Increasing the resilience of urban areas to extreme precipitation: Are the residents ready?

The receptivity for effective rainproof measures on private terrain in the neighbourhood De Baarsjes, Amsterdam

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TU Delft

Amsterdam Rainproof

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By

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Amsterdam Rainproof

Preface

The final product of my graduation thesis is embodied in this report for the master Water Resource Management at the faculty Civil Engineering of Delft University of Technology. The research was completed in cooperation with Amsterdam Rainproof. Valuable scientific knowledge about rainproof measures have been connected to the actual implementation and social components and behaviour theories.

The report gives information about the willingness of residents of De Baarsjes, Amsterdam to adapt to extreme precipitation on their private lot and thus increasing the resilience of the city.

Topics as urbanisation and its challenges, climate change, rainproofing measures and behaviour models are briefly introduced. The connection between effectiveness of rainproof measures and the receptivity towards such measures is indicated. The report gives advice which eventually helps to communicate about rainproof measures, its contribution towards a more resilient city and the implementation of such.

Katrice Krijnen

Amsterdam, 2020

Content

Summary

Water challenges the livelihood of all living beings through its scarcity as well as its abundance. Due to climate change these extremes will intensify in the future. As mankind continues to cluster in economic centre points, housing areas as well as infrastructure increases and thus decreasing the permeability of urban surface. This situation forces the water to run off rather than infiltrate. Inundated areas place a threat to health and mankind will be forced to increase the resilience in urban areas. This can be accomplished by introducing different adaptation measures within the scope of grey (drainage pipelines), hybrid (permeable pavement) green (green roofs) and/or blue-green (rainwater retention pond) infrastructure. Often implementation of countermeasures are taken in public spaces creating a more rainproof and thus resilient city. Regardless, adaptation to more extreme weather situation on private terrain is also necessary as the private space are contributing 50% of the area, and thus a considerably amount of run-off. Legally, citizens are responsible on their private lot. In order to stimulate the inhabitants to adapt different measures it is essential to get an idea of their receptivity to this responsibility. Are residents of Amsterdam, De Baarsjes willing to contribute to increase the resilience of the city to extreme precipitation?

The receptivity model of Jeffrey and Seaton (2009) offers a framework to understand with which of the 4 A's (Awareness, Association, Acquisition and Application) residents are struggling most. A sequential mixed method of combining questionnaires and focus groups was used to collect data on residents' receptivity and perceived effectiveness of potential rainproof measures[1]. Additionally, the hydrologic expected effectiveness of selected rainproof measures that are suitable for private terrain was analysed with help of the Adaptation Support Tool and compared to the perceived effectiveness.

The question remains: Increasing the resilience of urban areas to extreme precipitation: are the residents ready to contribute by implementing measures on their own property?

Although residents are developing all 4 A's simultaneously to different extent and speed, it appears that residents are struggling with Awareness. Residents are convinced about increasing precipitation and its intensity. They experienced flooding and water damage. This reveals awareness of the issue itself; however, hesitation to implement countermeasures was noticed.

Awareness includes being aware of solutions. This knowledge is missing for more than half of the respondents. Furthermore, the association of potential actions with their own agenda and recognising its benefits is not (yet) widespread among residents. The Acquisition requirement of receptivity – hence the knowledge about the implementation, operation and maintenance of countermeasures – is missing. It is evident that the application requirement cannot be accomplished as acquisition is absent. Residents are aware of stormwater problems; however, they still demand additional information. The development of the 4 A's, specifically Association and Acquisition, require more attention. The focus group meetings revealed that residents recognise their own responsibility for the private lot. As precipitation goes beyond the private lot, shared responsibility and thus community actions are expected. Residents insist that the municipality and Waternet fulfil their tasks within their responsibilities. Transparency and communication with the residents are important features, whereby provision of tailor-made advice to has high importance.

The urge for change is recognised and residents desire a change; however, the action toward rainproof environment are interpreted differently. Recognising responsibilities and also dependencies between different stakeholders as well as knowledge requests reveal lacking receptivity and further encouragement is required. Frontrunners can hereby play an important role.

The effectiveness of countermeasures is an important consideration for increasing resilience. Evidently respondents indicated rainwater barrels as possible measure to temporarily store water. Green roofs were also well known. The perceived effectiveness scored relatively high (between 47% and 71%) for all temporary water storage measures. The Adaptation Support Tool (AST[2]) calculated effectiveness between 2% and 42%, where this is a percentage of a 60mm precipitation storage target (= 100% - sufficient effectiveness). Also the costs of the measures were investigated. The highest effectiveness of 42% (not even moderate effectiveness) is achieved by intensive green roofs, whereas the costs are relatively high. A rainwater pond on the other hand has low investment and maintenance costs and scored an effectiveness of 22% within its specifically chosen dimensions. Green gardens reveal higher costs, as indicated by the AST, but also greater

[1] Rainproof measures: measures that can ***store water*** and ***prevent water damage*** during heavy precipitation.

[2] AST = now called Climate Resilient City Toolbox (https://crctool.org/en/ or https://kbstoolbox.nl/nl/).

effectiveness. It is expected that all gardens already have some green spaces and a simple intervention as reducing tiles could increase the area, with little investment it could contribute up to 30% of the target. The calculations also demonstrate that none of the measures could achieve the target alone, provided that realistic dimensions are chosen. Hence combining several measures is necessary, whereby the order of implementation can be guided by their effectiveness and costs.

For increasing resilience of Amsterdam to extreme precipitation, by improving receptivity of residents, several points should be considered. First of all connect residents with similar issues. As they share a problem, they possibly motivate each other and develop an urge to action. Tailor-made information evenings rather than general context improves information distribution. Residents can acquire desired information within a minimum amount of time. Tailor-made advice can contribute towards a positive mindset connected to rainproof measures and their implementation. Residents are reluctant due to unfamiliarity with alternatives for their specific situation. Residents need to get in touch with stakeholders that can give such specific advice as too much information could initiate confusion and make the process towards receptivity for rainproof measures more complicated. It is also important that residents are aware of the effectiveness and the costs of the measures. Maybe not all measures can be implemented at once and one needs to choose for a measure. Therefore, it is important that residents do know about the total picture. The AST calculations give insight in the effectiveness and costs of the measures.

Transparency of tasks, responsibilities and choices of the municipality, Waternet and Amsterdam Rainproof could provide a positive mindset towards the implementation of rainproof measures. Thereby it needs to be clear why a certain street is adjusted with a rainproof mindset and other streets might be not. Communication is crucial.

Furthermore communication about (possible) barriers might be helpful in order to prepare residents. It is important to lobby and promote climate adaptation in the different levels in the municipality and also integrate climate adaptation within legal aspects (for instance demanding the integration of green roof when building an extension). It is important that the municipality promotes climate adaptation throughout the entire legal and organisational levels.

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Also, a special thanks to all the respondents to my questionnaire, the people who joined the focus group, providing valuable information for my research within their valuable time. I want to thank the people that facilitated a place where I could distribute some questionnaire. A great contribution was been made by allowing me to host the focus groups in MidWest, thanks a lot. It was really helpful, and I appreciate it.

My deepest thanks goes out to my family and friends for their love, encouragement and believing in me despite all the hampering circumstances. My mum who was constantly interested in my research and believed in me. To my family in law for all your affection and support. A special thanks goes out to my sister in law, Marieke Krijnen, for valuable feedback on my writings.

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“

Rain

You are often scarce and suddenly you are abundant,
Children love you - jumping through puddles triumphant.

What to do with your surprise?
Is there someone with advice?
You are life - part of our universe
Respect is what you most deserve.

”

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Glossary and Abbreviations

Glossary

Adaptation - '*In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects*.' (IPCC, 2018, p. 542).

Blue Green measures - '*These harness the ecosystem services naturally provided by urban vegetation to deliver multiple benefits to our towns and cities. Not only do Blue Green measures improve our protection against fooding – pluvial, fluvial, coastal and groundwater - but also, they protect against heat stress and drought.'* (Deltares, 2015) Examples for such measures are: *wetlands restoration; installation of grass and riparian buffers; urban trees; stream restoration; rivers, lakes, ponds, oceans and seas*. (Grimm et al., 2016)

Cities - are seen as '*heterogeneous, dynamic landscapes and as complex, adaptive, socioecological systems [...]*' (Grimm et al., 2008, p. 756)

Climate – '*Climate in a narrow sense is usually de ned as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years.'* (IPCC, 2018, p. 544)

Climate Adaptation – '*The process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities*.' (IPCC, 2012, p. 556)

Climate change - '*Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity.*' (IPCC, 2007, p. 871)

Climate extreme (extreme weather or climate event) – '*The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable.'* (IPCC, 2018, p. 545)

Coping capacity - '*is the capacity of society to reduce damage in case a disturbance exceeds the damage threshold.*' (van de Ven et al. 2011)

Data triangulation - involves using different sources of information in order to increase the validity of a study (Creswell, 2008)

Effectiveness – '*the degree to which something is successful in producing a desired result; success'* (Oxford English Dictionary)

Ecosystem – '*An ecosystem is a functional unit consisting of living organisms, their non-living environment and the interactions within and between them.'* (IPCC, 2018, p. 548)

Ecosystem services – '*Ecological processes or functions having monetary or non-monetary value to individuals or society at large'.* (IPCC, 2018, p. 548)

Extreme weather event – '*An extreme weather event is an event that is rare at a particular place and time of year.'* (IPCC, 2018, p. 549)

Game theory - '*is the study of the ways in which interacting choices of economic agents produce outcomes with respect to the preferences (or utilities) of those agents, where the outcomes in question might have been intended by none of the agents*.' (Ross, 2019)

Green infrastructure – '*a spatial structure providing benefits from nature to people, aims to enhance nature's ability to deliver multiple valuable ecosystem goods and services, such as clean air or water*' (European Commission, 2013, p. 7)

Grey infrastructure - '*grey approaches often do not tackle the root causes of risk and can increase the vulnerability of populations over the long-term*' (Depietri and McPhearson, 2017, p.91)
Grey infrastructures are hard, engineering structures like '*canals, pipes and tunnels of the drainage system; dikes; wastewater treatment plants; water filtration plants*.' (Grimm et al., 2016)

Groundwater flooding – flooding caused by a rising water table beyond the surface. (Flood Risk Management (Scotland) Act 2009.)

Hazard – '*The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.'* (IPCC, 2018, p. 551)

Human behaviour – '*The way in which a person acts in response to a particular situation or stimulus.'* (IPCC, 2018, p. 551)

'Hybrid' approaches – are combining GI/GBI and grey infrastructure. According to Alves (2020) such combination appear '*to be the most effective strategy in an urban context to mitigate flooding hazards and enhance system.'* (Alves, 2020, p.4). Examples of such infrastructure are: bioswales; porous pavement; green roofs; rain gardens; constructed wetlands; Sustainable Urban Drainage Systems (SUDS) (Grimm et al., 2016)

Livelihood – '*The resources used and the activities undertaken in order to live. Livelihoods are usually determined by the entitlements and assets to which people have access. Such assets can be categorised as human, social, natural, physical or financial*.' (IPCC, 2018, p. 551)

Pluvial flooding – '*flooding as a result of rainfall runoff flowing or ponding over the ground before it enters a natural (e.g. watercourse) or artificial (e.g. sewer) drainage system or when it cannot enter a drainage system (e.g. because the system is already full to capacity or the drainage inlets have a limited capacity)'* (Flood Risk Management (Scotland) Act 2009.)

Recovery capacity - the capability to recover as fast as possible form an extreme event (van de Ven et al. 2011)

Rainproof measures - measures that can ***store water*** and ***prevent water damage*** during heavy precipitation.

Receptivity or receptiveness – '*willingness to consider or accept new suggestions and ideas. The capability to be able to receive signals of stimuli and act on such*.' (Oxford Dictionary, 2017)

Resilience - '*The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation.'* (IPCC, 2018, p. 556)

Risk – '*The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain.'* (IPCC, 2018, p. 556)

Runoff - '*The ow of water over the surface or through the subsurface, which typically originates from the part of liquid precipitation and/or snow/ice melt that does not evaporate or refreeze, and is not transpired*.' (IPCC, 2018, p. 556)

Sewer flooding *and other artificial drainage system flooding – 'flooding as a result of the sewer or other artificial drainage system (e.g. road drainage) capacity being exceeded by rainfall runoff or the drainage system cannot discharge water at the outfall due to high water levels (river and sea levels) in receiving waters.'* (Flood Risk Management (Scotland) Act 2009.)

Skip sequencing - '*is a widespread survey practice in which the response to an opening question is used to determine whether a respondent should be asked certain subsequent questions*' (Manski and Molinari, 2008, p. 2).

Stormwater – '*Precipitation that is discharged across the land surface or through conveyances to one or more waterways and that may include stormwater runoff, snow melt runoff, and surface runoff and drainage.'* (Stormwater Glossary)

Urban Heat Islands - Higher temperatures in urban areas, compared to the surrounding rural areas, especially in the evening and during the night. (Hommes et al. 2016).

Urban water management - Coherent management of five types of water in the urban environment: groundwater, surface water, drinking water, wastewater and stormwater (De Graaf, 2009).

Water label - is connected to the storage capacities on private terrain. The label is ranging from G to A++. Low storage capacities correspond with a low rank of the water label (G), whilst high storage capacities are indicated by a high rank (A++). (STOWA)

Vulnerability - the degree to which the city is '*susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes*.' (IPCC, 2007, p. 6).

Abbreviations

AST	Adaptation Support Tool
FRD	Flood Risk Directive
GBI	Green-blue infrastructure
GI	Green infrastructure
GRP	Gemeentelijk rioleringsplan (wastewater-plan of the municipality)
GRPA	Gemeentelijk rioleringsplan van Amsterdam -
HBM	Health Belief Model
HIOR	Handboek Inrichting Openbare Ruimte (Handbook Designing Public Space)
IAP2	International Association of Public Participation
IPCC	Intergovernmental Panel on Climate Change
KNMI	Koninklijk Nederlands Meteorologisch Instituut (Royal Netherlands Meteorological Institute)
TPB	Theory of Planned Behaviour
UHI	Urban Heat Islands
VVE	Vereeniging van eigenaren (owners association)
WFD	Water Framework Directive

1 Introduction

Water challenges the livelihood of all living beings through its scarcity and abundance. Climate change will intensify these extremes in the future. Mankind continues to cluster in economic centre points, housing as well as infrastructure increases, remarkably reducing the permeability; forcing water to run off rather than infiltrate. Inundated areas place a health threat and result in direct and indirect economic damage forcing dwellers to increase resilience of urban areas. Measures, reaching form grey (drainage pipelines), hybrid (permeable pavement), green (green roof) and blue – green (rainwater retention pond) assist in reaching this goal and are often taken in public spaces. Adaptation of private terrain, contributing up to over 50% of cities, is inevitable. This transition legally falls in the responsibilities of residents. Understanding the receptivity of residents towards rainproofing measures provides a foundation for further stimulation of the implementation.

1.1. Urban challenges

Urban areas are important economic centres but due to clustering of people, housing and valuable infrastructure, several challenges arise. The following chapter indicates the main challenges connected to urban areas.

1.1.1. Urbanisation

Gaining benefits for economic growth is considered a driving force of cities developments. In 2014 approximately 54% of world's population occupied urban areas (UN DESA, 2014). Projections for 2050 revealed an increase up to 66%. Specific regions indicate even greater numbers, for instance 73% of Europe's population is settled in urban areas in contrast to 40% of Africans population (UN DESA, 2014). Urbanised areas in The Netherlands are increasing with high speed from 2% in 1900, 13% in 2000 (Daniels et al., 2016), 20% in 2011 (Van de Ven et al., 2011) and a projected increase of up to 24% in 2040 (Daniels et al., 2016). Green infrastructure (GI) is highly important to ecosystem services (Morzillo et al., 2016). The contradiction between exploitation of urban space for housing areas and industry versus preserving or developing GI increases. Not only urban expansion; densification of urban environments and increasing value per hectare urban area are drivers for adaptation, as damage sensitivity continues to increase. Without adaptation the risk for society would increase, while the acceptability of risk in our society is decreasing.

1.1.2. Urban water management

Ongoing urbanisation shows its impacts on the urban water cycle. Decreasing infiltration and evaporation, increasing runoff and polluted discharge can be detected. Urban water management is connected to managing water quantities and qualities thereby making a distinction between groundwater, surface water, drinking water, wastewater and stormwater (De Graaf, 2009). Managing the latter on private terrain is the subject of this research.

Stormwater in urban areas provokes several issues such as flooding, erosion, sedimentation, temperature rise, combined sewer overflow pollution, dissolved oxygen depletion, eutrophication and reduced biodiversity (De Graaf, 2009). The water system has not been designed for such extremes and is thus extremely vulnerable. The soil is not capable to deal with the new situation and more damage can occur. Geophysical circumstances are challenging due to the absence of a gradient, rainwater cannot easily be discharged. Gardens within The Netherlands are decreasing in amount and size (Brakelé, 2016). Shifting the relation between permeable and impermeable areas towards a higher percentage of the latter. Additionally to impermeable areas, high ground water does not support infiltration (Van de Ven et al., 2011).

Flooding can cause significant public health issues. Inundation of important infrastructure could damage buildings and/or cause social disruption. Many urban professionals are aware of pressures caused by urbanisation (Poustie et al., 2011). The need to adapt and cope with increasing precipitation is unavoidable. Water management in urban areas is essential to ensure the safety and health of citizens. Improving the

coping capacity and ability to recover is an important feature towards climate resilience. Van de Ven et al. (2011) argue that implementing blue and green measures positively influence climate resilience. Other research also indicated that combining Green – Blue Infrastructure (GBI) with grey infrastructure might be favourable (Depietri and McPhearson, 2017; Alves, 2020).

1.1.3. Climate Change induced Climate adaptation?

A continuing trend of more extreme weather conditions with longer duration and higher frequency was detected (Stock et al., 2009, KNMI, 2014, Daniels et al., 2016, Hommes et al., 2016). It is challenging to conclude direct regional risk based on global climate change scenarios (Stock et al., 2009). Annual precipitation increased by 26% between 1910 and 2013 as well as intensities significantly rose. Due to the vulnerability of urban areas such an increase has to be taken serious (Dai et al., 2017). Issues such as flooding will occur more frequently. A distinction between pluvial flooding, groundwater flooding, sewer flooding, fluvial flooding and coastal flooding can be made.

Pluvial flooding

Pluvial flooding – having a central role in this research- is an inundated area caused by high intensity precipitation. Excessive amount of water cannot infiltrate nor discharge immediately as sewer system reaches its capacity. Direct effects like economic and material damages and indirect impacts concerning health issues, lack of feeling safe at home, frightened of reoccurring events, lost working hours, traffic delays, inconveniences for pedestrians and the loss of recreational value might occur (Zhou et al., 2012; ten Veldhuis and Clemens, 2010).

Climate change and politics

From the 1980s onwards, climate change had an increasing importance on the political agenda (Gilissen, 2013). The high degree of uncertainty connected to climate change (Van Buuren and Teisman, 2009) causes uncertainties in the decision-making process. The Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) of 2001 and of 2007 concluded that climate change cannot be stopped, requiring a combination of mitigation and adaptation (IPCC, 2001; IPCC, 2007). Climate adaptation gained importance within the European Union (EU) (Crabbé, 2011). The Water Framework Directive (2000/60/EC; WFD) is one of Europe's first regulations demanding involving all relevant stakeholders (Newig et al., 2005), providing an essential foundation considering the implementation of adaptation measures in urban areas. Responsibilities towards climate adaptation was associated with governments, whereas not only the municipality, water managers, urban designers, spatial developers but also the private sector and residents (Holdijk, 2017) have to be involved. The European Flood Risk Directive (2007/60/EG; FRD) and WFD hence give a legal platform to address pluvial flooding within urban areas and the integration of residents (Appendix A).

Legal allocations

Legal allocation of responsibilities are often unarticulated (Gilissen, 2013). Draining public spaces is accounted for. Whereas on private terrain citizens are required taking responsibilities preventing and limiting negative consequences of stormwater, abundance of groundwater and water scarcity (Gilissen, 2013). Despite their responsibilities and possible advice by water managers, success of such implementation is depending on the attitude of residents towards climate change and adaptation (Gilissen, 2013). This shows, that through legal allocation a foundation is given to encourage residents.

Programmes such as Deltaprogramma Ruimtelijke Adaptatie (Delta programme spatial adaptation) support engaging residents. Also, instruments (watertoets) are developed to evaluate projects (Appendix A).

Resilience to extreme precipitation: Adapting to climate change and creating resilience what does it mean?

Creating resilience is connected to two aspects: first, recovering from internal and external changes induced by for instance extreme precipitation events and secondly adapting and adjusting to prevent future disruptions (Voskamp & Van de Ven 2015). The desired increase of resilience to extreme precipitation indicates the capability of cities to recover from and adjust to extreme precipitation events. If a city's sensitivity to extreme

precipitation is high, its resilience can be considered to be low, whereas low sensitivity corresponds with high resilience (Posma, 2015). Fröhlich and Knieling (2012) argue that negative effects such as flooding, Urban Heat Islands (UHI), changes in groundwater and biodiversity losses can be minimised by improving the resilience through adaptation to climate change. Creation of temporary surface water storage or infiltration possibilities facilitates resilience (Van de Ven, 2011). Eventually increasing resilience leads to a decrease of the vulnerability of a city.

Vulnerability of urban areas

The degree to which the city is '*susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes'* (IPCC, 2007, p. 6). Several factors influence the elements of risks and thus the vulnerability of urban areas. The exposure to an event, whereby the characteristics like magnitude, frequency, duration, inundated area and depth play an important role. But also the characteristics of these elements at risks (elevation, implemented adaptation measures, maintenance of such, maintenance of sewer system etc.) influence its vulnerability. The susceptibility (also called [damage] sensitivity or vulnerability) which connects to the impact on these element(s) as well as the system characteristics (awareness, preparedness, coping capacity, recovering ability) determine the vulnerability and thus the possible affected units and their damage potential.

1.2. Situation in Amsterdam in 2017/2018

Amsterdam, an important economical centre and touristic attraction in The Netherlands, is densely populated. Damage to infrastructure, housing and health of its residents can have an enormous impact. New building projects and expanding infrastructure put more pressure on urban water management, increases the vulnerability. In several parts of Amsterdam water damage has been reported for instance in Rivieren Island, Amsterdam Zuid, West, De Baarsjes etc.

Amsterdam strives to be more resilient to extreme precipitation. The municipality is held responsible for surface and ground water. Interventions on public terrain exclusively, cannot solve all flooding, as stormwater from private terrain exceeds the coping capacity of water systems and adaptive interventions. The relation between public space and private space can be found in Appendix B. The gemeentelijk rioleringsplan (GRP) of Amsterdam specifies that a 60mm precipitation event of one hour should not lead to damage of real estate and vital infrastructure (GRPA). Whilst the capacity of Amsterdam's sewer system is designed for 20 mm/hr (Locher and Dekker, 2016), stormwater of precipitation events exceeding this capacity cannot be transported and temporary storage elsewhere is essential. Legally residents are responsible for stormwater from private terrain (Gilissen, 2013, Hommes et al, 2016) and should be enabled to take action. Adaptation is crucial and relies on factors such as political and social problem perception, adequate knowledge or acceptance of the inevitability of adaptation (Heiland et al., 2012).

Amsterdam Rainproof

Within Amsterdam the initiative of Amsterdam Rainproof was established in 2011. The destructive precipitation event in Copenhagen in that year of 150mm/hr triggered the question **"*What would happen in Amsterdam if the same precipitation event would occur here?*"** Hereinafter, through analysis initiated by Waternet, it became clear that Amsterdam would have to deal with extensive pluvial flooding and substantial damage. A Regenwater-knelpunten-kaart (rainwater - bottleneck-map) (Appendix C) has been designed to indicate a range of areas reaching form urgent to extremely urgent. Waternet's initiative of Amsterdam Rainproof focusses on improving the situation by stimulating implementation, presenting examples, providing knowledge, giving advice, rising awareness for public projects as well as reaching out to Amsterdam's residents. Their motto: '*Every drop counts*', refers to the collection and (temporal) storage of every raindrop possible. Amsterdam Rainproof gets involved when reconstruction projects in public spaces are on the agenda by steering towards a more rainproof adaptation. Their online platform offers various information about the urgency and presents a toolbox of adaptation measures (among others) (www.rainproof.nl). The goal is to reach as many people and organisations as possible to increase the resilience and make Amsterdam more rainproof.

De Regenwacht (Engl.: The Rain-guard)

De Regenwacht (https://regenwacht.nl/) is an initiative of *Buro Regen en Water*, *Plan Bruist* and *Urban Boost* (all partners of Amsterdam Rainproof) that primarily offers help and advice to residents. They aim to increase awareness of extreme precipitation, risks of flooding and water damage, thereby connecting stakeholders and sharing information, knowledge and experiences. A direct contact with residents is crucial and they strive to solve issues but also connect, prioritise and define cases to generalise for similar situations all over the city of Amsterdam. Their vision is based on the idea that residents are the force that creates change, with some assistance.

1.3. Problem definition

A cocktail mixed of different ingredients: climate change, urbanisation and residents behaviour create a potentially dangerous combination for pluvial flooding. Its complexity influences the degree of vulnerability to extreme precipitation. Urbanisation and climate change pressure the urban water system and safety in Amsterdam. The occurrence of more extreme weather conditions combined with increasing impermeable surfaces are amplifying pluvial flooding. Extreme precipitation events like in Copenhagen in 2011 would cause tremendous damage in Amsterdam (see Appendix C2). Public terrain within the city centre consists of approximately 45% to 50% (Appendix B) and it is physically not possible to drain and/or store all stormwater solely on public terrain. Geophysical aspects influence storage capacities within unsealed soil. It can be argued that stormwater from private parking spaces and rooftops greatly contribute to water entering the sewage system (Hommes et al., 2016) depending on the location even half of the water is coming from private terrain. This significant contribution of the private sector is evidence for an urgent request for collaboration of public and private sector on resilience-building.

The urgency is based on:

- physical limitations of the drainage system that is not designed for (future) extremes
- physical limitations of infiltrating/capturing/storing on public terrain (45–50% of the entire area)

How can residents be motivated to take action? Gaining more insight in the receptivity of private land and asset owners for the implementation of effective rainproof measures is obligatory.

Based on the receptivity model of Jeffrey and Seaton (2004), which will be explained in Chapter 2 in more detail, receptivity is connected to the combination of four requirements: ***Awareness***, ***Association***, ***Acquisition*** and ***Application***. Knowing the threat, countermeasures and their benefits are relevant to be aware. These benefits are connected to the association with their own agenda Receptivity is also connected to the acquisition, the ability to acquire, implement, operate and maintain a certain measure. Application refers to the ability of residents to achieve benefits through legal and financial incentives (Jeffrey and Seaton, 2004, Rutten et al., 2009). A scarcely adaptation of rainproof measures on private terrain generates the assumption that not all these requirements are fulfilled in case of the residents of Amsterdam.

1.4. Decision for specific research area

After considering different areas in Amsterdam (see Appendix D), for this research a neighbourhood, which already experienced water issues ascribed to excessive precipitation on 28 July 2014, has been chosen. The research of Amsterdam West and Zuid (south) about water damage in houses (Dekker et al., 2016), gave an indication of vulnerable areas and for this research has been limited to De Baarsjes. The decision was validated based on district analysis (gebiedsanalyse) of 2016 and 2017 (Gemeente Amsterdam, 2016; Gemeente Amsterdam, 2017), where it was concluded that this neighbourhood is vulnerable to excessive precipitation. Flooding is occurring on following streets: Hoofdweg (between J.v. Galen and Mercatorplein), A10, Jan Evertsenstraat (between Hoofdweg and Admiralengracht), Slatuinen, Admiraal de Ruyterweg (at the intersection Jan Evertsenstraat) (Gemeente Amsterdam, 2016). Hereinafter indicated areas (Figure 1.1) are prone to damage (Gemeente Amsterdam, 2017, blue coloration). The yellow/orange/red indicates vulnerable buildings and infrastructure.

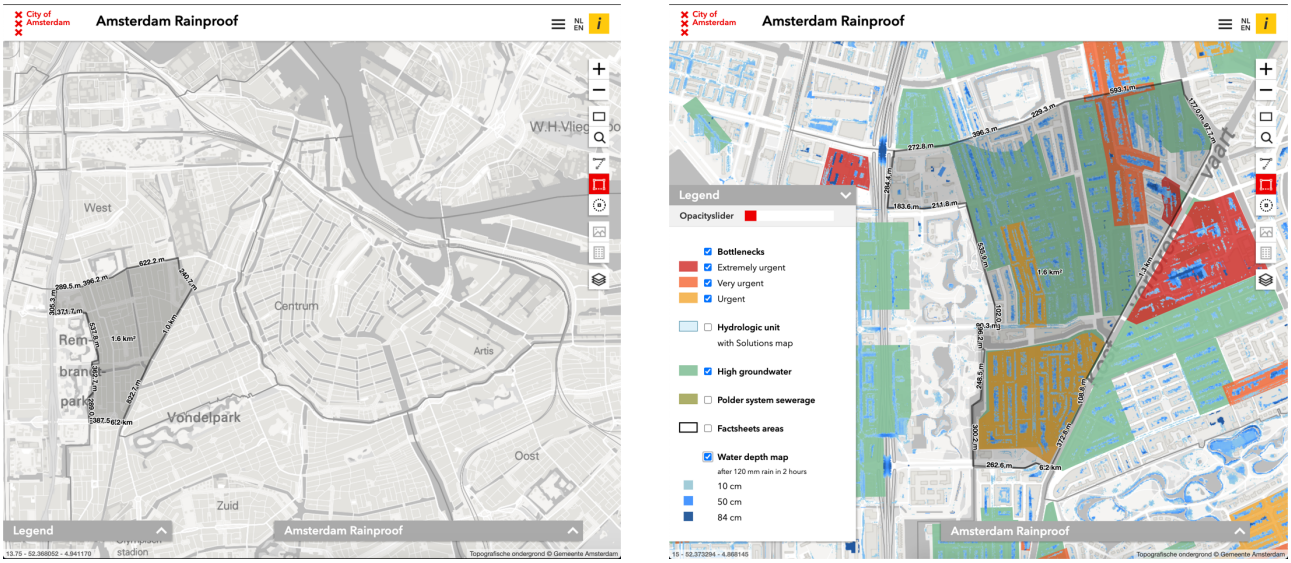


Figure 1.1 Vulnerability of De Baarsjes for extreme precipitation (https://maps.amsterdam.nl/rainproof/)

1.5. Research objective

The research objective is to determine the willingness of residents of De Baarsjes to increase the resilience to extreme precipitation. The research aims to identify shortcomings, challenges and opportunities associated with implementing effective rainproof measures on private terrain. Recommendations will be given to develop strategies and support a comprehensive but also tailor-made and understandable communication towards residents to stimulate implementation. Furthermore, the research strives for insight in interests and benefits residents associate with climate adaptation. Possible mismatches between the perception of residents and hydrological facts are pointed out. This will give an indication on which measures and messages to focus when promoting and stimulating the implementation. It is hypothesised that residents fail to meet all conditions of the receptivity model by Jeffrey and Seaton (2004). Perhaps an important variable to accomplish all components is missing.

1.6. Relevance

This research aims to achieve valuable information contributing to a suitable approach to increase resilience. This subchapter gives a brief indication of the scientific and social relevance of this study.

1.6.1. Scientific relevance

Within the scientific community striving for the implementation of the most effective measures is desired, whereas in practice perhaps other aspects are more relevant. In order to understand this link, the missing social component is investigated in this research. This possibly improves and provides a transparent communication of scientific knowledge. Enabling an optimisation, while balancing calculated effectiveness and the complexity influencing the implementation in practice. Furthermore, the research aims to provide information about the applicability and the limitations of understanding receptivity.

1.6.2. Social relevance

Hazardous situations influence the wellbeing, health and comfort of all residents of Amsterdam. The municipality desires to assure safety and wellbeing by increasing resilience. It has been identified that this goal cannot be achieved by the municipality only but requires initiative of residents. It is important to acquire insights in reasons why residents are (not yet) implementing rainproof measures. Another research showed that professional users of the Rainproof Toolbox (https://www.rainproof.nl/toolbox/maatregelen) desire more information about costs and effectiveness (Peltenburg & Kouwenberg, 2018). This also might be applicable for residents. This research aims to retrieve information to support residents and policy makers how to positively influence the behaviour of residents to achieve the goal of a resilient city.

1.7. Research question

The main research question is as follows:

To what extent are residents receptive towards increasing the resilience of the city to extreme precipitation?

The following Table 1.1 gives an overview of the research questions and the respectively used method, as well as the Chapter with its findings.

Table 1.1 Systematic overview of the research approach to answer the research questions and used method and respective chapter.

Research question	Method	Results
To what extent are residents receptive towards increasing the resilience of the city to extreme precipitation?	Conclusion based on the results of the Questionnaires and Focus group	Chapter 7
What is effectiveness?	Literature review	Chapter 2
Are the residents of De Baarsjes, Amsterdam receptive for effective adaptation measures?	Gaining information through Questionnaire and Focus group	Chapter 4
Which of the 4A's require the most attention?	Gaining information through Questionnaire and Focus group	Chapter 4
What measures are associated with rainproof measures?	Gaining information through Questionnaire and Focus group	Chapter 4
Which measures can be applied on private property in De Baarsjes?	Preparation for analyses with Adaptation Support Tool (AST)	Chapter 5
Which measures are effective in De Baarsjes?	Analyses with Adaptation Support Tool (AST)	Chapter 5
What information could help to stimulate the implementation?	Combination of Questionnaire, Focus group and AST	Chapter 8 (Advice)

1.8. Thesis outline

To answer the research question and subquestions, it has been chosen to apply data triangulation for this research. Secondary data collection combined with questionnaires, focus groups and the use of the AST give a more objective idea of the situation. The following sub-chapter gives a brief indication of the thesis structure.

Chapter 1 is characterised by the background information and the problem statement.

In ***Chapter 2*** a literature review gives an overview of different behaviour models and a brief insight in other researches related to private gardens and effectiveness of rainproof measures. Thereby aiming to answer the subquestion: *What is effectiveness?*

Chapter 3 describes the theoretical framework of the research and the methodology used to answer the research questions.

Chapter 4 Shows the main results of the questionnaire and focus groups and gives information about the following subquestions: Are the residents of De Baarsjes, Amsterdam receptive for effective adaptation measures? In which phase of the receptivity model are the residents of De Baarsjes? What measures are associated with rainproof measures?

Chapter 5 gives the results which form the basis to answer the following subquestions: Which measures can be applied on private property in De Baarsjes? Which measures are effective in De Baarsjes?

In ***Chapter 6*** the most important results are discussed, whereby also the limitations of the methods are identified.

The conclusions to all research questions are summarised in ***Chapter 7.*** The main research question: *Increasing the resilience of urban areas to extreme precipitation: are the residents ready?* is answered based on all the results of the research.

Recommendations connected to further research and advice is given in ***Chapter 8***. This advice can provide a basis in order to increase the resilience of the city of Amsterdam.

Finally, in the ***Appendix*** more in-depth and additional information are given.

2 Literature review

Literature has been consulted to build a foundation for this research. This chapter gives a brief insight in the complexity of human behaviour. Also, effectiveness will be addressed as well as some examples of relevant research are shortly introduced.

2.1. The complexity of human behaviour – a brief summary

Human behaviour is complex. Connecting knowledge from a water management perspective with human behaviour to understand why residents of Amsterdam are (not) ready for the implementation of rainproof measures is challenging. Human behaviour is thereby a new component. The six following concepts are briefly introduced: Giddens's paradox, behaviour influenced by the conscious and unconscious mind, Theory of Planned Behaviour, Health Belief Model (HBM), Social learning theory and the Receptivity model.

2.1.1. Giddens's paradox

Based on this paradox, when residents are not implementing rainproof measures it can be argued that there is a lack of sense of urgency of the adaptation strategy, also called Giddens's paradox (Giddens, 2009). He claims that neither politicians nor citizens are realising the importance of adaptation as climate change is still an abstract concept in the perception of many people. Without the experience of its effect people are less convinced to act (Giddens, 2009). This might also influence the receptivity of residents, whereby people who already encountered pluvial flooding might be more receptive compared to the non-experienced.

2.1.2. Behaviour influenced by the conscious and unconscious mind

The most influential instrument of human behaviour is connected to the conscious mind. Several researches, however, show that the unconscious mind has a great influence as well (Van Raaij, 2012 ; Bargh and Morsella, 2008; Baumeister and Bargh, 2014). The conscious mind reflects on action and judges -from the unconscious mind- the 'activated' behaviour, concerning "*planning, logical reasoning, interpreting, and communicating*" (Baumeister and Bargh, 2014, pp. 46). It conserves the identity of a person as well as it collects information, communicates and eventually influences the unconscious behaviour (Van Raaij, 2012). Neither one can be responsible on its own for human behaviour (Baumeister and Bargh, 2014). Newell and Shanks (2014) indicate scepticism towards the assumption that the unconscious mind determines human behaviour, as not enough evidence is gathered. Note that despite this theoretical dissonance, this theory provides an interesting background. Residents may have different priorities or are unable to indicate the reasons for implementing rainproof measures.

2.1.3. Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour is based on the idea, that the intention to act has the biggest influence on the actual behaviour. This intention for certain behaviour is based on the attitude towards this behaviour and influenced by subjective norms and perceived behaviour control (Ajzen, 1985). The attitude comprised the evaluation of the behaviour and its consequences. Subjective norms, however, reflect social pressure that can be felt by individuals. Moreover, subjective norms are related to expectations from others, thus the normative expectations as well as the willingness to adjust. Behaviour is influenced by expected consequences of individuals in relation to a specific issue. The perceived behaviour control is linked if this action is actually performable. It is argued that TPB is not the right theory to plan and design interventions to change behaviour (Morris et al., 2012) rather understanding human behaviour.

Brakelé (2016) argues that citizens might feel excluded when neighbours have green gardens while their own gardens are still tiled (grey garden). This theory could be turned around. Exclusion could be experienced when implementing measures as neighbours might not appreciate their effort or even provide criticisms (fearing mosquitoes, frog noises, pollen etc.).

2.1.4. Health Belief Model (HBM)

The Health Belief Model (HBM) is often applied to direct health and health issues of people and aims to predict why people take action. Thereby several components characterise this model. Modifying factors (age, gender, location etc) influence the individual beliefs which results in the individual behaviour. The combination of a perceived threat and effectiveness of the behaviour will result in behaviour in itself. The cue to action, which is connected to experience of family and friends among others affects the behaviour.

The HBM is limited in such a way that attitudes, beliefs, or other individual determinants are neglected. Social acceptability, environmental nor economic factors which may prohibit or promote certain action has been taken into account. The assumption that actions are related to health are difficult to combine to environmental issues induced by climate change. The HBM merely can be used if residents perceive the susceptibility to pluvial flooding as a health threat. It is suspected that pluvial flooding might not be seen as direct threat. Other factors connected to urban areas such as decreasing green spaces could influence resident's health. Green spaces have a positive influence on human health as it helps to destress (Maas, 2008). The HBM model is not considered as suitable to understand why residents are (not) receptive to rainproofing measures.

2.1.5. Social learning theory

Personal factors (knowledge, expectations and the attitude towards certain behaviour) and environmental factors influence human actions (Bandura, 1971). These factors are influenced by experiencing new situations and actions with the corresponding consequences. This results in choosing the most successful action (Holdijk, 2017). Such action might be influenced by observation of surroundings and successful actions taken by others. This could refer to frontrunners, De Graaf (2009) argues that a successful implementation by visionary frontrunners have a huge impact on society.

2.1.6. Receptivity model

Receptivity is defined by Jeffrey and Seaton (2004) as "the extent to which there exists not only a willingness (or disposition) but also an ability (or capability) in different constituencies (individuals, communities, organisations, agencies, etc.) to absorb, accept and utilize innovation options" (pp. 281/282). This framework has been designed to evaluate policy instruments connected to water management. The emphasis of a receptivity analysis is on the "perceptual world of the recipient connected to an innovation" (Jeffrey and Seaton, 2004, pp 282). Thereby it is recognised that recipients think about products, measures and services in different terms compared to the technologists, policy makers, planners and suppliers (Jeffrey and Seaton, 2004). The recognition of opportunities can be magnified with receptivity (De Boer and Bressers, 2011, Bressers and De Boer, 2013).

The receptivity model comprises four aspects (Figure 2.1), the four A's (Jeffrey and Seaton, 2004):

Awareness: the knowledge of an existing problem, available alternative options and the capability to gain new knowledge

Association: recognising potential benefits and the association with own agenda

Acquisition: ability to acquire, implement, operate and maintain the alternative innovation.

Application: being able to achieve benefits through sufficient legal and financial incentives.

Jeffrey and Seaton (2004) argue that all four components cannot be seen as separate stages but preferably as phases without a chronological sequence. Acquisition and application can occur prior to or in complete absence of association, whereas accomplishing application is difficult before acquisition. The motivation to change is subject to the ability to change. The knowledge about an option cannot be compared to the ability of achieving benefits from these (Jeffrey and Seaton, 2004). Residents might also think in a wider scope and are concerned about environment or aesthetics of surroundings. Receptivity may vary among citizens (De Graaf, 2009) due to the variety of knowledge, priorities, definition of benefits, opinions.

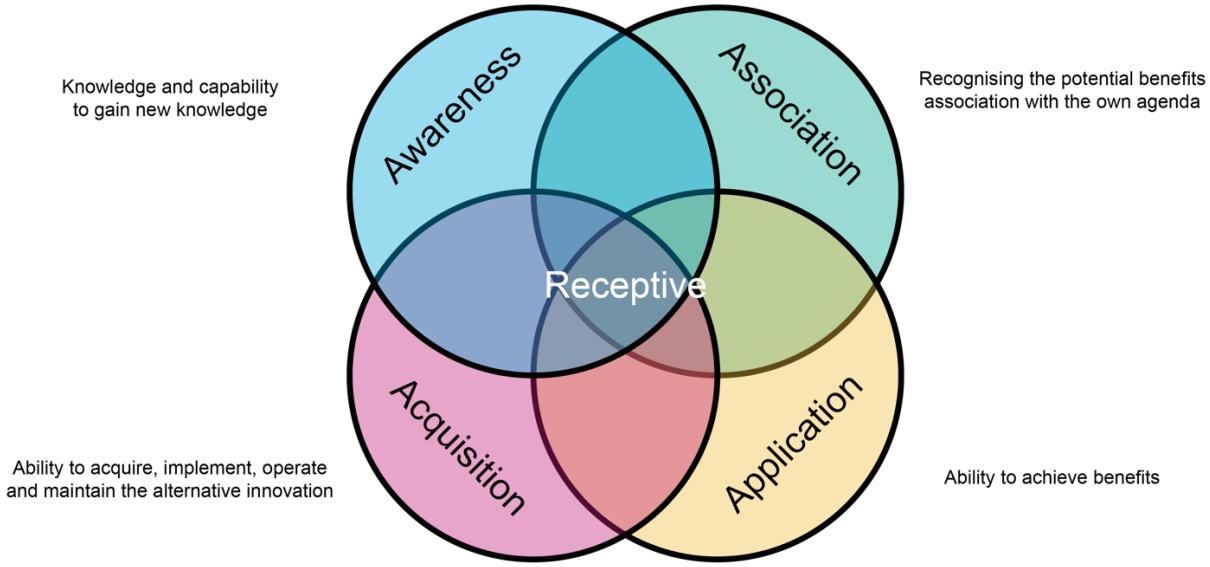


Figure 2.1 Own visualisation of the Receptivity model of Jeffrey and Seaton (2004)

A prior occurrence of water issues (a perception as such) directly or indirectly related to urban water systems probably creates ***awareness***. The recognition of the potential value or effect of a certain measure connects to ***association*** (Jeffrey and Seaton, 2004). Thereby the benefits of a measure play an important role. Residents are making connection between the necessity to address the issue and its benefits.

Acquisition contains several components such as implementation, maintenance and operation. It requires information about physical artefacts for instance where to obtain it as well as knowledge about installation, use and maintenance. The internal cost and benefit analysis might give a different view on such costs and benefits. An important aspect is the ability to imagine and try out different ways of doing things (Jeffrey and Seaton, 2004, pp.284).

Application refers to the ability and motivation of residents to obtain long term value within the context of all other activities and agendas they pursue (Jeffrey and Seaton, 2004, pp. 284). Hence the ability to integrate and connect to the innovation is essential. Moreover, the ability to make decisions about use, responsibility for maintenance, or the arrangement of maintenance as well as the preparedness for a potential failure of the innovation and the ability to achieve benefits through sufficient legal and financial incentives is required. Money has a big influence on the implementation (Jeffrey and Seaton, 2004). Financial barriers can slow down the implementation of new technologies. This tool is sensitive to spatial and temporal changes in perspective, attitude and behaviour of residents.

Capacity building is of utmost significance, when mainstreaming urban water management innovations. Capacity is required to implement and maintain these innovations (Brown and Keath, 2008). De Graaf (2009) states that the focus often lies on the awareness as well as stimulation through subsidies and legal reforms, whereas less emphasis is laid on long term processes as generating association and acquisition as there are no clear short-term results.

Selection of one particular behaviour model

The different behaviour models – Giddens's paradox, Health Belief Model, Theory of Planned Behaviour, Social learning theory and the Receptivity model – show similarities. Thereby awareness plays a central role in all models. Knowledge (Social learning theory) about norms (TPB), possible outcomes (TPB), benefits (TPB, the Health Belief Model, Receptivity Model) and a threat (the Health Belief Model, Receptivity Model) seem crucial before any action is taken. Regardless, knowledge in itself is not enough to take action. The social learning theory can be important when connecting 'frontrunners' with other residents, as behaviour of residents can be influences by observing successful behaviour of others. The social component of the research is a 'new' field to the researcher it has been chosen to use one model, rather than combining all (see Appendix E. The receptivity model, designed to evaluate water related policy instruments, builds a

foundation evaluating to what extent residents of De Baarsjes are willing to increase the resilience to extreme precipitation.

Similar approaches can be found within Amsterdam Rainproof, as they categorise and evaluate their network connections in several phases (Appendix F), which can in some way be connected to the theories of Jeffrey and Seaton.

2.2. Effectiveness of rainproof measures

The goal of Amsterdam is to increase the resilience to extreme precipitation. Knowing which measures have the highest contribution towards the goal is obligatory. The following sub-chapter gives more insight into effectiveness in connection to rainproof measures in the literature.

2.2.1. Effectiveness vs Efficiency

Effectiveness is defined as "*the degree to which something is successful in producing a desired result; success*" (Oxford Dictionary). Connecting it to rainproof measures it refers to the capability of measures to delay and/or store and prevent water damage. Measures with greater water storage or delay capacities have a higher effectiveness. More effective measures decrease the peak flow (Posma, 2015) and are pursuing the right goal (at most likely high costs).

Efficient is defined by the dictionary as follows: "*achieving maximum productivity with minimum wasted effort or expense.*" Hence storing or delaying of precipitation with a minimum investment (work and costs), thus for reasonable costs. Efficiency focuses on the means, whereas effectiveness on the end result in itself.

From a water management perspective the effectiveness of a measure is crucial to tackle the challenges related issues in urban areas. Investigating which measures are most effective for De Baarsjes and if residents connect this effectiveness respectively to rainproof measures is convenient. From the residents' perspective it is expected that the goal lays in achieving the maximum with the lowest associated costs. The most efficient measure does not have to be the most effective measure, as the costs of the most effective measure could exceed the threshold. The combination of effective and efficient is desirable: pursuing the right goal with reasonable costs and finding a measure that accomplishes the goal for an acceptable price and effort.

2.2.2. Rainproof measures

Rainproof measures can be defined as measures that can store water and prevent water damage during heavy precipitation and thus ensure the safety and wellbeing of citizens. Such measures are necessary to deal with excessive amount of water in urban areas. Amsterdam Rainproof provides a toolbox with a list of 56 rainproof measures (Amsterdam Rainproof, 2020d). These measures cover a range of solutions like water drainage, water harvesting, infiltration, water storage and water robust building materials. It offers also the opportunity to filter for the desired sort of solution as well as the location where it should be applied (see Figure 2.2).

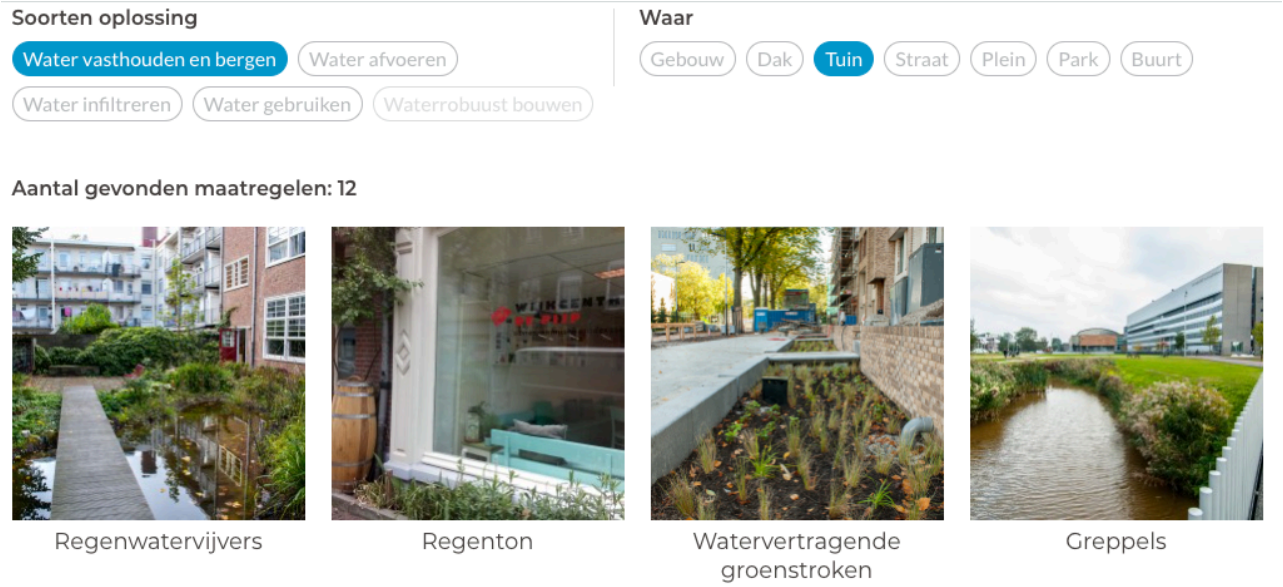


Figure 2.2 Screenshot of a few rainproof measures with an applied filter of water storage in the garden.

Table 2.1 shows some examples of rainproof measures. A complete list of all measures can be found on the toolbox website (https://www.rainproof.nl/toolbox/maatregelen). Several measures can be listed in more than one category, as for example infiltration measures also temporarily store water like wadis or infiltration crates.

Table 2.1 Some example of rainproof measures for the toolbox provided by Amsterdam Rainproof

water drainage	**water harvesting**	**infiltration**	**water storage**	**water robust building**
water square	water elements	green borders	extensive green roofs	building higher
re-introduction of sidewalk	rainwater harvesting/reuse	green facade	Intensive green roofs	flood barrier
disconnecting drainpipes	rain barrel	permeable pavement	rainwater retention ponds	closable buildings
	Constructed wetland	replacing tiles with green	rain barrel	rainproof construction material
		bioswale	infiltration crates	sill or elevated floor level

Not every rainproof measure is applicable for every location and circumstance. Some measures address large scale solutions and public spaces (for instance: Stadsuiterwaarden, Stedelijke waterlopen and Waterpleinen) whereas others require sufficient infiltration capacities. Infiltration measures can pose a risk for soil moisture and ground water quality as well as high ground water tables and thus the reduction of the stability of banks (Van de Ven, 2011, page 250).

Other measures are not feasible on private terrain nor effectively storing 60 mm. This threshold is appropriate for Amsterdam Rainproof.

The implementation of rainproof measures on private terrain depends on several aspects such as size of the terrain, hydrological conditions and the receptivity of residents to actually implement the measures among others. Based on the neighbourhood typology (Locher and Dekker, 2016) De Baarsjes is part of '*Hoogstedelijke kantoren omgeving transformatie zone*' (zone 5, pp.24, see Appendix F). Locher and Dekker

(2016) investigated five different categories of rainproof measures for their effectiveness (Locher and Dekker, 2016). A distinction has been made between water storage, water drainage, infiltration, water robust building (materials) and water harvesting. Figure 2.3 shows that an effectiveness of 70% for zone 5 can be accomplished with an implementation of rainproof measures. The first (water storage) and the fourth (water robust building) category contribute each 30% to the effectiveness. Drainage contributes 5% and the other two categories (infiltrate water and water harvesting) contribute less than 5% each. Water robust building significantly contributes to the effectiveness in the neighbourhood zone 5. This category focusses especially on the avoidance of water damage on houses.

