APPLYING ECOSYSTEM ACCOUNTING IN PROCUREMENT PROCEDURES TO STIMULATE THE USE OF NATURE-BASED SOLUTIONS

Katja J. M. Grimbergen
4276558

APPLYING ECOSYSTEM ACCOUNTING IN PROCUREMENT PROCEDURES TO STIMULATE THE USE OF NATURE-BASED SOLUTIONS

Master Thesis Construction Management and Engineering

Projects & People

By

Katja Grimbergen
4276558

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Dr. ir. M. (Marc) Ottele	Graduation Chair	(TU Delft)
Prof. dr. H.M. (Henk) Jonkers	Main Supervisor	(TU Delft)
Q. Reijtenbagh , MSc	Secondary Supervisor	(TU Delft)
X.E.K. (Xaief) Ezechiëls, MSc	Company Supervisor	(Witteveen+Bos)

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PREFACE

Hereby I present to you my thesis that I wrote to complete my master Construction Management and Engineering at the TU Delft. I had the opportunity to work on my thesis as graduate intern at Witteveen+Bos. For my thesis I had the chance to look at the construction sector and how we can help the sector to create a better world for not only tomorrow, but for many years to come. Because it is my personal belief that we need to think differently and not see sustainability as something to be ticked off a list of requirements, but as an integral objective of each construction project that we undertake.

From September 2022 to May 2023 I (mostly) enjoyed working on my thesis. Since my subject is relatively new, I received a lot of positive feedback on my subject. Although this was mostly an encouragement, I sometimes struggled with the pressure I felt because of it. In my bachelor Civil Engineering I found out I struggle a lot with perfectionism, and although I learned how to manage this, I felt it again multiple times during my thesis. A lot of this pressure came from myself, as this thesis does not only conclude my master, but it also concludes my time as a student. A time that started almost 10 years ago in September 2013, a time in which I was able to do so many fun things. I learned how to play Volleyball at Punch and did multiple committees there and eventually became a board member in 2017-2018. I started working in Hotel de Plataan, where I was not only a receptionist, but I was a hotel manager for multiple weeks in the summer too. I have met new people, who have become very good friends. But also, some of my less happy periods were during my student time. I had to deal with my perfectionism, my mother had breast cancer and my father suddenly died two years ago. And with finishing my thesis, I also want to finish this time in my life with a lot of insecurity, sadness and grief and start a new chapter.

That being said, I would like to thank multiple people that have helped me during my thesis and the years before my thesis.

My parents, with whom I made the agreement to go to Rome after I have finished my master even before I started my bachelor. Although my dad is not with us anymore in person, I still know that I feel his presence. I hear him comment on stuff I do, or I know how he would reply on the things I say. I know he would have been incredibly proud of me, his little girl, and that he would have been bragging about me a lot. My mother, who fortunately still is with me today, has become one of my best friends the past years. We have always been close, but in the past two years, we have become very close. You are one of my best friends and I cannot (and will not) vision a world in which you aren't here anymore too. I am very glad you two are my parents, in spite of all. Now it is Rome with just the two of us, but I know Pap will with us all the time.

My friends, especially Alicia, Chantal and Natasja. Alicia, you have been one of my best friends throughout my whole study, as I got to know you when I was just a sjaars. You have seen all my highs and lows and stayed with me through all that time. Chantal, you know when I need to focus and when I need to be comforted and always try to give me exactly what I need. Natasja, you are one of the few who really know how it felt the last two years, to live without a father. You have taught me that throwing rolls of toilet paper is an excellent way of getting your frustration out, but I love that we also got to do this with balls and bats and wine bottles.

My thesis buddy Eljoenai, who saw my name in an invitation for something I still have no clue about. But she contacted me, and thereafter we regularly met to work together on our theses. It was always

nice to share the struggles of graduating with someone in the exact same situation and our gossip sessions were nice small necessary distractions.

My group at Witteveen+Bos, Rob, Xaief, Matias and Sander. You have welcomed me, in your group, and although I was only a graduate intern, I have always felt taken seriously by you. I have always enjoyed our Mondays at the office, listening to the projects you were doing and your weekend plans. You have made my time at Witteveen+Bos really fun. Special thanks to Xaief, who was my supervisor at Witteveen+Bos. Although I still find it difficult to say that I have difficulty doing stuff, you always replied very understanding and gave me the confidence to keep going as I was doing great.

Lastly my thesis committee at the TU Delft. My supervisor Quirien who was very approachable for 'stupid' questions from my side. Your feedback always had a positive note that I was on the right track. My chair Marc and second supervisor Henk, whose critical attitude helped my thesis to reach the necessary academic level that it currently has.

There are probably a lot more people that have helped me the past years, but (just as the rest of my thesis), this is already way too long. I hope you enjoy reading my thesis and that it will help change the way you think about your construction projects.

Katja Grimbergen
Delft, May 2023

ABSTRACT

The Dutch construction sector has the task in the coming years, to build around 1 million new houses in the Netherlands, most of which will have to be built in urban areas. Together with existing (inter)national crises such as the climate change crisis and biodiversity loss crisis, this means the sector will have to think differently to not jeopardise the liveability of our cities. One way of doing this is to create more Nature-based Solutions in these urban areas, but the perception is that this is an expensive solution. By using the framework from Ecosystem Accounting, the benefits these Nature-based Solutions can give us, are monetised to show that the perception of it being expensive is wrong. The aim for this research was to see how Ecosystem Accounting can be used in procurement procedures to create more Nature-based Solutions.

With the double diamond approach, this study was split into two sections. In the first section of the research, a literature study and stakeholder interviews were used to find the most important themes for clients and contractors to have an ambition for Nature-based Solution. These themes were: biodiversity, climate adaptation, health & wellbeing and aesthetic value. In the second section, a new literature research combined with key informant interviews indicators for these themes were found. A total of four indicators (Vegetation layer score, shadow cover, air quality and soil quality) and five services (rainwater regulation service, local climate regulation service, health service of nature, visual amenity service of nature and visual amenity service of water) were found.

For effective use of the framework, three moments in time are important. In the ambition phase Ecosystem Accounting can be used to formulate the ambition of a project. In the tender phase (depending on the amount of design freedom in the contract) EA can be used as a requirement or as a MEAT-criterium. To assure that the plans are realised, the control phase should not be forgotten either.

SUMMARY

In the coming years, the Dutch construction sector has to create almost 1 million new houses, which will be mainly constructed within current urban areas. Not only do these projects jeopardize the liveability in our cities, but they also need to take into account the other crises we are facing such as the biodiversity loss crisis and climate change crisis. It is therefore necessary to change the current ways the construction sector works. To assure future liveability in Dutch cities, this sector needs to change the way it is building our cities. One way to do this is to incorporate Nature-based Solutions (NbS), which are *"actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being benefits" (United Nations Environment Programme, 2021b, p. 10)*. While this sounds like an easy solution, the use of NbS is currently not as widespread as the UN (United Nations) would like to see. This is mainly because the benefits a NbS generates are not as visible. The line of reasoning from the UN is, that if these benefits were to be made visible, this would stimulate the use of NbS. One way to do this, is to use their newly created framework for Ecosystem Accounting (EA). EA looks at the state of an ecosystem in five steps (Figure 1). First they look at the extent, or area surface of the different ecosystem types and in the second step they look at the condition of all these different types of ecosystems. The third and fourth step look into the services an ecosystem can provide, where step three focusses on the physical services and step four monetizes these service. The last step is to calculate the asset value of an ecosystem by calculating the nett present value of the services.
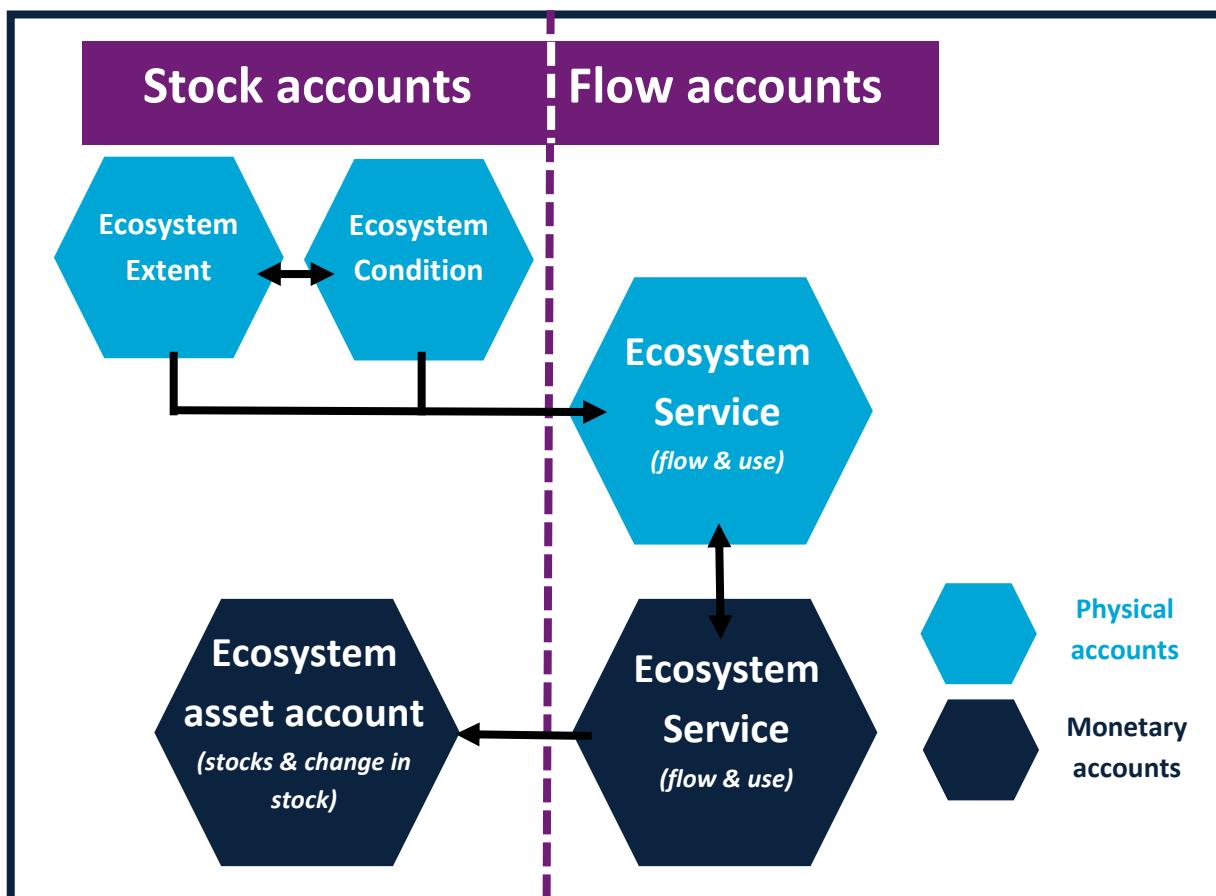
Figure i Ecosystem Accounting (adapted from United Nations et al., 2021)

The goal for this research is to explore how EA can enhance the procurement process in a way that it will reveal the hidden benefits of NbS. If these become visible, it should stimulate the use of NbS within urban areas in the Netherlands. To come to this conclusion, five sub-questions were drafted that help answer the main research question: "How can Ecosystem Accounting be used in Dutch procurement processes to create more Nature-based Solutions". The procurement process mentioned in the research question refers to the process in which quality (partly) determines which tenderer wins.

For answering the main research question, the double diamond design approach is used. The first diamond explores and defines the problem, with a literature study and qualitative stakeholder interviews. An inductive code scheme is used to analyse the interviews using the grounded theory. This part ends with a design brief for a form of EA that can be used in procurement processes. From these interviews it can be concluded that there are 4 themes that should be included in the framework: biodiversity, climate adaptation, health & wellbeing and aesthetic value. In the second diamond the implementation of these themes in EA is researched in an iterative process combining literature study with key informant interviews. Here it is concluded that in the condition account, four indicators should be used: vegetation cover, shadow cover, soil quality and air quality. For the service account, the following services are included: Local climate regulation service, rain water regulation service, health service of nature, visual amenity service of nature and the visual amenity service of water. These services cover all themes but biodiversity, as no service was found that could be used for biodiversity within Dutch urban areas. Based on the services and the indicators, not every ecosystem type that can be found in the Netherlands is necessary to have a place in the framework. Therefore only the four ecosystem types are used: residential and non-residential construction, urban green, infrastructure and water. A visual representation of the final framework can be found in figure ii or in Appendix K. The first table shows the combination of ecosystem extent and condition accounts, here per ecosystem type, the condition is assessed. The second table is the ecosystem service table that indicates the physical and monetary value per service per ecosystem type. For each ecosystem type, the first column represents the physical service value and the second column the monetary value. The last table indicates the asset value per ecosystem service and the total asset value. The arrows between the tables represent the relationships between the different rows of the different tables, showing which condition indicators influence which service values and how the service values relate to the asset values.

Within a procurement process this framework should be used at three moments at least. In the beginning of the project when the ambition is formed, the framework can show the condition and service value of an area before anything has taken place. During this time, the ambition for a future value can be determined. In the call for tenders the framework can be used to review the different plans tenderers made. Positive deviations from the minimum required service value will receive a higher discount. In the control phase the frameworks will be used to verify the project.

The biggest limitation in this research is the current knowledge on the link between the ecosystem condition and the ecosystem service. Currently the condition account seems redundant as the condition account does not impact the service account directly. But increase in certain characteristics in the condition account, do influence the service values. However, future research could also focus

on other ways of monetizing the services in a way that they are less dependent on the number and value of houses.

The use of this framework helps assess positive contributions as NbS to an ecosystem in a procurement process. By doing this in each project, it can change the way of thinking on urban development from construction first to putting the ecosystem as a whole first. This will result in incorporating NbS in plans to create urban areas in the Netherlands that will assure liveability not only for now, but also for the future as it helps improve the biodiversity, adapt to the changing climate, improve the health and wellbeing of residents and is overall positively appraised for its aesthetic value.

Asset value
Asset life
Discount rate
Monetary service value

Local climate regulation service
Visual amenity services
Health service of nature
Rain water regulation service

Overall asset value

Overall monetary service

Water — Monetary service / Physical service
Infrastructure — Monetary service / Physical service
Urban Green — Monetary service / Physical service
Residential and non-residential construction — Monetary service / Physical service

Local climate regulation service
Visual amenity services
Health service of nature
Rain water regulation service

Residential and non-residential construction
Urban Green
Infrastructure
Water

Shadow cover
Vegetation layer score
Air quality
Soil quality

Figure ii Schematic overview of EA for procurement. First table shows the combination of ecosystem extent and condition accounts. The second table is the ecosystem service table that indicates the physical and monetary value per service per ecosystem type. The last table indicates the asset value per ecosystem service and the total asset value. The arrows between the tables represent the relationships between the different rows of the different tables.

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LIST OF ABBREVIATIONS

Abbreviation	English
BAU	Business As Usual
CBS	Centraal Bureau voor Statistiek (Statistics Netherlands)
DBB	Design Bid Build
DBB	Design & Build
DBM	Design, Build and Maintain
E&C	Engineer & Construct
EA	Ecosystem Accounting
EAA	Ecosystem Accounting Area
EC	European Commission
ESS	Ecosystem Service
ET	Ecosystem Type
FAOUN	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
IMF	International Monetary Fund
IUCN	International Union for Conservation of Nature
MEAT	Most Economically Advantageous Tender
MKI	Environmental Cost Indicator
MSR-VOLY	Maximum Societal Revenue - Value Of a statistical Live Year
NbS	Nature-based Solutions
NOVI	National Strategy on Spatial Planning and the Environment
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
RWS	Rijkswaterstaat (Ministry of Infrastructure and Water Management)
SDG	Sustainable Development Goals
SEEA	System of Environmental Economic Accounting
SEEA-CF	SEEA Central Framework
SEEA-EEA	SEEA Experimental Ecosystem Accounting
SQ	Sub-Question

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SUDS	Sustainable Urban Drainage Systems
TEEB	The Economics of Ecosystem and Biodiversity
UHI	Urban Heat Island
UN	United Nations
UNEP	United Nations Environmental Programme

I. Introduction

1 INTRODUCTION

According to the United Nations (UN), we are currently facing three planetary crises: the climate change crisis, the biodiversity loss crisis, and the pollution crisis *(United Nations Environment Programme, 2021a)*. These crises jeopardise the liveability in cities. At the same time in the Netherlands, the pressure on liveability in cities will increase even further as we are also facing a housing crisis. In the years until 2030 almost 1 million extra houses have to be realised *(Rijksoverheid, 2021)*. If the trend from 2018 to 2021 continues, almost 60% of these will be built within urban areas, which is also in line with the National Strategy on Spatial Planning and the Environment (in Dutch: Nationale Omgevingsvisie or NOVI) *(CBS et al., 2022)*.

With the task at hand to build almost 1 million additional homes, the way we build can heavily influence the liveability within these cities. For example, Urban Heat Island (UHI) effect, which is the phenomenon that the temperature in cities is higher compared to the city's surroundings, can increase even more due to bad city planning *(Akbari et al., 2015; Burgstall et al., 2019; Yang et al., 2016)*. By creating more waterbodies and nature within a city, this effect can be counteracted *(Akbari et al, 2015; Yang et al., 2016, United Nations Environment Programme, 2021b)*. These measures all help in reaching the United Nations Sustainable Development Goals (SDGs). In particular SDG 11: "*Make cities and human settlements inclusive, safe, resilient and sustainable" (United Nations, Department of Economic and Social Affairs, 2022a)* can benefit from more nature within cities. Not only SDG 11 will influence the construction sector. SDG 13: "Take urgent action to combat climate change and its impacts" *(United Nations, Department of Economic and Social affairs, 2022b)*, is an overarching goal that asks all sorts of actions against climate change which is therefore linked to all the SDGs. The Paris Agreement, often referred to as the Paris Climate Accord, is instated to address the climate change and to help reach SDG 13.

These efforts to make the world more sustainable are also visible in the construction sector. The analysis of the Dutch organisation *Bouwend Nederland (2022)* shows that the number of sustainable award criteria in tenders has risen from 252 in 2016 to 685 in 2021. These award criteria are also known as Most Economically Advantageous Tender (MEAT) criteria and are part of the public procurement procedure for governments. Within this procedure the government can use 2 types of criteria, the selection criteria which can exclude bidders from the tender procedure and selection criteria which assesses the quality of the bids. From the 685 MEAT-criteria in 2021, 64 cannot be put in one specific category, 162 criteria are about the CO_2 performance ladder, 316 criteria are about the execution and only 143 criteria are about the solutions *(Bouwend Nederland, 2022)*.

If the construction sector needs to act more sustainable on the solution too, adding more nature to counteract the UHI and biodiversity loss can be an example of such a sustainable solution *(United Nations Environment Programme, 2022a)*. The solution of adding more nature, or even create urban parks can be classified as Nature-based Solutions (NbS). NbS have multiple definitions in literature, but the most used definition comes from the International Union for Conservation of Nature (IUCN). They state that NbS are *"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" (United Nations Environment Programme, 2021b, p. 10)*. The different benefits NbS can generate are very diverse and range from Climate resilience to economic gains and from biodiversity conservation or increase to more circularity within cities *(Atanasova et al., 2021; United Nations Environment Programme, 2021b)*.

Although last paragraph makes it plausible that NbS are a solution to at least some of the earlier mentioned crises, the use of NbS is not as widespread as the UN would like to see. The most prevalent barrier for the use of NbS are the high investment costs and the invisible benefits *(United Nations Environment Programme, 2021b; United Nations Environment Programme, 2022b; Van Haaster-de Winter et al., 2020)*. The line of reasoning from the UN is that when the cost perception of NbS is changed by also valuating all the benefits, the use of NbS will increase.

An approach that will fully value all the benefits an ecosystem can create is Ecosystem accounting (EA). EA is *"a spatially-based, integrated statistical framework of organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity" (United Nations et al., 2020, p. 2)*. The international framework created by the UN can account for the different services an ecosystem can provide, an overview of this can be found in Figure 1.
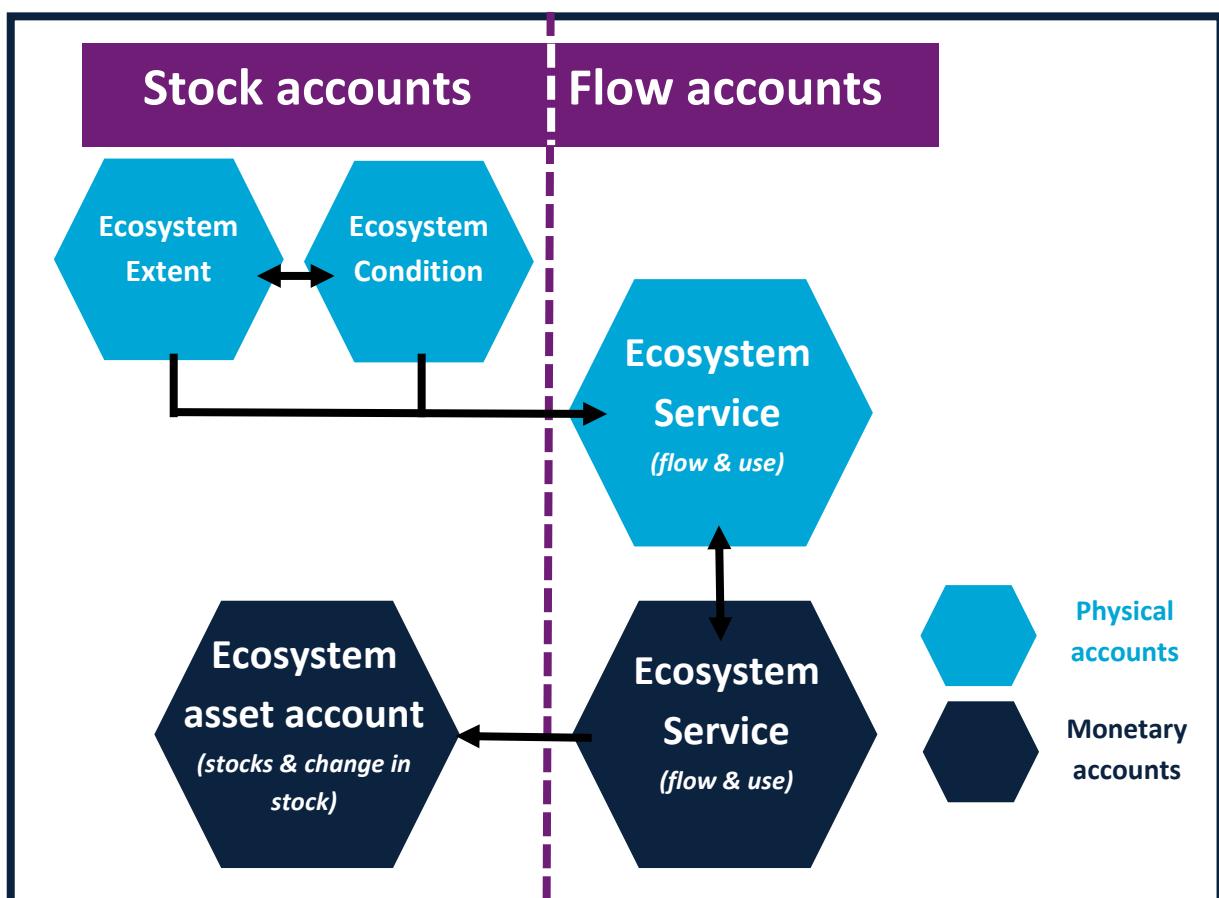
Figure 1 Ecosystem Accounting (adapted from United Nations et al., 2021)

Currently EA is mostly used in policy making. Since it can show trends in the increase or decline of the value of ecosystems, it can track whether or not a policy is working. However, the use of EA is not widespread yet, because it takes a lot of time to correctly create the different accounts and keep them up-to date. Currently thirteen ecosystem services have data that is sufficient to use for the Netherlands *(de Jongh et al., 2021)*, but this is not the full potential of services that EA can value in the future *(Hein et al., 2020)*. In the future, this can be extended, but this extension is limited as it

would be close to impossible to have every possible ecosystem service accounted for. As a result, the true value of an ecosystem can never be fully calculated, but only partly approached.

1.1 Problem statement

In the years to come, the Dutch construction sector has an enormous task of building almost 1 million homes, which will be mostly created within current cities *(CBS et al., 2022; Rijksoverheid, 2021)*. But with the already existing crises (climate change, biodiversity loss, pollution, etc.), the liveability of these cities will be jeopardized further if we do not start to build and organise our cities more sustainable *(Akbari et al., 2015)*. NbS would be a fitting solution to this problem but are currently not used often. The most prevalent barrier therefore are the clearly visible high investment costs and the mostly invisible benefits NbS can generate *(United Nations Environment Programme, 2021b; United Nations Environment Programme, 2022b; Van Haaster-de Winter et al., 2020)*. This research will explore how EA can enhance the procurement process to reveal the invisible benefits of NbS. The ultimate goal is to stimulate the use of NbS within urban areas in the Netherlands by enhancing the procurement process with EA.

1.2 Knowledge gap

To ensure the relevance of this research, the knowledge gap in academic literature will be explained here as well as the practical relevance of this work. In literature the following knowledge gaps have been identified:

- A lot is still unknown on how effective sustainable MEAT-criteria are *(Santen, 2020)*
- The focus of EA has currently been on policy making, other areas such as the procurement process have not been studied yet *(Hein et al., 2020)*
- Ways of measuring the effect of NbS on the environment towards SDGs are not very satisfactory yet *(Hein et al., 2020)*
- Almost all valuations of NbS are case-by-case, not with a commonly used method *(Viti et al., 2022)*

This research aims to fill these gaps by creating the framework that uses EA for the procurement process. This framework could be used by the client to create clear and quantitative MEAT-criteria that should stimulate the use of NbS. After the solution has been build, the same framework can also be used to track the effect of NbS on the environment.

Not only for academic researchers this thesis will be relevant, but also for the construction sector that aims to build more sustainable. Where the sustainability criteria currently aim mostly for a sustainable execution (solely use of electric vehicles) or a sustainable contractor (in possession of certain certificates) *(Bouwend Nederland, 2022)*, this framework can also be used to create sustainability criteria for the solution.

1.3 Scope

The main focus for this research is on NbS within an urban environment as this is where the main task for the construction sector lies. This means that only types of NbS that can be used within urban areas are studied. Examples of these NbS are green roofs and facades, but also city parks and street trees, community gardens and SUDS. Since EA uses datasets that are specific for a nation and Dutch accounts exist, this research will focus on urban projects in the Netherlands. The applicability for other nations will not be investigated.

1.4 Research Question

The main research question is: **"How can Ecosystem Accounting be used in Dutch procurement processes to create more Nature-based Solutions within urban areas?"**

To answer this research question, multiple sub-questions (SQ) are:

Sub-Question 1 How can the client and contractor in the current procurement process put their ambition for NbS into practice?

Sub-Question 2 What distinguishes NbS from grey solutions?

Sub-Question 3 What are the most important themes for clients and contractors to have the ambition for NbS within Dutch urban areas?

Sub-Question 4 Which ecosystem characteristics are important to value for the incentives explain in SQ3?

Sub-Question 5 How can these characteristics be used in the EA framework?

1.5 Research design

To answer the main research questions and the sub-questions, the double diamond method is used. The double diamond method is a design method that was developed by the Design Counsil in 2005 *(Design Council, n.d.)*. The method consists of 4 steps: Discover, Define, Develop and Deliver (Figure 2). It is a design method that uses divergent and convergent approaches to come to a design by looking first at the problem space and secondly at the solution space. Both diamonds are iterative steps and can be repeated multiple times, if necessary.

In the first diamond, the goal was to first look at the problem as broad as possible and thereafter define the requirements to be met by the solution. By having done literature research and stakeholder interviews, this research section concludes with a design brief for the framework. During the last quarter of 2022 the literature study took place in which three different topics were researched: the Dutch procurement process, NbS and EA. The first topic was researched by mainly grey literature that describes the rules and requirements for procurement in the Netherlands. For NbS multiple scientific databases (such as google scholar and Web of Sciences) were used to find articles with key words (and spelling variations of) "Nature-based Solutions". The literature study on EA had as basis a white paper from the UN *(United Nations et al., 2020)*, and was complemented using scientific papers that describe either the creation or use of EA. The same scientific databases were used to find these articles with search words as "EA", "EA Netherlands" and "Ecosystem Service" (all including spelling variations). The literature study answered both SQ1 and SQ2. With the analysis of the stakeholder interviews SQ3 was answered.

The second diamond used the design brief from the first diamond to do a literature research and perform key informant interviews. Based on the answer of SQ3 earlier found literature was reassessed in this literature research to see if they have already explored the right themes. Also new literature was added by searching the same. Possible answers for SQ4 and SQ5 were explored in a diverging way. After the analysis of these key informant interviews, SQ4 and SQ5 could be answered, and the framework was created. To assure the validity of the framework, it was tested with a fictional case.
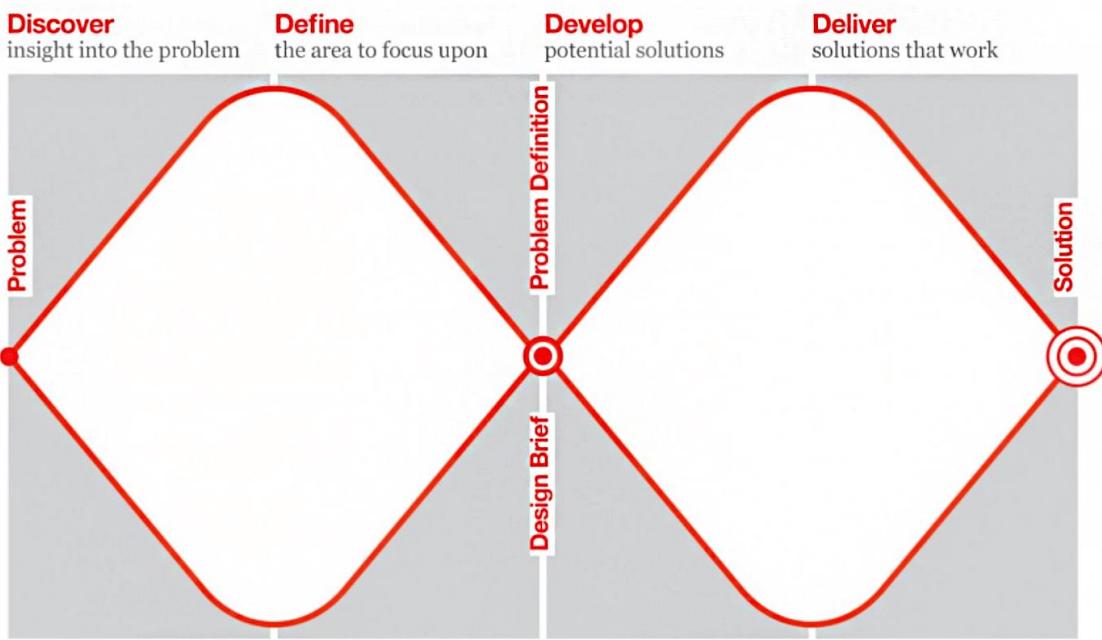
Figure 2 Double Diamond approach by Design Council (n.d.)

1.6   Outline

This research is split in five parts:

I.   Introduction
II.   Understanding the problem
III.   Creating the framework
IV.   Usage in practice
V.   Discussion and conclusion

After this introduction section II. discusses the first diamond of the double diamond approach. In Chapter 2 the findings from a literature study on three topics is shown: procurement in the Dutch construction sector, NbS and EA. After this chapter SQ 1 and SQ 2 can be answered. Chapter 3 discusses the methodology for the rest of this first diamond. In Chapter 4 the results from the stakeholder interviews are shown and Chapter 5 discusses these results. This part ends with the design brief (shown as the middle line in Figure 2) in Chapter 6 which helps answer SQ 3.

Section III. starts with the methodology in Chapter 7. The results from the second interview round, the key informant interviews are shown in Chapter 8. Chapter 9 discusses these results and in Chapter 10 the final framework is presented that will answer SQ 4 and SQ 5.

Section IV. encompasses two chapters. In Chapter 11 a test case is used to show the functioning of EA. Chapter 12 discusses when EA should be used in the procurement procedure to stimulate the use of NbS. These chapters help in formulating the answer to the main research question.

Finally in Section V. an overall discussion on the study is presented in chapter 13. Chapter 14 shows the answers to all sub-questions and the main research question.

II. Understanding the problem

2 LITERATURE STUDY

This research will use the literature study to answer the first two research questions and to lay the groundwork for the interview sessions. Sub-Question 1 will be answered in the section about Dutch procurement processes, 2.1. Section 2.2 on NbS will answer Sub-Question 2 and will already indicate possible answers on Sub-Question 3. To be able to create a functional framework that uses EA for Sub-Question 4, Sub-Question 5 and the main research question, EA will be explained more in-depth in section 2.3.

2.1 Procurement in the Dutch construction sector

For most construction works in the Netherlands, the governmental agency that works as a client, is bound by procurement law when they choose their contractor. There are 3 general areas public procurement is mandatory: the execution of works, the supply of products, or the provision of services. For the construction sector, the directives on the execution of the work are applicable. This means that if a contracting authority, a body governed by public law often referred to as client, wants to enter into a contract for the execution or both design and execution of a construction project with a value over the threshold value, they are bound by public procurement law. The current European threshold value for works contracts in 2022 is €5,382,999 *(The Office of Government Procurement, 2021)*. All the laws and directives from Dutch procurement law, stem from the European directive on procurement. The base of these laws are the following 6 principles:

- The principle of equal treatment and non-discrimination,
- The principle of transparency,
- The principle of proportionality,
- The principle of competition,
- The principle to state reason,
- The principle of protection of legitimate expectations and legal certainty *(Bruggeman, 2018)*.

These principles need to ensure a fair and equal chance for all bidders to secure the tender. It is possible that during the procurement process these principles can clash, but generally the principle of equal treatment and non-discrimination will then be seen as most important to adhere to.

2.1.1 Types of procurement

Not all procurement processes are the same, the most used procedures are:

- Open procedure
- Restricted procedure
- Competitive dialogue
- Negotiated procedure with prior publication of a contract notice
- Negotiated procedure without prior publication of a contract notice *(Bruggeman, 2018)*.

Both the open and restricted procedure can be used always. The difference is that with the open procedure an unlimited number of tenderers can join, where for the restricted procedure only a limited number of tenderers can submit a bid. This means that in the open procedure, the client has the task to assess a possibly very large number of bids. It was thought that this high number, would lead to a strong competition. But, in practice bidders put more effort in tenders with a smaller

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number of bids, and therefore competition is stronger in the restricted procedure *(Hombergen, 2022)*. The selection of the bidders in the restricted procedure happens in the selection phase.

The competitive dialogue and negotiated procedures can only be applied in *"limited and defined circumstances" (Bruggeman, 2018)*. For the competitive dialogue these circumstances can be the complexity of the contract, where not all specifications are known beforehand. The negotiated procedures can be used when there are no suitable bidders found or when a protection for technical or artistic rights needs to be ensured.

2.1.2 Procurement procedure

The procurement procedure consists of multiple steps, where the first three are governed by procurement law (Figure 3). In the first phase, the publication phase, the client lets it be known that they have a project that will be procured. In the selection phase, the different bidders are assessed, and only those that are qualified can enter the award phase. In this phase the different bids are assessed, whereafter the client can only go into contract with the contractor of the winning bid. After they have entered into a contract the last step will be completed, the control phase.

Figure 3 First three phases of procurement (adapted from Hombergen, 2022)

The publication phase

The first formal phase within the procurement procedure is the publication phase. Here the client formally announces that they want to procure something. A contract notice will then be published on TenderNed whereafter it will be automatically published in the European equivalent: European Announcement Bulletin *(Bruggeman, 2018; Hombergen, 2022)*. Thereafter open information rounds are being held where all contractors can ask question on the contract to decide whether or not they want to apply. These information rounds are open to ensure the six principles of procurement law and give all the tenderers the same information, but to protect their possible competitive advantage not many specific questions are asked in these written or spoken information rounds *(Bruggeman, 2018; Hombergen, 2022)*. If a contractor has a very innovative idea that they publicly ask the client about, it might inspire competitors to try and do the same or even improve that idea.

With the notice on TenderNed and the European announcement Bulletin, also documents with information about the works and contract need to be published *(Bruggeman, 2018; European Commission, 2016)*. This means that minimum requirements need to be published together with the method that will be used to evaluate whether or not these are met. Criteria for both the selection and award phase need to be unambiguous and correctly relate to the contractors and the bids

respectively. Again, these criteria need to consider the principles of procurement law. The principle of proportionality ensures for example that for the construction of a standard pedestrian and bicycle bridge, a selection criterion cannot ask the contractor to have experience in large bridges that are also suitable for trains.

The selection phase.

The next phase of the procurement process is the selection phase. In this phase the client verifies that the parties that applied meet the selection criteria. For an open tender procedure, this phase can be done simultaneously with the award phase. For procurement processes with a limited number of tenderers that can join, this is a separate phase. The candidates that have applied will be assessed on the earlier announced criteria. The client will then select a minimum of three parties (to ensure the principle of competition) that will be able to submit their bid *(Bruggeman, 2018)*.

In the selection phase, two different types of criteria can be distinguished, the grounds for exclusion and selection criteria. The grounds for exclusion can exclude tenderers if they, for example, are convicted for money laundering. The selection criteria are used to invite candidates who meet a certain minimum requirement. The grounds for exclusion can be applied for both open and restricted procedures, whereas the selection criteria are solely used in non-open procedures.

The award phase.

Where the selection phase emphasizes the candidates and their characteristics, the award phase focuses on the bids and their characteristics. In this phase, for all the bids will be checked whether or not they meet the minimal requirements. If this is not the case, or information is missing, the bid will be seen as invalid and will be discarded. Between the valid bids, a choice needs to be made to select the winner.

There are two different ways to select this winner, the client can either tender on the lowest price, or choose for the Most Economically Advantageous Tender (MEAT). Which option has been chosen should have been clearly stated in the publication phase. The first way of procuring (lowest price) will solely look at the price the candidate asks for their bid. Although this might sound like the cheapest option, this does not necessarily have to be the case *(European Commission, 2016)*. A low price can result in a lower quality and therefore earlier repair and maintenance costs. In a MEAT-procedure, the quality of the bid will be assessed as well as the cost, most often resulting in a more cost-efficient solution *(United Nations Environment Programme, 2021b)*. A tender awarded on quality is always possible, when it's based on the lowest price, this needs to be motivated. An example of such a motivation would be if no big differences on quality can be expected *(PIANOo Expertisecentrum aanbesteden, 2016)*. If the client has chosen to use MEAT-criteria, they can formulate many different types of award criteria to achieve quality based on:

- Technical merit,
- Aesthetic characteristics,
- Environmental qualities,
- Date of delivery,
- Etc. *(PIANOo Expertisecentrum aanbesteden, 2016)*

The winning bid is the one with the lowest fictional price. Each bid has a true price, the value the client has to pay the party if they win. But if a client can make a big enough difference on one of the MEAT-criteria, they can earn a fictional discount on the price. This means that it can pay off to invest

some more money to score higher on one of the criteria for the bidder. The MEAT-criteria can help generate value for the client in the area they desire.
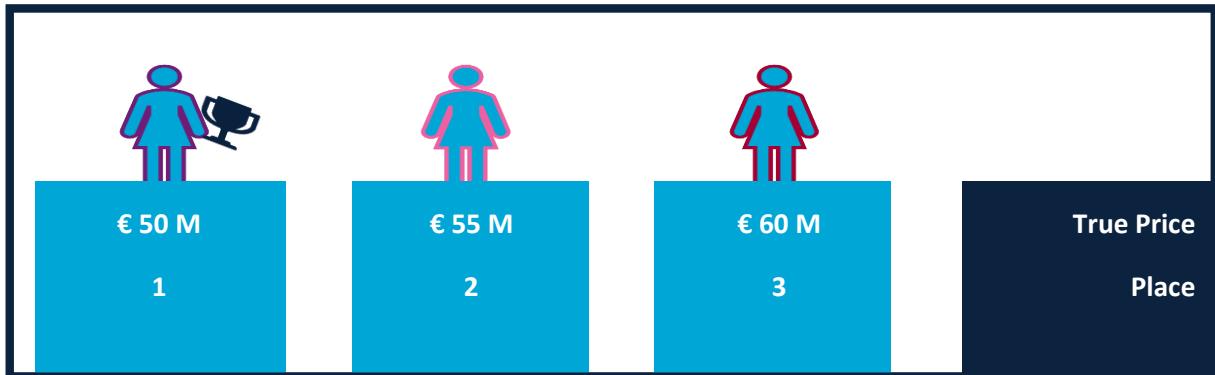
Figure 4 Bid assessment based on lowest price (adapted from Ramler, 2022)

An example of how the ranking of bids would go in the case of lowest price and based on MEAT-criteria can be seen in Figure 4 and Figure 5 respectively. In the first case there are 3 bids done by company Purple, company Pink and company Red. Based on the prices they offer, company Purple wins the tender and can enter into contract with the client.
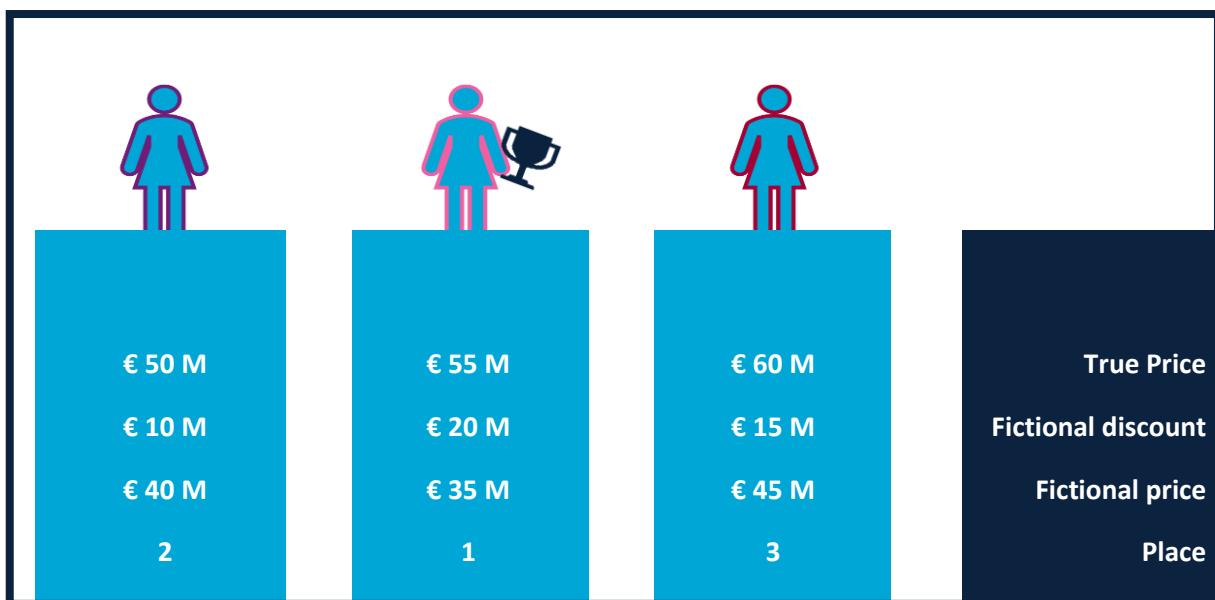
Figure 5 Bid assessment based on MEAT-criteria (adapted from Ramler, 2022)

If the client has MEAT-criteria, they can create a fictional discount. Still company Purple, Pink and Red have the real value that impacts the decision on who will win. But this time, the delivery date has been created into a MEAT-criterium. For each week early they can deliver the project, they will earn a 5-million-euro fictional discount. Company Purple can deliver two weeks early, giving them a fictional discount of €10,000,000, company Pink is four weeks early, and company Red is three weeks early resulting in a discount of €15,000,000. These fictional discounts will then be subtracted from the true price. Now the winner of the tender is company Pink. They can now enter into contract with the client.

After the winner of the bid has been chosen, the two parties (client and winner) can now choose to enter into a contract with each other. If the client is not satisfied with the winning solution, they are

not allowed to choose one of the others and enter with them into contract. They can choose to not let the works be executed or tender again with significantly different requirements and/or criteria.

However, if we are to assume that the client is satisfied with the winning solution, there is a small waiting period, the stand still period, before they will actually enter into contract. This waiting period of twenty calendar days is in place to give tenderers who do not agree with the outcome a chance to start a judicial procedure *(Bruggeman, 2018)*. If a client enters into contract with the winner within these twenty days and a judicial procedure has been started, this can result in a possible voidability of the contract. After those twenty days, the client is safe to enter into contract. If a tenderer starts a procedure after this, the contract between the client and the winning tenderer cannot be voided.

