sources for the literature review were found in different stages of the thesis period. Moreover, the interviews also worked as guidance to identify additional sources. To enable categorisation and organisation of literature a qualitative data analysis computer software package called Nvivo was used.

To find the information presented in the section called Description and Analysis, three "categories" of sources were used; i) NATURVATION's database online and associated report, ii) documents, websites and books related to local and national legislation in Sweden as well as on the city's sustainability efforts and iii) reports related to each NBS project. Information about the different cases was sourced from a wide range of literature- from articles about each case to more comprehensive evaluation reports. Some material did not represent explicitly stated facts about each case, but in sources such as blogs and articles, the authors expressed opinions about the project.

3.3.2 Stakeholder interviews and site visits

In total 16 interviews were conducted- either in-person, over telephone or email- and 17 people were interviewed. One interview was carried out as a group interview with two respondents. All the interviews are presented in Appendix I and referred throughout the thesis. Each interviewee is coded with a number (I:1 = the first interviewee in Appendix I). The interviewees were identified and selected from studying the three cases in Gothenburg, consequently, many of them were selected because of their involvement in one of the three NBS projects. In addition, several other people were identified as valuable for this study, such as researchers on NBS, municipality officers from different departments and an architect (see Table 3-2).

Table 3-2. The number of interviewees in each category, in total 17.

	Kvillebäcken	Kviberg	Vasakronan	Municipality officers	Researcher on NBS	Architect
Number of people interviewed	3*	2	3	7	1	1

* Four of the interviewees working in the municipality were connected in some way to case Kvillebäcken and therefore also belong to this category.

Source: Author's own elaboration

In total 36 people were contacted either over email or by phone. Contacted people had in most cases been suggested by other people, following the snowball sampling principle. The number of contacted related to a specific case were in total 19, while four researchers on NBS were contacted and 13 people working in the municipality (several different departments) or as architects.

All interviews were conducted between 13 of June and the 27 of August. The six in-person interviews were all semi-structured, designed as open-ended questions. Almost the same questionnaires were used for all the interviews, however, they were partly reformulated to apply to each of the respondents (see Appendix II, presenting two example of interview guides). All the face-to-face interviews were undertaken in Gothenburg at each of the interviewee's department or working place, except for the interview with the research that took place at the Swedish University of Agricultural Science (SLU) in the south of Sweden. In total nine telephone interviews were conducted. Six of those were undertaken in a similar way to the in-person interviews, using the same questionnaires. The remaining three telephone interviews were more of unstructured character, where questions related to the interviewee's responsibility and area of work were asked. One respondent gave written answers to a set of few specific questions by email.

All interviews were undertaken in Swedish except for the interview with the researcher, which was carried out in English. All interviews were recorded except for the three unstructured telephone interviews (where only notes were taken) and the answer received by emails. All the recorded interviews were transcribed but, in some cases, only the parts which were relevant for the thesis. All respondents were asked for their permission to be referenced in the thesis, three people are thus cited as anonymous. Direct citations of respondents were sent to them before completion of the thesis for approval.

The rain gardens in Kviberg and the green facade implemented by Vasakronan were visited in the end of June/beginning of July, to get a more comprehensive understanding of the two NBS projects. Kvillebäcken was visited at the beginning of September. Pictures used in chapter 4 Description and Analysis are pictures taken of each site when it was visited.

3.4 Analytical frameworks

This section explains the rationale for identifying the six different units of analysis in each NBS projects used in the chapter called Description and Analysis. Then the analytical method used to answer the first research question is presented, followed by a presentation of the two analytical frameworks used to answer the second and third research question, concerning barriers and drivers in up-scaling of NBS and how knowledge can be transferred between projects.

3.4.1 Units of analysis

Information presented about each case in the chapter called Description and Analysis is categorised in six units - i) Objectives ii) drivers iii) Implementation, iv) Barriers and Obstacles v) Impact assessment vi) New practices and learnings. The rationale lies in the research strategy. As embedded multiple case study each unit of analysis is identified by looking at the research questions stated. By identifying the different units of analysis in each case the validity of the project is ensured. This is important when the case units later are compared between projects, as they are in the cross-case analysis.

The units of analysis derived from the first research question were *objectives* and *impact assessment*. In the second research question two other units of analysis were identified, *barriers and obstacles* and *drivers*. In the third research question, the unit of analysis called *new practices and learnings* was recognised. The unit of analysis called *implementation* was identified as important since studying the implementation of NBS is the overarching aim of the thesis. Chronological structure, worked as guidance on how to present the different units of analysis, thus drivers and objectives are presented together as being units in the start of the project (they are the only two units of analysis which are presented under the same heading "objectives and

drivers" in the Description and Analysis chapter). Implementation, as the actual execution of the projects together with barriers and obstacles, is presented in the middle. Finally, impact assessment happens sometimes during the project period, but usually in the end or after the project is completed. Meanwhile, new practices and learnings can be generated in any stage of the project, thus both units of analysis are presented at the end of each case description.

3.4.2 Analytical framework for studying objectives and evaluated impacts of NBS

In the chapter called Discussion and Reflection, the two units of analysis called *objectives* and *impact assessment* from the three separated cases were compared by a cross-case analysis. The findings from the comparison were discussed and reflected. The findings were compared and synthesised with statistical data and background information about Gothenburg from the chapter Description and Analysis, as well as with the information presented in the literature review.

3.4.3 Analytical framework for studying barriers and drivers in up-scaling NBS

The framework used to answer the second research question related to barriers and drivers in up-scaling NBS, was adopted from two different papers (one which is yet unpublished), *Nature Based Innovation Systems: Introducing a framework to analyse the innovation pathways of nature-based solutions* (Raven et al., n.d) and from *The Nature of Innovation for Urban Sustainability* by NATURVATION (van der Jagt et al., 2017). The reports are written by the same authors and almost the same factors and processes are identified to work as drivers and barriers for innovation of NBS. In the first paper the framework is presented together with the concept of Technological Innovation systems (TIS), which is a field within innovation studies. Raven et al. (n.d), argue that technologies are often addressed as important drivers in the sustainability transition, and the same can be proven for NBS interventions. There are already developed frameworks for TIS and Raven et al. (n.d) identify variables and subfactors which can work as both drivers and barriers in the use of NBS. The framework (with variables and factors) forms the concept of Nature Based Innovation Systems (NBIS), which Raven et al. (n.d) compare with TIS to identify overlapping dimensions of the two systems. This paper is still unpublished.

There is not presented a framework in the paper by NATURVATION, but instead are the different variables, both barriers and drivers, suggested to influence innovation for urban sustainability. Van der Jagt et al. (2017) identify some additional variables compared to the NBIS paper; cognitive factors and two subfactors under the variable Local Geographical Context (see Table 3-3).

Variables and factors presented in the NATURVATION paper were used in this thesis, mainly because the paper presents more variables influencing the up-scale and innovative pathways of NBS than the one from Raven et al. (n.d). However, both papers' description of the variables and their influence on NBS pathways are being used as a basis for the analysis. In Table 3-3 the nine different variables are presented with their subfactors. For each variable and subfactor, there is a short description derived from both papers.

Table 3-3. The different variables and their subfactors influencing NBS pathways (each subfactor can either work as barrier, drivers or both). The variable and subfactors which are green coloured only exist in the paper by NATURVATION.

Variable	Subfactor	Description
Cognitive factors	Awareness	In terms of being aware of the problem where NBS has potential of being a solution. In term of being aware of the benefits provided by the NBS. Acceptance of NBS interventions by policymakers, sectors and the public.
	Uncertainty	Few have worked with NBS and it might mean new practices and ways of doing things, different than traditional methods. Knowledge gaps concerning the effectiveness of NBS.
	Sense of urgency	Some type of disturbing events; such as hurricanes, economic hunger etc might lead to more focus on resilience approaches.
	Flexibility	Adaptive governance and flexibility of institutions to enable fast response to changes.
Agency	Leadership and power	People and organisations working as leaders in the use and uptake of NBS.
	Commitment	Long time commitment by people and organisations to use and up-scale NBS.
Discourses and future visions		Aligning the vision of NBS with collective worldviews (such as sustainable cities, urban development etc).
Strategic plans, legislation, policies		Legislation and regulation influencing NBS, its use and uptake.
Institutional setups and governance structures		Diffusion of responsibilities and power between the different administration bodies.
Collaboration	Networks, partnerships and social interaction	Cross-sectoral interactions. High number of stakeholder groups involved.
	Participation	Process of engaging and involving several citizens in the use, development and maintenance of NBS.
Learning	Education and training	Individuals and organisations are educated and engaged in active learning.

	Research	More knowledge within the environmental and sustainability field. In case of NBS it is necessary to work interdisciplinary.
	Experimentation	Learning by doing, pilot projects and testing of new innovations.
	Monitoring and evaluation	Assess outcomes and impacts.
Resources	Materials, tools, technology	Technologies to enable implementation and use of NBS.
	Knowledge and human capital	Relevant knowledge, expertise and experience of individuals or groups.
	Financial factors	Funding, cash flows etc, are essential for sustainable innovations to succeed.
Local geographical context	Built environment and urban amenities	Infrastructure and amenities can work both as barriers and drivers of NBS.
	Environmental qualities and climate	Influences of a broad variety of natural process, soil condition, local fauna and flora can influence the feasibility and urgency of NBS.
	Societal processes	Demographics, urbanisation, economic growth.
	Local culture and image	Local entrepreneurial culture, identity, lifestyles, consumption habits.
	Land and property ownership	Land and property ownership can work as a barrier for NBS.

Source: Variables and subfactors derived from van der Jagt et al. (2017) but the descriptions are synthesised from Raven et al. (n.d) and van der Jagt et al. (2017).

This framework was used in the chapter called Discussion and Reflection, to discuss barriers and drivers experienced in the three NBS projects in Gothenburg. Many of the identified variables are connected and overlapping, and subfactors were therefore merged together, under the same variable in the discussion chapter.

3.4.4 Analytical framework for studying knowledge transfer between NBS projects

The third research question explores how knowledge transfer is facilitated between the different NBS projects. To answer this question an integrative conceptual framework based on knowledge transfer theory was used.

The framework presented in the paper by Goh (2002) is an integrative conceptual framework, which identifies factors influencing effective knowledge transfer. Goh (2002) focuses on intra-organisational knowledge transfer, however, in this thesis there is not a clear line between intra-and inter-organisational knowledge transfer. As NBS projects can be undertaken by the

same organisation as well as by different, knowledge transfer, in this case, can be both intra- and inter-organisational. Goh (2002) also emphasises that the factors identified are not the only elements which should be considered when trying to improve an organisation's ability to retain and transfer knowledge. Nevertheless, he argues for them to be of significance.

The integrative conceptual framework is presented in Figure 3-2, the key factors identified and how they are connected and related.

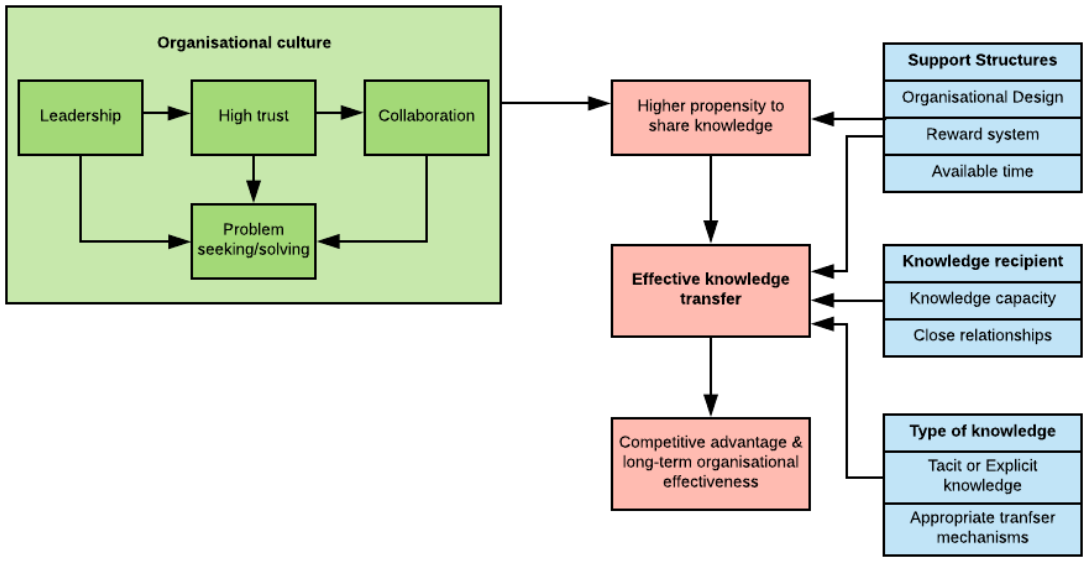


Figure 3-2. The integrative framework used to answer the third research question concerning how knowledge transfer is facilitated between projects.

Source: Remade from Goh (2002)

Organisational culture: This factor consists of four subfactors. Firstly, the leader or manager of the organisation has the responsibility to enable knowledge transfer and influences the organisational culture of the company, its openness and transparency. Secondly, the organisation should identify problems and improve. Learning and knowledge sharing is often taking place in situations where a problem must be solved. Therefore, an organisation should seek and encourage problem-solving. The two last subfactors are highly interlinked since good collaborations within or between organisations are vital to enable knowledge transfer and this highly depends on the level of trust.

Support Structures: Within this factor, there are subfactors such as technology, training and skills development, rewarding and organisational design. It is possible to transfer knowledge faster by using technology, and potentially also transferring the knowledge to a higher number of people. Moreover, it enables a more horizontal organisational structure if different departments can use technology to communicate in an easier way. The organisations should have a design, which enables cross-functional working teams to be formed. Thus, the organisational boundaries within the organisation should not restrict cross-department

collaboration. Recipients must be trained and educated in order to make use of the knowledge given to them. Additionally, sometimes a rewarding system for sharing knowledge helps to facilitate knowledge transfer, since it works as an incentive for people to share experience and knowledge, in other words, make them prioritise collective benefits instead of own interests.

Knowledge recipient: The relationship between the source of information and the receiver should be close and well-functioning. Even in an organisation where knowledge is freely accessible, it is up to the receiver to make use of the knowledge and therefore must be trained and educated in how to access information but also how to use it.

Type of knowledge: Tacit knowledge is personal and is suggested to be best transferred interpersonally, so-called face-to-face transfer. As this type of knowledge is more complex and is often gained and retained through own experience, it is not easily documented. In contrast, explicit knowledge can be more easily transferred by using technology, such as information systems, databases, online manuals etc.

4 Description and Analysis

The Description and Analysis consists of five main sections. Patterns of NBS interventions are first studied on three geographical scales - Europe, Sweden and Gothenburg. The four remaining sections are focused on Gothenburg, starting with an introduction to the city, its local legislation and most prominent environmental challenges. In the three following sections each NBS project is described and analysed.

4.1 NBS interventions in Europe

NATURVATION is a four-year project which seeks to analyse examples of NBS projects in European countries (Naturvation 2017a). A database called Urban Nature Atlas has been developed in the project, exploring almost 1000 NBS projects in 100 European cities (Naturvation 2017b; Almassy, et al., 2018). Information on each NBS project was collected between January and August 2017 and in total 976 questionnaires (NBS projects) were analysed in the report Almassy et al. (2018). The Atlas consists of 31 NBS in Sweden, distributed among the three largest cities - 10 in Stockholm, 10 in Gothenburg and 11 in Malmö. In this thesis statistical data is presented on three spatial scales -Europe, Sweden and Gothenburg.

Statistics about NBS projects on European level are directly derived from the report "Urban Nature Atlas: A Database of Nature- Based Solutions across 100 European Cities" by Almassy, et al. (2018), a report presenting analyses of data in the Atlas. However, the statistics on Swedish level and the city of Gothenburg were calculated using information obtained from the Atlas online (Naturvation, 2017b) and not from the report.

4.1.1 Categorisations of NBS interventions

In the Atlas all NBS interventions are categorised into 8 different domains. These include:

- *Parks and (semi)natural urban green areas,* large urban parks and forests, botanical gardens
- *Urban green space connected to grey infrastructure* such as street trees, gardens, green parking lots
- *Blue areas,* lake/pond, delta, rivers
- *Allotments and community gardens*
- *External building greens* such as green roofs, green walls and facades
- *Green areas for water management*, rain gardens, swales
- *Green indoor areas*
- *Derelict areas,* abandoned and derelict spaces with growth of green

It was shown that approximately 50% of the NBS interventions on all three spatial scales are in the domain of Parks and (semi)natural urban green areas (see Figure 4-1). Consequently, it is the most common ecological domain on all three scales. 40% of the projects in Europe were of the domain called urban green space connected to grey infrastructure, thus makes it the second most frequent domain in Europe. In Sweden blue areas is the second most common domain (35,5%) and in Gothenburg it is allotments and community gardens (30%). Many of the interventions (over half on European level) targeted more than one ecological domain.