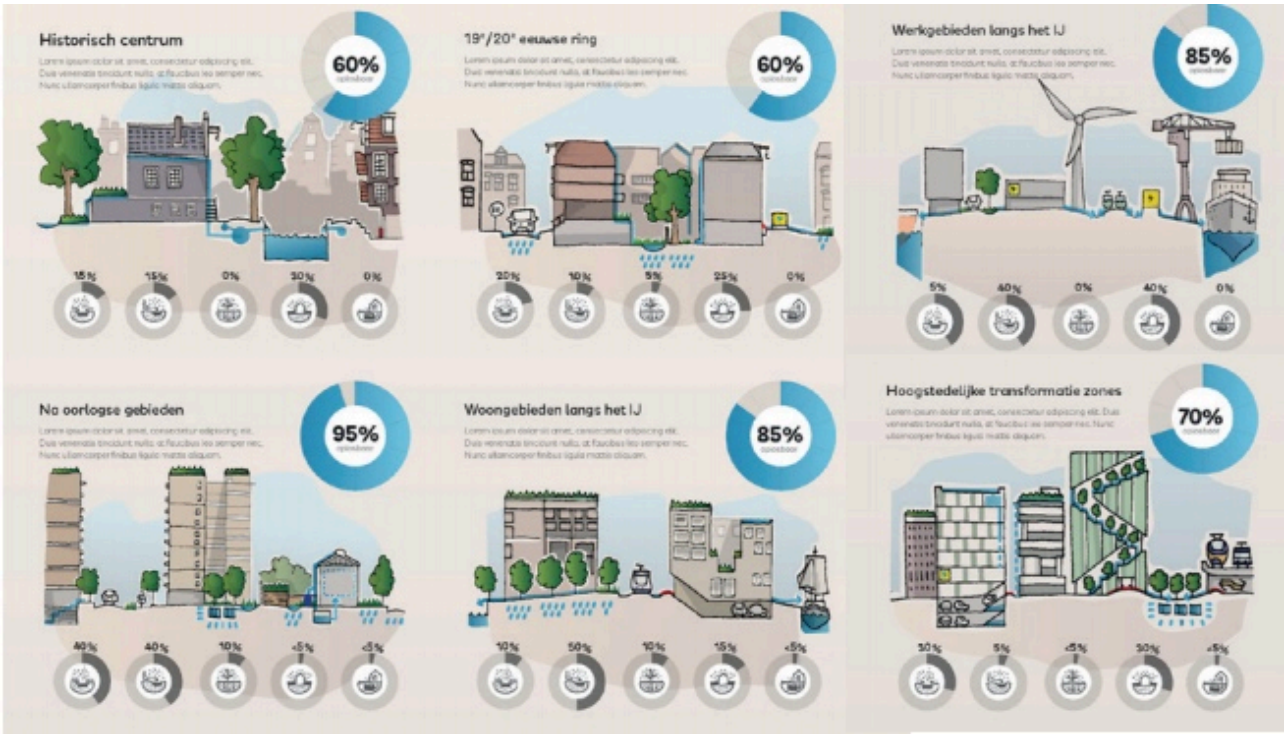


Figure 2.3 Screenshot of effectiveness of the measure categories for the different neighbourhood typologies (original by Locher and Dekker, 2016)

Posma (2015) concluded that several measures lowering the peak and thus pluvial flooding. The implementation can be effective around the house and gardens. The precipitation event of 28 July 2014 and a 60mm/hr precipitation event for comparison was used. Posma (2015) shows that in the old city centre (i.e.: Spuistraat) an increase of water storage capacity by green or blue roofs show the greatest potential. Intensive green roofs have the highest potential (decrease of total water on street up to 42%) but are depending on the buildings bearing capacity. A decrease of 27% has been found when implementing measures in private gardens. Posma (2015) also argues that within the crowded city centre permeable pavement could be relatively effective. Infiltration strokes on public terrain did decrease water on the streets by 85% and 67% for the 60 mm/hr event and the precipitation event of 2014 representatively. Infiltration opportunities are promising in combination with other measures. However, infiltration with deep percolation is not feasible in areas, such as De Baarsjes with high ground water levels.

A combination of several measures can create even more storage capacity. Lowering or even preventing the risk of pluvial flooding within Amsterdam could be possible with an implementation of small-scale measures (Posma, 2015). Therefore, the resilience of the city can be increased by adapting the strategy. This research gives an indication what to expect for effectiveness of rainproof measures on private terrain. The consideration of green roofs, infiltration strips and retention basin (wet pond) are also feasible for this particular research. The selection process of rainproof measures for the questionnaire and the analysis within the Adaptation Support Tool (AST) is explained in Chapter 3.

2.3. Green or grey?

Several studies were conducted to get more insight in for instance the effectiveness of adaptation measures (Posma, 2015; Locher and Dekker, 2016) as well as in the reasons why the transformation from grey to green is not done by all residents (Rietkerk et al., 2016; Reijnders, 2017). The latter indicates that green spaces have a high importance benefitting human health, increasing resilience to climate change and positively influencing biodiversity (Reijnders, 2017).

Decreasing green gardens due to extending houses or tiles in the garden has been observed throughout the neighbourhoods in Amsterdam (visual observation by the researcher). This was one of the reasons to develop the research question and get more insight in the matter. Lacking knowledge and communication regarding permeable materials or vegetation contributes negatively. If 10% of the gardens would be permeable, a decrease of 32,3 million m^3 stormwater flushing through sewer systems can be accomplished (Hommes et al., 2016), saving costs during the treatment process. Constraining the adaptation of mitigation and adaptation strategies are often related to uncertainties. Gifford (2011) also argues that key structural barriers (climate-averse infrastructure) and psychological barriers (ignorance, uncertainties, environmental numbness, mistrust, denial, social comparison, etc.) obstruct behavioural change. Both structural and psychological barriers need to be removed in order to move forward. The research of Reijnders (2017) shows that there are seven main reasons for not 'greening' the garden:

I – *Use and size of the garden*: desire to continue using the garden (children playing in garden, relaxing in the sun, storage for bicycles/motorcycles)

II – "*Green but how*" – missing knowledge and knowhow about plants and design

III – Not able/ not willing to do gardening

IV – Pets – might destroy plants, make it less attractive for cats of the neighbourhood (cat faeces)

V – Investment seems unnecessary if plans to move somewhere else have high priorities

VI – Green gardens are not for everybody aesthetic – for some it appears to be messy

Similar results have been observed by Rietkerk et al. (2016), whereby garden area is also seen as expansion of the living space, which to some extent corresponds with the desire to continue using the garden. People are more interested to create additional living room using tiles (Brakelé, 2016). Also, the indication of not being able to do gardening has been observed by Rietkerk et al. (2016); namely due to a lack of time. Additionally, the perception that lower expenses are connected to grey areas and its lower maintenance requirements are appealing.

3 Method

In order to answer the main research question: ***To what extent are residents receptive towards increasing the resilience of the city to extreme precipitation?*** This research endeavours to gain information on receptivity of residents of De Baarsjes, Amsterdam for effective *rainproof measures*. The used methods are presented in the following chapter.

3.1. Receptivity model

The receptivity model places citizens at the centre of policy tool evaluation (Jeffrey and Seaton, 2004) and is very useful as a conceptual model. Receptivity is connected to four requirements: Awareness, Association, Acquisition and Application – the 4 A's. All these conditions need to apply for residents to take action.

Awareness

The implementation of adaptation measures in Amsterdam presumably does not (yet) reach the storage capacity of 60mm/hr. Conceivably residents are unaware, for instance, of the threat by intense precipitation or of alternative options and/or the benefits and co-benefits of such.

Association

These benefits are connected to the association with their own agenda, not necessarily connected to water issues itself. An aesthetic improvement of residential areas could be potential motivation (Jeffrey and Seaton, 2004, Rutten et al., 2009).

Acquisition

Receptivity is also connected to acquisition and indicates the ability of residents to acquire, implement, operate and maintain a particular measure (Jeffery and Seaton, 2004).

Application

The fourth 'A' refers to Application. This is associated with the ability to achieve benefits through legal and financial incentives (Jeffrey and Seaton, 2004, Rutten et al., 2009). Several laws and directives may even oblige individuals to implement adaptation measures. Financial aid provided by governments (i.e.: subsidies for green roofs) might trigger such implementation.

Evidently not all these requirements are fulfilled in case of the residents of Amsterdam as rainproof measures are scarcely adapted on private terrain. Those four 'A's' are used as guideline to analyse the receptivity of residents for rainproof measures.

3.1.1. How are the 4 A's included in the method

In order to answer if residents are ready to increase the resilience, it is important to answer following sub question:

Which of the 4A's require the most attention?

Those 4 A's: Awareness, Association, Acquisition and Application, of the receptivity model are used through questionnaires. Despite its intertwining nature the concept of these four requirements has been simplified for the questionnaires in such a way that these were seen more similar to separate stages.

The following supporting questions, shown in Table 3.1, contribute as a guideline through the questionnaire and focus group.

Table 3.1 Supporting questions

4 A's	supporting questions	Remarks
Awareness	Did residents experience pluvial flooding? What measures are associated with rainproof measures? Which of the selected measures do residents know?	The knowledge of an existing problem, available alternative options and the capability to gain new knowledge
Association	What personal benefits are associated with the implementation of adaptation measures? What priorities do residents have?	Recognising the potential benefits and the association with the own agenda
Acquisition	Where do residents want to acquire information, materials for the implementation? What do residents know about maintenance and operation?	Ability to acquire, implement, operate and maintain the alternative innovation.
Application	To what extent are residents able to achieve benefits through sufficient legal and financial incentives?	Being able to achieve benefits through sufficient legal and financial incentives

3.1.2. Validation of the use of the Receptivity model

The theory of the receptivity model has been chosen as foundation utilising it as a guideline, rather than testing the theory. to obtain more insights if residents are willing and able to contribute to the strengthening of the city's resilience. The choice for this model is reasonable, as the theory has been used in other studies (e.g.: de Graaf, 2009; Rutten et al., 2009; De Graaf et al., 2011). Jeffrey and Seaton (2004) argue that this model has been designed to evaluate water policy instruments, in this case rainproof measures.

3.2. Research instruments and data collection

To answer the research question a sequential mixed method strategy (Creswell, 2009) was applied to firstly indicate necessary focus points and subsequently gain more detailed information. A quantitative method (questionnaires) was followed by a qualitative method (focus groups). A limited selection of rainproof measures, feasible on private lot, was made. This selection was evaluated by its effectiveness using the AST. This research instrument is explained in Chapter 3.4.

3.2.1. Questionnaires

The questionnaires aimed to gain information on the knowledge of residents about effective rainproof measures and their receptivity towards these. These selected measures covered different categories such as water storage, infiltration, drainage, water robust building as well as water harvesting. The framework of the receptivity model was not introduced to respondents.

Construction of the questionnaire

To ensure the highest possible response rate it was crucial that questions were kept short and clear, hence limited amount of questions were chosen. The use of skip sequencing (Manski and Molinari, 2008) was chosen. With this method it was determined whether a respondent where asked subsequent questions. For instance, it was assumed that a respondent, without any association of rainproof measure would not be able to give an indication about its perceived effectiveness. The concept of the receptivity model was simplified for

the questionnaires and the 4A's were dependent on each other. The questionnaire (in Dutch) can be found in Appendix H.

The questionnaire was structured in seven sections consisting of 13 questions:

(1) Introduction: a brief introduction of the researcher, the research and its relevance is given and the assurance of confidentiality.

(2) General Information: respondents were able to indicate demographic information as age and sex. Name, occupation, race, ethnicity, income level, employment was not collected.

The following sections regard the receptivity model, whereby the theory of the model is not introduced to the respondent and loosely translated and connected to the following:

(3) Awareness phase: requiring information about ownership (house-owner or renter, living location within the house, presence of garden, responsibilities of garden and roof); (encountered) water flooding due to severe precipitation; responsibilities; future development of precipitation events and their knowledge about countermeasures was enquired.

Skip sequencing was applied to ensure a higher accuracy of the perceived effectiveness. Presumably, only respondents that knew measures associate an effectiveness with a particular measure.

(4) Perceived effectiveness of measures: Thereby a separation between water storage measures and water damage prevention measures has been made. This is based on certain criteria, that water damage prevention does not actively store water. Whilst measures that store water can also prevent water damage. Merely a limited selection of countermeasures, feasible on private terrain, was presented, and can be found in Table 3.2. It was expected that a longer list of measures would hamper the response rate. A short description of the measures can be found in Appendix G.

Table 3.2 List of selected water measures[3]

Water storage measures	**Water damage prevention measures**
Green roofs	Elevated doorstep
Polder roof	Temporary barriers in the door
Infiltration crates	Elevated threshold of parking space
Height differences within the garden	Higher placement of the electricity connection
Wadi's	Rain-resistant building materials
Rainwater pond	
Rainwater tanks	
Rain barrel	
Water-retaining planters	
Rainwater fence	

(5) Association phase: enquiries concerning measure specific associated benefits and investment willingness (time and money) were enquired.

[3] No distinction was made between extensive and intensive green roofs to avoid confusion.

Another skip sequencing was applied to simplify and shorten the questionnaire for the respondents.

(6) Acquisition and Application: this section enquires information on how to acquire, implement, operate and maintain the countermeasures as well as the motivation to implement such measures.

Despite skip sequencing, all respondents were asked to contribute to the last section.

(7) Desired/required information: in this section respondents were able to pinpoint information requirements associated with counter measures (open question, whereby costs, maintenance, installation was given as an example). Respondents were asked to indicate their preference (through whom and which medium) of receiving such information.

The questionnaire gave respondents also the opportunity to identify questions and additional comments.

Sampling

Before the questionnaires were distributed and promoted, they were tested for its clarity and time consumption and adjusted. The distribution of those were done in November 2017. Printed versions and flyers (see Appendix I) with links to the online version were distributed, also in community centres to reach a broader audience. A deadline up to Christmas was given to fill them in. An indication of their interest in further collaboration through focus groups was enquired. Subsequently to introducing the research and its purpose residents were able to voluntarily participate. The collection of personal data was kept to a bare minimum, concerning anonymous demographic data of age and sex. Data such as name, race, ethnicity, employment were irrelevant for this research. For further research or interest in the results, respondents were able to provide contact data (email address or phone number and name). This was disconnected from the research data and stored encrypted. After accomplishment of the research and distribution of its results to interested respondents all remaining contact data is destroyed.

Analysis

The online platform: *www.enquetesmaken.com* was used, giving some options to analyse results and showing some information already during the process. Furthermore, Excel was used to further elaborate on the given information and analyse them in more detail statistically. The data helped to identify issues and supported a selection for the focus group. For instance, inhabitants' preferences for certain adaptation measures is based on their own perception of benefits. Such information can be used for further research. The perceived effectiveness was compared to the calculated effectiveness of adaptation measures using AST.

Most of the data retrieved from the questionnaire is nominal data, thus more restricted on the analysis. For the perceived effectiveness an ordinal scale was chosen, giving somewhat more freedom for the analyses (Garth, 2008). Choosing open questions provided qualitative data. This is important to keep in mind when looking at the results. Based on first insights of the questionnaire as well as the literature study, statements for the focus group meeting were constructed. More information about the focus group is given in the following subchapter.

3.2.2. Focus groups

As previously mentioned, a sequential mixed method strategy was applied. Focus groups were conducted to fulfil the qualitative data collection. Focus groups (Appendix J) are less time consuming compared to interviews and up to eight people gathered, to discuss several questions (given by the researcher) within the group.

Developing the statements

The questions or statements are, next to the participants, most crucial as they indicate the topic and provide its development. Before designing such, it was mandatory to reflect on the essence of the focus group. The goal of this data collection was to get qualitative insight in the receptivity of residents. A statement approach had been chosen rather than of a question approach to get insight in ***why*** residents are hesitant implementing rainproof measures. Thereby focus has been brought to the transition from ***Awareness*** to ***Association*** and ***Acquisition***.

Questionnaires revealed that responsibilities for implementation of rainproof measures are to some extent unclear. In the statements focus has been laid on these responsibilities. Moreover, barriers were worthwhile to investigate. Depending on the time frame and flow of the discussion some additional statements considering the reasons for implementation could be introduced. Such statements were designed to have some backup and the possibility to switch when a statement seemed inappropriate. The entire programme of the focus groups can be found in Appendix K. It was expected that some statements trigger deeper discussions compared to others, which also was depending on group dynamics and opinions within the group. The proposed language for the focus group is Dutch, hence the questions are formulated in Dutch presented in Table 3.3.

Table 3.3 Statements used for the focus groups in Dutch and English translation

Dutch statement	**English translation**
Als het extreem regent, ben ik zelf verantwoordelijk voor droge voeten thuis.	During extreme precipitation I am responsible to keep my home dry.
Op mijn eigen terrein mag de gemeente bepalen wat verplichte maatregelen zijn om wateroverlast te voorkomen.	The municipality is allowed to appoint obligatory measures on my own terrain in order to prevent water issues/ flooding.
Als mijn buren niets doen om wateroverlast te voorkomen, dan doe ik ook niets.	If my neighbour does not do anything to prevent flooding, then I won't do something either.
De gemeente moet de eerste stap zetten om wateroverlast te voorkomen.	The municipality has to do the first step towards preventing flooding/water damage.
Ik haal graag tegels uit mijn tuin als ik daardoor de biodiversiteit vergroot.	I would like to get rid of the pavements in my garden in order to increase the biodiversity.
Ik ga maatregelen om wateroverlast te voorkomen nemen als ik daardoor de muggenoverlast beperk.	I would take rainproof measures if this would ensure a decrease of the mosquito problems.
Als ik er geld mee kan besparen, sta ik open voor het investeren in maatregelen om wateroverlast te voorkomen.	If I can save money eventually I will invest in measures.

The concept of the receptivity model is not introduced to the participants as it supposedly would complicate the entire discussion. The ideas behind the concept are translated in statements and based on the first results of the questionnaire.

Managing the focus group session

The focus group was held in the community centre MidWest and participants were placed in a rectangular seating arrangement. A comfortable surrounding was created so respondents could feel free to join the conversation. A small introduction mellowed the conversation and was followed by presenting the statements (each at the time). It was aimed to treat both groups as similar as possible to compare and integrate the results.

Selection of the participants

As suggested by Krueger and Casey (2015) around eight people per focus group were recruited. Two focus groups with eight and nine participants were conducted. The selection of participants for the focus group was based on their indication of willingness to contribute. As the willingness was limited, all participants that were willing and able to join at the proposed dates were selected. By such a selection it is assumed that residents with greater interest are more likely to share valuable information.

Data analysis

Using the focus group method is connected to qualitative data analysis. It is mentioned by Rabiee (2004) that the large amount of data, produced by focus groups, can be overwhelming especially for novice. Hence the analysis of the data is time consuming. The transcription was based on a word content only as well as slightly summarising the comments. The behaviour within the group is less important; therefore, the particular choice was made against verbatim and including the silent content transcription. The conversation was recorded (with prior verbal permission) assisting the analysis afterwards and preventing information loss of important suggestions, ideas or comments.

3.3. AST for the effectiveness of rainproof measures

In order to answer the research question it was investigated what measures are most effective in De Baarsjes. Therefore, the Adaptation Support Tool (AST) of Deltares was used. This part calculated the effectiveness of rainproof measures to be compared with the perceived effectiveness within the public. The selection of the measures was closely related to those in the questionnaire. Some measures were less applicable in the specific neighbourhoods. For instance, high groundwater levels negatively influence the effectiveness of infiltration measures. However, the creation of (surface) storage might influence the peak-propagation. The evaluation was related to a threshold of a storage requirement of 60mm. Different scenarios are calculated with the AST.

3.3.1. Adaptation Support Tool (AST) – a brief introduction

The Adaptation Support Tool (AST) was developed by Deltares and in its purpose is to "s*upport collaborative planning*" (Deltares, 2019). Increasing resilience along with focussing on attractiveness of environment. Giving the possibility of comparing different adaptive measures in a specific setting and surrounding. This toolbox offers the opportunity to incorporate different stakeholder (urban planners, landscape architects, civil engineers and local stakeholders and decision makers) into decision-making process. AST provides "*quantified, evidence-based information on the climate resilience*" (Van de Ven et al., 2016, pp. 2) of different design ideas that can be reflected on through such process. As a support tool it is meant to give a foundation to communicate knowledge and discuss alternatives to proposed measures, location, size and corresponding costs and (co)benefits (Van de Ven et al., 2016). Hence AST helps to overcome the gap between vulnerability assessment and the actual planning and selection of appropriate measures as it enables the dialogue between different stakeholders.

Within the AST a long list of blue, green and grey adaptation measures consisting of 66 measures (in the beginning of 2019) is given. This list incorporates adaptation measures for the reduction of pluvial flooding, drought and heat stress (Van de Ven et al., 2016), consequently addressing not only extreme precipitation but climate adaptation as a whole. Furthermore, an assistant for the selection based on a ranking of the applicability of measures as well as an assessment tool for their representative effectiveness is provided (Van de Ven et al., 2016). Hence information about the effectiveness regarding climate resilience, water quality and costs are indicated by the tool based on the specific selection.

3.3.2. Approach

Various rainproof measures have different specifications and are influenced by the actual circumstances, for instance bearing capacity of buildings, groundwater levels, soil and space availability among others.

Comparing different measures and their effectiveness is challenging, as their dimensions are influenced by such circumstances, hence their effectiveness is to a certain degree expected to be location specific.

Defining effectiveness of rainproof measures to temporarily store water

Amsterdam Rainproof is thriving to ensure a storage capacity of 60 mm. In order to find out if a measure is effective it has to be checked against this threshold. Therefore, following classification was established, presented in Table 3.4, where also the corresponding water label is indicated. A water label (hemelwaterlabel) has been introduced by STOWA and Stichting RIONED to substantiate their policies connected to rainproofing measures on private terrain towards residents and companies. This water label is supposed to verify urgent bottlenecks, as low storage capacities correspond with low scores as seen in Figure 3.1. It is also supposed to stimulate an active implementation of rainproofing measures. It is desired to reach a higher water label score (favourably A to A++).

Table 3.4 Storage capacity classification and its effectiveness used for the research

Storage capacity in mm	**Storage capacity in %**	**Effectiveness**	**Water label**
0 mm	0%	no effectiveness	corresponding with water label G
30 mm	50%	moderate effectiveness	corresponding with water label C
60 mm	100%	sufficient effectiveness	corresponding with water label A
90 mm	150%	high effectiveness	corresponding with water label A+
120 mm	200%	extreme effectiveness	corresponding with water label A++

Hence if a measure is calculated to store 15 mm it would contribute 25% of the desired storage capacity, corresponding with ‘no effectiveness’ and ‘water label G’. The closer to the 100% the more effective a measure is. If one measure does not reach this goal a combination of several measures would be favourable to achieve 100%.

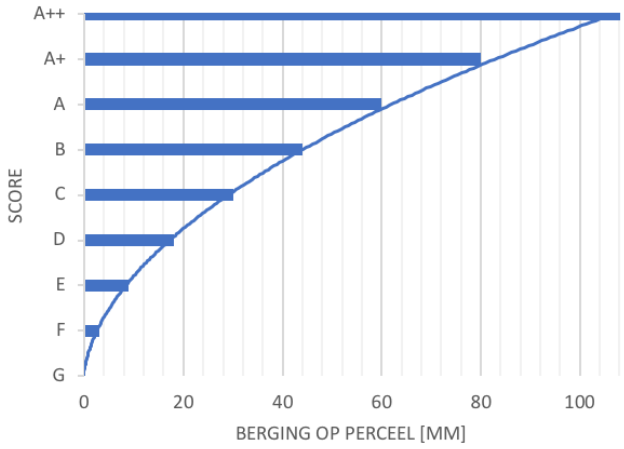


Figure 3.1 Water-labels corresponding with storage in mm on private ground (STOWA)

Area selection: downsizing to a building block

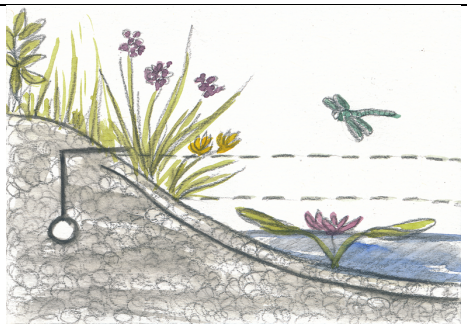
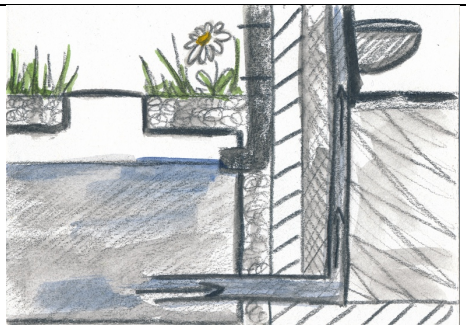
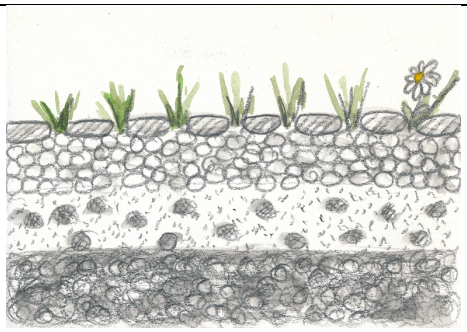
For the analysis of the effectiveness of rainproof measures the project area of De Baarsjes has been downsized to a building block along Admiraal de Ruijterweg and Bestevâerstraat. This choice is consistent with the indication of a very urgent area (area 45 of the knelpuntenkaart, see Appendix C indicated by Amsterdam Rainproof. Subsequently measures and their dimensions were defined. A stepwise approach has been chosen, whereby first measures were selected and evaluated. Secondly generalised to an object level and thirdly scenarios were constructed.

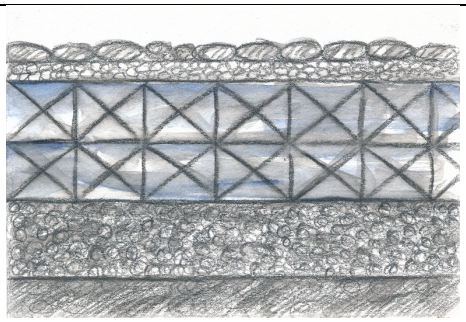
Step 1: Selection of the measures

First of all a selection of several rainproof measures has been made. Not all measures are feasible for private terrains. Therefore, literature as well as the toolbox of Amsterdam Rainproof were investigated. Additionally, as mentioned before, the selection was influenced by for instance high groundwater levels as they are a limitation for infiltration measures (see Appendix C). Albeit knowledge about groundwater levels is restricted to some measurement points. Groundwater levels, and thus suitability, might differ from one street to another. Note that due to the foundations of houses within Amsterdam maintaining a certain groundwater level is favourable.

Measures that go beyond private terrain (e.g.: increasing the capacity of the sewer system) or measures that require more space (Water square) have been neglected. The list of 66 measures has been filtered and the measures in Table 3.5 were selected to check their effectiveness.

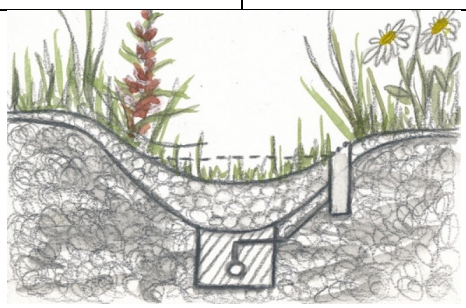
Table 3.5 Selection of measures to be analysed in AST

 Green garden	 Extensive green roof
 Intensive green roof	 Water retention pond
 Water harvesting	 Porous pavement



Shallow infiltration boxes

Rain tanks (rain barrels)



Wadi

Note that within the questionnaire extensive and intensive green roofs were not distinguished. This choice was made to prevent confusion. This influences the outcome of perceived effectiveness by participants. The storage capacity of extensive and intensive green roofs can differ significantly (30mm vs > 60mm).

Additionally it has been chosen to include porous pavements, which was neglected in the questionnaire. The reason to include porous pavement arises from the impression that many inhabitants tend to increase paved area within front or backyards (visual inspection within Amsterdam). The necessity arises to evaluate its influence and its value as an alternative achieving greater resilience combined with (personal) aesthetic comfort for residents.

Depth of the different measures

Within the AST it is possible to choose water storage depths for each measures. The AST manual provided information about those depths and thus a basis for decision making. Figure 3.2 shows the chosen depths.

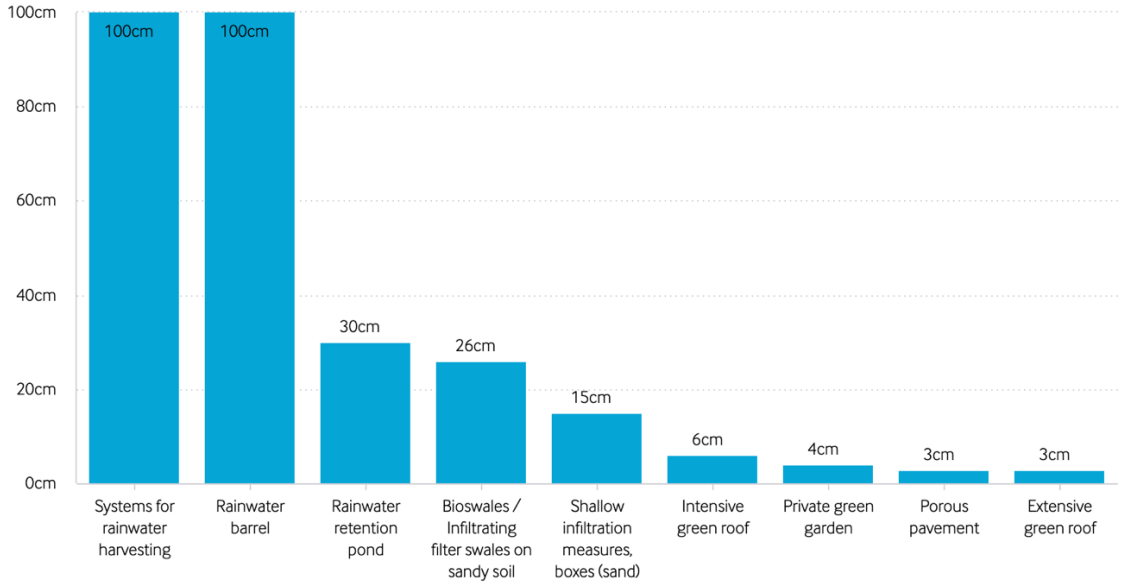


Figure 3.2 Chosen default depth used in AST of the different measures

In practice those can differ as for example the actual bearing capacity of a specific building can be high enough to carry an intensive green roof with a greater depth. To that end these depths are adaptable in the AST. The default depths were used to analyse the effectiveness of measures.

Expected effectiveness

As these different measures have different depths, an expectation about their effectiveness might arise. In this case rainwater barrels (rainwater tank) as well as systems for rainwater harvesting show a depth of 1 m. It could be assumed that therefore a high storage capacity can be associated. Albeit the area that a measures comprises influence such storage capacity enormously. One rainwater barrel has less storage capacity than an intensive green roof (90m^2) whereas the depth of green roofs is only a fraction of a rain barrel. The actual implementation and thus its size depends on choices that residents consider when 'designing' their space and can differ tremendously for different circumstances. The object level indicates the most likely division of the different measures assuming a realistic distribution within a garden unit.

Step 2: Generalising it to object level

The establishment of an object level used an estimation through Google maps of the average size of an arbitrary house within the selected street. Within the tool the dimensions of the different measures were approximated by logical reasoning. Nevertheless, the desired dimensions were not easily drawn within AST at a small scale. For instance the rainwater retention pond comprises an area of 9 m^2. These approximations have been applied within the AST. Due to drawing constraints it was impossible to draw extensive and intensive green roofs exactly the same size. Hence the closest approximation has been used. The following dimensions (Table 3.6) were applied.

Table 3.6 Proposed measures in the garden unit setting and their respective size approximation

Proposed measure	**Size approximation in m^2**
Average flat rooftop: 90 m^2 (entire roof approximately 104 m^2)	
Extensive green roof	90 m^2 **
Intensive green roof	87 m^2 **
Total garden size: 104 m^2	
Terraces and paved area (porous pavement)	20 m^2
Shallow infiltration boxes (under the terraces)	20 m^2
Rainwater retention pond	9 m^2
Rainwater tank (barrel)	0.25 m^2
Rainwater harvesting	3.14 m^2
Bioswale	6 m^2
Green garden	84 m^2 ***
** It was impossible to get both roofs the same size due to drawing restrains. The closest approximation has been used	
*** $A_{green\ garden} = A_{total\ garden} - A_{terrace}$: 84m^2 = 104 m^2 - 20m^2	

The entire area comprises 208 m^2. As mentioned before the strive for a temporary storage of 60 mm on the private ground has been used as a threshold for the estimation of the effectiveness. Hence the target that has been used for the AST is 12.48 m^3.

(1)	$A_{private\ area}$	x	threshold	=	Storage target
(2)	208 m^2	x	0.06 m	=	12.48 m^3

Step 3: Scenarios

After the calculations of the effectiveness on the object level scenarios were applied on the garden unit.

(a) only rain barrels

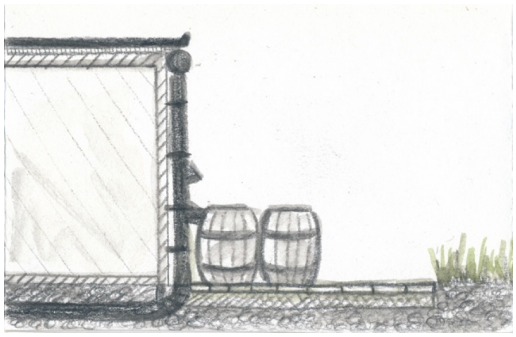
(b) only green garden

(c) only green roofs

(d) gardens all porous pavements

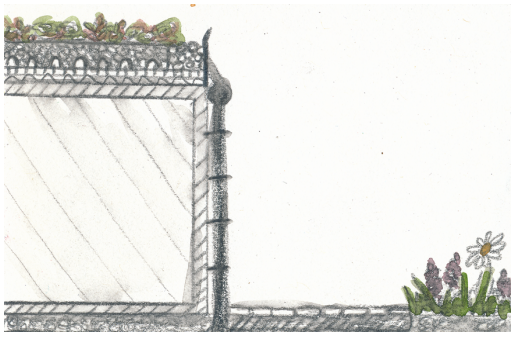
(e) combination of different measures towards an optimisation

Some scenarios might have a higher likeliness to be implemented than others. For instance as participants know rain barrels it might be more likely that all households would implement a rain barrel (**scenario a**). The implementation of two rain barrels per garden unit was assigned in this scenario.

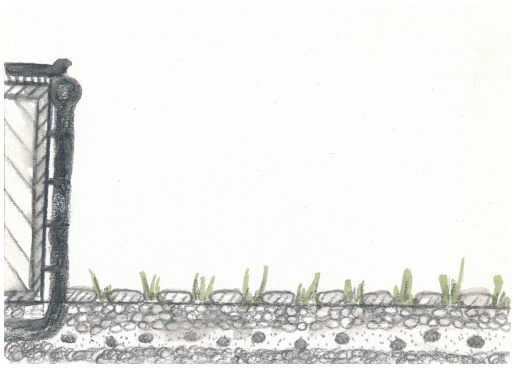


The second scenario is based on awareness campaigns and activities around the slogan "*tegels eruit - groen erin*" (Engl.: 'tiles out - green in the garden'). If all habitants would be reached and applied this measure (**scenario b**) the curiosity arises what this measure would accomplish. This translates to an entire garden size of 104 m^2.

As green roofs show a high preference in comparison with other measures this measure was applied in the third scenario (**scenario c**). Despite its low likeliness of implementing intensive green roofs a comparison between extensive and intensive was done. To the flat part of the roof, consisting of approximately 90 m^2 (see Table: 3.6) the measures were added. Furthermore, no other intervention were assumed, despite the existence of a green garden in combination with a (non-porous) terrace.



A fourth scenario of pavement has been chosen as a trend has been seen (solely by observation) that more gardens are covered by tiles (**scenario d**). If inhabitants actually do have a preference to use tiles in gardens this scenario would show the effectiveness of the use of porous tiles instead of less pervious tiles. The implementation of porous pavement within the entire garden was evaluated. In comparison the object level only considers 20m^2 of paved area.



The last scenario (**scenario e**) is based on a combination of different measures. This scenario is designed to reach a possible combination of measures that are efficient in collecting the target of 60mm as well as it will be checked against the costs that have been provided within AST. The assigned areas are closely related to Table 3.6 but then applied to the entire building block.

4 Results connected to the receptivity of the residents

Within this chapter the most important results of the questionnaire and focus groups are highlighted. Firstly the results of the questionnaire are indicated, (quantifiable data and qualitative data) and secondly the results of the focus group are presented (qualitative data).

4.1. Questionnaires

The questionnaire reached 181 respondents, where one already stopped after opening the questionnaire, hence cannot be counted in the entire statistics, thus 180 participants. Furthermore, due to skip sequencing the number or contributions are not equally throughout the questionnaire. The first section (general information and indication for awareness) had to be filled in by all participants, whereby 169 participants filled in the entire first section (12 did only the general part). The second section (association and effectiveness of the measures) was filled in by 71 participants. The third section was filled in by 60 participant. The following subchapters present the most important results concerning (1) general information (2) perceived responsibilities and (3) receptivity.

4.1.1. General information retrieved from the questionnaires

The following graphs show the general information retrieved (Figure 4.1) Of the residents that responded (n: 180), most of them were in the age range of 31–55 (approximately 61%). Secondly with 26% the group of 55+ filled in the questionnaires. Only about 13% were between 18 until 30 years.

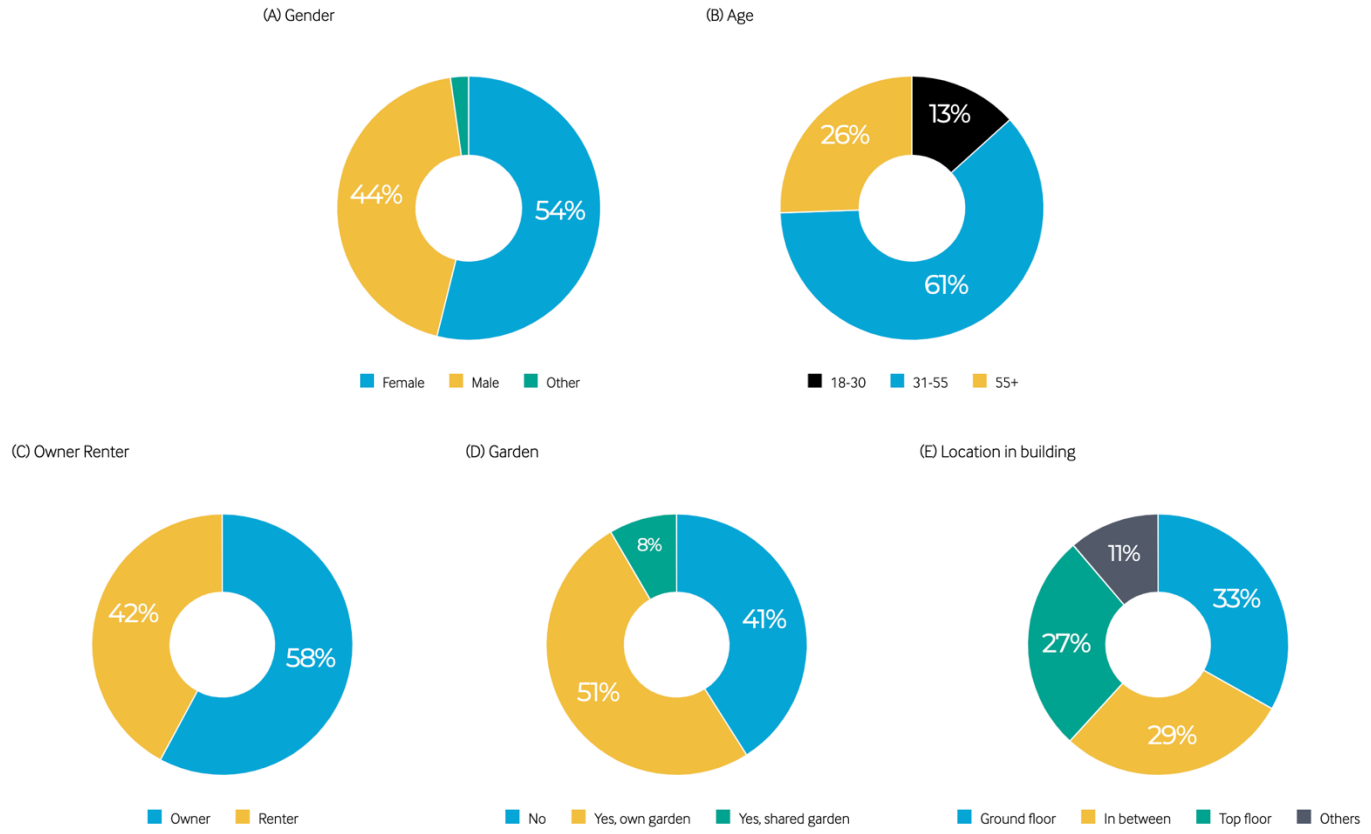


Figure 4.1 Distribution of respondents, showing gender (A), age (B), owner vs renter (C), presence of garden (D) and location in the building (E).

The distribution of owners and renters can be found in Figure 4.1 C. It is assumed that residents residing on the ground floor 33% (n: 59) and top floor 27% (n: 48) as well as basement (n: 3) are particularly interesting, as they presumably have more opportunities to implement rainproof measures (i.e.: green roofs, thresholds, etc). More than half of the respondents reside in either of these. Additionally, some respondents indicated that they are living in the entire house (n: 6) or several floors (*ground floor + basement*: n: 7). Less than 30% (n: 51) are living in between top and ground floor. More residents residing on either top or ground floor contributed. This distribution might also arise due to the urgency that residents connect to water issues. About 51% (n: 90) indicated the presence of their own garden, whereas about 41% (n: 73) specified the absence of a garden and about 8% (n: 15) are sharing a garden. It might not reflect on the real distribution of gardens versus no gardens in De Baarsjes. More research would be necessary to verify this.

4.1.2. Responsibilities for elements of the private lot

The following subsection gives an overview of the responsibilities related to the private lot.

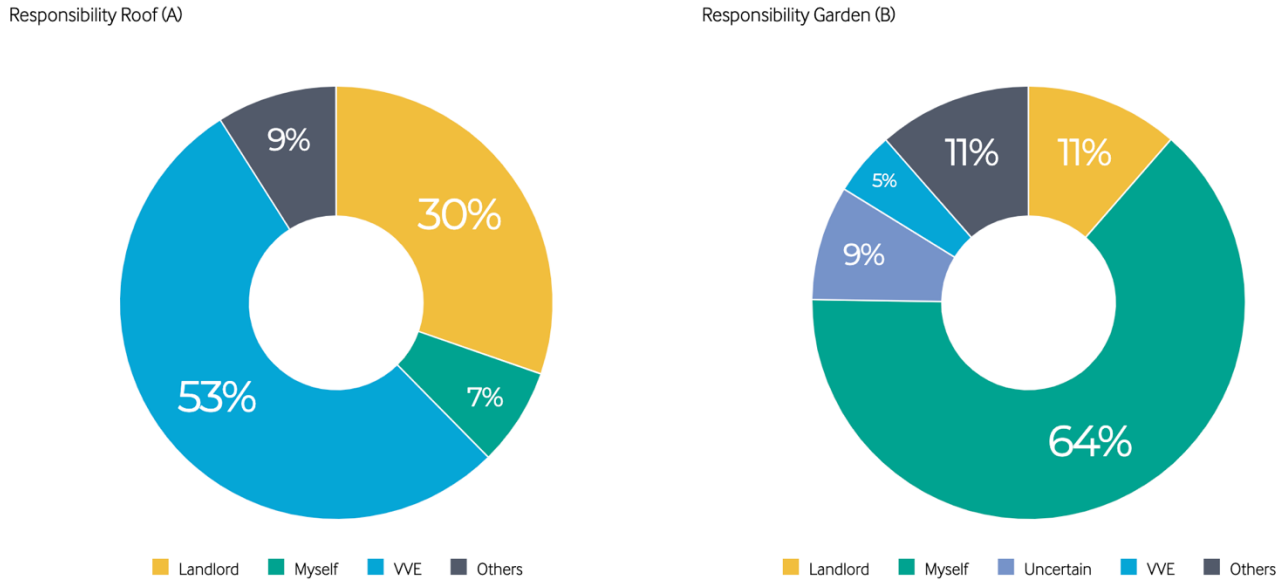


Figure 4.2 Responsibility of roof (A) and garden (B)

Roof

As seen in Figure 4.2 A the responsibility associated with roofs lies supposedly with the VVE (vereniging van eigenaren – 'owners association') according to respondents (53%, n: 95). About 30% (n: 54) responded that the responsibility lies with the landlord. A selection of owners (n:103) revealed that VVEs have great influence on decision-making (81%, n: 84). House-owners mentioned that VVEs were to some extent responsible, whereas roof-terraces or roof extension fall specifically in the responsibilities of the owner. Renters (n: 75) indicated that landlords are responsible for roofs (72%, n: 54). Only a few respondents declared their own responsibility and few others were unsure about responsibilities distribution (8% (n:6) uncertain, 1% (n: 1) themselves, 15% (n: 11) VVE and 4% (n: 3) others: woningbouw, VVE and landlord, owner).

Garden

Exclusively respondents (n: 105) that previously indicated a presence of a garden were asked to answer this question, as shown in Figure 4.2 B. About 64% (n: 67) indicated their own responsibility for gardens. Other options were mentioned by 11% (n: 12), whereby especially residents of the ground floor have been stated (n: 9) to be responsible. To a lesser extent landlords were found responsible 11% (n: 12) and about 9% (n: 9) were uncertain, whereby the VVE were less influential compared with roofs 5% (n: 5).

The preceding information was not meant to say something about receptivity rather to get an overview of the distribution of responsibilities. The second part of the questionnaire was aimed to gain knowledge about the different requirements of the receptivity model.

4.1.3. Insight about the receptivity of residents

This subchapter presents the main results that are connected to the four requirements (4 A's) of the receptivity framework.

Awareness

Awareness refers to the knowledge of an existing problem, available alternative options and the capability to gain new knowledge (Jeffrey and Seaton, 2004).

Experience with flooding and water damage

In order to address Awareness respondent were invited to indicate their experience with flooding after heavy precipitation. Multiple answers were permitted to declare possible encounter of flooding on streets and within the house and/or garden. The results are presented in Figure 4.3. Most of the respondents (n: 169) associate water on streets (38%, n: 64) rather than private terrain. There is a group that did not experience any flooding at all (25%, n: 42). About 16% (n: 28) indicated other answers for example specific indications about where in the house such as cellar, stairwell, attic, corridor or a location in the neighbourhood. More answers can be found in the Appendix L.

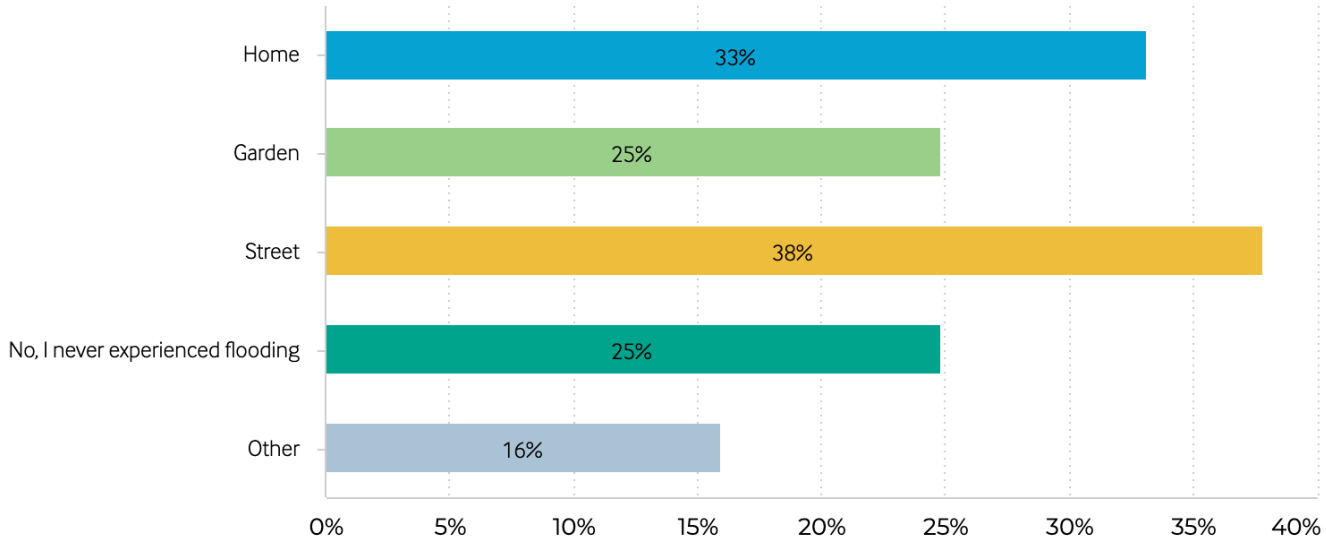


Figure 4.3 Flooding Experience

Flooding within the house

Respondents that encountered water within the apartment were asked to indicate (throughout an open question) where water entered the building. Not all answers will be listed but can be found in the Appendix L . Main leakages were associated with roof/ceiling, walls, windows, basement, through sewerage system (such as toilet, shower among others) as well as blocked drainpipes from the roof.

Residing location

It was interesting to investigate where residents (n: 42), with no flooding experience were residing within the building. The distribution was quite equally between top floor (29%, n: 12) in between (33.3%, n: 14) and lowest floor (33.3%, n: 14), entire house (others 5%, n: 2).

Figure 4.4 presents the results concerning the selection of residents on ground floor and top floor and their corresponding experience with flooding.

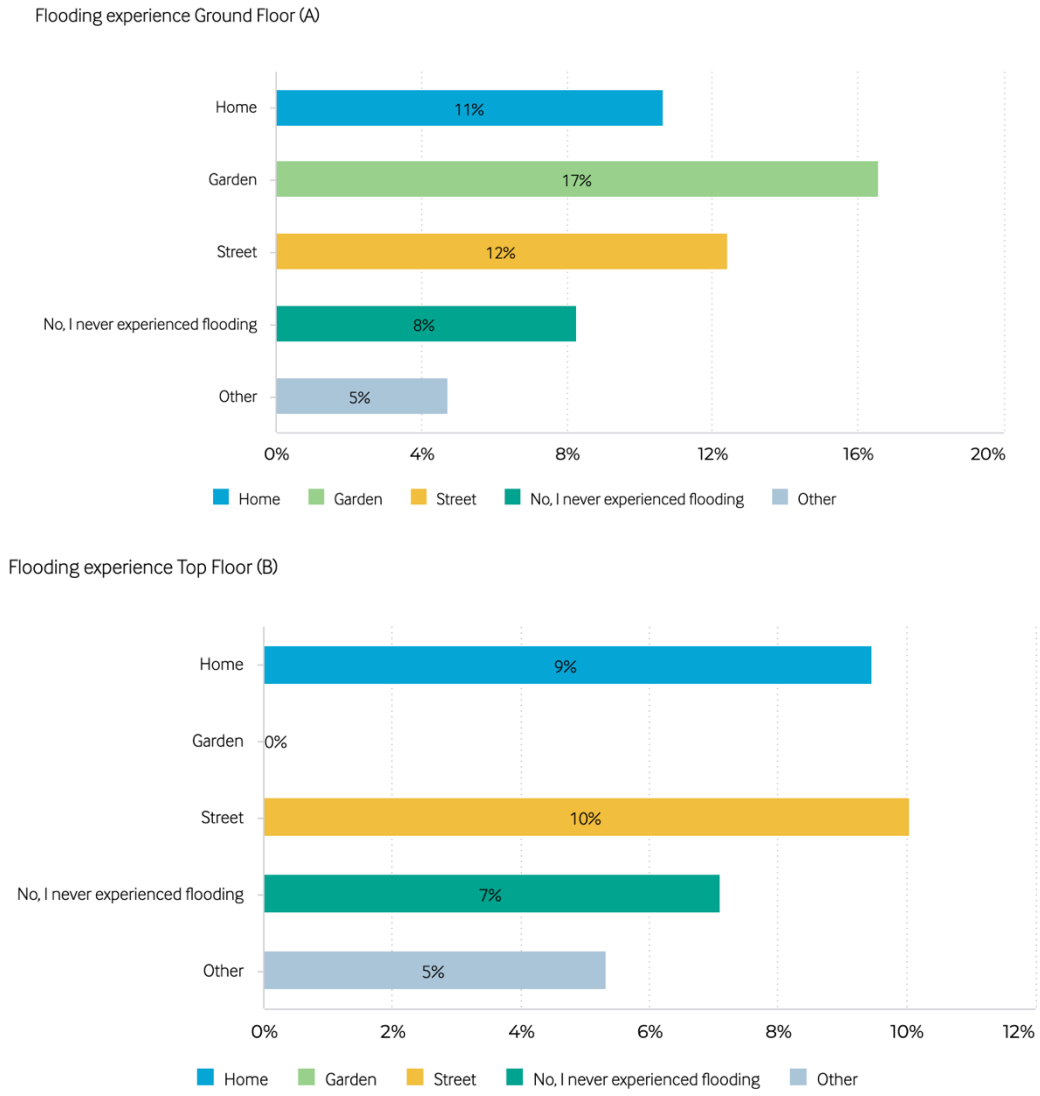


Figure 4.4 Experience and indication of flooding by respondents living at ground floor (A) and top (B).

Generally, the experience of flooding might possibly contribute to the awareness of the problem. Although the responsibilities perception presumable differ depending on the location of occurrence.

Responsibilities connected to flooding and water damage within the house and apartment

It is crucial to determine if residents recognise their responsibility. The following Figure 4.5 shows the distribution of perceived responsibilities for resolving water damage and water issues in and around the house (n: 168).

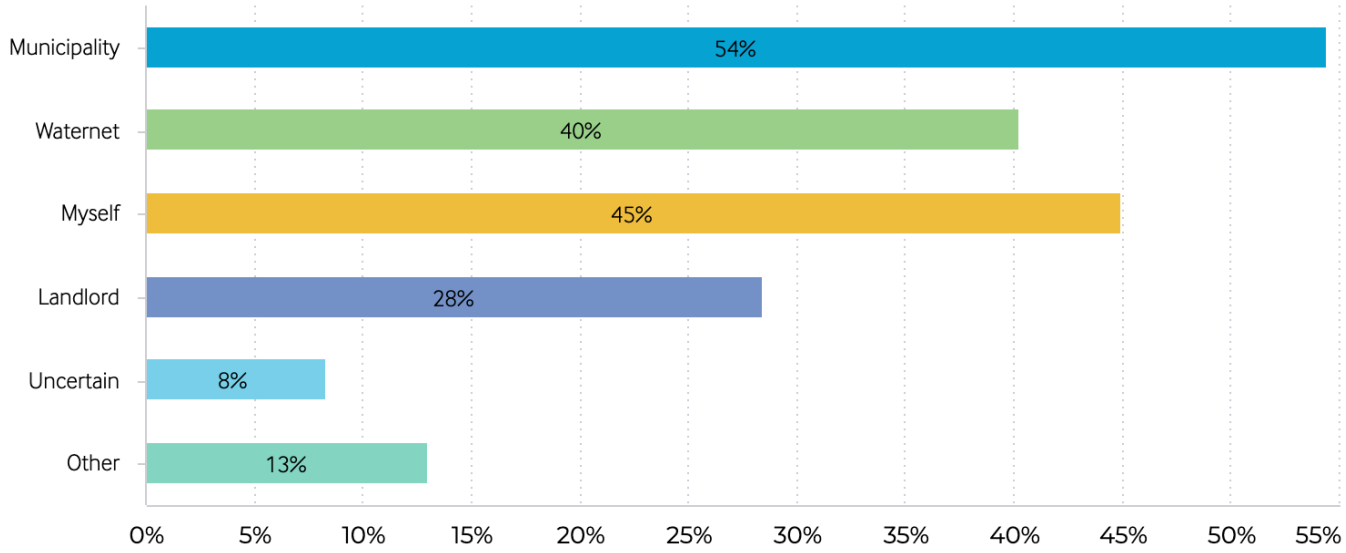


Figure 4.5 Associated responsibilities for flooding and water damage in an around the house.