Control phase
When everything has gone well and the contract between the client and the winning party has been drafted up, the control phase starts. This phase is not part of the public procurement law but is the result of the contract between the parties. To win the tender, the bid had to fulfil the requirements to be considered and possibly also had to fulfil some criteria. To assure that these requirements and criteria are also met in real life, the control phase exists. During and after construction, the client has the duty to check whether or not the contractor does as he promised. The way the client will check this, also has to be included in the documents published in the publication phase *(European Commission, 2016)*. If the contractor does not deliver as promised, the client will react with predetermined consequences, such as they right to withhold payment.

2.1.3 Alignment of contract type and award criteria
Before the first formal phase (the publication phase) takes off, the client has the job to properly prepare themselves and ensure that the all the requirements and criteria they set, are aligned with their goals and contract type.

Two different types of contracts can be awarded, traditional contracts or integrated contracts. Traditional contracts follow the design, bid, build (DBB) principle. The client asks an architect to design something, that design is being tendered and the contractor simply has to build what has been designed. In the integrated contract, (a part of) the design will be made by the contractor, giving them more freedom to differentiate themselves and their bid. If the traditional approach is used, technical specifications are being tendered and the contractor can differentiate on the execution. When functional specifications are given, a design & build (D&B), an engineer & construct (E&C) or design, build and maintain (DBM) contract is awarded. In these cases, a general solution will already be given, but there does exist some design freedom for the contractor. A next step in integrated contracts are the design, build, finance and maintain (DBFM) or design, build, finance and operate (DBFO) contracts, where only service specifications have been given. Most often, a mixture of a different specification levels is given for the project. Figure 6 shows an example of this for a sample project that has four different parts. For part 3 the client has a lot of the design responsibility, and the contractor can only decide how he executes this, while for part 2, the contractor has the responsibility to almost design that part of the solution fully.

This implies that a client beforehand needs to be sure about what they procure and how this fits into a contract. If they have a lot of inhouse knowledge about the specific solution they want, a more traditional approach is logical, as they can require all contractors to use that solution in their plans.

But if this knowledge lies more with the contractors, an integrated contract can give a more innovative solution and can stimulate new technologies *(Grandia et al., 2015)*.
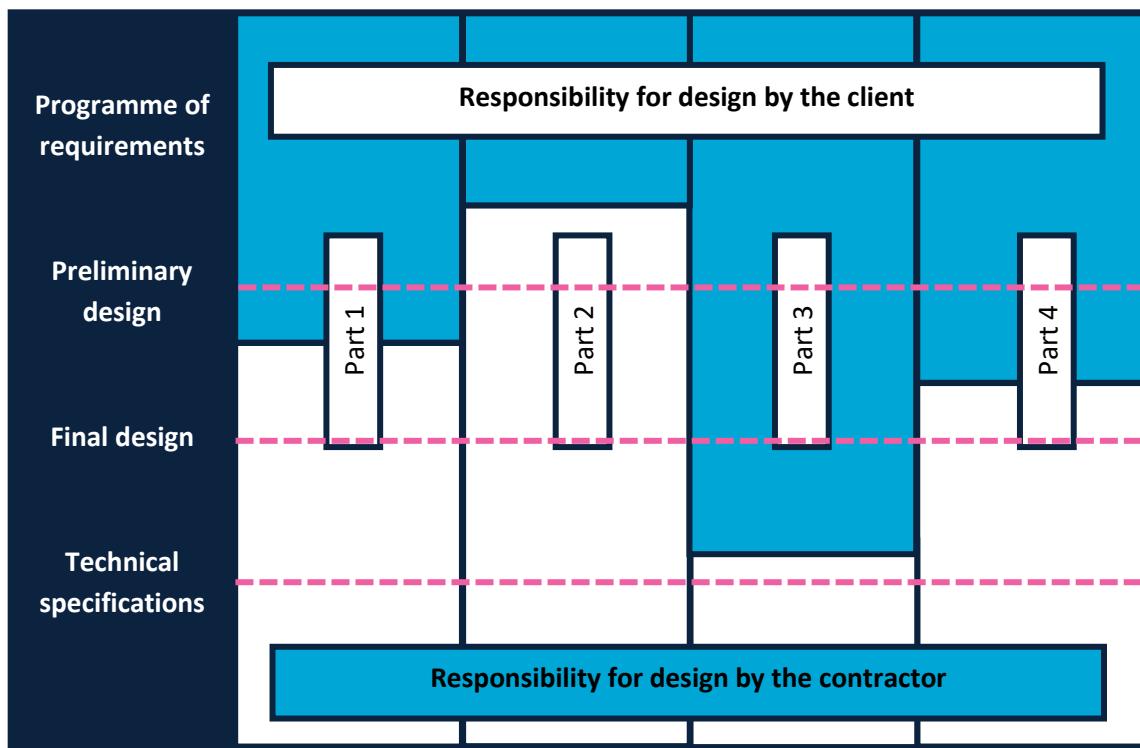
Figure 6 Design responsibilities (adapted from Hombergen, 2022)

When a more integrated contract form has been chosen, it is important for the client to have a clear difference if something they want should be minimum requirement or an award criterion *(European Commission, 2016)*. If they have set their mind to the use of a certain technique, it should be considered a minimum requirement. If it is being put as an award criterion, also other techniques can be used. This means that the client has less control about what they will exactly get, but it can result in a better solution when innovative techniques are being used. What is important in this discussion, is the procurement principle of competition; the client cannot put certain demands as requirements if only one party can supply this *(European Commission, 2016)*. When it has been decided that a certain wish will be translated into an award criterion, the right weight needs to be added for this. If very low virtual discount will be given, the tender will essentially be a lowest price tender again. The same holds if it is to be expected that all tenderers will score the same on a criterion, it cannot be used to differentiate between the bids and should be set as requirement instead *(PIANOo Expertisecentrum aanbesteden, 2016)*.

If the right match between the contract type and the different requirements and criteria has been found, the exact phrasing of this can also prevent, or result in problems. Ambiguity in requirements and criteria should be avoided and for the client the reason behind these requirements and criteria should be clear. An article in De Volkskrant shows an example of how municipality Utrecht did not do this well *(Kuiper, 2022)*. In this case, the municipality specified that they wanted a bus stop with a 'floating' bench to facilitate easy cleaning, as a requirement. The tender was between two parties, where the winner was decided partially because their plan was financially more appealing. After the construction of the bus shelters, the competing party discovered that the winning design did not have the required floating bench, as it was resting on two legs. The municipality stated that it was a

valid design as a bench can never actually be floating. After multiple court procedures, it was finally decided that the bench in fact was not floating, and that the municipality should not have accepted this bid as valid. The municipality now must compensate the losing party, the exact amount is not known yet, but is expected to be millions of euros *(Kuiper, 2022)*. This example illustrates how mistakes in the early stages of the tender, can result in bigger problems later.

2.1.4   Sustainable procurement in the Netherlands

As already mentioned in the introduction, the need for the Dutch construction sector exists to be more sustainable. Within the procurement procedure, both the client and contractor have possibilities to be more sustainable. To stimulate this, the European Union has written a handbook, "Buying Green!", that focusses on green procurement for clients. In this handbook, they state the importance for governmental agencies to procure sustainable, as they are an important instrument to meet environmental goals *(European Commission, 2016)*. Although this handbook and other literature focusses on general sustainable procurement, a lot of these findings can also be useful for NbS as this is a specific type of sustainable solution *(Atanasova, 2021; Randrup et al., 2020)*.

The decision to use sustainability criteria or requirements in procurement is made by the client. And although all clients work under the same regulations, their attitude towards sustainable procurement differs *(Grandia et al., 2015)*; in 2021 the Ministry of Infrastructure and Water Management (Rijkswaterstaat in Dutch or RWS) used sustainable award criteria in 56,4% of their projects, whereas municipalities only use these in 40,3% of their projects *(Bouwend Nederland, 2021)*. And although (local) governments may stimulate sustainable procurement, it is the behaviour of the procurers that influences the sustainability *(Grandia et al., 2015)*.

To improve the sustainable behaviour of procurers, guidelines from organisations as PIANOo and the European Union are written. However, regulations as written by PIANOo, are nothing more than guidelines, and they cannot result in any legal consequences and are even regarded as old-fashioned *(Vluggen et al., 2019)*. To reach the full potential of sustainable procurement, these procurers need to be included in creating a just sustainable procurement policy *(Grandia et al., 2015)*.

In practice, both the number of sustainable award criteria as the number of sustainable selection criteria has risen in the past years. In 2016 a total of 56 sustainable selection criteria were used in public procurements that year in the construction sector, where in 2021 this has already risen to 156 selection criteria *(Bouwend Nederland, 2022)*. Also, the number of award criteria has risen, from 252 in 2016 to 685 in 2021. Although these numbers sound promising, more than half of the public procurements in 2020 did not use a single sustainable award criterion *(Bouwend Nederland, 2022)*.

Sustainable selection criteria

As mentioned in the previous paragraph, in 2021 156 sustainable selection criteria were used in procurement processes for the Dutch construction sector *(Bouwend Nederland, 2022)*. Figure 7 shows how often these criteria have been used since 2016. The first criteria category is ISO 14001, this is a certificate that is awarded when organisations adhere to the international norm about sustainability and environmental management *(NEN, 2022)*. Category two is about the level a contractor has reached on the CO_2 performance ladder (in Dutch: CO_2-prestatieladder). This again is a certificate that companies can achieve on 5 different levels. The first three levels talk about how the company reduces their CO_2 emission themselves, to reach level 4 or 5, they also need to reduce emissions in the sector. The CO_2 performance ladder originates from ProRail in 209, but since 2022 it

is from Stichting Klimaatvriendelijk Aanbesteden en Ondernemen (SKAO or in English: Climate-friendly Procurement and Business Foundation) *(SKAO, n.d.-b)*. The number of times this type of criterium has been used, has decreased in the last year. Currently almost 60% of the companies with a certificate have this certificate for level 3, 40% has a certificate for level 4 or 5, and less than 1% only has reached level 2 *(SKAO, n.d.-a)*. This means that with this criterion, it is becoming more difficult to distinguish oneself from other companies. The most selection criteria were asked in the category reference projects, here the contractor needs to show that they can sustainably execute a project by showing earlier work. Although these sustainable criteria can help achieve more sustainable projects, they cannot help companies with innovative sustainable solutions to stand out *(Bouwend Nederland, 2022)*.
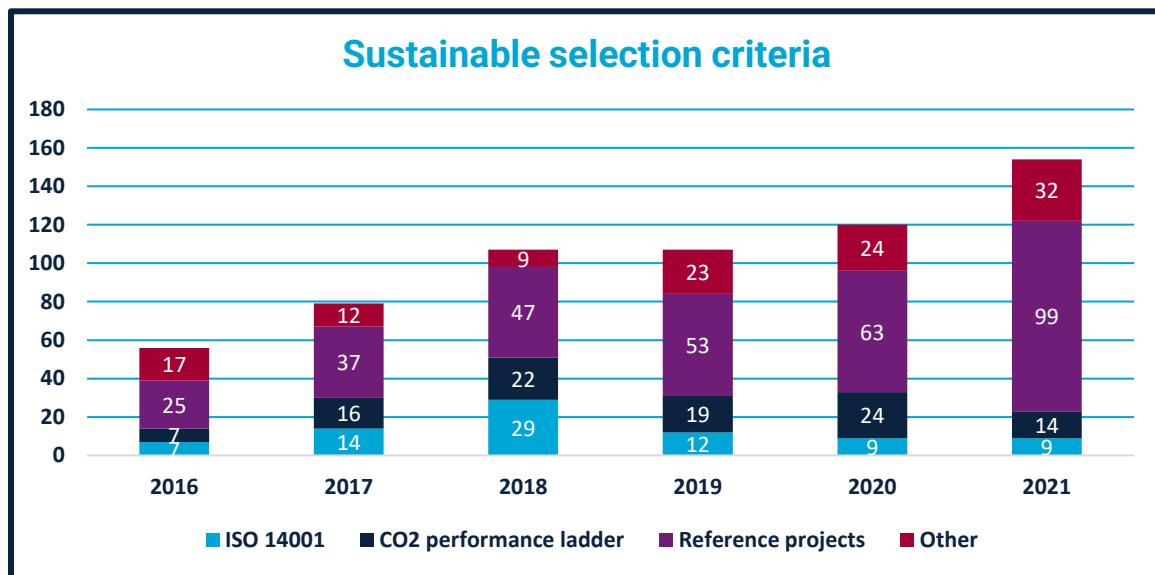
Figure 7 Sustainable selection criteria (adapted from Bouwend Nederland, 2022)

Sustainable award criteria

The award criteria could also be categorized into three categories (and a group of other criteria), Figure 8 shows how often these have been used for the past years. The biggest category here are criteria about the execution, an example of this is the use of sustainable equipment such as electrical machinery *(Bouwend Nederland, 2022)*. The second biggest category is the again CO_2 performance ladder, when this is used as award criterium, the contractor is asked to think about the level on the ladder in which they want to execute this project. During the control phase, the client checks whether or not the contractor has complied with the agreed level. The last concrete category is the solution criteria category. Here all sustainable criteria that help the contractor to differentiate their solution from others are put. An example of a criterium used here, is the Environmental Cost Indicator (in Dutch: Milieu Kosten Indicator or MKI). This indicator calculates the expected social costs to cancel out the negative environmental effects *(PIANOo Expertisecentrum aanbesteden, 2019)*.

Figure 8 Sustainable award criteria (adapted from Bouwend Nederland, 2022)

2.2 Nature-based Solutions

Traditional solutions in civil engineering were designed to fulfil one function or fight one risk, such solutions are called grey solutions *(Bouleau & Rouillé-Kielo, 2021)*. Currently, with the urbanization and climate change, these grey solutions can increase the magnitude of UHI or other natural hazards *(World bank, 2021)*. To counteract these and other negative impacts on cities, several concepts such as ecological engineering, green infrastructure, urban green (and blue) spaces and ecosystem-based adaptation have been used *(Atanasova et al., 2021, Randrup et al., 2020)*. An umbrella term for all such solutions that are inspired by nature, use nature and/or are supported by nature is NbS *(Frantzeskaki, 2019)*. Many different definitions have been used in literature for NbS, but the most commonly used is from IUCN. The IUCN defines NbS as *"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" (United Nations Environment Programme, 2021b, p. 10)*. Other definitions in literature are from the EC, who state that NbS are *"solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience" (Randrup et al., 2020)*, or the study from *Atanasova et al. (2021)* who define NbS as "*concepts that bring nature into cities and those* [concepts] *that are derived from Nature. NbS address societal challenges, enable resource recovery, climate mitigation and adaptation challenges, human well-being, ecosystem restoration, and/or improved biodiversity status within the urban ecosystems."*. Other definitions also exist, but certain aspects keep coming up. Ecosystems or nature are always mentioned and multiple benefits or addressed challenges are mentioned. Because opposed to grey solutions, NbS are designed to address multiple challenges and/or have multiple benefits *(OECD, 2020)*. Table 1 shows an overview of other differences between grey and nature-based solutions.

Although the term 'nature' is an important word in NbS, NbS documents, and NbS papers, the social and economic benefits they can provide, should not be overlooked *(Atanasova et al., 2021; Xie & Bulkeley, 2020)*. With the wide range of benefits NbS can provide, the implementation of such solutions require multiple stakeholders and specialists to engage *(World Bank, 2021)*. Although a multiple stakeholder approach can also lead to conflicting views as benefits can be valued differently

amongst multiple stakeholders *(Kooijman et al., 2021; Xie & Bulkeley, 2021)*. Trade-offs then need to be made, also with interventions that can also lead to ecosystem disservices such as allergies to flora used *(Kooijman et al., 2021)*.

Table 1 Characteristics on NbS and grey solutions (adapted from: OECD, 2020)

Characteristics	NbS	Grey
Time scales	Long time-horizons for benefits to materialise	Benefits are realised straight after construction
Spatial scales	Often implemented at landscape scale to be effective, crossing jurisdictional boundaries	Implemented "within the fence line" of jurisdictions
Performance reliability	Performance uncertainties are/can be unknown due to complex natural systems	Performance uncertainties are "known"
Quantification of benefits	Many co-benefits difficult to quantify (e.g. human health and livelihoods, food, energy security and biodiversity	Benefits easy to quantify (e.g. avoided damage to assets)

2.2.1   Classifications

Examples of NbS are green walls (to help regulate heat and counteract biodiversity loss and reduce air pollutions), river and stream renaturation (to regulate pluvial and riverine flood and counteract bank erosion), open green spaces (for pluvial flood regulation and heat regulation) and many others *(World Bank, 2021).* But with no unambiguous definition, no exhaustive list of all sorts of NbS exists, a database with currently more than thousand NbS does exist *('Urban Nature Atlas', n.d.)*.

To keep an overview in these NbS, classification of the solutions can help. The *Urban Nature Atlas* uses the challenges a NbS addresses and the category the NbS belong to, to classify the different solutions *(n.d.)*. The full table on NbS-challenge classification can be found in Appendix Athe twelve main categories in Table 2, the number behind the categories indicates the amount of times this challenge was mentioned among the 1140 projects in the *Urban Nature Atlas (n.d.)*. Other types of classifications are based on location. *WWF (2021)* divides them into Nature-based buildings & neighbourhoods, vegetation agriculture and forestry, living rivers, and living shorelines, while Witteveen+Bos discusses natural coasts, living rivers, resilient cities and healthy lakes on their website dedicated to NbS *('What Are Nature-Based Solutions (NBS)?', n.d.)*. A paper from the UN states that NbS can be located in one of three areas: within a city, around a city or away from a city *(United Nations Environment Programme, 2021b)*. A third type of classification is done by the *World Bank (2021)* and divides NbS by application.

Table 2 Classification of NbS based on addressed challenge (Urban Nature Atlas, n.d.)

Climate action for adaptation, resilience and mitigation (SDG 13)	423
Coastal resilience and marine protection (SDG 14)	50
Environmental quality	429
Green space, habitats and biodiversity (SDG 15)	1076
Regeneration, land-use and urban development	517
Water management (SDG 6)	510
Cultural heritage and cultural diversity	325
Health and well-being (SDG 3)	679

TUDelft

Witteveen+Bos

Inclusive and effective governance (SDG 16)	211
Social justice, cohesion and equity (SDG 10)	526
Economic development and employment (SDG 8)	326
Sustainable consumption and production (SDG 12)	252

From Table 2 it can be seen that SDG 15 is by far the most mentioned challenge to tackle with NbS, which is not very surprising as biodiversity is mentioned in one of the most used definitions of NbS *(Kooijman et al., 2021)*. Also the combination of SDG 15 and SDG 3 with 656 solutions is important, confirming with the definition of IUCN that states the solution should provide human well-being and biodiversity benefits *(United Nations Environment Programme, 2021b)*. The database from *Urban Nature Atlas (n.d.)* therefore suggests that both biodiversity and human well-being are the most important reasons to opt for a NbS. However, it could be that these are solely added benefits when creating NbS, but not main reasons for choosing NbS.

NbS within cities

With the biggest housing need in the next years being in urban areas, the most applicable projects that could use NbS will be those within cities. Also, cities are said to face issues as poor water, waste, and heat management, with high air pollution, a higher risk from extreme weather events and minimal green space *('What Are Nature-Based Solutions (NBS)?', n.d.)*. This combination results in cities being the most prominent location for future NbS realisation, as their multiple functions within a single NbS can address social, economic and ecological challenges *(Xie & Bulkeley, 2020)*. However, for fitting NbS an important question is to find which NbS are suitable at the desired location *(World Bank, 2021)*. The complex built environment of cities imposes space constraints on possible NbS *(World Bank, 2021)*, however, implementation is still possible and necessary as they can counter local environmental, social and, economic issues that help creating a resilient city *(Randrup et al., 2020; WWF, 2021)*. The *United Nations Environment Programme (2021b)* identifies 6 different types of NbS within cities: large urban parks, street trees, river restoration, sustainable urban drainage systems (SUDS), green roofs, and community gardens. According to *Almassy et al. (2020)*, two more types of NbS exist. Large urban parks are part of the "Parks and (semi)natural urban green areas" solution, street trees are seen as "Urban green areas connected to grey infrastructure", with other examples being railroad banks and house gardens, river restoration is part of the "blue areas", SUDS are "green areas for water management", green roofs are together with green walls part of "Building greens" or nature on buildings, community gardens are mentioned in "allotments and community gardens". Extra are the "green indoor areas" or nature in buildings and the "derelict areas" or intentionally unmanaged areas *(Almassy et al., 2020)*. Figure 9 on the next page illustrates these eight types of NbS.

Blue Infrastructure

This type of NbS includes lakes/ponds, rivers/streams/canals/estuaries, coastlines, wetlands/bogs/fens/marshes and other types of blue infrastructure.

Picture: Sand Motor, Monster, The Netherlands (Ellen Grimbergen, 2020)

Community gardens and allotments

This type of NbS includes allotments, community gardens and horticulture

Picture: Community garden Zuidas, Amsterdam, The Netherlands (Green Business Club Zuidas, 2021)

Green areas for water management

This type of NbS includes rain gardens, swales and filter strips, SUDS and other types of green areas for water management

Picture: Swale, Amsterdam, The Netherlands (Climatescan, 2020)

Grey infrastructure featuring greens

This type of NbS includes alley and street greens, riverbank greens, house gardens, green parking lots, green playgrounds and school grounds

Picture: Street greens, Arnhem, The Netherlands (Arnhem Klimaatbestendig, n.d.)

Nature in buildings

This type of NbS green walls and ceilings, atriums and other types of nature within buildings

Picture: PoppinPark, Amsterdam, The Netherlands (Het Parool, 2016)

Nature on buildings

This type of NbS includes green roofs, green walls and facades and other types of nature on the outside of buildings

Picture: City Hall Venlo, Venlo, The Netherlands (Mostert De Winter, n.d.)

Parks and urban forests

This type of NbS includes large urban parks or forests, pocket parks/neighbourhood green spaces, green corridors and green belts

Picture: Malieveld, The Hague, The Netherlands (Van Leeuwen, 2018)

Intentionally unmanaged areas

This type of NbS includes abandoned spaces with growth of wilderness or greens

Figure 9 Eight types of NbS within cities

2.2.2 Benefits of NbS

The benefits NbS can provide are versatile, with multiple examples already mentioned in previous sections. The most important benefit mentioned is improved biodiversity *(Kooijman et al., 2021; Urban Nature Atlas, n.d.; World Bank, 2021; WWF, 2021; Xie & Bulkeley, 2020)*. This improved biodiversity can be achieved through many ways, where most mentioned quantified benefits are the increased number of different species found in an area *(WWF, 2021)*.

Next to these biodiversity benefits, literature mentioned different co-benefits such as disaster risk reduction, social benefits, water security, carbon storing, providing clean air and green jobs *(Frantzeskaki, 2019; Kooijman et al., 2021; WWF, 2021)*. However, to get an extensive list of all the different benefits NbS can provide, will be difficult. What can be done, is dividing the services they can provide into different categories of services *(Almassy et al., 2018)*. An often-used classification is the TEEB classification which recognizes provisioning services, regulating services, habitat or supporting services and cultural services *(TEEB - The Economics of Ecosystem and Biodiversity, 2011)*. In some frameworks, habitat or supporting services are part of the regulating services *(United Nations et al., 2020)*. These different types of services are all Ecosystem Services (ESS), which is a term used for the benefits people can derive from nature, or as *Randrup et al. (2020)* beautifully described it *"natures gift to us"*.

What remains difficult is to quantify the measures one takes with the use of NbS and to value them with a general framework *(OECD, 2020; Viti et al., 2022; Xie & Bulkeley, 2020)*. Especially the monetary valuation of the benefits NbS can generate is challenging *(Kooijman et al., 2021)*. And although usually NbS are cost-effective, the monetary benefits remain quite invisible *(Kooijman et al., 2021; Randrup et al., 2020)*, and all people can think of are the (in their perception high) investment costs (Figure 10) *(United Nations Environment Programme, 2021b; Van Haaster-de Winter et al., 2020)*.
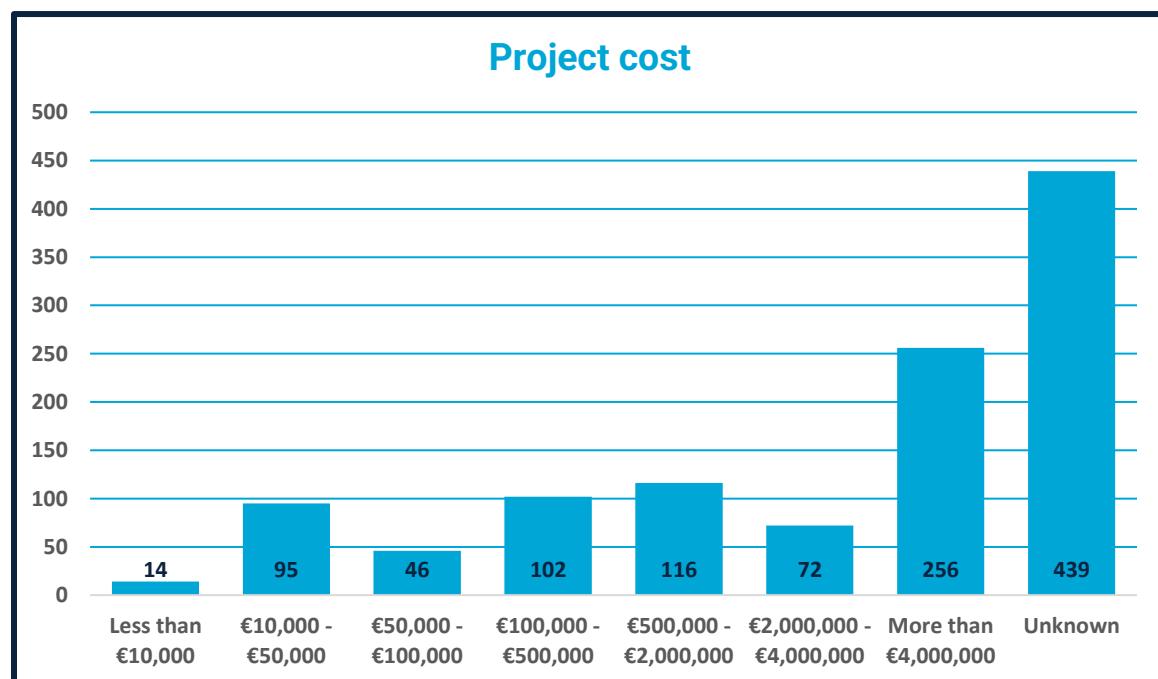
Figure 10 Project costs NbS (Urban Nature Atlas, n.d.)

2.3 Ecosystem Accounting

The line of reasoning van from the UN is that if we can quantify the benefits of NbS, we will remove the barrier *(United Nations Environment Programme, 2022a)*. One of the suggested ways to do this, is by using the Ecosystem Accounting (EA) framework. EA is *"a spatially-based, integrated statistical framework for organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity"* *(United Nations et al., 2020, p. 2)*. Since the benefits of NbS can be expressed in different ecosystem services it is likely that this is indeed a good framework to value NbS.
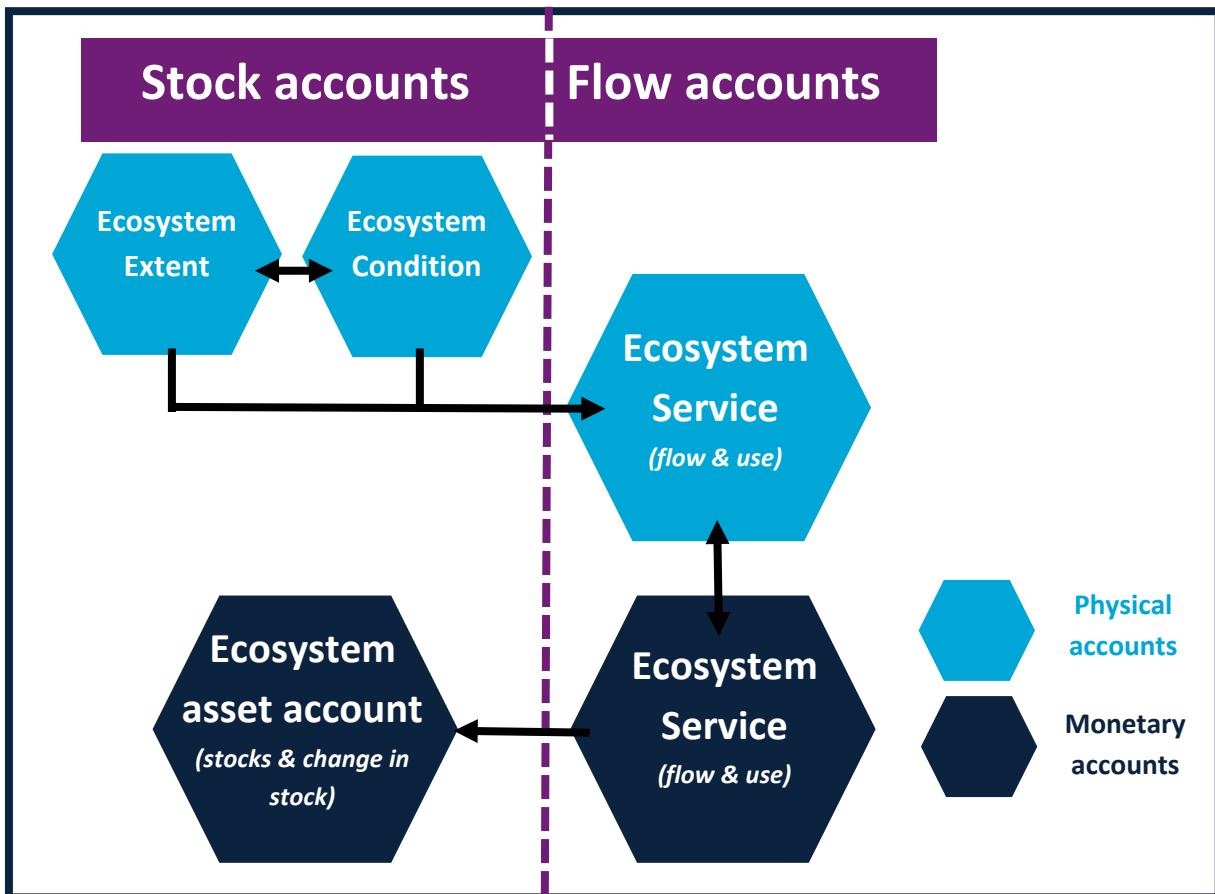
Figure 11 Ecosystem Accounting (adapted from United Nations et al., 2021)

This international framework is created by the UN and part of the System of Environmental Economic Accounting (SEEA). The SEEA is an internationally accepted framework developed by the UN, the EC, the Food and Agriculture Organization of the United Nations (FAOUN), The Organisation for Economic Co-operation and Development (OECD), International Monetary Fund (IMF) and the World Bank Group. It is used to organize and present statistics on the environment and the relation between the environment and the economy and is in line with the system of National Accounts (SNA) *(United Nations, n.d.)*. The first version of EA (SEEA Experimental Ecosystem Accounting or SEEA EEA) was created from 2011 to 2013, where the publishing was used to encourage experimentation with the framework *(Edens et al., 2022)*. The final version was published in 2020 *(United Nations et al., 2020)*. Next to EA, the Central Framework (SEEA CF) is also part of the SEEA *(United Nations et al.,*

2020). To use in the international framework, national accounts for the Netherlands have been created by the CBS *(Statistics Netherlands and WUR, 2021)*.

2.3.1 Steps

One of the questions that can be answered with EA is "what is the contribution of ecosystems and their services to the economy, social well-being, jobs and livelihoods?" *(United Nations, n.d.)*. However, to answer this, the five steps the system entails, must be completed *(United Nations et al., 2020)*. An overview of these steps can be found in Figure 11, the following paragraphs will each focus on one of the hexagons.

Step 1: Ecosystem Extent (physical)
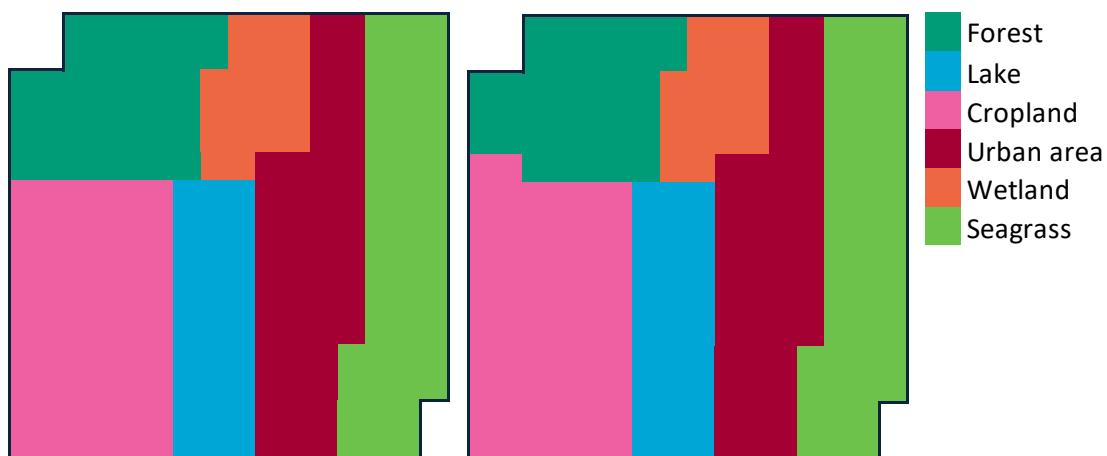
Figure 12 Sample map of ecosystem types on opening (left) and closing (right) (adapted from United Nations et al., 2021)

The first step in EA is dividing the chosen ecosystem accounting area (EAA) in the different ecosystem types and calculating the size of each ecosystem type (ET). An EAA in this case, can be any plot of land, for which one would analyse the status. A simple example of how this can be dived can be found in Figure 12. This figure shows how the sample area is divided on January 1st (left) and December 31st (right) of the same year. This means that in the year between, some area that was classified as a forest, has changed to cropland. It is not necessary to show this in the form of a map, but it can help gain understanding on what is happening in an area. It is often also shown in matrix form as shown in Table 3. When the extent has been monitored for a longer period of time with multiple survey dates, a trend in ecosystem decline or increase could be found. The ETs listed in this example are very generic, where for the Dutch accounts, a list of 50 possible ETs has been used *(CBS, 2022a)*. A full list of all ETs used in Dutch accounts can be found in Appendix B Ecosystem Types.

Table 3 Ecosystem extent account (adapted from: United Nations et al., 2021)

		Closing Extent						**Opening**
		Forest	Lake	Cropland	Urban area	Wetland	Seagrass	
Openin	Forest	38		2				40
	Lake		30					30
	Cropland			60				60

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				50			50
Urban area				50			50
Wetland					20		20
Seagrass						50	50
Closing	38	30	62	50	20	50	250

Step 2: Ecosystem Condition (physical)

The second step within ecosystem accounting is the ecosystem condition account. Here one can find biophysical information on the condition of the different ETs that can be found within the surveyed area. It assesses the quality of the ETs by using different biotic and abiotic characteristics and landscape characteristics *(United Nations et al., 2020)*. To create the ecosystem condition account, multiple sub-steps have to be taken.

First the different characteristics need to be selected. *Czúcz et al. (2021)* created twelve selection criteria to choose the fitting characteristics. This was divided into three categories: conceptual criteria, practical criteria and ensemble criteria. The first category assures that the characteristics are relevant for the purpose of measuring those characteristics, the practical criteria help in finding the right metrics to quantify a relevant characteristic. The last group of criteria, the ensemble criteria, make sure that the chosen group of characteristics is meaningful.

Once the characteristics have been found, they are listed for both their opening and closing value, and the change per characteristic is calculated. An example of how this can look is shown in Table 4. Her one can see that the imperviousness of the area and the NO_2 concentration has increased, while the number of different birds and the percentage of tree cover has been reduced. This indicates that the condition of the ecosystem has declined in the year *(United Nations et al., 2021)*.

Table 4 Condition stage step 1 (Adapted from: United Nations et al., 2021)

Urban area		**Variable descriptor**	**Measurement unit**	**Variable values**		
				Opening	**Closing**	**Change**
Abiotic characteristics	Physical state	Imperviousness (soil sealed per area)	%	55	57	2
	Chemical state	NO_2 concentration	Ug/m^3	10,5	12,3	1,8
Biotic characteristic	Compositional state	Bird species richness	Number per sampling day	53	45	-8
	Structural state	Tree cover	%	31	30	-1
	Functional state	*No variable selected*				
Landscape characteristics	Landscape mosaic	Share of dominant natural land types in the surrounding	%	56	52	-1

To make sense of the values per characteristics, a lower and upper reference level need to be set. Because how bad is the increase in NO_2 condition really? How these reference levels are set, depends on multiple factors. According to the United Nations, there are five possible reference conditions: undisturbed or minimally-disturbed condition, historical condition, least disturbed condition, contemporary condition and best-attainable condition *(United Nations et al., 2020)*. For natural ecosystems, where the main influence on the system comes from natural processes, the first four reference conditions can be used. The best-attainable condition will not make sense, as this implies human interference and therefore will change the ET to an anthropogenic one. For anthropogenic ETs, the opposite holds, here the undisturbed or minimally-disturbed condition cannot be used, as an anthropogenic ET by definition is mainly influenced by human activities. To calculate the reference levels (once the right type has been selected), seven possible methods are mentioned. In Table 5, the possible combinations of methods and levels can be found. A combination of different methods can also be used, for example, first using reference sites and validating these findings with help of experts.

Table 5 Methods for determining reference conditions (United Nations et al., 2020)

Reference condition	Undisturbed or minimally disturbed condition	Historical condition	Least disturbed condition	Contemporary condition	Best-attainable condition
	Natural Ecosystems				
		Anthropogenic ecosystems			
Reference sites	X	X	X	X	
Modelled reference conditions	X	X	X		X
Statistical approaches based on ambient distributions			X		X
Historical observations and paleo-environmental data		X			
Contemporary data				X	
Prescribed levels					X
Expert Opinion	X		X		x

Since the method for finding the right reference levels differs per ET, the value of the refence level can also be different per ET. This means that for a forest the upper level for tree cover (the highest possible value), can be higher than that level in an urban area.

With the reference level per characteristic clear, the opening and closing values can be scaled and the relative change calculated. The relative change indicates how much the change impacts the condition of the ET.

The last sub-step of the condition account, gives weight to the different characteristics. Usually, the characteristics are divided into 3 classes: Abiotic characteristics (with sub-classes physical state and chemical state), biotic characteristics (with sub-classes compositional state, structural state and functional state) and landscape/seascape characteristics. According to *United Nations et al. (2020)* each sub-class receives a weight of 0,16/0,17. If multiple characteristics per sub-class have been used, the weight will be distributed evenly of these characteristics. In the first version of the Dutch accounts, this step has not been executed, all characteristics carry equal weight *(CBS, 2022a)*.

Step 3: Ecosystem Service (physical)

The next step in EA is calculating the physical values of the different ecosystem services (ESS) an ecosystem can provide. The classification of ES used within EA is based on the TEEB framework, with the difference that habitat and support services are part of the regulating and maintenance services *(TEEB – The Economics of Ecosystem and Biodiversity, 2011; United Nations et al., 2020)*. The definitions used by the UN and examples of those services can be found in Table 6. Within the white paper from *United Nations et al. (2020)*, thirty-three different services are mentioned. This list is not exhaustive, as currently each category also holds an "other services" line which indicates that the scholars that wrote the white paper do not think the list is complete.

Table 6 Types of ecosystem services

Type of ecosystem services	Definition by *United Nations et al. (2020, p. 130)*	Examples *(Almassy et al., 10`8; Atanasova et al., 2021; TEEB – The Economics of Ecosystem and biodiversity, 2011; United Nations et al., 2020)*
Provision services	"… ecosystem services representing the contributions to benefits that are extracted or harvested from ecosystems"	• Provisioning of raw materials such as wood • Provisioning of food such as crops
Regulating and maintenance services	"… ecosystem services resulting from the ability of ecosystems to regulate biological processes and to influence climate, hydrological and biochemical cycles, and thereby maintain environmental conditions beneficial to individuals and society"	• Local climate regulation • Wastewater treatment with microbiological processes
Cultural services	" experiential and intangible services related to the perceived or actual qualities of ecosystems whose existence and functioning contributes to a range of cultural benefits"	• Recreation • Tourism • Mental and physical health • Spiritual experience

For the Dutch accounts, in total 16 services are identified. For provisioning services, *CBS (2022a)* identifies crop provisioning services, fodder and grazed biomass provisioning services and wood provision services. For regulating services those identified are water purification services, carbon

sequestration, pollination, air filtration, coastal protection, protection against flooding due to heavy rainfall and local climate regulation. Lastly for cultural services the three identified services are nature recreation, nature tourism and amenity services *(Horlings et al., 2020)*. The choice for these was made after careful deliberation, also depending on the availability of data *(Hein et al., 2020; United Nations et al., 2020)*.

In this third step, the ecosystem services are measured as a physical flow and not yet in monetary units. For the crop provisioning service, it is measured in the weight of the crops and for local climate regulation in the reduction in temperature *(CBS, 2022a; United Nations et al., 2020)*. The top of Table 7 shows this for the non-Dutch service "Global climate regulation" which is measured in tonnes CO_2 and the recreation service which is measured in number of visits. On the opening and closing date (which are the same dates used in the previous steps), the flow of tonnes CO_2 remained constant, but the number of recreational visits has increased. This means that for the physical account the global climate regulation service has not increased nor decrease, but that the recreational services have increase.

Table 7 Ecosystem service and asset accounts (Adapted from: United Nations et al., 2021)

Urban Area		Opening value (January 1st, 2020)	Closing value (December 31st, 2020)
Expected Physical Flows	Global climate regulations (tonnes CO_2)	5	5
	Recreation-related services (# visits)	2.400	2.600
Prices	Global climate regulations	€25,-	€26,-
	Recreation-related services	€5,-	€5,-
Exchange values	Global climate regulations	€125,-	€130,-
	Recreation-related services	€12.000,-	€13.000,-
	Total	€12.125,-	€13.130,-
Net present Value	Global climate regulations	€5.387,29	€5.602,79
	Recreation-related services	€517.180,22	€560.278,57
	Total	€522.576,51	€565.881,36
Change in NPV			**€43.313,84**
Assumptions	Asset life (in years)	100	100
	Discount rate	2%	2%

Step 4: Ecosystem Service (monetary)

Step four within EA recalculates the values for the ES from physical to monetary units. Different techniques for valuing the ecosystem services are mentioned in the white paper on EA including but not limited to, directly observing values of ESS or retrieving prices from similar markets, resource rent method, productivity change methods and hedonic pricing *(United Nations et al., 2020)*. For

eight Dutch services, the best valuation model was determined by *Horlings et al. (2020)*, the results from this can be found in Table 8. Stated preference approaches were not found as a best method for a single type of ESS, but it was recognised that those approaches are relevant when used in public policy decision making *(Horlings et al., 2020)*.

Table 8 Best valuation methods (Statistics Netherlands and WUR, 2021)

Ecosystem Service	Valuation Method
Crop production	Rental price
Timber production	Stumpage price
Water filtration	Replacement costs
Air filtration	Avoided damage costs: Maximum Societal Revenue - Value Of a statistical Live Year (MSR-VOLY)
Carbon sequestration	Avoided damage costs: carbon price
Nature recreation	Consumer expenditure
Nature tourism	Consumer expenditure
Amenity Services	Hedonic pricing model

The valuation of an ESS will be done by determining the value of a single unit of the services mentioned in the previous paragraph. When the service "Global climate regulation" is measured in tonnes of CO_2, the valuation method will determine the monetary value of a single tonne of CO_2. This means that the value for one tonne CO_2 will not differ for the different ETs in which the service is found *(United Nations et al., 2020)*. In Table 7 this can be seen in the lines called "prices". The total value of a single ESS will be the product of the monetary value per unit and the size of the ESS flow *(United Nations et al., 2021)*, the result thereof can be found again in Table 7 in the lines called "Exchange values". In this line one sees that the total value for the Global climate regulation service is €130, which is the amount of tonnes CO_2 (5), multiplied by the price per tonne of €26.

Step 5: Ecosystem Asset Account (monetary)

The last step in calculating the value of the ecosystem assets, is "simply" calculating the Net Present Value (NPV) of the different ecosystem services *(Statistics Netherlands and WUR, 2021; United Nations et al., 2020; United Nations et al., 2021)*. The formula for calculating the NPV can be found in Equation 1, here it shows that the NPV is the sum of all future exchange values R (in €) divided by 1 plus the discount rate i, to the power of the lifespan t (in years). For the sample area, this can be seen in Table 7. To calculate the NPV, not only the values of the ESS need to be known (R), but also the discount rate (i) and life span (t). For the Dutch accounts, assumptions are made for these numbers: the life span is assumed to be 100 years and the discount rate 2% or 3% depending on the ESS *(Horlings et al., 2020)*. For both recreation and carbon sequestration this is 2%, but it will decline after 30 years to 1,5% and the last 25 years to 1% *(Statistics Netherlands and WUR, 2021)*.