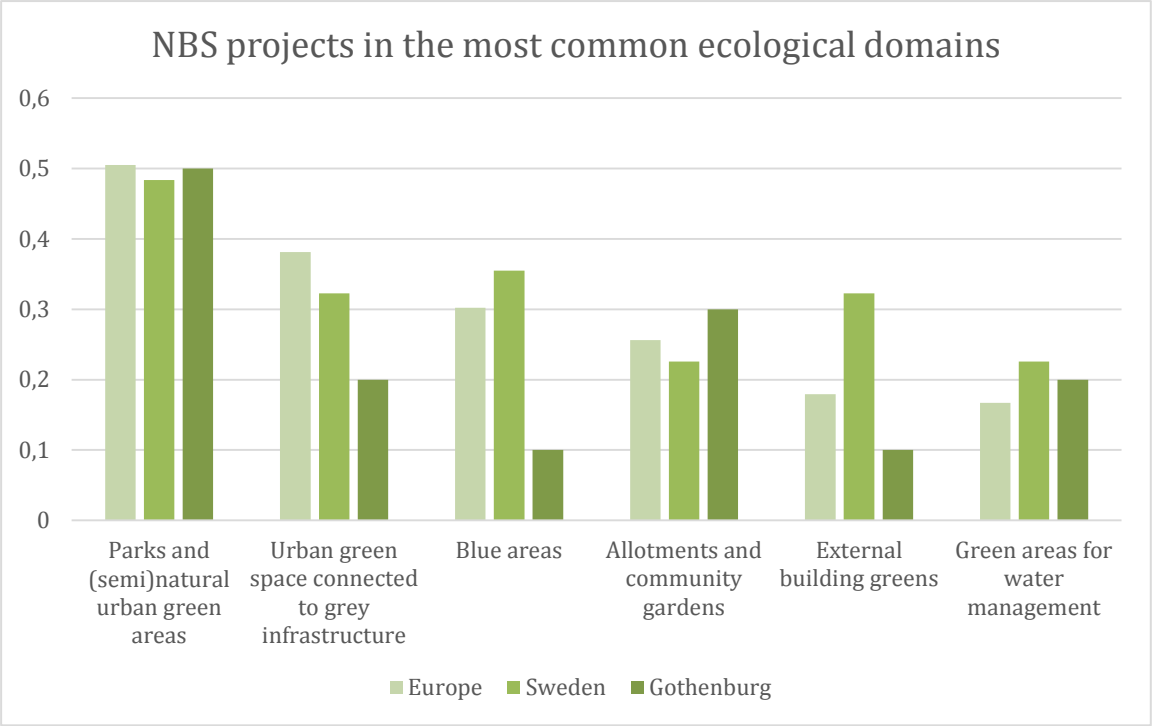


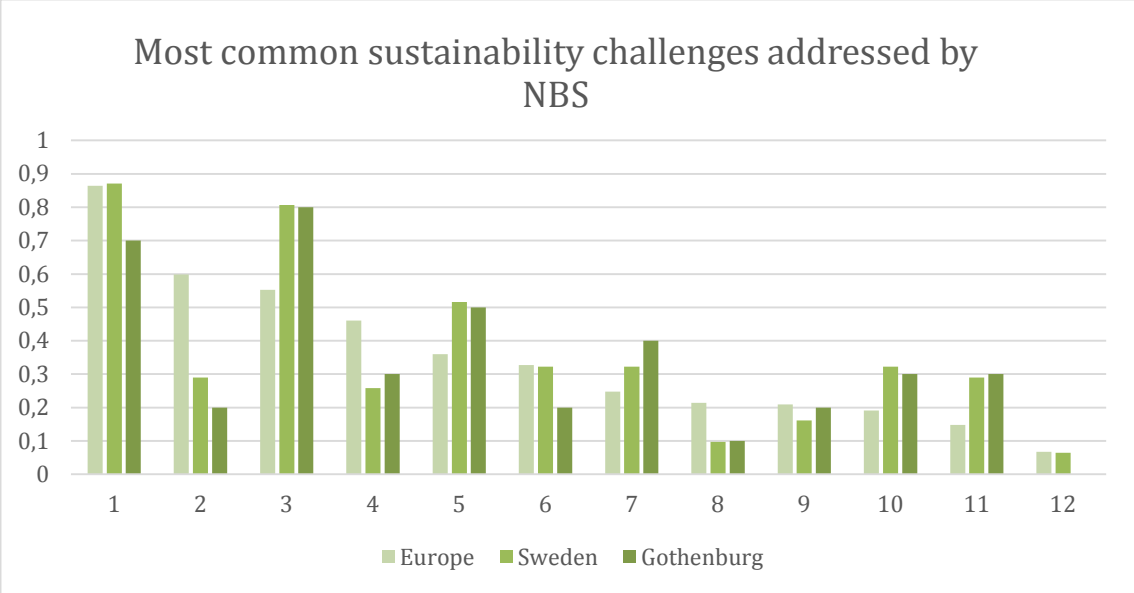
Figure 4-1. Illustration of the most common ecological domains of NBS interventions on three geographical scales- Europe, Sweden and Gothenburg. The x-axis represents domains and y-axis the percentage of NBS interventions in each of the domains on all three geographical scales.

Source: Statistics on a European level is sourced from Almassy et al. (2018) and statistics on Sweden and Gothenburg from the Atlas (Naturvation 2017b).

4.1.2 Sustainability challenges addressed by NBS

The Atlas presents 12 different sustainability challenges, which the NBS interventions can respond to. The sustainability challenges were identified in each project's environmental goals, target and implementation. More detailed information on how the challenges were identified, is described in the report presenting analyses of the database, by Almassy et al. (2018).

The database revealed that 86,4 % (843 projects) in Europe and 87,1 % in Sweden (27 projects), tackle challenges related to green space, habitats and biodiversity. The most addressed sustainable challenges in Gothenburg is health and wellbeing with 80 % (8 projects) (see Figure 4-2). The overall trend in Sweden and Gothenburg is more NBS projects aiming to address health and wellbeing and water management, compare to the rest of Europe. However, regeneration, land-use and urban development are not addressed to the same extent in either Sweden or Gothenburg compared to Europe. Coastal resilience is rarely addressed in any of the geographical scales.



Sustainability challenges

1. Green space, habitats and biodiversity
2. Regeneration, land-use and urban development
3. Health and wellbeing
4. Environmental quality, including air quality and waste management
5. Water management
6. Climate action for adaptation, resilience and mitigation
7. Social justice, cohesion and equity
8. Cultural heritage and cultural diversity
9. Sustainable consumption and production
10. Inclusive and effective governance
11. Economic development and descent employment
12. Coastal resilience and marine protection

Figure 4-2. Illustration of the most common sustainability challenges addressed by NBS interventions on three geographical scales- Europe, Sweden and Gothenburg. The x-axis represents sustainability challenges and y-axis, the percentage of NBS interventions, addressing each specific sustainability challenge on each geographical scale.

Source: Statistics on a European level is sourced from Almassy et al. (2018) and statistics on Sweden and Gothenburg from the Atlas (Naturvation, 2017b).

4.1.3 Impacts and evaluation of NBS projects

To use a monitoring system and assess impacts provided by the NBS is of high importance, in order to know if the intervention fulfils its objective. The Atlas contains information whether NBS projects have monitoring systems, written evaluation report(s) or use indicators in their assessments.

In Europe, 61 % of the NBS projects are listed as unknown of the existence of a monitoring system (see Table 4-1). This refers to that no monitoring system was identified in the project documentation sources at the time the database was constructed. Europe has consequently a higher percentage of unknown cases compared to Sweden and Gothenburg where 74% and 80% of all NBS projects are known to have a monitoring system respectively.

Table 4-1. Percentage of NBS projects with, without or unknown monitoring system on three geographical scales- Europe, Sweden, Gothenburg

	Europe	**Sweden**	**Gothenburg**
Monitoring system			
Yes	34%	74%	80%
No	5%		
Unknown	61%	26%	20%

Source: Statistics on a European level is sourced from Almassy et al. (2018) and statistics on Sweden and Gothenburg from the Atlas (Naturvation 2017b).

In total 68 % of all projects in Sweden and 60 % in Gothenburg have been identified to have an evaluation report, which is distinctively many more than projects in Europe, see Table 4-2. The number of NBS projects where it is unknown if the NBS project holds an evaluation report is much higher for Europe (65 %) than for Sweden (32 %) and Gothenburg (40 %).

Table 4-2. Percentage of NBS projects with, without or unknown evaluation reports on three geographical scales- Europe, Sweden, Gothenburg

	Europe	Sweden	Gothenburg
Evaluation report			
Yes	30%	68%	60%
No	5%		
Unknown	65%	32%	40%

Source: Statistics on a European level is sourced from Almassy et al. (2018) and statistics on Sweden and Gothenburg from the Atlas (Naturvation, 2017b).

Lastly, when it comes to using indicators for assessment of impacts, less is known in Europe than in Sweden and Gothenburg, see Table 4-3. In total 61 % of all projects in Sweden use indicators in their assessment with Gothenburg using 60 %.

Table 4-3. Percentage of NBS projects with, without or unknown indicators used in assessment on three geographical scales- Europe, Sweden, Gothenburg

Indicators	Europe	Sweden	Gothenburg
Yes	28%	61%	60%
No	5%	3%	
Unknown	67%	36%	40%

Source: Statistics on a European level is sourced from Almassy et al. (2018) and statistics on Sweden and Gothenburg from the Atlas (Naturvation, 2017b).

The Atlas shows how on European level most of the studied NBS projects claimed to provide several different impacts. Yet relatively few, 10%, was found to have applied quantified assessment tools for assessment of impacts. Of the assessment tools identified more than half were for assessing environmental impacts, 7% were for economic evaluation and only 5% for assessment of social impacts.

4.2 NBS interventions in Gothenburg

This section consists of a description of the city of Gothenburg to support the following analysis of the three NBS interventions. The most prominent environmental problems are presented in which NBS can respond to and policy documents relevant for the use and implementation of NBS.

4.2.1 Introduction to the city of Gothenburg

The city of Gothenburg is the second largest city in Sweden with a population of almost half a million, located on the west coast (Göteborgs Stad n.d a). The city has historically been important to the shipbuilding industry and passage to the rest of the world, and is still holding one of Scandinavia's most important export ports (Port of Gothenburg, n.d; Göteborgs Stad, 2012). Today the trade-industry is diversified (Business Region Göteborg n.d) and the city is on its way to becoming a knowledge economy and innovative centre with high focus on international collaboration (Göteborgs Stad, n.d b; Göteborgs Stad, 2012).

Now Gothenburg is a city actively working to address sustainability challenges and has in the last years increased its efforts towards urban sustainability planning (Green Gothenburg, n.d a). It has adopted both an environmental programme (Göteborgs Stad, 2015) and climate strategy plan (Göteborgs Stad, 2014a) which will guide and operationalise the city's environmental work. Moreover, the city has one of the largest urban development projects in all Nordic countries, called Älvstaden (River City). River City is undertaken with a clear vision of developing the inner city, focusing on the three dimensions of environmental, societal and economic sustainability (Göteborgs Stad, 2012). Despite not working directly with the concept of NBS, the policymakers and city planners are using similar terms and concepts in their governance of the city and in steering and policy documents, such as ES, GI and BI.

4.2.2 Challenges in the city of Gothenburg

Strong and rapid growth, as experienced in the city of Gothenburg, entails a lot of opportunities but also risks of increasing existing problems in the city.

Densification: The inner city of Gothenburg is going through a strong expansion phase and policymakers have the intention to use more green elements as well as strategies for climate change adaptation in the developments (Göteborgs Stad, 2012). To densify cities has been one common strategy in urban sustainability, yet it causes significant loss of unexploited green areas (Wingren et al, 2015). Despite efforts in increasing GI and BI's through trees and green roofs in cities, they are said to not be enough to compensate the loss of green areas related to densification (Göteborgs Stad, 2017a). Like many other countries it is currently discussed in Sweden how synergies between densification and greening of cities can be achieved (Wingren et al, 2015). The dichotomy between green and dense has been discussed ever since modern urban planning started (Sthåle, 2009). For a city to adapt to climate change and the increasing urbanisation, it is often advised that changes are taken step by step (Wingren et al, 2015). Consequently, Gothenburg's high exploration can be challenging to get in line with sustainable and green urban planning.

Climate Change: How Gothenburg should mitigate and adapt to climate change is currently one of the main challenges addressed in the city and has been discussed for many years (Göteborgs Stad, 2017a). Extreme weather is experienced more frequently (Göteborgs Stad, 2012). The amount of rain has significantly increased, and the rising sea level is a serious threat, especially to areas along the Göta River (I:10). The city is today using so-called

downpour models and climate model simulations, predicting consequences of climate change such as flooding and rain falls (Göteborgs Stad, 2015). Despite the significant threats from climate change, there are no strategies to protect the city from flooding caused by cloudbursts and streams (Göteborg Stad, 2017a). Nevertheless, there is developed a comprehensive plan of adaptation strategies to be undertaken in new developments and projects, which is currently in the last so-called examination phase of approval. It should be mentioned, that until this year Sweden has been missing a national strategy for climate adaption (Regeringskansliet, 2018). New regulation as from September this year (2018) will influence the possibility to protect green space in each detailed development plan (Prop. 2017/18:163).

Segregation: Like several cities in Sweden, questions regarding social inclusion, integration and diversity are more heavily discussed in city planning (I:4; I:5; Lundström et al, 2013; Wingren et al., 2015). Today, Gothenburg is suffering segregation from a socioeconomic perspective (Andersson et al., 2009). There are clear differences between districts, where some areas have a high percentage of unemployed citizens with a low educational level, while other areas have a higher percentage of people who in average have good income (Göteborgs Stad, 2012). One of the identified reasons is the homogenous and poor variation of housing options, making it difficult for people with lower income to afford to live in certain areas, which become inhabited by the same wealthier socioeconomic groups (Andersson et al., 2009).

4.2.3 Steering documents in the city of Gothenburg

From an international perspective, the land usage planning is highly decentralised in Sweden. This means that municipalities in Sweden have a great responsibility and power to steer developments (Lundström et al, 2013). In accordance to the Swedish Planning and Building Act, each municipality must have "the vision of the city" and a *comprehensive plan,* where future developments are outlined, and usage of land and water resources specified (Lundström et al, 2013). The Planning and Building Act regulates only the basic demands and gives room for flexibility for the local needs. The Planning and Building Act refers to the so-called Environmental Code which addresses protection and conservation of natural resources and is highly related to the 16 environmental quality standards set on the national level.

The city has adopted 12 environmental standards from the 16 environmental quality standards. Some are planned to be fulfilled by 2020 while others are predicted to not to be accomplished until the year 2050 (Göteborgs Stad, 2017b). In the Environmental program there are specified actions which have to be undertaken to fulfil the 12 environmental standards (Göteborgs Stad, 2013). In addition, the city has adopted a climate programme which embodies the cities ambitions and long-term climate efforts (Göteborgs Stad, 2014a).

A document strongly related to NBS interventions is the steering document for greening the city, called the Green Strategy (Göteborgs Stad, 2014b). The Nature and Landscape Administration (NLA) is managing the city's green areas and adopted the Green Strategy in year 2014. This strategy is strongly connected to two other documents outlining specific strategies, and also connected to the Vision of River City. In the environmental programme, the specific actions related to storm water management and sustainable urban drainage systems are mainly in the responsibility of the Circular and Water Administration CWA (Göteborgs Stad, 2013), who was designated this task recently (I:4; I:6).

Figure 4-3 presents the relation between the Green Strategy and other documents. Several documents and strategies steer and guide the sustainable urban planning and developments in the city of Gothenburg. Thus, it is important to highlight that Figure 4-3 has an outset from the Green Strategy, and only documents related to this specific strategy are presented.

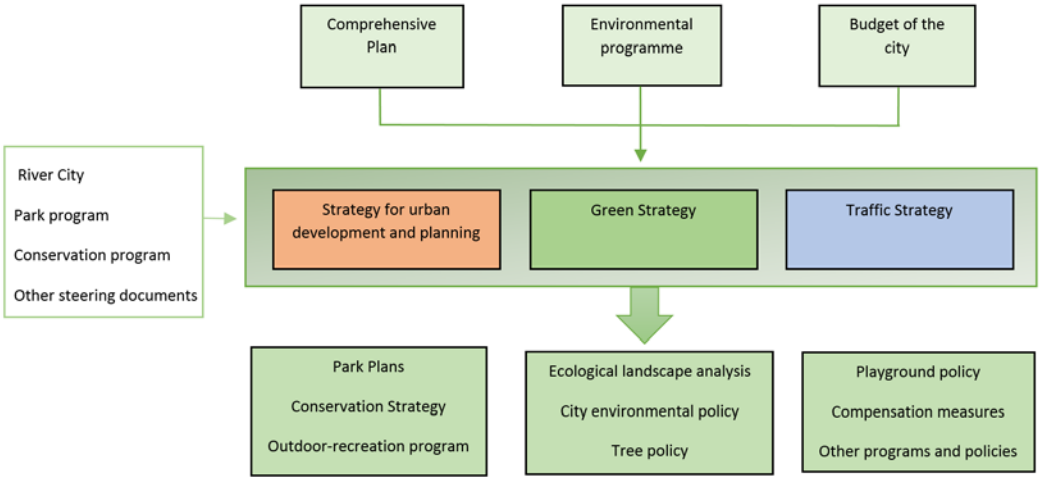


Figure 4-3. Illustration of how the Green Strategy is related to other policy documents. The Green Strategy, together with the Strategy for urban development and planning and the Traffic Strategy, is primarily based on the comprehensive plan, the environmental program and the budget of the city. Other documents influencing and steering the Green Strategy are park programs, vision River City etc. The Green Strategy steers other policies and documents such as tree policy, conservation strategy etc.

Source: Remade from Göteborgs Stad (2014b)

The Green Strategy is essential in the city's work forwards social and environmental sustainability (Göteborgs Stad, 2014b). In the strategy there is a great emphasis on the value of ES and the importance of strengthening BI and GI. The city of Gothenburg has recently developed their own Green Factor[4] together with the Swedish University of Agricultural Science (SLU) (I:10). The Green Factor is planned to be used in new construction and exploitation projects to guarantee a certain percentage of green areas are kept and can provide their benefits to the city (Nilsson et al., 2017).

[4] Green Factor is a measure on how much ES a specific area provides and how important these services are for tackling urban challenges and problems such as retention and delay of stormwater, improved local air quality and provision of recreation areas and biodiversity. There are several different Green Factor-models used in Swedish cities and Gothenburg is striving to develop a version which is site specific, so the model regards to challenges connected to the specific location (Nilsson et al, 2017).

4.3 Case 1: Kvillebäcken

District East Kvillebäcken, centrally located on Hisingen north of the city centre, was the first district transformed as a part of the larger city scale project River City (Kvillebäcken 2018a; Lundström et al., 2013). The idea of transforming the district to an area with diversity, greenery and sustainability as core themes started already during the 1990s. In 2004 Älvstrandens utveckling AB (municipality development company) became responsible for the project and brought together six property owners to realise the vision of a sustainable district (Kvillebäcken 2018a). The first construction processes started 2011 and by 2019 the intention is to have constructed over 2000 apartments in a mixed-use city district. Today, Kvillebäcken is attractive, centrally located, with high diversity of companies such as restaurants, shops, schools and libraries. It became the first district where all buildings are classified according to the Swedish Green Building Council System (SGBC) (in Swedish Miljöbyggnad) and thus became a pioneer in Swedish urban and building development (Kvillebäcken, 2011).