Respondents were able to identify several options. The municipality is appointed to be responsible by 54% (n: 92). This is striking as the question referred to the responsibilities when considering flooding on the private lot. About 45% (n: 76) indicated their own responsibilities. Furthermore, Waternet is stated to be responsible for flooding (40%, n: 68). This distribution of responsibilities could indicate a misunderstanding of the question, whereby respondents did not associate merely gardens with 'around the house' but most likely the surrounding public area. Approximately 28% (n: 48) designate responsibilities with landlords. VVEs as well as neighbour responsibilities have been declared in the option '*others*' (13%, n: 22). Approximately 8% (n: 14) of the respondents are uncertain about responsibilities.

Respondents (n: 56) that encountered flooding within the house appointed the responsibilities also to the municipality (50%, n: 28) followed by Waternet (32%, n: 18). The landlord (36%, n: 20) was also indicated to be responsible. Their personal responsibilities where recognised by 45% (n: 25) which can be connected to either their own apartment or garden. It is crucial that residents have a sense of responsibility in order to increase the resilience of the city.

Precipitation in the future

Residents (n: 168) of De Baarsjes do expect more extreme precipitation in the future (approximately 88%, n: 148). Only 9.5% (n: 16) did not know if there is any change and approximately 2% (n: 4) did not expect more extreme precipitation. Thus most residents of De Baarsjes are aware of the change in precipitation in the future and might be able to link this knowledge to more risks and possible water issues (when nothing will be done).

Knowledge of possible countermeasures

Knowledge of possible countermeasures is linked to Awareness. Slightly less than half of the respondents (47%, n: 80) knew some measures to store water and approximately 32% (n: 54) knew water damage prevention measures. Of the respondents (47%) that did know measures to store water approximately 60% (n: 48) did also know measures to prevent water damage. Approximately 7% (n: 6) of the respondents that did not know any measure to store water (n: 89), however, they did know water damage prevention measures. The known measures are listed in Appendix L .

Knowledge about alternatives related to flooding and water damage

For more insight it has investigated if residents who encountered water damage are aware of possible countermeasures. It could be expected that residents who experienced water damage within the house or garden knew about rainproof measures, especially connected to damage prevention. Nevertheless, the knowledge of water storage measures did not considerably change in comparison to the entire group. For water damage prevention measures the knowledge increased to about 41% (n: 56) for respondents that had encountered flooding in the house (see Table 4.1).

For residents that experienced flooding in gardens (n: 42) the picture slightly shifted. About 62% (n: 26) indicated specific water collection measures. This might be connected to the availability of garden space as well as the recognition of their own responsibilities. Furthermore 45% (n: 19) did know measures to prevent damage caused by water intrusion. 65% of the respondents (n:13) that encountered both water in the apartment and garden, did know water storage and damage prevention measures.

Selecting respondents that did not experience any water damage (n: 41), only 32% (n: 13) did know about some measures to capture water. About, 83% (n: 34) of the residents (n: 41) without water damage experience were unaware of water damage prevention measures.

The following Table 4.1 shows the results filtered by ownership and living location within the building. It can be seen that only 14% (n: 3) of owners (n: 22) that are living in between the top and the ground floor are encountering flooding in the building. Residents living at the ground floor indicated that 53% (n: 20) of owners (n: 37) and 42% (n: 10) of renters (n:24) experienced flooding in the garden. That residents residing on other floors did not experience flooding in the garden is connected most likely to the 'ownership' of the garden.

Table 4.1 Different distributions depending on ownership and residing location

	Owner (n: 103)				**Renter (75)**			
	top floor	in between	ground floor	other	top floor	in between	ground floor	other
	26%	22%	37%	15%	28%	37%	32%	3%
Flooding location								
No	32%	45,5%	24%	67%	22%	16%	21%	50%
Apartment	44%	14%	34%	53%	28%	32%	30%	
Garden	-	9%	53%	67%	-	-	42%	-
Street	48%	27%	39.5%	47%	28%	44%	29%	
Other	12%	18%	8%	13%	28%	16%	25%	
Knowledge of measures to store H_2O								
Yes	52%	48%	53%	80%	28%	38.5%	37,5%	50%
No	48%	52%	47%	20%	72%	61.5%	62,5%	50%
Knowledge of measures to prevent damage								
Yes	36%	33,3%	26%	73%	11%	31%	25%	50%
No	64%	66,7%	74%	27%	89%	69%	75%	50%

Most common alternatives known by the residents

As mentioned, of all respondents approximately 47% (n: 80) and 32% (n: 54) did know measures to store water and measures to prevent water damage respectively. A categorized list can be found in Figure 4.6 for water storage and Figure 4.7 for water damage prevention. The entire list of measures that were mostly

indicated by respondents can be found in Appendix L. It was an open question and no suggestion were made. Afterwards the indicated measures were categorised and counted. Not all indicated measures are included in the table.

Measures such as rain barrel (n: 40), green roofs (n: 24), green garden (n: 16) as well as using less impermeable materials (tiles, asphalt, stones) were suggested. As water storage measures do also prevent damage it was expected that some measures were listed twice.

Additionally, some measures that were not yet mentioned in the preceding question were listed such as impregnating, waterproofing of cellars, maintenance of roofs, drainpipes in the house and sewage system. Furthermore, the installation of pumps was listed by some respondents.

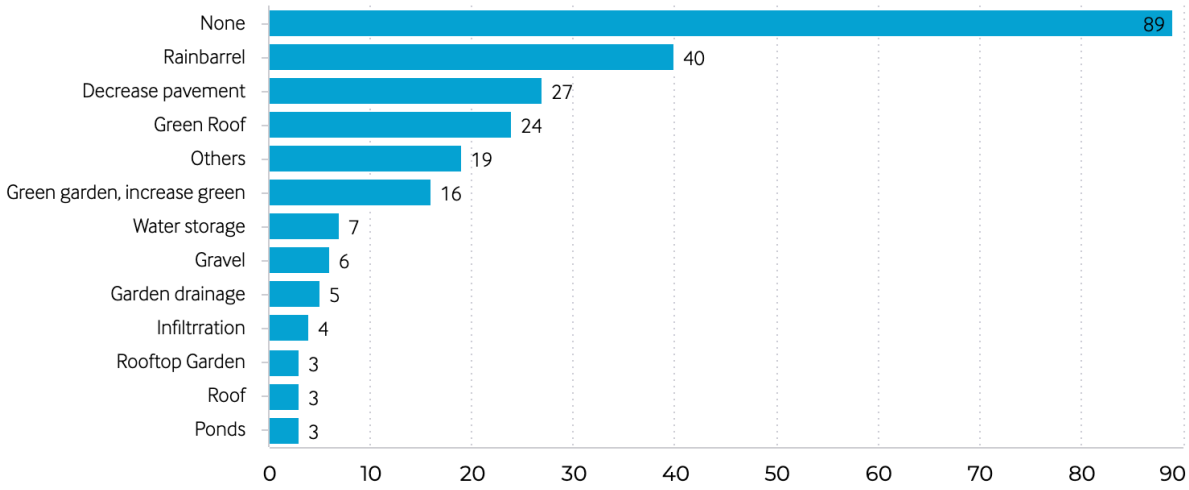


Figure 4.6 Categorized mentioned measures to store water.

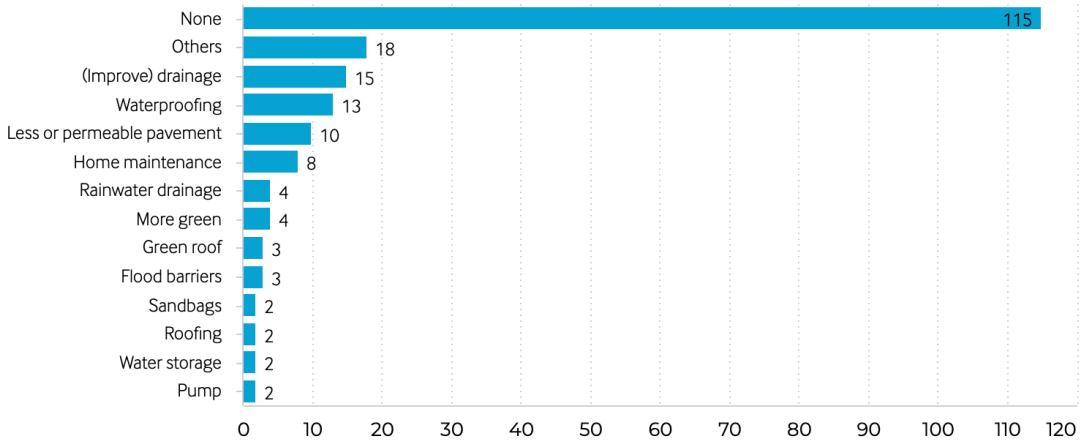


Figure 4.7 Categorized mentioned measures to prevent water damage.

Skip sequencing has been used to filter residents that supposedly can indicate effectiveness. The results of this questions can be found in Chapter 5. Thus the response rate of the following questions is lower based on this specific selection.

Association

Recognising benefits refers to the association of these with their own agenda and is not necessarily connected to water issues itself (Jeffrey and Seaton, 2004).

Benefits of alternatives

Addressing Association is challenging as residents might connect to a wider context concerning other matters than it would be expected from a water management perspective. To evaluate recognition of potential benefits respondents were enquired to identify associated benefits. The following Figure 4.8 shows the distribution of

those. Note that respondents were able to select several benefits, such aided knowledge approach respondents can be influenced in their thoughts. Respondents were able to add benefits that were not included.

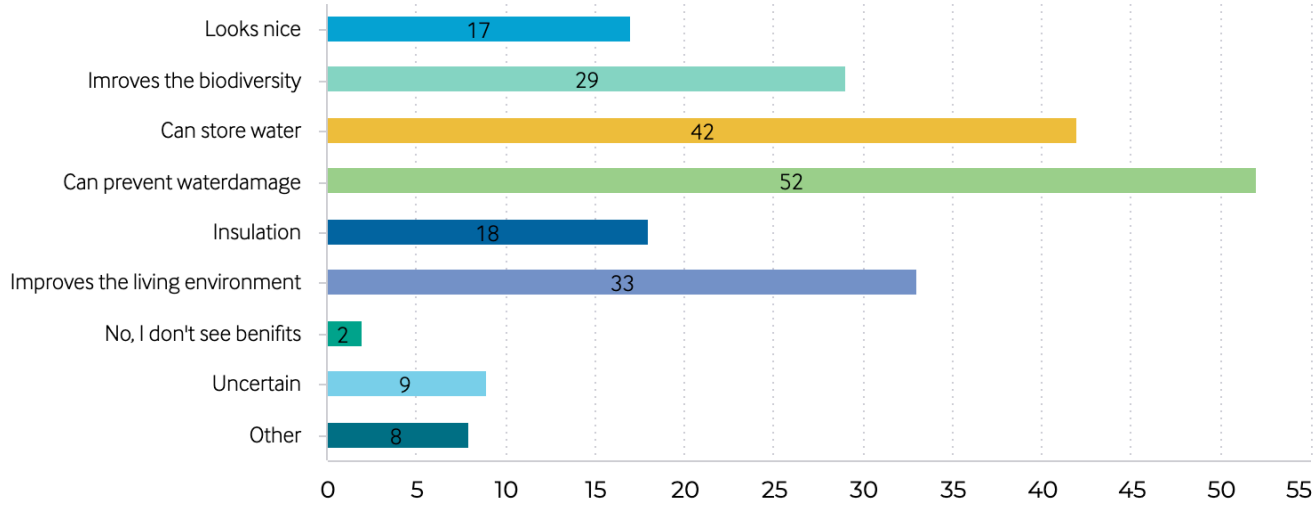


Figure 4.8 Associated benefits of measures in number of respondents.

Respondents mentioned other benefits (11%, n:8) which can be found in the following Table 4.2.

Table 4.2 Other benefits mentioned by the respondents

Dutch	English translation
Actief bezig met klimaatadaptatie en verduurzaming leefomgeving.	being active with climate adaptation and increasing the sustainability of the living environment.
Het lijkt voor mijn probleem nvt. In mijn achtertuin staat geen water.	It is not applicable for my own problem, as there is no water in my garden.
Door water op te slaan zou ik gelijk water hebben om mijn planten water te geven in een drogere periode.	When collecting/storing water it can be used during dry periods.
Ik vind dat het rijk en de gemeente alle milieu problemen moet oplossen natuurlijk.	I am convinced that the government and the municipality have to solve all issues concerning environment (*red.* and hence water issues).
Groen dak minder waterinfiltratie nodig en koeling in zomer.	Less water infiltration (*red.* at different places) is needed when installing a green roof and in the summer it can provide cooling.
Het huis is meer geld waard.	It increases the value of the house.
Niet van toepassing voor mij.	It is not applicable for me.
Nog meer muggen. Ik heb daar al jaarrond last van.	(red. That would mean) even more mosquitoes; I already have a lot of issues all year around.

Also a negative association has been identified by a respondent: '*Nog meer muggen*' (Engl.: '*even more mosquitoes*'). The mosquito issue has been emphasised by several respondents and through a discussion in a Facebook group concerning mosquito issues in De Baarsjes. Merely measures such as rainwater harvesting and extensive green roof were preferred. Whereas other measures seem to be attractive for mosquitoes according to the respondent ("*Regen water gebruiken voor toilet. Sedum dak op schuur [...] Overige tuinoplossingen [...] te* ***aantrekkelijk voor muggen en daar heeft deze buurt nu al last van***.")

Connecting it to their agenda

Besides the knowledge of potential benefits it is crucial that residents connect measures and their benefits to their own agenda. This is most likely a complex process, which is influenced by the conscious and unconscious mind, their surroundings and specific situation. For example certain circumstances (such as age, illness, lack of money, other dependencies and urgent matter) could hamper the association.

The respondents (n: 71) indicated that 44% (n: 31) were definitely willing to invest time and money to implement rainproof measures, whereas 46.5% (n:33) are only willing to invest little time and money and about 10% (n: 7) is not willing to invest at all. This gives an indication about the degree of association; however, note that much more complexity is connected than what can be investigated through this specific questionnaire.

Acquisition

Acquisition refers to the ability to acquire, implement, operate and maintain an alternative innovation (Jeffrey and Seaton, 2004). An open question was provided to investigate this requirement. Firstly a scenario was introduced where they are able to acquire these measures provoking respondents to answer about implementation (which and why). Secondly, a question referring to information requirements and accessibility was asked. The pure ability to retrieve information and implement is neglected in order to simplify the questionnaire.

Insight was sought whether respondents do connect countermeasures with their own agenda and are aware of their possible benefits. It gave an indication of favoured measures without proposing specific answers by the researcher. Several measures mentioned by the respondents are summarised below, but do not cover all. A complete overview can be found in the Appendix L .

Green roofs

Respondents would implement green roofs; additionally rooftop gardens were mentioned, as they also have aesthetic benefits and provide isolation additionally to increasing resilience. Some respondents indicated that this is their only option, living on the top floor. Regardless, they also pointed out that this is merely possible in cooperation with the VVE. Besides, respondents indicated, previous installed solar panels would complicate its implementation and increases expanses. Furthermore respondents declared limitations concerning finances: [...] Green garden and sedum roof, whereby the latter one is still **a bit expensive**. I am **searching for advice**."

Creating water storage

Creating more water storage can be referred to several measures that have been indicated by the respondents, such as rainwater ponds, rainwater fence, wells, water reservoirs and height differences in gardens.

To some extent, rain barrels create additional storage; however, the water quantity that can be stored is size depending. This specific measure was mentioned 15 times, whereby some respondents indicated that bigger rain barrels are necessary. Furthermore rainwater harvesting and reuse has been mentioned. It was also implied that rain barrels could however increase mosquito issues.

Increasing infiltration capacities

Respondents recommended the implementation of infiltration opportunities such as using less impermeable material, infiltration crates, gravel pits, wadis as well as ground improvement by using sand. More green could also improve the infiltration and more vegetation was considered a desired measure: "*A lot of green in the*

garden. it will improve the biodiversity, a healthy feeling and helps to process rainwater." ("*Veel groen in de tuin. Dat vergroot de biodiversiteit, geeft een gezond gevoel en helpt om regenwater te verwerken.*") (Engl.:). Thus it not only tackles the issue with water but also increases the biodiversity and improves the living environment.

Disconnecting stormwater

Disconnecting rainwater/stormwater from the combined sewerage was also an option that was seen as an opportunity. This separation and possible reuse for toilet flushing might overcome the issue of an overload on the sewerage system.

Implemented or intended

Several respondents indicated that they are already planning to implement certain measures or that the implementation was accomplished (receptive). For example it has been stated that a second rain barrel could save tap water and money when using rainwater in the garden.

Lacking knowledge

Nevertheless, it also can be seen that respondents are unsure about measures. It is not so straightforward which of the measures would fit which situation the best. Thereby not only the hydrological situation needs to be considered but also the personal situation of residents.

Obtaining knowledge

For the Acquisition the ability to gain information as well as to implement, operate and maintain the measure are required. This was also an open question in order to let respondents think freely about different options without any suggestion.

Respondents allude to data sources such as internet (n: 18), specialists (n: 8), municipality (n: 10), Waternet (n: 4), Amsterdam Rainproof (n: 4), contractors ("*aannemers*") (n: 4), waterboard (n: 2), among others (entire list can be found in the Appendix L). Based on this indication residents often use online platforms but they also desire information from the municipality. Additionally a respondent states that the municipality as well as the waterboard is probably most objective, hence gives unbiased advice. Furthermore Amsterdam Rainproof and Waternet were mentioned, which probably connects to their expertise as well as responsibilities. Also, specialists play an important role providing information.

Application

Being able to achieve benefits through sufficient legal and financial incentives refers to the fourth requirement of the receptivity model. Its evaluation is complex and most likely depends on specific situations and level of incentives. An indication of their motivation of implementation has been enquired. The following Figure 4.9 gives an overview of different motivations.

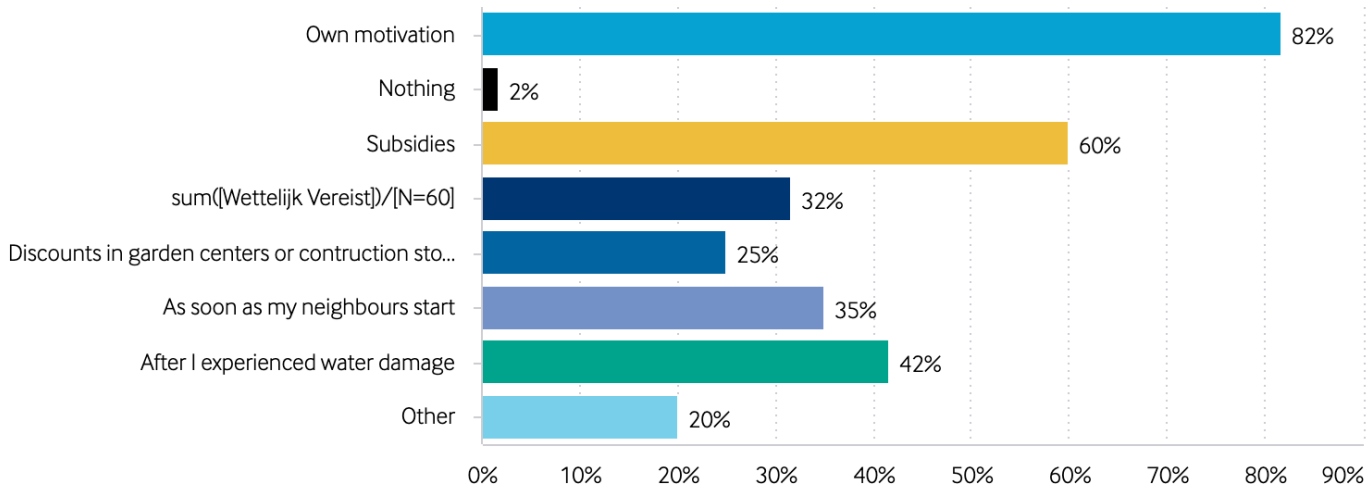


Figure 4.9 Driving force to take action in % of participants (n: 60).

It can be seen that the personal motivation scores quite well followed by financial incentives such as subsidies. Other driving forces were indicated such as board decisions, mosquito issue, sustainability, availability of clear solutions among others (see Appendix L). A selection of longer remarks from participants of the questionnaire can be found in Appendix M. The next subchapter presents the main results of the focus groups.

4.2. Focus group

This subchapter presents the findings of the focus group meetings and reflects on their comments. Two focus group sessions were held, one on 30 January and the second on 1 February 2018. The group of 30 January contained seven respondents. Another respondent showed up later but had a completely different agenda and interpretation of the evening. On this day actually 12 respondents were supposed to arrive, whereby two excused themselves beforehand and another one afterwards. On 1 February 2018, seven respondents were supposed to participate; however, one participant brought two neighbours. Hence the group was bigger than expected. The size of both groups within the restraints for focus groups (eight and nine participants). The programme for the focus groups can be found in the Appendix K.

4.2.1. Focus group on 30 of January 2018

In this focus group session participants already shared valuable information during their introduction. Not only about water issues but also advices were given to one another. It was remarkable that participants experienced similar water issues and were living close by each other in the neighbourhood but never discussed these problems before among another. The similar living location (ground floor) and thus comparable water issues was striking and influenced the communication. The introduction revealed that participants were eager to overcome water issues. They were interested in advice and tips, as well as in new developments and about the contribution of different measures towards a solution. Furthermore, already during the introduction it was mentioned that it seems to be a shared problem. The topic of introducing more plants to the city was also slightly touched.

Before the first statement was announced participants were asked to say briefly something about their recollection of an extreme precipitation event:

'Denk daarbij aan een hevige regenbui die jullie mee hebben gemaakt. Wat zijn jullie herinneringen daaraan?'

This question was supposed to loosen the participants and get them openminded for upcoming topics. As this question triggered laugher, participants were much more eased to continue the discussion. The recollection of the memories provoked the association with fear of flooded cellars during high intensity and long duration precipitation. Besides, participants relate extreme cloudburst with gardens turning into swimming pools. Due to poor maintenance of neighbouring rain pipes, participants were not comfortable at

work during extreme precipitation and felt the urge to check. One resident already suggested some compensation when building an extension to the house like implementing green roofs.

The following statement presented: ***'Als het extreem regent, ben ik zelf verantwoordelijk voor droge voeten thuis.'*** (Engl.: During extreme precipitation I am responsible for keeping my home dry.) The first reaction was: "yes, it is difficult to make the neighbours responsible". Throughout the discussion it arose that they are responsible for their own property and hence keeping water out of the house is their personal responsibility. However, the municipality and Waternet are responsible for the drainage of stormwater (afwatering). A shared responsibility considering gardens played a role in the discussion. Thereby they indicated that the definition of 'home' is crucial to this statement. Responsibilities might be overlapping and showing dependencies on VVEs. In circumstances connected with renters and landlords the situation is different compared to house-owners.

An entire discussion arose about groundwater whereby uncertainties emerged about groundwater levels, its extractions, regulation and responsibilities. Thereby it became clear that participants consider this an important topic to better understand their own situation. They all experienced flooding or moisture on ground floor or cellar. High groundwater levels or water accumulation connected to the question how groundwater is flowing and regulated had a major influence on the discussion. Thereby they gave each other explanations and shared their knowledge. To some extent it was connected to responsibilities for groundwater extraction and groundwater level, yet drifted away from the responsibilities of their private lot. Nevertheless, this discussion gave valuable insight in the topics that are dominant when addressing water issues concerning ground floor and cellar.

As this statement did not bring up new ideas about responsibilities and came back to groundwater the next statement was presented bringing them back to focus:

'Op mijn eigen terrein mag de gemeente bepalen wat verplichte maatregelen zijn om wateroverlast te voorkomen.' (Engl.: The municipality is allowed to appoint obligatory measures on my own terrain in order to prevent water issues/ flooding.)

The first reaction was that this would only be acceptable when private terrain is the cause of water issues for the surrounding. If water issues merely appear on own terrain, then owners themselves should be responsible and decide. The discussion drifted towards raising gardens and how this could influence flooding of neighbouring gardens.

A different suggestion arose: If it is impossible to solve the problem on the street, why not use gardens to overcome flooding on the streets? "*De binnentuin als buffer [...]* (*binnentuinen als uiterwaarden*)" This idea was to some extent accepted by the rest of the group as it seemed a logical alternative; however, it was also mentioned why not other solutions on public space for instance lower laying parking places could be considered first.

Agreement with the statement was also articulated by one participant as it does not seem practical if one tries to solve an issue that concerns everyone. Hence the (municipality and) government and their advice, support and coordinating role are essential (*"Eens met stelling, [...]. Allemaal stukje bijdragen, daar hebben we overheid bij nodig."*). As the municipality has the complete picture on issues such as: sewer system, groundwater levels, pumping regulations, it could be accepted that they determine the necessary measures.

It was proclaimed that if the municipality decides about obligatory measures it could prevent free riders. The topic of other obligatory measures like green roofs were introduced particularly. For instance a mandate via the destination plan ('*bestemmingsplan*') could give some regulations.

It was also steered back to the necessity of temporary stormwater storage rather than drainage. Hence providing water storage during precipitation events which can be used during dry periods "*[....] water niet weggooien, maar vasthouden voor in droge periodes*". This indicates awareness about the urgency to retain water at the location rather than draining it fast.

The occurrence of a tension was pointed out as restrictions by regulations were unpleasant; however, it also is a shared issue and if there is a common interest it might be possible to find a common solution. Thereby it was also indicated that it should be balanced. The issue of taxes was mentioned as they already pay for

sewage and expect that the municipality takes their responsibilities. As there were a lot of uncertainties about the groundwater, expert information from Amsterdam Rainproof was used to clarify the issue: Waternet is thereby the executing party and has the legal obligation to exercise diligence concerning rainwater and groundwater (’*Hemelwater en grondwater zorgplicht*’). Hence different ideas were connected to this statement, whereby participants agreed to some extent upon the necessity to the municipality’s or governmental involvement. In which way exactly can differ and depends on the specific situation.

The following statement was presented: ’***Als mijn buren niets doen om wateroverlast te voorkomen, dan doe ik ook niets***.’ (Engl.: If my neighbour does not do anything to prevent flooding, then I won’t either.) This statement did not provoke a deep discussion. The participants were convinced that this would not be any solution but also pointed out that the cooperation is the best way to go forward. It was also referred to the game theory. A system enabling participation to reach the common goal through enough incentives is necessary (‘systeem wat de prikkels zo heeft dat iedereen optimaal meedoet aan gezamenlijk goede’).

Based on the reaction to the given statement participants are not held back on their decision to actively do something about flooding (when they experience this issue), even though neighbours might not feel the urge to do so themselves. The common goal plays an important ambition to tackle water issues as a community.

The last statement that was introduced to the participants was as follows: **“*De gemeente moet de eerste stap zetten om wateroverlast te voorkomen.*”** (Engl.: The municipality has to do the first step towards preventing flooding/water damage.)

The first reaction on this statement was: “*Een paraplu boven de stad.*” (Engl.: ‘umbrella above the city’). This could indicate that the municipality does need to find a solution or that the statement is not taken seriously. It might also demonstrate the complexity of water problems providing difficulties to pinpoint what the first step could be.

Throughout the discussion responsibilities came up again. Thereby it was emphasised that even if the municipality is responsible, residents need to signalise issues that should be addressed. As it is a common problem, cooperation seems necessary. Also the expectation of getting advice, information and initiatives were mentioned by participants, which refers to the role the municipality can play in order to set a first step. It was accentuated that residents do not have the knowledge and knowhow to approach the issue properly. Thus the municipality should make it easy for residents to gain knowledge and offer advice (not only general but also specific advice). It is stressed that Amsterdam Rainproof can play an important role in this process.

4.2.2. Focus group on 1 February 2018

The second focus group was conducted on the 1st of February 2018. Nine participants were present during this session. This time the tables were brought a bit closer to each other in order to create a more ideal surrounding. The group arrived on time and the ambience felt relaxed and open. The same programme (see Appendix K) was maintained. Whereby due to the first experience more confidence for the facilitation of the second focus group was present.

A short introduction round gave some interesting insight in the group. This group showed different characteristics compared to the first group. The first group for instance were more homogeneous, experiencing the same water issues. Regardless this diversity they all appeared to be interested in the topic. They all seem to be aware of the problems considering precipitation. The extent in expectations towards measures differed considerably form solving leakages, pure interest what is out there up to reusing water in the house.

After the introduction also this group was asked to recall any memories about an extreme precipitation event: ***‘Denk daarbij aan een hevige regenbui die jullie mee hebben gemaakt. Wat zijn jullie herinneringen daaraan?’***.

The first reaction was a memory of getting rid of the water in front of the door with a broom. It triggered also already the question if water on the street is caused by rising groundwater or by stormwater that cannot

infiltrate. It was also indicated by some participants that neighbours are communicating, also during extreme precipitation, and warning each other. Furthermore the question towards other participants arose if all belongings are raised. This demonstrated that some knowledge about damage prevention is present in the group as well as the eagerness to share knowledge and give advice to each other.

The first statement was presented: '***Als het extreem regent, ben ik zelf verantwoordelijk voor droge voeten thuis***.' (Engl.: During extreme precipitation I am responsible to keep my home dry.) Thereby the first reaction to this statement was: 'N*o, the weather gods*'. Which brought up laughter. Additionally this statement was analysed by participants:

> Does the statement consider one day, month, years?
>
> What is responsibility?
>
> As owner – you are probably responsible.
>
> But is the municipality allowed to enforce certain measures?
>
> Can you expect stimulating measures from the government?
>
> I think as owner of the terrain you are responsible for monetary issues.

These thoughts already brought up many topics which were supposed to be introduced later. Notwithstanding it showed the complexity of the topic is recognised by residents. But it also shows uncertainties about responsibilities, or the interpretation of responsibilities. Throughout the discussion it also became clear that a collective responsibility is recognised towards this topic, whereby also the municipality should be part of it. Especially when it comes to stimulation of adaptation measures.

It was also pointed out that one question remains: '*gaat dat wat opleveren?*' (Engl.: '*does it yield anything?*'). According to participants, generally people are not willing to invest money, especially if they do not gain anything through this investment. But also if others might not do so, some would not feel responsible themselves ('*Als mijn buurman het niet doet, waarom ik wel.*'). All these considerations were brought up during the discussion of the first statement. Throughout the discussion it was also indicated that if people are experiencing for instance an excessive amount of water in the garden they will cooperate to solve the issue.

Additionally responsibilities for the sewer system were mentioned. It was suggested that water pumped from the house on the street would return as the sewer system cannot cope with such extreme amounts of water. Sharing responsibilities for rainfall was thereby a reoccurring subject. Different options such as temporary storage of rainwater on private terrain might relieve the public water system, but the actions of the municipality were questioned. (*[...] uit binnentuin bufferen, na verloop [...] terug straat op. [...] kost veel geld, en voelt scheef (wat doet gemeente?) maar als het heftig wordt moeten we het wel zelf oplossen door bufferen.*"; "*[…] hwa afkoppelen, enige wat ik kan doen. Is niet erg dat ik dat doe, maar ligt vooral ook bij waternet.*"). Nevertheless, it was equally suggested that with an increasing trend of extreme precipitation the necessity arises to create temporary water storage by residents. Suggestions were done such as implementing grey water system. Thereby it has been made clear that this should be supported and facilitated by Waternet ('*komt meer water bij zuiveringsinstallaties, niet alleen regen, maar ook gebruik. Nieuwe installaties kunnen dit aan, maar is slechte gedachte. Als waternet zou zeggen grijs-water WC, bespaart 30 kuub per huishouden. [...]').* It was suggested that the reuse of stormwater can be promoted when drinking water prices would increase. Due to low drinking water pricing, residents are using lots of water and are not considering the usage of grey water in their household. This could have an impact on the water issue.

Another recommendation to tackle the water issue was brought up when considering the mostly impermeable gardens (*'Verantwoordelijkheid. Tuin vol met tegels [...]. Je eigen tuin zo inrichten zodat water weg kan lopen.'*). The so-called tile-tax was introduced by respondents. This concept, which manifested itself already in for instance Germany, could encourage residents to use less impervious material and hence does not hamper the infiltration. Thus the participants were already thinking about possible solutions.

It was also declared that issues with the procedure of the municipality are occurring. The expectation towards solutions by owners themselves comes first. One respondent revealed that she/he invested time and money;

however, the problem was not found on the private lot. Merely after all his/her effort the municipality was willing to check on public space. Nevertheless, the already invested money was lost, which affected the frustration level. It seemed appealing for respondents to change the structure within the regulations and/or communication between municipality and residents.

It was intriguing that the first statement triggered already plenty of thoughts that were supposed to be debated in the following statements. Participants did not only discuss the responsibilities that could be connected to their own terrain also legal boundaries played a significant role. Water does not follow the rules of such boundaries. Furthermore "*Hoe het gecoördineerd wordt maakt niet uit, als er maar verteld wordt welke maatregelen we samen nemen?*" shows the urgency that something will be done and that pinpointing appropriate measures that will be introduced can play a crucial role. Throughout the discussion it also became clear that the sewer system, its maintenance and durability plays an important role and information about this might help to get a better idea of the situation.

In order to have a similar setting compared to the first focus group the second statement was introduced: **'*Op mijn eigen terrein mag de gemeente bepalen wat verplichte maatregelen zijn om wateroverlast te voorkomen.*'** (Engl.: The municipality is allowed to appoint obligatory measures on my own terrain in order to prevent water issues/ flooding.) Note that participants already mentioned this thought. The first reaction was that the municipality does it already for example that without a permit cutting trees was forbidden. It was also mentioned that it depends on the responsibilities, for instance if owners are responsible for water on roofs then the municipality is allowed to impose measures, when it causes issues for the surroundings. However, if Waternet is responsible it should not be allowed to force owners to implement certain measures. Another respondent declared that this statement does work, but only if the municipality also takes over their responsibilities. It will be more accepted when responsibilities are shared and the municipality does not only require standards but also implements and facilitates interventions. Participants indicated that this aspect triggered the feeling that the municipality creates only more flooding due to the usage of asphalt and creating parking spaces instead of green areas.

This gave the opportunity to retrieve which tasks the municipality should cut to invest in climate adaptation measures: **'*De gemeente moet andere taken laten vallen maar wel in klimaatbestendigheid investeren.*'** (Engl.: The municipality has to let go of several tasks to invest in climate resistance.) It became clear that this statement was not fitting, as no tasks where pointed out but it was emphasised that the choices that the municipality is making have to be different. Hence it was disclosed that while accomplishing all their tasks, the municipality should make their choices accordingly to a climate resilient approach. This idea was agreed upon within the group.

The following statement was presented: '***Als mijn buren niets doen om wateroverlast te voorkomen, dan doe ik ook niets***.' (Engl.: If my neighbour does not do anything to prevent flooding, then I won't either.) Participant did not agree with the statement. They indicated that communication with the neighbours might be helpful but probably not always successful. The participants also suggested that some neighbours might not recognise the issues like a tiled garden or feel the urgency. Various solutions were acknowledged but pointed out that not all are desirable.

Generally this statement did not provoke a deep discussion as participants were convinced that this would not be a solution. Eventually everybody wants to prevent damage in their own home. So it is not advisable to wait for others to take the first step.

As this statement did not trigger a discussion the next statement was introduced: **'*De gemeente moet de eerste stap zetten om wateroverlast te voorkomen.*'** (Engl.: The municipality has to do the first step towards preventing flooding/water damage.)

The definition of 'the first step' is crucial for this statement. It was also indicated that the municipality could facilitate initiatives: "*De gemeente zou allemaal initiatieven kunnen initiëren, elkaar inspireren. Maar welke eerste stap? Voldoen aan zorgplicht.*". Moreover it was suggested that the municipality should follow up on their obligation to exercise diligence. It seemed that participant would be open for '*reduced taxes*' when using less tiles, similar compared to the concept already applied in Germany. The obligation of awareness creation

by the municipality was pointed out. It appeared that communication about the water issues is desired. Good communication could give clarity about the different tasks, responsibilities, possibilities and tools for all stakeholders. Facilitating actions and stimulation as well as specific information on measures was longed-for.

Participants mentioned that it might not always be favourable to give all information to the residents as it could also create panic. Residents might overreact as they do not know how to deal or react to threatening situations like chance of flooding. This comment seemed an assumption why at the moment not all details are shared with residents. The urgent request of participants for information is more relevant in the discussion.

The last statement was the following: ***'Als ik er geld mee kan besparen, sta ik open voor het investeren in maatregelen.***' (Engl.: If I can save money eventually I will invest in measures')

This statement got a clear agreement. It was also pointed out that this should not be the main driver in order to invest in measures but it does help to choose for it. It was also denoted that it could positively contribute in a large area of De Baarsjes due to lacking financial stability. For instance, renters might have a different situation. The question arose who is responsible in such a case, renters or land lords? From the questionnaire renters pinpointed the responsibilities were connected to the land lords. This discussion showed that financial benefits, like it was expected, could facilitate and stimulate the implementation of rainproof measures. Especially households that are less financially stable could be more open to such measures, when money could be saved by solving the problem instead of fighting the symptoms.

5 The perceived effectiveness versus the calculated effectiveness through AST of rainproof measures

The second part of the research is connected to effectiveness of rainproof measures, that are suitable for private ground.

5.1. Effectiveness of rainproof measures associated by the respondents

Within the questionnaire the perceived effectivity was sought. The results are briefly presented in the following chapter.

5.1.1. Effectiveness of rainproof measures

Effectiveness of measures can be defined from different point of views. When looking at measures from a water managers perspective the effectiveness of measures can be referred to as the amount of water that they can store and/or delay and the damage prevention connected to it. Hence, it relates to water quantity and its corresponding relief of the water system. The effectiveness calculated within AST is calculated on the storage capacities only. When all water is stored it cannot inflict damage. From the point of view of residents a different picture may appear. Perhaps effectiveness is connected other benefits and reasons they are associating with rainproof measures (biodiversity, aesthetics).

5.1.2. Perceived effectiveness of rainproof measures by residents

The respondents (n: 62) of the questionnaire were asked to indicate for a limited selection of adaptation measures: '*if they **don't know** the specific measure*', '*if they **know** it but did not implement it (yet)*' or '*if they **implemented** the specific measure*' as a reference about their knowledge. Respondents that selected one or several measures with '*know them and implemented them*' can be called receptive to these rainproof measures.

5.1.2.1 Measures that store water

Next to the presented countermeasures to store water, respondents were able to add measures that were not indicated in the list (Appendix L). Table 5.1 shows purely the measures that were given.

Table 5.1 Indication about the percentage of residents that do (not) know a water collection measure or already implemented it (n: 62)

Measure	Unknown	Known	known and implemented
Green roofs	9%	84%	7%
Polder roof	78%	22%	-
Infiltration crates	56%	43%	1%
Height differences within the garden	24%	60%	16%

Wadis	57%	43%	-
Rainwater pond	18%	76%	6%
Rainwater tanks	25%	72%	8%
Rain barrel	4%	87%	9%
Water-retaining planters	33%	55%	12%
Rainwater fence	78%	21%	1%

Rain barrels are well known they have not been implemented a lot. Only about 8% (n: 6) of the respondents indicate that they implemented them.

Effectiveness

When looking at the ranking for perceived effectiveness to store water only predetermined measures can be compared. Other measures were only mentioned once and thus do not give a realistic picture. Figure 5.1 visualises the perceived effectiveness reaching between 47% and a maximum of 71%. Note, that the scale only used four options reaching from '--' collects very little water (0%) to '++' collects a lot of water (100%). The count if these four options is visualised in a histogram. The average effectiveness is indicated by the yellow line. The entire outcome of the known measures and the respectively perceived effectiveness including the added measures by the respondents can be found in the Appendix N.

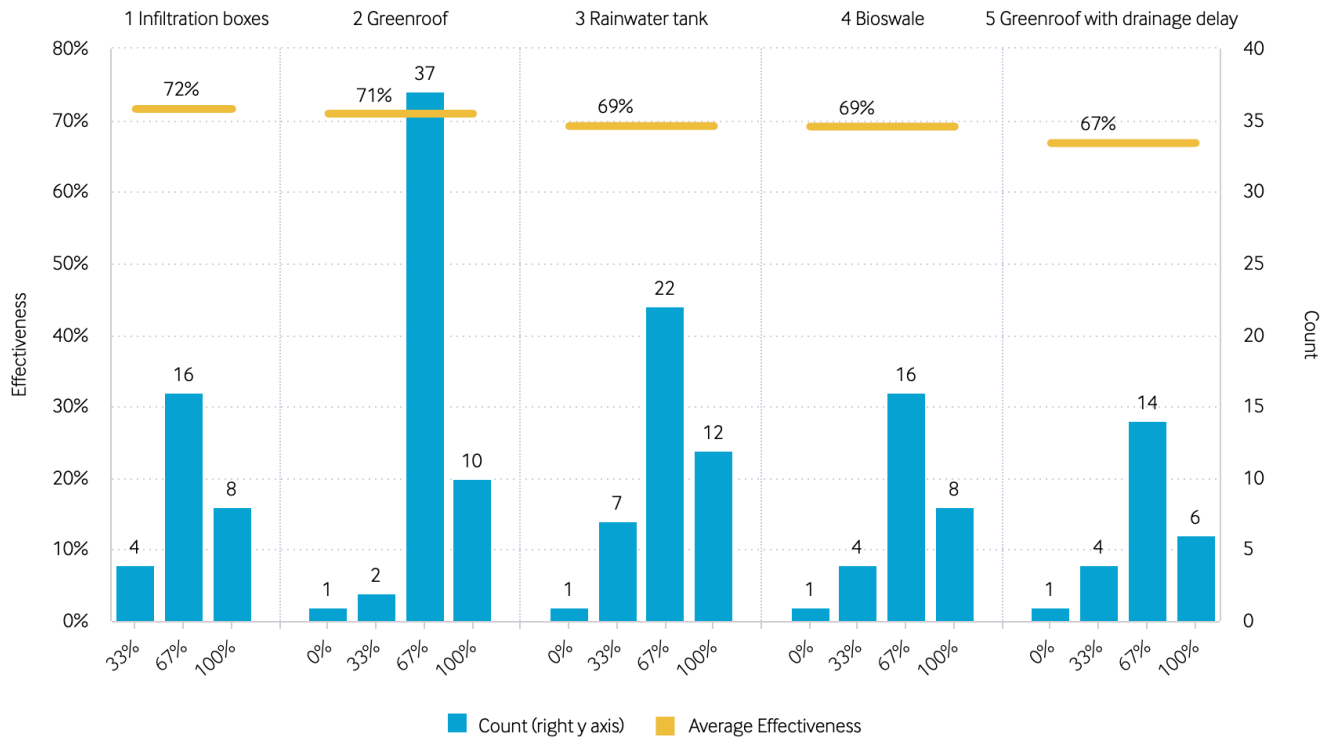


Figure 5.1 Estimated effectiveness of rainproofing measures as perceived (store water) in % by the respondents (n:71). Rank 1-5

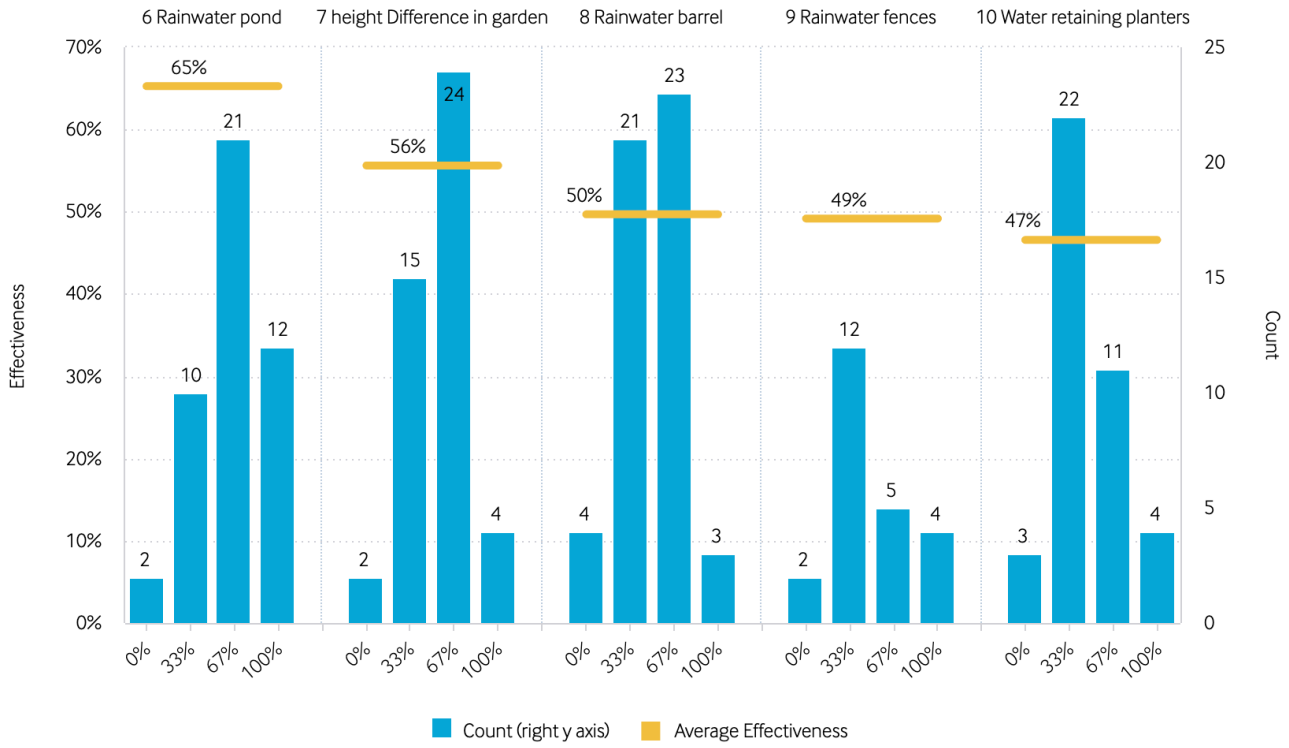


Figure 5.2 Estimated effectiveness of rainproofing measures as perceived (store water) in % by the respondents (n:71). Rank 6-10.

As can be seen in the Figure 5.1 and 5.2, green roofs are associated with an effectiveness of 71%, polder roof, which are much more unknown by the respondents is ranked with an effectiveness of 67%. Infiltration crates (72%) get nearly the same estimation as green roofs. For infiltration boxes none of the respondents indicated 'collects very little water (0%)'. Rainwater tanks and wadis are estimated third highest with an effectiveness of 69% followed by polder roofs (67%). Rainwater ponds score an estimation of 65% followed by height differences in the garden with 56%. Rainwater barrel scores lower compared to the before mentioned measures; however, it is still considerable with an effectiveness of 50%. Rainwater fences are estimated slightly lower with 49% and lastly water containing planters with 47% is ranked the lowest. As the percentage of the perceived effectiveness cannot be compared with the calculated effectiveness a ranking has been introduced.

5.1.2.2 Measures that solely prevent water damage

The second part of perceived effectiveness addresses water damage prevention measures. Thereby a similar table had to be filled in, only varying in the measures themselves. The results are presented in Table 5.2.

Table 5.2 Indication about the percentage of residents that do (not) know a water damage prevention measure or already implemented it.

Measure	Unknown	Known	known and implemented
Elevated doorstep	14%	75%	11%
Temporary barriers in the door	46%	54%	-
Elevated threshold of parking space	47%	53%	-
Higher placement of the electricity connection	42%	47%	11%
Rain-resistant building materials	41%	45%	14%

It can be seen that *elevated doorstep* is the most common measure known by the respondents with about 75%. The other measures that are known but have not been implemented correspond with the results of the section unknown measures: approximately 54% does know *temporary barriers in the door*, 53% *elevated threshold of parking space*. Hence slightly more respondents (n:) knew some measures, or even implemented a measure.

Furthermore some additional measures were indicated by the respondents, such as and improved roof, bypass rain pipe, '*injecteren*' (Engl.: inject), large and strong sewer pipes, lower groundwater levels and hence more storage capacity, waterproofing of the foundation of the building ('*buitenkant gevel van souterrain (onder de grond) uitgraven en besmeren met bitumen*'), disconnecting rain pipes from sewer, more plants and adequate reparations.

Effectiveness

The estimated effectiveness indicated by the respondents is shown in Figure 5.2 and is reaching between 47% and 59%. The combined table of the results can be seen in Appendix N

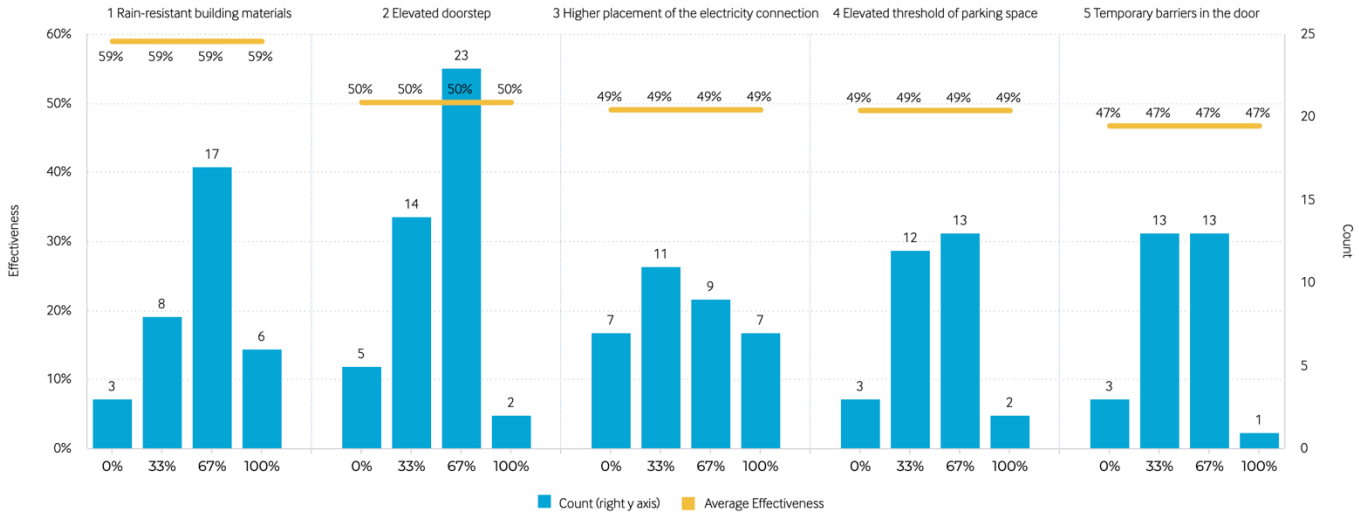


Figure 5.3 Perceived effectiveness of water damage prevention measures in % by the respondents (n:66)

Based on the answers for this question the usage of rainproof materials and construction methods (*Rain-resistant building materials 59%*) is associated to be most effective (59%) compared to the other measures. Closely followed by e*levated doorstep* with 50%, *elevated threshold of parking space* 49%, *higher placement of the electricity connection* 49% and *temporary barriers in the door* 47%.

The following Subchapter 5.2 shows the results of the analysis of a selection of rainproof measures with the Adaptation Support Tool (AST).

5.2. Calculations of the effectiveness within Adaptation Support Tool (AST)

To compare the perceived effectiveness of rainproof measures the calculated effectiveness from a water managers perspective the AST has been used. Within the method (Chapter 2.4.2 Approach) the steps taken towards this calculations and assumptions were explained. Note, that only water collecting measures can be calculated with the AST; damage prevention measures are not included in this tool. The following subchapter reveals the results of the calculation.

5.2.1. Object level

The effectiveness of the measures was compared within an object level setting, whereby specific dimensions were assigned to them. As the goal for this object level is to cope with a temporal storage of 60 mm each measure has been compared to this specific threshold value. Table 5.3 gives the underlying dimensions of the measures for the object level. Screenshots from the AST showing the object level implementation can be found in Appendix O.

Table 5.3 Proposed measures in the garden unit setting and their respective size approximation.

Proposed measure	**Size approximation in m^2**
Average flat rooftop: 90 m^2 (entire roof approximately 104 m^2)	
Extensive green roof	90 m^2 **
intensive green roof	87 m^2 **
Total garden size: 104 m^2	
Terraces and paved area (pervious pavement)	20 m^2
Shallow infiltration boxes (under the terraces)	20 m^2
Rainwater retention pond	9 m^2
Rainwater tank (barrel)	0.25 m^2
Rainwater harvesting	3.14 m^2
Wadi	6 m^2
Green garden	84 m^2 ***
** It was not possible to get both roofs the same size due to drawing restrains. The closest approximation has been used	
*** $A_{green\ garden} = A_{total\ garden} - A_{terrace}$: 84m^2 = 104 m^2 - 20m^2	

Table 5.4 shows the storage capacities and consequently effectiveness as well as a first estimate of corresponding construction costs and annual maintenance costs of the measures, based on the information from the AST, with specific assigned dimensions. For this specific setting and chosen dimensions an intensive green roof can contribute up to 42%, not even moderate effectiveness. Followed by green garden with 27% and third ranked measures: shallow infiltration boxes with 25% and a system for rainwater harvesting also 25%. Extensive green roof and rainwater retention pond (of 9 m^2) can store up to 22% of the target. Porous pavement contributes 5% and rainwater barrel 2%. None of the measures scores a 100% (sufficient effectiveness) coverage of the required 60 mm storage. In order to achieve a rainproof garden a combination of different measures is required.

