Climate information - a potential stepping stone towards enhancing urban pluvial flood resilience?

An exploration of the role and influence of climate information within the decision-making process of relevant local stakeholders aiming to enhance urban pluvial flood resilience in comparison to other potential influential factors

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Abstract

Climate change impacts are expected to be causing more extreme precipitation events, and thus pluvial flooding events in Dutch urban areas. While the problem has been recognized in Dutch national politics (e.g. in the Deltaprogramme), the adaptation to these impacts needs to be done by more local based Dutch governmental stakeholders (municipalities; water boards; provinces) and private stakeholders such as citizens. To do so requires them to take decisions regarding the implementation of spatial measures to change the spatial design of Dutch urban areas accordingly. This research looks at the main contribution that information about climate change impacts (climate information) and its information design as well as other factors (e.g. societal; economic; legislative; political) and resilience capacities have on the choices made during the decision-making process, how it leads to enhancement of urban pluvial flood resilience, and how large these contributions are to the overall decision-making process. To this end, in three Dutch cities (Hoogeveen, Meppel and Drachten) data was collected via a document analysis, semi-structured interviews with governmental stakeholders, a worksession with members of the water board, municipalities, and the provinces, and a survey amongst inhabitants in these three cities. The results show that climate information has a mostly signalling function within the decision-making process, whereas cost-effectiveness of measures, political awareness and willingness, local circumstances and other spatial (re)development in the area are more leading influences that determine when, where and what spatial measures will be taken to reduce the vulnerability of urban areas against extreme precipitation. Additionally, the research also showed that the way climate information is presented to different stakeholders may also affect its ability to transfer this information in a way that it is fully understood or useable by the receiving stakeholder. As such, the research also concludes that there are several so-called 'usability-gaps' present between the offer of climate information and the information needs of local stakeholders.

Keywords: Pluvial flood resilience; Climate adaptive urban design; Climate information; Information design; Local decision-making; Climate change adaptation; Local governmental stakeholders; Citizens

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In front of you lies (or if you are reading it from a screen: is projected) the result of my work into researching on how resilience against pluvial flooding in the Netherlands can be achieved, as well as deciding factors influencing this process (for more information, just read the abstract or the thesis itself). However, this work would not be possible without the support of other people in terms of help, advice, providing data or that did contribute in any way to my thesis during the time I required to finalize it

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The only thing left to say is that I hope that you will have an informative read!

Sincerely yours,

Gerben Koers

PS: If you are at the moment of reading working on your own thesis, I have provided DOI- or web links to most of the literature that I used in my reference list. This can hopefully ease your search for literature you need. Also, in that case, good luck with writing your thesis. I was able to do it, and so are you!

Colophon

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List of used abbreviations

Abbreviation	Dutch name (if applicable)	English name
DPRA	Deltaplan Ruimtelijke Adaptatie	Deltaplan Spatial Adaptation
EASAC	-	European Academies Science Advisory Council
EEA	-	European Environmental Agency
I&M	Ministerie van Infrastructuur & Milieu	Ministry of Infrastructure & Environment
I&W	Ministerie van Infrastructuur & Waterstaat	Infrastructure & Water Management
IPO	Interprovinciaal Overleg	Interprovincial Consultation
KNMI	Koninklijk Nederlands Meteorologisch Instituut	Royal Dutch Meteorological Institute
OECD	-	Organisation for Economic Co-operation and Development
RMH	Respondent gemeente Hoogeveen	Respondent Municipality Hoogeveen
RMM	Respondenten gemeente Meppel	Respondent Municipality Meppel
RMS	Respondent gemeente Smallingerland	Respondent Municipality Smallingerland
RPD	Respondent provincie Drenthe	Respondent Province of Drenthe
RPF	Respondent provincie Friesland	Respondent Province of Friesland
RWBF	Respondent waterschap Friesland	Respondent water board of Friesland
RWDOD	Respondent waterschap Drents Overijsselse Delta	Respondent water board Drents Overijsselse Delta
Stichting CAS	Stiching Climate Adaptive Services	Foundation for Climate Adaptive Services
STOWA	Stichting Toegepast Onderzoek Waterbeheer	Foundation for Applied Water Research
VNG	Vereniging van Nederlandse Gemeenten	Association of Dutch Municipalities
VROM	Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer	Ministry of Housing, Spatial Planning and the Environment
WBF	Waterschap Friesland	Water board Friesland
WDOD	Waterschap Drents Overijsselse Delta	Water board Drents Overijsselse Delta

Table 1: List of abbreviations used in the document

Chapter 1: Introduction

“Everyone talks about the weather, but nobody does anything about it”

- Charles Dudley Warner

1.1 Background

An important modern societal challenge is climate change and how to adapt to its impacts. It is a serious problem as these can lead to material damage, economic loss, disruption of traffic, loss of life and overall affecting and necessitate changes in society (Patz, 2005; Campbell, 2006; Tol, 2009). Furthermore, even with successfully implemented mitigation and adaptation measures, the damage caused by the consequences of climate change is expected to be in the trillions of US dollars (Action Aid, 2010; Mathew & Akter, 2011). For some areas, these impacts include droughts, for others high temperatures and heat stress or more frequent and intense precipitation events (EEA, 2008; EEA, 2015). Furthermore, new research also shows that climate change, and thus these impacts, is most likely happening faster than originally predicted (Lenderink et al., 2011; Westra et al., 2014; Lenderink et al., 2017; EASAC, 2018). One of these areas is the Netherlands. Especially extreme precipitation, which can cause pluvial flooding (Houston et al., 2011) is one of the predicted climate impacts that requires preparation against (I&M, 2017). This can occur in every part of the Netherlands and has already put itself in the spotlight of both Dutch media and politics (e.g. Van Hoof, 2018; Unie van Waterschappen, 2018).

The issues of extreme precipitation and pluvial flooding have already been acknowledged as a threat to the Netherlands for a long time (I&M, 2017). Scenarios and observations done by the Dutch Royal Meteorological Institute (KNMI) (Van Hurk et al., 2014) showed that, compared with the 1950's, the amount of extreme precipitation events has increased two to fivefold. The prediction is that these amounts will increase further over the course of this century. This is troubling as the intensity of these events is expected to increase as well (STOWA, 2015). This could result in an increase of both the occurance and damage caused by future pluvial flooding events. This type of flooding often occurs when a sewer system cannot process all precipitation that is entering the sewer (Boer, 2012; Ochoa-Rodriguez et al., 2013). In practice pluvial flooding can occur with precipitation amounts of around 25 mm/h, but this can decrease to 10 mm/h in cases where the soil is already saturated with water due to earlier precipitation events (Falconer, 2009; Maksimovic & Saul, 2015; Sörensen & Mobini, 2017). This can, in urban areas, lead to flooded streets (RIONED, 2006), property damage (Ten Veldhuis, 2010; Stone et al., 2011) and disruption of (economic) traffic (Penning-Roswell, 2005; Stone et al., 2011). Additionally, if a shared sewer system (residential wastewater and rainwater flow through the same sewer pipes) overflows, pluvial flooding can also cause negative health impacts when people come into contact with faeces-contaminated flood water (Sterk et al., 2008).

The damage caused by pluvial flooding in the Netherlands is estimated to be currently around 90 million euros annually but is expected to increase to as much as 200 million in the future (NOS, 2016). However, these amounts are not completely set in stone as, for example, in the last few years pluvial flooding caused 300 million euros worth of damage in the province of Limburg (Opdenacker, 2018), while approximately almost 110 million euros of damage caused by pluvial flooding was claimed by Dutch citizens via home and content insurances in 2008 (appendix I). Furthermore, figure 1, shows more recent reported pluvial flood events in the Netherlands by the Dutch media. This data can be used to support the earlier made statement that pluvial flooding events that are the result of extreme precipitation are not spatially bound to specific areas in the Netherlands, as the locations where extreme precipitation occurs is largely due to random chance (Zijlstra & Hofs, 2016). However, while both rural and urban areas are at risk of experiencing pluvial flooding, the impact in urban areas is much larger due to a higher density of properties and population, as well as the presence of vital infrastructure and economic value located in these areas that can be disrupted or damaged (Ochoa-Rodriguez et al., n.d.).

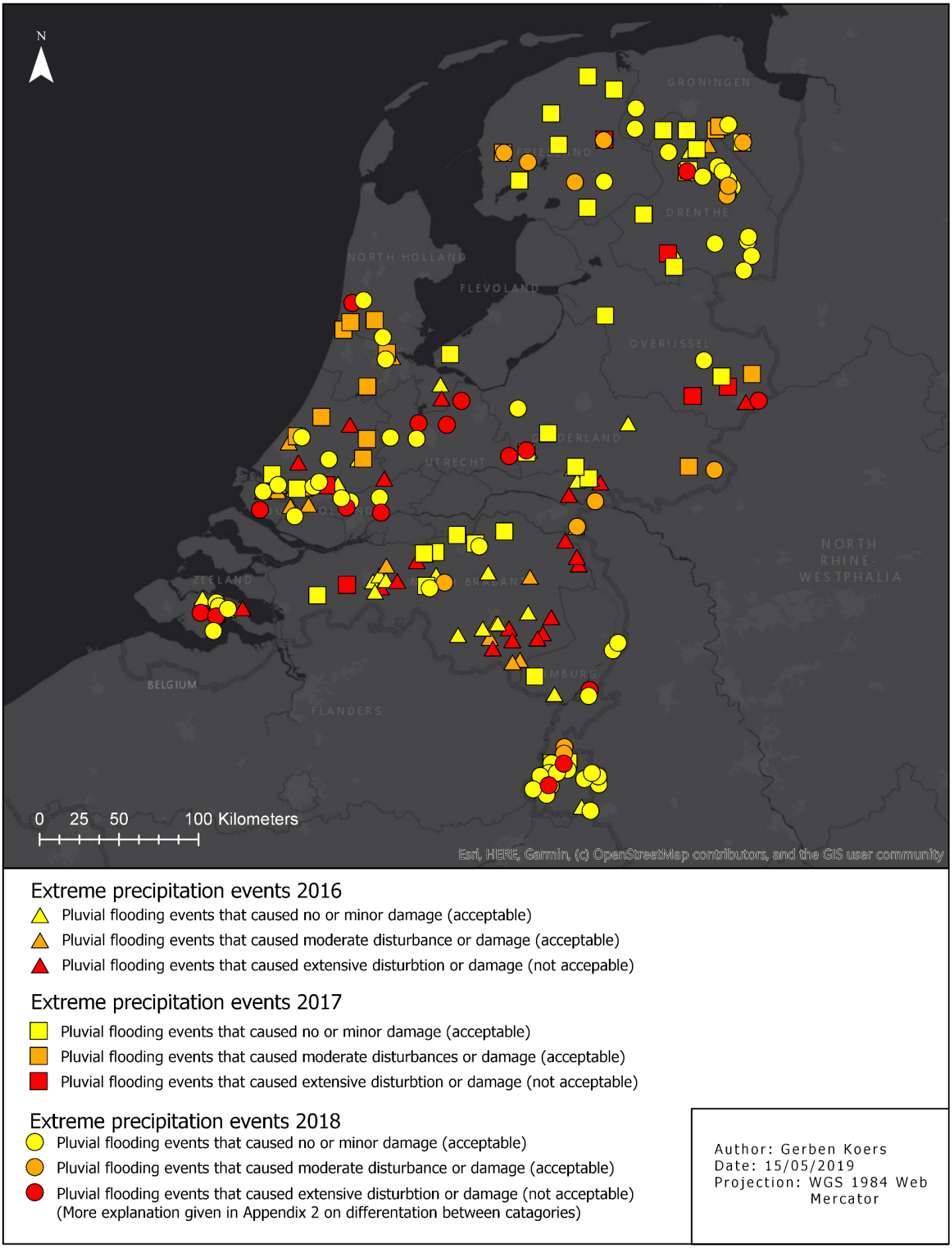

Figure 1: A visualization of the location of reported pluvial flooding events by the Dutch media that occurred in the Netherlands in the period May 2016 - May 2018 (made by author; source: Esri et al., 2019a; appendix II)

As such, both the Dutch ministries of Infrastructure and Water Management (Formerly called the Ministry of Infrastructure and Environment) and Economic Affairs and Climate carry the responsibility for making the Netherlands climate adaptive. To this end they release annual versions of the 'Delta Programme'. This policy document serves as a guideline for the national Dutch strategy for climate change adaptation. It lays out the overall perspective on the necessary actions and measures that are needed; which stakeholders are responsible or should be involved (more); and the deadlines that must be met to achieve the goal of a climate adaptive Netherlands in a timely fashion. An important part of the Delta Programme since 2017 to this end is the chapter 'Deltaplan Spatial Adaptation' (Deltaplan Ruimtelijke Adaptatie) or DPRA for short. This chapter focusses on the measures needed to make the spatial design of the Netherlands water and climate resilient (these actions will be mentioned as spatial measures for the remainder of this document). This resilient spatial design will then be able to limit both the chance, and/or consequences of pluvial flooding. Furthermore, the DPRA also focusses on enhancing the ability of responsible stakeholders to learn from events ands supports potential new research, developments and insights regarding climate change to change the spatial design in order to handle future extreme precipitation and pluvial flooding events better and more efficient (I&M, 2017).

This approach towards extreme precipitation and pluvial flooding also shifts the implementation responsibility from the national government to lower, more local and regional based, Dutch governmental stakeholders (provinces, water boards and municipalities) (I&M, 2017). As both extreme precipitation and pluvial flooding mostly occur and affect local areas, it makes sense that solutions and improvements to the spatial design should be implemented on this scale as well (Houston et al., 2011). Other climate change adaptation literature (e.g. Urwin & Jordan, 2008; Measham et al., 2011; McEwen & Jones, 2012; Uittenbroek et al., 2013) also support this focus on the local scale for effective implementation of climate adaptation measures. These more local and tailored measures take into account the local contextual circumstances for solving problems caused by climate change such as extreme precipitation and pluvial flooding, increasing their effectiveness. On the local scale, citizens (e.g. home owners and renters) are involved as well due to the responsibilities this group has with regarding handling precipitation (Mols & Schut, 2012; I&M, 2017). This is because citizens are in the first instance responsible for capturing, holding and processing the precipitation that falls on their property according to Dutch law (Mols & Schut, 2012). Therefore, this group can be considered as relevant as well for making Dutch urban areas more resilient against pluvial flooding. This is done by letting them implement measures on their private property or providing input on the design of spatial planning projects (Mees et al., 2016; Dai et al., 2017b).

This relevance is furthermore also due to a high percentage of land and property in Dutch urban areas is owned by citizens (Operatie Steenbreek, n.d.). As a result, this limits the influence that governmental stakeholders have as they can only implement measures in the remaining public space (sewers, streets, and parks). However, pluvial flooding is heavily affected by the overall amount of hardened surface (concrete, asphalt or stones) in the area where precipitation is falling (OECD, 2014). This means that the presence of hardenend surfaces in privately owned space can worsen the overall resilience capacity of the urban spatial design, even with appropriate actions being taken in public spaces. Governmental actors can therefore choose to involve citizens voluntary (e.g. via subsidies that promote individual actions or by raising awareness) or more forced (e.g. via building codes or regulations) (Mees et al., 2016; Dai et al., 2017).

Additionally, we can also observe the so-called 'pluvial flood resilience approach' on how to approach extreme precipitation and pluvial within the employed Dutch pluvial flooding strategy. Inherent in this approach is that we, as a society, not only aim to prevent pluvial flooding, but also try to limit the consequences if it does happen. This is because the probability of a flooding to occur can never be completely removed and as such that structures and inhabitants will therefore need to be prepared for a potential flood event to limit the consequences of a flood (e.g. by using more water-resistant building

materials (White, 2010; Houston et al., 2011; Scott, 2013). From this perspective, the DPRA's choice of adopting the concept of resilience is logical. This concept focusses on the ability of an urban area to limit the consequences of the remaining flood probability through spatial planning through the spatial design of that area (White, 2010; Davoudi, 2012; Scott, 2013). This is done through the attributes or 'capacities' of resilience (Restemeyer et al., 2015). One important capacity of resilience is that an area should be able to withstand extreme precipitation which can lead to flooding, and thus limiting the chance of such an event to happen (robustness) (Restemeyer et al., 2015). This can be done by for example by capturing precipitation, or by making sure that the sewer system can process all rainwater that falls in the urban area. Various other authors (e.g. Folke et al., 2010; Galderisi et al., 2010; Davoudi et al., 2013; Scott, 2013; Hegger et al., 2016) furthermore also point out three other important attributes of resilience as well: 'absorption', 'adaptability' and 'transformability'. These link to the idea that a flooding may still occur, and as such the rest of the urban area must be prepared to reduce the consequences of a flooding in the area, as well as what kind of changes need to be made in order to achieve this (Restemeyer et al., 2015).

Firstly, absorption is the capacity of an area to reduce the potential damage that may be caused by pluvial flooding (e.g. raising the high of house entrances to prevent water from entering properties) (Klijn et al., 2004; Folke, 2006; Mens et al., 2011; Liao, 2012). This is an extension of robustness by also incorporating damage reduction within the spatial design when it comes to pluvial flooding. Adaptability and transformation on the other hand focus on the type of changes that are done to the spatial design as well as how these changes came to be. Adaptability changes the spatial design with the current existing configuration of involved stakeholders as well as that conventional methods and approaches are used to enhance the robustness and absorption capacities of an urban area against precipitation and pluvial flooding. (Walker et al., 2004). However, using only the currently stakeholders or strategies may prove to be not enough to reduce the vulnerability of an urban area against pluvial flooding (e.g. private property has a lot of hardened surface which forces rainwater to flow to the sewer, which then reaches its maximum capacity resulting in pluvial flooding). A potential transformation would then be change in the current configuration of involved stakeholders in order to reduce the vulnerability by including them. At this moment, transformability is needed to change the spatial design sufficiently enough. This attribute therefore focusses on changing or including (new) involved stakeholders, as well as using different or new methods and strategies to approach the problem of pluvial flooding (Walker et al., 2004; Folke et al.,2010; Restemeyer et al., 2015). As such, the focus in transformability is on innovation and discovering new ways to approach the problem rather than following the beaten path (Davoudi et al., 2013) as stakeholders can act on new insights or developments that can prove to be more successful than currently used ones (Restemeyer et al., 2015). Examples of transformation are the shift from government to governance in flood management (Meijerink & Dicke, 2008) or the transition from a flood resistance to a flood risk management approach (Pahl-Wostl, 2007). Underneath the resilience attributes of robustness, absorption, adaptability and transformability lies is also the learning capacity of stakeholders (Davoudi et al., 2013) which informs them on the performance of taken measures, what potential changes should be made to the spatial design, or approaches, insights and stakeholders that could be included to (further) enhance these attributes.

However, in practice, questions about social justice and equity are often neglected when talking about resilience and making an urban area more 'resilient' (Davoudi, 2012; White & O'Hare, 2014, Meerow & Newell, 2016, De Bruijn et al., 2017) while seen by some researchers as an important aspect within the academic debate on resilience (e.g. Williamson, 2013; Cretney, 2014; Cutter, 2016; Meerow & Newell, 2016). This is because a resilience-based approach should not only focus on the question on how to enhance resilience against pluvial flooding, but also against what exactly (the problem of pluvial flooding a whole; focussing certain aspects of that problem (e.g. material damage or economic disturbances) or the resilience against multiple disturbances (e.g. both extreme precipitation and drought by increasing the water storage capacity of an urban area to withstand both disturbances better) (Walker & Salt, 2006).

Secondly, it also asks the question of 'resilience for whom', as resilience looks at the capacity of an urban area to handle a certain impact and that this capacity may be as (un)desirable/insufficient. But who exactly determines what is (un)desirable, which parts of the system are designated as such, or which groups benefits from potential taken measures, are also aspects embedded in the concept of resilience as ideas on desirability of a system state is socially constructed (Engle, 2011; Porter & Davoudi, 2012; Cutter, 2016; Meerow & Newell, 2016). As such, a resilience perspective does not only encompass the measures can be taken in relation to pluvial flooding, but also on how these measures affect the social equity in an area. This means that, ideally, a resilience approach should let everyone benefit from taken measures and that there are no 'winners and losers' in the end by also considering vulnerable groups during the enhancement of resilience capacities (Houston et al., 2011). However, in practice the costs and benefits of measures will also be considered by relevant stakeholders during the decision-making process (Adger et al., 2005).

One area within the climate adaptation process where this equity is influenced lies in the aspect of informed decision-making about spatial measures. This is since municipalities and water boards are required to perform a 'stress test' by 2019 to support the goal (as stated in the DPRA) of making the Netherlands water and climate resilient through its spatial design. This analysis helps to identify the impact of extreme precipitation on a local level and thus giving them information to act upon. This information regarding climate change impacts (climate information) that is created with the analysis can help to make informed decisions for implementing appropriate spatial measures (I&M, 2017, Kennisportaal Ruimtelijke Adaptatie, 2017). However, governmental stakeholders are not the only stakeholders to be expected to implement spatial measures against pluvial flooding. This leads in the first place, to the question of whether the results from stress tests are also accessible by private stakeholders and citizens. Secondly it can be argued whether these tests provide appropriate and enough climate information to successfully inform the decision making by all relevant stakeholders (governmental, private and citizens) for implementing spatial measures. This appropriateness of information is called the 'utility gap' and refers to the potential gap between climate information that is presented to stakeholders, and the climate information that they see as useful for their decision-making process (does the available climate information fulfil the knowledge needs of the stakeholder that is using this information or is more (or different) information needed as well?) (Lemos et al., 2012). This gap can affect the usefulness of information, which can in turn delay the process of implementing measures against climate change as well as reduce its effectiveness (Weaver et al., 2013).

Furthermore, this knowledge needs of a stakeholder can also change during the procedural steps that the implementation of climate adaptation measures entails (e.g. European Commission, n.d.; Miralles-Wilhelm & Castillo, 2014). For example, a stakeholder needing information about which possible adaptation options that can be implemented requires different information than one that must be made aware that there are potential climate change impacts in the first place or where these may occur. The idea of stakeholders following these different steps is based on the so-called 'policy cycle' which can be used to give insight in the decision-making process and actions that taken by stakeholders in coming to a measure as well as the climate information that is required in these steps (Moser & Ekstrom, 2010; Van Buuren & Warner, 2014; Buijze, 2015; Mees et al., 2016; Dai et al., 2017b). As such, the usefulness of information and their information needs can potentially change as stakeholders are progressing through this cycle.

Additionally, based on the research done by Moser (2010), it can also be established that the usefulness of information can also be affected by certain aspects. Her research shows that to communicate climate change impacts, the targeted audience, the goal of the information, the way it is framed, and the format (text/graph/map/etc.) through which information is communicated may all affect the transfer of communication. This shows the need for attention on the potential means of relaying information and knowledge to stakeholders just as much as the information that is communicated. This also means that

different stakeholders will perceive the same information differently when presented in the same information formats (maps; reports; models; story-telling), and as such tailoring of information through the chosen information format may be necessary to let the information successfully reach the targeted end-user (Vaughan et al., 2016). Additionally, the communication channel through which the information is communicated also affects how well the information is received (Orr et al., 2015). Using digital ways of communicating information (e.g. websites or web-based tools) may for example yield limited success to reach the targeted audience if it consists mostly of elderly people, or other societal groups with limited access and use of the internet.

A final notion is that additional or more useful information may not be needed by stakeholders and that their ability and willingness to participate and act is affected or constricted by other factors. Examples of these factors are previous experiences with pluvial flooding, the perception of the problem of pluvial flooding by the stakeholder or the social status of the stakeholder which can affect the financial capacity for investing in spatial measures (Burningham et al., 2008; Martens et al., 2009; Brossard & Lewenstein, 2010; O'Sullivan et al., 2012). Additionally, also environmental factors such as local height differences (Heidrich et al., 2013; Tehrany et al., 2015), political factors such as the willingness to act (Runhaar et al., 2012), etcetera, may also be potential influences on this process.

1.2 Research objectives and questions

The goal of this research is to explore how climate information that is available to relevant stakeholders is being used by them and how this contributes to their decision-making process surrounding the enhancement of the urban pluvial flood resilience through the implementation of spatial measures. To this end, the research firstly focusses on researching which climate information is available to each relevant stakeholder and what this information contributes to the decision-making process. This research goal links to the 'usability gap' mentioned by Lemos et al. (2012) as the contribution of climate information may be affected by this gap. However, it is also possible that there are other reasons as well. Therefore, the research also focusses on what may be the other potential causes for this reduced effectiveness if this is indeed the case. This ability and willingness to act' can be influenced as earlier mentioned factors such as whether there is sufficient enough information available, the usefulness of this information or other potential factors (economical, political, etc.) (e.g. Moser & Ekstrom, 2010; Biesbroek et al., 2011; Runhaar et al., 2012) that may have their own contributions and influence on the course that the decision-making process.

For answering the main research question and sub-questions (presented in table 2) the research also made use of case studies in three Dutch cities that have experienced pluvial flooding in the past and/or are at risk of experiencing this when exposed to an extreme precipitation event: Hoogeveen, Meppel and Drachten. These are located in the northern Dutch provinces of Drenthe and Friesland. These case studies were used to explore the above stated goal in practice. By looking at two different provinces it does however mean that there can occur differences within the approaches and information used by different stakeholders due to potential different organizational views on pluvial flooding, the adaptation towards it, experiences and local circumstances. At the same time however, it can also be said that these stakeholders in different provinces have also similar roles and responsibilities that are based on Dutch law and legislation (e.g. the municipalities of Drachten, Meppel and Hoogeveen carry responsibility towards pluvial flooding in the public area due to the Water Act) (Rijksoverheid, 2009b). Therefore, these organizations in different geographical locations can therefore be considered 'similar' in the context of this thesis, which is also supported by Rose (1991) who opts for the use of similar 'concepts' and units of analysis for comparing case studies. For other stakeholders such as citizens, the area that they can have an influence on is limited to their own property, leading to a limited effect of the different provinces for

these stakeholders. The advantage of including more 'different' cases is that it gives a chance to locate more general applicable insights by looking at the similarities between different cases. Additionally, even while the thesis focusses on smaller cities in the Dutch context, it is important to have somewhat similar case studies, with somewhat similar characteristics (Sartori, 1991). This means that these cities need to be of a similar size (e.g. comparing a village with a metropolitarian area would not work due to too different factors and aspects). From a more practical perspective it must therefore be noted that within the context of Drenthe, this however is not possible as the other options in the Province of Drenthe (Assen, Emmen, Coevorden) are either much larger or smaller than Meppel and Hoogeveen, leading to the practical inclusion of Drachten as third case study city with a comparable size as these other selected cities, as well as being also located in the north of the Netherlands. A more detailed description of these cities and neighbourhoods can be found in chapter 4.

Main research question
What is the current contribution of climate information to the decision-making process of relevant stakeholders (governmental organizations and (towards) citizens) for taking pluvial flood resilience enhancing spatial measures in local urban areas and how is this contribution affected by information communication aspects, as well as other influencing factors (e.g. political, environmental, legislative) and information?

Theoretical sub-questions	**Practical sub-questions**
1: What is seen as pluvial flooding within the context of Dutch urban areas?	7: How is the available (climate) information being used by relevant stakeholders within their decision-making process in practice?
2: Which stakeholders are relevant for enhancing pluvial flood resilience of local Dutch urban areas, and what are their responsibilities for this?	8: How do information communication aspects affect the use of (climate) information by relevant stakeholders in the decision-making process in pratice?
3: How can pluvial flood resilience be defined within the context of Dutch urban areas?	9: Which other relevant factors influence the decision-making process by relevant stakeholders besides (climate) information and its design in practice?
4: What is climate information and which aspects may affect communication of information and usage?	10: How do the taken decisions affect the pluvial flooding resilience of urban areas in terms of the resilience capacities of robustness and absorption in practice and vice versa?
5: How does the decision-making process for stakeholders for the development and implementation of spatial measures take place, and which contribution does climate information have within this process?	11: How do the taken decisions affect the pluvial flooding resilience capacities of adaptation and transformation in practice and vice versa?
6: Which other relevant factors may influence the decision-making process of stakeholders?	

Table 2: Overview of the main research question and supporting theoretical and practice-oriented sub questions (Source: Author)

1.3 Scientific relevance of the research

The research is of value to field of spatial planning, and then in particular the subfield of climate adaptive planning against extreme precipitation and pluvial flooding. This is since the findings of the research help understand how spatial planning measures can contribute to improve the pluvial flood resilience of urban areas. It also adds insights and empirical evidence to the field regarding the role that the inclusion of citizens can play in spatial climate adaptation approaches focusing on pluvial flooding. These insights can serve as evidence for what the potential role and contribution can be of citizens can be in governance arranged climate adaptation approaches, a question that is also raised by Termeer et al (2012) and Runhaar et al. (2012) in their studies on climate adaptation and the role of governance in this process. Additionally, the exploration into other factors that may also influence the decision-making process regarding climate adaptation also provides empirical evidence that may also support the research done on the aspect of climate adaptation barriers (e.g. Moser & Ekstrom, 2010; Biesbroek et al., 2011, Runhaar et al., 2012; Biesbroek, 2014) as well as how to better overcome these barriers.

Furthermore, the findings of this research can be of relevance to several other academic fields. Firstly, to the scientific fields of information- and risk communication. This is because the research adds new insights to the communication, use of climate information by stakeholders, and especially the role that different communication formats play in communicating information to stakeholders. This is related to the earlier mentioned 'usability gap' (Lemos et al., 2012) which can cause delays in climate adaptation efforts done by stakeholders (Weaver et al., 2013). By researching how the choice of format in which climate information is presented is understood, perceived and used by stakeholders in decision-making could serve as a stepping stone to find solutions to bridge or reduce this gap. This is since while information is important, there are also other factors which influence the use of this information such as the information format (Berkhout et al., 2014; Raaphorst et al., 2017; Raaphorst et al., 2018). The findings from this research therefore also connect to research recommendations made in a study done by Vaughan et al. (2016). They recommend that more research needs be conducted on how climate information is communicated, the information that is needed by the end-users versus the information that they have access to, and the capacities that are used regarding climate change adaptation. This research can provide an empirical contribution to answering these questions by researching the information that is available to relevant local stakeholders and knowledge needs of relevant stakeholders in the case of adapting to extreme precipitation and pluvial flooding, as well as how and which information related to it is communicated to these stakeholders.

Finally, the research also contributes to the field of resilience as it adds insight to how what the role of climate information is within resilience enhancement. This question is also raised by Tschakert & Dietrich (2010) and findings from this research could contribute to understanding how the use of climate information and its different formats can contribute to the implementation of measures that can enhance different capacities of pluvial flood resilience.

1.4 Social relevance of the research

According to Weaver et al. (2013), the existence of the 'usability gap' in climate information can lead to a delay the implementation of climate adaptive measures in practice by relevant stakeholders. Therefore, the findings from this research can serve as a guideline for providers of climate information on how to communicate this information to different relevant stakeholders in a way that best conveys this information to end users in practice. Hereby especially findings on the relation between the usefulness of the information by different groups of stakeholders and its communication format can be of use to these

creators and providers, but also for example municipalities when they want to communicate such information to other stakeholders.

Additionally, municipalities may have gained a more active role in approaching climate adaptation through decentralization (Vermeij et al., 2012; Mees, 2014) and municipalities in turn also include the help of residents in shaping the urban spatial design since the 2000's (Mees et al., 2014) However, there is not yet enough empirical data available on whether this approach towards improving the pluvial flood resilience of local urban areas is also effective (Dai et al., 2017). As such, this research can also have a practical output for Dutch municipalities to give an indication on whether this approach of including residents does indeed help to improve the effectiveness of climate adaptation efforts on a local level.

1.5 Thesis outline

This final section gives an overview of the different chapters in the rest of the thesis. Note for computer users: clicking the names in bold will send you to the according chapter.

Chapter 2: Theoretical framework – This next chapter will explore how pluvial flooding and its impacts and causes are perceived within the context of Dutch urban areas to gain an understanding of against what urban pluvial flood resilience should be enhanced, and whos responsible for this. Additionally, it also discussed what 'urban pluvial flood resilience' encompasses as a concept, as well how climate information and other factors could influence and contribute to the decision-making process of stakeholders.

Chapter 3: Methodology – This chapter will focus on the methodological choices that were made for the research in terms of data collection methods and process, and the analysis of gained data create transparency about the process through which the data, and therefore the results, were gained.

Chapter 4: Case study description – In this section a description is given of the case study cities that were used for collecting data, as well as the neighbourhoods that were selected for spreading the survey. The main purpose is to give the reader a context of the areas in which data is collected.

Chapter 5: Results – This chapter is a summary of the relevant data that was found during the data collection process of this research. Additionally, the results for each case study area were brought together within the conceptual model presented at the end of chapter 2 in order to present an overview of the case studies, and to provide a direct link to the theory.

Chapter 6: Discussion and conclusions – This final section reflects the theoretical answers on sub question 1 till 5 with the empirical data that was used for answering sub question 6 till 10, , as well as the outcomes of other academic research and literature. Furthermore, conclusions are drawn based upon the answers that were found by answering these sub-questions to in turn answer the main research question posed at the end of section 1.2.

Chapter 2: Theoretical framework

“Scientific theory is a contrived foothold in the chaos of living phenomena”

- Wilhelm Reich

2.1 Pluvial flooding within the context of Dutch urban areas

2.1.1 How is pluvial flooding seen in Dutch urban areas?

The definition of pluvial flooding is a flooding that is caused by large amounts of precipitation in a short time frame, or over a longer period in an area (Houston et al., 2011). This can then result in rain-driven ponding or an overland flow (Falconer et al., 2009; Carter et al., 2015). In urban areas this flooding can occur when the sewer system reaches maximum capacity and is can no longer process any new precipitation (Boer, 2012; Ochoa-Rodiguez et al., 2013). The causes for a sewer system to reach its peak capacity can be separated into two categories: ones originating from the sewer system itself and ones originating from local area features.

On the one hand, the structure of the sewer system, which can be shared (rainwater and residential wastewater flows through the same sewer pipes) or separated (rainwater and residential wastewater flows through different sewer pipes) may affect the precipitation processing capacity. The latter increases the capacity that the sewer system has for processing rainwater, thereby lowering the risk (Houston et al., 2011; Sörensen & Mobini, 2017). Additionally, clogged sewer pipes (Dai et al., 2017b) or sewer inlets (Golding, 2009; Leitão et al., 2017) can also reduce the local processing capacity of a sewer system and heighten the risk of pluvial flooding in those areas. On the other hand, local height differences can lead to rainwater to flow to lower laying areas, overloading the sewer in those areas (Heidrich et al., 2013; Tehrany et al., 2015). Additionally, the land cover in an area such as large amounts of hardened surface (or soil composition, e.g. clay or rock) reduces the infiltration capacity of the surface, leading to extra rainwater flowing into the sewer outlets increasing the amount of water they must process (La Barbara et al., 1994: OECD, 2014). Furthermore, hardened surface can also cause water to stay on the surface due to not able to infiltrate into the ground. Finally, multiple precipitation events in a short time period may also reduce the water retention capacity of the ground as it is then already saturated (Falconer, 2009; Maksimovic & Saul, 2015; Sörensen & Mobini, 2017). It is important here to note that all previous mentioned causes can occur separately from one another but can also reinforce one another (e.g. pluvial flooding due to one cause may lead to debris blocking other sewer inlets worsening the precipitation impact within that area) (Dawson, 2015).

Within the Netherlands, extreme precipitation and pluvial flooding are one of the predicted climate change impacts (I&M, 2017). Based on previous experiences, an official categorization (table 3) has been made of the severity of pluvial flooding within the Dutch urban context, as well as when responsible Dutch governmental stakeholders such as the municipality are by law required to act and change the spatial design to reduce the risk of pluvial flooding to occur during future precipitation events. This is seen as an acceptance of pluvial flooding to a certain level (RIONED, 2006; Van Riel, 2011).

Hindrance (Hinder):	Rainwater cannot be processed fast enough by the sewer system, which results in water staying on the streets. However, this is only a few centimetres at worst, and only lasts for 15-30 minutes. *(acceptable)* (Example: see 2a)
Severe hindrance (Ernstige hinder):	Rainwater cannot be processed fast enough by the sewer system, which results in water staying on the streets. The amount of water on the street is severe and lasts for 30-120 minutes. Additionally, it can also cause health hazards due to residential waste water flowing on the streets or poses a danger for traffic. *(acceptable)*
Nuisance (Overlast):	Rainwater cannot be processed fast enough by the sewer system, which results in water which stays on the streets for a longer period in a larger area. Additionally, it can also lead to material damages in property and hindrance of economic infrastructure. *(not acceptable)* (Example: see 2b, 2c, 2d)

Table 3: Overview of different categories of severity of pluvial flooding in the Netherlands (Source: RIONED, 2006)

Based on this categorization, it becomes clear that not all pluvial flooding is seen in the Dutch urban context as urgent and severe. The most important point for acknowledging pluvial flooding severity is the point of whether the water stays in the streets, and other designated public spaces, or flows into privately owned space (e.g. buildings; 2c). Alternatively, it is also considered pluvial flooding when it disrupts the traffic flow (see example 2b). This is also reflected in the acceptance of pluvial flooding by Dutch governmental stakeholders, such as the municipality, seeing water on the street being acceptable until it starts to damage property or creates dangerous situations (Van Riel, 2011; RIONED, 2015). The reasoning behind this acceptance is since the sewer system in the Netherlands is designed to be cost-efficient in terms of costs and benefits (RIONED, 2015). This is due to the often-high costs of expanding or upgrading the sewer system, and the reluctance of municipalities (who are responsible for the maintenance and expansion of the sewer) to spend large amounts of money as it increases taxes for local citizens (Dai et al., 2017b).

Figure 2: Examples of pluvial flooding categorizations made by RIONED (2015) - Top-left (2a): Hindrance as water on the road forms large puddles at the roadside; Top-right (2b): Nuisance as a tunnel is flooded, making it impossible for traffic to pass through; Bottom-left (2c): Damage to property as water is able to flow inside; Bottom-right (2d): Danger is occurring as a manhole cover is moved by water, exposing a hole where someone can fall in, or a car can run into (Source: RIONED, 2015)

Therefore, a key underlying concept in Dutch urban areas is the so-called "Three-Step Approach" which encompasses the capture, retention and processing of precipitation wherever it falls, if this is possible to do so (Dai et al., 2017a). This focus is also found in relevant Dutch legislation (section 3.5 of the Water Act) determining the responsibility stakeholders have towards handeling precipitation (Rijksoverheid, 2009b). By doing so, water problems are not shifted or redirected to other neighbouring areas or plots (Keessen et al., 2016; Municipality of Utrecht, 2016; Dai et al., 2017b). Here the focus lies mostly on rainwater capture and urban water storage (Stumpe & Tielrooij, 2000; Showstack, 2014) in measures in both the public space (e.g. water plazas or surface water) and on private property (e.g green roofs, separating rainwater or placing a water reservoir in the garden) (Dai et al., 2017b). An important notion here is for the realization of these steps in urban areas, a mixture of different measures, policies and local stakeholders is required (Mees et al., 2014; Massey et al., 2015; Mees et al., 2016). This last part brings us to the next section on the different relevant stakeholders in local Dutch urban areas necessary for the implementation of spatial measures in these areas.

2.1.2 Relevant stakeholders regarding pluvial flooding in Dutch urban areas and their responsibilities

As already mentioned, there are several relevant stakeholders for implementing pluvial flood risk reducing spatial measures in urban areas. Broadly, these groups can be put in two categories: governmental- and private stakeholders (Meijerink & Dicke, 2008), each with their own responsibilities, capacities and influence for implementing measures and incentives (Birkholz et al., 2014). Furthermore, these stakeholders can be further divided into different organizations and groups, with the municipalities, water boards, provinces and the Dutch national government forming the governmental stakeholders while citizens are the private stakeholders within the context of this research (e.g. businesses, social housing associations and NGO's may be considered private stakeholders as well) (Meijerink & Dicke, 2008; Mees et al., 2016). Their role related to pluvial flooding adaptation in urban areas will now be further discussed.

Governmental stakeholders

Municipalities

In urban areas, the municipality is firstly legally responsible for the maintenance, upgrades and expansion of the sewer system (Rijksoverheid, n.d.), as well as to collect and transport precipitation captured with this sewer system (Rijksoverheid, 2009b; De Jong & Hobma, 2012). Furthermore, they also carry responsibility for designing and implementing spatial measures in the public space, although at the design process of these measures, citizens can also give input (Mees et al., 2016). These measures can be implemented in the green (e.g. parks) and blue urban areas (e.g. surface water), as well as roads or other public locations (e.g. squares) (Dai et al., 2017b). Additionally, the municipality is also responsible for collecting the rainwater run-off of private owners in urban areas that have no way of capturing and storing it themselves. Examples include the lack of a garden (De Jong & Hobma, 2012), no nearby surface water to let the water flow into, or that the groundwater level is too high for them to let rainwater infiltrate into to the ground (Rijkswaterstaat, n.d.; RIONED, 2008; RIONED, 2009). The municipality can also choose to involve private stakeholders and citizens voluntary (e.g. via subsidies that promote individual actions or raising awareness) or more forced (e.g. via building codes or regulations) (Mees et al., 2016; Dai et al., 2017b). Finally, municipalities can also make it mandatory for private stakeholders and citizens to store rainwater on their property where it is now voluntary with municipalities having the choice to make it mandatory. This step has already been taken in at least 40 Dutch municipalities (Kennisportaal Ruimtelijke Adaptatie, n.d.b.; Van Ammelrooy, 2017).

However, talking about the municipality as one single entity requires a correction. Instead it consists of different departments, as well as being split between both civil servants and politicians (city council; mayor and aldermen) (Stalman & Ter Haar, 2013; Castenmiller et al., 2015). This structuration leads to not one person or group being solely responsible for pluvial flooding and climate adaptation, but rather a fragmentation of responsibilities over these different groups. This may potentially lead to conflicts of interest, as well as potential overruling of civil servants by the political side of the municipality, since the civil servants have a supporting role to the executive side of the municipality (alderman). These may choose to take actions that support other interests over climate adaptation (Campbell, 1996; Stalman & Ter Haar, 2013). Finally, the city council serves as a supervisory organ that can decide on whether enough is being done regarding climate adaptation (VNG, 2017).

Water boards

The second Dutch governmental stakeholder to discuss is the water board. It has a more advisory role in urban areas for implementing spatial measures regarding pluvial flooding. This role comes forth from the

'Water Test' (translated: watertoets) which requires the water board to give advice on spatial plans made by the municipality in urban areas on what the impact of these plans are for local and regional water management, which includes pluvial flooding (Rijksoverheid, 2009a; Bügel et al., 2010; Dai et al., 2017b). Furthermore, the water board is also responsible for the management of surface water in Dutch urban areas (Rijkswaterstaat, n.d.a), which may serve as rainwater retention areas during precipitation events. Water boards can also work together with municipalities on pluvial flood prevention. This is since solving problems may require a collaboration between the local urban and regional water system (managed by the water board) and the sewer system and spatial design of urban areas (which is managed by the municipality) (Gerritse et al., 2016; Dai et al., 2017b). Another collaboration is found in approaches in which the municipality and the water board look together at where pluvial flooding can occur and what potential measures could be (e.g. Gemeente Meersen, n.d.; Gemeente Boxmeer & Waterschap Aa en Maas, 2018), or by sharing knowledge (e.g. Waterschap Zuiderzeeland, 2015).

Provinces

The third governmental stakeholder involved in spatial measures taken against pluvial flooding in urban areas are the Dutch provinces. While not as active in the urban areas itself (in comparison to the water boards or municipalities), they do play a role in adaptation to pluvial flooding. According to research done by the IPO (2011) (Interprovincial consultation), provinces play a role of agenda setting; the formation of visions regarding climate adaptation (which includes pluvial flooding due to extreme precipitation); integrated area development; and the legal role of the province to adopt climate change in their policy documents such as the structural vision or provincial vision (e.g. Provincie Groningen, 2012). Furthermore, in the agreements made in the Water Management Agreement in 2011, the Provinces also gained the task of building the framework on how to prevent regional pluvial flooding. As such, the role of regional director was taken up up by the Province regarding spatial planning and regional development. The water boards are also instrumental in this task as well by taking measures that help further this ambition (Rijksoverheid, n.d.; Unie van Waterschappen et al., 2011). Finally, research done by Den Hertog (2014) points out that the province as stakeholder could serve as an advisor to for example municipalities that have difficulties with adopting climate change within their agenda, actions and policies.

National government

Finally, the Dutch national government has a much more regulatory role in the background through the Delta Programme that was already mentioned in the introduction. Via this document they give the municipalities, water boards and provinces but also private stakeholders directions on how to approach the problem of pluvial flooding due to climate change (I&M, 2017). However, decentralization limits the role of the national government in local Dutch urban areas. In the Delta programme, local and regional stakeholders are given the task to take measures on a local level, as these measures are often better tailored towards local circumstances. This becomes even more important when considering the local scale impact extreme precipitation events have in urban areas. This approach is also well documented in academic literature (e.g. Wilson, 2006; Gupta, 2007; Biesbroek et al., 2009; Lyles et al., 2018).

Private stakeholders - Citizens

Citizens that live in urban areas also have responsibilies regarding pluvial flooding (Mees et al., 2016). However, according to Hegger et al (2017) it must be stated that this group from an academic literature perspective was largely overlooked in the past, although literature is now emerging (e.g. Mees et al., 2012; Tompkins & Eaking, 2012; Mees et al., 2013). The responsibilities of this group regarding extreme precipitation and pluvial flooding are also regulated by section 3.5 of the Water Act (Rijksoverheid, 2009b). This section states that citizens are in the first instance responsible for capturing, holding and

processing the precipitation that falls on their property according to Dutch law (Mols & Schut, 2012). Furthermore, they can also be included in the spatial planning of the urban design by giving input to the municipality (Mees et al., 2016).

Furthermore, citizens can also be hit harder by pluvial flooding as well than for example governmental stakeholders. This is due to the 'personal discomfort' that they can experience as a result of flooding (e.g. clean up efforts, limited access to services) (Tapsell et al., 2002; Van Riel, 2011) as well as potential (long-term) psychological effects such as stress (Tapsell et al., 2002) or even PTSD (Mason et al., 2010) in the aftermath of a flood. Additionally, citizens must also live in flooded property, which can lead to potential health impacts, well after a flood has already passed (Tapsell et al., 2002; Azuma et al., 2014). Citizens themselves can however take a voluntary, more pro-active, role by implementing measures themselves on their own property (Mees et al., 2012; Tompkins & Eakin, 2012). This is furthered by initiatives such as 'Operatie Steenbreek' who, together with municipalities, try to stimulate residents to implement measures by giving them information about potential measures that can be taken (Operatie Steenbreek, n.d.). These suggested measures are mostly based on reducing the amount of hardened surface on the property of residents, which has a significant potential effect on the potential occurrence of pluvial flooding (Grahn & Nyberg, 2015). These measures can help themselves (e.g. limiting potential flood damage to their property) or by improving the water buffering capacity of the community by reducing the amount of hardened surface on their properties (Tompkins & Eakin, 2012). The notion of local initiatives is also found in the Netherlands by Mees et al. (2016), although they do suggest that it does occur ad hoc, and that most often buildings are not made flood-resilient, as is for example the case in the UK.

Finally, according to research done in the Netherlands, residents do often keep looking at governmental actors such as the municipality to act rather than take measures themselves. At the same time, only half of the residents asked was willing to implement measures, or alternatively pay more taxes (Meindertsma & Van der Parre, 2018). This suggests that even with initiatives, residents may prove to be a difficult group to activate to take measures, which be problematic since the actions, responsibilities and attitudes towards climate adaptation they have as individuals are only held by themselves (Mees et al., 2012; Tompkins & Eakin, 2012). This can also be worsened by active municipalities when they take over responsibilities from the citizens, which can lead to passivity amongst the latter (Dai et al., 2017b).

Other private stakeholders

While the focus in this research, in terms of private stakeholders will be on citizens, there are also other private stakeholders that may also affect urban pluvial flood resilience in the Netherlands. These are businesses (Van Riel, 2011), social housing associations (De Kroon et al., 2016; Dai et al., 2017) and insurance companies (Houston et al., 2011). While they will not be included in this research due to time constraints, they are worth mentioning to complete the image as that citizens are not the only private stakeholders in pluvial flood prevention and are also certainly stakeholders whose role towards urban pluvial flooding resilience should be addressed in future research.

Overview role and responsibilities stakeholders

Based on the descriptions made of the relevant stakeholders regarding their roles and responsibilities in the previous pages towards pluvial flooding in local Dutch urban areas we can come up with the following summarizing overview presented on the next page (table 4).

Stakeholder	Type	Responsibility	Role	Area of influence
Municipality	Governmental	- Collecting rainwater falling in public spaces or that is runoff from private property. - Management, expansion and upgrading of the sewer system in the urban area. - Collecting rainwater from private property that residents themselves are unable to hold to a reasonable degree. - Making necessary changes to the urban spatial design.	- Collection of rainwater - Managing the sewer system. -Stimulate/influencing businesses and residents to take measures to hold water and decrease pluvial flooding probability via subsidizing, building codes, awareness raising or regulations. - Planning needed changes to the urban design.	- Public green and grey spaces, as well as the sewer system. - Businesses, social housing associations and residents via regulations and support.
Water board	Governmental	- Management of surface water (quality) in urban areas. - Giving advice about the effect of spatial development plans by the municipality on the regional water system.	- Managing surface water (quality) in urban areas. - Advising municipalities or potentially collaborating with them.	- Public blue space - Urban municipal development via giving advice through the water test.
Province	Governmental	- Agenda setting - Formation of visions - Setting legal norms for acceptance of pluvial flooding - Creating regional plans on for example climate adaptation	- Supporting municipalities and water boards - Advising municipalities	- Legal framework - Provincial policy documents
National government	Governmental	- Giving goals and guidelines to lower, more regional, governmental actors, businesses, residents and	- Guiding the actions taken by municipality, water board, the province, businesses, social housing association and residents	- General nationwide regulations
Residents	Private	- Capturing, holding and processing precipitation falling on their property. - (Optional) Giving input on spatial design plans.	- Through holding rainwater on their own property, as well as implementing measures, reducing the pluvial flooding probability. - Giving input to spatial plans made by the municipality.	- Own property - Neighbourhood through citizen initiatives & through improving local water buffering capacity. - Spatial development of the municipality though input on spatial plans.

Table 4: Summarizing overview of relevant stakeholders regarding pluvial flooding in Dutch urban areas and their responsibilities and 'sphere of influence' based on the findings described in paragraph 2.1.2

2.2 Pluvial flood resilience

2.2.1 The concept of pluvial flood resilience as an approach within flood risk management

One of core theoretical concepts used within the scope of this research is 'pluvial flood resilience' as approach to prepare local urban areas against the consequences of extreme precipitation and pluvial flooding via spatial measures. This approach can be placed within the larger concept of flood risk management in urban areas. By encompassing both the chance and consequences of a flood it goes beyond the more traditional perspective of only focussing on reducing the chance that a flood will happen (Pahl-Wostl, 2007). This is because traditional approaches emphasis the use of engineered constructions such as sewer systems which are considered inflexible and therefore unable to be changed fast to changing circumstances (Vis et al., 2003; Hooijer et al., 2004). As mentioned in the introduction, the frequency and intensity of extreme precipitation is increasing due to climate change and these changes are also happening faster than expected. This is a valid argument to divide the focus between chance and consequences, and therefore to also look at how consequences of a pluvial flooding can be decreased (Douglas et al., 2010). This focus on both aspects is also present in the formulation of risk (Hooijer et al., 2004) which can be adapted to pluvial flooding as:

Pluvial flood risk = the probability of a pluvial flooding event to happen x the consequences that a pluvial flooding event can cause

When applied to pluvial flooding, it leads to a focus on both stopping pluvial flooding to occur during precipitation events, as well as limiting the damage and disruption of everyday life that pluvial flooding can cause if they happen (Dai et al., 2017b). As such, it requires a mix of measures that can address either one, or both aspects.

Besides physical measures, also organizational effort is needed to ensure this adaptation to changing circumstances occurs. This capacity focusses on the learning process of relevant stakeholders via adaptive governance to make changes to the spatial design if the design is no longer performing adequately to handle the impacts of extreme precipitation (Huitema et al., 2009). As such, pluvial flood resilience adds learning capacity to flood risk management to cope with these changing circumstances by adopting new approaches and ideas, if needed. Additionally, the choice for a governance approach (inclusion of other stakeholders besides governmental ones) is since a pluvial flood resilience approach to urban areas requires knowledge from different disciplines and encompasses a wide spectrum of different interests located in the urban areas and as public space is limited in urban areas (Albers et al., 2015; Dai et al., 2017b). However, the definition of pluvial flood resilience is not straight forward as the theoretical concept of resilience itself can be considered ambiguous. Within the concept, different strands of resilience can be identified which hold different ideas on what is considered as resilience, how it operates in practice, and which can ultimately also influence how this notion of pluvial flood resilience is operationalized (Davoudi, 2012; White & O' Hare, 2014).