4.3.1 Objectives and Drivers

The objectives behind the transformation of Kvillebäcken are many. Initially the project did not have noteworthy high sustainability focus, instead, it increased over the project time (I:17). When Älvstranden became responsible for the development, one main aim was to make the district more consistent with the vision of the whole city. Another aim was to strengthen the physical connection to the city centre on the opposite side of the river (Lundström et al., 2013). Based on the vision of River City there were three key focus areas; i) Connect the City ii) Embrace the Water iii) Reinforce the Centre. Kvillebäcken became the first concrete district and phase of the city's regeneration.

Kvillebäcken was previously a centre of industries, and many streets and properties were poorly maintained and in high need of restoration (Göteborgs Stad, 2014c; Hällhed & Sundberg, 2013). There was extensive soil contamination, and the river Kvillebäcken passing through the area contained high concentrations of pollutants (I:6). Thus it was necessary with sanitation of large areas before the development could start (Göteborgs Stad, 2014). In addition, Kvillebäcken was well-known for high criminality, entitled, Gothenburg's equivalence to "Gaza strip" by local media and politicians. The area was perceived as an unsafe and an unattractive place to live (Hällhed and Sundberg, 2013; Fehler, 2014; Gustavsson & Elander 2013). Therefore, this area considered a problematic area in need of major improvements (Hällhed & Sundberg, 2013). However, high costs associated with the transformation and the fragmented ownership structure, caused the project not getting started until Älvstranden together with NCC (construction company) and Wallenstam (property company) became landowners (Hällhed & Sundberg, 2013; Kvillebäcken, 2018a).

The consortium later applied to a project called the Delegation for Sustainable Cities (DSC), from which they received funding. This enabled a different focus of the project, now aimed to be an innovative arena for new technology, collaborations and practice in the field of sustainable urban development.

The project was undertaken at the time when sustainability was starting to be more discussed in construction projects (I:6) and therefore got influenced to happen by several other projects undertaken at the time. For example, was the large transformation of Hammarby Sjöstad in Stockholm one external event influencing the project to happen (I:6). Development projects in Copenhagen, the capital of Denmark, also inspired the project as well as other projects of passive and energy smart buildings undertaken (Gustavsson & Elander, 2013). The Green Factor developed in Malmö was also a source of inspiration (I:17).

4.3.2 Implementation

Following the "River city model" for cooperation, Älvstranden formed a consortium together with six other developers. Together all the members formulated and signed the Kvillebäcken Treaty (Kvillebäcksfördraget), an agreement where all the developers promised to transform Kvillebäcken into an economically, socially and environmentally sustainable district (I:6; I:16: I:17; Lundström et al., 2013; Kvillebäcken, 2018a).

Kvillebäcken Treaty outlined eighth clear focus areas for the transformation which then were made more precise in the project's environmental program;

1. Connect Hisingen to the city centre and increase the accessibility
2. Attractive and thriving outdoor environment, with parks and greenery
3. Social inclusion, safe area, and diversity
4. All buildings should be constructed in accordance with new building standards
5. Life cycle thinking
6. Residents should have the ability to influence
7. Environmental sounding mobility
8. Recycling facilities

The second focus area was especially important for enabling the implementation of NBS interventions (Kvillebäcken, 2018a). This focus area has resulted in that Kvillebäcken today has several non-commercial parks, pocket parks and one larger park called Kvillebäcksparken.

The project established "An environmental group" meant to monitor the development processes and secure fulfilment of outlined ambitions (Kvillebäcken, 2010). The environmental program consisted of an environmental plan, specifying environmental goals which each of the property owners should fulfil (I:6; I:16; I:17). Throughout the whole project time, each developer had to report and fill out the environmental plan and share it online to make it accessible for the other member in the consortium, the municipality, and public (Kvillbäcken, 2011). This environmental plan was formulated based on Gothenburg's environmental program for sustainable construction, certification requirements from the SGBC and specific requirement in Kvillebäcken (I:6; I:16). In an early stage, a marketing group was formed which came to be important in communicating the transformation and its environmental focus to the public (I:16).

Kvillebäcken is today famous for the green courtyards in each block (Kvillebäcken, 2018a), see Figure 4-4. Every developer was given responsibility for the greenery in its own block (Hällhed and Sundberg, 2013; Samuelsson & Rasmussen, 2014), and different themes and biotopes have inspired each courtyard (I:6; I:16). Kvillebäcken was the first project in Gothenburg to develop and use the tool Green Factor, to secure high greenery and biodiversity in the courtyards (I:6; I:17). The tool was developed over the project time and it both helped and triggered the developers to increase their courtyards' score, causing an internal competition between the developers (I:6).

There has been a high focus on the implementation of green roofs and many of the buildings have today sedum which delays water flow and increase the retention (I:16). Rain gardens are implemented to allow slower drainage and improved water management (Kvillebäcken, 2018a, Hällhed & Sundberg, 2013). The intention was to increase the greenery and use open storm water management in both private and public spaces, however today, when the district is almost completed there are still few green areas in the public spaces (I:6).

In the early start of the project, it got financed by DSC, a four-year state project (Kvillebäcken, 2010). At this early stage of the development six focus areas were specified in the application, however, the project's focus was changed over the project time. The six focus areas were; i) High recycling rate of household waste ii) Low energy usage in households (using district heating), iii) Shuttle, running on renewable fuel, between the district and the other side of Göta river, iv) Parking and storage for bicycles v) Energy efficiency of heavy vehicles vi) Information platform and knowledge sharing.

Figure 4-4. Courtyards in Kvillebäcken

Source: Author, 2 September 2018

4.3.3 Barriers and Obstacles

In an interview with an environmental strategist involved in the project, it was explained how Kvillebäcken has been a project confronted and criticised by many people (I:17). She explains that the project has had many barriers, but was important since it disclosed several factors, which can be improved in the city's organisation. She saw it as an important opportunity for the municipality to improve its organisation and explains how the project resulted in new experiences and valuable learnings that can be used in future projects.

She also raises the issue of not having all the important departments from the municipality involved throughout the whole project period. According to her, it would have been beneficial to maintain all the important actors in the entire process, so there could be mutual learning throughout the whole project. However, she highlights how the city of Gothenburg has improved on this matter and today the collaboration across departments has improved and so also the cooperation between the municipality and developers.

In the interview with the environmental strategist she mentions that there were many barriers in the beginning of the project and lack of knowledge among the actors (I:17). By the time, around 2010, there was still many uncertainties regarding how to work with GI and BI. She explains how it in large projects are many conflicting interests and in general there is a high avoidance among people to take risks. Question and uncertainties related to maintenance and costs abated the whole implementation and use of NBS interventions in Kvillebäcken.

Another interviewee, working at Älvstranden as project manager for project Case Kvillebäcken, considers it as a failure that the greenery mainly became installed and used in the courtyards and not in public places (I:6). The project had many successful aspects of sustainability, but the use of GI and BI was not used and prioritised to the extent it first was planned. She explains how solutions like NBS require well-functioning collaboration and

coordination between actors with diverse expertise and priorities. Furthermore, she explained how there are many situations where GI and BI are simplified or forgotten throughout the process. In detailed development plans there are high ambitions of using NBS, but they are often lost and reduced along the way.

"All questions concerning greenery and water, I usually separate in real problems and made-up problems. The real problem is that we cannot, if we have a rain garden, make water travel upwards, therefore the ground must go downhill. A made-up problem is that it requires much more planning and details to make it work compared to traditional methods like wells and pipes, only a question about coordination, a made-up problem." (I:6).

The interviewee explains that in many cases NBS are not considered to be real solutions with the potential to replace traditional methods and technical solutions. According to her, like-minded people are working in the construction industry, and she sees it as barrier in projects where it is necessary to have a variety of ideas and expertise.

4.3.4 Impact assessment

Kvillebäcken has received a lot of attention and has been projected as a model and inspiration for other sustainable urban developments. Assessment of economic, societal and environmental outcomes were early discussed in the project and to some extent the six sub projects funded by DSC were evaluated (Gustavsson & Elander, 2013; Fehler, 2014; Brorström, 2014; Hällhed & Sundberg, 2013; Göteborgs Stad, 2014c)

In the year 2016 the learning-project Case Kvillebäcken started. The consortium had the intention to have an evaluation report finished already by 2015 (mid time of the project). However, despite never having finalised the report 2015 the new insights from the learning-project Case Kvillebäcken are used to improve future and on-going projects in the River City project and today there are reports regarding learnings from the project (I:6). Case Kvillebäcken is not focussed on assessing whether the initial objectives of the project have been fulfilled but addresses other aspects, which have come to be of higher importance in a later stage (Johansson, 2018; I:6; I:17). Six new focus areas were developed for Case Kvillebäcken, which are 1) lessons learned from changing the identity of a district, 2) lessons from densifying urban development 3) lessons from political conformation and sustainability 4) lessons from mobility 5) lessons from designing ground floors 6) lessons from preschools (I:6). In these reports, Älvstranden has tried to gather all the existing information on Kvillebäcken- reflections, opinions, and views (Johansson, 2018). Some reports are accomplished while others are still to be completed.

Two reports were completed in 2018 (Kvillebäcken, 2018 a and b). Before this, the reporting was only undertaken by each property owner who reported fulfilment of requirements to Älvstranden and the SGBC in the environmental plan (I:6). In the two recently completed evaluation reports of Case Kvillebäcken (Kvillebäcken 2018 a and b), there is a minimum assessment of impacts provided by GI and BI and according to one interviewee it has not been prioritised (I:6). One report is focused on social aspects of the district such as residents' perception (Kvillebäcken 2018b). In the report it is presented how 2% of 300 interviewed residents were not too happy to live in the area while 88% thrive in the district and 10% did not feel neither happy nor dissatisfied (Kvillebäcken 2018b). However, in the report there are also comments from the residents thinking the outdoor environments are boring and insufficient maintained, Figure 4-5 shows the green park along the river Kvillebäcken in the district.

The second report is following up the eight focus areas outlined in the treaty (Kvillebäcken, 2018a). It presents learnings from the project in addition to statistics on the socioeconomic

groups living there. The groups are younger people, with a higher income than the average citizen in Gothenburg. In addition, it is apparent from the report that there have been efforts towards ensuring a large percentage of rental apartments, to enable a mix of people in the district.

Project Kvillebäcken has been criticised for being a demolishment of old Kvillebäcken and accused for so called state led gentrification. Before the construction could start auto repair shops, second hand markets, migrant associations and mosques in the area were closed down and forced to move (Björk & Krusell, 2015; Fehler, 2014; Isitt, 2016; Thörn & Holgersson, 2016). The city of Gothenburg has been defendant to not reduce segregation, but in practice, Kvillebäcken has become a district with higher housing prices thus leading to gentrification (Thörn & Holgersson, 2016). The public private partnership between Älvstranden and the real estate owners is seen as main enabler of the transformation. Consequently, the partnership has been accused for planning the "upgrading" of the district in a non-transparent way. The old Kvillebäcken has been an important part of the culture and history of the old city of Gothenburg. The district has also been a place where certain socioeconomic classes can afford apartments in the inner city (Björk & Krusell, 2015; Thörn & Holgersson, 2016). The social aspects in NBS projects were not especially prioritised compared to today, where gentrification receives more considerations (I:6; I:17)

Figure 4-5. Green areas along river Kvillebäcken

Source: Author, 2 September 2018

4.3.5 New practices and learnings

The 6th sub project, funded by DSC, had as aim to make Kvillebäcken a test arena for the development of new technologies in urban sustainable planning and an information platform for knowledge sharing (Göteborgs Stad, 2014c). Region Business Gothenburg (RBG), a non-profit company, worked as the main driver of the project, to create favourable conditions for trade and industry (I:17). RBG was highly involved and a support to the developers by helping them to find suppliers and experts, who could provide green solutions used in the courtyards. The idea was to favour the home market for environmental small sized tech companies, by allowing them to show how their products work in real practice (Göteborgs Stad, 2014c). Thus, increasing the companies' chances of gaining recognition from international actors and investors.

Throughout the project-period, several workshops and matchmaking meetings were arranged to enable the members of the consortium, companies and other relevant actors to meet (Göteborgs Stad, 2014c; I:16). This initiative was meant to open up for new collaboration, partnerships and knowledge sharing. In total, five workshops were held, and one was focused on storm water management and green areas. In those workshops the estate owners were exchanging experience and solutions used in each of their courtyards.

An essential part of the sub project was to invite international companies and investors to look at the different solutions in Kvillebäcken (Göteborgs Stad 2014c). As Kvillebäcken started to re-develop, it became a district for site visits and one of the most popular objects to visit by delegation and groups from all over the world. Today, it is still possible to arrange study visits to Kvillebäcken on the website Green Gothenburg. Furthermore, Kvillebäcken is also a visit site in two city tours (Green Gothenburg n.d b).

Additionally, the property owners have arranged their own study visits and hosted delegations.

"I have constructed many buildings in south of Sweden and have never had as many study visits [….] We had so many interested in the project that I needed to say no to people" (I:16).

The gained knowledge and experiences from the project have been shared using several different media and through extensive marketing (Göteborgs Stad, 2014c; I:6). The project has been marketed in websites, twitter and on fairs and events (Göteborgs Stad, 2014c). Moreover, it has been the selected case for representing Swedish sustainable development in several different international conferences and fairs.

The so-called River City model, designed to be applied in the developments of the different districts, was tested in the project (I:6; I:17; Göteborgs Stad, 2014c). In this model, learning is one of six key elements, emphasizing how River City should use pilot projects as test arenas for new innovative solutions, and that the knowledge should be transferred from one project to another. Consequently, based on experiences from Kvillebäcken this model was developed and improved to be used in future projects (Göteborgs Stad, 2014c).

4.4 Case 2: Rain gardens in Kviberg

In 2015 the largest rain gardens in Sweden were implemented in Kviberg, an area in the north-eastern part of Gothenburg (P-bolaget, n.d). The district is still under development and at the time the rain gardens were implemented many of the surrounding areas were not constructed. A new multi sports arena had just been built and the municipality owned parking company, P-bolaget, assigned to construct new parking lots outside the arena (I:8). During the same time period the two administrations, Park and Landscape Administration (PLA) and Water and Recycling Administration (WRA), were searching for a suitable location for a pilot project on rain gardens (I:1). The actors found each other and established a pilot site for rain gardens as a part of an open drainages system (Dahlström, et al., 2017). The planning process of the project started in 2013 and the rain gardens were completed by 2015.

4.4.1 Objectives and Drivers

The rain gardens in Kviberg became a collaborative pilot project with several different stakeholders involved (I:1; I:8). The initiative came from the two administrators in the City of Gothenburg, PLA and WRA, who wanted to learn more about rain garden, design and implementation.

According to an interviewee, working at the WRA, the department already had a good theoretical understanding of rain gardens (I:1). However, the aim of the project was to increase the knowledge base on how to achieve and enable the city's examples of sustainable storm water solutions. Improved water management is of high priority because of the increasing danger of floods and rainfalls due to climate change. Analyses show that the sewage and storm water systems are undersized to manage the future rainfalls (SMHI, n.d). There are scenarios where heavy and sudden rain has led to destruction of sewage systems and pipes, causing black water to get mixed with storm water (SMHI, n.d). Eventually, the mix of untreated sewage and storm water enters the recipient. If this happens in Kviberg, the mixed water will enter the Säve river, a NATURA 2000 area.

The main reasons for P-bolaget to get involved, was to fulfil requirements on water management stated in the detailed development plan for the district (I:8). To comply with the regulation, it would have been necessary to implement traditional treatment methods. Thus, rain gardens were considered to be a more interesting option. The rain gardens became an adaptation and mitigation strategy to tackle some of the consequences experienced due to climate change and to the meet the city's own set environmental and climate goals (Göteborgs Stad, 2017b). It became funded by the larger project called "Climate-secured system solutions for urban areas", a VINNOVA project, aimed to research on innovative green sustainable urban drainage systems and permeability of surfaces in cities (Klimatsäkrad Stad, n.d). Rain gardens in Kviberg is one of several pilot sites VINNOVA uses to study and explore the solutions for sustainable water management.

4.4.2 Implementation

The working group consisted of the initiators of the project PLA and WRA, P-bolaget and Serneke construction company, who built and owns the sport arena. P-bolaget and Sarneke own the parking lots and P-bolaget leases the land where the parking and rain gardens are located. SWECO, a building service system consultant, was responsible for projection and evaluation of the rain gardens while another consultant company called WSP was responsible for projection of the parking area (Dahlström et al., 2017).

The project took approximately one year to complete. Throughout the project, working group meetings were held where all involved actors were informed about the whole construction

process (I:8). Much of the "in-house" knowledge was used to secure that the same persons did most of the different steps in the process, seen as essential to gain and retain knowledge from the project.

Several rain gardens were installed along the sides of the two parking lots (Dahlström et al., 2017; SMHI, n.d), see Figure 4-6. The car parking lots were designed to slope downwards, so water is transported to the rain gardens. The redundant water gets transported to a drainage bed, where the water enters the ordinary drainage system located in the lowest point of the rain gardens. In case of extreme water volumes, water domes work as a backup (see Figure 4-6). Most of the water should be retained by the vegetation, and the installed rain gardens are estimated to manage 10-20 millimetres of rain per meter square of the parking lot. The vegetation is diverse with many different species of plants, grass and trees.

The PLA has undertaken the maintenance of the rain gardens (I:8). They are doing this on the behalf of P-bolaget, who is the responsible actor for the maintenance. The maintenance plan holds specific information on the frequency of maintenance, technical as well as botanical (P-bolaget, n.d). The rain gardens should be checked in case of extreme weather, oil spills or if there seems to be decreased infiltration capacity. According to SWECO the rain gardens have an estimated lifespan of 30 years. Purified water samples and samples from the reference (comparator) installation will be taken to monitor the concentration of pollutants. Concentrations will be reported to the Environmental Administrator, where they are compared with allowed concentrations.

Figure 4-6. Rain gardens in Kviberg

Source: Tobias Hagman, 3 July 2018

4.4.3 Barriers and Obstacles

Actors involved in the project came across organisational and collaborative challenges which resulted in some technical mistakes along the way. In addition, there were other actors and activities carried out in the district which highly influenced the process and completion of the project, causing delays and mistakes. Some of the mentioned barrier and problems are described in Table 4-4.