Equation 1 Net Present Value calculation

$$NPV = \sum_{t=0}^{n} \frac{R_t}{(1+i)^t}$$

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Table 7 on the previous page shows the results of the sample area from Figure 12 in the urban areas, but this is only a partial result. Because changes have also happened in the other ETs. If the calculations done in the ecosystem condition and ecosystem service accounts will be repeated for all ETs, the total asset value of the ecosystem can be computed by calculating all the different NPVs. Although it can be interesting to see the combined NPV of an ecosystem, this cannot be seen as the total worth of the ecosystem. The true value of an ecosystem will incorporate many more ESS than one can reasonably assess, meaning that the "true" value of an ecosystem will be higher than it is valued in EA. However, comparing the value of ESS from different years can show a trend in either increase of decline of an ecosystem *(Remme et al., 2015; United Nations et al., 2020)*. Also comparing the aggregated (local) ESS with (local) GDP can show how much nature attributes to this *(Horlings et al., 2020)*.

2.3.2 Use of EA

The potential use of EA is diverse, and new applications will emerge in the next years. In the revision period of the Experimental EA, the UN identified seven global applications and uses for the frame work *(United Nations, Department of Economic and Social Affairs, 2019)*:

- Detailed spatial information on ecosystem services supply
- Monitoring the status of ecosystem assets
- Highlighting the ecosystem assets, ecosystem types and ecosystem services of concern to policymakers
- Monitoring the status of biodiversity and indicating specific areas or facets of biodiversity under threat
- Quick response to information needs
- Monitoring the effectiveness of various policies
- Use in economic and financial decision-making

Practically most of these applications come down to helping assess whether or not certain sustainable policy goals are being met and if certain interventions help in reaching the policy goals *(Edens et al., 2022)*. Possible applications for these policies are within spatial planning and for water authorities *(Edens et al., 2022; Remme et al., 2015)*. Next to policy applications, it can also help identifying or choosing sustainable investments *(Vysna et al., 2021)*, or determining compensation and damage claims *(Horlings et al., 2020)*.

Policy applications

Policy making is a cycle process that exists of five steps: identification, formulation, decision making, implementation and evaluation *(United Nations, 2021)*. First the issue(s) need(s) to be identified and the agenda needs to be set. Thereafter a goal will be set, and a fitting policy to reach this goal will be formulated. Once this is done, the decision will be made to adopt the policy, whereafter it will be implemented. Lastly the issue will be monitored and evaluated. For the analysis of (possible) policies, different scenarios can be used: exploratory scenarios (where different future outputs are analysed), target seeking scenarios (where different scenarios will be analysed that all reach the same goal), policy screening scenarios (where the best policy for reaching a goal will be sought), and lastly the retrospective policy evaluation (where the chosen policy will be evaluated and the expected result will be compared to reality). EA can be used in all four types of policy assessments, as it allows for mathematical simulation models for all scenarios *(United Nations et al, 2020)*. With retrospective

evaluation, an issue can be identified such as a decline in the condition of an ecosystem, while exploratory scenarios can identify future issues if the current policy on the specific ecosystem will continue. Target-seeking and policy-screening scenarios can be used comparing different policies and to formulate and implement the best policy *(United Nations, 2021)*.
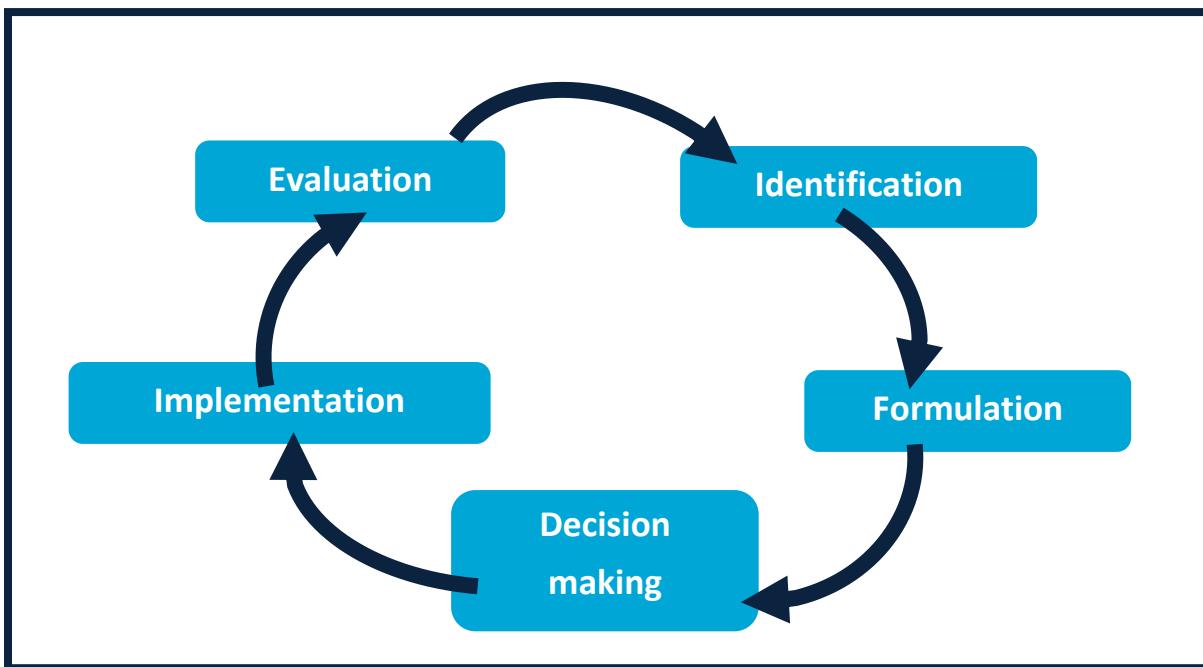
Figure 13 Policy cycle (Adapted from United Nations, 2021)

Practical applications

In the Netherlands several different (experimental) uses of EA have taken place. The first uses of the experimental version of EA, focused on showing that EA can be applied to value ESS in the Netherlands. A study in Limburg showed that the average value per hectare for the calculated ESS (crop production, fodder production, drinking water extraction, air quality regulation, carbon sequestration, nature tourism, and hunting) was €508,- *(Remme et al., 2015)*. The first use of EA in the whole country helped developing a peat management strategy *(Hein et al., 2020)*. For Amsterdam the "Groene baten planner" (green benefits planner), was used to assess 4 different scenario's and compare those to the Business As Usual-scenario (BAU-schenario). The Groene baten was used to assess which location types would be best-suited for more green (local green in the centre and green roofs, a green network of bike and pedestrian routes, city parks or metropolitan parks). The planner calculated the options using EA *(Centraal Bureau voor de Statistiek, 2021; RIVM, n.d.)*, where the first scenario created the most benefits. Internationally accounts for EA have also been set up. In Guatemala the use of EA showed that the contribution their forests have on their total economy is higher than they expected. Combined with illegal deforestation, this lead to a new policy regarding forest protection. Afterwards the country also generally opted for more data-driven decision making, as was now done based on EA *(Warnell et al., 2020)*.

2.4 Key findings

Concluding, a few important take-aways from the literature study. Due to the multiple crises that exist, the Dutch construction sector needs to be more aware of the impact their work has on both the environment and the liveability of cities. To create more sustainable solutions, one of two routes have to be followed within the procurement process. The client can push sustainable innovation by

setting high sustainable requirements or minimum criteria which the contractor needs to follow. If the client does not have the necessary knowledge themselves, they can also stimulate the contractors to innovate by setting sustainable MEAT-criteria. With the MEAT-criteria on sustainability the different contractors can distinguish themselves from others by creating more sustainable solutions which leads to a higher fictional discount and a higher chance at winning the contract. To ensure that the solutions improve the liveability after completion of the project, it is best to set criteria on the exact solution and not only on the execution. Using MEAT-criteria to create more sustainable solutions can only be done in integrated contracts when the contractor has enough design freedom to actually integrate their sustainable ambition in the solution. Since with traditional contracts the designs have already been finalised before procurement, only MEAT-criteria for the execution can be used.

An example of a sustainable solution are NbS. A NbS is a solution in which nature is incorporated in the design to not only solve the practical problem, but to also increase biodiversity and improve human well-being. This opposed to traditional grey solutions that only has to fulfil its main purpose. There's a common misperception that NbS are more expensive than grey solutions, which is mainly because the benefits they can bring are currently not valued. These benefits are the improvement of different ESS. To see how much an NbS actually improves an ecosystem, the ESS should be given a (monetary) value.

EA is a framework that links ecosystems to human and economic activities. The framework exists of five steps that can be either implemented completely or only partially. The frameworks has been used mostly in experimental settings showing that it can be used to value ESS. However in the Netherlands it has been used to assess four different scenarios in Amsterdam for best-placement of new green areas.

3 METHODOLOGY

This chapter introduces the methodology for the analysis of the stakeholder interviews. The goal for this research section was to find which themes are found to be most important when making design choices, to answer SQ3. The Dutch construction sector has multiple types of contracts in which different degrees of design freedom exist. The result thereof is a sector in which multiple organisations can make decisions that impact the final project and the use of NbS. In order to create a framework that can be used during the procurement process to stimulate the use of NbS, it should assess the themes that all different organisations find important. To analyse these multiple perspectives a qualitative approach was used *(Lanka et al., 2021)*.

3.1 Data gathering

Data was gathered by doing four semi-structured stakeholder interviews. Semi-structured interviews were chosen since they give the flexibility to further question on different topics that come up during the interview, while at the same time not losing track of the central thread of the interview. The central thread of the interview were three blocks with questions related to the same theme: choice for NbS, tendering phase, and control phase. With the nature of the interviews being semi-structured, the order in which the questions within a question block were asked, could be rearranged during the interview. To assure that the question will help answer SQ3 and create the framework, the interview protocol was reviewed by several supervisors and where necessary improved.

To be able to have a complete picture of views of stakeholders, stakeholders with different backgrounds were being interviews. A stakeholder in this study is seen as a person or group of people that have influence on the procurement phase. The three main parties from which people can have this influence are: client, contractor, and advisory/engineering company. The client since they will procure the project, the contractor as they try to acquire the project and the advisory/engineering firm since they can support one of both parties in procurement. In total four stakeholders were interviewed, one from the client side, one from the contractors perspective and two associated to an advisory/engineering firm.

To avoid the recognition of any of the interviewees they have all received a number and are mentioned using gender-neutral pronouns. This means that if later in this thesis a certain quote is labelled as 1.4 it is the fourth quote of the first stakeholder. Table 9 shows the number of the stakeholder and their associated party.

Table 9 Interviewees stakeholder interviews

Stakeholder	Associated party	Function
1	Advisory/Engineering company	Advisor contracting and tendering
2	Advisory/Engineering company	Advisor contracting and tendering
3	Client	Project- and contract manager and advisor sustainability
4	Contractor	Advisor sustainability

Both stakeholder 1 and stakeholder 2 work as an advisor contracting and tendering, where they are involved in project design. Stakeholder 3 currently works for the client as both a project and contract

manager and as an advisor on sustainability. They have previous experience for another client and for an advisory company in the same functions. Stakeholder 4 has a lot of experience in the different parties involved in the Dutch construction sector. They are interviewed specifically about their experience on the contractor side where they worked as an advisory sustainability, but they also have experience with industry associations and knowledge platforms about the Dutch construction sector and NbS.

The interviews were held on different days and times in December 2022 and January 2023, based on the availability of the stakeholders. Interviews took place either through teams while recording both audio and video, or in real life while recording only audio. Through both types of interviews, notes were taken, to identify statements that require further questioning and to kickstart the analysis by identifying important statements. Several days before the interviews, the protocol was send to the stakeholders, giving them time to prepare for the interview. The full interview protocols can be found in Appendix C to Appendix E. Together with the interview protocol the stakeholders received an informed consent form (Appendix F), to make them aware of was going to happen with the information from the interviews. All interviews started with an introduction of the researcher and the topic after which the stakeholder was asked to introduce themselves. Thereafter the three blocks of questions were asked. The interview ended with an open invitation for the stakeholder to add thing that had not been touched upon earlier.

3.2 Analysis

As mentioned the goal for the interviews was to find out how the framework of EA should be shaped and what the contents should be, to assure that it can be effectively used. To analyse this, the grounded theory approach is used. This approach can be used when a theory needs to be built based on qualitative data opposed to testing a theory or hypothesis *(Khan, 2014)*. Since there is no pre-established theory about which themes are found to be important by stakeholders that needs to be proven, the coding of the interviews was done inductively and iterative. This meant that in multiple rounds the code system was created. To ensure validity of the analysis, (scientific and grey) literature will be used to strengthen conclusions drawn from the interviews.

The first two rounds of coding had a different focus point for the analysis. During the first the focus was on the reasons why one would have an ambition for NbS. Whenever a stakeholder mentioned such a reason, that quote was labelled with a general code. For example, when a stakeholder says they wanted to do increase the number of different plants used, that quote was labelled as 'Biodiversity'. In the second round, the focus was on things that need to be done or changed in the current processes in order to create more NbS. Again a general code would be put on this quote. After the initial two rounds of coding, the interviews and codes would be reread to rename certain codes to either more specific or more general codes. The code 'Biodiversity' turned out to be too general and a division was made between 'Flora' and 'Fauna'. This would therefore change the label on the previous 'Biodiversity' quote to 'Flora' as it specifically focusses on the variety of plant species. An overview of all relevant quotes from the stakeholder analysis can be found in Appendix I.

When this was done for multiple rounds, the codes were all written down to create a scheme of the different codes. The codes were divided in two categories, depending on whether they applied to the form or the contents of the framework. Within these categories, further subdivision was made.

4 RESULTS ON STAKEHOLDER INTERVIEWS

This chapter focusses on the results of the stakeholder interview analysis. As explained in the previous chapter, multiple rounds of coding were done before the final coding scheme was established. The codes were combined into two different code themes: contents and shape. An overview of the final coding scheme can be found in Table 10.

4.1 Contents

All the codes belonging to this code theme, are possible answers to SQ3 as they are reasons for organizations not to choose for a grey solution. The code theme is referred to as contents, because in a later stage of the research, the detailed contents of the framework were based on these codes.

During the analysis 5 types of themes were found: sustainability, biodiversity, climate adaptation, health & wellbeing and aesthetic value.

4.1.1 Sustainability

With the code sustainability ways of meeting todays needs without compromising the needs of the future is meant. Sustainability is an umbrella term that includes many different things. Stakeholder 4 illustrated this by saying that *"NbS is more the green direction of sustainability, while much more often the grey technical side of sustainability is looked at" [quote 4.33]*. The grey technical side of sustainability that they mentioned has resulted in two specific codes: Energy Consumption and Material Use. Energy Consumption is *"largely CO2 emission reduction…" [quote 3.13]*, which stakeholder 3 mentions as the most used MEAT-criterium for sustainability *[quote 3.13]*. Stakeholder 4 adds to this by saying that *"… you can do something with electric and zero emission transport or something like that, but you actually have very few options" [quote 4.35]*.

Stakeholder 3 explained what is included in the code material use when they said *"We are doing the maximum requirements on MKIs for concrete, we are specifying minimum percentages for reused material more, we only had a base number at first" [quote 2.30]*. In this quote they illustrated both sub-codes for material use: circularity and MKI. In total the code Material Use was used on 25 different quotes

4.1.2 Biodiversity

The theme of biodiversity (variety of species) is a hot topic these days in construction, but it is not already incorporated in everyone's work. Stakeholder 1 illustrated this by saying *"But what I come across most is still the flat, technical content, like we need to have a project and oh yes, we still have to do something with biodiversity" [quote 1.48]*. Also others expressed their desire to do more with biodiversity *"and I would like to focus a bit more on biodiversity myself, and how we can include that as standard in our contracts" [quote 2.4]*. This difficulty with biodiversity could be related to the fact that often people prefer to have measurable indicators in their project and they do not know how to do measure things related to biodiversity. Stakeholder 3 talked about the difference between the theme of sustainability and biodiversity and explained that *"…with DuBoCalc and MKI with CO2, there is clearly something to measure, which is often difficult for biodiversity" [quote 3.37]*.

The term biodiversity relates to both the variety of plant species together with the variety of animal species. Both these terms were therefore created as a code within the theme biodiversity. However, the twice as much stakeholders referred to biodiversity related to Flora (30 times) compared to a variety of animals, as Fauna was only mentioned 14 times. More importantly, not once was a quote

labels Fauna, without also being labelled as Flora and only stakeholder 4 explicitly includes animals in his quotes *[quote 4.21. quote 4.34 and quote 4.65]*, while others use more vague terms as in *quote 3.10: "Then the distinction is less distinguishable, you already have to go into more detail, is there or is there not water, is there or is there not dead wood, is there or is there not gradient, is there or is there not the possibility of increasing species richness…"*.

4.1.3   Climate adaptation

As third theme climate adaptation emerged in the analysis, *"I already mentioned the question of climate adaptation, which is one that does last, including at the urban planning level" [quote 4.62]*. With this theme different ways of dealing with climate change are meant. In the interviews, two different areas of climate adaptation were uncovered, both mentioned by stakeholder 4 in the same quote: *What measures can you do to have less temperature fluctuations in the neighbourhood, that it gets less hot, and can you do something about water management? [quote 4.45]*. The two areas within climate adaptation are therefore referred to as water, which was found 10 times and temperature, with 9 mentions.

Water management has two sub-codes. The first one being drainage *"it happens now that people come to live here and they largely empty their garden and tile it and then the next moment they are surprised to find that they have water problems"[quote 4.47]*. The second sub-code is retention, which talks about keeping the water in the soil after it has rained to avoid drought in dryer periods.

With the temperature rises due to climate change, problems with heath can occur both outside and inside. To be able to distinguish both problems, the sub-codes inside and outside were created. The creation of shadow by trees in front of a building, can prevent sun from heating up the inside of that building *[quote 4.13]*, Where as a green roof, can help temperature fluctuations outside *[quote 4.37]*.

4.1.4   Health & Wellbeing

The fourth theme that was found in the interviews was health & wellbeing. Stakeholder 4 mentioned it as a positive benefit from an area with more green, they stated *"those returns you get back [on an area with more green], that people are healthier…" [quote 4.55]*. And although they think it is one of the most difficult things to ask for in a procurement process *[quote 4.39]*, they do mention studies that have shown this positive effect *[quote 4.56]*, and international examples of how to do this *"you do have the well-standard for well-buildings, from America, so you can do something with that. But that is still very rarely applied or asked for" [quote 4.20]*. References to health & wellbeing were made eight times.

4.1.5   Aesthetic value

With nine mentions, the last theme that came from the stakeholder interviews was the theme aesthetic value. Aesthetic value is the appreciation of how an area looks. According to stakeholder 4 it is important for clients to have be an attractive or appealing municipality to live in *[quote 4.58]*. However, stakeholder 3 mentions that this can potentially clash with other themes. They illustrate this by saying that *"the architects working on infrastructure, they like a nice avenue of trees and not an avenue with an ash and an oak and everything mixed together or sets together. They just want a clean line" [quote 3.30]* and *"at that stage, it is often the landscape architects who go for beautiful rather than bio-diverse and the architects who also go for beautiful rather than beautiful with a twist so you come up with more opportunities [quote 3.18]*.

4.2 Shape

The second code theme from the stakeholder interviews was shape. All themes and codes within shape say something about the requirements for EA to help stimulate the use of NbS. These requirements are divided into four themes: pricing, cooperation, parties and attention.

4.2.1 Pricing

For a construction project, the price is always important, but the price of a solution can be determined through multiple options. During the stakeholder interviews, two different pricing methods were mentions, pricing based on the investment costs and based on the life cycle costs. When looking only at the investment costs of a project, one looks at the initial costs of a solution, up to and including the construction. But after a project has been finished, costs can also occur due to maintenance or demolition. When these costs are included as well, one looks at the life cycle costs, or all costs made during the life span of a solution. Stakeholder 4 illustrated why it is important to look at both type of costs with an example: *"The roof overhang of a building has disappeared for years, because it saved material to make a roof that only comes up to the façade. But if you start looking at the maintenance or maintenance needs of what such a building needs, with that kind of construction, you are bound to have problems with the façade, especially on the south-west side"* [quote 4.54]. Here they show that although it may seem cheaper to not build a building with a roof overhang, because you spend less on material, it may cost more on the long run due to extra maintenance costs, as the roof overhang can also protect a façade from environmental effects. However, looking at both types can still be difficult in practice as *"the combination of realisation and maintenance, which are different departments at a client and are therefore also different pots of money, and to bring the two together, that is already quite a task" [quote 1.45]*. More frequent use of investment costs in projects is also reflected in the number of times this code has been applied compared to the use and application of the life cycle costs. Where the code investment costs was used 15 times throughout the interviews, the life cycle costs were mentioned only nine times.

4.2.2 Cooperation

Where a project is being undertaken, different parties work together to create a solution. However, the way these parties interact and what type of agreements they have, can influence what solution will be created. This resulted in the created of the theme cooperation. Which includes different aspects of the way different parties work together.

The first code used for the cooperation was the code integral with 22 mentions. With integral it was meant that a project is not split up in different phases or departments and that people only look at their own phase or department, but that there is cooperation between the different sections *"…it is incredibly important that you work as a team in this" [quote 4.40]*. This relates also back to the difficulty in using life cycle costs for a project as stakeholder 1 illustrated with *quote 1.45*. Here they state that due to the division between realisation and maintenance, the use of life cycle costs is difficult, although they do prefer to use this integral pricing method. According to stakeholder 4, the most integral way to work together and to create the best or most sustainable solutions is by using a bouwteam *[quote 4.10]*.

A bouwteam is a special form of cooperation, with its own contract form where the design is created in cooperation between client and contractor. In this contract form, both parties can use their specialized knowledge to create the best solution. Other contract forms include the traditional

contract where the design is solely made (or commissioned by) by the client, or the integrated contract where a general solution is created by the client but with room for design choices by the contractor. During the interviews, 18 times a stakeholder referred to the contract type and how this could influence the final solution of a project. In the more traditional contract, the only way for a contractor to create a more sustainable solution lies *"mainly in your equipment and how you are going to build it" [quote 1.53]*, while in an integrated contract *"the contractor can really let go and then they can show nice different things" [quote 1.2]*. Stakeholder 2 elaborates on this by stating that *"with more design freedom for the contractor, because then you say he knows more about it, he can actually come up with ideas we haven't thought of"[quote 2.21]*.

Apart from the an integral cooperation that is written down in the right contract form, the last aspect of cooperation is the financial incentive to do the right thing, or the bonus/penalty regulations. This code has been split up in the bonus regulation of a fictional discount for quality MEAT-plans and the fine for contractors when they do not meet requirements as specified in the contract. Both sub-codes are mentioned 9 times. These codes are included in the cooperation theme, as they have strong relations with the contract type code. Stakeholder one explained that the fictional discount on the design can only happen in more integrated contract forms as *"The more room there is for bidders to come up with and propose a solution, the more you can differentiate it" [quote 1.8]* which will result in a fictional discount that influences which bid will win a tender *[quote 1.9]*. He then went on to explain that all promises made to receive a fictional discount and to win a project, will be translated into requirements in the contract and that *"If you don't deliver what you promised, you do get fined in hard euros and usually it is also 1.5 times the benefit you achieved, so it can be quite expensive" [quote 1.10]*. Stakeholder 2 also explained that although the client has the right to fine a contractor, this does not always happen as *"it is not much use to the client either, his goal is not to collect money and get rich from the project. He wants sustainable solutions to be realised"[quote 2.29]*.

4.2.3   Parties

The third theme that emerged in the stakeholder interviews was parties, within this theme the different parties that should be able to have their viewpoints be included in the decision regarding the final solution. The first decisions are often made by the client, as they procure the project in such a way, that certain decisions have been made. For example, they can specifically ask for a sustainable solution by specifying that in the requirements *[quote 1.24]*. But with more integrated contracts, a lot of space for design choices also lies with the contractor *[quote 3.16]*. Specific knowledge about NbS lies with other parties according to stakeholder 4: *"that [knowledge] is with designers, with architects, with engineers, with ecologists, with biologists" [quote 4.59]*. Knowledge about more innovative solutions can also come from advisory or engineering firms *[quote 4.26]*. In total 5 different parties were used as code in the final coding scheme. The client was referred to 24 times and the contractor 20, advisory or engineering firms were mentioned 18 times, architects 10 and ecologists 5 times. Biologists and designers as mentioned in *quote 4.59*, were not included as those were the only times these parties were mentioned. Next to the limited mentions, ecologists are a type of biologists, and architects a type of designer, meaning that mentioning both would lead to overlap in codes.

4.2.4 Attention

The last theme that was created after analysing the interviews was attention, or more specifically the moments during a project where the goal for a NbS should be made explicit. Stakeholder 3 summarized this as *"so it is mainly securing [your initial ambitions] in all phases of your project life"* *[quote 3.9]*, but 3 different codes were created that talk about the different moments.

Three out of four stakeholders explicitly agree that in the early stages of a project an ambition for NbS should be formulated*, "…that is definitely where the most profit can be made…"[quote 1.41]*, because *"…how sustainable you can make it, if you start early you can still go either way. But if you have already made choices in the first phase, you can only achieve limited results" [quote 2.19]*. However, with just creating an ambition for a NbS, one does not automatically receive a NbS in the final solution. Stakeholder 3 explained that in early session to create the ambition (ambition web sessions or in Dutch: ambitiewebsessies) nice plans can be formulated but that the risks exists that *"… the result of such a session ends up in a folder somewhere and if you are lucky, something is done with it in the contract phase and then it stops" [quote 3.43]*. In total the code ambition was used 18 times.

The second phase in which attention for the NbS should exists is the call for tenders. This code was also used 18 times and refers to the moment when parties are given the opportunity to join in the tender. This can be either in the form of a requirement or as a MEAT-criterium. Stakeholder 3 explains how this they do this as a client *"We have an implementation framework for innovation and sustainability in infrastructure projects. First, it describes how we want to work with the "ambitieweb" and how we want to deal with the sustainability award criterion. Basically, we award between 60 and 100% on quality, and of that amount, on average 50% is sustainability, with a small variation depending on the freedom in the contract" [quote 3.26]*. By doing this almost every time they explain that this automatically results in tender teams with more experience in sustainability *[quote 3.44]*. By creating a more sustainable design contractors will receive a higher fictional discount and have a higher change of winning the contract.

To assure that the promises made in a tender, will also end up in the final solution, those promises are translated into requirements, but those have to be verified. This verification process is necessary because if one does not do this, it can result in a situation where *"…the ones who promised the nicest things, they get the most points and nothing is ever done with them" [quote 1.7]*. Multiple reasons were mentioned why this verification process is not always flawless, according to stakeholder 3, not all the necessary documents to check all the plans are asked in this phase *[quote 3.34]*. The fact that often different teams are responsible for the control, was also mentioned *[quote 1.12]* together with the fact that the control on specific parts is sometimes simply forgotten *[quote 1.38]*. In total the code control phase, that was used for this phase, came up 23 times.

Table 10 Explanation and coding scheme stakeholder interviews. First column shows the third-order codes, in the second column the second- order codes are shown and the third column shows the first-order codes. The number in the brackets shows the amount of times this code was found. Some codes have sub-codes, these are in italics in the explanation of the first-order codes

| **Contents**: Reasons for parties not to choose for a grey option | **Sustainability**: meeting todays needs without compromising the needs of the future | **Energy Consumption** *(21)*: conscious use of energy |
| | | **Material Use***(25)*: conscious use of materials. Subdivided in reuse of materials to improve |

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		circularity and use of materials with low environmental costs measured with *MKI*
	Biodiversity: variety of species	**Flora** *(30)*: variety of plant species
		Fauna *(14)*: variety of animal species
	Climate adaptation: ways of dealing with climate change	**Water** *(10)*: ways to deal with (potential) flooding and drought. Subdivided in *drainage* and *retention*
		Temperature *(9)*: ways to deal with (potential) heat problems. Subdivided in managing temperature *inside* and managing urban *heat islands*.
	Health & wellbeing *(8)*: positive influence of a green area layout	-
	Aesthetic value *(9)*: appreciation of an area layout	-
Shape: requirements for the framework to be effective	**Pricing**: different methods of determining the value of a solution	**Investment costs** *(15)*: Initial costs needed for only constructing the solution
		Life cycle costs *(9)*: all costs incurred during the solutions life span
	Cooperation: important aspects of the way the different parties work together	**Integral** *(22)*: cooperation during different project phases with the same individuals
		Bonus/penalty: financial incentives subdivided in *fictional discount (9)* for quality MEAT-plans and *fine (9)* when requirements are not met
		Contract type *(18)*: depending on the necessary design freedom for the contractor, a different contract can be chosen
	Parties: people with different viewpoints that should be included in the design.	**Client** *(24)*: people working for the organisation that orders the project
		Contractor *(20)*: people working for the organisation that constructs the project
		Advisory/engineering company *(18)*: people working for the organisation that supports either the client or the contractor
		Architect *(10)*: people specialized in designing a solution
		Ecologist *(5)*: person specialized on the sub-science of biology that focusses on the relationship between organisms and their environment
	Attention: moments during the project where	**Ambition** *(18)*: earliest moment where goals and sub-goals for the project are formulated

	the goal for a NbS should be explicit	**Call for tenders** *(18)*: the moment where parties are given the opportunity to join the tender
		Control phase *(23)*: the moment(s) of validation and verification.

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5 DISCUSSION ON STAKEHOLDER INTERVIEWS

This chapter discusses the results of the stakeholder interviews. Since the results from these interviews were used as input in the later stages of the study, it is important to discuss these before continuing the study.

The goal for the interviews was to find out what themes are of importance in the choice for NbS and what requirements should be met for EA to help stimulate the use of NbS. However, not all codes mentioned in Table 10, directly relate to one of these goals. Sustainability was often mentioned, but it was often used for deciding between a sustainable project execution and a non-sustainable execution and not in the choice between a NbS and a grey solution. Sustainability talks for example on which equipment is used, which does not relate to the final solution.

The second question for the results of the stakeholder interviews is whether the results are reliable, or in other words, would the same results be found if other stakeholders would be interviewed or if the interviews would be done at another time. The validity of the results is therefore compared to different literature findings. Because also without a pre-established theory about which themes are found to be of importance, there are some indications in the literature on the importance. The Urban Nature Atlas (n.d.) for example tells us that 94% of the NbS in their database contribute to biodiversity. This does not mean that stakeholders find it important, but is a remarkably high number, which does suggest the importance. For the theme climate adaptation, the reliability comes from the definition of NbS used by *United Nations Environment Programme (2021)*. Here they state that NbS includes actions that address societal challenges adaptively *(United Nations Environment Programme, 2021)*, which relates to climate adaptation. Next to this climate adaptation is also included in the Dutch policy "City Deals" *(Agenda stad, 2021)*. A same argument can be made for health & wellbeing, as this theme was also included in the definition used *by United Nations Environment Programme (2021)* as they define NbS as actions that "provide human well-being benefits". For the inclusion of the last theme, *Frantzeskaki (2019)* makes the argument that aesthetically pleasing NbS are better appreciated and protected by citizens. And although the results of solely the interviews or only the literature mentioned in this paragraph does not make it reliable, the combination of these does imply that the results presented in the previous chapter are reliable.

6 PROGRAM OF REQUIREMENTS

The conclusion for this part of the research and the first diamond of the double diamond approach is the program of requirements for EA to have it create more NbS in the procurement process. Based on the analysis and discussion of the interviews, a final schematic overview of these requirements can also be seen in Figure 14.

In conclusion there are four themes that were included within EA. The first one is biodiversity which is the variety of both plant and animal species, although the focus for the stakeholders lies on variation of flora. The second theme was climate adaptation which includes both temperature management (preventing heat stress and keeping buildings cool inside) and water management (prevention of flooding while also retaining water in the soil). The third theme that would be included was health & wellbeing which includes the positive effects on humans when being in green areas. Lastly to be included was aesthetic value. The theme sustainability will not be included as it did not have direct relations with NbS.

If EA is used to stimulate NbS, it should not only be used in the tender process itself, but at three different moments: the moment the ambitions are formed, the call for tenders and the control phase. In the first two, EA specifically can help to find the best plans, while the latter assures that the plans made, are executed in the right way. This means that for optimal results, different parties should use EA. It was concluded that at least the client, contractor, advisory/engineering company, architect and ecologist should be incorporated in one or multiple stages of the process. The way they cooperate, is laid out in the contract, where the type of contract dictates the exact relationship. Within this contract, also financial incentives such as fines are included when the contractor does not uphold the promise they made to gain a fictional discount. This means that the project should be looked at as one integral project, from ambition to construction even including maintenance. This means that the focus should not only lie on the investment costs, but also the maintenance costs should be included as often is stated that the life cycle costs of NbS are lower than those of grey solutions.
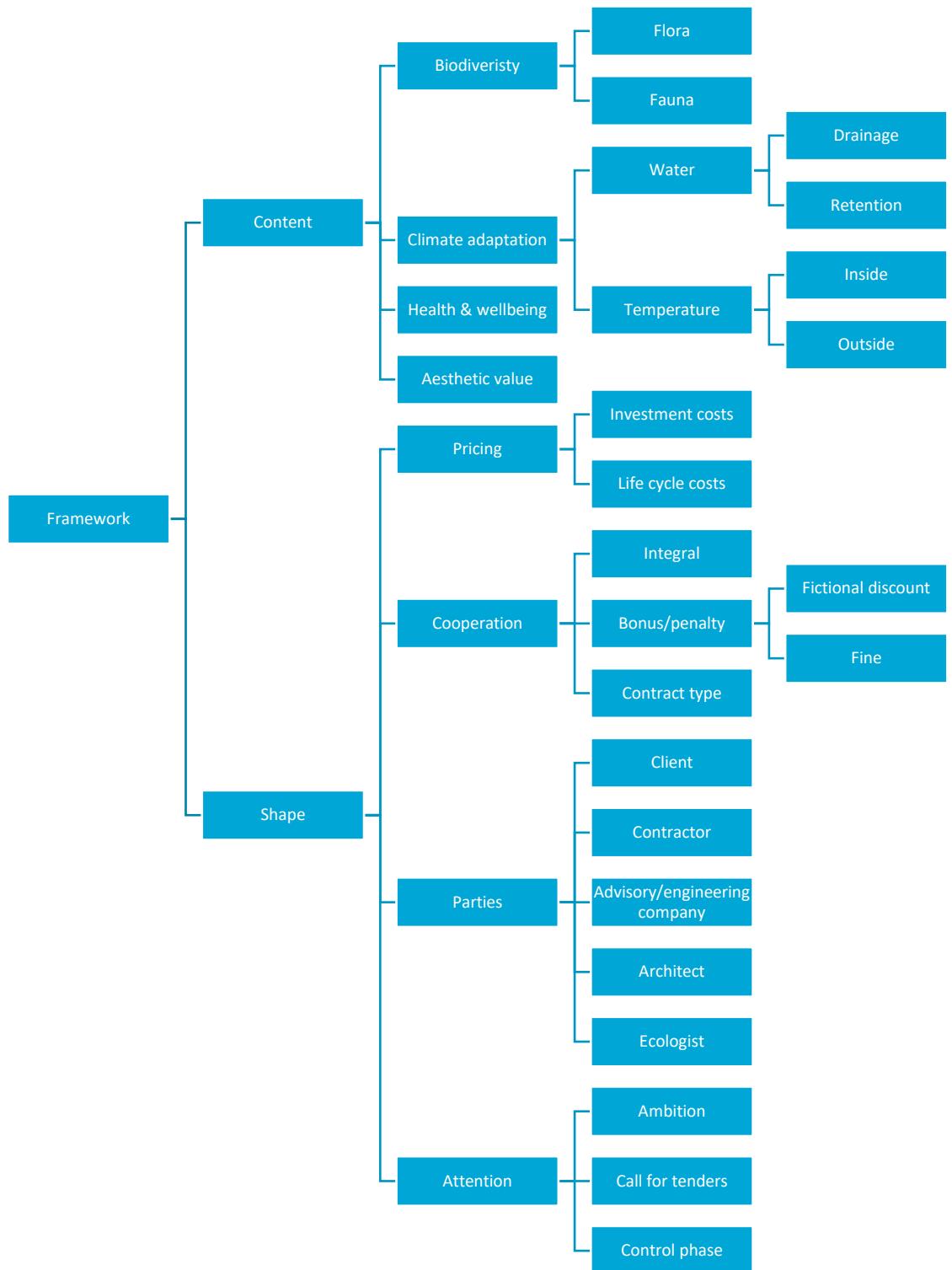
Figure 14 Schematic overview of the final code scheme

III. Creating the framework

7 METHODOLOGY

This chapter explains the methodology for the second diamond in the double diamond approach.

The goal for this research section was to find the indicators that are used within the framework. In the previous chapters it was concluded that four different themes should be included within EA: biodiversity, climate adaptation, health & wellbeing and aesthetic value.

7.1 Data gathering

Data was gathered by doing a literature research and four semi-structured key informant interviews. The literature research was done to provide input for the interviews and the key informant interviews were done to see what experts thought of these indicators.

7.1.1 Literature study

For the literature study, earlier found literature was reassessed to see if they have already explored the previously established themes for EA. Also new literature was conducted in the first quarter of 2023 by using search engines as Google Scholar and Web of Sciences. The search terms used here were word combinations as "Ecosystem Accounting [theme]" (with [theme] being either biodiversity, climate adaptation, health & wellbeing and aesthetic value), "condition account [theme]", "service account [theme]" and "monetary valuation [theme]" and spelling and synonym variations thereof. For the time period in which the literature was published no range was set, as the literature regarding these topics was relative new (mostly from the last five to ten years). From these searches and the white paper *by United Nations et al. (2020)*, a deductive code framework was created to analyse the interviews.

7.1.2 Key informant interviews

The key informant interviews were chosen as they are used to collect qualitative information from different people who know what is going on in a community, from here on referred to as experts *(UCLA Center for Health Policy Research, 2005)*. Again semi-structured interviews were chosen based on their flexibility without losing the central thread. In these interviews the central thread was the deductive coding scheme created based on the literature study. The flexibility was used to also add new codes based on answers the experts gave. With the nature of the interviews being semi-structured, the order in which the questions within a question block were asked, could be rearranged during the interview.

The goal for these interviews was to have experts involved who could use their knowledge of the real world to underpin conclusions drawn from theoretical documents and come up with new ideas. To have an all-round view on the themes, experts with different expertise were asked to interview. In Table 11 an overview of the experts and their area of expertise can be found. To avoid any confusion when using quotes from the experts, the numbers are next to those of the stakeholders. This means that a quote numbered quote 6.X is the Xth quote from the expert on Urban Nature-based Solutions. To avoid the recognition of any of the interviewees they have all received a number and are mentioned using gender-neutral pronouns. A full overview of all relevant quotes from the key informant interviews can be found in Appendix J

Table 11 Interviewees key informant interviews

Expert	Expertise	Role

5	Ecology	Ecologist
6	Urban Nature-based Solutions	Advisor NbS
7	Urban development	Landscape architect
8	Ecology	Ecologist

All experts are working within Witteveen+Bos, but only interviewee 5 and 8 have the same area of expertise. They are both specialized in Ecology, but have worked on different projects and can therefore complement each other's knowledge. Expert 6 is one of the people within Witteveen+Bos who is specialized in Nature-based Solutions within the urban environment. Lastly, expert 7 is experienced in the field of Urban development.

The interviews were held on different days and times in January and February 2023, based on the availability of the experts. All interviews took place through teams while recording both audio and video. During the interviews notes were taken, to identify statements that require further questioning and to kickstart the analysis. Several days before the interviews, the protocol was send to the experts, giving them time to prepare for the interview. The full interview protocols can be found in Appendix G. Together with the interview protocol the experts received an informed consent form (Appendix G), to make them aware of was going to happen with the information from the interviews. All interviews started with an introduction of the researcher and the topic after which the experts was asked to introduce themselves. Thereafter the interviewer provided a detailed explanation on EA. This explanation was provided regardless of their experience and background and was supported by a presentation that can be found in Appendix H. Not all questions written down in the protocol were asked to each interviewee, as they all had a different expertise. Based on their expertise those questions were asked first and a more in-depth discussion was held. Thereafter other themes were discussed, but shorter and more in general. The interview ended with an open invitation for the stakeholder to add thing that had not been touched upon earlier.

7.2 Analysis

As mentioned the goal for this research section is to see which indicators should be used within EA. To analyse this the deductive part of the coding scheme was created based on the literature study. If, during the interviews new codes emerged they could be added to the code scheme too.

7.2.1 Deductive coding scheme

This paragraph will explain the deductive coding scheme that was constructed after the literature research. Per account in EA, the 4 themes will be described. An overview of the coding scheme that was created before the analysis of the interviews can be found in Table 12.

Ecosystem Condition

For biodiversity within the condition account, multiple possible variables were be found in literature. *United Nations et al. (2020)*, mentions that variables that tell about the presence or abundance of species can be used to indicate biodiversity, the species richness. *De Jongh et al. (2021)* in their publication on the Dutch accounts, came up with four different indicators for biodiversity: % protective areas, Living Planet Index (LPI), characteristic species and structure & function. However, from these four, it was already concluded that only the LPI is suitable as indicator in urban (built-up or green) areas *(Lof et al., 2019)*. LPI is defined as '*a measure of the state of the world's biological*

diversity based on population trends of vertebrate species from terrestrial, freshwater and marine habitats' (WWF, n.d.). However, biodiversity has a focus on both flora and fauna and this indictor only focusses on specific animals, LPI disregards the floral part of biodiversity which has been found as more important for the building sector. To counteract the focus on animals, indicators that are specific for biodiversity among plants have been sought. Although both vegetation cover and tree cover, do not indicate any diversity in plant species, they do indicate the presence of vegetation and therefore might be interesting *(United Nations et al., 2021)*.

The results of the stakeholder interviews have shown that climate adaptation has two important aspects that should both be included: water management and temperature management. For water management one example indicator for the condition account came from *United Nations et al. (2021)*: imperviousness (area % of soil sealed). Line of reasoning for this indicator was that the more the soil is sealed, the less water can runoff to groundwater and the higher the chance of flooding and water running of to surface waters leaving the soil dry. For climate adaptation, stakeholder 4 earlier mentioned multiple examples of how vegetation outside an help manage interior temperature by keeping the sun out *[quote 4.13]* and how vegetation on roofs can help fight the UHI-effect *[quote 4.37]*. Research from *Hogeschool van Amsterdam & KuiperCompagnons (2020)* showed that for cooling a city down, shadow is an important aspect together with vegetation. They state that 40% shadow coverage is the target for keeping important routes to essential functions accessible *(Hogeschool van Amsterdam & KuiperCompagnons, 2020)*. The claim that vegetation helps keep cities cool was also substantiated by *Remme et al. (2018)* who showed that the actual UHI effect can be calculated partially based on the amount of vegetation in the surroundings. This resulted in two possible indicators: imperviousness and tree/vegetation cover.

The third theme that was researched was health & wellbeing. Within *United Nations et al. (2021)*, one potential indicator was found: the air quality measured in NO_2 concentration in the air. In the Netherlands this is assess by using maps from Atlas Leefomgeving, where the concentration NO_2 ranges between 0 µg/m^3 and 40 µg/m^3 *RIVM (2020b)*. Suggested by stakeholder 4 in the stakeholder interviews, the 3-30-300 rule was researched *[quote 4.19]*. The rule stated that each house should have a view of at least 3 trees, each neighbourhood should have at least 30% tree canopy and each house should have a public green space within 300 meters *(Konijnendijk, 2022)*. This rule can be translated to the indicator second indicator for health & wellbeing: tree/vegetation cover.

The last theme that would be included in the condition account is the aesthetic value an area can have. From the literature no clear condition indicator was found. Studies have shown that houses that have a view on nature, sell for a higher price than similar houses that do not have that view *(Luttik & Zijlstra, 1997)*. This indicates that people prefer an area that has more vegetation, therefore the indicator of tree/vegetation cover can be used.

Ecosystem service

The next step in EA is the physical service account. The previous condition account together with the extent account (surface area of all different ecosystem types) relate to the capacity of an ecosystem to deliver a service *(Maes et al., 2018)*. Although not all direct relations between the service account and the condition and extent account are fully known, there should be a link between these two accounts *(United Nations et al., 2020)*. This means that the chosen indicators for condition should tell something about the accompanying ecosystem service. This paragraph will explain the different possible services that will be discussed during the interviews.

The search for a biodiversity related service was rather difficult. One possible service was found in *United Nations et al. (2019)*: Pollination service. The given definition of pollination services is *"the ecosystem contributions by wild pollinators to fertilization of crops that maintains or increases the abundance an/or diversity of other species that economic units use or enjoy"* *(United Nations et al., 2020, p. 133)*. In the study by *McDougall et al. (2022)*, this service was measured by putting out model plants in clusters of 12 to 14 plants in different private and community gardens in Australia in October. Then, during multiple observations all insects that were visiting one of the flowers on the model plants were recorded. In the Dutch accounts the pollination service is only incorporated in the financial service account as the avoided loss of crop production due to pollination by wild pollinators *(De Jong et al., 2021, p. 34)*.