Table 5.4 is sorted by the effectiveness of each measure. The first rank corresponding with the highest effectiveness and the last rank with the lowest. This has been done to be able to compare the perceived effectiveness with the calculated effectiveness (see Chapter 5.3). Based on the storage capacity values it shows that Green Infrastructure (GI) like intensive green roofs or green gardens contribute more towards a rainproof garden compared to for instance a rain barrel. This is also connected to the dimension of the measure.

Table 5.4 Storage capacity, construction and maintenance costs and effectiveness of the different types of measures.

Measure type	Storage capacity in m^3	Construction costs	Annual maintenance costs	Effectiveness 60mm - 100%
Intensive green roof	5.22	€ 8,700	€ 435.00	42%
Private green garden	3.72	€ 5,040	€ 50.40	27%
Shallow infiltration measures, boxes (sand)	3.15	€ 8,400	€ 1,260.00	25%
Systems for rainwater harvesting	3.14	€ 3,141	€ 157.05	25%
Rainwater retention pond	2,7	€ 180	€ 3.60	22%
Extensive green roof	2.7	€ 5,400	€ 270.00	22%
Bioswale	1.56	€ 420	€ 4.20	13%
Porous pavement	0.6	€ 200	€ 10.00	5%
Rainwater barrel	0.25	€ 250	€ 12.50	2%

The implementation of rainproofing measures is connected to investment and maintenance costs, also indicated in Table 5.6. These costs are design specific related to the chosen dimensions of the object level. Comparing the construction costs of the different measures; a rainwater retention pond, followed by the porous pavement (terraces) have the lowest investment costs, whereas intensive green roof has the highest construction costs. Shallow infiltration tanks also have high construction costs. The absolute values make it difficult to compare for different design choices; therefore, following question arises:

Do higher construction costs correspond with a high effectiveness?

It is interesting to check the costs against the effectiveness of a measurement. Figure 5.4 shows the construction costs versus the effectiveness.

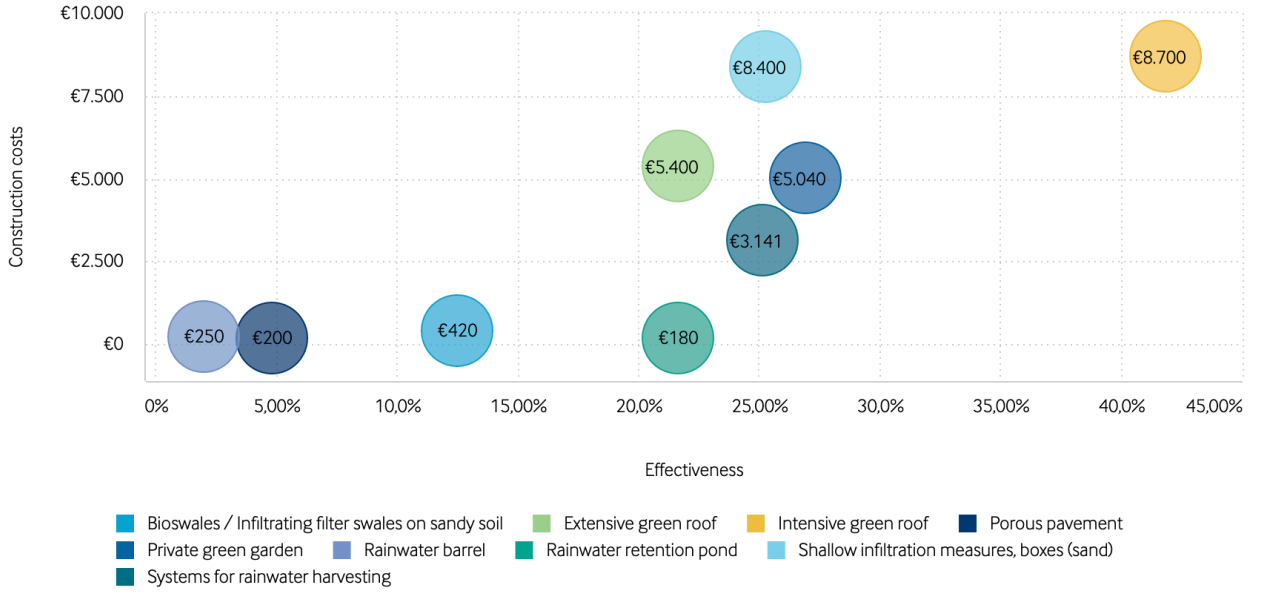


Figure 5.4 Calculated effectiveness plotted against the construction costs of the specific design choices of the object level.

Generally, the more effective a measure is the higher the investment costs. Yet, a rainwater retention pond of 9m^2 reveals low construction costs whereas the effectiveness corresponds with 22%. This measure gives for the lowest costs, the highest effectiveness for a temporal storage of rainwater. The effectiveness also has been plotted against the maintenance costs (Figure 5.5). An outlier can be detected. This outlier was reported to the makers of the AST and is currently being revised.

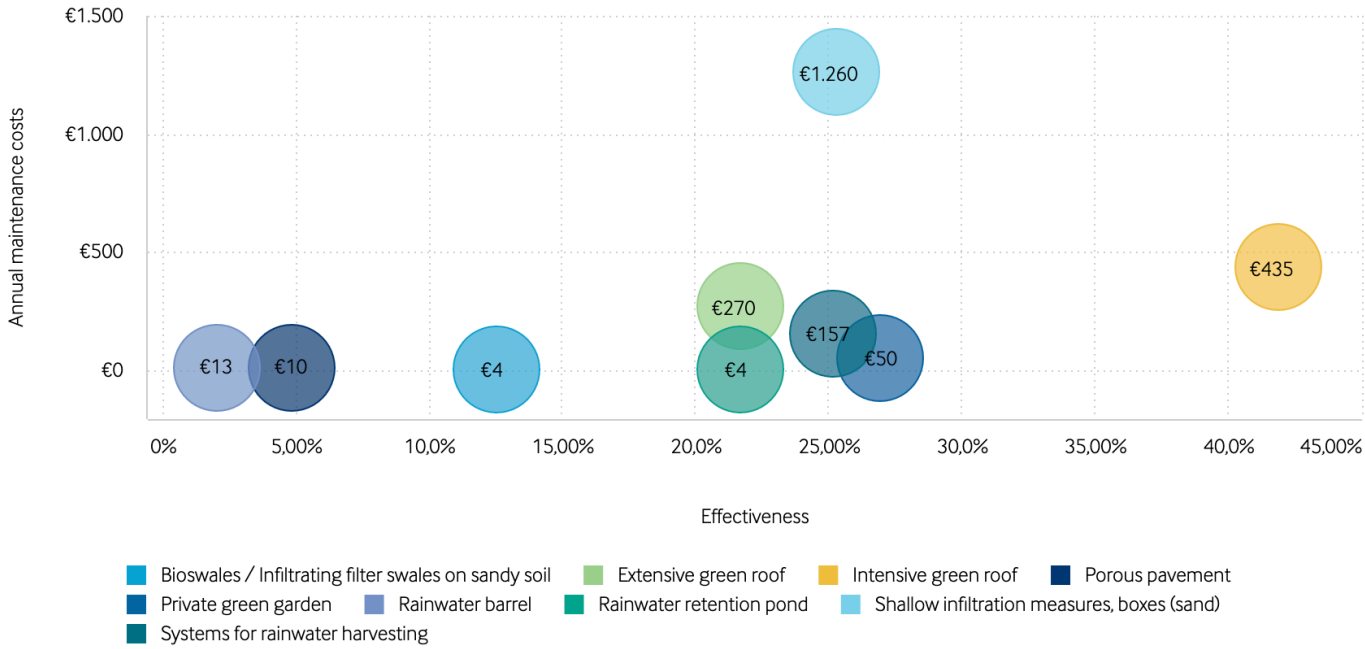


Figure 5.5 Calculated effectiveness plotted against the maintenance costs of the specific design choices of the object level.

Despite the outlier the maintenance costs show similarities to the construction costs plotted against the effectiveness.

5.2.2. Scenarios

The object level showed the effectiveness of the different measures. As none of the measures fulfilled the target, a combination of different measures was analysed based on possible scenarios. The selected area for calculation comprises 13635 m^2. Hence 818,1 m^3 of water have to be stored in order to reach the goal of 60 mm, thus 100%. Which corresponds with a sufficient effectiveness (introduced in Chapter 3).

(1)	A $_{\text{selected area}}$	x	threshold	=	Storage target
(2)	13635 m^2	x	0.06 m	=	818,1 m^3

Five potential scenarios where analysed to find the best combination of different measures. The first four scenarios include single-measure options; the fifth is a potential combination of all these measures for reaching the storage target. It is expected that an optimisation of different measures would give the most desired outcome.

5.2.2.1. Scenario a: Only rain barrels

Rainwater barrel is one of the rainproof measures that is well known by the residents. It is promoted by hardware stores and the investment costs as well as the maintenance costs are manageable. Furthermore the rainwater barrel has a nice benefit – as water can be used for plants. In the context of "*every droplet counts"* it is a nice start.

Table 5.5 Scenario a – with information about storage capacity of rain barrels, corresponding effectiveness, construction costs and costs per additional percentage increase.

Scenario a	Storage capacity in m^3	Effectiveness	Construction costs	cost per %
two rain barrels per lot	32 m^3	4%	€ 32,000	€ 8,181

As expected, the implementation of only rain barrels on private terrain does not collect much water. It only collects 32 m^3 compared to the target of 818 m^3. The implementation of only rain barrels, in this case two per private garden corresponds to an effectiveness of 3.9% as shown in Table 5.5, hence not effective, water label G. The table shows also the construction costs of the implementation of the rain barrels for the entire area. Additionally, it is indicated how much every increase of percentage would cost. For rain barrels an investment of €8,181 per % increase would be necessary.

5.2.2.2. Scenario b: only green garden

With a not even moderate effectiveness of approximately 30% in the object level, the implementation of green gardens are more promising than rain water barrels. Also as the slogan: '*tiles out, plants in*' is promoted maybe some residents will be pushed over the edge towards a more rainproof private terrain. The entire backyard is calculated for green gardens. The following Table 5.6 shows the outcome for the storage capacity as well as the corresponding costs of the AST calculations.

Table 5.6 Scenario b storage capacity of green gardens, corresponding effectiveness, construction costs and costs per additional percentage increase.

Scenario b	Storage capacity in m^3	Effectiveness	Costs	Cost per %
Green gardens	259	32%	€ 387,900.00	€ 12,271.50

The effectiveness shows a slightly higher percentage compared to the object levels as the entire backyard is covered by green garden; however, this measure on its own is not capable to deal with 60mm of rainfall.

5.2.2.3. Scenario c: green roofs (extensive vs intensive)

The third scenario is based on the introduction of green roofs for the entire building block. Green roofs are subsidised in Amsterdam which might increase its popularity. Within this scenario both, extensive and intensive green roofs are compared with each other. It is expected that the intensive green roof is more effective based on the calculations of the object level. Furthermore no other interventions will be made. Nonetheless it is expected that 50% of the gardens are green. This is a rough estimation and in reality might differ (more or less green). Hence a combination of these two is expected, whereas the green roof is expected to be a new intervention and the green garden as existing situation. When comparing extensive (2.7m^3) and intensive (5.22m^3) green roof it can be seen that the default storage capacity of the intensive green roof is nearly twice as high.

Table 5.7 shows that the situation with an extensive green roof would be able to cope with approximately 40% (just below moderate effectiveness) of the target, whereas intensive green roof would be able to cope with even 68% (moderate effectiveness) of the target of 60 mm (in combination with the already existing green gardens.)

Table 5.7 Scenario c – storage capacity of green roofs, corresponding effectiveness, construction costs and costs per additional percentage increase.

Scenario c	Storage capacity in m^3	Effectiveness	Costs	Cost per %
Green roof (extensive)	198	24%	€ 395,160.00	€ 16,362.00
Green roof (intensive)	429	52%	€ 714,900.00	€ 13,635.00
Green gardens 50%	129	16%	(€ 193,950.00)	€ 12,271.50
total extensive plus garden		40%		
total intensive plus garden		68%		

5.2.2.4. Scenario d: gardens all porous pavements

Through observation throughout Amsterdam it seems that tiles take over front and backyards. Hence it is interesting to see what influence the usage of porous pavements have in the equation.

Table 5.8 below shows the storage capacity and the corresponding effectiveness for different porous pavement thicknesses when paving the entire backyard. Thereby it is clear that thicker pavement subbase can store more water. With a thickness of 10cm the depth would correspond with 30%, hence factor 0.3, thus 3cm. A thicker subbase layer of pavement would create more storage capacity. A thickness of approximately 33 cm does not correspond with the required storage capacity to effectively store 818,1 m^3 (storage target). Either its thickness should be increased or a combination with other measures is required.

Table 5.8 Scenario d – storage capacity of porous paved backyards of different depths, corresponding effectiveness, construction costs and costs per additional percentage increase.

Scenario d	Storage capacity in m^3	Effectiveness	costs	cost/%
Paved 10 cm	195	24%	€ 65,140.00	€ 2,727.00
Paved 16.7 cm	326	40%	€ 65,140.00	€ 1636.20
Paved 33.3 cm	651	80%	€ 65,140.00	€ 818.10

5.2.2.5. Scenario e: Combining different rainproof measures towards a possible optimisation – Combining effectiveness and efficiency

As mentioned before, it is required to combine different measures in order to reach the target. This scenario does not only focus on the effectiveness of each measure but also considers the costs of the measure as well on a logical combination for spaces. As for example making the entire backyard a rain water retention pond would not be a desirable option.

In this specific neighbourhood intensive green roofs are most likely not feasible due to its weight and the expected deficiencies of bearing capacities for the building block – without extra building costs – thus is this option removed from the list of potential measures.

In order to combine the different measures, the costs were investigated, thereby the measure with the lowest costs were considered first. Hence the rainwater retention pond scores quite high for its effectiveness in combination with the costs.

Table 5.10: Scenario e – storage capacity of different measures, corresponding effectiveness, construction costs, costs per additional percentage increase, maintenance costs and costs per household.

Table 5.9 Scenario e – storage capacity of different measures, corresponding effectiveness, construction costs, costs per additional percentage increase, maintenance costs and costs per household.

Optimal	Storage capacity	Effectiveness	Construction costs	Cost/%	Annual maintenance	Investment per household
Rainwater retention pond 669m² 0.3m depth	200.7	25%	€ 13,380	€ 545	€ 268	€ 209
Porous pavement (terrace) 1280m² 0.03m depth	102.4	13%	€ 16,000	€ 1,278	€ 640	€ 250
Bioswale 768m² 0.26m depth	200	24%	€ 53,760	€ 2,203	€ 538	€ 840
Rainwater tank 320m² 1m depth	320	39%	€ 320,000	€ 8,181	€ 16,000	€ 5,000
Rest Green Garden 3748m² 0.04 m depth	150	18%	€ 224,880	€ 12,272	€ 2,249	€ 3,514
Total	**972.7**	**119.33%**	**€ 620,040**	**€ 24,479**	**€ 19,694**	**€ 9,813**
Green roof (extensive) 6586m² 0.03m depth	198	24%	€ 395,160	€ 16,362	€ 19,758	€ 6,174
Total including green roofs	**1170.28**	**143.33%**	**€ 1,015,200**	**€ 40,841**	**€ 39,452**	**€ 15,987**

Table 5.8 shows the results of the calculation. It shows that the combination of interventions on the private terrain would be able to meet and exceed the 119% of the target of 60 mm – in fact 119% – excluding the capacity of the implementation of a green roof (143% of the target when green roofs are included in the implementation – just below high effectiveness). Moreover the table shows that three 'low cost' measures are to be combined with at least one of the high cost solutions to meet the target of 60 mm storage on private lots.

5.3. Perceived effectiveness versus calculated effectiveness

The effectiveness of rainproof measures were estimated by the respondents and secondly calculated within the AST. For both a percentage has been calculated. Regardless, these cannot be directly compared with each other as one percentage is based on a descriptive and the other percentage (AST part) is based on a threshold value. Hence for the comparison these percentages solely give an indication of the order of the perceived versus expected effectiveness.

A potential mismatch between the perceived and expected effectiveness can point out requirements for awareness. When one measure is perceived as highly effective, but merely marginally adds to the goal, education about the effectiveness should be considered. As residents might focus on the wrong measure for the wrong reasons. On the other hand, when a measure is ranked low whilst achieving a high expected effectiveness this rainproofing measure can be highlighted as beneficial measures.

The following Table 5.10 presents the different the measures by orders of perceived versus calculated by AST effectiveness. When using the optimised scenario, the situation would differ as for example intensive green roof are neglected due to the probable lacking bearing capacity of the buildings.

Table 5.10 Comparison of the order of rainproof measures whereby the left side shows the ranking of the perceived effectiveness and the right side shows the ranking of the expected effectiveness.

Order of perceived effectiveness	**Object level calculations within the AST**
Infiltration boxes	Intensive green roof (42%)
Green roof	Private green garden (27%)
Wadis (= Bioswale)	Shallow infiltration measure/boxes (25%)
Rainwater tanks	System for rainwater harvesting (25%)
Polderdak (AST: green roof with water retention)	Rainwater retention pond of 9 m^2 (22%)
Rainwater pond	Extensive green roof (22%)
Height differences in the garden	Bioswales (13%)
Rainwater barrel	Porous pavement (5%)
Rainwater fence	Rainwater barrel (2%)
Water-retaining planters	

Infiltration boxes reveal a high perceived effectiveness, which with the right circumstances can align with the calculated effectiveness. Therefore, parameters like groundwater levels are influential. Shallow infiltration boxes, ranking on the third place, score considerably less in the actual storage capacity compared to the first ranked measure (intensive green roofs: 42% versus 25% of the infiltration measure). Deep infiltration measures have a higher storage capacity which would more align with the highest perceived effectiveness. Perhaps uncertainties about groundwater levels influence the perception.

The participants of the questionnaire estimated that green roofs have a high effectiveness after the infiltration crates. As mentioned before no separation between intensive and extensive green roof has been made (by choice). But the AST estimation also shows a great difference between those two, whereby the intensive green roof shows the highest effectiveness. This intervention might not be feasible without adjusting the foundation and/or roof construction of the house in order to reach a sufficient bearing capacity of the building. Extensive green roofs, which are likely to be feasible for numerous buildings have nearly half of the storage capacity of intensive green roofs. Some design choices might slightly improve its effectiveness, but public perception seems to significantly overrate extensive green roof's performance.

Bioswale has a perceived high effectiveness (rank 3), whereas the calculations in AST reveal a low effectiveness of 13%, largely due to the limited scale of applicability at private terrain. As 57% of the respondents (n: 62) indicate that they do not know this measure the perceived effectiveness might be influenced.

Rainwater tanks are not significantly lower estimated than infiltration boxes. The storage capacity is directly related to the dimension of the tanks. The effectiveness of a system for rainwater harvesting significantly scores lower compared to the first ranked measure within the calculations but still ranked fourth. Residents might expect more storage capacity than it actually achieves. Nonetheless the storage capacity can accomplish the goal in combination with other measures and provides additional benefits (reuse of water).

As 78% of the respondents did not know the rainproofing measure 'polderdak' the indicated effectiveness cannot be connected to the perception of such. It is a pure estimation not based on knowledge. Intensive green roof score the highest effectiveness (compared to the selected measures). As '*polderdak*' is a green roof with drainage delay it can be assumed that the effectiveness is relatively high in reality. Knowledge distribution about this measure is advisable, provided that the bearing capacity of buildings is sufficient. As in De Baarsjes it is suspected that a great amount of buildings do not fulfil such requirements it is questionable if all residents should be educated on this matter.

Rainwater ponds are in a comparable ranking of both lists. It is not seen as the most effective measure but also not as the least effective one which correlates with the calculation. From the results of the AST this specific measure show low costs for its representative effectiveness. However, from a resident perspective, the area contributing to a rainwater pond can be seen as lost. These 'cost' might be too high for residents as usable space in small gardens is scarce. Additionally it could be associated with danger for households with children as young children are prone to drowning and residents might repel this measure.

The rainwater barrel ranked low on both lists. Even though for the estimated effectiveness the rain barrel scores between moderate and considerable water storage, whereas through the calculation in AST it barely collects water. The depth of rain barrels was promising to store some water; however, as the size of a rainwater barrel is commonly limited to approximately 0.25 m^2, the rain water barrel would only be effective if a great number of barrels would be implemented in each garden. Albeit in reality, every house would have one to two rain barrels.

6 Discussion

6.1. Reflection on the choice of conceptual model

In addition to the Receptivity theory the Theory of Planned Behaviour (Ajzen, 1985) or the Health Belief Model were also considered as a possibility to evaluate the research question. The different theories showed similarities with the receptivity framework of Jeffrey and Seaton (2004). As different studies such as Rutten et al. (2009), De Graaf (2009) and De Graaf et al. (2011) used the receptivity model of Jeffrey and Seaton (2004) the choice to use this specific model seemed appropriate. Note that the unconscious mind also influences the behaviour and choices of residents, respondents might not always know why they acted a certain way and hence are not able to identify it in their answers.

Jeffrey and Seaton (2004) designed the framework for '*evaluating water innovative management policy instrument*s' (pp. 280) as well as designing such instruments. As rainproofing measures are part of such policy instrument the theory in itself is applicable. Jeffrey and Seaton (2004) stress that there is a necessity of an innovation (i.e.: rainproofing measures) residents can be aware of, associate with, acquire and apply. This was possible for this research as rainproofing measures accommodate all these options. Jeffrey and Seaton (2004) argue that limitations of this framework are connected to the requirement to involve a big group of stakeholders. Their conceptual instrument does not provide an answer but rather a dialogue and thus the generation of relevant information towards the planning and management aspects of the policy instruments.

6.2. Reflection on the methods

The following sections summarise some limitations connected to the questionnaires and focus groups.

6.2.1. Limitations of questionnaires

The questionnaires were conducted between mid-November until the week before Christmas, whereas the online link was open until the end of the year. Perhaps it influenced the response rate, as residents were occupied with Saint Nicholas and Christmas preparations. Respondents were less open to answer questions at the door. Less respondents were reached compared to online promotion and distribution of flyers of the online version (Appendix I). Distributing the flyer and offering an online questionnaire increased the response rate considerably. Note that the research instrument itself might educate the study population which could influence the response for further questions (Kumar, 2011). As the topic was introduced by questionnaires it might influence the outcome of the focus group. It might gauge the attitude towards a certain direction, respondents can feel that they reacted too positive or negative (Kumar, 2011).

Structures and choices for the questionnaire

The 4 A's can develop simultaneously, as criticised by Brown and Keath (2008) and De Graaf (2009) it is often failed to address the entire complexity of receptivity. By simplifying the framework for the questionnaire this issue could arise through skip sequencing. The integration of focus groups to obtain more insight and the acknowledgement of the complexity of receptivity provided some compensation. Despite the chosen simplicity the methodology seemed appropriate to answer the research question. The questionnaire most likely filtered out frontrunners and residents who experienced water issues. Perhaps not the entire spectrum of residents were reached.

The perceived effectiveness was influenced by the (lack of) knowledge about all presented countermeasures. In the online version respondents were not able to skip the evaluation of the effectiveness of a measure. Hence when a respondent did not know another of the presented measure they still were required to rank the perceived effectiveness to collect water from "-- : *does not store a lot of water*" to "++ : *does store a lot of water*" (Ranking of effectiveness -- (no water - 0%) to ++ (plenty of water - 100%) with two steps in between:

'-' ~ 33,3% and '+' ~ 66,6%. This is expected to affect the results but also gives an indication what respondents do associate with different rainproof measures.

6.2.2. Limitations of focus groups

Certain limitations are attached focus groups. These limitations are connected to the selection of discussion statements, participants, lacking experience and time restrictions. The following subsections will give a brief indication of these limitations.

Development and selection of the statements

Before the statements of the focus group were established, the questionnaires were analysed. A limited time frame restricted the analysis of the questionnaire. The statements are chosen and adapted depending on the focus group dynamics itself. Note that the choice was made by the moderator, making data vulnerable to bias. Some ideas might be neglected and others emphasised through the statements. It was aimed to treat both groups as similar as possible to reduce this influence.

Selection of the participants

As mentioned by Krueger and Casey (2015) the selection of the participants should be done carefully. The willingness to participate was limited, hence the selection was purely done based on willingness and availability. Through this approach it is possible to select participants who are most likely in the same receptivity phase. Similar to the questionnaire, most likely frontrunners were selected. Consequently, the conclusions drawn were influenced.

Lack of experience

Another limitation refers to the experience to design the statements, moderate the focus group, take notes and later analyse the responses. As there was no prior experience, more focus groups could have improved the outcome. Thoughtful preparation of the programme and statements increased the ability to facilitate the focus group. Careful supervision and advice eliminated as much as possible issues. The Dutch language and professional terminology might have influenced the communication to some degree. Furthermore the interpretation as well as transcription of the focus group can to some extent be influenced. Certain expressions could have been misunderstood. This does not necessarily make this analysis less valid but should be kept in mind.

Time restrictions

It is suggested by Krueger (1994) that several focus groups should be conducted until a theoretical saturation arises. Yet, it is also indicated by several authors (according to Rabiee, 2004) that for a simple research question the number of focus groups can be reduced. Based on the theoretical background 3 to 5 focus groups would have been advisable to improve the sessions. However, due to time and availability constraints two sessions have been chosen. In this case it seemed reasonable as the focus group method is not the only data collection method that has been used.

Validity and reliability of the questionnaire and the focus group

As validity refers to the extent a research instrument actually measures what it is supposed to measure, testing is required. The questionnaire and focus group statements were tested for content validity. Anonymity was assured, which gave participants the opportunity to openly share their opinion. For the external validity it is crucial to generalise the outcome for the entire research population. The questionnaires require a representable sample size. With 181 responses this seems sufficiently reliable. The results of the focus groups cannot be generalised as with 17 participants it comprises only little data. Nevertheless, it gives an idea for following research and issues which should be considered when stimulating the implementation of rainproof measures. Thus the expected external validity is limited when considering the results of the focus group.

The reliability of the research instruments might be influenced by wording, physical settings and mood of both moderator and respondent. Throughout the conduction of the questionnaires and the focus group positive feedback about the research has been received. Residents appreciated the research and were interested in the results.

6.2.3. Limitations of the calculations of the effectiveness with AST

Selection of measures were partly based on indication of residents but also on feasibility for private property and groundwater level vs infiltration. Afterwards curiosity arose about different measures, that were not evaluated by the respondents. Such measures, that also could be interesting for private terrain could be evaluated in follow-up research. Also, in contrast to the questionnaires, a distinction has been made between intensive and extensive green roofs in the AST, although it is expected that the constructive capacity of buildings is most likely not sufficient. Concerning the AST itself a design on small level makes it difficult to draw the measures precisely. For some measures already a small change in square metres influenced the effectiveness. The calculation of the effectiveness within the object level showed a susceptibility to the choice of the dimensions of a measure. Comparing green gardens (27%), shallow infiltration boxes (25%), system for rainwater harvesting (25%), extensive green roofs (22%) and rainwater retention ponds (22%) show only small differences, whilst some adjustments within the dimensions due to design choices could rearrange the ranking of these measures. Thus the effectiveness of measures are related to design choices based on hydrological conditions (groundwater levels) and (subjective) preferences. The AST was made for conceptual design, not for final. Moreover, the AST used in this study was version 1.0, loaded with generic Dutch data such as default values for water storage depth and cost. The dataset still contained some flaws and the validity of national data for a local application in De Baarsjes can be questioned. The chosen water storage depth of a measure had an enormous impact. High ground water levels lessen the storage capacity of gardens. Hence if the design in the AST differs from a possible design, the effectiveness of a specific measure will change. The accuracy of the effectiveness for the specific location depends on the accuracy of the (applicable) dimensions of measures.

6.3. Results

The case study in De Baarsjes identified several interesting topics, a few are discussed in the following subchapter. Note, that not all residents are physically able to implement rainproof measures due to a lack of garden and lacking responsibilities of the roof. This could apply to renters or owners who are living on floors between the ground floor and the top floor. Furthermore it is expected that there is a difference between residents, that own an apartment and residents that rent an apartment. Owners have much more direct responsibilities and thrive for higher values of their house, whereas renters probably stay a limited time and do not invest time nor money in their apartment. Regardless, they could influence the home owner to take action. The motivation to change is subject to the ability to change. The knowledge about an option cannot be compared to the ability of achieving benefits from these (Jeffrey and Seaton, 2004).

Reflecting on the knowledge of counter measures, it was expected that several measures would be indicated in both questions – water storage measures and water damage prevention measures. This assumption was confirmed and as some respondents referred specifically to their answers in the preceding questions, it became clear that they are aware that several measures can provide a solution to both issues. Several respondents of both questionnaire and focus group revealed that they already implemented counter measures, as green roofs, rain barrels, green garden, hence these residents were receptive for these specific measures. Some also declared their intention to implement other measures. It can be seen that residents are already actively dealing with rainproof measures such as rain barrel and green roofs among others. Depending on their success and euphoria they probably communicate about their ideas, perhaps persuading some neighbours. The focus group meetings revealed that uncertainties about groundwater and its flow has an important role. In the first focus group the discussion of groundwater and pumping of it was always reappearing. The groundwater flow and level seemed to be very important. This most likely is also connected to their living situation as they all are living on the ground floor and experienced groundwater flooding in cellar or apartment.

The online form provided some restrictions to implement the evaluation of the perceived effectiveness. A limited selection of measures has been made. This limits the possibility to compare many different adaptation options, but was done to ensure a higher response rate. 'Green gardens' as a measure has been neglected as it seemed a vague measure which would have required more detail. Additionally due to varying groundwater levels throughout the neighbourhood the indication about its effectiveness is subject to a great range. Saturated soils are not able to store much water, whereas low groundwater influence the water storage possibility of green gardens positively. This complexity of the measure did contribute to its exclusion within the questionnaire. Within the questionnaire extensive and intensive green roofs were not distinguished to limit the possible confusion. However, the effectiveness between these both differ significantly as can be seen in the calculations by AST. Thus respondents that are familiar with either one perceived different effectiveness. The questionnaire also indicated polder roofs which on the other hand has been neglected for the AST calculation as it is suspected that the building strength (bearing capacity) is in most cases insufficient. Also it was seen that not many respondents knew about this specific measures. Hence the exclusion for the AST calculation seemed appropriate.

6.3.1. Setting the results in perspective – what was found in different research?

The pilot study in De Baarsjes can be related to several other studies. For instance Hommes at al. (2016) emphasise the necessity to understand the reasons behind (non-) implementation. In the literature different studies address this subject and show similarities to the case study in De Baarsjes.

Rietkerk et al. (2016) observed that personal circumstances in particular obscurities of definitions within rental contracts as well as short-term duration of the renting situation (Reijnders, 2017) result in passivity. Residents of De Baarsjes also indicated their inability to take action connected to their rental situation. The uncertainties that residents point out about responsibilities connected to stormwater confirms a research done by Munster (2017), whereby it was concluded that first of all they do not recognise the urgency of the problem. Secondly nor connect the obligation to act on it with themselves rather the municipality and the government. Dai et al. (2017) also argue that clarity about the responsibility considering the ratio of public/private is necessary. They argue that a lack of awareness of these responsibilities hamper the implementation. This argument can be confirmed as uncertainties about responsibilities have been indicated. An overcompensation in action by the municipality results also in passive behaviour of residents (Dai et al., 2017). This might be true to some extent; however, this research shows that awareness (also about their responsibilities) alone is not enough to actually take action as well as respondents required that the municipality also takes responsibilities. Awareness of a certain issue is not enough to actually get actively involved. It is possible that residents are aware of the water problems and challenges but have other priorities or the circumstances are not right to act. Residents might also think in a wider scope and are concerned about environment or aesthetics of the surrounding. For instance climate change could have been connected to "*stoppen met fossiele brandstoffen*" (Engl: '*stop using fossil fuels*'). This shows awareness of several issues, which are beyond the scope of this research.

Even if residents consider implementation, the actual realisation of measures on private terrain might be hampered or threatened by organisational and management structures within the municipality. It is important to focus on several levels within the governance structure of urban areas. The broader picture should be considered. It was also observed that willingness to act is increased when time and effort investments are low (Munster, 2017). This has been equally noticed for residents in De Baarsjes. Respondents indicated financial limitations, as several measures (i.e.: green roofs) are still expensive. This reveals the influence of costs on decisions towards or against certain measures. Nevertheless, this specific respondent indicated to be open for advice. Which demonstrates willingness to improve the situation by adapting measures, provided that it fits the financial circumstances. It can be suspected that low-threshold solutions have a positive influence on receptivity. Stimulation can also be given by subsidies; respondents indicate that this could motivate them to take action. Such economic incentives taken by organisation have been observed by Holdijk (2017).

Residents desired more information for instance on costs and effectiveness as pointed out in the focus group. This specific request was also observed in research by Peltenburg and Kouwenberg (2018) assessing improvement – requests by professionals using the Rainproof Toolbox.

As mentioned before receptivity differ throughout stakeholders, consequently a one size fits all approach is barely appropriate. It can be seen that receptivity varies for all residents considerably, which confirms the findings by De Graaf (2009). A general approach to improve receptivity is not advisable rather a wide ranging and tailor-made approaches should be considered. The research of Dai et al. (2017) is focussing on the approach of the municipalities, although this research is investigating the private sector, the need for tailor-made solutions, can be seen in both studies. The specific circumstances (geophysical, social, etc.) are hence of great importance towards adapting climate resilient approaches.

De Graaf (2009) argues – based on a case study – that association with technical options with their agenda is necessary, whereas Jeffrey and Seaton (2004) argue that receptivity could occur also in complete absence of association. Association seems to be an important feature also in this research as residents need to identify themselves not only with the issue but also with the solutions. It can be argued that the absence of association influences the time frame it requires towards receptivity. An exception could be an '*imposed*' receptivity, as rules would imply a certain standard, hence residents would need to implement. De Graaf (2009) found in the research that more emphasis is necessary for the association and acquisition improvement rather than application.

Residents are vulnerable to extreme precipitation. This vulnerability of the city and its citizens has been mentioned in several studies (De Graaf, 2009; Van de Ven et al., 2011; Locher and Dekker, 2016; Depietri and McPhearson, 2017; Dai et al., 2017; Alves, 2020) and should be taken seriously. This can be confirmed as residents indicated the experience of flooding (garden, street, house). They also expect more extreme precipitation in the future. It can be argued that the vulnerability of citizens will increase, when no adaptation to climate change will be done. The implementation of blue and green measures do have influence on climate resilience (Van de Ven et al., 2011). This research gives insight in the effectiveness of rainproofing measures and the receptivity towards such. This contributed towards a better understanding as Van de Ven et al. (2011) argue that such knowledge gaps need to be filled in order to get a complete picture.

The AST verified the assumption that rain barrels are not effective, except when the entire garden is filled with rainwater barrels or a huge rainwater tank is implemented higher effectiveness can be accomplished. The calculations with the AST- Tool showed that for instance intensive green roofs have a high effectiveness. This specific research focussed on the effectivity of blue and green measures and showed a combination of measures show an effective approach on storing rainwater on private terrain. Locher and Dekker (2016) indicated a high contribution of water storage and water robustness considering effective measures. Posma's (2015) research revealed that the most effective measures in public terrain can be considered as (1) infiltration strip (2) bioswale (3) Rainwater pond (4) greening. The evaluated measures for rooftops care ranked as follows: (1) intensive green roofs, (2) extensive green roofs (3) water roofs. Also a ranking for measures on private terrain were concluded: (1) infiltration strips (2) Bioswale (3) greening. The calculations with the AST are confirming that intensive green roof are most effective (of the chosen measures) for private terrain in the specific location. Notably the calculations with the AST-tool, however, refute that greening is least effective. Green gardens are ranked more effective in this particular research. This might arise from the assumptions made on groundwater levels and dimensions used for the calculations of the effectiveness. Infiltration boxes were considerably shallow ascribed to ground water levels. Also the garden size is reasonably high (65m2) and has a higher impact compared to infiltration measures with smaller dimensions. The dimension choices within the tool considerably influence the effectiveness. Posma (2015) is concluding that infiltration strips and intensive green roofs are the most effective for public and private terrain.

From a water management perspective these measures contribute the most towards creating resilience. When considering the investment costs, these measures are possible less attractive to residents. Furthermore, the capacity of the buildings and the infiltration capacity has to be investigated in each case. This discrepancy between these case studies probably arises resulting design choices and assumptions made. Therefore, making the right design choices seems important in order to give tailor-made advice. The suggestion of tailor-made advice can be confirmed in different studies. Hommes et al. (2016) presented the argumentation that tailor-made advice on neighbourhood level or even street-level is required to choose the most effective measures, which goes along with the findings of this case study. Within different literature much evidence can be found promoting a tailor-made advice. Van de Ven et al. (2011) are concluding that the to be taken measures are highly location and preference depending. This has been found in this research as well. Preferences by residents have a high influence but also the feasibility of measures in the specific

location plays an important role. Rietkerk et al. (2016) mention that the group of (garden-) owners are divers and a one for all approach would most likely not be possible.

The researches of Depietri and McPhearson (2017) and of Alves (2020) show that combining Green-Blue Infrastructures and grey infrastructure can contribute to an effective approach. This can to some extent be confirmed, as for the effectiveness of the measure a hybrid measure was also analysed (permeable pavements). Additionally, residents are willing to use the garden and permeable pavement would be a good consideration compared to impermeable materials.

Summarising the results of this research show similarities to other researches. Therefore, these results can be generalised to a certain point. Location specific circumstances (geophysical situation, cultural, social circumstances) have influence on individual choices.

In De Baarsjes several obstacles were revealed such as mosquito issue, uncertainties about responsibilities, renter/owner problem as well as it was seen that there are already frontrunners presented. Not all of these topics can (only) be connected to the receptivity framework. To some extent these topics possibly fall into Awareness (uncertainties about the responsibilities). But the barriers cannot be solely explained by the receptivity model.

The mosquito issue could to some extent be connected to the HBM as residents see mosquitoes as a health threat (vector borne diseases, sleepless nights etc.). Measures that create breeding options are thus not favourable. Residents could associate such with all measures (due to lacking knowledge) and thus feel uncomfortable implementing rainproofing measures and looking into different directions to solve the mosquito problem. It appears that residents – that encountered mosquito issues – are favourable towards a fast drainage. Pluvial flooding like any standing water is associated with breeding places. Such a relation should be further investigated as well as the impact of the HBM versus the receptivity towards rainproofing measures.

Landlord - renter discrepancy and its influence on receptivity possibly cannot be explained by the receptivity framework. For renters who are willing to implement, the application is constraint. Jeffrey and Seaton (2004) indicated that the motivation to change is subject to its ability. The ability to actually apply the knowledge is interfered by landlords and in case of owners by VVEs. Some landlords might be struggling with the 4A's, this discrepancy between two stakeholders and the resulting (dis)abilities is a shortcoming with the receptivity framework and only connects with the (dis)ability. Different models or a combination might apply to investigate the balance between these stakeholders. Part of the behaviour of landlords might be linked to conscious and unconscious mind. They cannot always relate why they did not take an action. It might be possible to investigate this relation and its influence on receptivity with a combination of different theories as social learning or TPB. Giddens's paradox could also explain the 'non-receptivity' of the owners as they do not see the urgency of the issue. Perhaps, as they are not living there they do not see the pluvial flooding occurring in the backyard. Connecting the impact of frontrunners on other residents with different theories might be valuable. The influence of frontrunners could be connected to the social learning theory. Frontrunners, as the name already refers to, are a step ahead and in this specific case receptive. Frontrunners could also play an important role within the receptivity framework, as their knowledge and success-story could provide valuable input for the 4A's. Through their example, residents might feel obliged to follow. Nevertheless, it is questionable if frontrunners, as well as laws could to some extent impose or force receptivity. Thereby it can be argued that forced receptivity cannot be called receptivity, but the implementation itself could be forced. Hence residents might not comply with all four components of the receptivity framework. Eventually its result is the same, rainproofing measures are implemented. Frontrunners can provide valuable information, which limits the time investment of other residents. It is questionable if the residents could then accomplish faster all 'points' of the 4 A's or is some points are even skipped and a part of the social learning theory could be used to explain an accomplished implementation. Residents indicated that motivation to implement a measures could be achieved by the enforcement of laws. These 'points' illustrate that the receptivity model cannot explain everything and might need to extended.

Jeffrey and Seaton (2004) indicated that additional evaluation is required when applied to a wider variety of policy instruments. Such valuable information can be provided by this case study. It is debatable if Jeffrey and Seaton (2004) would see rainproof measures as one policy instrument, rather than several instruments on their own.

In the research the assumption has been made to consider rainproofing measures as one policy instrument, which leads to some valuable lessons. Throughout the research the question arose: ***Can receptivity be generalised for all rainproof measures?*** The findings revealed that receptivity cannot be generalised. This

argument emerges as participants indicated implementation of certain measures; however, they desired information for other measures. To emphasise the hypothesis that receptivity cannot be generalised to a broader context two measures can be compared: rain barrel versus rainwater tank. Both collect water, which can be reused in the garden (tank could also provide the possibility for rainwater harvesting), but differ in its size and costs. Receptivity for rain barrels was accomplished for some residents, whereas other rainproof measures still are necessary to increase resilience. However, residents were not receptive for other measures (yet). Hence accomplishing all 4A's again for a different solution is necessary. Nonetheless it can be argued that a certain awareness threshold has been reached, also hurdles holding residents back might be lower and a certain foundation within all components of the 4 A's has been achieved. Thus receptivity cannot be generalised but is based on specific measure and circumstances, someone can be receptive for a certain measure. When using the theory it is important for upcoming studies to keep this in mind. Thereby it could be valuable to investigate to what extent receptivity is transferred from one measure to the other after being receptive. Receptivity for a certain measures could be based on different values and benefits. Residents might not be receptive for the rainproof measures in the traditional sense, this aspect is a side effect, but for aesthetics or biodiversity.

When taking a step back and considering the requirement of Jeffrey and Seaton (2004) to evaluate the application of the model to a wider variety of policy instruments it can be argued that the use of AST in combination with the evaluation of the receptivity of residents for rainproofing measures can be considered as such. The AST provides a platform to – individually or with different stakeholders – investigate, evaluate, compare and select rainproofing measures based on a specific location with the known circumstances. For an orientation the Rainproof Toolbox could also provide valuable information, but – as revealed in the research (Peltenburg and Kouwenberg, 2018) – the lack of completeness towards cost and effectivity as well as different location specific information gives more restrictions compared to the AST. For comparison and selection the AST is a transparent tool which can be used by various actors. As Jeffrey and Seaton (2004) striving for more information about the processes behind the selection of instruments, such tools could be a valuable example. Hence this research shows that analysis for receptivity in combination with the analysis of the policy instruments by an appropriate tool provides valuable information which can contribute to the advice about policy instruments.

Imagine, a resident is receptive and does implement a rainproofing measures the question could arise: what happens next? Does the receptivity framework assume, that maintaining this measure is given? It would be possible that someone implements an effective rainproofing measure, however neglects on a long run its maintenance. Therefore the measure might become ineffective, depending on the degree of maintenance that is necessary to keep the measure working. It could be argued that the implementation in itself can be analysed with this framework but also the maintenance - is someone receptive to maintain a rainproof measure?

Based on the receptivity framework, the long run cannot be explained (straightforward). When using this framework, assumptions are necessary considering maintenance, or maintenance needs to be seen as a policy instrument on its own. Perhaps it would be possible to extend the framework to overcome this 'shortcoming'.

7 Conclusion

Extreme precipitation intensities are increasing and the entire city of Amsterdam stands confronted with the challenge of dealing with the excessive rain. This research is relevant in order to take further steps. This chapter will answer the main research question:

To what extent are residents receptive towards increasing the resilience of the city to extreme precipitation?

Receptivity is characterised by (Jeffrey and Seaton, 2004) four A's: the degrees of Awareness, Association, Acquisition, Application. This theoretical framework was used to collect and analyse data in the pilot area De Baarsjes in Amsterdam, in the hope that the results could contribute to the ongoing Amsterdam Rainproof programme. The receptivity framework was adequate guiding model to analyse the receptivity as it gives a foundation to recognise the complexity of human behaviour. The receptivity of residents was investigated using questionnaires in combination with two focus group session. The choice for its simplicity was appropriate within the questionnaire to gain concise insights and assure a higher response rate. Using focus groups considered the different degrees within the four A's and gave qualitative data insights. The framework gave the opportunity to pinpoint missing links towards the receptivity and assisting to understand that awareness of a certain issue and the knowledge about possible solutions is not enough to be receptive.

Increasing the resilience of a city is connected to the effectiveness of rainproofing measures. The more effective a countermeasure, the higher its positive impact on resilience. Therefore, the Adaptation Support Tool (AST) was appropriately chosen to calculate storage capacity and compare it to a desired threshold. The perceived effectiveness by the questionnaire respondents gave an indication of the ranking but cannot be related to a certain threshold. Hence a comparison shows whether the perception of effectiveness correlates to the calculated effectiveness ranking.

Answering the subquestions contributes to indicate receptiveness of residents.

Subquestion I: What is effectiveness?

Effectiveness is defined within the dictionary as follows: "*the degree to which something is successful in producing a desired result; success*" (Oxford Dictionary). The goal of rainproof measures is to deal with rainwater in such a way that water does not overfill the sanitary system and does not hinder necessary infrastructure nor inflicts damage. Therefore, from a water management perspective it refers to the quantity of water that they can store and/or detain (delay runoff) and thus offering relief to the water system.

Subquestion II: Are residents of De Baarsjes, Amsterdam receptive for effective adaptation measures?

In order to answer this subquestion, it is supported by several other subquestions, which are connected to effectiveness of measures and the degree of the 4 A's: **Awareness** (*knowing existing problems, available alternatives, being capable to acquire new knowledge*), **Association** (*recognising potential benefits, association with own agenda*), **Acquisition** (*ability to acquire, implement, operate and maintain alternative innovations*) and **Application** (*ability to achieve benefits through sufficient legal and financial incentives*).

Subquestion IIA: Which of the 4A's require the most attention?

Based on the questionnaire the awareness, is still a major part in the process towards receptivity (58%). **Awareness** of an issue itself seems common but awareness of alternative countermeasures is often lacking or connected to many uncertainties (benefits, effectiveness, responsibilities, among others). The focus group participants however showed already a higher degree of awareness; nevertheless, a request for more information about the different measures (for instance effectiveness) arose. **Association** with the benefits of countermeasures was observed in both the questionnaire and focus groups. It occurred simultaneously with

the growth of awareness. Side-note to this is that frontrunners in climate adaptation dominated the focus groups. The questionnaire as well as the focus group confirmed that participants have some ideas how to obtain information (**Acquisition**). But especially throughout the focus group discussions it became clear that uncertainties about measures (i.e.: effectiveness) remained. Focus groups revealed the ability of residents to share information and advice about several measures and their implementation. A higher degree of acquisition has been observed. Consequently residents were simultaneously developing all four requirements of receptivity, though to different extent and speed. Some participants already implemented measures (**Application**), hence it can be argued that they are receptive. Nevertheless, the focus group showed a desire for additional information for other countermeasures, thus residents were receptive for a specific rainproofing measures. The receptivity for other measures were lacking. Participants showed to have a limited overview of all the potential countermeasures.

Can receptivity be generalised for all rainproof measures?

Based on the findings through the questionnaires and focus group receptivity cannot be generalised. Participants who implemented a certain measure, still desired information for other measures. The 4 A's of the receptivity model need to be completed once more for the next measure. It is possible that it is less time consuming for a second (or third etc.) countermeasure. A foundation is already established concerning awareness of the issue as well as association, whereas time needs to be invested in the specific measures, their benefits and its implementation. For certain measures residents identify different benefits and values (Association), for instance biodiversity or aesthetics, rather than the intentions and associations water managers recognise. Hence residents might be receptive for rainproof measures where the rainproof aspect in itself is a side effect. Thus the reason why someone implements rainproof measures might differ and influences the receptivity for different measures.

Factors that influence the receptivity

Generally residents feel responsible to protect their home. They also indicate that rainwater issues are shared problems and refer to cooperative responsibility and action. They expect the municipality and Waternet to fulfil their tasks like maintenance of sewer system and groundwater levels, which – as a role model – can stimulate residents to take action. Receptivity is possibly influenced by communication and transparency about tasks and responsibilities. The information requests for more tailor-made advice shows the challenges of actual implementation. Time consuming searches for knowledge, whereby some information might not always be applicable for their specific circumstances hampers the receptivity of residents.

Besides, the structure within housing cooperation might obstruct the entire process. The responsibility of cooperations for many houses, the connected planning and their budget might not recognise the urgency nor have budget available to implement rainproof measures.

Renters have thereby the challenge that they might be willing to implement measures or are at least aware of rainwater problems; however, they cannot act as it complicates the landlord - renter relationship. It would be possible to stimulate the communication between renters and landlords. The collaboration between neighbours seemed to be of high importance. Thereby a platform connecting neighbours with similar issues could facilitate such process towards a more receptive approach. Additionally, participants spoke highly of initiatives or pilots, that could be promoted for instance by the municipality, connected to the introduction of rainproof measures.

It is assumed that frontrunners can play an important role. A successful implementation can show impact on the society and trigger others to follow. This could be associated with the social learning theory or as argued by Hendriks (2008) with the elitist technocratic approach. Visionaries set an example. Through their enthusiastic communication about issues and solutions towards others they can enlighten them.

The results of the questionnaires revealed that most respondents do not (yet) fulfil all aspects of Awareness. Even though Jeffrey and Seaton (2004) claim that all 4 A's can coexist, without the knowledge about alternatives no benefits can be associated, neither associated with their own agenda nor actually implemented. While residents are to some degree developing within all 4 A's, obstacles towards the implementation can be found.

Subquestion IIB: What measures are associated with rainproof measures?

Rainproof measures are defined as follows: "*Measures that can store water and prevent water damage during heavy precipitation.*" Respondents associate different measures with rainproof measures, whereby rain barrels were broadly known. Beforehand it was expected that rain barrels are better known compared to other countermeasures. This is supported by the outcome of the questionnaire. Also green roofs are well known, whereby it would be interesting for which features they are known best (temporary water storage, biodiversity, aesthetics). Furthermore residents associated green roofs, green gardens and infiltration opportunities ascribed to less impermeable materials with rainproofing their environment. Respondents associated the following with water damage prevention measures: impregnating, waterproofing the cellar, maintenance of roof, drainpipes, sewage system, installation of pumps.

Subquestion IIC: Which measures can be applied on private property in De Baarsjes?

Generally not all rainproof measures are suitable for all spaces throughout the city. Some measures are better for public spaces (for instance water square) and others are not suitable due to specific features of a place (high ground water levels influence the drainage).

In De Baarsjes, it has been chosen to neglect deep infiltration features as both residents and groundwater monitoring recordings indicated high groundwater levels in several areas. Rainproof measures that seem appropriate for this neighbourhood are the following: green roofs (extensive, intensive, polder roof: depending on the bearing capacity of the roof) , infiltration measures (shallow), height differences within the garden, bioswales, rainwater retention pond, rainwater tanks, rain barrel, water-retaining planters, rainwater fence as well as green gardens and porous pavement. This selection has been made for the research; nevertheless, other measures might be applicable as well.

Subquestion IID: Which measures are effective in De Baarsjes?

Residents perceived high effectiveness of green roofs, followed by infiltration crates and rainwater tanks. The perceived effectiveness of those were not significant. The AST calculations revealed the highest effectiveness for intensive green roofs, followed by green gardens, shallow infiltration boxes and systems for rainwater harvesting. Intensive green roofs appears to be the better choice rather than extensive roofs. Investments in such a measure are also influenced by other parameters, such as construction costs, maintenance costs and its suitability in the actual circumstances (bearing capacity of buildings). Also porous pavements were considered for evaluation. If a trend – using more tiles – is continued porous pavement with greater thickness of the (porous) sub-base would be advisable. Also the construction and maintenance costs are manageable. A rain barrel is least effective. It is a nice addition for households in order to water some plants. Rainwater tanks are assumed to comprise higher storage capacities owing to its greater dimensions. Large scale rainwater tanks could cope with more stormwater, hence investing in such solutions assists rainproofing the neighbourhood.

Green roofs in combination with green gardens (50% of the backyard area) are not able to cope with the target storage capacity of 60 mm set by Amsterdam, even though these measures reach a higher storage capacity. If all roof tops are considered, the target cannot be met; combinations with other measures are required.

The associated costs for installation and maintenance have a crucial influence on the implementation. A logical combination based on costs and its relative increase of benefits should be considered. Based on these calculations it would be advisable to first invest in rainwater retentions ponds. It might be possible that height differences in the garden for temporary water storage would be a feasible alternative. The consideration of porous pavement for terraces is advisable. Costs per increased effectiveness were more favourable for a greater sub-base thickness. Bioswales also have relatively low construction costs with a relatively high effectiveness. The combination of the before mentioned measures reaches 100% of the target, coping with 60mm, hence sufficiently effective. This corresponds with a water label A (Chapter 3.4.2, Figure 3.2).

When using the entire backyard area for green gardens, the area can cope with even higher intensity showers, increasing the effectiveness to high. High effectiveness could also be reached in combination with intensive green roofs, corresponding with water label A+.

Summarising the answer to subquestion II

Receptivity of residents of De Baarsjes for rainproofing measures is still limited. More than half of the respondents to the questionnaire still lack (some) Awareness. Awareness of the issue itself is common but awareness of alternatives countermeasures is often lacking or connected to uncertainties about their benefits and effectiveness. The results of the questionnaire and focus groups revealed that association was quite common. Association grew simultaneously with the awareness. Participants knew how to acquire information. But especially throughout the focus group meetings it became obvious that many unknowns and uncertainties about rainproofing measures (effectiveness, applicability, costs, responsibilities) remain. Some participants already implemented measures, hence they are receptive and can be considered as frontrunners. The focus group showed that they too still desire additional information. They are receptive for one specific measure but perhaps not for other rainproofing measures

Generally spoken, residents feel a responsibility to keep water out of their own home and identify the water problem as a shared problem, whereby cooperative responsibility and action are necessary.