Table 4-4. Barriers and Obstacles experienced in the project. Three sources, I:8 (interviewee 8), I:1 (interviewee 1), R (the report by Dahlström et al., 2017)

Problem	Description	Source
Organisational and collaborative issues	• It was not always clear who was the project manager from each actor group. This caused the organisation and areas of responsibility for each actor in some cases unspecified, which in turned caused collaborative challenges.	I:8 & I:1
Mistakes in the design and construction	• One parking was constructed wrong, causing the water to overload one rain garden. • A misunderstanding caused one rain garden (the one which was overloaded) being installed as a normal garden instead of a biofilter. • Mistakes in the construction caused erosions of the parking lots.	R
External factors	• An event in the arena shorten the project period despite that more time was needed. • Much of the traditional sewage system had not been implemented in the district, causing water from surrounding areas to enter the rain gardens (water overload). • Lack in communication with developers of the surrounding area caused some of the rain gardens to get destroyed when other actors started projects in the area.	I:8
Sensitiveness	• Rain gardens are sensitive and can easily get destroyed under the project time and implementation.	I:8
Require maintenance	• The rain gardens clearly require maintenance.	I:8

Source: Author's own elaboration

4.4.4 Impacts assessment

As a part of the VINNOVA project, SWECO did an evaluation project to study water quality (SMHI n.d). They used the modelling program called StormTac to measure pollutants such as copper, phosphorus, cadmium and suspended solids. Water samples were compared with water results from another parking area with conventional storm water systems (Dahlström et al., 2017). When comparing the results to allowed concentrations, all pollutants were of acceptable levels, except copper and zinc. An assessment of the retention of Kviberg's rain gardens have been carried out by a master student at Chalmers University of Technology,

Department of Civil and Environmental Engineering (Hellberg, 2016). Hellberg (2016) evaluated different parameters, using a software model, which are influencing the retention capacity of the rain gardens. Considering uncertainties and assumptions, the study shows that Kviberg's rain gardens have the potential of being a possible alternative in water management to conventional solutions. The study of Hellerbg (2016) showed removal of pollutants such as phosphorus and copper.

In the autumn/winter 2016 and summer 2017 visual evaluation of the rain gardens were undertaken, to secure good maintenance and establishment of vegetation (Dahlström et al., 2017). Most plants seemed to have survived (I:8). Plant species have been assessed to determine which are suitable for retention and purification of storm water in rain gardens, showing how some plants are not able to survive the volume of water (Dahlström et al., 2017). Lastly, infiltration capacity was measured, although in an early stage when yet few plants been established.

According to the interviewees, the rain gardens have a noticeable well-working detention (I:1; I:8). In case of heavy rain, the water level first increases to later gradually sink, proving the water is being absorbed by the vegetation and slowly transported to the recipient. The intention was to start measuring water quality directly after the completion of the rain gardens. However, this has not yet been fully achieved because of several obstacles over the project-time (I:8). However, the plan is to start measuring more regularly in order to evaluate the retention of the gardens. The cost for the rain gardens came to be within the budget, likely because of transparency between the different actors involved (I:8). Social impacts have not been measured in this project and is not planned in the future. The evaluation time is set to three years and still on-going. Thus, the involved actors still arrange meetings to discuss the project (I:8).

4.4.5 New practices and learnings

Inspiration to the project came from several other successful projects in Stockholm and Portland (US), where the rain gardens helped to purify the water (SMHI, n.d). One interviewee explains; how some of the challenges or mistakes made in the project generated new learning and experience, which have already been applied in new projects in the city of Gothenburg (I:1).

The project was completely new for P-bolaget and significantly different than any previous projects. One interviewee explains how the project was far from as straightforward as implementation of traditional drainage systems (I:8).

"However, a pilot project should challenge traditional methods and result in new learnings" (I:8)

As a part of the project "Climate-secured system solutions in urban areas" the information and knowledge regarding the rain garden have been shared and described online as well as published in reports (Dahlström et al., 2017). Especially the report by SWECO called "Biofilter in Kviberg-learnings and experiences" contributed to this (Dahlström et al., 2017).

Study visits have been arranged for other municipalities and actors interested in implementing rain gardens. During these visits the two administrations PLA and WRA have organised presentations about the project (I:1; I:8) Additionally, signs have been placed next to the gardens, with information about their purpose and construction to increase the public awareness about rain gardens' significance in sustainable water management.

4.5 Case 3: Green facade constructed by Vasakronan

Vasakronan is one of Sweden's leading and largest property companies (Tollesson 2018; Vasakronan n.d), active in the growing regions - Stockholm, Gothenburg, Malmö, Uppsala and Lund. With the vision of "future-proof", the company feels obligated to have sustainability as an integrated part of their business and organisation. In 2015, Vasakronan took the initiative to re-green the city of Gothenburg and to highlight the importance of ES by implementing the company's first green facade in Gothenburg. The green facade consisted of 60 square meters on the street Kyrkogatan in the city centre (Wahlberg and Nilsson 2015). The facade composed of 2000 plants and 17 different species when it was constructed. The green facade is meant to increase the urban biodiversity and to improve the urban climate.

4.5.1 Objectives and Drivers

The initiative came from Vasakronan, with the objective to increase ES in the dense city centre (Vasakronan, n.d). However, Vasakronan also wanted to be a frontrunner and pioneer by showing how it is possible to construct green walls in urban areas. According to the project manager, the intention was to learn how living walls work on a smaller scale, and then use the experience in future projects (I:11). The project came to happen because of a detail in the development plan of the whole area, where an architect had decorated an entire building in something green, without specifying any details. This made Vasakronan agree on trying to actualise the green constellation on the parking house.

4.5.2 Implementation

The project was enabled through collaboration between a green wall designer from the UK, Ramböll (consultant company) and Vasakronan (Andersson and Simu, 2015). Additional actors involved in the project were a design engineer, an architect and a construction entrepreneur. The facade was implemented on the wall of a car parking house in one of the busy shopping streets. The initial plan was to design an even larger wall on another building, however it was seen as a too risky investment and this project was aimed to gain knowledge about construction, design and maintenance of living walls (I:11).

Referring to previous interview material from the thesis "Maintenance of living walls", the green wall-designer thought the communication was straightforward and uncomplicated throughout the project (Andersson and Simu, 2015). The project leader from Vasakronan and the green wall-designer had two to three meetings and continual communication by email. The process from planning to implementation took approximately five to six months (including getting the construction permission), while actual implementation took just about two weeks. Vasakronan was responsible for the implementation of the steel frame and to handle the permission process. The designer of the green facade selected plants and installed the facade together with one of his co-workers, and the construction entrepreneur installed the steel frame. The design engineer helped with the construction of the steel frame. The collaboration with the architect was in terms of ensuring the green facade had a design in accordance to the detailed development plan of the entire district.

The maintenance of the facade was supposed to be easy and the construction was expected to last for approximately 30 years (Andersson and Simu, 2015). When the facade was completed the green wall-designer educated an operations manager and gave instructions of maintenance. In addition, it was formulated a one-year contract which ensured the wall to be reviewed from time to time by the green wall-designer. The minimum maintenance consisted of touching the plants regularly to make sure the irrigation system worked and to replace dead plants. Once a year, nutrients were to be added to the wall while cutting and thinning of the plants were only undertaken in case plants started to cover windows and doors.

Today there is a new operations manager whom together with the property manager is responsible for the facade. The maintenance is undertaken by a consultant company hired by Vasakronan (I:7). In interviews with the project manager and property manager, they explain how there has been, in the recent years quite a lot of vegetation dead after the winter (I:11; I:7), see Figure 4-7 showing photographs of the green facade. This problem has made it necessary to call for an emergency meeting where the property manager together with the current operations manager and the consultant company discussed potential causes and solutions (I:7).

Figure 4-7. Green facade in the city centre by Vasakronan

Source: Author, 6 July 2018

4.5.3 Barriers and Obstacles

Interviews with the green wall-designer and project manager in the thesis "Maintenance of living walls", address challenges and difficulties experienced in the project (Andersson and Simu, 2015). The designer points out, that the Swedish working culture makes it more difficult to work in Sweden compare to UK. He has noticed the pattern that swedes in general have high ambitions, but many meetings do not result in actual projects. Another limitation is the lack of affordable plants on the Swedish market.

Sweden's cold climate is another factor making it challenging to design green roofs, walls and facades. The designer has constructed approximately 50-60 green walls and has tried for many years to find plants, which could survive the colder climate in Sweden. Another challenge was to design an irrigation system that works in the, sometimes, lukewarm winters in Sweden, where the temperatures are not always low enough to shut off the irrigation. He emphasises the importance of plant schools and research in the field, to fasten the development of better solutions in cold climate. According to the designer, plant cultivation is a low paid position and therefore there is not enough drive and engagement in the sector. He also highlights the precautionary mentality in Sweden as a central factor for the slow progress in the field.

According to the project manager from Vasakronan, it was most difficult to get the permission from the City Planning Authority, since the project was associated with high risks (Andersson and Simu, 2015). The location of the facade, in the middle of the city, caused additional challenges since it was a busy street with many people passing. Today, she considers the difficulties associated with the project to be equal to other projects (I:11).

However, it is necessary to find people with right knowledge and expertise (I: 11). She thinks there is a good expertise regarding living walls implemented indoors in Sweden, but walls outdoors are still not as common. Today the facade, as mentioned, experiencing challenges in aspects of maintenance and up to 60 % of the vegetation died over the winter 2017/2018 (I:7), and a solution has yet to be found.

4.5.4 Impact assessment

The facade is meant to be evaluated in parallel with the development of the district (Andersson and Simu, 2015). Nonetheless, there has not been a clear evaluation of the project. According to Vasakronan's environmental manager, no quantitative assessments are planned of the green facade (I:13). There are, however, impacts assessment methods which could be undertaken, but these assessment measures are foreseen to be too costly compared to the actual gained value.

"We are convinced the green walls are good for both people and the environment and it is better for us to invest money in greenery in the city, rather than in investigations" (I:13).

No societal or environmental impacts have been assessed, but the facade has been given positive reactions from the public (I:11). Vasakronan's decided to focus mainly on the emotional value that the facade brought to people, however, the green facade has most likely also increased the real estate value of the building (I:13).

4.5.5 New practices and learnings

The project manager saw the project in most aspects as very similar to other projects, but clearly required knowledge and expertise in other fields (I:11) In its completion 2015 the facade received a lot of attention and a sign was placed underneath with information about the project, additionally it was marketed on their website. The wall conveys information about the importance of greening cities and Vasakronan received comments from tenants, consultants, entrepreneurs and the public passing by.

The facade has been used as an object of study in the thesis called "Maintenance of living walls" by Jönköping University in Sweden (Andersson and Simu, 2015). Several living walls in Sweden are examined in the report and it contains two longer interviews with the project manager of Vasakronan's green facade and the green wall-designer. Consequently, it has contributed to sharing knowledge and information about the green facade and more precisely about opportunities and challenges in implementing living walls in Sweden.

After the completion of the facade there was no outlined follow-up plan, which the project manager states as a drawback (cited in the report by Andersson and Simu, 2015).

After the project the project manager has not taken part in any new projects where a living wall or facade has been implemented (I:11) However, Vasakronan has two additional famous outdoor living walls, one in Stockholm and one in Uppsala. It is unknown for Vasakronan whether their green walls have inspired or enabled other projects, they only know their walls have received a lot of attention (I:13).

5 Discussion and Reflection

In this section, firstly the three NBS project objectives and evaluated impacts are compared to identify similarities and differences between the different cases. The second and third research question, addressing barriers and drivers in up-scaling and how knowledge transfer can be facilitated between projects, are discussed by using the two analytical frameworks presented in the methodology.

5.1 Objectives and impacts of NBS

In this section, the three NBS project objectives and evaluated impacts are compared through a cross-case analysis. The analysis is then compared to theoretical propositions in the literature review and to patterns seen on three scales- Europe, Sweden and Gothenburg. The comparisons are important in the generalisation of the three cases, which makes the study fulfil its external aim to contribute to an improved understanding of NBS interventions and their implementation.

5.1.1 Objectives

Using the ecological domains defined in the Atlas by NATURVATION, project Kvillebäcken has all the six most common domains of NBS implemented. As a transformation of an entire district, Kvillebäcken was a large-scale project, with several NBS interventions implemented. Consequently, it was a project distinctly different from the two other projects where one isolated NBS intervention was implemented in each case. All the different NBS interventions seen in the district today, were not specified in the objectives of the project more than that parks and greenery are important elements to fulfil the objectives of creating a sustainable district. The vision got operationalised in the Kvillebäcken Treaty, but with much room for interpretation. Each property owner got the responsibility to develop its own courtyards. However, using the Green Factor as a tool to guarantee enough greenery in the district, they together were to achieve a Green Factor score of 0,5. Expressed by one consortium member, every developer tried to use as much greenery as possible and mainly on their own they found suppliers, designers and consultants to help them achieve a sufficient level of greenery. Today, the district has green courtyards, green streets and a park along the river Kvillebäcken. Additionally, community gardens have stimulated activity and created coherence in the neighbourhood.

Referring to the different typologies of NBS presented in the literature review, there are different categorisations of what NBS can generate and which environmental problems (if several) the solution can address. There is a high risk the interventions are lacking assessments of impacts, if there is not a specified purpose and identified problem for each NBS intervention. This could be seen in project Kvillebäcken where each intervention's purpose was not specified. Being able to identify what more specifically an NBS intervention is intended to provide is a difficult task but, increases the likelihood of the intervention being assessed and monitored. Moreover, it would increase the acceptance and support from a range of sectors, where NBS interventions today are seen as solutions giving several "unspecified benefits".

In contrast, the rain gardens were specified to work as an alternative to conventional drainage systems and their purpose and objectives were clearly formulated. The green facade, as the only intervention in the domain called "external building greens" in Gothenburg, was implemented as a single NBS intervention. However, unlike the rain gardens, where only one NBS intervention was implemented, the intended impacts provided by the green facade were not specified. In project Vasakronan they wanted to increase greenery and identified several

potential benefits provided by the wall such as improved biodiversity and air quality. However, despite a broad spectrum of benefits in its aim, the project has not been quantitatively assessed and has today problem in its maintenance.

When comparing the objectives of the projects there are three aspects of the objectives which they have in common. Firstly, in accordance with what is presented in the existing literature on the concept of NBS, they are solutions which should address certain ***sustainability challenges***. In Europe and Sweden, the most addressed challenges are, according to the NATURVATION Atlas, in the category of green space, habitats and biodiversity. In Gothenburg this challenge is addressed in all three projects. However, in Gothenburg the most commonly addressed problem is health and wellbeing, demonstrating how the NBS interventions have gained recognition of providing societal benefits. An example is project Kvillebäcken, where the objectives changed to increasingly focus on aspects of social sustainability. According to interviews, the knowledge base and the perception of what sustainability should entail, has changed since the project started for almost ten years ago. As a city with evident problems of segregation, it might be the reason why four out of ten NBS projects in Gothenburg address problems of social justice cohesion and equity.

It is more common to use NBS interventions in water management in Sweden and Gothenburg than in Europe. Almost all interviewees mentioned or highlighted heavy rainfalls and increased risk of flooding as the most acute problem, likely being an underlying reason for the city's focus on implementing sustainable urban drainage systems. Rarely used, sustainable drainage systems are according to interviewees, still the most common NBS intervention. In Kviberg the rain gardens were implemented as adaptation and mitigation strategies to climate change. Likewise, the green facade and green courtyards in Kvillebäcken are used for retention of water.

Secondly, Kvillebäcken and Kviberg had in their objectives to ***comply with a regulation***, demonstrating how regulation and legislation work as drivers. It also shows how environmental legislation and mandatory requirements have become more extensive. Vasakronan on the other hand did not implement the green facade in response to a strategy or legislation but decided as a leading property company to act. Thirdly, all projects were identified as pilot projects and thus had in the objective to ***generate learnings and knowledge***. This aspect, together with the fact that almost all the other seven NBS projects identified in Gothenburg were not completed, validates how NBS interventions are new to the city and have yet not been used to a large extent.

It was clear in project Kvillebäcken how the project got influenced by external events and factors over the ten years the development was undertaken. The objectives of the project changed over time as it was realised how other aspects should be prioritised than originally intended. In Kvillebäcken purpose of the NBS interventions were not specified at the start of the project, therefore it is not possible to assess if they have changed. Still, the project shows how NBS projects constantly should be monitored and assessed, and perhaps most importantly, should allow flexibility and adaptation throughout the whole project. To have an adaptive governance, flexibility should be balanced with a clear purpose of the NBS. Consequently, this is one of the most significant challenges of formulating objectives of NBS projects - as they should be both specific and adaptable.

5.1.2 Impacts

All the three NBS projects had objectives of giving environmental benefits as well as, more or less explicitly stated, societal and economic benefits. However, as the objectives of the NBS interventions were not clearly defined in two of the projects the impacts tend to not be

quantitatively assessed. Visually, all the three projects have provided environmental impacts. For example, project Kvillebäcken was a successful project in the sense it transformed a district from being associated with high criminality and contaminated soil, to a new neighbourhood with a high degree of natural elements. Likewise, Vasakronan's green facade clearly increased green elements in the city and received appreciation from people passing by.

Nonetheless, despite that most of the interviewees mentioned the importance of assessing intended impacts, it was not prioritised to a large extent in the projects. Generally, in almost all the interviews (and not only those directly related to the three cases) it was mentioned how assessments are rarely undertaken. The reasons behind this was mentioned to be lack of time, shortage of competent people and low engagement. Another reason is that the task to assess impacts is not clearly devoted to a person or a specific department. In the Atlas by NATURVATION, only 10% of all NBS projects had undertaken impact assessments in Europe. Like in the rest of Europe, impacts assessments are seldom undertaken in Gothenburg. In the three NBS projects the efforts were focussed on environmental benefits but there were in addition evaluations of societal benefits. For example, was a quantitative assessment of societal impacts undertaken in Kvillebäcken. Gentrification became a central problem and was likely one of the reasons why social impacts became one area of focus at the end of the project. Moreover, it has been mentioned in the interviews how societal benefits, provided by nature, is more acknowledged today than before. Furthermore, the providence of social benefits is increasingly used as an argument for increasing the implementation of NBS in cities. It should be highlighted that impacts can still be provided even if an assessment of impacts is not undertaken.

