Adapting urban areas to climate change: a necessary evil or a world of opportunities?

Inclusion of interests and benefits of stakeholders in the Adaptation Support Tool

Kyra Wouters

Technische Universiteit Delft

TU Delft Delft University of Technology

Deltares Enabling Delta Life

Challenge the future

ADAPTING URBAN AREAS TO CLIMATE CHANGE: A NECESSARY EVIL OR A WORLD OF OPPORTUNITIES?

INCLUSION OF INTERESTS AND BENEFITS OF STAKEHOLDERS IN THE ADAPTATION SUPPORT TOOL

by

Kyra Wouters

in partial fulfillment of the requirements for the degree of

Master of Science
in Watermanagement

at the Delft University of Technology,
to be defended publicly on Thursday August 25, 2016 at 3:00 PM.

Student number:	4133978	
Supervisor:	Dr ir Frans H. M. van de Ven	TU Delft / Deltares
Thesis committee: Chair	Prof. dr ir Nick C. van de Giesen,	TU Delft
	Dr Fransje L. Hooimeijer,	TU Delft
	Dr Reinder J. Brolsma	Deltares

An electronic version of this thesis is available at http://repository.tudelft.nl/.

TU Delft Delft University of Technology

Deltares Enabling Delta Life

ABSTRACT

Urban areas are having trouble adapting to weather extremes and omitting weather related hazards, which will only worsen in the future due to the increased pressure of climate change. This climate change will have far-reaching implications for both average and extreme weather characteristics, which will result in more hazardous events. In order to omit the impact of these hazards it is necessary to adapt the urban areas to increase their resilience. This adaptation can be done by using grey measures, which are artificial measures that use man-made solutions. However, blue-green measures can be used as well, which are measures that incorporate natural and semi-natural green and blue spaces. Blue-green measure can have many additional benefits for the stakeholders, making these measures more attractive and feasible than the traditional grey measures. However, the difficulty lies in implementing adaptive measures, as urban areas are densely built and have many stakeholders present. This creates the need to include climate adaptation in the urban planning and spatial planning processes, which makes the decision-making process very complex. In order to make it easier to come up with adaptation plans that are accepted and can be executed, the engagement of the stakeholders in these processes is necessary. This can be done with the support of planning support systems, like the Adaptation Support Tool which has been developed by Deltares. The main goal of this tool is to support its users during program development and conceptual design, by offering information on possible grey and blue-green measures and their effectiveness. The tool allows users to situate measures in the project area and gives information on the effectiveness of the measures for the climate resilience and cost. In practice, it turns out that the stakeholders use different interests and effects as motive to select measures, besides the effects for climate resilience. In order to increase the support the tool provides, these interests and effects should be included in the tool as well.

Looking into the methods other planning support tools use to value the effects of urban development, shows that the same aspects keep returning in the other tools. This might be an indication that these aspects are the main interests of the stakeholders in urban development. This assumption was tested by interviewing the main group of stakeholders in urban development, the municipalities and the landscape architects that have much experience working with municipalities. In these semi-structured interviews the important interests in urban development were determined and the required representation of the information on these was discussed. The results of these interviews show that the interests of importance are the social cohesion, perception of the surroundings, safety, mobility, quality of the external climate, health and parking. These interests show large similarities with the aspects found in the other tools, leading to the conclusion that these are important and should be included in the tool. The results for the representation of the information on these interests is more diffuse and three different demands can be found, namely representation based on monetary units, qualitative representation and visual representation.
Before including these interests, it was determined what requirements the information should meet for the additional information to be useful and reliable. Based on these requirements, the selected interests for inclusion in the tool are the perception of the surroundings, the social cohesion, the safety and health. For each of these four interests, indicators were determined that reflect on the characteristics and mechanisms behind the effects of the measures for each interest. Every measure in the tool was ranked for these indicators based on a qualitative ranking scale. With the help of these ranks and indicators the calculations could be made and included in the Adaptation Support Tool. By using these calculations the Adaptation Support Tool now can show the effectiveness of the blue-green measures for these four interests. It was expected that the inclusion of these interests would improve the support of the Adaptation Support Tool. This assumption was tested with a workshop in which student teams used the tool to make a conceptual design for an urban area in Delft. The results show two very different approaches and different uses of the information in the tool. Overall, the results indicate that the added information could increase the support for the stakeholders that are not solely interested in the climate resilience of their design. However, the fact that the workshop was organised for only two small student teams, makes the results less reliable.

The conclusion of this research is that it is possible to include some of the important interests of the stakeholders in the Adaptation Support Tool. This can be done by using indicators that reflect on the mechanisms behind the effects for these interests. The result of this thesis shows a first indication that this added information could increase the support of the Adaptation Support Tool and make it better applicable for the large diversity of possible users. However, further evaluation with more participants could shed further light on the effectiveness of the inclusion.

TABLE OF CONTENTS

List of Figures

List of Tables

GLOSSARY AND ABBREVIATIONS

GLOSSARY

(Climate) Adaptation: "The process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities."[1, p. 556].

Anthropogenic: "Resulting from or produced by human beings"[1, p. 556].

Blue-green measures: Measures that incorporate natural and semi-natural green and blue spaces, which have environmental features that enable multiple ecosystem services [2].

Climate change: "A change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer."[1, p. 557].

Ecosystem: "A functional unit consisting of living organisms, their non-living environment, and the interactions within and between them."[3, p. 1452].

Ecosystem-based adaptation (EbA): The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change [4].

Ecosystem services: "Ecological processes or functions having monetary or non-monetary value to individuals or society at large"[5, p. 1764].

Evapotranspiration: "The combined process of evaporation from the Earths surface and transpiration from vegetation [1, p. 559]."

Exposure: "The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected"[5, p. 1765].

Fluvial flooding: "The overflowing of the normal confines of a stream or other body of water"[5, p. 1765].

Global surface temperature: "An estimate of the global mean surface air temperature"[1, p. 560].

Hazards: "The potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources"[1, p. 560].

Impacts: "Detrimental and beneficial consequences of climate change in natural and human systems"[1, p. 561].

Indicators: Quantitative or qualitative parameters that represent certain phenomena in a simple and reliable manner.

Mitigation (of climate change): "Interventions to reduce the sources or enhance the sinks of greenhouse gases"[1, p. 561].

Pluvial flooding: "The accumulation of water over areas not normally submerged due to precipitation"[5, p. 1765].

Resilience: "The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions"[1, p. 563].

Runoff: "That part of precipitation that does not evaporate and is not transpired, but flows through the ground or over the ground surface and returns to bodies of water"[1, p. 563].

Stakeholders: "An individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project"[6].

Sustainability: "A dynamic process that guarantees the persistence of natural and human systems in an equitable manner"[5, p. 1774].

Sustainable development: "Development that meets the needs of the present without compromising the ability of future generations to meet their own need."[7]

Vulnerability: "The propensity or predisposition to be adversely affected"[5, p. 1775].

Urbanisation: "A shift in a population from one that is dispersed across small rural settlements towards one where the population is concentrated in larger, dense urban settlements "[8].

ABBREVIATIONS

AST: Adaptation Support Tool
BREEAM: Building Research Establishment Environmental Assessment Method
CSIRO: Commonwealth Scientific and Industrial Research Organisation
DPL: Duurzaamheidsprofiel van de Locatie
EbA: Ecosystem based Adaptation
IAP2: International Association of Public Participation
IPCC: Intergovernmental Panel on Climate Change
LEED: Leadership in Energy and Environmental Design
MUS: Multiple-Use Water Service
TEEB: The Economics of Ecosystem and Biodiversity
UHI: Urban Heat Island

PREFACE

This report is the final product of my graduation thesis for the master Water Resource Management at the faculty Civil Engineering of Delft University of Technology. The thesis has been completed in cooperation with Deltares.
The report is meant for the ones interested in the combination of climate adaptation with other important interests in urban development. It gives background information on climate adaptation in urban areas and describes the process of the inclusion of additional interest in the Adaptation Support Tool.

Finally, there are some people I would like to acknowledge for their support and help during my thesis:
First of all, I would like to thank my thesis committee for all their feedback and support during these seven months as they helped me many times with realising my ideas. Secondly, I would like to thank all the people that allowed me to interview them and gave me a moment of their valuable time to help me better understand urban development and climate adaptation in urban areas. Thirdly, I want to thank those amazing and enthusiastic students who came back to the university during their summer break to test the tool and create a fruitful afternoon, which was also very entertaining for me. Furthermore I would like to thank Deltares, the urban water section and Ralph Peelen for their support during these seven months. Lastly, I would like to thank my friends and family, who have been there for me, while listening to me going on about some tool, for their support, wise words, jokes and the much needed fun distractions.

I hope you enjoy reading this report as much as I have enjoyed these last seven months. May it be as entertaining, instructing and most of all interesting.

Kyra Wouters
Delft, July 2016

1

INTRODUCTION

More and more people are moving to urban areas each year, making these areas increase in size and importance. At the same time, the existing urban areas are already pressured by changing climate conditions, increasing the risk of hazards and the need for adaptation. This research looks into the climate adaptation of urban areas and the interests that are of importance when (re)developing urban areas, in order to increase the support of a planning support tool during this process.

1.0.1. CLIMATE CHANGE AND HAZARDS

Due to anthropogenic influences, the climate is changing and will continue to change in the future. These changes can have an enormous effect on various climate characteristics like temperature and precipitation. The Intergovernmental Panel on Climate Change (IPCC) regularly releases reports on these changes, which provide future projections of climate variability and change. Although there will always be variability on the regional scale, there are some general remarks about climate change on the global scale that can be made [3, 9]. First of all, the most well-known change, the global surface temperatures will rise substantially and subsequently the mean sea level will increase as well. Besides these changes in average conditions, the climate change will also cause the weather to become more extreme. So, temperature extremes will increase and heat waves will be both longer and occur more frequently. Furthermore, the frequency of heavy precipitation and the proportion of total rainfall from heavy falls will increase. At the same time, droughts will intensify and will be both longer and occur more frequently. On the other hand, an on-going process of urbanisation is taking place [8]. Today, over half of the worlds population (54%) lives in urban areas. It is projected that this percentage will increase to 66% in 2050, due to profound changes in the size and spatial distribution of the global population. This rise means an increase of the urban population with 2.5 billion people.
These two processes combined lead to an increasing importance of urban areas, while the urban areas are under an increasing pressure by the changing weather conditions at the same time. This pressure can lead to more hazardous events which will bring along negative effects for stakeholders, making them undesirable.
Several hazards can occur in the existing urban areas due to extreme weather conditions. The first hazard is pluvial flooding, which is flooding caused by high intensity precipitation. As in the urban environment many surfaces have become less permeable or even impermeable, the infiltration capacity of the area and the transpiration of plants is decreased. This leads to the fact that a larger percentage of the precipitation needs to be stored in open surface waters or transported by drainage networks. An increase in precipitation intensities would put more strain on such waters and drainage networks and subsequently could lead to more frequent pluvial flooding. This flooding can not only be very inconvenient, but it will also have adverse financial and health effects [5]. Another hazard that can be caused by extreme precipitation events is fluvial flooding. The increase in precipitation intensities and the larger amounts of precipitation from heavy rainfalls in river basins could lead to higher peak water levels in rivers, which can cause rivers to over top their banks and flood urban areas. This flooding, just like pluvial flooding, can be very inconvenient and can have adverse financial and health effects [10]. The last hazard that causes flooding of urban areas is coastal flooding. According to the IPCC [11], more than two thirds of the world's large cities are vulnerable to rising sea levels. Furthermore, many cities are sinking due to groundwater extraction and land subsidence, increasing the risk of coastal flooding even further[11, 12]. This situation is illustrated in Figure 1.1. The impact of

this kind of flooding can range from mild inconvenience and economic losses to extreme floods that disrupt the normal life and cause a large number of deaths.

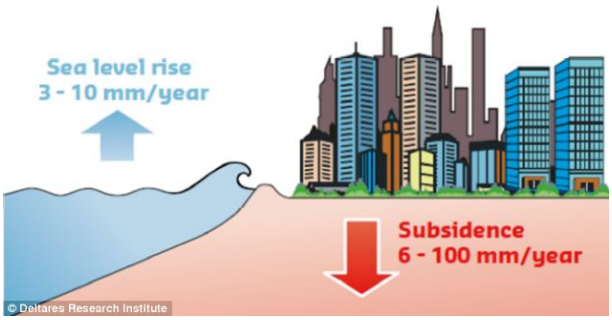


Figure 1.1: An illustration of the hazard due to rising sea levels and land subsidence [12]

Another hazard that can occur in urban areas is a temperature related hazard, called heat stress. This heat stress causes a large range of adverse health effects and will decrease the productivity of the population in urban systems [5]. Heat stress is particularly important in urban areas due to the Urban Heat Island (UHI) effect. This is the phenomena that temperatures in urban environments can be up to 10 °C higher than in rural areas [13]. Figure 1.2 illustrates the effects of UHI. These effects are caused by the large surfaces of non-reflective materials in urban environments and smaller percentage of vegetation in urban environment, which reduces the cooling effect of shading and transpiration that vegetation normally provides. Also, the built-up surfaces obstruct rural air flows, which could have provided the urban environments with some cooling effects, further aggravating the UHI [14].

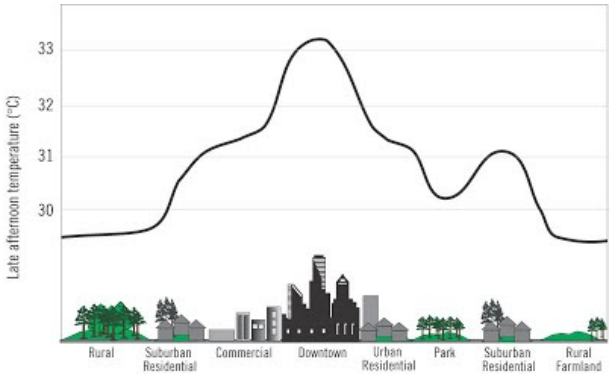


Figure 1.2: An illustration of the Urban Heat Island effect [14]

The last hazard for urban areas is droughts, because besides an increase in the intensity of precipitation, there will also be periods of less precipitation or no precipitation at all, leading to droughts [15]. In urban systems these droughts will be worsened due to the high percentage of pavement in urban areas, which decreases the infiltration of water into the soil. This will lead to several adverse effects, like a reduction of the ecosystem services and qualities of surface waters, lowering of groundwater tables, saltwater intrusion, rotting of wooden piles in foundations and the reduction of the cooling effect of plants [16–18].

1.0.2. ADAPTATION

As already mentioned above, the changes in climate will lead to an increase in hazardous events in the urban areas, which can have many adverse effects for the stakeholders. These negative effects can lead to increasing cost, as the climate changes further [11]. Even when mitigation of climate change is successful in the future, a part of the climate change is already unavoidable due to past emissions. Therefore, adaptation is necessary to (partly) omit the negative effects for the urban environment [11]. There are different definitions of adaptation, however, the following definition will be used in this thesis:

"The process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities."[1, p. 556].

By adapting urban areas, they could become more resilient for the expected weather extremes and reduce the risk of hazards and the accompanying cost. This adaptation can be done with the help of traditional grey measures, which are measures that use artificial and man-made solutions and processes, like enlarging the sewerage capacity or heightening dikes. However, blue-green measures can be used to adapt urban areas as well. These blue-green measures are measures that incorporate natural and semi-natural green and blue spaces, which have environmental features that enable multiple ecosystem services [2]. These ecosystem services are "the ecological processes or functions having monetary or non-monetary value to individuals or society at large"[5, p. 1764]. Besides the fact that these blue-green measures facilitate the adaptation of systems to climate change and variability, these measures also create multiple social, cultural and economic co-benefits for local communities. Moreover, blue-green measures are more flexible, cost effective and sustainable than grey measures and contribute to achieving sustainable development goals[19]. This could make these blue-green measure very attractive for the stakeholders.
However, adapting urban areas by implementing measures in urban areas is a complex process regardless the differences between grey and blue-green measures. Most existing urban areas are densely built and have many stakeholders present. The support and involvement of these stakeholders is often required for solutions to be proficient and accepted [20].

1.0.3. ADAPTATION SUPPORT TOOL

In order to support this difficult adaptation process in urban areas, Deltares developed the Adaptation Support Tool (AST). This tool has been developed to support during the conceptual planning processess of stakeholders in their efforts to make their urban area more resilient for climate change [21]. Users can define their program of demand and adaptation targets with the support of the tool. Furthermore, the tool provides 62 different blue-green and grey measures to select and implement in co-created conceptual design plans. For both single measures and total packages of measures the AST gives the effectiveness for climate resilience, water quality and the investment and maintenance cost.

1.1. PROBLEM DEFINITION

The Adaptation Support Tool has already been used for cases all over the world and it has shown its added value. However, as it turns out, stakeholders often select measures for the expected co-benefits and effects for other interests, besides climate resilience and cost [21]. Even when using a tool developed for climate adaptation, other interests seem to be as important or even more important when selecting measures to implement in the plans. This has not only been observed during these cases, also in literature it can be found that in practice the preferred strategy is to invest in more comprehensive solutions instead of opting for measures that only serve climate adaptation issues [22]. This shows that the effectiveness of the measures for other interests is very important for its users and should be included in the tool as well, to provide the users with all the information necessary to make a founded decision. The problem is that there is not a clear overview of these other important interests yet. Moreover, how these interests can be included in the tool and the preferred representation of information is still unclear as well.

1.2. RESEARCH OBJECTIVE

Based on the problem, as defined above, the focus of this research can be determined. This focus is on the interests of stakeholders and the corresponding effectiveness of the adaptive measures, which should be included in the tool, in order to improve the support the tool gives for the decision-making process of stakeholders in urban development. In order to reach this goal, the following research question will be answered in this thesis:

In which way can the adaptation support tool reflect on the interests and benefits of the involved stakeholders in order to better support the decision-making process of these stakeholders in the climate adaption of urban areas?

In order to answer this research question the following sub-questions need to be answered:

- What are the interests and potential benefits of stakeholders in the process of climate adaptation of urban areas?
- Which indicators can be used to reflect the effectiveness the measures have for the interests of the involved stakeholders in the Adaptation Support Tool?
- What are the limitations of the inclusion of the interests with the defined indicators?
- What effect will the inclusion of these interests have on the decision-making process?
- How can the inclusion of interests be further optimized in the future?

1.3. RESEARCH APPROACH

In order to answer these sub-questions and the research question several steps were taken, leading to the approach that will be discussed in this section. A visual representation of the approach can be found in Figure 1.3.

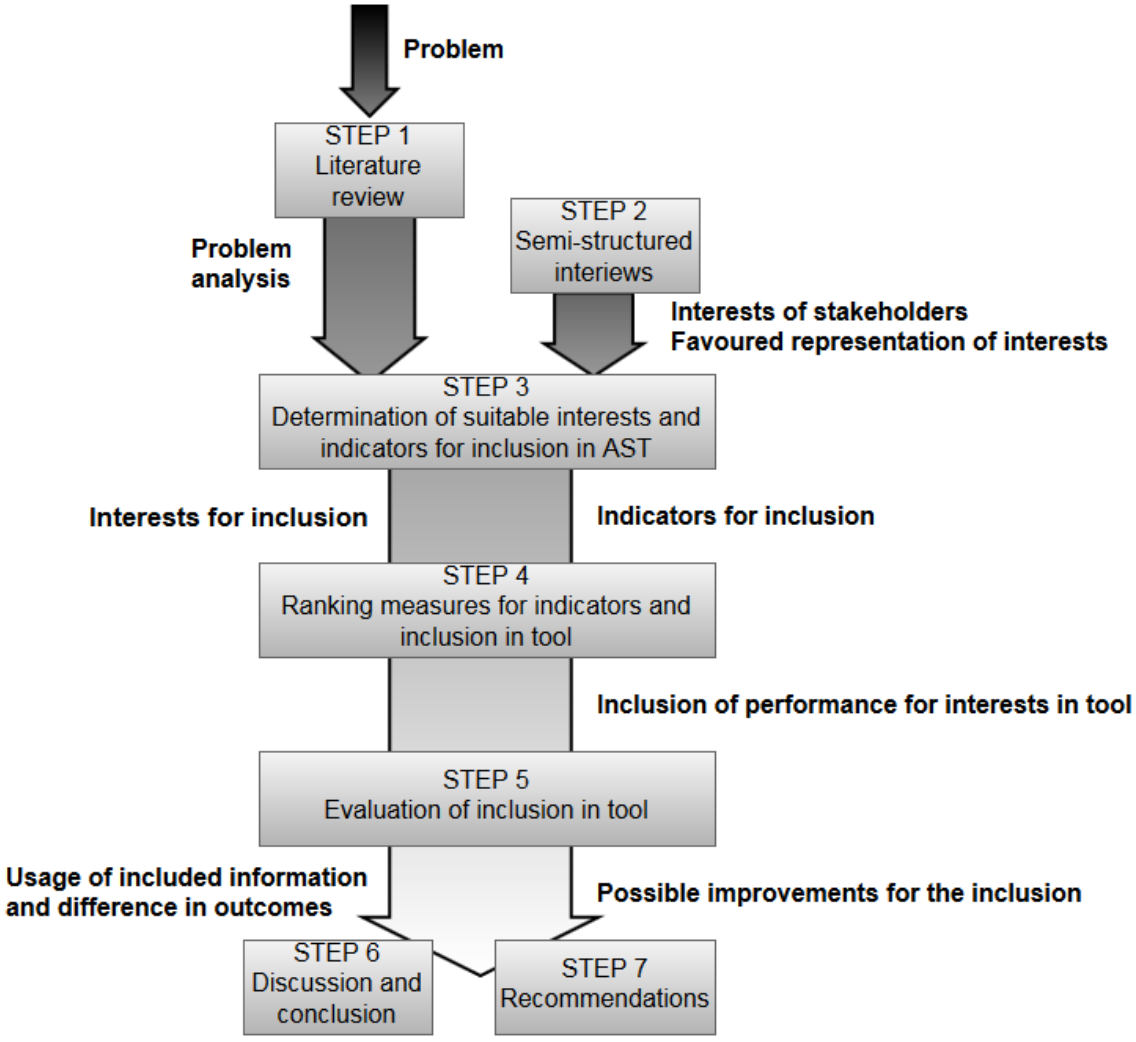


Figure 1.3: A visual representation of the approach of this research

The starting point of this research was the problem definition as defined above. The first step was to get a better understanding of the problem itself, by a thorough literature research. The goal of this literature research was to analyse the problem and to map the different processes that are connected to this problem. The output of this step is an overview of the different subjects and processes that are of importance for this problem and how these are linked with each other.

The next step was to determine the interests of the stakeholders in urban development. This was done by conducting semi-structured interviews with stakeholders. The main focus points were their interests and favoured manner of representation of information. As there are many different stakeholders in urban development, it was not possible to interview all these stakeholders for this research. Therefore, it was decided to hold the interviews only with the largest stakeholder group, the municipalities and with landscape architect with much experience on climate adaptive urban design. The output of this step was an overview of the interests of the largest stakeholder group and their favoured ways of representation information on these interests.
Based on the analysis of the problem and the output of the second step, the interests suitable for inclusion in the AST were determined. The interests were selected for applicability, reliability of information on this interests and importance. In this step indicators were determined as well, that can be used to include these interests in the AST. This was realised with the help of a second, smaller literature research into the effectiveness of the measures in the tool for these interests and the enabling mechanisms behind these measures. The output of this step is an overview of interests that are suitable for inclusion in the tool and an explanation on indicators that can be used to reflect on these interests in the tool.
The following step was including the interests in the AST. To make this happen, all the measures in the tool were ranked for the indicators, which were determined in the previous step. With these ranking the performance of each measure for the interests can be calculated and represented in the tool. In this step the ranking was made, calculations and formulas were drawn and the representation of the information in the tool was discussed. The output of this step is the actual inclusion of the interests in the tool and the representation of the performance of each measure in the AST.
As the objective of this research is to include interests of stakeholders to increase the support of the Adaptation Support Tool, the inclusion was evaluated in the next step. This evaluation was done with a workshop with student teams. The student teams got an assignment and a project area and had to make a conceptual design for this area. During the workshop the students were observed and the students themselves made notes and filled in questionnaires. Based on these results the usage of the included information was discussed and the effect it has on outcomes of the AST. These are the outcomes of this step and at the same time these are the input for the last two steps. One of these steps was discussing this research and drawing the conclusions. The other step was making recommendations for future improvement of the AST and the inclusion of interests in the AST.
Together these seven steps form the approach that has been used in this research to answer the research questions.

1.4. THESIS OUTLINE

The second chapter of this thesis will concern the most important findings of the literature research and represents the information on which this thesis is founded. In the third chapter the set-up and results of the interviews can be found regarding the interests of the stakeholders and the wishes for representation of information. Following, in chapter four the requirements for the additional information will be drawn and the interests for inclusion will be determined. Based on chapter four, chapter five discusses the manner of inclusion in the tool and the indicators that are used. In chapter six, the workshop that is used to evaluate the inclusion is discussed and the results are presented. After these main chapters, the discussion of the research will be given. The last chapter will discuss the conclusions of this research based on the results. In this chapter, there will also be a section that gives recommendations for future research and improvements for the AST in general. Together, these last two chapters will give the answers to the sub-questions and research question of this research.

2

LITERATURE REVIEW

Before looking into the research questions and the main goal of this thesis, the problem itself needs to be better understood. Therefore, a literature research has been conducted first, using the large variety in literature that is available on the subjects of importance for this particular problem. The key findings can be found in the overview below. This overview will give the most important information per subject and will elaborate the links between these different subjects. It forms the basis for this thesis and will be referred to throughout the entire thesis and the chapters to follow.

2.1. THE TIMING OF IMPLEMENTATION

In the introduction the different possibilities for adapting urban areas have been discussed briefly, as using both grey and blue-green measures are possible. However, in practice the most difficult part is not finding adaptive measures or making new urban areas climate resilient, but implementing adaptive measures in the existing urban areas. Most cities are already complex and densely built and often there are few opportunities to implement adaptive measures without some changes in the structure of the built environment. Fortunately, due to the dynamic character of the built environment of existing cities, there are continuously changes being made to maintain, modify and renew areas[23]. By using these dynamics for adaptation, opportunities can be created to implement adaptive measures during such structural changes. Making use of these 'windows of opportunities' reduces the implementation cost[23]. On the other hand, using these 'windows of opportunities' also makes the implementation of adaptive measures more complicated as the existing structures pose many limitations and restrictions to implementation [23]. This timing of adaptation and the fact that these measures often need to be implemented in the existing built environment, makes the planning process complex and it requires the inclusion of many stakeholders in the process. The complexity of climate adaptation in the planning processes and need for the inclusion of stakeholders will be further discussed in the next two sections.

2.2. URBAN AND SPATIAL PLANNING PROCESSES IN THE CLIMATE ADAPTATION OF URBAN SYSTEMS

Both the urban planning and the spatial planning processes are of importance when looking at the climate adaptation of urban areas. Below, both processes will be discussed, starting with the urban planning process.

2.2.1. URBAN PLANNING PROCESSES

When it is decided to include the climate adaptation of urban systems into the urban planning process, this is due to a sense of urgency that originates from one or several problems. For climate adaptation, this sense of urgency is created by the possible hazards caused by climate change, which have been described in section 1.0.1. In urban areas the largest sense of urgency is caused at municipalities, which leads to the municipalities taking initiative in solving the problems [24]. In order to solve these problems a plan needs to be made and when looking at the climate adaptation of the area in question, special attention should be given to the water management of the area [24]. Making such a plan is not a simple process and the urban planning process exists of several consecutive phases. The first phase is the research and analysis phase in which the system

is analysed, the problem is defined and the program development is drafted [21, 24, 25] After the first phase, the synthesis or design phase is started in which the conceptual, preliminary and final designs are created and the implementation of the plan is described. In Figure 2.1 this process is described visually. With the implementation of the plan, the urban planning process is finished.

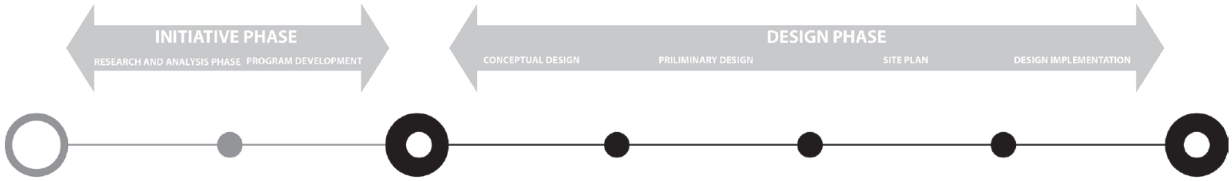


Figure 2.1: A visual representation of the phases in urban planning [25]

2.2.2. SPATIAL PLANNING PROCESSES AND GOVERNMENT

There is a widespread recognition that the spatial configuration of cities and towns has significant implications for climate adaptation. This configuration is shaped by many factors of which one factor is formed by the spatial planning interventions. Therefore, climate adaptation is not only an urban planning process, but should also be included in the spatial planning process as it is a spatial problem as well [26]. Spatial planning is seen as the 'switchboard' for implementing adaptive measures on the local and regional scale, but in order to fulfil this role, the different perspectives of climate scientist and spatial planners have to get more attuned to one another[27]. This has not been reached yet, as spatial planning has a broader perspective than just climate change and therefore, it could focus on more urgent challenges that arise locally [27]. Another important factor is the fact that spatial planning is a public task, which is expressed in many different institutions, laws, policy, instruments and regulations that operate on different levels; national, regional and local [28]. For climate adaptation to be embedded in the spatial planning, all these different laws, regulations and instruments should be integrated with the subject climate adaptation, which can be challenging. Linked to this is the fact that even though the local and regional level is the most optimal level for climate adaptation, the development of local and regional adaptation plans has only been started recently and research on local adaptation measures and strategies is still limited. On the other hand, cities do receive input and guidance from scientific and governmental institutions at the national level, but this has not led to the large scale development of adaptation plans of local governments[29]. This shows that there are effort being made to start integrating climate adaptation in spatial planning, but the lower levels have not reached this integration yet. In order to create successful climate change policy at local levels in the near future, a fruitful combination of horizontal and vertical collaboration is necessary [29].
Horizontal collaboration is a form of **self-government**, that can take different forms and shapes. This includes the collaboration between cities and regions and it can lead to the establishment of national and transnational city networks.
Vertical collaboration can be subdivided in three different subgroups, which focus directly on local climate policy [29]:

1. **Government through enabling.** National governments can stimulate and facilitate action by making guidelines for local authorities and the dissemination of best-practice cases. This collaboration revolves around the transfer of information and knowledge in order to build capacity at the local level. It can be expanded in two different directions: benchmarking the best-performing local authorities by using awards and competitions and drawing up voluntary certification schemes.