To what extent are residents receptive towards increasing the resilience of the city to extreme precipitation?

The urge for change is recognised and residents desire a change; however, the actions toward this change are interpreted differently. This is also connected to a missing negative experience for some residents, hence water issues are not on their agenda (yet). Residents are more aware of the problem when they experienced flooding. There are numerous barriers towards implementing rainproofing measures. Not only the recognition of responsibilities but also dependencies between different stakeholders as well as knowledge requests indicate that residents still need stimulation. Residents who already experienced water damage or flooding showed a more active role. Frontrunners recognise the importance of shared responsibilities, taking part of the action, inspiring others to move forward.

Summarising it can be argued that awareness about a certain problem, like pluvial flooding and increasing extreme precipitation is not enough for residents to implement rainproof measures. Attention should be given to several aspects considering also the association phase and the acquisition phase of the receptivity model of Jeffrey and Seaton (2004). Building capacity is an important feature to improve the receptivity (Brown and Keath, 2008) of residents. The implementation and maintenance of rainproofing interventions also require skills and capacity to do so. Therefore, focussing only on the awareness phase is not enough to obtain results. Providing a guidance framework by addressing all phases with adjustable priorities is essential.

Rainproofing is a complex process and it requires more than purely distributing information to create receptivity. This project showed that residents of De Baarsjes, Amsterdam are not (yet) ready to increase the resilience of the city to extreme precipitation.

The conclusions of this research are transferable to other areas (within Amsterdam or other cities) with comparable circumstances. Considering the mindset of residents, an accumulation of visionary frontrunners shifts the magnitude of receptivity. Different rules and building requirements of the municipality could impose receptivity.

A larger sample size, however, would increase the reliability of the results. The repeatability and transferability of research approach to other areas is given. Many variables of the method are adaptable. The guiding model of the receptivity framework provides valuable insights in human behaviour independent of the research area or the researcher. Also the utilisation of the AST is applicable in various circumstances. Some adjustments of the to be evaluated measures is advisable, considering the specific circumstances (groundwater levels, bearing capacity of buildings etc.).

8 Remarks, recommendation and advice

This chapter gives an overview of remarks that should be kept in mind considering the results of this research and the reproduction of it. It forms the answer to subquestion III, 'What information could help to stimulate the implementation'. It gives a brief summary of issues, which were to some extent reflected on in the discussion. This advice could positively contribute towards a more resilient city.

8.1. Remarks

The collected data (2017/2018) perhaps does not represent the current situation of receptivity. Policy changes, communication, experience, prices of measures will have changed and could positively contribute towards the increase of the resilience of the city. But the data reveals interesting subjects that are most likely still relevant. This is based on visual personal evaluation of the situation in different neighbourhoods in Amsterdam. The situation within Amsterdam, its regulation and the approach of Amsterdam Rainproof has not been re-evaluated and it would be recommended to reflect on when considering the advices given through this research. Some personal experience of the researcher is mentioned in Appendix P.

The calculations of the effectiveness with the AST was made in the beginning in 2019. Since then the tool changed; data are updated and the tool is now publicly accessible (kbstoolbox.nl). Also some information within the tool and its handleability (might) differ. The outcome of the analysis remains the same, but by going through all steps once more additional insights might be revealed. Moreover, all residents can now use the tool now to make their own adaptation plan for their own lot, street or district. They can do that individually or in groups with different stakeholders. It would be interesting to investigate how residents react to the tool and if they would be interested in informative evenings.

8.2. Recommendation

This study reveals some shortcomings and requirements for further research:

I – Research in other neighbourhoods: more research considering this matter can give an insight in the receptivity of all residents in other districts of Amsterdam. Keeping in mind that some neighbourhoods are more prone to for instance pluvial flooding than others.

II – Research about structures within the municipality: detailed information about the structures within the municipality, permits, and rules connected to permits concerning sustainability of the city gives an insight in the shortcomings and strength of the municipality towards increasing the resilience of the city. Obligatory measures (through destination plan 'bestemmingsplan' and the Handboek Inrichting Openbare Ruimte (HIOR)) for instance green roofs might stimulate the implementation of other measures. Generally ascribed to extending buildings - garden sizes are decreasing. It is interesting to investigate if a change concerning permits might help to make the city more resilient for climate change.

III – Suitability of buildings and private terrain: more detailed information about buildings and the carrying capacity for the specific neighbourhood is necessary to make a more accurate decision about the implementation of intensive green roofs. Intensive green roofs are more effective (but also more expensive) and thus a measure that would be a good combination with other measures. For this research it has been neglected for the combined implementation as it requires a high carrying capacity of the buildings. It was assumed that most of the buildings in this specific neighbourhood would not fulfil this requirement. Detailed

research could reveal different indications. Additionally detailed information about gardens infiltration capacity could reveal other suitable measures.

IV – Additional research with a larger sample size (in the same neighbourhood): a larger sample size of the questionnaire increases the reliability of the research and gives the opportunity to generalise the conclusions to the entire neighbourhood. This is pointed out as a limitation of this research (see discussion: Chapter 6). In order to generalise the results to the entire neighbourhood, follow-up research is necessary.

V – Additional focus group interviews: when using focus groups for follow-up research, more experience and knowledge of the analysis of its results is beneficial. Also a different season should be considered. Through communication and networking it is advisable to organise more than two focus group sessions until a clear pattern emerges to reach a theoretical saturation (Rabiee, 2004). The composition of the group should be homogenous to a certain extent. As the specific topic should concern the participants (Freitas et al., 1998). For instance participants encountering flooding through groundwater are less likely to join a discussion about green roofs. All participants need to feel comfortable to share their ideas and need to feel involved in the dialogue. Nevertheless, a discussion cannot be stimulated when all participants have the same perspective towards the topic. Hence some diversity is necessary to encourage the exchange of different ideas on the same topic (Freitas et al., 1998).

VI – Mosquito issue: residents have been indicating nuisance with mosquitoes. Detailed information about the mosquito issue in De Baarsjes could positively contribute towards a better idea how to integrate this topic with the implementation of rainproof measures. This should also connect back to the rainproof measures and its influence on breeding places or biodiversity and thus predator species, which could decrease the mosquito population.

8.3. Advice

In order to make the city of Amsterdam more resilient for extreme precipitation, and thus improve the receptivity of the residents it is important to pay attention to several points.

I – Connect residents with similar issues: it is important to get residents with the same issues connected with another. As they share the same problem, they are more likely to develop an urge to take action through groups-motivation. Information evenings for specific problems rather than covering a broad context improves the information distribution. Residents can get the desired information within a minimum amount of time and do not need to filter all information on their own.

II – Being aware of the mosquito issue: specific measures could trigger frustration, as they could increase the issues with mosquitoes, which is a valid concern in this neighbourhood. This issue is experienced throughout the neighbourhood, so try to communicate about it and design measures which reduce breeding opportunities for mosquitoes. Connecting the residents with each other (according to advice I) is useful to deal with the mosquito problem. But also within the organisational and advisory levels this specific issue should be considered. More insight is required to understand the driving factors behind the mosquito problem as well the misbalance in the ecosystem and disrupted biodiversity in cities (see recommendation VI). The possibility exists that an increased biodiversity, the existence of butterflies or birds brings positive association. The introduction of certain species might even decrease the mosquito population as larvae will be consumed. Broadening the picture from rainproof to an eco-friendly approach possibly enhances the benefits. Residents seem to be more open for more nature within the city to some extent.

III – Addressing the appropriate stakeholder: residents are influenced by the ownership of the buildings. When communicating about possible implementation it is necessary to address the person who is able to make such decisions. Thereby a platform or mediators could help with the communication within the VVEs as they influence the decision-making (shared gardens or adjustments necessary for the roof).

IV – Tailor-made advice: providing tailor-made advice can contribute towards a positive mindset on rainproof measures and adaptation, as the general knowledge about the urgency of the rainwater issue is widely spread but uncertainties about the specific alternatives for their own situation holds residents back. Residents without a garden would be overwhelmed with garden specific information. Residents need to get in touch with stakeholders that can give such specific advice as too much information could initiate confusion. For housing corporations, a limited budget in combination with many different buildings could hamper the implementation. Tailor-made advice how to invest the limited budget with the highest benefits could help with the implementation. Especially if costs connected to damage could be prevented. It will be a challenge to address the right people with the right subject. Lobbying and networking could help to attract firstly frontrunners, who will positively influence their surroundings.

V – Promoting the benefits of measures: knowledge of the benefits of measures has a positive influence towards the receptivity. Connecting the abundance of water with dry periods through water storage and thus recycling of water could trigger certain residents to implement water storage measures. The implementation of blue and green measures could also reduce the Heat Island Effect.

VI – Transparent communication about effectiveness and costs of measures: it is also important that residents are aware of the effectiveness and costs of measures. Maybe not all measures can be implemented at once and one measure needs to be chosen. Therefore, the total picture for their specific situation should be known. This requires tailor-made support from experts in this field to local initiatives. Financially attractive solutions have a higher value and might provoke the implementation. The AST calculations showed that local rainwater ponds might be a good start to implement as the costs are relatively low for the effectiveness the measures achieves. Also collective solutions might influence the financial issue positively.

VII – Enhance effectiveness with minor adjustments of the current situation: green gardens show a positive effect on increasing the resilience, however, are indicated as high costs by the AST. In backyards where green gardens already exist it could be possible to ‘adjust’ the garden with relatively low costs in such a way that it increases the effectiveness or integrate other rainproof measures.

VIII – Transparency and accountability: transparency of tasks, responsibilities and choices of the municipality, Waternet, Amsterdam Rainproof and the Committee for Spatial Quality could provide a positive mindset towards the adaptation of rainproof measures. Thereby it needs to be clear why certain streets are adjusted with a rainproof mindset and other streets might be not. The local authorities could play a role model on certain streets, so that residents can take an example and be convinced of the positiveness of taking action concerning rainproof measures. Accountability and transparency about the implementation or even the lack of implementation (despite pluvial flooding) of measures as well as tasks on the public terrain is crucial. The underlying guidelines for the Committee for Spatial Quality need to be aligned with the goal to increase the resilience of the city.

IX – Information about ground water: Through the focus group it became clear that a lot of uncertainties are connected to ground water levels, the flow and the maintenance of such and its impact on water issues within neighbourhoods. Disclosure and distribution of such data and information could give clarity.

X – Open communication about challenges towards residents and the provision of (legal) advice might be helpful to prepare residents. Yet, this should be done carefully as residents should not be frightened. It is advisable to provide them with help and advice through the process.

XI – Promotion of climate adaptation throughout the organisation: the municipality should promote climate adaptation throughout its own organisation, at all legal and organisational levels. Open communication about the challenges is first of all needed internally, to remove internal barriers to rain- and climate-proofing.

Communication about (possible) barriers, especially throughout the process, like complications with the Committee for Spatial Quality, barriers introduced by the HIOR and other legal and financial issues are the first step towards resolving these issues. It is important to lobby and promote climate adaptation in the different levels in the municipality and also integrate climate adaptation within legal aspects (for instance demanding the integration of green roof when building an extension). The city should continue developing a helping attitude towards its residents; helping them with independent expertise and advice to manoeuvre through this complex process of making their living environment more rain- and climate-proof.

Appendices

Appendix A: Climate Change - some additional information

Climate Change Effects

According to Fröhlich and Knieling (2012) negative effects such as flooding, urban heat islands (UHI), changes in groundwater and biodiversity losses can be minimised by improving the resilience through adaptation to the climate change. In 2014 the Royal Netherlands Meteorological Institute (KNMI) issued the most resent climate scenarios (KNMI'14, Skelton et al., 2017). These are the foundation for decision making related to climate change (Skelton et al. 2017). A continuous temperature rise can be seen (KNMI'14). The winter temperatures show the highest temperature increase, whereas the spring temperatures shows the least increase. Furthermore the likelihood of heat waves as well as the number of warm days increases. Additionally a stronger temperature rise has been simulated in the inland. Moreover the temperature differences between inland and coastal areas increases in the summer, however decreases in the winter. In addition more precipitation is expected, whereby the likelihood of extreme precipitation (with thunderstorm and hail) is higher. The sea level rise is depending on the global temperature. In 2050 it probably will have increased by 40 cm compared to 1981-2010. Moreover in 2085 the sea level rise of 80 cm is expected with a continuing trend (KNMI'14). By adapting to climate change, negative effects can be minimised and resilience will be maximised (Fröhlich and Knieling, 2012)

Variabele	Indicator	Climate 1981-2010	Scenario changes for the climate around 2050				Scenario changes for the climate around 2085				Natural variations averaged over 30 years
			G_L	G_H	W_L	W_H	G_L	G_H	W_L	W_H	
Global temperature rise:			+1 °C	+1 °C	+2 °C	+2 °C	+1.5 °C	+1.5 °C	+3.5 °C	+3.5 °C	
Change in air circulation pattern:			low value	high value	low value	high value	low value	high value	low value	high value	
Sea level at North Sea coast	absolute level	3 cm above NAP	+15 to +30 cm	+15 to +30 cm	+20 to +40 cm	+20 to +40 cm	+25 to +60 cm	+25 to +60 cm	+45 to +80 cm	+45 to +80 cm	±1.4 cm
	rate of change	2.0 mm/yr.	+1 to +5.5 mm/yr.	+1 to +5.5 mm/yr.	+3.5 to +7.5 mm/yr.	+3.5 to +7.5 mm/yr.	+1 to +7.5 mm/yr.	+1 to +7.5 mm/yr.	+4 to +10.5 mm/yr.	+4 to +10.5 mm/yr.	±1.4 mm/yr.
Temperature	mean	10.1 °C	+1.0 °C	+1.4 °C	+2.0 °C	+2.3 °C	+1.3 °C	+1.7 °C	+3.3 °C	+3.7 °C	±0.16 °C
Precipitation	mean amount	851 mm	+4 %	+2.5 %	+5.5 %	+5 %	+5 %	+5 %	+7 %	+7 %	±4.2 %
Solar radiation	solar radiation	354 kJ/cm²	+0.6 %	+1.6 %	-0.8 %	+1.2 %	-0.5 %	+1.1 %	-0.9 %	+1.4 %	±1.6 %

Figure A1: climate scenario's for The Netherlands by the KNMI (KNMI'14)

Urban Water Management

Rainwater converts to stormwater when touching paved and unpaved surfaces. Stormwater in urban areas can provoke several issues. These are connected to flooding, erosion, sedimentation, temperature rise, dissolved oxygen depletion, eutrophication as well as reduced biodiversity (De Graaf, 2009). Stormwater enters the sewer system, however extreme precipitation may exceed the capacity of the sewer system. Issues like combined sewer overflows (CSO's) might take place: diluted wastewater and sewage sludge are mixing with urban surface water (De Graaf, 2009), inflicting water quality problems. A separated sewer system approach, disconnecting paved surfaces

from combined sewer system and installing infiltration areas for stormwater (which has been widely adopted in the Netherlands since 1980's) (De Graaf, 2009) can counteract these issues.

Brief history of urban water system of The Netherlands

The Netherlands was and is managing water throughout history, thereby designing polder cities and making marshlands suitable through artificial management of surface - and groundwater (De Graaf, 2009). De Graaf, 2009 summarised the following approaches:

1. *Acceptation (until 1000):* Adapting settlement to water system
2. *Defensive(1000-1500):* Construction of dikes and sluices
3. *Offensive(1500-1800)*: Reclamation of polder
4. *Early manipulative (1800-1890)*: Reclamation of polders
5. *Manipulative (1890-1990)*: Separation of civil engineering and urban design. Water problems were solved by civil engineers.
6. *Adaptive manipulative (1990-today)*: Adaptation to increasingly natural system instead of manipulation was induced by environmental awareness and climate chance, whereby the intertwining nature of urban planning and water management plays an important role.

The current urban water system are criticised on their lack of sustainability and the parasitic behaviour of cities (De Graaf, 2009, pp. 4). As cities extract their water from the surrounding area a reuse of stormwater could improve the efficiency and would counteract groundwater depletion in surrounding ares. Thus with the introduction of adaptation measures a more cyclic water flow would be created on the city scale (De Graaf, 2009). Thus urban water management in the Netherlands reached a point where adaptation to the situation has a high value. An important aspect is that in a climate sensitive system not all actors are vulnerable to the same amount as well as the adaptation possibilities, related to for instance the ability to recognise danger and finances may differ (Stock et al., 2009).

Urban Heat Island (UHI)

Another underlying issue of cities are Urban Heat Island Effect. Throughout this research is was mentioned, that the implementation of rainproof measures might have a positive effect to cope with UHI. They tend to warm up more than the rural surroundings (Nakayama and Fujita, 2010) due to its radiative and geometrical features the creation of a micro climate occurs. Urban areas have a high percentage of roofing and paving, whereas the amount of vegetation remains low (Gartland, 2011). This unfortunate combination accommodates the UHI effect. High temperatures can provoke heat stress, which influences the health as well as the productivity of the citizens. The temperature in an urban area can be up to 10˚C higher compared to the surrounding areas/rural areas (Hommes et al., 2016). The greatest difference can be found in the evening and during the night (Gober et al., 2009, Fallmann et al., 2013), as build up areas still emit higher temperatures (Hommes et al. 2016). As several rainproof measures accommodate the use of blue and/or green infrastructure it could be agued that the implementation of such measures has a positive influence on UHI and can release stress of the water system (wet and dry periods).

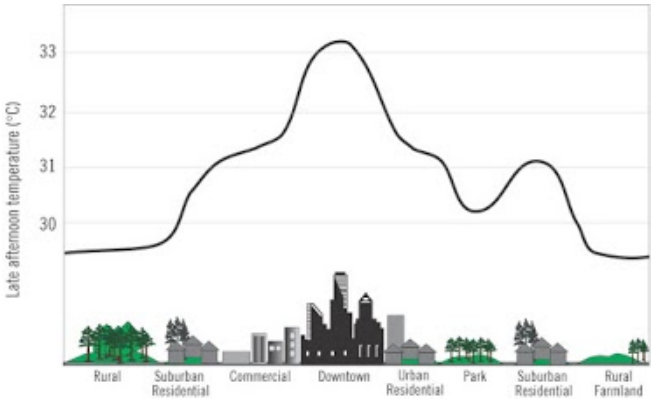


Figure A2: UHI effect demonstrated in the temperature profile of a city. (Arrau and Peña, 2015)

Pluvial flooding
The high percentage of paved areas can provoke pluvial flooding due to high intensity precipitation. The excessive amount of water cannot infiltrate nor be transported through the sewer system as it reaches its capacity. Thus it has to be stored locally or transported elsewhere through a drainage network (Wouters, 2016). Due to the increasing precipitation intensity storage capacities as well as the drainage network's hydraulic capacity will be challenged frequently.

Fluvial Flooding

An increase in precipitation intensity as well as quantities in river basins can lead to higher peak levels in the river. If the storage capacity of the river bed is exceeded the river overtops its banks. Fluvial flooding poses a thread to health and has adverse financial effects for urban areas.

Coastal Flooding

Urban areas in coastal regions are facing an additional threat, as coastal areas come along with economic benefits mankind settled close to the coast. With the increasing urbanisation in combination with the rising sea level coastal flooding can occur. Moreover coastal urban areas that are subject to land subsidence are facing two mechanism intensifying the threat to the city. Thus the mechanisms of sinking cities and rising sea level amplify the risk of coastal flooding immensely whereby the impact of such an event can be quite tremendous and could lead to disruption of the normal live and economic losses even cause casualties.

Groundwater flooding

Groundwater flooding is characterised by a rising groundwater table beyond upper boundary's. In regions where the groundwater table is high the chance for groundwater is greater compared with low groundwater tables. High groundwater tables influence the infiltration capacity negatively.

Sewer flooding

When the capacity f the sewer system is reached it cannot cope with abundant stormwater and can overflow and flood the surroundings. Such an overflow can also be caused if the sewage system is clocked. Especially combined sewers (wastewater and stormwater) can cause health issues in case of flooding.

European Flood directive and Water framework directive

the European Flood Risk Directive (2007/60/EG; FRD) addresses flood assessment, planning, management and adaptation of measures. Bedsides, it obligates member states to involve all relevant stakeholders. The Water Framework Directive (WFD) emphasises active involvement and public participation in water management (2000/60/EC; WFD), which is used in the FRD: '*Member States shall encourage the active involvement of* ***all interested parties*** *[...]. Member States shall ensure that, for each river basin district, they publish and* ***make available for comments to the public****, including users [...]*' (Article 14, 2000/60/EC; WFD, bold added by the author)

Deltaprogramma Ruimtelijke Adaptatie (Delta program spatial adaptation)

Programs such as the Deltaprogramma Ruimtelijke Adaptatie (https://ruimtelijkeadaptatie.nl/) strive towards resilience on national level. Achieving climate resistance and water robustness of The Netherlands is aspired by 2050 and accomplishing the integration of strategies within the policy by 2025. The responsibilities are to be taken at the regional and local level. Thereby public as well as private terrains should be considered (Deltaprogramma Ruimtelijke Adaptatie, 2017).

Watertoets

The Watertoets is another process instrument, evaluating the consideration of water related issues within spatial planning. If water interests are relevant for a project it is crucial that following aspects are considered: water safety, water storage, groundwater and wells, facility and water quality, management and maintenance of waterways, sewage and rainwater. These aspects will be evaluated by the water-board and an advise is given, which might include recommendations for adjustments (https://www.helpdeskwater.nl/onderwerpen/water-ruimte/watertoetsproces/).

Appendix B: Public space - private terrain

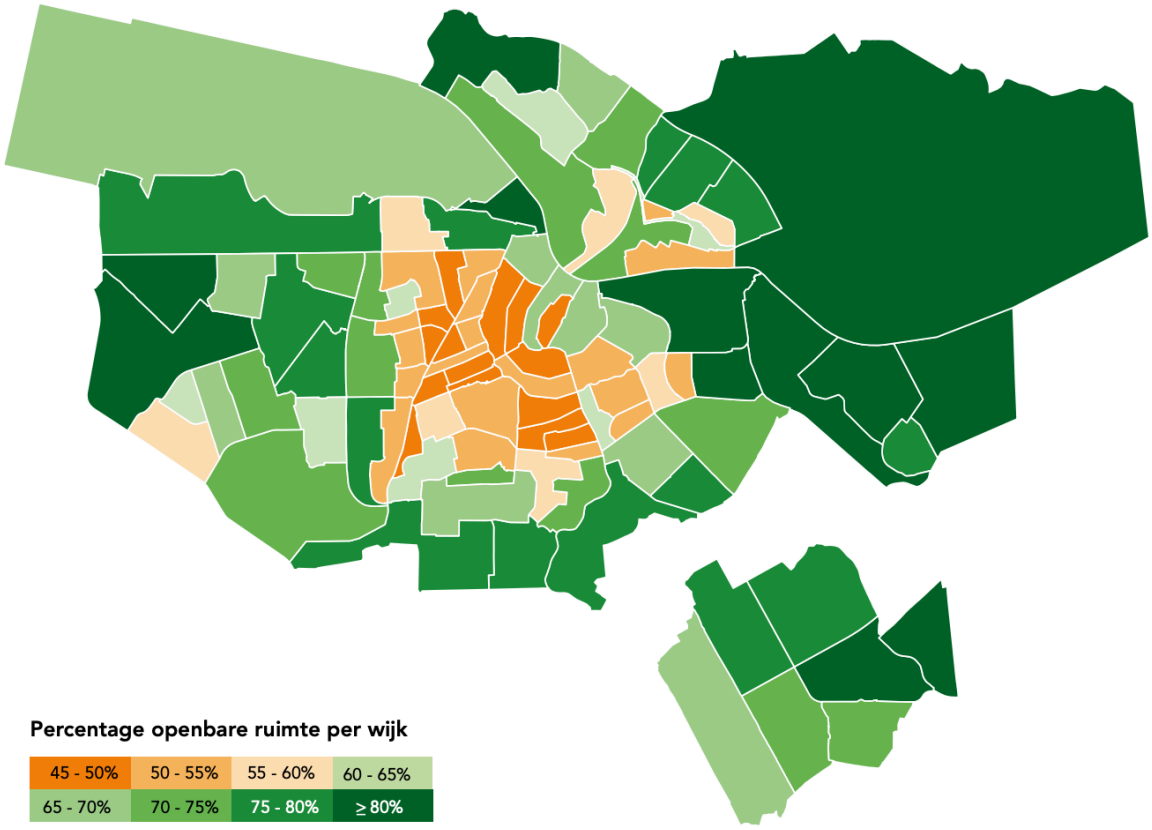


Figure B1: Amsterdamse Thermometer van de Openbare Ruimte 2019 - Gemeente Amsterdam 2019

Appendix C: Knelpuntenkaart (Rainwater-bottleneck-map) and infographic Amsterdam Rainproof

Amsterdam rainproof analysed the vulnerability of the city of Amsterdam with a stress-test. Through calculations with a computer model, using information on the sewer-system, streets, plains, buildings and gardens it has been calculated if and where pluvial flooding can occur. A precipitation event of 120mm in 2 hours has been used. The results have been analysed and the following rainwater-bottleneck-map has been created.

A bottleneck (knelpunt) is a (part of) street or neighbourhood that is (extreme) vulnerable to pluvial flooding and the induced damage.

Three categories are indicated:

Red - extreme urgent: chance of substantial damage to real estate, vital infrastructure, hospitals and museum as well as disrupting the accessibility could be induced by excessive rain

Orange - really urgent: chance of damage to real estate and traffic obstacle induced by excessive rain

Yellow - urgent: Chance of damage to real estate

It is indicated that also areas outside the bottlenecks have chance of damage and disruptions and should be taken in consideration. The interactive card can be found: https://maps.amsterdam.nl/rainproof/

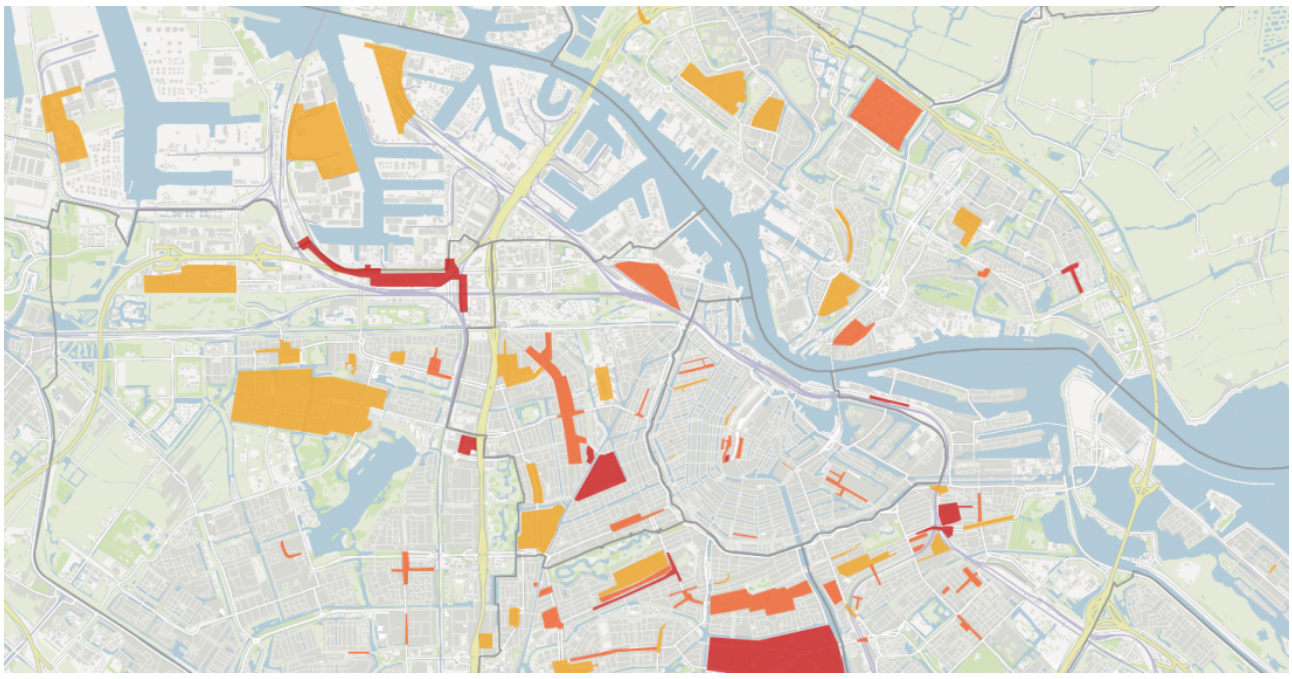


Figure C1A: Knelpuntenkaart (Rainwater-bottleneck-map) by rainproof.nl.(Amsterdam Rainproof, 2020c)

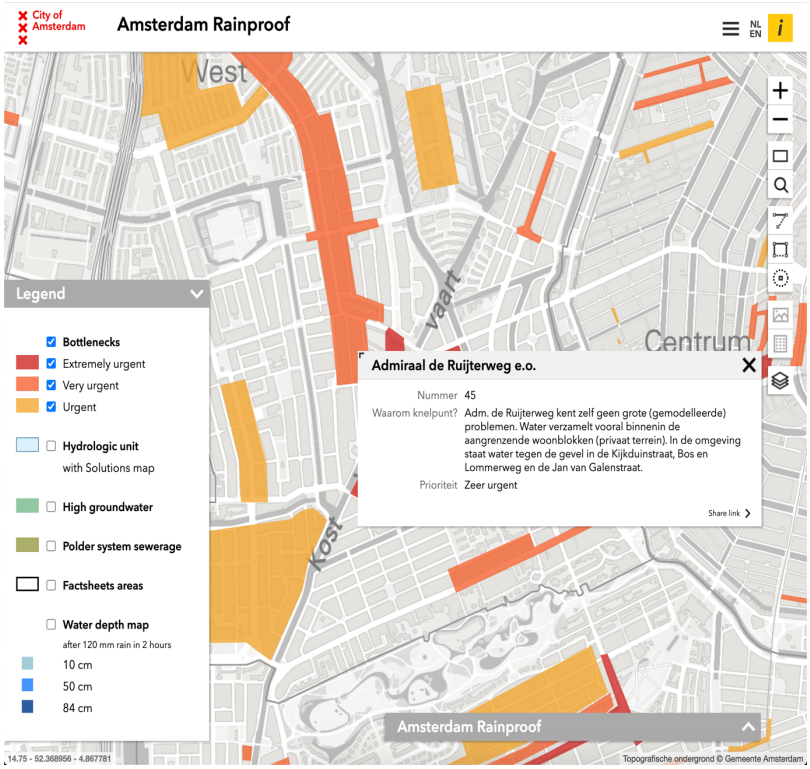


Figure C1B: Knelpuntenkaart (Rainwater-bottleneck-map) by rainproof.nl.

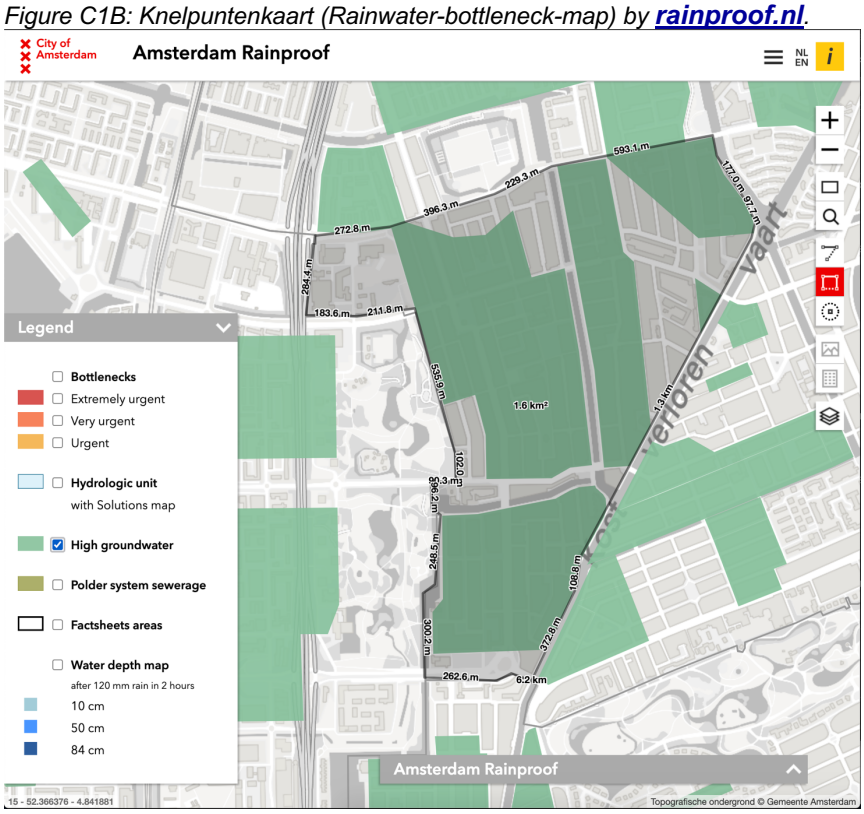


Figure C1C: Knelpuntenkaart (Rainwater-bottleneck-map) by rainproof.nl.

The following Figure C2 presents the infographic created by Amsterdam Rainproof. Providing brief information about the issue, possible solutions and opportunities that can be taken and where to retrieve more information.

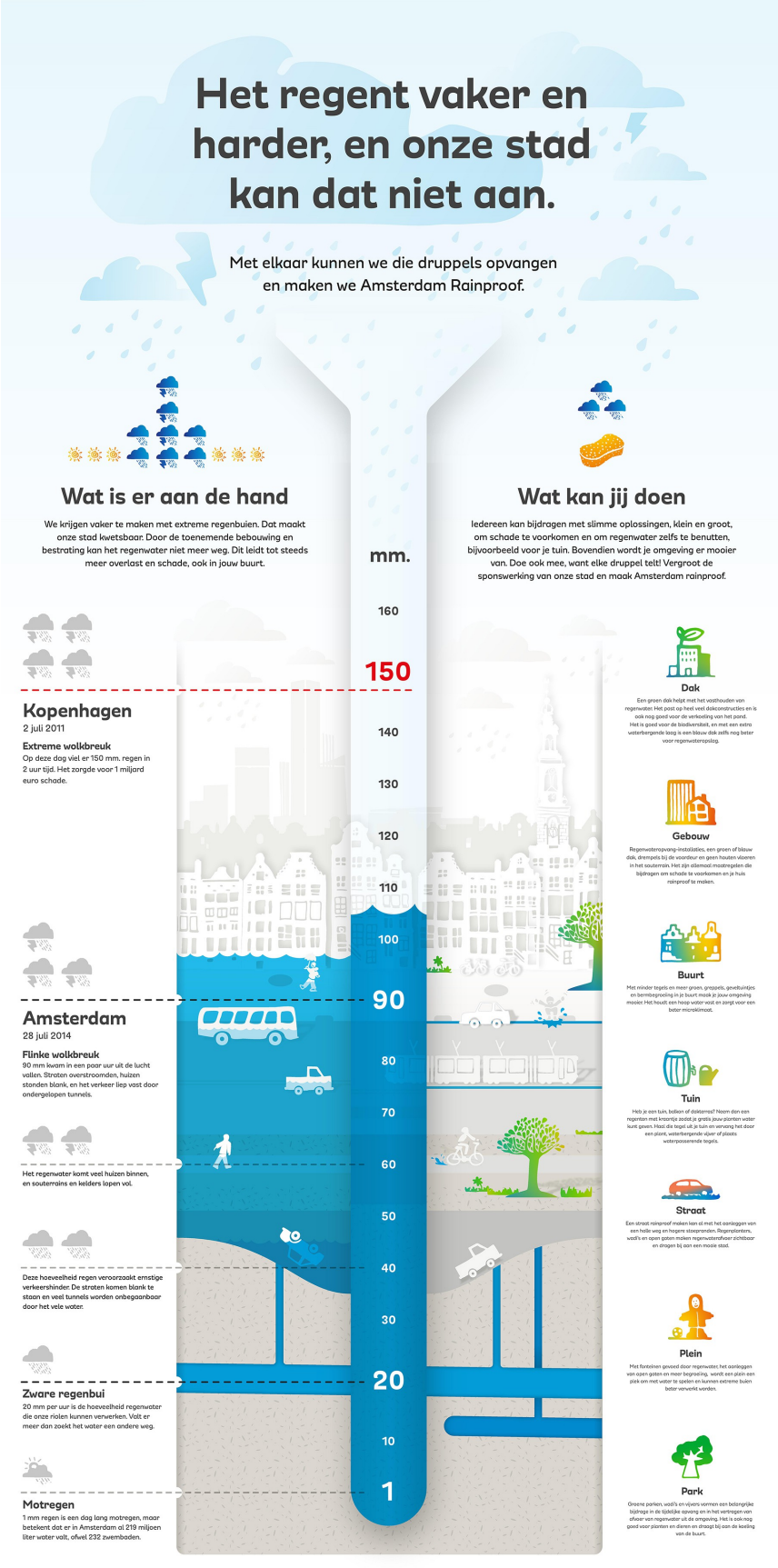


Figure C2: First page of Infographics of Amsterdam rainproof

Appendix D: Selection of the research area

The design of cities and their water-systems outdated and does not consider climate change. The sewage system can deal with 20mm/h and high intensity precipitation events cannot be drained. Water issues allover the city of Amsterdam are occurring. For this research it was chosen to limit the research area to one neighbourhood. Based on communication within rainproof as well as different research several neighbourhoods can be considered. During some talks with rainproof is already became clear that the focus would lie on Amsterdam West or Amsterdam Oud - Zuid. Also the district analysis of the municipality of Amsterdam has been considered. Thereby following neighbourhoods could be selected: Amsterdam West, Oud-Zuid and Watergaafsmeer. The district analysis (gebiedsanalyse) Oud-Zuid 2016 shows that Oud-Zuid is vulnerable to excessive precipitation. Especially Schinkelbuurt and Museumkwartier are vulnerable due to the vulnerable and valuable collections (Gemeente Amsterdam, 2016a). This vulnerability is connected to public vulnerability and valuables to the society and to a lesser extend the vulnerability of single households. The district analysis shows also the water issues can occur in streets such as: de rotonde op de Amstelveenseweg, Lairessestraat, Roelof Hartplein, PC Hooftstraat (situation after reconstruction (herprofilering) is unclear), Stadionweg en Beethovenstraat. This indicates that the district is vulnerable. Connecting this to a previous research concerning water damage within Amsterdam West and Zuid (south) it shows that this neighbourhood and its residents can contribute with valuable information.

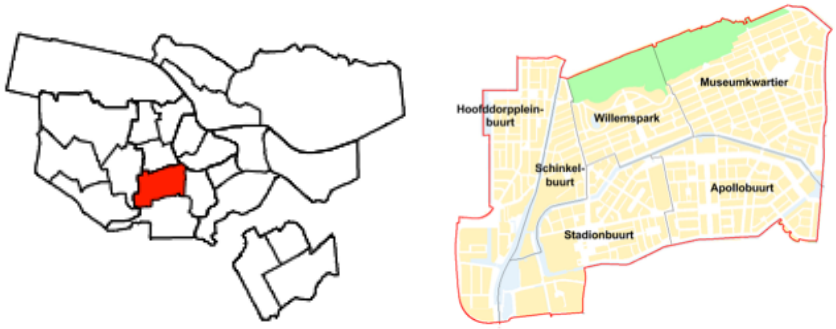


Figure D1: Amsterdam Oud-Zuid (Gemeente Amsterdam, 2016a)

Also West could contribute with valuable information. Based on the district analysis water issues can arise at Haarlemmerplein, Jordaan, Grachtengordel West, Burgwallen- Oude Zijde due to excessive rainfall (Gemeente Amsterdam, 2016b).

Figure D2: Amsterdam Centrum West (Gemeente Amsterdam, 2016b)

Another neighbourhood which seemed suitable is Westergraafmeer. Also in Westergraafsmeer issues with pluvial flooding have been seen in this region (Gemeente Amsterdam, 2016c). Already some research was done providing additional information. It is also known that people are willing to contribute, however do not know how. Also the connection between the project managers and the residents are missing, which makes the participation difficult.

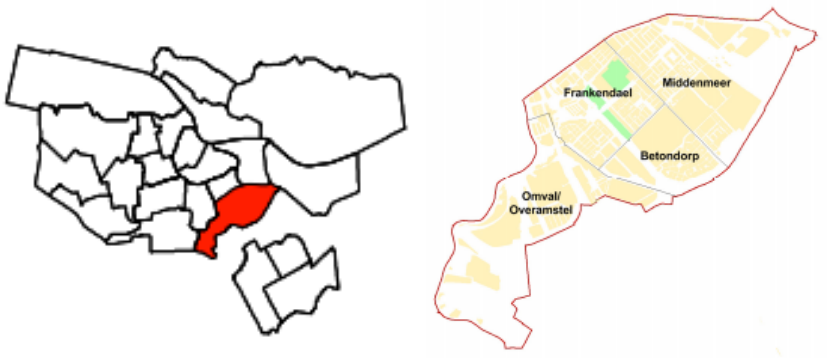


Figure D3: Amsterdam Westergraafsmeer (Gemeente Amsterdam, 2016c)

Within the gebiedsanalyse (district analysis) it is also stated that a restructuring will be done in 2018 and more climate proof adaptation. This would be favourable for the research and the possible stimulation of the implementation of rainproof measures. However throughout conversations within Amsterdam rainproof it became clear that some reconstruction has already been stared in the public space and residents are not thrilled by the construction works and the durations. Which makes them less open for rainproof measures. A combination of more neighbourhoods is out of scope for this specific research.

Another possible neighbourhood for this research would be De Baarsjes (see Figure A4). In the district analysis of Amsterdam (2016) it became clear, that this neighbourhood is vulnerable for extreme precipitation.

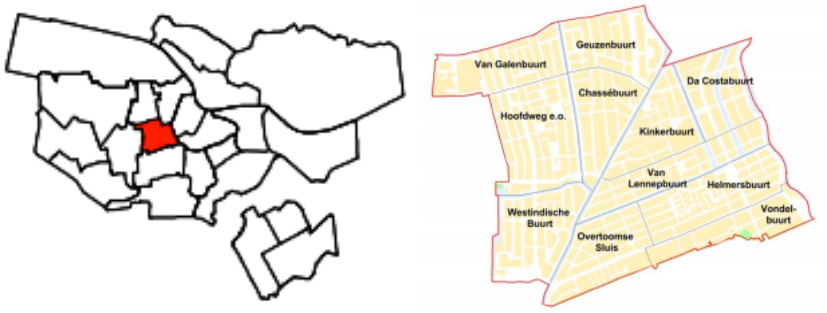


Figure A4: Amsterdam Oud-West/De Baarsjes Stadsdeel West (Gemeente Amsterdam, 2016d)

Vulnerable areas and streets have been indicated as followed: Binnenterreinen Hoofdweg, Helmersbuurt, Overtoomse Sluis and Vondelbuurt and surroundings, Chassébuurt, Geuzenbuurt and de Kinkerbuurt. Furthermore some bottlenecks can be found for the following (parts of) streets: Hoofdweg (between J.v. Galen and Mercatorplein), A10, Jan Evertsenstraat (between Hoofdweg and Admiralengracht), Slatuinen, Admiraal de Ruyterweg (near Jan Evertsenstraat), Frederik Hendrikstraat, Bilderdijkstraat, Kinkerstraat Oost and Midden, Bellamystraat and surroundings, Schimmelstraat and surroundings, Jacob van Lennepstraat near Bilderdijkstraat, Eerste Helmersstraat, Overtoom, Kanaalstraat. Hence this neighbourhood shows several vulnerable locations for extreme precipitation and gives thus an opportunity for further investigation. This neighbourhood experienced water damage by previous heavy precipitation.

De Baarjes is locates in the western part of Amsterdam. Before 1921 this neighbourhood was part of the former municipality of Sloten and is now a neighbourhood of the municipality of Amsterdam. Since 2010 is De Baasjes a part of Amsterdem West, before 2010 it was a separate “stadsdeel’ of Amsterdam. The area of De Baasjes reaches a surface of approximately 1.64 km2, whereas 0.1 km2 can be accounted for water. In 2010 this neighbourhood was inhabited by 33.847 citizens.

Residential characteristics

According to the area analysis of Amsterdam, De Baarsjes is part of the Gordel ’20-’40 and characterised by many squares (Gemeente Amsterdam, 2016d). Not many families are residing in this specific neighbourhood as this neighbourhood is represented by ‘single households’ (59%) or couples without children (21%). Especially people in their twenties and thirties are living in this neighbourhood (45%) whereby more women than men have been counted (Gemeente Amsterdam, 2016d).

Due to renovations and transformation, more owner-occupied homes (In 2015 approximately 29% ‘koopwoningen’) can be accounted for, as well as an improvement of their quality. However these apartments are small compared to the average size in Amsterdam (66% smaller than 60m² versus 38% in Amsterdam). However the WOZ-waarde (waardering onroerende zaken - property valuation) in 2016 per m2 is above the average (€ 3.209) (Gemeente Amsterdam, 2016d). This could even be higher in 2017 as the value is still increasing. The percentage of apartments that are rented out for the private sector (37%) is higher than the average (25%) in Amsterdam, with a relatively high percentage of cheap housing opportunities (37% below €425) (Gemeente Amsterdam, 2016d). The municipality pinpoints that Oud West/ De Baarsjes is densely populated and a scarcity of space can be seen. A daily bustle (drukte) is recognised, that is higher than the average for the municipality of Amsterdam.

Groundwater in De Baarsjes

Waternet investigated the groundwater situation and thus drainage plan in 2007. In the entire area a separate sewer system is installed. The research area is part of the ‘stadsboezemgebied’ where a level of NAP - 0.40m is maintained (Drainageplan Waternet, 2007). Throughout the year the groundwater level is at some points in time lower than the average highest groundwater level that has been used for the analyses of the drainage by Waternet. According to the drainage plan it is concluded that none of the drainage system is able to effectively lower the level to the desired groundwater levels (Drainageplan Waternet, 2007).

On the following page some pictures are shown, that were taken in the research area after a precipitation event.

Appendix E: Behaviour Models - Connecting behaviour models

Combining these three models shows similarities which can be overlaid:

Awareness

(environmental knowledge)

-> Perceived threat

(perceived susceptibility and seriousness)

-> Attitude towards behaviour **Cues to act**

(environmental attitude)

-> Association

-> Effectiveness of behaviour

(based on perceived benefits and barriers)

-> Intention

-> Acquisition

-> Application

Pro-environmental Behaviour

Behaviour

Receptivity and urban water management

In one of the researches by Jeffrey and Seaton (2004) it became clear that money has a big influence on the implementation of in this specific case a water filter. Thus financial barriers can slow down the implementation of a new technology (technology uptake). Jeffrey and Seaton (2004) argue that the receptivity model as a conceptual model is very useful and gives additional insights as the model places the citizens at the centre of policy tool evaluation. Furthermore they claim that this approach enables the product designers to place themselves in the role of the consumers. Nonetheless this tool is sensitive to spatial and temporal changes in the perspective, attitude and behaviour of the people. This should be kept in mind when using the receptivity model. The outcome of an analysis using the receptivity model gives an opportunity to address certain issues and *suggests and agenda for policy mechanism deployment*. (Jeffrey and Seaton (2004)

A change in the urban water system can easier be introduced when they are connected to a upcoming project of "*standvernieuwing*". In the research of Rutten et al. (2009) it became clear, that in Rotterdam the citizens participating in the research are hardly aware of possible consequences for urban water systems imposed by climate change. The biggest thread was associated with flooding by the sea, whereas the issues within the city through precipitation are rather neglected. Citizens have not enquired the necessary information about possible rainproof measures, feasible in their own backyard, to relieve the urban water system according to Rutten et al. (2009). However it has been found that they do implement measures to prevent water damage within and to their own house. For example concerning groundwater flooding, citizens have implemented *domplepompen* en het *storten* van *vochtnemende materiaal* as well as the isolation of the floor. Throughout their research they provided the citizens with information, whereby the citizens stated that they were not provided with enough information beforehand from the municipality about the urban water system.

The participation of citizens has a high importance when considering the realisation of new measures (Rutten et al. 2009). But it is also mentioned by de Graaf (2009) that quite a big difference between the current situation and the desired situation is occurring, which is also confirmed by the research of Rutten et al. (2009). Citizens are confirming in the research of Rutten et al. (2009) that they are willing to take action, however this needs to be connected to financial support/benefits and simplicity. They (Rutten et al. 2009) also found out that subsidies for green roofs is not known by the citizens in Rotterdam. In their research Rutten et al. (2009) argue that the receptivity of citizens in Rotterdam is relatively low. This is most likely connected to the lack of awareness about climate change and its possible negative consequences for the urban water system. Furthermore they conclude that if citizens can connect the water system to a project or an element of their neighbourhood they are more interested in. Additionally depending on the bonding in the neighbourhood and the liveability, residents are more likely to actively participate in an improvement. Thus if the connectivity within the neighbourhood is high the involvement of the citizens is also high. Additionally financial incentives are a boost for the consideration of involvement for the citizens. Rutten et al. (2009) also state that is is necessary to get the agendas synchronised. Capacity building, as proposed by Brown and Keath (2008) is one of the most significant activities in order to mainstream urban water management innovations. Capacity is required to implement and maintain these innovations. As mentioned before receptivity may differ throughout the stakeholder, consequently a *one size fits all* approach is barely appropriate. De Graaf (2009) argues that it is advantageous to strive for '*wide range of adjusted tailor made, specific approaches*' in order to achieve capacity building.Research has been done concerning receptivity of urban water managers towards innovative urban water management (De Graaf et al., 2011) and to analyse the receptivity in water management (Poustie et al. 2011). Thereby the receptivity of Jeffrey and Seaton (2004) has been applied. Generally these researches covered different fields of urban water management (water retention, sanitation, etc.) These researches showed that urban water managers are well aware about the technical innovations (De Graaf et al., 2016). Nevertheless De Graat et al. (2016) point out that their knowledge level of innovation is generally low. Furthermore professionals are not yet convinced that these innovations actually would support sustainable water management. A similar approach for policy making strategies can be seen in the research of Dunn and Laing (2017). They are suggesting that applicability, comprehensiveness, timing and accessibility (ACTA) give a good estimate of the principal concerns in policies (Dunn and Laing, 2017).

Appendix F: Amsterdam Rainproof network characteristics

Amsterdam Rainproof evaluates its network connection based on 5 characteristics.

1. openness and understanding (openstaan en begrijpen)
2. Willing (willen)
3. Ability (kunnen - omgaan en uitvoeren)
4. Doing (doen)
5. maintain (volhouden)

These 5 characteristics could be linked to the 4 A's of the receptivity framework. The first characteristic possibly can be connected to Awareness and to some extend also Association. As Association connects to the recognition of the benefits and connected to understanding. The willingness to achieve goals could be connected to the Association requirement as it refers to the association with the own agenda. The ability to act can be connected to Acquisition, but also Application. Both A's refer to a ability to, firstly to acquire, implement, operate and maintain the alternative innovation and the latter to the ability to achieve the benefits. The fourth and fifths characteristic could refer to that the network 'position' is receptive and is implementing and maintaining the implementation, hence all 4 A's are accomplished. Equivalence with the receptivity framework of Jeffrey an Seaton (2004) can be seen.

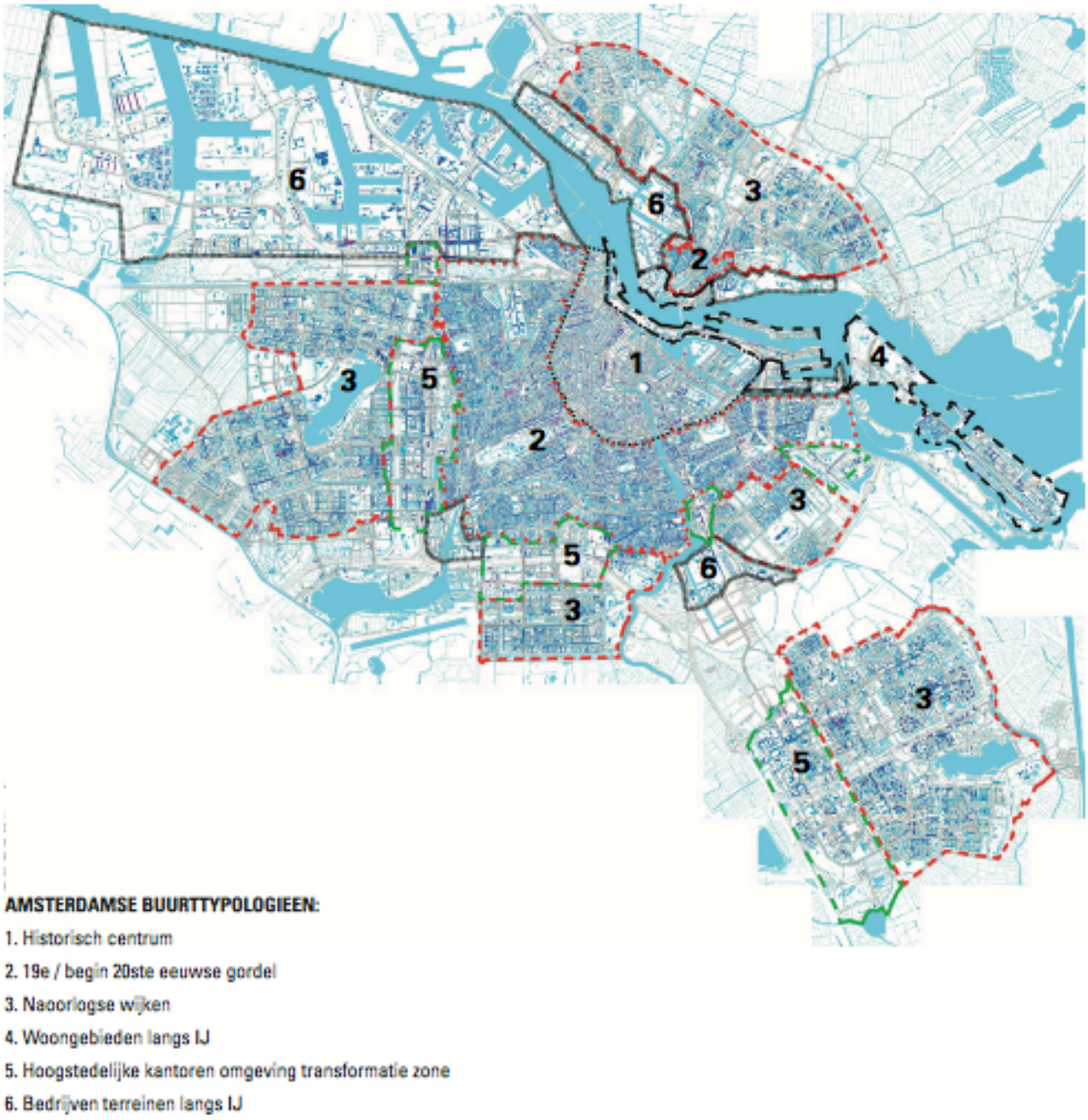


Figure F1 : Screenshot of Neighbourhoodtypes within Amsterdam (Locher and Dekker, 2016)

Appendix G: Feasible rainproof measures for private lot - a selection

Rainproof measures suitable around the house

There are several measures that are suitable around the house. On the website of Amsterdam Rainproof the following measures are indicated:

Figure G1: Indication of measures that can be applied around the house. 1: Green roof, 2: Disconnecting Drainpipe, 3: Rain barrel, 4: Rainwater harvesting, 5: Green facade , 6: Elevated doorstep/floor level, 7: water robust cellar, 8: pomp, 9: facade garden. (Amsterdam Rainproof: https://www.rainproof.nl/wat-kan-ik-doen/gebouw)

Rainproof measures suitable for the garden

Amsterdam rainproof gives several options on their website that are suitable for the implementation in gardens. The following Figure B8 gives an indication of possible measures.