Environmental impacts: All the three projects have clearly led to increased use of NBS in the city of Gothenburg. It is striking how Kvillebäcken was transformed from a post-industrial area, with a bad reputation, to an internationally recognised sustainable urban district. In this project, the environmental impacts are significant in the sense that the whole area has more greenery and is less polluted after the sanitation, with the improved water quality of river Kvillebäcken as a result. The Green Factor developed in the project has been essential in the development of the City's Green Factor. Yet there has not been developed any tools or indicators to assess impacts provided by every isolated NBS intervention in the district.

During project Kviberg it was researched how the implemented rain gardens can work as an alternative to conventional storm water systems and it was proven the rain gardens can keep concentrations of most pollutants on acceptable levels. When the rain gardens were visited in late June/early July, a high variety of different plant species were observed. Consequently, they have likely not only worked for water management but also increased biodiversity. The green facade by Vasakronan has so far not had any environmental impacts assessed, making it difficult to evaluate outcomes. Thus, an example of how NBS projects can be implemented quite easily but often are lacking the attention to what impacts they should provide.

Economic and Societal Impacts: Neither of the two projects, Kviberg and Vasakronan, seemed to have assessment tools for social or economic impacts. Actors involved in project Kviberg did not emphasise many of the possible co-benefits rain gardens can provide. Despite a focus on social aspects related to using nature in cities, project Vasakronan did not undertake any quantitative assessment of people's perception of the green facade. However, in project Kvillebäcken there was recently a public report completed, where 300 residents gave their opinion about how it is to live in the district with suggestions on improvements. Consequently, this can be seen as an important step in engaging the residents and assessing societal impacts. The results showed how most residents enjoy living in Kvillebäcken.

Yet there has been a debate and several articles and reports written about the "unfair game" said to be have been played by the city of Gothenburg, Älvstranden and the other actors in the consortium. They have been accused of planned gentrification and a redrawing of the area, where historical parts of Gothenburg got demolished and turned into a new exclusive residential area. This is an example of the importance of communicating changes in a transparent way and how large changes must gain acceptance by the public. It also shows how urban sustainability entails trade-offs, thus not necessarily positive outcomes for everyone. As a result of the negative impacts, the city has undertaken more research on gentrification in their learning-project Case Kvillebäcken. Social impacts, such as gentrification are difficult to assess, and has been proven to be a challenging aspect needed to be addressed by the city.

It is also important to highlight possible positive impacts of Kvillebäcken's transformation and its relevance for the continuing development of Hisingen and other projects in the city. The city has gained new learnings, which will be used by the municipality and probably by other urban projects around the world. After being well-marketed, the project still has people's curiosity especially in relation to how the district will tackle problems with segregation in the future. Today the district has several new businesses and the project likely spurred the innovation of green economy and the market for green jobs. Centrally located, it has influenced the attractiveness and enhanced activities in surrounding districts.

Most interviewees are arguing that it is neither more difficult nor more expensive to implement NBS interventions, but that problems are often of organisational character. As an example, rain gardens have proven to be more sensitive than conventional drainage systems. Thus, they cannot be implemented until most of the district or area is developed since they would be destroyed in the construction process. This causes problems as a drainage system is needed during the construction period. As a result, in parallel to rain gardens a conventional drainage system is needed and "a double system" is implemented. Consequently, NBS interventions have in some situations the potential of being as affordable as conventional solutions, but since practicalities in the construction cannot be solved they usually end up being more expensive.

Monitoring: Sweden and Gothenburg, are significantly better on providing information about monitoring practices undertaken in their projects. Eight of ten projects (80%), were known to be monitored in Gothenburg, while a much lower number is confirmed in Europe. Project Vasakronan is one of the two cases which were not monitored in Sweden. Consequently, there is no monitoring system, evaluation report, indicators used in reporting (see Table 5-1). The situation is different for Kvillebäcken and the rain gardens in Kviberg, where there are some evaluation reports and indicators used in their assessments.

Table 5-1. Monitoring undertaken in the three projects.

Monitoring	**Kvillebäcken**	**Kviberg**	**Vasakronan**
Monitoring system	Yes	Yes	No
Evaluation report	Yes	Yes	No

Indicators	Yes	Yes	No

Source: Author's own elaboration

In the interview with the researcher on NBS, the problem with lack of monitoring of NBS interventions was addressed;

"yeah, I can understand why they are focusing on implementation. They want to show results to their cities or to their citizens I should say. And monitoring takes time and also requires capacity. Which is not always there in the cities" (I:15).

In both Kviberg and Vasakronan there were problems in the maintenance of rain gardens and the green facade respectively. In Kviberg there exists a maintenance protocol with specified information how the rain gardens should be maintained, however some sections are not properly maintained. Vasakronan have expressed their concerns as many of their plants are dying during wintertime. This proves how maintenance is an essential part of NBS and should not be underestimated or taken lightly.

5.2 Variables and factors working as drivers and barriers in up-scaling NBS

In this section there is a discussion on barriers and drivers related to NBS, using the framework described in Raven et al. (n.d), and the report from NATURVATION van der Jagt et al. (2017). Identifying what drivers and barriers are associated with NBS is an essential step in the process of mainstreaming and up-scaling NBS, since isolated factors together can work as a leverage point and result in changes of entire systems. Interviewees were directly asked about what they saw as potential barriers in the implementation of NBS and some information was obtained from answers to other questions and from gathering information about the three cases.

Cognitive factors: People's attitude and awareness concerning environmental problems, and more specifically NBS interventions, is a significant factor influencing the diffusion of NBS. In interviews with the different departments in Gothenburg's municipality, it was shown how some actors working with urban development and projects have old ideas and view conventional solutions as superior to the NBS. This resistance to change might arise from low awareness of the benefits and services provided by NBS solutions and environmental problems. It can also be a fear people have of trying new things. Interviewees mentioned how there sometimes is low engagement in the departments holding financial means and among those working with technical solutions. According to one environmental director at Älvstranden, there is still lacking knowledge of the value provided by nature. NBS's are by some professions, seen as mainly aesthetic solutions, providing only "soft" benefits. NBS interventions often provide several co-benefits, that some people will argue are not evidently important to humans. Thus, leading to a screw prioritisation when NBS's are in competition with other solutions, which have a clear function and purpose.

"You still do not see nature as a part of the infrastructure, no matter how much we talk about greenblue infrastructure, and all those concepts, such as greenblue infrastructure, ecosystem services and nature technical solutions. Well, they all mean the same thing, but they are basically just different ways of communicating to make sure we reach out to technicians" (I:6)

However, in project Kvillebäcken interviews also anticipated that the knowledge base of NBS has become much better and that the green solutions are increasingly integrated into policymaking and urban planning. Approximately ten years ago, when project Kvillebäcken started, it was different and today the overall knowledge among directors, suppliers and architects is higher and commonly people are familiar with the importance of GI and BI in the city. All the three projects prove that there is a high willingness to learn how to implement and use NBS intervention in Gothenburg, but many are pilot projects and the first of their kind. Consequently, these projects might in due course result in improved knowledge base and acceptance in the city.

Agency: In this framework, the agency is referred to as the role of people and organisations in the implementation and use of NBS interventions. This variable is highly connected to cognitive factors since facilitators and champions for NBS are likely feeling responsible for the environment and believe solutions must integrate nature in some way. Among the interviewees some are optimistic in their belief that the municipality has a good knowledge base and power to influence the use of NBS. However, the other interviewees meant that many old practices and ideas still exist in the departments. Top-down facilitation is seen as an important way of bringing change, and on the European level, the EC's funding research on NBS is highlighted as an essential driver for implementation and up-scaling. Nevertheless, bottom-up facilitation is also important in enabling changes. In project Kvillebäcken, the engagement and enthusiasm of four people and the developers were one of the key reasons why the transformation had significant environmental focus. This project shows how single individuals are drivers for NBS and how one or several promoters and champions can enable change.

Discourses and future visions: NBS interventions have the potential to change visions and current discussions in the urban sustainability discourse but can likewise be influenced by local and global norms and trends. Thus, NBS interventions should try to be in line with present discussions as well as constantly challenge the current beliefs and practices to enable improvements. This is a difficult balance. Change is important, not least in the environmental discourse, where it is constantly alleged as necessary and must happen in a near future. However, a gradual change should be to work in synergy with the rest of the development. The researcher at the Swedish University of Agriculture points out the different gradual changes of visions and how the digital age and sustainability discourse should adapt and evolve together in parallel.

In one interview, it is addressed how industry adaptability and innovation propensity vary between industries and is especially minimal in the construction industry. The construction industry relies on well-proven methods and procedures used for a long time, contrasting to high-tech companies where innovation is rewarded.

Yet, in the constant change of society- visions, discussions and technology, it is necessary to constantly be one step ahead and act with a vision consisted by futuristic goals. Kvillebäcken was a district development ground-breaking in its way of having environmental aspects as fundamental and mandatory in every step of the development process. However, today, ten years after it started, some things that were new then are common practices today. This is a typical example of how visions and references are constantly changing and the reason why some projects sound initially very ambitious and unmanageable.

Strategic plans, legislation, policies: As NBS is a concept within the sustainability field it is usually favoured in a situation where the environmental legislation gets stricter with a higher demand on sustainability and environmentally friendly practices with reduced environmental

impact. In Gothenburg regulative requirements on water management has driven the development of solutions, like rain gardens in Kviberg and Kvillebäcken. However, it is important to highlight that policy and legislation are highly influenced by current visions and respond to what is seen as urgent. The European ambitions, such as the Paris Agreement and Sustainable Development Goals (SDGs), are also clearly influencing the pathways of NBS. However, it takes some time for the new regulation, agreements and efforts to travel from EU-level down to national legislation and municipalities.

However, legislation can also hinder or at least complicate the process of implementing NBS. One interviewee explained how property law can prevent installation of rain gardens. Similarly, lack of legislation and enforcement may prevent actions from being taken. Sweden's first climate adaptation strategy on a national level, was the main theme at the climate adaptation conference in Stockholm, September 2018. At the conference, there were many expressing dissatisfaction that it had taken too long time to formulate the strategy and lacking a national strategy had made it difficult to act on a local level.

In general, it seems like NBS interventions are not solely driven by regulation and legislation, but also by voluntary schemes and efforts. The Green Factor was developed in project Kvillebäcken and highly encourage the developers to work with NBS interventions in their courtyards. Still, the tool was not mandatory. The same can be noticed in the use of certifications schemes, such as the one by SGBC. Vasakronan mentioned how they implement green walls, facades and trees because they give them higher points in SGBC certification. Potentially there is increasing pressure to implement NBS intervention from voluntary initiatives.

Institutional setups and governance structures: Some of the employees at the municipality mentioned how Gothenburg has an institutional setup, where many departments share responsibility for the environmental work. According to one interviewee, Gothenburg, compared to other cities in Sweden, has a higher number of departments. Every department has its own focus area. For example, Property Management Administrator is responsible for the provisioning ES while the PLA is responsible for supporting ES such as biodiversity. In larger projects representatives from each department are commonly involved, thus making the projects have several managers.

Decentralised governance structure can increase the likeliness of getting influences and inputs form a broad range of disciplines and people. In Gothenburg some of the interviewees express good collaboration between departments and points out how it has clearly improved in the last years. However, when there is a high number of departments involved it is essential with a well-structured organisation, where everyone knows their responsibility as well as good communication and cooperation. In Kviberg, the number of different departments involved in the construction clearly made the collaboration difficult. Furthermore, there was one project owner or manager from each department, though, it seemed like the RWA and PLA had several people involved in the project with the same legitimacy without anyone having the ultimate responsibility.

In the River City projects there are constantly the organisational challenges associated with the involvement of many different divisions, departments and stakeholders. All actors must have the same interest and aiming for a result with the same purpose and function, otherwise the different departments will work separately, with their own purpose and reasons. The researcher explained, that there are many examples on governance structures where poor communication between the departments and "silos thinking" exist, averting faster and easier implementation and operation.

In interviews the problem of enabling cross-functional collaboration is addressed:

"But these solutions, which we still have not implemented to a high extent, are seldom clear. Who should be responsible for the green corridor and street-section? […] it is connected to a cost, and the budget is not always consistent with the costs [....] I would say that this is the greatest obstacle". (I:4)

"It is also very clear how the organisation of the municipality is structured so each department only manages its own questions, instead of implementing the green corridor which is a street, a park and at the same time some type of water management. It is very unclear who is responsible for this type of solution." (I:5)

Collaboration: A variety of stakeholders and cross-sectoral collaborations are fundamental components of NBS. NBS projects can enable new networks and partnerships, and therefore pathways of NBS are highly dependent on a mass of people working together for its recognition and use. As a part of this, it is always important to include the public- citizens and communities. The benefits of NBS are easier realised and understood by the public if they personally get engaged. In projects like Kvillebäcken the number of people involved from start to end can be up to 1000, everything from city planners and architects to biologists and constructors. Collaboration is therefore important for the innovation pathways of NBS since knowledge from several fields is the recipe for creativity. Innovation can be on many different levels and does not have to entail creating something new. As mentioned, NBS itself is based on existing concepts.

Even in a smaller scale project, like the green facade at Vasakronan, it is necessary to involve people with specific expertise, as the living wall designer. This shows how new agreements and partnerships, like the one-year contract after the wall was finished, are necessary to make the NBS deliver its benefits.

The importance of engaging with citizens was constantly mentioned in the interviews, and the researcher explains how NBS is not enabled solely by governance efforts but by the combination of Top-down and Bottom-up processes. Citizens can build up a supporting network for NBS and form partnerships. Likewise, perceptions of NBS interventions can be undermined if awareness of the NBS's function is not communicated and understood by people. In both Kviberg and Vasakronan information signs were used to increase the awareness of NBS. In some cases, NBS interventions like rain gardens look like traditional gardens and it might be necessary to inform citizens about their purpose.

Learning: Research can clearly work as a driver for NBS interventions as it increases the knowledge base of NBS as well as contributing with new technologies and methods pushing for NBS up-scaling. In all the three NBS projects there were collaborations with academia. Project Kvillebäcken has been studied several times such as in the field of socially sustainable urban development and innovative solutions. The master thesis on "Modelling detention and pollutant fate in bioretention systems" became one of the few efforts on evaluating the rain gardens and their retention effectiveness in Kviberg.

All the three projects were identified as being pilot projects and had an aim to increase the knowledge base. Consequently, meant to have a high focus on "learning by doing approaches", where different perceptions were challenges and new technology, governmental arrangements and partnerships tested.

Some interviewees and policymakers involved in project Kvillebäcken addressed the poor evaluation as a major barrier for up-scaling NBS, stating it as a common problem in many organisations. However, others like Vasakronan state their lack of evaluation as a question of prioritisation, and that increasing their use of NBS is more important than investing in evaluation. However, as the interviewed architect mention, skipping evaluations is a way of making a shortcut. She explains how it is necessary to evaluate a project in order to know what can be improved.

Resources: Successful implementation and maintenance of NBS interventions depend on the availability and use of resources such as knowledge, financial means and technologies. NBS's are very context specific and therefore require adaptation to where they are implemented. In the project green facade by Vasakronan, it was vital to have the facade designer with a good understanding on what plant species that could survive the cold Swedish climate. In each of the NBS there is nothing like "one size fits all" but rather tailor-made solutions for specific sites. However, as one interviewee pointed out. Communication, organisation and management are skills, which are always desirable in NBS projects, especially because NBS require involvement and coordination between many stakeholders. One interviewee explained that she thinks the municipality of Gothenburg has all the knowledge required for implementation of NBS, however when implementing NBS more expertise in a specific field is needed. For example, in the implementation of green parks more people from the PLA is required.

Kvillebäcken and Kviberg were co-funded between public national budget and public local authority´s budget. This shows how national projects as the Vinnova project (Swedish government agency which administrates funding for research and innovation) and DSC become important in driving projects with a focus on urban sustainability. According to the interviews, national funded projects where several "sister projects" are undertaken, are especially important to also increase knowledge sharing between projects.

The funding from DSC made Kvillebäcken initially have a strong focus on six subprojects. Additionally, Kvillebäcken became the first district to realise the City of Gothenburg's programme for green building, and to enable all buildings to fulfil the criteria for environmental certification. Potentially, Kvillebäcken would not have been as well-evaluated and shared if it was not funded by DSC, however it also made the project get attention on its negative aspects. As one interviewee explained the publicity of Kvillebäcken caused high expectation and this might have been the reason why it also got heavily criticised.

Financially some of the interviewees thought NBS projects to be often more expensive to implement than conventional solutions. The reasons why NBS interventions can become costlier compared to conventional solutions, is that these solutions not always can replace the conventional. This is often the case with rain gardens, where both NBS and conventional systems are built.

Technology wise it is most vital to develop technology and techniques which support the use of NBS. NBS themselves are technologies, like the rain gardens in Kviberg and the green facade. The Green Factor is one tool that has been developed to ensure ES are recognised. The necessity to develop better tools in assessing NBS impacts and benefits has been mentioned by the interviewees. The currently used techniques do not always give high quality or precise assessments.

Local geographical context: Several interviewees have expressed how local events and geography highly influence what is prioritised in a city. One employee at the Environmental

Administration explains how sustainable water management is the most commonly used NBS intervention, likely because of Gothenburg's location next to the sea and threats from climate change. Additionally, high exploration has been mentioned to create barriers for implementing NBS. In cities where space is lacking, technologies and conventional solutions underground are preferred. At Vasakronan they try to make use of available space in the city and have started to see the potential of using walls, roofs and spaces between the buildings. Nevertheless, the maintenance of the green facade also proven how plants must be suitable to the local climate.

Likewise, the surrounding area influenced the rain gardens in Kviberg. When other parts of the area's development were delayed it also caused implications in the project. In Kviberg the environmental qualities of the geographical context were proven to be essential in the construction and function of the rain gardens. The interviewee, working at the PLA, explains how they were lucky because the soil characteristics were especially favourable in the project area. In the rest of Gothenburg, the soil is compact causing problem for vegetation and retention of water.