2. **Government by provision.** National governments can go further than providing information by also offering additional services for local authorities, like positive incentives and funding programs for local projects. Funding schemes that support the preparation of climate action plans and capacity building can be used, when the lack of financial resources restrains the ability of local authorities to draw up climate change policies. These can help to put climate change policy on the political agenda and create local capacities.

3. **Government by regulation.** National governments can also intervene directly in local climate politics, by drawing up regulations and legislation. Spatial planning is characterized by a hierarchical relationship between local authorities and national governments and this relationship can be used in order to ensure that local decision makers fulfil national demands. However, when this hierarchy is not strong and local governments enjoy a higher degree of autonomy, this form of government will have a considerable lower impact on climate change policies on local levels.

The explanation above shows that there are multiple ways that climate adaptation can be governed and that this potentially could have a large influence on the creation of climate change policy at local levels.
So in conclusion it can be said that climate adaptation is both an urban planning and a spatial planning problem and in order to implement it successfully extensive preparations are needed that include; a phased development of possible solutions, the inclusion of other spatial planning problems in the solutions, and the proper collaboration at multiple levels. To complete these preparation many decisions need to be made, which can be quite challenging due to the large number of stakeholders present in the processes for urban areas. These decisions and the role of the stakeholders in the decision-making process will be further elaborated in the next section.

2.3. PARTICIPATORY DESIGN AND JOINT DECISION MAKING PROCESSES IN CLIMATE ADAPTATION OF URBAN SYSTEMS

"Any designed solution is only as good as the amount of stakeholder support, and the quality of the stakeholder involvement" [20, p. 296].

The decision-making process is extremely complex in urban development. Multiple stakeholders negotiate in multiple arenas and the timing of the implementation of adaptive measures complicates it even further, as described in section 2.1. This results in sequences of interrelated decisions, of which each decision brings along their own way of negotiation and their own issues. Furthermore, this complexity makes impact assessments unusable and tedious exercises [30]. Moreover, due to the uncertainties in climate change and the consequences of these changes, it is difficult to quantify the impact of plans and makes it hard to compare different alternatives.
Besides that, decision-making in urban development is often considered to be a bounded-rational process [31]. This implies that the decision-making is influenced by power and values and therefore, the number of alternatives overseen is limited. Furthermore, the support of stakeholders is valued very highly and thus the chosen alternative might not always be the one with the biggest impact, as the stakeholder support lacks for this alternative.

These statements combined lead to the conclusion that the engagement of stakeholders in the creation of an adaptation plan will make it more likely for the plan to be accepted and executed. This statement is also reflected by the quote at the start of this section. The stakeholder engagement can be created in participatory processes that will enlarge the involvement of stakeholders, the use of the information the stakeholders provide and their opportunities to influence the decisions [32]. Besides increasing the support from stakeholders, stakeholder engagement integrates local knowledge, which makes participatory design and co-creation a fruitful tool in climate adaptation of urban systems. Local stakeholders might have self-generated knowledge on their experiences of the effects of climate change and extreme events. This knowledge can shed a light on both the existing capacity and the current shortcoming. Furthermore, it can make adaptation plans better suited to local conditions and improve disaster risk reduction [9]. Last of all, by increasing the engagement of local stakeholders, more awareness is raised and adaptation decision-making can be strengthened by creating political support and momentum for follow-up research and adaptation planning [5].

2.4. THE STAKEHOLDERS AND THEIR INVOLVEMENT

As already mentioned in section 2.3, there are many stakeholders present in urban (re)development. In order to increase the likelihood of acceptance of adaptation plans, these stakeholders should be engaged in the creation by using participatory processes. To be able to engage these stakeholders in the planning processes, it should be clear which stakeholders are present in the project and when they should be involvement in order to enlarge the benefits from participatory design. Every project will have its own set of stakeholders, so it is not

possible to describe a single set of stakeholders and their involvement for all projects. However, in general in the process of climate adaptation, the relevant stakeholders are the people that are particularly vulnerable to the potential climate change impacts within their systems (regions, industries, or communities). According to the CSIRO flagship(Commonwealth Scientific and Industrial Research Organisation) these stakeholders can be divided into categories, which creates a reasonably detailed (but incomplete) list of the stakeholders that potentially could be relevant in climate adaptation [33]:

1. Specific communities, which are vulnerable based on their location.
2. Federal, state and local governments and associated groups, e.g. local government associations, water boards, government departments and advisory groups.
3. Infrastructure management agencies.
4. Industry groups and particular industries, including construction, health, park management and natural resource management, tourism, forestry and fisheries, agribusiness, insurance and finance, and emergency management.
5. Non-government organisations and associations, including the ones that are responsible for the natural environment and the built environment.

For climate adaptation in urban systems the number of stakeholders in those five categories could be very large and neither should all stakeholders be involved in the planning process nor is their involvement the same during all the steps in the planning process. The degree of involvement of the stakeholders depends on the phase of the process and the stakes. During phases this degree of involvement can change and different stakeholders will have different levels of involvement. The degree of involvement can be divided in five different levels according to the International Association of Public Participation (IAP2). Below these levels will be elaborated in order of their level of stakeholder involvement and starting with the lowest level [34]:

1. **Inform.** This level does not provide the opportunity for participation actually, but rather provides the stakeholders with information about the process and the decisions made.
2. **Consult.** This level provides minimal opportunities for stakeholders to participate in the process, by giving input that can be considered when making decisions.
3. **Involve.** This level is just higher than the consultation level and it offers the stakeholders multiple opportunities to give input for the making of decisions. However, it still does not give the stakeholders the power to make decisions and it does not build consensus among stakeholders.
4. **Collaborate.** This level is the first level that allows the stakeholders to actively engage in the decision-making. It includes all the elements from the previous levels, but it allows stakeholders to work together in an attempt to reach consensus. The degree to which this consensus will be reached can be variable, but at this level the stakeholders will still be excluded from the decision-making.
5. **Empower.** This level, the highest level of involvement, provides the stakeholders with the opportunity to be included in the decision-making.

For each stakeholder the right level of involvement should be linked to each phase of the planning process. The two highest levels of involvement can be difficult to reach, when a large group of stakeholders is present, which can be the case in urban development and climate adaptation. In order to support these levels of involvement planning support systems can be used, to engage the stakeholders on the right level of involvement and to create the opportunity for participatory design. In the next chapter these planning support systems will be further discussed.

2.5. PLANNING SUPPORT SYSTEMS

Ideas about planning support systems (PSS) have been around for several decades. However, the focus of research has mainly been on the technical sides and less on the usage and planning context [35]. In order to better understand the usage of PSS, the roles of planning support within planning practices and the added values of planning support need to be defined. According to a study into the added value of planning support system, they can assume 4 different roles[35] :

1. **Scientific-analytical planning support.** This refers to the direct usage of knowledge in the planning practice, which always has been a traditional part of spatial planning.

2. **Tactical planning support.** This role refers to the awareness of the interests of the involved actors and the power relations they have. It does not aim to gain new insights, but rather to arrive at a result, without a change in positions. This does mean that the outcomes of the planning support do not matter; however, the tactical perspective could lead to more open discussions about the different stakes and interests of the actors.

3. **Learning.** The knowledge is not used to reach a straightforward and direct solution to the problem, but rather to enlighten and create understanding.

4. **Interactive planning support.** Planning support can be a social process that enables consensus seeking, collaboration and participation, by interactive elements.

In order to let PSS better support these roles, it is essential for PSS to accommodate both qualitative and quantitative information. This is important for PSS to support all the knowledge demands, for those from technical inclined stakeholders and for the stakeholders that are not technically inclined.
When all this is taken into account and the support from PSS is optimal, these systems can deliver a range of added values to the process[36]. These added values are show in Table 2.1 for three different levels, individual, group and outcome and those are the strong points that PSS can gain by optimizing. Several papers [35, 37] mention that most PSS are not functioning optimally just yet and that more empirical research is needed to evaluate and refine the ideas on the methodology of PSS and how to optimise them.

Added value	Definition
Individual	
Learning about the object	Gaining insight into the nature of planning object
Learning about other stakeholders	Gaining insight into the perspective of other stakeholders in planning
Group	
Collaboration	Interaction and cooperation among the stakeholders involved
Communication	Sharing information and knowledge among the stakeholders involved
Consensus	Agreements on problems, solutions, knowledge claims and indicators
Efficiency	The same or more tasks can be conducted with lower investments
Outcome	
Better informed plans or decisions	A decision outcome is based on better information and / or a better consideration of the information

Table 2.1: Summary of added values at three levels [36]

2.6. ADAPTATION SUPPORT TOOL

One of the PSS that supports participatory design is the focus of this research, the Adaptation Support Tool (AST). This tool is part of the Adaptation Support Toolbox, which has been developed by Deltares to effectively support the planning process. Its goal is to assist during the conceptual planning efforts of the stakeholders in their efforts to make their urban area more resilient for climate change. Below, an elaboration of the background information, the functioning and the current performance of the AST will be given.

2.6.1. BACKGROUND

The Adaptation Support Tool or AST was developed to fill the gap between the many tools that asses the vulnerability and need for adaptation on policy-level of cities and the actual urban planning and design practice [21]. As effective as these tools are in defining the procedures to assess the vulnerability, they do not support the selection of appropriate packages of adaptation measures. Therefore, the AST was developed to support

its users during program development and conceptual design [23]. The tool offers a choice from 62 different blue, green and grey adaptation measures to be selected and implemented in co-created conceptual design plans. The tool provides for each implemented measure and the total design evidence-based performance information on the effectiveness regarding climate resilience, water quality and cost. By doing so, it gives important information to feed the dialogue on how and where measures can be applied and which can be used to create conceptual designs. Figure 2.2 gives an overview of the tool, which has different panels; left, centre and right

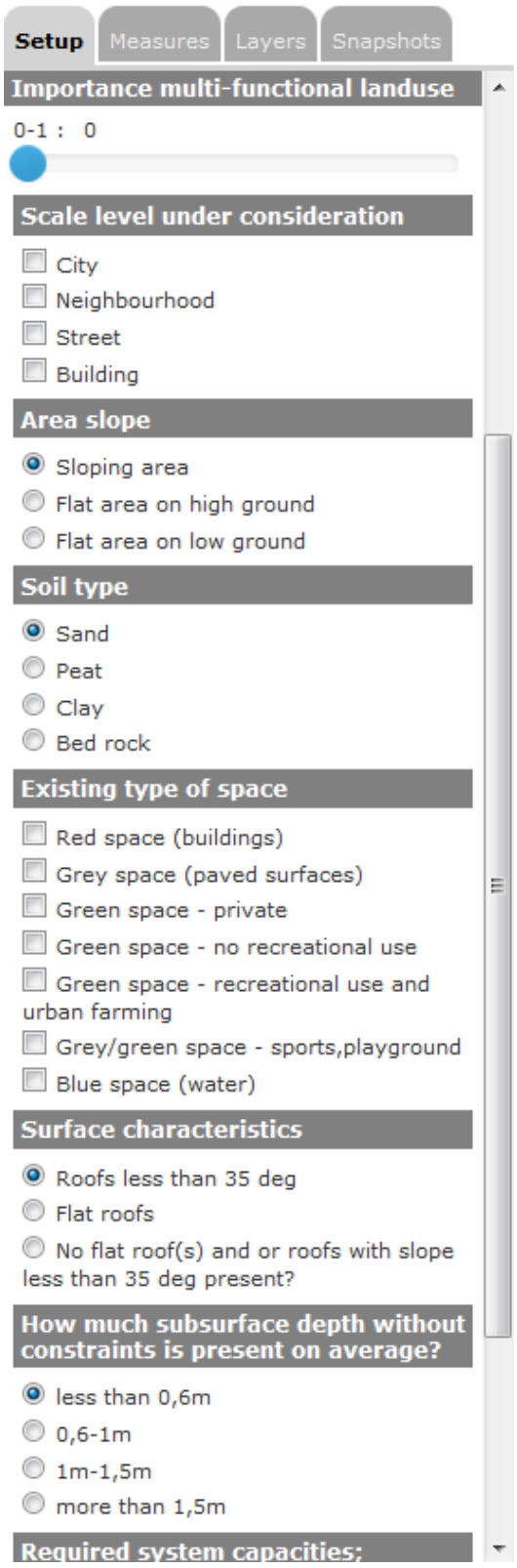
Figure 2.2: An overview of the Adaptation Support tool, including the three panels

2.6.2. FUNCTIONING

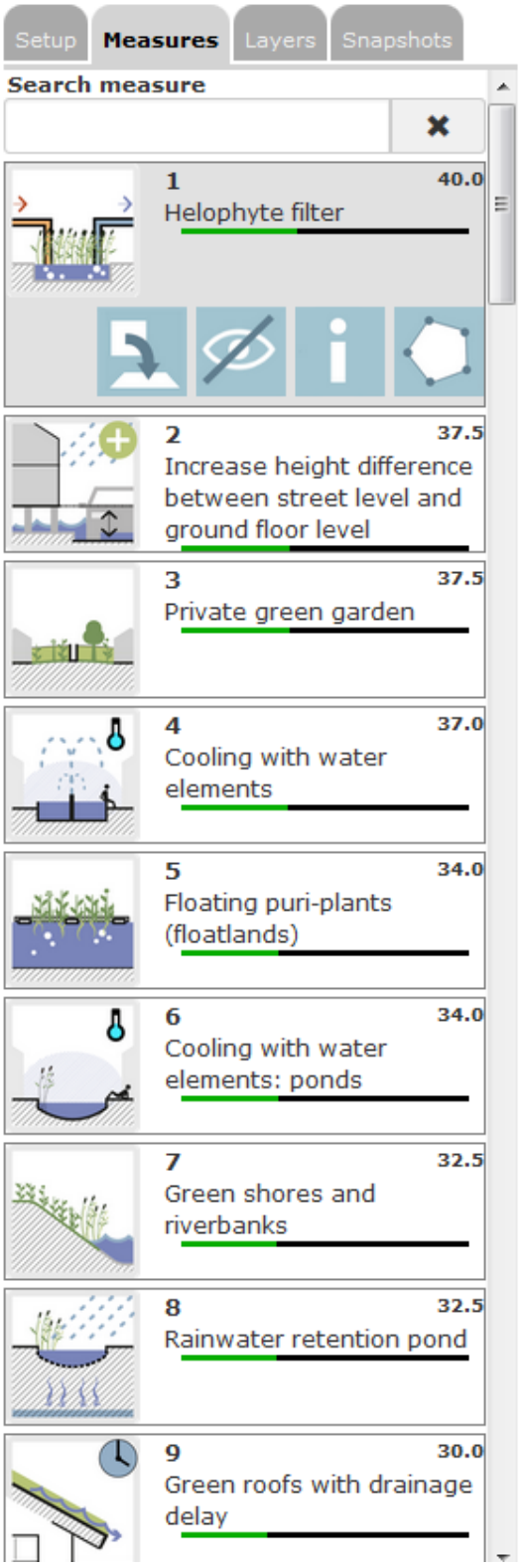
The AST includes 62 different measures for pluvial flooding, drought and heat stress including the traditional grey measures, but the emphasis is on the blue and green measures and their effects. In the left panel, the following characteristics of the project area can be fed in by the user; importance of multifunctional land use, implementation scale of interventions, relief of the area, subsurface type, existing type of land use, surface characteristics, available subsurface space and adaptation targets [23]. Based on these characteristics the measures are ranked and this ranked list appears in the left panel after finishing the input of the characteristics. In this list more information can be found about the measures, like the visual representation of the measures and a first indication for the effectiveness of each measure. Figure 2.3 shows the input and ranked list in the left panel.

The central panel is the drawing area in which different map layers can be shown. Besides the default layers, Google Earth and OpenStreetMap, additional layers can be shown. Users can draw the selected measures on the map layers and with some additional input by the users the AST estimates the performance of the drawn measures.

The performance of the measures for the storage capacity, normative runoff, heat stress reduction, water quality and cost is shown in the right panel that includes several tabs. In the overview tab the results are given in a percentage of the targets. These targets can be given by the users and the qualitative representation gives a quick overview of the effectiveness of the selected measures. Under the detail tab the effectiveness is given for the entire scenario in a quantitative manner. Furthermore, in this tab also the contribution of each measure and the cost plus maintenance of each measure can be found separately. Figure 2.4 gives an overview of the overview and detail tab of the right panel. Results of each session can be saved as snapshot and thus several scenarios can be created and compared.

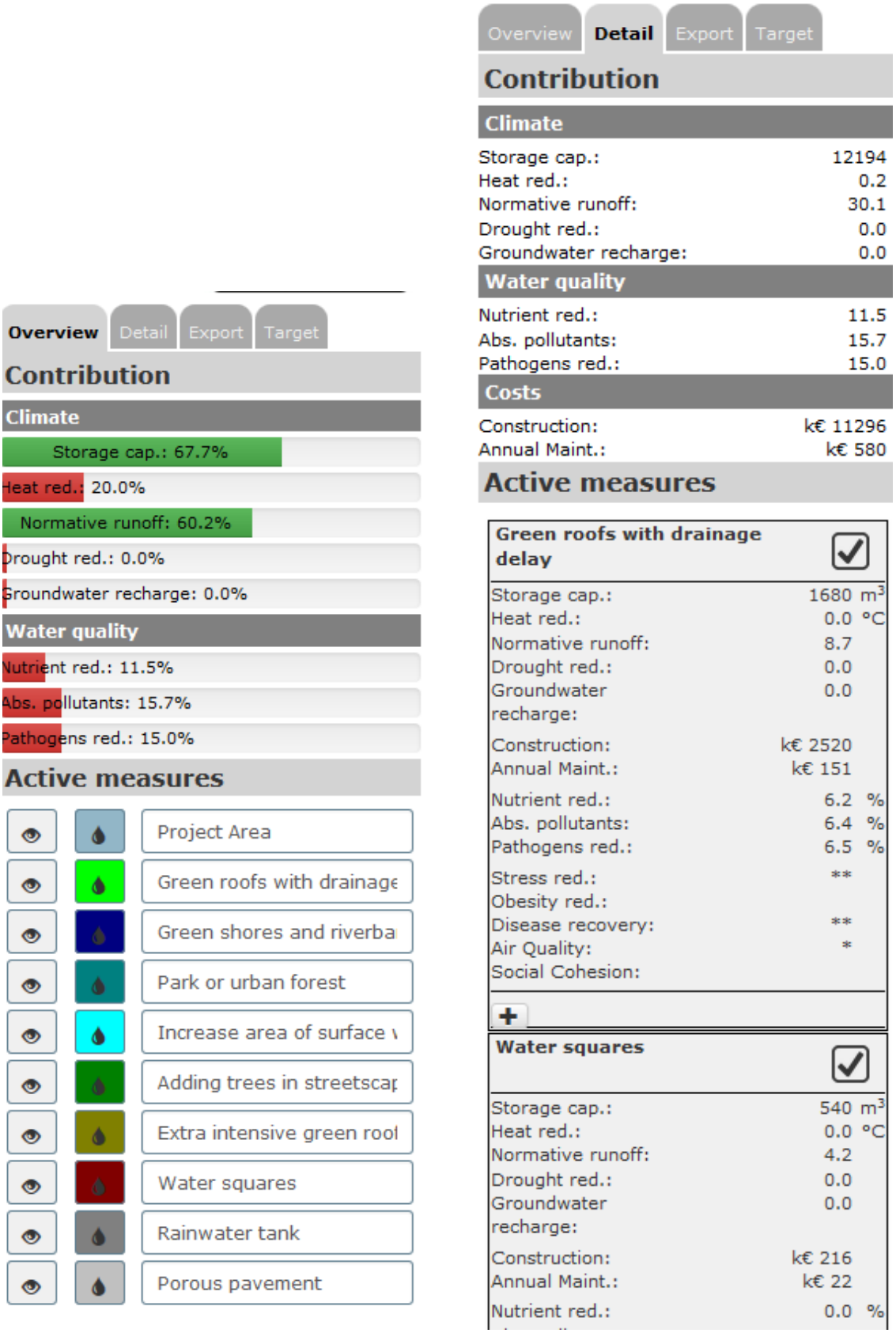


(a) The input for the characteristics



(b) The ranked measures

Figure 2.3: The left panel of the AST



(a) The overview tab

(b) The detail tab

Figure 2.4: The right panel of the AST

2.6.3. CURRENT PERFORMANCE

The tool has been used for several cases and has shown its added value for users. During these cases it also turned out that many adaptation measures were selected for their expected co-benefits for the liveability of the urban environment. As long as the set targets for adaptation were met, climate resilience was treated more as a valuable co-benefit, instead of the primary target the tool was designed for [21]. Thus, it might be valuable to include more information about the possible effects for the liveability and other important interests, as users select measures for the effects they could have for such interests instead of their effect for climate resilience. There are already some co-benefits included in the tool, like disease recovery, but these values are only given on a scale from zero to three and it is not sure whether these match the interests of the stakeholders. The actual interests of the stakeholders will be determined later on, but how these can be included in the tool is not clear yet. Therefore more about the inclusion and valuation of interests will be discussed in the next section.

2.7. THE INCLUSION OF ADDITIONAL INTERESTS IN THE TOOL

As mentioned in section 1.0.1, blue-green measures will be encompassed by many additional benefits, besides their ability to enhance the climate resilience of urban systems. Increasing climate resilience is just one of the many interests that play an important role in urban development. As climate adaptation does not create large economic benefits in the short term, the interest in it is weak and the political support is low. It would be most optimal if adaptation actions offer both development benefits in the short term and a reduction of vulnerability in the long term. In order to give climate adaptation a higher priority, without having to wait for incidents to occur, explicit targeting of co-benefits is necessary [5, 38]. So, the benefits of the blue-green measures might be very important to further increase the climate adaptation of urban systems in the future and could be used as reason to embed climate adaptation in broader sectoral initiatives [11]. Furthermore, these benefits may increase the support and involvement of stakeholders, which is important in the climate adaptation of urban systems, as explained in section 2.4. According to Markandya and Watkiss [39] information on the cost and benefits provides useful and important information to the decision maker, even if it is incomplete. They advise to include any measurable effect, to be able to allocate scarce public funds for adaptation. Moreover, as has been discussed in section 2.2.2, climate adaptation is also a spatial problem. In spatial planning many different problems and interests are important and thus information on all these interests is necessary to make a founded decision. Therefore, the effects that blue-green measures can have for these important interests should also be included as well.
Last of all, as mentioned in the section 2.6, the current users of the AST are already trying to select measures, based on the effects for their interests, other than climate resilience. Now this information about these effects is lacking in the tool and by including it, the support of the tool could possibly be improved.
So in conclusion, the additional effects are important for the interests of the stakeholders and will increase their support and involvement. Furthermore, these effects might be beneficial and cause the inclusion of climate adaptation in broader sectoral initiatives. This would make this information important for the decision-makers. Therefore, it would be useful to include such additional effects in the Adaptation Support Tool, to make the Adaptation Support Tool better fit the interests and stakes of the stakeholders, which are included in the decision-making process.

However, the difficulty lies in defining the effects in such a way that they can be compared and interpreted by the stakeholders. Some methods and planning support systems already have developed a way to value and include the effects of urban development in the planning and decision-making process. Below, the different methods will be elaborated and their applicability for the inclusion in the Adaptation Support Tool will be discussed.

2.7.1. VALUATION METHODS FOR THE EFFECTS OF BLUE-GREEN MEASURES

Ecosystem services of blue-green measures can have multiple benefits ranging from damage mitigation to social coherence. However, expressing the values of such effects is not easy, partly due to the large range they cover and the differences for each case. There are already methods developed by a global initiative to estimate the values of the effects in a way that they can be compared and discussed by stakeholders. Below this method will be explained and the applicability of this valuation method in a planning support system will be discussed.

THE ECONOMICS OF ECOSYSTEM AND BIODIVERSITY (TEEB)[1]

TEEB is a global initiative that has as objective to mainstream the values of ecosystem services and biodiversity in order to include such values in decision-making. It offers a structured approach that helps decision-makers to understand the wide range of benefits of the ecosystem services as provided by blue-green measures. TEEB demonstrates the economic value of these benefits and gives help to include the values in the decision-making. The approach has as goal to express the benefits in monetary units, for which several extensive techniques, based on economic processes, are provided. However, to execute these techniques, detailed economic and ecological studies of each ecosystem of interest are needed, which is expensive, time consuming and such information cannot be included in a planning support tool. However, the TEEB approach also provides some additional valuation methods that take into account that lengthy economic and ecological studies are not always possible. These methods, so-called benefit transfer (BT) methods, could be an valid option for the inclusion of benefits in planning support tools. With such methods, the value of an ecosystem service is estimated by transferring an existing valuation for a similar ecosystem. When both systems do not entirely match, values need to be adjusted accordingly to reflect the differences. There are four categories in benefit transfer methods, which are increasingly complicated: 1) Unit BT, 2) Adjusted unit BT, 3) Value function transfer, and 4) meta-analytic function transfer. Below these categories will be explained briefly:

1. Unit BT is the easiest and most simple way of estimating the value of an ecosystem service. It multiplies a mean value, as found in the study site, with the quantity at the site of interest. These values can be expressed per household or per unit of area.

2. Adjusted unit transfer includes some small adjustments to the unit values in order to reflect on the differences between the study site and the site of interest. Examples of such differences can be differences in income or differences in price levels.

3. Value function transfer methods transfer values by using functions that are estimated through valuation applications, like travel cost or choice modeling. The transferred values are calculated by plugging parameters of the site of interest in the value function, in order for them to better reflect the site of interest.

4. Meta-analytic transfer methods base their value functions on multiple study results, combined with parameter values for the site of interest, in order to estimate the values. This enables the inclusion of both site characteristics and study characteristics, leading to greater variation.

All four of these categories transfer values in terms of value per unit of area of ecosystem or in terms of value per beneficiary. However, in practice, it is difficult to find out who will benefit exactly from each ecosystem service. Therefore, to define values for transfer in terms of units of area is more practical. This method of valuation could also be applicable in planning support tools, as it does not require extensive studies and gives an easy and fast way to value the benefits.

TEEB-stad [2]

One of the planning support systems, which uses benefit transfer, is TEEB-stad, a Dutch system that uses key figures to calculate the benefits from blue-green measures in Dutch cities. These key figures transfer values to the site of interests, by multiplying the area or objects present with two key figures. The first key figure translate the value from the study site to the site of interests and the second key figure translates the values for the site of interests to monetary units. By doing so, the users are able to compare the cost and benefits in a quantitative way. Its goal is to express all the benefits in monetary units to show if and how cost can be earned back and which elements can be used to create benefits. Furthermore, it gives information which parties will receive the benefits, in order to create more funding for the implementation for blue-green measures.

2.7.2. VALUATION METHODS USED OUTSIDE OF THE ECOSYSTEM SCOPE

The idea of valuing certain effects in urban development, in order to compare alternatives, is not only important in the implementation of climate adaptive measures. There are several methods that are used to value the effect of certain urban developments on district level, street level or even building level. The ways that these methods value these effects could possibly be implemented in the valuation of the effects of blue-green

[1] based on [40]
[2] based on [41]

measures as well. Therefore, some of these methods will be mentioned below, to give an overview of the possibilities. The methods that will be discussed all value sustainable development, as this subject is similar to climate adaptation in a couple important characteristics. Namely, both subjects are very broad subjects that have increased in awareness over the last couple of years. Furthermore, both subjects have to be embedded in urban development projects, while also looking at other subjects. Last of all, for both subjects there often is not a separate budget available. Based on these similarities, the valuation methods of these schemes might be useful to compare the effects of climate adaptation in urban projects.

DUURZAAMHEIDSPROFIEL VAN DE LOCATIE (DPL) (ENGLISH: SUSTAINABILITY PROFILE OF THE LOCATION)[3]

DPL has as goal to contribute to the development of sustainable neighbourhoods. It is a computer program that calculates the sustainability profile of a neighbourhood and it allows the comparison of different neighbourhoods, to highlight strong and weak points of each neighbourhood. It rates them on three themes; People, Planet and Profit, which are subdivided in 11 policy themes like water, nuisance, etc. These sub-themes are scored by using 26 indicators that are compared to a reference neighbourhood. These scores are expressed on a scale of one to ten, with six being equal to the reference neighbourhood. The scores can be used to compare the neighbourhoods and to find possible improvements of the planned development in order to optimise the effects. An overview of all the themes, sub-themes and aspects in DPL can be found in appendix B.

BUILDING CERTIFICATION SCHEMES[4]

There are several more scoring schemes that can be used to assess the effects of sustainable development of urban areas. However, most are extensions of building certification schemes and therefore these are discussed separate from DPL. Such area scoring schemes are for example Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM) and GPR urban planning. These are used to reduce the misunderstandings about sustainable building, to standardize sustainability and to establish unified criteria to assess the development of urban areas, both new and existing ones. They fit in with the government mechanism through enabling as has been discussed in subsection 2.2.2.
These schemes are all different, but in essence they function the same way. They rate a list of characteristics, like materials, energy use, waste-streams, location selection, etc. and provide the urban areas with a certain score or certificate based on the ratings it got. These schemes rate the urban development areas in comparison to certain targets and based on that they give a score or certification that expresses the effects of the development for the sustainability of the area. Furthermore, they provide information about characteristics in a qualitative way, which is easy to understand and compare. More information and the aspects that are used by the schemes can be found in appendix B.