2.2.2 Different perspectives on resilience and their influence on approaching extreme precipitation and pluvial flooding in practice

The concept of resilience originates from engineering as it was "used by physical scientists to denote the characteristics of a spring and describe the stability of materials and their resistance to external shocks" (Davoudi, 2012, p.300). In the 1960's it was then adopted by the field of ecology, during the rise of system thinking, to describe how ecosystems can handle disturbances such as droughts or forest fires (Holling,

1973; Davoudi, 2012). However, since that time it has also been adopted and implemented in other fields such as disaster risk management (e.g. Cutter et al., 2010), flood risk management (e.g. Restemeyer et al., 2015), economics (e.g. OECD, 2017) and psychology (e.g. Seery & Quinton, 2016). In its core, resilience is a framework that helps us to think about processes in a more dynamic and holistic way (Davoudi et al., 2013). It focusses on the ability of a system (in the research context urban areas that are at risk of experiencing extreme precipitation and pluvial flooding) to withstand and recover from 'disturbances' that are impacting the system.

Within the context of the research, this disturbance is the extreme precipitation and pluvial flooding, and the ability to resist, to reduce or adapt to the consequences the resilience. Additionally, learning from these events and other insights is also seen as part of this idea of resilience as well (Huitema et al., 2009; Davoudi et al., 2013; Restemeyer et al., 2015). However, the term 'resilience' does not have one singular meaning. In resilience literature, we can identify three different 'strands of resilience', each with their own ideas about what resilience encompasses and how a system is able to withstand disturbances (Davoudi, 2012; White & O'Hare, 2014).

Engineering resilience

This first strand sees resilience as the ability of a system to return to its original state (the 'equilibrium' or stable state of a system) after a disturbance (bounce back), as well as the resistance of the system against these disturbances (Bruneau et al., 2003). How 'faster' the system can return to this equilibrium, the 'better' the resilience of that system is. However, in practice it means that there is no drive to improve the system, as its only focus is to return to this original state. It therefore makes this notion of resilience impractical to use in the scope of the research as being not capable of adapting to the increasing intensity and frequency of extreme precipitation. Additionally, it also does not incorporate the ideas of reducing the chance and consequences of pluvial flooding as this would alter the original state of the area. As such, it cannot act to foreseen changes which would require the implementation of additional measures or policies to prevent future damage (Davoudi, 2012; White & O'Hare, 2014).

Ecological resilience

The problem of not adapting to changing situations is addressed in the second strand of resilience: ecological resilience. Here resilience no longer means the 'return time' to the original state of a system after a disturbance, but its ability to resist disturbances, as well as to 'bounce' to another equilibrium if this is deemed necessary (bounce forward). In this idea, the idea of potentially adapting to changes and disturbances that are stressing the system is inherit. The condition for this to happen is regulated via the idea of a 'threshold'. This is a certain moment until when reached the system can resist disturbances. When this threshold is crossed, the system is no longer capable of resisting the disturbance and it instead moves into an alternative stable state of the system in which it can be stable again, the bounce forward. This makes it able to adapt to changing circumstances in the system (Davoudi, 2012; White & O'Hare. 2014). This makes it already more practical to use within our idea of pluvial flood resilience. However, this notion does have one drawback as adaptation is done in a reactive manner (White & O'Hare, 2014). In practice this means that adaptation to extreme precipitation and pluvial flooding will only takes place once its impact on urban areas is severe enough. However, as we can see changes are happening, it therefore lacks the capacity to adapt proactively on these observations. This is also supported by White & O'Hare (2014) who argue that in practice a socio-ecological resilience approach is used due to its effect on both human as well as natural systems.

Socio-ecological resilience

We can conclude that the two previous strands focus on achieving an equilibrium which leads to stability in the system (White & O'Hare, 2014). Opposing this idea is socio-ecological resilience (or also sometimes

called evolutionary resilience in literature) (e.g. Davoudi, 2012), which is a reaction to the other strands to as it rejects the idea of an 'equilibrium'. Rather, it argues that a system is in a continuous state of movement and change (Davoudi, 2012). This is since socio-ecological resilience includes the interaction between human society and its environment. The reasoning for this is that the development of our society cannot be seen loose from the environment in which it takes place (Folke et al., 2016). In this perspective, it sees the societal side of resilience as "a complex adaptive system full of uncertainties that are difficult to forecast" (Kim & Lim, 2016, p.2).

As such, resilience is seen here as the ability of a system to reorganize, adapt, change and improve. Both from the impact that extreme precipitation and pluvial flooding has, as well as other influences that can have an impact on the ability of an urban area and relevant stakeholders act (e.g. economic changes, shifting political landscape, new insights) (Carpenter et al., 2005; Scheffer et al., 2009; Hassink, 2010; Seelinger & Torok, 2013). Therefore, it includes an underlaying learning capacity present in the system based on re-evaluation of the conditions present in a system (Leach, 2008; Davoudi et al., 2013). Furthermore, whereas ecological resilience focusses on changes that can be made within the system (bounce forward), socio-ecological resilience can go one step further. If changes within the system are no longer able to resolve the stress that is pressuring the system, the current state of the system is seen as undesirable. To resolve this, instead of adaptation within the system, a transformation of the system is then seen as necessary to change the system so that the stress can be resolved (Davoudi, 2012; Restemeyer et al., 2015). This 'transformation' can express itself in the form of innovation (e.g. from building dikes to giving room to the river), which can require a different mindset, the openness to the acceptance of new approaches or perspectives, or the presence of mechanisms for learning that can lead to the most appropriate way of dealing with pluvial flooding (Restemeyer et al. 2015; Hegger et al., 2016).

These abilities make it possible for socio-ecological resilience to also proactively react to the threat that precipitation and pluvial flooding poses to urban areas, whereas the ecological resilience does so only reactive, and engineering resilience neglects this completely. In practice this means that relevant stakeholders act upon the predictions and observations that extreme precipitation and pluvial flooding may become worse in the future (Van Hurk et al., 2014; STOWA, 2015). In doing so, both the chance and consequences of pluvial flooding can be changed accordingly to these insights so future damage may potentially be reduced. The adding of the word 'potentially' comes forth from the fact that chance and consequences in a risk-based approach can never be taken away completely (White, 2010; Houston et al., 2011; Scott, 2013). As such, when talking about pluvial flood resilience, we adopt the perspective given by socio-ecological resilience from here on out. Within this notion, resilience encompasses the following capacities of resistance (to prevent a pluvial flooding event), absorption (to reduce the consequences of pluvial flooding event), adaptation (make changes within the current system) and transformation the capacity to make changes to the system in order to make changes that can help the reduce the pluvial flood risk) (Restemeyer et al., 2015; Hegger et al., 2016). These attributes can be further 'enhanced' via spatial measures or policies that can enhance the resilience capacities of an urban area, as well as through organizational changes. Underneath these attributes lies the so-called 'preparedness' or learning capacity of stakeholders to prepare for disturbances through enhancing and improving the system through the enhancement of the resistance, adaptation, recovery, adaptive and transformative attributes of a system by these stakeholders (Davoudi et al., 2013).

Additionally, recovery is also named in resilience literature (e.g Hegger et al., 2016). However, this attribute is not considered within the scope of this research due to its focus on spatial measures in the public space and policies aimed at private stakeholders to do so as well. Recovery in contrast, in the context of pluvial flooding, includes the access of stakeholders to insurances or the response of emergency services in the aftermath of a flood (Van Riel, 2011). As spatial measures serve as a way for an area prepare but focus on reducing the chance and consequences of pluvial flooding without contributing to the actual

recovery itself of an area, hence the decision to not take this capacity into account within the context of this research (although spatial measures can ease the recovery by limiting the damage that needs to be recovere from).

However, before we can discuss how pluvial flood resilience can be enhanced two important notions within the practice that have been neglected so far first must be given attention. Firstly, pluvial flooding as an impact in urban areas is not a singular impact, but rather a multitude of different ones that can require different approaches and measures (Van Riel, 2011). As such, resilience can focus on part of the impact caused by pluvial flooding, on pluvial flooding as a problem in general or even cover other climate change impacts besides pluvial flooding as well (Walker & Salt, 2006). Secondly, the point of who determines whether when pluvial flooding poses a problem, and whether this problem is (un)desirable, is within its nature subjective (Porter & Davoudi, 2012; Cutter, 2016; Meerow & Newell, 2016). Therefore, when talking about enhancing resilience, different stakeholders can have different interests and reasons to focus on certain aspects pluvial flooding. As such, we can make two questions regarding these notions: resilience for whom and against what?

2.2.3 Resilience for whom and against what? – Criticism on the concept of resilience

While resilience is useful for approaching extreme precipitation and pluvial flooding, it is also no panacea. One major flaw mentioned in literature is how the importance of power, politics, agency and knowledge, in its view on systems and how they change, is undervalued or even absent within resilience (e.g. Hornborg, 2009; Evans, 2011; Olsson et al., 2015). These factors can lead to an uneven distribution of resilience enhancement for the different groups in an area. This can cause problems when used for implementing spatial measures (as is the goal of this research) due to the impact of spatial planning by the power dynamics that influence spatial implementation and that the decision-making process surrounding it seldom takes place in a vacuum (Wilkinson, 2011). As spatial interventions are meant to change an apparent problematic situation, the question arises about the potential focus on specific problems (resilience for what?) and who benefits from these interventions (resilience for whom?).

Resilience against what?

This question is about what exactly an urban area should be resilient against, which sectors and social networks are included, and whether the focus is on a generic, or a specific, type of pluvial flooding impact (Walker & Salt, 2006; Van Riel, 2011; Meerow & Newell, 2016). As Walker & Salt (2006) explain that resilience enhancement can focus on solving a specific problem that is part of a larger problem (e.g. implementing shared sewer system to reduce the health impacts as a result of contaminated flood water), the problem on its own (e.g. the reduction of pluvial flooding events occurring in urban areas) or overlapping problems (e.g. improving the green-blue infrastructure in an urban area to make the area more resilient against both heavy precipitation, drought and heat stress). Each of these foci has their own set of measures that can be implemented. However, the implementation of measures requires financial measures and that financial capacity of a society is limited also plays a role. This notion leads to each implemented measure using part of this limited capacity, which can act as a constraint in the implementation of enough climate adaptation measures to handle the different pluvial flood impacts overall (Runhaar et al., 2012). As such considerations need be made, to focus on which capacity of resilience to enhance, to focus on which problem and how to cope with the lack of capacity in other areas of resilience (Abel et al., 2006). This relates to both the next question, 'resilience for whom', as well as the power dynamics that are in place in contemporary society as who determines on what aspects of resilience to focus, which implementations will used, and how the limited available financial capital needs be used.

Resilience for whom?

This question focusses on who benefits from resilience enhancement in the case of an 'undesirable' situation. This is since physical, social, economic and politic contexts can constrain the range of options that are available to adapt to extreme precipitation and pluvial flooding as well as what is learnt from them (Manyena, 2014). These limits become important within the enhancement of resilience when there is maybe the need to implement different measures for reducing the consequences of pluvial flooding towards critical infrastructure and for reducing the consequences of pluvial flooding in a neighbourhood. In this case, insufficient budget or manpower to implement both measures, may lead to choices that need to be made between both cases. At that moment, the resilience against pluvial flooding in a one area may be enhanced, but at the cost of not enhancing the resilience in another area, or ignoring a different impact aspect of pluvial flooding. This can eventually lead to negative effects and inequality if ignored over time (Van Rijswick et al., 2014; Sovacool et al., 2015). This is also supported by Houston et al. (2011) who recommend that identifying vulnerable groups in relation to resilience enhancement is necessary, and that responsible stakeholders should take social vulnerability into account during the planning process. Therefore, when talking about enhancing pluvial flood resilience in practice, the interests that are served with enhancing pluvial flood resilience against a certain aspect of pluvial flooding must be considered. Especially, as it can lead to only a select group of stakeholders benefiting from implemented measures, resulting in 'winners and losers'.

Another way that this also plays a role is in the form of 'spill-over' effects of pluvial flooding. While a community could be 'safe' from pluvial flooding, the rainwater still must be left somewhere. This can, based on the option, chosen lead to a decrease of resilience of other areas, as water levels in the regional water system can rise, leading potentially to a heightened flooding risk, or in the case of sewer discharge also additional health risks as well as a decrease in for example living comfort.

Further criticism on resilience

While resilience is gaining more and more track, both in academia as well as in practice (De Bruijn et al., 2017), the concept, while promising, is no completely free of criticism. The first point, the lack of inclusion of politics, agency, power dynamics and knowledge within the concept was already mentioned and discussed earlier. However, this is not the only point of criticism. The ambiguity of the term 'resilience' is also seen as a problem (White & O'Hare, 2014; De Bruijn et al., 2017) as it has led to the concept to become a buzzword that is drifting away from the operational paradigm that it inherits (Linkov et al., 2014). At the same time, using the concept in practice also has difficulties with using the concept as it is a rather fluid concept due to this inherent ambiguity. Parallels here can be drawn to the boy who cried wolf fable, as using a concept too often, both appropriate and inappropriate, will result in losing the concept having a certain appeal and no longer reach the desired effect. Furthermore, it also is being used by some practitioners interchangeably with adaptability even while both concepts theoretically differ from one another (adaptation is actor oriented, while resilience is a feature of the system) (Nelson et al., 2007). This is caused by the ambiguous description of the concept resilience, which leads to different ways to frame resilience as a concept (Wong-Parodi et al., 2015), as well as difficulty to apply the concept successfully in practice (Maynena, 2006; Moser, 2008; Djalante & Thomella, 2011). Therefore, to operationalize the concept of resilience within the scope of this research, these points of attention must be taken into consideration

2.2.4 Enhancing the pluvial flood resilience in urban areas

Pluvial flood resilience, as previously mentioned, can be enhanced through four different attributes: robustness, absorption, adaptation and transformability (Restemeyer et al., 2015; Hegger et al., 2016). Underneath these attributes lies the attribute of preparedness, or also known as the learning capacity of

stakeholders (Davoudi et al., 2013) These attributes determine the capacity of the spatial design of an urban area to reduce the chance that pluvial flooding will occur (robustness), the potential consequences of pluvial flooding in the area (absorption); The ability of stakeholders to change the spatial design accordingly to changing circumstances in the frequency and intensity of extreme precipitation through current strategies and insights (adaptation); Or by employing new insights in how to deal with pluvial flooding or evaluating the performance of current employed strategies for possible improvements (transformability) (Restemeyer et al., 2015; Hegger et al., 2016). However, based on the notion made by Walker & Salt (2006) enhancing the resilience of an urban area against pluvial flooding can be split up into the different pluvial flooding impacts can occur in that area (Van Riel, 2011). As such, enhancing the pluvial flood resilience in urban areas must focus on a mix of different approaches, each with their own level of effectiveness and efficiency (Mees et al., 2014) as well as different implementation scales and keeping focus on the different aspects of pluvial flooding (Apreda, 2016). An overview of different structural measures that can be taken to enhance the resilience of an urban area against pluvial flooding, together with the scale on which they can be implemented can be found in table 5. These measures are categorized in short term (resistance) and long term (resilience) measures when it comes to adapting an urban area against an increasing frequency and intensity of extreme precipitation (Apreda, 2016).

Categories	Measures	Spatial scales		
		City / Catchment	Neighbourhood / Public spaces	Building private property
Resilience measures				
Source control / attenuation	Green roofs, blue roofs, green walls			x
	Green areas, pervious surfaces	x	x	x
Filtration	Filter strips, filter trenches, bio-retention areas, constructed wetlands		x	x
	Infiltration basins	x	x	
Infiltration	Soakaways, infiltration trenches, rain gardens.		x	x
	Swales, channels, rills	x	x	
Transport and convey	Inlets, outlets and control structures (landscaped pipes, perforated pipes, weirs, orifices, vortex control devices and spillways		x	x
Retention and detention	Detention basins, retention ponds, geo-cellular drainage	x	x	
Reservoirs / storage	Water squares, artificial detention basins	x	x	
	Underground reservoirs, cisterns, rain barrels			x
Elevation	Building elevation			x
Relocation	Building relocation			x
Floatation	Floating pathway, platform and islands	x	x	
	Floating buildings			x
Raising	Cantilevered pathways, elevated promenades		x	
Resistance measures				
Barrier	Dams, breakwaters	x		
	Floodwalls, demountable barriers, embankments	x	x	x
Flood proofing	Wet proofing, dry-proofing			x
	Waterproofing external walls and materials			x
	Emergency floodproofing measures (sandbag dykes)		x	x

Table 5: Overview of different structural measures that can enhance the resilience of an urban area against pluvial flooding by reducing the chance and/or the consequences of it (source: Apreda, 2016, p.241)

When linked to the 'area of influence of stakeholders' mentioned in table 4, we can see the measures that each stakeholder can take to help enhance the pluvial flood resilience, with citizens operating on the building/private property scale or when they collaborate on the neighbourhood scale, while the municipality, water board and province can operate on the city/catchment as well as the neighbourhood/public space scale. An addition to this overview, when approaching it from pluvial flood

resilience, is also the addition of measures and policies that enhance the learning capacity of stakeholders as well, which can then in turn lead to more appropriate measures being taken due to new insights, learning from experiences and experimentation and new developed approaches or new information regarding extreme precipitation and pluvial flooding (Huitema et al., 2009; Restemeyer et al., 2015). As such, the capacity of relevant stakeholders to learn and change over time is a key part of enabling and supporting the enhancement pluvial flood resilience through spatial measures (Tyler & Moench, 2012).

This also brings us to the following question: when and how does change and adaptation happen in an urban area when it is confronted by an increase of (extreme) precipitation and pluvial flooding risk? For this, two different mechanics within pluvial flood resilience can be of use: the adaptive cycle and panarchy.

2.2.5 The concepts of the adaptive capacity cycle and panarchy and their ability to enable change in urban areas

The capacity of urban areas to adapt to changing circumstances such as climate change and the increase of (extreme) precipitation and pluvial flooding risk is due to two mechanics inherent in within the concept of resilience.

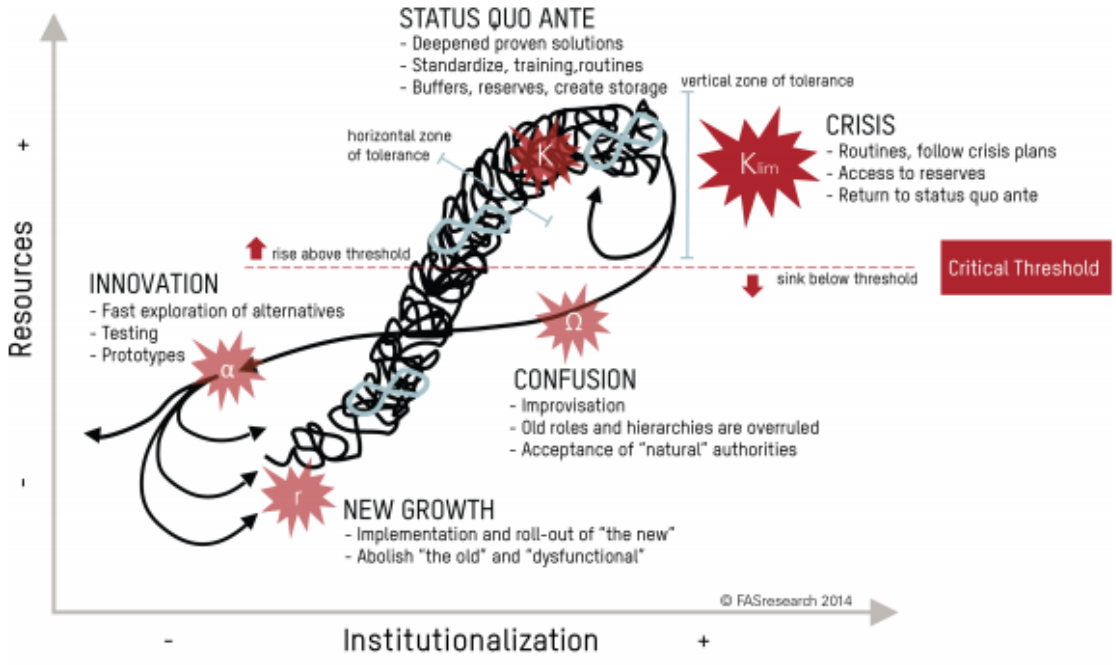

Figure 3: The adaptive cycle as proposed by Holling (1986) which shows the phases a system passes through to adapt to changing circumstances (Source: Fath et al., 2015, p. 3)

The first mechanic that resilience uses to change and adapt to new and changing circumstances is the 'adaptive cycle', first proposed by Holling (1986) (see figure 3). This cycle is based on four different phases through which a system proceeds: (r) The growing phase, (K) the conservation phase, (Ω) the creative destruction phase and finally (α) the re-organization phase. The cycle follows the idea of a feedback cycle, where new ideas and policies are implemented (r), have a certain effect (K), at some point start to work less effective as first (Ω) and are finally replaced or patched up in the r-organization phase (α) (Garmestani et al., 2008). As such, there must be monitoring and evaluation capacities in place that keep track of the capacity of a system to withstand disturbances. If it shows that the capacity of handling

stress is decreasing, ideally, relevant stakeholders will then reconsider and change their strategy in the hope that it helps improving this capacity.

This relates to the notion of transformability made by Restemeyer et al. (2015), as including new insights, information and potential approaches can lead to changes in the spatial measures that are implemented in urban areas. These can be implemented during the re-organization phase (α) of the adaptive cycle to experiment with and potentially serve as a basis for a new strategy on how to approach the changing circumstances (in our case more and heavier precipitation events) (Gunderson, 2010). This then leads to a new strategy that can be used until it is no longer adequate, starting the process anew. This moment, called a 'window of opportunity', will emerge in the creative destruction phase (Ω) and the re-organisation phase (α) during which which new ideas will be possible to implement as the current approach is not enough, leading to necessary changes (Kingdon, 1984; Birkmann et al., 2010; Huitema & Meijerink, 2010). However, these changes are also influenced by a second mechanic inherit in resilience: panarchy.

This mechanic is based on the idea that changes and disturbances in the system do not occur, nor are influenced on only one spatial or time scale (Gunderson & Holling, 2002) (See figure 4). For example, the global climate change can lead to climatic changes on a more local level as well, as is the case with extreme precipitation in the Netherlands. This then leads to changes that need to be taken on lower scale levels to handle these changes. Alternatively, change may also come from a local level if for example several influential induvial persons in a town are against a certain approach, leading to the need to come up with an additional approach to build resilience against a certain problem. This interaction between scales also means that a 'butterfly effect' can take place: small, and at first sense, insignificant events can have far stretching consequences on higher scales, while at the same time large scale interventions may have little to no effect as well. As such, changes in the system are always uncertain (Duit et al., 2010; Davoudi, 2012), but also brings new opportunities and re-organization of approaches. This needs to be considered when spatial measures to enhance pluvial flood resilience are implemented in terms of their desired effectiveness and potential (un)desired side effects.

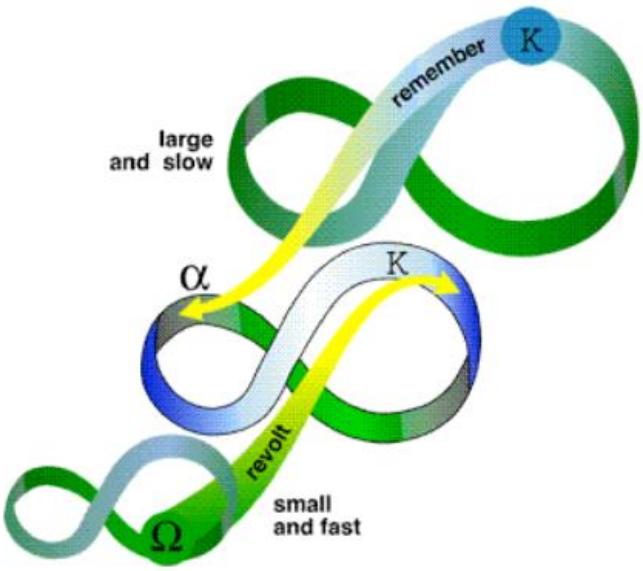

Figure 4: The visualization of panarchy where changes occur on different spatial scales (from global to local) (Source: Resilience Alliance, n.d; Gunderson & Holling, 2002).

These two mechanisms in pluvial flood resilience, the adaptive cycle and panarchy, give pluvial flood resilience the ability to change accordingly to new developments, both from a local scale (adaptive cycle)

as well through influences on higher or lower scales (panarchy). One of these new developments that can lead to change is by using so-called 'climate information' which gives relevant stakeholders new insights in what the climate change impacts will be in their local urban area. This makes it better possible to act proactively on new developments (Hurlimann & March, 2012). Examples of climate information are scenarios, models or risk maps, which give information to the stakeholders about potential impact in an area. By doing so, an area can act on anticipated impacts rather than reacting to it once it has happened. However, this information is also affected by the way it is presented and communicated to stakeholders (Berkhout et al., 2014; Raaphorst et al., 2017; Raaphorst, 2018) and the context in which relevant stakeholders themselves are located (Burningham et al., 2008; Martens et al., 2009; Brossard & Lewenstein, 2010). This may act as a barrier that reduces information communucation or may lead to a different perception by different stakeholders for using the same information. This communication of information, the format in which information is presented, the use of this information by stakeholders and potential other factors that may influence its use and the decision-making process are discussed next.

2.3 The use and influence of (climate) information and DESTELP factors on the decision-making process of stakeholders to enhance urban pluvial flood resilience

2.3.1 Defining 'climate information' within the context of the research

Before talking about how climate information can be used by relevant stakeholders, as well as how framing can influence this usefulness, a definition of what is defined as climate information must be established. A starting point is Lemos et al. (2012) who define climate information as seasonal climate forecasts and climate projections. In this definition the focus is on the potential climate change impacts, however at the same time, it can be argued that this definition is too narrow. As, according to the EU (European Commission, 2015) climate information must be seen broader by including the products that are based on climate information and data as well (e.g. projections, trends, advice, development and evaluation of solutions), which is called climate services. These climate services can be based on both modelled data as well as observational data (Bowyer et al., 2014). Climate information, in this case, no longer only gives information about climate impacts, but also about potential approaches as well. This is in line with other literature who see climate services as "the development and/or provision of climate information and knowledge to support users' decision-making through tools, websites, and tailored products" (Hewitt et al.,2012; Vaughan & Dessai, 2014; Bruno Soares et al., 2018, p.6). This definition is complemented by Medri et al. (2012), Orr et al. (2015) and Brasseur & Gallardo (2016) who also argue that information used for education and awareness raising purposes can be defined as climate information as well. Finally, this information can come from official sources (e.g. knowledge institutes or governmental actors) (Hegger & Dieperink, 2014), be generated through participatory means (e.g. citizens) (Wehn et al., 2015; Star et al., 2016), or a mix of different stakeholders (Hegger & Dieperink, 2014; Meadow et al., 2015).

Based on these insights we can define climate information as:

Information about climate change impacts which can help the decision-making process of stakeholders by raising the awareness about climate change impacts of stakeholders, providing insight in the impact that climate change has on their surroundings as well as offering advice on potential solutions and implementations for handling these impacts and the evaluation of these. This information can be communicated to stakeholders via different tools, formats and products that they can use to make an informed decision.

2.3.2 Key aspects for the communication and use of climate information to and by stakeholders

However, climate information cannot just randomly be communicated to stakeholders as research shows that different stakeholder groups can react to, and will interpret information differently based on so-called 'communication formats' (e.g. reports, storytelling, maps etc.) through which information is presented (Berkhout et al., 2014; Raaphorst et al., 2017; Raaphorst, 2018). Furthermore, according to Moser (2010), there are several key elements in the communication process that need to be considered when communicating climate information to stakeholders:

- What is/are the intended goal(s) of the information?
- Who is the intended audience?
- How is the information framed? (e.g. what language, metaphors and images)
- The used modes and channels to communicate the information

These four points will now be discussed in further detail in their relation to one another, as well as their relation to climate change information.

Intended goal of the communication

This first point is referring to what the purpose of the information is. According to Moser (2010), as well as other literature, there are three different goals that can be identified:

- Inform and educate individuals (Blake, 1999; Major & Atwood, 2004; Jackson, 2005; Crompton, 2008)
- Achieving social engagement and action (De Young, 1993; McKenzie-Mohr & Smith, 1999; Halpern et al., 2004; Jackson, 2005)
- Bringing about changes in social norms and cultural values (Nilsson et al., 2004; Jackson, 2005; Crompton, 2008; Griskevicius et al., 2008; Schultz et al., 2008; Ockwell et al., 2009)

These goals can range from informing stakeholders, all the way to changing their perspective and values. This fits with what earlier was established as climate information as it can concern informing (European Commission, 2015) or educating/awareness raising goals (Medri et al. 2012; Orr et al., 2015; Brasseur & Gallardo, 2016, Hamaker et al., 2017). Generally, a distinction can be made between models or predictions that serve to inform, and information that focusses on what can be done in response (Hamaker et al., 2017). However, Terpstra (2011) does acknowledge that not all communication goals are successful if certain pre-conditions aren't fulfilled. This should be seen, for example, as that citizens will only take adaptive measures once they can acknowledge the risk that they are exposed to, and that they know what they can do to reduce this risk (Lindell & Perry, 2004). This 'sensitivity of the local context' is also important within the scope of this research as studies done by Terpstra & Gutteling (2008), the OECD (2014) and Willems (2017) point out that Dutch citizens are often not aware of their responsibilities towards (pluvial) flooding, while they are relevant stakeholders in enhancing the pluvial flood resilience in urban areas. Often, they see it as a task for the government, while they are in fact responsible themselves. As such, this has implications for what to communicate these stakeholders when talking about decision-making in the context of pluvial flooding in Dutch urban areas.

Intended audience

Secondly, the intended audience is an important aspect for whether the information is helpful to the end-user. Firstly, because society is not one homogeneous mass, but consists of different audiences, each with different values and that hold different perspectives to problems that society faces, and can act out of different interests (Benett, 1997). As such, from the perspective of 'audience segmentation' (Hine et al., 2014), different audiences require different information (Moser, 2010). As such, Moser (2010) and Lemos et al. (2012) press the importance for tailoring information based on the intended audience to successfully transfer knowledge and information about climate change based on for example their knowledge about the subject. For climate information it thus means that the used language (level of technical terms) and format are important and can potentially affect the use by end-users (the so-called 'utility gap' suggested by Lemos et al., 2012 and Weaver et al. 2013). This is also supported by the UK-based Science and Technology Committee (2014) who report that, for example, governments need scientific information, that informs them so that they can take evidence-based decisions for policies or interventions. Another point is made by Neset et al. (2015) who report that some climate information support tools are not intuitive, which limits the usability of these tools for laymen. This shows that the level of substantive knowledge can differ per audience.

An additional problem with the intended audience is also whether the information is communicated via an on- or offline environment. As O'Sullivan (2012) notes that older people in the contemporary society are less likely to use the internet, making it harder to reach out to them via websites. Therefore, audience characteristics like these are also important to keep in mind when trying to successfully reach out to the intended audience. (Orr et al., 2015).

Framing information

The third point made by Moser (2010) is how information is framed. This also relates to the previous point as the framing of information can lead to different interpretations of the same information by different audiences. Furthermore, the tone, clarity, consistency, information and advice given should all be helpful and fit to the intended group (Haggart, 1994; Orr & Twigger-Ross, 2009). The tone aspect is also supported through research done by O'Neill & Nicholson-Cole. (2009) who concluded that using for example fearful imagery to 'scare' people in to changing towards a climate adaptive way does not work as people become desensitized and won't react as intended at some point. Another example could be that the audience may be hostile or ignorant towards expert knowledge (Bucchi, 2008) or that previous experiences, the social and cultural context in which stakeholders are located and personal circumstances can also affect how people process information (Burningham et al., 2008; Martens et al., 2009; Brossard & Lewenstein, 2010). This all affects the way information needs to be framed to have a successful information transfer.

Modes and channels of communication

The final point raised by Moser (2010) is the influence that the modes and channels of communication have on information and knowledge transfer. As explained earlier, climate information can come in a variety of different forms. This in turn also means that these different forms have different potentials, roles, benefits and limits (Moser, 2010). However, there can be made a distinction in the first place between written, verbal and non-verbal communication (Moser, 2010). This in turn affects whether there is an option for dialogue, reflection and learning (two-way communication) or one-way communication (see figure 5). In general face-to-face, two-way communication is more persuasive and focussing on learning and engaging the subject that is discussed (Dillard & Pfau, 2002; Dunwoody, 2007), while written or verbal one-way communication is less appropriate for this (Nagda, 2002; Hayes & Matusov, 2005; Tan & Brown, 2005). As such, when reflecting this point on the earlier mentioned goals of communication, it can be stated that one-way communication is applicable communiciating information useful for understanding situations and subjects but lacks in educating and changing users. Two-way communication in that case is preferable.

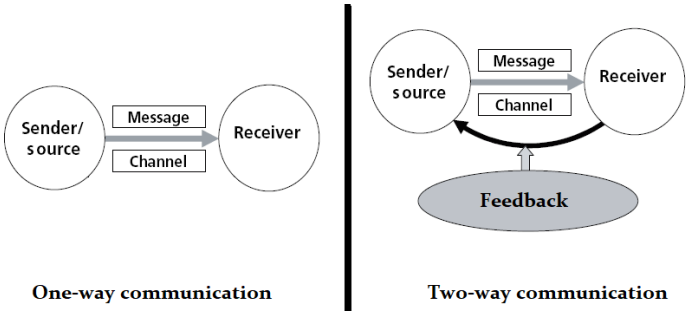

Figure 5: Visualization of one-way and two-way communication (Source EWO, 2015; Edited by author)

The aspect of communication is further influenced by the chosen mode in which the information is communicated (e.g. maps, reports, maps). As information can come in a variety of different forms (e.g. Stichting CAS, 2019), this choice is not one that must be taken lightly. This point is also supported by research done by Neset et al. (2015), who concluded that maps mostly focus on showing/visualizing data on hazards, vulnerabilities and risks, while more often cannot provide information that helps with concrete climate adaptation. However, Burch et al. (2010) and Schroth et al (2015) do also report that visualizations can be powerful in communicating in practice, and serving as talking points, they do acknowledge that information on its own is not enough. Rather, that in the decision-making process political and economic aspects also have a large influence as well. These are other factors that may influence the will and ability to act (Runhaar et al., 2012). This will also serve as a bridge to the next section, which will focus on how information can influence the decision-making process and the potential role that it can play during this process as well.

To end this section, a reflection on these four points raised by Moser (2010) made on how they interact with one-another. It can be established that there is a step-by-step progress through the different points as the information goal and intended audience will affect how the information is framed, as well as the format and channel through with the information is communicated. This is since the audience determines the level of expertise that is necessary to understand the information. Additionally, the chosen goal also affects the language use for framing as well, as changing/convincing your intended audience requires a different presentation of your information than informing the audience. This also rings true for the chosen format in which the information is presented as each form has its strengths, weaknesses and limitations that can help the transfer of information, or act as a barrier instead. This is summarized and visualized in figure 6.

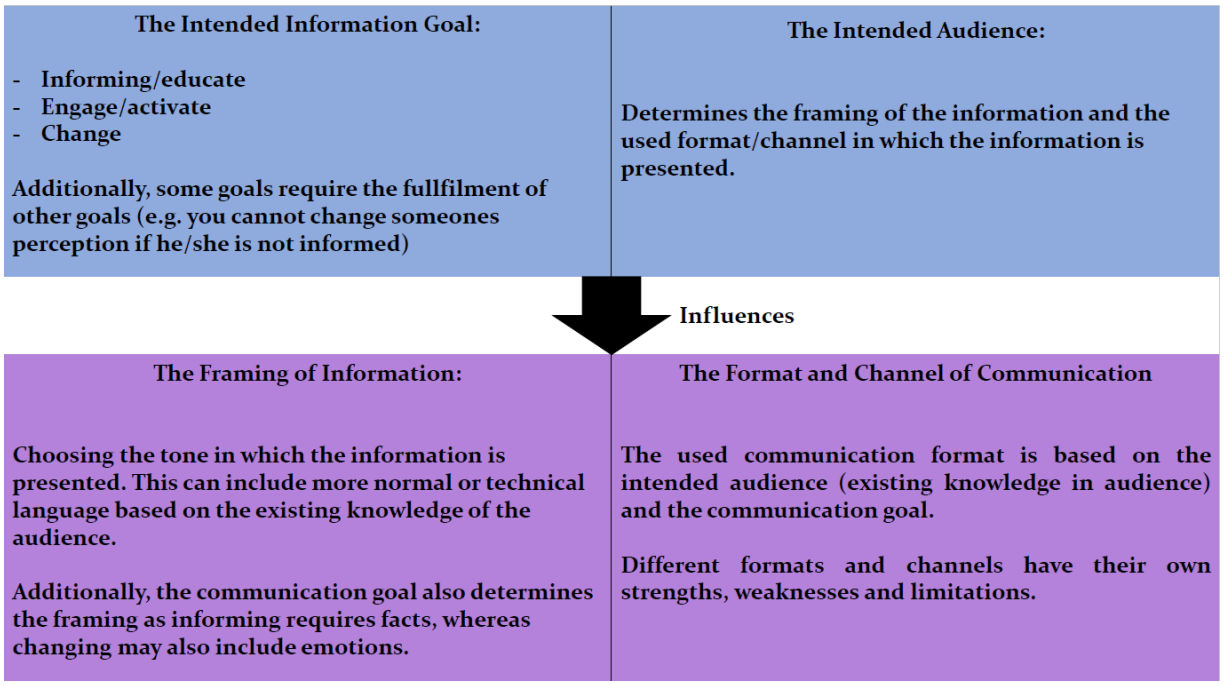

Figure 6: Interaction between the different aspects of communicating information raised by Moser (2010) (Source: Author)

2.3.3 The influence and use of (climate information) on the decision-making process

As already mentioned earlier, the social and cultural context, previous experiences regarding pluvial flooding and personal circumstances all affect the way in which stakeholders will perceive and use information that is presented to them. This notion is important as it shows that information may be ineffective in leading to informed decision-making or moving stakeholders to action when these contexts are not considered (Burningham et al., 2008; Martens et al., 2009). To gain insight in these contexts, the first step is to understand how people take decisions regarding climate change adaptation. This is necessary as this process runs through different stages through which an actor progresses, and the need of different information during each stage. For example, giving information on possible solutions for a problem while they are not aware of the problem in the first place may prove to be ineffective. At the same time trying to raise the awareness of people that are already aware will not lead to action as they maybe would require information on what potential options are. A good overview of these different stages is provided by the policy cycle (Dai et al., 2017b). In this cycle the basic idea is that stakeholders first need to have awareness of climate change impacts before being able to and then moving towards looking at the risks and potential options in later stages. While the tool has a focus on governmental stakeholders, and also shares characteristics similarities with the government-oriented policy cycle (e.g. Anderson, 2003; Jann & Wegrich, 2007), the basic idea of first raising awareness, and then moving towards looking at the risks and potential options in later stages that is behind it is still applicable for other types of stakeholders than governmental as well (Termeer et al., 2017).

An example of using this policy cycle for climate adaptation is done by the European Union's Climate-ADAPT project (European Commission, n.d.) adaptation support tool (table 6).

Step in the climate adaptation cycle	Action taken
1: Preparing the ground for adaptation	"Introducing key elements important to build the basis for a successful adaptation process"
2: Assessing risk and vulnerabilities to climate change	"To develop a comprehensive picture of current and future climate change risks as well as further stress factors to be expected"
3: Identifying adaptation options	"Adaptation options aim to address the previously identified concerns to bring negative impacts at an acceptable level. Further, adaptation options may allow taking advantage of any positive opportunities that arise from climate change"
4: Assessing adaptation options	"Assessment and prioritization of the compilation of options based on a detailed description and criteria"
5: Implementation	"To implement the strategy is to prepare an action plan which sets out what needs to be done to convert adaptation options into action, specifying by whom and when and allocating sufficient resources"
6: Monitoring and evaluation	"To understand progress and performance, learn and communicate lessons and inform future policy and practice"

Table 6: Example of steps taken in the climate adaptation policy cycle (source: European Commission, n.d.)

A somewhat similar approach to different stages in the climate adaptation process are also suggested in the model proposed by Moser & Ekstrom (2010), which can be found in figure 7. Here it should be said that this involves an 'idealized' adaptation process (Moser & Ekstrom, 2010), which means that the process may contain differences when compared to the climate adaptation process in practice. Different from the steps proposed by the European Commission (n.d.) is that Moser & Ekstrom (2010) in their research also identified potential barriers during each stage which may prevent moving on to the next phase in the adaptation process. These barriers can be found in table 7.

The barriers proposed by Moser & Ekstrom however are mainly focused on governmental organizations, as the barriers include involve political willpower, leadership or monitoring plans, which are less likely of a factor for a resident that just wants to take a few tiles out of his or her terrace to plant a tree there or sow some grass. Additionally, many of the barriers named by Moser & Ekstrom (2010) are 'mallable' barriers, especially the social ones, as Adger et al (2009) argue that these can be overcome when enough social support, available resources and effort are put in.

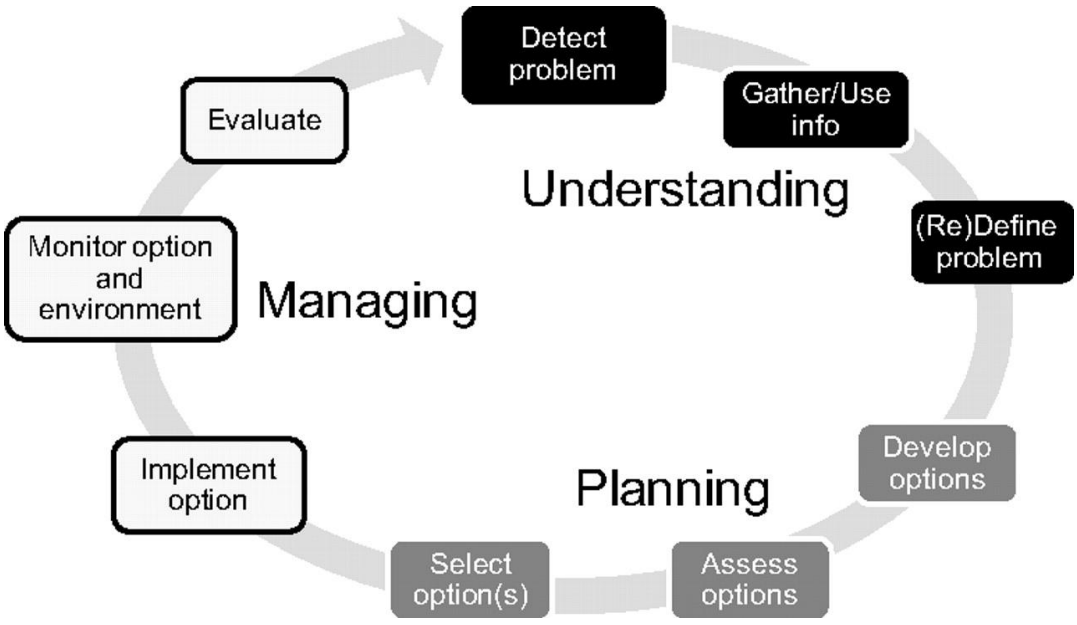

Figure 7: The different phases and subprocesses throughout the adaptation process (source: Moser & Ekstrom, 2010, p. 22027)

Phases and process stages: Understanding	**Barriers**
Detect problem	Existence of a signal
	Detection (and perception) of a signal
	Threshold of concern (initial framing as problem)
	Threshold of response need and feasibility (Initial framing of response)
Gather/use of information	Interest and focus (and consensus, if needed)
	Availability
	Accessibility
	Salience/relevance
	Credibility and trust
	Legitimacy
	Receptivity to information
	Willingness and ability to use
(Re)define problem	Threshold of concern (reframing of the problem)
	Threshold of response need
	Threshold of response feasibility
	Level of agreement or consensus, if needed
Phase and process stages: Planning	**Barriers**
Develop options	Leadership (authority and skill) in leading process
	Ability to identify and agree on goals
	Ability to identify and agree on a range of criteria
	Ability to develop and agree on a range of options that meet identified goals and criteria
	Control over process
	Control over options
Assess options	Availability of data/information to assess options
	Accessibility/usability of data
	Availability of methods to assess and compare options
	Perceived credibility, salience, and legitimacy of information and methods for option assessment
	Agreement on assessment approach, if needed
	Level of agreement on goals, criteria, and options
Select option(s)	Agreement on selecting option(s), if needed
	Sphere of responsibility/influence/control over option
	Threshold of concern over potential negative consequences
	Threshold of perceived option feasibility
	Clarity of authority and responsibility over selected option
Phase and process stages: Managing	**Barriers**
Implement option(s)	Threshold of intent
	Authorization
	Sufficient resources (fiscal, technical, etc.)
	Accountability
	Clarity/specificity of option
	Legality and procedural feasibility
	Sufficient momentum to overcome institutional stickiness, path dependency, and behavioural obstacles
Monitor outcomes & environment	Existence of a monitoring plan
	Agreement, if needed, and clarity on monitoring targets and goals
	Availability and acceptability of established methods and variables
	Availability of technology
	Availability and sustainability of economic resources
	Availability and sustainability of human capital
	Ability to store, organize, analyse, and retrieve data

Evaluate effectiveness of option	Threshold of need and feasibility of evaluation
	Availability of needed expertise, data, and evaluation methodology
	Willingness to learn
	Willingness to revisit previous decisions
	Legal limitations on reopening prior decisions
	Social or political feasibility of revisiting previous decisions

Table 7: The common barriers found in the adaptation process during the different stages of the understanding, planning and managing phases (Moser & Ekstrom, 2010, p. 22028-22029).

Furthermore, additional literature on climate adaptation barriers (e.g. Runhaar et al., 2012; Uittenbroek et al., 2013; Reckien et al., 2015) also support the choice of barriers made by Moser & Ekstrom (2010), such as socio-economic, instutional and environmental factors that can all act as a barrier to climate adaptation against, in our case, pluvial flooding in urban areas. Within these barriers, climate adaptation does certainty have a role. The most obvious stage is of course the gathering and use of data stage where climate information serves as input for the further decisions that need to be made, as well as to be able to define the problem at hand in an urban area and the scale of its impact, the so-called climate risk assessment (Bowyer et al., 2014). However, McColl et al. (2012) also suggest that climate information can help with generating awareness of certain problems, which also links back to the first stage proposed by Moser & Ekstrom (2010): detecting problems. Furthermore, McColl et al. (2012) menion that climate information can help to create a baseline to determine what potential (future) weather impacts would be setting a threshold for options to be successful both now and in the future, as well as defining the potential problem itself. This again links to the climate adaptation stages, this time the definition of the problems, as well as serving as an input for the choices of measures that may be needed and how effective they need to be by for example using models to look at the impact of measures on the expected climate change impacts (Van de Ven et al., 2016). Finally, during the managing phase, and its process stages, climate information can also be used as a part of an evaluation tool. By having an earlier established baseline (McColl et al., 2012) that can be updated based on new insights, climate information could serve as input for evaluation of the performance of measures (e.g. Masson et al., 2014). This also links to the learning capacity mentioned earlier (Davoudi et al., 2013) as these new insights could lead to preparedness, as well as helping to re-evaluate the situation through these insights (hence why the cycle leads back to the first stages again) (Leach, 2008; Davoudi, 2013). Based on this, it can be stated that climate information can be mainly used as an input into the decision-making process, but that it also can act as a catalyst to act in the first place through, for example, awareness raising.

These different phases can therefore be considered different contextual stadia in which stakeholders may be located and move through. As such, different climate information may be needed by stakeholders depending on the current phase that they are located (Miralles-Wilhelm & Castillo, 2015). This can thus also lead to a mismatch between the information that is available for a stakeholder and the information that is required. This is further supported by Moser & Ekstrom (2010, p. 22029-22030), who point out that: "the issue of deeply held values and beliefs that influence how people perceive, interpret, and think about risks and their management, what information and knowledge they value, what concerns have standing and so on—in short, a foundational influence on the decisions and choices made during the adaptation process. Individuals look at new problems, tasks, and solutions through the lens of their pre-existing values, preferences, beliefs, norms, and experiences."

Within this decision-making process are also the adaptive and transformative capacities discussed earlier in relation to of resilience. This is since changes can be made to on one side the spatial design of urban areas to reduce pluvial flooding risk, while at the same time the process itself can also be improved (Mitchell et al., 2014). A visualization of this can be found on the next page in figure 8.

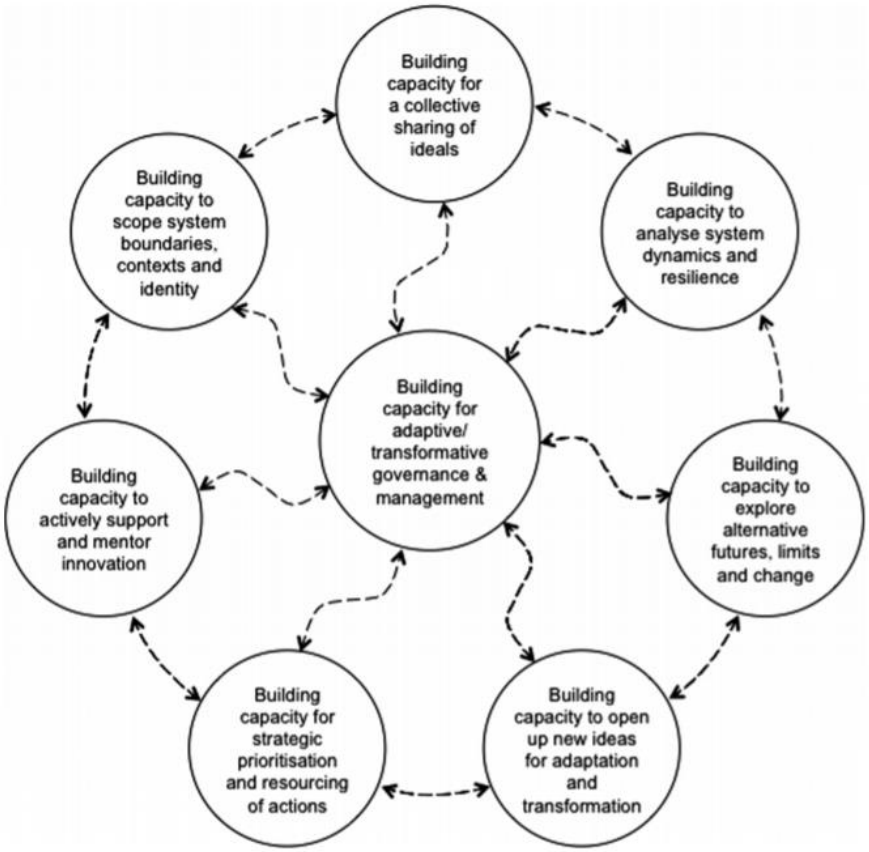

Figure 8: An overview of potential options for enhancing the adaptive and transformative capacities of both the urban spatial design and the decision-making process (Source: Mitchell et al., 2014, p. 309)

2.3.4 DESTELP factors that may also affect the decision-making process of stakeholders

Whereas the previous sections focussed on information, this alone may not be enough to help stakeholders to take informed decision-making and come up with good solutions as "basic tenets of effective practice, such as knowing one's audience, relating to people in ways that resonate with pre-existing values and beliefs, engaging respectfully and addressing the whole human being, not just assuming that there is an information deficit, but also tapping into deep motivations and understanding resistances and barriers to action—all of these hold as firmly as ever in communicating adaptation" (Moser, 2014; Moser, 2017, p.14). This correlates with research done by Lemos & Morehouse (2005) and O'Sullivan et al. (2012) who also suggest that there may be barriers that climate information may not affect or take away when it comes to taking climate adaptive measures.

These barriers or factors can be categorized via the so-called DESTEP method, which stands for Demographic, Economic, Social, Technological, Ecological and Political aspects/factors (Frue, 2017). Each of the factors are presented in table 8, accompanied with an explanation and examples. These factors can also overlap, as for example a lower socio-economic status can lead to a lower financial capacity, but also link to a lower education and capacity to understand presented information (Burningham et al., 2008). Additionally, as already explained in section 2.1.2, stakeholders also have a legislative role towards pluvial flooding that affects the decision-making due to certain situations that may fall within their legislative determined role which forces them to act (e.g. municipalities have responsibility over the functioning over the sewer system, or that citizens are required to hold water on their own property initially). Therefore, regarding influences on the decision-making of stakeholders, this factor should be included as well. As such, the L of Legislative is added to the DESTEP acronym as well.