For climate adaptation both the subthemes for water management and temperature management should be included. From the reference list, water flow regulation services and local climate regulation services were found to be fitting *(United Nations et al., 2020)*. The water flow regulation service is defined as *"the ecosystem contributions to the regulation of river flows and groundwater and lake water tables. They are derived from the ability of ecosystems to absorb and store water"* *(United Nations et al., 2020, p. 132)*. In the Dutch accounts the service rain water regulation was found, which focusses on the contributions of rain water specifically *(De Jong et al., 2021)*.

For climate regulation service the definition found in the white paper by *United Nations et al. (2020, p. 132)* is: *"the ecosystem contributions to the regulation of ambient atmospheric conditions … through the presence of vegetation that improves the living conditions for people and supports economic production"*. For urban ecosystems especially the part on improving the living conditions of people appears to be important. *Remme et al. (2018)* showed with calculations how the spatial lay-out of an ecosystem with focus on vegetation and water can help cool down urban areas.

The third theme was Health & wellbeing. Within United Nations et al. (2020), air filtration services was mentioned, a service that would help improve the health of residents due to less pollutants in the air. The benefits created could be measured by fewer patients do to cleaner air. However, when looking further into the health benefits of an ecosystem, research from *KPMG Advisory N.V. (2011)* showed that an investment into urban green leads to better health. This was because people feel better and have fewer mental health issues and it invites them to exercise more leading to better physical health.

Aesthetic value can be included in EA by using the visual amenity services. *United Nations et al. (2020, p. 133)* define these services as "the ecosystem contributions to local living conditions, in particular through the biophysical characteristics and qualities of ecosystems that provide sensory benefits, especially visual". Research has shown that houses that have a view on green and/or water, are more in demand, because their prices are higher compared to similar dwellings without that view *(Luttik & Zijlstra, 1997)*. Within the coding scheme 2 versions of the visual amenity service were included, visual amenity service of nature and visual amenity service of water.

Table 12 Explanation and coding scheme key informant interviews. In the first column the third-order codes are shown, these are the accounts from EA that was talked about. The second column, shows the second-order codes which are the themes as identified from the previous interviews. The third column has the first-order codes which are possible indicators that could be used in EA.

Ecosystem condition account	Biodiversity	Tree/vegetation cover: amount

		of area covered in trees and/or other vegetation
		Living Planet Index: a measure of the state of the world's biological diversity based on population trends of vertebrate species from terrestrial, freshwater and marine habitats *(WWF, n.d.)*
		Species Richness: the number of different species within the project area
	Climate adaptation	**Imperviousness**: the amount of surface from which the soil is covered, preventing water retention
		Tree/vegetation cover: amount of area covered in trees and/or other vegetation
	Health & wellbeing	**Air quality**: measurement of pollution in air
		Tree/vegetation cover: : amount of area covered in trees and/or other vegetation
	Aesthetic value	**Tree/vegetation cover**: : amount of area covered in trees and/or other vegetation
Ecosystem service accounts	**Biodiversity**	**Pollination service**: the ecosystem contributions by wild pollinators to fertilization of crops that maintains or increases the abundance an/or diversity of other species that economic units use or enjoy *(United Nations et al., 2020, p. 133)*
		No service: no meaningful service can be measured for biodiversity
	Climate adaptation	**Water flow regulation service**: the ecosystem contributions to the regulation of river flows and groundwater and lake water tables. They are derived from

		the ability of ecosystems to absorb and store water *(United Nations et al., 2020, p. 132)*
		Rain water regulation service: the ability of the ecosystem to retain rainwater in the soil without causing flooding in the area due to the application of additional measures
		Climate regulation service: the ecosystem contributions to the regulation of ambient atmospheric conditions … through the presence of vegetation that improves the living conditions for people and supports economic production *(United Nations et al., 2020, p. 132)*
		Cooling service of vegetation and water: the ability of an ecosystem to help cool an area due to the amount of vegetation and water
	Health & wellbeing	**Filtration service**: the ecosystem contributions to the filtering of air-borne pollutants through the deposition, uptake, fixing and storage of pollutants by ecosystem components, particularly plants, that mitigates the harmful effects of the pollutants *(United Nations et al., 2020, p. 132)*
		Health service of nature: the effect of nature on the physical and mental health of residents
	Aesthetic value	**Visual amenity service of nature**: the ecosystem contributions to local living conditions that provide visual benefits due to the view on

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		nature
	50	**Visual amenity service of water**: the ecosystem contributions to local living conditions that provide visual benefits due to the view on water

8 RESULTS KEY INFORMANT INTERVIEWS

This chapter shows the results from the key informant interviews. First the results that are part of the ecosystem condition account are presented. Thereafter the results that are part of the service account are shown. In this result section, quotes have been used to tell the stories of the experts. The full quotes can be found in Appendix J.

8.1 Ecosystem condition account

The four options for biodiversity as shown in Table 12 were presented to the experts. From expert 5 the suggestion came to look at the presence of all different vegetation layers. For vegetation, four different vegetation layers were mentioned in this interview: moss layer, herb layer, shrub layer and tree layer. Analogous to this they explained that for animals also different layers can be analysed, the trophic layers. The presence of all different vegetation layers, can provide habitat for species from all trophic layers, as *"for example, a certain species can have their nests in trees, but they get their food from shrubs, if you then don't have your shrub, does it make sense that you have that three where they nest?" [Quote 5.5].* The presence of different vegetation layers can therefore be a good starting point for an indicator that tells us about the condition of biodiversity. Expert 8 commented on the LPI and stated that they have never used it as they do not know what it entails. But they do state, that to have a variation in living species, the right conditions for them to live should exist. Expert 7 made these conditions explicit by saying *"is there a nesting opportunity … is there migration opportunity … and is there foraging opportunity" [quote 7.3]*. Arguments were given to also include species richness of animals by counting all the individual species in an area, but this will be unrealistic *[quote 5.8]*.

For climate adaptation the two options from Table 12 were discussed. During the discussion with expert 5 on the imperviousness of the area, they stated that even when the soil is not sealed, it does not automatically mean that the soil can retain the water. Stakeholder 6 states that *"… for a long time we focused on water discharge. As a result there is now a lot of drought in a lot of places…" [quote 6.5]*. Therefore stakeholder 5 suggests looking at the soil quality, they explain *"If you have sand from the dunes, that's just white. And if you see what we use, potting soil, that is the same grain of sand, but surrounded by a layer of organic matter and then that grain turns black. And the more organic matter in the soil, the more water remains trapped in those soil layers and so the more it is retained by the soil and so the longer it is available to plants" [quote 5.20]*. When discussing the tree/vegetation cover as possible indicator, expert 6 mentioned that for cooling down a city, shadow is an important aspect, regardless of whether that is because of buildings or trees *[quote 6.6]*.

The discussions on indicators for both health & wellbeing and aesthetic value with the experts were less extensive. Expert 7 did explain the multiple components of health & wellbeing and that one of those is to not come into contact with substances that are harmful to the human body. This means that one should breath clean air to keep the lungs healthy or not swim in contaminated water. The other two aspects they mention are related to physical activity (does the environment enable cycling and walking for example) and mental condition *[quote 7.1]*. On aesthetic value no new insights emerged from the interviews.

8.2 Ecosystem service account

One of the questions that was the biggest cause for discussion was which service would provide information on biodiversity. From the experts no input came, before the definition found in literature was provided to them. When this definition and measurement method was discussed with expert 5,

they explained that results on observations as these can vary very much depending on the season. Not every insect has their peek at the moment you are observing and not every plant is interesting at that moment. If you were to conduct the same experiment with the same plants during different months, the results cannot be compared *[quote 5.11]*. Expert 7 confirmed this point of view that measuring pollination services in this way does not provide any useful information *[quote 7.2]*. In the discussion with the experts, Expert 5 suggested that to be able to use a service for biodiversity, the links between the different plants and insects should be known, *"Imagine that one plant, forty species depend on it for their food, so if you no longer have that plant, then those forty species have less food. But now imagine you have a plant species, they only have one pollinator, if that pollinator stops, then those plants will also stop" [quote 5.14]*. The whole ecosystem, when functioning correctly is balanced, but if disrupted in any way pest species, such as mosquitos or rats, may grow *[quote 5.15]*.

For climate adaptation, two sub-themes were discussed with the experts. The first sub-theme was on water management, where experts 7 stated it should talk about the absorption capacity of the soil *[quote 7.4]*. Expert 6 talked about this more in detail and stated that we need to look at *"more natural measures, but also some more technical measures that can then retain water. And yes, I think you could look at that in you ecosystem services, whether those measures are there and how much capacity they have then" [quote 6.10]*. An example of such a measurement was given by expert 8, when they said that we should look at *"the ability to collect water at ground level without causing flood nuisance…" [quote 8.6]*.

The second sub-theme that was discussed was temperature management. Expert 6 stated that the only thing that would really help cool down public space is evaporation, because due to the evaporation of water extracts energy from the air *[quote 6.11]*. Expert 5 agreed with this by stating that *"…the more trees we have, the more cooling.." [quote 5.17]*. Expert 8 continued on this by stating that *"it [ways of cooling down urban areas] could be anything. It could be moisture content of vegetation or open water. Just something that doesn't warm up quite as well" [quote 8.5]*.

The third theme that was discussed in the interviews was health & wellbeing. The two different ways of looking at this (air filtration services, and health service of nature) were presented. The explanation from expert 7 on what health entails is useful in determining which service would be the best fit. They state that to be able to value health, all aspects of health should be taken into account and not just breathing clean air *[quote 7.1]*.

The last theme that was discussed during the interviews were the ecosystem services related to aesthetic value. During the interviews no new insights emerged on this theme.

9 DISCUSSION ON KEY INFORMANT INTERVIEWS

In this chapter, the results from the key informant interviews are discussed as the framework is being constructed. Per paragraph one or multiple accounts in EA are discussed.

9.1 Ecosystem condition account

From the multiple options, the presence of the different vegetation layers was the best fit to measure biodiversity within the ecosystem condition account. Next to biodiversity, the presence of different vegetation layers also relates to climate adaption due to the cooling effect of vegetation, people are healthier in green environments and they appreciate a green area. From the stakeholder interviews it was found that diversity in plant species was more important for the construction sector in determining their plans than diversity in animal species. By using the presence of vegetation layers as an indicator for biodiversity it relates directly to plant variety, and indirect to animal variety. It is therefore important that all different layers are present in an ecosystem, as a missing layer results in loss in a complete habitat type. It is therefore more important that every layer is at least present in a small area than increasing an already present layer in area coverage. This can be calculated with a logarithmic formula. To avoid extreme values close to the axis asymptote, all values smaller than 0,1 (1/1000th part of the area) should be valued as -1 (Equation 2). Note that the values of single vegetation types will not be included in the framework, but the sum of the different vegetation types will be used as shown in Equation 3.

Equation 2 Logarithmic function vegetation cover

$$Vegetation\ cover_x = \begin{cases} -1, & \frac{Area\ coverd\ by\ vegetation_x}{Total\ area} < 0,1\% \\ \log(\frac{Area\ covered\ by\ vegetation_x}{Total\ area} * 100), & \frac{Area\ coverd\ by\ vegetation_x}{Total\ area} \geq 0,1\% \end{cases}$$

Equation 3 Vegetation layer score

$$Vegetation\ layer\ score = Vegetation\ cover_{tree} + Vegetation\ cover_{shrub/herb} + Vegetation\ cover_{moss}$$

Equation 2 shows the formulae per vegetation layer, here both the area covered per vegetation type and the total area are measured in m^2 or ha (both should use the same measurement). This results in a vegetation cover and a vegetation layer score that has no unit attached to it. When using the vegetation score in the condition account, upper and lower values should be determined to scale the actual values to. The score for individual layers can range from -1 to 2 when that layer is absent or fully present in an area, which results in a vegetation score that can range from -3 to 6. However, this was not a realistic value as no area would be 100% covered by all three vegetation layers at the same time. Based on comments made by experts and stakeholders and the literature findings, an upper boundary of 30% area coverage per layer was more realistic. This resulted in an upper value for the vegetation score in 4.43 in most ecosystem types. The exception area urban green areas, where the upper value for area coverage by moss can be 100%, which lead to an upper value for the vegetation layer score in urban green areas of 4.95.

The second indicator that was included in the condition account was the shadow cover. To fight UHI both vegetation and shadow are important, therefor only relying on the presence of vegetation layers was not enough. Because due to shadow, the sunlight cannot reach certain surfaces and cannot heat them. The area covered in shadow will change throughout the year, with the sun not

being in the same position each day. Since UHI is especially a problem in summers when the sun is at its highest point, this indicator should be determined based on the position of the sun on June 21st at 12 am. The lower value for shadow cover is 0%, which is close to impossible value, the upper value is determined to be 40%, the target shadow coverage. In practice this value can be somewhat higher if desired, but complete absence of sunlight is not ideal as well.

As a third indicator the soil quality was added, since the carbon-richness of the soil helps retain water in that soil. As this indicator did not came up before the key informant interviews, no possible ways of measuring this were researched in the literature study. The claim that a carbon-rich soil helps retain water, was also found in literature *(Government of Western Australia, Department of Primary Industries and Regional Development, n.d.)*. In the Netherlands the soil quality can be measured using maps form Atlas Leefomgeving that show the amount of carbon in the upper 30 cm of the soil, ranging from 50 tonC/ha to 175 tonC/ha *(RIVM, 2020a)*. These numbers were therefore used as lower and upper values. If desired one could also sample the soil in the area and calculate the amount of carbon. To determine future values of the soil quality, maps of areas with similar land use and nature can be compared.

Last indicator that was added was the air quality measured in $\mu g/m^3$ NO_2 in the air. The lower value will be 40 $\mu g/m^3$ and the upper value 0 $\mu g/m^3$. In the Netherlands the air quality can be measured using maps from Atlas Leefomgeving that show the NO_2 concentration in the air *(RIVM, 2020b)*. To determine future values of the air quality, maps of areas with similar land use and nature can be compared.

9.2 Ecosystem service accounts

This paragraph discusses both the physical and monetary service accounts. Per theme the first the physical valuation is discussed. Thereafter the monetary valuation is shown for the chosen ecosystem service.

9.2.1 Biodiversity

For the theme biodiversity, one service was found before the interviews with the experts. But during these interviews the experts it became clear that this service would not provide any useful information. No other service came up or was found in literature, therefore no ecosystem service for biodiversity was included in EA.

9.2.2 Climate adaptation – water management

 The second theme that was discussed, was climate adaptation with its sub-theme water. During the interviews it became clear that the focus should lie on ways to prevent flooding while at the same time having the opportunity for retention of rain water. The final service related to this theme was therefore rainwater regulation service. In Table 12 it was defined as "the ability of the ecosystem to retain rainwater in the soil without causing flooding in the area due to the application of additional measures". It is measured in the amount of water (in cm) that can be retained due to extra measurements, such as rain gardens and green roofs, that would otherwise lead to flooding, which would result in damage costs. The monetary valuation of this service are the avoided damage costs for flooding, such as repair costs on houses or offices where the water runs in or economic damages when a (part of a) road cannot be used.

Monetary valuation
The avoided damage costs for flooding can be calculated based on estimates from the WaterSchadeSchatter (WaterDamageEstimator in English) by *STOWA & Nelen & Schuurmans (2022)*.

Originally both the direct damages, as well as the indirect damages are computed. Direct damage is the damage that occurred due to direct contact with the water, for example the costs to re-lay a floor on the ground level. Indirect damage occurs due to the direct damage, if the floor that has to be re-laid was in a shop and that shop could not be open during that relaying of the floor, the revenue the shop owner has missed is indirect damage *(STOWA & Nelen & Schuurmans, 2022)*. The full equation for the water damage estimator in euros is in Equation 4.

Equation 4 Damage formula for direct and indirect flood damage (STOWA & Nelen & Schuurmans, 2022)

$$Damage = max.\,direct\,damage * \gamma_{depth} * \gamma_{duration} * \gamma_{season} + indirect\,damage\,per\,day * repair\,time$$

To not overcomplicate the framework, only the part of the direct damages will be included. The final equation will therefor look like Equation 5. Here max. direct damage is the maximum damage in euros per unit of area, which depends on the type of ecosystem. γ_{depth}, $\gamma_{duraction}$ and γ_{season} are the partial factors for water depth, flood duration and season that help determine the actual damage costs per unit of area.

Equation 5 Formula for flood damage (Adapted from: STOWA & Nelen & Schuurmans, 2022)

$$Damage = max.\,direct\,damage * \gamma_{depth} * \gamma_{duration} * \gamma_{season}$$

For buildings it does not matter how long the flood lasts or which season it is, both partial factors ($\gamma_{duration}$ and γ_{season})will be 1. The partial factor for the depth can be calculated using Equation 6, were d stands for the water depth in cm. The maximum costs will be when the water height is 15 cm (150 mm) and γ_{depth} is 1.

Equation 6 Depth factor for water damage in buildings (STOWA & Nelen & Schuurmans, 2022)

$$\gamma_{depth} = \begin{cases} 0.05 + d * 0.05, & d \leq 1\,cm \\ d * 0.1, & 1\,cm < d \leq 5\,cm \\ 0.25 + d * 0.05, & 5\,cm < d \leq 15\,cm \\ 1, & d > 15\,cm \end{cases}$$

For the maximum direct damage, the WaterSchadeSchatter offers three price-levels, minimum, average and maximum. The amounts mentioned in the WaterSchadeSchatter are based on the price levels in 2015. To determine the correct prices of 2023 the inflation calculator by *Hoekstra (2017)* was used that statds that €100,- in 2015 is worth now €122.17. These buildings have an average damage costs of €331/m^2 (ranging from a minimum of €199/m^2 to a maximum of €464/m^2) in 2023 *(Hoekstra, 2017; STOWA & Nelen & Schuurmans, 2022)*.

For infrastructure, again the partial factor for the season is always 1 as it does not matter in which season the infrastructure is flooded. For the duration factor, it can be found that already within 1 hour of flooding, damage occurs of 50% worth of the maximum value, this gradually increases to 100% of the damage costs when the duration is 1 day *(STOWA & Nelen & Schuurmans, 2022)*. For usability of EA, this factor will therefor always be at 0.5. For the infrastructure including the inflation, the maximum direct damage costs were determined to be €928/ha *(Hoekstra, 2017; STOWA & Nelen & Schuurmans, 2022)*.

To determine the maximum direct damage of the nature, no explanation on the seasonal and duration partial factors was found. However, for grass in particular it was determined that the average seasonal factor was 0.76 (ranging from 0.3 to 1 throughout the year). Since many types of

nature within urban environment (such as parks or sport fields), include grass, this will be used for the whole of this category. For the depth factor Equation 7 can be used, here d is again the depth in cm. The maximum damage for sport parks is €928/ha in 2023 and for cemeteries, allotment gardens, recreation and other nature in urban environment it is on average €1,327/ha (ranging from €1,062/ha to a maximum of €1,592/ha) *(Hoekstra, 2017; STOWA & Nelen & Schuurmans, 2022)*.

Equation 7 Depth factor for water damage in nature (STOWA & Nelen & Schuurmans, 2022)

$$\gamma_{depth} = \begin{cases} 0.5 * d + 0.5, & d < 1\ cm \\ 1, & d \geq 1\ cm \end{cases}$$

When the monetary valuation for all the different ecosystem types is completed, it can be summed up over the different ecosystem types to calculate the total avoided damage costs.

9.2.3 Climate adaptation – temperature management

During the interviews multiple mentions were made on the effect of vegetation and open water on the local temperature. These mentions are in line with *Remme et al. (2018)*, who showed how to calculate this effect (Equation 8).

Equation 8 Calculations to determining the cooling effect of urban green and water (Remme et al., 2018)

$$Cooling\ effect\ urban\ green\ and\ water = Maximum\ UHI\ effect - Actual\ local\ UHI\ effect$$

$$Actual\ local\ UHI_i = Potential\ UHI_i * \left(1 - \sum fr\ Reduction_{type}\right)$$

$$Potential\ UHI_{i,j} = Maximum\ UHI_{i,j} * frSoil\_sealing_{1km}$$

$$Maximum\ UHI = -1.605 + 1.062 * \log(population_{10km}) - 0.356 * wind\ speed_{10m}$$

The cooling effect of urban green and water is measured in °C by subtracting the local UHI effect (in °C) from the maximum UHI effect (in °C). Here the actual UHI effect is calculated by multiplying the potential UHI effect with 1 minus the reduction factor for the effect of land cover type. The potential UHI is determined by multiplying the maximum UHI with a factor on the percentage of the soiled that is sealed. The maximum UHI is calculated using the population in an area and the wind speed at 10 meter high. Although these formulae are accurate in calculating the cooling in an area, they cannot be used in EA, as there is no monetary valuation for this service in the Netherlands. Very to little information exists on how much residents value a 1°C reduction. Only information that was found, stated that in Singapore residents were willing to pay USD$563.80 per year for UHI mitigation measures *(Borzino et al., 2020)*. With the conditions in Singapore being very different than those in the Netherlands (population density of Singapore in 2020 was 7919 residents/km while the Netherlands was at 518 residents/km *(The World Bank, n.d.)*), this information cannot be used in a Dutch study. Therefore, different calculation methods should be used.

As already mentioned, residents prefer to live in in houses that are in cooler areas of a city. This cooling can be done through green and blue areas that are within a 400-meter range of a house *(Luttik & Zijlstra, 1997)*. This means that for the local climate change service, the number of houses that are within a 400-meter range of either a park (green area) or an open water or pond (blue area) will be determined. As this service does directly relate to houses, this will only be determined for

areas that are classified as residential areas or areas that are a combination of residential and other areas. Other ecosystem types will state that the number of houses is 0 automatically.

For the monetary valuation of this service, the willingness to pay for this service based on the hedonic pricing model is used. The study of *Luttik & Zijlstra (1997)* concluded that the value of each house that is within the range increases with 6%. As from the previous step the number of houses is known, this step will determine the value increase based on the average property value (WOZ waarde in Dutch).

9.2.4 Health & wellbeing

For health & wellbeing the option for health service of nature was added to the framework. This service includes the different aspects mentioned in the interviews and also includes the effects of clean air due to filtration, making the use of air filtration service redundant.

This service is calculated in the number of patients that is reduced due to the spatial layout of the ecosystem. To calculate the health service of nature, the first step is to calculate how many people will not become a patient due to the spatial layout of the ecosystem. Studies from *KPMG Advisory N.V (2011)* and *Maas et al. (2009)* showed that a green neighbourhood reduces the number of patients, the exact relationship that was found here was that each increase of 1 percentage point of the area reduces the number of patients with 0.347 per 1000 residents. This means that if an area has 2000 residents and it has 20% green area, the reduction in patients will be 7, as can be seen in Equation 9. For the number of residents exact data can be used, or an estimate can be used based on the number of houses and the average number of residents per house.

Equation 9 Example calculation of reduction in patients

$$Reduction\ in\ patients = area\%\ green * 3.47 * 10^{-4} * residents$$
$$= (20 - 10) * 3.47 * 10^{-4} * 2000 = 6.94 \approx 7\ patients$$

If the reduction in number of patients is determined, the avoided damage costs of these patients are used to calculate the monetary value of this service. On average for the different diseases that are included in these studies, a patient costs € 917,- per year *(Rijksinstituut voor Volksgezondheid en Milieu, n.d.)*. The monetary value is the product of the reduction in patients and the costs per patient.

9.2.5 Aesthetic value

For the last theme, aesthetic value, the visual amenity services for nature and water view are included.

Based on the study from *Luttik & Zijlstra (1997)* the visual amenity service of nature is measured in the number of houses that have a view on nature. A view on nature is a line of minimum three trees. In the monetary account a similar calculation will be used as for the cooling service: the hedonic pricing model. Based on the average WOZ value of the houses and the 5% price increase that a nature view has on these houses the monetary value can be calculated *(Luttik & Zijlstra, 1997)*.

But it is not only a view on green nature that is being appreciated. If a house has a view on a body of water, the value increases as well. For the physical component of this service again the number of houses will be determined. To calculate the monetary value, a price increase of 8% should be taken into account *(Luttik & Zijlstra, 1997)*.

10 CONSTRUCTING THE FRAMEWORK

This chapter gives the conclusion on the previous chapters and presents the final framework. Within the framework, the four themes of biodiversity, climate adaptation, health & wellbeing and aesthetic value are assessed. A schematic overview of how EA looks like for procurement can be found in Figure 15 and in larger size in Appendix K. The first table shows the combination of the extent and condition account, the second table in Figure 15 shows the monetary and physical service account per ecosystem type and the last table shows the asset account.

10.1 Ecosystem extent account

For the extent account the starting point was the list of Dutch ecosystem types as presented in Appendix B. However with the scope being on urban areas, the most important ecosystem types to include are the urban and other (semi-) built-up ecosystem types. Using this classification on urban ecosystem types, however does not work in areas with a mixture of different uses in the same building. For example, some buildings have a mixture of different types of uses, for example an apartment complex can have shops on the lower floor(s) and a public park can be used as sport park as well with other possibilities for residential recreation. To not overcomplicate the framework and allow for the mixed use of areas, only three types of urban ecosystem types are used: residential and non-residential construction, urban green and infrastructure.

The whole list of agricultural ecosystem types will not be included. Smaller types of agriculture can still exist in urban areas, but are in that case classified in other ecosystem types such as urban green. From the (semi-)natural ecosystem types, most do not exists in urban areas either, and if they do exist such as open nature, it is often in smaller amounts that can also be classified in urban green. Only the ecosystem types that are part of the water ecosystems can be present in urban areas and need to be classified in a separate type. This resulted in the classification of ecosystem types as presented in Table 13.

Table 13 Final list of ecosystem types

Category	Ecosystem type	Example uses
Urban and other (semi-) built-up	Residential and non-residential construction	Living
		Economy
	Urban green	Sport
		Recreation
		Parks
		Allotment gardens
	Infrastructure	Primary roads
		Secondary roads
		Tertiary roads
		Other roads
		Rail
(semi-) natural	Water	Streams and rivers
		Lakes

The start of the division of ecosystem types is by looking at the cadastral plots with buildings on them. These plots fully adhere to residential and non-residential construction when the building(s) makes up 25% or more of the area. If more than 75% of the area falls within another ecosystem type, that ecosystem type is used for the full plot *(Van Leeuwen et al., 2017)*. Other divisions can be made by using different kinds of (digital) maps. In Figure 15 the used ecosystem types can be seen in the table that combines the extent account with the condition and in the second table that combines the extent account with the service accounts.

10.2 Ecosystem condition

In the condition account, a total of four conditions are assed:

- Vegetation layer score
- Shadow cover
- Soil quality
- Air quality

The vegetation layer score looks at the area surface of the different vegetation layers and links with biodiversity, climate adaptation, health and wellbeing and aesthetic value. The shadow cover is measured in the area which is shaded and is important for the temperature sub-theme within climate adaptation and the soil quality is measured as the carbon-content of the soil and is related to the water sub-theme. The air quality talks about the concentration NO_2 is linked to health & wellbeing. In Figure 15 these indicators are each represented on one of the rows in the first table. Per ecosystem type the condition is assessed.

10.3 Ecosystem service (physical)

A total of five ecosystem services are valued:

- Local climate regulation service
- Rain water regulation service
- Health service of nature
- Visual amenity service
  - of nature
  - of water

These services are all represented by a row in the second table of Figure 15. The arrows between the first and second table shows to which indicator each service is related. Per ecosystem type the physical service is shown in the first column of the service table in Figure 15

Local climate regulation service assesses the number of houses that are within a 400 meter range of a park or body of water that can help lower the temperature in that area. This service is related to the vegetation layer score, as for parks to be present, the vegetation layer score should be relatively high. This service is related to the sub-theme of temperature that is part of the climate adaptation theme.

The second theme is rain water regulation service and is related to the other sub-theme of climate adaptation. This service looks at the amount of water that can be retained extra in an area due to measures taken as rain gardens.

For health & wellbeing the health service of nature is measured that looks at the reduction in patients. This service is related to both the vegetation layer score and the air quality. If an area has more vegetation, the air can be cleaner which leads to a smaller risk of residents getting physically ill. Next to this, more vegetation also influences the mental wellbeing of the residents.

The last services that are included are the visual amenity services of nature and water. Here the number of houses that either have a view on nature or a view on water are measured. This service is part of the aesthetic value theme and relates to the vegetation layer score. If there is very few nature in an ecosystem, only a small number of houses can see this, more nature therefor relates to a higher service value.

The theme of biodiversity has no specific service that is assessed in this account.

10.4 Ecosystem service (monetary)

For the services that are assessed in the physical service account, a monetary valuation is given in the monetary service account. In Table 14 per ecosystem service the monetary valuation will be given. In the second column per ecosystem type in the service table of Figure 15 the monetary value of each service is shown. The last column of the service table is the sum of all ecosystem types per service.

Table 14 Monetary valuation methods

Ecosystem Service	Monetary valuation
Local climate regulation service	Hedonic pricing model
Rain water regulation service	Avoided flood damage costs
Health service of nature	Avoided medical costs
Visual amenity service of nature or water	Hedonic pricing model

For all the services that use the hedonic pricing model, the monetary valuation is based on the WOZ value of the houses are the physical service. For local climate regulation service the monetary value is 6% of the WOZ value, for the visual amenity service of nature it is 5% and the visual amenity service of water has a monetary value of 8% of the WOZ value. For the rain water regulation service the damage costs are calculated if that retained water first flooded the streets. These costs are dependent on the amount of water and the ecosystem type and area. With health service of nature, the average medical costs per person are known. This service is the multiplication of the reduction in patients times the average medical costs per person.

10.5 Ecosystem asset account

The final step of the framework is calculating the asset value. This step is shown in the last table of Figure 15. As mentioned in the theory the asset value can be calculated using the NPV method. For all the services an asset life of 100 years will be assumed and depending on the type of service the discount rate will be either 2% or 3%. Which discount rate belongs to which service can be found in Table 15. When using excel to calculate this, Equation 10 can be used. In this equation R is the ecosystem service value (in euros) as calculated in the previous account, i is the discount rate and t is the life span of 100 years.

Equation 10 Net Present Value formula

$$NPV = \sum_{t=0}^{n} \frac{R_t}{(1+i)^t}$$

Table 15 Discount rate per ecosystem service

Discount rate	Service type	Services
2%	Regulation and maintenance services	• Local climate regulation service • Rain water regulation service
3%	Cultural services	• Health service of nature • Visual amenity services
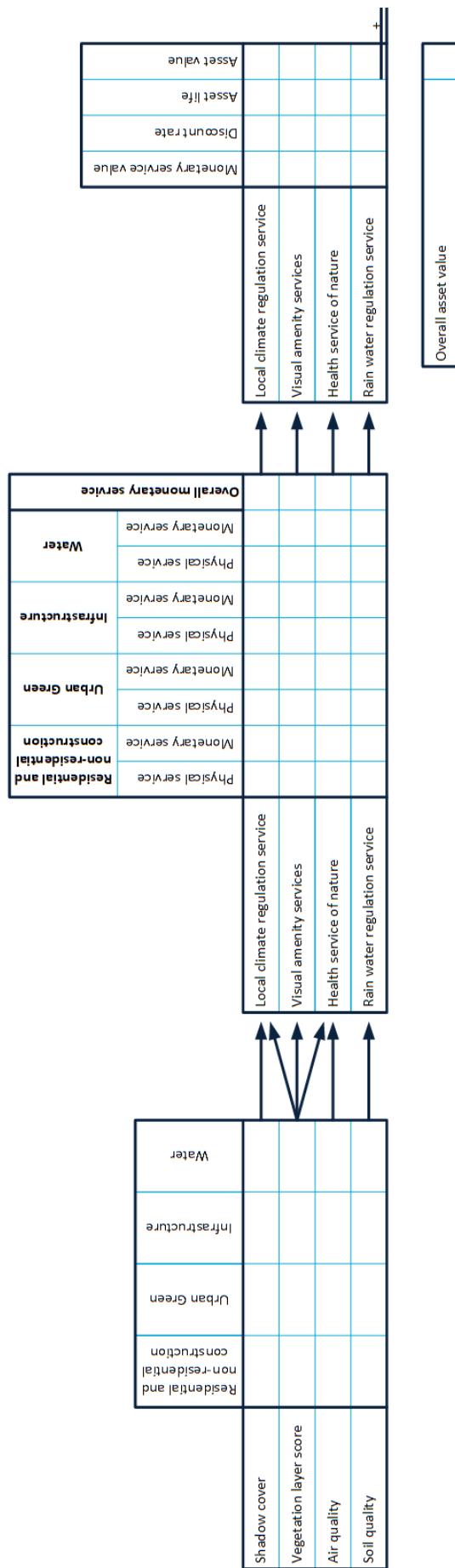
Figure 15 Schematic overview of EA for procurement. First table shows the combination of ecosystem extent and condition accounts. The second table is the ecosystem service table that indicates the physical and monetary value per service per ecosystem type. The last table indicates the asset value per ecosystem service and the total asset value. The arrows between the tables represent the relationships between the different rows of the different tables.

IV. Usage in practice

11 TEST CASE

To validate the framework, it was tested using an area development project. First the requirements for an appropriate test case will be explained. In paragraph 2 the project is introduced and the ambitions the client had for the project are addressed. Thereafter in paragraph 3, the numerical information on the case is presented.

11.1 Requirements for validation

To validate that the framework as created in the previous chapters works correctly, a (fictional) case was used to test it. Not any case could be used for this, therefore some selection criteria have been set. The test case should:

- be within the Netherlands
- be within the built environment
- have an ambition for one or multiple NbS.

These selection criteria have been set because they assure that the case falls within the scope of this research. Next to this there was a preference for a case:

- that has minimal two different variations in design
- in which the four themes of biodiversity, climate adaptation, health & wellbeing and aesthetic value are important for the client.

The goal of these preferences is to first see how the framework shows differences between spatial designs of an area and especially ones these differences are relatively small. The second point in the preference list assures that this framework will help measure what the client of the project does find important and therefore can help in making a correct decision. If these preferences could not be met, it would not automatically mean that the test case is unqualified, but a project that did meet these criteria, had preference over one that did not.

11.2 Redesign of Beurskwartier, Utrecht

In the city of Utrecht, the Netherlands, lies the neighbourhood Beurskwartier. The area close to the train station Utrecht Centraal and between Croeselaan, van Zijstweg, Graadt van Roggenweg and the yet-to-be-realised Beursstraat-Noord and Beursstraat-Zuid is subarea 1 for the whole project. Currently only for this subarea the plans are known, therefore only this subproject is used for testing the framework. In Figure 16 Figure 16 Project area Beurskwartier from De Nijs et al. (2022)the full project area, and subarea 1 (blue) are shown.

Figure 16 Project area Beurskwartier from De Nijs et al. (2022)

Currently the main use of the area is office space and parking for the Jaarbeurs, but in 2027 the area will be redeveloped with housing as main function combined with spaces for offices, hospitality, healthcare and education *(De Nijs et al., 2022)*. In the project area, two buildings currently exitst: the Jaarbeurs, and the Kinepolis cinema, the rest is currently used as parking or as construction site for the main towers: the Galaxy tower and Wonderwoods. In later stages the Jaarbeurs and parking in this area will be remodelled, Kinepolis will keep its current building and location. In different building blocks the area will be completed, with each block having mixed functions. The Municipality has 6 principles for the project:

1. the area will be designed using city blocks
2. use of the most sustainable transportation mode will be stimulated
3. the housing should be mixed and inclusive
4. innovation and sustainability are of high importance
5. the design should benefit humans, plants and animals
6. per city block the area will be constructed *(De Nijs et al., 2022)*.

These principles correlate with the main themes discovered in earlier stages of the research. Biodiversity is integrated in the fifth principle, both the structure of green in the area as well as the choice of vegetation are designed to promote biodiversity. The design in different city blocks, allows for the green areas to be continuous throughout the area creating uninterrupted foraging grounds for animals. The theme of climate adaptation is integrated in the fourth principle, as the municipality of Utrecht sees sustainability in this project as "a neighbourhood that is robust and climate

adaptative…" *(De Nijs et al., 2022)*. This is also visible in the NbS rain garden that is used multiple times in the area to help retain rain water and the NbS green roofs. Health & wellbeing is incorporated in the principle that the design should benefit humans, as a healthy human is central in their plans by creating a space with clean air where a healthy lifestyle is promoted. Lastly the aesthetic value is more implicit present. The urban development plan does not say anything in the lines of "the goal is to create a beautiful area", but in the visual quality plan, a colour scheme for the whole project is presented *(De Graaf & Leroi, 2022)*. This is to assure that Beurskwartier will be a place "where you feel at home, where you come home" *(De Graaf & Leroi, 2022 p. 9)*. A map of how the future area will be laid out can be found in Figure 17.

Figure 17 Plans for Beurskwartier from De Nijs et al. (2022)

With its location, this project ticks of the boxes for the first two selection criteria. The addition of rain gardens, ticks of the last box. And although the first preference has not been met (there is no alternative design known), the second preference is met, as biodiversity, climate adaptation, health & wellbeing and aesthetic value are of importance for this project. Therefore this project is suitable to be used as a test case.

To also show how differences in the spatial design can make a different, a fictional variation on this plan was also assessed. With this fictional variation a comparison will be made between two plans, to see how small variations impact the service value of Beurskwartier. The two project are at base the same, but within both parks in the variation, a body of water will be constructed. The current situation is referred to as "current", the original plans are referred to as "Scenario A" and the fictional alternative is referred to as "Scenario B".

11.3 Input for EA

To value the redesign of Beurskwartier, certain values were inserted in the earlier created framework. With this case not every indicator could be precisely known, but in future cases this could be the same, therefore some assumptions were made. This chapter explains which values are used to calculate the added value for the municipality Utrecht from Beurskwartier and explain how certain assumptions were made.

11.3.1 Ecosystem extent account

The total area for this project is about 6,4 hectares. This is the of only subproject 1 and without the construction sites for the Galaxy tower and the Wonderwoods towers. As mentioned there are currently some buildings that will either be demolished or integrated in the new design. The current buildings take up approximately 27% of the area amounting to 1.72 hectares. There is very little urban green present, only 2%, and the rest of the area is parking lot and roads which is part of the infrastructure ecosystem type *(Google, 2023)*.

After the project is finished several building blocks have emerged with inner gardens. Since these inner gardens are partially only for residents and are part on the territory of the building blocks, those are counted as part of the buildings when calculating the extent of each ecosystem type. After remodelling the buildings take up a bit over 50% of the area, and the two parks are the urban green and take up 17%. The remaining 32% will be part of the infrastructure network, which this also includes little beds. In both the current situation and plan A, there is no space left for water.

In the alternative plan B, half of the parks are water, which means that the area for urban green has been cut in half compared to plan A and both the water and urban green area make up approximately 8.5% or the area. An overview of the division in all plans can be seen in Table 16, this also shows that in the new plans, more than 50% of the area will be used for residential and non-residential construction.

Table 16 Extent account Beurskwartier

	Current area	Area%		Area plan A	Area%	Δ plan A		Area plan B	Area %	Δ plan B
Residential and non-residential construction	1.72	26,8%		3.24	50.5%	+ 1.52		3.24	50.5%	+ 1.52
Urban Green	0.12	1.8%		1.10	17.1%	+ 0.98		0.55	8.6%	+ 0.43
Infrastructure	4.57	71.4%		2.08	32.4%	- 2.50		2.08	32.4 %	- 2.50
Water	0.00	0.0%		0.00	0.0%	+/- 0.00		0.55	8.5%	+ 0.55
Total	6.41	100.0%		6.41	100.0%	+/- 0.00		6.41	100.0%	+/- 0.00

11.3.2 Ecosystem condition account

The second step in EA and in therefore also in the test case, is to fill out the ecosystem condition account. This paragraph will discuss each indicator individually. The last paragraph shows the overall condition of the Beurskwartier

Vegetation layer score

To calculate the vegetation layer score, the area coverage of the 3 vegetation layers (tree, shrub/bush and moss), are determined. When looking at the current Beurskwartier, satellite images

from google, were used to determine the area coverage *(Google, 2023)*. It was determined that approximately 75% of the residential and non-residential construction area is covered by houses or sheds or is paved. For the other 25% of the area is unpaved garden. 20% of this area is ground-covering vegetation. The other 5% is bush and shrub cover. Approximately half of the ground that is covered by a ground-covering vegetation is also covered in trees. The urban green part of the current Beurskwartier is for 70% covered in trees, this whole area is covered in some ground-covering vegetation and 10% is covered in the middle layer. On the infrastructure area, less than 1 percent is covered in trees. Other types of vegetation are not present.

For the future Beurskwartier plan A the amounts of vegetation are determined using the different plan documents such as the visual quality plan *(De Graaf & Leroi, 2022)* and the urban development plan *(De Nijs et al., 2022)*. The residential and non-residential construction area is almost fully covered in moss layer, as also most roofs are green roofs covered in ground-covering vegetation. Only the tops of the highest towers are not coved, these make up 14% of this ecosystem type. This means that 86% of the area is covered in some type of vegetation, mostly ground-covering. Within each inner garden at least 1 tree will be planted. The estimate is that 5% of this ecosystem type will be covered in trees, 15% will be the interlayer and 81% of the residential and non-residential area will be covered in the moss layer. For the urban green layer, between 20 and 25% of the area will be covered in the middle layer. 85% of the area will be covered in moss layer and 30% of the area will be covered in trees. From the infrastructure area, only the tree cover exists, this is only between 0 and 5 percent coverage. These scores were scaled between the earlier established lower and upper value to establish the indicator value. The index value is the indicator value multiplied with the weight factor of 0.25.

When looking at plan B the vegetation score stays the same, as it is parts of the urban green area that are transformed to lake, but the lay out of the unchanged areas stayed the same, resulting in a same condition. The results of the future plans for Beurskwartier can be found in Table 17.

Table 17 Vegetation layer score index results

	Variable plan A	Indicator plan A	Index plan A		Variable plan B	Indicator plan B	Index plan B
Residential and non-residential construction	3.72	0.91	0.23		3.78	0.91	0.23
Urban green	4.76	0.98	0.24		4.76	0.98	0.24
Infrastructure	-1.6	0.19	0.05		-1.06	0.19	0.05

Shadow cover

Next step in the condition account is the shadow cover of the area. In the current residential and non-residential area, approximately 15% of the area is covered in shadow *(Google, 2023)*. For urban green this area is the same as the coverage by trees and for infrastructure this is 0.

For the plan A the amount of shadow is the amount of shadow created by the tree cover + extra shadow cover due to the high rise buildings. For construction this means that approximately 10% of the inner-gardens are in shadow. But some of the trees that create shadow are already in the shadow of the buildings, resulting in an area covered in shadow of 35%. The urban green will for the

most part receive its shadow from the trees, which results in a shadow cover of 30%, a little bit extra shadow will be created due to the buildings, but this will cover between 5 to 10 percent extra. For infrastructure a lot of the shadow will be created by the buildings. From trees only this shadow cover would be 2,5% only, but adding another 20% for the shadow due to buildings will lead to 22,5% shadow. This will lead to the index results as shown Table 18 when using the upper and lower values to calculate the indicator and weight of 0.25 to calculate the index value.

For plan B, the same argument holds as for the vegetation score, since the lay-out of the areas not converted to water stay the same, the shadow cover of those areas does not change either.

Table 18 Shadow cover index results

	Variable plan A	Indicator plan A	Index plan A	Variable plan B	Indicator plan B	Index plan B
Residential and non-residential construction	35%	0.88	0.22	35%	0.88	0.22
Urban green	38%	0.94	0.23	38%	0.94	0.23
Infrastructure	23%	0.56	0.14	23%	0.56	0.14

Soil quality

Third is the soil carbon stock. As mentioned this can be found on maps from Atlas Natuurlijk Kapitaal. For the original condition, it can be found that the carbon stock is around 50 ton C/ha *(RIVM, 2020a)*.

For the plan A and B, no values are known yet, but will be the same as the lay-out of the non-water areas is the same. Looking at locations with similar amounts of nature in the area, can give an idea of how the soil will be after completion. If one looks at the neighbourhood Lunetten, a value can be seen of approximately 100 ton C/ha *(RIVM, 2020a)*. It is plausible that the same value can be generated for Beurskwartier as Lunetten although there are differences between them. The main difference is that Lunetten is an older neighbourhood (building started in the 1970s) with low-rise buildings *(Gemeente Utrecht, 2019)*. But since nature has an important role in both, it is plausible that for Beurskwartier a value of approximately 100 ton C/ha will be created in the urban green area. For the residential and infrastructural area a little lower soil quality of 75 ton C/ha is used, as it is less necessary to use a carbon-rich soil with nutrients. These values are recalculated to indicator values using the lower and upper boundaries of 0 and 175 ton C/ha as described in chapter 5. To calculate the index as shown in Table 19, the indicator value was multiplied with the weight per indicator, which is 0.25.