2.7.3. APPLICABILITY FOR INCLUSION IN THE ADAPTATION SUPPORT TOOL

When comparing the methods of valuation of TEEB-stad, DPL, LEED, BREEAM and GPR, it can be seen that most use qualitative valuation methods to express the effect of development for the aspects of the schemes. Each of these schemes has its own strong points in their manner of valuation. For example, both LEED and BREEAM define minimum requirements to reach a certain level, making it easy to understand the rankings. Furthermore, both DPL and GPR rank the aspects on a scale from one to ten, which makes it easy to compare alternatives and take averages of aspects and sub-themes. When looking at the valuation methods, TEEBstad is very different by expressing all the effects in monetary units. All these valuation methods are to a certain degree applicable in the tool and for the inclusion in the tool. The strong points of these valuation methods, as mentioned above, will be used to determine the valuation in the tool itself.
However, when looking at the aspects that are included in the schemes, there are large similarities to be found, with the exception of LEED. LEED is the only scheme that has been developed for a country other than the Netherlands, which makes it logical that it includes different aspects, as this has been developed to fulfil the need of spatial and urban planners in the US. Taking the aspects of LEED aside, the other schemes show similar subjects with the included aspects and the following subjects or aspects are reflected by most of the other four schemes:

1. The prevention of flooding by precipitation and/or adaptive capacity.

[3] based on [42]
[4] based on [43–45]

2. The reduction of energy usage and/or the use of sustainable energy sources.
3. The external and public safety in the area.
4. The quality and/or perception of the surroundings in the area
5. Social cohesion
6. Nuisance due to the external climate, like the air quality and noise.
7. Mobility

The fact that these four schemes share these aspects, while not being selected for these similarities, could indicate that these aspects are interesting and important during urban development. Valuing aspects or subjects that are not interesting to stakeholders would be illogical and make the schemes less useful. Based on this assumption it could be that these aspects are important interests for the stakeholders and they should be included in the AST. However, the only way to check whether these aspects match the interests of the stakeholders in urban development is to ask the stakeholders themselves what their interests are. Therefore, interviews were conducted with possible stakeholders in order to compare their interests to these aspects and to decide on the interests that will be included in the tool. The next chapter will discuss these interviews and the results. The valuation methods were the last subject covered by this literature research and the information found in this literature research will be used for the further steps of this thesis.

3

INTERVIEWS

In order to supplement the literature, interviews were conducted to gather information on the interests and benefits that are important for stakeholders within the climate adaptation of urban areas. The main focus was on the leading interests that are present during the (re)development of urban areas and thus climate adaptation. The second point of focus was the manner in which the information regarding these interests should be represented in order for it to be useful to the users. Because it was anticipated that many of the answers to these questions would be both personal and extensive, it was chosen to conduct semi-structured interviews. To use the personal experiences of each interviewee in the most optimal manner, the number of focus points of the interviews has been kept low. This ensures that the interviewees have enough space to introduce their own ideas regarding subjects that are related to these focus points. By using such a flexible interview set-up, the interviews could be adapted to the type of interviewee and their opinions on the matter. However, some structure was provided by several interview plans that included the focus points, main questions that should be answered en sub questions that could be used to retrieve more detailed information on different subjects. These interview plans can be found in appendix B.
In total nine persons of interest were interviewed in person and one interview was conducted over the phone, leading to ten interviews in which a whole range of subjects was covered, besides the focus points. These ten persons consisted of landscape architects, urban designers and spatial planners, department members of several municipalities, users of the AST, initiators of several climate adaptation movements, an expert on planning support tools and the developers of the AST. Some interviewees had several roles and therefore could provide information that included several important viewpoints. An overview of the interviewees and their roles can be found in Table 3.1. The results of the interviews will be discussed below. All statements have been made anonymously and therefore no direct quotes or names will be used in this overview of the results.

General function	**Roles**	**Extra information**
Landscape architect	Co-developer	Has been part of earlier research to include co-benefits of blue-green measures in the tool. Sees the added value of this, but is sceptical concerning the feasibility.
Landscape architect	Co-developer and expert on implementing blue-green measures in urban areas	Supports the idea of including co-benefits of blue green measures in the tool. His vision is to extend the data of the tool, so it can compare the changes measures make to the current situation.
Landscape architect	Reviewer of tool and expert on implementing blue-green measures in urban areas	Has been asked to review the tool and reflect on missed opportunities in order to make the tool easier to "sell"to possible clients.

Environmental designer	Expert on climate adaptive design and citizen participation	Owns a company that supports climate adaptive development and helps municipalities and citizens to redevelop areas in participatory design
Ecologist of municipality	User, stakeholder and expert on green roofs and green facades	Has been present at workshops organised for his municipality with the tool. Has low recollection of the use of the tool, but much experience on the current policy of the municipality on the implementation of green roofs and green façades.
Urban designer of municipality	Stakeholder and expert on climate adaptation of cities	Urban planner in pro-active municipality that has been working on climate adaptation for some years already. Works on redeveloping the financial system for urban development in order to solve future problems, when the hype around climate adaptation has passed.
Urban designer of municipality	Stakeholder and expert on climate adaptation of cities	Urban designer in active municipality that uses climate adaptation to keep up reputation and attract educated citizens.
Spatial planner of municipality	Stakeholder and working on adaptation strategies + citizen input	Works for spatial planning department of a medium sized municipality that struggles to start with climate adaptation. Works on initiative to use current citizens participation platforms to develop climate adaptation strategies and plans for neighbourhoods.
Strategic adviser of municipality	Stakeholder and initiator of several large adaptation strategies and programs	Strategic adviser of pro-active municipality and has been involved in the climate adaptation of this municipality for some years now. Initiator of several large adaptation strategies and programs and overall leading force in many new initiatives.
Expert on planning support systems	Has done research regarding the optimization of PSS.	Much experience on the link between the theoretical functioning of PSS and the actual functioning when used.

Table 3.1: Overview of the roles of interviewees

3.1. THE INTERESTS AND REQUIRED INFORMATION

A large number of interests can be linked to climate adaptation due to the large group of stakeholders and the interfaces with urban planning and spatial planning. As it is not possible to interview all the stakeholders that could be present during urban development, the most important group of stakeholders was selected. This group consists of the municipalities and the employees of the planning and spatial departments. As mentioned in section 2.2, the municipalities will experience the largest sense of urgency and will be the ones to take initiative. Furthermore, the municipalities manage the interests of the inhabitants of their municipality. Also, most urban (re)development plans are funded by the municipalities. These reasons all make the municipalities one of the most important stakeholders and possible users of the AST. In order to represent the municipalities well, employees of several municipalities were interviewed, including both very innovative and pro-active municipalities and municipalities that are just starting to look into the subject of climate adaptation.
In order to get a different perspective on the important interests in urban (re)development, landscape architects were interviewed as well. As it is their job to shape the final designs, while making sure they fit the

surroundings, most of them have a good grasp of the most important interests of the other involved stakeholders, besides the municipalities. The information they give, can be used to make sure that other important interests than the ones mentioned by the municipalities are not overlooked. By interviewing both the employees of municipalities and landscape architects the views of both the most important stakeholders and the people that work regularly with stakeholders are included in the results.

Besides gathering information on the important interests, the interviewees were also asked how they want the information to be represented. In sections 2.7.2 and 2.7.3 some valuation methods have been discussed and these showed to have both similarities and differences in their representation of information. However, which method of representation is preferred by the possible users of the AST is unknown. To be able to increase the support of the tool, the representation of the information is also important, as this determines the degree to which the information can be used and helps the process. This explains the importance of this second focus point and after the results for the interests, the results for the representation will be discussed.

3.1.1. INTERESTS ACCORDING TO MUNICIPALITY EMPLOYEES

First the interests that were mentioned by the employees of the municipalities will be elaborated, as these showed both large similarities and differences. This can be explained by the different strategies municipalities use and the fact that interviews were conducted at multiple municipalities.

INVESTMENT AND MAINTENANCE COST

Almost all the employees of the municipalities expressed their wish to have an indication of the investment cost in order to compare this aspect of the different solutions and choose the one that is the most effective for their case in relation to the investment cost. Another important interest that was mentioned often, regards the maintenance of the solutions. This is often outsourced to a separate department, which is not always included in the (re)development of areas. In order to prevent degradation over time due to high maintenance cost or the unexpected requirement of intensive involvement of local residents, this interest also is of importance according to most.
The fact that this aspect can be overlooked in practice is highlighted by the example of the Benthemsquare in Rotterdam, which one of the interviewees gave. This water square is very innovative and well received both locally and internationally and is often used an example for water squares in other places. It is this very innovative design and shape that makes it impossible to use larger equipment to clean it after it has been used to store water. Therefore, after each larger rainfall event the maintenance department has to clean it by hand, which is of course very time consuming and expensive. As the department of maintenance was not directly involved in the design of this square, this was a negative side effect for them, which could have been prevented, would they have been consulted in the design phase.
Another interviewee also mentioned that due to the fact that many municipalities do not have much experience with climate adaptive measures, they are hesitant to commit themselves to the implementation and maintenance of such measures, without having an idea what kind of maintenance and cost they commit themselves to for a longer period of time. Furthermore, not only the maintenance that the municipality should initiate is important, some solutions also ask a certain commitment and maintenance from the local residents or companies. Therefore, it is also important to consider this commitment of solutions and whether the minimum amount of commitment that is needed fits the profile of the area.

OTHER INTERESTS

As unified the interviewees were on the need for information on investment and maintenance cost, as divided were they in their opinions on the need for other interests. The members of the proactive municipalities had the opinion that social interests were of importance during climate adaptation. They use proof of social benefits of previous development projects to create a larger political support for new development projects regarding climate adaptation. In Rotterdam they are even working on a new financial model that will bind area developers to certain investments in climate adaptation and blue-green measures in exchange for certain advantages given by the municipality. This way they secure the resilience of the city, without needing to invest large amounts of money in an unprofitable manner. However, this financial model is still in the testing phase and most municipalities are not capable of using such models yet. The employees of the other municipalities were not sure whether these other interests and the linked benefits could be used to gain more

political support for climate adaptation. Although the opinions are divided whether information about other interests determines the start of an adaptation project, most agree that interests like social cohesion, perception of surroundings, safety, mobility, health and parking are of importance when (re)designing a new area. They believe that this information could lead to a more integral solution.

INCENTIVES AND MOTIVATION BY INTERESTS

Another interesting opinion of an employee of the municipality of Utrecht is that most of the time the interests do not matter as much as the motive. Motives as being innovative or having a green and sustainable reputation is according to him a much larger incentive than all the additional effects of climate adaptation and blue-green measures combined. This has also been found while developing the new financial model in Rotterdam. Many area developers care more for the benefits for their reputation and brand awareness as climate adaptation and blue-green measures are a kind of hype right now. This interest has nothing to do with the possible effects from blue-green measures and it will stop being an incentive when other things in urban development are being hyped. It shows that right now the possible effects are not always an important incentive; however, they should be emphasized more in the future to keep providing incentives to use blue-green measures after other motives have diminished. Some employees indicate that municipalities do not have good information about these effects right now and here the tool could be used well to inform and teach about all the possible measures and the effects these measures will encompass.

CONCLUSION FOR MUNICIPALITIES

So the employees of the municipalities put an emphasis on the investment and maintenance cost as main interest, which is logical as many municipalities are bound by strict budgets and have to invest the available funds as good as possible. Experience in Rotterdam and Amsterdam has shown that the effects in the social field and the liveability of areas can be substantial and can be used as an incentive for the climate adaptive renewal of areas with blue-green measures. However, the sparse amount of information on these effects for the measures makes many municipalities still restrained in using these benefits as incentive for climate adaptation even when these fit the general interests in urban development. So, there is a need for information on the effects that match the following interests; social cohesion, the perception of surroundings, safety, mobility, health and parking.

3.1.2. INTERESTS ACCORDING TO LANDSCAPE ARCHITECTS

The landscape architects are the ones that will possibly use the output of the AST to make a final design for an area, by furnishing the area and making it fit the surroundings. The interviewed landscape architects are experienced in climate adaptation and blue-green measures and all of them are well aware of the multiple benefits they can have. As their designs should meet the most important interests of their client, they also know what the most important interests are in urban development. The interests that are most frequently named are liveability, social cohesion, health and stress-reduction, air quality and last of all maintenance and cost. Remarkable is that the foremost interest at municipalities is the least mentioned one by the landscape architects, but the other interests largely match the ones named by the other interviewees.
All the landscape architects are of opinion that these interests can be fulfilled best with the blue-green measures and have personal experiences that show the many benefits one can reap when implementing blue-green measures in the right way.

3.1.3. THE REQUIRED REPRESENTATION OF INFORMATION

When asked which representation of the information is required to inform on the interests mentioned by the interviewees, the interviewees give many different answers, which can be divided into three different groups.

MONETARY UNITS

The first group, existing of some of the employees of municipalities, wants their information solely expressed in monetary units. In their experience it is hard to convince others why it is necessary to adapt cities and it can be helpful to show these others the benefits of adapting in the current time-frame with the use of blue-green measures. As many departments in municipalities still put their main focus on the cost and benefits of measures and want them expressed in monetary units, these interviewees believe this to be the best way to

represent information on the effectiveness of climate adaptation. They are of opinion that this makes measures easy comparable and information better suited to inform or persuade other employees and departments on the benefits of climate adaptation and blue-green measures in general.

QUALITATIVE REPRESENTATION

The second group, consisting of some of the employees of municipalities and some of the landscape architects, believes that the information should be given in a qualitative way. Their experience has shown them the dependency of many of the characteristics of measures on the local situation and therefore, it is not possible to express the cost, maintenance and effects in a quantitative way with high accuracy. Besides, many of the effects of the blue-green measures are hard to express quantitatively as there is no direct market present for them and their valuation is often personal and subjective. Furthermore, an expert on PSS also mentioned that de tool is used as an orientation or quick- and–dirty tool in which exact numbers can lead to scepticism or discussion about those numbers, while such detailed information and discussion is not important in this stage yet. Another interesting argument by an employee of the municipality of Amsterdam is the free choice of councillors to choose whether they want to implement climate adaptation or not. So, when a councillor is not interested in adaptation, he or she can ignore the benefits easily, whether they are expressed in monetary units or not. They often are easier to persuade with a touting story or image, which leads to the argument of the third group.

VISUAL REPRESENTATION

The third group, existing of mostly landscape architects, explains the importance of visual representation of the interests. By including pictures of the possible effects, the users can better understand the many possibilities of blue-green measures and the benefits they have for their interests in their opinion. An expert on PSS argues that people are set to process visual information. So, they are able to process visual information better and faster. This argument can be followed by representation of information by pictures, as suggested by some of the landscape architect, but also by including graphs or pie charts which give more information about the interests of users or the linked benefits of the blue-green measures. Returning to the argument of the employee of Amsterdam, a touting story or image and appealing images or examples, which are well known on the international scale, are often a good incentive to create the enthusiasm and political support, which is necessary in most adaptation projects.

3.2. OTHER IMPORTANT OR INTERESTING RESULTS OF THE INTERVIEWS

Besides the interests and representation of the information that is important for the users, the interviews lead to many other important or interesting results due to their open character.

The first remark has been mentioned briefly above, but it needs more emphasis. This remark regards the high dependence of the functioning of blue-green measures on the local characteristics. So therefore, all the information in the tool will be a generalisation, while it is essential to implement the measures in a certain correct manner to achieve certain effects. An idea that has been suggested by a landscape architect is to include information about the correct implementation of the measures and the influence of certain characteristics on the effectiveness in the information about the measure itself. By providing this information up front the user can still see which effects a certain measure has and use the measure on the map, while having the information which conditions are necessary for the measure to be effective and to have certain benefits. This enables users to take these conditions into account when placing the measurements. Furthermore, based on these conditions, users can determine whether a measure can be implemented at the selected area, without having to wait until more detailed designs are made.

Another idea that has been suggested is to include a check-list at the end of each session, which describes the conditions that should be met for the measures to be effective. These suggestions both draw on the idea that the effectiveness and benefits of measures are conditional and that users should be attended to these conditions.

Another important remark is that the effectiveness of measures for certain interests can vary. This is good, because users than can choose the measures that fit their interests best. However, all this extra information on the effectiveness of measures will also make it harder to select the proper package of measures. As the expert on PSS remarks, the capacity to process information is limited to about seven subjects, but even then it is hard to compare all of them. Furthermore, some interests will be more important than others, so it would be

nice to give each interest a different weight that reflects its important to compare the measures and scenarios to find the most optimal package for each situation.
Linked to this remark is the observation that it might be better if some information about the effectiveness of measures for several interests is given before the users start drawing the measures into their area. This way they can select the measures to fit their interests and do they not need to look at the outcomes to see which measures fit their situation best. In order to keep the tool from overflowing, while using such a system for the information, a certain layering in the information might be beneficial. This could also help to adapt the tool to different groups of users and different levels of expertise.
As a part of the interviewees has quite some experience with blue-green measures and/or the Adaptation Support Tool or decision support tools in general, their opinion on the AST was asked in order to use this as feedback to improve its functioning. This feedback covers many different subjects and can be found in appendix G.

4

DETERMINING THE INTERESTS FOR INCLUSION

Based on the results of both the literature research and the interviews it can be determined which interests should be included in the tool. However, before more can be said on which interests are included in the tool and how this inclusion is realised, first it should be determined which requirements the information on these interests should meet, in order to improve the support and for the added information to be useful. This should also be taken into account when determining these interests. Therefore, first the requirements for the information to improve the support will be discussed. Afterwards the outcomes of the interviews will be compared with the valuation schemes, which are mentioned in the second chapter. Based on this comparison and the requirements for the information, the interests that are both important and applicable in the tool are determined. For these interest the possible effects of the blue-green measures will be described. At the same time it will also be determined how these effects come about by looking into the characteristics of the measures and mechanisms that can create these effects. Based on these characteristics and mechanisms, indicators will be determined for each of these interests that can be used to include the effects for the selected interests in the tool.

4.1. THE REQUIREMENTS FOR INFORMATION TO IMPROVE THE SUPPORT

In order for the added information on the interests to improve the support of the AST, the requirements this information should meet, have to be contemplated. These requirements might be very important for the determination of interest that are to be included in the tool. These requirements are divided into a couple of important characteristics that should be looked into, before deciding which information is included and how this information is represented. These characteristics are the usefulness and amount, which are elaborated in below.

4.1.1. USEFULNESS OF INFORMATION

In order to be used, information should be seen as useful and in itself this seems to be a very obvious statement. However, information can only be seen as useful when it fits the purpose of the tool, it is accessible to its users and it is user-friendly [46]. In order to fulfil these three requirements the goal and the intended user group should be defined, before expanding the information of the tool. Only then the information can be included in such a manner that it is seen as useful. This requirement has been fulfilled by asking the intended user group, municipalities, about the information they want and need for the tool to fulfil its purpose and make the information better accessible for everyone.
Besides these requirements, a fourth requirement, that the information is perceived as valid, should be fulfilled in order to be useful[46]. This validity is based on the perception of the users of the tool and therefore, it is hard to determine which information can be seen as valid. Furthermore, different groups of users can have different perceptions on information and use, which might deviate from the ideas of researchers and developers[46]. In order to understand and use these perceptions, the users and their perceptions should already be included during the development process of a tool. One thing that should be kept in mind is that also should be looked into the differences in perception of the involved parties, as for example someone from

the spatial planning department will have a different perception than someone from the urban planning department of the same municipality. Furthermore, it is important to choose a certain group and goal for the tool as catering for too many different types of perception can lead to inconsistencies and to the questioning of the validity [46]. For this reason, the interviewees were asked how the information should be represented for it to be useful and valid at the same time. The fact that there are many different perspectives is shown by the different wishes in representation methods and when deciding which method to use, these different perspectives should be taken into account.

4.1.2. AMOUNT OF INFORMATION

The amount of information that persons can judge and process is limited and including more information than this limit will only lead to confusion and an overload of information that will hamper the process. This amount is limited by three different processes [47]:

- There is a limit in the magnitude of variables one can identify, which is called the span of absolute judgment. Usually, this span is somewhere around seven variables. However, there are three techniques to increase this span and the accuracy of our judgment:
  - By making a relative judgment rather than an absolute judgment, so comparing different alternatives for each variable.
  - By increasing the number of dimensions along which the variables can differ.
  - By arranging the judgments in such a way that a sequence of absolute judgments occurs, instead of making all the judgments at once.
- There is a limit in the magnitude of successive judgments that can be made due to a limited span of immediate memory. Thus, this will limit the increase in the span in absolute judgment by making a sequence of absolute judgments. The span of immediate memory is about seven items in length. This is the same as the first span, but this is caused by a different underlying process. Another important difference is that the span of immediate memory is about seven items, thus not seven variables. This can also be seven groups of variable or other clusters of information. So the span of immediate memory could include more than seven variables, by clustering variables in to groups.
- There is a limit in the magnitude of things one can distinguish in one glance due to a limited span of attention. Therefore, showing more than six different objects will create a situation that cannot be seen and comprehended in one glance.

Based on these three processes, it becomes clear that the maximum amount of information that is represented in the tool is limited to about six different objects. When using more different objects the information in the tool will become harder to comprehend and will also reach the limit of the absolute and successive judgment. This might mean that not only the extra information that can be included is limited, but also that the current information has to be changed in order to keep the total amount of information under all the limits.

4.2. THE COMPARISON AND THE EFFECTS FOR THE INTERESTS

As can be seen in Table 4.1, there are large similarities between the interests based on the valuation schemes and the interests given by municipalities and landscape architects. However, not all interests in the table can be included in the tool. First of all, the information must be useful and valid for the users, so at least most of the users should find the interests important. As both sustainable energy and parking are mentioned by only one group, these interests are not included for lack of importance and probably usefulness. Second of all, the total amount of information that can be included in the tool is limited, because of the limits in information processing capacities as discussed above. Therefore, the possible inclusion of all the remaining interests and whether they meet the requirements is discussed below. Based on this information it is decided which interests will be included in the tool. While determining the interests that are included it is important to keep in mind that more is not always better in this case, due to the information processing limitation discussed in section 4.1.2.

4.2.1. PERCEPTION/ATTRACTIVENESS OF SURROUNDINGS

The perception of surroundings is an important interest, which has been reflected in the interviews and the schemes. Even TEEB-stad, which has been developed to foresee the needs of municipalities, tries to express

Valuation schemes	Municipality	Landscape architects
Perception of surroundings	Perception of surroundings	Perception of surroundings
Social cohesion	Social cohesion	Social cohesion
Safety	Safety	
	Cost and maintenance	Cost and maintenance
The quality of the external climate		Air quality
	Health	Health
Mobility	Mobility	
Sustainable energy		
	Parking	

Table 4.1: Comparison interests

the perception of surroundings by the increase of the value of housing. However, the perception of an area is not an easy characteristic to express and it depends on many different characteristics of an area. The interviewed landscape architects all agreed that blue-green measures can increase the perception of an area and can result in rising housing prices and increased commitment of local residents to keep their neighbourhood clean. Furthermore, the importance of environmental aspects, such as air-quality, noise, attractive street scenes and green spaces within walking distance is gaining weight in the perception of the surroundings [48]. As blue-green measures both can increase the attractiveness of the street scenes and reduce the distance to green spaces, they can be an important part of the perception of surroundings and increase this perception. Therefore, the degree to which a measure is blue-green and looks natural is an important indicator as measures that look like the natural blue and green areas will increase the perception more than measures that look very man-made and only have small blue or green elements. For example, a natural looking pond with plants will increase the perception more than an artificial looking concrete construction that stores water. This degree will be called the natural factor from now on and will be used as an indicator for the perception of the surroundings. Second of all, for measures to increase the perception, they need to be visible, so this will be an indicator as well.
Proposed indicators: visibility and natural factor

4.2.2. SOCIAL COHESION

Another interest that has been mentioned in most interviews is the social cohesion. Social cohesion or some aspects from it are also reflected in most of the valuation schemes, except the TEEB-stad scheme. This is because social cohesion is very hard to express in monetary units. Most of the interviewees did see social cohesion as the combination of solidarity and the opportunities to meet others in the neighbourhood. As blue-green measures can be used to create places where people can meet and children can play, they can increase this definition of social cohesion. The fact that most interviewees mentioned social cohesion and that social cohesion is an important part of society, makes this also an interest that should be included in the tool. Blue-green measures can be meeting points, when designed correctly, leading to informal interactions that can stimulate social cohesion and integration [49–51]. By providing such meeting points, measures can lead to the binding of people, which leads to this stimulation of the social cohesion. Furthermore, when different groups are targeted by the measure, bridging between these different groups can occur as well, increasing the social cohesion even further [50, 51]. An example of people meeting in blue-green measures can be found in fig 4.1, which shows the meeting function of the Vondelpark in Amsterdam during a summers day.
So for measures to increase the social cohesion,they need to enable people to meet and target different groups of people, so the meeting function is an important indicator for the social cohesion. Most importantly, to be able to meet people in a certain measure, the measure needs to be accessible, thus making the accessibility the second indicator for the social cohesion.
Proposed indicators: accessibility and meeting function

4.2.3. SAFETY

An important aspect of the liveability of urban area is the safety and therefore it is logical that both the schemes and the employees of municipalities deem this aspect an important interest. Whether inhabitants feel safe in an area is determined by the level of safety they perceive, the subjective safety [53]. This subjective safety can be influenced by blue-green measures, as blue and green areas can alter human behaviour and

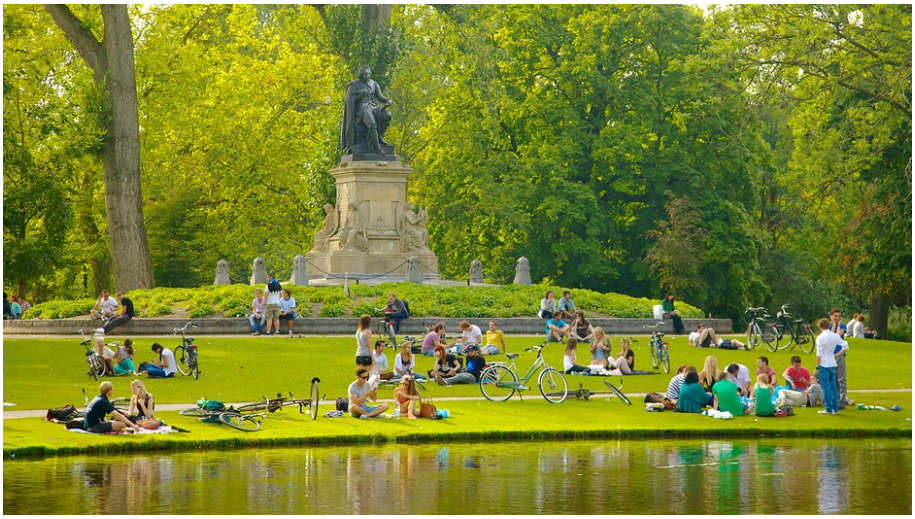


Figure 4.1: An illustration of meeting function of the Vondelpark in Amsterdam[52]

interactions between people in public space [54]. It was thought for a long time that blue-green areas reduced the subjective safety and offered hiding spaces for criminals and crimes [53, 55]. However, when these blue-green areas have an open character it turns out that they can increase the perception of safety. This is caused by the fact that natural looking blue-green spaces reduce aggressive and violent behaviour and thus lead to lower crime rates [55]. Furthermore, the blue-green measures can be used to attract more people and to meet others, leading to increased surveillance and thus a higher perception of safety [53, 55].
For the measures to increase the safety, they need to be visible, so this is an important indicator. Second of all, blue-green measures can reduce aggressive behaviour, when they look like natural blue and green areas, thus the natural factor is also of importance for the safety. Furthermore, increased surveillance can also influence the perception of safety, so whether a measure has a meeting function due to which people are present in the measure to survey the area is also an important indicator for the safety. Last of all, blue and green areas can only increase the subjective safety when they are sufficiently open, making this the most important indicator and a boundary condition at the same time. Linked to this boundary condition is the need for measures to be well maintained, which is illustrated in Figure 4.2. It is assumed that this need is met at all times, as the Adaptation Support Tool is used for the design of plans and not for the implementation of plans itself.
Proposed indicators: openness, visibility, natural, accessibility and meeting function

4.2.4. INVESTMENT AND MAINTENANCE

The results of the interviews clearly showed the interest in the investment and maintenance cost. As municipalities often have a limited budget, it is important for them to know what it costs to implement measures and the cost for maintaining the measures. The tool already includes the cost for both implementing and maintaining blue-green measures. However, these cost are now given in the detail tab, instead of the overview tab. The fact that this interest is of importance indicates that this information should be given in a way that it is easier to find and to compare. As this is already included in the tool, there is no need to further elaborate this interest, as the main focus is to include interests in the tool. The importance of this interest does indicate that it might need improvement in the future, but this will not be discussed here.

4.2.5. QUALITY OF THE EXTERNAL CLIMATE

There are different types of nuisance in urban areas, which can have large adverse effects on the quality of the external climate of urban areas. The most important aspects of the external climate are the air quality and noise, which affect many people living in urban areas on a daily basis. Therefore, it is not surprising to see that these aspects are mentioned by the schemes and the landscape architects. Besides that these aspects are very important, there is also much research done that proves the positive effects of blue-green measures can have by reducing the nuisance due to air quality and noise [50, 51, 56, 57]. However, determining the effects blue-green measures have for reducing the nuisance due to air quality and noise is more complicated. First of all, blue-green measures can improve the air quality by catching some of the pollution. However, when

Figure 4.2: Not maintained measures can overgrow and have a very reduced openness, like in the Mercers Country Park, UK ©Copyright David Martin

they are situated wrong, they could also possibly decrease the air quality. This depends on the location of the measures, the local characteristics and the effect the measures have on the ventilation of the city [50, 51, 57]. Because it is not possible to answer whether the effects will be positive or negative for the air quality, it could be that a certain measure will always have a negative influence on the air quality, no matter how the design is made. Therefore, it is not clear whether certain measures could potentially increase or decrease the air quality and it is not possible to express the potential of measures, as this could be both positive and negative for that situation. For this reason, it is decided not to include the effects for the air-quality in the tool, as it would be confusing to include information with such a large uncertainty. Second of all, blue-green measures can reduce the impact of noise, both physically by acting as a barrier and by the psychological response people have to blue-green measures [50, 51, 56]. However, this is only the case, when they are situated near the source and in between the source and the receiving point. As noise pollution is not included in the tool, it is not possible to determine in the tool whether the measures can act as such a barrier. Therefore, this aspect will also not be included, which results in the fact that this interest will not be included in the tool. The benefits of blue-green measures can be very positive for this interest, but it depends too much on the local situation to make even an educated guess of the possible effects in each situation.