Factor	Explanation
Demographic	These factors can include demographic changes in urban areas such as an increase in population (CBS, 2016). More inhabitants in an area can lead to an increase in necessary housing and therefore to a potential increase of hardened surface as well. This, as explained earlier, can lead to a higher risk of pluvial flooding in urban areas (La Barbara et al., 1994: OECD, 2014).
Economic	These factors can be found in the context of the financial capacity that individuals, communities and organizations have for climate change adaptation research and implementation of measures (Smit & Pilifosova, 2001; Adger, 2003; Grothmann & Patt, 2005). This can constraint the ability to for example implement measures when there is a lack of financial capacity.
Social	These factors include previous experiences with pluvial flooding, which can affect both the stance stakeholders take (e.g. Werner & Plapp, 2006; Burningham et al., 2008) as well as the capacity to process information (Orr et al., 2015). These effects can lead to from psychological fear and stress that hinders the capacity to act appropriate (Vözer et al., 2016), which can happen on an individual or household level (Douglas et al., 2011), to an increase in preparedness due to previous experiences (Brooks et al., 2004). Finally, also nothing can happen in the case that an area has yet to experience such an event (Orr et al., 2015). Furthermore, the social and cultural context in which stakeholders are located may also affect how they are using available climate information (Burke et al., 2013). According to Burningham et al. (2008) the social class of stakeholders plays an important role in the awareness of people as they argue that this can be caused by individuals having a lower education or inappropriate information leading to misunderstanding of the information that is given or even a potential lack of interest.
Technological	These factors include the availability of technology and knowledge, as well as limits that exist. This can be seen in the fact that climate change predictions still include assumptions and that an increase in the scale of time can lead to uncertainty (Golding, 2009; Runhaar et al., 2012). The same can of course also be true for implementation of spatial measures as well, as current technologies may not yet be adequate enough to solve problems (Moser & Ekstrom, 2010).
Ecological	These factors include the local circumstances in which measures have to be implemented, and which in turn can also affect the choice for certain measures over others (Heidrich et al., 2013; Tehrany et al., 2015). For example, if there is a high groundwater level, water retention in the underground may be less effective, or that the presence of urban water surfaces in an area can lead to different solutions than in areas that lack these. As such, this factor is case-dependent.
Legislative	This factor includes the legislative rules that may bind or force stakeholders to make certain choices in their decision-making. For example, municipalities are required to adjust the public space or sewer system in an urban city in order to prevent pluvial flooding from occurring if this is severe enough (RIONED, 2006).
Political	These factors include the political willingness and support to solve problems surrounding pluvial flood prevention and adaptation. This can be found in for example that there is problem recognition, and that potential steps are taken to implement measures by governmental stakeholders (Runhaar et al., 2012). Furthermore, this also reflects to the dualist nature of Dutch governmental stakeholders, where the political side may be after different goals than the civil servant one (Stalman & Ter Haar, 2013), making political willingness an important aspect in this factor.

Table 8: Overview of the DESTELP factors and their influence on the decision-making process

2.4 Conceptual framework

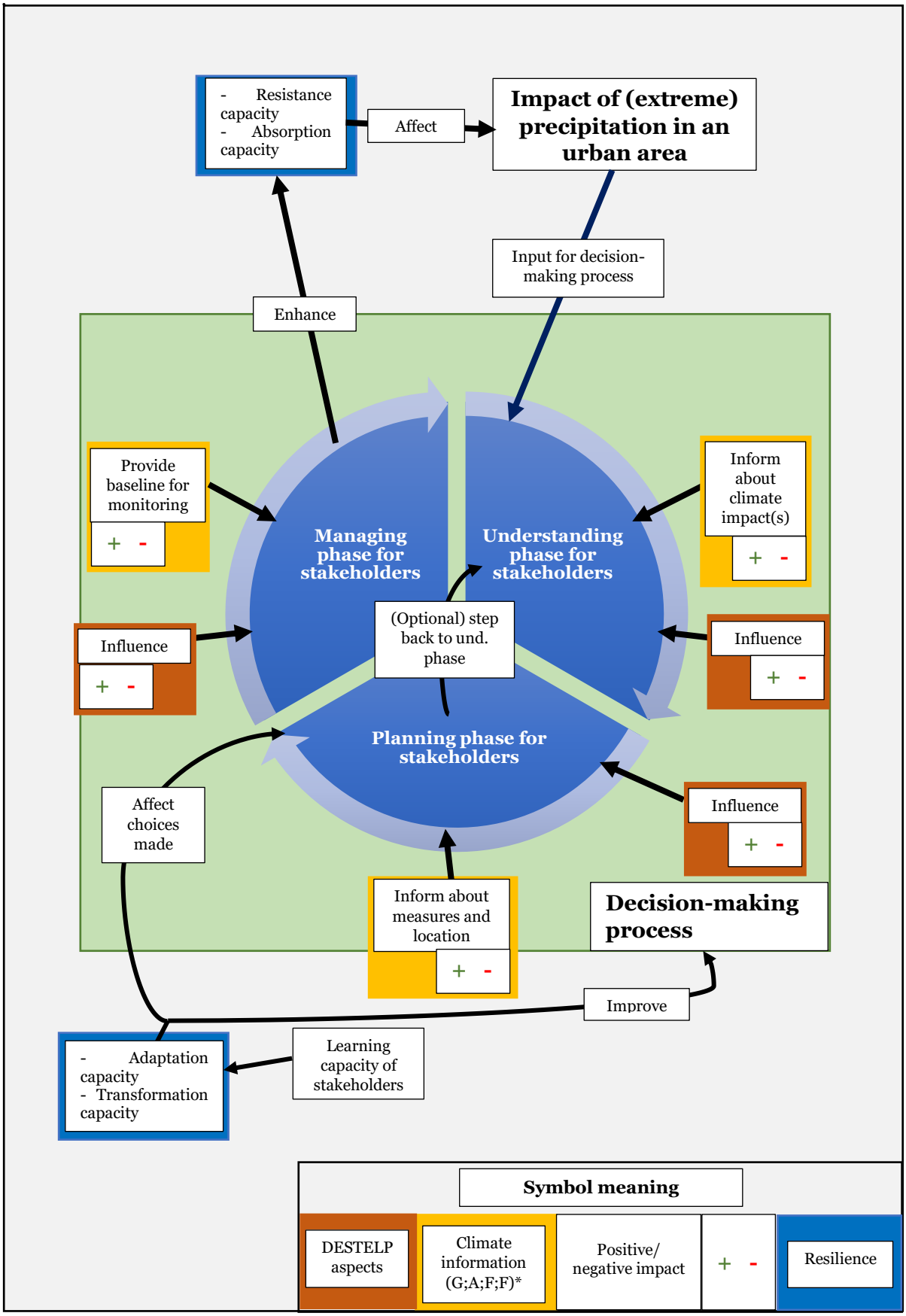

Figure 9: Conceptual framework used as basis for the research (Source: author)

*Goal / Audience / Framing / Format & Channel

The conceptual framework, as presented in figure 9, combines the theory that is discussed throughout this chapter and how these different pieces of theory are interacting with one another.

However, two aspects must be considered when reading this framework. The first is that, while visually all three phases look equal in time, this is not the case in practice. For example, if it is already quite well known what the problem is (e.g. a pluvial flooding event took place) the understanding phase may therefore be relatively short in comparison to the other two phases. Secondly, in the conceptual model, the influencing factors that affect the decision-making process can be negative or positive (hence the plus/minus near each text box). This may in practice vary from case to case (e.g. if political willingness is present it may be a posive factor on the decision-making process, while a lack of this same willingness may negatively affect the process instead). Therefore, the model should be seen read a generalization that in this manner tries to encorporate these differences that are present.

Chapter 3: Methodology

"I think you can have a ridiculously enormous and complex data set, but if you have the right tools and methodology then it's not a problem”

- Aaron Koblin

3.1 Research approach

Within scientific research methodology, two different paradigms can be distinguished: the qualitative and quantitative research traditions (O'Leary, 2014). This dichotomy can be traced back to their philosophical roots within interpretivism, subjectivism & constructivism, and positivism & empiricism respectively (Newman & Ridenour, 1998; Hennink et al., 2011; O'Leary, 2014).

The qualitative tradition presents the idea that the perceived reality is a social, dynamic and value-laden construction, that can differ per person (interpretivism), which in turn makes it subjective (Hennink et al., 2011; Yilmaz, 2013). As such, its emphasis lies on making sense of the context, experiences and perceptions people have about a subject, as well as understanding human behaviour in order to make sense of 'reality' (Bryman, 2008; Hammersley, 2013). In practice this relates to research that is done in which findings are not found by using statistical analyses or quantification (e.g. interviews or observations) (Strauss & Corbin, 1998). Additionally, the goal of this data is "the study of people, cases, phenomena, social situations and processes in their natural settings in order to reveal in descriptive terms the meanings that people attach to their experiences of the world" (Yilmaz, 2013, p. 312). The quantitative tradition on the other hand tries to find standardized answers to explain phenomena (positivism) in which the thought is that reality can be explained empirically (Golafshani, 2003; Hennink et al., 2013). As such, the focus, in comparison to the qualitative tradition, shifts to "emphasising the measurement and analysis of causal relationships between isolated variables within a framework which is value-free, logical, reductionistic, and deterministic, based on a priori theories" (Yilmaz, 2013, p. 312). This results therefore into a more static reality, as aspects can be explained through statistics and measurements (Lincoln & Guba, 1985; Glesne & Peshkin, 1992).

While both research approaches can be used together in a research project (mixed methods approach) (Denscombe, 2008), this earlier mentioned dichotomy remains an important point when selecting research collection and analysis research methods to answer research questions. This is especially true for social sciences as it has moved away from positivistic approaches during the second half of the 20th century in favour as "the contexts of theory, including their social and historical background, shape not only theories but also what we count as evidence to assess them" (Allmendinger, 2009, p. 32). In doing so, social sciences, which includes spatial planning, started to focus on understanding people and their motivations as autonomous beings, opening also the rise of more awareness of, for example, the influence power has within spatial planning (Allmendinger, 2009), to understand decisions taken and the larger contexts in which these take place (Bohman, 1991). As a result, at the start of selecting research methods, the first question is therefore whether the research has the purpose to understand why something is happening, and to understand underlying reasons, beliefs and motivations (qualitative research); or whether it has the purpose to measure, count and find correlations in the data with as goal to extrapolate the results to a broader population (quantitative research) (Hennink et al., 2011).

With this as a starting point, an additional necessary aspect that needs to be given thought before selecting research methods is the goal that the research is trying to achieve (methodological approach) (O'Leary, 2014). According to O'Leary (2014, p.110), four different approaches can be distinguished:

- *Understanding a problem:* "I want to find out more about the situation"
- *Finding workable solutions:* "I want to figure out what can be done"
- *Working towards solutions:* "I want to actually change the situation"
- *Evaluating change:* "I want to know if initiatives have been successful"

The chosen approach is determined by the research question that needs to be answered. This order of basing your research methods on your research question is needed, as it hard to retrofit a research question to collected data (O'Leary, 2014). As such, it is good to return to the main research question posed in this research in the light of choosing fitting research data collection and analysis methods:

What is the current contribution of climate information to the decision-making process of relevant stakeholders (governmental organizations and (towards) citizens) for taking pluvial flood resilience enhancing spatial measures in local urban areas and how is this contribution affected by information communication aspects, as well as other influencing factors (e.g. political, environmental, legislative) and information?

Based on this main research question, and previously mentioned research approaches, we can conclude that the most appropriate research approach for this research would be a mixed methods approach consisting of both interviews and surveys. The main aim is to understand the view of stakeholders on climate information formats, their experiences of using this information to make decisions, and other factors that may also affect their decision making. Furthermore, in the light of the four goals stated by O'Leary (2014), this research question fits the 'evaluating change' goal best due the focus of the research goal being on evaluating whether the access to climate information and communication aspects (Moser, 2010) can contribute to enhance the pluvial flood resilience capacities of urban areas. As such, by adopting a qualitative research approach, the next step would be to choose the most appropriate data collection methods. However, this choice to include quantitative data in the research approach is made due to two reasons:

- Appropriate approaches need to be chosen for each stakeholder group (governmental and citizen). Since interviews with several individual citizens cannot provide representative generalizing answers (Cresswell, 2013). It is therefore necessary to adapt a mixed methods research approach (Denscombe, 2008). While interviews can be used for governmental stakeholders with a limited number of relevant respondents (Longhurst, 2011), for reseaching citizens, with a larger and more diverse population, a survey is more appropriate (McLafferty, 2011).

- By using a mixed methods approach consisting of both qualitative and quantitative data collection methods, a new problem arises: How can this data be combined in order to make on overal representative statements, and how do they hold up in representing a stakeholder group to one another? (Harris & Brown, 2010). Also, the question is how many surveys are needed (sample size) to make a reliable general statement about a case study location, as the sample size in relation to the population size is important for determining an appropriate p-value of the null-hypothesis (Norusiš, 2010; O'Leary, 2014). These are based on the number of potential respondents in each case study location (private properties of citizens with a private property).

The data collection was conducted amongst citizens living within several neighbourhoods located in the cities of Hoogeveen, Meppel and Drachten (surveys), as well as interviews with organizations whose 'geographical area of responsibility' covers these neighbourhoods. These are firstly the municipality, who is responsible for the sewer system as well as the spatial design of urban public space (Rijkswaterstaat, n.d.b.; Mees et al, 2016). Secondly, the water boards in which these cities are located, water board Drents Overijsselse Delta and water board Friesland. This is since they provide municipalities with advice about the spatial design of the urban regarding the impact on water management (Rijksoverheid, 2009b; Dai et al., 2017b), as well as the management of urban surface waters where precipitation can be stored (Rijkswaterstaat, n.d.a.). Finally, also the Provinces of Drenthe and Friesland are included as well as they provide the frameworks in which spatial developments in these urban areas take place (Rijksoverheid,

n.d.b; Unie van Waterschappen et al., 2011) and provide norms for the acceptability of flooding (Rijksoverheid, n.d.).

Additionally, policy documents were analyzed to gain information about how pluvial flooding is seen in these documents, as well steps taken that may enhance urban pluvial flood resilience. Especially as practice and what was planned beforehand may differ from one another. This inclusion of policy documents also serves the purpose of triangulation (Yin, 2003) as using multiple sources to gather data on this topic can then be used to establish an overall view on topic within the case studies. Finally, for the project that the researcher was involved in during this time as an intern, as well as junior researcher a worksession was organized for governmental stakeholders (municipalities, the water board and provinces of Drenthe and Overijssel) that investigated the information needs of these stakeholders. As the respondents from the municipality of Hoogeveen, the water board Drents Overijsselse Delta and the province of Drenthe were involved in this session a report of this session was also included. During the research approach this report was analyzed the same way as the policy documents and thus any further remarks made regarding policy documents in this chapter on this topic are also applicable for this report as well. Finally, the report was also added to the research and can be found in appendix VI.

3.2 Research design

As previously stated, the research design has a mixed research design in the form of a multiple-case study (Yin, 1994; Creswell, 2013). These cases are formed by the citizens located in neighbourhoods in these cities, as well as governmental stakeholders carrying responsibility in these areas (such as the municipalities and water boards). These stakeholders per location were researched to gain a better understanding of how each stakeholder is involved in enhancing the pluvial flood resilience of a neighbourhood, as well as the climate information they have access to and use, and potential other factors that may be at play. The reason for doing is because a case study offers a detailed and extensive analysis of a geographical location (Bryman, 2008) within a real-life context, to gain a better understanding of a phenomenon (Yin, 2013). Additionally, Yin (2013) also states that using multiple cases for a case study is considered to making it more robust and compelling as well. For each case study, a combination of interviews and surveys was held to collect data. The selection for the cities itself has been due to their experience with pluvial in the recent years (RTV Drenthe, 2008; Waldnet, 2012; Klomp & Manenschijn, 2016; Leeuwarder Courant, 2017; Leeuwarder Courant, 2018; RegioNieuws Hoogeveen, 2018) (or the lack thereof in the case of Meppel).

Within these case studies, as mentioned above, either interviews or surveys were used to collect data in each case study city, based on the type of stakeholder. The selection of the survey areas within the cities was based on the several aspects. Firstly, these areas needed to be in the urban area of the case study areas, as the focus of this research is on pluvial flooding in urban areas. Secondly, as mentioned already in the theoretical framework, hardened surfaces in the urban areas increase the vulnerability of urban areas against extreme precipitation (La Barbara et al., 1994: OECD, 2014). Therefore, a moderate to high amount of hardened surface had to be present as well. Lastly, the outcomes of rainfall modelling done for the 'Klimaateffectatlas' for the city of Drachten (Kennisportaal Ruimtelijke Adaptatie, n.d.a.) and the WDOD Klimaateffectatlas for Hoogeveen and Meppel (Nelen & Schuurmans, 2016) will serve as a third criteria on which these areas are selected. By using similar situations for each selected case (higher risk of experiencing pluvial flooding and impact, as well as heightened percentage of hardened surface) allows for cross-case conclusions (Yin, 2013) as differences between cases are more noticeable. The results of using these criteria, as well as a visualization per city can be found in chapter 4 which gives a description of the selected case study cities, as well as selected survery areas. Additionally, as mentioned before, policy

documents were analyzed to compare the situation in practice with the more planned reality captured in these documents as well as to triangulate the outcomes of the different data sources.

For the interview the research tried to rely on 'key informants (O'Leary, 2014). According to O'Leary (2014), these are people that have expert knowledge (in the scope of this research for example the water board or municipality) which can then make it easier to access the information locked in these groups as a researcher.

3.3 Data collection methods

This research focusses in the first place on the gaining insight in how well climate information is used and received by relevant stakeholders regarding pluvial flooding in Dutch local urban areas (section 2.1.2) when it comes to making decisions regarding spatial measures and policies that affect the pluvial flood resilience of urban areas and other possible influential factors. Furthermore, it also tries to understand how this resilience is enhanced by the taken spatial measures and policies. To this end, this research makes use of both semi-structured interviews for stakeholders that are part of an organization, as well as a survey for larger population groups such as citizens living within the urban areas in the case study cities.

Semi-structured interviews

The first data collection method used within this research used to collect data from stakeholders are semi-structured interviews (or also sometimes known in literature as in-depth interviews) (e.g. Hennink et al., 2011). These are done to understand the situation and context in which different key informants from the established relevant institutions take decisions regarding spatial measures that limit pluvial flooding risk (O'Leary, 2014). These were done face-to-face, and at their work location as opposed to a more neutral location (e.g. a café or a bar). The choice for using this method versus structured and unstructured interviews was since it seeked to cover certain essential topics during the interview (e.g. view and use resilience in practice, use of climate information, possible constraints towards acting), while at the same time also leaving room for potential different additional data, ideas or topics that came up during the course of the interview (O'Leary, 2014). As both structured and unstructured interviews can only cover one of these goals respectively (O'Leary, 2014), the most appropriate method choice was therefore deemed the use of semi-structured interviews to collect data from these stakeholders.

Additionally, an interview guide was developed as well, which served as a guideline during the interview (Hennink et al., 2011). The interview guide firstly contains an introduction with the goal to make use that the respondent understands the objective of the interview as well as informing the respondent about ethical issues (see section 3.6). It also contains opening questions that cover broader topics related to the research topic (e.g. questions about background and relevance of work of respondent to the research topic) that eases the interviewee into the conversation; focussed key questions that are designed to collect data and information that can be used to answer the research questions; and closing questions that are again more broader and the finalize the conversation again (Hennink et al., 2011). This increasing and then decreasing focus during the interview is based on the idea of building rapport. These interview guides can be found in appendix V. Furthermore, table 9 also provides a chronological ordered overview of the stakeholders that are interviewed, their organization and the theme of the function they fulfil and when and where the interview has been held. Additionally, the choice for the selected interviewees is due to their connection to the topic of pluvial flooding, the influence on choices made in the case study areas that influence in turn the vulnerability for experiencing pluvial flooding, or their influence on water management in the urban areas. This is fits within the idea of using 'key-informants' that can provide the research with meaningful data about the subject (DiCicco-Bloom & Crabtree, 2006).

Interviewee	Organization	Themes covered respondents position	Date of interview
Interviewee 1	Water Board Drents Overijsselse Delta	Policy making for urban surface water and spatial adaptation	18-05-18
Interviewee 2+3*	Municipality of Meppel	Policy making for (urban) water, sewer system and spatial design	28-05-18
Interviewee 4	Municipality of Hoogeveen	Policy advise for urban water and climate adaptation	28-05-18
Interviewee 5	Municipality of Smallingerland	Policy advise for urban water and spatial planning	11-06-18
Interviewee 6	Province of Friesland	Policy making for urban water and climate adaptation	11-06-18
Interviewee 7	Province of Drenthe	Policy making for regional water management	10-07-18
Interviewee 8	Water Board Fryslan	Policy advice for municipalities on climate adaptation and water issues	17-07-18

Table 9: Overview of interviews that are taken as part of the data collection process (Source: author)
**The interview at the municipality of Meppel was held with two persons*

Internet survey

Thes second approach used for collecting data from stakeholders was an internet survey. The general focus for this survey were citizens that reside within the case study locations. The reason for also useing a survey was to explore the way citizens perceive and gained knowledge about climate change impacts, as well as whether they have taken measures themselves to either reduce the chance of pluvial flooding in their neighbourhood in the event of extreme precipitation (robustness) and/or reducing the impact of pluvial flooding (absorption). This information was statistically analysed to see if certain factors may have had an influence on the decision to take such measures (Appendix VIII). The exploration of this aspect may then also provide valuable data on how to (potentially) more effectively communicate and activate citizens to let them take measures themselves. An aspect that has become more important in the Netherlands as a shift towards the inclusion of citizens is occurring, with this group gaining more responsibilities (Mees et al., 2016)

However, not every citizen household is of use for collecting data. As explained in section 2.1.2, citizens are only responsible for collecting, holding and processing precipitation, and capable of doing so if their property includes a plot of land (e.g. a garden) adjacent to their house (section 3.5 of the Water Act) (Rijksoverheid, 2009b). Additionally, spatial measures such as a green roof could also still be implemented if there is no available land adjacent to the house. Furthermore, citizens can also potentially focus on 'flood proofing' their building instead of taking measures that could potentially limit pluvial flood probability. As a result, a preselection needs to be made based firstly on this criterium. The first selection criterion is therefore:

- A property needs to include a plot of land next to their residence, or a 'whole building' which serves as a location where they can implement spatial measures. Additionally, the building needs to be at least located on the ground floor as well (which excludes for example apartments located in multiple story buildings) and to have a roof. The focus here is on the capacity of individual property owners to take measures on this property rather than the collective ability of citizens to do so.

Additionally, with the help of the 'klimaateffectatlas' presented by both Kennisportaal Ruimtelijke Adaptatie (n.d.) for the urban area of Drachten, and Waterschap Drents Overijsselse Delta (Nelen & Schuurmans, 2016) for the urban area of Hoogeveen and Meppel, the impact of precipitation events was used to find areas in the case study locations that can potentially experience severe pluvial flooding. The reasoning behind this choice is that if citizens reside in these areas, the necessity for acting against pluvial

flooding would be potentially higher as well. This makes it interesting to see what citizens may have done regarding implementing spatial measures. Especially in the light of the potential role citizens can have in relation to the prevention or limitation of the occurrence pluvial flooding in urban areas (Tompkins & Eakin, 2012; Grahn & Nyberg, 2015). These selected areas are shown in more detail in chapter 4. A note here must be made that the data presented in these visualizations are still simplified approximations of the impact that a precipitation event has in an urban area (Nelen & Schuurmans, 2016). As such, potential areas may have a different experience in practice during similar precipitation events as the ones that were used in the model used to make the maps.

The selected part of the population in the selected urban areas will be the targeted audience for the survey. For this population, no distinction is made between subgroups, and respondents are chosen based on the geographical location of their property. However, the sample size of the population in the case study locations can be a problem since a larger sample size can give a better representation of population (McLaffety, 2010). This sample size can also be affected by this method of collecting data due to factors that impact the accessibility of the survey:

- Approaching respondents via an internet questionnaire tool potentially excludes people without access to internet or limited proficiency regarding operating a computer and/or the internet (e.g. elderly people) (McLafferty, 2010).
- Distribution of an internet questionnaire to respondents in practice often goes via social media (e.g. Facebook or Twitter). However, this also has drawbacks as not everyone is active on social media and that groups may have been made of which not potential respondents are a member or vice versa. This point was partially covered through the use of spreading the survey link manually in the selected case study areas via a paper flyer, simplifying the internet link via a custom made link with https://bitly.com/, adding a QR-code and giving clear instructions people are asked to manually enter the link into the address bar of their internet browser. This approach was used for the spreading the survey in the selected areas. An example flyer is added in appendix VIII.

These flyers were spread around in the targeted area via the letterbox of houses. If people opened the door or were outside, the goal of the research was explained. For every selected urban area around 500 handouts were spread. The potential respondents were chosen based on their geographical location rather than randomness. Each household that fitted the earlier mentioned characteristics, and that was in this selected area received a flyer in their mailbox.

According to Fowler (2009), the precision benefits of using a larger sample begin to wear off at sample sizes in the range of 150 to 200 respondents. As such, the aim of the questionnaire was to get enough respondents to get into that range. As can be seen in Table 10, this has succeeded as there were 167 fully filled in surveys.

Location	Survey invitations (N=)	Returns (N=)	Fully completed returns (n=)	Response rate (%)
Hoogeveen	976	50	46	4,71
Meppel	970	75	66	6,80
Drachten	985	59	55	5,58
Total	2.931	184	167	5,70

Table 10: Overview of the returns of the survey invitation spread out in the neighbourhoods that are the subject of this research.

With these results the appropriate p-value and margin of error can be determined (Kadam & Bhalerao, 2010) for using each case study group as separate entities (testing significance of locational bound factors) as well as the areas together. The p-value is the confidence interval in which you can say that approximately, and respectively, 90, 95, 99% of the population mean is included in the sample size (with a p-value of 0,1; 0,05, 0,01). The margin of error on the other hand shows how often different samples would have been produced if repeated samples would have been drawn (Norušis, 2010). The following p-values and margins of error have been found using the sample size calculator provided by the online survey programme 'Qualtrics':

Location	Used p-value	Margin of error (%)
Hoogeveen	0,05	11,70
Meppel		14,80
Drachten		12,90
Total		7,40

Table 11: Overview of the selected p-values and the margin of error for the populations of the case studies combined and in total.

Based on the p-valueand so the margin of error, it can be stated that outcomes from statistical analyses based on data from the survey may not have a high level of accuracy regarding the populations of the case study areas. This is also further confirmed, at first glance, by the reported educational level of the respondents, as many of the respondents in each case study location has a finished educational degree from the University of Applied Sciences (HBO) or higher, whereas in practice about 30% of the Dutch population has a higher educational degree (CBS, 2013). This does not mean that the results cannot be used within the context of the research. This is since the educational level of citizens is only one of the factors that may also affect the willingness to take appropriate action (Burningham et al., 2008). As such, it can show in a significant amount of people that may potentially have acted within the sampled population due to the high level of highly educated people. Additionally, experience of pluvial flooding is also a determining factor in theory (Brooks et al., 2004) that may be found in the population regardless of educational level.

The questions asked in the internet survey can be found in appendix VII.

Policy documents

Finally, also policy documents were used to gather information. These policy documents were selected by asking the interview respondents for semi-structured interviews which policy documents were relevant for them in their daily work. In the case these informants did not respond back on this request (as it was sent after the interviews via e-mail), a desk-research was done instead to try and identify potential policy documents that could potentially be influential regarding pluvial flooding in the selected case study cities. A list of these documents can be found in appendix III.

Governmental stakeholder	Number of relevant policy documents
Municipality of Hoogeveen	4
Municipality of Meppel	3
Municipality of Smallingerland	4
Province of Drenthe	2
Province of Friesland	3
Water board Drents Overijsselse Delta	2
Water board Friesland	4

Table 12: An overview of the amount of relevant policy document per relevant governmental stakeholder

3.4 Data analysis methods

For analysing the interviews, the interviews were first transcribed. After that, coding was used to analyse these transcripts. For this end, the qualitative data analysis programme Atlas TI was utilized. Codes are topics that are discussed with the participant of an interview and which are identified by reading the transcript (Hennink et al., 2011). The use of coding allows the researcher to identify topics and issues raised in the interview (Cope, 2010.) as well as categories and patterns (Cope, 2010) This use of coding is important as it helps the researcher to discover connections between issues raised in the interview and to place these within the context of the case study (Cope, 2010). It is therefore important that the codes that are developed to analyse the transcript connect closely to the topics and issues raised in the research questions so that the found information can help provide an answer to them (Cope, 2010). The used codes can be found in appendix IV. The used codes are firstly based on the role that stakeholders have regarding pluvial flooding. This can both be active (taking spatial measures themselves or implementing policies) or more supportive (providing information, knowledge etc.). Additionally, also potential collaboration between different stakeholders was also investigated as well. Secondly, as resilience is also an important aspect of this research, the four different aspects of resilience (robustness, absorption, adaptation and transformation) as well as the learning capacity of stakeholders are part of the code as well to see if elements of these aspects can be identified as well. Thirdly, the interviews were also analysed on the climate information that is being used in practice by the key-informants what were interviewed. Furthermore, it is also analysed to identifiy potentially missing information and how the format of this information influences the usability of the information for the key-informants. Finally, also code was made to identify other factors, besides information, that may also affect the decision-making of stakeholders.

For analysing the results from the qualitative questionnaires, the answers were analysed via SPSS, a quantitative data analysis programme by using a binary logistic regression analysis. This choice was made in order to determine the influence different answers have had on the choice of respondents to take (or not to take) measures themselves that have helped to improve the pluvial flood resilience of their neighbourhood (robustness and absorption aspects). The results from this statistical analysis can be found in appendix VIII, as well as the steps that were taken to come from the raw dataset to the data that was used within the analysis. Additionally, in Appendix VIII it is also described how the data that was gathered with the surveys was made suitable for this analysis.

Finally, the selected policy documents were also analysed by scanning these documents for certain themes. For this analysis, the code that was used for the semi-structured interviews was used for the analysis of these documents as well.

3.5 Positionality of the researcher within the research

Another aspect that researchers must consider is what that their position is that they have towards their respondents (Bryman, 2012). This is important as sharing the same language, culture, nationality or region of origin can help improve the power relationships between the respondent and the researcher, making data collection more effective as building rapport is easier (Flowerdew & Martin, 2012). In the case of this research, the researcher shared the same region of origin (North of the Netherlands / Drenthe). This fact is important for two reasons. The first one being that this research is done primarily for the University of Groningen, located in Groningen in the Northern part of the Netherlands. And secondarily for the research institute Deltares located in Utrecht and Delft, in the Western part of the Netherlands. The second reason is that there exists a somewhat soured relationship between the Northern part of the Netherlands and the Western part of the Netherlands due to feelings of economic and social neglection of the North by the West (Van Es, 2014). These two reasons make it harder for data collection via

interviews when respondents approached are approached in name of the Western-based knowledge institute versus the Northern-based university. This can then lead to the feeling that the researcher will be an outsider. As such, by sharing a similar background, the position of the researcher shifts more towards that of an 'insider'. This is further strengthened when the focus is also put upon the fact that this research is primarily done for the University of Groningen, further establishing. This however does not mean that the need to think about positionality changes since a researcher is always an outsider in terms of the relation to the respondent (e.g. differences in the position as an expert; and the researcher is (most likely) not part of the same organization as the respondent) (Flowerdew & Martin, 2012).

3.6 Ethical accountability

During the interviews, respondents were explained the aim of the research and the role that these interviews had in the research. Furthermore, they were asked if they allowed audio recordings to be made to make transcription of the interviews possible and whether they wanted to remain anonymous in such a way that given answers cannot be traced back to these respondents. Finally, they were told that the results of this research will only be used for academic purposes (Hay, 2012; O'Leary, 2014). This last point was addressed in term to the online questionnaire that was used to collect data as well, especially as the conclusions of this research are also shared with the research institute where the researcher did his internship and is currently employed. However, raw data (audio recordings; notes made during interviews; questionnaire outcomes) and analysed data (coded transcripts) will not be shared with the institute.

3.7 Conflicts of interest

During the duration of writing this thesis, the author did an internship, as well as obtained a position as junior researcher/consultant at the research institute 'Deltares', located in both Utrecht and Delft, the Netherlands. During the time of writing this thesis, he was, amongst several other projects, involved in EU-funded project 'EVOKED' for which conclusions of this research could be used as empirical input. However, the data collection, analysis, and the conclusions drawn from the data are not influenced by this internship and are held by academic standards. As such, the researcher reports no conflicts of interest.

Chapter 4: Case study descriptions

"To become an academic expert takes years of studying. Academic experts are experts in how and what others have done. They use case studies and observation to understand a subject."

- Simon Sinek

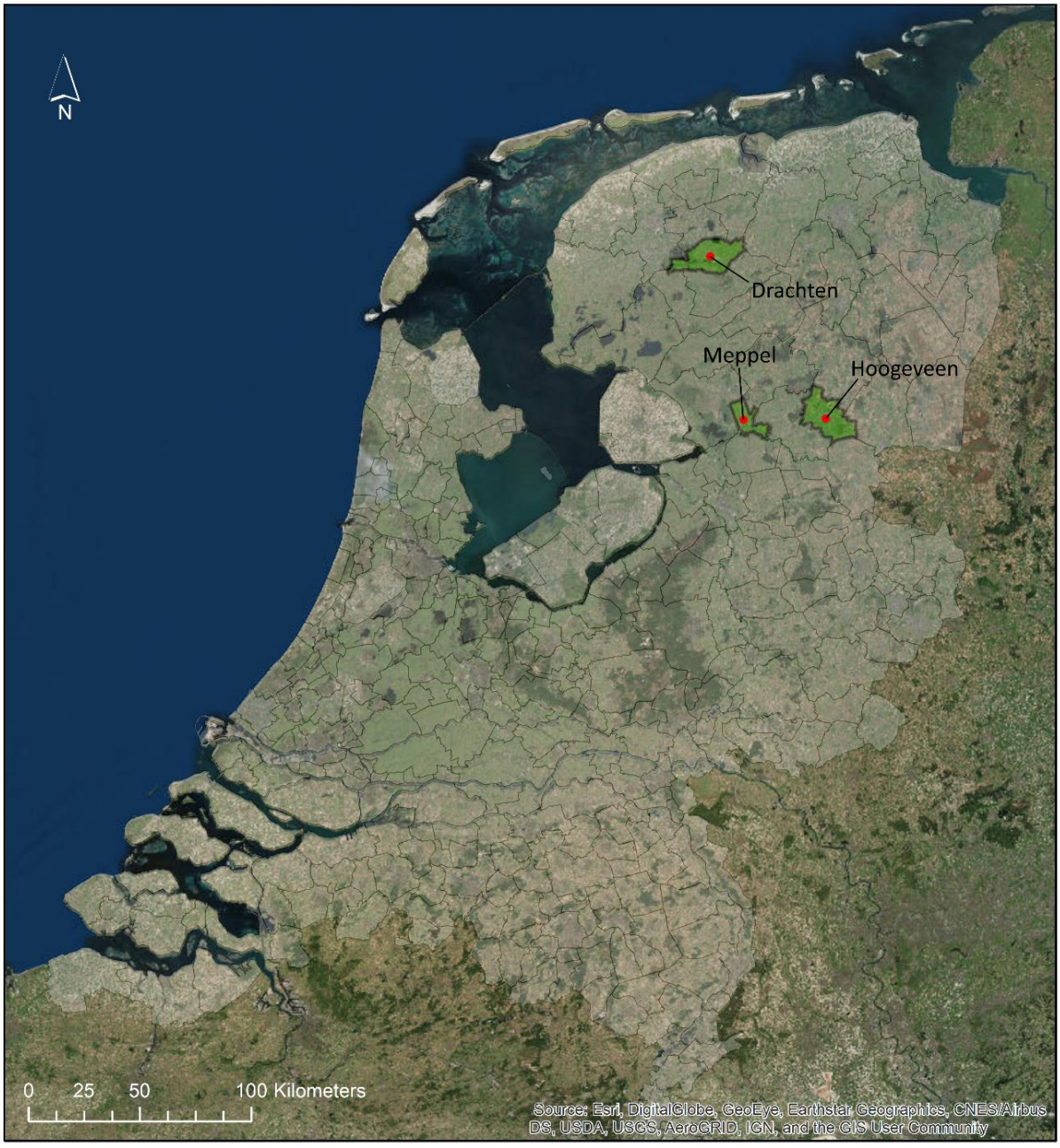

Figure 10: Map showing the geographical location of the case study cities in their municipality areas that form the focus of the research (Hoogeveen; Meppel; Drachten) within the Netherlands (Source: Esri et al., 2019b; Imergis, 2019; Edited by author)

4.1 Overview of the city of Hoogeveen

Figure 11: Aerial overview showing the city of Hoogeveen and areas where the survey were held (Source: Esri et al., 2019b; Imergis, 2019; Edited by author)

4.1.1 Core information about Hoogeveen as a city

The first Dutch case study city in this research is the city of Hoogeveen, located in the northern province of Drenthe. The city has roughly 39.000 inhabitants living inside its urban area (Gemeente Hoogeveen, 2017b) while being surrounded by rural areas as figure 11 also shows. The city itself is located on higher ground which is also given away by the place name (Hoogeveen = Hoog Veen = Raised bog) (De Vries, n.d.). This is also seen back in figure 12 with Hoogeveen laying on considerable higher ground as for example Meppel. This in turn also means that the groundwater level be lower, which leads to more water being able infiltrate into the ground in the case of precipitation events. Additionally, within the city itself, the height map in figure 13 does show that there is some sloping within the city as the eastern part of the city is higher than the western part. Finally, figure 11 shows that large areas of the city consist of hardened surface, which may increase the vulnerability of pluvial flooding within the urban area.

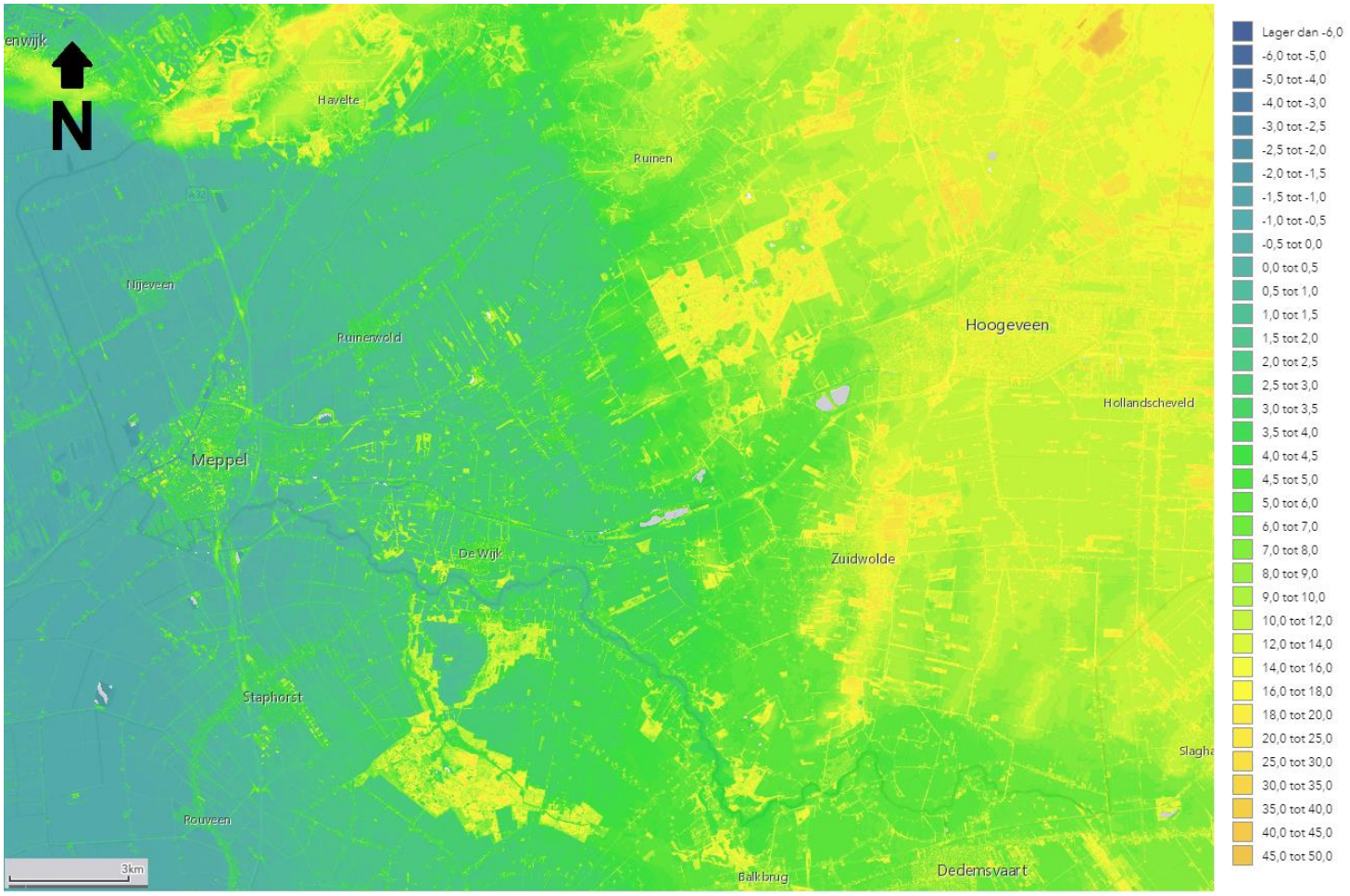

Figure 12: Height map of the area in meters surrounding Hoogeveen and Meppel. (Source: Esri Nederland & AHN, n.d.; Edited by author)

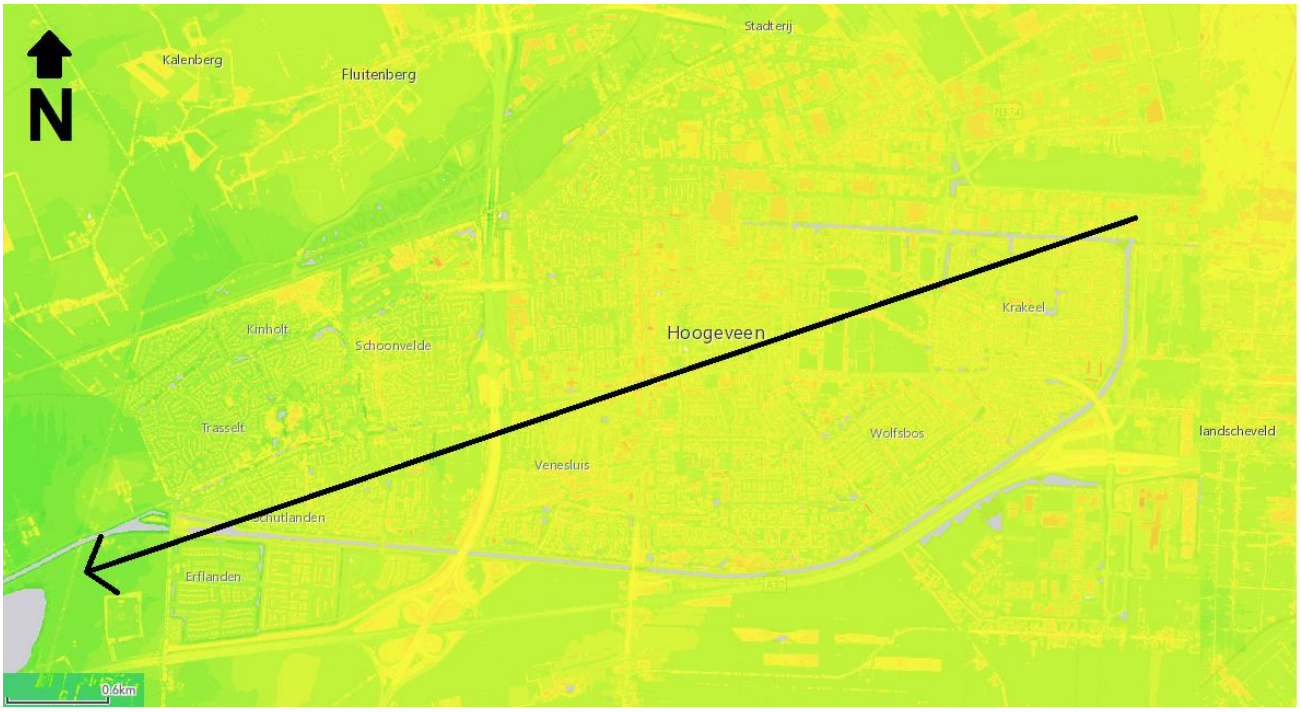

Figure 13: Height map of Hoogeveen is meters, showing the slope in the landscape going from east (high) to west (low). (Source: Esri Nederland & AHN, n.d.; Edited by author)

4.1.2 Main governmental stakeholders involved in the urban area of Hoogeveen

Within the city of Hoogeveen three governmental stakeholders can be distinguished. Firstly, the municipality of Hoogeveen, secondly the water board Drents Overijsselse Delta and lastly the Province of Drenthe. For the last two stakeholders, their 'area of responsibility' extends beyond the municipality of Hoogeveen. The legal responsibilities of each of these stakeholders have already been explained in the theoretical framework presented in chapter 2 and will therefore not be repeated.

4.1.3 Experiences with pluvial flooding

In the past, Hoogeveen has experienced several pluvial flooding events due to extreme precipitation (RTV Drenthe, 2008; Klomp & Manenschijn, 2016; RegioNieuws Hoogeveen, 2018). Especially the 2012 event can be considered as an important moment for the development of policies towards climate adaptation in Hoogeveen, of which spatial adaptation against extreme precipitation is considered part of. Furthermore, this event caused traffic disruption in multiple areas in the city (including in front of the local hospital) as well as damage to buildings (Klomp & Manenschijn, 2016). That pluvial flooding has occurred in the city is also supported by the pluvial flood risk map created by the water board Drents Overijsselse Delta (figure 14) which shows the potential water heights in Hoogeveen in the case of 60mm/hour precipitation event. The results show that large areas of the city are vulnerable to pluvial flooding during such an event.

These events have also resulted in a 'stresstest' (modelling of precipitation impacts in the urban area of Hoogeveen) (Hydrologic, n.d.) as well the flood risk maps created by the water board Drents Overijsselse Delta (as shown in figure 14). More importantly also a policy document that sets out to describe the strategic goals for climate adaptation in Hoogeveen was developed (Gemeente Hoogeveen, 2017a). This creation was furthermore also supplemented by master classes on climate adaptation to raise the awareness of climate impacts and adaptation with the municipal organization (Klomp et al., 2015).

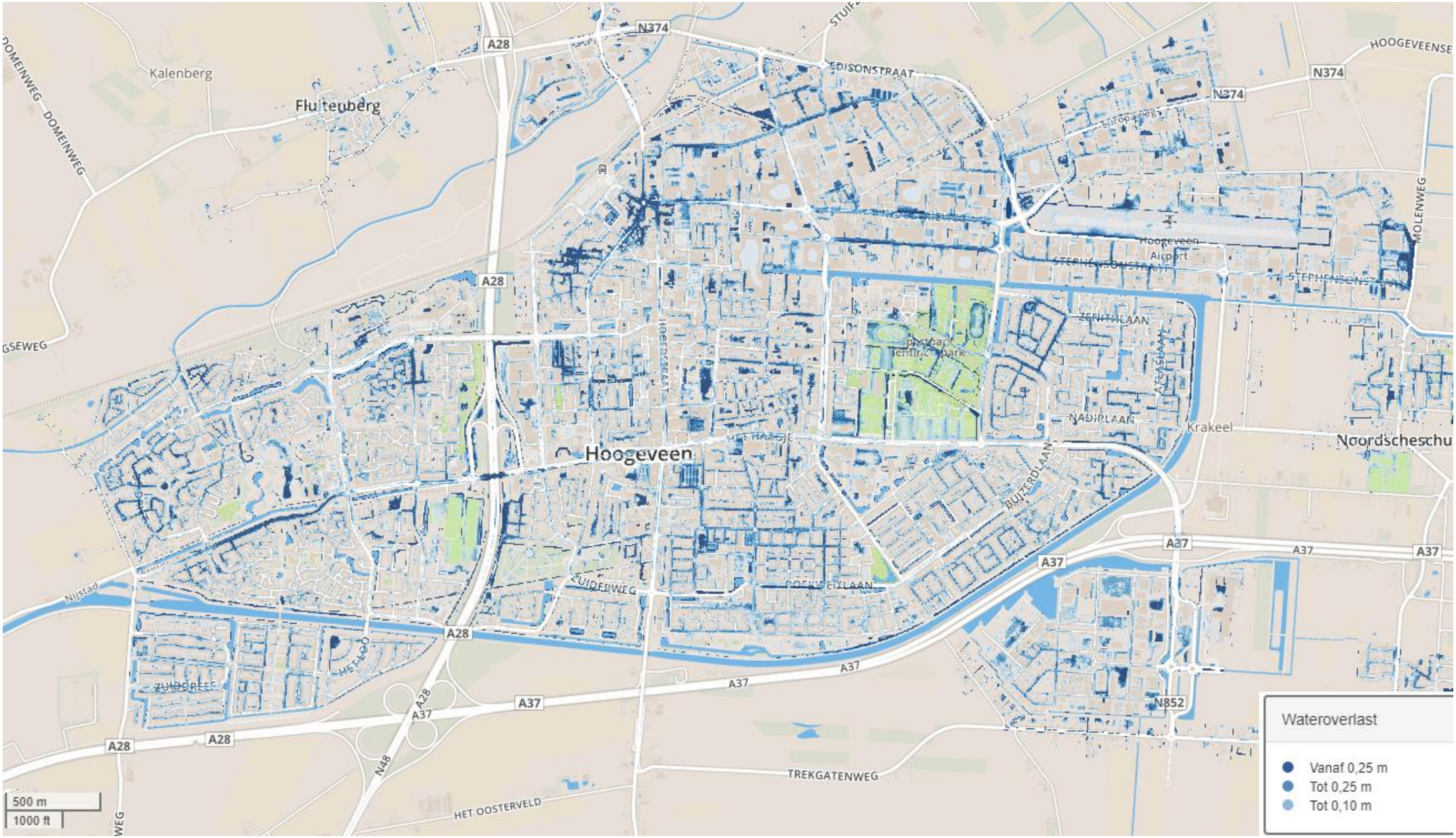

Figure 14: Map showing potential pluvial flooding areas in the city of Hoogeveen in the case of a precipitation event of 60mm in an hour. (Source: Nelen & Schuurmans, 2016)

4.1.4 Survey areas in the urban area of Hoogeveen

4.1.4.1 Hoogeveen-Noord

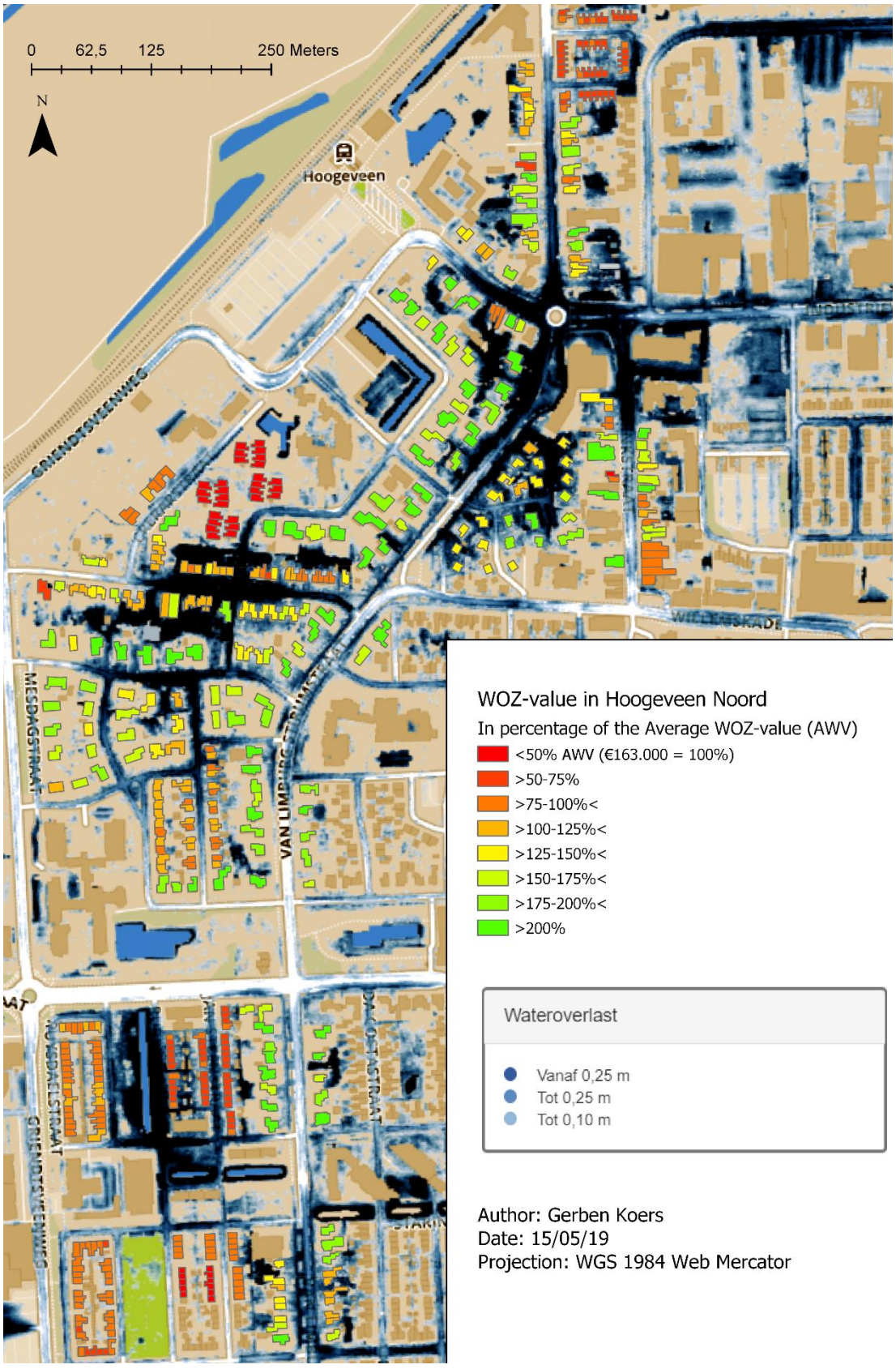

Figure 15: Map showing the WOZ-value per house in Northern Hoogeveen, as well as the predicted extreme precipitation impact in the area (Source: OpenStreetMap, 2019; Rijksoverheid, 2017; CBS, 2017; Nelen & Schuurmans, 2016; Edited by author)

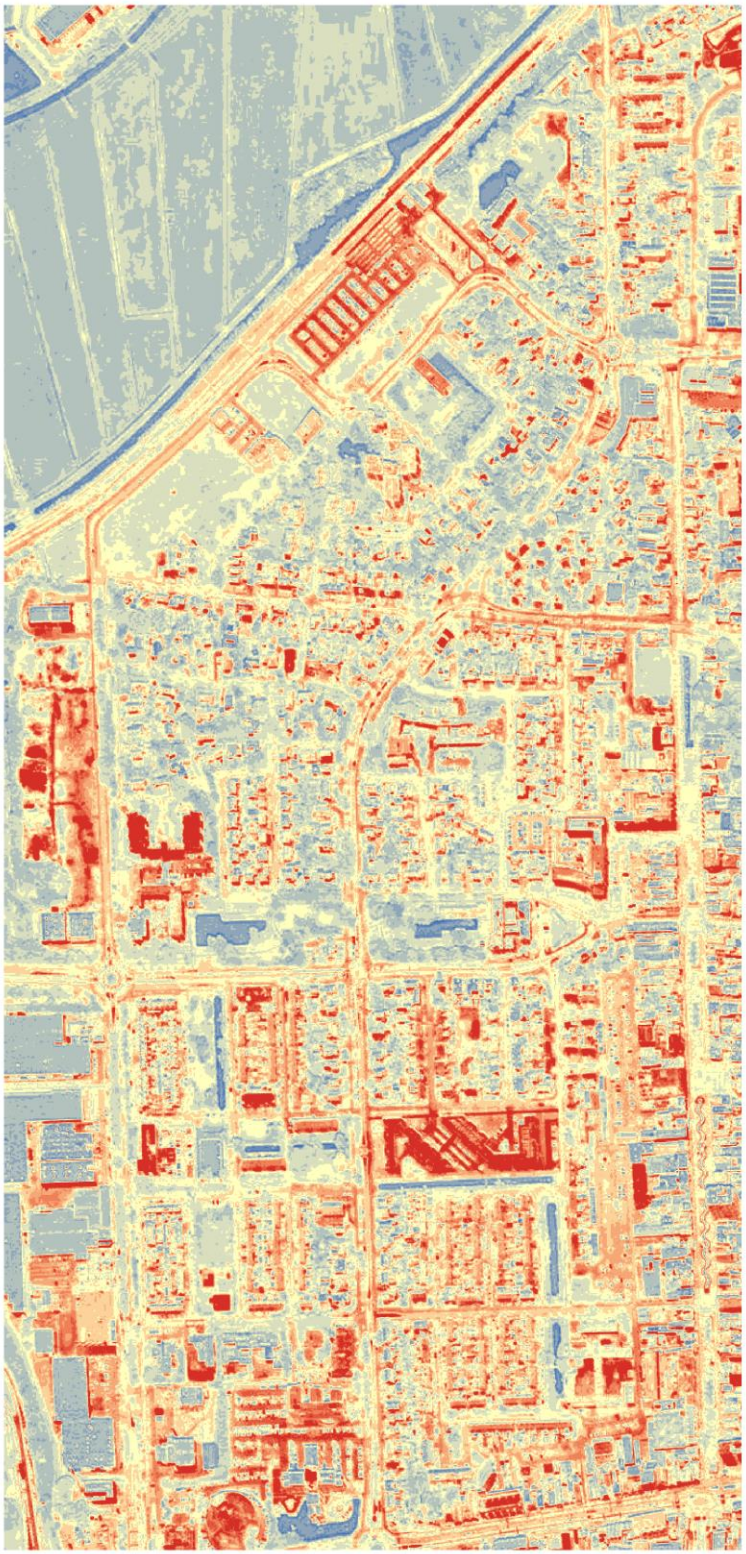

Figure 16: The amount of hardened surface in the area of Northern Hoogeveen by approximation (Source: Microsoft, 2019; Edited by author)

The first selected survey area is located in the northern part of Hoogeveen (see figure 11 and 15). The reason for including this area was due to the heavy precipitation impact that is predicted in the WDOD Klimaateffectatlas (figure 15). Additionally, figure 16 also shows that most likely there is a moderate amount of surface hardening. This is also visible in the photos in figure 17, which confirms this observation. Finally, figure 15 shows that in terms of property value, a significant number of houses are above the average house prices in Hoogeveen. The reason for including the WOZ-value is because it can be used as an indicator for social inequality, with lower values potentially meaning a lower socio-economical status (Kenniscentrum MVS, 2018). This is also the case for the use of this value in subsequent maps. As such for this neighbourhood it can be stated that the socio-economic status of the area is most likely quite well.