The strong segregation in Gothenburg is a prominent problem, which can work as a barrier in NBS implementations. As seen in Kvillebäcken, the transformation caused disapproval from many people in the city. Local culture is another factor, which might have worked as a barrier in Kvillebäken. More specifically, there has been complained about the current architecture, seen as uniform and boring compared to the previous old small businesses in the area, which for some reminded citizens of older Gothenburg and its industrial era.

The interviewed architect explains how people today ask for houses and buildings, which are adapted to the local landscape. Yet there are still many projects where they remove all vegetation and start from scratch without consideration of the uniqueness of the place. Moreover, she believes in green architecture to improve areas with a bad reputation, but that is must happen in cooperation with the residents.

5.3 Knowledge transfer between projects

The previous section presents different variables all relevant in the up-scaling process of NBS, each variable working either as a driver, barrier or both depending on the situation. In addition, this thesis aims to study the actual application of knowledge gained in the projects and how it is transferred between projects. This specific factor has yet not been given much attention in the up-scaling process of NBS.

All the three NBS interventions have been inspired by other projects. Still, the interviewees could not think of any knowledge gained from other projects applied in the three cases. When studying how knowledge gained in the projects has been used in other projects, it is much more evident that at least two of the cases, Kvillebäcken and Kviberg, have generated knowledge which has been transferred and used in new projects (see Table 5-2). As three pilot studies, the question of retaining and uses of gained knowledge/experience had a significant focus in all the three projects. Nevertheless, Vasakronan has not enabled knowledge transfer to a noticeable extent despite its focus on learning.

Table 5-2. Knowledge transfer to and from the three NBS projects.

Project	Kvillebäcken	Rain gardens in Kviberg	Green facade by Vasakronan

What influenced the project to happen?	Several projects inspired NBS interventions in Kvillebäcken, such as the Green Factor in Malmö and the transformation of Hammaby Sjöstad. Yet no concrete knowledge was transferred from one NBS project to Kvillebäcken.	Inspiration came from other cities in Sweden like Tyresö, outside Stockholm, and other countries like Portland in the US.	Did not receive concrete knowledge transferred from other projects. Yet inspiration was drawn from green walls implemented in other countries.
Did it support other projects to happen?	Knowledge gained in Kvillebäcken is retained and directly applied in new projects and developments of areas such as Frihamnen, Lindholmen and Backaplan (three districts in the River City project). In addition, have the developers used their experience and applied it in new projects. Moreover, the project was heavily marketed, and knowledge was transferred in workshops, study visits etc.	The knowledge gained has been used in the planning process of other rain garden projects in the city of Gothenburg.	Vasakronan has two other living walls in Sweden, one in Stockholm and one in Uppsala. However, Vasakronan does not know how much the facades have influenced each other, and knowledge exchange is not taking place.

Source: Author's own elaboration

Notwithstanding that knowledge transfer has taken place in at least two of the interventions multiple interviewees explain how knowledge and experience gained from different projects seldom are structurally transferred. Commonly because of time and financial constraints. Many of them see knowledge transfer as extremely important and an area which should get more attention. Gained knowledge suffers the high risk of being lost at the end of the project, when the working group dissolves and the final date has passed. Kvillebäcken is the only case where structured knowledge transfer was undertaken. Learnings and knowledge gained have been share to other stakeholders and interested delegations from both Sweden and other countries (see Table 5-3).

Table 5-3. The four factors, influencing effective knowledge transfer in the integrative framework. Here presented, for each of the three NBS projects.

Factors influencing effective knowledge transfer	**Kvillebäcken**	**Kviberg**	**Vasakronan**
Organisational culture	Good, high trust, people transferring knowledge	Good	Good
Support structure	Horizontal, however interviewees have expressed how a "silos mentality" exists and that knowledge sharing is lacking between departments in the municipality.	Horizontal, however interviewees have expressed problems in collaboration especially in communicating learnings.	Unknown
	Technology used in the marketing of the projects, and between actors involved.	Technology used in the marketing of the projects and between actors involved.	Technology used in the marketing of the projects, and between actors involved.

Knowledge recipient	Knowledge transfer between "sister projects" in the River City, a sign of close relationships. Good international collaborations, consequently several possible recipients of knowledge. Involvement and engagement with citizens.	Resulted in new projects in the city, where same departments in the municipality are involved. Information to the public.	No clear recipient. Information to the public.
Type of knowledge	High variety of knowledge. Mainly tacit and specific tools like the Green Factor.	Tacit and explicit knowledge.	Tacit and explicit knowledge.
	Documentation and interpersonal, workshops, study visits etc.	Documentation and interpersonal, meetings etc.	Documentation and interpersonal, meetings etc.

Source: Author's own elaboration

Organisational culture: Knowledge transfer is enabled when there is a willingness to learn and an organisational culture which enables changes. As mentioned all the three projects had as their main purpose to generate new knowledge, meant to be used in future projects and urban development. In theory, knowledge transfer is more effective when it is included in the budget and aim of the project. These can be essential factors to why at least Kviberg and Kvillebäcken have been well-communicated cases and moreover have had knowledge transferred into new projects. In Kviberg, the largest rain gardens in Sweden were installed and worked clearly as an experimental site to learn how rain gardens can be implemented in practice. All the three projects had an organisational culture were experimentation and learning from trial and error was acceptable. All the working groups for the three projects must have had collaborations, with the allowance of sharing ideas, knowledge and expectations. In Kvillebäcken all the property owners had to share their efforts in greening the courtyards. One interviewee explains how important it was with a good collaboration and high trust between them (all actors). All actors involved were clear with what they wanted to achieve but at the same time always friendly.

Well- functioning and transparent communication and collaboration are argued as important in all NBS projects. Nevertheless, those factors are commonly lacking, and learning gained from NBS interventions are often concerning how to improve communication between involved actors. In addition, they are related to how to ensure all parties involved are informed about the overall purpose of the NBS intervention. Since NBS can provide several benefits, they are also referred to trade-offs and commonly there are different areas of interest among the actors involved. Thus, it is important to agree on shared goals. Actors who were involved in the three projects, express how they have realised how specific NBS interventions should be included as early as possible in the project planning process.

It is proven how individuals play an important role, when knowledge is transferred from one project to another. It is very apparent how the people involved in Kvillebäcken have been transferred to other projects like the development of Lindholmen (one of the district projects in River City). Even in large projects, like Kvillebäcken, with a high employee turnover, there are key persons moving from one project to another. In one interview, it is also highlighted

how all the property owners are significant knowledge brokers. The interviewed person sees the property owners as a fast way to transfer knowledge, since they are learning by doing and often build ten similar properties at a time. A benefit is that the knowledge does not have to be documented but is directly transferred through a person.

The fact that knowledge is bounded to one person is a benefit but can potentially also prevent knowledge transferring. In all projects, there is the risk of losing knowledge when individuals are changing job or when consultants are hired. Once the project is over the gained knowledge leaves with the person. This drawback of consulting is highlighted in several interviews. Therefore, evaluation of projects is important to recognise knowledge gained and to make it accessible and documented.

Support structures: There was not an organised process of knowledge transfer in project Kviberg. Mostly, the rain gardens were communicated and marketed separately by the different actors and departments. According to an interviewee, this fact probably led to a less efficient knowledge transfer of a broad spectrum of knowledge, compared to a collaborative between actors. In contrast, it was clearly organised in Kvillebäcken where the property owners constantly had to inform and share their efforts in fulfilling goals and requirements outlined in the environmental plan of the project. Without an organisational structure which allows collaboration between the projects, there is a high risk that each department will work separately and focus on its own interest. However, in project Kvillebäcken, one interviewee explains that some important departments in the municipality were not fully involved. Consequently, the mutual learning which could have taken place did not happen. This hindered a faster execution of other projects were suppliers and developers had experienced a similar project before and knew what to do, while it was new for some departments at the municipality.

Technology has shown to be important in both enabling knowledge transfer and to fasten the transferring process. In project Kvillebäcken it is noticeable how the online reporting made the sharing of knowledge faster and easier. In Kviberg and Vasakronan, technology has mainly been used to coordinate the different actors while in Kvillebäcken it was used to transfer knowledge to citizens, the public and for those interested.

Knowledge recipient: In addition to actors involved in the project, an important part of knowledge transfer is lying within how the NBS intervention is communicated to other stakeholders (either within the organisation or outside), to the public, citizens and communities. It is important to engage with the public to increase the awareness and acceptance of NBS, and to establish recognition of their benefits. Project Kvillebäcken had high stakeholder involvement in both the planning of the area and during the project time. As the development proceeded, there were several projects in the district meant to increase the social sustainability and residential involvement, such as community gardens, district walks and historical walks. The first green roof terrace was built in consultation with residents and became a new place for relaxing and gardening. Moreover, the evaluation undertaken of the project has been on evaluating people's satisfaction level.

In the other two projects, the engagement and communication of the NBS interventions have mainly been putting up information signs next to the interventions. Vasakronan and also the municipality additionally communicated information on their website about the green facade and rain gardens respectively.

According to the interviews, there are noticeable improvements in how NBS interventions are communicated to the actors involved in the projects. Today, NBS projects are communicated

more pedagogically. However, there is still room for improvements in how to communicate and engage a broader public. As one interviewee suggests, a specific example would be to instead of producing charts and complicated maps of the developing districts in black and white, it could be beneficial to use colours and clearly draw each tree in the development plan. This would make each tree more easily recognised, and especially its significance for the overall atmosphere and environment in the district. In addition, project Kvillebäcken was communicated online, at fairs as well as on study visits and guided tours. This have been important ways of transferring knowledge and insights gained from the projects, as the methods also have allowed feedback and reflections of the project, thus increasing the owners of the projects own learning.

Type of knowledge: As mentioned both in the literature and in the integrative framework, there are two main types of knowledge. In project Kviberg, the intention with implementing the rain gardens was to give tacit knowledge to the different municipality departments which were involved in the project, and thus time and resources were spent on evaluation of the project. The new knowledge has already been used in a similar project in Gothenburg, where there are plans of installing new rain gardens. In Kvillebäcken the learnings and knowledge gained resulted in that the city of Gothenburg decided to develop a Green Factor, which soon shall be used in all projects in the municipality. Moreover, the specified requirements for Kvillebäcken inspired the municipality to change the so-called process of land allocation. Consequently, NBS is supposed to be included already in this early stage of the development process.

Thus, the knowledge was not only transferred to new isolated projects but got integrated into the decision making and planning of the entire city. In interviews, it is mentioned how experience from Kvillebäcken was directly applied in sister-projects within the River City, and Kvillebäcken increased focus on GI in the other projects. Open sustainable urban drainage systems were installed in the courtyards by the developers, but not in the public spaces as initially was the intention. However, drainage systems in the public spaces are now planned at Lindholmen, Frihamnen and Backaplan. So forth, Kvillebäcken has resulted in more hands-on knowledge, transferred through communication and face-to-face meetings, but also in documents and reports.

Technological knowledge closer to a tacit form of knowledge was gained in all the projects. As an example, during project Kviberg employees at the departments increased their understanding of technical aspects of rain gardens such as soils permeability, what plants are suitable for rain gardens and which species work in the local Swedish climate etc.

Vasakronan mentioned how they evaluate the project but seems to use the information solely within their organisation. As a smaller private company, they might not be in the same need of using documentation of knowledge gained in the project but rather use direct communication within the company. This is in accordance to the theory of knowledge transfer in small companies. However, there seems to be limited knowledge transfer between their different projects, since all interviewees did not have much information about the projects undertaken in neither Stockholm nor Uppsala.

6 Conclusions and Recommendations

This section contains key findings to the three research questions and a discussion on the generalisability of findings. Last, are recommendations given on what could be improved in the implementation of NBS and its up-scaling in Gothenburg and areas recommended for future research.

6.1 Key Findings

In situations where the NBS interventions have clear defined purpose, such as rain gardens providing the tangible service of water retention, it is more likely the impacts will be assessed since it is defined what benefits the interventions should provide. In project Kvillebäcken there were several NBS interventions implemented but each intervention's purpose was not specified. The same was evident in project Vasakronan, where the objective of increasing greenery in the city was not specified to address one or a few problems but rather to provide several undefined benefits. It is important to state what are the objective and purpose of each NBS to increase the likelihood of them being assessed, which is important to identify not only benefits provided but also unwanted outcomes. Moreover, it ensures recognition of the NBS interventions and increases their support among all stakeholders- from engineers and citizens to politicians.

All three projects did to a certain extent fulfil their objective and delivered co-benefits. Yet there have been clear trade-offs between the different impacts as in project Kvillebäcken. In Kvillebäcken some social groups suffered from the transformation of the district and gentrification was a significant negative consequence of the project. In addition to more qualitative interpretation of the results, quantitative evaluation has been undertaken. However, the quantitative evaluation is not done in the extent needed to provide concrete evidence of the three pillars of sustainability in each project, which emphasizes the need of impact assessments. It is evident that the city focuses on implementing NBS interventions, rather than prioritising their maintenance and evaluation.

Furthermore, without a clear stated objective there are uncertainties related to when the evaluation and assessment of impacts should be undertaken. Another question relates to whether there is a point when the evaluation and monitoring of projects are completed. This is a central question which potentially hinders evaluations. Firstly, there is lacking knowledge and expertise on how undertake evaluation and on what are the actual impacts which can be assessed. This uncertainty leads to the second problem, of finding and deciding on who should be the responsible actor or department. There is commonly low willingness amongst people to undertake something which is considered unclear, without a specified starting and finishing date. In addition, there are uncertainties related to when the outcomes will be provided by the NBS. When the objectives are vague and changed over the project time, as in project Kvillebäcken, the evaluation gets even more difficult do to the lack of well-defined indicators for the assessment. Thus, constant monitoring and adaptation of the project are important, but it is equally important to specify objectives, which should be evaluated.

The same factors are working as drivers and barriers for up-scaling NBS. In the implementation of NBS, it is of high importance that the value of the NBS is recognised and supported among a broad range of stakeholders. Stakeholders can prevent the implementation of NBS, as some professions are more like-minded and in favour of conventional solutions. However, stakeholders can also ensure the uptake of NBS interventions. In Kvillebäcken, NBS interventions were implemented because of a few engaged and motivated stakeholders.

The institutional setups at the municipality level has been a clear barrier in the execution of project Kvillebäcken and Kviberg. The implementation of NBS interventions, as well as the planning and evaluation, requires involvement of people, with different expertise, power and influence. This fundamental criterion for NBS interventions makes the collaboration most vital but also difficult to achieve. "Silos mentality" is problematic in the municipality and there is often not one person designated with the overall responsibility. This problem combined with lacking specific strategy plans containing concretise actions, makes NBS interventions difficult to integrate with policymaking and urban planning processes.

As a concept NBS is not used in the city, however other related concepts such as ES are increasingly recognised and much more integrated then for ten years ago when project Kvillebäcken started. The fast changes of discourses and vision bring challenges, but also opportunities in the up-scaling of NBS. If the city sees the ability and possesses the required flexibility, it can fast adapt the implementation of NBS interventions and make them work in synergies with other fast-changing and promoted agendas. Today, the NBS interventions are defined in an early planning process, yet it is necessary to always recognise them in each stage of the project since they still tend to be of low priority. It has been proven that the geographical context highly influences whether the NBS is implemented. Thus, the NBS interventions are driven and hindered by prominent sustainability challenges in the city and are influenced by cultural and societal views and resources both money- and knowledge wise.

As NBS interventions require many stakeholders in the implementation and thus create a more or less temporal organisational structure, the interventions can suffer from the learning paradox. The character of the projects enables interdisciplinary and unique collaborations, yet the temporal nature can cause some of the gained learning being lost when the organisation is dissolved. In Kvillebäcken and Kviberg the learnings got transferred and used in other projects, probably because the evaluation and sharing of knowledge were already within the budget of the two projects as well as in the projects' aim. Still it was much more structured knowledge transfer in Kvillebäcken, where the knowledge was interpersonally transfer in the organised workshops, guided tours etc, but also through documentation. Besides, more effective knowledge transferring can be achieved by ensuring good collaboration between the different actors in an open and friendly organisational culture and by having dedicated project managers.

6.2 Generalisation

The decision to study Gothenburg, a city which recently started to implement NBS interventions, can potentially bring insights into what are the common challenges for a city which has not yet well-established procedures to enable NBS in urban development. The city has gained and retained knowledge in the field in the last years and the study likely produces findings which are useful since sustainable planning is necessary in most cities, eventually also to those which are not considered pioneers. Yet, each city has local variations which create opportunities and challenges in implementing NBS interventions, causes some conclusions not applicable to cities in distinctly different geographical contexts.

6.3 Main recommendations

Gothenburg has one of the largest development projects in the Nordic countries, and therefore has great opportunities in up-scaling the use of NBS interventions and integrate it into governance and decision-making. Room for improvements have in many cases already been addressed by the interviewees.

Improvement of knowledge transfer and knowledge base: Firstly, knowledge base and experience of how to use and integrate NBS interventions into each stage of the planning process could be strengthened in the city and the number of concrete examples of NBS interventions. In each phase of the development process it is important to have right knowledge and an organisational culture which is open to change existing practices to include NBS interventions. Thus, it is not only important to have a well-functioning collaboration between the different departments, but each sector and department could have a variety and diversity of people, and preferable one designated person with focus and expertise in the NBS field.

To enable an increase the knowledge base of NBS and its acceptance it could be important to:

1. **Invest in research and in pilot projects and experimentation.** As the use of NBS interventions is new to the city it is central to build up the local competence and knowledge base of how NBS can be used and be best implemented. Better assessment of impacts and challenges in maintenance are two key research areas, which could be emphasised and prioritised. Experimentation and creating an organisational culture, which allows learnings from trial and error could potentially be encouraged especially in the construction sector where many routines are fixed, and innovation and experimentation seen as risky.
2. **Document the gained learning and knowledge.** In this stage, when the municipality is in a learning process, every project could have learning and evaluation as a criterion and already designated time and resources. The evaluation of knowledge gained could be retained and publicly available online. This procedure would allow knowledge transfer and make it possible for other projects and cities to learn from the specific project, but also to guarantee the process is always transparent.
3. **Educate people.** Tacit knowledge is commonly difficult to share and transfer. Consequently, it is often communicated in a verbal way rather than in reports and documents. Thus, teaching people that work with NBS, but also engagement with public in a direct way is of importance for NBS to gain acceptance. This can be done through workshops, seminars, training classes, debates. Over time this may furthermore support reciprocal knowledge exchange, i.e. learning between cities (which is connected to recommendation nr 1).