Table 19 Soil quality index results

	Variable plan A	Indicator plan A	Index plan A	Variable plan B	Indicator plan B	Index plan B
Residential and non-residential construction	75 ton C/ha	0.43	0.11	75 ton C/ha	0.43	0.11
Urban green	100 ton C/ha	0.57	0.14	100 ton C/ha	0.57	0.14
Infrastructure	75 ton	0.43	0.11	75 ton	0.43	0.11

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		C/ha				C/ha		

Air quality

Last indicator that was assessed is the air quality. This was assessed in approximately the same way as the soil quality. For the original condition, the value is known and lies between the 20 and 25 ton µg/m^3 *(RIVM, 2020b)*. In EA the average value of 22,5 will be used.

Looking at plan A, again the numbers of Lunetten can be used. Air quality is severely impacted by the emissions of vehicles driving by. This can be easily seen on *RIVM (2020b)*, as the main high ways in the Netherlands run like a red thread through the map. Lunetten is an area in which there are not many movements with motorized vehicles within the area, but it is located in between the A12, A27, waterlinieweg and the railway which generates emissions. For Beurskwartier a similar situation holds, it is located close to the railway, and although in the area itself not many emissions from vehicles are expected as most is a pedestrian zone, the area surrounding it sees a lot of motorized traffic. It is therefore expected that Beurskwartier can see the same air quality as Lunetten, which is between 18 and 20 µg/m^3 *(RIVM, 2020b)*. As it is not in between highways, but in the city centre and the main part will be car-free, here the lower end of 18 µg/m^3 will be used. Since air will move throughout the different ecosystem types, the same number for the whole area will be used. The calculations for the indicator and index values can be seen in Table 20

Unlike the previous indicators, the air quality is different in plan B compared to plan A. Since the air quality is influenced by the vegetation and the vegetation in this scenario is less than in A, the air quality will be lower. This is now expected to be 20 µg/m^3 in all ecosystem types. This will lead to an indicator value of 0.5 and an index value of 0.13 for all areas but water. As can be seen in Table 20 for water the indicator and index values are equal, as this is the only indicator within water and therefor has a weight of 1.

Table 20 Air quality index result

	Variable plan A	Indicator plan A	Index plan A		Variable plan B	Indicator plan B	Index plan B
Residential and non-residential construction	18 µg/m^3	0.55	0.14		20 µg/m^3	0.50	0.13
Urban green	18 µg/m^3	0.55	0.14		20 µg/m^3	0.50	0.13
Infrastructure	18 µg/m^3	0.55	0.14		20 µg/m^3	0.50	0.13
Water	N/A	N/A	N/A		20 µg/m^3	0.50	0.50

Conclusion condition account

The index values can show the quality of the ecosystem types. Table 21 shows that the quality of the residential and non-residential construction is at 0.69 for plan A, which indicates that the condition of this ecosystem type is at 69% of what it can maximally achieve. For the urban green in plan A this is even higher, 76%. Only on infrastructure the score in plan A is low, as it is only 43%. For plan B the scores on residential and non-residential construction, urban green and infrastructure are al 0.01 or 1% lower due to the air quality.

Table 21 Index scores per ecosystem type

	Plan A				Plan B			
	Residential and non-residential construction	Urban green	Infra-structure		Residential and non-residential construction	Urban green	Infra-structure	Water
Vegetation layer score	0.23	0.24	0.05		0.23	0.24	0.05	N/A
Shadow cover	0.22	0.23	0.14		0.22	0.23	0.14	N/A
Soil quality	0.11	0.14	0.11		0.11	0.14	0.11	N/A
Air quality	0.14	0.14	0.14		0.13	0.13	0.13	0.5
Sum	0.69	0.76	0.43		0.68	0.75	0.42	0.5

11.3.3 Ecosystem service account

The next step in the test case, is to calculate the services. Just as the explanation in chapter 5, this paragraph will explain both the physical and monetary service in the same paragraph per service.

Local climate regulation service

For the local climate regulation service, the amount of houses that are within 400 meters of park or a body of water should be determined. Since all the houses are part of the construction ecosystem type, only for this ecosystem type the service will be calculated.

Currently very few houses are in this area, but approximately 50 of the current ones are within 400 meters of the Veilinghaven *(Google, 2023)*. This means that for the physical service account in the current situation 50 houses will be entered. The average WOZ value in the municipality of Utrecht in 2022 was €392.000,- *(CBS, 2022b)*. Based on the added value of 6% for being in proximity of a green of blue area *(Luttik & Zijlstra, 1997)*, the price for this service will be €23.520,- per house. In the current situation this will add up to €1.176.000,-.

In the both plan A and plan B, 2.500 new homes will be created. Since this is all in close proximity of the two parks (and bodies of water for plan B) in the middle of the construction sites, all of these houses will be within the 400 meter range of a park or body of water (Table 22). Therefore in the framework for both plan A and plan B the value of 2.500 will be filled in for the physical service account. Since the only thing that is known about the values of the future houses is that it will be a mixture of more cheap and more expensive housing *(De Nijs et al., 2022)*, the same average WOZ value of the municipality of Utrecht will be used. This will again lead to a price of €23.520,- per house, but this means the total value of this service will be €58.800.000 once the project is finished.

Table 22 Physical services related to climate adaptation

		Regulation and Maintenance services	
		Local climate regulation	Rain water regulation
		#houses in proximity	mm rain retained
Residential and non-residential construction	Current	50	0
	Plan A	2500	35

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	Plan B	2500	20
Urban Green	Current	0	0
	Plan A	0	35
	Plan B	0	20
Infrastructure	Current	0	0
	Plan A	0	35
	Plan B	0	20
Water	Current	0	0
	Plan A	0	0
	Plan B	0	0

Rainwater regulation service

To determine the rainwater regulation service, it should be determined how much of the rainwater can be retained due to extra measures. In the current situation no specific measures for retention are in place, this means that the current value here for all ecosystem types is 0.

In plan A, parts of the urban park will be designed as raingardens. Also the roofs of the buildings will retain rain water. All these measures together will ensure that 35 mm of rainwater can be retained on top of the normal retention *(De Nijs et al., 2022)*. This means that for the physical account for the ecosystem types construction, urban green and infrastructure, this service will be valued at 35mm (Table 22).

To calculate the monetary value of this service, different calculations need to be made. Starting with a reminder of the equation that will help determine the damage costs in euros as shown in Equation 11.

Equation 11 Damage calculation for flooding

$$Damage = max.direct\ damage * \gamma_{depth} * \gamma_{duration} * \gamma_{season}$$

For residential and non-residential construction the maximum value for direct damage is determined to be €331/m^2 and the total area of this is 32370.5 m^2. The γ_{depth} is determined to be 0.35 with a water depth of 35 mm and the other partial factors are 1. This results in a service value in the construction ecosystem type of €3,750,122. For urban green the damage value is €1,327/ha, the area surface is 1.1 hectares, the γ_{season} equals 0.76 and the other factors equal 1. The result for this is a service value in urban green of €1,105. Lastly also for infrastructure this calculation will be made. Here only the $\gamma_{duration}$ will not equal 1, as it is 0.5. The price per hectare is €928 and the area is 2.08 hectares. This leads to the service value within infrastructure of €964.

In plan B the calculations used a different input. With the amount of urban green cut in half, there is less space available for the raingardens, and it is assumed that now only 20 mm can be retained instead of the original 35 mm (Table 22). Therefore the residential and non-residential construction will have a monetary value of €2,142,927. For urban green the value in scenario B will be half of the value of plan A, as here the depth does not influence the damage costs, and all other partial factors are the same, so only the area surface influences the price. This lead to a service value for rainwater regulation in plan b of €553. For infrastructure the depth does not influence the damage costs, which means that this price is the same as for plan A infrastructure.

Health service of nature

For the health service, the number of residents in an area should be calculated. For the current situation the PDOK viewer van *Kadaster (2020)* shows that for the 2 postal code areas 3521BK and 3521BL (the 2 areas that make up the current 75 houses), there are respectively 35 and 105 residents. This gives a total of 140 residents. In the same area there is in the current situation 1,84% green. Using Equation 12, this means that in the current situation there will be 0,09 patient less because of the nature in the area.

Equation 12 Reduction in patients

$$Reduction\ in\ patients = area\%\ green * 3.47 * 10^{-4} * residents = 1.48 * 3.47 * 10^{-4} * 140 = 0.09\ patients$$

For plan A and plan B, the number of residents is still unknown. What we do know is the number of future houses (2500 *(De Nijs, 2022)*) in both plans and an average of 2,14 persons per house in 2021 *(CBS & Planbureau voor de Leefomgeving, 2022)*. If we assume that this average will be the same in the new dwellings, this will result in 5.350 residents in the new Beurskwartier for both plan A and B.

Not only the number of residents increases, but also the urban green space in the area. As already mentioned in the extent account, the two parks make up 17% of the area in plan A. But the area also has multiple beds that make up an extra 10% and the indoor gardens that add an extra 12%. This means that the total green area surface in the new Beurskwartier will add up to 39%. This results in a reduction of 72 patients for plan A (Table 23). In plan B the number of patients is a bit less, as 8.5% of the area surface that was urban green is now water. Using a percentage of 31% for area covered in green, the number of patients that will be reduced due to the green lay-out is 58.

To calculate the monetary value the number of patients should be multiplied with the medical costs per patient. Resulting in a monetary value of €80 in the current situation, and a value of €66,392 in the plan A and €52,773 in plan B.

Table 23 Physical services related to health & wellbeing and aesthetic value

| | | Cultural services | | |
| | | Visual amenity services | | Health service |
		#houses with nature view	#houses with water view	Reduction in #patients
Residential and non-residential construction	Current	75	0	0,09
	Plan A	500	0	72
	Plan B	500	200	58
Urban Green	Current	0	0	0
	Plan A	0	0	0
	Plan B	0	0	0
Infrastructure	Current	0	0	0
	Plan A	0	0	0
	Plan B	0	0	0
Water	Current	0	0	0
	Plan A	0	0	0

	Plan B	0	0	0

Visual amenity service

To calculate the visual amenity service, two similar calculations need to be made. First it needed to be determined how many houses have the right view (either green or blue nature). In the current situation all the houses (approximately 75) have a view on green *(Google, 2021)*. None of the houses have a view on a body of water.

In the future situation there will be approximately 2500 houses in the area. With all the indoor gardens and parks and beds, the lower layers will all have the right view. But if you go up too high, you will be higher than the trees and only see other buildings or a view over the city. However, to counteract this, all building blocks exist out of smaller sub-blocks of different heights with roof gardens on top of them *(De Nijs et al., 2022)*. This means that also some of the higher living people can still have this green view. It is determined that approximately 20% of the 2500 houses have this green view in plan A and plan B, which is 500. Since no new water bodies will be created in Beurskwartier in this plan A, this number will be 0, whereas in plan B this number is estimated at 200. These numbers can also be found in Table 23.

To calculate the monetary value of this service, the number of houses with the right view, should be multiplied with the average WOZ value of €392,000 *(CBS, 2022b)* and the extra value created of 5% for a green view *(Luttik & Zijlstra, 1997)*. This means that per house with a green view the price of the amenity service is €19,600 and per house with a blue view this is €31,360.

Result service accounts

As an overview, Table 24shows the value of the different ecosystem services per service. Her it shows that only for local climate regulation service and the visual amenity service of nature, the values of plan A and B is the same. For all the other services, the values differ. Plan A has a higher value for rain water regulation and the health service, but plan B has a way higher value of the visual amenity service of water. This results in a highest value for plan B.

Table 24 Ecosystem service values for Beurskwartier

	Current	Plan A	Plan B
Regulation and maintenance services			
Local climate regulation	€ 1,176,000	€ 58,800,000	€ 58,800,000
Rain water regulation	-	€ 3,752,192	€ 2,144,443
Cultural services			
Health	€ 80	€ 66,392	€ 52,773
Visual amenity – Nature	€ 1,470,000	€ 9,800,000	€ 9,800,000
Visual amenity – Water	-	-	€ 6,272,000
Sum	€ 2,646,080	€ 72,418,584	€ 77,069,217

11.3.4 Ecosystem asset account

The last step for Beurskwartier is to calculate the asset value. The sum of all monetary values per service has been calculated in the last step. Using the present value formula in excel, with the sum of

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the monetary values per service as payment, it will give the asset value. In Table 25 these numbers for the current spatial layout of Beurskwartier can be found and in

Table 26 it shows the numbers for the plan A for the new Beurskwartier and Table 27 for plan B. Comparing both the asset values of plan A and plan B to the current asset value, it shows that this increases a lot. This is mainly because of the local climate regulation service,

Table 25 Asset value of the current Beurskwartier

	Discount	Asset life	Monetary value	Asset Value
Regulation and maintenance services				
Local climate regulation	2	100	€ 1,176,.000	€ 50,383,662
Rain water regulation	2	100	€ 0	€ 0
Cultural services				
Health	3	100	€ 80	€ 2,534
Visual amenity – Nature	3	100	€ 1,470,000	€ 45,450,391
Visual amenity – Water	3	100	€ 0	€ 0
Sum				€ 97,136,586

Table 26 Asset value of plan A for Beurskwartier

	Discount	Asset life	Monetary value	Asset Value
Regulation and maintenance services				
Local climate regulation	2	100	€ 58,800,000	€ 2,534,183,076
Rain water regulation	2	100	€ 3,752,192	€ 161,713,270
Cultural services				
Health	3	100	€ 66,392	€ 2,097,922
Visual amenity – Nature	3	100	€ 9,800,000	€ 309,669,272
Visual amenity – Water	3	100	€ 0	€ 0
Sum				€ 3,007,663,540

Table 27 Asset value of plan B for Beurskwartier

	Discount	Asset life	Monetary value	Asset Value
Regulation and maintenance services				
Local climate regulation	2	100	€ 58,800,000	€ 2,534,183,076
Rain water regulation	2	100	€ 2,144,442	€ 92,421,895
Cultural services				
Health	3	100	€ 52,773	€ 1,667,579
Visual amenity – Nature	3	100	€ 9,800,000	€ 309,669,272
Visual amenity – Water	3	100	€ 6,272,000	€ 198,199,334
Sum				€ 3,136,130,156

11.4 Result of EA

This version of EA was created with the goal to stimulate the use of NbS, meaning that is should result in higher values for plans that include NbS. In plan A and Plan B different NbS have been used. In Table 28 the different types of NbS and their application in the plans are shown and as can be seen, multiple NbS are used in both plans.

Table 28 Use of NbS in Beurskwartier

Type of NbS	Plan A	Plan B
Blue infrastructure	No	Yes, ponds in the middle of both parks
Community gardens and allotments	No	No
Green areas for water management	Yes, rain gardens	Yes, rain gardens
Grey infrastructure featuring greens	Yes, street greens	Yes, street greens
Nature in buildings	No	No
Nature on buildings	Yes, green roofs	Yes, green roofs
Parks and urban forests	Yes, two parks	Yes, two parks
Intentionally unmanaged areas	No	No

The local climate regulation service relates to the NbS of blue infrastructure, parks and urban forests and the intentionally unmanaged areas. For the rain water retention service green areas for water management are valued. The health service of nature looks at all the green areas in an ecosystem and therefore includes the community gardens and allotments, green areas for water management, grey infrastructure featuring greens, nature on buildings, parks and urban forests and intentionally unmanaged areas. The visual amenity services value the blue infrastructure for the visual amenity service of water and parks and urban forests. Only the NbS nature in buildings is not valued through the current framework of NbS.

The results from the test case also show that the addition of an extra NbS in the area (blue infrastructure) increase the value of the visual amenity service of water. The local climate regulation service was also related to this NbS, but did not increase as no extra houses were in proximity of either a park of a body of water. The addition of the extra NbS also resulted in less space for the rain gardens and other types of green nature. This is also shown in the asset values of those related services. For the rain water regulation service the asset value fell by 40% and the health service of nature dropped by 20%. Overall the asset values show plan B is the plan with a higher asset value for its ecosystem. If decision-makers were to base their decision on the impact of their plans on the local ecosystem, they would opt for plan B.

12 PROCURE FOR NBS

This chapter talks about how EA can be used within the procurement project to create NbS. Based on the literature studies and the interviews, it was found that this usage differs per contract type and that not only the procurement phase itself is important. The first paragraph talks about the procurement process for traditional contracts and the second paragraph discusses the integrated contracts. As from the stakeholder interviews was concluded, the creation of a NbS does not only come from the procurement phase itself, a good preparation in the ambition phase and proper validation in the control phase are also necessary. Both paragraphs therefore discuss these three important moments chronologically.

12.1 Traditional contracts

The first contract type that was discussed in the literature study, was the traditional contract. This contract followed the design, bid, build (DBB) principle. The impact from EA on this process will be discussed based on the three phases that should use EA: Ambition phase, call for tenders and control phase.

12.1.1 Ambition phase

For traditional contracts, the ambition phase entails shaping the ambition up to setting the requirements for the design to be created by an architect. The early ambitions are often created during ambition web sessions. According to *Duurzaam GWW (2017)*, the ambition web has twelve themes help formulate the ambitions and translate them to requirements: energy, materials, water, soil, ecology, land use, spatial quality, wellbeing, social relevance, accessibility, investment and business climate. Per theme the ambition can be on one of three levels:

Level 1:   Insight and minimum level of improvement
Level 2:   Measurable/verifiable objectives and achieving a significant improvement
Level 3:   Maximum commitment and achieve highest achievable performance *(Duurzaam GWW, 2017)*.

On either of the three levels EA can help to create the necessary insight (level 1), to use measurable indicators (level 2) and to help assess what the highest achievable performance is (level 3). The four themes that were found in the early stages of this study (biodiversity, climate adaptation, health & wellbeing and aesthetic value) all have their own place within the ambition web. The themes water and soil relate to the sub-theme of water management from climate adaptation, and the theme for land use relates to the temperature part of climate adaptation. Wellbeing relates to the theme health and wellbeing and

Biodiversity relates to the theme ecology, where explicitly the link with ecosystem services is made and where improvements compared to the grey solutions are part of level 2. Climate adaptation with sub-theme water management falls in the ambition web themes water and soil, and the sub-theme temperature management is part of land use. Wellbeing relates to the themes of Health & wellbeing and aesthetic value. Ecology relates directly to biodiversity, but also the other themes as the link with ecosystem services and using their (monetary) valuation as KPI is made explicitly here *(Duurzaam GWW, 2017)*. This means that already within current instruments there is a place for EA.

Once the ambition has been formulated, the ambition can be translated into requirements for the architect. These requirements can be made explicitly (at least x.x% of the area should be urban

green), or directly relate to EA (at least a value of €xxx should be created for service Y). The decision on how to formulate the requirements can be based on the experience of both the client and the contractor with EA. If the architect is familiar with the framework and they know a lot about NbS, the architect can create the design based on the EA-requirements. If the architect is less experienced in the framework or applying NbS or the client wants to use specific types of NbS, the client can make the requirements more explicit. What both options have in common is that after the architect has finished the design, NbS should be incorporated and no design freedom for the contractor is left.

12.1.2 Call for tenders

The second phase that should be discussed is the call for tenders. During the call for tenders, first the client publishes the project, whereafter a selection on the bidders can be made and lastly the contract is awarded to the best bid. Depending on the type of procurement the contract can be awarded based on the lowest price or the best quality plan.

For traditional contracts, there is no design freedom left for the contractor, which means that they can only win based on the lowest price of their construction method or the lowest price in combination with the quality of this method and the process. In this phase for this contract type, EA cannot be used, as EA focusses specifically on the spatial design and the differences a design can make.

12.1.3 Control phase

After the contract has been awarded construction can start. During this construction and at the delivery, the clients should check whether or not the contractor does as they promised and as required in the contract.

All the design choices that were made by the architect (based on EA) have been put in the contract as requirements, meaning that the NbS as designed will be constructed if the contract would be followed. However, as multiple stakeholders mentioned, sometimes the clients lacks action in the control phase to really check if a contractor holds up the promises they made in the tender or as were specified in the contract. Although EA cannot directly check if the contractor did as promised, as the contractor made no design choices, the themes used in EA are of importance and should therefore require attention in this phase.

In this phase, the contractor can also request design changes. These request can be accepted or denied by the client, depending on the reason behind the request and how this impacts the costs for the project. If a design change is significant, the contractor can use EA to see how this request impacts the ecosystem and base their decision on this impact. If a design request negatively impacts the value of an ecosystem, this can be one of the reasons for a client to not accept it. An expensive request for the client can however still be an attractive choice as it may impact the ecosystem positively. EA can therefor support decision-making for the client in the control phase.

12.2 Integrated contracts

The second type of contracts that are used within the Dutch construction sector are the integrated contracts. Where technical specifications are the basis of the traditional DBB contracts, Integrated contracts ask for functional specifications for D&B, E&C and DBM contracts or even service specifications in DBFM and DBFO contracts. This gives contractors more design freedom to come up

with their own solution. How EA can be used for these contracts is discussed in the following paragraphs.

12.2.1 Ambition

For integrated contracts, the ambition phase entails shaping the ambition, setting the requirements for the design and/or making the first design choices up to the tender phase. Similar to the traditional contracts, for this phase often the ambition web is used. By assessing the project during ambition web sessions, EA can be used to formulate the ambition for the project.

The difference in this phase between the integrated and the traditional contracts is, that for a traditional contract all design requirements will be used as input for the design by the architect and contractors simply have to follow that, where in integrated contracts some of the ambition will be translated into requirements or design choices contractors have to follow, while others will be translated into MEAT-criteria that contractors can decide to ignore. This means that ambitions that you, as a client, want to be sure are met, should be a requirement and the ambitions that you would like to be met can become MEAT-criteria.

To link this back to the goal to stimulate NbS, this means that a specific NbS can become a requirement in the project. However, due to the principles of procurement, this is not always possible. If a certain NbS uses an innovative technique that only one contractor can deliver, the principle of competition violated. There can also be other reasons to put a NbS as a MEAT-criterium instead of a requirement. By asking for NbS with MEAT-criteria, the client invites contractors to innovate, which means they can come-up with solutions, that were not know yet to the client.
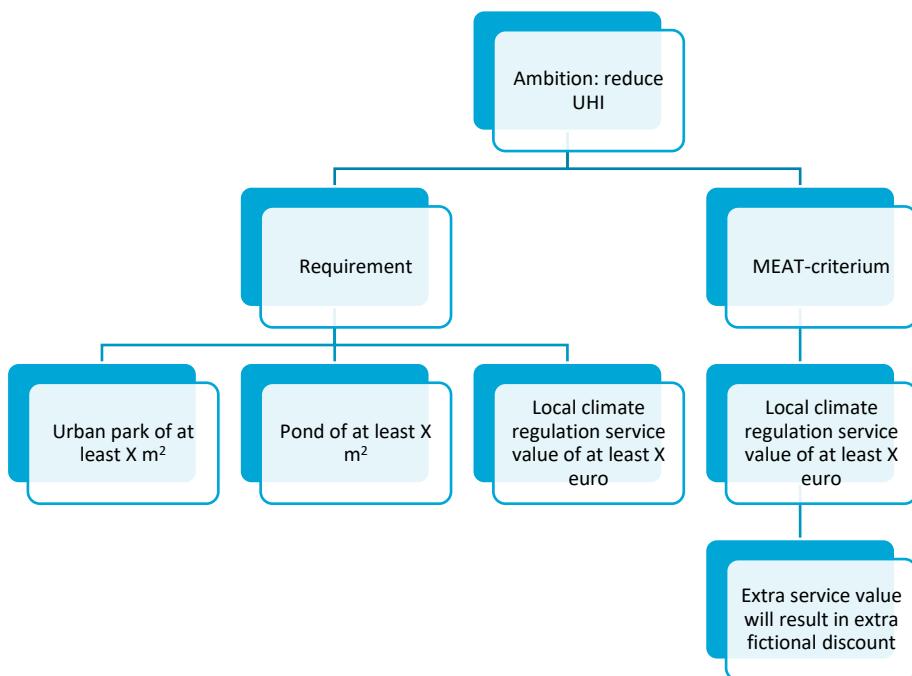
Figure 18 Flowchart for procurement with an ambition to reduce UHI

When the ambition exists to reduce the UHI-effect, this can be done by adding more vegetation in the area such as an urban park, or create blue areas such as lakes in the area. Both these solutions are nature-based, and both these solutions influence the local climate regulation service within EA. When the client has made the choice they want to fight UHI by adding more vegetation, they can require the contractor to make space for a park or pond within their design of at least X m². They can

also state that they want to have a minimum value for the local climate regulation service of X euro. This can be a requirement, where extra value does not create extra benefit for the client, or it can be a MEAT-criterium. In the second case extra value for that service does result in extra benefits for the client in the form of fictional discount. In Figure 18a flow chart of these choices can be found. If there is no one specific service or NbS that is favoured over others, the client also has the choice to ask for a minimum of the total service value of €X either as a requirement or a MEAT-criterium.

12.2.2 Call for tenders

After the client has decided what to put in the requirement and what in the MEAT-criteria the next step is the call for tenders. Most often, the tender is awarded based on quality and price, and only for limited reasons the client can award on lowest price. However, in contracts that have a certain level of design freedom for the contractor, these arguments do not hold, meaning that for integrated contracts, the awarding is always based on a combination of quality and price. The quality is assessed through one or multiple MEAT-criteria. During the tender phase, selection criteria for the different tenders could also be used, however since this does not relate to the use of EA, this will not be discussed in this section.

This means that a client should find a balance between keeping their price low, but also creating enough quality and therefore receiving enough fictional discount that the sum of these two will make them the winner. Provided they have met all the requirements.

Looking at the example on fighting the UHI-effect by putting it in a MEAT-criterium (right column in Figure 18), the bid will be invalid if the minimum value for the local climate regulation value will not be met. If the contractor has just met the minimum value, they cannot differentiate their plans from the others. However, if a contractor was able to create a design where they created a lot of space for both a park and pond, they can receive a higher fictional discount compared to one that just barely met these minimum requirements. If the fictional discount was based on the total service value in a project area, they could try to find their ultimate balance between the different services and the investment costs. If they were able to create rain gardens using their own new technique where they can retain even more water, and combine that with a lot of extra space for green and water, the highest fictional discount can be awarded if others do not come close to their design.

However, what clients should be aware of, is that for contractors in this phase, their main goal is to win the tender. This means they will analyse the framework to see where they can most easily create the most value for the lowest price. In the current version, 3 service values are dependent on the WOZ-value of the houses and the number of houses (local climate regulation service and both visual amenity services). This means that it can be interesting to either create houses with a higher WOZ-value or simple create more houses as this will automatically raise the overall service value without adding any measures that help the ecosystem. In the future this can be countered by implementing different ways of valuing the ecosystem services, for now clear guidelines on the number and type of housing that should be included are necessary. This could also be combine with using different weight-factors depending on which theme the client finds most important, however this is not looked into further in this study.

In the end, the client that was able to create the best quality combined with the lowest price while adhering to all requirements wins the tender in this phase. Both for assessing the quality and the requirements EA could be a useful addition. All promises that the winner made to get the contract,

will be translated into requirements as well, meaning they have to fulfil these as well in the later stages.

12.2.3 Control phase

The last moment that is discussed is the control phase. During this period the design and construction will be verified with the contract. Since all promises the contractor made during the previous phase are translated into requirements, it does not matter if the NbS was set as a requirement or a meat-criterium: the contractor has to create these. In the case that they fail to meet something they promised to receive a fictional discount, they can be fined for this. According to multiple stakeholders, this can result in a fine that is 1.5 times the amount of fictional discount the contractor received with that promise.

The effectiveness of these fines is also debatable. Never fining the contractors when they do not follow a contract, can lead to a contractor with an indifferent attitude to complying. Fining the contractor however, can disrupt the relationships. The contractor loses money, that he will probably have gain somewhere else in the project by asking for additional work payments. The client also does not win anything from the fine, he does save money, but as most clients in the construction sector are public entities, their goal is never to gain money. The height of the fine is also debatable, as it can feel as disproportionate since the client does not lose the same value on the project as they fine the contractor for. EA can also help in this instance if the service values were used for the MEAT-criteria. If the deviations to the plan were rather small in total service value, a less big of a fine can be imposed on the contractor. If the changes made by the client result in losing all the extra service value, the total fine of 1.5 times the fictional discount is reasonable. The upside in using EA throughout the tender for MEAT-criteria is that it gives the client in the control phase measurable criteria that can also help determining proportionate fines. If the changes made by the client would have resulted in only 75% of the fictional discount they have received, a fine of (25% of 1.5 =) 37.5% of the fictional discount can be given. This could lead to a lower threshold for clients to fine the contractor, while still being an incentive for the contractor to follow the contract.

V.   Discussion & Conclusion

13 DISCUSSION

This chapter discusses the findings as presented in the study. Throughout the different research parts, I tried to assure the validity of my findings by combining different sources. These discussions can be found in the earlier discussion chapters. This chapter focusses therefor on the discussion of the latter part: Usage in practice and the study as a whole.

13.1 Discussion on usage in practice

To see how the framework values real plans, the test case for Beurskwartier was used. Information on this case was found in serval documents presented by the client, but also by looking at similar areas and by assumptions. Especially the fictional plan B relies on a lot of assumptions. This means that the exact numbers that are shown for the different indicators in the condition account and the values for the different services can be different in practice. However, the test does show that alteration is plans result in different values and that for the eight types of NbS, seven influence the asset value of an ecosystem positively. Only the nature in buildings is not valued through the framework. However this NbS being indoors, it will be less interesting for clients whether or not it is used.

What the test case also shows, is that the direct link between the ecosystem condition and extent and the ecosystem service account is not fully known. I have tried to show how they relate to each other, but we cannot state that an increase in vegetation layer score of X results in an increase of the health service of nature of Y. However, a higher vegetation layer score indicates more area is covered by some type of vegetation, which does influence the health service of nature.

In chapter 12, I talk about how based on the value of different ecosystem services, a fictional discount can be created. Fictional discounts should always in some way relate to the total sum of a project. If the discount is too small, it does not differentiate the different bids, meaning that the procurement will be based on the price alone, where as a too high of a discount, results in neglecting the investment costs. This means that a balance between these two is necessary. Since I did not look into the relationship between the investment costs of NbS and the service value, I deliberately did not mention any size of fictional discount in the previous chapter.

Last point I want to address here is misuse of the framework. For contractors it is very important to win a tender procedure, as that will grant them the projects on which they make money. If contractors do not win any tenders, they cannot make money. Contractors will therefore analyse a tender to see where they can make the biggest impact (highest fictional discount) for the lowest price. This is something that the client should be aware of, or even set some regulations about. Since a lot of the value currently is tied to the WOZ-value of the houses, contractors can increase their service value if more or more expensive houses are built. If the client is clear about the amount and type of houses they want, and also set a maximum on the amount and price of these houses, they can counteract that. Vegetation is also an important part of the value of an ecosystem, but it is relatively cheap to implement. Some might think that the easiest way to win is to just add more trees and other vegetation. This is not an unwanted effect, many NbS also have the relationship with nature, meaning that more nature is desirable. And if more parties try to get an easy win by just adding trees, those parties that use other NbS as well, will still be valued higher than those that only planted some extra trees.

13.2 Reliability on whole study

As mentioned I tried to assure the reliability and validity of my study throughout the different phases. However, improvements can always be made regarding these points. The biggest one being the number of interviews that were held and the interviewees.

The reliability could be further improved by interviewing more people with the same and other standpoints. An example on this is that stakeholder 4 was very pro-NbS and thinking in ecosystems, but they were the only interviewee from the contractor side. If more people from the contractor were to be interviewed who might not have the same ideals, this could impact the results. Other themes could be valued of importance, or more sub-themes relating to one of the existing themes could have been found. With different results in this part of the study, the next section of the study could have looked different, as other (sub-)themes could have been included.

The same holds for the key informant interviews, where most experts had an expertise on either the biodiversity or climate adaptation theme, but less knowledge for the other two themes was present. Also all the experts were working at Witteveen+Bos Raadgevende Ingenieurs, a Dutch engineering and consultancy firm, that has a certain attitude towards for example biodiversity, which is currently one of the important goals in projects for them. Experts with more knowledge on the latter themes of health & wellbeing and aesthetic value could have come up with different indicators on the condition account and different services for the physical and monetary service accounts.

However, as for both the interview types the results are discussed together with the literature, I would say that the results found are reliable.

13.3 Attribution to scientific literature

At the beginning of this study, four knowledge gaps in scientific literature were found. This study tried to fill these gaps in the following ways.

This study is (on of) the first that looks at how EA can be used in procurement procedures. This directly links to the second knowledge gap identified by *Hein et al. (2020)*. They stated that focus of EA currently has been on policy making, while other areas were not studied yet. By first looking at what themes are important during the tender and how these themes can be shaped within EA, I tried to make a start on filling this knowledge gap.

Another knowledge gap was identified by *Santen (2020)*, who stated that study is necessary on effective sustainable MEAT-criteria. By looking specifically at the procurement procedure with the goal to stimulate NbS, I tried to add knowledge to this gap. With the use of EA, characteristics that value the benefits of NbS are measurable, and can be used as MEAT-criteria.

By creating the framework as I did, I tried to make a standard that can be used within urban development in the Netherlands. This standard can help fill the gap that was found by *Viti et al. (2022)*. According to them, all valuations of NbS were done case-by-case. By using a standardized version of EA as I created, also comparison between different cases can be made.

The measurements of the effect of NbS relate to the other knowledge gap from *Hein et al. (2020)*. Here they stated that how NbS contribute towards the SDGs cannot be measured in a satisfactory way currently. Although this study did not relate to the SDGs directly, it does valuate NbS based on themes that are related to the SDGs.

13.4 Attribution to practitioners

Not only did this study attribute to the scientific literature, but it also adds information that can be used by practitioners. The framework was created with four important themes, these themes were directly based on the information from practitioners themselves. This means that it can help them currently in the areas they themselves find important.

The framework values an ecosystem based on biodiversity, climate adaptation, health & wellbeing and aesthetic value. It can show the effect of NbS in an urban area in the increase of the ecosystem services, and their monetary values. By looking at the ecosystem as a whole and the effect of design choices on the whole ecosystem, it can help shift their way of thinking from only looking at one problem and solution at a time, to looking at the total ecosystem and the relationship between different services. Adapting this way of thinking, will be necessary when trying to reach the SDGs and to keep our cities liveable in the future as well. Because even though the current focus in construction is on the CO_2 emissions, the switch to using more NbS is something that should be considered in parallel.

During my research I also spoke with multiple people outside of the interviews, that were enthusiastic about the practical use. Many times I have heard, that they indeed struggle with asking for a sustainable solution in a procurement instead of only asking for a sustainable execution of the project. With the framework the sustainable solutions are made measurable which makes it easier to ask these solutions.

Next to this, I also tried to explain how and when the framework be of good use withing the procurement process. From these findings I would advise practitioners to look at the projects as a more integral process instead of different separated steps. Because currently already in the beginning nice ambitions are created in the ambition web sessions, but if in later stages other people take over the project that do not know of these ambitions, they will lose their importance.

13.5 Limitations

The scope of this research was clear, I would only focus on the use of EA within urban environments in the Netherlands. Future research can focus on the use of EA in other environments and therefore with more different ecosystem types included, in other countries or a combination of both. However other limitations have also been found during this study.

First limitation that was found, was the accuracy of the framework. As interviewee 4 also mentioned, if you want to have a framework that is usable, it should not be too complicated *[quote 4.15]*. Therefore decisions were made to balance the accuracy and the usability. An example here is the Equation 8 (see page 56) that precisely demonstrated how much the UHI would be compensated in a certain area. However precise these calculations might be, they need a lot of input and overcomplicate the latter use of the results. Therefore I chose not calculate how much cooler it would be in an area, but to see how many households would benefit from the effects of vegetation and water on the temperature. This accuracy does not necessarily have to become a problem if it is being used to differentiate between different plans. All plans are evaluated using the same method, and not the exact result but the difference between the results are of importance in that case.

As mentioned in a previous paragraph, a lot is still unknow about the exact relationship of the condition and the service account in current literature. This means that in my framework there is no direct known influence between these two accounts given. As explained an increase in the vegetation layer score will probably influence the health service positively, but to wat extent is not known. This means that currently, the condition account is not very important with the results only focussing on the ecosystem service account. This could be improved if future research could find the exact effect the condition has on the service account. What will however keep being a problem, is that the theme of biodiversity currently is only found in the condition account. With that much weight being on the service account, the theme of biodiversity could lose all of its value in the current framework.

As touched upon in paragraph 1 of this chapter, clients should set up some guidelines or requirements when they want to use EA properly in the procurement procedure. Although I gave some examples of these guidelines (set a minimum/maximum amount and value for the houses to be build), the exact necessary guidelines differ per case. When an area is relatively small, addition of one house impacts the results more that for a bigger area with more houses already. Per case the client should (in the ambition phase), look at what the pitfalls for misuse are and how they can counter these. Especially in the early stages of using EA, when client and contractor do not have much experience in using EA, this could limit the effectiveness of EA.

13.6 Future research

From the past discussion paragraphs, some ways to build on this research have already been shown. As mentioned it would be interesting to either repeat this research but with more interviews with people from a broader background. By doing the same research in a different environment (other engineers, other contractors and other clients), the results could differ, as they might not all be as much in favour of NbS as the current interviewees were and come up with other themes or sub-themes. Although this does not necessarily mean that the results will be different and other themes will emerge as important, it will help strengthen the conclusions from this study.

A similar suggestion for future research is to broaden this study to other (semi-) natural environments as well. These were now completely left out of this research, but can be useful as well. With the current talk about buying out farmers *(NOS, 2023)*, it could be interesting to see what the effects on ecosystem service are if cropland will be redesigned to a new neighbourhood to fight the housing crisis that is currently a problem in the Netherlands. In the same way the study can also be broadened by looking at other countries and researching how they would value certain services.

What can however be seen as the most important recommendation for future research is more research in the relationship between the ecosystem condition and the ecosystem service account. In the literature it was mentioned that the condition of an ecosystem can show the maximum potential of an ecosystem service, however the practical knowledge of this is currently unknown. This means that we do know that the condition of the soil implicates the quality of the vegetation, but that we do not know how this higher or lower quality of vegetation relates to the reduction in patients. This means that in the current framework the ecosystem condition account looks redundant. By doing more research on this relationship between the two accounts, the condition account will have more practical relevance.

Next to this, also more research on the relationship between the physical services and the monetary services can be done. Where for current the local climate change regulation currently the number of houses that can experience the cooling benefits of vegetation and water is leading, it would be more interesting to see how much they experience these benefits. The formulas to calculate these are known, but as explained, we currently cannot translate the cooling effect to a monetary amount, as it is unknown how much a Dutch resident would be willing to pay for a cooler environment. When the relation between the cooling effect and the willingness to pay is known, the effect of more NbS can be included. Green wall do help cool of the environment, but are currently not included in the calculations for this service. However, what should be kept in mind for both this research suggestion and the research in the relationship between the condition and the service account, is that it should not tip the scale to being very accurate, and therefore losing its usability.

An extension on this study, can also be to discuss the correlation between the investment costs and the monetary service value. EA shows the value of certain important services for an area, but it does not take the investment costs into account. It can be interesting to see when the investment costs outweigh the service value and vice versa. Insight in this could improve future business cases that use EA. If a certain investment costs way less than the value it generates, it could become an easy way to win a tender while not playing into needs of the client.

14 CONCLUSION

This chapter will draw the final conclusions of the study. First the answers to the sub-questions will be given. Thereafter the main research question will be answered.

14.1 Sub-questions

As was explained in the introduction, 5 sub-questions were drawn up to answer the main research question. This paragraph will explain the answers to each of these sub-questions.

Sub-Question 1   How can the client and contractor in the current procurement process put their ambition for NbS into practice?

For the client the way they can assure that they will receive a NbS is to put the specific NbS in the requirements of the project. This way the NbS will be tendered as such, and the contractor has no other choice than to build this NbS. However, if the client does not know which NbS would be best fitting, or they have a project that leaves a lot of design freedom for the contractor they can put this whish for a NbS in the MEAT-criteria. This can be done with EA and asking for a minimum value of a specific service or for a minimum of the total service value. For the contractor these criteria can be used to differentiate themselves positively from other tenderers, receive a higher fictional discount and hopefully win the tender. When from the client side, no ambition for NbS exists, the contractor can still implement them in their plans if that design freedom exists in the tender, but they will not be rewarded for this.

Sub-Question 2   Wat distinguishes NbS from grey Solutions?

The difference between a NbS and a grey solution is that the NbS tries to solve a problem in a way nature would solve it, where a grey solution builds extra facilities to solve this same problem. This means that NbS have added benefits for the ecosystem as they often tackle multiple issues at once. The addition of trees in an area can not only create shadow to fight UHIs, but they also improve air quality and provide habitat for birds. A grey solution that would provide the same shade would be a canopy, which does nothing for the air quality or biodiversity.

Sub-Question 3   What are the most important incentives for clients and contractors to have the ambition for NbS within Dutch urban areas?

From interviews with stakeholders, backed up by literature study, the most important incentive currently is to improve the biodiversity. Secondly it is found to be of great importance that urban areas can adapt to the current climate change crisis, meaning they both fight the UHI-effect, and they can retain rainwater in the soil for dryer periods. The third incentive for a NbS is that they can help improve the health and wellbeing of residents who live in proximity of these NbS. Last incentive is the aesthetic value a NbS can bring to an area.

Sub-Question 4   Which ecosystem characteristics are important to value for the incentives explained in SQ3?

The four incentives can be characterized in both the condition account and the service account. When looking first at the condition account, four different characteristics are interesting (Table 29). The first is the presence of different vegetation layers, which mainly exists for biodiversity. The presence of all different vegetation layers indicates a direct diversity in floral species. Indirect it also

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provides possibilities for fauna diversity as it assures all different habitat and foraging space for different animals from all trophic layers. The presence of vegetation layers also helps aesthetic value as a view of nature is appreciated and in health & wellbeing as people are healthier when they are surrounded in more nature. Another indicator for health & wellbeing is the air quality. One of the ways to ensure health is to avoid direct damage to the body. Foul air can directly harm the lungs and the health of individuals. For climate adaptation, two sub-themes were found: water management and temperature management. Each sub-theme has its own indicator. For water management the soil quality will be assessed as water retention after a rain shower was important. A carbon rich soil can retain more water than a low-carbon soil. For temperature management the area covered in shadow will be included. Shadow in a neighbourhood can ensure that sunlight does not reach surfaces and heaths these surfaces.

Table 29 Important characteristics per theme

Theme	Characteristic in condition account	Characteristic in service account
Biodiversity	Presence of vegetation layers	-
Climate adaptation	Soil quality	Rainwater retention
	Shadow cover	Cooling effect of vegetation and water
Health & wellbeing	Presence of vegetation layers Air quality	Health effect of nature
Aesthetic value	Presence of vegetation layers	Visual amenity service

For the service account, also four characteristics were found. For climate adaptation the two sub-themes again, each have their own service. For water management the rainwater retention service was introduced and for temperature management the cooling effect of vegetation and water was found. As it is known that the presence of nature reduces the risks for certain diseases the health effect of nature will be measured for health and wellbeing. The visual amenity service of houses overlooking either nature of water is the service that will be included for aesthetic value. Unfortunately, there was no relevant or meaningful service found for biodiversity.

A schematic overview of how this looks like can be found in Appendix K.

Sub-Question 5 How can these characteristics be used in the EA framework?

For all indicators the values are determined per ecosystem type. The long list of ecosystem types used in the Netherlands is first shortened to only the urban ecosystem types and the natural types that include water. For usability all the water types are grouped together as one ecosystem type simple called 'water'. The urban types are divided into three groups: residential and non-residential construction, urban green, and infrastructure. Together these 4 make up the whole of an urban area.

Within the condition account, the presence of vegetation layers is the most difficult expression. A logarithmic function calculates the score of each individual vegetation layer (moss, shrub/herb, and tree) based on the area this vegetation layer covers with a minimum score of -1. The presence of vegetation layers is the sum of these different vegetation layer scores. As the lower level of these scores is -1, the vegetation score has a minimum of -3. The upper level for the vegetation score is 4,43 based on the 30% target area per vegetation layer.

The soil quality can either be determined by sampling the ground in the area or by using online maps from RIVM (2020a) to see how much carbon there is. For determining the future score in an area, maps of areas with similar ground and nature use can be compared. The soil quality will be measured in ton C/ha and will be compared to the lower level of 0 ton C/ha and the upper level of 175 ton C/ha.

The shadow cover is determined by the amount of shadow on June 21st at 12 am when the sun is at its highest position and shadows are minimalized in their area coverage. The shadow cover is an area % of the whole area and will be evaluated against the lower value of 0% coverage and the upper value of 40% coverage which is the target coverage to still be able to walk outside.

The air quality is the last condition indicator which will be determined in approximately the same way as the soil quality. Only here one looks for the amount of NO_2 in the air, which can be determined by measures or by using maps from RIVM (2020b). The amount of nitrogen dioxide is determined in $\mu g/m^3$. The lower level here is a concentration of 40 $\mu g/m^3$ and the upper value is 0 $\mu g/m^3$.

When looking at the service account, the first service to take into account, is the rainwater retention. This is the water that can be retained in the soil due to extra measures that would otherwise flood the area if it were to be retained naturally. This service is measured in mm. To calculate the monetary value the avoided damage costs are determined per ecosystem type. The maximum values per area for the different ecosystem types are found in Table 30.