4.2.6. HEALTH

Health has also been mentioned by several interviewees as health related issues are very expensive and most municipalities therefore strive to improve the health of their citizens. This is also an explanation for the inclusion of health in the TEEB-stad tool, which again shows the importance of this interest for municipalities and the many benefits that can be received when using blue-green measures. Although this interest is not really reflected in the other schemes, the fact that the municipalities are interested in health and reducing health related problems can gain many benefits, this interest is favoured to be included in the tool. Furthermore, there is data available on the effect of blue-green measures on the physical and mental health, making it easier to include this interest in a credible and useful manner.

Mentally, blue-green measure can have several positive effects on the health of people. Seeing of blue-green elements can reduce stress and even more individual trees can increase the health perception of people [49, 51, 58]. This effect of blue-green measures is also applied in hospitals and medical centres, Figure 4.3 shows an example of a healing garden at the Bergan Mercy Medical Center in Omaha, Nebraska, which is implemented for its effects for the mental health.

Furthermore, physical activity in "green environmentsälso results in significantly higher benefits for the self-image, mood, stress-reduction and blood pressure than for physical activity outside of green environments[50]. These effects are present both on the short and the long run.

Figure 4.3: A picture of a healing garden at the Bergan Mercy Medical Center in Omaha, Nebraska[59]

Physically, the effect of blue-green measures seems to be a lot smaller on the health of people. Although some studies show an increase in physical activities when more green measures are present, this is does not seem the case in the Netherlands [49, 60]. The total amount of physical activity stays the same, although more activities will take place in blue and green areas, leading to the mental health benefits described above. However, for children there might be an effect as research in the USA indicated a lower Body Mass Index of children living in green areas and a research in the Netherlands found a reduction in ADHD-medication when green spaces increase [51, 61]. So measures that target children and encourage children to move (like playgrounds) could have extra benefits for the health.
Another physical benefit of blue-green measures would be due to the reduction of heat stress. This reduction of heat stress is already included in the tool, therefore, it is chosen not to include the benefits for the physical health by the reduction of heat stress in the tool to prevent the representation of the same effect twice.
For the measures to increase the mental health by reducing stress, they have to be visible and look like natural blue and green areas, thus the visibility and natural factor are important indicators for the increase in mental health by the first mechanism. Furthermore, for measures to increase the mental health by physical activity in them, they need to be accessible and encourage physical activity. So the accessibility and the physical activity of the measures are the important indicators for the second mechanism behind the health effects.
Proposed indicators: visibility, natural factor, accessibility and physical activity

4.2.7. MOBILITY

The last interest that is reflected by at least two groups is the mobility. As urban areas are dense and the mobility is important for everyone to be able to reach these dense areas, it is understandable that this is an important interest during the design of a new area. However, in order to be able to indicate how measure will influence the mobility, it is necessary to know the current situation, the exact situation of the measures and the local characteristics. These all cannot be included in the tool as the tool only uses the map as an orientation in space and for scale. For this reason this interest cannot be included in the tool.

4.3. EFFECTIVENESS OF GREY MEASURES AND BLUE-GREEN MEASURES

So based on the information and considerations in this chapter, four interests have been chosen for inclusion in the tool; Perception, social cohesion, safety and health. For each of these interests, indicators have been selected which reflect the mechanisms that provide effects for these interests. With these indicators the effectiveness of measures to contribute to these interests can be shown. The focus was on the effects of the blue-green measures, as the literature showed that these effects are specific co-benefits for blue-green measures. However, this does not One of the indicators is the natural factor which is important for three of

these four interests. As this natural factor expresses the degree to which measures look natural, it will only be significant for the blue-green measures and not the grey measures, which are man-made and artificial. The other indicators like the meeting function and physical activity can be significant for grey measures in general, but not for the grey measures included in the AST. All grey measures in the AST will not support a meeting function or encourage physical activity, leading to the decision to not include the effectiveness of grey measures for these interests as it will be non-existing. So from this point onwards, when the inclusion for interests is mentioned, the inclusion of the effectiveness for blue-green measures is meant. It is not surprising that the effectiveness for the grey measures is non-existing as the effectiveness for these interests are specific co-benefits of blue-green measures, which have been mentioned before as possible incentives for stakeholders to choose for blue-green measures over grey measures.
Another important remark at the end of this chapter is the limitations of the literature on the effectiveness of blue-green measures for these interests. Most literature does describe the effects blue-green measures can have for these interests, but only for blue-green measures in general and without any detail on the differences for sort of measure, size, etcetera. This makes it not possible to use the benefit transfer method as described in section 2.7.1.1. Therefore, another method for valuation will be used, based on the indicators and the strong points of the other valuation methods, as described in section 2.7.3. This valuation method will be discussed in the next chapter.

5

INCLUSION OF THE INTERESTS

Based on the requirements for the additional information, the comparison of the results and the applicability of the interests in the tool, four interests have been selected in the previous chapter to be included in the tool; The perception of the surroundings, social cohesion, safety and health. For each of these interests a set of proposed indicators has been given, which can be used to determine the effects of the blue-green measures for these interests. These indicators are all based on the information found in the literature, but this literature does not describe how different blue-green measures fulfil these indicators as most studies focus on the effects of blue-green measures in general. So there is information on how blue-green measures can have effects for these four interests and which characteristics and mechanisms are important, but not on the differences between different blue-green measures. Therefore, the values of the indicators cannot be based on current studies. This has lead to the choice to make a new ranking scale for each indicator, that can be used to express the differences between the blue-green measures. The ranking scales will use the characteristics and mechanisms found in the literature to express these differences.
As the ranking scales are made and based on literature that solely describes general effects, they can only give a qualitative representation of the effectiveness, while the rest of the information in the tool is quantitative. This is not expected to be problematic as many indicated during the interviews that qualitative information would be their preferred representation. Furthermore, these interests are hard to express quantitatively, even when there would be information on the effects of different measures. Last of all, in the conceptual design phase this qualitative overview of the effects will give enough information to compare different measures and scenarios. Based on these qualitative ranking scales the effectiveness of the blue-green measures for the interests will be included in the tool.
The ranking scales will use the strong points of the other valuation methods, which have been mentioned in section 2.7.3. These strong points are the definition of minimum requirements to reach a certain ranking and the ranking on a scale that can be divided in deciles to make them easy to compare. Thus these characteristics will be used in the ranking scales as well. For indicators that also function as boundary conditions, the ranking scales are from zero to one. With zero meaning that the boundary condition is not met and one meaning that the boundary condition is fully met, leading to the most optimal effectiveness. For the other indicators the ranking scales are from zero to ten, with zero meaning that a measure has no effectiveness for that indicator and ten meaning the most optimal effectiveness can be reached.
First the indicators and ranking scales used for the inclusion will be explained. Afterwards the calculations that the tool will make to express the effects will be discussed, alongside with the representation of the effectiveness in the tool.

5.1. VISIBILITY AND ACCESSIBILITY

Both the visibility and the accessibility can have a large influence on the potential effects of measures. However, both indicators are also largely dependent on the local characteristics and form an important boundary condition for the effects. For this reason, it is decided that the users of the tool can give the visibility and accessibility of each measure in the input window that appears when situating a measure. This way the users can also change the visibility and accessibility to see how these indicators influence the effects and how the local conditions affect the results. Furthermore, the users can change the visibility and accessibility to match

the local characteristics of the area in combination with the measure they want to implement. By doing so, the users will also learn what boundary conditions need to be met in order to reach certain effects, creating information on the boundary conditions as has been mentioned in the interviews and in section 3.2. Last of all, these values for the visibility and accessibility can also be given to the landscape architects as certain minimum requirements to reach their desired effectiveness, making it possible to take these conditions into account when making the final design.
Both indicators are ranked on a scale from zero to one. This has been decided as these two indicators function as boundary conditions and their ranking determines the degree to which a certain effectiveness can be reached. Zero means that the measures are not visible or accessible at all and thus the measures will not be effective at all. While one means the exact opposite, that the measures can reach their full potential, based on the rankings for the other indicators. As in some cases the visibility and/or accessibility will be unknown to the users, a default ranking for both indicators has been made for all blue-green measures, giving a ranking solely based on the characteristics of the measures. This default ranking will only be used when the users do not fill in rankings themselves, so the default ranking is always overruled by manual input. Below the ranking scales for both the visibility and the accessibility are given in Table 5.1 and Table 5.2. The default ranking of each measure and the justification can be found in appendix C.

Explanation for visibility	Very bad visibility from most sides and blocked by most objects or almost always overlooked.	Poorly visible from most sides and could be easily blocked or overlooked.	Fairly visible from most sides, but could be partly blocked or overlooked.	Good visibility from most sides and hard to overlook or block.	Very visible from all sides and not possible to overlook or block sight.
Scale	0	0.25	0.5	0.75	1

Table 5.1: Ranking scale visibility

Explanation for accessibility	Not accessible at all, closed for all.	Poorly accessible from most sides and could be closed to entering on some sides.	Fairly accessible from most sides, but could be closed from entering on some sides.	Good accessibility and easy to enter from most sides.	Very accessible from all sides.
Scale	0	0.25	0.5	0.75	1

Table 5.2: Ranking scale accessibility

5.2. MEETING FUNCTION

For both the social cohesion and the perceived safety it is important to which degree a measure offers a meeting function. For social cohesion it is important, as people should be able to meet others and other groups for them to both bind to other people and bridge differences between different groups. It is important for safety as well, as for the social surveillance to increase, more people need to be present and meet each other in the public space. The meeting function is ranked on a scale of zero to ten, with zero meaning that the measure offers no meeting function at all and ten meaning that the measure offers plenty possibilities to meet others and different groups of people. Below the ranking scale of the meeting function of measures is given in Table 5.3. The ranking of each measure and the justification can be found in appendix C.

5.3. OPENNESS

The openness of a measure is important for the perceived safety, as closed measures could hide criminal activities or criminals from sight, leading to a feeling of not being safe. However, blue-green measures can increase the feeling of safety in the neighbourhood, when these measures are sufficiently open. This makes the openness a boundary condition for the effectiveness of measures for safety. Therefore, this openness is ranked on a scale from zero to one, just like the visibility and accessibility, with zero meaning that the measure is entirely closed and one meaning that the measure is entirely open. Below the ranking scale of the openness

Explanation for meeting function	Could not provide any possibilities to meet other people.	Could provide some possibilities to meet other people. The measure provides meeting function for one specific group, leading to binding.	Could provide some possibilities to meet other people. The measure provides functions for some different groups, leading to both bridging and binding.	Could provide many possibilities to meet other people. The measure provides functions for some different groups, leading to both bridging and binding.	Could provide abundant possibilities to meet other people. The measure provides functions for several groups, leading to both bridging and binding.
Scale	0.0	2.5	5.0	7.5	10.0

Table 5.3: Ranking scale meeting function

Explanation for openness	Relatively closed landscape, large obstruction of sight. Obstructions are higher and could hide persons/criminal activities.	Relatively closed landscape, medium obstruction of sight. Obstructions are higher and could hide persons/criminal activities.	Relatively open landscape, small to medium obstruction of sight. Obstructions are mostly low to the ground.	Very open landscape, small obstruction of sight. Obstructions are low to the ground.	Totally open landscape, no obstruction of sight at all.
Scale	0.0	0.25	0.50	0.75	1.0

Table 5.4: Ranking scale openness

of measures is given in Table 5.4. The ranking of each measure and the justification can be found in appendix C.

5.4. PHYSICAL ACTIVITY

The degree to which a measure offers the space to be physically active and makes it attractive to be active in or around that area is important for the health. Blue-green measures can increase the health by two mechanisms; stress-reduction, which depends on the visibility of the measures and mental benefits, due to being physically active in blue-green areas. Therefore, the physical activity indicator is ranked based on the degree to which a measure offers space and attractiveness, with zero meaning no space or attractiveness and ten meaning much space and attractiveness. The ranking scale for physical activity is given below in Table 5.5 and the ranking and justification for each measure can be found in appendix C.

Explanation for physical activity	Does not provide space with main function for physical activity, neither makes it more attractive to be active.	Does not provide space with main function for physical activity, does make it more attractive to be active.	Does provide some space with main function for physical activity, does make it more attractive to be active.	Does provide much space with main function for physical activity, does make it more attractive to be active.	Only provides space for physical activity, makes being active very attractive.
Scale	0.0	2.5	5.0	7.5	10.0

Table 5.5: Ranking scale physical activity

5.5. NATURAL FACTOR

Most of the effects are based on the idea that the blue-green measures look like natural blue and green areas and not man-made. Therefore, the last indicator is the natural factor, which is ten for most blue-green me-

asures, as these measures will look natural due to the use of plants and water. However, some blue-green measures will look partly man-made, reducing the effects of these measures. These are ranked five when they still partly resemble natural areas, or two when they look very man-made and only have a small resemblance with natural areas, this scale can be found in Table 5.6. The natural factor has a different ranking scale from the other indicators as there are less different states that can be defined for the different measures. Furthermore, there is a big difference between the natural factor of the blue-green measures, which explains the choice for a slightly more skewed distribution instead of the equally distributed ranks for the other indicators. There are only a couple of measures that are ranked five; the cooling water elements in the form of ponds and ditches/infiltration strips. The same goes for the measures that are ranked two; the cooling water elements in the form of fountains, the tree pit bioretention and the normal swales.

Explanation for natural factor	Does not look natural at all, includes no natural blue or green areas	Looks only a bit natural and includes some small natural looking blue and green areas	Looks partly natural and includes some natural looking blue and green areas.	Looks very natural and exists almost entirely out of natural looking blue and green areas.
Scale	0.0	2.0	5.0	10.0

Table 5.6: Ranking scale natural factor

5.6. CALCULATION OF THE EFFECTIVENESS

With these indicators the potential effectiveness of the blue-green measures can be computed. This potential will be a performance indicator on a scale from zero to ten, with zero meaning that the measures will not be effective at all for a certain interest and ten meaning that the most optimal effectiveness can be reached with the implementation of these measures. This potential represents an indication of the effectiveness that can be reached, when the measures are designed correctly, so it assumes that the measures are designed in such a way that they fit the area well and the most optimal results can be obtained. When this is not the case, the effectiveness of the measures will be lower than this potential. This potential will only be a way to compare the possible performance of measures and make it easier to discuss this, so it does not reflect any physical effects or results. Besides this potential, also the contribution of each measure, scaled over the entire project area will be calculated. This will also give a number on a scale of zero to ten, with ten meaning that for the entire area a potential of ten is reached and zero meaning that for the entire area no potential at all has been reached. The contribution of each measure is thus dependent on the size of the measure in relation to the size of the entire area, meaning that the contribution will always be smaller or equal to the potential.
There are several reasons to express the effectiveness in these two ways: First of all, the implemented measures can form hot-spots for certain functions and interests and for this reason their potential is interesting. With the potential the effectiveness of measures at the site of implementation can be compared, regardless of the size of the entire project area. For the area in and directly around the hot-spot, the relative effectiveness depends on the potential a certain measure could have and not its size in relation to the size of the project area. For this reason the potential of each measure and each package of measures is given. Secondly, the contribution could be very small for small measures, while their performance locally could be very large, regardless of their small size (assuming that their size is always large enough to reach the potential). Providing the users only with the contribution could be discouraging and lead to very small changes in contribution when using small measures. While the effectiveness of the measures for the local area were they are implemented could be substantial. The decision to include the potential of each measure and each scenario is based on these two reasons.
However, the potential alone is not enough to be able to compare different measures and scenarios as the area of each measure still has some influence on the effects. This is the reason for the inclusion of the contribution in the tool. The potential is convenient to compare the performance of a measure at hot-spots and when looking at the effectiveness at the site of the measure itself. However, the potential does not provide information on the influence of the size of each measure. Within certain limits, larger or more measures will have more effect and the potential does not take this into account. The contribution does, by taking the area of each measure in relation to the area of interests into account. By doing so, the effectiveness of different measures with different sizes can be compared and entire scenarios can be compared for the effect they have for the

entire project area. Furthermore, the size has a direct relation to the cost and maintenance of measures. The potential for each measure stays the same, regardless of the size, which does not express the additional effects the larger investment for larger or more measures could have. This could lead to a distorted image, therefore the contribution is important as it offers something that can be compared in relation to other measures and to the cost and maintenance.

Both the potential and contribution will be calculated for each measure and the total package of measures, leading to four different calculations.

5.6.1. THE CALCULATIONS PER MEASURE

First the calculation for each measure will be explained. The potential of each interest is calculated with a separate formula, in which the indicators are multiplied with the boundary conditions. This multiplication represents the restrictive nature of the boundary conditions, as the degree to which these are met determine the effectiveness of measures. The boundary conditions are the visibility, accessibility and openness, which are in bold in the formulas. The potential represent the performance of a measure, without taking the size of the measure into account. Besides this potential, also the contribution of each measure is calculated, which takes the size of the measure into account. This way the effectiveness of measures with different sizes and potentials can be compared, assuming that the effectiveness of the measure increases as the size of its increases. The formulas for the calculations are shown below.

$$Perception(measure)_{potential} = \boldsymbol{visibility} \cdot naturalfactor \tag{5.6.1}$$

$$Socialcohesion(measure)_{potential} = \boldsymbol{accessibility} \cdot meetingfunction \tag{5.6.2}$$

$$Safety(measure)_{potential} = \frac{\boldsymbol{visibility} \cdot naturalfactor + meetingfunction \cdot \boldsymbol{accessibility}}{2} \cdot \boldsymbol{openness} \tag{5.6.3}$$

$$Health(measure)_{potential} = \frac{\boldsymbol{visibility} \cdot naturalfactor + \boldsymbol{accessibility} \cdot physicalactivity}{2} \tag{5.6.4}$$

$$Perception(measure)_{contribution} = Perception(measure)_{potential} \cdot \frac{area_{measure}}{area_{projectarea}} \tag{5.6.5}$$

$$Socialcohesion(measure)_{contribution} = Socialcohesion(measure)_{potential} \cdot \frac{area_{measure}}{area_{projectarea}} \tag{5.6.6}$$

$$Safety(measure)_{contribution} = Safety(measure)_{potential} \cdot \frac{area_{measure}}{area_{projectarea}} \tag{5.6.7}$$

$$Health(measure)_{contribution} = Health(measure)_{potential} \cdot \frac{area_{measure}}{area_{projectarea}} \tag{5.6.8}$$

5.6.2. THE CALCULATIONS PER SCENARIO

Besides the effectiveness of each measure, also the effectiveness of entire scenarios can be computed. The potential of the entire package of measures is computed by using the weighted average of the measures, based on the area of the measures. This can be seen in formulas 5.6.9 to 5.6.12. The area of each measure is divided by the sum of the areas of all implemented measures, with "n"being the number of measures. This outcome is multiplied with the potential of the measure in question. Next, the outcome for each measure is added to find the weighted average of all the implemented measures, depending on the area of each individual measure and the sum of the areas of all the implemented measures. Also, the contribution for each scenario is computed, which is the sum of the contributions of the measures. This way the users can compare the different scenarios for their potential and total contribution. The potential will express the effectiveness of the scenario by giving it a performance indication that can be used to compare different scenarios. The contribution will give the potential for the entire project area, based on the size of the implemented measures, enabling to compare different scenarios for effectiveness and the efforts needed to reach this effectiveness.

$$Perception(scenario)_{potential} = \sum_{i=1}^{n} \frac{area_{measure(i)}}{\sum_{j=1}^{n} area_{measure(j)}} \cdot Perception(measure(i))_{potential} \tag{5.6.9}$$

$$Socialcohesion(scenario)_{potential} = \sum_{i=1}^{n} \frac{area_{measure(i)}}{\sum_{j=1}^{n} area_{measure(j)}} \cdot Socialcohesion(measure(i))_{potential} \tag{5.6.10}$$

$$Safety(scenario)_{potential} = \sum_{i=1}^{n} \frac{area_{measure(i)}}{\sum_{j=1}^{n} area_{measure(j)}} \cdot Safety(measure(i))_{potential} \tag{5.6.11}$$

$$Health(scenario)_{potential} = \sum_{i=1}^{n} \frac{area_{measure(i)}}{\sum_{j=1}^{n} area_{measure(j)}} \cdot Health(measure(i))_{potential} \tag{5.6.12}$$

$$Perception(scenario)_{contribution} = \sum_{k=1}^{o} Perception(measure(k))_{contribution} \tag{5.6.13}$$

$$Socialcohesion(scenario)_{contribution} = \sum_{k=1}^{o} Socialcohesion(measure(k))_{contribution} \tag{5.6.14}$$

$$Safety(scenario)_{contribution} = \sum_{k=1}^{o} Safety(measure(k))_{contribution} \tag{5.6.15}$$

$$Health(scenario)_{contribution} = \sum_{k=1}^{o} Health(measure(k))_{contribution} \tag{5.6.16}$$

5.7. REPRESENTATION OF THE EFFECTIVENESS

These calculations give much additional information, that has to be represented properly, to be useful for the users. It also has to comply with the information, that was already included in the tool, to make the comparison of all the results possible. All the additional information will be added in the right panel, as this is the panel that shows the results of the measures and packages of measures.
In the overview tab the weighted average of the potential will be given for the entire package of measures. For the climate and water quality the results for the entire package are given as well, so in order to keep all the information similar, the weighted average for the entire scenario is represented in this tab. Just like the other information in this tab, it has been given in bar graphs as this complies with most of the suggestions that were mentioned during the interviews. The results of the interviews showed that the interviewees either want the information in monetary unit, qualitatively or visually. The monetary units were not possible, but the other suggestions were met by using the same bar graphs, as the ones that were already included for the climate and water quality information. The bars show the information as a percentage of the target, which is qualitative information. At the same time, the bars get fuller and change colour when the percentage gets higher, giving the information visually. In Figure 5.1 the overview tab of the updated version of the tool is depicted. In this figure the bar graphs can be seen of all the interests that are included in the tool. Also the colour changes of the bars are visual, between 0%-20% the bars are red, between 20%-60% the bars are orange and above 60% the bars are green. This form of representation was already used in the tool and proves to fit the results of the interviews and therefore it is also used for the additional information, keeping the information consistent and easy to compare. When the potential for a certain interest is 100% for a scenario, this means that the highest performance indicator of ten out of ten is reached. This means that all the implemented measures have the highest possible performance for this interests and the potential effectiveness is most optimal. So this percentage gives information on the overall performance of the scenario for the interests.
As has been mentioned in section 5.6, the contribution of the measures is small and there will only be small changes when implementing additional measures, which could demotivate the users. However, this information is very useful, thus it will be given in the detail tab in the overview, which includes the quantitative representation of the effects for climate and water quality. In order to make this overview complete, the weighted average of the potential is included as well. In this section all the information is given in numbers, so there is no visual representation. Furthermore, there is a small difference between the information about climate and water quality and the added interests, as the effects for climate and water quality are quantitative numbers, while the potential and contribution are qualitative numbers. The overview in the detail tab

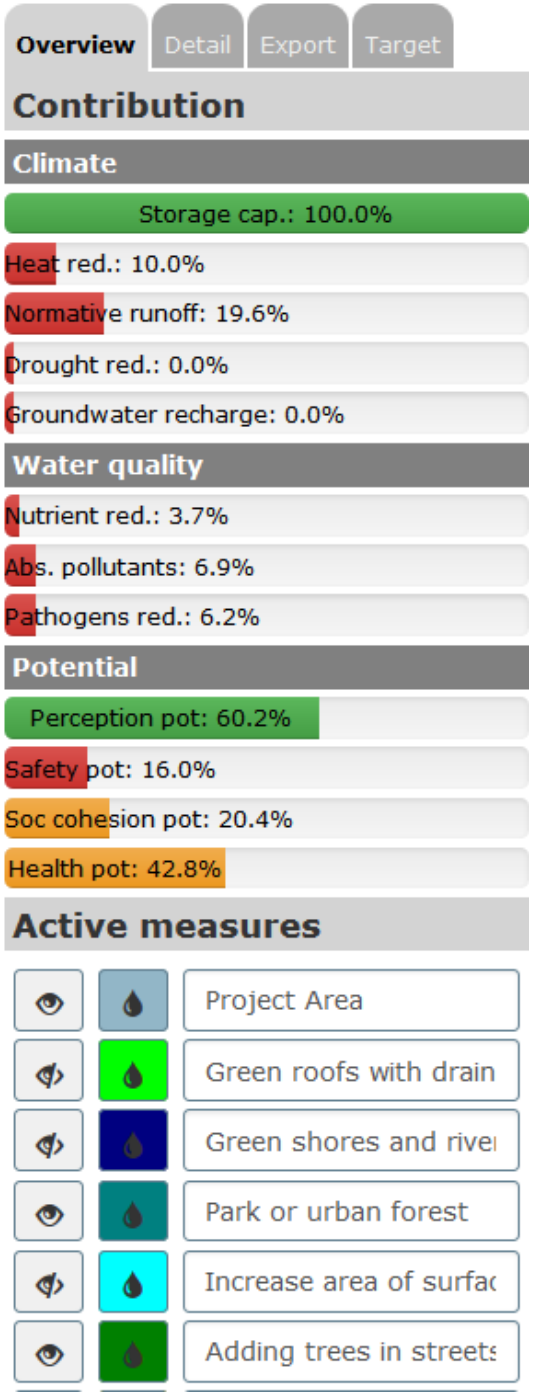
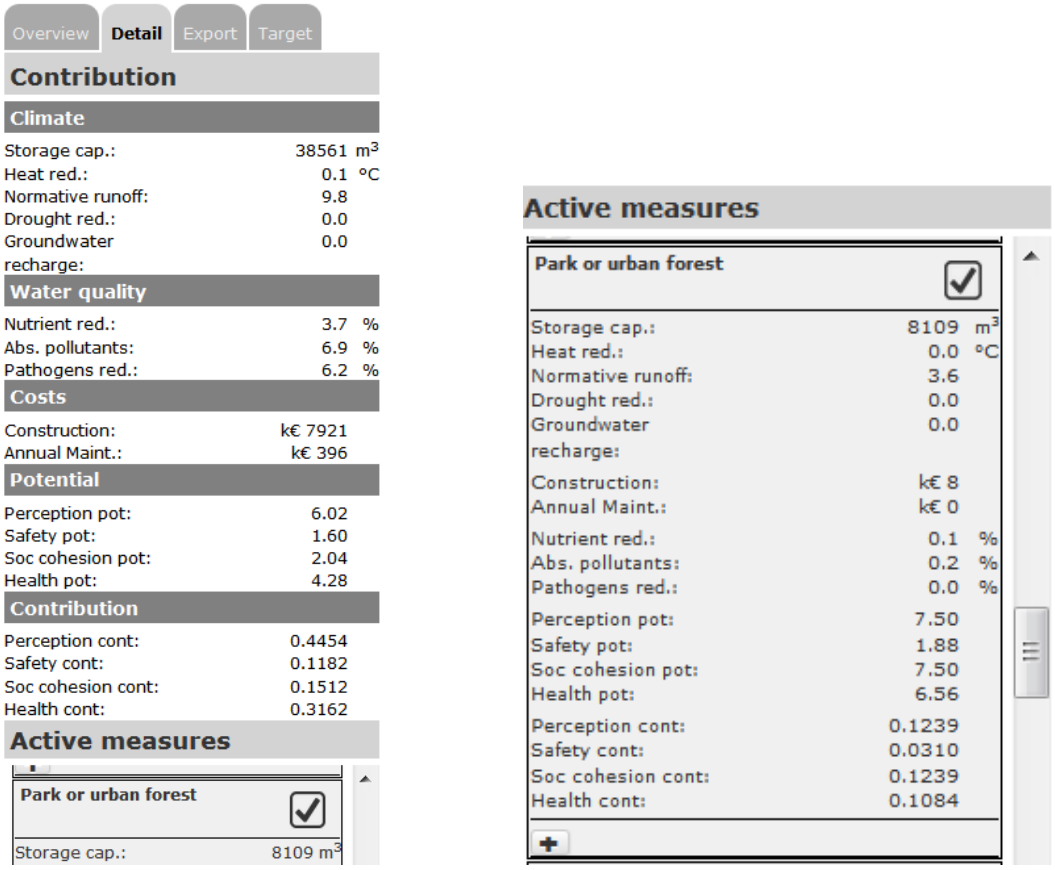


Figure 5.1: The overview tab in the right panel of the updated version of the AST



(a) The overview

(b) The information per measure

Figure 5.2: The detail tab in the right panel of the updated version of the AST

is shown in Figure 5.2. The contribution and potential of scenarios can not to be compared, as the potential is an average performance and the contribution is a sum of the performance over the entire area. They both express something different and should be discussed separately during the use of the tool.
Besides the potential and contribution for the entire package of measures, the detail tab also represents the information per measure. This information can be found for each active measure underneath the information on climate and water quality of each measure. Figure 5.2 gives an example of the representation for a single measure. This information is also included in the same manner as the information about the climate and water quality, to keep the information throughout the tool consistent.
The calculations and representation are composed in such a fashion that the information is useful for the users, easy to comprehend and compare, and to keep all the information in the tool consistent. However, it is important to know how this added information can be used and the opinion of users on the output and representation. This evaluation of the inclusion will be discussed in the next chapter.

6

EVALUATING THE USE AND RELIABILITY OF THE INCLUDED INFORMATION

In order to evaluate the inclusion of the interests, the usage and contribution of this added information was tested. As during this stage the tool can not be provided to real users yet, students were used to assess the inclusion and the support of the added information. This assessment was based on a workshop with students with the updated version. Below the objective, approach, set-up and assignment of this workshop with the updated version will be explained. Afterwards the results of the workshop will be discussed.