Organisational improvements: Gothenburg's organisation between the departments have been described as sometimes not well-functioning and that "silos-mentality" is a problem which prevents implementation of NBS. Some responsibility areas, such as GI for water management, have not been easily designated to one department and for a while not managed by any department. Moreover, projects clearly need a designated project manager and someone with the overall responsibility so there is not a fragmented organisation. However, a designated person needs supporting structures, which can enable a cross-functional collaboration and implementation of NBS. Today, the city of Gothenburg has project groups where the relevant departments have representatives. There are also in some projects environmental directors and process managers who have the responsibility to secure that NBS interventions are implemented and not lost throughout the project processes. Consequently, more is needed to enable implementation of NBS than just devoted project managers.

To get enough resources the projects need national and local political support. Projects which are meant to "break up" department boundaries in the municipality, like NBS projects, where a broad range of expertise and knowledge is needed, could get dedicated budgets and funding. Moreover, evaluation and knowledge transfer could be included in the budget. The specific budget stream could be designated to projects where mutual interests are achieved and where

cross-functional collaborations are undertaken. This would make them be prioritised and in addition work as an incentive to undertake evaluations and to strengthen knowledge transfer. In addition to this, it is necessary with dual ownership, where support from top management and heads of departments, are given to the experts and devoted project managers (securing there is ownership in the whole chain of decisions). With this dual ownership together with political support, an organisational structure and culture can be formed which enable and favour projects where cross-functional collaboration is necessary, such as in NBS projects.

To enable a break up of "silos-mentality" NBS projects need:

1. **Committed and dedicated project managers from each department** in the working group.
2. A **dual ownership of projects between top management and dedicated project leaders** to ensure the support structure exists for implementation of NBS.
3. Lastly, the NBS projects need **political support** where a course of action is taken with a budget stream allocated to NBS projects. This would influence and work as an incentive for the departments to prioritise cross-functional collaborations. A requirement to receive money from the budget stream could be to include evaluation and knowledge transfer in the project. This would allow evaluation of learnings being planned and included in an early stage.

It is worth mentioning that some interviewees think that Gothenburg is not proceeding fast enough and viewed as spending more time on investigations than actual action- taking. A better organisational setup and more cross-functional collaboration between the different departments can potentially enable more projects being not only planned but also undertaken in practice.

Flexible projects with clear objectives: In the city of Gothenburg as well as in each project the ambitions are high. The River City project has a timeframe which requires fast development of large areas and many districts should be constructed before 2035. As mentioned this fast development entails opportunities for the city but also great responsibility to make the city adaptive and ready for future challenges. On one hand, it is important to act fast to address climate change and other prominent problems in urban cities, but on the other hand changes should not be rushed to enable comprehensive planning and implementation of GI which is consistent with cultural and historical buildings. This is a complex balancing-act. It requires clear formulated objectives of each project, how each stage of the process shall be executed, monitored and evaluated. If each project is to a high extent monitored and evaluated the projects have higher adaptability and flexibility which is importance since external factors influence the projects. It is evident that changes happen fast, and because the context and environment in which the projects are undertaken is not permanent, the projects themselves should be adapted and constantly questioned.

Main recommendations

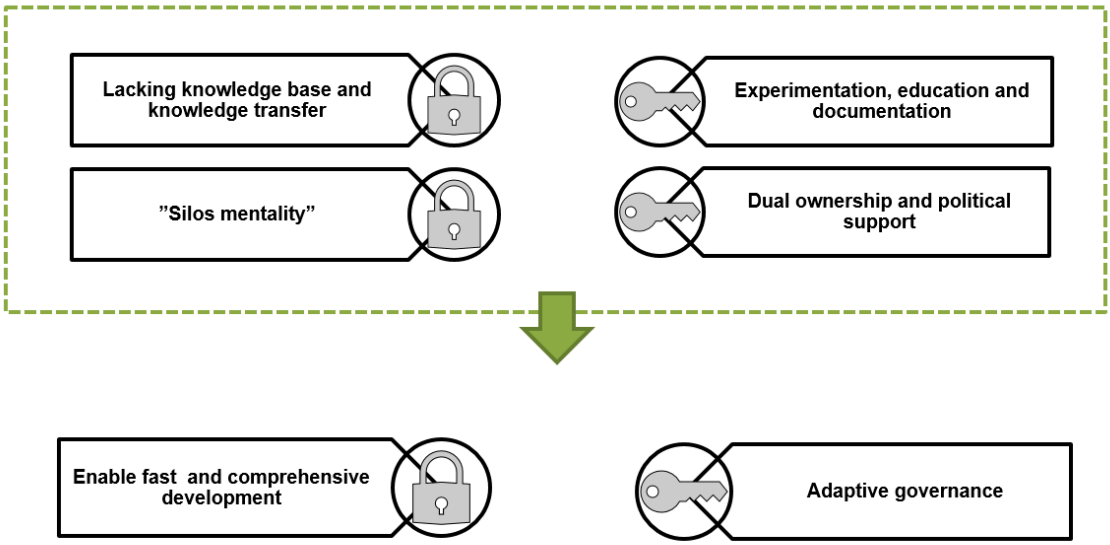


Figure 6-1. On the left side are identified problems/challenges in the municipality and on the right side possible solutions. The two first identified solutions are highly interlinked and their solutions will enable a solution of the third identified challenge. Consequently, improved knowledge base on implementation of NBS together with collaboration between departments, enable an adaptive governance. Being adaptive will allow fast development of the city but at the same time ensure new trends and solutions are explored and realised.

Source: Author's own elaboration

6.4 Future Research

The existing literature in the field has addressed many knowledge gaps, and this thesis emphasises how it is necessary with better impact assessments of NBS interventions. Research is needed to develop quantitative measures which easily can be used to assess co-benefits provided by each intervention. To enable mainstreaming of NBS, assessment and indicators, which are easily used by each technician or project director, are important to guarantee assessment is undertaken. This research has revealed the need for better, more reliant and less costly social and economic impact assessments as well as better maintenance for successful projects.

There are many factors that can influence the up-scaling of NBS implementation. Yet this thesis did only identify barriers and drivers, and not how these might influence NBS to different degrees. Thus, more research is needed to explore which are the most important factors influencing the up-scaling process and how the different factors are interlinked and interdependent and moreover, how much their influence varies with the context. This would provide useful information to the policymakers on which drivers and barriers should be prioritised.

Currently, as mentioned several times, tacit knowledge is transferred mainly through interpersonal means, like face-to-face, mentoring, workshops etc. Being recognised as an

important knowledge type for enabling faster and improved implementation of NBS there should be more research on how to retain this knowledge and make it useful for more people. Documented knowledge can be shared and becomes easier accessible to more people, consequently there should be a focus on developing better ways of coding and document tacit knowledge into evaluation reports.

Bibliography

Ajith Kumar, J., & Ganesh, L. S. (2009). Research on Knowledge Transfer in Organizations: A Morphology. *Journal of Knowledge Management 13(4),* 161–174.

Almassy, D., Pinter, L. & Rocha, S., Nayumann, S., Davis, M., Abhold, K. & Bulkeley, H. (2018). Urban Nature Atlas: A Database of Nature-Based Solutions across 100 European Cities.

Amoly, E., Dadvand, P., Forns, J., López-Vicente, M., Basagaña, X., Julvez, J., Alvarez-Pedrerol, M., Nieuwenhuijsen, M. J. & Sunyer, J. (2014). Green and blue spaces and behavioral development in Barcelona schoolchildren: the BREATHE project. *Environ Health Perspect 122,* 1351–1358. doi:10.1289/ehp.1408215

Andersson, J & Simu, M. (2015). Maintenance of living walls: Opportunities and challenges in a Swedish urban climate. Jönköping University

Andersson, R., Bråmå, Å. & Hogdal, J. (2009). Fattiga Och Rika – Segregerad Stad Flyttningar Och Segregationens Dynamik i Göteborg 1990–2006. Retrieved from http://goteborg.se/wps/wcm/connect/857b3540-1561-419b-b46a-bf4ae3ee1f87/OPA_Fattigarikasegregeradstad.pdf?MOD=AJPERES.

Argote, L., Ingram, P., Levine, J. M. & Moreland, R. L. (2000). Knowledge Transfer in Organizations: Learning from the Experience of Others. *Organizational Behavior and Human Decision Processes 82(1),* 1–8.

Bakker, R. M., Cambré, B., Korlaar, L. & Raab, J. (2011). Managing the Project Learning Paradox: A Set-Theoretic Approach toward Project Knowledge Transfer. *International Journal of Project Management 29(5),* 494–503.

Balian, E., Eggermont, H & Le Roux, X. (2014). Outputs of the Strategic Foresight workshop "Nature-BAsed Solutions in a BiodivERsA context", Brussels June 11-12 2014. *BiodivERsa,* 45.

Barick, R. (2016). 3.7 Research Strategy: Case Study. *MeanThat.* Retrieved from https://www.youtube.com/watch?v=ectS1ote8uA, accessed June 20, 2018.

Barton Alane, M. (2016). Nature-Based Solutions in Urban Contexts. International Institiute for Industrial Environmental Economics: 69.

Biodiversa. (n.d). About us. Retrieved from http://www.biodiversa.org/2, accessed March 7, 2018.

Biomimicry Institute. (n.d). A sustainable world already exists. Retrieved from https://biomimicry.org/what-is-biomimicry/, accessed May 3, 2018.

Björk, J. & Krusell, M. (2015). Gentrifieringen av Kville. Ohyresrätten. Retrieved from http://ohyresratten.se/stadskamp/gentrifieringen-av-kville/, accessed August 13, 2018.

Bockarjova, M., & Botzen W. J. W. (2017). Review of Economic Valuation of Nature-Based Solutions in Urban Areas. *Naturvation: 34.*

Brorström, S. (2014). Hållbara Kvillebäcken: En studie om innovativa lösningar. Mistra Urban Futures. Gothenburg Research Institute. Retrieved from https://www.mistraurbanfutures.org/sites/mistraurbanfutures.org/files/hallbara_kvillebacken_en_studie_om_innovativa_losningar_mistra_urban_futures_papers_2014.2.pdf

Bulkeley, H., Bracken, L., Almassy, D., Pinter, L., Naumann, S., Davis, M., Reil, A., Hedlund, K., Hanson, H., Dassen, T., Raven, R. & Botzen, W. (2017). State of the Art Review: Approach and Analytical Framework. Naturvation.

Business Region Göteborg. (n.d). Diversified Trade and Industry. Retrieved from https://www.businessregiongoteborg.se/en/our-region/region-opportunity/diversified-trade-and-industry, accessed August 22, 2018.

Chaudhary, S., McGregor, H., Houston, D. & Chettri, N. (2015). The evolution of ecosystem services: A time series and discourse centered analysis. *Environmental Science and Policy, 54,* 25-34.

Cohen-Shacham, E., Walters, G., Janzen, C. & Maginnis, S. (2016). Nature-based Solutions to address global societal challenges. *International Union for Conservation of Nature and Natural Resources (IUCN).* doi: http://dx.doi.org/10.2305/IUCN.CH.2016.13.en

Connecting Nature. (n.d). What Is Connecting Nature? | Connecting Nature. Retrieved from https://connectingnature.eu/what-connecting-nature, accessed July 12, 2018.

Costanza, R., d'Arge, R., Groot, R.D., Farber, S., Grasso, M., Hannon, B., Belt, M.V.D. (1997). The value of the world's ecosystem services and natural capital. *Nature 387,* 253–260.

Dahlström, A., Bodin-Sköld, H. & Lindfors, T. (2017). Biofilter i Kviberg- lärdomar och erfarenheter. Del i projektet Klimatsäkrade systemlösningar för urbana ytor. Vinnova – Utmaningsdriven innovation – Hållbara attraktiva städer. Retrieved from http://klimatsakradstad.se/media/2017/11/PM_Biofilter-i-Kviberg-L%C3%A4rdomar-och-erfarenheter_slutkoncept.pdf, accessed July 17, 2018

deMarrais, K. B. & Lapan, S. D. (2003). Foundations for Research: Methods of Inquiry in Education and the Social Sciences. Routledge.

Eggermont, H. Balian, E., Azevedo, J. M. N., Beumer, V., Brodin T., Claudet, J. Fady, B., Grube, M., Keune, H., Lamarque, P., Reuter, K., Smith, M., Van Ham, C., Weisser, W. W. & Le Roux, X. (2015). Nature- based solutions: New influence for Environmental Management and Research in Europe. *GAIA - Ecological Perspectives for Science and Society, 24(4),* 243-248.

Esterby-Smith, M., Lyles, M. A. & Tsang, E. W. K. (2008). Inter-Organizational Knowledge Transfer: Current Themes and Future Prospects. *Journal of Management Studies.* Blackwell Publishing Ltd.

European Commission. (n.d a). What is Horizon 2020. Retrieved from https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020, accessed March 6, 2018.

European Commission. (n.d b). Nature-based solutions. Retrieved from https://ec.europa.eu/research/environment/index.cfm?pg=nbs, accessed March 6, 2018.

European Commission. (2014). Green Infrastructure and the finance sector. Retrieved from http://ec.europa.eu/environment/nature/ecosystems/pdf/Green%20Infrastructure/GI_finance.pdf

European Commission. (2015). Towards an EU Research and Innovation Policy Agenda for Nature-Based Solutions & Re-Naturing Cities. *European Union.* dio: 10.2777/765301

Faivre, N., Fritz M., Freitas T., de Boissezon, B., & Vandewoestijne, S. (2017). Nature-Based Solutions in the EU: Innovating with Nature to Address Social, Econoic and Environmetnal Challenges. *Environmental Research, 159,* 509-518.

Fehler, J. (2014). Socialt hållbar stadsutveckling från ide till praktik. Begrepps utveckling i Kvillebäcken. Sveriges Landsburksuniversitet. Retrieved from https://stud.epsilon.slu.se/6944/1/fehler_j_140630.pdf.

Frantzeskaki, N. and Kabisch N. (2016). Designing a Knowledge Co-Production Operating Space for Urban Environmental Governance—Lessons from Rotterdam, Netherlands and Berlin, Germany. *Environmental Science & Policy, 62,* 90–98.

Gerring, J. & Cojocaru, L. (2015). Case-Selection: A Diversity of Methods and Criteria. Department of Political Science, Boston University.

Goh, S. C. (2002). Managing Effective Knowledge Transfer: An Integrative Framework and Some Practice Implications. *Journal of Knowledge Management 6(1),* 23–30.

Gómez Sánchez, I. (2017). Greening Cities: Assessing the Implementation of Nature-Based Solutions. International Instituite for Industrial Environmental Economics: 80.

Green Gothenburg. (n.d a). About Green Gothenburg. Green Gothenburg. Retrieved from http://www.greengothenburg.se/our-story/about/, accessed August 22, 2018.

Green Gothenburg. (n.d b). Kvillebäcken- First Green District. Green Gothenburg. Retrieved from http://www.greengothenburg.se/details/, accessed August 20, 2018.

Green Surge. (2014). GREEN SURGE. Retrieved from https://greensurge.eu/, accessed July 12, 2018.

GrowGreen. (n.d). Project. GrowGreen. Retrieved from http://growgreenproject.eu/about/project/, accessed July 12, 2018.

Brussad, P. F., Reed, J. M. & Tracy, C. R. (1998). Ecosystem management what is it really? *Landscape and Urban Planning, 40*, 9-20.

Gustavsson, E. & Elander, I. (2013). Social Hållbarhet Inte Bara ”sustainababble”? Från Mångtydig Vision till Analytiskt Redskap Vid Uppföljning Av Stadsbyggnadsprojekt. Örebro Universitet. Retrived from http://www.diva-portal.org/smash/get/diva2:697644/FULLTEXT01.pdf.

Gustafsson, J. (2017). Single Case Studies vs. Multiple Case Studies: A Comparative Study. Halmstad University: 15.

Göteborgs Stad. (n.d a). Kort kommunfakta. Retrieved from http://goteborg.se/wps/portal?uri=gbglnk%3agbg.page.28413487-4f02-44b5-ace7-c661ee58892c, accessed July 23, 2018.

Göteborgs Stad. (n.d b). Gothenburg’s History & Heritage. Retrieved from http://www.goteborg.com/en/gothenburgs-history/, accessed August 22, 2018.

Göteborgs Stad. (2010). Hållbar stadsutveckling i Kvillebäcken: Komplettering av ansökan om statligt stöd till investeringar för åtgärder som främjar hållbar stadsutveckling. Retrieved from https://www.boverket.se/contentassets/a51343b05b8a44b197294b73da907170/kompletterande-ansokan-hallbar-stadsutveckling-i-kvillebacken.pdf

Göteborgs Stad (2012). Vision Älvstaden. Göteborgs Stad. Retrieved from http://alvstaden.goteborg.se/wp-content/uploads/2015/05/vision_alvstaden_sv_web.pdf, accessed August 22, 2018.

Göteborgs Stad. (2013). Göteborgs Stads Miljöprogram 2013. Retrieved from http://goteborg.se/wps/wcm/connect/f1b89f28-ea89-4b39-8ece-4ef54849f827/Goteborgstad_Miljoprogram.pdf?MOD=AJPERES, accessed August 22, 2018.

Göteborgs Stad. (2014a). Climate Programme for Gothenburg. Retrieved from https://international.goteborg.se/sites/international.goteborg.se/files/field_category_attachments/climate_programme_for_gothenburg.pdf, accessed August 22, 2018.

Göteborgs Stad. (2014b). Grönstrategi För En Tät Och Grön Stad. Park och Natur förvaltningen. Retrieved from http://goteborg.se/wps/wcm/connect/0bbf9fb8-a6a9-43bf-9548-34e7697d8f0e/Gr%C3%B6nstrategi_20140324.pdf?MOD=AJPERES, accessed July 23, 2018.