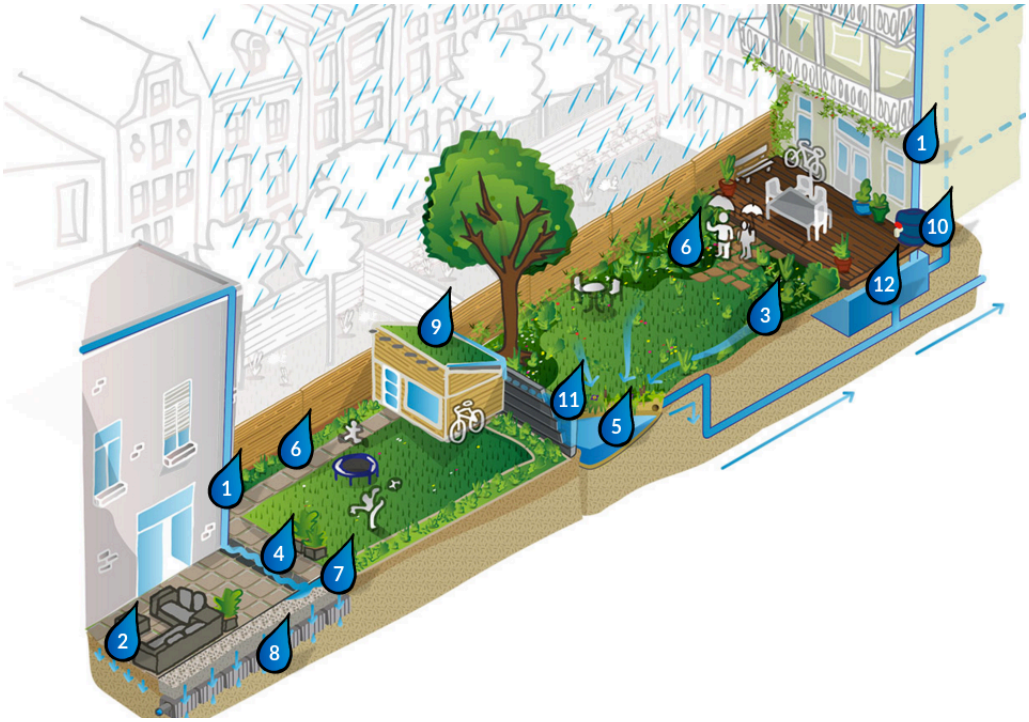


Figure G2: Rainproof measures suitable for gardens. 1: Disconnecting Drainpipe, 2: Pervious pavement, 3: Hight differences in garden, 4: open gutter 5: Rainwater retention pond, 6: Tiles out - green in, 7: Gravel strips, 8: Infiltration boxes, 9: Green roofs on garden sheds, 10: Rain barrel, 11: Rainwater fence, 12: Rainwater harvesting (Amsterdam Rainproof: https://www.rainproof.nl/wat-kan-ik-doen/tuin)

G1: Rainwater storage measures

Rooftops contribute up to 50% of the impervious surfaces (Speak et al., 2013) as well as the research of Posma (2015) shows that rooftops can contribute to the temporal storage of stormwater. Due to its aesthetic appearance green roofs can contribute to a greener city. Additionally when well watered in the dry season, green roofs can contribute to some extent to a more comfortable environment. A distinction between extensive and intensive green roofs can be made, which is shown in the Figure B2 below. A extensive green roof is characterised by a maximum vegetation thickness of 15 cm (weight: 80-130 kg/m²) (Amsterdam rainproof; Kennis voor Klimaat, 2014), whereas intensive green roofs contribute a thickness of 15-25 cm (weight: 100-300 kg/m²). Additionally the soil substrate is thicker, thus the intensive green roof can store more water (ca. 30-80 l/m²) compared to the extensive green roof (ca. 25 l/m²). Rooftop gardens show even a higher storage capacity (ca. 110-160 l/m²) , however are heavy 320-570 kg/m². It is expected that older buildings to not have the bearing capacity (without extra foundation and constructions) and will thus not be considered for this research. Retention (reduction of total outflow volume (Palla et al., 2012)) and detention (delay in initial runoff time (Palla et al., 2012) is possible with green roofs as they temporarily store water, causing a delay in the initial runoff time and a reduction of the total outflow volume. Water is also stored in the substrate and drainage layer. The storage capacity of green roofs depends on its characteristics, such as the thickness of the vegetation layer, surface area and evaporation rate (Posma, 2015). This appendix gives an overview of the selected rainwater storage measures (AST measures overview, Amsterdam rainproof, 2020d).

Green gardens: are characterised by plenty of vegetation and minimum (permeable) tiles. Permeable qualities enable the infiltration of stormwater. Green gardens offer aesthetic benefits and positive influence on: UHI (Krüger and Pearlmutter, 2008), air pollution and biodiversity.

Extensive green roof: A roof system containing of multilayers which is covered with vegetation (partially or entirely). Its maximum depth is (6) inches. The layers are consisting of a growing media, waterproofing membrane, drainage, and often irrigation component. Having shallow root plant material, an extensive green roof has less weight compared to the intensive green roof. It require less structural support and reduced maintenance.

Intensive green roof: Like the extensive green roof, the intensive green roof is also characterised by multilayers, covered with vegetation (partially or entirely). Thereby its minimum depth is (6) inches, consisting of a growing media, waterproofing membrane, root barriers, drainage, and irrigation component. Its weight is considerably higher compared to extensive roofs and require additional structural support and maintenance.

Polderdak (green roof with water retention - AST): also called blue-green roofs. The extra layer underneath the growing medium enables a temporary water storage. A control system enables the discharge of water to create more storage capacity (just) before a precipitation. A dynamic control systems provides the opportunity to use water for plants on the roof when it is dry and create storage when precipitation is expected.

Rainwater fence: collects water of the rooftops. It consists of modules, which makes it possible to adjust its design (length and height) to the desired and feasible circumstances. It is possible to reuse the water for watering plants.

Water-retaining planters: are waterproof. Within the planters layers of grind, soils plants can be found. Additionally a drainpipe and an overflow, necessary when too much precipitation in extreme short duration is occurring, is installed is done. Such planters are feasible on locations where no infiltration options are given like impermeable pavement, high ground water levels, or polluted soil where infiltration is prohibit.

Height differences in the garden: Depressions/excavated areas within the garden detain water temporarily. A green garden enables infiltration and could provide more storage capacity compared to a flat garden, depressed areas could detain more water. Besides the increased water storage capacity, like a green garden aesthetic benefits as well its positive influence on UHI, air pollution, biodiversity can be encountered.

Rainwater retention pond: are permanent water bodies which collect and detain stormwater. During precipitation events the water level rises above the static elevation. Such difference in volume characterises the storage capacity. Planted vegetation on the edges can provide positive influence on the water quality and the aesthetic.

Rainwater harvesting: a rainwater harvest system collects stormwater of rooftops. Capturing water throughout the site and byproducts like air conditioner condensate are also possible. The accumulated water is stored for its reuse on site, whereby the collection unit can be installed above ground or in the subsurface.

Permeable Pavement: this measure has many variations, Basically stormwater can pass through void spaces on the surface. After entering the subbase water is detained. Pollutants like suspended solids and heavy metals are filtered, being a beneficial side effect. Some examples of the variations are as follows: pervious concrete, pervious asphalt, permeable interlocking concrete pavers.

Shallow infiltration boxes: are underground structures, which detain, retain and infiltrate storm water. This measures facilitates a maximum land use for other functions. This measure manages water below the surface - in the subgrade.

Wadi's (bioswales): are depressed planted areas containing overflow structures. They collect, detain, infiltrate and filter stormwater runoff at site.

Rain tanks (Cisterns): contain storage capacities of approximately 400L up to 37,854L and are comparable to large rain barrels. This measure can be either installed above or under the surface. Run-off of rooftops and adjacent impervious surfaces is collected and temporarily stored. The structure can be implemented above ground of in the subsurface. The collected water can be used for irrigation.

Rain barrels: are small stormwater tank with a typical size of 150 to 400 liters. As the rainwater tank is collects runoff from rooftops. Water can be used for watering plants in the garden. Greater units are available like rainwater tanks offering more storage capacity and thus more water for irrigation.

G2: Rainwater damage prevention measures

Elevated doorstep: an elevation of few centimetres provides a small barrier keeping stormwater out of the apartment. Depending on the height of the elevated doorstep more or less protection is given. `Unfortunately a discomfort comes along with this measure, the apartment is less accessible.

Temporary barriers in the door: can protect during high intensity precipitation and keep water outside of the building. Such barriers are portable elements filled with water of sand, they can be placed wherever barriers against water are necessary.

Elevated threshold of parking space: Like the elevation of doorsteps, elevated thresholds of parking places limits the chance of water entering the parking space and hence preventing damage.

Higher placement of the electricity connection: a higher placement of vital infrastructure within the house provides safety against water damage. This measure does not prevent water entering the building but decreases the damage connected to such an entering.

Rain-resistant building materials: Using building materials or construction methods that are rain-resistant provide the possibility to make the building easily useable after periods of flooding. It is limiting the damage as far as possible. Thereby choosing materials that are less prone to water damage.

Why implement adaptation measures?

Extreme precipitation and the sealed surfaces lead to the accumulation of stormwater. This runoff challenges the sewer systems (Hommes et al. 2016), hence it if beneficial to relieve the sewerage system by disconnecting the rainwater. Thereby it is possible to create temporary water storage on the surface or to create infiltration possibilities for the water (van de Ven, 2011). From the water management aspect the implementation of adaptation measures is beneficial as it has a positive influence considering the damping of the load variation (van de Ven, 2011). Furthermore it reduces the pipe network costs as well as the discharge of polluted matter. The infiltration of rainwater also allows to maintain the groundwater level, which thus prevents subsidence connected to the changing groundwater. However infiltration also can pose a risk for the soil moisture and ground water quality (van de Ven, 2011, page 250). Additionally a disturbance of the flow can be induced by a higher moisture content. An increased moisture content influences the bearing

capacity and higher groundwater levels reduce the stability of the banks (van de Ven, 2011). It also need to be mentioned that the knowledge and experience necessary for the infiltration techniques is lacking, which creates a greater risk for errors when it is implemented by citizen as well as concerned technical personnel (with the lack of knowledge). Adaptation measures can not only be beneficial during precipitation but some measures have the capacity to store water for the dry periods (Hommes et al. 2016). Hommes et al. (2016) argue that unsealed soil give lot of benefits, which make it thus favourable in order to deal with the extreme weather conditions. These benefits are connected to storage, soil evaporation, deep percolation and the accommodation of vegetation. This helps to regulate the temperature and the air humidity as well as it improves the air quality and thus improved the health of the inhabitants.

Benefits of green roofs are the durability of roofs compared to roofs without vegetation (Hommes et al. 2016). The coverage against UV-, wind and precipitation is beneficial to the lifespan of green roofs, isolation of noice (geluidsabsorbatie) and enhances the living comfort of the residents. Hommes et al. (2016) also argue that green roofs helps cooling the city, has an aesthetic benefit and it is argued that it has beneficial influence on biodiversity and it connects green spaces. Capturing fijnstof is an interesting influence for the topic.

For all these benefits additional research (cases and literature) might be considered. Nevertheless is the communication of such benefits a good starting points, as these different aspects could go along with different aspects on the agendas of residents.

Benefits of rainproof measures (Hommes et al.,2016):

(1) less water through the sewer, less water that needs to be cleaned, less water goes to oppervlaktewater
(2) groundwater recharge
(3) Reducing UHI effect
(4) rainwater drainage delay
(5) more water available for green

Hommes et al. (2016) argues that 10% of the grey areas transformed into green gardens could 32.3 million m3 rainwater less through the sewer system and green roof can store 50% to 60% of rainwater. This positively influences the costs for the sewer system as less water has to be cleaned. Integrating more green in the urban environment has a positive influence on the UHI effect, and can thus be one part of the solution towards a climate resilient city. The benefits (koeling, luchtzuivering) of such an integration are also emphasised by (groen voor klimaat)

Appendix H: Questionnaire (Dutch)

Maatregelen tegen wateroverlast: een bewonersonderzoek

Beste bewoner,

Mijn naam is Katrice Krijnen, studente aan de TU Delft (opleiding: Water Management). Ik ben op dit moment bezig met mijn afstudeeronderzoek in opdracht van de organisatie Amsterdam Rainproof. Daarbij zou ik u als bewoner in een enquête willen vragen in hoeverre u openstaat voor het nemen van maatregelen voor het opvangen van regenwater op uw eigen terrein.

Waarom dit onderzoek?
Het regent vaker en harder. Door de bebouwing en toenemende bestrating kan het regenwater niet wegstromen. Daardoor ontstaat wateroverlast, met negatieve gevolgen voor de samenleving. Met dit onderzoek willen we inzicht krijgen in hoe we bewoners kunnen helpen wateroverlast op eigen terrein te voorkomen, en samen de stad Amsterdam rainproof te maken.

Invullen van de enquête duurt circa 5 minuten
We zijn benieuwd naar uw mening en interesses. Daarom zijn er geen goede of foute antwoorden op de vragen. Alle gegevens worden anoniem verzameld en verwerkt. Alvast hartelijk bedankt voor uw medewerking!

Enquête online

Liever de enquete online invullen? Dat kan. Laat uw e-mailadres achter en we sturen u de link.
E-mail: ……

Of ga naar: https://www.enquetesmaken.com/s/DeBaarsjes

Contact:
Katrice Krijnen
E-mail K.Krijnen-1@student.tudelft.nl
Telefoon []

Algemene informatie

Leeftijd:

□ 0-17 □ 18-30 □ 31-55 □ 55+

Geslacht:

□ Man □ Vrouw □ Anders

Eigenaarschap

1A. Bent u eigenaar of huurder van uw woning?

□ Eigenaar □ Huurder

1B. Waar woont u in het gebouw?

□ Begane grond □ Bovenste verdieping □ Tussenin □ Souterrain

1C. Is er een tuin aanwezig?

□ Ja, een eigen tuin □ Ja, een gezamenlijke tuin □ Nee, er is geen tuin aanwezig

1D. Bij wie ligt de verantwoordelijkheid van het dak en de tuin?

Dak:
□ Verhuurder □ VVE □ Uzelf □ Weet ik niet
□ Anders, namelijk ….....

Tuin:
□ Verhuurder □ VVE □ Uzelf □ Weet ik niet
□ Anders, namelijk ….....

Wateroverlast

2. Ervaart u na een hevige regenbui weleens wateroverlast in uw:
Meerdere antwoorden mogelijk.

□ Woning, kwam binnen door .....
□ Tuin
□ Straat
□ Anders, namelijk.....
□ Nee, ik heb nooit wateroverlast gehad

3. Wie is volgens u verantwoordelijk voor de aanpak van wateroverlast in en om uw woning?
Meerdere antwoorden mogelijk.

□ Gemeente □ Waternet □ Uzelf □ Weet ik niet □ Verhuurder
□ Anders, namelijk.....

4. Verwacht u dat hevige buien vaker voorkomen in de toekomst?

□ Ja □ Nee □ Weet ik niet

5A. Kent u maatregelen om water op te vangen?

□ Ja, namelijk:.....
.....
.....
□ Nee

5B. Kent u maatregelen om waterschade te voorkomen?

□ Ja, namelijk:.....
.....
.....
□ Nee

Indien u 'nee' heeft ingevuld voor zowel vraag 5A en 5B ga door naar vraag 12 (pagina 8).

Effectiviteit van maatregelen

6A. Wat denkt u dat de effectiviteit is van onderstaande maatregelen voor het opvangen van water? *Geef ook aan of u de maatregel heeft toegepast.*
Als u de effectiviteit voor het opvangen van water niet kunt inschatten laat deze dan leeg.

Maatregel	**Onbekend**	**Bekend**	**Toepassing**	**Schat in hoe effectief deze maatregelen water op kunnen vangen** -- - + ++	
	Kruis aan als u deze deze maatregel niet kent.	*Kruis aan als u deze deze maatregel kent maar niet heeft toegepast.*	*Kruis aan als u deze maatregel heeft toegepast.*	*vangt zeer weinig water op* --	*vangt heel veel water op* ++
Groendak				-- □ □ □ □ ++	
Polderdak				-- □ □ □ □ ++	
Infiltratiekratten				-- □ □ □ □ ++	
Hoogteverschil in de tuin				-- □ □ □ □ ++	
Wadi's				-- □ □ □ □ ++	
Regenwater vijver				-- □ □ □ □ ++	
Regenwater tanks				-- □ □ □ □ ++	
Regenton				-- □ □ □ □ ++	
Tegels eruit, groen erin				-- □ □ □ □ ++	
Watervasthoudende plantenbakken				-- □ □ □ □ ++	
Regenwater schutting				-- □ □ □ □ ++	
anders, zoals				-- □ □ □ □ ++	

6B. Wat denkt u dat de effectiviteit is van onderstaande maatregelen voor het voorkomen van waterschade in uw eigen woning? *Geef ook aan of u de maatregel heeft toegepast.*
Als u de effectiviteit voor het opvangen van water niet kunt inschatten laat deze dan leeg.

Maatregel	**Onbekend**	**Bekend**	**Toepassing**	**Schat in hoe effectief deze maatregelen waterschade voorkomen** -- - + ++	
	Kruis aan als u deze deze maatregel niet kent.	*Kruis aan als u deze deze maatregel kent maar niet heeft toegepast.*	*Kruis aan als u deze maatregel heeft toegepast.*	voorkomt weinig water schade --	voorkomt veel waterschade ++
Verhogen drempel voor de deur				-- □ □ □ □ ++	
Tijdelijke deurschotten				-- □ □ □ □ ++	
(Verhogen) drempels parkeer kelders				-- □ □ □ □ ++	
Verhogen elektrische aansluitingen				-- □ □ □ □ ++	
Regenbestendige materialen en constructie methodes				-- □ □ □ □ ++	
anders, zoals				-- □ □ □ □ ++	

7. Ziet u voordelen van deze maatregelen voor uw huis, en zo ja, welke?
Kruis alle opties aan die u ermee associeert.

□ Ziet er mooi uit.
□ Het verhoogt biodiversiteit.
□ Het kan water opslaan.
□ Het kan waterschade voorkomen.
□ Isolatie (maatregel:.....)
□ Verbetert de leefomgeving.
□ Overige zoals.....
□ Nee, ik zie geen voordelen.
□ Weet ik niet.

8. In hoeverre bent u bereid om in maatregelen te investeren (tijd en geld)?

□ Ik ben zeker bereid. □ Ik ben een beetje bereid. □ Ik ben niet bereid.

Ga naar vraag 12 (pagina 8), indien u 'ik ben niet bereid' heeft ingevuld voor vraag 8.

Toepassing van maatregelen

9. Stel dat u de mogelijkheid heeft maatregelen voor het opvangen van water toe te kunnen passen. Welke maatregelen voor uw huis en/of tuin zou u kiezen en waarom?
.....
.....
.....
.....
.....
.....
.....
.....

10. Stel dat u een of meerdere maatregelen zou willen toepassen, waar zou u de informatie (kosten, beheer, aanleg, materialen, advies) hiervoor vandaan halen?
.....
.....
.....
.....
.....
.....
.....
.....

11. Wat zou u motiveren om maatregelen toe te passen?

□ Mijn eigen motivatie
□ Niets
□ Subsidie
□ Wettelijk vereist
□ Kortingsacties in bouwmarkten en tuincentra in de buurt
□ Als mijn buren ermee aan de slag gaan (voorbeelden uit de buurt)
□ Nadat ik waterschade heb gehad
□ Anders, namelijk.....

12. Zou u graag meer informatie (Bijvoorbeeld: kosten, materialen, aanleg, beheer) over eventuele maatregelen willen verkrijgen?

□ Ja □ Nee

Zo ja:

A: Welke informatie vindt u belangrijk? (*kosten, beheer, uitleg over installatie, etc.)*

.....

B: Van wie verwacht u deze informatie?

□ Gemeente
□ Buurthuis/buurtcentrum
□ Waternet
□ Anders, namelijk .....

C: Via welk medium zou u de informatie willen ontvangen?

□ Brief
□ Bewonersavonden
□ Internet
□ Anders, zoals.....

Opmerkingen

13. Als u nog vragen of opmerkingen heeft naar aanleiding van deze vragenlijst dan kunt u die hieronder kwijt.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

Vervolgonderzoek en informatie

14. Zou ik u nog een keer mogen benaderen om een uur mee te denken over het onderwerp via een interview of focusgroep?

□ Ja □ Nee

Indien ja, wilt u uw contactgegevens invullen?

Binnen het onderzoek is de anonimiteit gegarandeerd.
Uw contactgegevens worden alleen gebruikt om in contact te komen voor een vervolgafspraak.

Naam:
Telefoonnummer:
of email-adres:

Bedankt voor uw medewerking! Dankzij u krijgen we meer inzicht in het regenbestendig maken van onze stad Amsterdam. Ik verwacht in maart 2018 klaar te zijn met mijn onderzoek.

Wilt op de hoogte blijven van mijn onderzoek? Laat dan uw e-mailadres achter: .....

Meer informatie over het rainproof maken van de stad? Bekijk de animatie op: www.rainproof.nl/animatie

Appendix I: Flyer

This flyer was used to promote the questionnaire. 5000 flyers have been distributed throughout the neighbourhood.

Note that flyers have been distributed in mail boxes as well as community centres. It has to be stressed that the flyers were only 'inserted' in mail boxes that excepted (yes yes sticker or no sticker at all). It has been respected that no advertising papers were desired. Even though it was not an advertisement but rather an invitation to contribute to a research. Reflecting on this, it has to be pointed out that not all residents that might have been interested in this topic have been reached.

It could be expected that residents that do have a 'no' sticker at their mailbox are either just fed up with all advertisement or they are much more aware of their environment for which they choose to not contribute too much trash. Hence it would be possible that more aware residents were not reached throughout the flyer distribution.

Also other households, where a yes sticker was applied, might have 'lost' the flyer within all the advertisement and did not recognise the flyer as an promotion of the research. Even though the flyers seemed to increase the online responses, there were also drawbacks considering the reachability.

Limitations of the flyer

While designing the flyer it was difficult to come up with a catching question to get people interested in the matter. The following slogan has been chosen: "*Heeft u weleens wateroverlast*?" (English: "*Do you experience flooding at some point in time?*"). This however might only trigger residents that

actually do experience flooding, whereas others might not feel addressed. The flyer possibly did not reached all residents that could have been reached with a different slogan. This could give a biased influence on the research.

Some additional Remarks to the distribution of the questionnaire.

Distribution and response rate

While distributing the questionnaire and flyers, someone suggested to drop some questionnaires at a specific neighbourhood community centre. However at this location the advise was not to do so as many of the people coming there were illiterate or did not understand Dutch nor English language. This gave an indication that within De Baarsjes some limitations already arose solely connected to language skills, which probably also influenced the response rate and might have a biasing influence on results and conclusions.
The questionnaire has been distributed in different community centre. This has been communicated with the person who worked there, however when returning to collect them it was not possible to retrieve them, someone apparently moved the questionnaires. It is possible that some valuable data has been lost or the questionnaire did not even reach certain residents and probably influenced the response rate.

Time limitations

Distribution of the questionnaire was time limited. More time could have resulted in a greater response rate. Additionally, it was chosen to limit the questionnaire to a certain amount of questions as residents are more likely to fill in a questionnaire when the timeframe is relatively short. This however gave some restriction for the complexity of the questionnaire. The concept of the receptivity model had to be simplified and could not be addressed in detail.

Appendix J: Some additional Information about focus groups

As suggested by Krueger and Casey (2015) around 5 to 8 people per focus group were recruited.

The moderator encouraged the respondents to share their thoughts connected to the questions and the topic and guided them through the evening (Krueger and Casey, 2015). Thereby the moderator did not insert her opinion. It was aimed to be an unbiased and neutral relation. In the beginning of the focus group it was made clear, that there are no wrong answers, which also motivated participants to share their thoughts.

Structure of the focus group

As mentioned before the conversation was guided by the moderator. She introduced study and guides the discussion. Thereby it is advisable to have smooth and snappy introduction (Krueger and Casey, 2015). Whereby the moderator should welcome all participants, give an overview of the topic and sets up ground rules. Then she or he can introduce the first question. Depending on how much time is planned for every question, the amount of questions should be adjusted. Participants should not be rushed through the discussion as they might feel uncomfortable or not given enough space. The moderator should also encourage participants that not yet had a possibility to share their opinion about the topic. Also follow up questions can be beneficial as well as pauses and probes. Hence it is essential that the moderator is alert and free from distractions (Krueger and Casey, 2015).

Developing statements

When constructing questions or statements for the focus group it is necessary, that these are clear, short and easy to understand. Questions should be open ended and one-dimensional (Krueger and Casey, 2015). It is important that the moderator does not struggle with a question and it should be kept conversational in words participants are most likely to use themselves. Also a good directions should be included (Krueger and Casey, 2015). The questions should be reviewed before the focus group event. It is challenging to develop questions to get the desired information from the participants. Experience does help to design sharp and fitting questions. It is also possible to develop statements and the participants can indicate their position towards these statements.

Focus group theoretical background

For the second part of the sequential mixed method strategy (Creswell, 2009) the focus group method has been chosen. The focus group seemed applicable as well as it gives the opportunity to get more insight information compared to questionnaires. The focus group is developed after the questionnaires have been collected. The questionnaires give already an indication of the situation, as well as respondents were able to indicate if they were willing to participate in a follow up. The hereunder section will give some general background information about focus groups. Followed by the limitations as well as the specific questions used for the focus group.

Characteristics of Focus Groups

Krueger and Casey (2015) suggest that a focus group should be around 5 to 8 people per group, which should be carefully recruited. Furthermore, the environment needs to be comfortable and friendly. Circle seating is preferred, as I suppose is a beneficial setting that respondents feel welcome and on the same level. It is also suggested to record the audio of the conversation. The audio tape helps to analyse the entire event afterwards and prevents losing important suggestions and ideas or comments brought up by the respondents. Furthermore, it is essential that the moderator is skilful in group discussions and makes use of pre-determined questions. He or she is also responsible for the establishment of permissive and nonthreatening environment (Krueger and Casey, 2015).

The moderator should encourage the respondents to share their thoughts connected to the questions and the topic and guide them through the evening (Krueger and Casey, 2015). Thereby t is important that the moderator does not insert her or his own opinion. It should be an unbiased and neutral relation. It needs t be clear, that there are no wrong answers, which also encourage participants to share their thought. Furthermore, an assistant moderator is crucial. She or he helps with preparation and welcoming the participants, however stays in the background throughout the actual conversation (solely when summarising in the end), while taking notes. Afterwards the data is systematically analysed with verifiable procedures and needs to be reported appropriately.

First of all, some questions were designed, however the choice has been made to work with statements. These statement were based on the first impressions from the results of the questionnaires. The following statements have been designed in order to get more insight why residents are not yet implementing rainproof measures. Thereby the focus has been brought to the transition from the awareness phase to the association and acquisition phase. As Jeffrey and Seaton (2004) state all the phases should not be seen as a chronological sequence. Hence association might occur at the same time as the awareness or even not at all. Therefore the transition to the acquisition phase also has been chosen. To complete the application phase it is required that the awareness phase as well as the acquisition phase is accomplished. As the questionnaires revealed that the responsibilities are to some extent unclear a focus has been laid on these responsibilities. Furthermore the barriers were worthwhile to investigate further. Depending on the time frame and the flow of the discussion some statements considering the reasons for implementation could be considered in the discussion.

It was expected that some of the statements can trigger deeper discussions compared to others, which also was depending on the group dynamics and the opinions within the group. Even more statements were designed in order to have some back up and also the possibility to switch to another statement when other statement do not seem to be applicable. These additional statement as well as the program of the focus groups can be found in Appendix A.

Hence the statements are chosen and adapted depending on the focus group itself, which means that there is a possibility that some of the statements will not be mentioned due to time constraints as all as they might be inappropriate. This choice is made by the by the moderator. It needs to be pointed out that this makes the data more vulnerable to be biased, as some ideas might be neglected and others emphasised through the statements. Therefor it is important that the moderator is treating both groups as similar as possible and thus considering mainly the same statements.

This concept of the receptivity framework is not introduced to the participants as it supposedly would make it only more complicated. The ideas behind the concept are translated in statements and based on the first results of the questionnaire.

Data analysis

Using the focus group method is connected to the analyses of qualitative data, as it is part of qualitative data research. The number of focus groups and participants are restricted, hence it is not possible to make a statistical analyses. For this particular case, two focus groups with eight and nine participants were conducted. Therefor it is not a representable sample size to preform a quantitative analysis, as it will not be valid and reliable. Regardless this method has been chosen to get more in-depth information about the receptivity of residents in De Baarsjes. Hence a qualitative analysis is appropriate.

It is mentioned by Rabiee (2004) that the large amount of data, that is produced by focus groups, can be overwhelming especially for novice. Hence the analysis of the data is time consuming. The transcription was based on a word content only as well as slightly summarising the comments. This has been done as the data of the focus group is not the only data collection and gives additional insights into the receptivity of residents of De Baarsjes for rainproof measures. The behaviour within the group is thus less important, Therefore the particular choice against verbatim and including the silent content transcription. After the transcription a content analysis has been done, hence codes have been applied. The coding is connected to the receptivity

model as well as the outcome of the questionnaires, whereby the Awareness, Association, Acquisition and Application plays a role. This was done to give an idea in which phase the participants are.

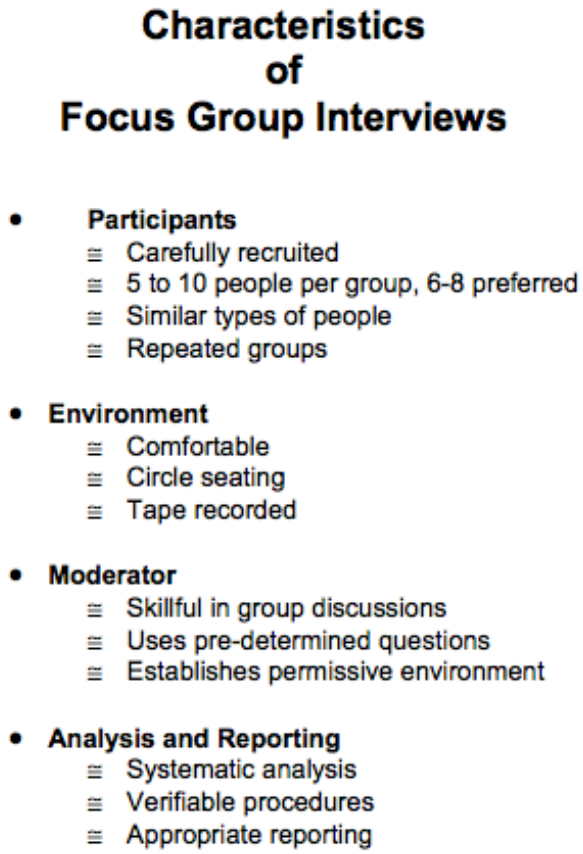
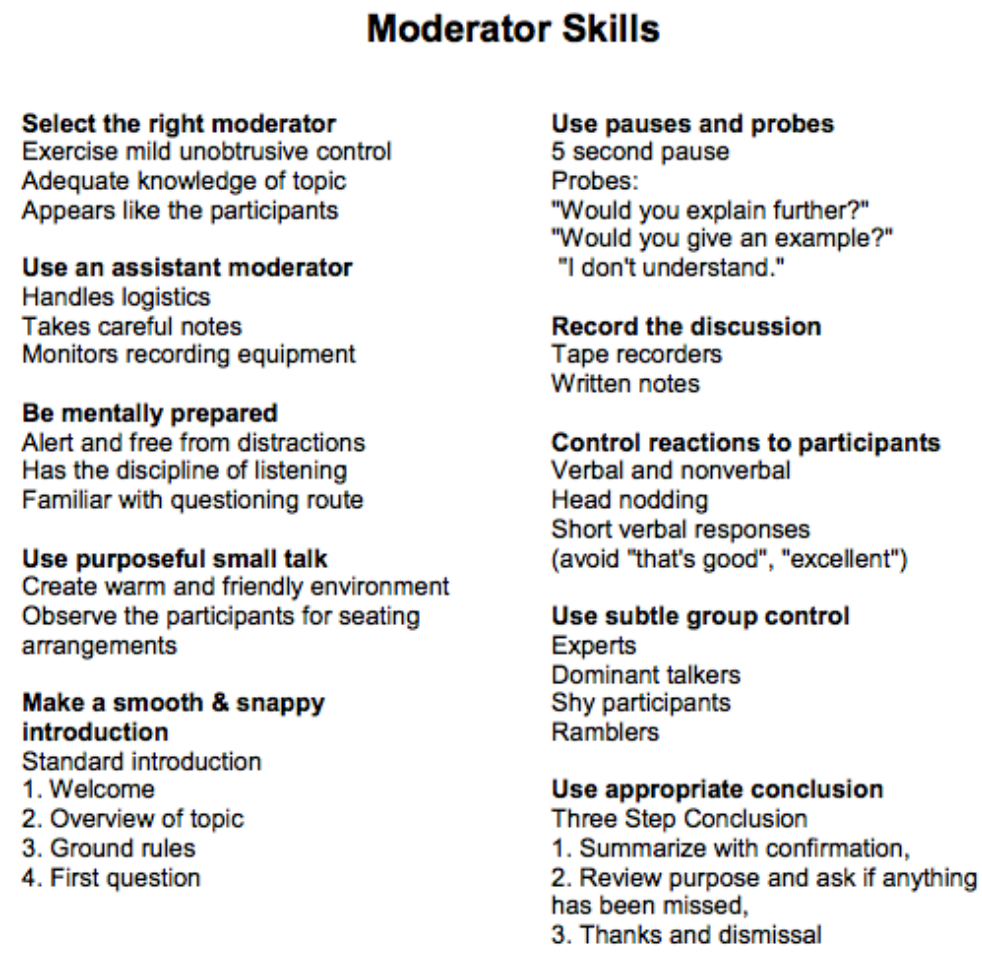


Figure J1: Screenshot characteristics of focus group interviews (Krueger, 2002; p.1)



Moderator Skills

Select the right moderator
Exercise mild unobtrusive control
Adequate knowledge of topic
Appears like the participants

Use an assistant moderator
Handles logistics
Takes careful notes
Monitors recording equipment

Be mentally prepared
Alert and free from distractions
Has the discipline of listening
Familiar with questioning route

Use purposeful small talk
Create warm and friendly environment
Observe the participants for seating arrangements

Make a smooth & snappy introduction
Standard introduction
1. Welcome
2. Overview of topic
3. Ground rules
4. First question

Use pauses and probes
5 second pause
Probes:
"Would you explain further?"
"Would you give an example?"
"I don't understand."

Record the discussion
Tape recorders
Written notes

Control reactions to participants
Verbal and nonverbal
Head nodding
Short verbal responses
(avoid "that's good", "excellent")

Use subtle group control
Experts
Dominant talkers
Shy participants
Ramblers

Use appropriate conclusion
Three Step Conclusion
1. Summarize with confirmation,
2. Review purpose and ask if anything has been missed,
3. Thanks and dismissal

Figure J2: Screenshot of moderating skills (Krueger, 2002; p.2)

Incentives

Furthermore due to the limited budget it was not possible to give a financial incentive or present to the participants. The driving incentive of the participants were most likely attached to their opportunity to share their thoughts as well as experience on this topic. It was also proposed to have the opportunity to talk afterwards to Amsterdam Rainproof and during the first focus group the '*Regenwacht*', which has been communicated beforehand. This might have been an incentive as participants were able to speak to experts concerning water issues.

Lack of experience

When research budget is available some tasks can be outsourced and professional advice can be sought. For this research both the experience is lacking as well as the financial budget. Despite the circumstances it has been chosen to be the most appropriate for acquiring the desired information.

Appendix K: Program and statements (Dutch)

Focus groep - avondprogramma

Ontvankelijkheid voor rainproof maatregelen (TU Delft & Amsterdam Rainproof)

Ontvankelijkheid: Awareness overgang naar Acquisition (Association deels invloed deels niet)

Awareness: the knowledge of an existing problem, available alternative options, capability to gain new knowledge

Association: recognising the potential benefits and the association with the own agenda

Acquisition: ability to acquire, implement, operate and maintain the alternative innovation

0 | vooraf 5 min | 19.30 – 19.35

- • doelstelling, vervolgtraject en vragen
- •keuze voor de opzet, reageren openheid om te leren,

Goedenavond en welkom. Van harte bedankt, dat u/jullie vanavond de tijd heeft/hebben genomen om over wateroverlast te praten. Ik ben Katrice Krijnen. Ik ben studente aan de TU Delft en nu bezig met mijn afstudeerproject. Daarbij ben ik aan het kijken hoe ontvankelijk bewoners voor rainproof maatregelen op het eigen terrein zijn.
Dit is mijn man Daan Krijnen. Hij heeft me geholpen alles op te zetten en hij gaat ook notulen bijhouden.
Irene Poortinga is ook aanwezig vanuit Amsterdam Rainproof. Zij is erbij omdat ze ook erg geïnteresseerd is in jullie ideeën. Ze zal zich op de achtergrond houden maar ook als expert betrokken mogen worden als het nodig is. Nadat we ons gesprek afronden kunnen jullie natuurlijk altijd vragen aan haar stellen.

We hebben jullie namen op een kaartje geschreven, zodat het makkelijker is elkaars naam te onthouden. Voordat ik de eerste vraag ga stellen zou ik u willen vragen om uzelf kort te introduceren.

a | voorstellen 10 min | 19.35 – 19.45

- • persoon, werk leven
- • hoe je woont & hobby's
- • waarom je het leuk vind in De Baarsjes te wonen
- • why are you here and what are your expectations or hopes fort his evening?

Is iedereen akkoord mee als we vanavond elkaar tutoyeren? [rond kijken, misschien navragen als iemand 'raar' kijkt of het hoofd schud]

Ok. Waar gaan we het vanavond over hebben? Wateroverlast is helaas een probleem in Amsterdam, in de publieke ruimte maar ook op privé-terrein.
Afgelopen half jaar heb ik me bezig gehouden met mijn afstudeer project over de ontvankelijkheid van bewoners voor maatregelen om wateroverlast te voorkomen. Om meer inzicht te verkrijgen in het onderwerp heb ik een enquête ontworpen die u/jullie allemaal hadden ingevuld. Van harte bedankt daarvoor, deze informatie is heel waardevol. Daarbij kwam ik achter dat er verschillende ideeën over verantwoordelijkheden maar ook verschillende barrieres zijn en de redenen wel maatregelen

toe te gaan passen ook heel breed zijn. Daarom wil ik vanavond graag met een aantal stellingen werken om meer inzicht in deze onderwerpen te krijgen. Jullie input zal leiden tot meer inzicht in wat de drempels en ook de verwachtingen zijn wat het oplossen van wateroverlast betreft. Deze informatie zal ik in mijn afstudeeronderzoek gebruiken. Als u geïnteresseerd bent kan deze later in worden gezien. Ik zal jullie erover informeren, als ik mijn afstudeeronderzoek afrond heb.

Mijn rol vanavond is om jullie door de avond te leiden. Het gaat over jullie mening en inzichten en jullie weten het best wat voor jullie persoonlijk of in jullie buurt de belangrijkste drempels zijn.

Er bestaan geen foute antwoorden, alleen verschillende meningen. Voel je vrij om je mening in deze ronde te delen, zelfs als het een andere mening is dan wat andere hebben. Alle commentaren positief of negatief gaan bijdragen om een beter beeld van de situatie te verkrijgen. Het gaat de avond wat interessanter maken als jullie met elkaar in gesprek gaan over deze stellingen. Dus jullie mogen op elkaar reageren en jullie meningen delen. De commentaren moeten niet aan mij geadresseerd worden. Voor iedere stelling hebben wij ca. 7 minuten tijd.

Jullie hebben zeker al de recorder gezien. Ik zou heel graag deze sessie opnemen zodat niks van de gesprekken verloren gaat, aangezien we niet snel genoeg kunnen schrijven om alle commentaren vast te leggen. We willen geen commentaar missen. Gaan jullie/Gaat u akkoord mee dat ik de sessie op ga nemen?

In mijn afstudeer rapport zal ik geen namen noemen; alles wat jullie vertellen is vertrouwelijk. [Check of iedereen eens?]

Als u een mobieltje bij u heeft zou het fijn zijn als u deze uit kunnen zetten. Als er een belangrijk belletje verwacht wordt zou het fijn zijn als u dan eventjes naar buiten gaat en zo snel mogelijk terug komt, zodat het de anderen niet gaat storen.
Zijn er nog vragen? [rond kijken, wachten…]
Laat ons beginnen.

Voordat ik met de stellingen begin wil ik jullie graag vragen wat jullie met extreme regen associeren.
Denk daarbij aan een hevige regenbui die jullie mee hebben gemaakt. Wat zijn jullie herinneringen daaraan?

5 min | 19.45 – 19.50

b | stellingen 55 min | 19.50 – 20.45

Verantwoordelijkheid:

•Als het extreem regent, ben ik zelf verantwoordelijk voor droge voeten thuis.

•Op mijn eigen terrein mag de gemeente bepalen wat verplichte maatregelen zijn om wateroverlast te voorkomen.

Barrières:

•Als mijn buren niets doen om wateroverlast te voorkomen, dan doe ik ook niets.

•De gemeente moet de eerste stap zetten om wateroverlast te voorkomen

Rangschikken van barrières

Maatregelen tegen wateroverlast zijn te duur

De verantwoordelijkheid ligt niet bij mij

Onzekerheden over effectiviteiten van de maatregelen

Ik vind het onbelangrijk

Redenen om maatregelen te nemen:

•Ik haal graag tegels uit mijn tuin als ik daardoor de biodiversiteit vergroot.

•Ik ga maatregelen nemen als ik daardoor de muggenoverlast beperk.

•Als ik er geld mee kan besparen, sta ik open voor het investeren in maatregelen.

Eventuele vragen om gesprekken te stimuleren:

Zou u een voorbeeld kunnen geven?

Kunt u het in meer detail uitleggen?

Is er nog iets wat iemand graag toe wil voegen?

c | afronden 15 min | 20.45– 21.00

- Van harte bedankt voor jullie input! Dit is heel waardevol voor mijn afstudeerwerk en voor het verbeteren van …
- Vertel wat je vervolgens gaat doen. Hoe kunnen de deelnemers meer informatie krijgen? Zal jouw afstudeerwerk open toegankelijk zijn? Krijgen ze een samenvatting van de meeting?

- • Als je 1 minuut zou hebben om advies te geven aan (mij/Katrice) wat zou je zeggen?
- •

21.00 - 21.30 optie om met rainproof en regenwacht te kunnen praten

•

Opties als er tijd voor is of als andere statements beter passen:

Verantwoordelijkheid

De gemeente moet ervoor zorgen dat ik droge voeten thuis heb.

De belastingen mogen omhoog zodat de gemeente wateroverlast op kan lossen.

De gemeente moet andere taken laten vallen maar wel in klimaatbestendigheid investeren.

Als het riool de regen niet aan kan, moet Waternet de capaciteit vergroten.

Barrières:

Ik koop liever een fiets dan een groendak.

Ik ga liever op vakantie dan dat ik geld en tijd aan regenbestendigheid uitgeef.

Ik ga eerst isoleren voordat ik mijn tuin aanpak.

Ik blijf niet lang hier wonen dus waarom zou ik investeren?

Redenen om maatregelen te nemen:

Natuur en biodiversiteit zijn heel erg belangrijk in de stad.

Als het mooi is ga ik wel investeren in rainproof maatregelen.

Appendix L: More answers of the questionnaire, including raw data.

L1: Location of flooding and water entering - additional

Aantal deelnemers: 169

56 (33.1%): Woning

42 (24.9%): Tuin

64 (37.9%): Straat

42 (24.9%): Nee, ik heb nooit wateroverlast gehad

28 (16.6%): Ander

Antwoord(en) van het extra veld:

straten in de buurt, bv. Hoofdweg
In de schuur
In tegenstelling tot vorig jaar, (eerste jaar eigenaar van de woning) staat nu de schimmel op de buitenmuur. (wel te verstaan aan de binnenkant. Dit hoewel de verwarming regelmatig brandt.
Het dak
Waterplassen op het dak, naast het dakterras
Trappenhuis
Kelder
Op de galerijen van mijn complex
zolderkamer
niet binnen in mijn woning, maar wel bij de bewoner op de begane grondzij heeft hierdoor gezondheidsproblemenen in het trappenhuis waar het houten luik steeds wegrot.
Kruipruimte, vermoeden we, met muggenoverlast tot gevolg
Buitenkant woning: dakgoot onder mijn raam raakt verstopt met blad en stroomt over.
Muggenplaag door stilstaand water
Op de overkapping aan de straatkant
Douche (riolering)
In trapportaal
Op het balkon
Bij balkon en overloop dak buren
lekkage dak, waar water op bleef staan
balkon
buurt
kelder
kelder

Kelder
in hetpark eb op de stoep
Galerij
Schuurtje
op de Lelylaan richting station Lelylaan heeft het in de nacht hard geregend dan word ik drijfnat door auto's die hard door een grote plas rijden. is levensgevaarlijk

L2: Location water entering in the house

Rioolafvoer, kelder, voorgevel via balkon
Via de gevel en kozijnen
Kelder
Achtergevel
In het souterrein, vanuit de tuin door de muur. Is nu goed gerepareerd.
via raamkozijnen woonkamer en slaapkamer, aan voorkant woning (straatkant)
Verstopte regenpijp, via het plafond
Lekkage aan de voorzijde van de woning bij het raam. Eerst ook midden op het plafond maar toen is het dak opnieuw geisoleerd en was de lekkage verdwenen. Aan de voorzijde lekt het echter nog steeds.
We hebben een grote lekkage gehad doordat er een probleem was met de bitumen op het dak en doordat er via de gevel water direct over het raam stroomde.
via het raam souterrain.
Op de straat kant van het huis kwam het water uit de stopcontacten, uit de deurraamen etc. Toen was een lekkage op het dak. Dat was 3.5 jaar geleden.
via toilet door hoge waterstand riool en door de muren en dak van de aanbouw
Via muren en uit waterafvoerbuizen in kelder
via raamposten/plafond. De regen is door overstroming hemelwaterafvoer in de spouwmuur terecht gekomen en vervolgens de woningen in.
Heel veel dakproblemen gehad
Dat water op balkon blijft liggen. Het komt niet naar binnen. Wel eens lekkage bij onderburen veroorzaakt door vol afvoerputje op balkon
Met bakken via platje zolderetage
Lekkage vanaf dak
Via de kieren van het raam en in mijn kruipruimte.
Voorgevel, bij de kozijnen

Dat hebben wij, ivm houtrot van het luik bij de voordeur en gezondheidsproblemen door vocht in huis van de bewoner op de begane grond, via de VVE laten onderzoeken, maar het is helaas het niet duidelijk. Misschien komt het onder de voordeur door, misschien trekt het van onder het huis via de muren omhoog. De kruipruimte is helaas te klein om goed te inspecteren hoe het er onder het huis uitziet.
In het souterrain
Lekkage door het plafond (verstopte afvoer op het dak) en lekkage door kieren van ramen.
van het balkonnetje op de voorkant van het gebouw
Ramen lekken
Het water komt aan de voorgevel bij zuidwestenwind bij grens muur en raamkozijn binnen
Berging 4e verdieping
dak is porreus
kelder,door te hoog grondwater
In de slaapkamers op de 4de etage, onder de dak: via het plafond. In de woonruimte: via onderaan de openslaande deur.
Raamkozijnen
Douche
Kelder
Via het dak
Dak, lekkage van 4e verdieping
Via de muur, overstort regenpijp verstopt, waardoor water langs gevel, verhuurder kwam pas na weken
Vanaf boven zijmuur en bij de keukenkast
vloeren en muren van het souterrain
Aan de voorzijde, mogelijk door de lucht/ventilatie gaten die te hoogte van de stoep zitten,
en aan de achterzijde sijpelt wel eens , na een paar dagen heftige regenval, water door de muur.
De achterzijde is reeds geinjecteert.
Kelder.
Eerste keer overvloedig regenwater van plat dak, dat via de regenpijp buiten in de kelder op het riool loosde. Riool was (onder de stoep) verstopt, dus overstroming in de kelder
Tweede keer: water komt door de muur aan de voorkant heen, onder het maaiveld, na zware regen.

los van een hevige regenbui hebben we een keer een overstroming in de keuken gehad via de gootsteen. Blijkbaar kon het riool de afvoer van het water van onze bovenburen niet aan en liep het bij ons over de gootsteen. Erg smerig. zie ook mijn opmerking verderop m.b.t. tot de Amsterdamse riolering en het zwaar achterstallig onderhoud wat mijnsinziens vooral voor wateroverlast zorgt. Ook zie ik regelmatig waterkolken die totaal dichtgeslibd zijn en die volgens mij door Waternet ontstopt horen te worden. Dat gebeurt dus niet.
via de stoep in de voortuin, nog net niet de kelder binnen
Via het dakterras
Via de hemelwaterafvoer van de buren (geldt ook voor de tuin)
Koekoek, buitendeur.
Via dakgoot op platje m n huis in
Toilet. Aanbouw
als grondwater
Via de tuin, dan is grondwater te hoog
Via de buitenmuren en ook via de koekoek toen we hier net woonden. Dat hebben we toen verholpen
keldermuur
door de vloer van de kelder
Via de tuin achter en via de te smalle regenpijp die overbelast is, omdat op dit moment drie daken van pand 100, 102 en 104 op dezelfde dakafvoer zitten die bij ons door het souterrain naar de riolering in de straat loopt om het regenwater af te voeren.
door het plafond vanaf het hoger gelegen balkon soms en voor de renovatie door de muren van de kelder
Via straatkant van de kelder
Buitenmuur, lekkage plafond keuken, plafond badkamer
Onder de grond
via rioolafvoer, via muren en via tuin
Via de muren in het souterrain
Souterrain
Wand van het souterain
Dak, vanwege lekkage
Dakopbouw

L3: Alternative solutions - rainproofing measures

5a)

regenton
Groen dak, planten aan de gevel, gescheiden hemelwaterafvoer, minder bestrating
regenton, vijvers.
dak, regentonnen
Regenton
Ik ken alle rainproof maatregelen, zoals regenton,, groen dak, tegels eruit, wateropdlag etc
Regenton, groen dak, niet teveel betegelen in de tuin, drainage systeem in de tuin
Vijvers
Regenton, een groene tuin
voor mij niet van toepassing. wel zie ik heel regelmatig dat er een enorme plas blijft staan net buiten mijn huis. Op straat, daar waar een put is gelegen, ogenschijnlijk zit deze helemaal vol. Ik heb het gevoel dat het grondwaterpijl extreem hoog is. Mijn buren klagen over vocht en sompige lucht in het trappenhuis.
drainage, groene tuin
Daktuinen
Minder beton, groendak
Regenton
Groene daken, regenton, minder bestrating
grindput/bekken, daktuin
Minder tegels
Groen dak regenton
Groene daken
Regenton enz enz
Groen dak, groene tuinen,
weinig tegels maar gras en borders, regenton, groene daken
tuinen met beplanting i.p.v. tegels en asfalt, groene daken, goed aangelegde waterafvoer.
Regenpijp met regenton
In de tuin geen tegels, regenton, houtsnippers
Ton, begroeiing, minder tegels
Minder asfalt en minder stenen, meer planten en grond. Water moet ergens heen kunnen. Wellicht ook capaciteit van afwatering verruimen bij herinrichting.
Er zou en maximum moeten komen aan de hoeveelheid bestrating/bebouwing van een tuin. Op heel veel plekken kan het water nergens naar toe.