6.1. OBJECTIVE OF THE WORKSHOP

The goal of the workshop is an evaluation of the functioning of the AST with the added performance indicators for the interests and the use of the added information. By working on an assignment the attendees use the tool in a similar way as during a real case. By doing so, the attendees can evaluate the functioning of the information and at the same time observations can be made on the usage of the tool. Both outcomes can be used to explain more about the effectiveness of the inclusion in the tool. The goal of the workshop is to be able to answer the following questions in order to assess the effectiveness of the inclusion:

- Does the added information influence the usage of the tool?
- Does the added information lead to different outcomes?
- Is the added information received as reliable?
- Is the added information received as useful?

6.2. APPROACH OF THE WORKSHOP

In total two groups of students attended the workshop and both groups used the updated tool. This allows the comparison of the usage of the tool and the plans made by the groups to see whether both groups reacted similarly. Each group received the same assignment, which has been drafted in such a way that it makes the use of the tool as similar to real use as possible. The groups read the assignment first and all individuals were then asked to fill in the first questionnaire. After this the groups were briefed on the functioning of the tool and had 2.5 hours to create their plan and the accompanying explanation for their plan plus its focus points. After this creation phase, each individual was asked to fill in the second questionnaire and the workshop was completed with a short summary of the afternoon.
Besides the questionnaires, the groups were asked to keep track of their most important discussions and decisions, which will be used to evaluate the process of the group. Furthermore, the groups were also observed during the workshop to learn more about the usage of the tool and the problems they encountered. Thus three different ways of gathering information were used to make sure that all the important processes and events were registered and can be used to evaluate the tool in general and the additional information.

6.3. SET-UP OF THE WORKSHOP

In order for the results of the workshop to be useful, the set-up of the workshop had to be carefully considered and designed. As there was only a small group of attendees, the results had to be as optimal as possible without being able to use different assignments or cases as these could not be compared. Therefore, an earlier workshop for a different research that also used the AST was observed and this observation was used to draft a set-up that would give the most optimal results. Below these observations are evaluated and used to draft a fitting assignment for the workshop.

6.3.1. EVALUATION PREVIOUS WORKSHOP WITH AST

In order to let the workshop run smoothly the observations made during another workshop for a different research have been used to prepare a set-up that will yield the necessary results. This other workshop was conducted with mainly students of the water management track. The students got an assignment for a neighbourhood in Dordrecht and were free to draft their own plan to improve the climate resilience of the neighbourhood. The extensive report of the observations can be found in appendix D. Below, the most important observations will be discussed and it will be discussed how these can influence the results of the workshop.
Of course, by using students, the workshop will never reflect the reality perfectly, as the students lack the knowledge and viewpoints of all the different stakeholders that are present in a real case. Furthermore, students can assume a certain role, but still decide based on their own knowledge and background, making it impossible for them to mimic the decisions of the role entirely. However, during this workshop all groups failed to use the tool as it is intended to be used. They selected all the measures before even looking at the tool and did not use or discuss the results to adapt their packages of measures to be more effective for their roles' interests.
Second of all, most groups struggled with the roles and tried to reach an optimal solution for all the interests, while in real cases people will be divided between measures as some might have no effects at all for their interests and others will. So the groups discussed less and therefore also did not use the results of the tool to adapt their plans or change them.
Thirdly, the groups lost much time looking on Google to get familiar with the neighbourhood and to find areas were they could implement measures. They were lacking the input of local knowledge and information to be able to decide quickly where they could implement certain measures, which will be present during real cases.
So the workshop did not reflect the functioning of the tool or the usage during a real case. Therefore, the assignment given during the workshop with the updated version of the AST should be drawn in a way that prevents similar problems during the workshop of this research.

6.3.2. OPTIMISATION BASED ON PREVIOUS WORKSHOP

In order to reflect on the effectiveness of the additional information in the tool during normal use, the workshop had to approach reality as good as possible. As has been discussed above, by using students, this approximation will never be perfect, but the observations during the previous workshop are used to make a better approximation during this workshop.
So during this workshop the students were assigned a project area in Delft. As most students live in Delft, this area will be more familiar and some might be even living there, providing local knowledge. This prevented long searches on Google to learn more about the neighbourhood and where measures can be situated.
The assignment the students received was an assignment that set fixed adaptation targets and general requirements that the design need to meet in order to force the students to look at the results in the tool and resemble a real situation better. So it gave a clear problem statement, budget and information on the area. This allowed the students to spend more time on the design itself as they did not have to discuss the problem they wanted to solve and which interests are important. Moreover, for the plan to fulfil most of the interests and requirements, which is the goal during real cases, the students had to use the results of the tool actively to check whether the adaptation targets were fulfilled.
The different roles were removed as the previous workshop has shown the difficulties students have with assuming these roles. To make sure that the different interests still were taken into account in the process several small requirements were included in the assignment. These requirements explained the importance of the support by municipality and water boards and the fact that it is financed by the municipalities, thus forcing students to take the interests of these two stakeholders into account. The assignment also explained the multi-annual targets of the municipalities and the students were encouraged to also take the interests of

other stakeholders into account. By doing so, the real situation with clashing interests and priorities was tried to be mimicked.
The exact assignment and the questionnaires that were given to the students during the workshop can be found in appendix E.

6.4. RESULTS OF THE WORKSHOP

In this section the results of the workshop will be discussed, which are obtained in three different ways, by the questionnaires, the notes from the groups and the observations. First the results of the notes and the observations will be discussed together as they complement each other and afterwards the results from the questionnaires will be discussed. During the workshop there were two groups of each three students, with mixed group members. Most students were water management students, similar to the previous workshop and the other members were hydraulic engineering students. The students have different educational backgrounds for their bachelor degree, like architecture, civil engineering or educations abroad. Each group contained a mix of these different educational backgrounds to simulate the use by people with different backgrounds, like during real cases. All observations, notes and questionnaires have been made anonymous, therefore, the groups will be called group 1 and group 2 in the text below.

6.4.1. THE GROUP PROCESSES AND OBSERVATIONS

Both groups happened to have a different approach to the assignment by own choice, which will be explained here and the important steps they made will be mentioned.
Group 1 chose to make an integrated design that fits the environment and wishes of the residents. Their second focus point was reaching the technical demands and targets for climate resilience and water quality. They started with trying out measures they found appealing and fitting in the neighbourhood, Delft in general and the multi-annual plans. Soon they realised that most measures are quite expensive so integrating them with other projects and subjects was necessary. They actively searched for other ways to fund the design and put the emphasis on creating awareness and including the residents in the design. One of these ways was to increase the perception of the area, which subsequently increases the housing values and thus the tax incomes for the municipality of Delft. Furthermore, the next step they took was to increase the awareness by creating a green avenue to the park in the neighbouring area. Lastly, they decided to activate the residents by looking into measures that residents can take themselves in exchange for tax benefits. In these steps they created a plan that did not reach all the targets, but did take the requirements and interests into account with use of all the information in the tool. This group looked often at the added information in order to address and justify additional cost and to determine whether measures would increase the attractiveness and awareness in the area.
Group 2 had a different approach and started to list all the interests that they deemed important for the municipality, waterboard, residents and local businesses. Based on these interests they had as goal to meet the technical demands and targets, while reducing the nuisance for the residents and local businesses and if possible increasing the attractiveness of the area. The limited budget moved them to test many different measures first, to determine the most cost-effective ones, that fit their goal. They also found the budget to limited, so they decided to ignore it and try to find the most cost-effective measures that also would improve the neighbourhood. The attractiveness of the measures was determined on the information in the left panel. The focus of group 2 was on the results on climate resilience and water quality. They did not meet the targets due to the limited amount of time and the fact that the tool reacted very slowly with them.
Based on these notes and observations it can be seen that both groups had different goals and approaches, leading to a different use of the information. Group 1 used mostly the results in the right panel to see whether they met their targets, what effect the measures had on the attractiveness of the area and to find other ways of funding their plan. While group 2 used the information in the left panel and only the results on climate resilience and water quality in the right panel as they wanted to create a plan that reached the technical demands and neglected the funding for now as they deemed it impossible to meet that requirement. As there were only two groups the conclusions based on these results are not very reliable. However, it seems that the information demand is different for each group of users and this could indicate the need to select the information on the different interests, which is presented in the tool. Although the approaches differed for the two groups, both groups did not use the information in the detail tab, as they preferred to see their information in one glance, without clicking and scrolling. This lead to them missing important information and complaining about the fact that there is only information presented for the entire area and not for the

specific areas around the measures. This phenomenon can also be found when looking at the results of the questionnaires, which are discussed below.

6.4.2. THE QUESTIONNAIRES

The questionnaires give an answer to the expectations of the students and the degree to which the tool lives up to these expectations and its support. As these do not provide information about the processes of the group or their approach, all the answers to the questionnaires will be given together in appendix F, without making a division between the questionnaires of group 1 and group 2. First the most important results and answers to the first questionnaire will be given to explain the expectations of the students and afterwards the second questionnaire is discussed.

The information demand of the students covers a large area, from technical and hydrological details to the wishes and interests of all the stakeholders. Some demands are mentioned several times, like an overview of the project area, the cost of measures, the possible measures and the current situation regarding free space, blue-green spaces and the current climate resilience of the area. The interests that are mentioned most often are the interests of the municipality, as they have to pay and the residents as they can have the largest nuisance and benefits. However, when looking at the goals, there are some clear contradictions, some mention the goal to reach the targets and technical constraints,while others focus more on making the area more attractive or liveable. Most mention more than one goal; to meet the targets or to increase the liveability, while being either cost-effective, increasing the biodiversity, or meeting all the interests of the stakeholders. These differences in goals are interesting to mention and could explain the different approaches used by the groups. The second questionnaire gives the answers of the students on the functionality of the tool, its support and the information given by the tool. The answers show that the students have rated the support of the tool rather low. This is due to the fact that the tool reacted very slowly for one group and the inconsistency of the information in the tool. For example, the cost of the grey measures are not included and the results for drought reduction and the groundwater are not included in the tool. This gives the tool an unfinished feeling for the students and therefore the support is rated low. Nonetheless, they do value the large number of possible measures and the information on the effectiveness these measures. Furthermore, for the measures that have a cost indication, they value this information. If the cost for all the measures would be included and the results for the drought reduction and groundwater would be included, they would rate the support to be sufficient in combination with the detailed information on the measures. However, the largest inconvenience regarding the information is for most students the lack of information on the current situation and the different types of area that are already present in the project area. Furthermore, they mention that the tool does not provide the interests of the stakeholders, which is information they indicated in the first questionnaire as necessary in order to make a design. Another lack of information that has been mentioned by several students is the representation of future plans and projects in the area, in order to link these to measures in the tool.

The effect of the tool on the reaching of their goals cannot be be determined as both groups could not finish their plan in time. Nonetheless, they could give their opinions on the information in the tool. Most found the information both reliable and useful, but wanted the total combined effect of the measures in the overview tab, which is not the case for the potentials. Second of all, some indicated to miss certain information, which could be found in the detail tab. The representation of the information was found clear by most students, but some advise to give more detailed information on the definitions in the tool, like the normative runoff and explain how these are calculated.

So overall, the outcome of the second questionnaire is that when all the missing information is included, the tool gives a nice overview of all the possible measures and makes it possible to compare them for cost-effectiveness. There are some small adaptations, which could make the information more clear and increase the support. The students indicate that the tool would be best for comparing measures and scenarios in a fast manner to make a first draft of a project, which is also the intended goal of the tool.

7

DISCUSSION

The approach used in this thesis was to start reading into the literature and to conduct semi-structured interviews. Based on the results of these two steps, the interest of the most important stakeholders were determined. For the inclusion of these interests, the effectiveness of blue-green measures for each interest and the important mechanisms behind these effects were determined. Afterwards, these mechanisms were linked to indicators, for which every blue-green measure was rated on a scale from zero to one or zero to ten. For each interests a formula, based on the indicators, has been drawn and included in the tool. The last step was to evaluate this inclusion with the help of a workshop. Even though all the steps have been made with proper consideration, in hindsight there are some remarks to be made about the methodology, which might be important for follow-up research and should be taken into account when looking at the results and drawing conclusions.

7.1. INTERVIEWS

The interviews, that were used to determine the interests and benefits of stakeholders, were prepared with much care, but there are still some limitations that need to be mentioned. One limitation regards the limited group of interviewees. Namely, the interviews were conducted with the most important stakeholder group, the municipalities. However, they are not the only important stakeholder group, so some groups are not represented in this research. On the other hand, even for the interests of the municipalities more interviews could shed a better light on the information demands, interests and benefits that are of importance. So the interests that are determined based on these interviews do not reflect the interests of all the stakeholders.

7.2. INCLUSION

The inclusion of the interests may add information to the tool, but this will have certain limitations, based on the manner of inclusion. These limitations are important when assessing whether the added information will improve the support the tool offers its users. Therefore, its limitations will be discussed here.
First and foremost, like with the climate adaptation and water quality calculations, the tool does not take the current situation into account when calculating the effects of the measures for the added interests. It uses the map to situate the measures, but this map does not include a database about the current situation regarding blue and green that is already present in the neighbourhood. So it could be that the potential that the tool gives is higher than what could actually be reached with proper implementation and good designs as it can be expected that there is a limit to the effectiveness one can reach with certain measures. Therefore, when for example, many trees are already present in an area, the additional effectiveness of adding trees will be less and thus the potential that the tool gives for the implementation of trees in this neighbourhood will be much larger than the effects that will actually occur with the implementation of additional trees.
Secondly, the potential the tool gives is like its name suggests, only a potential and gives an indication for the performance of measures. Therefore, it could be that in reality the effects are different and that some measures function worse than this potential indicates. As the local conditions and the design determine largely what the effects in reality will be, it is not possible to remove such uncertainties entirely. These differences

could lead to disappointment, so it is important to explain that these potentials need to be assessed with some reservation and have as goal to compare different measures by providing some kind of expression for the expected performance instead of giving exact effects or benefits.
Furthermore, the calculations base the contribution of the separate measures on the assumption that the relation between contribution and size of the total area of a measure is linear, without a minimal or maximum boundary to this area. This is an assumption, made due to a lack of data on the relation between area and effect of the measures. However, by making this assumption the calculations do not include the possible different relations for the different measures, or the minimum area needed to reach any effectiveness at all. On the other hand, it also does not use a maximum area, above which the additional effectiveness is negligible. As the tool does not take the current situation into account, this would have been hard to implement even when data on this would have been available. So the contribution the tool gives, could give a distorted image as it does not include the minimum and maximum areas for certain effectiveness or the different relations of each measure between the size of the area and the effectiveness.
Moreover, as could already be seen in the difference in aspects of the valuation schemes discussed in chapter 2, there might be differences in the important interests in different countries. The interests, for which the performance of the measures is included during this thesis are based on the Dutch valuation schemes and interviews with Dutch municipalities and landscape architects. So the interests, although they are very general, might be less fitting in other countries.
Lastly, besides the results of the calculations, the users do not receive information on the effectiveness for certain interests before the implementation of measures. In order for them to actively select the measures for their performance for the added interest, they also need information about the effectiveness before implementing the measures and comparing the results. This would mean more extensive information in the left panel of the tool, which has not been realised yet.
These are the most important limitations of the inclusion and when they are summed up like this, they might seem very large. However, the information in the tool could still be very useful to its users as there is still a lack of information in the combination of climate adaptation and other interest. Besides, as has been mentioned in section 2.7, information on the cost and effects of measures is useful even when it is incomplete. Moreover, the information might have its limits, it still can be used to compare different measures as there are the same limitations for all the measures. This comparison makes it possible to include the four added interests in the discussion during the use of the AST. It offers its users information that is now lacking and it makes it possible to include these interests in the design, as they can be discussed among the users. Additionally, the information is all given in a qualitative manner, which is not very precise, so some limitations might have a small or negligible effect that could not be distinguished on such a qualitative scale.

7.3. WORKSHOP

A workshop with student teams was used to evaluate the effectiveness of the inclusion of additional interests in the AST. However, the workshop has some important limitations. First of all, the results of the workshop are based on the use and opinions of students. As one can expect, students can never mimic the real situation with the different stakeholders and different and/or conflicting interests. Therefore, whether they deem the information useful and supportive does not determine the actual support this information provides during a real case with actual users. The ways in which the students used the information can indicate how the information can be used and the support this can create, but it does not determine the actual support during a real case.
Secondly, the results of the workshop are based on two small groups of students, which increases the uncertainties in the results. Because there are only two groups, it cannot be said what results or processes will happen in most groups as this information will be based on the results of only two groups. This does not mean that the information is useless, as it is interesting to see what happened in these two groups. It does mean that it cannot be concluded what is most likely to happen with the included information. The results can only be viewed as an indication that certain processes can occur. More reliable data should be obtained in future research to be able to determine the exact effect of the inclusion in the usage of the tool and the support it offers during the decision-making process.
Furthermore, the results of the questionnaires will be influenced by both the assignment that has been given and the fact that the tool did not function optimally that afternoon. The assignment did pose some requirements, like the inclusion of the interests of the municipality that did influence the information demand of the students. Therefore, this information demand does not entirely reflect the information that the students

would have required, when they could have designed anything they liked. However, the assignment was necessary to be able to create a design in a reasonable amount of time, by students that do not particularly have experience with designing plans for urban areas. The second influence, the functioning of the tool, was a large influence as it made the tool react very slowly with one of the groups, which reduced their trust in the tool and its results. Moreover, the fact that there were headers for the results for drought reduction and groundwater, while the tool does not give information on these yet, also influenced the results of the questionnaires as this did contribute to an unfinished and less reliable feel for the students. Due to this the results of the second questionnaire can be more negative than the actual opinions on the information in the tool, would this slow functioning not have occurred and the headers for drought reduction and groundwater not have been shown.

These are the most important limiting factors for the results of this thesis and it is not possible to explain for all of these limitations what influence they will have on the results. These limitations do explain what the most important incentives for further research are and should be taken into account when assessing the results and drawing conclusions, which will be done in the next chapter.

8

CONCLUSION AND RECOMMENDATIONS

The final step is to answer the research question and sub-questions, which have been drawn at the start of this thesis. Based on the results of the interviews and the workshop and discussion, conclusions will be drawn for these questions. Also, some recommendations will be made for the improvement of the inclusion, the Adaptation Support Tool in general and future research. First the conclusions are presented in section 8.1 and next the recommendations are given in section 8.2.

8.1. CONCLUSION

This thesis has shown that the Adaptation Support Tool can reflect on some of the interests of the stakeholders by including the accompanying effectiveness of the blue-green measures, namely for the perception of the surroundings, safety, social cohesion and health. This effectiveness can be determined with the use of indicators for which all blue-green measures are ranked on a qualitative scale. The inclusion of the effectiveness of measures for these interests could possibly increase the support for the most important group of stakeholders, the municipalities, as it makes more integral solutions possible and provides information, which is better suited. Based on the evaluation, it can be concluded that the effect of the inclusion on the decision-making process is not entirely clear yet, but indications can be found that the information supports goals beside reaching the technical targets for climate resilience and water quality. Furthermore, there are indications that the information can draw attention to these interests, which opens the discussion on the importance of different interests and the benefits of measures. Together, these would increase the support for stakeholders that have other interests than only climate resilience. Below it will be explained, which information and reasoning have lead to this conclusion.

8.1.1. CONCLUSIONS ON THE INTERESTS AND EFFECTS FOR STAKEHOLDERS

So first of all, as shown in the literature research, this thesis is not the first research in which is attempted to value the interests present in urban development for users to better understand and compare designs and alternatives. There are already multiple valuation schemes present in which the same aspects keep returning. It was expected that this re-occurrence was an indication that these aspects reflect some of the interests of the stakeholders. The results of the semi-structured interviews, which were conducted with the most important stakeholder group, the municipalities, showed large similarities with the aspects found in the valuation schemes. Based on these results and the similarities found in the valuation schemes, it can be concluded that the following interests are of importance for the largest group of stakeholders in urban development: Investment and maintenance cost, perception of the surroundings, social cohesion, safety, the quality of the external climate, health and mobility.
What also can be concluded when looking at the results of the interviews and the available literature is that the blue-green measures can have significant benefits for these interests and solve multiple problems by using these benefits to create an integral solution. The more experienced municipalities are using these benefits actively and they indicate that this could be valuable information for the less experienced municipalities.

8.1.2. CONCLUSIONS ON THE INCLUSION OF THE INTERESTS IN THE ADAPTATION SUPPORT TOOL

However, not all interests can be applied in the Adaptation Support Tool and the information processing capacity of humans shows that just adding more information does not automatically lead to an increased support. For this reason, the interests for inclusion were prioritised based on their usefulness and whether it is possible to express the effects in a credible manner in the Adaptation Support Tool. The fact that the tool does not take the current situation into account, makes determining the effectiveness of measures for the mobility and the quality of the external climate in the tool not possible, which has lead to the elimination of these interests. The investment and maintenance cost are already included in the tool for the blue-green measures, so this interest does not need a new inclusion. This reasoning has lead to the decision to include the effectiveness of the measures for the perception of the surroundings, social cohesion, safety and health in the tool. Hence, there can be more interests found for the stakeholders, but based on the results and the requirements it can be concluded that only these four interests are suitable to be included in the tool at this moment.

For each of these interests potential effects can be determined as previous studies have described the benefits for stakeholders of blue-green measures. The fact that these studies describe the effects for the blue-green measures in general and do not specify the difference in effects for different measures, causes that the most accurate representation that can be given is the potential for effectiveness for each measure. This potential is based on the visibility and accessibility of the measure and other indicators. These other indicators reflect on the mechanisms that cause the effects for each interest. For example, for social cohesion to increase, people should meet other people, making the meeting function the indicator that reflects on the mechanism that people need to meet in order to increase the social cohesion. As a result of the determination of these mechanisms the meeting function, openness, physical activity and natural factor are the indicators used to reflect on the effectiveness of measures in the tool. For each measure, these four indicators are given a ranking on a qualitative scale to reflect the degree to which the measure supports the mechanisms that create certain effects. The visibility and accessibility can be given by the users, but also a default ranking has been made on a qualitative ranking scale. So the selected interests and effectiveness of measures can be included in the tool with the help of the four indicators that reflect the mechanisms behind the effects and the boundary conditions imposed by the visibility and accessibility.

8.1.3. CONCLUSIONS ON THE EFFECTIVENESS OF THE INCLUSION

As it can be concluded that it is possible to include additional interests in the tool, it is also important to evaluate how effective this inclusion is. This effectiveness of the inclusion is evaluated in a workshop with two student teams. Both teams used a different approach, which lead to a different usage of the information of the tool. One group focussed on the adaptation targets and thus did not use the added information. They used the information in the left panel to select the measures for attractiveness and looked in the right panel to see whether they had reached their adaptation targets. The other group had as approach to make a plan that included awareness, budget allocation and activated the local residents. To be able to allocate budget, they looked at the added information and discussed the effectiveness of measures for these interests. So one group used the the added information, while the other group did not look at it or include it in their discussions. Hence it is possible that the added information influences the usage of the tool by enabling users to make more integrated designs that fit the area and can be integrated in other projects, while also optimising the effectiveness for all the interests. However, the results do not exclude the option that the usage stays exactly the same as before the inclusion and they can not be used to predict which type of usage is most likely to happen.

The same goes for the effect of the inclusion on the outcomes of the usage, one group did have different outcomes as the information enabled them to outsource budget and to incorporate their design in the multi-annual plans in order to make the city more attractive. Their plan also included the idea how their design would increase the awareness of the residents and how it connects to the areas around the project area. The other group had outcomes that focused on the increase in climate resilience and the attractiveness of the area. The outcomes are very different and both possible outcomes of the use of the tool. So again the results indicate that the added information could make the outcomes more diverse. Based on these results it can be concluded that the inclusion could be effective by changing the usage and outcomes of the tool. Furthermore, the inclusion could increase the support for the stakeholders that have different interests, besides climate resilience, water quality and cost, by enabling them to make more integrated designs and providing information to discuss the effectiveness and values of measures for these other interests. However, the reliability of the

results of the workshop is insufficient due the low number of participants, therefore the conclusions based on these results can only give indications of possible effects.
Besides the effect of the inclusion on the usage and outcomes of the tool, the workshop also evaluated the added information itself. Based on the results it can be concluded that overall the included information is received as both reliable and useful. On the other hand, the information that seems to be missing, like the effects for drought reduction, gives the tool a less reliable or unfinished feel. Another conclusion that can be drawn is that the weighted average of the potential in the overview tab needs more explaining as it can seem demotivating and harder to interpret when it goes down instead of up. Hence, it can be concluded that the information in the tool is received as reliable and useful, but there are several minor errors and flaws in the AST which need to be fixed to reach a higher level of support, as these disrupt the process and can lead to a lower trust in the results and the designs created in the tool.

Based on these conclusions it can be consequently said that the Adaptation Support Tool can reflect on some of the interests and accompanying effectiveness of measures, besides their effect for climate resilience and water quality. The inclusion of these interests could possibly improve the support of the tool during the decision-making process as indicated by the results of the workshop. However, these conclusions are affected by the limitations mentioned in the discussion chapter and therefore, the results of this thesis can only give an indication of the effectiveness of the inclusion. In order to learn more about the inclusion of interests in the AST and the effect this has for the support of the AST, further research is necessary. Recommendations to improve the inclusion and its support in this future research will be given in the next section.

8.2. RECOMMENDATIONS

There are several recommendations that can be made regarding the inclusion and the Adaptation Support Tool in general. First, the recommendation regarding the inclusion of interests and its effectiveness will be given and how this could be optimised in future research. Secondly, the recommendations regarding the general optimisation of the tool will be given, based on the findings of this thesis.

8.2.1. THE INCLUSION AND ITS EFFECTIVENESS

The inclusion itself was mostly hindered by the limited amount of research that has been done regarding the effects of different measures and the effects in general. Many studies proved that blue-green measures have certain effects, but only a few try to explain the relation between size, sort of measure and the magnitude of the effects. This has lead to the use of indicators that try to mimic the mechanisms behind the effects, but this manner is far from optimal as it only gives the potential for the effects. In order to improve the inclusion, more extensive information is needed on the effects, their relation with the sort of measure and the size and/or number of the measures. Furthermore, as has been mentioned in section 2.7.1.1, benefit transfer could be a useful manner to include the effects in the tool. To be able to use this, research into the effects at reference sites is necessary, which again underlines the importance of more extensive research into the effects of blue-green measures. That this information is important is mentioned in the interviews as well. Employees of the municipality of Rotterdam mention their use of the effects at sites that have implemented blue-green measures to estimate the effects at new sites and use this information in the implementation. If these effects would be documented or published, they could be combined to make a framework that can be used to estimate the effects in the tool.
In this thesis a first evaluation of the inclusion has been executed as well. However, this evaluation was done based on a workshop with only two student teams, making the number of participants very small and the use by students will only partly resemble use during real cases. Therefore, it is recommended to further evaluate the effectiveness of the inclusion in the future. The updated version of the tool is not yet suitable for use during real cases, as it needs to be further evaluated first. However, it can be recommended to organise more student workshops with more groups for further evaluation as this could shed a better light on the effectiveness of the inclusion and how this inclusion can be further improved.

8.2.2. THE ADAPTATION SUPPORT TOOL

Based on the results also some remarks can be made regarding the optimisation of the Adaptation Support Tool in general. These are not solely about the inclusion of the additional interests or the representation of

this information, but they could improve the functioning of the tool further. First of all, as the interviews have shown, the investment and maintenance cost are very important interests for the municipalities. This information is already included in the tool, hence they were not taken into account for inclusion. However, their importance stresses the need for more emphasis on them in the tool. Now this information can only be found in the detail tab, but ideally they would also be represented in the overview tab somewhere. Furthermore, only the investment and maintenance cost of blue-green measures are included in the tool at the moment, while the comparison of all the measures would also need the investment and maintenance cost for grey measures.
The second remark regards the information in the left panel. In this research the focus was on the inclusion in the right panel, but the results from the interviews and workshop have shown that also information on the effectiveness in the left panel could be useful. This way, the users can actively select measures for certain effects and do they not need to implement random measures to see the results and determine whether that measure has an effect for the interest in question. Besides more information on the effectiveness, also a better visual representation and examples of implemented measures in the left panel could increase the functioning of the tool. Several interviewees mentioned the importance of visual information on the possibilities and the strength of touting stories or examples.
Thirdly, also the right panel could still use some optimisation, as it now includes much information, which exceeds the information processing capacities as discussed in the results of the interviews and in section 4.1.2. Climate adaptation might not always be the largest concern in real cases, thus it would be not correct to reduce the information about the other interests, while the climate resilience information is very extensive. What would improve the functioning is to implement layering of the information, as has been mentioned in the interviews. Besides layering, selecting the interests of importance could also reduce the information that needs to be processed. Combined these two adaptations could improve the functioning of the tool further, making it more flexible and usable in a larger range of settings. Another remark that regards the right panel concerns the bars for drought reduction and groundwater. The tool does not yet provide information on these, but the bars are shown underneath the header climate, which could give users the feeling that the tool is unfinished or not working properly. This has also been mentioned by the students during the workshop and this lowered their rate on the support of the tool and the reliability. So it can be recommended to either hide the headers at this moment or to include the effects of measures for drought reduction and groundwater in the tool.
Another recommendation regarding the right panel is the remark that the detail tab needs to be improved. At the moment the detail tab is not used by the users, which is also reflected by the results of the workshop. The students indicated to miss certain information that can be found in the detail tab. In this tab much useful information can be found, but when users do not use this tab they miss out on this information. So the detail tab needs to be renamed or rearranged for the users to use this information as well.
Next, another recommendation for the right panel regards the fact that there is much information in the tool that is not explained like the definitions of potential and contribution, which should be included to increase the understanding of the tool and the calculations it makes. This could increase the reliability of the information for its users and give an insight in the effectiveness of measures that might be interesting for its users.
The last remark regards the fact that the tool does not take the current situation into account, while both the results of the interviews and the results of the workshop mark the need for this information. Whether it is possible to create a database that reflects the current situation and use this during cases is questionable as it is also unclear which information on the current situation is required by the users. More information on this requirement and how this should be taken into account is needed before the current situation can be included in the tool. It might be very interesting to look into as it could improve the truthfulness of the results and expand the possibilities for the usage of the tool.

These are the most important conclusions, remarks and recommendations that can be made regarding this research and its results. These show that the effectiveness of the inclusion of the interests in the Adaptation Support Tool seems promising, but for optimisation further research and evaluation is necessary.