Figure 17: Photos of the Northern part of Hoogeveen to give an impression of the area (Source: author)

4.1.4.2 Centre of Hoogeveen

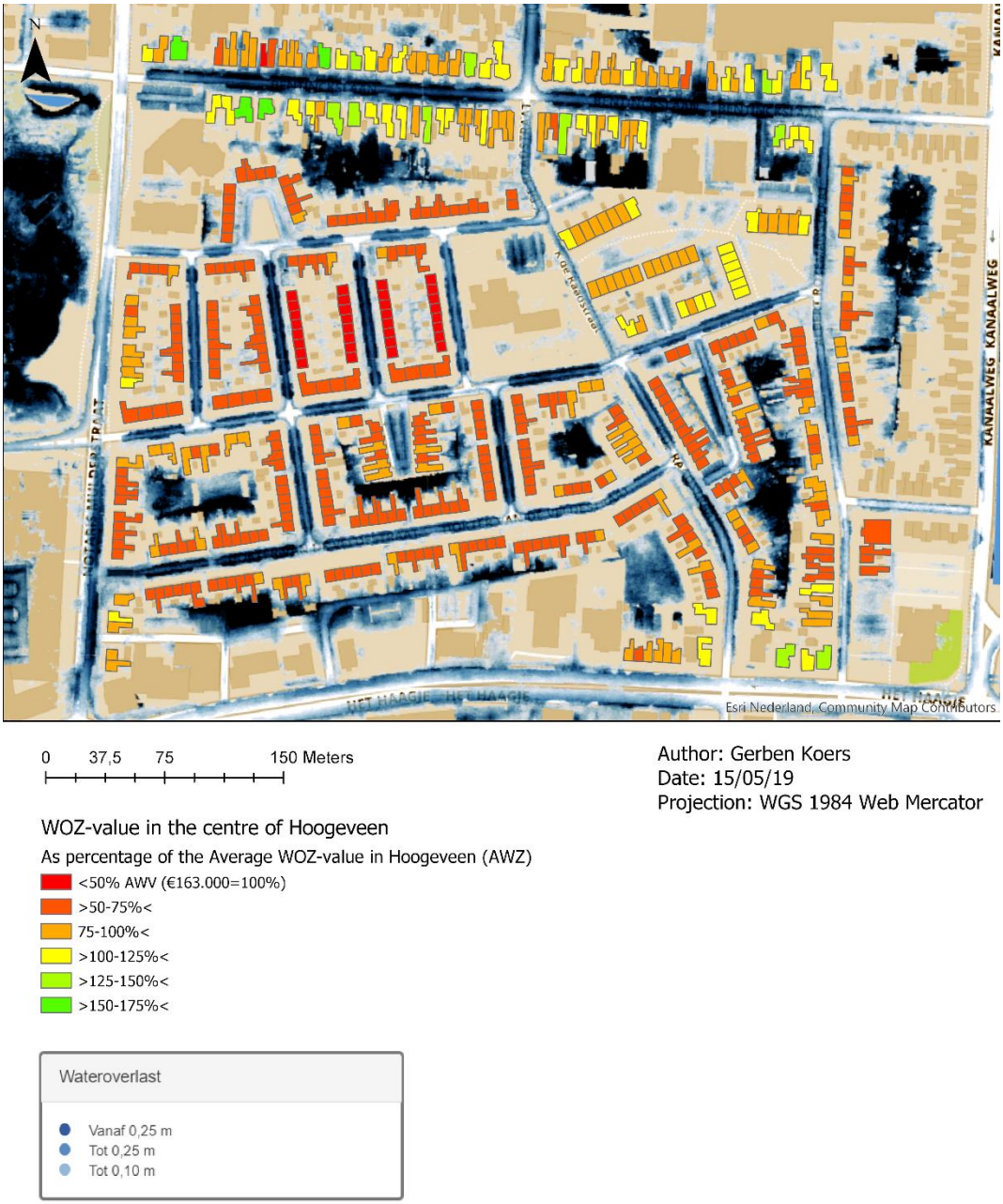

Figure 18: Map showing the WOZ-value per house in the centre of Hoogeveen, as well as the precicted impact of extreme precipitation impact in the area (Source: OpenStreetMap, 2019; Rijksoverheid, 2017; CBS, 2017; Nelen & Schuurmans, 2016; Edited by author)

The second selected survey area in Hoogeveen is located more towards the city centre. Just as for the other survey area in Hoogeveen, the WDOD Klimaateffectatlas also predicts pluvial flooding impacts in the case of a precipitation events (figure 18). The area is additionally also home to a moderate degree of hardened surfaces (figure 19). Part of this is due to the overall lack of front gardens in the area as is also shown in the pictures in figure 20. A difference between the first location however is that a larger percentage of houses in the area has a lower value, which be an indication of lower socio-economic prosperity (figure 18). This was also found during the spreading of the flyers for the survey as several houses in the neighbourhood were boarded up in preparation for demolition (see bottom photo in figure 20).

Figure 19: The amount of hardened surface in the centre of Hoogeveen by approximation (Source: Microsoft, 2019; Edited by author)

Figure 20: Photos of the Northern part of Hoogeveen that give an impression of the area (Source: author)

4.2 Overview of the city of Meppel

Figure 21: Aerial overview showing the city of Hoogeveen and areas where the survey were held (Source: Esri et al., 2019b; Imergis, 2019; Edited by author)

4.2.1 Core information about Meppel as a city

The second case study city is Meppel, located to the southwest of Drenthe, and to the west of Hoogeveen (as is shown in figure 12). The city itself has roughly 28.500 inhabitants (Stadsindex, 2019a). Just as with Hoogeveen, the city is also surrounded by rural areas (shown in figure 21). Additionally, the city, and its surrounding area, are also crossed by several streams that flow from the higher areas of the Drentse Hondsrug through Meppel to Lake IJssel in the southwest. As these streams are also coming together in the area of Meppel, it seen as a bottleneck for the river basin of this area. These streams enter the city from the northeast and leave in the southwest, as well as running along south of the city (Respondents Municipality Meppel, 2018) (Now named RMM, 2018 from now on). Furthermore, the height map (figure 22) also shows that Meppel as a city is also located in low laying areas due to its geomorphological history of being located in the moors of Drenthe that are located to the west of the Hondsrug. This in turn means

that also the groundwater levels will be higher in the area, meaning less infiltration capacity in the city, and thus a higher risk of experiencing pluvial flooding during an extreme precipitation event.

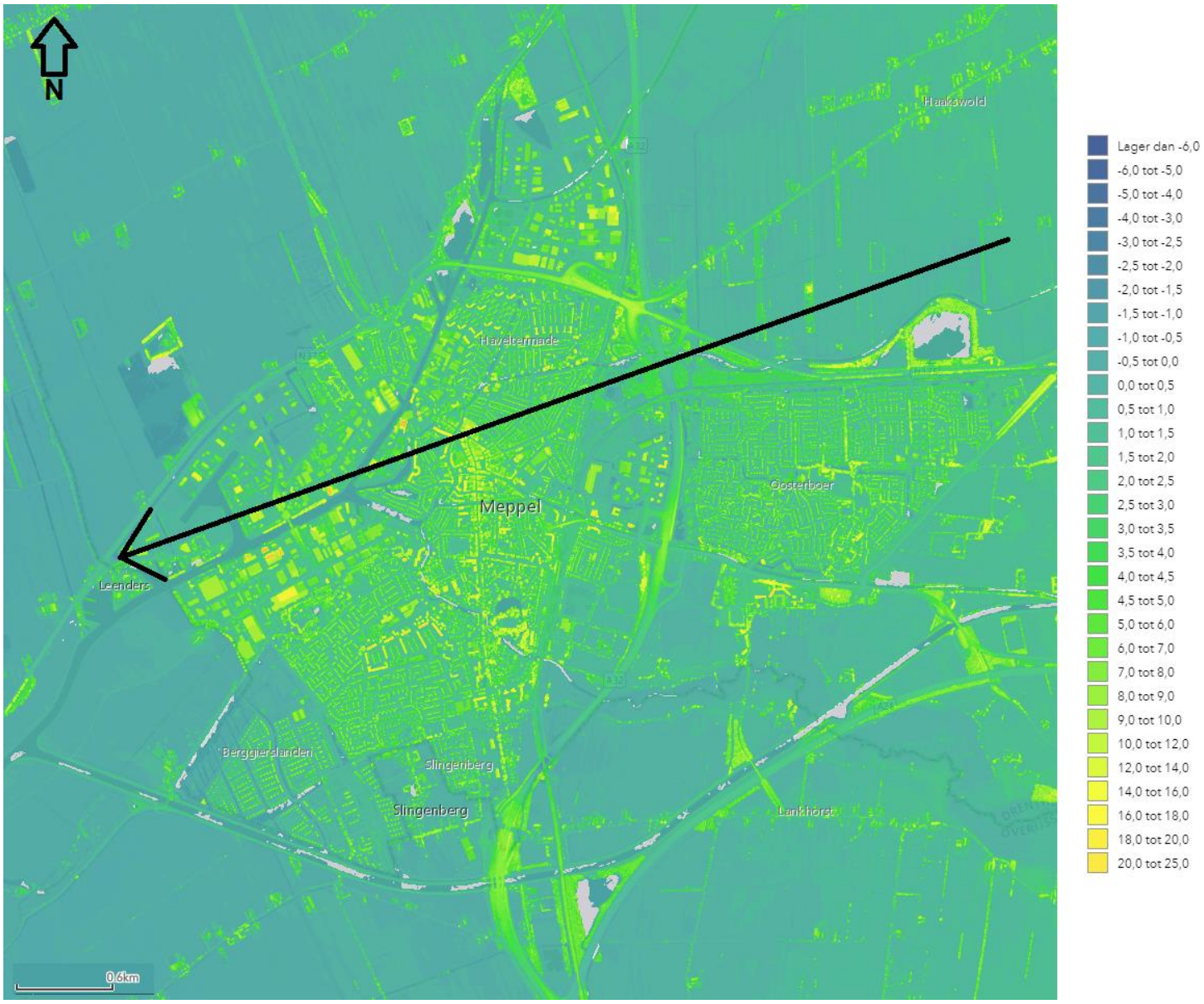

Figure 22: Height map of Meppel in meters, showing the slope in the landscape going from east (high) to west (low), as well as the surrounding lower areas. (Source: Esri Nederland & AHN, n.d.; Edited by author)

4.2.2 Main governmental stakeholders involved in the urban area of Meppel

Just as in the city of Hoogeveen, the main governmental stakeholders are the Province of Drenthe, the water board Drents Overijsselse Delta, and the Municipality, this time being the municipality of Meppel.

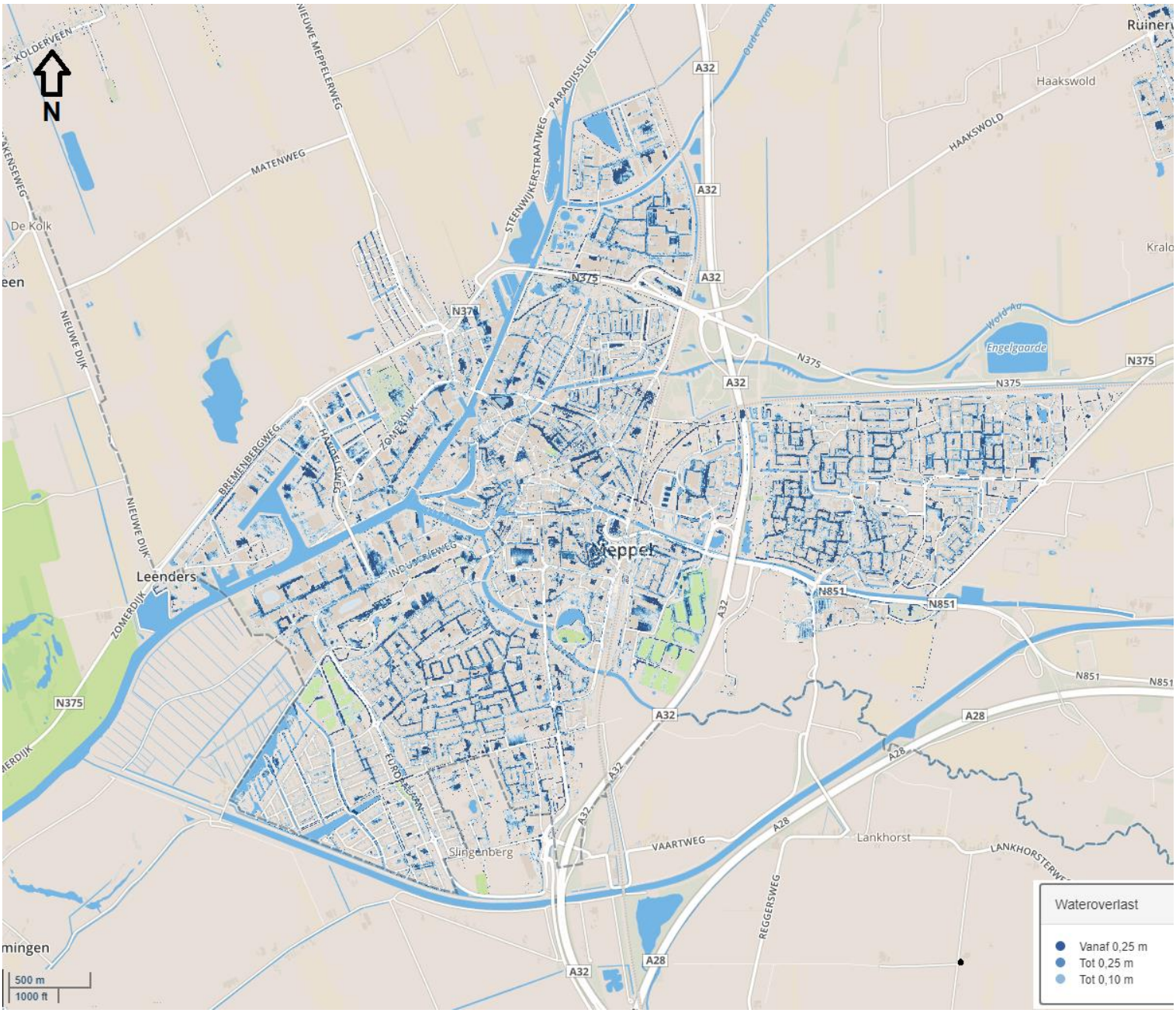

Figure 23: Map showing potential pluvial flooding areas in the city of Meppel in the case of a precipitation event of 60mm in an hour. (Source: Nelen & Schuurmans, 2016)

4.1.3 Experiences with pluvial flooding

Unlike the cities of Hoogeveen and Drachten, the city of Meppel does not have a recent history with pluvial flooding due to their not yet being an extreme precipitation event. However, the city did experience an almost flooding in 1998. This flooding was caused by a longer period of rain in Drenthe, which led to high water levels in the regional water system. As mentioned earlier, Meppel is seen as a bottleneck in this water system due to the different streams coming together in Meppel (shown clearly in figure 18). This led to the city to almost flood, and subsequently led to investments to be made to increase the water retention capacity upstream (RMM, 2018). Finally, figure 23 also shows that areas in Meppel can also experience pluvial flooding in the case of extreme preciption events.

4.2.4 Survey areas in the urban area of Meppel

4.2.4.1 Koninginnebuurt

WOZ-value in Koninginnebuurt

As percentage of the Average WOZ-value (AWV) in Meppel

- <50% AWV (€186.000 = 100%)
- >50-75%<
- >75-100%<
- >100-125%<
- >125-150%<
- >150-175%<
- >175-200%<
- >200%

Author: Gerben Koers
Date: 15/05/19
Projection: WGS 1984 Web Mercator

Wateroverlast

- Vanaf 0,25 m
- Tot 0,25 m
- Tot 0,10 m

Figure 24: Map showing the WOZ-value per house in the Koninginnebuurt, as well as the precicted impact of extreme precipitation impact in the area (Source: OpenStreetMap, 2019; Rijksoverheid, 2017; CBS, 2017; Nelen & Schuurmans, 2016; Edited by author)

The Koninginnebuurt neighbourhood in Meppel is located just south of the city centre. It is diverse neighbourhood that on the one hand has a lot of terraced houses, while also detached houses can be found in the south of the neighbourhood. Most houses in the north of the area also don't have a front garden which increases the chance of pluvial flooding to happen in the event of extreme precipitation due to the

increase in hardened surfaces. In the south this is less of a problem as is also shown on the photos in figure 25. As such, the most vulnerable areas to experience pluvial flooding in this area are the terraced houses in the north of the area, which is also shown in figure 24. This difference in house types is also found back in the property value of houses in the area (figure 24). When compared with the pluvial flooding prediction map in figure 30, it can be stated to a degree that the richer area of the neighbourhood is less vulnerable than the richer ones.

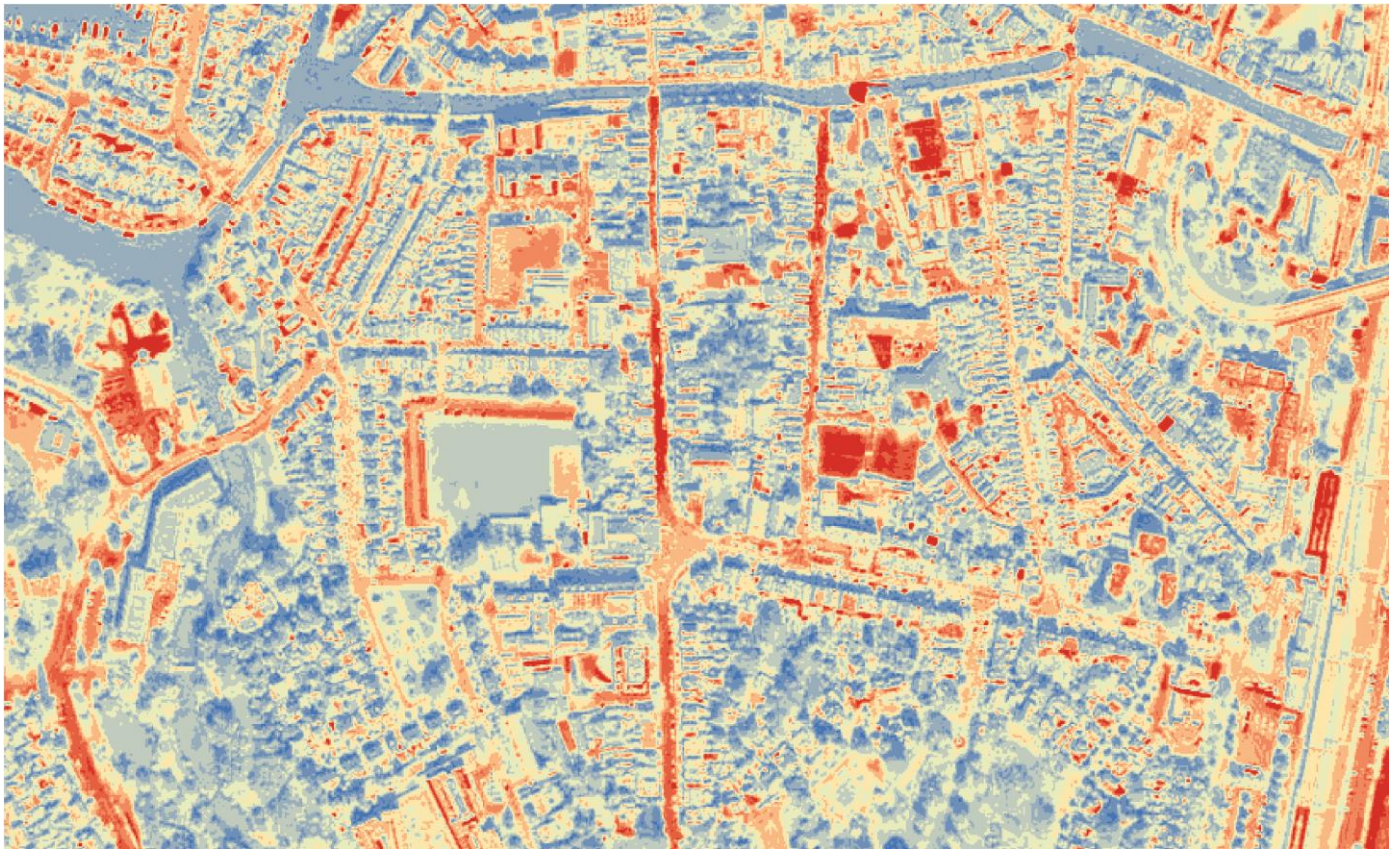

Figure 25: The amount of hardened surface in the Koninginnebuurt neighbourhood by approximation (Source: Microsoft, 2019; Edited by author)

Figure 26: Photos of the Koninginnebuurt neighbourhood in Meppel that give an impression of the area (Source: author)

4.2.4.2 Oosterboer

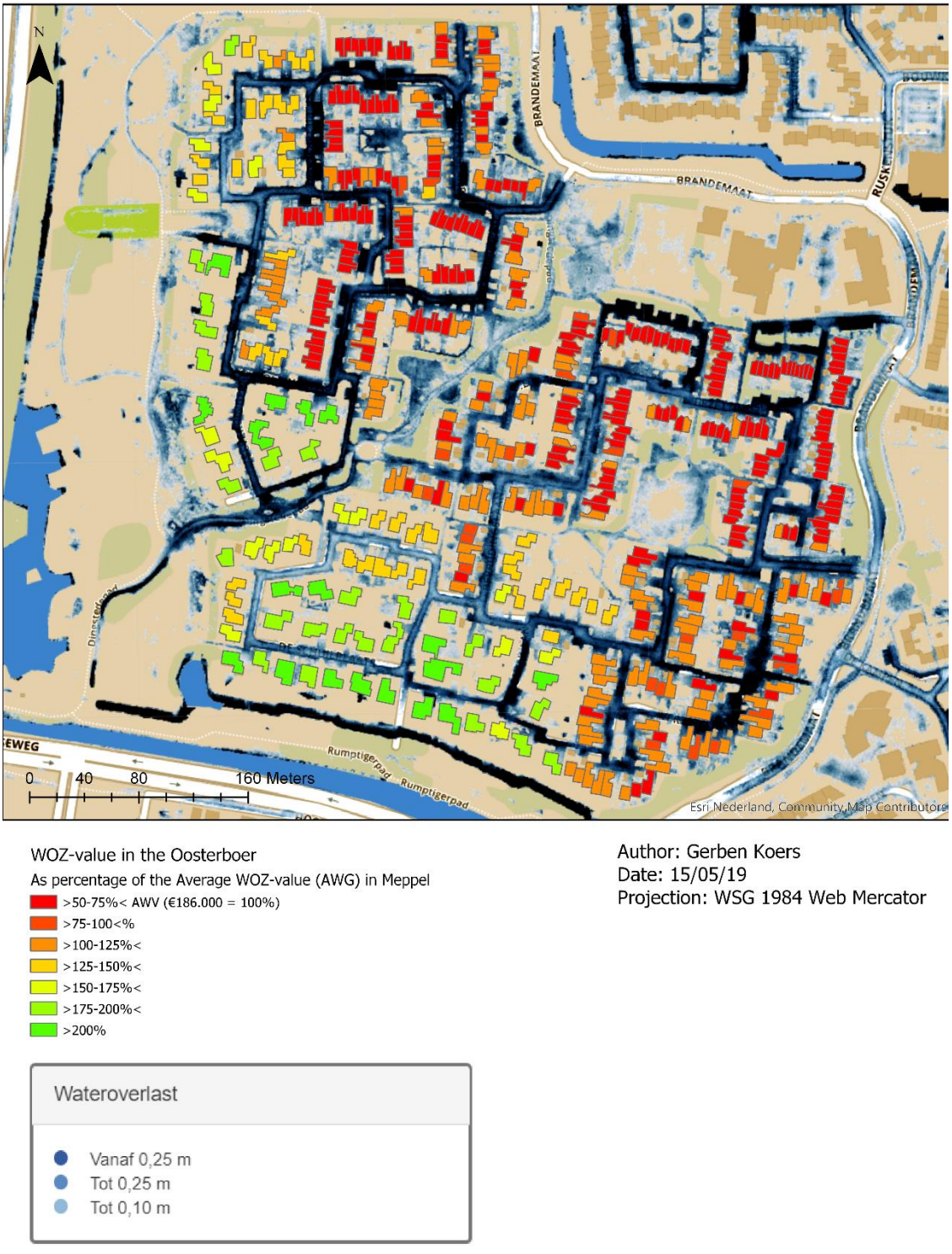

Figure 27: Map showing the WOZ-value per house in the Oosterboer, as well as the precicted impact of extreme precipitation impact in the area (Source: OpenStreetMap, 2019; Rijksoverheid, 2017; CBS, 2017; Nelen & Schuurmans, 2016; Edited by author)

The Oosterboer neighbourhood differentiates from the Koninginnebuurt by having relatively more detached houses, as well as green space. However, figure 28 does show quite a bit of hardened surface, which in turn lead to potential pluvial flooding in the case of extreme precipitation. This is supported by the photos in figure 29. Additionally, when comparing the WOZ-value with the flood risk map (figure 27)

again the higher value houses are also less at risk of experiencing pluvial flooding (especially in the south of the neighbourhood).

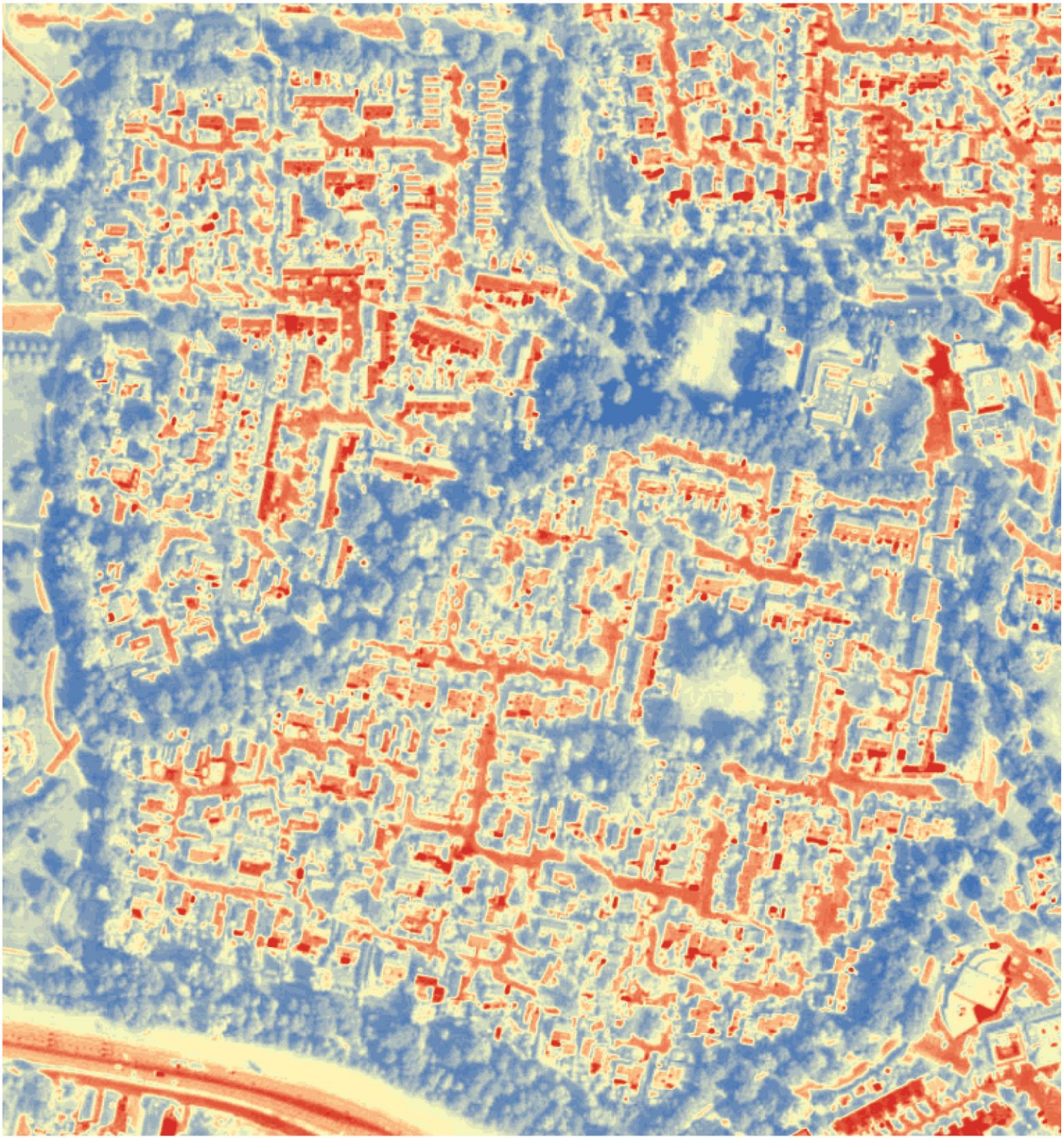

Figure 28: The amount of hardened surface in the Oosterboer neighbourhood by approximation (Source: Microsoft, 2019; Edited by author)

Figure 29: Photos of the Oosterboer neighbourhood in Meppel that give an impression of the area (Source: author)

4.3 Overview of the city of Drachten

Figure 30: Aerial overview showing the city of Drachten and areas where the survey were held (Source: Esri et al., 2019b; Imergis, 2019; Edited by author)

4.3.1 Core information about Drachten as a city

The third and final city is Drachten, located in the northern province of Friesland. It has around 44.500 inhabitants living within its urban areas (Stadindex, 2019b). Just like the other case cities is it is also surrounded by rural areas (figure 30). Additionally, Drachten can be compared with Meppel in the way that it is also located in the former moors (Ottergraafjes, 2019). As a result, the city is also laying lower, with even lower areas where the previously mentioned moors used to be which can be seen in figure 31. This map also shows that Drachten is sloped as the east of the city is higher than the west. Finally, the aerial photograph (figure 30) shows that parts of the city have a higher percentage of hardened surface, while others do not (e.g. the southwest of the city is greener). Finally, also a disclaimer has to be made in regard to the pluvial flooding maps shown in this section (figure 32, 33 and 36) as these are based on the older data presented in the klimaateffectatlas. As new information is now available in the form of the new Frisian Klimaateffectatlas, the used data is outdated. However, the choice was made to include this old data as the selection for the survey areas in Drachten was also based on this older data at the time in order to preserve transparency in the research process.

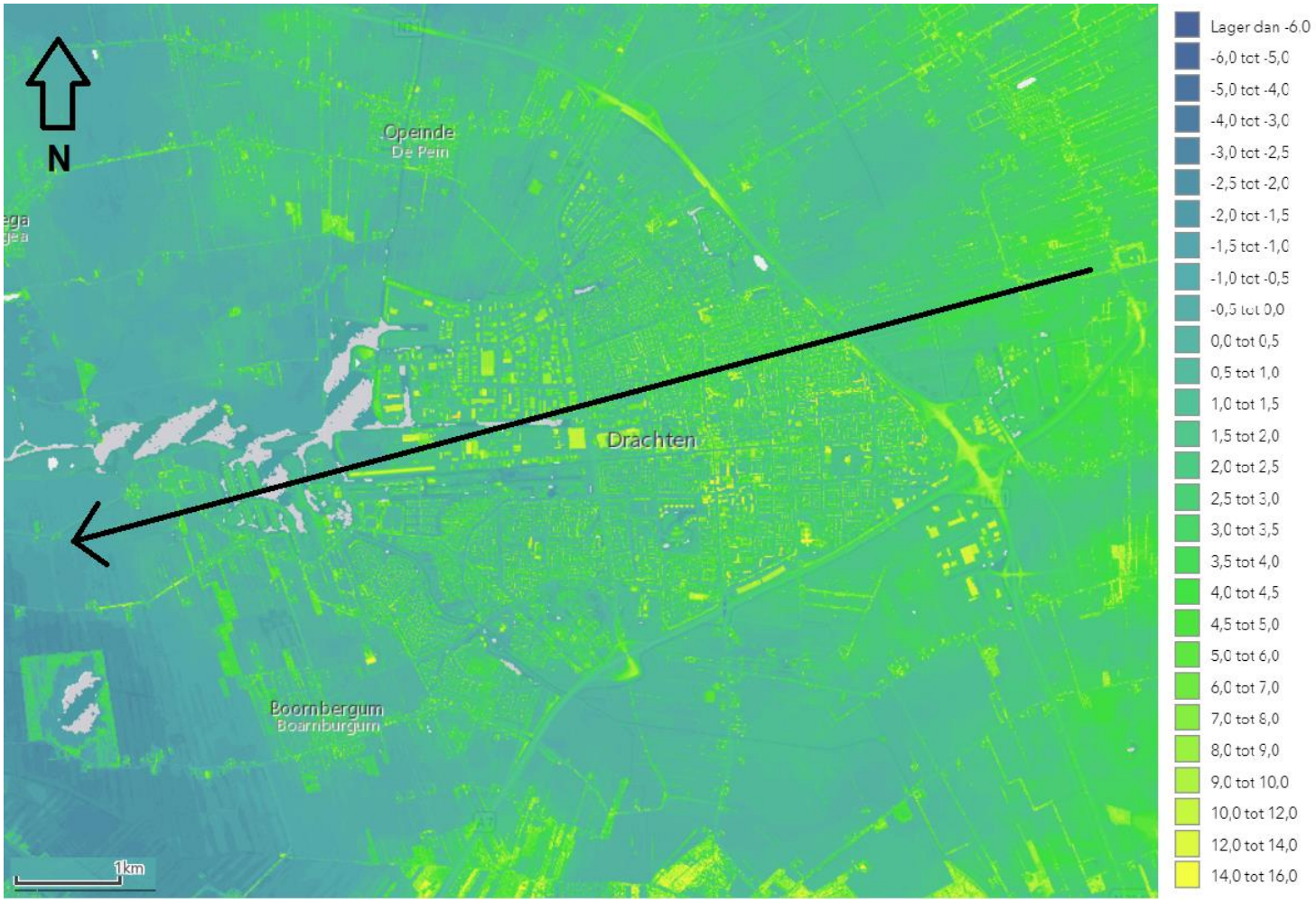

Figure 31: Height map of Drachten in meters, showing the slope in the landscape going from east (high) to west (low). (Source: Esri Nederland & AHN, n.d.; Edited by author)

4.1.2 Main governmental stakeholders involved in the urban area of Drachten

As Drachten is located within the province of Friesland, different governmental stakeholders are involved in this city. This being the province of Friesland and the water board Friesland. Additionally, as was also the case with the other two stakeholders, also the municipality is active as well, this time being the municipality of Smallingerland in which Drachten is located and having similar areas of influence in comparison.

4.1.3 Experiences with pluvial flooding

Drachten has experienced pluvial flooding in the past within its urban areas (Waldnet, 2012; Leeuwarder Courant, 2017; Leeuwarder Courant, 2018). This lead in 2017 to the development and subsequential use of a new version of the municipal water plan (Gemeentelijk Waterplan Smallingerland) (De Vries, 2017). In this document the measures are described that are taken in order to lower the vulnerability of the area against extreme precipitation and pluvial flooding. Additionally, the city, at the time of doing interviews with the stakeholders, was also involved in doing a provice-wide 'stresstest' to look at the impact of extreme precipitation in the urban areas (Respondent Municipality Smallingerlans, 2018; RPF, 2018). In doing so, more insight is gained in potentially vulnerable urban areas to pluvial flooding in the case of extreme precipitation events. Finally, Smallingerland as a municipality also joined the Operatie Steenbreek-movement in order to get more citizens involved in taking measures on their property to reduce the amount of hardened surface in the area (dwjm, 2019).

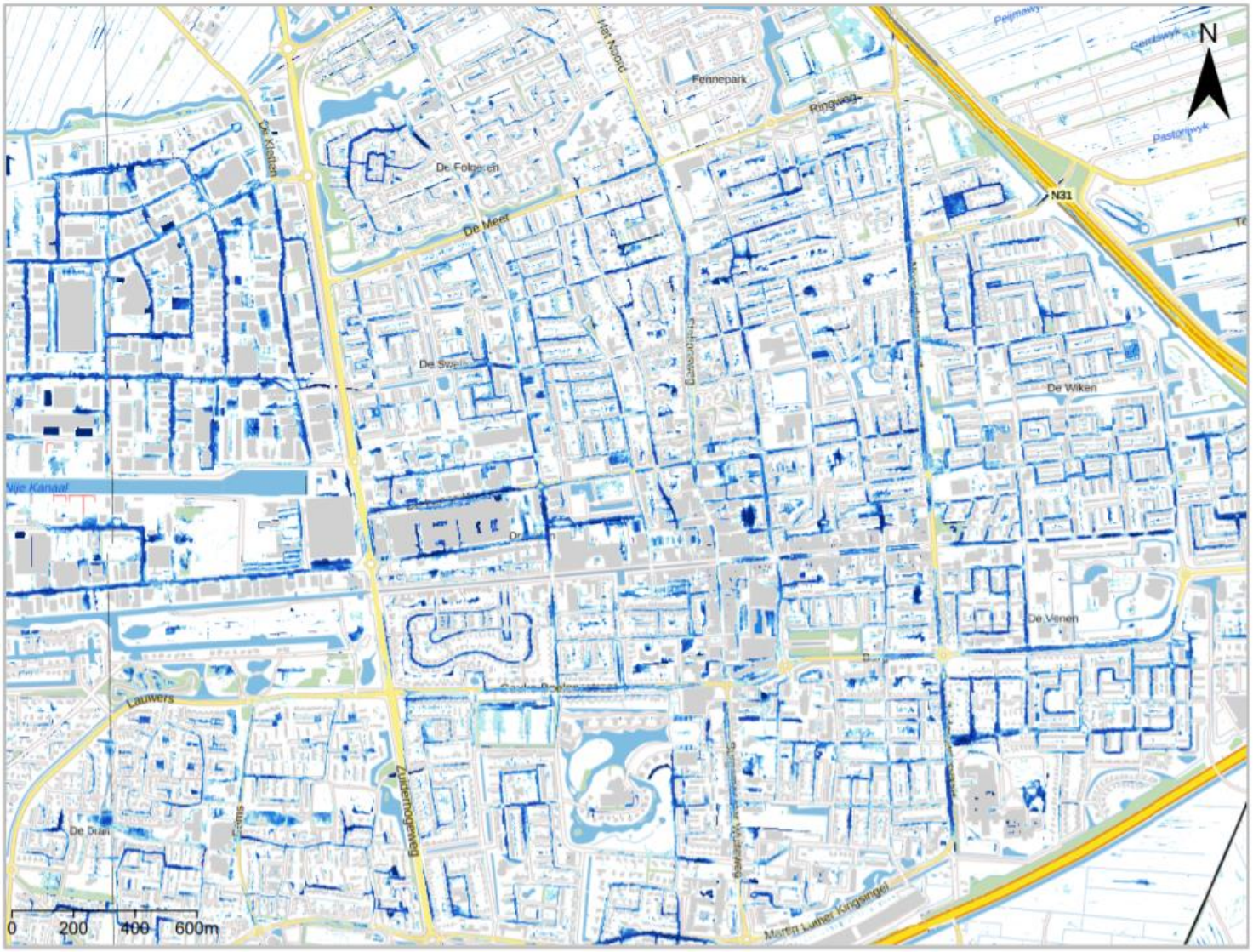

Figure 32: Map showing potential pluvial flooding areas in the city of Drachten in the case of a precipitation event (Source: Stichting CAS, n.d.)

4.3.4 Survey areas in the urban area of Drachten

4.3.4.1 De Venen

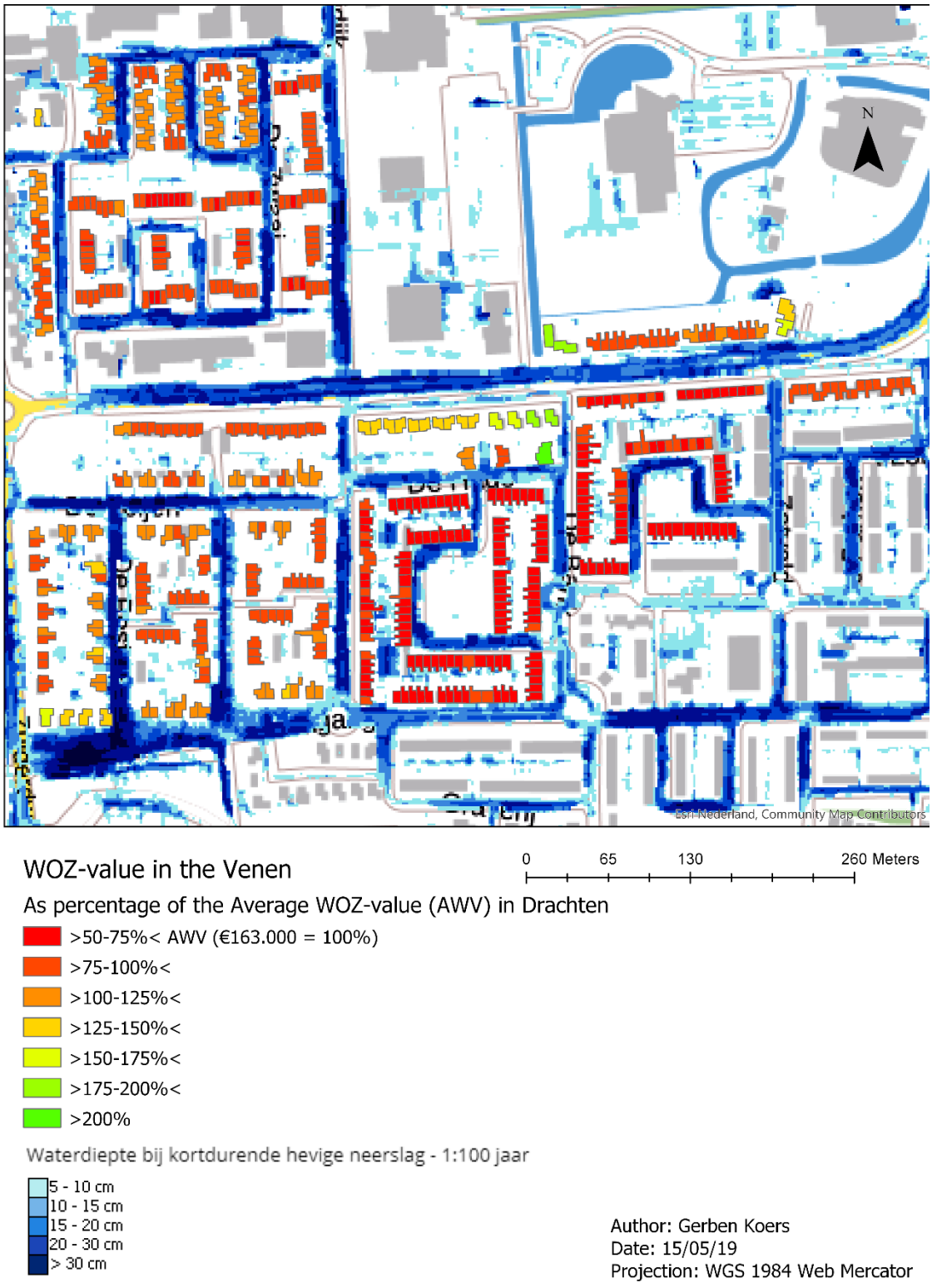

Figure 33: Map showing the WOZ-value per house in the Venen, as well as the precicted impact of extreme precipitation impact in the area (Source: OpenStreetMap, 2019; Rijksoverheid, 2019; CBS, 2017; Stichting CAS, n.d.; Edited by author)

The first survey area in Drachten, the neighbourhood 'De Venen', is in the southeast of the city. The area has relatively little surface water and a higher percentage of hardened surface (Respondent Municipality Smallingerland, 2018) (from this point on named RMS, 2018). This is also supported by figure 33 as it shows that there are relative fewer blue areas, which shows that a large degree of the neighbourhood has some degree of hardened surfaces. As the images portrayed in figure 35 also show this, the fact area can experience a significant amount of pluvial flooding in the case of an extreme precipitation event (as seen in figure 33) is not surprising. Finally, figure 33 also shows that most houses in the area also have a lower than average property value, which can indicate that most of the citizens living in the area also have a lower socio-economical status, which may limit their ability to take measures themselves.