Göteborgs Stad. (2014c). Hållbar Stadsutveckling i Kvillebäcken: Slutredovisning till Boverket för 2011-2014. Retrieved from https://www.boverket.se/contentassets/a51343b05b8a44b197294b73da907170/fardig-slutrapport.pdf

Göteborgs Stad. (2015). City of Gotneburg Environmental Programme The Green Link in Our Enironmental Work. Retrieved from https://goteborg.se/wps/wcm/connect/566a56ae-6a4f-4813-a593-dd4474e76a46/City+of+Gothenburg+Environmental+Programme.pdf?MOD=AJPERES, accessed August 22, 2018.

Göteborgs Stad. (2017a). Förslag till Översiktsplan För Göteborg Tillägg För Översvämningsrisker. Stadsbyggnadskontoret. Retrieved from http://www5.goteborg.se/prod/fastighetskontoret/etjanst/planobygg.nsf/vyFiler/%C3%96versiktsplan%20-%20Till%C3%A4gg%20f%C3%B6r%20%C3%B6versv%C3%A4mningsrisker-%C3%96versiktsplan%20-%20utst%C3%A4llning-%C3%96versiktsplan%20-%20Till%C3%A4gg%20f%C3%B6r%20%C3%B6versv%C3%A4mningsrisker/$File/Utst%C3%A4llning.pdf?OpenElement, accessed July 24, 2018.

Göteborgs Stad. (2017b). Uppföljning av Göteborgs lokala miljömål. Miljöförvaltningen. Retrieved from http://goteborg.se/wps/wcm/connect/c7301090-a5f3-4d2d-88e5-bf3238422ba3/Uppfoljning_av_stadens_lokala_miljomal_2017_R_201809.pdf?MOD=AJPERES

Haffner, J. (2015). The dangers of eco-gentrification: what's the best way to make a city greener? Guard 5–7, accessed September, 12, 2018

Hanson, H., Veerkamp, C., Nordin, A., Lazarova, T., Hedlund, K., Olsson, P. & Schipper, A. (2017). Assessment of Biophysical and Ecological Services Provided by Urban Nature-Based Solutions: A Review. *Naturvation: 70*.

Haase, D., Kabisch, S., Haase, A., Andersson, E., Banzhaf, E., Baro, F., Brenck, M., Fischer L. K., Franzeskaki, N., Kabisch, N., Krellenberg, K., Kremer, P., Kroneberg, J., Larondelle, N., Mmathey, J., Pauleit S., Ring, I., Rink, D., Schwarz, N. & Wolff, M. 2017. Greening cities - To be socially inclusive? About the alleged paradox of society and ecology in cities. *Habitat International*, *64*, 41-48.

Hellberg, M. (2016). Modeling Detention and Pollutant Fate in Bioretention Systems. Master's Thesis in the Master's Programme Infrastrucutre and Environmental Engineering. Chalmers University of Technology.

Hällhed, S. & Sundberg, G. (2013) Östra Kvillebäcken En gröna stadsdelen? En fallstudie över östra Kvillebäcken i Göteborg. Departement of Economy and Society, Human Geography & Department of Earth Science University of Gothenburg.

Isitt, M. (2016). Vem vill promenera i Kvillebäcken? Göteborgs-Posten. Retrieved from http://www.gp.se/1.10493, accessed August 13, 2018.

Izadi Moud, H. & Abbasnejad, B. (2012). Factors Affecting Knowledge Transfer in Projects Based Organization. Department of Construction Management, Chalmers University of Technology.

Johansson, E. (2018). Uppföljning lika viktigt som planering. Hållbar Stad. Retrieved from https://hallbarstad.se/alvstranden/uppfoljning-lika-viktigt-som-planering/, accessed July 26, 2018.

Kabisch, N., Frantzeskaki, N., Pauleit, S., Naumann, S., Davis, M., Artmann, M., Haase, D., Knapp, S., Korn, H., Stadler, J., Zaunberger, K & Bonn, A. (2016). Nature-Based Solutions to Climate Change Mitigation and Adaptation in Urban Areas: Perspectives on Indicators, Knowledge Gaps, Barriers, and Opportunities for Action. *Ecology and Society 21(2), 39*.

Kabisch, N., Korn, H., Stadler J. & Bonn, A. (2017). Nature-Based Solutions to Climate Change Adaptation in Urban Areas. *Theory and Practice of Urban Sustainability Transitions*. Springer International Publishing. doi: 10.1007/978-3-319-56091-5

Keesstra, S., Nunes, J., Novara, A., Finger, D., Avelar, D., Kalantari, Z. & Cerda, A. (2018). The Superior Effect of Nature Based Solutions in Land Management for Enhancing Ecosystem Services. *Science of The Total Environment 610–611*, 997–1009.

Klimatsäkrad stad. (n.d). Projektbeskrivning. Retrieved from http://klimatsakradstad.se/om-projektet/projektbeskrivning/ , accessed July 18, 2018.

Krekel, C., Kolbe, J. & Wüstemann, H. (2016). The greener, the happier? The effect of urban land use on residential well-being. *Environ Econ, 121,* 117–127.

Kvillebäcken. (2018a). Hållbar Stadsutveckling i Kvillebäcken: Uppföljning av hållbarhetsprogrammet 2010-2017.

Kvillebäcken. (2018b). Attitydundersökning Kvillebäcken.

Kvillebäcken. (2011). Program För Hållbar Utveckling i Kvillebäcken. Retrieved from http://docplayer.se/6172565-Hallbar-utveckling-i-kvillebacken.html

Lundström, M. J., Fredriksson, C. & Witzell J. (2013). Planning and Sustainable Urban Development in Sweden. Stockholm: Föreningen för samhällsplanering.

Lund University. (2018). Urban Nature. Centre for Environmental and Climate Research. Retrieved from https://www.cec.lu.se/research/urban-nature, accessed June 14, 2018.

Maes, J. & Jacobs, S. (2015). Nature-Based Solutions for Europe's Sustainable Development. *Conservation Letters 10(1)*, 121–124.

Maia a Roche, S., Almassy, D. & Pinter, L. (2017). Social and cultural values and impacts of nature-based solutions and natural areas. *Naturvation.*

Millennium Ecosystem Assessment (MEA). (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

NAIAD. (n.d). NAIAD - NAture Insurance Value: Assessment and Demonstration. Retrieved from http://naiad-nbs.eu/, accessed July 11, 2018.

Nature4Cities (n.d) European NBS Project Ecosystem. Nature4Cities - Be Part of the Green Transition! Retrieved from https://www.nature4cities.eu/h2020-nbs-projects, accessed July 11, 2018.

Naturvation. (2017a). About. NATURVATION. Retrieved from https://naturvation.eu/about, accessed June 8, 2018.

Naturvation. (2017b). Urban Nature Atlas | NATURVATION. Retrieved from https://naturvation.eu/atlas, accessed September 11, 2018.

Nesshöver, C., Assmuth, T., Irvine, K. N., Rusch, G. M., Waylen, K. A., Delbaere, B., Haase, D., Jones-Walters, L., Keune, H., Kovacs, E., Krauze, K., Külvik, M., Rey, F., van Dijk, J., Vistad, O. I., Wilkinson, M. E. &

Wittmer, H. (2017). The science, policy and practice of nature-based solution: an interdicilpinary perspective. *Science of Total Environment, 579,* 1215-1227.

Nilsson, H., Källstrand, K., Eriksson, E., Gustafson, L., Alvarsson, K., Otterman, Y., Ekstrand, M., Lukas, M., Schiötz, C., Nordlander, I-B., Johnson, D., Malmroth, S., Lundberg, L., Lindh, J., Barnegård, H., Strömer, C., Persson, G., Edgren, U., Gondinger, E., Ramnerö, A-M., Rydeving, P., Roth, A., Ramnerö, A-M. & Malm, A. (2017). Grönytefaktor i Plan och Exploateringsprojekt i Göteborgs stad. Göteborgs Stad.

P-bolaget. (n.d). Skötsel Av Biofilteranläggning Kviberg.

Port of Gothenburg. (n.d). History of the Port of Gothenburg Gateway to the World since 1620. Retrieved from https://www.portofgothenburg.com/about-the-port/history-of-the-port/, accessed August 22, 2018.

Potschin, M., Kretsch, C., Haines-Young, R. Furman, E., Berry, P. & Baró, F. (2016). Nature-based solutions. *OpenNESS*. Retrieved from http://www.openness-project.eu/sites/default/files/SP_Nature-based-solutions.pdf

Prop. 2017/18:163. Nationell strategi för klimatanpassning. Retrieved from https://www.regeringen.se/494483/contentassets/8c1f4fe980ec4fcb8448251acde6bd08/171816300_webb.pdf, accessed September 20, 2018.

Raven R., van der Jagt, A., Dorst, H., Runhaar, H. (n.d). Nature-Based Innovation Systems: Introducing a framework to analyse the innovation pathways of nature-based solutions.

Raymond, C. M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M. Razvan Nita, M., Geneletti, D. & Calfapietra, C. (2017). A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science and Policy, 77,* 15-24.

Regeringskansliet. (2018). Nationell strategi för klimatanpassning. Retrieved from https://www.regeringen.se/rattsliga-dokument/proposition/2018/03/prop.-201718163/, accessed September 11, 2018.

Ren, X., Deng, X. & Liang, L. (2018). Knowledge Transfer between Projects within Project-Based Organizations: The Project Nature Perspective. *Journal of Knowledge Management 22(5),* 1082–1103.

Rolfsdotter-Jansson, C. (n.d). Sustainable Malmö. Malmotown English. Retrieved from http://www.malmotown.com/en/article/sustainable-malmo/, accessed August 17, 2018.

Samuelsson, L. & Rasmussen, S. (2014). Grönyttefaktorn i ett nytt perspektiv Går ekosystemtjänster att mäta med fjärranalys? Retrieved from https://gupea.ub.gu.se/bitstream/2077/36112/1/gupea_2077_36112_1.pdf

Schindler, M. & Eppler, M. J. (2003). Harvesting Project Knowledge: A Review of Project Learning Methods and Success Factors. *International Journal of Project Management 21(3),* 219–228.

Seawritgh, J. & Gerring, J. (2008). Case Selection Techniques in Case Study Research A Menu of Qualitative and Quantitative Options. Political Research Quartely.

SMHI. (n.d). Regnrabatter i Göteborg, Fördjupning | SMHI. Retrieved from https://www.smhi.se/klimat/klimatanpassa-samhallet/exempel-pa-klimatanpassning/regnrabatter-i-goteborg-fordjupning-1.117301, accessed June 10, 2018.

Sthåle, A. (2009). More green space in a denser city: Critical relations between user experience and urban form. Spatial Analysis and Design, School of Architecture and the Built Environment, Royal Institute of Technology.

Szulanski, G. (1996). Exploring Internal Stickiness: Impediments to the Transfer of Best Practice within the Firm. *Strategic Management Journal*, 27–43.

The economics of Ecosystems & Biodiversity Ecosystem Services. (n.d). Retrieved from http://www.teebweb.org/resources/ecosystem-services/, accessed May 3, 2018.

Thiry, M. & Deguire, M. (2007). Recent developments in project-based organisations. *International Journal pf Project Management, 25,* 649-658.

Thörn, C. & Holgersson, H. (2016). Revisiting the Urban Frontier through the Case of New Kvillebäcken, Gothenburg. City 20(5): 663–684.

Tollesson, N. (2018). Vasakronan får A3-rating från Moody's. Fastighetssverige. Retrieved from https://www.fastighetssverige.se/artikel/vasakronan-far-a3-rating-fran-moodys-28219, accessed July 2, 2018.

Udomcharoenchaikit, P. (2016). Nature-based solutions for urban Stormwater management: Experiences in Malmö and Copenhagen a case study analysis on the decision-making process. International Institiute for Industrial Environmental Economics.

UNaLab. (n.d). About Us. Retrieved from https://www.unalab.eu/node/51, accessed July 11, 2018.

URBAN GreenUP. (n.d). About URBAN GreenUP. Retrieved from http://www.urbangreenup.eu/about/about.kl, accessed July 12, 2018.

van der Jagt, A., Dorst, H., Raven, R. & Runhaar, H. (2017). Nature of innovation for urban sustainability. *Naturvation.* Copernicus Institute for Sustainable Development Utrecht University.

van Waveren, C. C., Orelemans, L. A. G. & Pretorius, M. W. (2014). Knowledge Transfer in Project-Based Organizations. A Conceptual Model for Investigating Knowledge Type, Transfer Mechanisms and Transfer Success. *IEEE International Conference on Industrial Engineering and Engineering Management*, Bandar Sunway, 1176-1181. doi: 10.1109/IEEM.2014.7058824

Vasakronan. (n.d). Sustainability - Welcome to Vasakronan. Vasakronan. Retrieved from https://en.vasakronan.se/welcome-to-vasakronan/sustainability, accessed July 2, 2018.

Verschuren, P. & Doorewaard, H. (2010). Designing a Research Project. 2th edition. The Netherlands: Eleven International Publishing.

Wahlberg, V. & Nilsson, V. (2015). Helt uppåt väggarna? Vasakronan. Retrieved from https://vasakronan.se/artikel/vaxtvagg-kyrkogatan, accessed July 2, 2018.

Wiewiora, A., Trigunarsyah B. & Murphy, G. (2009). Barriers to effective knowledge transfer in project-based organisations. Proceeding of the 2009 International Conference on Global Innovation in Construction Proceedings: 11.

Wingren, C., Alsanius, B., Karlén, H. & Lindström, V. (2015). Urbana nyanser av grön- om grönskans roll i en förtätad klimatsmart stad. Movium.

World forum on Natural Capital. (n.d). What is natural capital? Retrieved from https://naturalcapitalforum.com/about/, accessed May, 03, 2018.

Yin, R. K. (2014). Case Study Research: Design and Methods. 5th edition. SAGE Publication.

Yin, R. K. (2009). Case Study Research: Design and Methods. 4th edition. SAGE Publication.

Zainal, Z. (2007). Case Study as a Research Method *Jurnal Kemanusiaan.* Faculty of Management and Human Resource Development Universiti Teknologi Malaysia.

Appendix I. Interview list

No.	Organisation	Relevance	Name	Type of interview	Date of interview
1	Circular and Water Administration at Gothenburg municipality	Project leader for project rain gardens in Kviberg	Anonymous	Structured in-person interview	13/06/2018
2	Älvstranden	Environmental manager	Christine Olofsson	Unstructured phone interview	20/06/2018
3	Nature and Landscape Administration at Gothenburg municipality	City garden planner	Helena Bjarnegård	Unstructured phone interview	21/06/2018
4	City Planning Authority	Project leader for the proposed programme in the planning process of Backaplan (a sister-project to Kvillebäcken)	Liv Caroline Valen	Structured in-person interview	27/06/2018
5	City Planning Authority	Architect, developer of the planning document of Backaplan	Filippa Andersson	Structured in-person interview	27/06/2018
6	Älvstranden	Process Manager, project leader of Case Kvillebäcken	Evelina Johansson	Structured in-person interview	28/06/2018
7	Vasakronan	Property owner of the green facade	Jörgen Törnqvist	Unstructured phone interview	29/06/2018
8	P-Bolaget, municipality owned parking company	Project leader for rain gardens Kviberg	Tobias Hagman	Structured in-person interview	03/07/2018
9	Älvstranden	Project leader for implementation of project Frihamnen (a sister-project to Kvillebäcken)	Anna- Lena Isacson	Structured in-person interview	04/07/2018
10	Environmental Administration	Environmental investigator	Klara Jansson	Structured in-person interview	04/07/2018
11	Vasakronan	Project leader for green facade Vasakronan	Malin Bergsten	Structured phone interview	05/07/2018

12	Environmental Administration	Environmental investigator with focus on water related questions	Anonymous	Structured phone interview	06/07/2018
13	Vasakronan	Sustainable director at Vasakronan	Anna Denell	Answered to specific question over email	06/07/2018
14	White Architecture	Senior sustainability advisor	Elise Grosse	Structured phone interview	10/07/2018
15	Interdisciplinary social researcher on Swedish University of Agricultural Science	Researcher on NBS	Anonymous	Structured in-person interview	16/07/2018
16	Derome	A developer in project Kvillebäcken, a member of the consortium	Hans Palmqvist	Structured phone interview	23/08/2018
17	Friends of Gothenburg innovation (previously Älvstranden)	Environmental strategist in project Kvillebäcken	Erica Svantesson	Structured phone interview	27/08/2018

Appendix II. Interview guide

The interview questions were adapted to each interviewee. Thus, these two interview protocols are examples of interview questions asked, but it should be highlighted that in each interview slightly different questions were asked. Before the interview each interviewee was introduced to the project and to the concept of NBS.

List of interview questions to stakeholders who have been involved in the design/implementation of specific NBS projects:

1. **Introduction:** What was your role in the project?
2. **Objective:** Can you tell me the "story" behind the project and how everything started?
3. **Fulfilment:** To what extent has the NBS project lived up to its ambitions?
4. **Types of NBS:** Can you give examples of NBS interventions implemented in the project?
5. **Impacts:** What have been the societal, economic and environmental impacts of the intervention? Have they been assessed?
6. **Evaluation:** Has the project been evaluated and who is responsible for its maintenance?
7. **Barriers:** What have been the main obstacles in the project and what are the potential barriers in implementing NBS?
8. **Stakeholders:** What stakeholders were involved in the project's different stages? Were citizens or community members involved in some way in the design/implementation process?
9. **Knowledge:** Has the project resulted in new knowledge, and if so has it been transferred and used in new projects?

List of interview questions to administrations in the municipality of Gothenburg:

1. **Introduction:** Can you introduce yourself and how your work is related to NBS?
2. **NBS in Gothenburg:** When did NBS interventions started to be used and implemented in Gothenburg? What were the drivers behind it?
3. **Types of NBS:** What are the most common NBS interventions in the city?
4. **Challenges:** What are the most prominent sustainability challenges in the city today and how do you think NBS can be used to address them?
5. **Barriers:** What are the main barriers experienced when implementing NBS?
6. **Involvement:** How important are involvement and engagement from citizens and the public in succeeding and enabling implementation of NBS?
7. **Knowledge:** How does Gothenburg work with evaluation of projects and how is knowledge retained and used in new projects and in urban sustainable development?
8. **Future:** How will Gothenburg work with NBS in the future?