A

OVERVIEW OF THE VALUATION SCHEMES

All the valuation methods described in section 2.7.2 function in different ways and have different goals. However, it might be interesting to see which aspects they include in order to better compare them and see what could be important for the inclusion in the Adaptation Support Tool.

A.1. TEEB-STAD

TEEB-stad consists of six themes and 14 aspects that are given a financial value based on certain parameters and the key figures. It gives the benefits in monetary units for each aspect, for each theme and for the entire project. It can be used to compare different scenarios and to find the benefits per measure, for example per tree.

Theme	***Aspect***
1. Health	1. Less health related cost (general)
	2. Less loss in jobs
	3. Less health related cost due to increase in air quality
	4. Less health related cost due to reduction of heat stress
2. Energy usage	5. Energy reduction by coverage of trees
	6. Energy reduction by isolation of green roofs
3. Value of housing	7. Increase real estate value of existing housing
	8. Higher real estate value of new housing
	9. Increase real estate value of existing housing by more quality of maintenance of public green areas
4. Recreation and leisure	10. More recreation possibilities by an increase in green and/or quality
	11. More profit for businesses owners through higher willingness to pay due to a greener street
5. Social cohesion	12. Avoiding expenses of moving by greater social cohesion
6. Water management	13. Protection against water nuisance due to an increased water storage capacity
	14. Avoided investments in sewage treatment due to an increased water storage capacity

Table A.1: Overview TEEB-stad

A.2. DPL

DPL exist of three themes, ten subthemes and 25 aspects that are used to score area development on sustainability. Each aspect is scored on a scale of one to ten in comparison to a reference project. The reference

project is scored a six and the aspects are scored in reference to this score. By taking averages the score can also be given per subtheme and theme, making it easy to compare projects. However, the outcome is largely dependent on the chosen reference project.

Theme	*Subtheme*	***Aspect***
1. Planet	1. Supplies	1. Spatial use
		2. Materials
		3. Collection of waste
	2. Climate	4. Energy use
		5. Generation of sustainable energy
		6. Drainage of precipitation
		7. Flood risk
	3. Biodiversity and green	8. Green and water in the neighbourhood
2. People	4. Nuisance	9. Soil quality
		10. Air quality
		11. Noise
		12. Odour
	5. Safety	13. External safety
		14. Social safety
		15. Traffic safety
	6. Quality of neighbourhood and house	16. Quality of housing and surroundings Green and water in the neighbourhood
		17. Cultural and historical value
	7. Social cohesion	18. Social cohesion
3. Profit	8. Services	19. Services and shops
		20. Sustainable transport
	9. Economic vitality	21. Local employment
		22. Diversity of business
	10. Sustainable business	23. Sustainable business
		24. Mixed uses
		25. Flexibility

Table A.2: Overview DPL

A.3. LEED FOR NEIGHBOURHOOD DEVELOPMENT

LEED consists of five themes and 59 aspects and is a scheme that has been developed for the U.S. This is the only scheme that is not designed for the Netherlands and this can also be seen when looking at the different aspects. Furthermore, the LEED scheme has some aspects that are required to be fulfilled to acquire the certification. These aspects are in the grey cells of the table below. All the other aspects have a different number of points that can be assigned to the project. All the points are assigned when an aspect is fulfilled and it is not possible to receive only a part of the points. Based on the points, the project is scored with each theme having the same weight. Based on this score the project receives a certification that can range from just a certification, to a silver, gold or even platinum certification.

Theme	***Aspect***
1. Smart Location and Linkage	1. Smart Location
	2. Imperiled Species and Ecological Communities
	3. Wetland and Water Body Conservation
	4. Agricultural Land Conservation
	5. Floodplain Avoidance
	6. Preferred Locations
	7. Brownfield Remediation
	8. Access to Quality Transit
	9. Bicycle Facilities
	10. Housing and Jobs Proximity
	11. Steep Slope Protection
	12. Site Design for Habitat or Wetland and Water Body Conservation
	13. Restoration of Habitat or Wetlands and Water Bodies
	14. Long-Term Conservation Management of Habitat or Wetlands and Water Bodies
2. Neighbourhood Pattern and Design	15. Walk-able Streets
	16. Compact Development
	17. Connected and Open Community
	18. Walk-able Streets
	19. Compact Development
	20. Mixed-Use Neighbourhoods
	21. Housing Types and Affordability
	22. Reduced Parking Footprint
	23. Connected and Open Community
	24. Transit Facilities
	25. Transportation Demand Management
	26. Access to Civic and Public Space
	27. Access to Recreation Facilities
	28. Visitability and Universal Design
	29. Community Outreach and Involvement
	30. Local Food Production
	31. Tree-Lined and Shaded Streetscapes
	32. Neighbourhood Schools
3. Green Infrastructure and Buildings	33. Certified Green Building
	34. Minimum Building Energy Performance
	35. Indoor Water Use Reduction
	36. Construction Activity Pollution Prevention
	37. Certified Green Buildings
	38. Optimize Building Energy Performance
	39. Indoor Water Use Reduction

	40. Outdoor Water Use Reduction
	41. Building Reuse
	42. Historic Resource Preservation and Adaptive Reuse
	43. Minimized Site Disturbance
	44. Rainwater Management
	45. Heat Island Reduction
	46. Solar Orientation
	47. Renewable Energy Production
	48. District Heating and Cooling
	49. Infrastructure Energy Efficiency
	50. Wastewater Management
	51. Recycled and Reused Infrastructure
	52. Solid Waste Management
	53. Light Pollution Reduction
4. Innovation and Design Process	54. Innovation
	55. LEED ®Accredited Professional
5. Regional Priority Credits	56. Regional Priority Credit: Region Defined
	57. Regional Priority Credit: Region Defined
	58. Regional Priority Credit: Region Defined
	59. Regional Priority Credit: Region Defined

Table A.3: Overview LEED

A.4. BREEAM AREA DEVELOPMENT

BREEAM consists of six themes and 44 aspects, which all need to be scored. The themes have different weights and for each aspect a different number of points can be earned. The points for each aspect are given when a certain level is reached. So there are strict rules when each point is earned and which evidence needs to be supplied in order to get this number of points. For each theme these points are added and multiplied by the weight. The resulting score determines which certificate is given to the project, ranging from just pass to good, very good, excellent and outstanding, with pass receiving one star and outstanding receiving five stars.

Theme	*Aspect*
1. Area management	1. Management
	2. Stakeholder analysis
	3. Participation
	4. Phase transition to management and occupancy phase
	5. Management and user manual
	6. Socially responsible entrepreneurship
2. Synergy	7. Characteristics of the area
	8. Visionary plan
	9. Adaptive Capacity
	10. Sustainable return on investment
	11. Synergy
3. Sources	12. Limit primary energy consumption
	13. Generate renewable energy
	14. Water consumption
	15. Material cycle
	16. Substantiated Origin of Materials
	17. Robust design
	18. Food
4. Spatial Development	19. Land use
	20. Contaminated soil
	21. Urban Programme
	22. Reuse of existing structures
	23. Cultural Heritage
	24. Abiotic structures
	25. Ecological values
	26. Mobility
	27. Underground infrastructure
	28. Sustainability performance buildings
	29. Flood risks
	30. Rainwater management
5. Welfare and Prosperity	31. Public safety
	32. Social cohesion
	33.Perception of the surroundings
	34. Regional employment and business activity
	35. Ownership
6. Area climate	36. Thermal outdoor climate
	37. Wind climate
	38. Air quality
	39. Water quality
	40. Soil quality
	41. Noise
	42. Daylighting
	43. Light nuisance
	44. Radiation Hazard

Table A.4: Overview BREEAM

A.5. GPR URBAN PLANNING

GPR urban planning consists of five themes and 16 aspects. Each aspect can be scores on a scale from one to ten, with six being the minimum requirement according to the Dutch spatial and environment laws for development of new areas. When an aspect has been met in a manner that exceeds these requirements the score is higher than six and vice versa. The average of the aspects gives the score for each theme and allows planners to compare alternatives and optimize project plans.

Theme	***Aspect***
1. Energy	1. Reduction of energy demand
	2. Energy performance
2. Spatial planning	3. Spatial concept and area use
	4. Nature (green)
	5. Water (blue)
	6. Development and infrastructure (grey and red)
3. Health	7. Noise
	8. Air quality
	9. External safety
	10. Nuisance and comfort
4. Quality of use	11. Mobility
	12. Functionality
	13. Perceived value
5. Future value	14. Future-oriented facilities
	15. Flexibility
	16. User value

Table A.5: Overview GPR

B

INTERVIEW PLANS

B.1. SAMPLE INTERVIEW PLAN (STAKEHOLDER WITHOUT EXPERIENCE WITH AST)

step 1 introduction

Hello, my name is Kyra Wouters, and currently I am graduating on a project at Deltares. I will be looking into a tool that supports climate adaptation in urban development in the next couple of months and my goal is to let the tool better support stakeholders during the decision-making process. The tool can be used to co-create climate resilient designs for new developments or redesign of current areas. It gives a list of measures that can be used to adapt the urban environment and in the design workshops these measures can be situated in the project area. The goal is to create discussion between different stakeholders to facilitate a learning process. At this moment it gives stakeholders the opportunities to situate measures and subsequently it ranks the effectiveness of the multiple scenarios with hydrological indicators and costs. I am striving to better support the decision-making process by including the many co-benefits of blue-green measures in order to reflect the interests and stakes of the stakeholders. I would like to discuss the following topics with you:

- Your role in the decision-making process
- Interest that should be included in the adaptation tool for founded decisions
- Importance of climate adaptation for your interests and stakes
- Your opinion and knowledge on the benefits of blue-green measures
- Your opinion on the chances adaptation can create for your stakes
- Any other business + conclusion

With your permission I would like to record the interview. I believe that this will increase the flow of the interview and I will be able to give your answer my full attention. These recordings will only be used to process everything that is mentioned in the interview and for nothing else. The interview and its contents will be used for my research only and this information will not be given to third parties. All the information will be anonymously presented in the final report and quotations will only be made with your permission.
With these topics in mind, I would like to obtain your opinion as ….. on these matters.

Step 2 interview
Role in the decision making process

Main question	Additional questions	Clarifying questions
Can you describe the role you normally would have in the decision-making process when (re)designing urban areas? OR How would you be included in the decision-making process?		Can you expand a little on this?
Which arguments/information can you use to influence the decision-making process? AND How would you try to safeguard your interests in the decision-making process?		
What is your opinion about the added values of participatory design? OR How does collaborative design support your interest?		

Inclusion of interests

Main question	Additional questions	Clarifying questions
On which interests do you determine whether a plan is acceptable or even attractive? OR Which information regarding your interests would you require to make a founded decision?	How accurate does the information need to be in order to connect a certain performance to it?	Can you expand a little on this?
How would you like your interests to be reflected when being included in the AST? OR In your opinion, would it be beneficial if your interests would be reflected by certain indicators in the AST?	Would you rather have a quantitative or a qualitative indicator? What indicators would you suggest to reflect your interest? How will this extra information influence the discussion?	

Importance of climate adaptation for your interests and stakes

Main question	Additional questions	Clarifying questions
How do you value climate adaptation for your interests and stakes? OR How important is climate adaptation for you and your interest?		Can you expand a little on this? Can you tell me anything else?
Which opportunities does adaptation create for you and your stakes?	Given the fact that adaptation is accompanied by renewal of an area, which chances could this create for you?	

How would you compare scenarios with high and low climate adaptation abilities with differences in effectiveness for your stakes?		
Which benefits could blue-green measures have for you? OR In your opinion, do blue-green measures have any co-benefits for you?	On which knowledge is this based? How do these co-benefits change your opinion about climate adaptation measures and their importance?	

Conclusion

Main question	**Additional questions**	**Clarifying questions**
So in conclusion, it can be said that planning support tools would better support the decision-making process if they better reflected upon (.. interests of stakeholder...) OR Is there anything that you want to add to this interview that should be included in planning support tools to better support the planning process?		

B.2. SAMPLE INTERVIEW PLAN (STAKEHOLDERS WITH EXPERIENCE WITH AST)

step 1 introduction

Hello, my name is Kyra Wouters, and currently I am graduating on a project at Deltares. I will be looking in the Adaptation Support Tool in the next couple of months and my goal is to let the tool better support stakeholders during the decision-making process. I would like to discuss the following topics with you:

- First impressions working with AST
- Your role in the decision-making process
- Roles and Decision-making strategies
- Inclusion of interests
- Importance of climate adaptation for your interests and stakes
- Any other business

With your permission I would like to record the interview. I believe that this will increase the flow of the interview and I will be able to give your answer my full attention. These recordings will only be used to process everything that is mentioned in the interview and for nothing else. The interview and its contents will be used for my research only and this information will not be given to third parties. All the information will be anonymously presented in the final report and quotations will only be made with your permission.
With these topics in mind, I would like to obtain your opinion as ..... on these matters.

Step 2 interview

First impressions

Main question	Additional questions	Clarifying questions
Can you describe the first time you got into contact with the adaptation support tool? OR How was the adaptation support tool introduced to you?	Was the tool introduced during a meeting? Did you already have information about climate adaptation? Had you already heard from the adaptation support tool?	Can you expand a little on this? Can you tell me anything else? Which case study was the tool introduced?
In your experience, was the functioning of the tool clear? OR In your opinion, what was the added value of the tool to the decision-making process?	Did you immediately feel like there were added values? Did your opinion on the added values change during the workshop? What could have increased insight in the functioning of the tool at the start of the workshop?	

Role in the decision making process

Main question	Additional questions	Clarifying questions
Can you describe the role you normally would have in the decision-making process when (re)designing urban areas? OR How would you be included in the decision-making process?		Can you expand a little on this?
Which arguments/information can you use to influence the decision-making process? AND How would you try to safeguard your interests in the decision-making process?		

Decision-making strategies

Main question	Additional questions	Clarifying questions
Which strategy did you have in mind, at the start of the planning process? OR What was your goal, before starting the discussion with the tool?	What end goal did you have in mind? What reasons did you have to participate in the discussions? How accurate does the information need to be in order to connect a certain performance to it?	Can you expand a little on this? Had you already heard from the adaptation support tool?
Which influence did the use of the app have on your decision-making strategies/role in the discussion? OR	Were you encouraged by the tool to discuss more freely? Did you feel like everyone could give their input in the discussion with help of the tool?	

How did the adaptation tool influence your role in the group discussion?		
In your opinion, what was the effect of the tool on the group dynamics?		
Did you feel like the tool increased or decreased the usefulness of collaborative planning?	Why do you think this?	

Inclusion of interests

Main question	Additional questions	Clarifying questions
On which interests do you determine whether a plan is acceptable or even attractive? OR Which information regarding your interests would you require to make a founded decision?	How accurate does the information need to be in order to connect a certain performance to it?	Can you expand a little on this?
Which extra information regarding your interests would you require to make a founded decision?	Did you feel like the current tool supported your decision sufficiently?	
How would you like your interests to be reflected when being included in the AST? OR In your opinion, would it be beneficial if your interests would be reflected by certain indicators in the AST?	Would you rather have a quantitative or a qualitative indicator? What indicators would you suggest to reflect your interest? How will this extra information influence the discussion?	

Importance of climate adaptation for your interests and stakes

Main question	Additional questions	Clarifying questions
How do you value climate adaptation for your interests and stakes? OR How important is climate adaptation for you and your interest?		Can you expand a little on this? Can you tell me anything else?
Which opportunities does adaptation create for you and your stakes?	Given the fact that adaptation is accompanied by renewal of an area, which chances could this create for you?	
How would you compare scenarios with high and low climate adaptation abilities with differences in effectiveness for your stakes?		
Which benefits could blue-green measures have for you? OR	On which knowledge is this based?	

In your opinion, do blue-green measures have any co-benefits for you?	How do these co-benefits change your opinion about climate adaptation measures and their importance?	

Conclusion

Main question	Additional questions	Clarifying questions
So in conclusion, it can be said that planning support tools would better support the decision-making process if they better reflected upon (.. interests of stakeholder...) OR Is there anything that you want to add to this interview that should be included in planning support tools to better support the planning process?		

B.3. SAMPLE INTERVIEW PLAN (URBAN DESIGNERS AND LANDSCAPE DESIGNERS)

step 1 introduction

Hello, my name is Kyra Wouters, and currently I am graduating on a project at Deltares. I will be looking into a planning support syste, for climate adaptation in urban development in the next couple of months and my goal is to let the tool better support stakeholders during the decision-making process. The tool can be used to co-create climate resilient designs for new developments or redesign of current areas. It gives a list of measures that can be used to adapt the urban environment and in the design workshops these measures can be situated in the project area. The goal is to create discussion between urban planners and the different stakeholders to facilitate a learning process.
At this moment it gives stakeholders the opportunities to situate measures and subsequently it ranks the effectiveness of the multiple scenarios with hydrological indicators and costs. The final plans will be given to designers as an inspiration for their redesign of the urban area. I am striving for the tool to better support the decision-making process by including the many co-benefits of blue-green measures in order to reflect the interests and stakes of the stakeholders.
I would like to discuss the following topics with you:

- Important values and characteristics for your designs/plans
- Importance of climate adaptation for your designs/plans
- Your opinion on planning support tools
- Improvement of planning support tools
- Any other business

With your permission I would like to record the interview. I believe that this will increase the flow of the interview and I will be able to give your answer my full attention. These recordings will only be used to process everything that is mentioned in the interview and for nothing else. The interview and its contents will be used for my research only and this information will not be given to third parties. All the information will be anonymously presented in the final report and quotations will only be made with your permission.
With these topics in mind, I would like to obtain your opinion as ..... on these matters.

Step 2 interview

Important values and characteristics for your designs/plans

Main question	Additional questions	Clarifying questions
Which values/characteristics are important for you when you are making a plan or design? OR What values do you want to be reflected by your designs and plans?	Which of these values do you deem the most important and the least important? Are these values based on personal interests or on more general interests?	Can you expand a little on this? Can you tell me anything else?

Importance of climate adaptation for your designs/plans

Main question	Additional questions	Clarifying questions
Can you describe the importance of climate resilience for you designs/plans? OR How important is climate adaptation in your plans?	Why is it/isn't it important in your designs? Do you feel like it is your responsibility as designer/planner?	Can you expand a little on this?
Would you priorities climate adaptation above other values? OR If climate adaptation is a requirement, how would you balance this when it affects the important values?	Would you feel like climate adaptation hampers your process? Is climate adaptation an added value to your designs, in your opinion?	

Your opinion on planning support tools

Main question	Additional questions	Clarifying questions
What is your opinion on the functioning of planning support tool? OR In your opinion, how do planning support tools actually support you?	What added values do they have for you design/plan? Do you think you can learn more about climate adaptation and other stakeholders by using a planning support tool? Have you had some experience with planning support tools?	Can you expand a little on this?
To which degree do planning support tools inform you on values that you deem important? OR In your opinion, how applicable is the information a planning support tool gives for your designs/plans? OR		

In your opinion, are planning support tools a valuable addition to your designs/plans?		
When collaborative design is important, would you then feel like planning support tools would support you? OR What added values could a planning support tool have for you, when collaborative design is used?		

Improvement of planning support tools

Main question	Additional questions	Clarifying questions
In your opinion, how can planning support tools be improved? OR Which improvements are necessary to let planning support tools better cohere with your designing process?		Can you expand a little on this?

Conclusion

Main question	Additional questions	Clarifying questions
So in conclusion, it can be said that planning support tools would better support the decision-making process if they better reflected upon (.. interests of stakeholder...) OR Is there anything that you want to add to this interview that should be included in planning support tools to better support the planning process?		

C

VALUATION OF THE INDICATORS FOR ALL BLUE-GREEN MEASURES

C.1. VISIBILITY

number	measure	colour	ranking	justification
1	Adding green in streetscape: grass/herbs	Green	0,25	Grass and herbs are low and therefore easily blocked from view by objects. Without special attention to creating an open view on this measure, it could easily be blocked.
2	Adding green in streetscape: Shrubbery	Green	0,5	Shrubbery is a medium height, which makes this measure better visible from more sides and it can only be blocked by higher objects.
3	Adding green in streetscape: Trees	Green	0,75	Trees are higher than most objects in the streetscape, making them both visible and hard to block.
4	Artificial urban wetlands	Blue/Green	0,5	Urban wetlands are not necessarily of medium height, but their size will always be big enough for it to be fairly visible and harder to be blocked.
6	Bioswales/Infiltrating filter swales	Green	0,25	Bioswales are low and therefore easily blocked from view by objects. Without special attention to creating an open view on this measure, it could easily be blocked.
7	Cooling with water elements: fountains	Blue	0,5	Most fountains are of medium height, which makes this measure better visible from more sides and it can only be blocked by higher objects.

8	Cooling with water elements: ponds	Blue	0,25	Ponds are low in height and therefore easily blocked from view by objects. Without special attention to creating an open view on this measure, it could easily be blocked.
11	Ditches, Infiltration strips with above-ground storage	Grey/Green	0,25	Ditches are low in height and therefore easily blocked from view by objects. Without special attention to creating an open view on this measure, it could easily be blocked.
12	Extra intensive green roof	Green	0,25	Green roofs are often not visible from street level and could be blocked from viewing them from above by other buildings.
13	Floating puri-plants (floatlands)	Green	0,5	Floating puriplants can have several heights, but their visibility is mainly determined by the fact that they float on water, so there will be less objects nearby that can block the view.
14	Green facades	Green	0,75	Green facades are higher than most objects in the streetscape, making them both visible and hard to block.
15	Green roofs (extensive)	Green	0,25	Green roofs are often not visible from street level and could be blocked from viewing them from above by other buildings.
16	Green roofs (intensive)	Green	0,25	Green roofs are often not visible from street level and could be blocked from viewing them from above by other buildings.
17	Green shores and riverbanks	Green	0,5	Green shores and riverbanks are not necessarily of medium-large height, but their size will be big enough for it to be fairly visible and harder to be blocked.
18	Helophyte filters (horizontal and vertical)	Blue/Green	0,5	Helophyte filters can reach medium height, which makes this measure better visible from more sides and it can only be blocked by higher objects.
22	Infiltration fields with above-ground storage	Green	0,25	Infiltration fields are low in height and therefore easily blocked from view by objects. Without special attention to creating an open view on this measure, it could easily be blocked.
25	Parks and urban forests	Green	0,75	Parks and urban forests are higher than most objects in the streetscape, making them both visible and hard to block.

27	Private green gardens	Green	0	Private green gardens are private and it is assumed that these are not visible at all.
28	Rainwater retention ponds, with or without infiltration possibilities	Blue/Green	0,5	Rainwater retention ponds are not necessarily of medium height, but their size will always be big enough for it to be fairly visible and harder to be blocked.
34	Specific seasonal storage facilities (larger ones)	Blue	0,5	Seasonal storage facilities are not necessarily of medium height, but their size will always be big enough for it to be fairly visible and harder to be blocked.
36	Swales (subsurface storage)	Blue/Green	0,25	Swales are low and therefore easily blocked from view by objects. Without special attention to creating an open view on this measure, it could easily be blocked.
38	Tree pit bioretention	Green	0,25	Tree pit retention is low in height and therefore easily blocked from view by objects. Without special attention to creating an open view on this measure, it could easily be blocked.
39	Urban farms/ urban agriculture	Green	0,75	Urban farms can cultivate varying crops, with varying heights, but on average the height of this measure will be medium. However, urban farms have a larger area, which makes this measure better visible and less easy to block.
40	Water roofs/Blue roofs	Blue	0,25	Water roofs are often not visible from street level and could be blocked from viewing them from above by other buildings.
41	Water squares	Blue	0,5	Water squares are not necessarily of medium height, but their size will always be big enough for it to be fairly visible and harder to be blocked.
42	Green roofs with drainage delay	Green	0,25	Green roofs are often not visible from street level and could be blocked from viewing them from above by other buildings.
43	Bioswales/Infiltrating filter swales on sandy soil	Green	0,25	Bioswales are low and therefore easily blocked from view by objects. Without special attention to creating an open view on this measure, it could easily be blocked.

60	Green ventilation grids	Green	0,75	Green ventilation grids could have varying heights, but their idea, to ventilate areas, requires a certain openness, which will lead to less objects around them that can block them.This combined with the use of shrubbery or trees could lead to a good visibility of this measure.

Table C.1: Valuation visibility

C.2. ACCESSIBILITY

number	measure	colour	ranking	justification
1	Adding green in streetscape: grass/herbs	Green	1	Grass and herbs are very accessible when no additional objects or structures are placed around them.
2	Adding green in streetscape: Shrubbery	Green	0,5	Shrubbery is less accessible than grass as one cannot walk over them and thus can only access them via pathways or walk along them.
3	Adding green in streetscape: Trees	Green	0,75	Trees are good to access when they are placed together, as there is space left to walk among them or one could walk along them.
4	Artificial urban wetlands	Blue/Green	0,5	Artificial urban wetlands are fairly accessible when designed well. The wetlands themselves are not easy to access, but it is easy to situate walkways in them, which can make this measure accessible from most sides.
6	Bioswales/Infiltrating filter swales	Green	0,75	Bioswales are well accessible as they are often open, with some grass or shrubbery on them, which makes them easy accessible on most sides.
7	Cooling with water elements: fountains	Blue	0,75	When designed well, fountains can be well accessible, when located on ground level and without further obstructions.
8	Cooling with water elements: ponds	Blue	0,5	Ponds are fairly accessible when designed well, but do need some pathways and entering points for them to be accessible in most cases.
11	Ditches, Infiltration strips with above-ground storage	Grey/Green	0,75	Ditches and infiltration strips are low and can be easily accessed in most cases.

12	Extra intensive green roof	Green	0,25	Roofs have in most cases a low accessibility. The building on which they are situated needs to open them for public use and then the only access point is the stairs or lift in that particular building.
13	Floating puri-plants (floatlands)	Green	0	Floating Puri-plants are located on water and therefore not accessible.
14	Green facades	Green	0	Green facades are built against walls and therefore not accessible.
15	Green roofs (extensive)	Green	0	An extensive roof is not meant to be accessible by public in most cases. It is lighter and has a thinner soil layer, so the structure below has not necessarily been designed to support public.
16	Green roofs (intensive)	Green	0,25	Roofs have in most cases a low accessibility. The building on which they are situated needs to open them for public use and then the only access point is the stairs or lift in that particular building.
17	Green shores and riverbanks	Green	0,75	Green shores and riverbanks are in most cases easy to access and could be entered without many additional created options like pathways.
18	Helophyte filters (horizontal and vertical)	Blue/Green	0	Helophyte filters are situated in the water and therefore not accessible.
22	Infiltration fields with above-ground storage	Green	0,75	Infiltration fields are in most cases easy to access and could be entered without many additional created options like pathways.
25	Parks and urban forests	Green	0,75	When designed well, urban parks and forests are in most cases easy to access and could be entered without many additional created options like pathways.
27	Private green gardens	Green	0	Private green gardens are private and therefore not accessible for the public.
28	Rainwater retention ponds, with or without infiltration possibilities	Blue/Green	0,5	Ponds are fairly accessible when designed well, but do need some pathways and entering points for them to be accessible in most cases.
34	Specific seasonal storage facilities (larger ones)	Blue	0,5	Ponds are fairly accessible when designed well, but do need some pathways and entering points for them to be accessible in most cases.

36	Swales (subsurface storage)	Blue/Green	0,75	Swales are well accessible as they are often open, with some grass or shrubbery on them, which makes them easy accessible on most sides.
38	Tree pit bioretention	Green	0	Tree, pit retention is a small measure, around trees, which is not accessible for people.
39	Urban farms/ urban agriculture	Green	0,5	Ponds are fairly accessible when designed well, but do need some pathways and entering points for them to be accessible in most cases.
40	Water roofs/Blue roofs	Blue	0	Water roofs are used to store water and are not designed to be accessible for public.
41	Water squares	Blue	0,75	Water squares have an open structure, which makes them easy accessible on most sides. However in some cases some additional pathways could be necessary
42	Green roofs with drainage delay	Green	0,25	Roofs have in most cases a low accessibility. The building on which they are situated needs to open them for public use and then the only access point is the stairs or lift in that particular building.
43	Bioswales/Infiltrating filter swales on sandy soil	Green	0,75	Bioswales are fairly accessible as they are often open, with some grass or shrubbery on them, which makes them easy accessible on most sides.
60	Green ventilation grids	Green	0,75	Ventilation grids have an open structure for their main purpose, making them easy accessible on most sides.

Table C.2: Valuation accessibility

C.3. MEETING FUNCTION

number	measure	colour	ranking	justification
1	Adding green in streetscape: grass/herbs	Green	2.5	On grass and low herbs children could possibly play or people could sit outside, in front of their house when they do not have a garden. This measure does not have a specific function, neither will it provide functions for different groups. Therefore, the meeting function of this measure is limited and it will not lead to bridging.

2	Adding green in streetscape: Shrubbery	Green	0	Shrubbery do not offer a certain function that promotes meeting others, or even leads to meeting possibilities. Therefore it is ranked zero.
3	Adding green in streetscape: Trees	Green	0	Trees do not offer a certain function that promotes meeting others, or even leads to meeting possibilities. Therefore it is ranked zero.
4	Artificial urban wetlands	Blue/Green	2.5	When designed right, wetlands could be used to walk through or to sit and enjoy the view. Therefore, it could provide some possibilities to meet other people. In itself, it does not provide different functions to attract different groups and thus it could lead to some binding, but not necessarily bridging.
6	Bioswales/Infiltrating filter swales	Green	2.5	When designed right, bioswales could provide areas to sit outside (by for example, adding a bench or pick-nick tables). This will not give the measure the specific function to meet others, but it could provide the possibility of meeting others. However, it does not target different groups specifically, therefore it will not support bridging.
7	Cooling with water elements: fountains	Blue	5	When designed right, fountains could be a meeting place for children to play and adults to gather and enjoy the structure. As different groups could gather at fountains, this measure could both lead to binding and bridging. However, it is not a measure that provides many possibilities to meet other people, but meeting other people is certainly a possibility.
8	Cooling with water elements: ponds	Blue	5	When designed right, ponds could be a meeting place for children to play in the water and adults to sit or walk around the pond and enjoy the structure. As different groups could gather at the ponds, this measure could both lead to binding and bridging. However, it is not a measure that provides many possibilities to meet other people, but meeting other people is certainly a possibility.