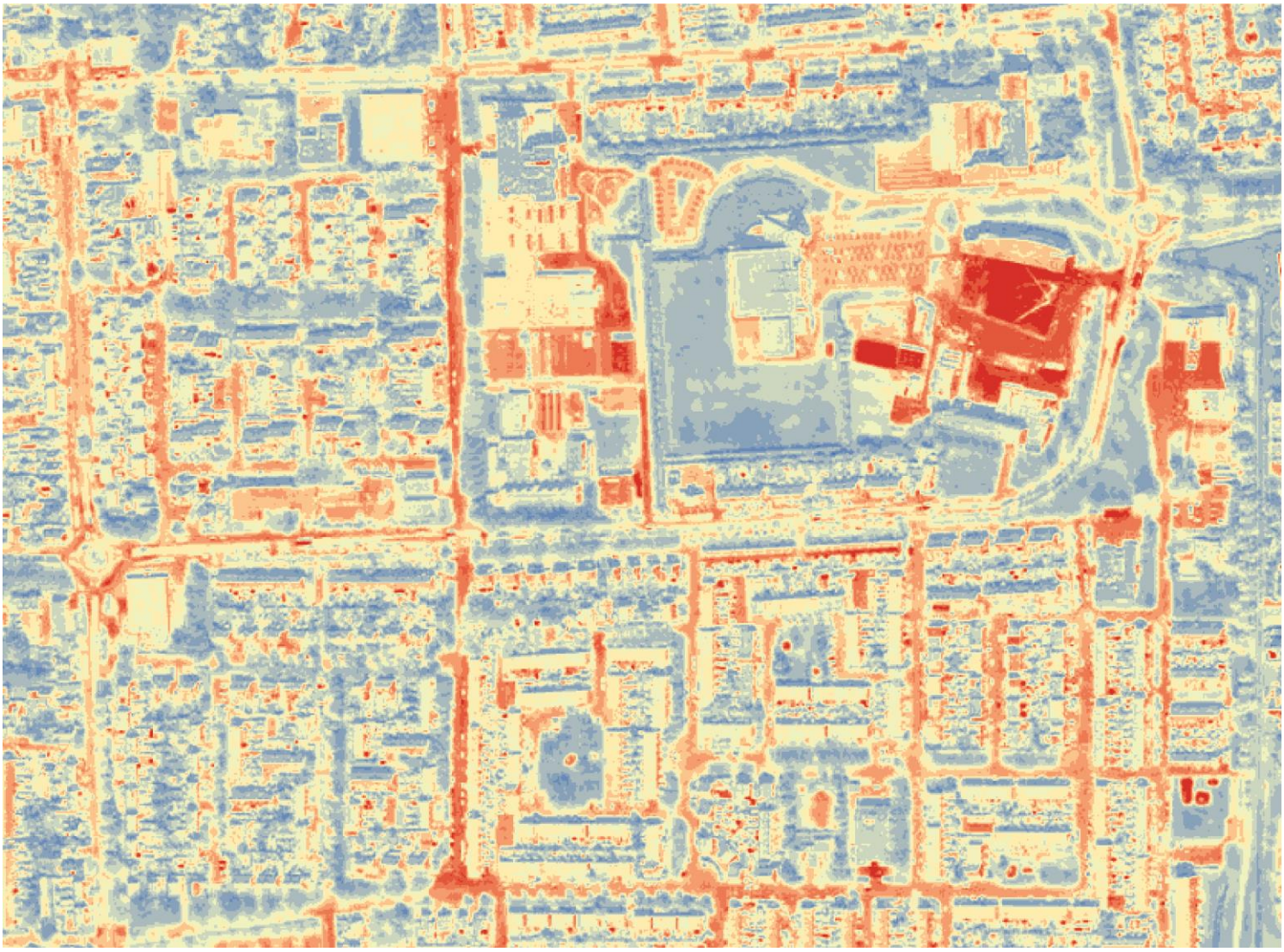

Figure 34: The amount of hardened surface in the Venen neighbourhood by approximation (Source: Microsoft, 2019; Edited by author)

Figure 35: Photos of the Venen neighbourhood in Drachten that give an impression of the area (Source: author)

4.3.4.2 De Swetten

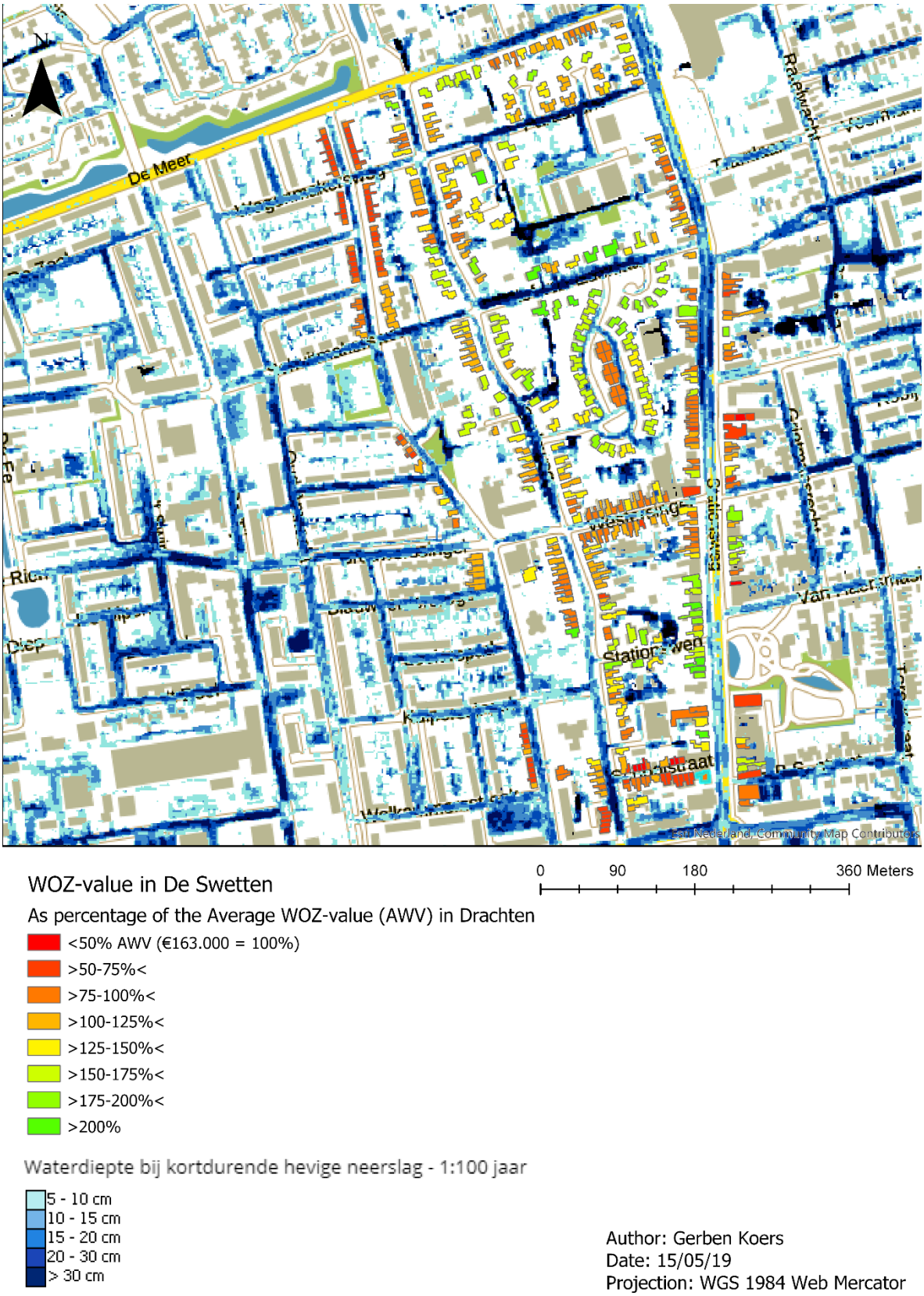

Figure 36: Map showing the WOZ-value per house in the Swetten, as well as the precicted impact of extreme precipitation impact in the area (Source: OpenStreetMap, 2019; Rijksoverheid, 2019; CBS, 2017; Stichting CAS, n.d.; Edited by author)

The second survey area in Drachten is in the 'Swetten' neighbourhood. When compared with the Venen, the neighbourhood has more detached houses as opposed to more terraced houses in the Venen (figure 36 and 38). Additionally, also the amount of hardened surface is also lower (figure 37), which in turn may also explain why the impact of extreme precipitation in this area is lower as well when looking at the map (figure 36). This is also supported by the pictures in figure 38, as the area looks greener. Furthermore, the average house prices are also higher in this area (figure 36) in comparison with the Venen, which may therefore indicate that the socio-economic situation in this neighbourhood is better, which may in turn result in the inhabitants to be able to afford measures on their own property to reduce pluvial flood vulnerability, as well as reducing the risk of it to happen in the case of extreme precipitation.

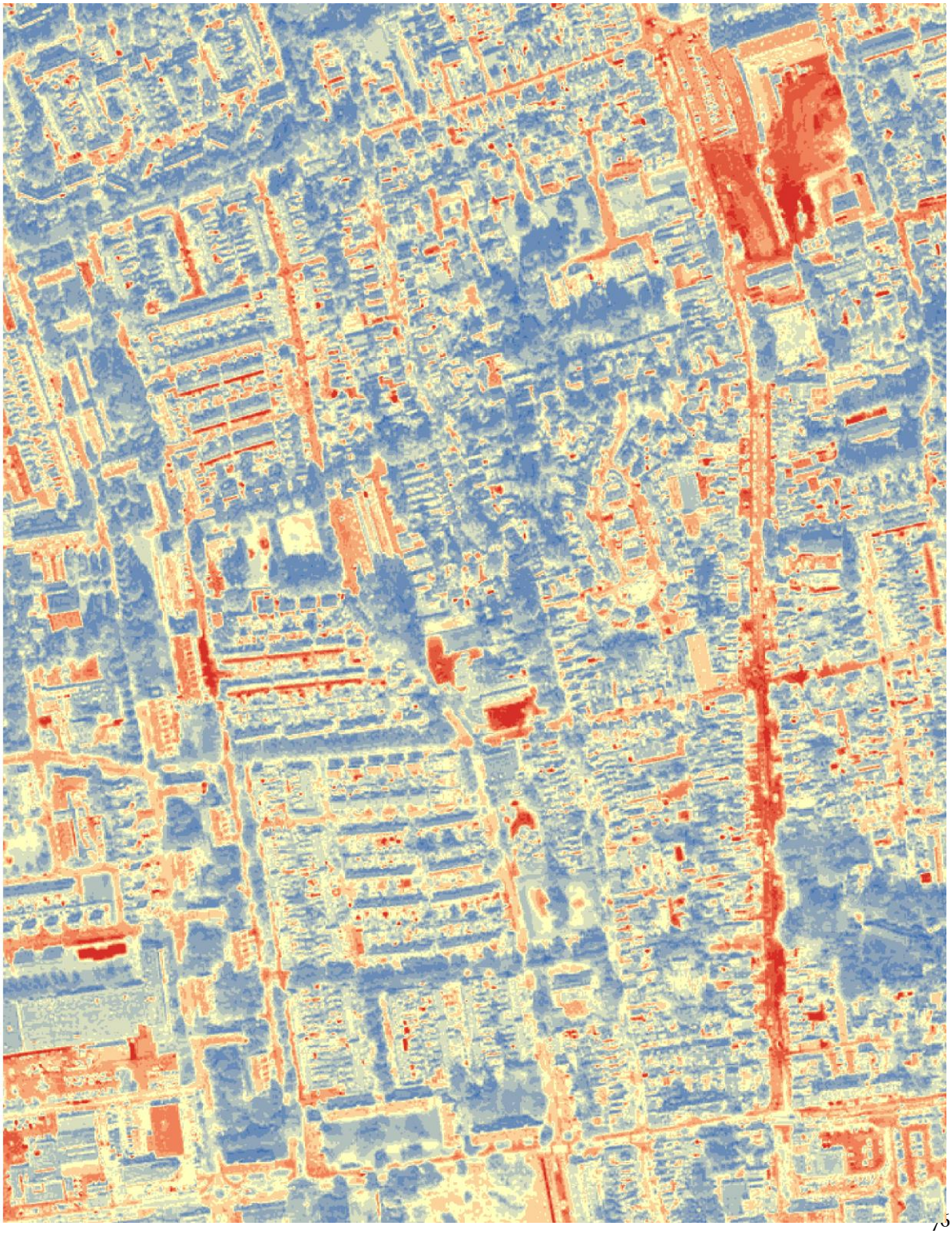

Figure 37: The amount of hardened surface in the Swetten neighbourhood by approximation (Source: Microsoft, 2019; Edited by author)

Figure 38: Photos of the Swetten neighbourhood in Drachten that give an impression of the area (Source: author)

Chapter 5: Results

“I pass with relief from the tossing sea of cause and theory to the firm ground of results and facts”

- Winston Churchill

5.1 Governmental stakeholders – Findings in the Hoogeveen urban area case study

5.1.1 Role of stakeholders in the case study

Municipality of Hoogeveen

During the interview, the respondent from the Municipality of Hoogeveen (2018) explained that the municipality has a leading role on reducing the impact that (extreme) precipitation events have on urban areas. This active municipal role was also mentioned during interviews with respondents from the Province of Drenthe (2018) and the water board Drents Overijsselse Delta (WDOD) (2018). This is shown in practice in that the municipality, as an organization, has actively made changes to the urban spatial design. Most of which were done after the precipitation (and subsequent pluvial flooding) event in July 2012 to reduce the potential consequences of future events, as well as creating new policies to help accomplish that goal. Additionally, they also created a policy document that serves as a guideline to support this endeavour (Gemeente Hoogeveen, 2017a). Furthermore, the municipal respondent (2018) also stated that the active role of the municipality serves as an example to other stakeholders who may feel then more pressured to also take actions themselves. However, the municipality does also have a supportive role as they support other private stakeholders (e.g. citizens) in taking actions themselves (e.g. through providing and sharing knowledge or raising awareness) (Oranjewoud, 2010; Gemeente Hoogeveen, 2017a; Respondent Municipality Hoogeveen, 2018) (Respondent Municipality Hoogeveen, 2018 is from this point is cited as RMH, 2018) as well as through the development of a legislation that forces these stakeholders to act as well (Niezen & Hartemink, 2015b).

Water Board Drents Overijsselse Delta

Compared to the municipality, the regional water board has a more supportive and advising role. This was explained during the interview held with the respondent from the water board (RWDOD, 2018) (From now cited as RWDOD, 2018). According to the respondent this is since the municipality carries the responsibility for the spatial design in urban areas, whereas the water board carries the responsibility for the management of surface waters in these areas. This means that the WDOD needs to make sure that there is enough water retainment capacity available in surface water bodies located in the urban area of Hoogeveen (Oranjewoud, 2010). However, at the same time the WDOD also provides advice to the municipality about the impact that spatial developments have on the local and regional water system with the water test (Waterschap Groot Salland et al., n.d.; Waterschap Drents Overijsselse Delta et al., 2015; Respondent, WDOD, 2018). Additional advice is also given with the 'WDOD Klimaateffectatlas' that was made available for stakeholders to help them identify locations that may be at risk of flooding during an extreme precipitation event (RMH, 2018). Finally, the water board also provides support for citizens through financial support that citizen groups can apply for to fund part of their cost for taking measures (RWDOD, 2018). This supportive role is also further confirmed through a policy document which states that the role of the WDOD is also to facilitate initiatives of other stakeholders rather than act themselves (Waterschap Drents Overijsselse Delta et al, 2015).

Province of Drenthe

The Province of Drenthe also has a more supportive and advising role when it comes to urban pluvial flooding. This is again for similar reasons as the water board since the municipality carries responsibility for changes in the spatial design in the urban areas (Respondent Province of Drenthe, 2018) (from this point on Respondent Province of Drenthe, 2018 will be refered to as RPD, 2018). However, the respondent

did state that they do give advice to municipalities on a non-commitment basis on how they could potentially change the spatial design of urban areas to reduce the pluvial flooding risk. This supportive role is furthermore also found back in policy documents as it is stated that the Province focusses on creating the policy framework which supports and guides interventions undertaken by the municipality or the water board (Provincie Drenthe, 2014).

Collaboration between governmental stakeholders

Most of stakeholder collaboration in the urban area of Hoogeveen takes place between the water board and the municipality. According to the respondent from the municipality, the water board is seen as one of the most important partners when it comes to preventing pluvial flooding in the urban areas (RMH, 2018). This is due to the WDOD being responsible for the management of surface waters in these areas, which are used by the municipality to retain water during precipitation events (RWDOD, 2018). This collaboration is also mentioned in policy documents as the water board should help municipalities to develop their visions on how to become more 'climate resilient' (Waterschap Groot Salland et al., n.d.; Gemeente Hoogeveen, 2017a). Additionally, the Province of Drenthe also collaborates with the municipality and the WDOD by providing advice to both (RPD, 2018), as well as working together with them. This is since water retention in urban areas may affect the regional water system (e.g. higher water levels) which could in turn lead to flooding from here. However, at the same time, the Province can also steer its partners through legislative tools, if needed, from a provincial point of view, as well as what is written down in, for example, the Provincial structural vision and the regional water plan (Provincie Drenthe, 2014). Finally, the municipality and the WDOD also work together alongside other local municipalities in a work region collaboration called 'Fluvius'. In this work region, the focus is on the sharing of knowledge and experiences between the different partners involved in the region when it comes to pluvial flooding (appendix VI).

5.1.2 The understanding phase

In the first phase of decision-making process cycle (Moser & Ekstrom, 2010), the focus is on problem detection, the gathering and use of information and (re)defining potential problem(s). It therefore serves as the phase in which information is collected, goals are established that are then further planned out and potentially implementation in the form of spatial measures and policies. In the Hoogeveen case, the pluvial flooding event of 2012 kickstarted this cycle due to the failures of the sewer system and spatial design to properly process the preciptation. This flooding impact was recorded through video and photos by both the municipality and citizens, which served as practical input for the problem definition and gathering of information (RMH, 2018). Thereafter, according to the respondent (2018) this 'impact evidence' was mapped geographically and compared to existing information from modelling based on the spatial design and sewer system performance to gain insight in where this information could be incorrect. By also applying acceptability norms for pluvial flooding in urban areas as well (Oranjewoud, 2009; Niezen & Hartemink, 2015b; Gemeente Hoogeveen, 2017a), priority could be given to different locations during the action phase.

Additionally, the municipality will also do a so-called 'stresstest' in 2019 that will provide new insight about the potential impact extreme precipitation has within the urban area of Hoogeveen (appendix VI). This is a continuation of the modelling and subsequent mapping done for the already mentioned regional 'WDOD Klimaateffectatlas' (Nelen & Schuurmans, 2016). Furthermore, according to the respondent from the municipality of Hoogeveen, as well as policy documents, climate information is used in the decision-making process mostly as an indicator for where potential problems may occur, and therefore to inform the stakeholder (Niezen & Hartemink, 2015b; Gemeente Hoogeveen, 2017a; RMH,

2018). This is further supported by the respondents from the water board and the Province (RPD, 2018; RWDOD, 2018). Finally, also complaints from citizens are input for localizing problem areas as well (Niezen & Hartemink, 2015a).

However, there is also critique on the currently used climate information formats. While maps and models may provide insight in precipitation impacts in the urban areas, practical and local knowledge are also required to provide validation and legitimacy to this information, and to understand the meaning of these predicted impacts in practice (e.g. does a park flood or a neighbourhood) (RMH, 2018). A mentioned limitation is also that maps as a climate information format will only show results based on the used variables (e.g. are hardened surfaces and parts of the sewer system considered, or other variables as well?). This in turn affects the information presented by the resulting map. Therefore, climate information presented with maps needs to be supplemented with other data (e.g. images) or earlier experiences in order fully understand the local precipitation impact. Therefore, a larger emphasis also needs to be put on own made observations and experiences by stakeholders (RMH, 2018; Appendix VI). The respondent also mentioned that the precipitation data on which the current pluvial flood maps for Hoogeveen (WDOD Klimaateffectatlas) were based may be out of date already as the used 60 mm/h precipitation input is considered now 'too light' to realistically estimate impacts in practice (appendix VI). Additional input on this topic by the respondent from the Province is also that the information presented on the map does not necessarily have to be accurate, as the model that generated the map may also be using wrong assumptions (RPD, 2018; appendix VI). Furthermore, in order to create prioritization and urgency of climate impacts, the damage that caused by precipitation events is also seen as important information, while not yet available at the moment of writing (appendix VI). This could then also help to place it on the political agenda, which will be discussed next. Finally, the respondent from the municipality (2018) explained that reading maps is a skill that not anyone is able to do properly, which in turn can limit the usability of displaying information via maps.

These flooding events led in Hoogeveen to firmly planting the problem on the political agenda according to the municipal respondent (2018; appendix VI). The respondent described that by presenting local politicians and aldermen the results of this comparison between modelled and real impact of extreme precipitation in the urban area of Hoogeveen, as well as showing images and video of the flooding event it helped to convince them to act. This corresponds with the (re)defining phase of the decision-making process cycle (Moser & Ekstrom, 2010). Additionally, by showing not only maps but supplementing these with videos and images, the information the map gave was made more understandable for laymen (RMH, 2018). This point is also further supported by input given by municipal respondents during the workshop (appendix VI). This now also brings us to the next phase in the decision-making process cycle: the planning phase.

5.1.3 The planning phase

This phase moves from the gathering of information towards utilizing this information to make choices about which measures (or policies) should be implemented where. This is done by developing, assessing and finally choosing the options that are available for a stakeholder (Moser & Ekstrom, 2010). In this phase, local circumstances start to play a more important role to determine which measures are best fitted for solving the problems found such as an insight in the local urban water system (RWDOD, 2018), area height (Gemeente Hoogeveen, 2017a; RWDOD, 2018) and performance of the sewer system (RWDOD, 2018). Also, examples of measures can also serve as inspiration for generating potential measure options (Gemeente Hoogeveen, 2017a). Additionally, other spatial (re)development projects also proved to be a leading factor in where and whether measures, and changes to the spatial design, will be implemented (Oranjewoud, 2009; Niezen & Hartemink, 2015; Gemeente Hoogeveen, 2017a). This finding is also

supported by the municipal respondent (2018) through the example of a business park redevelopment in Hoogeveen in 2010. During this redevelopment climate adaptation was not given enough consideration, and as investments have now already been made, these areas will not be redeveloped until the spatial design has again reached its replacement age. The respondent does however acknowledge that flaws in the localized spatial design flaws that can cause flooding (e.g. speed bumps directing rainwater in the wrong direction) will be still be solved regardless of replacement age. Additionally, the Municipality can also set certain norms that project plans must meet in order to be considered (Appendix VI). This can then be an alternative way to decide between different measure options and to bring climate adaptation into development plans.

While the municipality may plan measures and spatial developments during this phase, the WDOD also has influence over the final designs that will be eventually implemented. This is because the WDOD can advice the municipality about the impacts these plans will have on the local (or regional) water system with the water test (Waterschap Groot Salland et al., n.d.; Waterschap Drents Overijsselse Delta, 2015 et al.; RWDOD, 2018). This is an assessment of spatial plans that will help municipal stakeholders to choose the options that have the least inherent negative effect on the urban and regional water system. Another choice that also affects the choice for certain measures is the cost-effectiveness of measures (Gemeente Hoogeveen, 2017a; RPD, 2018; RWDOD, 2018). This is since stakeholders have a limited budget for taking measures, which means that choices need to be made. However, the respondent from the municipality (2018) does mention that this perspective is not set in stone, as in some cases long-term effects are also considered and may lead to on a short-term cost-ineffective measures to be taken if these do pay off in the long term (e.g. by improving liveability).

Finally, dialogues with citizens, and the use of local knowledge also used to develop plans tailored to the local context (RWDOD, 2018; Appendix VI). This was also mentioned during the interview with the respondent from the municipality of Hoogeveen (2018) and a policy document written by the WDOD (Waterschap Drents Overijsselse Delta et al., 2015) who argue that citizens should be involved. Additionally, if possible, their wishes should be included in the spatial (re)developmen. This involvement in turn can then lead to citizens taking pluvial flood prevention measures as well, such as decoupling or reducing the amount of hardened surface.

5.1.4 The managing phase

In the third phase of the decision-making process (Moser & Ekstrom, 2010), the focus shifts again. This time towards implementing, and after that the (periodical) monitoring and evaluation. In this phase climate information will be of use for establishing norms to test the adjusted urban design with. This monitoring focusses mainly to test on the capacity of the sewer system and the urban spatial design to process (extreme) amounts of precipitation (e.g. through modelling and calculations), and to observe the performance and effectiveness of measures and taken interventions in practice through observations and (lack of) complaints from citizens (Oranjewoud, 2010; Niezen & Hartemink, 2015b). This overlaps with the first phase (localizing potential problem areas) as the information gained through evaluation can potentially lead to a new cycle as more understanding about found problems in the monitoring and evaluation is needed. Additionally, in the managing phase, the available budget for the management of the urban design also affects the effectiveness of implemented measures (Gemeente Hoogeveen, 2017a). This is since if measures cannot be properly maintained it can in turn affect the (long-term) performance of these. For example, clearing up clogged sewer pipes, or can blocked sewer inlets (Niezen & Hartemink, 2015a), or in the WDODs case that they manage the urban surface water bodies (RWDOD, 2018).

Additionally, this phase can also be used as input for the decision-making process by creating insight in the efficiency of measures that are taken (Niezen & Hartemink, 2015a). This can then serve two goals: firstly, it shows which measures are effective; and secondly working measures can also serve as good practice examples which are then used as inspiration in the planning phase (Gemeente Hoogeveen, 2017a).

5.1.5 The enhancement of the urban pluvial flood resilience (robustness and absorption)

The respondent from the municipality of Hoogeveen pointed out that there is a focus on decoupling the rainwater pipes of houses from the sewer system so that the system can handle more precipitation (RMH, 2018). This is also further suported by a policy document (Niezen & Hartemink, 2015b), which explains that the municipality has the legal power to force citizens to comply to decoupling via legislation and regulations. Although, another policy document, as well as the municipal respondent, do mention that the municipality would rather use 'the carrot than the stick' if possible (Gemeente Hoogeveen, 2017a; RMH, 2018).

Furthermore, the municipality has also improved the urban design of the public space. So were parts of the sewer system been replaced and upgraded to a shared system; has the amount and capacity of water retention areas in the city been increased (in blue and green infrastructure, as well as with green roofs); has the water structure in Hoogeveen been improved and more connected with one another and is the infiltration of rainwater into the ground been improved by installing, for example, permeable parking places. Furthermore, areas that are were causing problems during extreme precipitation events (e.g. speed bumps) have been adjusted accordingly. Additionally, in order to reduce pluvial flood damage, for new (re)development projects, building codes are now in place that dicate building heights to prevent flood water from entering these buildings. Finally, also in order to prevent flooding of streets, where possible, parts of the roads have been lowered so that precipitation can flow off the streets and be retained in surface water (Oranjewoud, 2010; Niezen & Hartemink, 2015b, Gemeente Hoogeveen, 2017a; RMH, 2018). A leading idea in taking these measures is that the urban water system (e.g. the sewer system) (Oranjewoud, 2010), green spaces and surface water (Gemeente Hoogeveen, 2017a), as well as other parts of the urban system are integrated and work together (Oranjewoud, 2010). The same also applies for policies as well, by integrating climate adaptation within them (Gemeente Hoogeveen, 2017a).

5.1.6 Aspects of resilience in the decision-making process and changes in stakeholder approaches (adaptation and transformation)

Durign the interview with the respondent from the municipality a major aspect of transformation that was found in the stance that citizens, as well as other private stakeholders, should also be included in regard to efforts to lowering the pluvial flooding risk (RMH, 2018) This viewpoint is also shared during interviews with respondents from the WDOD (RWDOD, 2018) and the Province of Drenthe (RPD, 2018) as well mentioned in different policy documents (Oranjewoud, 2010; Niezen & Hartemink, 2015ab; Waterschap Drents Overijsselse Delta et al., 2015; Gemeente Hoogeveen, 2017a; Waterschap Groot Salland et al., n.d.). By doing this, governmental stakeholders can increase the array of different options they have in the planning phase such as to include supporting citizen efforts to implement measures. This is already implemented by the WDOD (RWDOD, 2018), and considered by the Municipality of Hoogeveen (Respondent Muncipality Hoogeveen, 2018). Additionally, also education of citizens and raising awareness about the role they have in pluvial flood prevention are aspects that have gained more attention now as well (Niezen & Hartemink, 2015a; RMH, 2018). Finally, the municipal respondent (2018) also explained that in order to make plans tailored to the local situation, where and when possible, dialogues should be started with local inhabitants in order to 'activate' them to also take measures themselves, and to work

together with them and incorporate this in the local urban spatial design. An additional benefit of these dialogues is that these can potentially lead to new ideas (Gemeente Hoogeveen, 2017a), thus potentially leading to new insights and approaches.

Furthermore, adaptability aspects were also found within the context of Hoogeveen. This is firstly because changes were made to the spatial design after pluvial flooding events happened in the last years (RMH, 2018). These changes were however a continuation of already existing techniques (e.g. water retention, shared sewer system etc.) (Oranjewoud, 2010; Niezen & Hartemink, 2015b; Gemeente Hoogeveen, 2017a) and thus fall within the adaptation aspects of resilience. However, underneath these measures lay transformative aspects as another viewpoint that is gaining momentum as well: looking at pluvial flooding problems and solutions through a multi-disciplinary, integrated lens (Gemeente Hoogeveen, 2017a; RMH, 2018). In the past, pluvial flooding responsability was normally housed in the department responsible for sewer management. However, new insights point out that the urban blue-green infrastructure (beside the public grey spaces) should play a role in solutions as well (Waterschap Drents Overijssele Delta et al., 2015; Gemeente Hoogeveen, 2017a). As such, other departments in the municipality or the water board also needed to be involved due to a diversifying in required knowledge (e.g. ecology). This in turn can, and most likely will, also lead to new information needs, as new potential stakeholders may be involved that can provide input, who may have their own needs in terms of information. Furthermore, this has also led to the creation of the policy document 'Klimaatrobuust Hoogeveen'. This was according to the respondent from the municipality (2018) the first time the city attempted to create a document that has climate adaptation as its own focus rather than being housed in for example a sewer-plan (translation: grp). This underlines the transition towards disciplinary integration within the municipal organisation. For the WDOD and the Province of Drenthe this is more difficult to spot due to the limited space and role they have in regard to urban pluvial flooding. However, for the WDOD, one of the policy documents does point out that the role of water boards is changing from an active to a more supportive role (Waterschap Drents Overijsselse Delta et al., 2015).

Finally, the learning capacity of the stakeholders was also be found in the case study in way of how they integrated new knowledge and approaches to previous experiences. This especially after their past experiences with pluvial flooding. The aftermath showed that stakeholders were open to learn from the event in order to improve the spatial design of vulnerable urban areas, as well as making changes in the how to approach pluvial flood resilience (e.g. involving citizens). As such during a later extreme precipitation event these locations were not flooded again (e.g. the location near the hospital). This also served as feedback for the effectiveness of spatial measures taken, and as conformation that taken interventions helped to improve the urban pluvial flood resilience. (RMH, 2018). However, between the interviewed stakeholders differences can be found as the WDOD and the Province are more conservative when it comes to adapting new information and insights (RWDOD, 2018; RPD, 2018) whereas the Municipality of Hoogeveen has a more progressive stance (RMH, 2018).

5.1.7 Visualization of the results from the Hoogeveen case study placed within the conceptual model

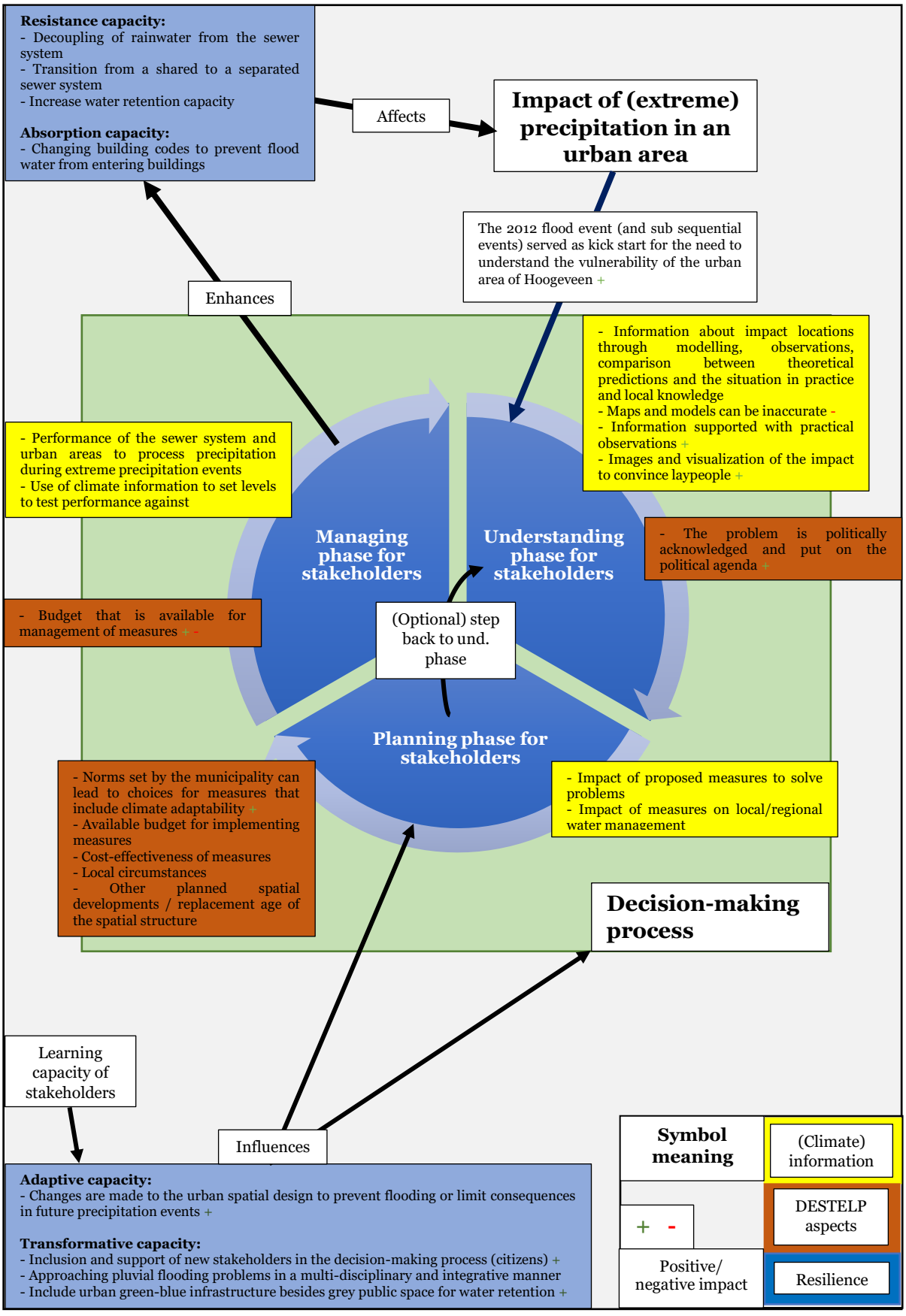

Figure 39: Conceptual model adapted to the case results of Hoogeveen

5.2 Governmental stakeholders – Findings in the Meppel urban area case study

5.2.1 Role of stakeholders in the case study

Municipality of Meppel

According to the respondents from the Municipality of Meppel, the role that the municipality has towards pluvial flooding is to collect precipitation that falls in the city and ends up in the public area with the urban sewer system or to retain it. Additionally, the municipality was, at the time that the interview was held, also looking into joining the Operatie Steenbreek movement. This could then increase the scope of role the municipality now has by adding raising awareness and education of citizens about their potential contribution to this role (RMM, 2018). This last aspect is also supported by the policy document 'Watertakenplan Fluvius 2016-2021 - Specificatie Meppel' which states that the municipality need to try informing and advice citizens in an active way, as well as answering questions citizens have for the municipality (Niezen & Hartemink, 2015c). The document furthermore also explains that the municipality can also create and implement new policies that can help reduce the pluvial flooding risk in urban areas. This is further supported by another policy document that explains that the municipality is responsible for the creation of extra retention capacity in the case of spatial redevelopment, if this is deemed necessary (e.g. large amount of hardened surface is added) (Oranjewoud, 2009).

Water Board Drents Overijsselse Delta (WDOD)

As the WDOD's working area encompasses both the cities of Meppel and Hoogeveen, the role described about how the WDOD operates in relation to pluvial flooding in the previous paragraph is also valid for the city of Meppel.

Province of Drenthe

As Province of Drenthe's working area encompasses both the cities of Meppel and Hoogeveen, the role described about how the Province of Drenthe operates in relation to pluvial flooding in the previous paragraph is also valid for the city of Meppel.

Collaboration between governmental stakeholders

Any collaboration between the WDOD and the Province of Drenthe as was described in the previous section is also valid for the city of Meppel. Furthermore, the Municipality of Meppel and the WDOD are both active in the work region collaboration called Fluvius (Respondents Municipality Meppel 2018). Therefore, this collaboration, as explained in the Hoogeveen case study, is also applicable for the Meppel case study.

Furthermore, the municipality collaborates with the WDOD. The respondent from the WDOD mentioned as example that the WDOD and the municipality have together created a water retention area at the edge of the city (RWDOD, 2018). Additionally, the municipality uses the 'WDOD Klimaateffectatlas' which is a form of advice and support from the WDOD (RMM, 2018). The WDOD furthermore also provides advice with the water test which gives input to the municipality about the impact that urban spatial developments can have on the regional water system (Waterschap Drents Overijsselse Delta et al.,2015; Niezen & Hartemink, 2015c; RWDOD, 2018).

Finally, the municipality also works together with so-called 'neighbourhood platforms' (translation: wijkplatforms) through which residents of a neighbourhood are represented and discuss about problems that exist within neighbourhoods in the city. These groups are recognized by the respondents as a potential important future group of stakeholders for raising awareness regarding pluvial flooding and how citizens could help to reduce pluvial flooding risk (RMM, 2018). This development is also supported in a policy document that argues that the knowledge of property owners can be used to give input for taking spatial measures (Niezen & Hartemink, 2015c), as well as that citizens should be more involved in the process (Niezen & Hartemink, 2015a).

5.2.2 The understanding phase

For the WDOD and the Province of Drenthe, any statements about factors that may have an impact in the decision-making process of these stakeholders specific that are already discussed earlier in the Hoogeveen case-study are also applicable for the Meppel case study and will therefore not be discussed again. This is also true for the rest of the section.

During the interview with the respondents from the municipality of Meppel (2018) it was mentioned that the municipality hasn't experienced an extreme precipitation event that could lead to a pluvial flooding in recent years. As such, they lack the practice experience that for example the municipality of Hoogeveen has. Therefore, all knowledge about potential vulnerable locations for experiencing pluvial flooding are modelled assumptions. This knowledge is gained through modelling the performance of the sewer system and urban design (Niezen & Hartemink, 2015c; RMM, 2018). Unfortunately, the respondents do point out that the data that served as input for these models (e.g. sewer characteristics etc.) was incomplete at the time and that therefore real-life experiences may differ from these modelling outcomes. Additionally, the respondents also pointed out that citizen complaints will also be used to pinpoint and gain knowledge about potential problematic locations if pluvial flooding would occur. Finally, the Klimaateffectatlas that is developed by the WDOD is a source of information that the respondents can utilize. However, one of the respondents (2018) does admit that the current maps that show the impact of (extreme) precipitation events dooes not provide enough information to base decisions on. This is since these maps lack information about the urgency and amount of damage that is caused by pluvial flooding. Therefore, the information in this phase is mainly used to locate vulnerable locations in the urban area.

Another influencing factor in the Meppel case was the the lack of pluvial flooding on the political agenda. The respondents from the municipality (2018) pointed out that the necessity to act in the urban area of Meppel was not yet felt by local politicians (as opposed to the civil servant side of the organization). This is due to the earlier mentioned lack of experience with pluvial flooding in Meppel. Furthermore, this believe is reinforced due to lack of understanding by local politicians on how pluvial flooding can occur. The respondents explained that politicians thought that large investments done in the regional water system in the aftermath of the near-flooding from the regional water system of 1998 were sufficient. As pluvial flooding is a different type of flooding, these measures do not affect the pluvial flooding risk of urban areas. This misunderstanding made it difficult to add adequate measures in spatial (re)development projects. However, after the latest municipal elections in 2018, a new city council was installed and in their new programme climate adaptation, which covers extreme precipitation, has gained a more prominent place. This shows that the topic is now more present on the political agenda. However, the respondents do have the idea that an extreme precipitation event in the urban area of Meppel could be helpful for bringing attention to the problem. Additionally, images of extreme precipitation impacts, as well as cases from elsewhere in the Netherlands could also help to activate local politiancs to have more awareness for what these events can cause (RMM, 2018).

5.2.3 The planning phase

For the planning phase, as was also found in Hoogeveen, local circumstances also play a large role in determining which measures can be implemented where. For a large area of Meppel, for instance, infiltration of precipitation into the ground is not viable because high groundwater levels limit the storage capacity of the underground (Niezen & Hartemink, 2015a; Niezen & Hartemink, 2015c; RMM, 2018). Another leading factor that affects where and when measures are taken are when other spatial (re)development projects take place, as was also found in Hoogeveen (Oranjewoud, 2009; Niezen & Hartemink, 2015a; RMM, 2018). Additionally, the cost of measures and the increase in the total project costs versus the amount of money that can be earned with housing development is also mentioned as an important factor. This is mostly politically and connects to the earlier point made that local politicians in the past lacked a good understanding of why these measures are necessary and were seen as expensive and unnecessary (RMM, 2018). Finally, climate information is used to establish norms and a baseline against which proposed spatial interventions can be measured against (e.g. by looking at the effectiveness of measures to retain water, as well as the predicted amount of water that would need to be retained) (Oranjewoud, 2009; Niezen & Hartemink, 2015a; Niezen & Hartemink, 2015c).

Additionally, as already mentioned above, the municipality also has dialgues with so-called 'neighbourhood councils' about problems that exist in their neighbourhoods (RMM, 2018). These dialogues with citizens can help during the planning phase to create more tailored plans. These should not only improve the resilience of these urban areas against pluvial flooding, but also take wishes from citizens into account for improving their living environment, thereby increasing the acceptance of interventions in the areas.

5.2.4 The managing phase

In this phase, information is gathered about the effectiveness of the urban area in practice to reduce the pluvial flood risk through its sewer system, surface water system, and spatial design through the use of modelling, calculations and (lack off) complaints from citizens (Oranjewoud, 2009; Niezen & Hartemink, 2015c; RMM, 2018). As is also the case for Hoogeveen, this part overlaps with the first phase as evaluation and subsequent conclusions can lead to a new round of information gathering and subsequent steps if the performance is not deemed adequate. This was also the case after performance measurements in Meppel in 2009, that led to a new round of planning and implementation of spatial measures to improve the performance where necessary. Climate information in that case served as a norm to determine whether the performance was passible for the future (Oranjewoud, 2009; Niezen & Hartemink, 2015c).

Additionally, information is also needed for the management of spatial measures. This information focusses on the management status of, for example, urban surface water. This in turn can help to gain insight in where management is needed, which in turn helps to improve the capacity of an urban area to retain water and thus the reduce pluvial flooding risk (Niezen & Hartemink, 2015c). Linked to this is also the management budget, as the costs must be manageable (Niezen & Hartemink, 2015c).

5.2.5 The enhancement of the urban pluvial flood resilience (robustness and absorption)

According to the respondents from the municipality of Meppel (2018), the view on pluvial flood resilience is a combination of processing precipitation through the sewer system, as well as retaining the water where necessary and possible. Important to note here is that the respondents are also aware that the sewer system can only partially solve the problem, and therefore of the necessity of retainment areas. As such,

decoupling is also seen as an important measure in Meppel, where water will instead be retained or allowed to flow to surface water via the road system. This is also supported by policy documents as spatial measures that are suggested in these documents besides decoupling also cover a transition towards a separated sewer system increasing its capacity as well as increasing retention capacity within the urban blue-green infrastructure (Oranjewoud, 2009; Niezen & Hartemink, 2015c; RMM, 2018). This transition towards a separated sewer system and decoupling of areas from the sewer system is also now standard included in new spatial developments in the urban area of Meppel (Niezen & Hartemink, 2015c). Additionally, also a water retention area has been developed in collaboration between the municipality and the WDOD on the northern border of the city (RWDOD, 2018), as well as retainment that occurs along the south side as well (RMM, 2018). Finally, drainage is also implemented in the urban area of Meppel to increase the quite limited retention capacity of the ground (Oranjewoud, 2009; Niezen & Hartemink, 2015c; RMM, 2018).

Additionally, for new spatial developments in the urban area of Meppel, the prevention of damage in the potential case of pluvial flooding is also given attention. This is done by making setting standards for building heights of new buildings to be high enough to prevent flood water from entering the building (Niezen & Hartemink, 2015c). This was for example done in a newer neighbourhood in Meppel (RMM, 2018).

5.2.6 Aspects of resilience in the decision-making process and changes in stakeholder approaches (adaptation and transformation)

While for the Hoogeveen case study it can be stated that a lot of measures are taken in urban areas to enhance the urban pluvial flood resilience, this is less the case in Meppel. This has to do with, as earlier mentioned, lack of political support to start adapting to the increasing threat to experience extreme precipitation and potentially pluvial flooding (RMM, 2018). However, what can now be observed in Meppel is a shift towards a more acceptance from the political side of the municipality to support adaptive action to be taken in the urban areas of Meppel. For example, the choice to add decoupling in spatial redevelopment, as well as the transition towards a separated sewer system and inclusion of blue-green infrastructure for water retention (Oranjewoud, 2009; Niezen & Hartemink, 2015c; RMM, 2018) can be considered as outcomes of this stance. Furthermore, the wish to join the 'Operatie Steenbreek movement' can also be considered here as well by including citizens. (RMM, 2018). However, when the interview was held this was still being discussed internally (RMM, 2018). This course taken by the municipality is also supported in policy documents used by the municipality of Meppel (Niezen & Hartemink, 2015a; Niezen & Hartemink, 2015c).

As such, it can be stated that about the aspects of adaptation and transformation, the Municipality of Meppel is not as far advanced as Municipality of Hoogeveen. However, new insights were discussed within the organization to keep up to date on new developments. However, as the person that did this now has a different function in the organization, question marks can be placed on whether this practice will continue in the future (RMM, 2018).

5.2.7 Visualization of the results from the Meppel case study placed within the conceptual model

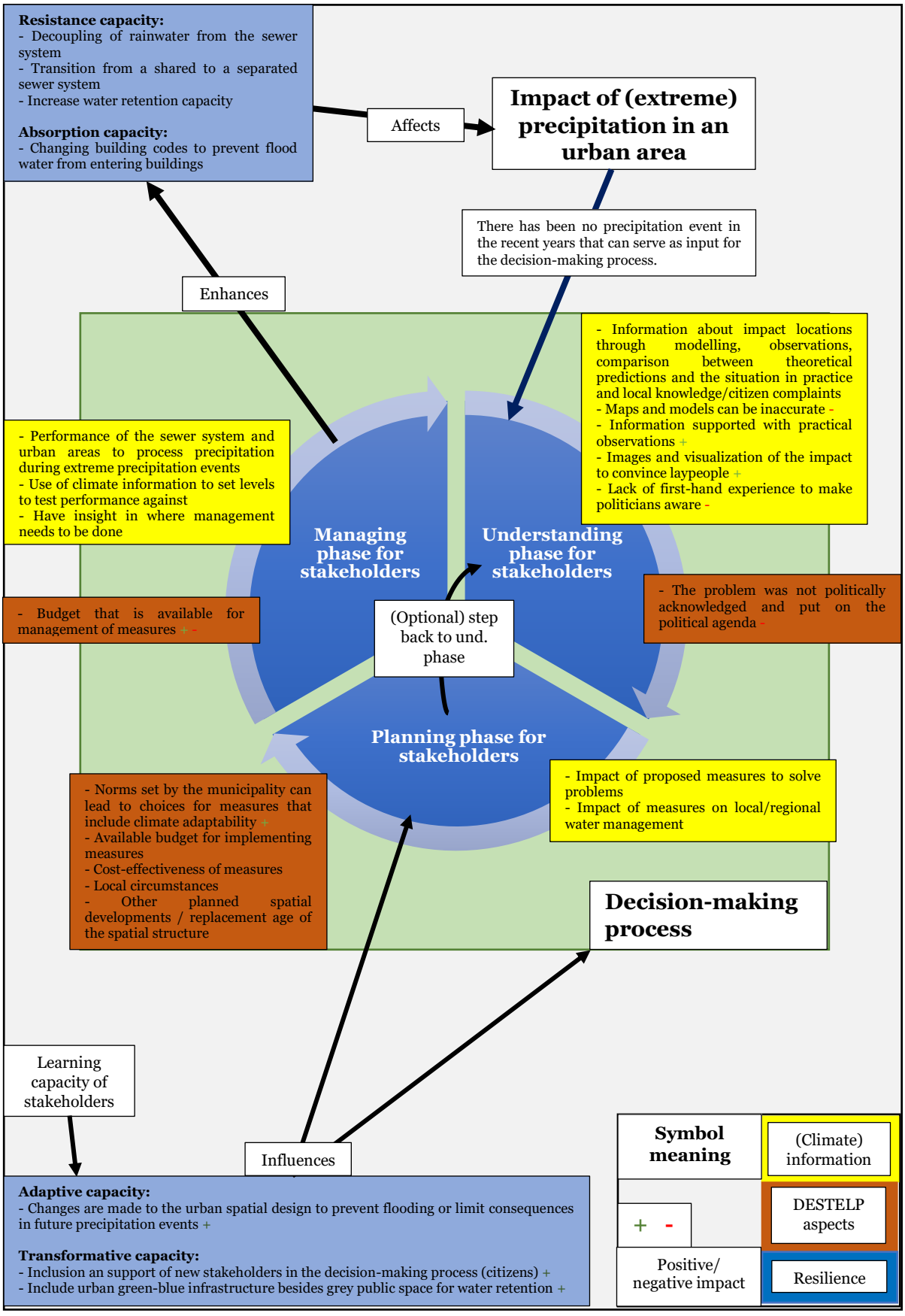

Figure 40: Conceptual model adapted to the case results of Meppel

5.3 Governmental stakeholders – Findings in the Drachten urban area case study

5.3.1 Role of stakeholders in the case study

Municipality of Smallingerland

According to the respondent from the municipality, on the one hand, they take spatial measures in the public spaces as well as making changes to the urban spatial design that reduce the pluvial flooding risk in the event of extreme precipitation (e.g. improving the sewer system, reducing hardened surface; expanding the blue-green infrastructure) (RMS, 2018). This is also supported by policy documents who give this same impression (De Kraker et al., 2016; De Vries, 2017; Gemeente Smallingerland, 2017). This active stance is also pointed out by the respondent from the water board Friesland (WBF) who states that the municipality Smallingerland is pro-actively looking for locations where pluvial flooding could potentially occur in the event of extreme precipitation and what measures could be taken (Respondent WBF, 2018) (From now on cited as RWBF, 2018). On the other hand, the municipality also focusses on raising the awareness of citizens through, for example, 'Operatie Steenbreek' which moves citizens to also take measures on private property, as well as supporting these actions financially. This is also supported by policy documents (De Kraker et al., 2016; De Vries, 2017; RMS, 2018). This is since citizens are seen in the first place as responsible for retaining the water that falls on their property (De Kraker et al., 2016). Therefore, it can be stated that the municipality takes a pro-active stance against pluvial flooding by taking measures and also activating other stakeholders in the urban area of Drachten to also take measures themselves through providing support in the form of financial resources and knowledge.

Water board Friesland

The WBF, according to the respondent, is actively taking measures in the urban areas of Friesland (including Drachten), as well as making municipalities aware of the importance of taking climate adaptation measures. Especially this advising role is something that the WBF has been focussing on for the last two years by having talks with municipalities (RWBF, 2018). Another way that the water board is also having an advising role is with the water test that is used to help advice municipalities about the consequences these developments have for the regional water system and the pluvial flooding risk (Waterschap Friesland, 2016; RWBF, 2018). For the active measures, this is mainly concentrated on the management and increasing the retention capacity of urban surface waters (Arcadis & Waterschap Friesland, 2014). However, as is also seen in the other cases, the municipality has in general a more active role in the urban area of Drachten, which is then supported by the WBF through advice and potentially also financial support as mentioned by the respondent during the interview (RWBF, 2018).

Province of Friesland

The Province of Friesland also has a more supportive role when it comes to pluvial flooding in the urban area of Drachten. This is pointed out by the respondents from the Province of Friesland, the WBF and the municipality (Respondent Province of Friesland, 2018; RWBF, 2018; RMS, 2018) (Respondent Province of Friesland is from now on cited as RPF, 2018). This supportive role is also mentioned in policy documents which state that the frameworks by which measure development must take place, as well as the norms that serve as the standard for these measures are provided by the Province. The municipality then must act to make sure that the spatial design in the urban areas can hold up to these norms (Provincie Friesland, 2016; Province of Friesland, 2018; RMS, 2018). The Province however does make these frameworks and norms in collaboration with the municipality to make sure that they are realistic to be met (RPF, 2018).

Collaboration between governmental stakeholders

First, the municipality works together with the WBF in the urban area of Drachten. This is both on a strategic level, as well as on a operation level. For example, one of the leading policy documents regarding pluvial flooding in the urban area in Drachten, 'Gemeenschappelijk Waterplan Smallingerland' is a collaborative document written by these stakeholders. Additionally, the WBF also finances part of the measures taken in the urban area (De Vries, 2017; RMS, 2018). On a more operation level, the sewer system is also acknowledged as part of the water system and is thus managed by both the municipality and the WBF (De Kraker et al., 2016). Finally, talks also take place between the municipality and the WBF about the approaches on measures in the urban area. These talks are done by people representing the Municipalities in these talks, so-called 'water ambassadors' (RWBF, 2018).

Furthermore, there is also collaboration between the municipality, the WBF and the Province of Friesland as these stakeholders all worked together on performing the province-wide 'stresstest' which gives insight in the potential vulnerable locations (RPF, 2018). However, the respondent from the WBF does point out that the Province did not had a leading role in this process. Finally, these stakeholders also sometimes participate together in awareness projects towards citizens (e.g. Operatie Steenbreek). However, the municipality is leading in this, and the WBF and the Province will mostly contribute financially or help by providing people or knowledge (RPF, 2018; RWBF, 2018).

5.3.2 The understanding phase

As was also found in Hoogeveen, the city of Drachten has also experienced pluvial flooding due to extreme precipitation events in the recent past (RMS, 2018; RWBF, 2018). According to the respondent from the municipality (2018), these events served as a practice example about whether the urban spatial design, as well as water retention areas and the sewer system function as planned, or whether there are still vulnerable areas. This then complemented the model outcomes of the sewer system, urban surface water system and measurement of groundwater levels within the urban area (De Kraker et al., 2016; RMS, 2018). However, the respondent (2018) does admit that these models use assumptions and are therefore never 100% accurate, an observation also found in the other case studies (RMM, 2018; RMH, 2018; RPD, 2018; RWBF, 2018). Therefore, these outcomes should be supported by practical input and past experiences in order to determine determine the urgency of the problems in the areas at risk (e.g. a flooded grassfield versus neighbourhood) (RMS, 2018). Other stakeholders (e.g. citizens or other interest groups) can also provide input. This could be for example by sending pictures of pluvial flooding events so that the municipality has an indicator for how urgent a situation is (De Kraker et al., 2016; De Vries, 2017; RMS, 2018). However, the respondent does also point out that pictures only show a snapshot of a situation and not how long water stayed on the street. This perspective is also supported by the respondent from the WBF (2018) who mentions that a good insight in the case is necessary in order to determine whether action is required. Furthermore, last summer (2018), the Friesland-wide version of the 'Klimaateffectatlas' was published for use internally by governmental stakeholders (RMS, 2018; RWBF, 2018; RPF, 2018). However, the respondent from the municipality (2018) does acknowledge that their own models for internal use are more detailed than the Klimaateffectatlas, and therefore this new atlas will not be used as frequent to base decisions upon. Finally, also the KNMI climate scenarios are used to have a general idea about how the climate may develop itself into the future (Arcadis & Waterschap Friesland, 2014; De Kraker et al., 2016; RMS, 2018).

Additionally, there is also political support for taking measures against pluvial flooding within the municipality of Smallingerland (RMS, 2018). According to the respondent, policy plans are passed easily and do not lead to heavy debates. This can be contributed to not only providing information by civil servants to politicians, but that also internally information is passed through to new politicians as well

(RMS, 2018). However, as opposed to the other two case studies, the respondent from the municipality explains that in terms of providing information to politicians, maps that show risk locations are more than enough (RMS, 2018), whereas in the other two cases images and visualization are seen as more important (RMH, 2018; RMM, 2018; Appendix VI). However, in the Drachten case it is pointed out by the respondent (2018) that communication with politicians need to happen without the inclusion of technical terms as, in the end, politicians are (most likely) laymen in the subject in terms of understanding problems on a technical basis and in-depth.