Waterton
emmer
Regenpijp en sedem op t dak (hoewel nu nog iets te duur). Weet alleen niet of een regenton nou goed is of juist muggen aantrekken
Vervangen kozijn
Stukken land waar het water in opgevangen word.
Regenton,grintgeulen rondom schuur
Groene daken, regenton
Emmer!
grindbalkken
Regenton
Regenton
Tonnen en binnentuin
Eigen regenwater opvangen in ton voor de planten / groenvoorziening op dak /
gevel tuintjes en een aanzienlijk oppervlak van de achtertuin onbetegeld laten
grindbak, pijp de tuin in, begroeiing op dak
tegels uit alle tuinen (bij mij geen tegels, helaas bij aantal buren wel 100% betegeld..., waterbuffering aanleggen in kratten onder het gazon, wateropvang via regenpijp in grote opslagvaten (1000 liter) in de tuin. Is dan her te gebruiken voor tuin/wc/evt wasmachine
waterton, geen tegels, extra planten en bomen, voldoende ruimte voor water (vijvers, grachten etc.) waarmee het kan wegvloeien, riool
Kratten in de grond, regenton (weinig volume) tuin,dak
Ja, regentonnen, tuin niet veel betegelen zodat het wegzakt.
minder tegels in tuinen; meer klinkers op straten ipv asfalt
klimaatvriendelijke tuinen aanleggen, daktuinen
minder bestrating
door de tuin te laten met grond/gras zonder te bestraten
groen dak
tuinen niet meer betegelen
Regenton, infiltratie, groen dak
groen dak en regenton
grindbakken, drainagebakken, geen steen in de tuin
Regenton, minder tegels, bepaalde soorten planten, meer grind en zand, groene dak.
Minder bestrating, meer wateroverloopgebieden, minder regulering van rivieren e.d., tijdelijke opslag (regenton e.d.), enz.
Drainage, opvang reservoirs, groene daken
naar riool afvoeren

Grond
Regenton
Bomen en struiken in de tuin....
Pomp, Kelderbak waterdicht maken
regenton/bassin?
Gebieden voor waterberging
Opzuigen
groen/blauw dak, regenton
groendak, waterberging in tuin
Regenbak, daken
Meer groen in de tuin
infiltratie van regenwater, zo min mogelijk tegels in de tuin
Waterton, water hergebruik voor toilet
Dakbeplanting geen tegels maar borders etc
Waterton
Waterton, tuin,
minder bestraat oppervlak, wadi in de straat, overloop-plein, groen dak
Regenton plaatsen
regenton
Groene Daken, Regentonnen

5b)

onttegelen
Gescheiden hemelwaterafvoer
groenstrook ipv tegels, waterdoorlatende tegels.
water in het binnentrrein niet zo laten ophopen
Afkoppelen HWA, groen dak, wateropdlag, etc
Overstort dak
Hoge drempels, zorgen voor goede waterafvoer
zie eerder
Bitumen
Je huis onderhouden
dak waterdicht maken

Waterdicht maken
goede afwatering putten en riolering, hemelwaterafvoer, groene daken, weinig bestrating in tuinen
buitenmuur impregneren (hebben wij laten doen)
Impregneren, betonbak
Zie 5A
Vorige vraag
Zorgen dat de afvoerputten vrij zijn van afval, bladeren en het regelmatig doorspoelen van de riolering.
Grintgeul rondom schuur
Goed onderhoud dak, loodslabben, regenpijpen e.d.
gaten dichten
impregneren
Meer groen in de tuin ipv tegels (bijv)
Minder tegels, bredere goot, lagergelegen vijver
Goede regenafvoer, regenpijpen schoonhouden, daken schoon houden
Hogere zinkranden / goede afloop regen pijpen / verkopen van verstoppingen etc.
injecteren van muren en vloeren, bitumen op buitenkant gevel
injecteren, dam aanleggen
kelder waterdicht maken
Keldermuur professioneel laten afdichten
is dat niet hetzelfde als bij 5A: als je het water beter opvangt voorkom je ook schade?
De stoep / ingang van de kelder verhogen. De gemeente moet de putten ontstoppen die zijn voor onze deur niet goed toegankelijk voor water . Het riool kan de grote hoeveelheden water niet aan.
vergroenen dak, minder tegels in tuin
zandzakken voor de deur
palen van het huis nathouden, water goed afvoren en dijken verhogen
zie 5A
Geveltuin afdiichten, waterprof koekoek, Kelderpomp, verhoging met pellets, schone riool, schone dak, helling terras, drenage.
STOPPEN MET FOSSIELE BRANDSTOFFEN!!!
zorgen voor goede afwatering
Zorgen voor voldoende en goede afvoer
Hoop ik, dan zou ik in de tuin een gleuf moeten graven tegen het huis aan en dat volstorten met beton? Grond water is erg hoog soms, gemaal wordt pas veel later aangezet waardoor er eerst water in de tuin blijft staan, probleem is ook dat mensen met geld en energie wel hun tuinophogen met zand, dus dan loopt teveel regenwater naar lagergelegen tuinen
Zie hierboven

snellere en grotere afvoer
we hebben nu 2 pompen in een waterput in de tuin die het water naar het riool pompt; zou eigenlijk gebruikt moeten worden
Regenpijp
Muur moet gerepareerd
zorgen dat de regenwaterafvoer goed doorloopt
zorgen voor goede afvoer of berging
Zandzakken en de ark van Noach
Huis onderhoud, grond meer water doorlatend (mengen met zand)
Waterdicht maken
Minder tegels goede afwatering dak isoleren souterrain
Zorgen. Voor genoeg tuin ipv steen
waterdicht maken kelderwand, lagere grondwaterstand

L4: Aquisition: List of which measures would residents implement

Aantal deelnemers: 54

Gescheiden hemelwaterafvoer, omdat riool aantal malen overbelast geraakt is. Daarnaast alle mogelijke groenoplossingen, omdat die de buurt een beter aanzien geven.
Groendak
Ik weet niet wat welke maatregel opleverd.
We hebben een groot binnenterrein met zo'n 100 huizen daar omheen.
Samen kunnen we heel veel: daar wil ik wel op inzetten.
Regenton plaatsen
Regenton op dak, groen dak op hoogste dak (we hebben nu een groen dak op de 1e van ca 100m2, maar we kunnen nog een groen dak op de 4e
Groendak, drainage in de tuin, regenton
Veel groen in de tuin. Dat vergroot de biodiversiteit, geeft een gezond gevoel en helpt om regenwater te verwerken.
Ik weet het niet goed. Ik heb absoluut geen stilstaand water in tuin of huis of anderzijds wateroverlast. Echter wel het probleem van vochtige muren. Dat denk ik althans door de schimmel die op de muren verschijnt. bovendien associeer ik de muggenoverlast met hoogstaand grondwater.
Daktuin, aangezien wij een dakterras hebben. Duurzame, slimme oplossing en ziet er ook netjes uit
Groene daken, woon op bovenste verdieping.
Groen dak, minder bestrating, regenton

daktuin; mooi en doeltreffend
een groen dak en waar mogelijk hangende tuinen
een tweede regenton, want het scheelt leidingwater en geld voor het begieten van de tuin
onderzoek of groendak iets is voor onze schuur (18 m2) omdat het isoleert en regen opvangt.
Groen dak, speciale plantenbakken, regentonnen, hogere drempel bij voordeur, maar vooral beter onderzoek naar de oorzaken en oplossingen.
Ik weet niet precies wat de genoemde mogelijkheden inhouden, dus dat kan ik moeilijk beoordelen (en ik heb geen tuin)
Waterreservoir aanleggen in tijden van regen, wat je kan gebruiken in tijden van droogte.
Regenton
Plantendak, zou gelijk voor isolatie kunnen zorgen in de zomer.
Waterton, of watervijver, maar geeft ook veel muggen.
Regen ton en regenschutting. Verhoging verschillen in m’n tuin. Groene tuin en sedem dak. Laatste is nog een beetje duur. Ben opzoek naar tips
Regenton voor toilet
Groen dak: goed voor meer dan alleen wateroverlast, esthetisch mooi
opvangen op groendak water putten,
Regenton
Verhoogde drempel voordeur
Schuttingen tuin
Ik woon 3 hoog dus ik zou kiezen voor groendak
Groendak
Groen voorziening op dak & wateropvang (regentonnen/ plantenbakken etc.)
afwatering bijvoorbeeld via pijp onder het gras van huis naar tuin. Opvangvat o.i.d. in de grond. Verhogen rand van de koekoeks. En eigenlijk alle maatregelen die nuttig kunnen zijn.
kratten/opvangvat/wadi/vijver
Geen idee, onze tuin is maar voor een heel klein deel verhard en staat vol planten, we hebben 2 regentonnen. Als er meer nodig is, wil daar eerst een beter beeld van hebben.
Loskoppelen hwa, tuin voorzijde, groendak (in overleg met VvE)
Eventueel groen dak (lastig, liggen al zonnepanelen) Tuinen zijn te klein voor wadi/vijver etc
meer planten
gaat bij mij m.n. om dak. We hebben een dakterras met beplanting. Zou mooi zijn als er meer groene daken zouden komen, al dan niet met of zonder terras. Ik heb zelf geen tuin maar ben wel voorstander van (meer) klimaatbestendige tuinen.
drempels, regenton

Vijver, mooi, biodiversiteit.
Ik pas al groen dak, regen ton, bloembakken, composteren toe. En communiceer zoveel mogelijk. Maar ik ben een van de weinigen om mij heen. Daarom vul ik deze enquete zo enthousiast in. Verwacht niet dat de buren dat gaan doen.....maar dat is een vooroordeel. Succes!
Groendak, drainagebakken, grindbakken, vergroenen tuin.
Drenage met pomp, regenton, meer zand in het grond, bypass regen in platdak, regenpijp balkonen, beter ramen koekoek.
Groen dak want mooi, isolatie
Pijpje dat direct van balkon op straat spuit
Grote regenton aan de achterkant om grote hoeveelheid op te vangen.
We zijn in overleg met de buren om water van het dak, per woning via de stand leiding van achter naar voorkant te regelen. Het gaat nu van 3 huizen via mijn standleiding en dat kan die pijp niet meer aan. Dus hopelijk is dat binnenkort geregeld. Water stroomt nu voor een gedeelte zo de tuin in
Een snellere afvoer van water lijkt de beste oplossing, Het probleem van water overlast is hier vooral de tuin die bij veel regenval volledig volloopt door de snelle verhoging van de grondwaterstand. Dat grondwater wordt verderop weggepompt in de Kostverloren Vaart (heb ik me laten vertellen). maar dat duurt wel even, vaak meer dan een etmaal voordat het grondwater weer op zijn oude pijl is.
Wellicht opslag en hergebruik voor toiletten bv. Groen dak, maar bovenburen willen misschien een dakterras maken.
Weet ik niet, ik zou me eerst laten adviseren
NVT moet ism VVE
Planten.
verticale drainage
Regen water gebruiken voor toilet.
Sedum dak op schuur, maar helaas een schaduw tuin.
Boom omhakken van buurman - zon helpt verdamping en ik zou in ruil daarvoor zijn tuin volzetten met kleinere bomen. :-)
Overige tuinoplossingen klinken mij te aantrekkelijk voor muggen en daar heeft deze buurt nu al last van.
Geen. Ik ga niet voor mijn buren iets doen. Dit lost alleen iets op als je het samen doet.
Vijver, regenton, hoogteverschil
infiltratie mogelijkheden bv kratten / infiltratie tank in de tuin. In de openbare ruimtewadi of waterplein
Groen Dak, als bovenhuis bewoner heb ik niet veel andere opties

L5: Obtaining knowledge - data source

Aantal deelnemers: 52

Gemeente
Deskundig bureau dat met nwe technieken werkt en maatwerk levert.
Hopelijk door niet alleen te opreren maar met de buurt samen dit te onderzoeken.
Amsterdam Rainproof zou hiet een rol in kunnen spelen maar is na een eerste kennismakeing een paar jaar geleden heel stil gebleven.
Ik heb alle info reeds
Aannemer
Rainproof
Via Amsterdam Rainproof of eventueel een tuincentrum.
Het zou voor mij goed voelen als de gemeente zich actief zou opstellen. Waarschijnlijk is dit een stads, zo niet een land breed probleem is. Bij de uitvoering en adviezen zou i graag volgen. Het lijkt mij onlogisch dat iedere bewoner zijn eigen advies gaat winnen. Ik vind het iets dat breder moet worden aangepakt.
Gemeente, daktuin-bedrijven, ervaringsdeskundigen
Gemeente
Gemeente website, doe-het-zelf en tuinzaken
internet
internet
bij buurt in transitie
VVE
Ik zou wat gaan googelen
Geen idee. Gemeente Amsterdam en Waternet wellicht.
Internet
Aanleg kosten
Beheer
Advies waar en wie t betrouwbaar kan aanleggen
Subsidie voor investeringen
Korting op aanschaf
Buurtclubjes om peer2peer te leren
Ik haal materialen van de straat
Op internet een bedrijf zoeken dat zich hierin specialiseert en via hen verder kijken
aanemers
Internet

Gemeente, waterschap, google
Via Vve en erkende organisatie of Waternet
Bij de Buurt-werkgroep waar ik mij heb aangesloten.
via internet, van waternet of organisaties tegen wateroverlast.
rainproof
internet
Over de maatregelen, hoop ik op informatie van gemeente en waterschap (dat lijkt mij het meest objectief). Daarna bij een uitvoerder.
Website over water gemeente. Kosten gedeelte met gemeenten. Eigen aanleg
Internet
internet
Zelf dus geen wateroverlast (woon op 2 hoog zonder tuin). Zou ook niet weten waar ik informatie vandaan zou kunnen halen, zou goed zijn om dat te ontsluiten voor bewoners, zodat iedereen niet opnieuw het wiel hoeft uit te vinden! Scheelt tijd en moeite en maakt de drempel aanzienlijk lager. Aansprekende voorbeelden delen die in de eigen buurt zijn getroffen kunnen ook inspireren, bewust maken en motiveren om zelf actie te ondernemen zonder dat dat traject te moeilijk en tijdrovend is.
aannemer
?
Tuincentrum
Ik ben op het moment bezig mij te oriënteren op het regenwaterbestendig maken van ons dak (VVE) en de tuin.
Internet
Internet
Weet ik niet
Eigenlijk geen idee, ik heb een buurman, waarvan ik denk dat hij er verstand van heeft.
Wij gaan binnenkort in overleg met de drie VVE's om te bespreken hoe we het overtollige dakwater effectief kunnen aanpakken.
Daarnaast is het tijdelijk hoge grondwater in de tuin een terugkerend probleem, waarvoor we overleg met bijvoorbeeld de Gemeente en Waternet zouden moeten hebben.
Internet, aannemers, adviseurs/specialisten
Internet
noet bekend
Gemeente en verhuurder.
waternet
Meerdere bronnen vooral onafhankelijk wetenschappelijk onderzoek
Gerenomeerd bedrijf die adviseert. Tevens gemeente maar die doen niks
Gemeente, internet
internet, specialistisch bureau (?), informeren bij gemeente/waternet
Internet

L6: Driving forces

Aantal deelnemers: 60

49 (81.7%): Mijn eigen motivatie

- (0.0%): Niets

36 (60.0%): Subsidie

19 (31.7%): Wettelijk vereist

15 (25.0%): Kortingsacties in bouwmarkten en tuincentra in de buurt

21 (35.0%): Als mijn buren ermee aan de slag gaan

25 (41.7%): Nadat ik waterschade heb gehad

12 (20.0%): Ander

Antwoord(en) van het extra veld:

Vve bestuursbeslissing
Het muggenprobleem
als er een duidelijk aanbod met een duidelijk prijskaartje zou komen, zodat ik dat niet zelf allemaal hoef uit te zoeken, zou ik eerder geneigd zijn om dit binnen de VVE voor te leggen.
Duurzaamheid
Duurzaamheid
Als ik een kant en klaar aanbod krijg en niets meer hoef te regelen
Info
de wens om het nu goed te regelen voordat er in de toekomst nog veel meer water gaat vallen en voordat ik oud ben.
Als ik beter weet welke risico's ik loop. Nu denk ik, dat het zo'n vaart niet loopt met schade.
Ik woon fantastisch en wil van lekkages af!
indien VVE initiatief neemt
Ik ben milieubewust

L7:

12. Zou u graag meer informatie (Bijvoorbeeld: kosten, materialen, aanleg, beheer) over eventuele maatregelen willen verkrijgen? □ Ja □ Nee

Zo ja:

A: Welke informatie vindt u belangrijk? (kosten, beheer, uitleg over installatie, etc.)

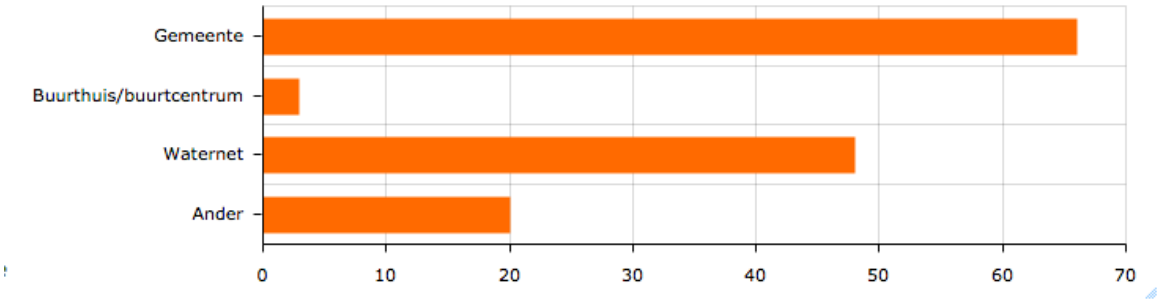
Aantal deelnemers: 63

Kosten en opbrengsten en subsidiemogelijkheden
Alle relevante maatwerkinfo, van deskundige bureaus tot aanschaf, installeren/uitvoering en beheer.
effect op een groot binnenterrein, kosten, beheer, tussen klein en groot, wat levert het nou op als je een nat dak maakt, etc.
Kosten en beheer
Allen
Installatie
Vooral wat bijdraagt aan het oplossen van de hoge waterstand. En dan het totale pakket. Van uitleg tot installatie tot kosten.
Kosten, mogelijkheid tot subsidie, onderhoudskosten
Al bovenstaande
uitleg
Omdat het via de VVE zal meoten lopen, is het kostenplaatje en beheer erg belangrijk. Alle aspecten dus
Kosten, installatie, bedrijven die dit uitvoeren (misschien kunnen we wel 1 bedrijf inhuren voor meerdere woningen en een deal maken)
Alle info is welkom
kosten en mogelijkheid
1. Kosten. 2. Beheer 3. Efficientie van de maatregel 4. Dat het er mooi uitziet.
Op zich alles, maar omdat ik in een huurhuis woon en nooit last heb van waterschade of overlast (behalve plassen op straat etc) toch ook weer niet
Alles
Beheer en uitleg
Dat alles, plus onderhoud en levensduur
Voor de tuin
Kosten
Beheer hoe zit dat en wat kost dat
Waar makkelijk advies in te winnen
kosten, uitleg, communicatie
Verhuurder (Rappange) heeft meerdere malen onderzoek laten doen door een verhuurder maar laat het verder maar zoals het is. Moeten er maar mee leven is de indruk. Waarschijnlijk zijn er ingrijpende werkzaamheden aan de voorgevel noodzakelijk.
Mogelijkheden en eventuele kosten
Algemene uitleg wat de gemeente doet en wat je zelf kunt doen: concrete maatregelen
Alle informatie
Rechten en plichten. Consequenties. Vooral objectieve informatie, geen commercieel pamflet.
Effect, kosten

Kosten, beheer, werkzaamheden, hoe het eruit ziet
Alles, vooral preventie
Alles over kosten, beheer en informatie hoe dit toe te oppassen en wat ik nu doe (plantenbakken) of dit effect heeft.
Alles eigenlijk. Maar vooral:
- soorten maatregelen met technische informatie over materialen en apparaten en hoe het aan te leggen, kosten,
- hoe je goed kunt samenwerken met buren (bijvoorbeeld voor het samen aanleggen van voorzieningen in de tuin)
- welke bedrijven goed bekend staan voor injecteren, betonwerken, tuinoplossingen etc.
simpele aanpak met subsidies voor de kleine beurs....
anders blijft het een luxe hobby voor mensen met veel geld
terwijl het in ieders belang is, dus hoemeer maatregelen hoe meer profijt voor IEDEREEN!!!
belangrijkste dus: concrete simpele aanpak plus financieen hiervoor !!!!
Eerst informatie, hoe groot het risico is. Dan welke maatregelen in ons geval effectief zijn. En daarna komen afwegingen zoals kosten, beheer, effecten op comfort (ruimtegebruik, mooie plantenbakken), etc.
Kosten
alles eigenlijk wel
kosten, wie kan het aanleggen
Alles
Uitleg installatie
Wateroverlast in de toekomst en je daar op voor te bereiden.
kosten, moeite en uitvoerbaarheid.
Uitleg innovative oplossingen, kosten, jaarlike grondwaterpeil.
Informatie over wat bij mij mogelijk en toegestaan is
Alles
beheer, evt kosten
Installatie, ideeen voorbeelden en inzicht in kosten
kosten om de keldermuur waterdicht te maken
kosten, beheer, uitleg over installatie, etc
Zowel kosten als beheer, uitleg over de beste methoden om effectief snel veel water te lozen.
uitleg mogelijkheden, kosten en beheer
Effectiviteit, kosten
alles wat kan bijdgaren aanbeeldvorming, kosten / baten etc

Alle bovenstaande informatie is belangrijk.
nut en noodzaak, kosten en wijze van aanleg
Alle info. Een compleet plaatje
Mogelijke manieren om wateroverlast in de schuur te voorkomen, omdat wij het laagste punt zijn van alle tuinen in de buurt
Kosten, beheer,
Alles
Alles
Mogelijkheden om water (ondergronds) in de tuin tijdelijk op te slaan om later te infiltreren of om in de openbare ruimte tijdelijk op te water op te slaan en na de piek bui af te voeren via het riool.
Knelpunt voor ondergrondse opslag in de tuin is de hoge grond waterstand en het langzame wegzakken van het water in drogere periode. In een regenachtige periode (een aantal dagen met veel neerslag) staat de tuin blank. In een droge periode is er de drooglegging 50 cm.
Uitleg, benodigdheden, kosten
Alles
Alles

B: Van wie verwacht u deze informatie?



Aantal deelnemers: 80

67 (83.8%): Gemeente

4 (5.0%): Buurthuis/buurtcentrum

49 (61.3%): Waternet

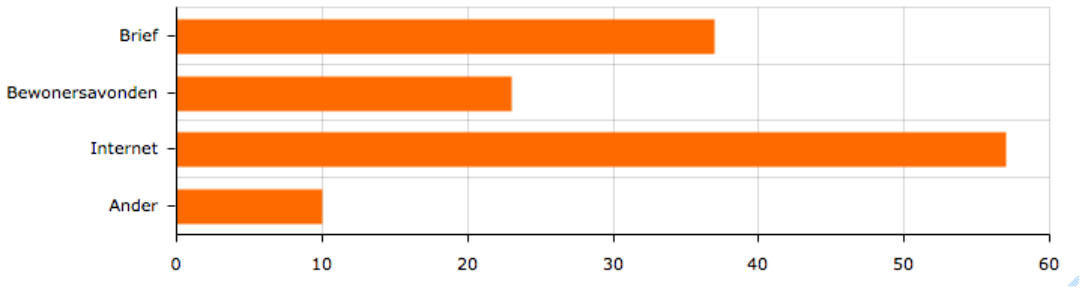
21 (26.3%): Ander

Antwoord(en) van het extra veld:

van buurt/stadgenoten die al aan de slag zijn gegaan
Amsterdam Rainproof
Bedrijven

VVE
vve
buurt in transitie, waternet
Verhuurder
Eigenaar
combinatie van deze instellingen die ieder zijn verantwoordelijkheid heeft hierin.
door overheid gefinancierde kenniscentra met informatie van wetenschappers
verhuurder
zou mooi zijn als er op maat voor de buurt informatie beschikbaar komt. B.v. via buurt website, flyer, buurtkamer e.d.
Rijksoverheid
Weet ik niet
Verhuurder
verhuurder
geen idee
Milieu stichtingen
Wellicht op social media. Wellicht is er een start-up die er iets mee kan en wil
Buren
?

C: Via welk medium zou u de informatie willen ontvangen?



Aantal deelnemers: 78

38 (48.7%): Brief

24 (30.8%): Bewonersavonden

58 (74.4%): Internet

10 (12.8%): Ander

Antwoord(en) van het extra veld:

Amsterdam Rainproof
Mail
Campagne op pleintjes
ook via internet /email voor kennis en informatie
zowel online als off line is nodig, anders bereik je mensen niet. Aantrekkelijk en persoonlijk maken, buurtgebonden, dat wekt interesse
persoonlijk overleg door gemeente
Workshops
Diverse media. Oplopenden trap.
Mail, facebook
email

L8: remarks

Aantal deelnemers: 32

Ten aanzien van de laatste vragen over eventuele maatregelen, kennis en informatie daarover: ik ben huurder van deze woning. De gevel, dak en alle andere eventuele probleemgebieden waar wateroverlast voorkomt zijn aan de verhuurder. Dus het is geen desinteresse maar ik ben niet juiste persoon om daar iets aan te doen.
Water op t dag stroomt niet weg met als gevolg dat je "dood water" krijgt en muggen hun larven daarin leggen.
Gevolg....muggen overlast
Neem contact op met VVE Beheer Amsterdam mercatorstraat 11-85
geen vragen of opmerkingen
suggestie: mensen met tuin hebben vaak schuren, die daken kunnen gebruikt.
veel mensen bij onze buurt hebben al dakterrassen, daar kunnen we ook wat mee
bij ons zit de hemelwaterafvoer soms buiten de gevel, daar zou je af kunnen tappen voor de geveltuinen
Leuk onderwerp. Interessant en noodzakelijk voor de toekomst.
Wij hebben hier in de hele wijk last van hoog grondwaterpeil en verzakte (en daardoor gebroken) bodemafsluiters. Hierdoor hebben we gigantisch veel muggenoverlast tot diep in de winter. In de Vespuccistraat zijn er mensen met 50 muggen per nacht! Ik heb hier ook filmpjes en foto's van.
Huurhuis he
Maatregelen van gemeenten voor straat en tuinniveau :

Gemeente: doe onderzoek naar de gevolgen van de vergunningvrije-uitbouw van beneden woningen tot 4 meter in de binnentuinen, (waardoor er bij mij beneden maar net 4 meter tuin is overgebleven). Deze groene voorzieningen van de binnentuinen die ook voor de bovenwoningen zijn bedoelt gaan helemaal op aan uitbouwen, zonder rekening gehouden met de bewoners van de bovenwoningen, maar ook zonder rekening te houden met wateroverlast en warmteopvang van de stad (bomen geveld). Ook zorgen de zwarte platte daken voor opwarming van mijn balkon! Ik kan er niet meer zitten zomers, alleen met plantenbakken kan ik enige verkoeling bewerkstelligen.
Werkgroepen in de buurt heeft meer effecten wat betreft waterbeheer
ik hoop ook op meer solidariteit onder bewoners (huurder en koop/wooneigenaren) om de investeringsmaatschappijen en hun uitbreidingsdrang te kunnen stoppen in onze wijk. Het sociale woninggenot wordt door de 'gelddrang' onnodig onder druk gezet.
Nog vergeten te melden bij gewenste informatie: informatie over mogelijkheden en kosten van het verstevigen van betonnen souterrains. Veel huizen in de Chassébuurt hebben een betonnen bak als souterrain van begin vorige eeuw. Die bakken vertonen scheuren en moeten dan vaak herhaaldelijk geinjecteerd worden, wat dan soms nog steeds niet afdoende helpt. En uiteindelijk wordt dit beton natuurlijk steeds slechter. En injecteren blijft een lapmiddel. Ik zou graag willen weten of er niet een meer structurele bouwkundige oplossing bestaat, misschien een betonnen laag aan de binnenkant er 'tegen aan plakken' of van de buitenkant uitgraven en het beton dikker en moderner maken of wat dan ook.
hopelijk komt er een laagdrempelige aanpak (financieel gezien dan) dan kan er eindelijk wat gebeuren!!!
Het onderzoek lijkt er van uit te gaan, dat iedereen overtuigd is van de urgentie. Ik denk dat dit nog niet zo is. Maar wij nemen vooral maatregelen die bijdragen aan waterbesparing, biodiversiteit en natuurlijk afvoer. Geen maatregelen om schade aan ons huis te voorkomen (behalve een waterdichte kelder). Het onderzoek lijkt er ook van uit te gaan, dat het effectief is om per huishouden maatregelen te nemen. Naast individuele maatregelen, moeten de maatregelen volgens mij vooral passen in een plan voor de wijk, de stad en 'onze polder'. Dat lees ik niet terug in de vragen. Ben je bereid om mee te doen aan een plan voor de wijk, en mogelijke maatregelen die daar bij passen.
Goed bezig! Succes met het onderzoek!
Leuk onderzoek ! De hele Hoofdweg heeft last van natte kelders, de busjes van bedrijven die gespecialiseerd zijn in kelderafdichting staan dagelijks in de straat geparkeerd. Ben wel benieuwd hoe die markt eruit ziet. En vooral: wat is de beste methode om een kelder af te dichten? Ik heb vier bedrijven offertes laten uitbrengen. Ze kwamen met drie methodes (injecteren, keldermuur helemaal kaalbikken en twee lagen speciale stuc erop en gewoon even opschuren en vochtwerend stuc erop), met wild uiteenlopende prijzen: van 500 ex BTW tot 4000 ex BTW.
Als je zicht krijgt op effectiviteit van methodes: dan hou ik me aanbevolen.
zou wel willen weten wat de uitkomsten zijn van deze enquête en wat er verder mee gedaan wordt
een van de redenen voor wateroverlast in de straat is het achterstallig onderhoud aan de riolering in Amsterdam.
B.v. Graag willen wij weten of de gemeente gaat investeren in de Baarsjes om de toekomst veilig te houden ivm de klimaatverandering en wateroverlast maar ook of de gemeente de bewoners op de hoogte gaat brengen over de maatregelen die zij gaan nemen en wanneer in welke delen zij die gaan uitvoeren.
Binnenblokken zijn hier niet aangesloten op het riool. Goede zaak, infiltratie ter plekke, maar maar beperkt zinvol om regenwater van hoosbuien op te vangen.
Groene daken op nieuwbouw, uitbouw, opbouw verplicht stellen zou wat helpen (bestemmingsplan).
Verder is hier een apart rioolstelsel voor regenwater, da's ook al mooi.
Ik woon hier 80 jaar en heb nog nooit wateroverlast gehad
Misschien is het een idee om specialisten op dit gebied bij de mensen thuis langs te laten komen en te adviseren. Ik weet er redelijk veel van, maar vermoed dat het niet bij iedereen zo is.
Een verkeerde aanvinken op -+ ++ kan niet gewist worden.

Helaas kan ik als tussenbewoner niet veel bijdragen. Veel succes.
In mijn buurt komt wateroverlast voor op de Willem de Zwijgerlaan, op het verbindingsstuk tussen de stille kant en de drukke kant van de Willem de Zwijgerlaan (dat is tegenover de M.H.Trompstraat). We hebben de gemeente erover gebeld om te waarschuwen.
Zo te zien heeft de buurman van 50 huis verschillende wateroverlast beperkende maatregelen in zijn tuin genomen. Ik zal het enquetekaartje in zijn brievenbus doen.
door toedoen van de gemeente/overheid, oa de slechte waterafvoer en de aanleg van de stratenaanleg komt het water niveau onder de vloer (lees kruip ruimte) steeds hoger, waardoor het muf gaat ruiken en de balken en vloeren worden aangetast
Wij zijn ons bewust van de problemen van wateroverlast. Daartoe hebben we sinds kort contact met andere bewoners om ons heen via de VVE's . Gezamenlijk willen we de overlast aanpakken. Hoe we dat precies gaan doen is De grote vraag.
Succes, goed project!
ik wiin op 3 hoog in een appartementencomplex van 6 verdiepingen gebouwd in de jaren 90. dus de kans oo waterschade door regen is nihil. het zou fijn zijn as de wateroverlast in het Rembrandt aangepakt wordt, door aanlef van wadis en betere ondergrondse drainage
success met het onderzoek
Dank je. Goed om hier weer eens over te denken.
Hergebruik van regenwater voor toiletten heeft mij persoonlijk altijd aangesproken. Je vangt "meerdere vliegen", naast goed gebruik van regenwater, scheelt het verspilling van drinkwater.
Heel benieuwd naar de resultaten en oplossingen! Succes!
Ik denk dat boven omschreven situatie moet worden onderzocht. Ik zij d daar v weg in de ochtend en word door de grote kracht met de fiets op de stoep geduwd. Mijn doel van de tocht is de Metrokrant op te halen op het station Lelylaan. veel buurtgenoten klagen ook over deze overlast van regen water op de Lelylaan.

Responsibility

Within the focus group more detail about the responsibility was sought. Participants feel a responsibility for their own home, that all their possessions stay dry and undamaged. Nevertheless, they also pointed out that the municipality should fulfil their tasks, as they are responsible for the water on the streets, that cannot be drained or infiltrated. Thus based on this the municipality should play an active role:

"*Het zou voor mij goed voelen als de gemeente zich actief zou opstellen. Waarschijnlijk is dit een stads, zo niet een land breed probleem is. Bij de uitvoering en adviezen zou ik graag volgen. Het lijkt mij onlogisch dat iedere bewoner zijn eigen advies gaat winnen. Ik vind het iets dat breder moet worden aangepakt.*"

It shows that the municipality should take over a role model, so that residents can take an example and be convinced of the positiveness of taking action concerning rainproof measures in order to create a more resilient city.

Furthermore not only the municipality is expected to play an active role but also Waternet, as they are responsible for the sewer system among others. The Flooding on the street was connected by residents with the lack of maintenance of the sewer system: ***"een van de redenen voor wateroverlast in de straat is het achterstallig onderhoud aan de riolering in Amsterdam."*** Hence residents expect the municipality as well as Waternet to thoughtfully execute their tasks in order to prevent flooding and water damage by precipitation, as water on public terrain or flooding of sewer system also influences the private terrain. Nevertheless residents also recognise their own responsibilities. Throughout the focus group participants indicated a

shared responsibility. Especially as more stormwater can be expected in the future, which probably cannot be drained immediately, private ground would be an opportunity to use for temporary storage. Responsibility connected to stormwater is widespread throughout different levels connected to public and private terrain. Therefor municipality and Waternet have to be actively taking responsibility on the public terrain, which motivates residents to do the same on their own terrain. Residents which already experienced water damage or flooding showed a more active role.

Hence residents are aware (Awareness phase) of their own responsibility, however show also expectation towards other stakeholders. Furthermore the association phase is 'touched' by especially the respondents in the focus group in so far, that residents recognise the responsibility, the urgency and the benefits taking action in general. Shared responsibilities is thereby an important feature, as other stakeholders also fulfil their tasks or if cooperation is possible residents are more motivated to act.

Ownership

In De Baarsjes and Oud West more renters can be found compared to owners, as there are approximately 32% of the housing are '*koopwoningen*', 33% are '*corperatie woningen*' and 36% are '*particuliere huur*'. This is the combination of these both neighbourhoods and it is expected that the De Baarsjes shows a similar pattern. However more owners than renters responded for the questionnaires (owners: 58%; renters: 42%). Thereby the question arises if they have a different stake. It is possible that owners are more concerned about the value of their house or the expenses connected to the reparation of possible damage.

Based on the questionnaires and the focus group, owners indicated the recognition of their own responsibilities in and around their house connected to stormwater. However they also indicated the dependency on the VVE (vereniging van eigenaren: cooperation of owners). As they also have an influence on the actions taken around the house for instance when deciding to implement a green roof, the actual implementation could be hampered as the VVE decides against a certain measure. Hence it is influenced by the receptivity of other stakeholders.

Renters also showed awareness throughout the questionnaire, however also indicated that they cannot take action as the landlord is responsible for action in and around the house connected to reparation and maintenance. Hence as indicated by the renters landlord should take up their responsibilities connected to stormwater.

Based on the questionnaire the awareness of owners connected to measures seem to be higher compared to renters (renters are aware of the problem but not always about alternatives). Also the responsibilities and hence opportunities to take action is different between owners and renters. Owners connect the possible implementation of measures already to their agenda to a certain extend. This was also reflected in the focus group as all the participants were owners and open for possible implementation. For the renters this trend was not found, which most likely can be connected to the responsibilities.

The participants in the focus group showed that more detailed knowledge about the different measures were missing. The question arose which measures could be combined to solve 100% of the water issue. Hence the effectivity of the different measures, especially for their unique situation was an interesting subject. Certain knowledge already existed but more detail for the specific circumstances could provoke eventually the actual implementation of measures.

Apartment type.

it was expected, that the location within the house ha influence on the receptivity towards rainproof measures. water damage due to water through the roof as well as water damage/flooding within the lowest floor and basement was expected to be more common compared to flooding/ water damage in the floors in between.

Flooding and water damage within the house were found throughout the questionnaire. Thereby basement flooding as well as water through the roof was experienced, but also through walls and windows (kozijnen), whereby the latter was not necessarily connected to either top or lowest floor. The focus group showed that many participants struggles with flooding in the basement also connected to the high groundwater levels.

These residents showed more knowledge about alternative measures and already implemented one or several measures to prevent flooding and water damage.

Hence the participants showed a high level of awareness as not only the knowledge about the problem is there but also the knowledge about alternatives as well as the ability to gain additional knowledge. They recognise the urgency of the topic which was higher when they already experienced flooding. As certain measures were already implemented for damage prevention it can be argued that these residents are receptive for these particular measures. The focus group showed that residents with groundwater issues already implemented measures, thus went through all phases but still are interested in more information of other alternatives to tackle the issue. Some participants of the focus group also implemented green roof (receptive for green roof), but generally were open for measures and desired either advice, inspiration or some kind of approval. Hence the different phases of the conceptual model of receptivity are to some extend fulfilled, but also more information demand connected to the different measures is occurring.

Barriers and motivation

The receptivity of the residents is hampered by for instance the uncertainties about measures and responsibilities. Especially the responsibilities and dependencies from other stakeholders (landlord, VVE, etc.) form a barrier for the residents.

Additionally the uncertainties about ground water levels, ground water flow and its maintenance make it unclear for residents what the possible alternatives would provoke or how effective which measure would solve the water issues. Thus the missing knowledge is and important barrier for residents. The uncertainty if the measures would be applicable and efficient in their circumstances can hold them back in their action.

The questionnaire also showed that the association with their agenda is missing to a certain extend, whereas the focus group showed a high degree of association, which is most likely connected to the frontrunners. They are more likely to implement rainproof measures as they identified with the problem and are willing to invest and to gain knowledge.

The main driver to implement a measures is the own motivation, which might be connected to earlier experience of the water damage. The thrive to optimise a situation can be connected to gaining more information (Acquisition) and the actual implementation of measures and achieving the connected benefits (Application).

Appendix M: Selected remarks

Responsibilities

Renters vs owners

The following remark points out that the responsibility for water issues on private terrain depends also on the ownership: "*Huurhuis [...]*" ("rental house [...]"). Residents that are renting an apartment might not be able to make a change. It would be possible that they communicate with the owner but eventually it is the decision of the owner if, when and what should be done: "*[...] ik ben huurder [...]. De gevel, dak en alle andere eventuele probleemgebieden waar wateroverlast voorkomt zijn aan de verhuurder. Dus het is geen desinteresse maar ik ben niet de juiste persoon om daar iets aan te doen*".

Due to misbalance in responsibilities concerning rental places, residents are not able to actively act on water issues, they are restricted to certain boundaries. Even if they are aware about the issue they are depending on the awareness (which could be increase through communication) but also the willingness and priorities of the owner.

Location within the building

Also the living location within the building has an influence on the possibilities and thus receptivity: "*Helaas kan ik als tussenbewoner niet veel bijdragen. [...]*", hence residents, that are living in between the top floor and the lowest floor are restricted in their power of action. However they might influence the receptivity of other residents through communication.

VVE

It also has been indicated that residents are searching for solutions. As in certain circumstances they are dependent on the VVE these considerations have to be discussed through the coalition of owners. This comment indicates that the awareness of the issues with water is present, however the solutions are yet to be determined together: "*Wij zijn ons bewust van de problemen van wateroverlast. Daartoe hebben we sinds kort contact met andere bewoners om ons heen via de VVE's. Gezamenlijk willen we de overlast aanpakken. Hoe we dat precies gaan doen is De grote vraag.*"

Municipality

Flooding is often also connected to the responsibility of the municipality. This probably also depends if residents only experience such issues in public space rather than on private ground. A respondents indicated that water issues are related to the deferred maintenance of the sewer systems: "*Een van de redenen voor wateroverlast in de straat is het achterstallig onderhoud aan de riolering in Amsterdam*." According to the respondents they experience increasing ground water levels due to the inferior drainage as well as the construction of streets. These influence the moisture content in the buildings and affect the beams and floor: "*door toedoen van de gemeente/overheid, oa de slechte waterafvoer en de aanleg van de stratenaanleg komt het water niveau onder de vloer (lees kruip ruimte) steeds hoger, waardoor het muf gaat ruiken en de balken en vloeren worden aangetast*".

The responsibility of the municipality is an important argument by the respondents. Not only the sewer system but also investment in climate adaptive solutions. Additionally information about plans, measures, timeframes are highly valued by the residents: "*B.v. Graag willen wij weten of de gemeente gaat investeren in de Baarsjes om de toekomst veilig te houden ivm de klimaatverandering en wateroverlast maar ook of de gemeente de bewoners op de hoogte gaat brengen over de maatregelen die zij gaan nemen en wanneer in welke delen zij die gaan uitvoeren.*"

This shows that residents desire good communication what about plans, opportunities and actions in the public space and want to be involved in the process as it concerns their own neighbourhood.

General remarks from the participants

Residents came up with suggestions how the rainwater issue could be tackled and refers to the reuse of rainwater, as it not only collects the rainwater but also saves drinking water: ***"Hergebruik van regenwater voor toiletten heeft mij persoonlijk altijd aangesproken. Je vangt "meerdere vliegen", naast goed gebruik van regenwater, scheelt het verspilling van drinkwater."*** Additionally the introduction of obligatory measures for instance green roof was suggested. This could be regulated for instance through the 'bestemmingsplan' (*"Via een bestemmingsplan kun je dit reguleren"*).

Mosquitos

Another issue pointed out, which has not been encountered throughout the literature review are mosquitos.

It is possible to tackle this issue when tackling water issues in the neighbourhood, thereby it is important to reflect on the measures that can be adapted as several measures might not be applicable as they could provide more breeding areas for mosquitos, for instance blue roofs (water is standing on the roof) when not regulated. Such measures could possibly be adjusted in order to minimise breeding opportunities or different measures should be considered that are more appropriate. The mosquito issue might also arise from a less appropriate way of dealing with the water issues in the neighbourhood.

Respondents are claiming that water is ponding and thus providing mosquitoes with breeding areas: "*Water op t da[k] stroom niet weg met als gevolg dat je 'dood water' krijgt en muggen hun larven daarin leggen. Gevolg....muggen overlast*". Which results in a mosquito plague in the neighbourhood. It is also pointed out that the high groundwater levels influence the issue "*Wij hebben hier in de hele wijk last van hoog grondwaterpeil en verzakte (en daardoor gebroken) bodemafsluiters. Hierdoor hebben we gigantisch veel muggenoverlast tot diep in de winter. [...]*". As this issue is experienced throughout the neighbourhood it is important not to neglect the issue but try to communicate about the issue and measures which might help to decrease breeding opportunities for mosquitoes.

Ideas and suggestions by the respondents about how to approach water issues

Throughout additional comments it showed that respondents are thinking about possible solutions and how to approach the circumstances. For example it was mentioned that in the neighbourhood the roofs of the garden sheds would be useful as well as addressing roof terraces. Furthermore the use of stormwater for '*geveltuinen*' was suggested by respondents: "*[...] mensen met tuin hebben vaak schuren, die daken kunnen gebruikt. veel mensen bij onze buurt [h]ebben al dakterrassen, daar kunnen we ook wat mee[.] Bij ons zit de hemelwaterafvoer soms buiten de gevel daar zou je af kunnen tappen voor de geveltuinen*". Not only could the water be used for gardening but also toilets, which solves the issue with stormwater and preserves drinking water: "*Hergebruik van regenwater voor toiletten heeft mij persoonlijk altijd aangesproken. [...] naast goed gebruik van regenwater, scheelt het verspilling van drinkwater."* Hence respondents are conscious about water issues and are thinking of the bigger picture.

It has been pointed out that separate sewer system as well as disconnecting the storm water from the sewer system can positively affect the issues concerning precipitation. Furthermore, according to the following remark, obliged installation of green roofs on new buildings (determined by the '*bestemmingsplan*') would also have a positive influence: "*Binnenblokken zijn hier niet aangesloten op het riool. Goede zaak, infiltratie ter plekke, maar maar beperkt zinvol om regenwater van hoosbuien op te vangen. Groene daken op nieuwbouw, uitbouw, opbouw verplicht stellen zou wat helpen (bestemmingsplan). Verder is hier een apart rioolstelsel voor regenwater, da's ook al mooi.*"

For some residents the chance to experience water issues in the house are smaller than for others. But throughout the entire neighbourhood flooding in public spaces are a concern. Thereby for

example it has been suggested to adapt wadis and improve the drainage system in order to tackle the issues in the Rembrandtpark: "*ik w[oo]n op 3 hoog in een appartementencomplex van 6 verdiepingen gebouwd in de jaren 90. Dus de kans o[p] waterschade door regen is nihil. Het zou fijn zijn as de wateroverlast in het Rembrandt aangepakt wordt, door aanle[g] van wadis en betere ondergrondse drainage*".

Besides respondents suggest that the involvement of specialist reaching out to residents would help to build up the required knowledge: *"Misschien is het een idee om specialisten op dit gebied bij de mensen thuis langs te laten komen en te adviseren. Ik weet er redelijk veel van, maar vermoed dat het niet bij iedereen zo is*." This specific respondent indicated that she/he does know quite a lot about the issue, however expects that neighbours are not so familiar with the subject. This points back to the lacking knowledge connected with the phases of receptivity. If residents are unaware of opportunities or installation they cannot be receptive. In this specific comment it is also indicated that specialists should go by the door, which possibly arises from the circumstances that residents only want to invest as less as possible, hence also time and effort to contact people. When providing the information in a effort saving matter residents might get more interested and enthusiastic throughout the process.

Another interesting issue came up in the remarks of the respondents was the possible influence of building restrictions. At the moment residents are able to extend their house by four meters without having to apply for any permit. It was suggested by a respondent that the municipality could do research about this effect, as green areas are reducing, hence the possibility of water to infiltrate. Furthermore the often black flat roofs are also contributing to the UHI effect: "*Maatregelen van gemeenten voor straat en tuinniveau: Gemeente: doe onderzoek naar de gevolgen van de vergunningvrije-uitbouw van beneden woningen tot 4 meter in de binnentuinen, [...]. Deze groene voorzieningen van de binnentuinen [...] gaan helemaal op aan uitbouwen, [...], maar ook zonder rekening te houden met wateroverlast en warmteopvang van de stad (bomen geveld). Ook zorgen de zwarte platte daken voor opwarming van mijn balkon!* [...]". Due to extending buildings the gardens decrease.
As it is possible to extend buildings by 4m (reaching in the backyard, only ground level) without permits residents are using this opportunity. Furthermore the black material used on flat roofs amplifies the heating up of this area. This issue is interesting to investigate as a change concerning permits might help to make the city more resilient for climate change, however will not be part of this research.

Issues Committee for Spatial Quality
It is moreover suspected that the *Committee for Spatial Quality* does not take environmental issues and climate change into account (as much as it would be necessary). For instance, an advice of the commission for a black house was positive, as the black colour reflects the 'eigentijdse' (engl.: contemporary) style of the house. Considering the issues of Urban Heat Islands (UHI), this advice seems not appropriate as this house will contribute to the urban heat effect. Several black modern houses have been seen, whereby the style is one component, as the *Committee for Spatial Quality* wants to improve the city. However contributing to UHI effect or neglecting issues concerning precipitation will eventually worsen the resilience of the city.

Wishes

Residents seem to be to some extend open to get active, however a financial attractive approach seems necessary for the actual implementation of measures: *"hopelijk komt er een laagdrempelige aanpak (financieel gezien dan) dan kan er eindelijk wat gebeuren!*" (engl.: "***Hopefully an accessible approach (financially) is achieved, so finally something can happen."***) Thus financially attractive solutions have a higher value and might provoke the implementation. This needs to be

kept in mind when advising residents. Also collective solutions might influence the financial issue positively. As there are already some financial help for making houses more sustainable, the communication of these funds might not be done thoughtfully. It is important that residents can access this information easily. The information should be also transparent and clear.

Appendix N: Results of effectiveness estimation by respondents

Table N1: Answers to question 6A: Perceived effectiveness of measures that can store water including added measures by the residents.

	Kruis aan als u deze deze maatregel niet kent. (1)		Kruis aan als u deze maatregel wel kent maar niet heeft toegepast. (2)		Kruis aan als u deze maatregel heeft toegepast. (3)				
	Σ	%	Σ	%	Σ	%	Ø	±	S
Groendak	6x	8,82	57x	83,82	5x	7,35	1,99	0,40	71%
Polderdak	53x	77,94	15x	22,06	-	-	1,22	0,42	67%
Infiltratiekratten	38x	55,88	29x	42,65	1x	1,47	1,46	0,53	71%
Hoogteverschil in de tuin	16x	23,88	40x	59,70	11x	16,42	1,93	0,64	56%
Wadi's	39x	57,35	29x	42,65	-	-	1,43	0,50	69%
Regenwater vijver	12x	17,91	51x	76,12	4x	5,97	1,88	0,48	65%
Regenwater tanks	17x	25,00	49x	72,06	2x	2,94	1,78	0,48	69%
Regenton	3x	4,35	60x	86,96	6x	8,70	2,04	0,36	50%
Watervasthoudende plante..	22x	32,84	37x	55,22	8x	11,94	1,79	0,64	47%
Regenwater schutting	52x	77,61	14x	20,90	1x	1,49	1,24	0,46	49%
?	-	-	1x	100,00	-	-	2,00	0,00	67%
asfalt vervangen door wate..	-	-	-	-	1x	100,00	3,00	0,00	67%
drainage van de gevel af	-	-	1x	100,00	-	-	2,00	0,00	33%
Drenage	-	-	1x	100,00	-	-	2,00	0,00	100%
Geen	2x	100,00	-	-	-	-	1,00	0,00	0%
Geen idee	1x	100,00	-	-	-	-	1,00	0,00	67%
Geen,per ongeluk aangev...	-	-	1x	100,00	-	-	2,00	0,00	67%
Gescheiden hemelwateraf...	-	-	1x	100,00	-	-	2,00	0,00	100%
Goede riolering	-	-	1x	100,00	-	-	2,00	0,00	100%
Minder tegels. Ophogen tu...	1x	100,00	-	-	-	-	1,00	0,00	67%
Parken, pleinen, sportveld...	-	-	-	-	1x	100,00	3,00	0,00	100%
pijp in tuin onder grond, op...	-	-	1x	100,00	-	-	2,00	0,00	67%
tegels eruit, groen erin	-	-	1x	100,00	-	-	2,00	0,00	100%
Terras op verhoging, afsch...	-	-	-	-	1x	100,00	3,00	0,00	67%
waterplein	-	-	1x	100,00	-	-	2,00	0,00	100%
waterpomp	-	-	1x	100,00	-	-	2,00	0,00	33%
Weinig tegels	-	-	-	-	1x	100,00	3,00	0,00	67%

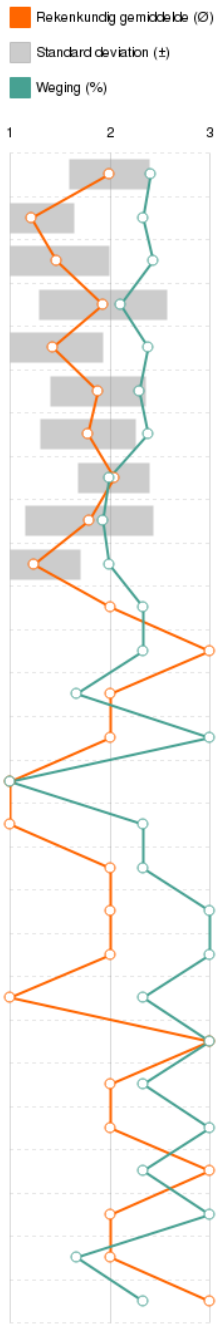
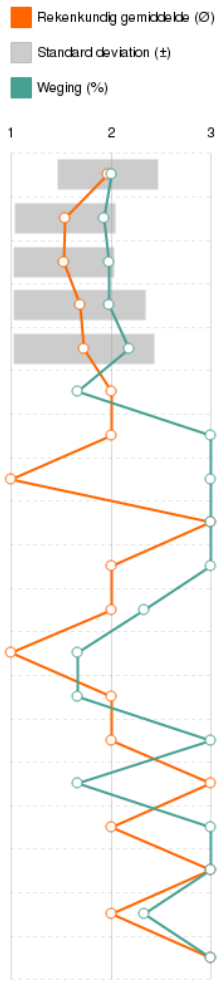
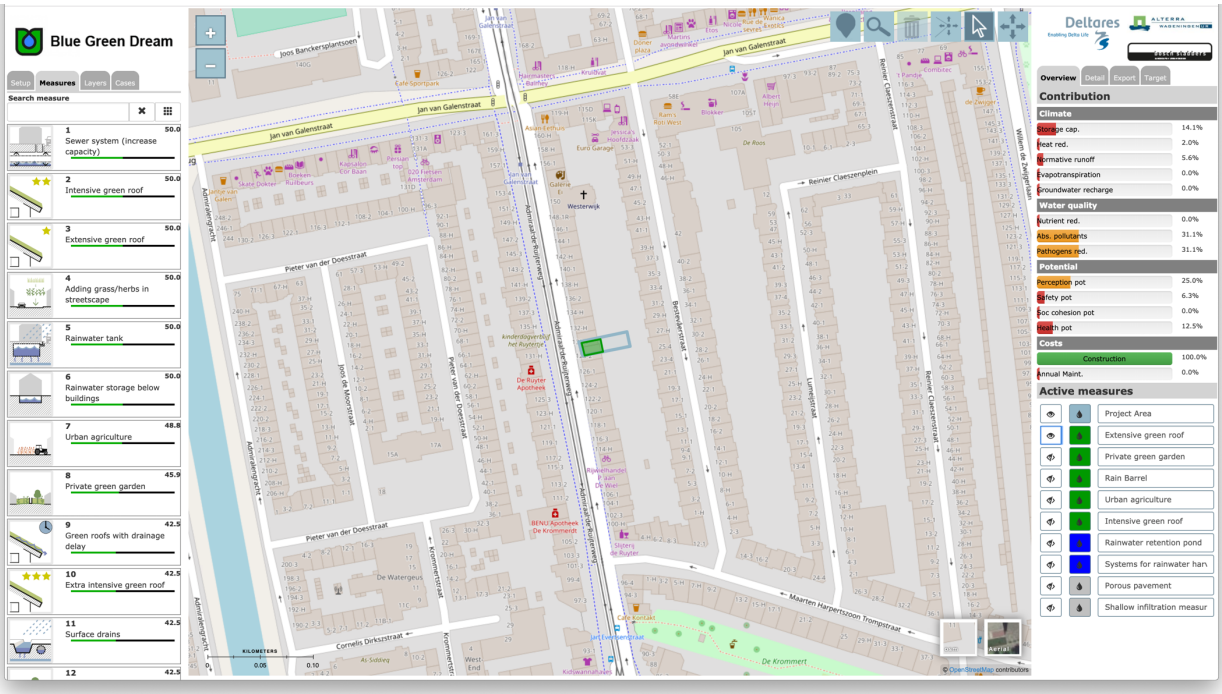


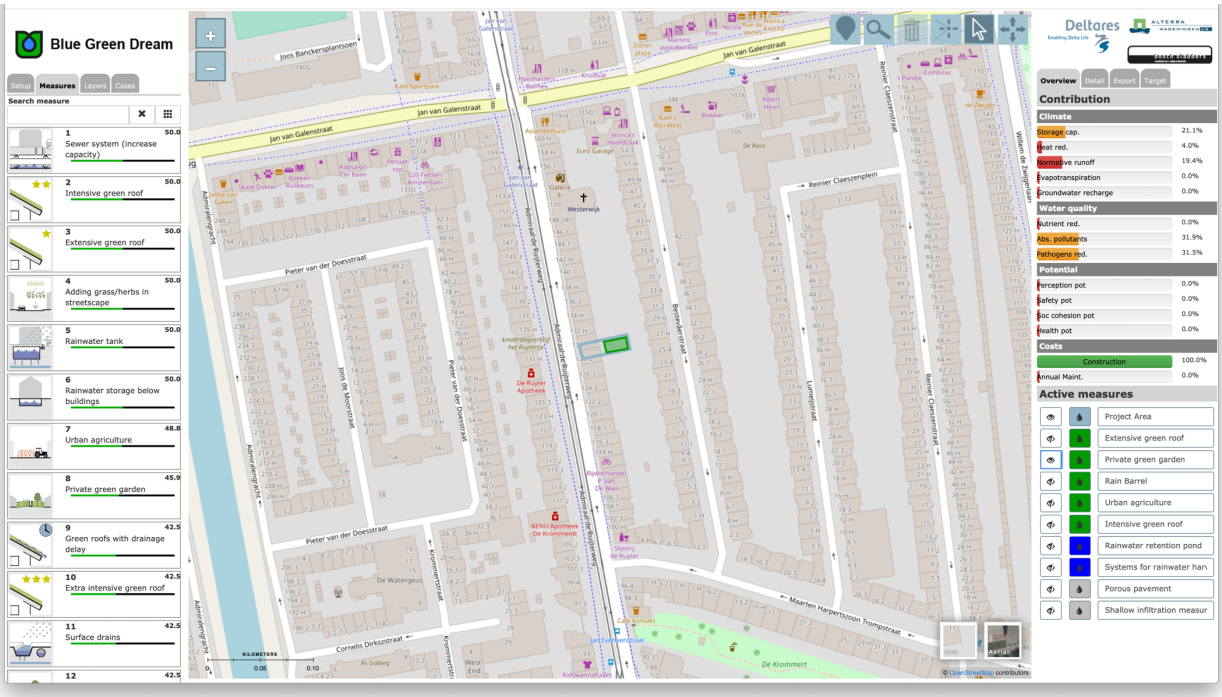
Table N2: Answers to question 6B.