Table 30 Maximum costs per area for water damage

Ecosystem type	Maximum price / area
Residential and non-residential construction	€ 331/m^2
Urban green	€ 928/ha
Infrastructure	€ 1.327/ha

For the cooling effect of vegetation and water the amount of houses that are within 400 meters of a park or a body of water are determined. Within this distance the houses experience the cooling effect of a park or water. Houses that experience this effect, experience an increase of 6% in their WOZ value compared to similar houses that are not within this distance.

The health effect of nature is the number of patients that is reduced due to the amount of nature in the spatial layout. Each percentage point the area covered by nature increases, a reduction of patients of 3,47 per 1000 residents is to be expected. To calculate the monetary value of this service this number should be multiplied by the avoided medical costs per patient of € 917.

Visual amenity services entail two individual services, the amenity service of nature and the amenity service of water. Houses that have a view on one of these also experience a higher WOZ value. Within the physical service account, the number of houses that have each view are determined. Houses that have a view on nature increase 5% in price, and houses that have a view on a body of water increase 8%.

14.2 Research question

The main research question to be answered in this study was **"How can Ecosystem Accounting be used in Dutch procurement processes to create more Nature-based Solutions within urban areas?"**

Nature-based Solutions improve the quality of urban areas compared to situation in which grey solutions are used. By assessing an ecosystem on the four important themes (biodiversity, climate adaptation, health & wellbeing, and aesthetic value), we can see how different choices impact this quality of an ecosystem.

The framework should be used first by the client, to help create their ambitions and make them measurable with EA. In these sessions they also decide what type of contract (traditional or integrated) they would like to use and if they opt for integrated if they want their NbS translated into a requirement or a MEAT-criterium. Since the tradition contracts do not leave any design freedom for the contractor, the NbS can then only be a requirement in the contract. In these contracts the designs are often made by architects and the client is supported by and advisory or engineering firm, but when looking at NbS also the specialized knowledge from ecologists can be useful. In this case EA can be used in the design by these parties to see what design creates the highest value by adding or multiple NbS and see the impact of those choices in the design.

If a more integrated contract type is used, a lot of design freedom exists for the contractor, which makes it possible to create a MEAT-criterium that askes for a minimum ecosystem service value. Here plans with positive deviations from this minimum value receive a bigger fictional discount than other plans that do only the bare minimum. This gives contractors with the help of other parties that provide specialized knowledge such as an advisory or engineering firm, architects, or ecologists the opportunity to tweak their plans to create a maximum ecosystem service value based on the four important themes.

In the control phase the same framework can be used to check if the contractor does as he promised in the tender. If this is not the case, fines can be issued based on the effect the deviation of the plan would have had on the fictional discount in the tender.

By using EA to assess tenders, positive attributions to an ecosystem will result in a higher score and a higher chance to win a project. The positive attributions can be made by incorporating NbS as these influence (all but nature in buildings) the ecosystem services that are assessed in EA. The incorporation of NbS in the plans for urban areas will positively influence liveability not only for now, but also for the future as it helps stimulate the biodiversity, adapt to the changing climate, improve the health and wellbeing from residents and is overall positively appraised for its aesthetic value.

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Appendix A CLASSIFICATIONS OF NBS

Table 31 Classification of NbS based on addressed challenge (Urban Nature Atlas, n.d.)

Climate action for adaption, resilience and mitigation (SDG 13)	423
Climate change adaptation	325
Climate change mitigation	176
Coastal resilience and Marine protection (SDG 14)	50
Coastal protection	46
Marine and biodiversity protection	27
Marine and coastal research and/or education	12
Environmental quality	429
Soil quality improvement	91
Air quality improvement	276
Waste management	100
Noise reduction	84
Green space, Habitats and biodiversity (SDG 15)	1076
Habitat and biodiversity restoration	355
Habitat and biodiversity conservation	369
Green space creation and/or management	983
Regeneration, land-use and urban development	517
Regulation of the built environment	193
Conversion of former industrial areas	77
Promotion of naturalistic urban landscape design	373
Water management (SDG 6)	510
Flood protection	276
Stormwater and rainfall management and storage	325
Improvements to water quality	212
Cultural heritage and cultural diversity	325
Preservation of natural heritage	194
Protection of historic and cultural landscape/infrastructure	193
Promotion of cultural diversity	48
Preservation of historic traditions	56
Health and well-being (SDG 3)	679
Enabling physical activity	287
Improving mental health	113
Improving physical health	112
Creation of opportunities for relaxation and recreation	631
Inclusive and effective governance (SDG 16)	211
Inclusive governance	141
Effective management	107
Combatting crime and corruption	12
Social justice, cohesion and equity (SDG 10)	526
Social cohesion	196
Social justice and equity	93
Social interactions	315

TUDelft

Witteveen + Bos

Environmental education	295
Environmental and climate justice	46
Economic development and employment (SDG 8)	326
Economic development: agriculture	99
Economic development: industry	19
Economic development: service sectors	53
Tourism support	115
Real estate development	86
Employment/job creation	76
Sustainable consumption and production (SDG 12)	252
Sustainable consumption	172
Sustainable production	228

Table 32 Classification of NbS based on type of solution (Urban Nature Atlas, n.d.)

Blue Infrastructure	401
Lakes/ponds	166
Rivers/streams/canals/estuaries	199
Deltas	8
Coastlines	47
Wetlands/bogs/fens/marshes	124
Mangroves	17
Other	33
Community gardens and allotments	314
Allotments	118
Community gardens	237
Horticulture	46
Other	39
Green Areas for water management	221
Rain gardens	50
Swales and filter strips	44
SUDS	152
Other	40
Grey infrastructure featuring greens	450
Alley and street greens	205
Railroad bank and track greens	46
Riverbank greens	130
House gardens	27
Green parking lots	29
Green playgrounds and school grounds	104
Institutional green space	73
Other	40
Nature in buildings	23
Green walls and ceilings	13

Atriums	7
Other	7
Nature on buildings	213
Green roofs	147
Balcony greens	27
Other	16
Parks and urban forests	639
Large urban parks or forests	327
Pocket parks/neighbourhood green spaces	275
Botanical gardens	30
Green corridors and green belts	165
Other	48
Intentionally unmanaged areas	7
Abandoned spaces with growth of wilderness or greens	7
Other	0

Appendix B Ecosystem Types

Table 33 Dutch ecosystem type classification

(Half-)natuurlijke ecosystemen	Bos	(Half-)natuurlijk bos	(semi-)natural forest
		Houstingel	Hedges and treelines
		Productiebos	Plantation forest
		Overig bos	Other forest
	Open natuur	Ruigte	Tall herbs
		Heide	Heathland
		Stuifzand	Drift sand
		Half natuurlijk gras	Semi-natural grassland
		Natuurlijk akkerland	Biodiverse cropland
		Overige open natuur	Other open nature
	Natte gebieden	Moerasbos	Swamp forest
		Hoogveen	Bog
		Laagveen	Fens
	Duin en strand	Kustduinen	Coastal dunes
		Kwelder	Salt marsh
		Strand	Beach
	Water	Waterloop	Streams and rivers
		Meer, plas	Lakes
		Brakwater	Brackish
		Intergetijdengebied	Intertidal
		Zandplaat	Shoals
		Estuarium	Estuary
		Noordzee	North sea
		Waddenzee	Wadden sea
Agrarische ecosystemen	Akkerbouw	Reguliere akkerbouw	Cropland, regular
		Extensieve akkerbouw	Cropland, extensive
		Meerjarig regulier	Perennuals, regular
		Meerjarig extensief	Perennuals, extensive
	Grasland	Grasland blijvend	Pasture, permanent
		Grasland tijdelijk	Pasture, temporal
		Grasland extensief	Pasture, extensive
	Intensieve tuinbouw	Glastuinbouw	Greenhouse horticulture
		Pot- en containerteelt	Nursery container fields
	Landbouw overig	Braakliggend	Fallow land
		Faunarand	Arable field margins
Bebouwde omgeving	Wonen	Urbaan bebouwd	Urban built-up
		Ruraal bebouwd	Rural built-up
	Economie	Bedrijfsterrein	Business park
		Grondgebonden	Mining, land fills, etc.
	Infrastructuur	Infrastructuur	Infrastructural
		Zee, overig (havens)	Marine, other

TUDelft

Witteveen + Bos

Recreatie	Sportterrein	Sports grounds
	Verblijfsrecreatie	Residential recreation
Overig	Overig grasland	Other grassland
	Overig terrein	Other terrain
Openbaar groen	Landschapstuin	Landscape garden
	Park	Public park (large)
	Plantsoen	Public park (small)
	Groenvoorziening	Green space, other
	Semiopenbaar groen	Semi-public green space

Formulier voor geïnformeerde toestemming stakeholderinterviews

Beste Dhr./Mevr. [Achternaam]

Graag nodig ik u uit om deel te nemen aan mijn onderzoek genaamd "Applying Ecosystem Accounting in procurement prodedures to stimulate the use of Nature-based Solutions". Ik (Katja Grimberen) voer dit onderzoek uit als afstudeerder van de masteropleiding Construction Management and Engineering aan de TU Delft tijdens mijn stage bij Witteveen+Bos.

Het doel van dit onderzoek is om te onderzoeken hoe het framework van Ecosytem Accounting gebruikt kan worden tijdens de aanbestedingsprocedure om het toepassen van Nature-based Solutions te stimuleren.

Nature-based Solutions zijn oplossingen die meerdere taken vervullen omdat ze meerdere voordelen voor de mens en natuur hebben. Ze zijn (in het Engels) gedefinieerd als: *"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"* *(United Nations Environment Programma, 2021, p. 10)*. Voorbeelden van NbS in de gebouwde omgeving zijn bijvoorbeeld groene daken en muren of stedelijke bossen, omdat deze stedelijke warmte tegengaan en tegelijkertijd ook geluidshinder verminderen en de luchtkwaliteit verbeteren.

Ecosystem Accounting is een raamwerk dat gecreëerd is door de VN en wat kan helpen bij het bepalen van de conditie van ecosystemen en de waarde van de diensten die de ecosystemen kunnen bieden. Hiermee zouden dus de voordelen van Nature-based Solutions inzichtelijk gemaakt kunnen worden. Het is door de VN gedefinieerd als "*a spatially-based, integrated statistical framework for organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity"* *(United Nations et al., 2020, p. 2)*

Dit interview zal ongeveer 1 uur in beslag nemen en de data zal gebruikt worden om te bepalen waar de ambitie voor een Nature-based Solution of een andere duurzame oplossing vandaan komt, hoe deze ambitie nu vertaald wordt in de aanbestedingsdocumenten en in het contract. U wordt gevraagd om tijdens het interview meerdere open vragen te beantwoorden en ik moedig u graag aan hierbij zoveel mogelijk voorbeelden te noemen.

Zoals bij elke activiteit is het risico van databreuk aanwezig. Ik doe mijn best om uw antwoorden vertrouwelijk te houden. Ik minimaliseer de risico's door persoonlijke data zo snel mogelijk te verwijderen. Tijdens dit interview zal de teamsvergadering opgenomen worden en automatisch getranscribeerd. Na afloop zal aan de hand van de video-opname de transcriptie verbeterd worden en met u worden gedeeld om deze te checken. Wanneer hier geen opmerkingen op zijn zal de opname verwijderd worden en het transcript geanonimiseerd. De niet-anonieme data zal opgeslagen worden in aparte mappen in mijn persoonlijke OneDrive en zal zo snel mogelijk verwijderd worden. Vanuit de geanonimiseerde transcripten zullen quotes worden opgenomen in het rapport. De geanonimiseerde transcripten worden als een bijlage bij mijn thesis opgeslagen bij de TU Delft voor visitatie doeleinden. Deze worden niet openbaar toegankelijk gemaakt, omdat ze geen onderdeel uitmaken van mijn publiek beschikbare thesis.

Uw deelname aan dit onderzoek is volledig vrijwillig en u kunt zich op elk moment terugtrekken zonder reden op te geven. U ben vrij om vragen niet te beantwoorden.

Ik wil u graag vragen om de vragen op de volgende pagina te beantwoorden, en dit document ondertekend naar mij terug te sturen. Ook dit formulier zal veilig opgeslagen worden tijdens het onderzoek.

Katja Grimbergen
Katja.Grimbergen@Witteveenbos.com

Vinkt u alstublieft het juiste vakje aan	Ja	Nee
Algemene vragen		
Ik heb de informatie over het onderzoek gelezen en begrepen. Ik heb de mogelijkheid gehad om vragen te stellen over het onderzoek en mijn vragen zijn naar tevredenheid beantwoord	☐	☐
Ik doe vrijwillig mee aan dit onderzoek en ik begrip dat ik kan weigeren vragen te beantwoorden en mij op elk moment kan terugtrekken uit de studie, zonder een reden op te hoeven geven.	☐	☐
Ik begrijp deelname aan dit onderzoek het volgende betekent: • dit interview wordt opgenomen (in audio en video) en er zal een automatische transcriptie mee zal lopen • de transcriptie handmatig nog verbeterd zal worden en ter inzage naar mij opgestuurd zal worden • de opnames van het interview zullen 10 dagen na het versturen van de transcriptie verwijderd worden, tenzij hier nog aanmerking op zijn • de transcriptie geanonimiseerd zal worden en quotes hieruit gebruikt kunnen worden in het rapport • de oorspronkelijk niet-geanonimiseerde transcriptie zal verwijderd worden direct na het anonimiseren.	☐	☐
Ik begrijp dat mijn deelname aan dit onderzoek niet wordt gecompenseerd	☐	☐
Ik begrijp dat dit onderzoek naar verwachting in maart of april 2023 zal eindigen	☐	☐
Potentiële risico's van deelname		
Ik begrijp dat mijn deelname betekent dat er persoonlijke identificeerbare informatie en onderzoeksdata worden verzameld, met het risico dat ik hieruit geïdentificeerd kan worden.	☐	☐
Ik begrijp dat binnen de Algemene Verordening Gegevensbescherming (AVG) een deel van deze persoonlijk identificeerbare onderzoeksdata als gevoelig wordt beschouwd, namelijk: • Naam • E-mailadres • Andere contactgegevens voor digitale communicatie • Beeld- en geluidsopname van dit interview	☐	☐
Ik begrijp dat de volgende stappen worden ondernomen om het risico van een databreuk te minimaliseren, en dat mijn identiteit op de volgende manieren wordt beschermd: • De data zal zo snel mogelijk geanonimiseerd worden • De niet-geanonimiseerde data zal in een aparte map worden opgeslagen	☐	☐
Ik begrijp dat de persoonlijke informatie die over mij verzameld wordt en mij kan identificeren, zoals naam, contact informatie en beeld- en geluidsopname, niet gedeeld worden buiten het studieteam.	☐	☐
Ik begrijp dat de persoonlijke data die over mij verzameld wordt, vernietigd wordt uiterlijk ten laatste bij het publiceren van het rapport	☐	☐
Publicatie, verspreiding en toepassing		
Ik begrijp dat na het onderzoek de geanonimiseerde informatie die in het rapport gebruik is, mogelijk gebruikt kan worden voor verder onderzoek en onderwijs	☐	☐

TUDelft

Witteveen + Bos

Signatures

_____   _____ _____

Naam deelnemer   Handtekening   Datum

Ik, **de onderzoeker**, verklaar dat ik de <u>informatie en het instemmingsformulier</u> correct aan de potentiële deelnemer heb voorgelegd en, naar het beste van mijn vermogen, heb verzekerd dat de deelnemer begrijpt waar hij/zij vrijwillig mee instemt.

Katja Grimbergen   _____   _____

Naam onderzoeker   Handtekening   Datum

Contactgegevens van de onderzoeker voor verdere informatie:

Katja Grimbergen – Katja.Grimbergen@Witteveenbos.com

Appendix C Protocol stakeholderinterview - IB

Start

Ik zou graag willen beginnen met je bedanken voor het feit dat je tijd vrij maakt om mij te helpen met mijn onderzoek. Zoals ik al eerder aangegeven heb in de uitnodiging voor dit interview, zal dit interview worden opgenomen. Met deze opname zal vertrouwelijk worden omgegaan en de opname zal alleen gebruikt worden voor het transcriberen van dit interview. Daarna zal de opname verwijderd worden.

Introductie

Eerst zal ik mijzelf even voorstellen, ik ben Katja Grimbergen, masterstudent Construction Management and Engineering aan de TU Delft en ik doe mijn afstudeerstage bij Witteveen+Bos. Mijn hoofdvraag is "Hoe kan Ecosystem Accounting gebruikt worden in Nederlandse aanbestedings-procedures om meer Nature-based Solutions in de gebouwde omgeving te creëren?".

Graag zou ik u willen verzoeken u ook even kort voor te stellen. Hiervoor volstaat uw naam en functie bij [bedrijf]. Mocht je denken dat jouw professionele achtergrond ook relevant is voor dit onderzoek, zou ik je willen vragen hier ook over uit te wijden in je introductie

Onderzoek

Zoals volgt mijn hoofdvraag, heeft mijn onderzoek 3 belangrijke componenten; de aanbestedingsprocedure, Nature-based Solutions en Ecosystem Accounting.

Met aanbestedingsprocedure bedoel ik een aanbesteding met EMVI-criteria waarbij de kwaliteit van de inschrijvingen mede bepaalt welke inschrijver er wint. Het doel van mijn onderzoek is namelijk om met behulp van de juiste criteria in de uitvraag het gebruik van Nature-based Solutions te stimuleren.

Nature-based Solutions zijn oplossingen die meerdere taken vervullen omdat ze meerdere voordelen voor de mens en natuur hebben. Ze hebben de volgende Engelse definitie: *"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" (United Nations Environment Programme, 2021b, p. 10).* Voorbeelden van NbS in de gebouwde omgeving zijn bijvoorbeeld groene daken en muren of stedelijke bossen, omdat deze stedelijke warmte tegengaan en tegelijkertijd ook geluidshinder verminderen en de luchtkwaliteit verbeteren.

Ecosystem Accounting is een raamwerk dat gecreëerd is door de VN en wat kan helpen bij het bepalen van de conditie van ecosystemen en de waarde van de diensten die de ecosystemen kunnen bieden. Hiermee zouden dus de voordelen van Nature-based Solutions inzichtelijk gemaakt kunnen worden. De VN definieert het als "*a spatially-based, integrated statistical framework for organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity" (United Nations et al., 2020, p. 2).*

Doel

Ik streef ernaar het raamwerk van Ecosystem Accounting op zo'n manier aan te passen, dat deze gebruikt kan worden in de aanbestedingsprocedure om zo het gebruik van Nature-based Solutions te stimuleren. Nature-based Solutions leveren per definitie meer milieu- en gezondheidsvoordelen tegelijkertijd en kunnen daardoor gebruikt worden voor een scala aan mogelijkheden om de leefbaarheid te verbeteren. Mijn doel voor dit interview is om uit te vinden waarom een ingenieursbureau opdrachtgevers adviseert om te kiezen voor een Nature-based Solution. Daarnaast wil ik ook bespreken hoe er momenteel omgegaan wordt met een ambitie voor een Nature-based Solution en waar nog ruimte voor verbetering ligt.

Aanpak

In dit interview wil ik graag jouw ervaring met Nature-based Solutions bespreken door het stellen van meerdere open vragen. Eerst wil ik bespreken waarom de keuze voor een ambitie voor een Nature-based Solution gemaakt wordt en door welke betrokken partij. Daarna bespreek ik graag hoe deze ambitie vervolgens vertaald kan worden naar aanbestedingscriteria en hoe hier daarna in de praktijk op gereageerd wordt. De focus in mijn onderzoek ligt op Nederlandse projecten, dus ik zou je ook willen vragen om bij het beantwoorden van de vragen dit ook zoveel mogelijk in gedachten te houden. Indien je geen ervaring met Nature-based Solutions hebt, kunnen de vragen ook beantwoord worden over projecten die een duidelijke duurzaamheidsambitie hadden bij aanvang. Nature-based Solution is namelijk een type duurzame oplossing.

Keuze voor een Nature-based Solution

	Vraag	Antwoordmogelijkheden
Q1.1	Kun je vertellen over jouw ervaring met Nature-based Solutions? Hoe vaak ben je dit tegen gekomen Wat voor projecten waren dit?	
Q1.2	Waarom zou je een opdrachtgever adviseren een Nature-based Solution te verkiezen boven een traditionele grijze oplossing?	
Q1.3	Waarom zou je een opdrachtgever adviseren een traditionele grijze oplossing te verkiezen boven een Nature-based Solution?	
Q1.4	Van welke betrokken partij bij een project zou de ambitie voor een Nature-based Solution vandaan moeten komen, en waarom?	• Opdrachtgever • Opdrachtnemer • Ingenieurs-/adviesbureau • anders
Q1.5	Welke betrokken partij bij een project heeft de meeste kennis om een Nature-based Solution te kunnen creëren, en waarom?	• Opdrachtgever • Opdrachtnemer • Ingenieurs-/adviesbureau • anders
Q1.6	Voor welke uitdaging of uitdagingen die nu spelen (in de gebouwde omgeving) kan een Nature-based Solution helpen?	
Q1.7	Hoe belangrijk is/zijn deze uitdaging(en) in het advies voor een Nature-based Solution, en waarom?	• Zeer onbelangrijk • Onbelangrijk • Neutraal

TUDelft

Witteveen+Bos

		• Belangrijk
		• Zeer belangrijk

Aanbestedingsfase

Q2.1	Hoe kan de ambitie voor een Nature-based Solution worden vertaald naar de aanbesteding?	• Minimale eisen
		• EMVI-criteria
		• anders
Q2.2	Hoe belangrijk is deze ambitie tijdens de aanbesteding, en waarom?	• Zeer onbelangrijk
		• Onbelangrijk
		• Neutraal
		• Belangrijk
		• Zeer belangrijk

Controle fase

Q3.1	Hoe kan de ambitie voor een Nature-based Solution worden gewaarborgd in de latere fases van een project?	
Q3.2	Hoe effectief is die waarborging momenteel, en waarom?	• Zeer ineffectief
		• ineffectief
		• Neutraal
		• effectief
		• Zeer effectief
Q3.3	Hoe kan deze waarborging nog verbeterd worden?	

Einde van het interview

Bedankt voor je tijd! Zoals eerder aangegeven zal ik in de komende dagen dit interview gaan transcriberen. Hierna stuur ik een kopie van het transcript, zodat je deze nog kan controleren op fouten. Als ik 10 werkdagen later geen reactie heb ontvangen, ga ik er vanuit dat alles goed is.

Na deze interviewreeks, zal ik nog een tweede interviewreeks houden met experts op verschillende gebieden die belangrijk zijn voor Nature-based Solutions, zoals bijvoorbeeld ecologie en klimaatadaptatie. Mocht je nog suggesties hebben wie ik hiervoor zou moeten interviewen, hoor ik dat graag. Dit mag natuurlijk ook achteraf nog in een los berichtje via Teams of via de e-mail. Wanneer je hierin geïnteresseerd bent, zal ik mijn rapport mailen zodra deze klaar is.

Afsluitende vragen

Q4.1	Zijn er nog andere zaken die je nog wilt delen tijdens dit interview?	
Q4.2	Mochten er bij mij nog onduidelijkheden zijn over de zaken die we besproken hebben in dit interview, mag ik je hierover nog contacten via e-mail of Teams?	

Appendix D Protocol Stakeholderinterview – OG

Start

Ik zou graag willen beginnen met je bedanken voor het feit dat je tijd vrij maakt om mij te helpen met mijn onderzoek. Zoals ik al eerder aangegeven heb in de uitnodiging voor dit interview, zal dit interview worden opgenomen. Met deze opname zal vertrouwelijk worden omgegaan en de opname zal alleen gebruikt worden voor het transcriberen van dit interview. Daarna zal de opname verwijderd worden.

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Graag zou ik u willen verzoeken u ook even kort voor te stellen. Hiervoor volstaat uw naam en functie bij [bedrijf]. Mocht je denken dat jouw professionele achtergrond ook relevant is voor dit onderzoek, zou ik je willen vragen hier ook over uit te wijden in je introductie

Onderzoek

Zoals volgt mijn hoofdvraag, heeft mijn onderzoek 3 belangrijke componenten; de aanbestedingsprocedure, Nature-based Solutions en Ecosystem Accounting.

Met aanbestedingsprocedure bedoel ik een aanbesteding met EMVI-criteria waarbij de kwaliteit van de inschrijvingen mede bepaalt welke inschrijver er wint. Het doel van mijn onderzoek is namelijk om met behulp van de juiste criteria in de uitvraag het gebruik van Nature-based Solutions te stimuleren.

Nature-based Solutions zijn oplossingen die meerdere taken vervullen omdat ze meerdere voordelen voor de mens en natuur hebben. Ze hebben de volgende Engelse definitie: *"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" (United Nations Environment Programme, 2021b, p. 10).* Voorbeelden van NbS in de gebouwde omgeving zijn bijvoorbeeld groene daken en muren of stedelijke bossen, omdat deze stedelijke warmte tegengaan en tegelijkertijd ook geluidshinder verminderen en de luchtkwaliteit verbeteren.

Ecosystem Accounting is een raamwerk dat gecreëerd is door de VN en wat kan helpen bij het bepalen van de conditie van ecosystemen en de waarde van de diensten die de ecosystemen kunnen bieden. Hiermee zouden dus de voordelen van Nature-based Solutions inzichtelijk gemaakt kunnen worden. De VN definieert het als *"a spatially-based, integrated statistical framework for organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity" (United Nations et al., 2020, p. 2).*

Doel

Ik streef ernaar het raamwerk van Ecosystem Accounting op zo'n manier aan te passen, dat deze gebruikt kan worden in de aanbestedingsprocedure om zo het gebruik van Nature-based Solutions te stimuleren. Nature-based Solutions leveren per definitie meer milieu- en gezondheidsvoordelen

tegelijkertijd en kunnen daardoor gebruikt worden voor een scala aan mogelijkheden om de leefbaarheid te verbeteren. Mijn doel voor dit interview is om uit te vinden wat, voor een opdrachtgever, de meest belangrijke redenen zijn om te kiezen voor een Nature-based Solution. Daarnaast wil ik ook bespreken hoe er momenteel omgegaan wordt met een ambitie voor een Nature-based Solution en waar nog ruimte voor verbetering ligt.

Aanpak

In dit interview wil ik graag jouw ervaring met Nature-based Solutions bespreken door het stellen van meerdere open vragen. Eerst wil ik bespreken waarom de keuze voor een ambitie voor een Nature-based Solution gemaakt wordt en door welke betrokken partij. Daarna bespreek ik graag hoe deze ambitie vervolgens vertaald kan worden naar aanbestedingscriteria en hoe hier daarna in de praktijk op gereageerd wordt. De focus in mijn onderzoek ligt op Nederlandse projecten, dus ik zou je ook willen vragen om bij het beantwoorden van de vragen dit ook zoveel mogelijk in gedachten te houden. Indien je geen ervaring met Nature-based Solutions hebt, kunnen de vragen ook beantwoord worden over projecten die een duidelijke duurzaamheidsambitie hadden bij aanvang. Nature-based Solution is namelijk een type duurzame oplossing.

Keuze voor een Nature-based Solution

	Vraag	Antwoordmogelijkheden
Q1.1	Kun je vertellen over jouw ervaring met Nature-based Solutions? Hoe vaak ben je dit tegen gekomen Wat voor projecten waren dit?	
Q1.2	Waarom zou je als opdrachtgever een Nature-based Solution verkiezen boven een traditionele grijze oplossing?	
Q1.3	Waarom zou je als opdrachtgever een traditionele grijze oplossing verkiezen boven een Nature-based Solution?	
Q1.4	Van welke betrokken partij bij een project zou de ambitie voor een Nature-based Solution vandaan moeten komen, en waarom?	• Opdrachtgever • Opdrachtnemer • Ingenieurs-/adviesbureau • anders
Q1.5	Welke betrokken partij bij een project heeft de meeste kennis om een Nature-based Solution te kunnen creëren, en waarom?	• Opdrachtgever • Opdrachtnemer • Ingenieurs-/adviesbureau • anders
Q1.6	Voor welke uitdaging of uitdagingen die nu spelen (in de gebouwde omgeving) kan een Nature-based Solution helpen?	
Q1.7	Hoe belangrijk is/zijn deze uitdaging(en) in het besluit voor een Nature-based Solution, en waarom?	• Zeer onbelangrijk • Onbelangrijk • Neutraal • Belangrijk • Zeer belangrijk

TUDelft

Witteveen + Bos

Aanbestedingsfase

Q2.1	Hoe kan tegenwoordig de ambitie voor een Nature-based Solution worden vertaald naar de aanbesteding?	• Minimale eisen • EMVI-criteria • anders
Q2.2	Hoe belangrijk is deze ambitie tijdens de aanbesteding, en waarom?	• Zeer onbelangrijk • Onbelangrijk • Neutraal • Belangrijk • Zeer belangrijk

Controle fase

Q3.1	Hoe kan de ambitie voor een Nature-based Solution worden gewaarborgd in de latere fases van een project?	
Q3.2	Hoe effectief is die waarborging momenteel, en waarom?	• Zeer ineffectief • ineffectief • Neutraal • effectief • Zeer effectief
Q3.3	Hoe kan deze waarborging nog verbeterd worden?	

Einde van het interview

Bedankt voor je tijd! Zoals eerder aangegeven zal ik in de komende dagen dit interview gaan transcriberen. Hierna stuur ik een kopie van het transcript, zodat je deze nog kan controleren op fouten. Als ik 10 werkdagen later geen reactie heb ontvangen, ga ik er vanuit dat alles goed is.

Na deze interviewreeks, zal ik nog een tweede interviewreeks houden met experts op verschillende gebieden die belangrijk zijn voor Nature-based Solutions, zoals bijvoorbeeld ecologie en klimaatadaptatie. Mocht je nog suggesties hebben wie ik hiervoor zou moeten interviewen, hoor ik dat graag. Dit mag natuurlijk ook achteraf nog in een los berichtje via Teams of via de e-mail. Wanneer je hierin geïnteresseerd bent, zal ik mijn rapport mailen zodra deze klaar is.

Afsluitende vragen

Q4.1	Zijn er nog andere zaken die je nog wilt delen tijdens dit interview?	
Q4.2	Mochten er bij mij nog onduidelijkheden zijn over de zaken die we besproken hebben in dit interview, mag ik je hierover nog contacten via e-mail of Teams?	

Appendix E PROTOCOL STAKEHOLDERINTERVIEW – ON

Start

Ik zou graag willen beginnen met je bedanken voor het feit dat je tijd vrij maakt om mij te helpen met mijn onderzoek. Zoals ik al eerder aangegeven heb in de uitnodiging voor dit interview, zal dit interview worden opgenomen. Met deze opname zal vertrouwelijk worden omgegaan en de opname zal alleen gebruikt worden voor het transcriberen van dit interview. Daarna zal de opname verwijderd worden.

Introductie

Eerst zal ik mijzelf even voorstellen, ik ben Katja Grimbergen, masterstudent Construction Management and Engineering aan de TU Delft en ik doe mijn afstudeerstage bij Witteveen+Bos. Mijn hoofdvraag is "Hoe kan Ecosystem Accounting gebruikt worden in Nederlandse aanbestedings-procedures om meer Nature-based Solutions in de gebouwde omgeving te creëren?".

Graag zou ik u willen verzoeken u ook even kort voor te stellen. Hiervoor volstaat uw naam en functie bij [bedrijf]. Mocht je denken dat jouw professionele achtergrond ook relevant is voor dit onderzoek, zou ik je willen vragen hier ook over uit te wijden in je introductie

Onderzoek

Zoals volgt mijn hoofdvraag, heeft mijn onderzoek 3 belangrijke componenten; de aanbestedingsprocedure, Nature-based Solutions en Ecosystem Accounting.

Met aanbestedingsprocedure bedoel ik een aanbesteding met EMVI-criteria waarbij de kwaliteit van de inschrijvingen mede bepaalt welke inschrijver er wint. Het doel van mijn onderzoek is namelijk om met behulp van de juiste criteria in de uitvraag het gebruik van Nature-based Solutions te stimuleren.

Nature-based Solutions zijn oplossingen die meerdere taken vervullen omdat ze meerdere voordelen voor de mens en natuur hebben. Ze hebben de volgende Engelse definitie: *"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" (United Nations Environment Programme, 2021b, p. 10).* Voorbeelden van NbS in de gebouwde omgeving zijn bijvoorbeeld groene daken en muren of stedelijke bossen, omdat deze stedelijke warmte tegengaan en tegelijkertijd ook geluidshinder verminderen en de luchtkwaliteit verbeteren.

Ecosystem Accounting is een raamwerk dat gecreëerd is door de VN en wat kan helpen bij het bepalen van de conditie van ecosystemen en de waarde van de diensten die de ecosystemen kunnen bieden. Hiermee zouden dus de voordelen van Nature-based Solutions inzichtelijk gemaakt kunnen worden. De VN definieert het als *"a spatially-based, integrated statistical framework for organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity" (United Nations et al., 2020, p. 2).*

Doel

Ik streef ernaar het raamwerk van Ecosystem Accounting op zo'n manier aan te passen, dat deze gebruikt kan worden in de aanbestedingsprocedure om zo het gebruik van Nature-based Solutions te stimuleren. Nature-based Solutions leveren per definitie meer milieu- en gezondheidsvoordelen

tegelijkertijd en kunnen daardoor gebruikt worden voor een scala aan mogelijkheden om de leefbaarheid te verbeteren. Mijn doel voor dit interview is om uit te vinden wat, voor een aannemer, de meest belangrijke redenen zijn om te kiezen voor een inschrijving waarbij gevraagd wordt naar Nature-based Solution. Daarnaast wil ik ook bespreken hoe er momenteel op de ambitie voor een Nature-based Solution gereageerd wordt, wat de ambitie van een aannemer zelf is en waar nog ruimte voor verbetering ligt in het uitvragen en reageren.

Aanpak

In dit interview wil ik graag jouw ervaring met Nature-based Solutions bespreken door het stellen van meerdere open vragen. Eerst wil ik graag bespreken waar de ambitie voor een Nature-based Solution vandaan komt of zou moeten komen. Daarna bespreek ik hoe graag hoe jullie op deze ambitie reageren in de aanbestedingsfase en tot slot hoe jullie hier na het winnen van een contract mee om gaan. De focus in mijn onderzoek ligt op Nederlandse projecten, dus ik zou je ook willen vragen om bij het beantwoorden van de vragen dit ook zoveel mogelijk in gedachten te houden. Indien je geen ervaring met Nature-based Solutions hebt, kunnen de vragen ook beantwoord worden over projecten die een duidelijke duurzaamheidsambitie hadden bij aanvang. Nature-based Solution is namelijk een type duurzame oplossing.

Keuze voor een Nature-based Solution

	Vraag	Antwoordmogelijkheden
Q1.1	Kun je vertellen over jouw ervaring met Nature-based Solutions? 　　Hoe vaak ben je dit tegen gekomen 　　Wat voor projecten waren dit?	
Q1.2	Waarom zou je als aannemer eerder inschrijven op een project met een Nature-based Solution dan een project met een traditionele grijze oplossing?	
Q1.3	Waarom zou je als aannemer eerder inschrijven op een project met een traditionele grijze oplossing dan een project met een Nature-based Solution?	
Q1.4	Van welke betrokken partij bij een project zou de ambitie voor een Nature-based Solution vandaan moeten komen, en waarom?	• Opdrachtgever • Opdrachtnemer • Ingenieurs-/adviesbureau • anders
Q1.5	Welke betrokken partij heeft de meeste kennis om een Nature-based Solution te kunnen creëren, en waarom?	• Opdrachtgever • Opdrachtnemer • Ingenieurs-/adviesbureau • anders
Q1.6	Welke uitdagingen die nu spelen in de gebouwde omgeving worden aangepakt met een Nature-based Solution?	
Q1.7	Hoe belangrijk zijn deze uitdagingen in de keuze voor een Nature-based Solution, en waarom?	• Zeer onbelangrijk • Onbelangrijk • Neutraal

| | | • Belangrijk |
| | | • Zeer belangrijk |

Aanbestedingsfase

Q2.1	Hoe is de door de opdrachtgever gestelde ambitie voor een Nature-based Solution zichtbaar in aanbestedingen?	• Minimale eisen • EMVI-criteria • anders
Q2.2	In hoeverre is de door de opdrachtgever gestelde ambitie voor een Nature-based Solution belangrijk bij het maken van jullie inschrijving, en waarom?	• Zeer onbelangrijk • Onbelangrijk • Neutraal • Belangrijk • Zeer belangrijk
Q2.3	Hoe maken jullie je eigen ambitie voor een Nature-based Solution zichtbaar in jullie inschrijving?	
Q2.4	In hoeverre is jullie eigen ambitie voor een Nature-based Solution belangrijk bij het maken van jullie inschrijving, en waarom?	• Zeer onbelangrijk • Onbelangrijk • Neutraal • Belangrijk • Zeer belangrijk

Controle fase

Q3.1	Op welke manier wordt de meerwaarde die jullie bieden met de Nature-based Solution gevalideerd?	
Q3.2	Hoe effectief is deze validatie momenteel, en waarom?	• Zeer ineffectief • ineffectief • Neutraal • Effectief • Zeer effectief
Q3.3	Hoe zou deze validatie verbeterd kunnen worden?	

Einde van het interview

Bedankt voor je tijd! Zoals eerder aangegeven zal ik in de komende dagen dit interview gaan transcriberen. Hierna stuur ik een kopie van het transcript, zodat je deze nog kan controleren op fouten. Als ik 10 werkdagen later geen reactie heb ontvangen, ga ik er vanuit dat alles goed is.

Na deze interviewreeks, zal ik nog een tweede interviewreeks houden met experts op verschillende gebieden die belangrijk zijn voor Nature-based Solutions, zoals bijvoorbeeld ecologie en klimaatadaptatie. Mocht je nog suggesties hebben wie ik hiervoor zou moeten interviewen, hoor ik dat graag. Dit mag natuurlijk ook achteraf nog in een los berichtje via Teams of via de e-mail. Wanneer je hierin geïnteresseerd bent, zal ik mijn rapport mailen zodra deze klaar is.

Afsluitende vragen

Q4.1	Zijn er nog andere zaken die je nog wilt delen tijdens dit interview?	
Q4.2	Mochten er bij mij nog onduidelijkheden zijn over de zaken die we besproken hebben in dit interview, mag ik je hierover nog contacten via e-mail of Teams?	

Appendix F FORMULIER VOOR GEÏNFORMEERDE TOESTEMMING KEY-INFORMANTINTERVIEWS

Beste Dhr./Mevr. [Achternaam]

Graag nodig ik u uit om deel te nemen aan mijn onderzoek genaamd "Applying Ecosystem Accounting in procurement prodedures to stimulate the use of Nature-based Solutions". Ik (Katja Grimberen) voer dit onderzoek uit als afstudeerder van de masteropleiding Construction Management and Engineering aan de TU Delft tijdens mijn stage bij Witteveen+Bos.

Het doel van dit onderzoek is om te onderzoeken hoe het framework van Ecosytem Accounting gebruikt kan worden tijdens de aanbestedingsprocedure om het toepassen van Nature-based Solutions te stimuleren.

Nature-based Solutions zijn oplossingen die niet alleen hun beoogde taak uitvoeren, maar ook nog andere bijkomende voordelen hebben voor zowel de mens als de natuur. Ze zijn (in het Engels) gedefinieerd als: *"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"* *(United Nations Environment Programma, 2021, p. 10)*.

Ecosystem Accounting is een raamwerk gecreëerd door de Verenigde Naties dat helpt in het bepalen van de conditie van ecosystemen en de waarde van de ecosysteem diensten die die ecosystemen kunnen creëren. Het is door de VN gedefinieerd als *"a spatially-based, integrated statistical framework for organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity"* *(United Nations et al., 2020, p. 2)*

Dit interview zal ongeveer 1 uur in beslag nemen en de data zal gebruikt worden om het framework van Ecosystem Accounting op een manier in te richten zodat deze geschikt is om tijdens de aanbestedingsprocedure het gebruik van Nature-based Solutions te stimuleren. U wordt gevraagd om tijdens het interview meerdere open vragen te beantwoorden en ik moedig u graag aan hierbij zoveel mogelijk voorbeelden te noemen.

Zoals bij elke activiteit is het risico van databreuk aanwezig. Ik doe mijn best om uw antwoorden vertrouwelijk te houden. Ik minimaliseer de risico's door persoonlijke data zo snel mogelijk te verwijderen. Tijdens dit interview zal de teamsvergadering opgenomen worden en automatisch getranscribeerd. Na afloop zal aan de hand van de video-opname de transcriptie verbeterd worden en met u worden gedeeld om deze te checken. Wanneer hier geen opmerkingen op zijn zal de opname verwijderd worden en het transcript geanonimiseerd. De niet-anonieme data zal opgeslagen worden in aparte mappen in mijn persoonlijke OneDrive en zal zo snel mogelijk verwijderd worden. Vanuit de geanonimiseerde transcripten zullen quotes worden opgenomen in het rapport. De geanonimiseerde transcripten worden als een bijlage bij mijn thesis opgeslagen bij de TU Delft voor visitatie doeleinden. Deze worden niet openbaar toegankelijk gemaakt, omdat ze geen onderdeel uitmaken van mijn publiek beschikbare thesis.

Uw deelname aan dit onderzoek is volledig vrijwillig en u kunt zich op elk moment terugtrekken zonder reden op te geven. U ben vrij om vragen niet te beantwoorden.

Ik wil u graag vragen om de vragen op de volgende pagina te beantwoorden, en dit document ondertekend naar mij terug te sturen. Ook dit formulier zal veilig opgeslagen worden tijdens het onderzoek.

Katja Grimbergen
Katja.Grimbergen@Witteveenbos.com

Vinkt u alstublieft het juiste vakje aan	Ja	Nee
Algemene vragen		
Ik heb de informatie over het onderzoek gelezen en begrepen. Ik heb de mogelijkheid gehad om vragen te stellen over het onderzoek en mijn vragen zijn naar tevredenheid beantwoord	☐	☐
Ik doe vrijwillig mee aan dit onderzoek en ik begrip dat ik kan weigeren vragen te beantwoorden en mij op elk moment kan terugtrekken uit de studie, zonder een reden op te hoeven geven.	☐	☐
Ik begrijp deelname aan dit onderzoek het volgende betekent: • dit interview wordt opgenomen (in audio en video) en er zal een automatische transcriptie mee zal lopen • de transcriptie handmatig nog verbeterd zal worden en ter inzage naar mij opgestuurd zal worden • de opnames van het interview zullen 10 dagen na het versturen van de transcriptie verwijderd worden, tenzij hier nog aanmerking op zijn • de transcriptie geanonimiseerd zal worden en quotes hieruit gebruikt kunnen worden in het rapport • de oorspronkelijk niet-geanonimiseerde transcriptie zal verwijderd worden direct na het anonimiseren.	☐	☐
Ik begrijp dat mijn deelname aan dit onderzoek niet wordt gecompenseerd	☐	☐
Ik begrijp dat dit onderzoek naar verwachting in maart of april 2023 zal eindigen	☐	☐
Potentiële risico's van deelname		
Ik begrijp dat mijn deelname betekent dat er persoonlijke identificeerbare informatie en onderzoeksdata worden verzameld, met het risico dat ik hieruit geïdentificeerd kan worden.	☐	☐
Ik begrijp dat binnen de Algemene Verordening Gegevensbescherming (AVG) een deel van deze persoonlijk identificeerbare onderzoeksdata als gevoelig wordt beschouwd, namelijk: • Naam • E-mailadres • Andere contactgegevens voor digitale communicatie • Beeld- en geluidsopname van dit interview	☐	☐
Ik begrijp dat de volgende stappen worden ondernomen om het risico van een databreuk te minimaliseren, en dat mijn identiteit op de volgende manieren wordt beschermd: • De data zal zo snel mogelijk geanonimiseerd worden • De niet-geanonimiseerde data zal in een aparte map worden opgeslagen	☐	☐
Ik begrijp dat de persoonlijke informatie die over mij verzameld wordt en mij kan identificeren, zoals naam, contact informatie en beeld- en geluidsopname, niet gedeeld worden buiten het studieteam.	☐	☐
Ik begrijp dat de persoonlijke data die over mij verzameld wordt, vernietigd wordt uiterlijk ten laatste bij het publiceren van het rapport	☐	☐
Publicatie, verspreiding en toepassing		
Ik begrijp dat na het onderzoek de geanonimiseerde informatie die in het rapport gebruik is, mogelijk gebruikt kan worden voor verder onderzoek en onderwijs	☐	☐

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Signatures

_____   _____ _____

Naam deelnemer   Handtekening   Datum

Ik, **de onderzoeker**, verklaar dat ik de <u>informatie en het instemmingsformulier</u> correct aan de potentiële deelnemer heb voorgelegd en, naar het beste van mijn vermogen, heb verzekerd dat de deelnemer begrijpt waar hij/zij vrijwillig mee instemt.