5.3.3 The planning phase

During the planning phase, a combination of several factors, as well as inputs affect the decision-making process for the urban area of Drachten. Firstly, knowledge and insight about the local environmental characteristics (e.g. soil characteristics, groundwater levels, height of the surroundings) serves as input to base decisions on regarding the type of pluvial flood measures (De Kraker et al., 2016; De Vries, 2017; RMS, 2018). Furthermore, the experiences other local municipalities have with pluvial flooding are also used as input to have an indication of what works or what potential problems are with certain measures. The same is true for projects done by the municipality itself as well (De Vries, 2017). This insight in what does or doesn't work can then help to make choices between the different options that are available. Additionally, the respondent (2018) also point out that if new insights and information are come across at this pont, if they are deemed necessary, a step back can be made to the understanding phase. This can be considered a feedback loop back towards this phase.

The respondent from the municipality (2018) also acknowledges that changes to the spatial design are following spatial (re)development efforts as otherwise money is wasted by breaking open (relatively) new roads. This perspective is also supported by policy documents (e.g. De Kraker et al., 2016). However, if the case is urgent enough (e.g. there is a high risk on damage or costs) then this can be leading instead and therefore overrule the replacement age (Gemeente Smallingerland 2017; RMS, 2018). Linked to this is also information about the cost-effectiveness of measures which also plays a role in deciding which measures need to be implemented where (Arcadis & Waterschap Friesland, 2014; De Kraker et al., 2016). Additionally, demographic and societal developments also serve as information for the potential increase of housing in the urban area of Drachten which in turn may lead to an increase of hardened surface in this area as a result (Gemeente Smallingerland, 2014; Waterschap Friesland, 2016; Gemeente Smallingerland, 2017; RMS, 2018). This information in turn can change the desired approach for a location (e.g. focus on reducing the amount of hardened surface on private property rather than finding solutions in the public space). Finally, norms for when action is required are also necessary (De Kraker et al., 2016). This is since pluvial flooding situations can be considered acceptable (e.g. a street is only flooded for 20 minutes and there is no damage to properties) (RMS, 2018).

Furthermore, the WBF, as is also the case with the WDOD in the other case, provides feedback on spatial developments done by the municipality in urban areas via the water test as was also found in the other cases (De Kraker et al., 2016; Waterschap Friesland, 2016; RWBF, 2018). This in turn also helps with the selection of certain measures over others. Finally, citizens can also give input about different measures that are desired in a neighbourhood (De Vries, 2017; RMS, 2018). This can then, according to the respondent (2018) lead to citizen involvement as their ideas can be realized if there is enough local support from neighbourhood residents for implementation of spatial measures such as surface water bodies. Similar stances are also found in policy documents (Waterschap Friesland, 2015; Provincie Friesland, 2018) which support the inclusion of societal wishes within spatial development plans.

5.3.4 The managing phase

During the monitoring phase, the performance of the spatial measures in the urban system are tested after their implementation. These are the sewer system, urban surface water system, urban green infrastructure and the urban spatial design (De Kraker et al., 2016; De Vries, 2017; RMS, 2018). These outcomes can then in turn be used again as input for a potential new round of measures if this is deemed necessary. As seen in the previous cases as well, climate information (e.g. predictions and historical data) serves as a baseline to test the system against (RMS, 2018). Furthermore, also information that is necessary for the maintenance and management of the different parts of the system such as the status of the system in general (Gemeente Smallingerland, 2015; Gemeente Smallingerland, 2017). This in turn affects the necessary costs for replacement and repairs, as well as the necessary budget that is needed to cover these expenses.

5.3.5 The enhancement of the urban pluvial flood resilience (robustness and absorption)

As mentioned earlier, the municipality makes changes to the urban spatial design of Drachten. This is done for example by making roads as narrower to reduce the amount of hardened surface in the public area, thus allowing more precipitation to infiltrate in the underground, or by retaining the water in green areas that can be extended into this previously occupied space. This also happens in conjunction with, for example, the replacement of a sewer system (RMS, 2018). This replacement can be also in combination of upgrading the sewer system to a separated one (Gemeente Smallingerland, 2014; De Kraker et al., 2016; Gemeente Smallingerland, 2017). Furthermore, the municipality also focuses on decoupling urban areas from the sewer system to increase its processing capacity. Additionally, the municipality is also busy with the development of more surface water in urban areas to improve the water retainment capacity. Important here to note is that these developments happen throughout a neighbourhood, rather than creating 1 or 2 water bodies (Arcadis & Waterschap Friesland, 2014; De Vries, 2017). Finally, drainage is implemented to increase the capacity of the ground to hold precipitation (De Vries, 2017; RMS, 2018). These measures all help to decrease the chance of pluvial flooding to occur in the urban area of Drachten and thus improve the robustness of this area.

On the other hand, the municipality also created norms for new housing development that helps to heighten house entrances above the street level to prevent flood water from entering the building in the case of pluvial flooding (De Kraker et al., 2016; RMS, 2018). This is done for (re)development in the urban area (RMS, 2018) and promoted by the Province of Friesland (Provincie Friesland, 2016). This in turn improves the absorption capacity of an area by reducing the potential consequences if pluvial flooding does take place. Finally, in the event of new spatial development, 10% of the added hardened surface must be compensated by surface water to limit the impact the added hardened surface will have on the pluvial flood risk (De Vries, 2017), an approach also seen in Meppel (Oranjewoud, 2009).

5.3.6 Aspects of resilience in the decision-making process and changes in stakeholder approaches (adaptation and transformation)

Just like in the other cases, there is also a shift present towards governance through an increasing role for citizens to reduce the pluvial flood risk in the urban area of Drachten (Waterschap Friesland, 2015; Waterschap Friesland, 2016; De Kraker et al., 2016; De Vries, 2017; RMS, 2018; RWBF, 2018). This shift is also supported by the municipality as they provide subsidies for green roofs for citizens, as well as through awareness raising and providing information (De Kraker et al., 2016; De Vries, 2017; RMS, 2018). Furthermore, pluvial flooding prevention is also approached in Drachten in an integrative and multi-

disciplinary way that encompasses multiple areas of the public space (e.g. making use of both blue and green infrastructure). Finaly, pluvial flood prevention is focusing on improvements and innovation through implementing and experimenting with new and innovative measures rather than only 'old' conventional ones. (RMS, 2018).

Additionally, the respondent from the municipality also mentioned that new insights in climate change (impacts) are used to improve plans, measures and policies. As such, the organization's decision-making process can be changed these changing circumstances. This is also seen within the organization as a good reason for extending deadlines for measures and plans, as it makes sure that these are adapted to these new insights. Furthermore, in new projects these new insights are also standard implemented (RMS, 2018). Finally, there are also aspects of the learning capacity found in the fact that the municipality is using the experiences from the previous pluvial flood events in order to improve the urban spatial design, as well as to set standards for potential future events as well. This is further strengthened by using new insights gained from climate scenarios order to improve these standards (RMS, 2018).

5.3.7 Visualization of the results from the Drachten case study placed within the conceptual model

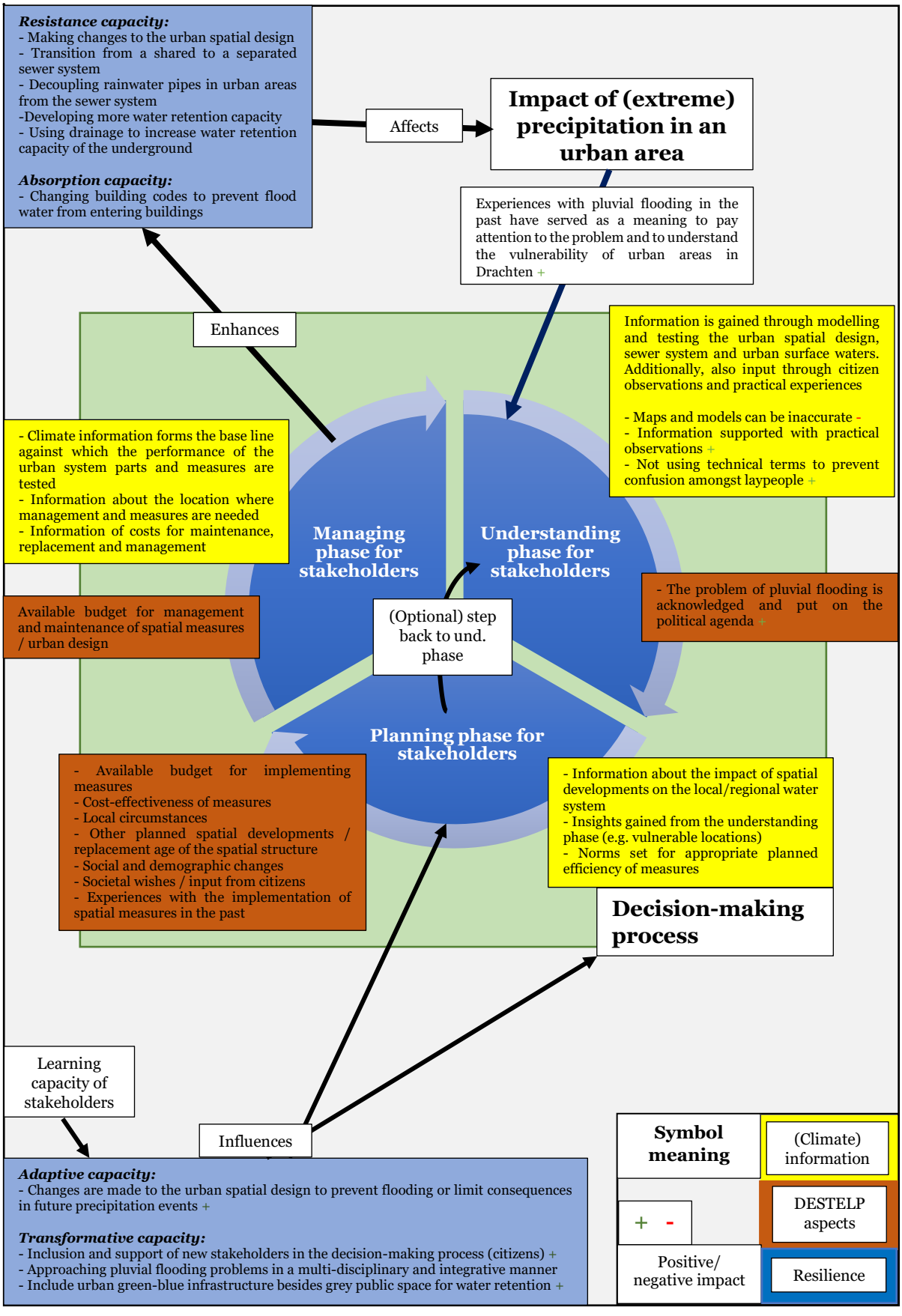

Figure 41: Conceptual model adapted to the case results of Drachten

5.4 Private stakeholders – Findings about citizens

5.4.1 Significant results from the binary logistic regression analysis and the interpretation of these results

As mentioned earlier in this chapter a shift can be seen towards governance with a role for citizens to reduce the pluvial flood risk in urban areas (RMH, 2018; RMM, 2018; RMS, 2018). This role is mostly located on the private properties that they own by taking measures that can improve the water retainment capacity of these areas, and to reduce the amount of hardened surface. Furthermore, respondents also mentioned that this role is supported through 'Operatie Steenbreek', as well as financial support (RWDOD, 2018; RMS, 2018) and knowledge (RMS, 2018). However, if citizens are not willing to take measures themselves it could also lead to higher sewer taxes as well in order to finance the extra measures that then need to be taken in public space (Niezen & Hartemink, 2015b; Gemeente Smallingerland, 2017). Additionally, citizens can also be forced to comply with decoupling through legislation and regulation if needed (Niezen & Hartemink, 2015b; RMH, 2018).

Another role that citizens have is providing knowledge to governmental stakeholders through dialogues (De Vries, 2017; RMM, 2018; RMS, 2018), complaints (Niezen & Hartemink, 2015b; De Kraker et al., 2016; RMH, 2018; RMM, 2018) and making use of the local knowledge embedded in the citizens (De Vries, 2017; Gemeente Hoogeveen, 2017a). This knowledge can then be used to develop measures that are tailor-made for their surroundings, or that also improve liveability aspects of their surroundings (RMH, 2018; RMS, 2018).

The variables that will be presented need to be seen from a governmental stakeholder perspective since these results can have an impact about how these stakeholders should communicate to citizens. This can be through raising awareness, presenting information about the role, etc. As citizens can also gain knowledge from other sources as well, it gives insight in which approaches the government could use, as well as how effective these are versus these other sources (e.g. the internet, the news, or talking with other citizens), as well as the experiences citizens have with pluvial flooding or demographic factors.

Results statistical analysis - Robustness enhancing measures

As earlier mentioned in the methodology chapter, a survey was held in neighbourhoods in the three cities that form the case studies in this research. From the analysis of these results the following results were found (note: the full analysis can be found in appendix VIII, and only significant variables are now mentioned). From this analysis, the following significant results were found to have had influence on whether respondents from the case study areas have implemented measures that either enhance the chance that pluvial flooding can occur in that local urban area (robustness measures; e.g. less hardened surface or water retainmens or infiltration on the property) or that lessen the consequences of a pluvial flooding event (absorption measures; e.g. stone floors or electricity sockets higher from the floor). These significant variables can be found on the next page in table 13.

The knowledge that extreme precipitation can lead to pluvial flooding and the influence it had on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
-9,318	0,000	0,005
The respondent gained knowledge about that extreme precipitation can lead to pluvial flooding through the news (on the tv or in a newspaper) and the influence it had on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
3,707	40,727	0,031
The respondent gained knowledge about that extreme precipitation can lead to pluvial flooding because someone told the respondent and the influence it had on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
-5,691	0,003	0,001
The respondent gained knowledge about the climate scenario's that will show future climate impacts in the Netherlands through the news (on the tv or in a newspaper) and the influence it had on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
3,042	20,937	0,006
The respondent gained knowledge about the climate scenario's that will show future climate impacts in the Netherlands because someone told the respondent and the influence it had on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
3,435	31,021	0,017
The respondent gained knowledge about the predicted impacts of extreme precipitation in his local area through scientific journals or policy documents and the influence it had on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
-6,807	0,001	0,014
The respondent gained knowledge about the predicted impacts of extreme precipitation in his local area through reading about it on the internet or seeing something about it on the tv (no news) and the influence it had on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
-6,385	0,002	0,010
The respondent gained knowledge about the predicted impacts of extreme precipitation in his local area through maps and the influence it had on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
6,524	681,609	0,019
The respondent gained knowledge about the predicted impacts of extreme precipitation in his local area through graphs and the influence it had on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
-7,621	0,000	0,023
The respondent gained knowledge about the predicted impacts of extreme precipitation in his local area through images & photos, and the influence it had on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
8,408	4482,445	0,006
The influence that a respondent has knowledge about the role that citizens can play to reduce the pluvial flooding risk on the respondent taking measures on their property that reduces the occurrence of pluvial flooding in their local surroundings.		
B	Exp(B)	Significance
-1,917	0,147	0,023
Nagelk**e**rke R	0,650	

Table 13: Significant variables from the binary logistic regression analysis that affect the robustness capacity of the local urban area (Source: Author)

This table 13 with outcomes from the binary logistic regression analysis present four values that are of interest for the research. These are:

Nagelkerke R	This value shows the explained variation in the dependent variable based on the model that is used (Laerd Statistics, 2018). As such it can be interpreted that with the above model 65% of all responses can be explained.
B	The influence that the independent variable has on the dependent variable. In this case it, for example, means the influence that the knowledge of respondents about the role that citizens can have to prevent pluvial flooding has on whether they have taken measures that enhance the robustness of their local urban area. This can be positive or negative, which will determine whether the influence is positive (e.g. if knowledge increases so will the amount of measures taken) or negative (if knowledge increases, the amount of measures will decrease).
B (exp)	This is the 'odds-ratio' and explains how the dependent variable is influenced if the independent variable is increased/decreased.
Significance	This value shows whether an outcome can be considered statistically significant, based on the used p-value (in this research, a value of 0,05 has been used). This is used to determine whether trends in the survey can be contributed to a sampling error or to characteristics of the population. As already mentioned, all outcomes mentioned in this chapter are significant.

Table 14: Explanation of the different values from the outcome of the binary logistic regression analysis that are of value for interpreting the results (Sources when applicable are mentioned in the table)

Based on these values several influencing factors are of interest for communication towards citizens. These are that:

- Citizens that are informed about the causes pluvial flooding in general, as well as about the predicted climate change impact scenarios in the Netherlands through the news, according to the analysis, would be more likely to take measures that positively affect the robustness of their properties. This in turn could also mean that municipalities or other governmental stakeholders don't always have to be the ones to communicate to citizens to make them more aware of pluvial flooding as they are themselves already aware and that therefore more focus could be put on what measures could be taken by them instead;

- Knowledge about the predicted climate change impact scenarios in the Netherlands is, according to the analysis, another influencing factor when citizens are told about it from other people though a conversation or a speech/presentation. As such, it can be stated that hearing about the impacts of climate change can also have a positive influence on whether citizens will take measures to improve the water retention capacity of their property;

- Knowledge about the predicted impacts of precipitation in their local area is seen, again according to the analysis as, an influencing factor when this information is presented through maps as well as photos or images. This last point is also supported by through input gathered from the workshop (appendix VI), during which it was pointed out that maps should be supported by a story, or that insight should be created of what it means in practice when, for example, there is a water level of 20 cm at a location.

Important to note here however is that awareness does not automatically lead to measures to be taken, as other environmental factors (e.g. income, experiences, local characteristics, own perspective and attitude on whether change is possible at all etc.) also ca play a role in whether a decision is made to

actually take measures in the end. This is also known as the 'attitude-action gap' (Mairesse et al., 2012) and receives attention from academia in the field of psychology as well (Kaiser et al., 1999).

Additionally, several other significant influencing variables are also present in table 13 but not mentioned in the text underneath. This is as can be read in table 13 (and later also in table 15) that their odds-ratio (Exp (B) in the table) has a value lower than 1 (and most of them even 0,003 or lower). This means that there is low likelihood of decrease of robustness measures taken if, for example, citizens are learning about the predicted impacts of extreme precipitation in their neighbourhood through scientific journals or policy documents due to the odds ratio being 0,001. This means for example that for the indepedant variable 'citizens learning about the predicted impacts of extreme precipitation in their local area through scientific journals and policy documents', the amount of measures taken would decrease by 0,6% (0,001 x 6,807) for each percentage of increase in the number of respondents. (Szumilas, 2010). However, as the odds-ratio (Exp(B) in the table) are low for these variables, this means that despite being significant the 'odds' of the outcome to occur when the outcome of the variable of interest (whether robustness measures were taken) is exposed to one of these variables mentioned in table the impact that these variables have on the dependent variable is almost negliglible (Szumilas, 2010). As such, these variables have is minor or even miniscule and will not be further discussed in this research. The same is true as well for variables with a low odds-ratio for the binary logistic regression analysis that was done for absorption enhancing measures.

Results statistical analysis - Absorption enhancing measures

For the absorption measures also a binary logistic regression analysis was performed (of which the full results can also be found in appendix VIII). Just like in the previous part, an overview of the variables that were significant will be given, which can be found in table 15.

The respondent gained knowledge about the fact that extreme precipitation can lead to pluvial flooding through their own experiences with pluvial flooding and the influence it had on the respondent taking measures on their property that reduces the potential consequences of pluvial flooding		
B	Exp(B)	Significance
-5,874	0,003	0,047
The respondent knows other people (family; friends; acquaintances; neighbours) that have experienced pluvial flooding that lead to street(s) near their property to flood, and the influence it had on the respondent taking measures on their property that reduces the potential consequences of pluvial flooding		
B	Exp(B)	Significance
6,886	978,624	0,028
The respondent is aware of the role citizens can have to reduce pluvial flooding occurrence and the influence it had on the respondent taking measures on their property that reduces the potential consequences of pluvial flooding		
B	Exp(B)	Significance
2,795	16,369	0,039
The living situation of the respondent (single or living together) and the influence it had on the respondent taking measures on their property that reduces the potential consequences of pluvial flooding		
B	Exp(B)	Significance
5,754	315,388	0,040
The average property value of a respondent and the influence it had on the respondent taking measures on their property that reduces the potential consequences of pluvial flooding		
B	Exp(B)	Significance
4,762	116,968	0,018
Nagelkerke R	0,664	

Table 15: Significant variables from the binary logistic regression analysis that affect the absorption capacity of the local urban area (Source: Author)

Based on the result of the binary logistic regression analysis that was performed (the full outcome can be found in appendix VIII), five variables were tested to be statistically significant (at a p-value level of 0,05), of which four are of interest for the research due to having a high exp(B) value.

- According to the analysis, the experiences that others had that were close to the respondents (e.g. family members or friends) with pluvial flooding in their surroundings that led to streets being flooded has potentially a major positive influence on whether absorption measures were taken.

- The awareness of respondents for the role, they have in reducing pluvial flooding in their local surroundings. Here, an increase of knowledge about this role, in theory, will therefore lead to more absorption measures to be taken.

- Finally, also the factors of whether a person is living alone or not, as well as the average value of the property are deemed influential. These two factors be potentially interlinked as a household with (potentially) two incomes can afford a higher valued property. The statistical results do point towards a positive influence for people that living together and have a higher value for their property will more likely also have taken measures that prevent or limit flooding consequences for their property.

5.4.2 Other factors that may have influenced why respondents may (not) have taken measures which could not be tested

During the survey, respondents were also asked about other factors that may have influenced their decision whether to take measures that affect either the robustness of the local surroundings against pluvial flooding or to enhance the absorption capacity of their property. However, these results cannot be analysed statistically due to being specific for whether measures have been taken by the respondent (which means that only a part of the respondents can answer the question), as well as that some of these questions had open answers. Therefore, only broad indications can be made based on these reasons.

Firstly, respondents also implemented robustness enhancing measures for aesthetic reasons such as wanting to have more green space on their property. This factor relates to answers given such as 'wanting to green the garden' or 'green gardens are more pretty than tiles'. Secondly, respondents also report that they have experienced pluvial flooding in the past or that water stayed after precipitation, and which a problem for these respondents. Thirdly, also regulations for the municipality, as well as attention on the news were reasons for implementing these measures. On the other hand, reasons for respondents for why they did not have taken measures vary, but were, for instance, contributed to a lack of knowledge about their role in pluvial flood prevention or what measures they could take themselves. This lack of knowledge could also contribute to the fact that respondents also did not always feel the necessity to take measures themselves. Furthermore, also a lack of time or financial capacity were also mentioned. Finally, about half of the respondents also declared that the reason why they have not taken measures was since robustness enhancing measures were already in place around the time, or that their property had enough unhardened surface for precipitation to infiltrate into the ground according to the respondents (table 28).

For absorption measures, respondents that had taken such measures, the most common reason mentioned was that they experienced damage from water in their house, or pluvial flooding in the vicinity of their property. This does however also have other reasons than pluvial flooding as leakage is also mentioned as well. Additionally, these measures can also be a secondary benefit as well as, for example, aesthetics are also named as a factor that influenced the implementation of stone floors in several cases. Respondents that did not take measures did mostly mention that they did not felt the necessity to take

such measures. Additionally, as a lack of knowledge about the potential necessity is mentioned as well, this could be affecting the previous mentioned factor as well. Finally, as these types of measures generally are large home improvement projects, the (potential) high financial cost of these measures was also seen by respondents as a reason why these measures were not implemented (table 28).

Chapter 6: Discussion and conclusions

" It is not easy to convey, unless one has experienced it, the dramatic feeling of sudden enlightenment that floods the mind when the right idea finally clicks into place. One immediately sees how many previously puzzling facts are neatly explained by a new hypothesis. One could kick oneself for not having the idea earlier, it now seems so obvious. Yet before, everything was in a fog."

- Francis Crick

6.1 The role and use of (climate) information in the decision-making process

This first section will cover the answer to the practical sub question: *How is available (climate) information used by relevant stakeholders in their decision-making process?*

6.1.1 The role and use of climate information by stakeholders

The role of climate information in the decision-making process of stakeholders for urban pluvial flooding focusses predominantly on the understanding and informing aspects of information use (Blake, 1999; Major & Atwood, 2004; Jackson, 2005; Crompton, 2008). This was found in the cases as climate information was often used to understand the impact of extreme precipitation in urban areas. This was found in all cases in both the interviews and in policy documents (e.g. Appendix VI, Niezen & Hartemink, 2015bc; RMH, 2018; RMM, 2018; RMS, 2018; RPD, 2018; RWBF, 2018; RWDOD, 2018). It also served to provide argumentation for making choices for measures during the planning phase. This information was supplemented by producers of climate information (e.g. municipality; experts such as specialized consultancy firms) (RMS, 2018; RWDOD, 2018) as well as through citizen participation (e.g. citizens complaining or sending in pictures/videos) (RMH, 2018; RMM, 2018). Furthermore, it was was also used to compare modelled situations with the situation in reality (Respondent Smallingerland, 2018). These uses of information are also mentioned in literature (Hegger & Diederink, 2014; Meadow et al. 2015; Star et al., 2016). Therefore, this research shows that this use of information, as described in these studies, was also found in the Netherlands and can help to, on one hand, tailor measures to local contexts by using local input and on the other hand serves to showcase the role and influence that citizen input can have on local spatial planning decisions (Mees et al., 2016; Dai et al., 2017b).

Additionally, climate information was also used as input for modelling to do the monitoring and evaluation of the performance of the urban sewer, surface water system and spatial design to handle extreme precipitation events (Oranjewoud, 2010; Nelen & Schuurmans, 2016; Niezen & Hartemink, 2015b; RMM, 2018; RMS, 2018). This takes place after measure implementation and can serve again as input for the understanding phase of the decision-making process. This is also reflected in the decision-making process presented by Moser & Ekstrom (2010) being a continuous cycle. As such, outcomes of the evaluation process lead to a repeat of the cycle if the outcomes do not meet the standards set by the stakeholder(s). Finally, climate information can also be utilized by governmental stakeholders for communication towards citizens for educational purposes, raising awareness, and making them aware of the role they have for reducing the pluvial flood risk (e.g. Operatie Steenbreek) (RMH, 2018; RMS, 2018). The transferred information in that case is an information input for the citizens own decision-making process. This use of information aligns with one of the information goals identified by Moser (2010) as information can be used for education or changes in the behaviour of the receiver.

However, as mentioned by Terpstra (2011), as well described in literature as the 'attitude-behaviour gap' (e.g. Kaiser et al., 1999; Mairesse et al., 2012), this information does not necessarily have to lead to desired changes. This is, amongst other things (e.g. the financial capacity of citizens to act), based on how information is framed, and whether it is applicable for the user. This is addressed in the cases as a focus was put on learning and explaining citizens about their role towards pluvial flood prevention (e.g. Respondent Muncipality Hoogeveen, 2018; RMS, 2018; RWDOD, 2018). This is seen as first step towards 'activating' citizens since they need to know why something is necessary before they can or will take measures. The outcomes from the survey analysis also support this as addressing the risk perception of citizens by showing them the impact of extreme precipitation may a positive influence on whether citizens will take measures themselves (appendix VIII). However, research (e.g. O'Sullivan et al., 2012) suggests

that even with a high awareness of the risk the may be exposed of, citizens may not lead necessarily to measures being taken when citizens believe that authorities need to take measures rather than themselves. This also connects to studies done in the Netherlands on this topic (OECD, 2014) as well as outcomes from the survey (half of the respondents did not know about their own role towards pluvial flood prevention). As such, following the points raised by Terpstra (2011) when communicating to citizens, this point must be addressed and solved first before additional information is communicated. Furthermore, the municipality could also evaluate their own stance towards taking measures as taking over the responsibilities of citizens have may lead to unintended passivity by citizens (Dai et al., 2017b), a stance also observed in the Netherlands in regard to for example fluvial flooding (OECD, 2014).

Also, transparent information about the potential damage that can be caused by extreme precipitation and the implementation costs of measures required. Especially this first aspect plays an important role when it comes to creating a sense of urgency, as well as prioritizing areas for implementing measures (Appendix VI; RMM, 2018). This in turn can then be used to convince other stakeholders of the necessity (e.g. politicians; citizens) (Appendix VI). This relates to the information goal of change and transformation mentioned by Moser (2010), as well as her mention of the importance of framing information. For communicating urgency, framing is important as it is about convincing stakeholders that certain choices may be more important than others. This rings especially true within the field of spatial planning due to the potential risk of having multiple spatial claims in a same area that may contradict one another such as economic growth, housing and nature (Campbell, 1996). The same is also found in both the Meppel case study (RMM, 2018) and in the talk with the respondent from the WBF (2018) who gave examples of municipalities choosing housing development and increasing economic wealth over including (sufficient) space for pluvial flooding measures in spatial (re)development projects.

Additionally, two potential usability-gaps (Lemos et al., 2012; Weaver et al., 2013) were found in the case studies. Firstly, between information that is available to the governmental stakeholders and their information need to understand the urgency of pluvial flooding events (Appendix VI; RMM, 2018). This gap is located around the lack of information about the impact of pluvial flooding in terms of damage done to property as this is currently missing in pluvial flood maps available to stakeholders. Additionally, when closing this gap, the provider of the added information should also consider information framing as well to convince political stakeholders that climate adaptive measures should be included. This was the case in Hoogeveen and Drachten, where politicians convinced via framing and using images and video to visually show them the impact of extreme precipitation (RMH, 2018; RMS, 2018). As such, the outcomes from the research show that information used by municipalities does not always uses the right communication goal, framing and information formats for use towards a more laypeople-based audience. This showcases the need in practice of providers of climate information to consider the use of the information by its users. For example, this could be done through dialogues between provider and user to create feedback loops that help to improve the usability of the information for the users (two-way communication) (Dillard & Pfau, 2002; Dunwoody, 2007; Moser, 2010).

A second usability-gap was found in the potential lack of accuracy in the modelling results of extreme precipitation impacts. This was addressed during several interviews and dialogues (Appendix VI; Province of Drenthe, 2018; RMH, 2018; RMM, 2018; RMS, 2018). This limits the usability of this information in planning practice. However, this gap is not easily closed due to difficulties with both data management and the amount of detail that is needed. Data management entails that all changes and variables to the sewer system or spatial design need to be documented and used as modelling input. Additionally, to accurately predict precipitation impacts, all street heights, sewer inlets, etc. would need to be added. However, this also requires a lot of manpower, and therefore financial capacity, to measure and document, a resource municipality only have a limited amount of. As such, the question then can be raised in whether this is necessary in the first place if an approximation is also possible, supported by information from

practice (Province of Drenthe, 2018; RMH, 2018; RMM, 2018; RMS, 2018). This is also supported by Dessai et al. (2009) and Foster et al. (2011) who acknowledge that precipitation modelling has inherent limits of accuracy and that policy makers should adjust to this by taking into account of the potential impacts rather than the modelled ones and thus building in capacity to cover potential differences between these. As such, both established literature as well as the research findings support the idea that in adaptive planning practice assumptions and estimations may be just as valid to base decisions on as precise information could be without going the extra mile, saving potential resources and manpower as a result.

6.1.2 The role and use of other relevant information

Besides climate information, also knowledge about the local circumstances and surroundings is needed as well as it allows spatial plans tailored to the local context (Niezen & Hartemink, 2015bc; De Kraker et al., 2016; De Vries, 2017; Gemeente Hoogeveen, 2017a; RWDOD, 2018). This makes sense from a spatial planning perspective as urban areas are built up by different layers that interact with one another ((under)ground layer, infrastructure layer and occupation layer) (VROM, 2001; Linden et al., 2004). As these different layers have a different rate in which they can change and adapt, 'upper' layers must adapt to these underlying layers (the local circumstances and surroundings affect the choices that can be made). Similar observations were also made by Runhaar et al. (2012) in that urban inflexibility can hinder climate adaptation efforts. This also further relates to aspects of local planning and decentralization as rather than using 'cookie-cutter measures' these plans are tailored to fit and make use of specific local surroundings. Furthermore, it also relates to the nature of pluvial flooding as well, as local circumstances (e.g. land use, terrain) (Heidrich et al., 2013; OECD, 2014; Tehrany et al., 2015), as well as the, often, local character of the flooding in urban areas requires a solution for the local causes of pluvial flooding (Dai et al., 2018b). However, these solutions do need to be placed in the larger regional perspective as well as, for example, water that is stored in the urban regional water system may potentially lead to flooding in different locations outside of the original area (Provincie Drenthe, 2014; RPD, 2018). This necessitates the collaboration between the local (municipalities) as well as the regional authorities (province, water board) within planning practice. A point also supported by Baker et al. (2012) and Nalau et al. (2015) who argue that in adaptive spatial planning a critical assessment of local cases should include taking these (potential) multi-level interactions into account.

6.1.3 Comparing the role and use of both types of information

When comparing the use of both types of information in the decision-making process, the first conclusion we can draw is that climate information is used mostly in the understanding phase, while other information (e.g. local circumstances) is required during the planning phase. Additionally, climate information also has a purpose in the managing phase by providing norms against which the performance of the spatial design can be tested against. Furthermore, the case study results also show that climate information and other information can be combined (e.g. the impact of extreme precipitation expressed in monetary costs). This use of information is also mentioned by Hamaker et al. (2017) as climate information can be operationalized in so-called 'climate services' that help to support decision-making.

6.2 The influence of information design of climate information on the decision-making process

This second section will cover the answer to the practical sub question: *How does the information design affect the use of (climate) information by relevant stakeholders in the decision-making process?*

Results from the case studies show that the used information format has a large influence on the information use in the decision-making process. Here especially a distinction can be made based on the inherent knowledge about the subject at hand that is present in the stakeholder that is using the information. The Hoogeveen and Meppel cases shows that for communicating information to laypeople, visualization and images work better than technical information (RMH, 2018; RMM, 2018). This was further supported by survey results as well, as the binary logistic regression analysis showed that for citizens images about the local impact of extreme precipitation, potentially combined with a flood height map, can have a potential positive influence on whether citizens did take measures that helped to enhance the robustness capacity of a local urban area, as well as hearing it from people in their vicinity who place the necessity in the larger context. (Appendix VIII). This relates to points raised by Moser (2010) and Hine et al. (2014), as considering the targeted audience is important for information transfer. Additionally, Corner & Clarke (2017, p.8) also agree to this by pointing out that "for many audiences, scientific language and technical figures are not helpful and that therefore reports should be made more engaging by using personal stories and images". By showing the influence these aspects can have in the decision-making process of relevant stakeholders in relation to pluvial flooding resilience, this research stresses the importance of choosing the right format to communicate (climate) information to stakeholders. Additionally, also other forms of communication besides maps should be considered as well, as the cases show a heavy reliance on maps while these may not be able to communicate some data all that well (e.g. the urgency of flood heights at a certain location as mentioned by the respondents of the Municipality of Meppel (2018)). These other forms of communication als relate back to the analysis results as these showed that for citizens these alternative forms of communication (e.g. hearing it from other people, the news or images) could also be potentially influencing factors on whether they took measures or not (Appendix VIII).

Additionally, when communicating information, the case study results also showed the importance of framing and setting the tone as part of the information design. This is especially the case towards politicians as they need to understand and feel the need to take measures in the first place (Appendix VI; RMM, 2018) as they are also the people that must approve the implementation of measures while civil servants having a more supporting role (Stalman & Ter Haar, 2013; Castenmiller et al., 2015). This fits within the political nature of the planning process (Albrechts, 2003), in which planners must navigate the political side of the decision-making process and be able to open and support dialogues between politicians and planning practitioners (Billger et al., 2017). As such, the findings of the case study show that the way how information is framed also helps to improve and speed up climate adaptive measures. This in turn may then also help to cross some of the political barriers mentioned by Runhaar et al. (2012) such as the competition with other spatial plans as well as potential unawareness of the issue by politicians. Therefore, when considering the framing of information towards the receiver, the battle for project approval may already be over by the time the plans are discussed in municipal meetings as was also the case in the Municipality of Smallingerland (RMS, 2018).

Furthermore, also the point made by Terpstra (2009), and already touched upon in the previous section, that certain communication goals can only be achieved when other ones have been accomplished earlier is a point that needs to be considered for developers of climate information. This is especially true for communication of information towards citizens as the survey results showed that approximately half

of the respondents did not knew about the role that they could play towards pluvial flood prevention on a local level (Appendix VIII). As such, this aspect can be considered crucial for governmental stakeholders if they want to communicate information towards citizens. Initiatives like 'Operatie Steenbreek' also focus on this (RMS, 2018), as well as by involving citizens (if possible, due to potential time constraints) when spatial (re)development takes place in the urban area (RMH, 2018). This also touches upon remarks made by Dai et al. (2018b) as making citizens more aware of their role will reduce the passivity of citizens. This is also found in the surveys as a part of the crespondents saw a larger role for governmental stakeholders to prevent flooding rather than acting themselves (Appendix VIII). On the other hand, involving citizens can lead to plans being much more likely to be implemented and supported (Wiseman et al., 2010; Baker et al., 2012). However, one note here that should be made, is that information should be v easy to find for citizens as information about potential financial support by the WDOD was difficult to be found by citizens and was thus not used as much as it could be by them (RMH, 2018), while this point is much more promoted by the Municipality Smallingerland in Drachten by comparison (RMS, 2018).

6.3 The influence of DESTELP factors on the decision-making process and comparison to (climate) information influence

This part will cover the answer to the following sub-question: *Which other relevant factors influence the decision-making process by relevant stakeholders besides (climate) information and its design?*

6.3.1 The influence of DESTELP-factors on the decision-making process

Demographical

Demographical factors influence the decision-making process as an increase of citizens living in an urban area affect the resilience of an area towards extreme precipitation due a potential increase of hardened surface. Although there is a part of uncertainty in these predictions (Simpson, 2012) the influence is nonetheless found in spatial planning questions such as housing demand. As the results from this research showed that housing development can be a lucrative business for municipalities, demographic changes can indirect lead to a decrease of resilience in urban areas against extreme precipitation if climate adaptation is given less attention over economical choices (Campbell, 1996). A point that has already been touched upon in section 6.1.1. Additionally, demographic changes can also have an effect regarding the economic factors since taxes are raised in the Netherlands to finance measures such as an upgrade of the sewer system or interventions done in public spaces (Gemeente Smallingerland, 2017). If urban areas experience a potential in- or decrease of citizens, the amount of taxes are also adjusted accordingly (Dai et al., 2017b). Therefore demographic changes can make it easier to finance measures with increased tax revenue; can increase the financial pressure on citizens to keep the same budget with a decreasing amount of taxable citizens, which in turn may make it more difficult for them to invest into measures on their own property; or the budget may decrease overall, which may lead to less, or alternative measures, being taken, or that the performance of measures will decrease due less managing being able to be done.

Economical

Linked, or almost intertwined with the political role is the economical aspect in decision-making. This was most clear in the interviews with the respondents from the Municipality of Meppel (2018) and the WBF (2018). This is since economic growth and profit sometimes overrule other influences on the decision-making process and can therefore lead to decisions that may not be in favour of promoting climate adaptive measures to be taken in, for example, the development of new neighbourhoods. In this economic aspect we can also find the damage in monetary costs which is seen by governmental

stakeholders as an important criterium for prioritizing areas to implement measures (Appendix VI). Furthermore, the cost-effectiveness of measures was also mentioned as a factor that may influence the choices made. This comes in the way that interview respondents mentioned that spatial redevelopment projects due to the replacement age of the urban spatial design are leading, as by implementing measures in combination prevents financial resources to be wasted (RMH, 2018; RMM, 2018; RMS, 2018). Biesbroek et al. (2011) also found financial resources to be a potential bottleneck as well for implementing spatial measures by governmental stakeholders. Additionally, the binary regression analysis, as well as answers given by respondents (table 15; table 28) showed that financial aspects could also be an important influence on whether citizens will take measures themselves.

Social

In the past, the cities of Hoogeveen and Drachten have experienced pluvial flooding within their urban area (RMH, 2018; RMS, 2018). This has resulted in steps being taken to reduce the vulnerability of urban areas here against pluvial flooding, as policy documents that help towards this goal (De Vries, 2017; Gemeente Hoogeveen, 2017). In contradiction, the city of Meppel, which has not experienced pluvial flooding in the recent past lacked this specific focus on pluvial flooding (RMM, 2018). This leads back to the municipality as organization having less experience with this type of flooding, as well unawareness of the phenomenon amongst local politicians and thus having a lower risk perception on these types of events. This is seen in other research as a potential climate adaptation barrier in and outside of the Netherlands by local governments (Werner & Plepp, 2006; Runhaar et al., 2012; Biesbroek, 2014), which this research further confirms. As such, the social aspects may therefore directly interfere with the decision-making process due to the lack experience, as well as subsequent also the political factors by leading to political unawareness and low levels of risk-perception of the precipitation impacts in urban areas amongst local politicians (Werner & Plapp, 2006; Orr et al., 2015; RMM, 2018). Finally, experiences with pluvial flooding by people that respondents were acquainted with also has a potential positive influence on whether they take measures themselves that help to reduce the consequences of pluvial flooding to their own property, which shows that social factors also impact the decision-making process of citizens.

Technological

Technological factors play a small role in the decision-making process in the case study areas. This influence mainly has to do with the lack of accuracy present in predicting and modelling precipitation impacts (Appendix VI; RPD, 2018) as the technology to accurately predict potential flooding is not there yet (Golding, 2009; Moser & Ekstrom, 2010; Thaler et al., 2019). This means that there is still uncertainty in decision-making in whether choices made are the right ones when based on modelling results. This has also been identified by Eliasson (2000) whose research sees the lack of easily accessible information for planners as a constraint in the spatial planning process. Furthermore, technological developments are occuring and promoting these developments has a place in the national core policy document regarding climate change adaptation in the Netherlands (I&W, 2018). However, Dessai et al. (2009) and Foster et al. (2011) do mention that more improved accuracy is not necessarily needed as climate information can also have a more signaling function and that stakeholders can always adjust to this accuracy by heighten the standards that the urban design should be able to withstand manually.

Environmental

Environmental factors also play a role in the planning phase due to the influence they have towards choosing options as most spatial planning interventions and measures need to be fitted in an already existing physical environment. This is of course a logical endpoint since pluvial flood risk is context

dependent on amongst other factors, the physical and spatial features of a place (Immink, 2005; Wiering, 2006; Heidrich et al., 2013; Tehrany et al., 2015). The results as such, therefore, as mentioned in section 6.1.2, information about these factors is useful for plan-forming and informing about the usability and feasibility of measures at vulnerable locations. Additionally, the notion made by Linden et al. (2004) is also of importance here as environmental factors such as the landscape of the area are defining for the choices of measures that should be made. A notion also found in the case studies (Niezen & Hartemink, 2015bc; De Kraker et al., 2016; De Vries, 2017; Gemeente Hoogeveen, 2017a; RWDOD, 2018)

Legislative

Legislative factors were also found to have an influence on the decision-making process. For example, the respondent from the WDOD (2018), as well as the respondent from the Municipality Hoogeveen (2018) spoke about having to act when severe pluvial flooding would occur due to problems in the spatial design or surface water management. This in turn would then also lead to certain measures being taken at locations that would normally not be considered that quickly or would overrule the decision-making process as governmental stakeholders are in these cases legally required to act. This also links back to the acceptability of pluvial flooding in urban areas to a certain degree as Dutch law dictates that in certain situations the situation cannot be accepted and the municipality or water board will therefore need to act by taking spatial measures (RIONED, 2006; Van Riel, 2011). As such, this can overrule other considerations, but this will only happen as a post ante-reaction on pluvial flood events.

Political

The case study results show that of DESTELP-factors, especially politics have a large influence on the decision-making process, especially in a negative way in the Meppel case. This is due to the influence the political agenda has on dictating the spatial planning process within municipalities (RMM, 2018). On the other hand, if there is political willingness, as is shown in the cases of Hoogeveen and Drachten, a lot more can be done to enhance the resilience of the urban area against pluvial flooding (RMH, 2018; RMS, 2018). As such, this research supports the findings of researchers such as Biesbroek et al. (2011) and Runhaar et al. (2012) whose research mentions political willingness as one of the important factors for enabling climate change adaptation efforts. While described in literature, this research expands on this notion by looking at how political willingness can be improved via closing the usability-gap of climate information of its users. As discussed, for achieving that this information needs to be used in a way that is understandable for politicians and focusses on (if needed) their willingness to act such as, as the results show: images and videos, as well as experiencines of citizens that show the local impact of extreme precipitation such pluvial flooding. These findings could therefore serve as a step towards way to help cross or lower this barrier (Dupuis, 2011; Dupuis & Knoepfel, 2011).

Reflecting now on the influences that the DESTELP-factors have on the decision-making process, it shows that the influence that these factors have on one another are just as relevant as well in this process. This makes sense from the perspective of seeing the urban area as a system, which we do in the context of this research as we adopted socio-ecological resilience as the underlying concept of resilience (Davoudi, 2012). This means that there are more influences in the urban area that may interact with one another (Carpenter et al., 2005; Scheffer, 2009; Hassink, 2010; Seelinger & Torok, 2013) and in which decision-making needs to be used to plot a course amongst these different changes. Furthermore, this also relates to the panarchy as well (Gunderson & Holling, 2002), as influences and events on different scales are interconnected, and may also affect other events and influences as well. This results in a complex web of influencing factors surrounding the decision-making process on a local scale which further complicates the process itself. Here the role spatial planning should be to weight these factors against one another and to aim for the approaches that best serve public interest.

6.3.2 The comparison between the influence that (climate) information and DESTELP-factors have on the decision-making process

Based on the case studies, the argument can therefore be made that for the overall planning process the DESTELP-factors have a larger influence on the decision-making process than climate information does. This is since whereas climate information provides information about where vulnerable urban areas are located, the character of the spatial planning process itself is more influenced by the DESTELP-factors. For example, the political agenda or age of the urban space have shown to override decision-making choices about where or whether measures will be taken in most cases (RMH, 2018; RMM, 2018; RMS, 2018). As such, it can be stated that in the decision-making process presented by Moser & Ekstrom (2010) climate information will be more used in the initial phases to localize problems and to put them on the political agenda via informing. The DESTELP-factors on the other hand are relevant for all steps in the decision-making process as for example political awareness, economic costs and environmental factors all contribute during these stages. This was also found by Eliasson (2000) whose research on this topic concluded that knowledge about climate, climate change and its impacts have a lower impact on the overall planning process, whereas limited budgets, lack of knowledge and other priorities in the planning process acted as constraints to act.

6.4 The impact of the decision-making process on the pluvial flood resilience capacities of robustness and absorption

This fourth section will cover and discuss the answer to the research question: *How do the taken choices affect the pluvial flooding resilience of urban areas in terms of the resilience capacities of robustness and absorption and vice versa?*

In chapter 5: results, it was concluded that aspects of both capacities were found in all the cities, both for public space (e.g. RMH, 2018; RMM, 2018; RMS, 2018) as well as private property (Appendix VIII). The first and most obvious is the sewer system improvement, as well a focus on blue-green infrastructure to retain water during precipitation events. Furthermore, decoupling of areas also serve to enhance the robustness of urban areas. For improving the absorption capacity of urban areas municipalities have provided building codes that help to increase the distance between potential flood water levels and house entrances. However, this is mostly the case for new or more recent housing projects, as was also pointed out by the respondents from the Municipalities of Smallingerland (2018) and Meppel (2018). As mentioned earlier, the relative inflexibility of urban spatial design (Linden et al., 2014) may make large-scale changes to the urban and spatial design near impossible or costly (e.g. neighbourhoods build on 'bad' places in the past will not be randomly torn down). Finally, the found types of measures are also mentioned by in the overview presented by Apreda (2016).

What however is interesting from these cases is the fact that, according to the survey results, most citizens in urban areas have not included absorption measures themselves in their houses (Appendix VIII). This can be explained from the idea that most citizens in the Netherlands are not aware of being at risk to experience pluvial flooding, something in line with findings from the OECD (2014) and supported by research done by Dai et al. (2017b) who state that Dutch citizens are often passive in taking measures themselves. Another point that may also affect these decisions is that pluvial flooding damage is covered by housing insurance (Kaufmann et al., 2015). This may also mean that people are less inclined to take measures against events that are covered by their insurance. However, this could potentially change in the future if insurance companies would charge a higher premium for citizens that are at risk of

experiencing pluvial flooding during extreme precipitation events, or that citizens may not even qualify for insurance in certain areas (Houston et al., 2010). Movements towards this may already have been started in the Netherlands as the Dutch insurance company Achmea was involved to categorize houses in urban areas based on the potential impact they can experience during such events (Achmea, 2018). This could then lead to negatively affect lower income citizens if they do not have to money to take measures, to leave, or in the worst case making it harder to sell their house/lower the value (Kaufmann et al., 2018). In that light we can also see a recent move from insurance company Klaverblad that insurers are also getting involved in climate adaptation via providing financial support to citizens (Van den Berg, 2019) showing that the increase in pluvial flood damages may concern them. However, this shift would require future research to determine to what degree this is planned by insurers side and may potentially impact the overall governance structure regarding pluvial flood resilience enhancement in urban areas.

Furthermore, the case studies showed that the decision-making process can also negatively affect the robustness and absorption capacities of urban areas against pluvial flooding. This can be the case if wrong inputs are used to base decisions on (e.g. wrong modelling outcomes) (Appendix VI; RPD, 2018) so that the taken measures do not contribute to enhancing these capacities; when certain insights were not not used in the past as these were not yet available at that point in time (RMH, 2018), or when information and inputs were ignored in the favour of economic growth and increasing the amount of hardened surface in these areas (RMM, 2018; RWBF, 2018).

On the other hand, the capacities may also affect the decision-making process in turn if these are deemed to be insufficient, which means that pluvial flooding and/or damage occurred in an urban area. As mentioned earlier, the understanding phase is, as the name suggests the phase in which stakeholders determine the problems, and to understand about what needs to be done. In Hoogeveen and Drachten, this phase had additional input in the form of extreme precipitation events (RMH, 2018; RMS, 2018). This can be seen from transition management and resilience literature as an example of a 'Window of Opportunity': a situation that can be exploited to introduce changes to the current status quo. This correlates example with the start of the adaptive cycle in which an impact, in our case an extreme precipitation event and subsequent pluvial flooding, puts stress on an urban area and leads to an undesirable state (Kingdon, 1984; Birkmann et al., 2010; Huitema & Meijerink, 2010; Kirchhoff et al., 2013). For these cases, these events served as a catalyst that eventually led to the introduction of new approaches and policy documents, as well as changes in the urban design (De Vries, 2017; Gemeente Hoogeveen, 2017a; RMH, 2018; RMS, 2018) which in turn enhanced the robustness and absorption capacities of the affected urban areas.

6.5 The impact of the decision-making process on the pluvial flood resilience capacities of adaptation and transformation and vice-versa

This section will cover the fifth and final practical research question: *How do the taken choices affect the pluvial flooding resilience capacities of adaptation and transformation, as well as vice versa?*

Firstly, in all cases adaptation of the urban spatial design took place as measures were taken to improve the robustness and absorption of urban areas against precipitation and pluvial flooding (although in some areas more than others). Most of this adaptation took place with conventional methods such as increasing water retention capacities in urban areas, as well as improving the sewer system capacity by upgrading to a shared system (Oranjewoud, 2010; Niezen & Hartemink, 2015c; de Kraker et al., 2016; De Vries, 2017). This fits with the resilience view on adaptation as the municipality is the traditional stakeholder to solve

problems regarding precipitation and pluvial flooding by using the sewer system to collect precipitation (Rijksoverheid, 2009b; De Jong & Hobma, 2012).

However, in all case study areas also a transformative capacity found as the responsibilities have shifted towards also wanting to include citizens in the decision-making process (e.g. Niezen & Hartemink, 2015c; De Vries, 2017; Gemeente Hoogeveen, 2017a; RMH, 2018; RMM, 2018; RMS, 2018). This shift also corresponds with neo-liberal trends in the Netherlands that move responsibilities from the government to citizens: 'de participatiesamenleving' (participation society) (Zijlstra, 2016b; De Vries & Oostveen, 2017). However, at the same time signals are showing that not all citizens are able to carry these responsibilities (Bekkers, 2017; De Bruijn, 2017). Research done in the Dutch place of Laren on making decoupling mandatory showed that this could potentially cost citizens thousands of euros (Zijlstra, 2016a), which is a financial burden not every citizen can carry. These signs are troubling as a major criticism of resilience is that it seen as a shift from governmental responsibility towards individual responsibility (e.g. Porter & Davoudi, 2012; Catney et al., 2013; Chandler, 2013), as well as raising the question: resilience for whom? (Cote & Nightengale, 2012; Manyena, 2014). As the survey shows that not all citizens have taken measures themselves, as well as that some of them mentioned the financial barrier to be an important reason (appendix VIII), it proves that this shift may lead to some citizens may potentially be excluded and left at risk of experiencing pluvial flooding or lowering the overall resilience capacities of the neighbourhood. The interviews furthermore also showed that only in Drachten subsidies on an individual level are provided (RMH, 2018; RMM, 2018; RMS, 2018). As such, the transformation of shifting responsibilities may have a potential negative influence on the decision-making process, and subsequent the robustness and absorption capacities of urban areas if not addressed properly by governmental stakeholders.