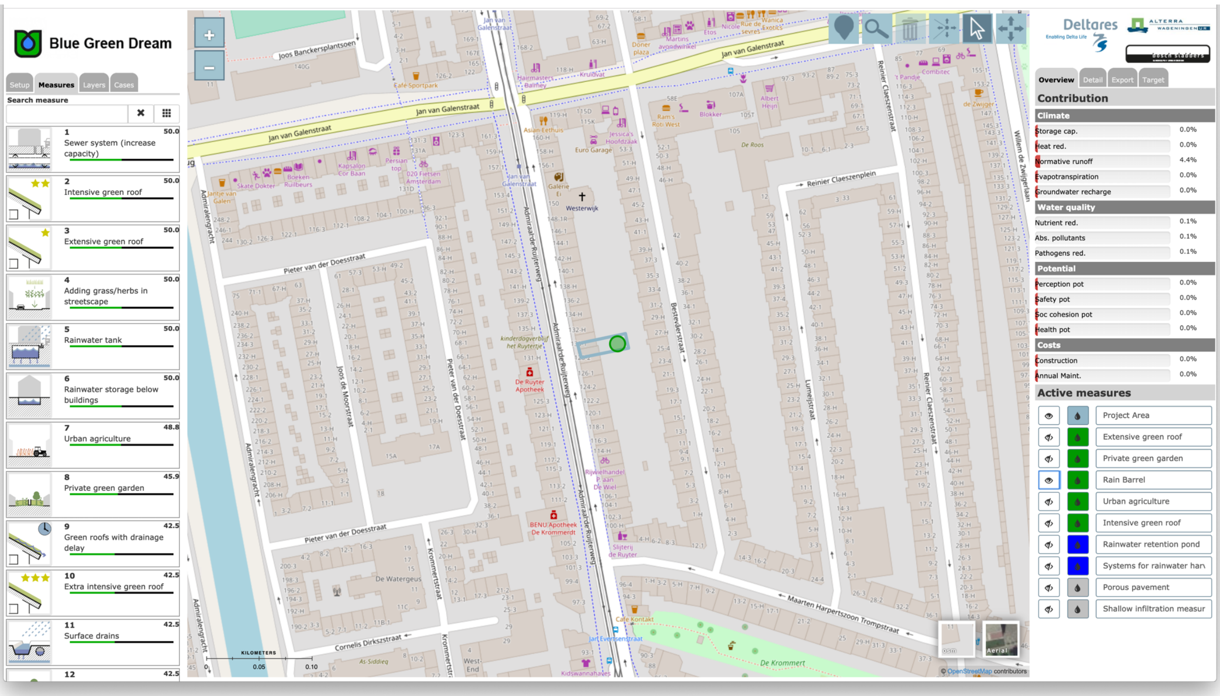
	Kruis aan als u deze deze maatregel niet kent. (1)		Kruis aan als u deze maatregel wel kent maar niet heeft toegepast. (2)		Kruis aan als u deze maatregel heeft toegepast. (3)				
	Σ	%	Σ	%	Σ	%	Ø	±	S
Verhogen drempel voor de…	9x	13,85	49x	75,38	7x	10,77	1,97	0,50	50%
Tijdelijke deurschotten	30x	46,15	35x	53,85	-	-	1,54	0,50	47%
(Verhogen) drempels park…	30x	46,88	34x	53,13	-	-	1,53	0,50	49%
Verhogen elektrische aans…	27x	42,19	30x	46,88	7x	10,94	1,69	0,66	49%
Regenbestendige materia…	26x	40,63	29x	45,31	9x	14,06	1,73	0,70	59%
?	-	-	1x	100,00	-	-	2,00	0,00	33%
beter dak	-	-	1x	100,00	-	-	2,00	0,00	100%
Blijkbaar ben ik gewodwon…	1x	100,00	-	-	-	-	1,00	0,00	100%
buitenkant gevel van soute…	-	-	-	-	1x	100,00	3,00	0,00	100%
Bypass regenpijp	-	-	1x	100,00	-	-	2,00	0,00	100%
gat in het balkonnetje bore…	-	-	1x	100,00	-	-	2,00	0,00	67%
Geen	2x	100,00	-	-	-	-	1,00	0,00	33%
Geen,per ongeluk aangev…	-	-	1x	100,00	-	-	2,00	0,00	33%
Grote en sterke rioolbuizen…	-	-	1x	100,00	-	-	2,00	0,00	100%
injecteren	-	-	-	-	1x	100,00	3,00	0,00	33%
lager grondwaterstand, me…	-	-	1x	100,00	-	-	2,00	0,00	100%
Meer planten	-	-	-	-	1x	100,00	3,00	0,00	100%
Pijpje dat direct water op s…	-	-	1x	100,00	-	-	2,00	0,00	67%
scheuren en barsten in de…	-	-	-	-	1x	100,00	3,00	0,00	100%

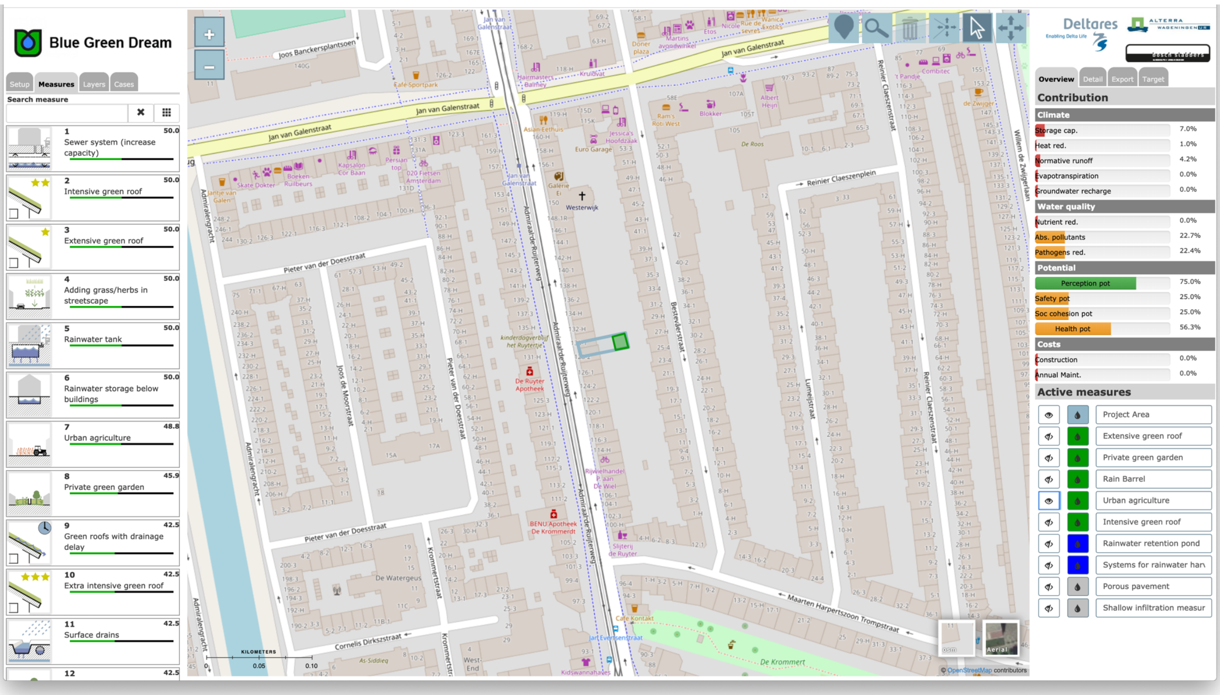


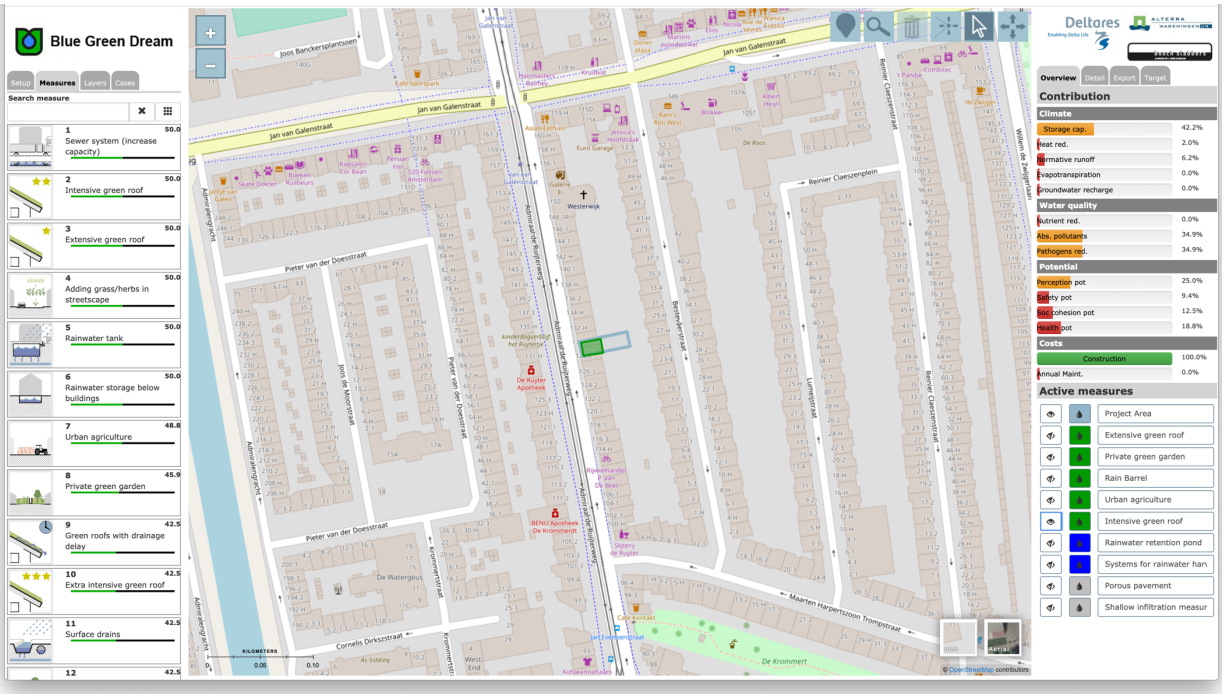
Appendix O: Screenshots AST implementation






Blue Green Dream
Setup
Measures
Layers
Cases
Search measure
1 Sewer system (increase capacity) 50.0
2 Intensive green roof 50.0
3 Extensive green roof 50.0
4 Adding grass/herbs in streetscape 50.0
5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 0.0%
Heat red. 0.0%
Normative runoff 4.4%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 0.1%
Abs. pollutants 0.1%
Pathogens red. 0.1%
Potential
Perception pot 0.0%
Safety pot 0.0%
Soc cohesion pot 0.0%
Health pot 0.0%
Costs
Construction 0.0%
Annual Maint. 0.0%
Active measures
Project Area
Extensive green roof
Private green garden
Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater harv
Porous pavement
Shallow infiltration measur


Blue Green Dream
Setup
Measures
Layers
Cases
Search measure
1 Sewer system (increase capacity) 50.0
2 Intensive green roof 50.0
3 Extensive green roof 50.0
4 Adding grass/herbs in streetscape 50.0
5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 7.0%
Heat red. 1.0%
Normative runoff 4.2%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 0.0%
Abs. pollutants 22.7%
Pathogens red. 22.4%
Potential
Perception pot 75.0%
Safety pot 25.0%
Soc cohesion pot 25.0%
Health pot 56.3%
Costs
Construction 0.0%
Annual Maint. 0.0%
Active measures
Project Area
Extensive green roof
Private green garden
Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater harv
Porous pavement
Shallow infiltration measur


Blue Green Dream
Setup
Measures
Layers
Cases
Search measure
1 Sewer system (increase capacity) 50.0
2 Intensive green roof 50.0
3 Extensive green roof 50.0
4 Adding grass/herbs in streetscape 50.0
5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 42.2%
Heat red. 2.0%
Normative runoff 6.2%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 0.0%
Abs. pollutants 34.9%
Pathogens red. 34.9%
Potential
Perception pot 25.0%
Safety pot 9.4%
Soc cohesion pot 12.5%
Health pot 18.8%
Costs
Construction 100.0%
Annual Maint. 0.0%
Active measures
Project Area
Extensive green roof
Private green garden
Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater han
Porous pavement
Shallow infiltration measur
Jan van Galenstraat
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Admiraal de Ruijterweg
Maarten Harpertszoon Trompstraat
Reinier Claeszenplein
De Krommert
Aerial
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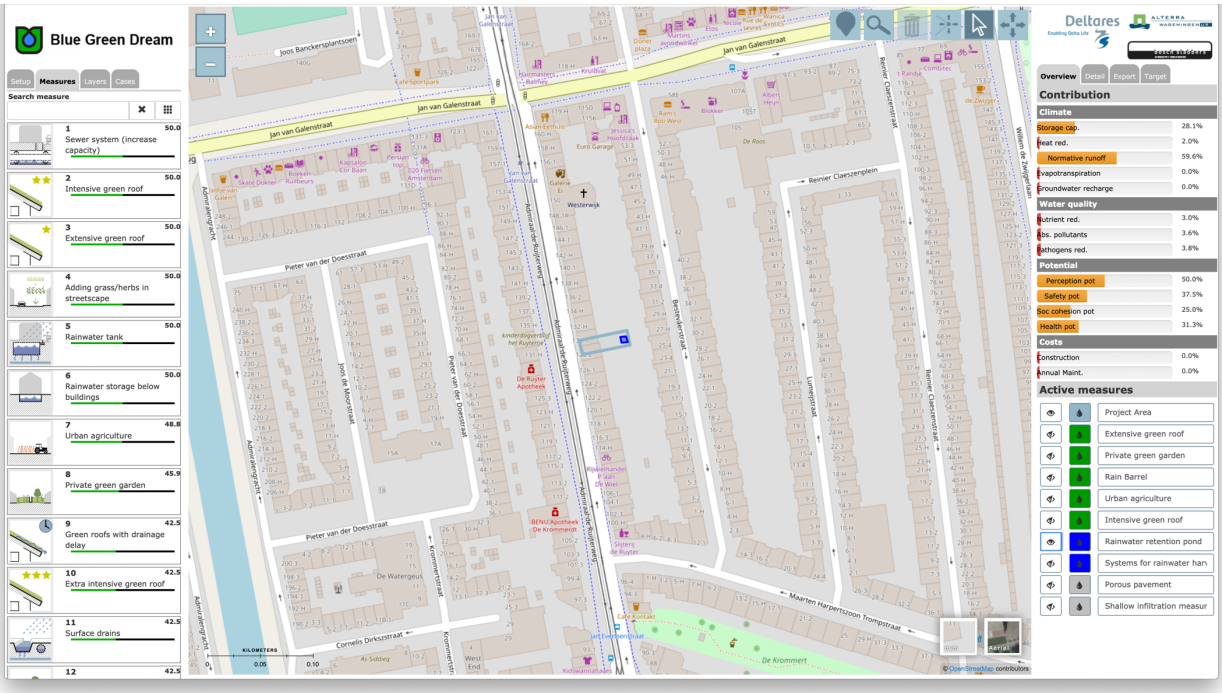
Blue Green Dream
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Measures
Layers
Cases
Search measure
1 Sewer system (increase capacity) 50.0
2 Intensive green roof 50.0
3 Extensive green roof 50.0
4 Adding grass/herbs in streetscape 50.0
5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 28.1%
Heat red. 2.0%
Normative runoff 59.6%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 3.0%
Abs. pollutants 3.6%
Pathogens red. 3.8%
Potential
Perception pot 50.0%
Safety pot 37.5%
Soc cohesion pot 25.0%
Health pot 31.3%
Costs
Construction 0.0%
Annual Maint. 0.0%
Active measures
Project Area
Extensive green roof
Private green garden
Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater han
Porous pavement
Shallow infiltration measur
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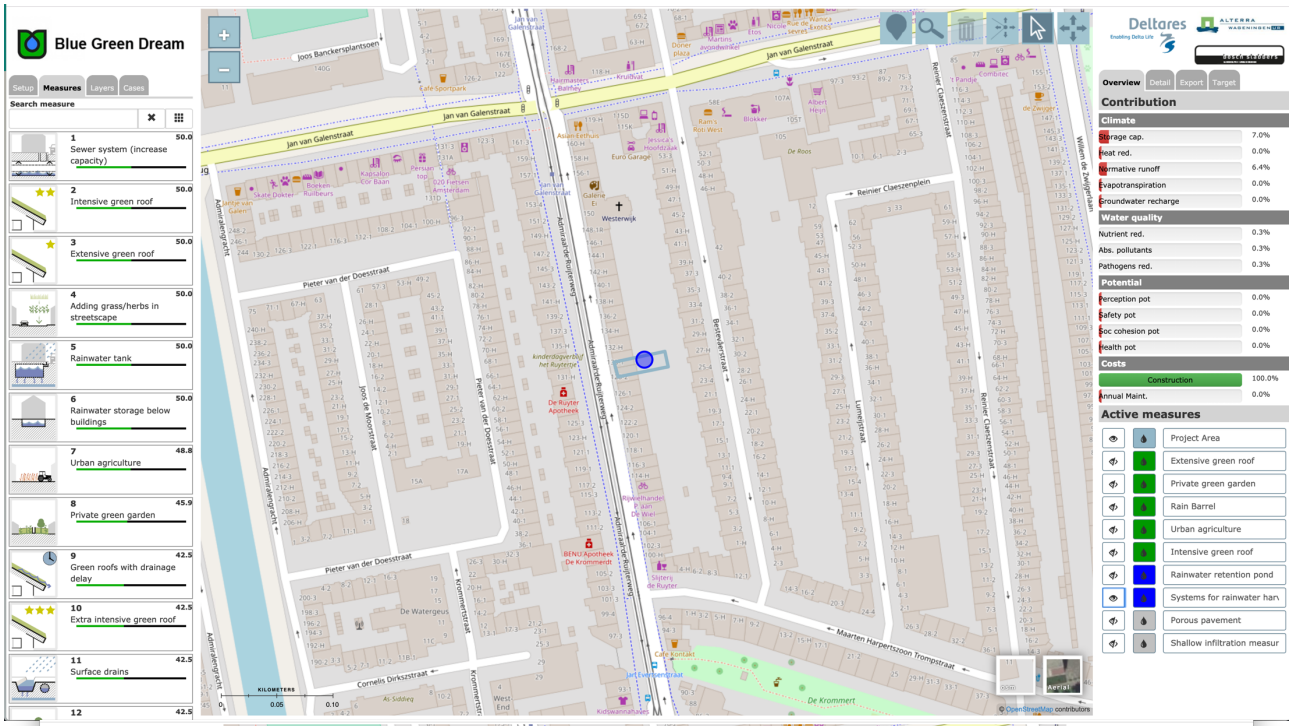
Blue Green Dream
Setup
Measures
Layers
Cases
Search measure
1 Sewer system (increase capacity) 50.0
2 Intensive green roof 50.0
3 Extensive green roof 50.0
4 Adding grass/herbs in streetscape 50.0
5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 7.0%
Heat red. 0.0%
Normative runoff 6.4%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 0.3%
Abs. pollutants 0.3%
Pathogens red. 0.3%
Potential
Perception pot 0.0%
Safety pot 0.0%
Soc cohesion pot 0.0%
Health pot 0.0%
Costs
Construction 100.0%
Annual Maint. 0.0%
Active measures
Project Area
Extensive green roof
Private green garden
Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater han
Porous pavement
Shallow infiltration measur
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Cornelis Dirkszstraat
De Krommert
Aerial
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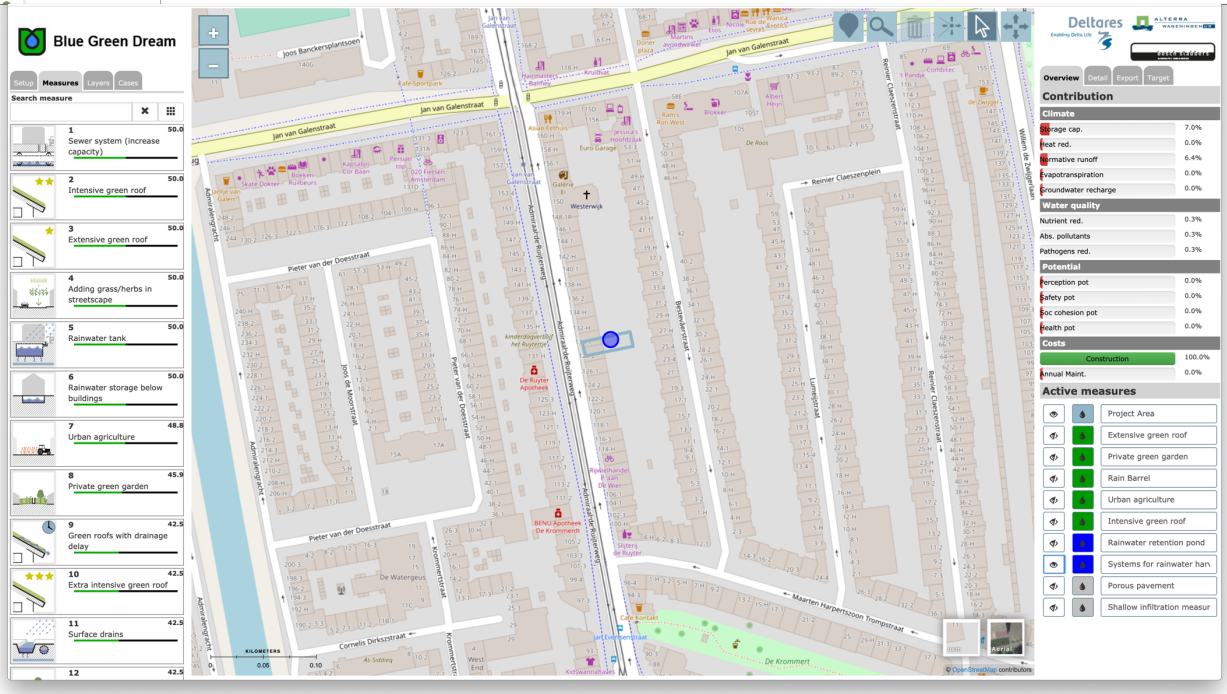
Blue Green Dream
Setup
Measures
Layers
Cases
Search measure
1 Sewer system (increase capacity) 50.0
2 Intensive green roof 50.0
3 Extensive green roof 50.0
4 Adding grass/herbs in streetscape 50.0
5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 7.0%
Heat red. 0.0%
Normative runoff 6.4%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 0.3%
Abs. pollutants 0.3%
Pathogens red. 0.3%
Potential
Perception pot 0.0%
Safety pot 0.0%
Soc cohesion pot 0.0%
Health pot 0.0%
Costs
Construction 100.0%
Annual Maint. 0.0%
Active measures
Project Area
Extensive green roof
Private green garden
Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater han
Porous pavement
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Cornelis Dirkszstraat
De Krommert
Aerial
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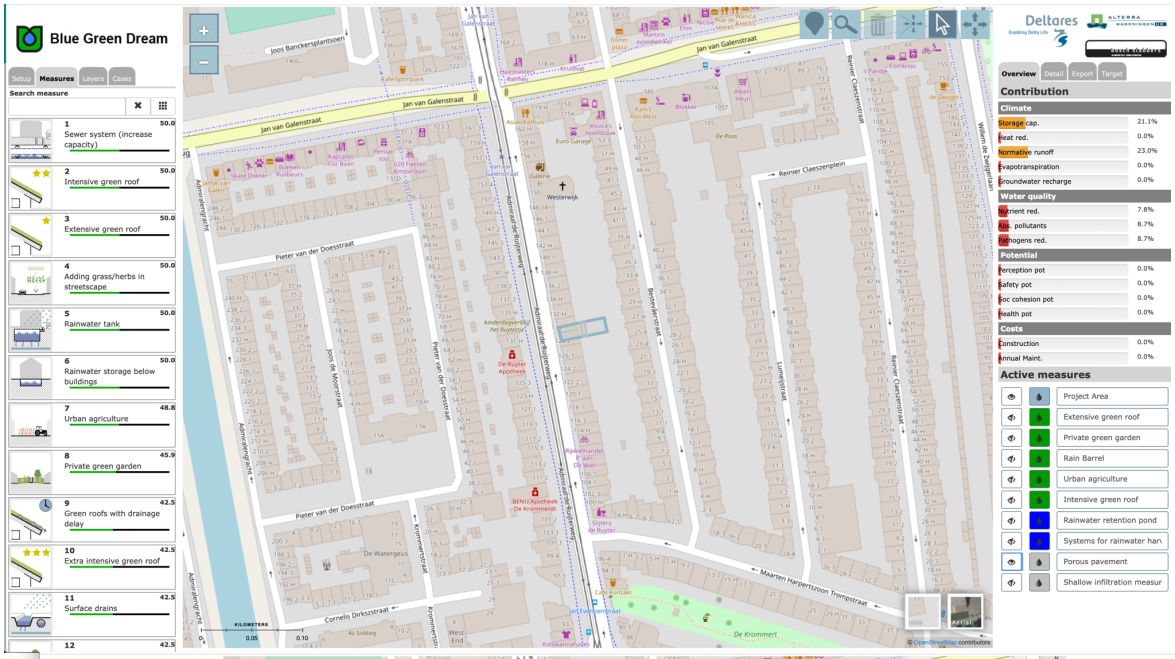
Blue Green Dream
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Search measure
1 Sewer system (increase capacity) 50.0
2 Intensive green roof 50.0
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5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 21.1%
Heat red. 0.0%
Normative runoff 23.0%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 7.8%
Abs. pollutants 8.7%
Pathogens red. 8.7%
Potential
Perception pot 0.0%
Safety pot 0.0%
Soc cohesion pot 0.0%
Health pot 0.0%
Costs
Construction 0.0%
Annual Maint. 0.0%
Active measures
Project Area
Extensive green roof
Private green garden
Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater harv
Porous pavement
Shallow infiltration measur
Joos Banckersplantsoen
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Cornelis Dirkszstraat
De Krommert
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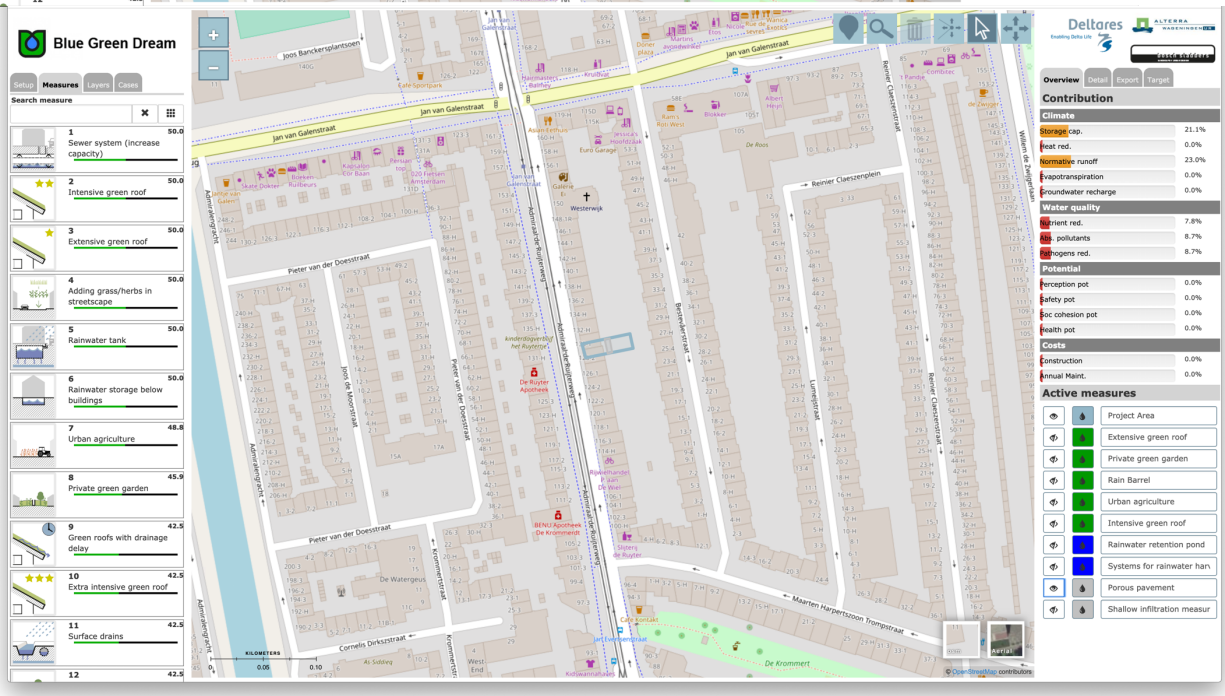
Blue Green Dream
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Cases
Search measure
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2 Intensive green roof 50.0
3 Extensive green roof 50.0
4 Adding grass/herbs in streetscape 50.0
5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 21.1%
Heat red. 0.0%
Normative runoff 23.0%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 7.8%
Abs. pollutants 8.7%
Pathogens red. 8.7%
Potential
Perception pot 0.0%
Safety pot 0.0%
Soc cohesion pot 0.0%
Health pot 0.0%
Costs
Construction 0.0%
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Active measures
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Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater harv
Porous pavement
Shallow infiltration measur
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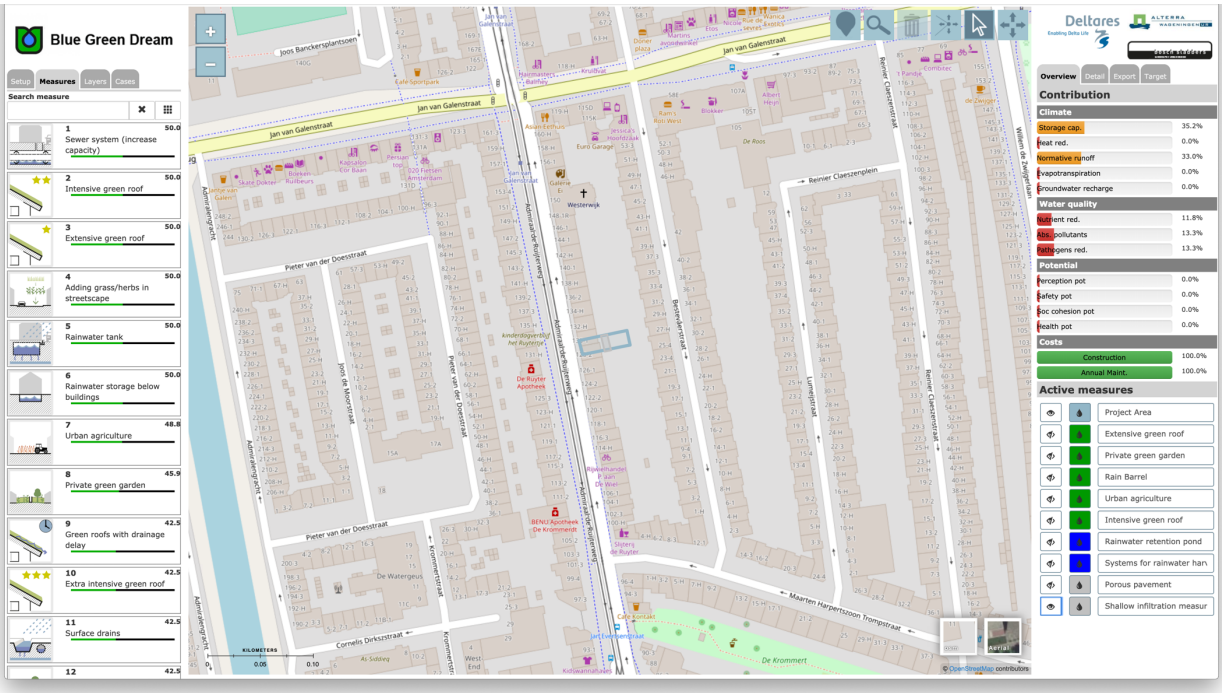
Blue Green Dream
Setup
Measures
Layers
Cases
Search measure
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2 Intensive green roof 50.0
3 Extensive green roof 50.0
4 Adding grass/herbs in streetscape 50.0
5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 35.2%
Heat red. 0.0%
Normative runoff 33.0%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 11.8%
Abs. pollutants 13.3%
Pathogens red. 13.3%
Potential
Perception pot 0.0%
Safety pot 0.0%
Soc cohesion pot 0.0%
Health pot 0.0%
Costs
Construction 100.0%
Annual Maint. 100.0%
Active measures
Project Area
Extensive green roof
Private green garden
Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater han
Porous pavement
Shallow infiltration measur
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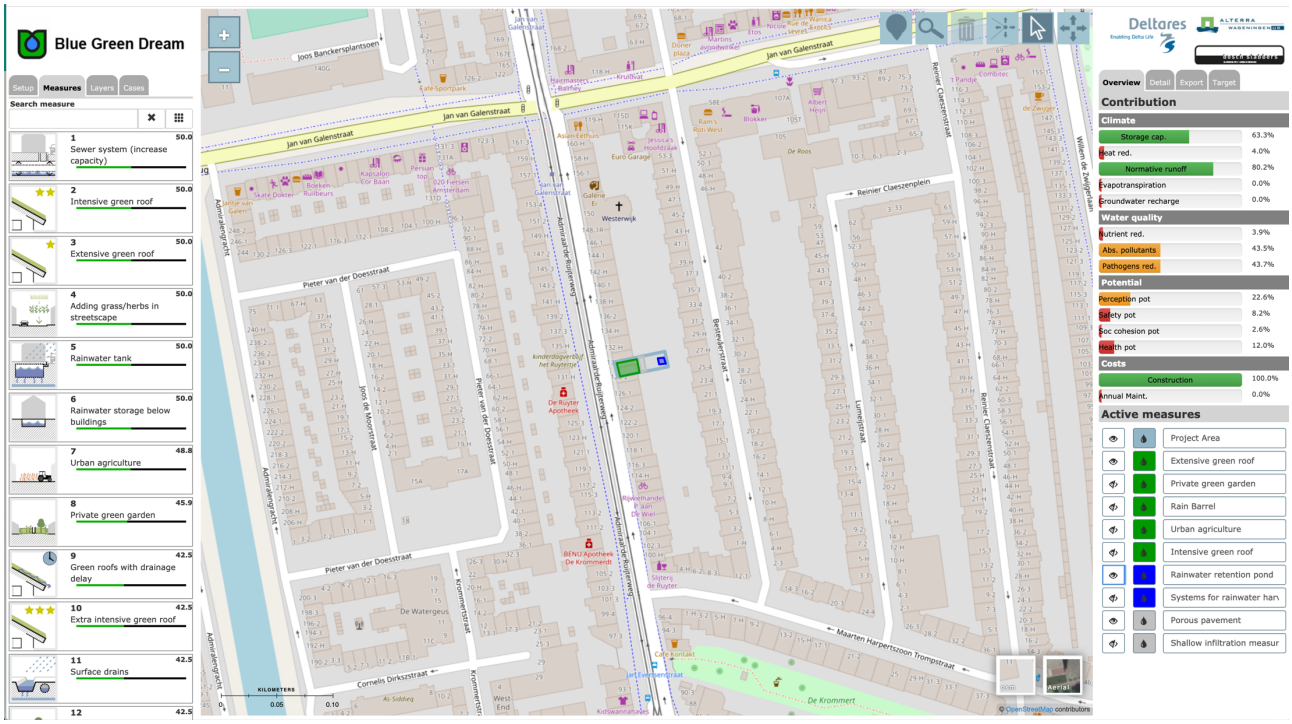
Blue Green Dream
Setup
Measures
Layers
Cases
Search measure
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2 Intensive green roof 50.0
3 Extensive green roof 50.0
4 Adding grass/herbs in streetscape 50.0
5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 63.3%
Heat red. 4.0%
Normative runoff 80.2%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 3.9%
Abs. pollutants 43.5%
Pathogens red. 43.7%
Potential
Perception pot 22.6%
Safety pot 8.2%
Soc cohesion pot 2.6%
Health pot 12.0%
Costs
Construction 100.0%
Annual Maint. 0.0%
Active measures
Project Area
Extensive green roof
Private green garden
Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater han
Porous pavement
Shallow infiltration measur
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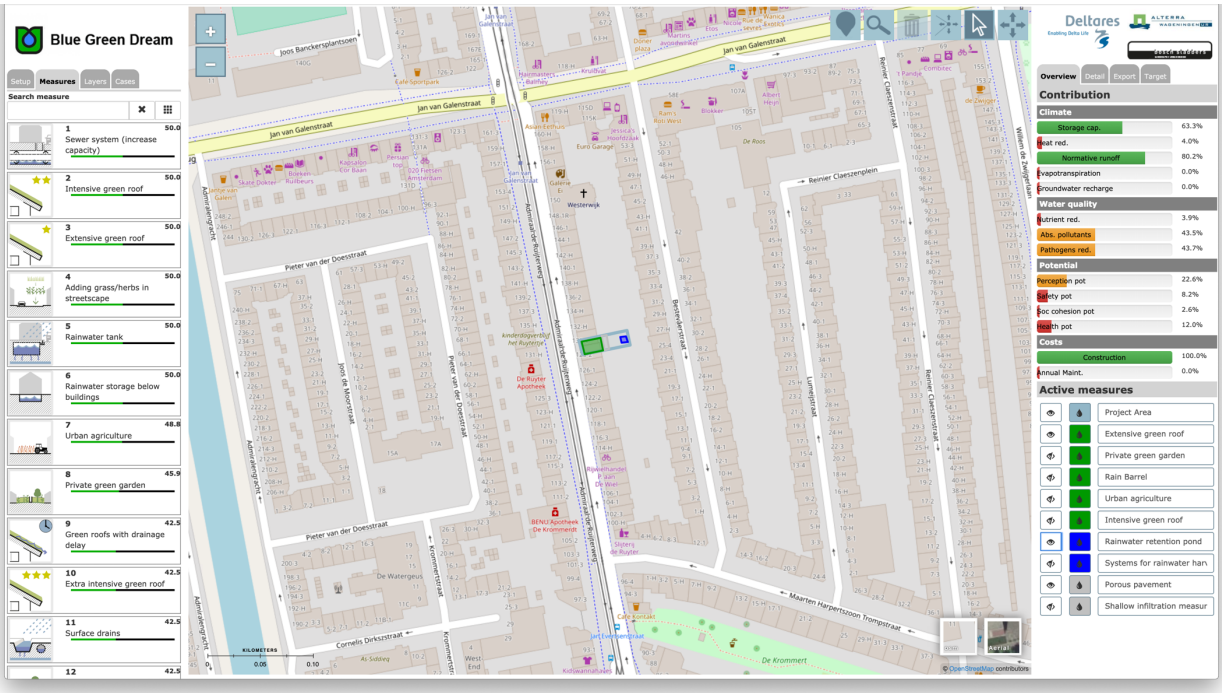
Reinier Claeszenplein
Cornelis Dirkszstraat
De Krommert
Aerial


Blue Green Dream
Setup
Measures
Layers
Cases
Search measure
1 Sewer system (increase capacity) 50.0
2 Intensive green roof 50.0
3 Extensive green roof 50.0
4 Adding grass/herbs in streetscape 50.0
5 Rainwater tank 50.0
6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 63.3%
Heat red. 4.0%
Normative runoff 80.2%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 3.9%
Abs. pollutants 43.5%
Pathogens red. 43.7%
Potential
Perception pot 22.6%
Safety pot 8.2%
Soc cohesion pot 2.6%
Health pot 12.0%
Costs
Construction 100.0%
Annual Maint. 0.0%
Active measures
Project Area
Extensive green roof
Private green garden
Rain Barrel
Urban agriculture
Intensive green roof
Rainwater retention pond
Systems for rainwater han
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Reinier Claeszenplein
Maarten Harpertszoon Trompstraat
Cornelis Dirkszstraat
De Krommert
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Aerial
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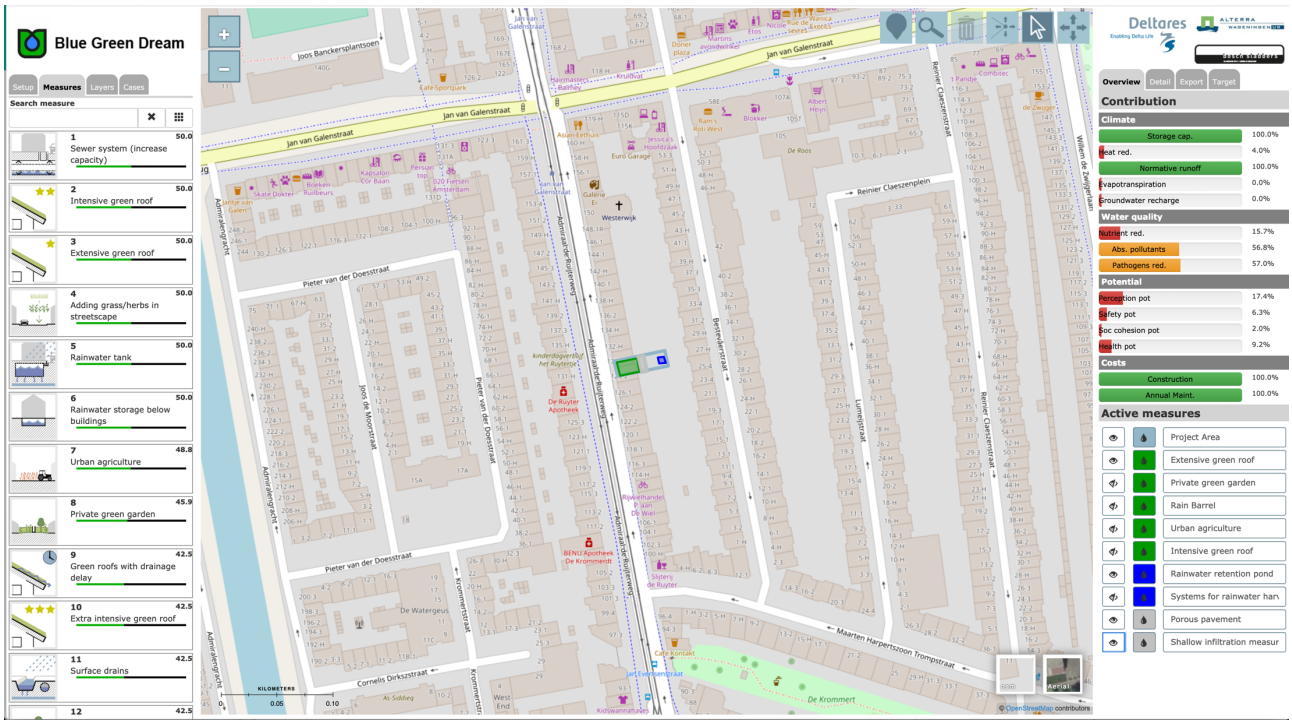
Blue Green Dream
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1 Sewer system (increase capacity) 50.0
2 Intensive green roof 50.0
3 Extensive green roof 50.0
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6 Rainwater storage below buildings 50.0
7 Urban agriculture 48.8
8 Private green garden 45.9
9 Green roofs with drainage delay 42.5
10 Extra intensive green roof 42.5
11 Surface drains 42.5
12 42.5
Deltares
Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 100.0%
Heat red. 4.0%
Normative runoff 100.0%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 15.7%
Abs. pollutants 56.8%
Pathogens red. 57.0%
Potential
Perception pot 17.4%
Safety pot 6.3%
Soc cohesion pot 2.0%
Health pot 9.2%
Costs
Construction 100.0%
Annual Maint. 100.0%
Active measures
Project Area
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Cornelis Dirkszstraat
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Aerial
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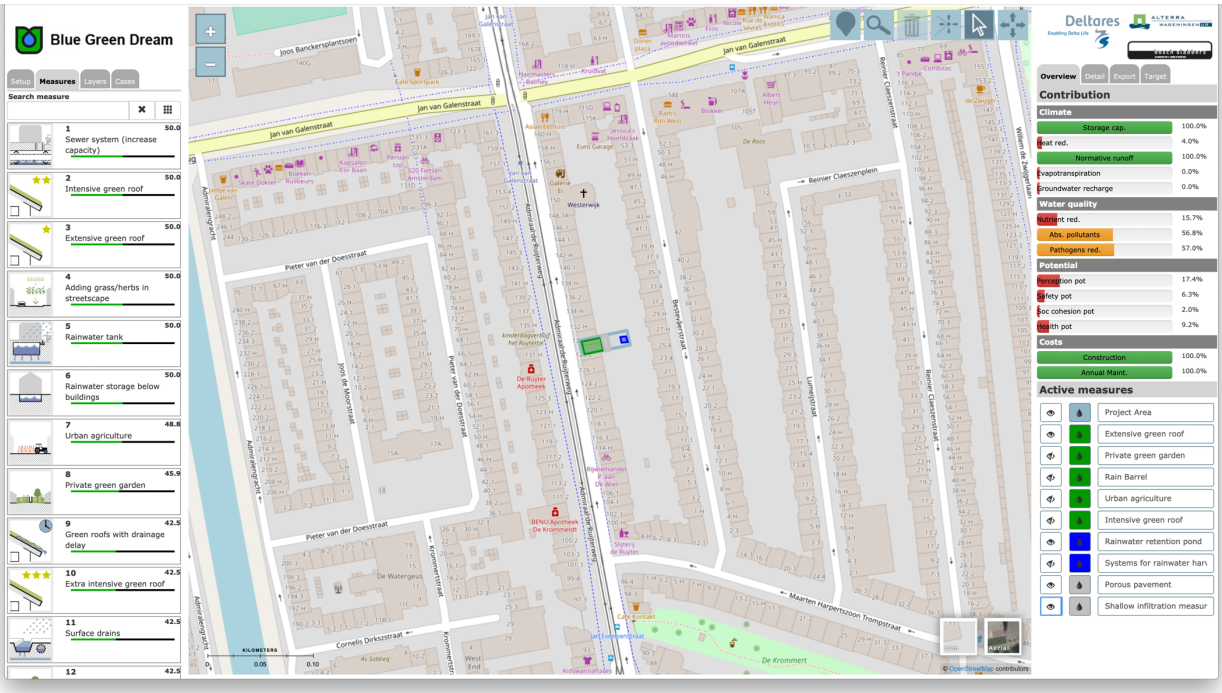
Blue Green Dream
Setup
Measures
Layers
Cases
Search measure
1 50.0
Sewer system (increase capacity)
2 50.0
Intensive green roof
3 50.0
Extensive green roof
4 50.0
Adding grass/herbs in streetscape
5 50.0
Rainwater tank
6 50.0
Rainwater storage below buildings
7 48.8
Urban agriculture
8 45.9
Private green garden
9 42.5
Green roofs with drainage delay
10 42.5
Extra intensive green roof
11 42.5
Surface drains
12 42.5
Deltares
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Overview
Detail
Export
Target
Contribution
Climate
Storage cap. 100.0%
Heat red. 4.0%
Normative runoff 100.0%
Evapotranspiration 0.0%
Groundwater recharge 0.0%
Water quality
Nutrient red. 15.7%
Abs. pollutants 56.8%
Pathogens red. 57.0%
Potential
Perception pot 17.4%
Safety pot 6.3%
Soc cohesion pot 2.0%
Health pot 9.2%
Costs
Construction 100.0%
Annual Maint. 100.0%
Active measures
Project Area
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Rainwater retention pond
Systems for rainwater han
Porous pavement
Shallow infiltration measur
Jan van Galenstraat
Pieter van der Doesstraat
Reinier Claeszenplein
Maarten Harpertszoon Trompstraat
Cornelis Dirkszstraat
Westerwijk
De Krommert
Aerial
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Appendix P: Own experience of the researcher (2017)

Commodities - Gathering materials

While renovating the house and willing to implement several rainproof measures. I came across some issues. For example when trying to get some material from a 'bouwmarkt' for a extensive green roof for the garden house the green roof was interpreted differently by the seller than expected. Material with the actual colour green, however no vegetation cover, has been suggested. Based on this experience it is not so straightforward that resident can gather all the materials. it is possible when resident feel struggles, achieving the goal might give up before reaching the goal as it might be more time consuming than anticipated beforehand.

Since then some change has been detected. It has been seen that more materials for instance for green roofs is available in 'bouwmarkten'

Vergunningstraject (permit trajectory)

Note this is a biased impression of the researcher throughout the application and might differ from other cases that residents want to implement rainproof measures. The situation was also influenced by the specific design of the architect and thus his idea of a sustainable design. A sustainable design could have been integrated in different ways and are thus subjective. Additionally the location of the house as well as the situation of the surroundings might influence such a process.

In combination with the renovation of the house we had to apply for a permit for as well a green roof and some other building works associated with the renovation.

Thereby the goal was to integrate an extensive green roof for the 'old' building due to the foundations and an intensive green roof on the new part anticipating the calculations of the foundations with the bearing capacity accordingly.

The first issue we came across that it is not so easy to convince the municipality form a new idea of construction. We had the idea that the sustainability had a lesser influence compared to the more traditional way of building. Additionally certain rules made it more complicated to integrate a flat roof for intensive green roof, as the preference of the municipality were the use of (schuin dak) inclined roofs.

After some explanation of the design and the functions of the elements (water detention and water retention of green roofs) we had the impression that the municipality is much more enthusiastic about the green concept behind the design.

As the first draft was rejected due to several reasons (one of them was the flat roof, but much more contributed to the rejection), other residents might give up their idea to implement a green roof. Even the architect thought of letting the green roof go at certain point in time due to its complication. Based on this experience it might be possible that a shift is required to integrate a sustainable vision in the decision making process.

As the commission was much more enthusiastic about the green concept it had to be adapted throughout the entire design, hence green walls were integrated (vegetation growth along the walls).

Fortunately the permission was granted. However reading through the permission we came across an interesting fact. As we wanted to implement several rainproof measures, we also wanted to disconnecting the rainwater. In the document it was criticised (even thought the permission was granted) that we did not comply all rules. One of them was indicated that rainwater had to be connected to the sewer system, which is according to the municipality a rule by Waternet. After some investigation we could find some rules/advice from Waternet. Their they indicate that the resident is responsible for the rainwater from his/her own terrain, which can be, as they indicate, infiltrated or drained to the closest surface water (not via the neighbours). If infiltration is not possible due to high groundwater or drainage is not possible as no surface water is close by and the resident does not have the possibilities to store and reuse the rainwater it can be connected to the stormwater system.

Based on this indication the resident does not necessarily have to connect the rainwater pipe to the stormwater system. However this should not be confused with wastewater. The water that is used in the house is required to be connected to the sewer system (grey water system is possible).

it seems that the rules of the municipality and Waternet are either not synchronised or the interpretation of the rules is differently. In our case the permission was granted, however such interpretation issues or desynchronization might influence the permission. Thus residents might not be able to disconnect of the rainwater due to these circumstances.

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