Katja Grimbergen   _____   _____

Naam onderzoeker   Handtekening   Datum

Contactgegevens van de onderzoeker voor verdere informatie:

Katja Grimbergen – Katja.Grimbergen@Witteveenbos.com

Appendix G Protocol key informant interviews

Start

Ik zou graag willen beginnen met je bedanken voor je tijd en dat je mij wilt helpen met mijn afstuderen. Graag zou ik dit interview willen opnemen. Deze opname zal vertrouwelijk behandeld worden en alleen gebruikt worden om een transcript te schrijven. Als je hier behoefte aan hebt, kan ik dit transcript nog opsturen ter controle. Wanneer dit transcript definitief is, zal de opname verwijderd worden.

Introductie

Ik ben Katja Grimbergen, masterstudent Construction Management and Engineering aan de TU Delft en ik doe mijn afstudeeronderzoek bij Witteveen+Bos. Mijn thesis gaat over het toepassen van Ecosystem Accounting in de aanbestedingsprocedure om het gebruik van Nature-based Solutions te stimuleren.

Ik zou graag vragen of jij je ook even kort van voorstellen.

Onderzoek

Zoals aangegeven heeft mijn onderzoek drie onderdelen; de aanbestedingsprocedure, Nature-based Solutions en Ecosystem Accounting. Met de aanbestedingsprocedure wordt de procedure bedoeld waarbij niet alleen naar geld wordt gekeken, maar ook de kwaliteit van de oplossing meegewogen wordt.

Nature-based Solutions zijn oplossingen die meerdere taken vervullen omdat ze meerdere voordelen voor de mens en natuur hebben. Ze hebben de volgende Engelse definitie: *"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" (United Nations Environment Programme, 2021b, p. 10).* Voorbeelden van NbS in de gebouwde omgeving zijn bijvoorbeeld groene daken en muren of stedelijke bossen, omdat deze stedelijke warmte tegengaan en tegelijkertijd ook geluidshinder verminderen en de luchtkwaliteit verbeteren.

Ecosystem Accounting is een raamwerk dat gecreëerd is door de VN en wat kan helpen bij het bepalen van de conditie van ecosystemen en de waarde van de diensten die de ecosystemen kunnen bieden. Hiermee zouden dus de voordelen van Nature-based Solutions inzichtelijk gemaakt kunnen worden. De VN definieert het als *"a spatially-based, integrated statistical framework for organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity" (United Nations et al., 2020, p. 2).*

Doel

Ik streef ernaar het raamwerk van Ecosystem Accounting op zo'n manier aan te passen, dat deze gebruikt kan worden in de aanbestedingsprocedure om zo het gebruik van Nature-based Solutions te stimuleren. Nature-based Solutions leveren per definitie meer milieu- en gezondheidsvoordelen tegelijkertijd en kunnen daardoor gebruikt worden voor een scala aan mogelijkheden om de leefbaarheid te verbeteren. Mijn doel voor dit interview is om uit te vinden waarom een ingenieursbureau opdrachtgevers adviseert om te kiezen voor een Nature-based Solution. Daarnaast

wil ik ook bespreken hoe er momenteel omgegaan wordt met een ambitie voor een Nature-based Solution en waar nog ruimte voor verbetering ligt.

Aanpak

Ik wil graag beginnen met een uitgebreide uitleg van het framework dat wordt gebruikt bij Ecosystem Accounting. Daarna wil ik wat vragen stellen over welke karakteristieken en diensten gebruikt kunnen worden om een ecosysteem te waarderen. Vanuit de literatuur en eerdere interviews is naar voren komen dat de meest belangrijke reden om te kiezen voor een Nature-based Solution biodiversiteit, klimaatadaptatie, gezondheid en welzijn en esthetiek zijn. Om het framework correct te kunnen gebruiken en dus Nature-based Solutions beter te waarderen dan grijze oplossingen, is het belangrijk dat de juiste karakteristieken en diensten gebruikt worden.

Ecosystem Accounting

Q.0.1.1	Ben je bekend met Ecosystem Accounting?	Ongeacht welk antwoord gegeven wordt, zal er een uitgebreide uitleg komen.

Ecosystem Accounting is een statistisch raamwerk wat in 5 stappen, zogeheten rekeningen, de activawaarde van een ecosysteem berekend. Een ecosysteem in dit geval, kan een willekeurig stuk land zijn waar gebiedsontwikkeling plaats gaat vinden.

De eerste stap is de omvang rekening. Hier zal het ecosysteem verdeeld worden in verschillende ecosysteemtypes en zal een vergelijking gemaakt worden van deze verdeling op verschillende momenten in tijd. Bijvoorbeeld, bij een vergelijking van 1 januari 2022 met 1 januari 2023 kun je zien wat er het afgelopen jaar veranderd is, of je vergelijkt de situatie van 1 januari 2023 met de geplande situatie van 1 januari van 2024. Vaak wordt deze vergelijking vergezeld van kaarten om het verschil visueel te maken.

De volgende stap is de conditie rekening. Hier wordt de conditie van het ecosysteem gecontroleerd. Voor verschillende karakteristieken de openings- en sluitingswaarde wordt gemeten of beredeneerd (in het geval van een toekomstige situatie). Voor elke karakteristiek worden vervolgens een hoogste en laagste referentiewaarde per ecosysteemtype bepaald, om de gemeten waarden te herschalen naar indicatorwaarden. Deze referentiewaarden kunnen een onverstoorde of minimaal verstoorde toestand zijn (alleen te gebruiken voor natuurlijke ecosysteemtypes), een historische toestand, een hedendaagse toestand of de best haalbare toestand. De laagste referentiewaarde hoeft niet noodzakelijk ook de laagste absolute waarde te zijn, maar gaat over de situatie waarin de conditie het slechtste is. Omgekeerd correspondeert de hoogste referentiewaarde met de beste conditie van het ecosysteem. Laatste berekening van stap 3 is een gewicht per karakteristiek bepalen om zo indexwaarden te bepalen.

In stap drie wordt de fysieke dienstenrekening opgemaakt (in tegenstelling tot de geldelijke dienstenrekening in stap 4). Een ecosysteemdienst is in het Engels definieert als "the contribution of an ecosystem to benefits used in economic and other human activity" *(United Nations et al., 2020, p. 27)*. Deze diensten zijn verdeeld in producerende diensten (zoals houtproductie in een bos), regulerings- en onderhoudsdiensten (zoals waterzuivering in moerasgebied) en culturele diensten (zoals recreatiebezoek in een bos of stedelijk gebied). Voor iedere ecosysteem dienst is de levering van die dienst bepaald per ecosysteemtype.

In de vierde stap word de geldelijke dienstenrekening gemaakt. Voor elke dienst wordt een prijs bepaald door het gebruik van bijvoorbeeld de huurprijsmethode, door het berekenen van de vervangingskosten of de vermeden schadekosten, door het bepalen van de consumentenuitgaven voor die dienst of door de hedonische prijsstelling. De geldelijke rekening wordt gecreëerd door de levering van een dienst per ecosysteemtype te vermenigvuldigen met de zojuist bepaalde prijs voor die dienst. Vervolgens kunnen deze waarden voor de geselecteerde diensten bij elkaar opgeteld worden per ecosysteemtype, per service of per ecosysteem.

De laatste stap van Ecosystem Accounting is de berekening van de netto contante waarde (NPV). Voor Nederlandse rekeningen wordt aangenomen dat de levensduur van een ecosysteem en haar diensten 100 jaar is. Het bijbehorende kortingspercentage is 2% of 3% afhankelijk van de dienst. Voor producerende en culturele diensten wordt 3% korting wordt gebruikt en voor regulerings- en onderhoudsdiensten het kortingspercentage van 2% wordt gebruikt. De netto contante waardes per ecosysteemtype worden opgeteld om de totale activa rekening voor de verschillende ecosysteemtypes en het gehele ecosysteem te kunnen opmaken.

Tijdens dit interview zullen we eerste de karakteristieken voor biodiversiteit bespreken, wat moet er gemeten worden, hoe meten we dat en wat zijn de juiste referentiewaarden? Daarna voeren we dezelfde discussie over eerst klimaatadaptatie, dan gezondheid en welzijn en tot slot ook over esthetiek. Nadat we de karakteristieken besproken hebben, zullen we het gaan hebben over de verschillende diensten per categorie. Waarschijnlijk ligt jouw expertise niet op alle gebieden, maar alsnog wordt het wel gewaardeerd als je hier ook over meedenkt.

Ecosystem Condition

Q.1.1.1	Welke karakteristiek(en) is/zijn het meest geschikt om biodiversiteit mee te bepalen?	• Boom/vegetatiedekking • Living Planet Index • Soortenrijkdom • Anders
Q.1.1.2	Welke conditie zou de referentie waardes van deze karakteristiek(en) moeten bepalen?	• Historische toestand • Minst verstoorde toestand • Hedendaagse toestand • Best haalbare toestand
Q.1.1.3	Kun je aangeven wat de laagste en hoogste referentiewaarden zouden moeten zijn voor dit/deze karakteristiek(en) in een stedelijk gebied?	
Q.1.1.4	Zo niet, hoe zouden deze waarden moeten worden bepaald?	• Referentielocaties • Gemodelleerde referentieomstandigheden • Statistische benadering gebaseerd op omringende gebieden • Historische waarnemingen • Hedendaagse gegevens • Voorgeschreven niveaus • Mening van deskundigen

			• Combinatie
			• Anders
Q.1.1.5	Is deze referentiewaarde geschikt voor alle stedelijke ecosysteemtypes (wonen, economie, infrastructuur, recreatie, openbaar groen en anders)?	

Q.1.2.1	Welke karakteristiek(en) is/zijn het meest geschikt om klimaatadaptatie mee te bepalen?	• Ondoordringbaarheid • Boom/vegetatiebedekking • Anders
Q.1.2.2	Welke conditie zou de referentie waardes van deze karakteristiek(en) moeten bepalen?	• Historische toestand • Minst verstoorde toestand • Hedendaagse toestand • Best haalbare toestand
Q.1.2.3	Kun je aangeven wat de laagste en hoogste referentiewaarden zouden moeten zijn voor dit/deze karakteristiek(en) in een stedelijk gebied?	
Q.1.2.4	Zo niet, hoe zouden deze waarden moeten worden bepaald?	• Referentielocaties • Gemodelleerde referentieomstandigheden • Statistische benadering gebaseerd op omringende gebieden • Historische waarnemingen • Hedendaagse gegevens • Voorgeschreven niveaus • Mening van deskundigen • Combinatie • Anders
Q.1.2.5	Is deze referentiewaarde geschikt voor alle stedelijke ecosysteemtypes (wonen, economie, infrastructuur, recreatie, openbaar groen en anders)?	

Q.1.3.1	Welke karakteristiek(en) is/zijn het meest geschikt om gezondheid en welzijn mee te bepalen?	• NO_2-concentratie • Anders
Q.1.3.2	Welke conditie zou de referentie waardes van deze karakteristiek(en) moeten bepalen?	• Historische toestand • Minst verstoorde toestand • Hedendaagse toestand • Best haalbare toestand
Q.1.3.3	Kun je aangeven wat de laagste en hoogste referentiewaarden zouden moeten zijn voor dit/deze karakteristiek(en) in een stedelijk gebied?	

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Q.1.3.4	Zo niet, hoe zouden deze waarden moeten worden bepaald?	• Referentielocaties • Gemodelleerde referentieomstandigheden • Statistische benadering gebaseerd op omringende gebieden • Historische waarnemingen • Hedendaagse gegevens • Voorgeschreven niveaus • Mening van deskundigen • Combinatie • Anders
Q.1.3.5	Is deze referentiewaarde geschikt voor alle stedelijke ecosysteemtypes (wonen, economie, infrastructuur, recreatie, openbaar groen en anders)?	

Q.1.4.1	Welke karakteristiek(en) is/zijn het meest geschikt om esthetiek mee te bepalen?	• Anders • Geen karakteristiek
Q.1.4.2	Welke conditie zou de referentie waardes van deze karakteristiek(en) moeten bepalen?	• Historische toestand • Minst verstoorde toestand • Hedendaagse toestand • Best haalbare toestand
Q.1.4.3	Kun je aangeven wat de laagste en hoogste referentiewaarden zouden moeten zijn voor dit/deze karakteristiek(en) in een stedelijk gebied?	
Q.1.4.4	Zo niet, hoe zouden deze waarden moeten worden bepaald?	• Referentielocaties • Gemodelleerde referentieomstandigheden • Statistische benadering gebaseerd op omringende gebieden • Historische waarnemingen • Hedendaagse gegevens • Voorgeschreven niveaus • Mening van deskundigen • Combinatie • Anders
Q.1.4.5	Is deze referentiewaarde geschikt voor alle stedelijke ecosysteemtypes (wonen, economie, infrastructuur, recreatie, openbaar groen en anders)?	

Ecosystem Service

Q.2.1.1	Welke ecosysteemdienst(en) is/zijn het meest geschikt om biodiversiteit mee te bepalen?	• Bestuivingsdienst
Q.2.1.2	Hou zou(den) deze dienst(en) gemeten moeten worden?	
Q.2.1.3	Kun je aangeven wat de bijbehorende prijs voor deze dienst(en) zou(den) moeten zijn?	
Q.2.1.4	Welke methode zou gebruikt moeten worden om de geldelijke waarden per eenheid van dienst te bepalen voor iedere ecosysteemdienst?	• Huurprijs • Vervangingskosten • Vermeden schadekosten • Consumentenuitgaven • Hedonische prijsstelling • Anders

Q.2.2.1	Welke ecosysteemdienst(en) is/zijn het meest geschikt om klimaatadaptatie mee te bepalen?	• Regenwater regulatiedienst • Verkoelingsdienst van vegetatie en water
Q.2.2.2	Hou zou(den) deze dienst(en) gemeten moeten worden?	
Q.2.2.3	Kun je aangeven wat de bijbehorende prijs voor deze dienst(en) zou(den) moeten zijn?	
Q.2.2.4	Welke methode zou gebruikt moeten worden om de geldelijke waarden per eenheid van dienst te bepalen voor iedere ecosysteemdienst?	• Huurprijs • Vervangingskosten • Vermeden schadekosten • Consumentenuitgaven • Hedonische prijsstelling • Anders

Q.2.3.1	Welke ecosysteemdienst(en) is/zijn het meest geschikt om gezondheid en welzijn mee te bepalen?	• Gezondheidsdienst van de natuur
Q.2.3.2	Hou zou(den) deze dienst(en) gemeten moeten worden?	
Q.2.3.3	Kun je aangeven wat de bijbehorende prijs voor deze dienst(en) zou(den) moeten zijn?	
Q.2.3.4	Welke methode zou gebruikt moeten worden om de geldelijke waarden per eenheid van dienst te bepalen voor iedere ecosysteemdienst?	• Huurprijs • Vervangingskosten • Vermeden schadekosten • Consumentenuitgaven • Hedonische prijsstelling • Anders

Q.2.4.1	Welke ecosysteemdienst(en) is/zijn het meest geschikt om esthetische waarde mee te bepalen?	• Visuele belevingsdienst van natuur • Visuele belevingsdienst van water
Q.2.4.2	Hou zou(den) deze dienst(en) gemeten moeten worden?	
Q.2.4.3	Kun je aangeven wat de bijbehorende prijs voor deze dienst(en) zou(den) moeten zijn?	
Q.2.4.4	Welke methode zou gebruikt moeten worden om de geldelijke waarden per eenheid van dienst te bepalen voor iedere ecosysteemdienst?	• Huurprijs • Vervangingskosten • Vermeden schadekosten • Consumentenuitgaven • Hedonische prijsstelling • Anders

Einde van het interview

Bedankt voor je tijd. Zoals ik eerder aangaf zal ik dit interview gaan transcriberen in de komende tijd. Als je het wil stuur ik je hierna een kopie van het transcript om te controleren of alles klopt. Wanneer ik 10 werkdagen na het verzenden geen feedback heb ontvangen, ga ik er vanuit dat alles correct is.

Op basis van mijn vorige antwoorden en mijn literatuurstudie ben ik al begonnen met het vormgeven van mijn framework wat de structuur van Ecosystem Accounting gebruikt. Na deze serie interviews zal ik dit framework gaan updaten zodat het in aanbestedingsprocedures gebruikt kan worden om zo Nature-based Solutions beter te waarderen. Mocht je hierin geïnteresseerd zijn, stuur ik later mijn volledige rapport.

Afsluitende vragen

Q.3.1	Zijn er nog andere zaken die je nog wilt delen tijdens dit interview?	
Q.3.1	Mochten er bij mij nog onduidelijkheden zijn over de zaken die we besproken hebben in dit interview, mag ik je hierover nog contacten via e-mail of Teams?	

Appendix H SLIDES KEY INFORMANT INTERVIEWS

To better inform the interviewees about the framework of Ecosystem Accounting, a presentation with visual examples was shown during the interview.

Slide 1

Het toepassen van Ecosysten Accounting om het gebruik van Nature-based Solutions te stimuleren

Masterthesis

Witteveen+Bos — TUDelft

Slide 2 — Nature-based Solutions

"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" (United Nations Environment Programme, 2022, p. 10)

Januari 2023 — Key Informant Interviews — 2

Slide 3 — Ecosystem Accounting

"A spatially-based integrated statistical framework for organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extend and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity" (United Nations et al., 2020, p. 3)

Januari 2023 — Key Informant Interviews — 3

Slide 4 — Ecosystem Accounting

voorraadrekeningen | stroomrekeningen

Ecosysteem omvang / Ecosysteem Conditie → Ecosysteem Dienst (stroom & gebruik)

Ecosysteem activarekening (voorraad & verandering in voorraad) / Ecosysteem Dienst (stroom & gebruik) → Fysieke rekening / Geld-rekening

Januari 2023 — Key Informant Interviews — 4

Slide 5 — Omvangrekening

Forest, Wetland, Cropland, Lake, Urban area, Seagrass

Januari 2023 — Key Informant Interviews — 5

Slide 6 — Conditierekening

Variabele	Een-heid	Opening	Sluiting	Verschil	Laagste referentie	Hoogste referentie	Openings-indicator	Sluitings-indicator	Indicator verschil
Ondoordring-baarheid	%	70	60	-10	100	0	0,30	0,4	0,1
NO₂-concentratie	Ug/m3	10,5	12,3	1,8	40	0	0,74	0,69	-0,05

Januari 2023 — Key Informant Interviews — 6

Slide 7 — Conditierekening

Variabele	Een-heid	Openings-indicator	Sluitings-indicator	Gewicht	Openings-index	Sluitings-index	Index-verschil
Ondoordring-baarheid	%	0,30	0,4	0,5	0,15	0,2	0,05
NO₂-concentratie	Ug/m3	0,74	0,69	0,5	0,37	0,35	-0,02
Totaal				1	0,52	0,55	0,03

Januari 2023 — Key Informant Interviews — 7

Slide 8 — Fysieke dienstenrekening

		Bos	Stedelijk gebied	Moeras-gebied	Totaal
Producerende diensten					
Houtproductie	m³	140			140
Regulerings- en onderhoudsdiensten					
Waterzuivering	Ton N verwijderd			7	7
Culturele diensten					
Recreatie	#bezoeken	1500	2500		4000

Januari 2023 — Key Informant Interviews — 8

Slide 9 — Geldelijke dienstenrekening

	Prijs	Bos	Stedelijk gebied	Moeras-gebied	Totaal
Producerende diensten					
Houtproductie	60 €/m³	€ 8.400,-			€ 8.400,-
Regulerings- en onderhoudsdiensten					
Waterzuivering	100 €/ton N verwijderd			€ 700,-	€ 700,-
Culturele diensten					
Recreatie	5 €/#bezoek	€ 7.500,-	€ 12.500,-		€ 20.000,-
Total		€ 15.900,-	€ 12.500,-	€ 700,-	€ 29.100,-

Januari 2023 — Key Informant Interviews — 9

Slide 10 — Activarekening

	Kortings-percentage	Bos	Stedelijk gebied	Moeras-gebied	Totaal
Producerende diensten					
Houtproductie	3%	€5.101.217,-			€5.101.217,-
Regulerings- en onderhoudsdiensten					
Waterzuivering	2%			€ 218.562,-	€ 218.562,-
Culturele diensten					
Recreatie	3%	€4.554.658,-	€7.591.097,-		€12.145.755,-
Totaal		€9.655.875,-	€7.951.097,-	€ 218.562,-	€17.465.534,-

Januari 2023 — Key Informant Interviews — 10

TUDelft

Witteveen+Bos

Appendix I QUOTES STAKEHOLDER INTERVIEWS

Number	Quotation	Codes
Quote 1.1	Het gevaar is dat het een mooie wollige tekst is en dat die vervolgens in een la belandt, al dan niet digitaal en dat er nooit meer naar gekeken wordt.	Call for tenders
Quote 1.2	Dan zit je automatisch al in de meer D&C-achtige oplossingen en die zijn toch duidelijk in de minderheid. En dan kan een aannemer echt zijn ei kwijt en dan kan die leuke verschillende dingen laten zien	Type of contract, Contractor
Quote 1.3	We hebben nog altijd veel projecten die worden voorbereid, ofwel als een uitgewerkt bestek, of als Engineer&Construct, maar waarbij al heel veel vast ligt. Dus dan maak ik een opdrachtgever, de belangrijkste ontwerpkeuzes in het project	Client, Ambition
Quote 1.4	Dan heb je niet dat effect dat als je dan minder waarmaakt dan een score die je gehaald hebt, dat je boete kan krijgen, maar je krijgt wel dat de partijen die dat heel goed opschrijven en concreet zijn en toetsbaar maken, dat die de hogere score krijgen.	Fine, Measurable
Quote 1.5	En het plaatje wat je hier hebt, dat doet me denken aan een project die we vorig jaar hebben aanbesteed. Helaas is die aanbesteding mislukt, Maar dat waren twee woontorens waar, onder andere ook groene begroeiing was. In het hele veld van allerlei gunningscriteria die er waren, was dit een van de zaken waar naar gekeken is.	Flora
Quote 1.6	Als je dat een beetje doortrekt, dan heeft het hele verhaal geen enkele zin. Ja, want dan is inderdaad gewoon degene die het meeste belooft die wint de opdracht en vervolgens hoeft hij helemaal niks waar te maken, dus dat is heel erg jammer.	Call for tenders, Control phase
Quote 1.7	Ja, en dan is het toch een beetje de degene die de mooiste dingen beloofd heeft. Die krijgen de meeste punten en er wordt nooit wat mee gedaan.	Control phase, Call for tenders
Quote 1.8	Hoe meer ruimte er is bij inschrijvers om tot een oplossing te komen en een oplossing voor te stellen, dan kun je daar ook onderscheid in maken.	Type of contract, Call for tenders
Quote 1.9	Als je echt wil onderscheiden, moet er ook genoeg tegenover staan. Qua effectieve korting of een andere manier, dat je wel echt onderscheid kan maken.	Fictional discount
Quote 1.10	Als je niet waarmaakt wat je beloofd hebt, dan krijg je wel een boete in harde euro's en meestal is die ook 1,5 keer het voordeel wat je gehaald hebt, dus dat kan flink in de papieren lopen.	Control phase, Fine
Quote 1.11	Als je daar dan een miljoenen project hebt, dan moet je er ook een miljoen aan effectieve korting tegenover zetten. Dan heb je die disbalans tussen de investeringskosten en de fictieve korting die er tegenover staat.	Investment costs, Fictional discount
Quote 1.12	Dat komt omdat het heel vaak andere teams zijn. Het ene team doet aanbesteding en een ander volgend team gaat de uitvoering begeleiden. Ja, als die zich niet goed realiseert dat ook zo'n plan van aanpak onderdeel van de aanbieding is en dat een hele strakke MKI aanbieding, dat die wel waargemaakt moet worden?	Integral, Control phase
Quote 1.13	Cradle to cradle is een aantal jaren heel hip geweest.	Material use
Quote 1.14	Dus ja, eigenlijk vind ik dat je altijd als je criteria stelt, dat je die wel moet toetsen. En in de praktijk gebeurt dat veel te weinig.	Control phase
Quote 1.15	Nee, die kennis, die moeten wij ze voor een deel aandragen	Advisory/Engineering firm
Quote 1.16	Want zeker bij gemeentes zien we heel veel nog de RAW-bestekken. Dan is daar überhaupt geen ruimte voor.	Type of contract
Quote 1.17	We hebben nog altijd veel projecten die worden voorbereid, ofwel als een uitgewerkt bestek, of als Engineer&Construct, maar waarbij al heel veel vast ligt	Type of contract
Quote 1.18	Maar als je ook uitstraalt als opdrachtgever of de naam hebt dat er toch nooit gecontroleerd wordt, dan zit je zelf eigenlijk te promoten dat men opportunistisch moet gaan inschrijven.	Opportunistic tenderer, Control phase
Quote 1.19	Plat gezegd is geld een hele belangrijke. Heel vaak heeft men het idee dat op het moment dat het alleen maar geld gaat kosten, dan is het ineens niet meer zo interessant. Dus als het kostenneutraal gaat dan prima, doe maar. Maar als het geld gaat kosten, dan doen we het vooral niet.	Investment costs
Quote 1.20	En dat kost bijna niks en dan kun je hoog scoren. Maar ja, is dat dan ook echt wat je wil	Investment costs, Fictional discount
Quote 1.21	Levensfase wordt wel steeds vaker meegenomen.	Life cycle costs

Quote 1.22	En dat zie je toch met heel veel overheden heel erg traditioneel zijn ingericht, echt hokjes met allemaal een eigen onderdeeltje. Om dat te combineren, om daar iets bij te halen om meerwaarde te krijgen of om minder onderhoud op termijn te gaan krijgen, om dat voor elkaar te krijgen bij een organisatie. Dat is verschrikkelijk moeilijk en dat is een hele grote drempel, onder andere ook voor dit soort zaken.	Integral
Quote 1.23	Maar als je een project hebt waar vormgeving een belangrijke rol in kan spelen, dan kan die wel weer heel goed aanhaken.	Aesthetic value
Quote 1.24	Duurzame oplossingen zien we steeds meer aandacht voor dan daarvoor. En soms is dat echt in gunningscriteria in aanbestedingsprocedures dat iemand met een betere oplossing hoger kan scoren, maar veel vaker nog, zitten we gewoon in een project wat wordt aanbesteed en is het eigenlijk al verweven in de keuze die de opdrachtgever heeft gemaakt.	Ambition, Call for tenders, Client
Quote 1.25	Als je het bijvoorbeeld hebt over energieverbruik van de realisatiefase ook, dan gaat het natuurlijk wel over de oplossing.	Energy use
Quote 1.26	Ook bij heel veel geïntegreerde contracten die als E&C op de markt worden gezet, is ook heel veel van de oplossing al voorgekauwd, dus is die ruimte er niet	Type of contract
Quote 1.27	Ik weet wel van diverse projecten dat ze bijvoorbeeld MKI hebben toegepast en dat het ook echt tot leuke dingen heeft geleid. Andere asfaltmengsels of dat soort dingen hebben of echt de partijen die minder transportbewegingen heeft, als beste uit de bus komt.	Material use, Energy use
Quote 1.28	Klopt, en dan zie je toch vaak dat het wel belangrijk is, maar niet zo belangrijk dat het tot de top 3 of 4 van criteria behoort.	Call for tenders
Quote 1.29	We proberen het wel te ondervangen door ook in de contractstukken op te nemen dat wat je belooft, dat het ook in eisen moet worden omgezet en ook in de verificatie meegenomen moet worden. Maar ja, als er daar ook niet op toegezien wordt dat het gebeurt, dan valt dat ook weer tussen wal en schip	Control phase
Quote 1.30	Dat is voor een deel de angst, "kan ik wel een boete opleggen?" of "het is zo'n gezeur."	Fine
Quote 1.31	Hoe concreter de beoordelingscriteria zijn, hoe makkelijker het ook is om aan te geven dat iets daar vanaf wijkt. We vragen ook heel vaak om een plan van aanpak en als die smart beschreven is, dan krijg je een hogere waardering.	Measurable, Control phase
Quote 1.32	Omdat heel vaak, als je gaat doorvragen, dan vinden ze dat belangrijk, maar als er een heel hele hoge korting aan komt te hangen, dan klinkt het toch wel heel zwaar in de oren of is het niet goed SMART te maken.	Call for tenders, Measurable
Quote 1.33	Nou, bij heel veel projecten wordt het wel genoemd als "daar moeten we iets mee" en "we hebben doelstellingen" enzovoort.	Ambition
Quote 1.34	Dat zie je ook wel eens een enkele keer dat de behaalde fictieve korting weer in euro's wordt omgezet, en dat die waarde ook in de verificatie en de toetsing meegenomen wordt.	Control phase, Fictional discount
Quote 1.35	Meestal zit ik in de situatie dat het project er al is en dat het moet worden aanbesteed. Dus als het echt gaat over het project en de invulling van het project, daar heb ik niet zo niet zo veel sturing op zeg maar.	Call for tenders, Ambition
Quote 1.36	Dan had je het over zonnepaneeltjes op de bouwkeet.	Energy use
Quote 1.37	Het is nu te veel een aanmoediging voor de opportunistische inschrijver. Beloof maar gouden bergen, want je wordt er meestal toch niet meer aangehouden.	Control phase, Opportunistic tenderer
Quote 1.38	Maar het begint vooral met aandacht ervoor, want het wordt gewoon te vaak vergeten.	Control phase
Quote 1.39	Als je echt wat wil, dan moet je ook durven om het belang wat hoger te stellen dan de echte waarde in euro's. Maar dan moet het ook wel goed uitgewerkt zijn, en dan moet je er ook echt wat voor over hebben.	Fictional discount
Quote 1.40	Ja, met name MKI, dat zie ik de laatste jaren het laatste jaar echt flink winnen.	Material use
Quote 1.41	Die zitten wat eerder aan tafel dan dat ik aan tafel zit en dan heb je het over de inhoud van het project. En ja, daar kan je het meeste sturen, dus daar is absoluut de meeste winst te halen en daar kun je ook de afweging maken.	Ambition
Quote 1.42	En als daar het gevoel vooral leeft van "als het maar iets meer geld gaat kosten, dan loopt het allemaal niet" dan wordt het ook niks	Fictional discount
Quote 1.43	En, als je het helemaal op het einde zit, als alles al klaar is, dan kan het vaak niet. Maar als je dat veel eerder meeneemt dan is het wel mogelijk.	Ambition

TUDelft

Witteveen+Bos

Quote 1.44	Als je dan de hele track beschouwd dat wordt natuurlijk een heel ander verhaal dan wanner je alleen puur kijkt naar de investeringskosten en de aanbesteding.	Life cycle costs, Investment costs, Integral
Quote 1.45	Maar de combinatie van realisatie en onderhoud, dat zijn verschillende afdelingen bij een opdrachtgever en dus ook verschillende potjes en om die twee bij elkaar brengen, dat is al een hele kunst.	Investment costs, Life cycle costs
Quote 1.46	En dat is natuurlijk sowieso een hele mooi moment, dat je iets gaat bouwen, dat je iets gaat realiseren, dat je dan werk met werk kan combineren, dan kun je tegen de laagste kosten de mooiste dingen realiseren.	Investment costs
Quote 1.47	En dat kan zijn van wat gaan we bouwen, hoeveel groen moet erbij zitten en dat soort zaken, tot aan voorschrijven van materieel dat minder uitstoot geeft	Energy use, Flora
Quote 1.48	Maar wat ik het meest tegenkom is toch wel de platte, technische inhoud, van we moeten een project hebben en oh ja, we moeten nog iets met biodiversiteit doen.	Fauna, Flora
Quote 1.49	Alleen als je echt zegt, "we gaan die en die harde maatregelen daadwerkelijk doen, we gaan die extra bomen planten."	Flora
Quote 1.50	En daar geldt hetzelfde voor ,als de waarde in euro's. Als die maatregelen relatief beperkt zijn in verhouding tot een hoge boete, dan is men heel snel toch geneigd om te zeggen "ja, een hoge boete gaan we maar niet opleggen omdat het disproportioneel? Dat is ook wel zo, maar het is niet voor niks.	Fine
Quote 1.51	Er wordt er getoetst, soms wordt het gewoon vergeten. Veel opdrachtgevers zijn ook bang om boetes op te leggen.	Control phase
Quote 1.52	Of, een beetje off topic voor jou verhaal denk ik, maar de inzet van materieel wat minder uitstoot oplevert en dat soort dingen.	Energy use
Quote 1.53	Als je oplossing al bijna vast ligt, dus zeker bij een bestek, dan is op dat niveau niet heel veel meer te doen, dus dan zit het eigenlijk vooral in je materieel en hoe ga je bouwen.	Energy use, Material use, Type of contract
Quote 1.54	"let op je, we houden je ook aan wat je beloofd hebt en als je dan niet waarmaakt, dan kunnen we daar een boete voor uitdelen." Want als je dat al niet doet, dan wordt het wel heel snel vergeten.	Control phase, Fine
Quote 1.55	En dan krijgen ze gelijk naar het hoofd geslingerd "het is disproportioneel en je lijdt niet zoveel schade als de boete die je nu oplegt"	Fine
Quote 1.56	En daar zien we dus heel vaak dat opdrachtgevers duurzaamheid hoog in het vaandel hebben	Ambition
Quote 1.57	En ja, als je het goed aan wil pakken, dan gaat het natuurlijk om het hele traject van bouw, van beheer, onderhoud misschien wel, of sloop zelfs	Integral
Quote 1.58	Die controle achteraf, daar heb ik niet zo heel veel zicht op, want ik ben heel vaak dan niet meer betrokken bij projecten.	Control phase, Integral
Quote 1.59	Alleen Als je dan kijkt naar wat er daadwerkelijk uiteindelijk in de projecten terechtkomt, dan is het wel een veel kleiner aandeel?	Call for tenders
Quote 1.60	Ja, de opdrachtgever. Die is natuurlijk degene die uiteindelijk de stukken op de markt brengt en die moet het al willen, dus het begint vaak al met een ambitie van vanuit de organisatie waar je dan op aan wil sluiten	Client
Quote 1.61	Je ziet steeds meer aanbestedingen voorbij komen waarbij je in de EMVI echt duurzaamheid op een of andere manier gekoppeld is, bijvoorbeeld door iets met MKI te doen of door beoordeling van een plan van aanpak waar dit soort aspecten meegenomen worden.	Material use
Quote 1.62	Je wilt toch minimaal op een aanneemsom 10% of 15% kunnen goed maken. Dus heel vaak zeg ik qua ordegrootte zou het bedrag van de fictieve korting ongeveer gelijk moeten zijn aan het bedrag van de aannemingssom	Fictional discount
Quote 2.1	Is je het kwantitatief doet kom je al snel bij MKI uit, Rijkswaterstaat hanteert dat volgens mij ook als standaard	Material use
Quote 2.2	Of dat er wel een ambitiewebsessie wordt gehouden, waarin wordt gezegd "dit is een mooi idee" en "dat moeten we meenemen", maar dan daarna gaan we allemaal weer verder aan het gewone project. Terwijl je eigenlijk dan ervoor moet zorgen dat je die uitgesproken ambities ook mee worden genomen in het integrale project en dat het niet zomaar iets is voor erbij wat soms eventjes weer de revue passeert.	Call for tenders, Ambition
Quote 2.3	dat is expliciet met eisen werken en het systeem definiëren en analyseren en dan ook toetsen of je ontwerpuitwerking ook voldoet aan die eisen. En dat zou dan een manier kunnen zijn om die ambitie expliciet mee te nemen	Control phase
Quote	In mijn discipline zit ik ook in een themagroep die zich bezig houdt met duurzaamheid en ik zou wel zelf wat meer willen richten op biodiversiteit hoe we dat	Flora, Fauna

TUDelft

Witteveen+Bos

2.4	mee kunnen nemen standaard in onze contracten.	
Quote 2.5	Wij zijn wel zo proactief dat we dan zeggen, we willen dat wel graag integraal meenemen	Integral
Quote 2.6	Duurzaam is dan ook, we kiezen voor een duurzaam materiaal.	Material use
Quote 2.7	Initieel denk ik inderdaad dat de opdrachtgever de gene is die met de projecten komt	Client
Quote 2.8	En afhankelijk van het type project, ik kom zelf als contractvoorbereiding alleen in aanraking met projecten die al richting contractvoorbereiding of planfase gaan. Ik heb zelf ook veel dijkversterkingsprojecten gedaan en dan heb je ook al eerder een aannemer die ermee bezig gaat.	Advisory/Engineering firm, Contractor
Quote 2.9	Dus ik denk dat de eerste stap echt ligt bij de klant en neem het ook expliciet mee in de uitvraag, want dan wordt het ook beprijsd door de inschrijvende partijen en zien die allemaal mooie kansen.	Call for tenders, Contractor
Quote 2.10	Ik denk ook dat wij als ingenieurstak best wel veel kennis hebben en ook wel proberend at te ontwikkelen.	Advisory/Engineering firm
Quote 2.11	Maar er is ook wat voor te zeggen dat de opdrachtgever, die ook beheerder wordt straks, zijn ariaal goed kent en ook de mogelijkheden daarvoor ziet.	Client
Quote 2.12	Maar ik doe ook een natuurproject met staatsbosbeheer, ja die weet natuurlijk wat daar zit en hoe ze dat beheren. Dus de opdrachtgever is ook en cruciale partij.	Client
Quote 2.13	Maar bij wie zit dan de meeste kennis, ik denk ook zeker bij hun. Zeker als je het hebt over het realiseren ervan. Je kan niet zomaar daar wat zaadjes neergooien en zeggen het komt wel goed.	Contractor
Quote 2.14	Gebiedskennis is de opdrachtgever, hoe leg je het daadwerkelijk aan, daarvan hoop je dat het bij de aannemers ligt	Client, Contractor
Quote 2.15	Maar hoe goed dat precies functioneert, dat kun je op voorhand niet zo goed bepalen. Er zijn natuurlijk wel allerlei onderzoeken, maar toch schuilt daar iets van een onzekerheidsmarge in.	Measurable
Quote 2.16	Dat is ergens op gebaseerd, dus daar zit wel een kostencomponent. En dat zijn de harde euro's, terwijl wat jij met EA meerekent dat is de waarde van een ecosysteem wat niet verdisconteerd zit in deze euro's, dus de baten die je ook hebt.	Investment costs
Quote 2.17	iedereen heeft de voorkeur om in een groene omgeving te wonen, of in ieder geval toch de meeste mensen wel.	Aesthetic value
Quote 2.18	De vraagspecificatie is een mijlpaal in het vormgeven van je opdracht, dus als in een vroeg stadium steeds al hebt gekozen voor een duurzame of een NbS oplossing. Dan heb je al een mooie basis staan, dus daar kun je meer verschil mee maken dan in je gunningscriterium.	Ambition, Call for tenders
Quote 2.19	Maar de bandbreedte van een duurzame oplossing, hoe duurzaam kun je het maken als je er vroegtijdig mee start kun je nog alle kanten op. Maar als je al keuzes hebt gemaakt in de eerste fase, dan kun je nog maar beperkte resultaten boeken.	Ambition
Quote 2.20	Dus hoe langer je ermee wacht hoe minder mogelijkheden er zijn. En dat geldt niet alleen voor duurzaamheid, maar dat is voor een heleboel thema's het geval. En dat is dan ook direct de bottleneck of het probleem, dat dat dus niet tijdig wordt meegenomen	Ambition
Quote 2.21	Met dus meer ontwerpvrijheid voor de aannemer omdat je dan zegt hij heeft er meer verstand van, dus hij kan dan nog met ideeën komen waar wij niet aan gedacht hebben	Type of contract
Quote 2.22	Maar bijvoorbeeld een sedum-dak, dat is misschien niet alleen de gene die het aanlegt, dus de aannemer, maar ook de leverancier van de verschillende onderdelen.	Contractor
Quote 2.23	Vanuit een circulaire gedachte, krijg je andere partijen die een grotere rol krijgen, zoals bijvoorbeeld de leverancier	Material use
Quote 2.24	En er is trouwens nog een extra partij, ik denk dat kennisinstellingen ook een rol hebben, die doen echt meer het fundamentele onderzoek.	Research result
Quote 2.25	Het kan in de uitvraag, als je zegt ik heb een vraagspecificatie van het PvE dus dan is het gerelateerd aan de scope, en daar zou het meeste wel in moeten zitten.	Call for tenders
Quote 2.26	Want wat je bij gunningscriteria erin steekt op basis van de methodiek is een nice-to-have het kan maar zo zijn dat er een inschrijver is die een hele lage prijs heeft, als je kijkt naar BPKV, dat iemand er met het project vandoor gaat zonder invulling te geven aan de gunningscriteria dat is in negatieve zin	Call for tenders
Quote	Ja, er wordt heel vaak bij EMVI beloftes de bepaling van RWS geïntroduceerd, dat beloftes die niet worden waargemaakt, daarvoor komt een boete van 1,5	Fine, Fictional discount, Control phase

2.27	keer de niet gerealiseerde fictieve korting.	
Quote 2.28	Want het is een fictieve korting, je gaat een bepaalde waarde bij de criteria monetaristen, dus je gaat er euro's aan koppelen, maar het is wel monopolygeld. Maar als je dat ineens trekt naar een boete worden het harde euro's.	Fine, Fictional discount, Control phase
Quote 2.29	En de opdrachtgever heeft er ook niet zoveel aan, het is niet zijn doel om geld te innen en rijk te worden van het project. Hij wil dat hij duurzame oplossingen worden gerealiseerd.	Control phase, Fine
Quote 3.1	Er zijn oplossingen waarbij dat geldt, maar er zijn ook dingen die ook helemaal niets uitmaken of die zelfs goedkoper zijn omdat je het net een tandje minder doet.	Investment costs
Quote 3.2	Wat wij nu hebben gedaan, we deden al ambitiewebsessies en de zaken die daaruit kwamen moesten in een contract komen.	Ambition
Quote 3.3	Vanuit die intrinsieke motivatie zijn we dingen in contracten gaan veranderen en hebben we werkende weg dat uitvoeringskader gemaakt.	Type of contract
Quote 3.4	En daarmee, als je het vergelijkt met een waterschap wat een dijk moet aanpassen, daar is het grotendeels materieel, ons werk heeft nog wel flink wat materiaal erin zitten en daarmee om je uitstoot te beperken is, is het beperken van je materiaal of het kiezen van duurzaam materiaal is een belangrijke manier om je MKI of CO2 uitstoot naar beneden te brengen.	Material use, Energy use
Quote 3.5	Ik vind dat je als opdrachtgever het voortouw moet nemen om aan te geven wat je wil. En dat je als opdrachtgever aan moet geven dat je duurzaamheid belangrijk vindt en dat je je doelen en doelstellingen daarmee heel expliciet maakt.	Measurable, Client
Quote 3.6	Als ze dat doen gaat het goed, maar het kan ook zijn dat ze zeggen ik weet het allemaal niet en dat is vooral ook dat we nu de bewijsvoering in het opleverdossier hebben opgevoerd. Zodat je op dat vlak wat meer ziet wat je kan doen. En er zitten bijvoorbeeld hele stomme dingen in het contract. Wij vragen bijvoorbeeld een plan vrijgekomen materialen, maar we vragen geen rapportage. Wel dat ze van tevoren nadenken, maar niet wat er nu daadwerkelijk is vrijgekomen. Ja daar krijg je een soort register van, maar geen rapportage. Dus daar moeten we wat scherper in worden om dan beter te kijken hoe dingen worden doorgevoerd.	Control phase
Quote 3.7	Veel opdrachtgevers sturen op de laagste prijs, ook op adviesdiensten en dat betekent dat je de goedkoopste contract-/bestekschrijver kiezen die ze kunnen vinden en dat is of een jonkie die nog niet zo breed heeft gekken of het is iemand die maar tot een bepaald niveau is gekomen anders worden ze te duur. En dus juist de integrale mensen die duurzame oplossingen in bestekken zouden kunnen fietsen die zijn vaak te duur.	Advisory/Engineering firm, Client, Lowest price, Integral
Quote 3.8	Met groen, zien wij dat niet omdat wij daarmee niet compenseren. We vragen alleen groen als dat echt nodig is en dat is dan dus niet zozeer het punt waar ze op kunnen scoren.	Flora
Quote 3.9	Dus het is vooral het borgen in alle fases van je projectleven.	Control phase
Quote 3.10	Dan is het onderscheid minder te maken, dan moet je al meer de details is, is er wel of niet water, is er wel of niet dood hout, is er wel of niet gradiënt is er wel of niet de mogelijkheid om de soortenrijkheid te verhogen, dan is het van richt je je dan op wat er zit, of richt je je op het inrichten van de voorwaarden met het idee van als ik de voorwaarden zo maak dan komen er vanzelf soorten.	Flora, Fauna
Quote 3.11	Ja, want dan kunnen wij het mee koppelen maar wij hebben niet het budget om uit onszelf alles mee te koppelen	Investment costs
Quote 3.12	En grotendeels is dat dus CO2 emissie reductie, maar wel met de ruimte dat als er specifiek dingen zijn om daar een extra gunningscriterium van te maken en innovatie zit daar ook bij.	Energy use
Quote 3.13	Dus er zijn een heleboel dingen die juist ook goedkoper kunt maken, omdat je het niet robuuster maakt dan wat er nodig is	Investment costs, Material use
Quote 3.14	Een bestuurder kijken niet vaak naar de hoeveelheid groen. Dus dan is het al snel een ondergeschoven kindje.	Call for tenders, Flora
Quote 3.15	We weten qua asfalt wel wat er kan, we weten qua beton ook gedeeltelijk wel wat er kan, qua heleboel andere dingen is het ook ga je iets wat je al hebt hergebruiken en is nu bijvoorbeeld een houtpaaltje een betere oplossing of is een paaltje wat gedeeltelijk bio-based is maar met nog een stukje composiet erin een beter oplossing.	Material use, Knowledge
Quote 3.16	Wij hebben veel geïntegreerde contracten wat betekent dat wij minimaal ontwerp meegeven. En dat ontwerp wat mij meegeven is van de bestaande weg of het is iets wat uit bestemmingsplanprocedures of anderszins is gekomen dat betekent dat in onze contracten vaak beperktere ruimte is voor adviesbureaus maar dat er vooral ruimte ligt voor aannemers	Advisory/Engineering firm, Type of contract, Contractor
Quote 3.17	Ook met de 3D-geprintte fietsbrug was de eerste stap om te kijken wat we met minder materiaal konden doen. Dus dat is een beetje de gezamenlijke zoektocht	Material use