Furthermore, transformation was also found in the case study areas as there was a shift made towards multi-disciplinary, integrative approaches by governmental stakeholders to address precipitation and pluvial flooding problems (e.g. by not only thinking about pluvial flooding prevention from the perspective of a sewer system, but also through retainment in green-blue infrastructure) (RMH, 2018; RMM, 2018; RMS, 2018). This last aspect also fits within the trend of building-with-nature approaches in other Dutch urban areas (Dai et al., 2017b) as well in other parts of the world (Wagner et al., 2013; Thorne et al., 2015; Dai et al., 2017a; Meerow & Newell, 2017) that are seen as a part of the shifting paradigms within urban precipitation management (Chocat et al., 2001; Delleur, 2003 Roy et al., 2008; Brown et al., 2009; Wong & Brown, 2009; Sörensen et al., 2016) . This type of thinking is also seen as a transition within the case study areas (Appendix VI; RMH, 2018) regarding the internal organization of municipalities as this can be considered as a departure from sectoral thinking about these types of problem towards integration and collaboration. This is also supported by Ache & Hospers (2016) as well as latest version of the Deltaprogramme (I&W, 2018). This in turn also changes the decision-making process as collaboration between different interal municipal departments is required, which leads to more discussion as well as a variety of discourses on the problem at hand, a situation that shares ground with collaborative planning (Healey, 1997; Flyen et al., 2018; Hölscher et al., 2018). Additionally, Flyen et al. (2018), as well as Measham et al. (2011), also focus on collaboration between different municipalities to exchange information and experiences about these topics. Again, this was also found back in the case studies as both Meppel and Hoogeveen exchange experiences via the Fluvius workregion (Appendix VI), while Drachten does this via the water board Friesland as well by discussing these topics on the provincial level with other municipalities and the Province of Friesland (De Vries, 2017; RPF, 2018; RWBF, 2018).

Finally, also the learning capacity of stakeholders played a role. As explained, this lays underneath the different resilience capacities and determines to what degree stakeholders are prepared or preparing themselves through enhancing resilience capacities (Davoudi et al., 2013). As explained in the results chapter, this was found back in all case city areas in varying degrees. Most important is that experiences with pluvial flooding events in urban areas were used to set and develop standards and approaches for

future events (RMH, 2018; RMS, 2018), as well as that new insights are adopted. On the other hand, other stakeholders (e.g. water board and province) showed to be less quick to integrate this knowledge and new insights towards climate change impacts in the Netherlands with their approaches. This practice also links back to ideas and theory about organizational and institutional change and learning (e.g. Alexander, 2005; Berkhout, 2006; Gupta et al., 2010) as well transition management (Geels, 2002; Loorbach, 2009). While not going into full detail about the subject, the found position of institutions such as the province and water board is mainly due to the scale on which they operate. As municipalities are much closer to planning practice and operate on a smaller geographical scale, potential adaptation of new information can be implemented as well, whereas introducing this in regional policy or on a larger scale is difficult to the larger overall impact these decisions may have without being properly tested (Loorbach, 2009). Therefore, the adaptation of new insights are therefore much more likely to start on lower levels (municipalities) than on higher ones (water board and provinces) as the findings of this research also point towards to.

6.6 Conclusions

In this first chapter we started out with the following main research question that this research is trying to answer:

What is the current contribution of climate information to the decision-making process of relevant Dutch stakeholders (governmental organizations and towards citizens) in taking pluvial flood resilience enhancing spatial measures in local urban areas, and how is this contribution affected by the chosen information design to communicate this information to these stakeholders, as well as other information, factors (e.g. political, environmental, social) and resilience aspects?

As read in the beginning of this chapter, the contribution that climate information currently makes to the decision-making process depends on the stakeholder. For governmental stakeholders, this contribution can be found in informing these stakeholders about potential vulnerable locations, as well as testing the effectiveness of both proposed and taken measures. On the other hand, for citizens climate information can serve the goal of education through raising the awareness of their role towards pluvial flood prevention by making them aware of the risk they have to experience pluvial flooding themselves. For meeting these goals, the data gathered from the case studies also revealed that the used format of the information matters on whether the information is understood and has meaning to the user. For example, towards local politicians, maps are less effective than hearing experiences and stories from citizens or reading about it in the news or seeing images/videos, and towards citizens images that show the local impact may also carry a stronger message that is better understood than just plain text or even a map. *As such firstly, the research concludes that the contribution of climate information towards the decision-making process is affected by the chosen information design as it may affect the communication of information to the end-user.*

However, when it comes to the degree of influence climate information has within the decision-making process, this is overshadowed by other factors. For example, even when information can signal that certain areas are vulnerable for pluvial flooding, the moment when spatial developments will take place in the public space will often overrule this insight due to the potential 'waste' of money that comes with replacing infrastructure before the infrastructure actually needed to be replaced. Additionally, also political or economical factors can lead to decisions that may lead to a decrease of capacity of an urban area to withstand extreme precipitation or lessen the damage caused by pluvial flooding. One of the potential causes for this overruling influence of political and economical factors may be due to usability gaps between the information that is available to stakeholders and the information that is required.

Especially the goal and framing of information plays a role here, although also the format can matter as for example urgency cannot be transferred that well in maps currently available to governmental stakeholders (RMM, 2018). *As such, the research also concludes that the contribution of climate information at the moment is mostly towards informing and localizing potential vulnerable areas or serving as a base line to test the effectiveness of measures and the urban spatial design against (e.g. by providing the heaviness of precipitation events to test in models). On the other hand, during the process, the DESTELP factors have often a more dominant influence during the decision-making process of stakeholders than climate information due to the political character of this process, as well as the influence of economic, environmental and financial factors and circumstances.*

The outcomes of the decision-making process also affect the resilience capacities of robustness and absorption of urban areas due to decisions that were made about the measures, policies and interventions in these areas. Alternatively, these capacities can in turn then also affect the decision-making process if new precipitation events lead to new pluvial flooding events. Additionally, the resilience capacities of adaptation and transformation can also affect the contribution that is made by climate information to the decision-making process. This can be seen by the fact that in the process itself new stances towards changing the spatial design of urban areas are considered for both spatial measures, as well changing approaches and views on how and by who this should be done. The learning capacity present in the organization in turn has an impact on capacities of transformation and adaptation as well by letting new insights and developments be used in changes that need to be made to the urban spatial design. *As such, the research concludes that the capacities of resilience have a visible influence on the decision-making process of stakeholders, whereas the decision-process will affect these capacities via either spatial interventions and policies (robustness and absorption) or its learning capacity which leads to enhancement of the capacities of adaptation and transformation.*

As such the final answer to the main research question can be summarized as:

The current contribution of climate information is mainly on the identification and localization of urban areas that may be vulnerable of experiencing pluvial flooding during extreme precipitation events, as well as either before or after the implementation of measures as evaluation standards. Additionally, this information can find its way to the political agenda, however other factors will determine whether actual spatial interventions are taken such as the urgency of the problem, political understanding of the problem, and the cost-effectiveness of taking measures versus the chance that such an event may take place. As such, climate information is only the first step in the process towards climate adaptive urban areas, whereas other factors will determine at which pace and how or whether this goal will be reached in the end.

6.7 Reflection

6.7.1 Reflections on the conceptual model

When reflecting on the conceptual model as presented in chapter 2 one major point was not included that ended up having an impact on the decision-making process in practice: that DESTELP-factors can also influence one another rather than then the decision-making process. As pointed out in the discussion a fix to include this as well in the conceptual model would be the inclusion of feedback loops directing back into the DESTELP-factors at during each phase. Furthermore, theoretically this could be explained as well from a systems-perspective as well as the concept of panarchy in that changes and events occurring in urban systems in practice cannot be assumed ceteris paribus. Every change will have ripple effects on other aspects (of course some more than others) which in turn may also affect the playing field for spatial planning once more.

6.7.2 Reflections on the research process

In reflection a few points of critique can be made on the research process that have brought this research document to its final form. Firstly, during the duration of the research new theory and insights have been added to especially further flesh out how information can be communicated towards stakeholders and the potential effects the information design can have. As a result, some of these insights may not have been included in the interviews or surveys and as such, it was tried to interpret the gathered data from interviews, the surveys, policy documents and the worksession in ways these insights might still be included and connected as well.

Secondly, during the identification of key persons that are part of the relevant governmental stakeholders in the case study locations, not all these persons were interviewed. In the case of the WBF, the main responsible person was not available for an interview. As such, a substitute person was found by the organization to replace the initial key person. While it was still informing and led to good data, potential specific case contextual data about the urban city of Drachten from the perspective of the water board Friesland may not have been gathered in this interview. As such, there is the case that local processes that may have been of value to include in the research are now omitted.

Thirdly, originally the research planned to include also housing corporations and businesses located in urban areas in the case study locations as well. However, time constraints, as well as difficulties to find respondents for housing corporations and a lack of a way to efficiently spread surveys amongst businesses in case study locations proved to make this aspect not viable to include. As such, while included at first in early stages of the research process (establishing a first version of the theoretical framework and methodology), it was decided to not include these groups in further stages of the research. This also is the reason why these stakeholders, amongst others have been included in the recommendations for further research.

Fourthly, while preparing the data necessary for doing the binary regression analysis, it turned out that not all data could be properly used within the analysis. This has also been the reason why in the results chapter a second paragraph was added with factors that may have influenced the decision-making of citizens that could not be included in the binary regression analysis.

6.8 Recommendations

6.8.1 Recommendations for academic research

The main recommendation for further academic research would be to further expand upon understanding the role other private stakeholders (e.g. housing corporations; businesses) may have regarding enhancing pluvial flood resilience and/or use of climate information. This could potentially also be further expanded towards also the rural areas and the role of the agricultural sector towards this goal, as well as how critical infrastructure management (e.g. drinking water production; flood defences; electricity and gas networks). Alternatively, also research could be done towards the use of climate information regarding other climate change impacts (e.g. drought; heat stress; fluvial- and coastal flooding; drinking water security) or even maybe an internation comparison. Due to the different scales on which these impacts work, also the use of information and its relation to other factors could potentially change.

Additionally, further research could also be done in the way that citizens perceive the current approaches of municipalities to making them more, with an additional focus on the communication

design. As this research to that point can be seen more as an exploration of the subject, additional in-depth research could be done towards this goal to further understand the role citizens could have. To this end, focus groups, interviews or even a town hall meeting could be used to further flesh out the usability that the communication design of these approaches has for citizens, and whether there are any usability-gaps (Lemos et al., 2012) that may require attention.

Also, the Netherlands is in terms of spatial planning legislation on the forevening of using the new 'Enviroment and Planning Act' (omgevingswet) from 2021 onwards. As this act has purpose to simplify and integrate different planning approaches and disciplines this will also have major consequences for how the decision-making proces for Dutch urban planning will take place (Lintsen et al., 2014). As such, research could be done towards providing an update on how the introduction of this legislation will affect the influence of the different named factors presented in the conception framework of this research.

Finally, if you as a reader decides to follow up on one of these recommendations for academic research or are doing research on these topics, could you please send me your final or published version of your work? I am always interested in how this topic develops or new information that comes available about it. My e-mail address is found in the colophon.

6.8.2 Recommendations for planning practice

This research has shown the importance of understanding the information needs of stakeholders. As such, the following recommendation can be given towards planning practice:

- Start dialogues with the stakeholders that you must work together with to reach a climate adaptive environment. The current climate adaptation course in the Netherlands will require governmental stakeholders to be holding risk dialogues with other stakeholders. Understanding how they perceive problems, as well as the information they require before carrying out the 'stresstest' may lead to being better in carrying out the risk dialogue, as well as starting the dialogue with the relevant information that is needed.

- The research points out the possibility that communication towards politicians requires different information than is needed to communicate towards civil servants. As political willingness and understanding is identified as a major barrier in this research, timely addressing problem from the civil servant side may help to improve the outcome of the decision-making process when it comes to making urban areas climate adaptive. Potentially using stories, images/videos and experiences regarding pluvial flooding in urban areas may connect more to the perception local politicians have of the phenomenon. Similar considerations could also be made in the communication towards citizens or other stakeholders. However, this may require trial and error as not all stakeholders have been addressed in this research and can therefore offer also no guidance.

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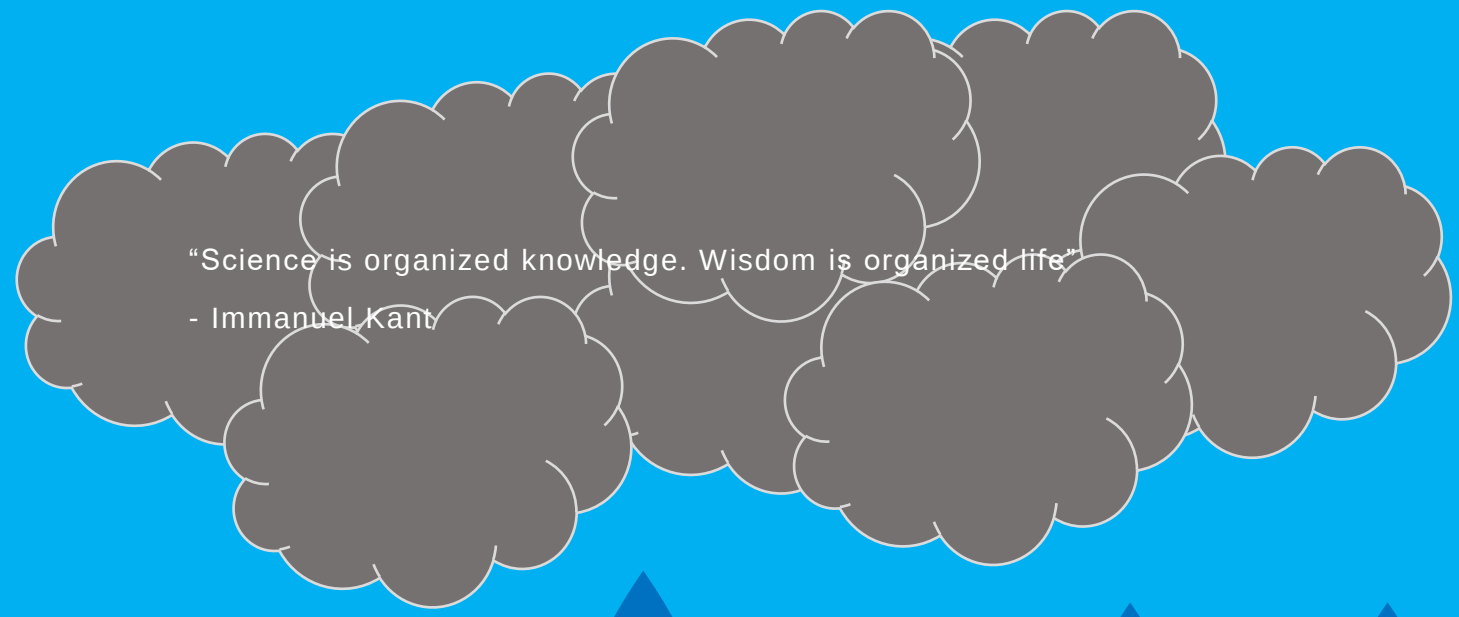

“Science is organized knowledge. Wisdom is organized life”

- Immanuel Kant

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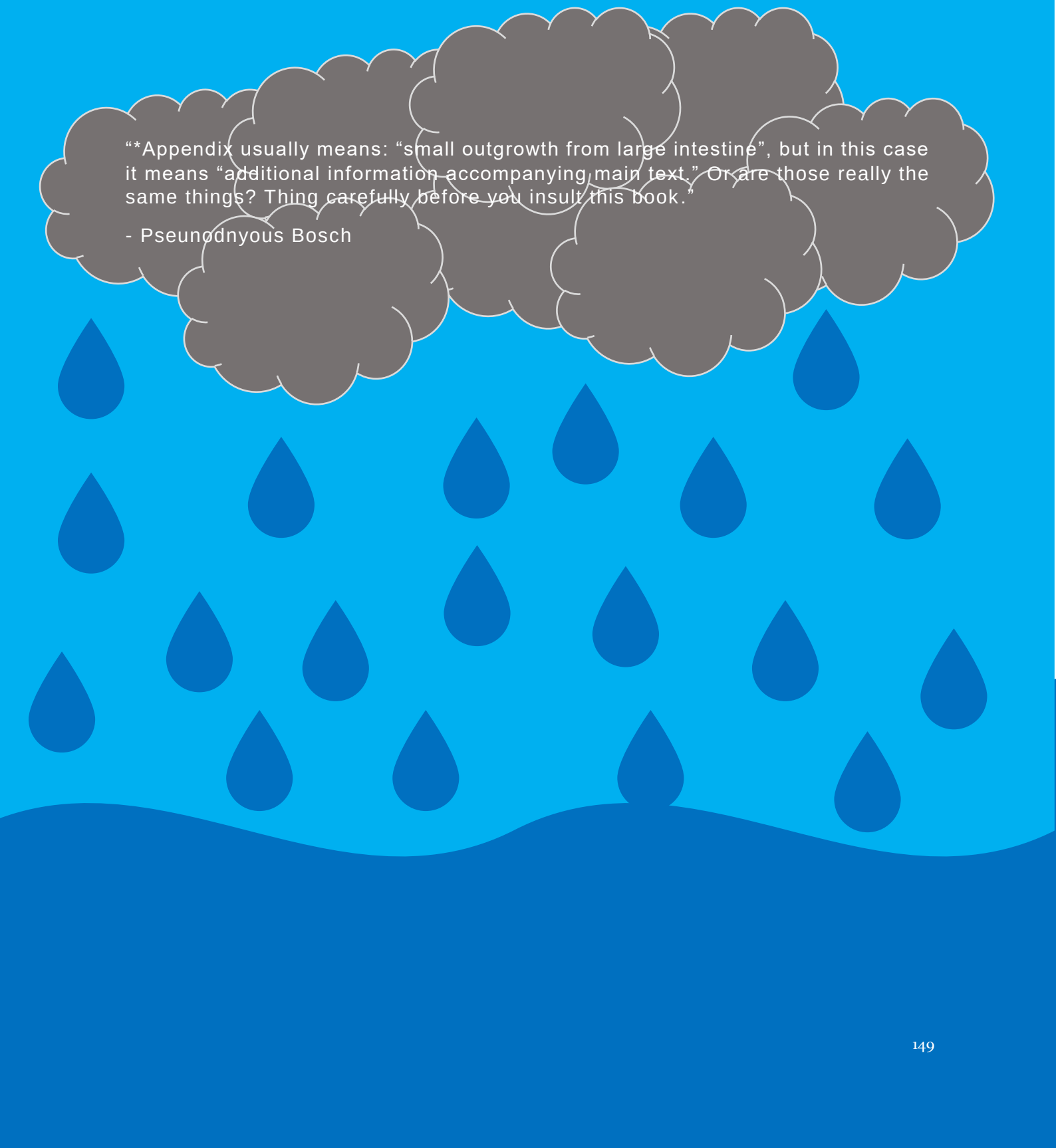
Appendixes



"*Appendix usually means: "small outgrowth from large intestine", but in this case it means "additional information accompanying main text." Or are those really the same things? Thing carefully before you insult this book."

- Pseunodnyous Bosch

Appendix I: Approximation of pluvial flood damage claimed in the Netherlands via home and content insurances in 2008

Home insurance				
Province	**Number of home insurance policies in 2008**	**Damage frequency per province (%)**	**Average height of damage per claim made (€)**	**Estimated total cost of damage claimed in mil (€)**
Groningen	123.700	1,16	2.400	3.44
Friesland	132.050	1,08	2.310	3.29
Drenthe	66.500	1,32	2.490	2.19
Overijssel	173.950	1,64	2.020	5.76
Flevoland	57.840	1,49	2.750	2.37
Gelderland	276.820	1,51	2.060	8.61
Utrecht	163.160	1,50	2.240	5.48
Noord-Holland	382.510	1,63	2.480	15.46
Zuid-Holland	519.120	1,92	2.220	22.13
Zeeland	76.570	1,31	2.210	2.22
Noord Brabant	333.550	2,64	2.050	18.05
Limburg	194.790	2,96	1.840	10.61
Total amount of damage claimed with home insurance in the Netherlands in 2008				99.62
Content insurance				
Province	**Number of home insurance policies in 2008**	**Damage frequency per province (%)**	**Average height of damage per claim made (€)**	**Estimated cost of damage claimed in mil (€)**
Groningen	294.310	0,132	718	0.28
Friesland	290.190	0,127	738	0.27
Drenthe	165.780	0,130	913	0.20
Overijssel	412.850	0,146	848	0.51
Flevoland	128.330	0,125	802	0.13
Gelderland	716.110	0,130	791	0.74
Utrecht	447.860	0,145	852	0.55
Noord-Holland	1.132.970	0,139	1.044	1.64
Zuid-Holland	1.718.030	0,159	1.074	2.93
Zeeland	170.730	0,142	792	0.19
Noord Brabant	921.560	0,142	991	1.30
Limburg	526.280	0,146	1.254	0.96
Total of damage costs claimed through content insurance in the Netherlands in 2008				9.71
Total amount of damage claimed through insurance in the Netherlands in 2008				109.33

Table 16: Overview of pluvial flood damage claimed via content and home insurance in the Netherlands in 2008. (Source: Ririassa & Hoen, 2010; edited by author)

Appendix II: Metadata for the map in figure 1

Meaning of the color code of the location, which is based on the acceptability of pluvial flooding in the Netherlands (RIONED, 2016):

Yellow: No damage at location due to pluvial flood event: street(s) flooded, but flood water did not reach property or caused damage or disturbances

Orange: Moderate damage at location due to pluvial flood event: street(s) flooded, cars stalled in tunnels or on parking places, potentially a few cellars may have flooded due to laying beneath street level.

Red: Extensive damage at location due to pluvial flood event (street(s) flooded, cars flooded in tunnels or on parking spaces; cellars flooded; water entered homes and caused damage)

Date of pluvial flood event	Location where the pluvial flooding took place	Extent of the damage on the location	Source
30-05-2016	Zevenaar	- Roof of theatre almost collapsed due to rain + theatre experienced flood - Roof of supermarket leaked water - Streets were flooded - Pluvial flood water entered private property	Omroep Gelderland, 2016
	Arnhem	- Flooded streets - Flooded tunnel - Damage to a car that was stalled in flooded tunnel	De Gelderlander, 2016b; Omroep Gelderland, 2016
	Groesbeek	- Flooded streets - Potential danger due to loose manhole covers - Flooded cellar	De Groesbeek, 2016; Omroep Gelderland, 2016
	Ede	- Flooded streets	Ede FM, 2016; Omroep Gelderland
	Otterlo	- Flooded cellars and garages - Flooded streets	Fraanje, 2016; Omroep Gelderland, 2016
	Bemmel	- Flooded streets - Flooded buildings	Omroep Gelderland, 2016; 112lingewaard, 2016
	Huissen	- Flooded streets	Omroep Gelderland, 2016; 112lingewaard, 2016
	Warnsveld	- Flooded playground	Omroep Gelderland, 2016
	Duiven	- Flooded streets	Omroep Gelderland, 2016
	Cuijk	- Tunnel flooded which lead to two cars being flooded - A lot of streets flooded - Potential danger due to loose manhole covers - Material damage to flooded buildings	Elzendoorn & De Bekker, 2016; De Maas Driehoek, 2016; Vostermans, 2016
	Oss	- Events cancelled due to rain	Vostermans, 2016
	Boekel	- A cellar flooded - Streets flooded	Udens Weekblad, 2016; Vostermans, 2016
	Schijndel	- Several streets flooded	Vostermans, 2016; TV Schijndel, 2016
	Udenhout	- Street flooded	Vostermans, 2016
	Waalwijk	- Material damage in shop due to pluvial flooding	Vostermans, 2016
	Enschede	- Flooded streets - Flooded cellars - Flooded houses and buildings - Damaged buildings	RTV Oost, 2016; Tubantia, 2016

02-06-2016	Boxmeer	- Flooded streets - Flooded parking garage - Stranded and damaged cars - Material damage due to flooded buildings and houses	De Gelderlander, 2016a; De Maas Driehoek, 2016b; Nu.nl, 2016v
	Beugen	- Flooded streets - Flooded parking garage - Damaged cars - Material damage due to flooded buildings and houses	De Maas Driehoek, 2016b; 112brabant. 2016
	Deurne	- Flooded streets - Flooded houses and buildings - Potential danger due to loose manhole covers	Weekblad voor Deurne, 2016; Vermonden, 2016
	Asten	- Flooded streets - Flooded houses, garages, cellars and shops - Temporal disruption of traffic	Hanssen, 2016; Peel Belang,2016;
	Someren	- Flooded streets - Flooded cellars, garages and shops	Hanssen, 2016, NOS, 2016a
	Maarheeze	- Flooded streets - Flooded cellars	Nu.nl, 2016b; Quekel, 2016
	Soerendonk	- Flooded street - Flooded garage - Flooded agricultural field + damage to crops	Weert de Gekste, 2016
	Heeze-Leende	- Flooded streets - Disruption of traffic - Flooded shops	Eindhovens Dagblad, 2016b
	Eindhoven	- Flooded streets	Eindhovens Dagblad, 2016b
	Waalre	- Flooded streets - Potential health hazards due to flooding sewers	Eindhovens Dagblad, 2016b; ZW14, 2016
	Vijlen	- Pluvial flooding on a farm	Nu.nl, 2016b
	Geldrop	- Flooded buildings - Flooded streets	Eindhovens Dagblad, 2016a; Nu.nl, 2016d
	Valkenswaard	- Flooded streets - Flooded buildings	Eindhovens Dagblad, 2016ab
04-06-2016	Rotterdam	- Flooded streets - Flooded cellars	RTV Rijnmond, 2016b
	Vlaardingen	- Flooded streets - Flooded cellars	RTV Rijnmond, 2016b
	Schiedam	- Flooded streets - Flooded cellars	RTV Rijnmond, 2016b
	Rozenburg	- Flooded streets - Flooded cellars	RTV Rijnmond, 2016b
	Maassluis	- Flooded streets - Flooded cellars	RTV Rijnmond, 2016b
	Rhoon	- Flooded streets - Flooded cellars	RTV Rijnmond, 2016b
13-6-2016	Eindhoven	- Flooded streets and tunnel - Stalled and damaged cars	Eindhovens Dagblad, 2016c
	Hoogeloon	- Flooded streets	Eindhovens Dagblad, 2016c
	Hunsel	- Flooded streets	Eindhovens Dagblad, 2016c
	Veldhoven	- Flooded streets	Eindhovens Dagblad, 2016c
	Helmond	- Flooded streets	De weblog van Helmond, 2016
17-06-2016	Yerseke	- Flooded streets - 100 Flooded houses - Material damage to houses - Potential health impact due to contaminated water	HVZ, 2016; Omroep Zeeland, 2016a; PZC, 2016
	Goes	- Flooded streets - Flooded parking garage	Omroep Zeeland, 2016a; PZC, 2016

		- Potential health impact due to contaminated water	
	Kapelle	- Flooded streets - Potential health impact due to contaminated water	Omroep Zeeland, 2016a; PZC, 2016
23-06-2016	Amsterdam	- Slightly flooded cellars - Flooded tunnel - Flooded streets	AT5, 2016
	Rotterdam	- Flooded streets - Flooded cellars - Potential danger due to loose manhole covers - Fatality due to electrocution in cellar - Flooded buildings - Small flood in hospital - Flooded tunnels - Damaged car	Nagtegaal, 2016; Media TV, 2016; NOS, 2016c
	Schiedam	- Flooded streets - Flooded houses	RTV Rijnmond, 2016a; Schiedam 24, 2016
	Brielle	- Flooded supermarket	RTV Rijnmond, 2016a
	Spijkenisse	- Flooded streets - Flooded parking garage	RTV Rijnmond, 2016a
	Bussum	- Flooded streets	NOS, 2016b
	Voorburg	- Flooded streets	NOS, 2016b
	Hilversum	- Flooded streets - Flooded tunnel - Flooded house with material damage	NOS, 2016b
	Gouda	- Flooded streets	Gouds Dagblad, 2016; NOS, 2016b
	Capelle aan den IJssel	- Flooded street	NOS, 2016c
	Den Haag	- Flooded streets - Flooded tunnel - Damaged cars	Nu.nl, 2016b
	Alphen aan den Rijn	- Flooded streets - Flooded houses - Flooded cellars - Stranded and damaged cars	Alphens.nl, 2016; nu.nl, 2016a
	Krimpenerwaard	- Flooded streets - Flooded houses - Flooded cellars	Kuiler, 2016
	Delft	- Flooded streets - Flooded buildings with material damage	AD, 2016
22-07-2016	Breda	- Flooded streets - Canceled event	Bredase Bode, 2016; Nijs, 2016a; Nijs, 2016b
	Bavel	- Flooded streets - Flooded houses - Material damage to houses	Bredaheadlines.nl, 2016
	Ulvenhout	- Flooded streets	BN De Stem, 2016; Nijs, 2016b
	Teteringen	- Mention of pluvial flooding	Nijs, 2016b
	Oostenhout	- Flooded tunnel - Damaged cars	De Bekker, 2016
	Dorst	- Flooded streets - Flooded playground	BN De Stem, 2016
	Rijen	- Flooded streets - Flooded houses	BN De Stem, 2016; De Bekker, 2016
	Kaatsheuvel	- Flooded street - Flooded house	De Bekker, 2016
	Waalwijk	- Flooded street	De Bekker, 2016
26-08-2016	Zuidlaren	- Flooded streets - Several flooded houses - Flooded business	RTV Drenthe, 2016
	Vries	- Mention of pluvial flooding	RTV Drenthe, 2016

	Hoogeveen	- Mention of pluvial flooding	RTV Drenthe, 2016
	Tynaarlo	- Mention of pluvial flooding	RTV Drenthe, 2016
07-11-2016	Goes	- Flooded streets	Omroep Zeeland, 2016b
	Kloetinge	- Flooded streets	Omroep Zeeland, 2016b
	Wolphaartsdijk	- Flooded streets	Omroep Zeeland, 2016b
28-06-2017	Drachten	- Flooded streets - Flooded businesses - Disrupted traffic	Leeuwarder Courant, 2017; RTL Nieuws, 2017c
	Zwolle	- Flooded streets	RTL Nieuws, 2017c; RTV Oost, 2017b; Telegraaf, 2017
	Heech	- Flooded streets	Elting & Buitenwerf, 2017
	Wolvega	- Flooded streets	Elting & Buitenwerf, 2017
	Hoogeveen	- Flooded streets - Flooded cellars - Flooded supermarket - Flooded houses	Hoogeveensche Courant, 2017; Regio Hoogeveen, 2017
	Diever	- Flooded streets	Molema, 2017
	Alteveer	- Flooded streets	Molema, 2017
07-07-2017	Den Haag	- Flooded streets - Flooded tunnels - Flooded cellars	AD, 2017a; Omroep West, 2017b
10-07-2017	Assen	- Flooded streets - Flooded tunnel	Asser Courant, 2017; RTV Drenthe, 2017; Van Dijk, 2017
	Hoogezand-Sappemeer	- Flooded streets	Van Dijk, 2017
	Tynaarlo	- Flooded streets	Van Dijk, 2017
	Eelde	- Flooded streets	Van Dijk, 2017
12-07-2017	Beek	- Flooded streets - Flooded celllars	De Limburger, 2017
	Schinnen	- Flooded streets	1limburg, 2017
	Drunen	- Flooded streets	Brabants Dagblad, 2017
	Tilburg	- Flooded streets	Brabants Dagblad, 2017; Kersten, 2017
	Rosmalen	- Flooded streets - Flooded supermarket	Brabants Dagblad, 2017; Mees, 2017
	Hedel	- Flooded streets	Brabants Dagblad, 2017
	Waalwijk	- Flooded streets	Brabants Dagblad, 2017
	Etten-Leur	- Flooded house	BN De Stem, 2017
	Roosendaal	- Flooded tunnel	Van Wolffelaar, 2017
	Oss	- Flooded streets	Regio Oss, 2017
30-07-2017	Rotterdam	- Flooded streets - Flooded buildings	Groenendijk & Venema, 2017
	Vlaardingen	- Flooded streets	Groenendijk & Venema, 2017
	Gouda	- Flooded streets - Flooded cellars	NOS, 2017; RTL Nieuws, 2017a
	Leiden	- Flooded streets - Flooded cellars - Flooded shop	NOS, 2017; Omroep West, 2017a
	Maasdijk	- Flooded streets	Groenendijk & Venema, 2017; Omroep West, 2017a
	Ter Aar	- Flooded greenhouse	Omroep West, 2017a
	Bodegraven	- Flooded streets - Flooded cellars	Omroep West, 2017a
	Almere	- Flooded tunnel	NOS, 2017
	Kropswolde	- Flooded cellars	Been, 2017; Hart van Nederland, 2017
	Hoogezand	- Flooded garage - Flooded cellars	Been, 2017; NOS, 2017
	Assen	- Flooded streets - Flooded bicycle tunnel	Been, 2017
	Roden	- Flooded streets	Been, 2017
	Veendam	- Flooded streets	Been, 2017
15-08-2017	Hengelo	- Flooded streets - Flooded tunnel - Flooded building	RTV Oost, 2017a; Weinreder, 2017
	Oldenzaal	- Flooded streets - Flooded tunnel - Stranded car	RTV Oost, 2017a
	Goor	- Flooded house	RTV Oost, 2017a

	Borne	- Flooded streets	Weinreder, 2017
30-08-2017	Ede	- Flooded streets	Omroep Gelderland, 2017; RTL Nieuws, 2017b
	Duiven	- Flooded streets	Omroep Gelderland, 2017
	Arnhem	- Flooded streets	Omroep Gelderland, 2017; RTL Nieuws, 2017b
	Otterlo	- Flooded streets	Omroep Gelderland, 2017
	Weert	- Flooded streets	RTL Nieuws, 2017b
16-09-2017	Dokkum	- Flooded streets	Omrop Fryslân, 2017
	Leeuwarden	- Flooded streets	Omrop Fryslân, 2017
	Kollum	- Flooded streets	Omrop Fryslân, 2017
	Grou	- Flooded streets	Omrop Fryslân, 2017
18-09-2017	Lichtenvoorde	- Flooded streets - Flooded cellars	Streekgids, 2017
	Bolsward	- Flooded streets - Flooded garage	Ditisfryslân, 2017
29-09-2017	Amsterdam	- Flooded streets - Flooded cellars	AD, 2017b
	Aalsmeer	- Flooded streets - Flooded cellars	AD, 2017b
	IJmuiden	- Flooded streets - Flooded cellars	AD, 2017b
	Wormerveer	- Flooded streets - Flooded cellars	AD, 2017b
	Beverwijk	- Flooded tunnel - Disrupted traffic	Nieuws.nl, 2017
11-04-2018	Rotterdam	- Flooded business	Nu.nl, 2018a
	Oisterwijk	- Flooded streets - Potential danger due to a loose manhole cover - Flooded industrial area	Oisterwijk Nieuws, 2018
	Nieuw Beijerland	- Flooded street	RTV Rijnmond, 2018
	Albasserdam	- Mention of pluvial flooding	Nu.nl, 2018a
	Molenaarsgraaf	- Mention of pluvial flooding	Nu.nl, 2018a
22-04-2018	Emmen	- Flooded streets	RTV Drenthe, 2018
30-04-2018	Roermond	- Flooded houses - Flooded tunnel - Flooded streets	De Limburger, 2018
	Kerkrade	- Flooded streets	De Limburger, 2018
	Eygelshoven	- Mention of pluvial flooding	Parren & Hubers, 2018
	Landgraaf	- Mention of pluvial flooding	De Limburger, 2018
	Vaals	- Flooded streets	De Limburger, 2018
	Heerlen	- Mention of pluvial flooding	De Limburger, 2018
	Tegelen	- Flooded streets	De Limburger, 2018
	Venlo	- Flooded streets	De Limburger, 2018
	Tilburg	- Mention of pluvial flooding	Brabants Dagblad, 2018
	Rotterdam	- Mention of pluvial flooding	Brabants Dagblad, 2018
	Amsterdam	- Mention of pluvial flooding	Brabants Dagblad, 2018
	Zaandam	- Mention of pluvial flooding	Brabants Dagblad, 2018
13-05-2018	Eext	- Flooded streets	RTV Drenthe, 2018c
	Drouwen	- Flooded streets - Flooded cars	RTV Drenthe, 2018c
	Bronneger	- Flooded streets	RTV Drenthe, 2018c
	Assen	- Flooded streets - Damaged building - Part of a platform at the station subsided	RTL nieuws, 2018; RTV Drenthe, 2018b RTV Drenthe, 2018c
	Rolde	- Flooded streets	RTV Drenthe, 2018a
	Gasselte	- Flooded streets	RTV Drenthe, 2018a
	Windschoten	- Flooded streets	Graafland, 2018
	Borger	- Flooded streets	RTL nieuws, 2018
	Emmen	- Flooded streets	RTL nieuws, 2018
	Erica	- Flooded streets	RTL nieuws, 2018, RTV Drenthe, 2018a
	Gieten	- Flooded streets	RTL nieuws, 2018
	Sappemeer	- Flooded streets	RTL nieuws, 2018
	Veendam	- Flooded cellar	RTV Noord, 2018
22-05-2018	Sittard-Geleen	- Flooded streets	Trepels, 2018

		- Flooded cellars - Flooded cars	
	Munstergeleen	- Mention of pluvial flooding - Flooded garage - Flooded streets	Trepels, 2018; 1limburg.nl, 2018
	Meersen	- Flooded streets - Flooded cellars - Flooded cars	Trepels, 2018
	Ulestraten	- Flooded streets	Trepels, 2018
	Berg en Terblijt	- Mention of pluvial flooding	Tiems, 2018
	Cadier en Keer	- Mention of pluvial flooding	Tiems, 2018
	Bunde	- Mention of pluvial flooding	Tiems, 2018
	Roermond	- Flooded tunnel	1limburg.nl, 2018
	Nuth	- Flooded street	1limburg.nl, 2018
	Schimmert	- Flooded streets	1limburg.nl, 2018
	Beek	- Flooded streets	1limburg.nl, 2018
	Rosmalen	- Flooded streets	Weeronline.nl, 2018
	Hegge	- Flooded streets - Damaged houses	Telegraaf, 2018
24-05-2018	''s-Gravenpolder	- Flooded streets - Damaged houses	Omroep Zeeland, 2018b
	Goes	- Flooded streets	Omroep Zeeland, 2018b
	Kloetinge	- Flooded streets	Omroep Zeeland, 2018b
27-05-2018	's-Gravenpolder	- Flooded streets - Collaped roof - Flooded houses	De Telegraaf, 2018; nu.nl, 2018b
	Borssele	- Flooded streets - Flooded houses	De Telegraaf
	Baarland	- Mention of pluvial flooding	Omroep Zeeland, 2018a
	Kappele	- Mention of pluvial flooding	Omroep Zeeland, 2018a
	Borger	- Flooded streets - Flooded cellar	Dagblad van het Noorden, 2018
	Drouwen	- Flooded streets - Flooded cellar	Dagblad van het Noorden, 2018
	Schoonebeek	- Flooded streets	Dagblad van het Noorden, 2018
	Oosterhesselen	- Mention of pluvial flooding	Asser Courant, 2018
	Maastricht	- Flooded streets	Verborg & Tiems, 2018
	Berg en Terblijt	- Flooded streets - Mud stream - Flooded houses	Verborg & Tiems, 2018
29-05-2018	Hellevoetsluis	- Two flooded schools - Flooded streets	NOS, 2018; Nu.nl, 2018
	Ede	- Flooded streets - Blocked traffic due to the flooding of a tunnel - Collapsed roofs	De Gelderlander, 2018
	Veenendaal	- Flooded streets - Flooded houses	RTV Utrecht, 2018b
	Baarn	- Flooded streets - Flooded houses	RTV Utrecht, 2018b
	Bilthoven	- Flooded streets - Flooded houses	RTV Utrecht, 2018b
	Maarsen	- Flooded streets - Flooded houses	RTV Utrecht, 2018b
	De Meern	- Flooded street	RTV Utrecht, 2018b
	Winterswijk	- Flooded parking garage	- De Gelderlander, 2018
	Brielle	- Flooded street	NOS, 2018
	Maassluis	- Flooded streets	RTV Rijnmond, 2018
	Hendrik-Ido-Ambacht	- Flooded streets - Flooded houses	RTV Rijnmond, 2018
	Hardinxveld-Giessendam	- Flooded streets - Flooded houses	RTV Rijnmond, 2018
	Ridderkerk	- Flooded streets	
	Millingen aan de Rijn	- Flooded streets - Flooded cellars	Verstraaten, 2018
	Groesbeek	- Flooded streets - Flooded cellars	Verstraaten, 2018
31-05-2018	Sneek	- Flooded streets	Leeuwarder Courant, 2018

		- Flooded cellars	
	Heereveen	- Flooded streets - Flooded cellars	Leeuwarder Courant, 2018
	Drachten	- Flooded streets - Flooded cellars	Leeuwarder Courant, 2018
	Bolsward	- Partially subsided quay	Leeuwarder Courant, 2018
	Glanerbrug	- Flooded streets - Flooded cellars - Flooded houses	Glanerbrug.info, 2018
	Almelo	- Flooded streets	AD, 2018
	Norg	- Flooded streets	Koene, 2018
	Grootegast	- Flooded streets	Koene, 2018
	Marum	- Flooded streets	Koene, 2018
	Oudehorne	- Flooded streets	Koene, 2018
	Voorthuizen	- Flooded streets	Omroep Gelderland, 2018
	Castricum	- Flooded school	NH nieuws, 2018
	Akersloot	- Flooded streets	NH nieuws, 2018
	Leidschendam-Voorburg	- Flooded streets	Hetkrantjeonline, 2018
	Lansingerland	- Flooded streets	Hartvanlansingerland, 2018
	Woerden	- Flooded streets	RTV Utrecht, 2018a

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Appendix III: Overview of analyzed policy documents that are relevant for local stakeholders on the topic of pluvial flooding

Document name	Reference
Gemeentelijk Waterplan Smallingerland 2017-2020	De Vries, D. (2017). *Gemeentelijk Waterplan Smallingerland 2017-2020.* Available: https://www.smallingerland.nl/Int/Milieu/Waterbeheer/Waterplan-Smallingerland-(2017-2020,-pdf).pdf. Last accessed 14th Dec 2018.
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Beleidsplan 2018-2021	Gemeente Smallingerland. (2017). *Beleidsplan 2018-2021.* Available: https://www.smallingerland.nl/Int/2017/Oktober/Beleidsplan-Smallingerland-2018-2021/Beleidsplan-2018-2021.html. Last accessed 14th Dec 2018
Gemeentelijk Rioleringsplan Smallingerland 2017-2021	De Kraker, M., Alma, J. & Den Besten, J. (2016). *Gemeentelijk Rioleringsplan Smallingerland 2017-2020.* Available: Send by interview respondent. Last accessed 12 Sep 2018.
Stedelijke Wateropgave Meppel	Oranjewoud. (2009). *Stedelijke Wateropgave Meppel.* Available: Send by interview respondent. Last accessed 23 Aug 2018.
Watertakenplan Fluvius 2016-2021 – Specificatie Meppel	Niezen, J. & Hartemink, J. (2015c). *Watertakenplan Fluvius 2016-2021 - Specificatie Meppel.* Available: https://www.meppel.nl/Bestuurenorganisatie/Beleid_regelgeving/Beleidsinformatie/algemeen_beleid/Fluvius_specificatie_Meppel_20151126_vastgesteld_klein_formaat.pdf. Last accessed 14th Dec 2018.
Klimaatrobuust Hoogeveen	Gemeente Hoogeveen. (2017). *Klimaatrobuust Hoogeveen.* Available: https://www.hoogeveen.nl/bis/dsresource?objectid=8bb5b528-47be-495d-bd34-7ac57f7b3096. Last accessed 14th Dec 2018.
Verbreed Gemeentelijk Rioleringsplan 2010-2014	Oranjewoud. (2010). *Verbreed Rioleringsplan Hoogeveen 2010-2014.*Available: https://www.hoogeveen.nl/dsresource?type=org&objectid=ca4198e1-317b-4770-9bb0-7fb059560c8e&versionid=&subobjectname=. Last accessed 14th Dec 2018
Watertakenplan Fluvius 2016-2021 – Specificatie Hoogeveen	Niezen, J. & Hartemink, J. (2015b). *Watertakenplan Fluvius 2016-2021 - Specificatie Hoogeveen.* Available: https://www.hoogeveen.nl/bis/dsresource?objectid=d741eeee-45cd-4171-9727-eae363dac46d. Last accessed 14th Dec 2018.
Watertakenplan Fluvius 2016-2021 – Hoofdrapport	Niezen, J. & Hartemink, J. (2015c). *Watertakenplan Fluvius 2016-2021 - Specificatie Meppel.* Available: https://www.meppel.nl/Bestuurenorganisatie/Beleid_regelgeving/Beleidsinformatie/algemeen_beleid/Fluvius_specificatie_Meppel_20151126_vastgesteld_klein_formaat.pdf. Last accessed 14th Dec 2018.
Fries Bestuursakkoord Waterketen 2016-2020	Provincie Friesland, Gemeenten Friesland, Vitens & Waterschap Friesland. (2016). *Fries Bestuursakkoord Waterketen 2016-2020.*Available: https://www.wetterskipfryslan.nl/documenten-catalogus/algemeen/diversen/fbwk-2016-2020.pdf. Last accessed 14th Dec 2018.
Bouwsteen Water – Voor de Omgevingsvisie van de Provincie Fryslan	Provincie Friesland & Waterschap Friesland. (2017). *Bouwsteen Water - Voor de Omgevingsvisie van de Provincie Fryslan* . Available: https://www.fryslan.frl/document.php?m=7&fileid=37039&f=bd82895e487ac923d5a794df6f5789ad&attachment=0. Last accessed 14th Dec 2018.
Vierde Waterhuishoudingsplan	Provincie Friesland. (2016). *Vierde Waterhuishoudingsplan.* Available: https://www.fryslan.frl/document.php?m=7&fileid=646&f=b33dfcd92ab57d9df3e31318432 64ab6&attachment=0. Last accessed 14th Dec 2018.
Koersdocument Omgevingsvisie Fryslan	Provincie Friesland. (2018). *Koersdocument Omgevingsvisie Provincie Fryslan.* Available: https://www.fryslan.frl/document.php?m=7&fileid=42238&f=87c08d996d46246od2bd6f9847bdeeef&attachment=0. Last accessed 14th Dec 2018.

Actualisatie Omgevingsvisie Drenthe	Provincie Drenthe. (2014). *Actualisatie Omgevingsvisie Drenthe.* Available: https://www.provincie.drenthe.nl/publish/pages/124413/omgevingsvisie_2018_-_provincie_drenthe.pdf. Last accessed 14th Dec 2018.
Provinciale Omgevingsverordening	Provincie Drenthe. (2018) *Provinciale Omgevingsverordening.* Available: https://www.provincie.drenthe.nl/onderwerpen/bouwen-wonen/omgevingsvisie/. Last accessed 15th May 2019
Waterbeheersplan 2016-2021 – Waterschap Drents Overijsselse Delta	Waterschap Drents Overijsselse Delta, Waterschap Rijn en IJssel & Waterschap Vechtstromen. (2015). *Waterbeheersplan 2016-2021 - Waterschap Drents Overijsselse Delta.* Available: https://www.wdodelta.nl/publish/pages/8140/waterbeheerplan_2016-2021_wdo_delta_ab_4_januari_26nov15.pdf. Last accessed 14th Dec 2018.
Water raakt!	Waterschap Groot Salland, Waterschap Reest en Wieden, Waterschap Rijn en IJssel & Waterschap Vechtstromen. (n.d.). *Water Raakt! Samen werken aan water in de stad.* Available: https://www.wdodelta.nl/publish/pages/8431/water_raakt_wdodelta.pdf. Last accessed 14th Dec 2018.
Waterbeheersplan Friesland 2016-2021	Waterschap Friesland. (2016). *Waterbeheerplan Friesland 2016 - 2021.*Available: https://www.wetterskipfryslan.nl/documenten/bestuur/waterbeheerplan-2016-2021/waterbeheerplan-2016-2021-19_april_2016-_v6.pdf/view. Last accessed 14th Dec 2018.
Meerjaren Perspectief 2016-2020	Waterschap Friesland. (2015). *Meerjaren Perspectief 2016-2020.* Available: https://www.wetterskipfryslan.nl/documenten/organisatie/meerjarenperspectief-wetterskip-fryslan-2016-2020.pdf . Last accessed 14th Dec 2018.
Veiligheidsplan II – Eindconcept onderzoeksrapport	Arcadis & Waterschap Friesland. (2014). *Veiligheidsplan II - Eindconcept Onderzoeksrapport.* Available: https://www.wetterskipfryslan.nl/documenten-catalogus/algemeen/calamiteiten/veiligheidsplan-ii.pdf. Last accessed 14th Dec 2018.

Table 17: Overview of relevant policy documents used by local stakeholders

Appendix IV: Codes used for the interview and policy document analysis

Used code / topic	Meaning
Role of governmental stakeholder towards pluvial flooding	
Active role	The stakeholder has an active role towards pluvial flooding in urban areas. This means that they will take an effort themselves (as a stakeholder) to improve resilience through measures and changes in the spatial design. The keyword is here that they themselves act rather than support other actors.
Supportive role	The stakeholder will not act themselves, but will instead support other stakeholders through, for example, provide advice, information or subsidy that other stakeholders (including citizens, businesses etc.) can use to take measures themselves.
Collaboration	The stakeholder will take measures in collaboration with other stakeholders. Keyword here is that it happens in collaboration rather than that one stakeholder is supported by another stakeholder.
Other involved governmental stakeholders	Other governmental stakeholders named in the interview transcript or policy document that have a role in pluvial flooding in urban areas.
Role of other involved governmental stakeholders	Other named governmental stakeholders can have a different role towards pluvial flooding then the stakeholder that was interviewed or for who the policy document was written (e.g. the role of the municipality in urban areas versus the role of the water board).
Other involved non-governmental stakeholders	Other non-governmental stakeholders (e.g. citizens) also have a role in taking measures against pluvial flooding.
Role of other non-governmental involved stakeholders	The role that non-governmental stakeholders play when it comes to taking spatial measures against pluvial flooding.
Actions taken to enhance pluvial flooding resilience characteristics	
Robustness	Measures that are taken that help to decrease the chance that pluvial flooding will occur in urban areas (e.g. increasing retention capacity, infiltration in the ground or sewer capacity).
Absorption	Measures that are taken that help decrease the potential consequences in case pluvial flooding would take place in urban areas (e.g. building height legislation, changes to the road profile to let pluvial flooding flow away from populated areas).
Adaptation	Conventional measures and approaches tare taken. Measures are already been used before, there is experience with implementing them and 'standard' stakeholders are involved during the implementation' (e.g. improving sewer capacity in collaboration between the water board and the municipality).
Transformation	New, and innovative measures and approaches are taken, or new stakeholders are being involved. Focus in this case is on innovation, or changes to current used approaches (e.g. moving from a governmental to a governance approach or including citizens).
Learning capacity	The learning capacity of stakeholders is how new information and insights are adopted by the organization and integrated into their approaches and decisions.
Use of information during decision-making process	
Climate information	Information that is used and can be classified as 'climate information', that includes, for example, climate change impacts and meteorological measurements.
Other information	Information that cannot be classified as climate information but is still seen as important by interviewed stakeholders (e.g. cost-effectiveness of measures or other spatial developments that dictate where measures will be taken).

Missing information	Information that is still missing according to the interviewed stakeholder. This can encompass both climate information as well as other relevant information.
Format in which the information is presented	
Format	The format in which used information is presented (e.g. maps, reports, models).
Potential (dis)advantages of used formats	The potential advantages or disadvantages of using the formats that are currently being used by stakeholders.
Factors that influence the decision-making process	
Climate information	Climate information that influences the decision-making process for implementing new measures.
DESTELP factors	Other factors than climate information that influence the decision-making process (e.g. cost-effectiveness of measures and experiences in practice with pluvial flooding measures).
Role of climate information in relation to other factors	The role that climate information has in comparison to other factors that influence the decision-making process.

Table 18: Explanation of the code used for analysis of the interview transcripts and relevant policy documents (Source: Author)

Appendix V: Interview guides (Dutch original and English translation)

Water board - Dutch

Introductie van de doel van het onderzoek en toestemming vragen voor opnemen interview

Hallo **(respondent van het waterschap)**,

Allereerst wil ik je hartelijk bedanken dat je mee wilt werken aan dit interview, en daarmee ook aan mijn onderzoek. We hebben via de mail het al gehad over het onderwerp van het onderzoek, namelijk de ruimtelijke adaptatie van stedelijke gebieden in **(case study area)**, en de rol die zowel het Waterschap als klimaatinformatie hierin spelen.

Verder wil ik je ook vertellen dat de informatie die besproken wordt in dit gesprek alleen gebruikt zal worden academische doeleinden. Ook zal alleen de functie en organisatie waar je werkt genoemd worden in mijn scriptie. Ga je hier akkoord mee? ***(Wachten op antwoord respondent)***

Tenslotte wil ik je vragen of dit gesprek opgenomen zou mogen worden om transcriptie van dit interview mogelijk te maken. ***(Wachten op antwoord respondent)*** Mocht je op een gegeven moment toch aan te willen geven dat je het gesprek niet verder opgenomen wilt laten worden, dan is dit uiteraard mogelijk. Heb je verder nog eventuele vragen voordat we beginnen? ***(Wachten op antwoord respondent)***

Dan kunnen we nu beginnen met het interview

Fade in

Achtergrond informatie van respondent

- Welke functie vervul je binnen het Waterschap **(case study gebied)** en hoe past deze functie binnen het onderwerp ruimtelijke adaptatie van stedelijke gebieden tegen wateroverlast?

- Hoe lang ben je al bezig in deze functie?