11	Ditches, Infiltration strips with above-ground storage	Grey/Green	0	Ditches do not offer a certain function that promotes meeting others, or even leads to meeting possibilities. Therefore it is ranked zero.
12	Extra intensive green roof	Green	5	When designed well, a green roof can have many different functions, of which several could provide the possibility to meet others and other groups of people. Therefore, it could provide both binding and bridging. As a roof always is limited in the possibilities, the meeting possibilities are also limited and therefore this measure is ranked in the middle.
13	Floating puri-plants (floatlands)	Green	0	Floating puri-plants do not offer a certain function that promotes meeting others, or even leads to meeting possibilities. Therefore it is ranked zero.
14	Green facades	Green	0	Green facades do not offer a certain function that promotes meeting others, or even leads to meeting possibilities. Therefore it is ranked zero.
15	Green roofs (extensive)	Green	5	When designed well, a green roof can have many different functions, of which several could provide the possibility to meet others and other groups of people. Therefore, it could provide both binding and bridging. As a roof always is limited in the possibilities, the meeting possibilities are also limited and therefore this measure is ranked five.
16	Green roofs (intensive)	Green	5	When designed well, a green roof can have many different functions, of which several could provide the possibility to meet others and other groups of people. Therefore, it could provide both binding and bridging. As a roof always is limited in the possibilities, the meeting possibilities are also limited and therefore this measure is ranked five.

17	Green shores and riverbanks	Green	5	Green shores and riverbanks could provide an area in which people can recreate, play or just enjoy the view. Therefore, they can provide the possibility to meet others and other groups leading to both bridging and binding. These possibilities are limited and thus this measure is ranked five.
18	Helophyte filters (horizontal and vertical)	Blue/Green	0	Helophyte filters do not offer a certain function that promotes meeting others, or even leads to meeting possibilities. Therefore it is ranked zero.
22	Infiltration fields with above-ground storage	Green	2.5	On infiltration fields children could possibly play or people could sit outside, in front of their house when they do not have a garden. This measure does not have a specific function, neither will it provide functions for different groups. Therefore, the meeting function of this measure is limited and it will not lead to bridging.
25	Parks and urban forests	Green	10	Urban parks and forest provide an area for many different functions for different groups. Therefore, they offer many meeting possibilities for different groups, leading to binding and bridging. As they can provide abundant possibilities, when designed well, this measure is ranked ten.
27	Private green gardens	Green	0	Private green gardens are, as the name explains, private and thus there will be no meeting others.
28	Rainwater retention ponds, with or without infiltration possibilities	Blue/Green	5	When designed right, rainwater retention ponds could be a meeting place for children to play in the water and adults to sit or walk around the pond. As different groups could gather at the ponds, this measure could both lead to binding and bridging. However, it is not a measure that provides many possibilities to meet other people, but meeting other people is certainly a possibility.

34	Specific seasonal storage facilities (larger ones)	Blue/Green	5	When designed right, storage ponds could be a meeting place for children to play in the water and adults to sit or walk around the pond and enjoy the structure. As different groups could gather at the ponds, this measure could both lead to binding and bridging. However, it is not a measure that provides many possibilities to meet other people, but meeting other people is certainly a possibility.
36	Swales (subsurface storage)	Blue/Green	2.5	When designed right, swales could provide areas to sit outside (by for example, adding a bench or picknick tables). This will not give the measure the specific function to meet others, but it could provide the possibility of meeting others. However, it does not target different groups specifically, therefore it will not support bridging.
38	Tree pit bio-retention	Green	0	Tree pit bioretention on itself does not offer a certain function that promotes meeting others, or even leads to meeting possibilities. Therefore it is ranked zero.
39	Urban farms/ urban agriculture	Green	5	Urban farms have a very specific function, which will bring people together and allows them to meet others. So it provides a possibility to meet others, but does not offer many different options or functions to meet others. Furthermore, as many different people can come to urban farms to farm, it will provide possibilities to meet other groups, leading to both binding and bridging.
40	Water roofs/Blue roofs	Blue	0	Blue roofs store water and are inaccessible/could not provide a meeting function. Therefore this measure is ranked zero.
41	Water squares	Blue	5	Although water squares are not very green or blue most of the time, they still can provide meeting functions, when designed well.

42	Green roofs with drainage delay	Green	5	When designed well, a green roof can have many different functions, of which several could provide the possibility to meet others and other groups of people. Therefore, it could provide both binding and bridging. As a roof always is limited in the possibilities, the meeting possibilities are also limited and therefore this measure is ranked five.
43	Bioswales/Infiltrating filter swales on sandy soil	Green	2.5	When designed right, bioswales could provide areas to sit outside (by for example, adding a bench or pick-nick tables). This will not give the measure the specific function to meet others, but it could provide the possibility of meeting others. However, it does not target different groups specifically, therefore it will not support bridging.
60	Green ventilation grids	Green	5	Green ventilation grids could provide some possibilities to meet others. The fact that these grids connect different parts of the urban area it provides the possibility to meet other groups, leading to both bridging and binding.

Table C.3: Valuation meeting function

C.4. OPENNESS

number	measure	colour	ranking	justification
1	Adding green in streetscape: grass/herbs	Green	1	As grass and herbs are low, when maintained well, they won't obstruct the sight at all.
2	Adding green in streetscape: Shrubbery	Green	0,75	Shrubbery is rather low to the ground, but still is a small obstruction of sight, as it covers the ground.
3	Adding green in streetscape: Trees	Green	0,5	Trees are higher obstructions, but in itself one tree or a line of trees will not be a large obstruction of sight. Therefore this measure is ranked five, even though trees are high obstacles
4	Artificial urban wetlands	Blue/Green	0,75	Artificial wetlands consist of ponds and water-related vegetation. The water itself won't form any obstruction, but the vegetation around it could form a small, low obstruction of sight.

6	Bioswales/Infiltrating filter swales	Green	0,75	Bioswales contain some vegetation, which could be grass, but also some shrubbery. This shrubbery would form a low obstacle and therefore this measure is ranked seven and half.
7	Cooling with water elements: fountains	Blue	0,75	Fountains are a sort of construction, which could be an obstruction of sight. However, most fountains are low and do not form a large obstruction of sight.
8	Cooling with water elements: ponds	Blue	1	Ponds are flat surface of water, which form no obstruction of sight whatsoever.
11	Ditches, Infiltration strips with above-ground storage	Grey/Green	1	Ditches and infiltration strips do not obstruct the sight.
12	Extra intensive green roof	Green	0,5	Extra intensive green roofs in itself will contain some vegetation, which will only be low obstructions of sight. However, green roofs are situated on top of buildings, which makes them less visible and could withdraw people from sight, when standing on street level. Therefore, this measure is ranked five.
13	Floating puri-plants (floatlands)	Green	0,75	Floating puri-plants are, when well maintained, only a low obstruction of sight.
14	Green facades	Green	1	Green facades are situated on buildings and do not form any additional blockage of sight.
15	Green roofs (extensive)	Green	0,75	Extensive green roofs only have a thin layer of soil, which can only support grasses and low vegetation, which do not form any obstruction to the sight. However, green roofs are situated on buildings, which could withdraw them from side, leading to a raking of seven and half.
16	Green roofs (intensive)	Green	0,5	Intensive green roofs in itself will contain some vegetation, which will only be low obstructions of sight. However, green roofs are situated on top of buildings, which makes them less visible and could withdraw people from sight, when standing on street level. Therefore, this measure is ranked five.

17	Green shores and river-banks	Green	0,75	Green shores and riverbanks will mainly contain low vegetation, which do not obstruct sight. However, the sloping shores or banks could withdraw people and obstruct the sight leading to a ranking of seven and half.
18	Helophyte filters (horizontal and vertical)	Blue/Green	0,75	Helophyte filters can form a some obstruction of sight, but as they are located in and around water, they will not cause large obstructions of sight.
22	Infiltration fields with above-ground storage	Green	0,75	Infiltration fields can contain some low vegetation leading to a low obstruction of sight.
25	Parks and urban forests	Green	0,25	Parks and forest contain all sorts of vegetation, both high and low leading to relatively closed areas.
27	Private green gardens	Green	0	Private gardens are private and often separated from open space with fences and hedges, leading to closed areas.
28	Rainwater retention ponds, with or without infiltration possibilities	Blue/Green	1	Ponds are flat surface of water, which form no obstruction of sight whatsoever.
34	Specific seasonal storage facilities (larger ones)	Blue	1	Ponds are flat surface of water, which form no obstruction of sight whatsoever.
36	Swales (subsurface storage)	Blue/Green	0,75	Swales can contain some small vegetation leading to low construction of sight.
38	Tree pit bioretention	Green	1	Tree pit biorention will not obstruct the sight any further, so these measures will not reduce the openness.
39	Urban farms/ urban agriculture	Green	0,5	Urban farms are used to cultivate crops, which will be low obstructions of sight. However, there will many crops planted on them, leading to a larger area that has been withdrawn from sight by these low obstructions. Therefore, this measure is ranked five.
40	Water roofs/Blue roofs	Blue	1	Water roofs are flat surface that can be filled with water, which will not obstruct sight.
41	Water squares	Blue	1	Water squares are measure that collect water, which leads to flat open surface of water. Therefore, water squares, when designed right, do not form an obstruction of sight.

42	Green roofs with drainage delay	Green	0,75	Intensive green roofs in itself will contain some vegetation, which will only be low obstructions of sight. However, green roofs are situated on top of buildings, which makes them less visible and could withdraw people from sight, when standing on street level. Therefore, this measure is ranked five.
43	Bioswales/Infiltrating filter swales on sandy soil	Green	0,75	Bioswales contain some vegetation, which could be grass, but also some shrubbery. This shrubbery would form a low obstacle and therefore this measure is ranked seven and half.
60	Green ventilation grids	Green	0,5	Ventilation grids can contain different vegetation, from very low to higher vegetation. However, the grids are used to ventilate the urban areas, leading to open structures and therefore leading to a ranking of five.

Table C.4: Valuation openness

C.5. PHYSICAL ACTIVITY

number	measure	colour	ranking	justification
1	Adding green in streetscape: grass/herbs	Green	5	Grass could offer a space for children to play on or adults to walk upon, so it both offers a space, which can have as main functionality to be active on and is more attractive than grey areas.
2	Adding green in streetscape: Shrubbery	Green	2,5	Shrubbery has not as main function to provide an area to be active in, but could sometimes be used to be active by f.e. children playing.
3	Adding green in streetscape: Trees	Green	2,5	Single trees or a line of trees has not as main functionality to provide an area to be active in, but the area could still be used for some activities.
4	Artificial urban wetlands	Blue/Green	7,5	Artificial urban wetlands could create a large area to be physically active, when designed well by including pathays to walk and cycle.
6	Bioswales/Infiltrating filter swales	Green	2,5	Bioswales could provide some small areas to be active on, but this will be very limited and most do not have being active as main functionality.

7	Cooling with water elements: fountains	Blue	5	Fountains could provide areas to be active by including playing elements and make it more attractive to be active. Therefore, they could provide some surface with main functionality to be active.
8	Cooling with water elements: ponds	Blue	2,5	Ponds do not necessarily have being active as main functionality, but could provide a small area to be also active.
11	Ditches, Infiltration strips with above-ground storage	Grey/Green	0	Ditches do no provide extra areas to be active.
12	Extra intensive green roof	Green	5	Green roofs could create some space with being active as main functionality.
13	Floating puri-plants (floatlands)	Green	0	Floating puri-plants do no provide extra areas to be active, neither do they make it more attractive, as there is already water present.
14	Green facades	Green	0	Green facades do not create extra areas to be active.
15	Green roofs (extensive)	Green	5	Green roofs could create some space with being active as main functionality.
16	Green roofs (intensive)	Green	5	Green roofs could create some space with being active as main functionality.
17	Green shores and riverbanks	Green	5	Green shores and riverbanks could create some space with being active as main functionality.
18	Helophyte filters (horizontal and vertical)	Blue/Green	0	Helophyte filters do not create extra areas to be active.
22	Infiltration fields with above-ground storage	Green	0	Infiltration fields do not create extra areas to be active.
25	Parks and urban forests	Green	7,5	Parks and urban forests create large areas to be active and make it very attractive to be active. However, they have many functions, of which being active is just one of them, therefore it is ranked seven and half.
27	Private green gardens	Green	0	Private green gardens do no provide extra areas to be active, neither do they make it more attractive.
28	Rainwater retention ponds, with or without infiltration possibilities	Blue/Green	2,5	Ponds do not necessarily have being active as main functionality, but could provide a small area to be also active.
34	Specific seasonal storage facilities (larger ones)	Blue	2,5	Ponds do not necessarily have being active as main functionality, but could provide a small area to be also active.

36	Swales (subsurface storage)	Blue/Green	2,5	Swales could provide some small areas to be active on, but this will be very limited and being active is not their main function.
38	Tree pit bioretention	Green	0	Tree pit bioretention does no provide extra areas to be active, neither does it make it more attractive.
39	Urban farms/ urban agriculture	Green	7,5	Urban farms provide a large area to be active by farming. However they only support this type of activity, therefore it is ranked seven and half.
40	Water roofs/Blue roofs	Blue	0	Water roofs do no provide extra areas to be active, neither do they make it more attractive.
41	Water squares	Blue	5	Water squares could provide some space with as main function being active and make it more attractive to be active.
42	Green roofs with drainage delay	Green	5	Green roofs could create space to be active and make it more attractive to be active.
43	Bioswales/Infiltrating filter swales on sandy soil	Green	2,5	Bioswales could provide some small areas to be active on, but this will be very limited and most do not have being active as main functionality.
60	Green ventilation grids	Green	5	Green ventilation grids could provide an area to be active in, when designed right and make it more attractive to be active.

Table C.5: Valuation physical activity

D

REPORT OF THE CRUD WORKSHOP FOR GROUP 2, 3 AND 4

In this chapter the observations made during the CRUD workshop on the 19th of May will be discussed for the three groups working with the Adaptation Support Tool, group 2, 3 and 4. During the workshops the groups got a project area in Dordrecht and the information that climate resilience was a problem and the funds were limited. Furthermore, they received a complaint overview of the complaints for water nuisance of the people living in the area and the multiannual investment plan of the municipality. Besides this, the group members all had to pick one of the roles, which they had to assume during the workshop. At the end of the workshop the groups had to present their plans and reasoning. The groups also had to fill in two surveys, but these are not important when looking at the process and whether their use of the tool reflects the use of the tool during real cases.
While observing these groups during the process it was tried to witness all important processes during the workshop for all three groups, however, it might be that some small steps may be missing when more than one group was making important progress at once. First, this report will discuss the observation per group regarding their behaviour, strategies and actions. Afterwards the general observations will be discussed, which regards all three groups. After these general observations the degree to which this workshop reflects the use of the tool in real cases will be discussed in order to assess whether the results will reflect reality.

D.1. OBSERVATIONS FOR GROUP 2

Group 2 started their process by introducing themselves in order to get more familiar with each other. After the first introductions, they divide the roles fast, based on practical reasons, without showing clear indications of having a certain affinity for their roles. As soon as they had been introduced to the tool, they appointed the person with the role of spatial planner to be the one to handle the touchscreen and the tool. However, after a short while it can be seen that other group members also want to have a go with the touchscreen in order to get a feeling with the touchscreen. The tool itself does not seem interesting to them at this point just yet.
The group organises itself by assigning a president and letting the president take the lead. The president takes a large clipboard on which the group writes down all the aspects they deem important. They discuss the structure of the neighbourhood, the problems which might be present beside the water related issues and spatial quality aspects like accessibility and parking. All the important remarks made in the discussion are written down with the use of bullet points and sub categories on the large paper sheets. The group does not seem to use their roles at this point and are more focussed on working together and including all the interest of each role.
Based on the overview they created on the large sheets they draw-up the most important problems and decide on a strategy to solve the water related problems, while also acknowledging the other problems that might be present in the neighbourhood. They combined the problems with the multi-annual investment plan (MIP) and selected solutions that will work with this plan in order to take the limited budget into account. The solutions are selected together by looking at the measures in the climate app. Yet again, they do not seem to take

their roles into account and it seems that to water managers that know each other well, take over the leading role from the president.
After this the group splits up and the two dominant water managers start drawing the three main measures in the tool (so the earlier decision to give the spatial planner the task of handling the tool seems forgotten). The others in the group focus on making visual impressions for the presentation and map the area using translucent paper. There seems no discussion about were the measures should be implemented and everyone is focussed on their own subtask until the presentation needs to be made. The presentation is prepared together to make sure that everything comes together nicely. By looking at the presentation it turns out that the group did have a general vision of the implementation of the measures by making a linear park that connects several important points in the neighbourhood. The other two measures were situated over the entire area. The costs were not further discussed, but as the tool does not give the costs for grey measures, like the cool pavement the group implemented in the entire neighbourhood, the costs the tool gave were not reliable. Whether the group considered this, is unclear as the costs have not been discussed visibly.

D.2. OBSERVATIONS FOR GROUP 3

Group 3 immediately starts by discussing the roles and decides to let everyone chose their favoured role one after another and if one does not agree/want the same role, he or she has to make it known. After the roles are divided they fill in the first survey. They discuss their roles during this survey to help each other find the most important interests for their role and actively make the interests of their role known to the others of the group.
After this first discussion, the group defines the problems they want to solve and give criteria which have to be fulfilled by possible solutions. They are very fast in linking the technical problems to other problems, like social characteristics, in order to be able to "sell" their solution at the end. Together they also draw up a general workplan and the goals they want to reach. During this stage the group start shifting in their roles, but this process is going slowly. When stuck, the group goes for coffee together, which could indicate solving the discussion in a more informal manner.
Afterwards the goals and input of the tool are decided on by the group. When faced with disagreement, the group decides to average the answers giving by each person, so at this phase collaboration still seems important. However, when looking at the measures they want to implement a real discussion starts and the group member all blend into their role. The collaboration seems to stop at this point and during the discussion the group members all try to get their roles' points across.
The watermanager that represents the water boards is the first to start arguing in a strategic manner and due to that he is able to link the multiannual development plan to the selected measures, in order to prevent extra costs for the water board. After this first person starts to argue strategically, the whole group starts to discuss the measures in a way that takes the wishes and ideas of their role into account. Due to the fact that this groups does use their roles, the discussion about the measures, which can be used, is long and complicated, because it is harder for them to make compromises. Also, the proper use of their roles, makes it harder to come up with a finance plan as no one wants to be the one that bears the cost and tries to explain that others are responsible for the expenses.
When the group is finished with discussing the measures, they split up in order to be able to draft the plan for their area and use the tool. One half of the group, consisting of the watermanagers, implements the selected measures in the tool in order to see what the effects of these measures are. The intended feedback loop seems to be missing, as the measures are selected beforehand and this selection is not changed, based on the results in the tool.
The other half of the group, consisting of the urban planning students map the area and the current situation, situate the measures in suitable places and make impressions of the design. Afterwards the group combines the results into one presentation.

D.3. OBSERVATIONS FOR GROUP 4

Group 4 also starts with discussing the roles and makes sure to divide them in a manner that has the consent from all. They discuss during the first survey and help each other filling them in, as some have trouble drawing up three important interests for their role. Afterwards they introduce their roles and the interests they have written down to each other and have a group discussion about those interests. Afterwards they

introduce themselves personally and one suggests to open eduGIS in order to retrieve information about the neighbourhood. This person opens eduGIS and the group discusses the important aspects of the neighbourhood, as found on this website. After a while the discussions drifts to other subjects and it takes a while to get it back on track.
The group shows to have some difficulties with combining their roles and their studies and background. For example, an urban students has as role the locals' perspective, but does not know how to combine this with his knowledge from his study. The group decides that he will guard the locals' interests from his own point of view. Other group members also struggle with this and decide to use the same solution, to guard the interests of their own role, but still from their own point of view and using their own knowledge.
After this the group seems a bit lost, and they grab a cup of coffee together. Although the observer does not know what is said during this break, the group seems more focused after the break and has an idea on how to move on. They decide to focus mainly on the heat stress, as they regard the flooding problems and drought to be less pressing. Based on the problem, they discuss possible measures with help of the climate app. This group, instead of selecting measures first, selects areas that are easy to adapt and can be used as an example. So they select several hotspots, which have different functions. The three selected hotspots are a residential parking lot, a commercial parking lot and the area surrounding the school in the neighbourhood. They also look at the MIP to determine what matching possibilities are present in the neighbourhood.
They also map the area, with use of some sheets of transparent paper, in order to have an overview of all the infrastructure, water and green areas in the neighbourhood and how they are located in relation to the three hotspots. Based on all the information from eduGIS, the chosen hotspots, problem and map of the area they discuss which measures can be used in the hotspots at length.
They split up into three groups to make for each hotspot a final selection of the measures that can be implemented and each group draws an impression of their hotspot. They make sure that the groups are formed based on the roles that they have, so the person with the role of local business undertaker works in the group that works on the commercial parking lot.
After all groups finished with their designs and impressions, the group makes a presentation together. They have not used the tool at all, but they state that if they had more time, they would have liked to implement the visions they have made for each hotspot in the tool.

D.4. GENERAL OBSERVATIONS

Overall, most groups were really nice and civilized to each other. Their strategy was to be open and straightforward about the different interests of the involved roles and cooperate with each other. Two out of three groups had problems with using their roles and this could be seen in their strategy, they wanted to reach consensus and make a superb design together. However, their wish for cooperation, lead them to defend the interests of their role less and reach consensus faster, which would be less likely when they really used their roles. This could be seen in the group that used their roles, they had a lot of discussion and reaching consensus was hard, as they really defended their interests instead of merely taking them into account, while making the design.
All the groups had problems with choosing proper measures and places to situate these, as they did not know the neighbourhood. So a lot of time was spent by looking on google earth, to get a better idea of the neighbourhood and all its possibilities. Furthermore, this lead to a lot of discussion in the groups and it was clear that the input of local knowledge was missing.
The tool was not used fully by any of the groups. Most selected the measures before even starting with the tool and therefore did not use any of the outcomes of the tool, to evaluate or change their design. One group used the cost directly in their presentation, but did not consider whether these were realistic as these costs are only an indication and did not compare the effectiveness of different measures in relation to their cost. The tool was only used to draw the selected measures and see which effect they had.

D.5. REFLECTION ON THE USE OF TOOL DURING REAL CASES

Of course, by using students, the workshop will never reflect the reality perfectly, as the students lack the knowledge and viewpoints of all the different stakeholders that are present in a real case. Furthermore, students can assume a certain role, but still decide based on their own knowledge and background, making it impossible for them to mimic the decisions of the role entirely.
However, during this workshop all groups failed to use the tool as it would have been used during a real case.

They selected all the measures before even looking at the tool and did not use the results to adapt their packages of measures to be more effective for their interests. During cases everyone wants to reach a solution that has benefits for their own interests, so the results will be discussed and different measures will be selected in order to compare them.
Second of all, most groups struggled with the roles and tried to reach an optimal solution for all the interests, while in real cases people will be divided between measures as some might have no effects at all for their interests and others will. So the groups discussed less and therefore also did not use the results of the tool to adapt their plans or change them.
So the workshop did not reflect the functioning of the tool or the usage during a real case. Therefore, it is hard to determine the functionality of the tool on this workshop. The information from this workshop will not be useful to assess the functioning of the tool or the effect the information has on the decision-making as the groups did not use the information from the tool to make decisions.

E

ASSIGNMENT AND QUESTIONNAIRES OF THE WORKSHOP

During the workshop the functioning and support of the tool with the additonial information was evaluated. This evaluation is based on three things; the designed plan for the assignment, the process of each group during this design and the individual answers to questionnaires. Below the assignment and the questionnaires that were used during the workshop can be found.

E.1. ASSIGNMENT

INTRODUCTION

During the last weeks heavy downpours have been tormenting the Netherlands and many places have been subjected to flooding and nuisance, which has increased the awareness for the influence of climate change on our urban areas. Besides these flooding events the influence of droughts and heat stress are also expected to increase in the nearby future, challenging cities to adapt to these pending changes. Delft is one of these cities that has to adapt to climate change, but the dense structure poses many challenges. Therefore you are selected to design a conceptual plan to adapt the area west of the central station, called hof van Delft. This area is densely built with many narrow paved streets, which can increase the hazards from flooding, heat stress and drought. Your challenge this afternoon is the design a plan for this area, while taking the limited budget, the stakeholders and the multi-annual development plans of the municipality of Delft into account.

REQUIREMENTS FOR YOUR DESIGN

The project area and targets for your plan can be found in the tool. You are free to choose the measures and places where you want to situate them, but the following requirements need to be met:

- The maximal budget for your design is €5000. If you want to spend more, you have to justify these investment cost and explain how you want to fund this. You have several options, you can merge them with upcoming development programs like maintenance of streets and sewerage, but you can also choose to let your plan improve the area in other aspects to address budget of other departments. Whichever you choose, you have to justify it and explain why your proposal will work and sway other to invest in your plan.
- The plan has to include the wishes of the stakeholders, like the municipality, the water board, the residents, local businesses and other stakeholders you think are important. As the municipality and waterboard have taken initiative, their wishes and interests have to be safeguarded in your plan for it to meet the requirements. You are free to choose whether you divide the roles of different stakeholders or discuss everything together, as long as you take the wishes of different stakeholders into account and justify your decisions for these wishes/show the consensus you have reached.
- The municipality of Delft has drawn a multi-annual development plan to transform Delft in a green, sustainable city which has a good mobility, cohesion and biodiversity. This states the following goals, which have to be incorporated in your plan:

  - Strengthening the biodiversity in the municipality.
  - Making Delft an attractive living and working environment.
  - Keeping a balanced distribution between green areas and buildings+pavement.
  - Increasing awareness for construction, management and maintenance of the public green areas and dividing the responsibility between municipality and other parties like residents.
  - Using green areas in an integral fashion to connect different areas and development plans.

- Mind the fact that climate adaptation is the incentive of this workshop, but there are many other important problems and interests that have to be taken into account during the design of a plan. So to make your design better, come up with an integral solutions that works for more problems than climate adaptation alone.

Additional information

You will be observed during this workshop and you are asked to fill in questionnaires. Everything will be processed anonymously, so there will be no mentioning of names or other references to you as a person. If you do not want to fill in the questionnaires, this is no problem. Just let me know!
You are asked to write down the most important discussions and decision of your group. One report per group is sufficient, which includes a written overview of the steps you have taken as a groups and your problems and accompanying decision.
At the end of the afternoon, I would like a short explanation of your plan and why it is going to work out and be the best possible plan that can be designed in this area. Please save your design as snapshot and write down the main points of your plan.

E.2. Questionnaires

The first questionnaire

Please complete this short questionnaire after reading the assignment and before starting with the tool. Your answers will be processed anonymously, so there will be no names linked to this questionnaire and there will be no names mentioned in the evaluation of this information. Please keep this questionnaire with you and hand it in together with the second questionnaire.

Question 1
Based on the assignment, which information do you think is necessary to be able to make a conceptual plan?
... ...
... ...
... ...
... ...

Question 2
What are the important interests that you want to take into account in the design of the plan? Why do you think that these are important?
... ...
... ...
... ...
... ...

Question 3
What goals will you be trying to reach during the design and how do you plan to reach these?
... ...
... ...
... ...
... ...

Question 4
Is there anything else that you think is important and you want to mention?
... ...
... ...

… …
… …
… …
… …

THE SECOND QUESTIONNAIRE

Please complete this short questionnaire after finishing the assignment and before presenting your plan. Your answers will be processed anonymously, so there will be no names linked to this questionnaire and there will be no names mentioned in the evaluation of this information. Please keep this questionnaire with you and hand it in together with the first questionnaire.

Question 1
How do you rate the support given by the tool on a scale of 0-10 and why do you give this rate?
… …
… …
… …
… …

Question 2
Did the tool support the interests you have written down in the first survey? Which information was valuable and which information was lacking?
… …
… …
… …
… …

Question 3
Did the final plan reach the goals you set out during the first survey? Why?
… …
… …
… …
… …

Question 4
Is the information in the tool reliable in your opinion? Why?
… …
… …
… …
… …

Question 5
Is the information in the tool useful in your opinion? Why?
… …
… …
… …
… …

Question 6
What is your opinion on the representation and location of the information in the tool?
… …
… …
… …
… …
… …

Question 7
In your opinion, did the tool provide relevant support and what did it add to the process?
… …
… …
… …
… …
… …

Question 8
Is there anything else that you think is important and you want to mention?
... ...
... ...
... ...
... ...
... ...
... ...

F

RESULTS OF THE QUESTIONNAIRES DURING THE WORKSHOP

Question 1 Based on the assignment, which information do you think is necessary to be able to make a conceptual plan?
The current situation, the construction method of the roads, the parking spots, the type of population and the trends in moving, a list of the stakeholders, budget, the opinions of the municipality and residents (to create support), previous projects and a list of the ongoing projects in the area.
A map of the area, number of residents, the current green/blue areas, the type of sewer system, implemented measures, local businesses and their location.
Precipitation data, sunlight hours, budget for the design, present measures in the municipality, the stakeholders and their goals, possible and preferable measures for each stakeholder, cost of the measures, timespan of the plan, willingness to pay by stakeholders and the project area specifics like areas, number of residents, etc.
The available budget, geographic information, weather information, population density, existing measures, current damage caused by the climatic events, awareness of the people.
The current drainage capacity, a map of the area, surface of hardened materials, costs for measures, available measures, the stakeholders and their interests.
The overview of the area, an overview of possible measures, costs, required space, effectiveness and an overview of the wishes of the stakeholders.
Question 2 What are the important interests that you want to take into account in,the design of the plan? Why do you think these are important?
The opinion of the residents and municipality (to increase support and acceptance), the local environment (multipurpose approach to reach highest efficiency), the technical constraints so that the flooding and heat stress is solved, the existing/on-going projects as they will form the boundary conditions.
Costs for municipality and water board, current green/blue areas to use these in solution for multiple goals like recreation and storage, the residential area and the solutions that can be implemented in this area like green roofs/storage in gardens, etc.
The budget, regulations and government, interests of the residents (like safety, wealth, etc.)
Budget (limiting factor for the design), current damages, existing measures (Can these be altered to enhance their efficiency?), buildings and population density.
The costs as it has to be paid for by the municipality, the interests of the municipality and waterboard and the liveability as you do not want the measures to decrease this. For example parking, mobility, etc.
The interests of the residents, as they have to live in the area, will be hindered by the construction and should reap the benefits. The interests of the municipality as they pay and maintain and the interests of the waterboards as they are responsible for the open water.
Question 3 What goals will you be trying to reach during the design and how do you plan to reach these?
Combining a technical design, complying with the technical constraints and a fully integrated design. The design should not be offensive to the population/environment, but instead be part of it.