Quote 3.18	In die fase zijn het vaak de landschapsarchitecten die gaan voor mooi i.p.v. bio-divers en de architecten die ook gaan voor mooi en niet voor mooi met een twist zodat je meer kansen bedenkt.	Architect, Flora, Aesthetic value, Fauna
Quote 3.19	En doordat zij al bepaalde shots maken is dat wat mensen verwachten en is dat waarop het bestuur of een omgeving al kiest voor die variant willen we gaan of voor dat onderdeel willen we gaan	Client, Aesthetic value
Quote 3.20	Je ziet wel in slimmigheidjes, zoals ik al zei dat ze asfalt in de berm gebruiken of dat ze materialen die ze eigenlijk nergens kwijt kunnen en waar het dus eigenlijk geld kost om dat af te voeren, dat ze dat dus in een talud kunnen verstoppen zodat je dat op een later tijdstip alsnog een keer tegen gaat komen. Daar moet je wel alert op zijn. Dus op het hergebruik of het sluiten van de cirkel dat ze dat niet te ver doorvoeren	Contractor, Opportunistic tenderer, Material use
Quote 3.21	Maar dan blijft het nog steeds een bestuurlijke beslissing welke variant je kiest.	Client
Quote 3.22	En wat we nu ook nog hebben toegevoegd een jaar geleden is dat we zeggen in principe moet je kijken of je de materialen die er zijn kan hergebruiken en als er nieuw materiaal nodig hebt, kijk dan eerst naar secundair materiaal, en als het dan nieuw moet zijn, kijk dan eerst naar bio-based oplossingen en pas de volgende is nieuw materiaal.	Material use
Quote 3.23	Dus die dingen komen er wel, maar het meten van het effect, dat is dan waar de verbeteractie nog op plaats kan vinden.	Measurable, Control phase
Quote 3.24	Bijvoorbeeld de randweg Boekel, waar Witteveen+Bos het ontwerp heeft gemaakt en het contract heeft gemaakt. Daarin stond Duikers CUR100, dat is een afwerkingsniveau van beton wat wil zeggen dat het hoogwaardig afgewerkt beton is. Als je dat doet voor een kolom die je ziet wat in de gebouwede omgeving zit, dan kun je daar ook wat van vinden, maar dan snap ik dat. Op het moment dat je dat voor een duiker in je contract hebt staan, dan heb je op dat punt niet over duurzaamheid nagedacht	Material use
Quote 3.25	Zo zie je ook dingen als er wordt bij een geïntegreerd contract gevraagd om een groen geluidsscherm, dat er dan op wordt gereageerd met we zetten hedera erop. Maar dat is dan 1 soort hedera, waarom niet 3? Daar hebben ze dan helemaal nooit bij stil gestaan, of dat nu adviesbureau of aannemer is, niemand die zegt, zou je daar niet eens meerdere soorten gaan zetten. Of dat er soorten gepland worden aan de zonzijde van een scherm zonder voorzieningen waardoor die dingen harstikke wegbranden	Flora, Contractor, Knowledge, Advisory/Engineering firm, Type of contract
Quote 3.26	WE hebben een uitvoeringskader innovatie en duurzaamheid infraprojecten. Daarin is eerst een stukje beschreven over dat we dus met het ambitieweb willen werken en hoe we met het gunningscriterium duurzaamheid willen omgaan. In principe is het zo dat wij tussen de 60 en 100% op kwaliteit gunnen, en van dat bedrag is in principe gemiddeld 50% wat dan duurzaamheid is, met een kleine variatie afhankelijk van de vrijheid in het contract.	Ambition
Quote 3.27	Dus je doet je duurzaamheidsacties voor het project en je contractacties voor een project maar je kijkt niet hoe je dat kan matchen.	Integral
Quote 3.28	Wat we ook zien is wat ik op veel plekken merk, ik heb bij een adviesbureau gewerkt, maar hier ook veel aan de opdrachtgeverszijde. Dat bij de meeste bureaus de duurzaamheidsmensen en de contractmensen niet praten.	Integral, Advisory/Engineering firm
Quote 3.29	We zijn de maximumeisen ten aanzien van MKI's voor beton aan het doen, we zijn minimumpercentages voor hergebruikt materiaal meer aan het specificeren, we hadden eerst alleen een basisgetal	Material use
Quote 3.30	De architecten die met infrastructuur bezig zijn, de architecten die houden van een mooie bomenlaan en niet een laan met een es en een eik en alles door elkaar of setjes bij elkaar. Die willen gewoon een strakke lijn	Aesthetic value, Architect, Flora
Quote 3.31	En vaak krijg je dan bij de wat grotere projecten ook de wat grotere namen en mag je niet de architect uit je eigen adviesbureau gebruiken, terwijl die vaak ook hun eigen architect in huis hebben.	Advisory/Engineering firm, Architect
Quote 3.32	Wat wij ook merken is zeker dat wanneer een ingreep impactvoller is, dus wanneer er kunstwerken of geluidsvoorzieningen nodig zijn, daar zit vaak in zo'n bestemmingsplanprocedure, of projectbesluit zoals het nu gaat heten, daar zit al zoveel interactie met de omgeving in. Daar zit vaak ook al een stukje landschapsdesign in, een stukje architectuurimpact wat maakt dat je speelruimte om dingen anders te doen in volgende stappen vaak maar heel beperkt is.	Architect, Client
Quote 3.33	We zijn een van de overheden die al een heel aantal jaren toestaan dat er hergebruikt asfalt in de deklaag komt.	Material use
Quote 3.34	En dan zie ik dan van we vragen naar een plan, maar niet naar een rapportage. Wel een register, maar geen rapportage waarin je terugkomt op de vergelijking op wat je ooit hebt bedacht. Dus dat is dan de fine-tuning die echt nog wel nodig is.	Control phase
Quote 3.35	Op het moment dat je veel bestekken hebt, dan heb je wel meer aan adviesbureaus.	Type of contract, Advisory/Engineering firm
Quote 3.36	Ze denken dan we moeten de CO2 voetprint naar beneden brengen, dan moeten we gaan voorkomen dat we dingen gaan slepen, oh er komt hier asfalt vrij, als we dat nu in de berm stoppen, heb je gelijk een hele mooie halfverharding. Dus het wil ook niet altijd zeggen dat er een slechte bedoeling achter zit. Soms zal het ook gewoon zijn, hoe kunnen we kosten beperken, maar het is absoluut niet altijd slecht bedoelt.	Energy use, Opportunistic tenderer

Quote 3.37	Wat je wel ziet, met DuBoCalc en MKI met CO2 is dat je een duidelijk iets hebt om te meten, waar dat met biodiversiteit nog een stuk lastiger is.	Energy use, Fauna, Flora, Material use, Measurable
Quote 3.38	Daar zit een standaard profiel in voor hoe een weg is opgebouwd. En de standaard opbouw had daar een dikte van 30 cm. Als ik nu ga kijken in onze contracten, daar waar we de dingen opgeven hebben we een dikte van 21 cm. Als ik ga kijken naar onze aannemers die worden gestimuleerd om de MKI zo laag mogelijk te houden, die komen meestal met een dikte van 15 tot 18 cm.	Material use
Quote 3.39	En veel mensen hebben het idee dat als het duurzaam is, dat het dan ook duurder is. Terwijl dat in heel veel gevallen helemaal niet duurder hoeft of soms zelfs goedkoper. Sterker nog als je van tevoren nadenkt of iets echt wel moet, dan kan het vaak zelfs veel goedkoper.	Investment costs
Quote 3.40	Ik denk dat je er meer aan zou hebben als iedereen een basis kennis heeft in plaats van dat een van de partijen in de schakel de meeste kennis heeft. Het gaat er juist om dat ieder weet hoe moet ik iets vragen, hoe moet ik iets ontwerpen, hoe moet ik iets bouwen? En als een van die drie heel veel meer weet dan de ander, dan ga je niet meer krijgen , want dan stuit je op heel veel onbegrip bij de anderen. Als je alle 3 een basiskennis hebt, dan kom je verder dan wanneer een van de 3 veel meer weet.	Client, Contractor, Advisory/Engineering firm, Knowledge
Quote 3.41	We zijn nu dus ook met dat dashboard bezig en we zijn ook bezig met onze eigen certificering op de CO2prestatieladder waar we ook een aantal zaken voor moeten verzamelen.	Energy use
Quote 3.42	En wij geven relatief gezien ook veel ruimte mee in contracten, dus dat betekent dat aannemers ons erkennen en herkennen als een organisatie waar ze een stapje verder mogen doen en een stapje duurzamer moeten doen dan op andere plekken.	Type of contract, Contractor
Quote 3.43	Want wat we merken is dat we best het een en ander aan ambitiewebsessies deden, maar als je tien adviesbureaus voor je hebt werken, dan doet iedereen dat op een andere manier en daarbinnen ook nog de verschillende adviseurs. En vervolgens wordt het resultaat van zo'n sessie ergens in een mapje terecht en als je geluk hebt wordt er dan in de contractfase nog wat mee gedaan en dan houdt het op	Call for tenders, Advisory/Engineering firm, Ambition
Quote 3.44	Ja, want wat je ziet is omdat wij duurzaamheid en innovatie zo zwaar waren krijg je een ander tenderteam. En omdat je een ander tenderteam hebt, krijg je andere oplossingen. Dus zelfs al heb je vervolgens een standaard team in de uitvoering omdat je een ander aanbod hebt gekregen, krijg je toch dat je in de realisatiefase dingen anders worden gedaan.	Knowledge, Call for tenders, Ambition
Quote 3.45	Er zijn erbij waar 60% hergebruikte materiaal in zit. We hebben doordat we de lage CO2footprint stimuleren, dat we zien dat partijen soms te slim gaan nadenken over waar ze materialen kunnen hergebruiken.	Material use, Energy use
Quote 3.46	Ehm, het zit er iets tussenin. Kijk het belangrijkste is dat je duurzame dingen vraagt en laat zien dat je duurzaamheid belangrijk vindt.	Ambition, Call for tenders
Quote 3.47	Dus je hebt natuurpunten systeem, wij werken hier zelf met meetlat biodiversiteit van IPC groen, we werken met natuurbehoudswaarden.	Flora, Measurable, Fauna
Quote 3.48	We weten ook dat het duurzamer moet en dat we dingen vrijer moeten laten, want als we wachten tot het ergens 10 jaar ligt voordat het proven technology is, ja dan komen we er niet	Research result, Type of contract
Quote 3.49	Dus ik had een student die bezig was met circulariteit, dus toen had ik ook gezegd, ga maar eens kijken wat je vindt	Material use
Quote 3.50	Dan moeten we zorgen dat we het aan de voorkant goed op orde hebben en we moeten ook zorgen dat we de monitoring goed op orde hebben.	Ambition, Control phase
Quote 3.51	En dan dus niet alleen civiel technisch een mooi recht leggen, of denk eens na over wat je achter kan laten aan groen, of wat je achter kan laten aan dood hout. Of denk eens na over hoe je de soortenrijkdom van wat je plant kun vermeerderen.	Flora
Quote 3.52	Je ziet wel dat er nu groepjes zijn die zich bezig houden met hoe biodiversiteit of natuurlijk kapitaal beter in projecten krijgt. Zowel in de bouw als in de infra.	Fauna, Flora
Quote 3.53	Vorig jaar hadden we hier een markt dag, duurzaamheid was een van de onderwerpen en we hadden een aantal tafels bedacht, biodiversiteit, circulariteit en nog iets anders	Fauna, Flora, Material use
Quote 4.1	Maar laten we even zeggen, de overheid of de opdrachtgever is dan wel echt als eerste aan zet.	Contractor
Quote 4.2	En biodiversiteit is gewoon te meten door ook een ecoloog in het gebied te sturen	Measurable, Ecologist
Quote 4.3	En dan moet je nog opletten of het echt alleen is dat je regenwater snel afgevoerd moet worden of dat het een integraal verhaal is, dat je ook water vast wil houden, dat is natuurlijk ook veel actueler	Water
Quote 4.4	Maar als eerste aan zet is natuurlijk de opdrachtgever, of de ingenieurs want die kunnen dit soort dingen goed aangeven en helpen met de aanbesteding	Advisory/Engineering firm, Contractor

TUDelft

Witteveen+Bos

Quote 4.5	Overheid is er voor de grote lijnen en de overheid kan helpen door geen project meer aan te besteden waarin biodiversiteit geen rol heeft als wij dat belangrijk vinden. Maar zeker niet om heel erg te gaan detailleren of te gaan voorschrijven wat je moet doen. Nee laat dat over aan een consortium, dat is mijn ideale wereld. En dan zou ik ook altijd zeggen, niet alleen de aanleg, maar ook het beheer, want dan ga je leren en investeren in een gebied.	Integral, Flora, Client, Fauna, Type of contract
Quote 4.6	Maar ik denk bijvoorbeeld dat kustbescherming veel meer nature-based zou kunnen, maar we worden eigenlijk nooit zo gevraagd. Het ultieme voorbeeld van NbS vind ik altijd het talud, en dat is wel al goed gegaan, al heette het toen nog niet NbS. Maar alle harde afscheidingen van water en land, daarvoor kun je wel een duurzaam materiaal gebruiken of het zo circulair mogelijk doen. Maar er zijn grenzen en je hebt altijd een harde grens die is minder interessant qua ecologie maar ook kwetsbaar. Maar op het moment dat je wat meer ruimte neemt en je maakt een sloot breder met een flauwere helling, dan kun je dat veel meer Nature-based doen	Material use
Quote 4.7	Maar ook op andere zaken zoals de bomen en de ecologische waarde van de kademuren	Flora
Quote 4.8	En daarbij kunnen ingenieurs ook zeker een rol spelen. Ingenieurs dat zijn bedenkers en samen met architecten hele praktische bedenkers en samen met ecologen kan je gewoon zonder dat je meteen miljoenen moet investeren kun je goed nadenken wat een prettige woonomgeving is en hoe groen en ecologie daaraan kan bijdragen.	Aesthetic value, Advisory/Engineering firm, Architect, Ecologist, Health & Wellbeing
Quote 4.9	Maar ook dat men de voorbeelden niet kent, dat men niet weet dat iets al een keer is uitgeprobeerd of toegepast, of dat een bepaald onderzoek iets aantoont. Dus dat je weet hoeveel water op wijkniveau een groen dak kan schelen	Research result, Knowledge, Water
Quote 4.10	Ik ben dus ook erg voor het bouwteam, omdat de ontwerper dan ook met de beheerder en opdrachtgever en de aannemer kan overleggen hoe voer je zo'n project met zo min mogelijk uitstoot uit.	Type of contract, Integral, Client, Contractor, Architect, Energy use
Quote 4.11	dat als je bomen plant dat het uitmaakt welke bomen dat zijn als dat bijvoorbeeld op de zuidkant van een gebouw is, want dan kunnen ze oververhitting voorkomen.	Temperature, Flora
Quote 4.12	Nu is er vooral aandacht voor biodiversiteit, dus dat wordt dan op de agenda gezet en dan krijg je bij een aanbesteding na enige tijd toch ook zulke vragen	Flora, Fauna
Quote 4.13	Bijvoorbeeld in Eindhoven staat een gebouw en daar staan Platanen voor of Linden, maar die bomen voorkomen in de zomer dat het heet wordt in het gebouw daarachter, dus dan hoeft er niet gekoeld worden. En het is natuurlijk super mooi. En in de winter verliezen ze hun blad en heb je gewoon optimale lichttoetreding	Temperature, Flora
Quote 4.14	Maar wij zijn dan wel in de positie om zo aanbod te doen	Contractor
Quote 4.15	Dan zou ik zeggen hou het eenvoudig. Liever een beetje grof en eenvoudig dan ingewikkeld en wat preciezer.	Simple
Quote 4.16	Maar stel dat ergens een gemeente meer wil doen met groen, en gesloten bladerdak en meer bomen in de omging, dan kost dat wat geld natuurlijk	Flora
Quote 4.17	Nou ik denk dat toch de opdrachtgever of de overheid aan zet is	Client
Quote 4.18	Als je nu kijkt waarop nu uitgevraagd wordt, dan zijn dat hele platte euro's en dan kom je ook tot een ontwerp waarbij onze collega's een maximaal aantal woningen plempen in een project en je scheidt alle functies, dan heb je een heel ander ontwerp dan wanneer je zegt we hebben nu een hele kale omgeving die we willen verbeteren zodat mensen zich beter voelen en dat je dan een integrale benadering hebt met de euro's voor de ecosysteemdiensten.	Health & Wellbeing, Investment costs, Integral, Lowest price
Quote 4.19	Ik weet niet of je gehoord hebt van het 3-30-300principe? Dat zegt dat je 3 bomen vanuit je huis idealiter moet zien, 30 slaat op 30% kroonoppervlak, dus bomen met een kroon die 30% van je wijk bedekt, en die 300 die slaat op het aantal meters naar een park of naar een groen omgeving.	Flora, Health & Wellbeing
Quote 4.20	Je hebt wel de well-standard voor well-buildings, uit Amerika overgewaaid, dus daar kun je wel iets mee. Maar dat wordt nu nog heel weinig toegepast of uitgevraagd	Health & Wellbeing
Quote 4.21	Dan kunnen we op basis van ervaring al zeggen dat dat ecologisch gezien veel rijker wordt door dan op zo'n manier en zo bewust van de flora en fauna te gaan bouwen.	Fauna, Flora
Quote 4.22	Maar dat is zeker nog wel een stukje bewustzijn dat dit een van de NbS is waarna je dus na constructie helemaal niet vaak meer naartoe hoeft en waarvan je kunt genieten van een wandelpad ofzo. En je hebt meteen ruimte voor water gecreëerd en voor flexibiliteit	Awareness, Water, Health & Wellbeing
Quote 4.23	Oplossingen delen is wel belangrijk, als je de oplossingen deelt, dan kan de opdrachtgever ook de verbanden gaan zien	Knowledge, Client
Quote 4.24	Ja, ja er zijn natuurlijk ook verschillende belangen daarin. Als ik natuurlijk zeg dat een goede materiaalkeuze het halve werk is, of meer dan het halve werk en dat je dan dus je installaties kleiner kan maken.	Temperature, Energy use

TUDelft   Witteveen+Bos

Quote 4.25	Veel dingen zijn al toegepast en een keer uitgeprobeerd. En dat doen we niet zo goed in de bouw, we hebben geen goede leercirkel	Knowledge
Quote 4.26	Dat soortoplossingen, moeten vooral gedeeld worden, en daar ligt ook een deel voor de ingenieursbureaus, deel ze maar en dan hoop je dat de opdrachtgever dat op een gegeven moment ook oppikt.	Knowledge, Client, Advisory/Engineering firm
Quote 4.27	Dus dat je een langere periode kiest, maar dan vinden veel opdrachtgevers ingewikkeld, want die hebben geleerd dat ze elke 3 jaar van plek moeten wisselen, dus moeten jobhoppen en die hebben dus een heel korte horizon en het bestuur heeft ook een horizon van niet meer dan 4 jaar. En dan moeten ze dat dus organiseren durven. Maar ik denk dat de combinatie van aanleg of renovatie met beheer, dan krijg je ineens veel meer ruimte voor allerlei goede oplossingen.	Integral, Client
Quote 4.28	Maar dan leer je ook nooit van je projecten en krijg je er geen band mee	Knowledge
Quote 4.29	Dus ik denk inderdaad niet alles dichtmetselen, maar juist de aannemer actief inschakelen als partij die ook met oplossingen kan komen	Type of contract, Contractor
Quote 4.30	Ja en dan hoef je ook echt geen miljoenenproject te hebben. Als je bijvoorbeeld als gemeente de openbare ruimte in een gebied voor 5 jaar aanbesteed en je zet goede eisen erop en tussendoor heb je regelmatig contact. Dan kun je een gebied heel aantrekkelijk maken	Aesthetic value, Client
Quote 4.31	Want de grote vragen bij bouwprojecten zijn nu of het stikstofvrij kan en wat doet het met de CO2. Dus jij vraagt nu ecosysteemprestaties, maar CO2 is natuurlijk ook een hele belangrijke die ook in de markt wordt gevraagd en die je goed kan meten	Energy use
Quote 4.32	En dit is alleen nog maar over de belangen, maar dan zou ik het ook nog apart willen benomen over bewustwording.	Awareness
Quote 4.33	NbS is meer de groene richting van de duurzaamheid, terwijl er veel vaker naar de grijze technische kant van duurzaamheid gekeken wordt.	Energy use, Material use
Quote 4.34	Dat is destijds helemaal ecologisch ontworpen en het interessante is dat daar integraal is gewerkt met een landschapsarchitect, die iets weet van groen en planten. Dus je hebt niet alleen de bouwkundig architect, maar ook een ecoloog en een groenspecialist die alles weet van de bloemetjes en de bijtjes en zij hebben daar groendaken op dat complex die nog steeds heel goed functioneren. Dus dat is een project uit 1989 geloof ik en dat groen dak functioneert boven verwachting en dat is super interessant om als casus een keer te bekijken.	Flora, Fauna, Ecologist, Architect, Integral
Quote 4.35	En dan kun je iets doen met elektrisch en emissieloosvervoer of zoiets, maar je hebt eigenlijk maar heel weinig mogelijkheden.	Energy use
Quote 4.36	Als je het dan hebt over duurzaam bouwen, dat wordt vaak duur genoemd en dat is vooral omdat we van tevoren bij het ontwerp niet goed nadenken vanuit de natuur.	Investment costs
Quote 4.37	Ik denk dat als daar nog vragen over zijn, of als daar nog echt te weinig onderzoeksresultaten voor zijn, dan zou ik zeggen, ga dat echt goed meten hè. Zo zijn we 30 jaar geleden begonnen met de moderne groene daken. Ik was als studentje betrokken bij zo'n project en daarvan werd van tevoren gezegd door de TUs dat kan nooit wat zijn. Maar daarna is men gaan meten en dan kun je laten zien dat het wel degelijk invloed heeft op de waterhuishouding en de temperatuur. Dus onderzoek is een belangrijke	Research result, Temperature, Water
Quote 4.38	En er is ook nog een innovatie-prestatietraject wat de gemeente Amsterdam doet. Dat is ook nog een vorm die wel interessant is om te noemen voor de kademuren en ook voor scholen	Type of contract
Quote 4.39	Gezondheid is denk wel een van de moeilijkste zaken om daar op uit te vragen	Health & Wellbeing
Quote 4.40	Dat is misschien ook een hele leuke, het is ontzettend belangrijk daarin dat je als team werkt	Integral
Quote 4.41	Maar de duurzaamheidsoplossingen die er zijn, worden meestal gezocht in de installatie of in de techniek terwijl je ook een huis of kantoor kan ontwerpen wat in de winter van zichzelf warm en behaaglijk is en in de zomer koel door slimmer te ontwerpen, door andere materialen te gebruiken, bio-based materialen. Ja dat is een ecologische zoekrichting waarbij je je ook laat inspireren door de natuur en een andere richting is dat je je richt op groene energie en dat opwekken en dan heb je installaties die moeten zorgen voor de verwarming en de koeling. Dat is een andere denkrichting.	Energy use
Quote 4.42	En dat is een innovatie-prestatieproject, waarbij je dus als consortium, dus dat zou ook Witteveen+Bos kunnen zijn waarbij je dan dus met partners een totaaloplossing aanlevert.	Advisory/Engineering firm, Type of contract
Quote 4.43	dat heet misschien wel bio-based of zoiets, maar die vragen ook behoorlijk integraal uit. En die hebben een project in Oirschot, daar wordt een nieuwe wijk ontwikkeld en die moet ook helemaal bio-based en ecologisch en biodivers zijn, dus dat zal een mooie voorbeeld zijn	Integral, Fauna, Flora
Quote 4.44	Ik heb zelf gewerkt aan een beginnetje voor de gemeente Almere, die zich zorgen maakt over hittestress en wateroverlast. Die hebben dan nu een uitvraag om een nieuwbouwwijk groener te maken en beter qua waterbeheer.	Contractor, Client, Flora, Water, Temperature

Quote 4.45	Wat kun je voor maatregelen doen om minder temperatuurschommelingen te hebben in de wijk, dat het minder heet wordt en kun je wat doen aan de waterhuishouding?	Water, Temperature
Quote 4.46	En zo zijn er meer projecten van Alberts en van Huut, die hebben een aantal groenprojecten gedaan waarbij ze steeds met ecologen en met kunstenaars werken. De Gasunie in Groningen dat gebouw, dat is ook met ecologen gedaan. En dat is meer aan de binnenkant met planten gewerkt, dat die een rol hebben, dat zou je ook een NbS kunnen noemen. Dat planten de rol hebben voor de luchtvochtigheid en goed binnenklimaat. Dat integrale is dat vooral belangrijk	Flora, Integral, Temperature, Architect, Ecologist
Quote 4.47	Ik woon zelf in een groene buurt, een jaren '70 buitenwijk en ja soms gebeurt het nu dat mensen hier komen wonen en dat ze hun tuin grotendeels leegmaken en dat betegelen en dan zijn ze het volgende moment verbaasd dat ze wateroverlast hebben	Water, Awareness
Quote 4.48	dan zie je dat building with nature internationaal ook nog wel echt een ding is en dan wordt er ook het verband gelegd met een urban forest, dat je groen in de omgeving hebt, maar dat je ook het cirkeltje rondmaakt dat als er hout bij vrij komt, dan kun je dat hout weer in de omgeving toepassen.	Material use, Flora
Quote 4.49	Ik kom ook regelmatig tegen dat mensen iets zeggen van de aannemer dit of dat of de gemeente dit of dat. Het is altijd de andere en dan hoeven wij niets te doen, en dat is natuurlijk heel jammer	Contractor, Client
Quote 4.50	Een andere belangrijke is denk ik best-practices. Dus dat je voorbeelden blijft verzamelen en steeds teruggeven	Knowledge
Quote 4.51	En wat ik heb begrepen is dat ze nu met zo'n prijsvraag en met goede ondersteuning dan krijg je de opdrachtgever enthousiast en je krijgt de markt enthousiast, dus dat werkt.	Contractor, Client
Quote 4.52	Want als je dus wil dat er meer met ecosysteemdiensten wordt gewerkt of aanbesteed, dan moet je het eenvoudig maken. En ik vind dat ook wel een taak van adviseurs en onderzoekers. Want ik merk gewoon dat als het te ingewikkeld is, dat mensen wel enthousiast zijn, maar dat het na 1 of 2 projecten weer weg zakt	Knowledge, Advisory/Engineering firm, Simple
Quote 4.53	Dat maakt het bouwen duur, nu doen we een heel stuk voorwerk bij Witteveen+Bos en nog bij een ander ingenieursbureau eventueel en bij een architect en dan gaan we naar de opdrachtgever die zet het in de markt, maar dan zit er ook al ruis op de lijn, dus dan is het ook alweer wat anders dan je zelf had bedacht en dan komt er uit de aanbesteding een aannemer en die komt met eigen ervaring met NbS of bepaalde werkzaamheden, maar die kan dat niet kwijt omdat hij met het plan moet werken wat iemand anders heeft opgesteld	Advisory/Engineering firm, Contractor, Client, Integral, Investment costs
Quote 4.54	Het dakoverstek van een gebouw is al jaren verdwenen, omdat dat materiaal scheelde om een dak te maken wat slechts tot de gevel komt. Maar als je gaat kijken naar het onderhoud of de onderhoudsbehoefte van wat zo'n gebouw nodig heeft. Dan heb je met zo'n soort constructie per definitie problemen met de gevel, zeker op de zuidwest kant	Life cycle costs, Investment costs
Quote 4.55	Maar die opbrengsten die je terugkrijgt, dat mensen gezonder zijn, dat er minder vandalisme is en dat er waarschijnlijk minder onderhoud nodig is voor dat gebied, dat er een lager energieverbruik is, dat er minder wateroverlast is	Aesthetic value, Water, Health & Wellbeing, Energy use
Quote 4.56	En het meten van welzijn in een wijk, daar zijn de eerste onderzoeken van, dat aangetoond kan worden dat alleen al het zien van groen of de nabijheid van een park dat dat lijdt tot minder ziekte in de omgeving, die eerste onderzoeken zijn er.	Health & Wellbeing, Research result
Quote 4.57	En van belang is dan eigenlijk wel dat de markt nu zo is georganiseerd dat ze een bouwbedrijf of ingenieursbureau of een combinatie inschakelen om iets aan te leggen en daarna is het beheer weer voor anderen. En die knip die is ongunstig voor alle bouw, maar zeker ook voor NbS	Integral, Life cycle costs
Quote 4.58	Voor de gemeente gaat dat dan over vestigingsklimaat, die wil ik hier nog wel even noemen, hoe wordt ik een aantrekkelijk gemeente. Ja zo wordt je een aantrekkelijke gemeente als je dat ziet	Aesthetic value
Quote 4.59	Ja die zit wel weer bij andere partijen. Die zit bij ontwerpers, bij architecten, bij ingenieurs, bij ecologen, bij biologen.	Advisory/Engineering firm, Architect, Ecologist
Quote 4.60	Al die benefits, die worden niet goed in kaart gebracht. Dus het is heel belangrijk om bouwen en beheer veel vaker te gaan combineren.	Integral
Quote 4.61	Dat zijn voorbeelden van als je het hebt over NbS, dan ga je veel integraler kijken naar de materie en ben je dus niet heel beperkend bezig met oogkleppen op ja dit zijn de euro's en energie en materialen die je erin stipt	Energy use, Integral
Quote 4.62	Maar ik noemde al de vraag naar klimaatadaptatie, dat is er een die is wel blijvend, ook op stedenbouwkundig niveau	Temperature, Water
Quote 4.63	Ja, dit soort dingen wordt veel gezegd om dan maar niks te doen. Ik ken die verhalen. Ook het cliché dat een aannemer alleen maar gericht is op de laagste prijs. Ja als je hem daarop uitvraagt, dan kun je het ze niet kwalijk nemen. Ja hij is alleen gericht op het minimaliseren van het risico, dat krijg je als je uitvraag alleen gericht is op prijs. Dus ik denk dat het voor jouw onderzoek dan ook echt belangrijk is dat je aanleg en beheer combineert, zodat je een heel andere dynamiek krijgt	Lowest price, Integral, Opportunistic tenderer
Quote	het is zo dat je dat de total cost of ownership noemt, je kan het ook de total benefits of ownership noemen, maar dat hangt wel heel erg af van de grenzen	Life cycle costs

4.64	die je legt.	
Quote 4.65	Het dakoverstek om je gevel te beschermen, of om de hoge zon uit het gebouw te houden zodat je geen of niet zo snel oververhitting hebt. Een groen dak om niet alleen te isoleren, maar ook een dak wat meedoet in de waterhuishouding, een dak van zichzelf koel is omdat de planten dat opnemen. Er zit een dempend effect in, het zorgt voor het ecosysteem in de buurt, voor de vogeltjes en kleine zoogdieren en de hele insectenpopulatie.	Water, Flora, Temperature, Energy use, Fauna

Quote 5.1	En even kijken de boom of vegetatie dekking, Dat is natuurlijk het percentage wat überhaupt met vegetatie bedekt is. Ja, dat lijkt me in zekere zin, misschien wel een startpunt.	Vegetation cover
Quote 5.2	Ja zo ja je kan letterlijk een soort gaan meten natuurlijk.	species richness
Quote 5.3	Heb je bijvoorbeeld de dus de graslaag heet die volgens mij en dan heb je de kruidlaag, de struiklaag, de boomlaag, dus dat.	Vegetation cover
Quote 5.4	Als je alleen maar gras hebt en bomen bij de dan mis je gewoon een hele hoop habitats.	Vegetation cover
Quote 5.5	Want als je alleen maar bomen hebt en een en een grond en stel er is geen verstoring, want dat is nog een heel ander verhaal dan. Dan heb je daar grond broedende soorten, dus soorten die hun nest op de grond bouwen, zoals meeuwen en je hebt een soorten die in een grote boom zitten, maar soorten die graag in een struikje zitten.	Vegetation cover
Quote 5.6	Die die heb je dan niet, dus is ook wel gerelateerd aan habitats. En soms heeft een soort bijvoorbeeld zijn nest in die boom, maar haalt hij zijn voedsel uit die struik dus als je dan die Struik niet hebt, dan heeft het geen zin dat je die boom hebt.	Vegetation cover
Quote 5.7	Ja, maar dat dat vertaalt zichzelf, dat het dan weer leefgebied is voor insecten en vogels.	Vegetation cover
Quote 5.8	Kijk idealiter om een heel goed beeld te krijgen ga je natuurlijk alles in beeld brengen, elk diertje en elke plant. Nou, dat is niet super haalbaar gok ik dus.	species richness
Quote 5.9	Er zijn een aantal dingen die je kan doen om dan een beetje grip te krijgen en dan wat ik nu benoemde over gras kruidlaag boomlaag, dan heb je het eigenlijk al een beetje over het habitat. Wat voor type habitat is daar dan aanwezig?	Vegetation cover
Quote 5.10	Ik denk ook die vast laag kruidlaag struiklaag dat dat ze ook wel gereed is dan wat voor type habitat zijn er.	Vegetation cover
Quote 5.11	Ja, ik zit te denken, bestuiving dat snap ik maar een uur kijken wat er langskomt, dat is natuurlijk onzin, want zo'n soort die bloeit weet ik veel een maand of zo en en gedurende die maand zijn er verschillende insecten die hun piek hebben en die daadwerkelijk bestuiven. Dus ik noem maar wat Vlinders die verpoppen, de een popt in mei, de ander vliegt in juni, de ander vliegt in juli. En, misschien zijn ze allemaal een deel van die tijd, afhankelijk van die ene plant. Dus als jij alleen maar een uur gaat kijken, ja, dat is van de gekken en meet je helemaal niks.	pollination service
Quote 5.12	Dat daar gelaten op zich is bestuiving als dienst. Ja, dat is natuurlijk wel gerelateerd aan biodiversiteit ja.	pollination service
Quote 5.13	Je kan zeggen hoeveel soorten zijn er afhankelijk van die plant. Wat eigenlijk is het, zie ik het een beetje andersom. Die plant is voedsel voor zoveel dieren. En het gevolg is dat die bestuift zeg maar.	pollination service
Quote 5.14	Stel je voor die ene plant daar zijn 40 soorten van afhankelijk voor hun voedsel, dus als je die plant niet meer hebt, dan hebben die 40 soorten minder voedsel. Maar stel je voor je hebt planten, die hebben maar een bestuiver, als die ermee ophoudt, dan houden zij er ook mee op.	pollination service
Quote 5.15	Als je ecosysteem hebt wat in balans is, dan heb je minder plaagsoorten	pollination service
Quote 5.16	Dus ik denk dat je het dan andersom moet bekijken, dat het goed is om bestuiving te te benoemen dat het waarde heeft. Maar het heeft waarde is voor de mens? Je moet die waarde denk ik niet meten vanuit biodiversiteit. Want heen variatie aan aan nectar planten heeft waarde voor biodiversiteit, ja. Maar variatie in nectarplanten, als wij daar daar van maar eentje gebruiken, dan heeft ze maar een waarde voor ons.	pollination service
Quote 5.17	Als je kijkt naar goed, hoe goed kan je met klimaatadaptatie omgaan dat ook daar je boom en vegetatiebedekking best wel een goede indicator voor kan zijn. Hoe meer bomen, hoe meer verkoeling ook en hoe meer je daarmee ook weer water kan afvangen	Vegetation cover, Cooling service
Quote 5.18	Ik denk dat ook daarvoor goede bodem hebt met veel koolstof, dus organische stof.	Soil quality
Quote 5.19	Maar ook hoe goed je bodem afgedekt is, hoe water weg kan stromen.	Imperviousness
Quote 5.20	Dat is eigenlijk, als je zand hebt van de duinen, dat is gewoon wit. En als je ziet wat wij gebruiken, potgrond, dat is diezelfde korrel zand, maar dan omringd met een laagje organische stof en dan wordt die korrel zwart. Ja, en hoe meer organische stof In de bodem, hoe meer water vast blijft zitten in die bodemlagen en het dus het wordt vastgehouden door de bodem en dus langer beschikbaar is voor planten.	Soil quality

Quote 5.21	Dat kan je volgens mij gewoon meten. Ja, waterabsorberend vermogen.	Rain water regulation service
Quote 6.1	Hoeveel moeite je wil steken in het meten, bijvoorbeeld van iets. Dus wil je bijvoorbeeld zeggen van we gaan gewoon kijken naar het oppervlak verhard en het oppervlak vegetatie en dan gaan we op basis daarvan aannames doen of wil je ook helemaal onderzoek doen naar hoe goed de bodem kan infiltreren en of er wel bijvoorbeeld met het hoogteverschil dingen zoals Wadi's of zo zijn aangelegd, waardoor het water ook naar de goede kant stroomt en daar kan infiltreren.	Imperviousness, Vegetation cover
Quote 6.2	Ja en dan zou je zeg maar al best wel kunnen kijken naar gewoon verharding, versus planten.	Imperviousness, Vegetation cover
Quote 6.3	Is het maaiveld dan wel slim ingericht dat het goed wordt geleid en kan infiltreren, want het gaat denk ik niet alleen over wateroverlast gaat tegenwoordig maar ook wel heel erg over droogte	Rain water regulation service
Quote 6.4	Dus je wilt het niet alleen afvoeren, maar je wilt ook zo ontworpen hebben dat het echt in het gebied kan worden geïnfiltreerd.	Rain water regulation service
Quote 6.5	Want dat is ook best wel belangrijk voor de ecosysteemdiensten waterbeschikbaarheid, want we hebben heel lang gefocust op waterafvoeren. Waardoor er nu in heel veel plekken veel droogte is en waardoor ja ecosysteemdiensten ook niet geleverd worden in bijvoorbeeld droge periodes.	Rain water regulation service
Quote 6.6	En voor bijvoorbeeld hitte gaat ook over schaduwen. Het gaat ook over groen, zeg maar groen tegenover verharding, maar bijvoorbeeld ook schaduw wat we ook door gebouwen zou kunnen creëren, maar ook bijvoorbeeld door bomen	Shadow cover, Vegetation cover
Quote 6.7	Bijvoorbeeld als je het hebt over hitte. Je kan eigenlijk niet zo goed meten of de hitte goed is of niet, maar je kan bijvoorbeeld wel meten bijvoorbeeld, hoeveel groen is er of hoeveel schaduw is er en is er schaduw op belangrijke routes? Dat soort dingen kan je wel weer makkelijk meten, dus dat is dan eigenlijk indirect	Cooling service, Shadow cover, Vegetation cover
Quote 6.8	Als het heel hard regent gaat dat water niet allemaal in dat grasveld infiltreren in een keer, dus dat gaat dan ergens heen stromen dus voor klimaatadaptatie is het wel belangrijk dat het water zeg maar goed ergens naartoe geleid wordt waar jij het wil. Nou als je dat bijvoorbeeld al als een soort van Ja-neevraag kan beantwoorden van "ik heb infiltrerende maatregelen bedacht", of zoiets, dan heb je denk ik al een soort van aanname gedaan, dat dat dan goed ontworpen is.	Rain water regulation service
Quote 6.9	Je weet nog niet precies welke planten, maar je kan natuurlijk wel zeggen "we gaan een grasveld aanleggen" of "we gaan een mix van lagere beplanting en bomen en verschillende habitats" of zoiets, dat kan je wel wel zeggen van tevoren.	Vegetation cover
Quote 6.10	Ja meer natuurlijke maatregelen, maar ook wat meer technische maatregelen die dan water kunnen vasthouden. En ja, Ik denk dat je daar wel naar zou kunnen kijken in je ecosysteemdiensten, of die maatregelen er zijn en hoeveel capaciteit die dan hebben.	Rain water regulation service
Quote 6.11	Ja en voor de openbare ruimte dan groen, dat is eigenlijk het enige wat echt kan verkoelen, dus zeg maar de verdamping door groen, de verdamping van water dat onttrekt energie uit de lucht, dus dat koelt en voor de rest is het meer het voorkomen van opwarming dus door schaduw en door het materiaalgebruik te zorgen dat een plek niet opwarmt.	Cooling service, Shadow cover
Quote 6.12	De zuiverende werking van bijvoorbeeld bomen. Het is een relatief klein percentage, wat zeg maar een boom zuivert. Dus een boom haalt inderdaad bepaalde stoffen uit de lucht. Aan de andere kant stoten bomen zelf ook bepaalde stoffen uit, dus het is wel zo, maar iemand van luchtkwaliteit zei dat eigenlijk het grootste effect wat een boom kan hebben op de luchtkwaliteit is dat er een omgevallen boom op de weg ligt en dat er geen auto's meer rijden.	Air quality, Vegetation cover
Quote 7.1	Nou gaat het gezondheid zit voor mij op 3 dingen, dus één is gewoon tast het je lichaam aan? Dus adem je vieze lucht in of kom je in aanraking met chemische spullen in het water, waardoor het via je haar haarvaten en je je huid naar binnen gaat. Tweede heeft te maken met beweging, dus nodigt de omgeving uit tot activiteit. Dus als jij een groene omgeving hebt met hele goede fietspaden die comfortabel fietsen en ook veilig zijn park, waardoor het dus uitnodigt tot beweging en beweging leidt er natuurlijk uiteindelijk toe dat je waarschijnlijk minder vaak in het ziekenhuis terechtkomt of naar de huisarts moet. Dus dat drukt de gezondheidszorgkosten naar beneden. En de laatste heeft te maken met mentale gesteldheid. En dan kom je toch heel snel op ontmoeten en dat soort dingen. Dus kan iemand die alleen is, een oudere bijvoorbeeld, ontmoet die een jongere in een park dat hij even een kletspraatje kan maken, en voelt hij zich daardoor minder alleen en hoeft hij minder vaak naar de psychologen.	Health service
Quote 7.2	Precies hetzelfde.	pollination service
Quote 7.3	Ja, dan kom ik terug op die 3. Dus is er nestgelegenheid? Dus hoeveel nesten kan een vogel bouwen of maken. Is er migratiegelegenheid, dus kan hij zich bewegen van de ene naar de andere nestgelegenheid. Kan dat überhaupt of staat er dan een muur tussen? En is er foerageergelegenheid, dus kan hij zijn voedsel zoeken. Kan hij ergens gewoon aan eten komen?	Vegetation cover
Quote 7.4	Ja, maar ik denk dat dat inderdaad zit in de door- of ondoordringbaarheid van de bodem. Dus hoe makkelijk gaat het water weg? Ik denk ook dat het gaat over de opnamecapaciteit voor het water.	Imperviousness, Rain water regulation service
Quote 8.1	Ja, Ik weet niet wat een living planet index is.	Living Planet Index
Quote	Dat is natuurlijk een vorm van diversiteit in habitat zeg maar, waardoor je ook diversiteit met soorten krijgt.	Vegetation cover

8.2		
Quote 8.3	Maar voor de diversiteit van het ecosysteem als geheel zou je misschien best een afwisseling willen tussen gras en vegetatie en struiken en bomen.	Vegetation cover
Quote 8.4	Voor biodiversiteit als geheel wil je gewoon al die lagen wel aanwezig hebben, want dan neemt die biodiversiteit toe.	Vegetation cover
Quote 8.5	Nou, dat kan van alles zijn. Het kan vochtgehalte van de vegetatie zijn, maar ook open water. Gewoon iets wat minder goed minder opwarmt.	Cooling service
Quote 8.6	Dat is voor hittestress en dan heb je natuurlijk ook wateroverlast, hè? Dus dat is dan die die doordringbaarheid van de bodem, maar ook zou Ik denk het vermogen om water op maaiveld op te vangen zonder dat het overlast geeft, zeg maar.	Rain water regulation service
Quote 8.7	En voor hittestress ook schaduw, natuurlijk.	Shadow cover