Using green/blue measures for the biodiversity, make the residents aware and use tax raises or the removal of taxes as incentive to let the residents implement green measures.
To integrate all the demands of the stakeholders in one sustainable solution, by determining the stakeholders and their interests.
To increase the ability or the resilience of the study area towards extreme climatic events, while still able to satisfy most of the stakeholders' interests. To assemble the most optimum set of blue-green measures based on the biophysical data (weather and soil) and population density. After that discuss these options with the involved stakeholders.
To implement effective measures for flooding and drought, for low costs. For example adapting pavement after sewage renovation. To create multifunctional green areas by balancing the goal with the biodiversity and awareness to create interactive green areas.
To increase the liveability of the neighbourhood by decreasing the burden of pluvial flooding, decreasing the heat stress and increasing the spatial quality (greenery, open water and space). To be cost effective.
Question 4 Is there anything else you think is important and you want to mention?
/
/
/
I think it is very important for the designers to be able to identify (most of) the involved stakeholders and their interests in the early steps of the design process. The success of these measures' implementation depends on how much the people will endorse them. This means early involvement of the stakeholders in the design process is important.
/
/

Table F.1: Results of questionnaire 1

Question 1 How do you rate the support given by the tool on a scale of 0-10 and why do you give this rate?
Unfortunately, a part of the software does not work properly yet and it was not possible to evaluate the storage and drought. Therefore, I will give a 4 for now, but having these options to work I believe the tool can be really useful.
5, as it does not really work. The tool is a bit difficult to learn in one afternoon. There is still a lot that does not work, drought, groundwater, etc.
6, as it is hard to see certain differences between measures, like the effectiveness. The cost per area or cubic volume is not shown at all.
7, it gives a very comprehensive set of measures and the impact of stand-alone measures or combination of different measures is quantified and therefore can be used to evaluate different combination of measures. On the other hand, the server was very slow and it would be better if I can rank the measure based on which parameter I want to optimize (heat reduction, runoff, or else).
Right now a 3, due to the bugs and lack of information for certain measures and for drought and heat stress, which makes no good conclusion possible. See the potential though, if the information becomes available.
With the explanation given at the start the tool was clear and easy to use. The support from the tool itself was limited, but because it was clear, maybe not that necessary, so a 6.
Question 2 Did the tool support the interests you have written down during the first survey? Which information as valuable and which information was lacking?
The list of the existing projects in this area is not available in the tool. The area to detail of the map is not implementable like green areas under trees or the structure of the roof of houses to implement roof tops. It was good that the costs of elements was implemented together with the runoff.
There was no information about population and the given area does not include characteristics, it is only a map. Also information of already implemented measures is missing.
There are no regulations incorporated within the program. It was also possible to fill in numbers/dimensions that could not be reached in practice.
I think the tool is already very helpful IF the designers/users themselves can identify what are the most important interests to safeguard (do not over complicate the tool).
Measures showed potential in which area, but this did not come forward in overview/details. Current capacities/information/where are green areas are not shown. Costs/map are available, as well as a detailed description of measures.

Information about the cost and effectiveness of the measures was useful. Also the information on the added value to the neighbourhood. It was lacking perhaps information on how easy it is to apply certain measures, though the cost might give an estimate of this. Water quality was included, cost and liveability, so all the aspects named before were mentioned.
Question 3 Did the final plan reach the goals you set out during the first survey? Why?
Once again, it did for the runoff, but not for the heat stress and drought reduction. It was possible to imagine the green areas to have an integrated design though. The information on the element to be added are quite nicely displayed.
We implemented green facades and green areas, so the biodiversity and connecting of green areas is improved. We tried to make the residents more aware by implementing a special tax-system.
The plan was not finished yet, so it did not reach all the goals.
Plan not finished due to slow server.
Due to the bug there were no results for drought and groundwater. Furthermore we had negative results for the storage capacity, but we expected our design to work.
Since we only did and exploration of all the possibilities, no final solution was presented.
Question 4 Is the information in the tool reliable and useful in your opinion? Why?
I guess the tool is reliable in term of cost prediction. Nonetheless, putting a green roof on a house requires structural assessment which is maybe not implemented in this tool/cost prediction.
I think the measures are in a way reliable but it is difficult to interpret them. The information that is given in the right boxes in hard to read.
Some errors, like NaN, give you the feeling the tool is not working well on certain measures. However, it is very useful to have an overview of all the measures and what they can be used for.
If the information is only used as a guideline for the decision process, then it is reliable enough.
As the current information is not available in the tool, how do you know the absolute value of improvement? Instead of average of the measures, I would like to see their combined total effect.
The information given sounded plausible and reliable. The bars for the different aspects like drought, pluvial flooding, etc. all had the same length, which seems a bit strange. The effects were clear for some, but not for all measures, like the green walls.
Question 5 What is your opinion on the representation and location of information in the tool?
I think it is nicely presented. Nonetheless, some extra definitions for the runoff are necessary for non-educated people on watermanagement systems. An explanation on how the percentages are calculated is also necessary since they are averaged. Often implementing a storage tank for example won't increase the drought reduction percentage since it is averaged.
The measures are easy to find and the contribution of these measure is also easy to find (only hard to understand what it stands for). So this information could be implemented.
This was actually really clear. I think if you work with this program for more than an afternoon, it is easy to önder de knie krijgen".
The representation is great, however, a possible improvement would be to give more background information for each measure, to be able to compare their effectiveness before implementation on the same screen.
Current facilities/green areas and their effect are not present, so the current situation might look worse then it is? The way the screen is build up is clear and shows a good overview.
Quite clear, perhaps only the distinction between overall measure and detail.
Question 6 In your opinion, did the tool provide relevant support and what did it add to the process?
The tool gives a nice overview (dynamic one) of the area of focus for the project. It is easy to setup a concept and compare several concepts together.
In a way it gives relevant support, because we can all think of measures, but that does not mean we know the costs or the actual contribution. So that helps thinking of a solution.
As already said before, it gives a really nice overview of the possible measures and its influence on the considered parameters. However, I can imagine that all stakeholders, and even different people with the same interests, make different choices for certain measures. It would be interesting to really do the role-playing and compare them.
Yes it did, it does certainly give you the ballpark guess of how effective & efficient the plan is, which is very helpful for people from different professional backgrounds.
If it would not be buggy, I think it would be relevant IF the current situation is also taken into account. It does show a large amount of possibilities that I did not knew before, so it adds to öut of the box thinking".

The tool helped to test different solutions and it was great to apply it directly to the case are and see its effectiveness. The downside was the speed of the process, which limited the amount of work that could be done.
Question 7 Is there anything else you think is important and you want to mention?
I think the tool is useful for comparing projects between each other and defining a first draft of a project. Nonetheless, a detailed concept cannot be obtained with this tool yet. As a result a complete detailed study is necessary as soon as "the best "concept has been selected with this tool.
/
It would be nice if there were little I's on the right panel, just like in the left panel to explain definitions like heat stress or normative runoff. The tool works good for comparing measures and projects, but it would be nice if multi-annual plans/future projects could be included as an extra layer. This layer could be used when choosing the proper area for the implementation of certain measures. It is questionable whether the information could be used to relocate budget, because what are the exact consequences of an increased perception or safety?-
I think it is important to note that the numbers are not absolute results of the measure application, but a very helpful guidance so that people/different stakeholders can make better decisions on urban planning.
The increase in sewage lowered the storage capacity? There is missing information for the green facades. Some explanation of definitions would be nice in case nonspecialist people have to work with it. Total improvement instead of average (adding measures could lower now, whereas total increases).
Do not click to much, it makes the application crash! Maybe buy in the heating/decrease temp. target?

Table F.2: Results of questionnaire 2

G

FEEDBACK ON THE AST BY INTERVIEWEES

As a part of the interviewees has quite some experience with blue-green measures and/or the Adaptation Support Tool or decision support tools in general, their opinion on the AST was asked in order to use this as feedback to better its functioning. As many different opinions came up during the interviews, the feedback will be given per subject:

- Several of the opinions concern the option to give more detailed information about the different materials one can use and the influence this has on the cost and the effects. Now the tool gives no information about this, while there is a need for more information about technical details as depth, materials, etcetera. This could be combined with an overview of the extra cost certain materials will yield and the accompanying effects, providing better insight in the effectiveness of certain measures and the height of the investment and maintenance cost.
- Several interviewees also mention a different way of providing the information about the cost. Now it gives the investment cost and annual maintenance cost, but in order to put this information into perspective, interviewees mention the total cost of ownership. So the investment cost and the total maintenance during the expected life cycle of a measure. One interviewee also mentions the need to link this to the effects, to show what a higher or lower investment could mean for the maintenance and effects during the entire life cycle of a measure. This could reduce barriers and inform better on the commitment that is needed for certain measures, but also show the possible extra advantages certain investments can yield.
- Another opinion that has been mentioned by several interviewees is the need to include boundary conditions for the functioning of the measures in the tool/workshops in order to know whether certain measures will function as expected in the area of choice. Furthermore, this information could also be used to select areas for implementation, when users want to use a certain measure in their area, but do not know where they want to implement it.
- The interviewees at more advanced municipalities like Rotterdam and Amsterdam did not think that the tool could add something to their plans for climate adaptation. Due to their experience, they can use examples from their own cities to convince others to implement measures at certain areas and they do not need a tool to communicate and discuss anymore.
- Due to this difference in experience in climate adaptation of users some believe that the information in the tool should be layered in order to keep it simple and fast. So during first gatherings, brainstorming and discussing is important, so the tool can reflect some first indications. During later stages or gatherings, the tool can give more detailed information and there is less need for speed and more for information. Then the amount and depth of the information can be tailored to the needs of the users, for both very inexperienced as more experienced users.
- Some experience the tool as very technical and believe that in order to make it better suited for non-technical users, the layout and/or information needs to change. Mentioned changes are the use of more images that also show impressions of use, social benefits and aesthetic values, besides technical images/representations.

- Another remark is that the tool does not take the current situation into account and this could have an impact on the results it gives. Furthermore, one person thinks it would be nice to score the area in relation to the Dutch average to be able to comprehend it better and make it comparable. This would demand a larger database, but could lead to less work for preparing the workshops.
- The names of the tabs on the right-hand side could be improved to make sure that the detailed information will be used more as this information is also deemed very valuable.
- Besides the remarks that concern improving the tool, there are also several interviewees, which already appreciate the working of the tool. They view it as a tool that can be helpful in the communication between departments and different groups. Furthermore, they are of opinion that the tool already provides very useful information that now is lacking in several departments of the municipalities. Especially the fact that there is already a cost indication and the effectiveness for climate adaptation included in the tool, makes it useful for municipalities that are not experienced with climate adaptation, yet. Another remark is that the tool is already rather complex and therefore one person believes that it could also be used to check plans and control the outcomes with the targets set for the area

BIBLIOGRAPHY

[1] IPCC, *Managing the risks of extreme events and disasters to advance climate change adaptation a special report of the intergovernmental panel on climate change,* in *A special report of the intergovernmental panel on climate change*, edited by C. Field, V. Barros, T. S. abd D. Qin, D. Dokken, K. Ebi, M. Mastrandrea, K. Mach, G.-K. Plattner, S. Allen, M. Tignor, and P. Midgley (Cambridge University Press, 2012).

[2] European Commission, *Green infrastructure(GI)–Enhancing Europe's Natural Capital*, Tech. Rep. (2013) communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.

[3] IPCC, *Climate change 2013: The physical science basis.* in *Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by T. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. Midgleu (Cambridge University Press, 2013).

[4] CBD Secretariat, *Connecting biodiversity and climate change mitigation and adaptation: Report of the second ad hoc technical expert group on biodiversity and climate change, montreal,* in *Convention on Biological Diversity Technical Series*, 41 (2009).

[5] IPCC, *Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects.* in *Contribution of working group II to the fifth assessment report of the Intergovernmental Panel on Climate Change*, edited by C. Field, V. Barros, D. Dokken, K. Mach, M. Mastrandrea, T. Bilir, M. Chatterjee, K. Ebi, Y. Estrada, R. Genova, B. Girma, E. Kissel, A. Levy, S. MacCracken, P. Mastrandrea, and L. White (Cambridge University Press, 2014).

[6] Project Management Institute, *A Guide to the Project Management Body of Knowledge*, 5th ed. (Project Management Institute, Newton Square, Pennsylvania, USA, 2013).

[7] World Commission on Environment and Development, *Our common future: Report of the 1987 world commission on environment and development,* United Nations, Oslo , 1 (1987).

[8] United Nations; Department of Economic and Social Affairs; Population Division, *World Urbanization Prospects: The 2014 Revision*, Tech. Rep. (2015).

[9] IPCC, *Managing the risks of extreme events and disasters to advance climate change adaptation.* in *A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change*, edited by C. Field, V. Barros, T. S. abd D. Qin, D. Dokken, K. Ebi, M. Mastrandrea, K. Mach, G.-K. Plattner, S. Allen, M. Tignor, and P. Midgley (Cambridge University Press, 2012).

[10] L. Feyen, R. Dankers, K. Bódis, P. Salamon, and J. I. Barredo, *Fluvial flood risk in europe in present and future climates,* Climatic change **112**, 47 (2012).

[11] IPCC, *Climate change 2007: Impacts, adaptation and vulnerability.* in *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by M. Parry, O. Canziani, J. Palutikof, P. van der Linden, and C. Hanson (Cambridge University Press, 2007).

[12] G. Erkens, T. Bucx, R. Dam, G. De Lange, and J. Lambert, *Sinking coastal cities,* Proceedings of the International Association of Hydrological Sciences **372**, 189 (2015).

[13] E. Gago, J. Roldán, R. Pacheco-Torres, and J. Ordoñez, *The city and urban heat islands: A review of strategies to mitigate adverse effects,* Renewable and Sustainable Energy Reviews **25**, 749 (2013).

[14] C. Arrau and M. Peña, *The urban heat island (uhi) effect,* http://www.urbanheatislands.com (2015), online, last visited on 09-02-2016.

[15] C. Rosenzweig, W. D. Solecki, S. A. Hammer, and S. Mehrotra, *Climate change and cities: First assessment report of the Urban Climate Change Research Network* (Cambridge University Press, 2011).

[16] S. S. Foster, A. Lawrence, and B. Morris, *Groundwater in urban development: Assessing management needs and formulating policy strategies*, Vol. 390 (World Bank Publications, 1998).

[17] P. Whitehead, R. Wilby, R. Battarbee, M. Kernan, and A. J. Wade, *A review of the potential impacts of climate change on surface water quality,* Hydrological Sciences Journal **54**, 101 (2009).

[18] R. T. Forman, *Urban ecology: science of cities* (Cambridge University Press, 2014).

[19] R. Munroe, D. Roe, N. Doswald, T. Spencer, I. Möller, B. Vira, H. Reid, A. Kontoleon, A. Giuliani, I. Castelli, and J. Stephens, *Review of the evidence base for ecosystem-based approaches for adaptation to climate change,* Environmental Evidence **1**, 1 (2012).

[20] S. Maase and K. Dorst, *Co-creation: A way to reach sustainable social innovation,* Proceedings of Perspectives on Radical Changes to Sustainable Consumption and Production , 295 (2006).

[21] F. H. van de Ven, S. Snep, S. Koole, R. Brolsma, R. van de Brugger, J. Spijker, and T. Vergroesen, *The adaptation planning support toolbox: providing decision-makers and stakeholders with measurable output on adaptation performance of urban design choices,* Environmental Science & Policy (2016).

[22] C. J. Uittenbroek, L. B. Janssen-Jansen, and H. A. Runhaar, *Mainstreaming climate adaptation into urban planning: overcoming barriers, seizing opportunities and evaluating the results in two dutch case studies,* Regional Environmental Change **13**, 399 (2013).

[23] I. Voskamp and F. Van de Ven, *Planning support system for climate adaptation: composing effective sets of blue-green measures to reduce urban vulnerability to extreme weather events,* Building and Environment **83**, 159 (2015).

[24] F. H. van de Ven, *Water management in urban areas (lecture notes),* (2011), hardcopy lecture notes, written for course CT5510 at TU Delft.

[25] T. Wierts, *Adaptation support tool,* (2015), evaluates the functioning of the AST and looks into closing the gap between the use of lanscape architects and urban plannes and the (scientific) background of the AST.

[26] S. Davoudi, J. Crawford, and A. Mehmood, *Planning for climate change: strategies for mitigation and adaptation for spatial planners* (Routledge, 2009).

[27] G. R. Biesbroek, R. J. Swart, and W. G. Van der Knaap, *The mitigation–adaptation dichotomy and the role of spatial planning,* Habitat international **33**, 230 (2009).

[28] L. Tummers, F. Hooimeijer, L. Maring, Y. Volchko, J. Norrman, J.-H. Kain, K. Touchant, and S. Broekx, *Harmonizing subsurface management in spatial planning. Experiences from the Netherlands, Sweden and Flanders.* (2015), Balance 4P.

[29] K. Kern and G. Alber, *Governing climate change in cities: modes of urban climate governance in multi-level systems,* in *Competitive Cities and Climate Change* (OECD, 2008) pp. 171–196.

[30] R. van Stigt, P. P. Driessen, and T. J. Spit, *A window on urban sustainability: Integration of environmental interests in urban planning through 'decision windows',* Environmental impact assessment review **42**, 18 (2013).

[31] R. van Stigt, P. P. Driessen, and T. J. Spit, *A user perspective on the gap between science and decision-making. Local administrators' views on expert knowledge in urban planning,* Environmental Science and Policy **47**, 167 (2015).

[32] PROVIA, *Provia guidance on assessing vulnerability, impacts and adaptation to climate change,* (2013).

[33] J. Gardner, M. C., and A. P., *A framework for stakeholder engagement on climate adaptation* (CSIRO Climate Adaptation National Research Flagship, 2009).

[34] Environmental Protection Agency, *Public participation guide,* https://www.epa.gov/international-cooperation/public-participation-guide-introduction-guide (2015), online, last visited on 04-03-2016.

[35] P. Pelzer, S. Geertman, and R. van der Heijden, *Knowledge in communicative planning practice: A different perspective for planning support systems,* Environment and Planning B: Planning and Design **42**, 638 (2015).

[36] P. Pelzer, S. Geertman, R. van der Heijden, and E. Rouwette, *The added value of planning support systems: a practitioner's perspective,* Computers, Environment and Urban Systems **48**, 16 (2014).

[37] P. Pelzer, G. Arciniegas, S. Geertman, and J. de Kroes, *Using maptable ® to learn about sustainable urban development,* Planning support systems for sustainable urban development , 167 (2013).

[38] R. Albers, P. Bosch, B. Blocken, A. Van Den Dobbelsteen, L. Van Hove, T. Spit, F. van de Ven, T. van Hooff, and V. Rovers, *Overview of challenges and achievements in the climate adaptation of cities and in the climate proof cities program,* Building and environment **83**, 1 (2015).

[39] A. Markandya and P. Watkiss, *Potential costs and benefits of adaptation options: A review of existing literature,* in *Technical paper prepared for the United Nations Framework Convention on Climate Change* (UNFCCC, Bonn, Germany, 2009).

[40] L. Brander, E. Gomez-Baggethun, B. Martin-Lopez, and M. Verma, *The economics of valuing ecosystem services and biodiversity,* in *TEEB, The Economics of Ecosystems and Biodiversity; Ecological and Economic Foundations.*, edited by P. Kumar (Earthscan, 2010).

[41] *Van teeb-stad naar teeb-stad tool: Inzicht in de waarde van groen in de stad.* Elbe Media (2013).

[42] Platform31, *Duurzaamheidsprofiel van de locatie (dpl),* http://kennisbank.platform31.nl/pages/23665/Projecten/Duurzaamheidsprofiel-van-de-locatie-DPL.html (2005), online, last visited on 28-02-2016.

[43] B. Crespi, A. Gonclaves, J. Kannan, A. Kudryavtsev, and J. Stern, *Leadership in energy and environmental design leed: Present structure and future needs.* Environmental Strategies (2004).

[44] PropertyEU, *Green buildings pay: Investor and developers are using sustainability to drive value,* PropertyEU magazine (2014).

[45] M. de Witt, *Welke tool voor welke situatie,* Duurzaam gebouwd , 111 (2014).

[46] S. Junier and E. Mostert, *A decision support system for the implementation of the Water Framework Directive in the Netherlands: Process, validity and useful information,* Environmental Science and Policy **40**, 49 (2014).

[47] G. A. Miller, *The magical number seven, plus or minus two: Some limits on our capacity for processing information,* Psychological review **63**, 81 (1956).

[48] A. V. Herzele and T. Wiedemann, *A monitoring tool for the provision of accessible and attractive urban green spaces,* Landscape and Urban Planning **63**, 109 (2003).

[49] J. Maas, *Vitamine G: Green environments – Healthy environments,* PhD (University of Utrecht, 2008).

[50] J. Aertsens, L. De Nocker, H. Lauwers, K. Norga, I. Simoens, L. Meiresonne, F. Turkelboom, and S. Broekx, *Daarom groen! waarom u wint bij groen in uw stad of gemeente,* VITO, Mol (2012).

[51] H. Gehrels, S. van der Meulen, F. Schasfoort, P. Bosch, R. Brolsma, D. van Dinther, G. Geerling, M. Goossens, C. Jacobs, M. de Jong, S. Kok, H. Massop, L. Osté, M. Pérez-Soba, V. Rovers, A. Smit, P. Verwij, and B. Weijers, *Designing green and blue infrastructure to support healthy urban living,* Tech. Rep. (2016).

[52] Expedia Inc, *Vondelpark,* https://www.expedia.nl/Vondelpark-Amsterdam.d507615.Bezienswaardigheid (2016), online, last visited on 05-08-2016.

[53] J. Maas, P. Spreeuwenberg, M. v. Winsum-Westra, R. Verheij, S. d. Vries, and P. Groenewegen, *Is green space in the living environment associated with people's feelings of social safety?* Environment and Planning A **41**, 1763 (2009).

[54] M. Van Winsum-Westra and T. De Boer, *(On) veilig in bos en natuur? Een verkenning van subjectieve en objectieve aspecten van sociale en fysieke veiligheid in bos-en natuurgebieden,* Tech. Rep. (Alterra, 2004).

[55] F. E. Kuo and W. C. Sullivan, *Aggression and violence in the inner city effects of environment via mental fatigue,* Environment and behavior **33**, 543 (2001).

[56] S. Jacobs, J. Staes, B. De Meulenaer, A. Schneiders, D. Vrebos, F. Stragier, F. Vandevenne, I. Simoens, K. Van Der Biest, S. Lettens, B. de Vos, B. Van der Aa, F. Turkelboom, T. Van Daele, B. Genar O., Van Ballaer, S. Temmerman, and P. Meire, *Ecosysteemdiensten in Vlaanderen: Een verkennende inventarisatie van ecosysteemdiensten en potentiële ecosysteemwinsten,* Universiteit Antwerpen, Ecosystem Management Research Group, Antwerpen (2010).

[57] J. Salmond, D. Williams, G. Laing, S. Kingham, K. Dirks, I. Longley, and G. Henshaw, *The influence of vegetation on the horizontal and vertical distribution of pollutants in a street canyon,* Science of The Total Environment **443**, 287 (2013).

[58] O. Kardan, P. Gozdyra, B. Misic, F. Moola, L. J. Palmer, T. Paus, and M. G. Berman, *Neighborhood greenspace and health in a large urban center,* Scientific reports **5** (2015).

[59] Placzek Studios, *Healing garden water feature sculpture,* http://www.healinggardenart.com/2013/10/03/water-feature-sculpture/ (2016), online, last visited on 05-08-2016.

[60] P. P. Groenewegen, A. E. van den Berg, J. Maas, R. A. Verheij, and S. de Vries, *Is a green residential environment better for health? if so, why?* Annals of the Association of American Geographers **102**, 996 (2012).

[61] S. de Vries, R. Verheij, and H. Smeets, *Groen en gebruik ADHD-medicatie door kinderen: de relatie tussen de hoeveelheid groen in de woonomgeving en de prevalentie van AD (H) D-medicatiegebruik bij 5-tot 12-jarigen,* Tech. Rep. (Alterra Wageningen UR, 2015).

[62] D. Adams, *Urban planning and the development process* (Routledge, 1994).

[63] H. Akbari, M. Pomerantz, and H. Taha, *Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas,* Solar energy **70**, 295 (2001).

[64] M. A. McGeehin and M. Mirabelli, *The potential impacts of climate variability and change on temperature-related morbidity and mortality in the united states.* Environmental health perspectives **109**, 185 (2001).

[65] L. Zhou, C. J. Tucker, R. K. Kaufmann, D. Slayback, N. V. Shabanov, and R. B. Myneni, *Variations in northern vegetation activity inferred from satellite data of vegetation index during 1981 to 1999,* Journal of Geophysical Research: Atmospheres **106**, 20069 (2001).

[66] S. Geertman and J. Stillwell, *Planning support systems: an inventory of current practice,* Computers, Environment and Urban Systems **28**, 291 (2004).

[67] C.-F. Fang and D.-L. Ling, *Guidance for noise reduction provided by tree belts,* Landscape and urban planning **71**, 29 (2005).

[68] J. C. Orr, V. J. Fabry, O. Aumont, L. Bopp, S. C. Doney, R. A. Feely, A. Gnanadesikan, N. Gruber, A. Ishida, F. Joos, R. M. Key, K. Lindsay, E. Maier-Reimer, R. Matear, P. Monfray, A. Mouchet, R. G. Najjar, G.-K. Plattner, K. B. Rodgers, C. L. Sabine, J. L. Sarmiento, R. Schlitzer, R. D. Slater, I. J. Totterdell, M.-F. Weirig, Y. Yamanaka, and A. Yool, *Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms,* Nature **437**, 681 (2005).

[69] R. Wilby, *A review of climate change impacts on the built environment,* Built Environment **33**, 31 (2007).

[70] B. A. Currie and B. Bass, *Estimates of air pollution mitigation with green plants and green roofs using the ufore model,* Urban Ecosystems **11**, 409 (2008).

[71] G. Lenderink and E. Van Meijgaard, *Increase in hourly precipitation extremes beyond expectations from temperature changes,* Nature Geoscience **1**, 511 (2008).

[72] J. Stroeve, M. Serreze, S. Drobot, S. Gearheard, M. Holland, J. Maslanik, W. Meier, and T. Scambos, *Arctic sea ice extent plummets in 2007,* Eos **89**, 13 (2008).

[73] J. Aerts, D. C. Major, M. J. Bowman, P. Dircke, and M. Aris Marfai, *Connecting delta cities: coastal cities, flood risk management and adaptation to climate change* (VU University Press, Amsterdam, 2009).

[74] A. Colls, N. Ash, and N. Ikkala, *Ecosystem-based Adaptation: a natural response to climate change* (IUCN, 2009).

[75] P. F. M. Opdam, B. Elands, C. Grashof-Bokdam, H. de Haan, J. Hagens, W. van der Knaap, R. Snep, and E. Steingröver, *Groen-blauwe netwerken in duurzame gebiedsontwikkeling* (Habiforum/WageningenUR, 2009).

[76] S. de Vries, *Nearby nature and human health: looking at mechanisms and their implications,* in *Innovative approaches to researching landscape and health*, 2 (Routledge, 2010) pp. 77–96.

[77] S. C. Moser and J. A. Ekstrom, *A framework to diagnose barriers to climate change adaptation,* Proceedings of the National Academy of Sciences **107**, 22026 (2010).

[78] M. Collins, R. Knutti, J. Arblaster, J.-L. Dufresne, T. Fichefet, P. Friedlingstein, X. Gao, W. Gutowski, T. Johns, G. Krinner, M. Shongwe, C. Tebaldi, A. Weaver, and M. Wehner, *Long-term climate change: projections, commitments and irreversibility,* in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental*, edited by T. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. Midgleu (Cambridge University Press, 2013).

[79] B. Kirtman, S. Power, A. Adedoyin, G. Boer, R. Bojariu, I. Camilloni, F. Doblas-Reyes, A. Fiore, M. Kimoto, G. Meehl, M. Prather, C. S. A. Sarr, R. Sutton, G. V. G.J. van Oldenborgh, and H. Wang, *Near-term climate change: Projections and predictability,* in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by T. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. Midgleu (Cambridge University Press, 2013).

[80] M. Shaw, J. Overpeck, and G. Midgley, *Cross-chapter box on ecosystem based approaches to adaptation emerging opportunities,* in *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by C. Field, V. Barros, D. Dokken, K. Mach, M. Mastrandrea, T. Bilir, M. Chatterjee, K. Ebi, Y. Estrada, R. Genova, B. Girma, E. Kissel, A. Levy, S. MacCracken, P. Mastrandrea, and L. White (Cambridge University Press, 2014) pp. 101–103.

[81] S. Bogar and K. M. Beyer, *Green space, violence, and crime a systematic review,* Trauma, Violence, & Abuse **17**, 160 (2015).

[82] M. S. Taylor, B. W. Wheeler, M. P. White, T. Economou, and N. J. Osborne, *Research note: Urban street tree density and antidepressant prescription rates—a cross-sectional study in london, uk,* Landscape and Urban Planning **136**, 174 (2015).

[83] S. Osborne, *What the world will look like in 2050,* http://www.independent.co.uk/news/uk/home-news/what-the-world-will-look-like-in-2050-a6984546.html (2016), online, last visited on 05-08-2016, source of cover picture.