Ervaring van respondent uit loopbaan / persoonlijke omstandigheden met wateroverlast in het algemeen of in stedelijke gebieden

- Heb je ook verdere ervaring met wateroverlast in stedelijke gebieden of met wateroverlast in het algemeen vanuit eerdere functies / studie / persoonlijke ervaring?

Rol die het speelt Waterschap in relatie tot wateroverlast in stedelijke gebieden

- In hoeverre wordt wateroverlast in stedelijke gebieden gezien als een probleem door het Waterschap? Indien niet, waarom wordt het niet gezien als een probleem door het Waterschap?

- Hoe zou je zelf de rol omschrijven die het Waterschap als organisatie heeft in betrekking tot het voorkomen van wateroverlast (schade) in stedelijke gebieden?

- Hoe effectief zou je het Waterschap zien in het vervullen van deze rol(len)?

- Hoe verhoudt het Waterschap zich als organisatie tot zijn mede-actoren op het gebied van wateroverlast in stedelijke gebieden? (bijv. gemeente; burgers; private partijen) en tot op welke zekere hoogte is er sprake van samenwerking om wateroverlast (schade) te voorkomen? Zo ja, hoe wordt er met welke partijen wordt er samengewerkt? Zo nee, waarom is geen sprake van samenwerking?

Rol van klimaat informatie voor het Waterschap voor het nemen van beslissingen

- Welke informatie omtrent wateroverlast is beschikbaar bij het Waterschap, en in welke vorm is deze informatie beschikbaar? (kaarten; rapporten; modellen; etc.)

- Neemt deze informatie ook klimaatverandering mee? / Is het gebaseerd of klimaatveranderings scenarios of voorspellingen?

- Hoe groot is de rol die deze informatie heeft bij het nemen van beslissingen omtrent de ruimtelijke adaptatie van stedelijke gebieden tegen wateroverlast? Wat zijn verdere afwegingen en factoren die meegenomen worden bij het nemen van deze beslissingen?

- Heeft de beschikbare informatie ook tekortkomingen in het gebruik door de Waterschap? Zou je verbeterpunten hebben?

- Hoe gaat het waterschap om met nieuwe informatie die beschikbaar komt betreffende wateroverlast in stedelijke gebieden (inzichten, methoden, etc.) of ? Zou je het Waterschap in dit opzicht flexibel noemen in het omgaan met nieuwe ontwikkelingen?

Het verbeteren van de resilience van stedelijke gebieden tegen wateroverlast door het Waterschap

- Ben je zelf bekend met het concept resilience / veerkrachtigheid van stedelijke gebieden tegen overstromingen door bijvoorbeeld hevige regenval? Zo ja, wat versta je hier dan onder?

- Wordt deze blik op het concept van resilience / veerkrachtigheid van stedelijke gebieden tegen wateroverlast ook gedeeld door de rest van de organisatie? Zo nee, hoe wordt dit dan gezien of bestaat het überhaupt binnen het Waterschap?

- Is er vanuit het Waterschap ook een focus op bepaalde aspecten van wateroverlast en kun hiervan je ook voorbeelden geven van maatregelen tegen wateroverlast in stedelijk gebied van **(case study gebied)** waar het Waterschap betrokken is geweest bij het implementeren hiervan?

- Is er vanuit het Waterschap ook een focus op bepaalde groepen of partijen als het gaat om het nemen van beslissingen rondom wateroverlast? Worden er ook groepen buiten beschouwing gelaten of zijn er groepen die moeilijker betrokken kunnen worden?

Fade out

- Heb je vanuit jouw eigen ervaringen betreffende wateroverlast nog praktische inzichten over wateroverlast waar ik nog niet over gevraagd heb, maar die eventueel interessant zouden kunnen zijn voor mijn onderzoek?

- Zou ik eventueel je kunnen benaderen voor mogelijke extra vragen mocht dit nodig blijken?

- Heb je ook nog interesse in de eindresultaten van het onderzoek na voltooiing van mijn scriptie?

Hartelijk bedankt voor je medewerking aan dit interview

Water board – English translation

Introduction of the goal of the research and ask permission for recording the interview

Hello **(respondent from the water board)**,

First, I want to thank you for letting me do an interview with you, and thereby contributing to my research. Via our previous email contact, we have already talked about the main topic of the research: spatial adaptation of urban areas in **(case study area)**, as well as the role that the water board and climate information towards furthering this goal.

Furthermore, I also want to tell you that information that is discussed during our converstation will only by used for academic purposes. Also, only a thematical description of your function and your organization be used in my thesis to guarentee anonomity. Do you agree to this? **(wait for response from respondent)**

Finally, I also want to ask you if I can record our conversation, so it is possible to transcribe this interview afterwards. **(wait for response from respondent)** It is also possible to ask me to stop recording the interview any time for the duration of the interview. Do you have any questions before we start? **(wait for response from respondent)**

Then we can now start with the interview.

Fade in

Background information about the respondent

- Which function do you fullfil within the water board and how does this function fit within the topic of spatial adaptation of urban areas against pluvial flooding due to precipitation?

- How long are you already working on this position?

Experiences the respondent has with pluvial flooding in urban areas or in general from personal experiences, earlier held positions or study background

- Do you also have experience with pluvial flooding in urban areas or in general from earlier held positions, study background or personal experiences?

The role that the water board has in relation to pluvial flooding in urban areas

- To what degree is pluvial flooding in urban areas seen as a problem by the water board? If not, why is it not seen as a problem?

- How would you yourself describe the role that the water board has as an organization for preventing pluvial flooding (damage) in urban areas?

- How effective do you see the water board in fulfilling this role?

- How does the water board as organization relate itself to other stakeholders involved in pluvial flooding prevention in urban areas (e.g. municipalities; province; citizens) and do you also collaborate with these stakeholders on this topic? If so, in what way do you collaborate with these stakeholder(s)? If no, why do you not collaborate with these stakeholder(s)?

Role of climate information in the decision-making process of the water board

- Which information regarding pluvial flooding does the water board have, and in which format is this information presented? (e.g. maps, reports, models, etc.)

- Does this information also consider climate change? Is it based climate change impact predictions and/or scenarios?

- How large is the influence that this information has for decision-making regarding the spatial adaptation of urban areas against pluvial flooding? What are other considerations and factors that influence this process?

- Does the available information also have shortages in its use by the water board? How would this information be improved according to you?

- How does the water board handle new information that becomes available about about pluvial flooding in urban areas? (e.g. insights, methods, etc.) Would you see the water board as being flexible in adapting these new developments?

Enhancing resilience of urban areas against pluvial flooding by the the water board

- Are you familiar with the concept of urban pluvial flood resilience? How do you see this concept?

- Is this view on resilience shared by others in the organization? If not, how is it seen by others or is present at all?

- Is there also a focus on certain aspects of pluvial flooding by the water board? If so, which ones are these?

- Could you give examples of measures or interventions that have been taken by the water board in **(case study area)**, or in which the water board was collaborating with other stakeholders?

- Is there also a focus on certain stakeholders by the water board during the decision-making process for pluvial flood measures and interventions? Are there also certain stakeholders that are ignored or are harder to reach and be involved?

Fade out

- Do you have from your own experiences still practical insights about pluvial flooding that I have not asked about, but that could be interesting for the research?

- If I have additional questions, could I then contact you for additional information and/or explainations?

- Are you interested in the results from my thesis when this is completed?

Thank you very much for particpating in this interview

Municipality - Dutch

Introductie van doel van het onderzoek en toestemming vragen voor opnemen interview

Hallo **(respondent van de gemeente)**,

Allereerst wil ik je hartelijk bedanken dat je mee wilt werken aan dit interview, en daarmee ook aan mijn onderzoek. We hebben via de mail het al gehad over het onderwerp van het onderzoek, namelijk de ruimtelijke adaptatie in het stedelijk gebied van **(case study gebied)** door middel van ingrepen in de ruimtelijke omgeving, en de rol die de gemeente **(case study gebied)** als organizatie, en daarnaast ook klimaatinformatie hierin spelen of hebben gespeeld.

Verder wil ik je ook vertellen dat de informatie die besproken wordt in dit gesprek alleen gebruikt zal worden academische doeleinden. Ook zal alleen de functie en organisatie waar je werkt genoemd worden in mijn scriptie. Ga je hier akkoord mee? ***(Wachten op antwoord respondent)***

Tenslotte wil ik vragen of dit gesprek opgenomen zou mogen worden om transcriptie van dit interview mogelijk te maken. ***(Wachten op antwoord respondent)*** Mocht je op een gegeven moment toch aan te willen geven dat je het gesprek niet verder opgenomen wilt laten worden, dan is dit uiteraard mogelijk. Hebben jullie verder nog eventuele vragen voordat we beginnen? ***(Wachten op antwoord respondent)***

Dan kunnen we nu beginnen met het interview

Fade in

Achtergrond informatie van respondenten

- Welke functie vervullen je binnen de gemeente **(case study gebied)** als organizatie en hoe past deze functie binnen het onderwerp ruimtelijke adaptatie van stedelijke gebieden tegen wateroverlast?

- Hoe lang ben je al bezig in deze functie?

Ervaring van respondent uit loopbaan / persoonlijke omstandigheden met wateroverlast in het algemeen of in stedelijke gebieden

- Heb je ook verdere ervaring met wateroverlast in stedelijke gebieden of met wateroverlast in het algemeen vanuit eerdere functies / studie / persoonlijke ervaring?

Rol die de gemeente (case study location) speelt in relatie tot wateroverlast in stedelijke gebieden

- In hoeverre wordt wateroverlast in stedelijke gebieden gezien als een probleem door de gemeente **(case study gebied)**? Indien niet, waarom wordt het niet gezien als een probleem door het gemeente **(case study gebied)**?

- Hoe zou je zelf de rol omschrijven die gemeente **(case study gebied)** als organisatie heeft in betrekking tot het voorkomen van wateroverlast (schade) in stedelijke gebieden?

- Hoe effectief zou je gemeente **(case study gebied)** zien in het vervullen van deze rol(len)?

- Hoe verhoudt gemeente **(case study gebied)** zich als organisatie tot zijn mede-actoren op het gebied van wateroverlast in stedelijke gebieden? (bijv. Waterschap; burgers; private partijen) en tot op welke zekere hoogte is er sprake van samenwerking om wateroverlast (schade) te voorkomen? Zo ja, hoe wordt er met welke partijen wordt er samengewerkt? Zo nee, waarom is geen sprake van samenwerking?

Rol van klimaat informatie voor de gemeente voor het nemen van beslissingen

- Welke informatie omtrent wateroverlast is beschikbaar bij de gemeente **(case study gebied)**, en in welke vorm is deze informatie beschikbaar? (kaarten; rapporten; modellen; etc.)

- Neemt deze informatie ook klimaatverandering mee? / Is het gebaseerd of klimaatveranderings scenarios of voorspellingen?

- Hoe groot is de rol die deze informatie heeft bij het nemen van beslissingen omtrent de ruimtelijke adaptatie van stedelijke gebieden tegen wateroverlast? Wat zijn verdere afwegingen en factoren die meegenomen worden bij het nemen van deze beslissingen?

- Heeft de beschikbare informatie ook tekortkomingen in het gebruik door de gemeente **(case study gebied)**? Zou je verbeterpunten hebben? Is het format waarin de informatie aangeboden wordt goed of leidt deze tot verwarring?

- Hoe gaat de gemeente **(case study gebied)** om met nieuwe informatie die beschikbaar komt betreffende wateroverlast in stedelijke gebieden (inzichten, methoden, etc.) of ? Zou je de gemeente **(case study gebied)** in dit opzicht flexibel noemen in het omgaan met nieuwe ontwikkelingen?

Het verbeteren van de resilience van stedelijke gebieden tegen wateroverlast door de gemeente (case study gebied)

- Zijn jullie bekend met het concept resilience / veerkrachtigheid van stedelijke gebieden tegen overstromingen door bijvoorbeeld hevige regenval? Zo ja, wat versta je hier dan onder?

- Wordt deze blik op het concept van resilience / veerkrachtigheid van stedelijke gebieden tegen wateroverlast ook gedeeld door de rest van de organisatie? Zo nee, hoe wordt dit dan gezien of bestaat het überhaupt binnen de gemeente **(case study gebied)**?

- Is er vanuit de gemeente **(case study gebied)** ook een focus op bepaalde aspecten van wateroverlast en kun hiervan je ook voorbeelden geven van maatregelen tegen wateroverlast in stedelijk gebied van **(case study gebied)** waar de gemeente **(case study gebied)** betrokken is geweest bij het implementeren hiervan?

- Is de gemeente **(case study gebied)** ook bezig geweest met ruimtelijke aanpassingen in de wijken **(case study gebied)** *(laat kaartje zien)*. Zo ja, wat is hier dan zoal gedaan? Zo niet, waarom is hier nog niets gedaan?

- Is er vanuit de gemeente **(case study gebied)** ook een focus op bepaalde groepen of partijen als het gaat om het nemen van beslissingen rondom wateroverlast? Worden er ook groepen buiten beschouwing gelaten of zijn er groepen die moeilijker betrokken kunnen worden?

Fade out

- Heb je vanuit jouw eigen ervaringen betreffende wateroverlast nog praktische inzichten over wateroverlast waar ik nog niet over gevraagd heb, maar die eventueel interessant zouden kunnen zijn voor mijn onderzoek?

- Zou ik eventueel je kunnen benaderen voor mogelijke extra vragen mocht dit nodig blijken?

- Zou de gemeente **(case study gebied)** bereid zijn om mee te willen helpen met het verzamelen van data onder bewoners?

- Hebben jullie ook nog interesse in de eindresultaten van het onderzoek na voltooiing van mijn scriptie?

Hartelijk bedankt voor je medewerking aan dit interview

Municipality - English translation

Introduction of the goal of the research and ask permission for recording the interview

Hello **(respondent from the municipality in case study area)**,

First, I want to thank you for letting me do an interview with you, and thereby contributing to my research. Via our previous email contact, we have already talked about the main topic of the research: spatial adaptation of urban areas in **(municipality in case study area)**, as well as the role that the **(municipality in case study area)** and climate information towards furthering this goal.

Furthermore, I also want to tell you that information that is discussed during our converstation will only by used for academic purposes. Also, only a thematical description of your function and your organization be used in my thesis to guarentee anonomity. Do you agree to this? **(wait for response from respondent)**

Finally, I also want to ask you if I can record our conversation, so it is possible to transcribe this interview afterwards. **(wait for response from respondent)** It is also possible to ask me to stop recording the interview any time for the duration of the interview. Do you have any questions before we start? **(wait for response from respondent)**

Then we can now start with the interview.

Fade in

Background information about the respondent

- Which function do you fullfil within the municipality and how does this function fit within the topic of spatial adaptation of urban areas against pluvial flooding due to precipitation?

- How long are you already working on this position?

Experiences the respondent has with pluvial flooding in urban areas or in general from personal experiences, earlier held positions or study background

- Do you also have experience with pluvial flooding in urban areas or in general from earlier held positions, study background or personal experiences?

The role that the municipality has in relation to pluvial flooding in urban areas

- To what degree is pluvial flooding in urban areas seen as a problem by the municipality? If not, why is it not seen as a problem?

- How would you yourself describe the role that the municipality has as an organization for preventing pluvial flooding (damage) in urban areas?

- How effective do you see the muicipality in fulfilling this role?

- How does the municipality as organization relate itself to other stakeholders involved in pluvial flooding prevention in urban areas (e.g. water board; province; citizens) and do you also collaborate with these stakeholders on this topic? If so, in what way do you collaborate with these stakeholder(s)? If no, why do you not collaborate with these stakeholder(s)?

Role of climate information in the decision-making process of the water board

- Which information regarding pluvial flooding does the municipality have, and in which format is this information presented? (e.g. maps, reports, models, etc.)

- Does this information also consider climate change? Is it based climate change impact predictions and/or scenarios?

- How large is the influence that this information has for decision-making regarding the spatial adaptation of urban areas against pluvial flooding? What are other considerations and factors that influence this process?

- Does the available information also have shortages in its use by the municipality? How would this information be improved according to you?

- How does the municipality handle new information that becomes available about about pluvial flooding in urban areas? (e.g. insights, methods, etc.) Would you see the municipality as being flexible in adapting these new developments?

Enhancing resilience of urban areas against pluvial flooding by the the municipality

- Are you familiar with the concept of urban pluvial flood resilience? How do you see this concept?

- Is this view on resilience shared by others in the organization? If not, how is it seen by others or is present at all?

- Is there also a focus on certain aspects of pluvial flooding by the municipality? If so, which ones are these?

- Could you give examples of measures or interventions that have been taken by the municipality in **(case study area)**, or in which the water board was collaborating with other stakeholders?

- Is there also a focus on certain stakeholders by the municipality during the decision-making process for pluvial flood measures and interventions? Are there also certain stakeholders that are ignored or are harder to reach and be involved?

Fade out

- Do you have from your own experiences still practical insights about pluvial flooding that I have not asked about, but that could be interesting for the research?

- If I have additional questions, could I then contact you for additional information and/or explainations?

- Are you interested in the results from my thesis when this is completed?

Thank you very much for particpating in this interview

Province - Dutch

Introductie van doel van het onderzoek en toestemming vragen voor opnemen interview

Hallo **(respondent van de provincie)**,

Allereerst wil ik je hartelijk bedanken dat je mee wilt werken aan dit interview, en daarmee ook aan mijn onderzoek. We hebben via de mail het al gehad over het onderwerp van het onderzoek, namelijk de ruimtelijke adaptatie van stedelijke gebieden in Drachten door middel van ingrepen in de ruimtelijke omgeving, en de rol die de provincie **(case study gebied)** als organisatie daarin, en daarnaast ook de klimaatinformatie hierin spelen of hebben gespeeld. Hierbij gaat het om de adaptatie van stedelijke gebieden tegen hevige regen die in korte tijd kan vallen.

Verder wil ik je ook vertellen dat de informatie die besproken wordt in dit gesprek alleen gebruikt zal worden academische doeleinden. Ook zal alleen de functie en organisatie waar je werkt genoemd worden in mijn scriptie. Gaan je hier akkoord mee? *(Wachten op antwoord respondent)*

Tenslotte wil ik vragen of dit gesprek opgenomen zou mogen worden om transcriptie van dit interview mogelijk te maken. *(Wachten op antwoord respondent)* Mocht je op een gegeven moment toch aan te willen geven dat je het gesprek niet verder opgenomen wilt laten worden, dan is dit uiteraard mogelijk. Hebben je verder nog eventuele vragen voordat we beginnen? *(Wachten op antwoord respondent)*

Dan kunnen we nu beginnen met het interview

Fade in

Achtergrond informatie van respondent

- Welke functie vervullen je binnen de provincie **(case study gebied)** als organizatie en hoe past deze functie binnen het onderwerp ruimtelijke adaptatie van stedelijke gebieden tegen wateroverlast door hevige neerslag?

- Hoe lang ben je al bezig in deze functie?

Ervaring van respondent uit loopbaan / persoonlijke omstandigheden met wateroverlast in het algemeen of in stedelijke gebieden

- Heb je ook verdere ervaring met wateroverlast in stedelijke gebieden of met wateroverlast in het algemeen vanuit eerdere functies / studie / persoonlijke ervaring?

Rol die de provincie (case study gebied) speelt in relatie tot wateroverlast in stedelijke gebieden

- In hoeverre wordt wateroverlast in stedelijke gebieden door hevige regen gezien als een probleem door de provincie **(case study gebied)**? Indien niet, waarom wordt het niet gezien als een probleem door het provincie **(case study gebied)**?

- Hoe zou je zelf de rol omschrijven die de provincie Provincie als organisatie heeft in betrekking tot het voorkomen van deze wateroverlast (schade) in stedelijke gebieden?

- Hoe effectief zie je de provincie **(case study gebied)** in het vervullen van deze rol? Wat zou eventueel beter kunnen?

- Hoe verhoudt provincie **(case study gebied)** zich als organisatie tot haar mede-actoren op het gebied van wateroverlast in stedelijke gebieden? (bijv. gemeente; Waterschap; burgers; private partijen) en tot op welke zekere hoogte is er sprake van samenwerking om wateroverlast (schade) te voorkomen? Zo ja, hoe wordt er met welke partijen wordt er samengewerkt? Zo nee, waarom is geen sprake van samenwerking?

Rol van klimaat informatie voor de provincie (case study gebied) voor het nemen van beslissingen

- Welke informatie omtrent wateroverlast is beschikbaar bij de provincie **(case study gebied)**, en in welke vorm is deze informatie beschikbaar? (kaarten; rapporten; modellen; etc.)

- Neemt deze informatie ook klimaatverandering mee? / Is het gebaseerd of klimaatveranderings scenarios of voorspellingen?

- Hoe groot is de rol die deze informatie heeft bij het nemen van beslissingen omtrent de ruimtelijke adaptatie van stedelijke gebieden tegen wateroverlast? Wat zijn verdere afwegingen en factoren die meegenomen worden bij het nemen van deze beslissingen?

- Heeft de beschikbare informatie ook tekortkomingen in het gebruik door de provincie **(case study gebied)**? Zou je verbeterpunten hebben? Is het format waarin de informatie aangeboden wordt goed of leidt deze tot verwarring?

- Hoe gaat de provincie **(case study gebied)** om met nieuwe informatie die beschikbaar komt betreffende wateroverlast in stedelijke gebieden (inzichten, methoden, etc.)? Zou je de provincie **(case study gebied)** in dit opzicht flexibel noemen in het omgaan met nieuwe ontwikkelingen?

Het verbeteren van de resilience van stedelijke gebieden tegen wateroverlast door de provincie (case study gebied)

- Ben je bekend met het concept resilience / veerkrachtigheid van stedelijke gebieden tegen overstromingen door bijvoorbeeld hevige regenval? Zo ja, wat versta je hier dan onder?

- Wordt deze blik op het concept van resilience / veerkrachtigheid van stedelijke gebieden tegen wateroverlast ook gedeeld door de rest van de organisatie? Zo nee, hoe wordt dit dan gezien of bestaat het überhaupt binnen de provincie **(case study gebied)**?

- Is er vanuit de provincie **(case study gebied)** ook een focus op bepaalde aspecten van wateroverlast en kun hiervan je ook voorbeelden geven van maatregelen tegen wateroverlast in stedelijk gebied van **(case study gebied)** waar de provincie **(case study gebied)** betrokken is geweest bij het implementeren hiervan?

- Is er vanuit de provincie **(case study location)** ook een focus op bepaalde groepen of partijen als het gaat om het nemen van beslissingen rondom wateroverlast? Worden er ook groepen buiten beschouwing gelaten of zijn er groepen die moeilijker betrokken kunnen worden?

Fade out

- Heb je vanuit jouw eigen ervaringen betreffende wateroverlast nog praktische inzichten over wateroverlast waar ik nog niet over gevraagd heb, maar die eventueel interessant zouden kunnen zijn voor mijn onderzoek?

- Zou ik eventueel je kunnen benaderen voor mogelijke extra vragen mocht dit nodig blijken?

- Heb je eventueel ook nog interesse in de eindresultaten van het onderzoek na voltooiing van mijn scriptie?

Hartelijk bedankt voor je medewerking aan dit interview

Province - English translation

Introduction of the goal of the research and ask permission for recording the interview

Hello **(respondent from the Province in case study area)**,

First, I want to thank you for letting me do an interview with you, and thereby contributing to my research. Via our previous email contact, we have already talked about the main topic of the research: spatial adaptation of urban areas in **(Province in case study area)**, as well as the role that the **(Province in case study area)** and climate information towards furthering this goal.

Furthermore, I also want to tell you that information that is discussed during our converstation will only by used for academic purposes. Also, only a thematical description of your function and your organization be used in my thesis to guarentee anonomity. Do you agree to this? **(wait for response from respondent)**

Finally, I also want to ask you if I can record our conversation, so it is possible to transcribe this interview afterwards. **(wait for response from respondent)** It is also possible to ask me to stop recording the interview any time for the duration of the interview. Do you have any questions before we start? **(wait for response from respondent)**

Then we can now start with the interview.

Fade in

Background information about the respondent

- Which function do you fullfil within the Province and how does this function fit within the topic of spatial adaptation of urban areas against pluvial flooding due to precipitation?

- How long are you already working on this position?

Experiences the respondent has with pluvial flooding in urban areas or in general from personal experiences, earlier held positions or study background

- Do you also have experience with pluvial flooding in urban areas or in general from earlier held positions, study background or personal experiences?

The role that the Province has in relation to pluvial flooding in urban areas

- To what degree is pluvial flooding in urban areas seen as a problem by the Province? If not, why is it not seen as a problem?

- How would you yourself describe the role that the Province has as an organization for preventing pluvial flooding (damage) in urban areas?

- How effective do you see the Province in fulfilling this role?

- How does the Province as organization relate itself to other stakeholders involved in pluvial flooding prevention in urban areas (e.g. water board; municipalities; citizens) and do you also collaborate with these stakeholders on this topic? If so, in what way do you collaborate with these stakeholder(s)? If no, why do you not collaborate with these stakeholder(s)?

Role of climate information in the decision-making process of the water board

- Which information regarding pluvial flooding does the Province have, and in which format is this information presented? (e.g. maps, reports, models, etc.)

- Does this information also consider climate change? Is it based climate change impact predictions and/or scenarios?

- How large is the influence that this information has for decision-making regarding the spatial adaptation of urban areas against pluvial flooding? What are other considerations and factors that influence this process?

- Does the available information also have shortages in its use by the Province? How would this information be improved according to you?

- How does the Province handle new information that becomes available about about pluvial flooding in urban areas? (e.g. insights, methods, etc.) Would you see the municipality as being flexible in adapting these new developments?

Enhancing resilience of urban areas against pluvial flooding by the the Province

- Are you familiar with the concept of urban pluvial flood resilience? How do you see this concept?

- Is this view on resilience shared by others in the organization? If not, how is it seen by others or is present at all?

- Is there also a focus on certain aspects of pluvial flooding by the Province? If so, which ones are these?

- Could you give examples of measures or interventions that have been taken by the Province in **(case study area)**, or in which the water board was collaborating with other stakeholders?

- Is there also a focus on certain stakeholders by the Province during the decision-making process for pluvial flood measures and interventions? Are there also certain stakeholders that are ignored or are harder to reach and be involved?

Fade out

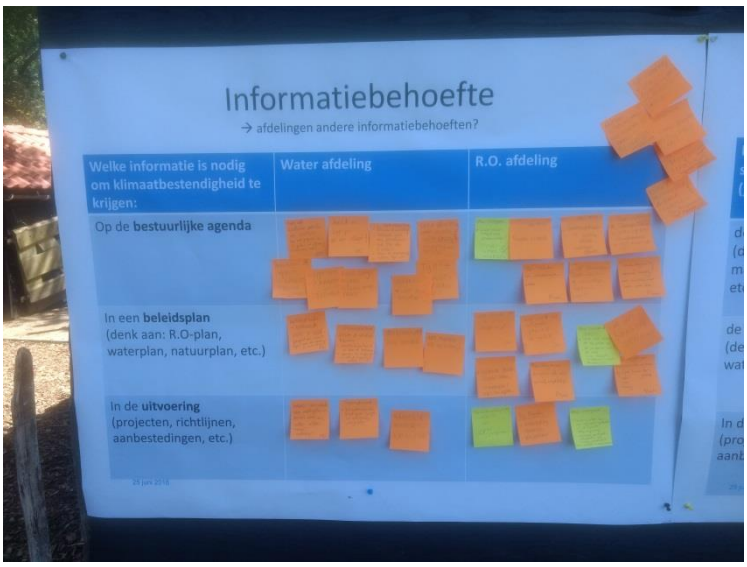
- Do you have from your own experiences still practical insights about pluvial flooding that I have not asked about, but that could be interesting for the research?

- If I have additional questions, could I then contact you for additional information and/or explainations?

- Are you interested in the results from my thesis when this is completed?

Thank you very much for particpating in this interview

Appendix VI: Report of the Fluvius Climate Workshop organized on the 26th of June 2018 (in Dutch)



Inleiding en presentaties

Op 26 juni vond de regionale klimaatbijeenkomst Fluvius plaats te Dwingeloo. Doel van de bijeenkomst was tweeledig: een gezamenlijk beeld creëren van wat de stresstest klimaat voor de regio betekent en de eerste verbinding tussen Water en RO binnen de gemeenten te maken en daarbij ook waterschap en provincie mee te nemen. Voor de lijst van aanwezigen zie bijlage 1.

<censored> van de gemeente Hoogeveen gaf de aftrap met een presentatie over het het Fluvius werkatelier in wording.

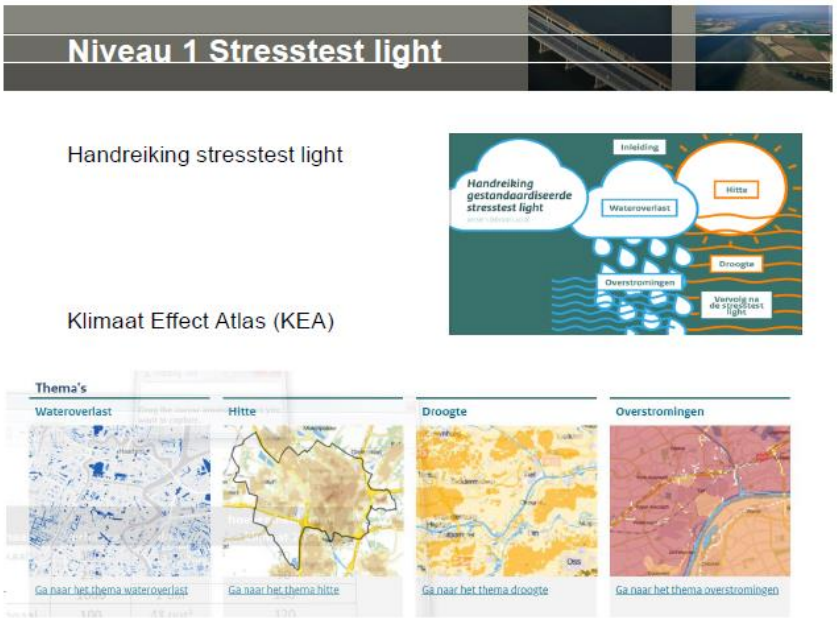
Vervolgens gaf <censored> van het waterschap Drents Overijselse Delta een toelichting op de 7 ambities van het Deltaplan Ruimtelijke Adaptatie zoals dat nu ook doorwerkt naar de werkregio's waarvan Fluvius er 1 is. Concreet betekent dit dat de regio's toewerken naar de volgende doelen:

- In 2020 handelen we waterrobuust en klimaatbestendig bij het (her)ontwikkelen van gebouwde omgeving
- In 2050 is de gebouwde omgeving zo goed mogelijk waterrobuust en klimaatbestendig ingericht

De eerste stap in de bovenstaande ambities is de stresstest – waarmee kwetsbaarheid van de regio ten aanzien van veranderingen van het klimaat in beeld wordt gebracht. Hierbij worden vier thema's onderscheiden: Overstromingen, Wateroverlast, Hitte en Droogte.

Hier neemt <censored> van onderzoeksinstelling Deltares het over. Wat is eigenlijk een stresstest? Welke vorm heeft deze? Hoe zorgen we ervoor dat de stresstest zo goed mogelijk bijdraagt aan de risicodialoog (de tweede ambitie) en vanuit dat perspectief welke informatie zou een stresstest moeten bevatten en in welke vorm. Dit zijn precies de vragen waar ook het Europese onderzoeksproject EVOKED zich op richt en wat ook de reden dat Deltares betrokken is bij de Fluvius.

Op dit moment is er een stresstest light beschikbaar voor Fluvius, in deze werksessie gaan we aan de slag met deze informatie om te zien of dit voldoende inzicht biedt om besluiten op te baseren.

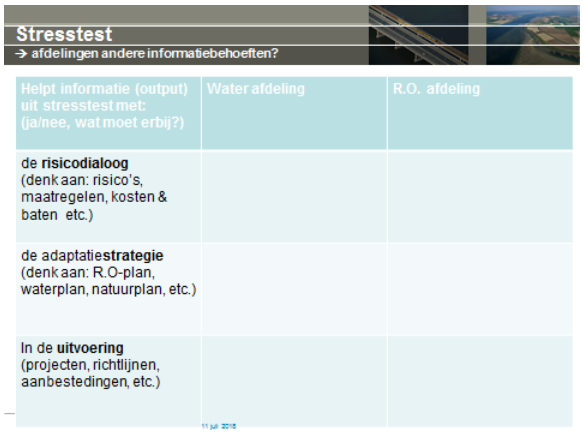


Opmerkingen tijdens de presentaties

- Niet iedereen neemt altijd water mee in hun werk (Gemeente Steenwijkerland, Ruimtelijke Ordening). Belangrijk om dit in gedachten te houden als het gaat om afhankelijkheid tussen RO en water.
- Volgens de provincie Drenthe mist de stresstest nog in het landelijk gebied. Als antwoord wordt hierop gegeven dat in eerste instantie eerst de focus is op het stedelijk gebied, en dat het landelijke gebied later komt.
- Duurzaamheid wordt gezien als klimaatadaptatie (Gemeente Westerveld)
- Iedereen weet wat een stresstest is in eerste instantie. De vraag die hier echter kan worden gesteld is of iedereen een eigen invulling heeft wat een stresstest inhoudt, of dat dit ook op één lijn zit.
- De aanname van de bui die in de Klimaat Effect Atlas (KEA) is gebruikt (60 mm / 1 uur) is nu eigenlijk al te licht volgens de gemeente Hoogeveen. Wel wordt aangegeven dat de KEA vrij accuraat is uit ervaring met een soortgelijke bui.
- Verder geeft Hoogeveen ook aan dat bij hittestress het ook gevraagd kan worden of er daadwerkelijk een probleem is. Dit kan namelijk verschillen per case of persoon. Dit kan dienen als input in de risicodialoog.
- Kosten en de effectiviteit van maatregelen worden ook gezien als mogelijk belangrijk voor het goed voeren van de risicodialoog.
- Kaarten die een overview geven van het klimaatprobleem kunnen helpen om een bestuurder mee te krijgen. Hierbij gaat het vooral om de bewustwording van bestuurders over deze problemen (Gemeente Midden-Drenthe).
- Standaardisatie van de stresstesten gaat om zowel de input als de output. Dit geldt voor de rapportage aan de deltacommissie, maar ook de voor adviesbureaus.
- Standaardisatie is nodig tot op een zekere hoogte, maar er is ook sprake van een eerlijke markt / marktwerking.
- Volgens de Provincie Drenthe kloppen de modellen niet altijd. Uit hun ervaring gaf een model aan dat er 1.5 / 2 meter water zou komen te staan op een plek in Assen, wat natuurlijk niet klopt. Verder geven ze ook aan dat de klimaatstresstest light kan dienen als een 'zeef' om te zien waar een prioritering van problemen kan worden gemaakt per gemeente. Aangezien iedere gemeente natuurlijk zijn eigen problemen heeft tot op een zekere hoogte.
- In modellen moet de uitkomsten daarom wel realistisch zijn (Provincie Drenthe). Hierin moet ook het verschil tussen een 'droog' en een 'verzadigd' systeem worden meegenomen, aangezien dit de uitkomsten kan beïnvloeden.
- De gemeente Hoogeveen geeft aan dat het ook goed is om zelf na te blijven denken en niet je blind te oriënteren op modellen (het gezonde verstand te *blijven* gebruiken).
- Volgens de provincie Overijssel zijn stresstesten niet het enige wat nodig is om een goede risicodialoog te kunnen voeren.

Werken in subgroepen

Vervolgens gaan de deelnemers in twee groepen uiteen waarbij ze in 2 ronden de volgende formats invullen (dmv geeltjes). Hierbij zijn we eerst gestart met een format gericht op algemene fasen in beleid en uitvoering: bestuurlijke agendering, beleidsvorming, uitvoering. Vervolgens hebben we in de tweede ronde concreet aangesloten bij de ambities van het Deltaprogramma: risicodialoog, adaptatiestrategie en uitvoering.



Ronde 1: Informatiebehoefte voor risicodialoog
De uitgewerkte flipovers staan in de bijlage. Hier is een link opgenomen waar deze zijn te downloaden.

Welke informatie is nodig om klimaatbestendigheid te krijgen op de:

Bestuurlijke agenda – Water afdeling - Groep 1

Volgens de deelnemende waterafdelingen zit dit vooral op de ervaringskant. Zo worden ervaringen van burgers genoemd, maar ook het zelf ervaren van een piekbui in de gemeente zelf. Daarnaast is een andere mogelijke optie ook de ervaring van andere bestuurders zelf die al een keer vanuit de bestuurderskant een piekbui hebben meegemaakt. Belangrijk is hier ook bij dat de schade, omvang en de kosten hieruit naar voren komen. Verder wordt ook feitelijke informatie, grafieken en cijfers genoemd als informatie die nodig is. Dit kan terugslaan op de schade en kosten van een mogelijke piekbui in een gemeente, dat deze informatie op die manier moet worden weergegeven. Tenslotte worden ook scenario's als mogelijkheid genoemd, alsmede het gebruik van de Provinciale Omgevingsvisie om klimaatbestendigheid op de bestuurlijke agenda te krijgen.

Bestuurlijke agenda – Waterafdeling – Groep 2

Ook hier wordt de impact van klimaatverandering genoemd als mogelijke manier om klimaatbestendigheid op de bestuurlijke agenda te krijgen. Dit kan dan bijvoorbeeld doormiddel van een kaart met kwetsbare gebieden, risicio's en knelpunten als startpunt van de conservatie. Ook mogelijke ervaringen van burgers worden hier weer genoemd als communicatiemiddel. Dit zou dan ook als een mogelijke koppeling kunnen dienen, samen met beelden, zodat kaartbeelden gaan 'leven'. Verder wordt bewustwording ook genoemd als een punt. Dit zou dan ook kunnen betekenen dat de eerste stap die nodig is, is om bestuurders bewust te maken van het belang van 'klimaat' en 'klimaatbestendigheid' voor zover dit nog niet gedaan is. Deze opmerking kan gezien worden als belangrijk omdat het aangeeft dat sommige bestuurders nog niet in de 'actiefase' zitten, maar eerder nog in de verkennende fase. Tenslotte wordt er ook aangegeven dat om klimaatbestendigheid op de bestuurlijke agenda te krijgen, er inzicht en begrip van collega's nodig is, dat er gekeken moet worden of er een probleem is, of dit probleem urgent is of dat het acceptabel is, en wie dit probleem heeft.

Bestuurlijke agenda – R.O. afdeling – Groep 1
Bij de R.O. kant wordt er veel meer gedacht in richtlijnen van bijvoorbeeld de EU, wetgeving en integrale samenwerking tussen verschillende aspecten binnen de ruimte zoals groen, water, en leefbaarheid. Binnen

deze integratie is het dan wel de vraag hoe adaptatie hierbinnen gewaarborgd kan worden. Hieruit vermoed ik dat de mensen die dit genoemd hebben zelf nog zoekende zijn naar zowel de integratie van deze verschillende aspecten, en daarnaast ook naar wat 'klimaatbestendigheid' hierbinnen betekend.

Bestuurlijke agenda – R.O. afdeling – Groep 2

Ook hier worden weer ervaringen genoemd als mogelijke manier om klimaatadaptatie op de bestuurlijke agenda te krijgen. Dit kan bijvoorbeeld door krantenkoppen bij extreme neerslag om mensen wakker te schudden. Alsmede leidt dit ook tot het volgende genoemde punt: bewustwording van de mogelijke problemen. Daarnaast wordt hier ook weer het in kaart brengen van problemen, fysieke knelpunten en kwetsbare gebieden genoemd. Nieuw is hier wel dat functies ook in kaart gebracht zouden moeten worden. Tegelijkertijd wordt wel gesteld dat er een afweging moet plaatsvinden tussen deze verschillende functies. Deze afweging leidt ook tot keuzes die de bestuurder moet maken als het neerkomt op de risico's van klimaatverandering waar de bestendigheid tegen zou moeten beschermen. Deze afweging wordt verder bemoeilijkt doordat de 'regeerrtermijn maar voor vier jaar is, terwijl er langere termijn plannen nodig zijn. Verder wordt ook aangeven dat de huidige vorm van communicatie ontoereikend is, en dat er anders gecommuniceerd zou moeten worden naar de gemeenteraad en de wethouders. Een mogelijke oplossing die gegeven wordt is het gebruiken van beelden en verhalen van voorbeeldprojecten om zo ook 'praktijkervaring' te gebruiken om klimaatadaptatie op de agenda te zetten.

Observatie van verschillen en overeenkomsten tussen beide afdelingen op het punt van welke informatie nodig is om klimaatbestendigheid op de bestuurlijke agenda te krijgen + eventuele interessante observaties

Aan de waterkant wordt nadenken over de verschillende ruimtelijke functies, en de afweging die hierin gemaakt zouden kunnen worden niet benoemd. Dit kan misschien verklaard worden vanuit het feit dat de afdeling water een gerichtere taak heeft dan de R.O. afdeling die meer bezig is met het vervlechten en inpassen van alle verschillende functieaspecten.

Qua informatieformats worden vooral kaarten en ervaringen benoemd. Echter lopen deze ervaringen wel uiteen van bijvoorbeeld bestuurlijke ervaring, tot praktijkervaring met piekbuien en ervaringen van burgers. Ook beelden zouden gebruikt kunnen worden als mogelijk communicatiemedium. Deze middelen, samen met grafieken, teksten en cijfers kunnen dan als communicatie dienen. Daarbij wordt wel gezegd vanuit de RO hoek dat er naar nieuwere methoden gekeken moet worden om informatie te communiceren naar bestuurders. Dit kan bijvoorbeeld door reframing en in te spelen op de spanningen die er zijn binnen het ruimtelijke speelveld.

Qua de soort informatie die er gebruikt zou moeten worden is er vooral oog voor het in kaart brengen van kwetsbare functies, de omvang en kosten, en feitelijke informatie. Daarnaast wordt het ook als belangrijk gezien dat de functies in de gebieden ion beeld gebracht moeten worden. De functie van de informatie is hier informeren over mogelijke impact en problemen, bewustwording en de urgentie van problemen. Dit laatste punt is een belangrijke aangezien er meer afwegingen en problemen op de bestuurlijke agenda zijn die allemaal vechten om een moment in de bestuurlijke 'spotlight'.

Welke informatie is nodig om klimaatbestendigheid te krijgen in een:

Beleidsplan – Water afdeling - Groep 1

Allereerst wordt er aangegeven dat er informatie nodig is over de schade die kan ontstaan door klimaatverandering in een gebied. Daarnaast is het ook belangrijk dat er inzicht is in het functioneren van het watersysteem en de water keten. Gelinkt hieraan is het ook belangrijk dat er inzicht is in de robuustheid van het systeem. Tenslotte moet de informatie ook helpen om een handelingsperspectief te bieden alsmede een eindpunt over waar er naar toe wordt gewerkt binnen een beleidsplan. Informatie die daarbij kan helpen is een prioritering van de verschillende problemen, bijv. door schade. Ook het 'verhaal' en eigenaarschap voor problemen kan bijdragen aan het borgen van klimaatbestendigheid binnen een beleidsplan. Mogelijke gerelateerde documenten die van toepassing kunnen zijn hiervoor zijn de provinciale omgevingsvisie, het waterstructuurplan en het uitvoeringsprogramma natuur.

Beleidsplan – Water afdeling – Groep 2

Een eerste stap die gezet moet worden is een visie en een strategie bepalen. Hiervoor moeten dan wel eerst de kwetsbaarheden in kaart gebracht worden, samen met de bijbehorende risico's. Dit zou dan bijvoorbeeld kunnen leiden tot een kaart waarop alle ontwikkelingen aangegeven worden samen met de eventuele meekoppelkansen voor klimaatbestendigheid. Dit is dan ook de input voor wat er opgeschreven moet worden in deze plannen. Tenslotte is de aankomende omgevingswet ook een punt dat een invloed hier heeft. Immers, deze wet veranderd de aanpak van plannen ook.

Beleidsplan – R.O. afdeling - Groep 1

De omgevingswet wordt ook bij de R.O. afdeling genoemd, en dan met name als een positief iets. Dit is omdat beleidsplannen omgevingsplannen worden binnen het kader van deze wet. Wel wordt er afgevraagd of er nog een soort adaptatieparagraaf komt binnen deze plannen, en ook wie dit zou moeten toetsen. Tenslotte wordt de omgevingsvisie van Overijssel genoemd als input voor het toevoegen van klimaatbestendigheid binnen beleidsplannen.

Beleidsplan – R.O. afdeling - Groep 2

Binnen deze groep wordt ook de NAS genoemd als belangrijk document voor klimaatadaptatie. Dit linkt ook meteen weer door naar twee dingen: wat de NAS betekend op het gemeentelijk niveau, en wat uit het integrale perspectief de visie moet worden. Dit omdat de NAS een meer integrale, of in ieder geval brede blik op klimaatadaptatie heeft vanuit de verschillende sectoren opgenomen in de NAS. Verder komt het integrale ook terug in het feit dat er informatie moet komen over welke maatregelen er mogelijk passen binnen de verschillende (beleids)processen die er spelen binnen de gemeentelijke organisatie. Dit wordt breder getrokken dan alleen water en R.O. door ook groenbeheer er bijvoorbeeld aan toe te voegen. Verder informatie die gezegd wordt nodig te zijn, zijn de kwetsbare gebieden en de mogelijke maatregelen die op deze kwetsbare plekken geïmplementeerd kunnen worden. Dit kan verhelderd worden met het behulp van bijv. risicodiagrammen die aangeven welke risico's wel of niet acceptabel zijn. Tenslotte vraagt men zich ook af wat hiervan eigenlijk zal gaan landen in het omgevingsplan (de opvolger van het beleidsplan onder de omgevingswet). Hier zit dus eigenlijk nog een stuk onduidelijkheid voor de aanwezigen.

Observatie van verschillen en overeenkomsten tussen beide afdelingen op het punt van welke informatie nodig is om klimaatbestendigheid in beleidsplannen te krijgen + eventuele interessante observaties

Aan de water kant wordt er vooral gekeken naar het functioneren van het water systeem als uitgangspunt voor beleidsplannen (met eventueel een doorkijk naar natuur). Dit is logisch, aangezien er een probleem nodig is als reden om nieuw beleid te ontwikkelen, en omdat natuur en water in Nederland hand in hand gaan. Binnen de R.O. afdeling wordt er wel breder gekeken naar de verschillende afdelingen binnen de gemeenten.

Bij de water deelnemers ligt qua informatie de focus vooral op schade (met in het verlengde daarvan ook de robuustheid en functioneren van het watersysteem). Deze informatie heeft vooral het doel om te dienen als een handelingsperspectief voor het bereiken van de eindambitie. Daarbij kan informatie dan prioriteit geven aan bepaalde problemen als bijvoorbeeld de schade of impact groot is. Ook is het van belang dat met deze risico's en kwetsbaarheden ook de meekoppelkansen voor klimaatbestendigheid worden meegenomen. Er is daarnaast ook een doorkijk naar de omgevingswet aangezien deze ook een impact zal hebben op het ruimtelijke beleid. In de R.O. hoek daarentegen staat vooral de omgevingswet centraal, alhoewel er wel nog steeds onduidelijk heerst over wat dit zal betekenen voor beleidsplannen (en in de toekomst omgevingsplannen). Daarnaast komt ook het integrale aspect weer naar boven door de NAS. Qua informatie zit de R.O. wel redelijk op één lijn met de water mensen doordat er ook vooral gekeken wordt naar kwetsbare gebieden, risico's en de acceptatie. Een verassend feit is echter wel dat ze spreken over een adaptatieparagraaf binnen de beleidsplannen. Dit aangezien het doel van de DPRA is dat adaptatie vervlochten is binnen de beleidsplannen.

Welke informatie is nodig om klimaatbestendigheid te krijgen in:

De uitvoering – Water afdeling - Groep 1

Vanuit de water afdeling ligt de focus vooral heel sterk op voorbeelden van ingrepen die gedaan zijn in de praktijk, en die werken (om klimaatbestendig te worden). Hierbij ligt sterk de nadruk op de bevestiging vanuit de praktijk. Wel wordt er afgevraagd of er bijvoorbeeld ook technische ontwerpnormen nodig zouden zijn. Tenslotte is het verantwoordelijkheidsgevoel ook een punt wat hier genoemd word.

De uitvoering – Water afdeling – Groep 2

De kaders, normen en voorwaarden worden hier ook genoemd. Daarnaast is er nog wel de behoefte aan financiële informatie qua kosten van implementatie en uitvoering. Tenslotte wordt er ook aangegeven dat klimaat robuuste maatregelen geborgd moeten worden in integrale projecten. Dit is interessant aangezien hier nu vanuit de water kan voor het eerst vanuit een integrale hoek gekeken wordt.

De uitvoering – R.O. afdeling – Groep 1

Het enige wat hier gemeld wordt is dat klimaatadaptatie zelden op zichzelf staat. Het is eerder vaak een onderdeel van andere plannen, en kan door meegenomen te worden een extra dimensie geven aan de implementatie en ook de ruimtelijke kwaliteit verhogen

De uitvoering – R.O. afdeling – Groep 2

Vanuit de R.O. kant wordt aangegeven dat klimaatbestendigheid een onderdeel moet worden van de beoordeling in principebesluiten. Hierbij zou klimaatadaptatie dus een belangrijke factor kunnen spelen in het wel of niet door laten gaan van ruimtelijke plannen en ontwikkelingen. Dit wordt verder benadrukt in het feit dat aangegeven wordt dat klimaat een eigen, apart, omgevingswetsprogramma zou moeten krijgen. Dit verankerd verder klimaatadaptatie als een pijler in de R.O. Tenslotte wordt er ook aangegeven dat er inzicht zou moeten komen in waar nu al ingrepen en maatregels worden gerealiseerd. Bij deze plannen zou gekeken kunnen worden of klimaatadaptatie mogelijk als meekoppelkans meegenomen zou kunnen worden.

Observatie van verschillen en overeenkomsten tussen beide afdelingen op het punt van welke informatie nodig is om klimaatbestendigheid in de uitvoering te krijgen + eventuele interessante observaties

Binnen de waterkant ligt de focus vrij sterk op de input die voorbeeld projecten zouden kunnen geven om te laten zien wat werkt. Onderliggend aan dit is ook een vorm van praktijk bevestiging. Daarnaast wordt ook aangegeven dat er eventueel normen, kaders en voorwaarden voor klimaatadaptatie moeten worden opgesteld voor de uitvoeringsfase. Dit is zodat plannen voldoende klimaatadaptatief zijn. Verder worden de kosten die komen kijken bij klimaatadaptatie ook genoemd. Dit is een belangrijk punt aangezien extra maatregelen mogelijk meer kosten met zich meebrengen, wat de boel kan vertragen als er naar extra fondsen of geld gezocht moet worden. Tenslotte wordt hier voor het eerst ook binnen deze kant gepraat over de borging van klimaat adaptieve maatregelen in integrale projecten. Vanuit de R.O. kant wordt aangegeven dat klimaatadaptatie inderdaad een integraal verhaal is, en dat het ook kan helpen de ruimtelijke kwaliteit te verhogen. Ook zien we hier weer de normering terug, aangezien R.O. stelt dat klimaatadaptatie de norm moet zijn in ruimtelijke projecten. Dit wordt verder doorgetrokken naar de omgevingswet, waar klimaatadaptatie een mogelijk belangrijke kernrol kan spelen. Toch geven ze aan dat het niet iets voor de toekomst is, en dat het nu zoveel mogelijk erbij in 'gefietst' moet worden binnen al bestaande, lopende, projecten. Over het algemeen kan gezegd worden dat de water en de R.O. afdelingen vrij redelijk op dezelfde lijn hier zitten.

Ronde 2: Informatiebehoefte voor stresstest

Helpt de aangeleverde informatie uit de stresstest en wat er eventueel aan informatie bij:

Het voeren van de risicodialoog- water afdeling – Groep 1

Missende informatie:

- Wat is de wateroverlast die kan optreden op snelwegen en de buitenwegen?

Dit komt omdat de klimaatstresstest-kaarten gericht zijn op het stedelijke gebied. Het landelijke gebied volgt later. Het gaat hierbij om informatie over waar mogelijk wateroverlast kan optreden op wegen, en de bereikbaarheid van deze wegen. Dit is omdat dit vaak belangrijke / vitale infrastructuur betreft.

- Wateroverlast voor spoorwegen

Zelfde verhaal

- Kansenkaart voor landbouw / Opbrengstderving landbouw

Door klimaatverandering zullen ook de omstandigheden veranderen waarbinnen gewassen groeien (of kunnen groeien). Het is daarom goed om te zien wat de mogelijk kansen zijn voor de landbouw in de toekomst. Dit punt valt ook samen met de opbrengstderving van de landbouw, wat in plaats van de kansen juist de risico's en bedreigingen moet laten zien voor de landbouw sector in Drenthe / Overijssel.

- Effecten van wateroverlast en droogte op de communicatie, infrastructuur en elektrische infrastructuur

Mocht er wateroverlast of droogte optreden, kan deze bovengenoemde vitale infrastructuur nog functioneren. Dit kan dienen als mogelijke input voor maatregelen die genomen moeten worden.
- Verandering van soorten en van de samenstelling van natuurgebieden

Informatie die laat zien wat mogelijke effecten van klimaatverandering zijn op soorten en de samenstelling van natuurgebieden.

- Huidige watersysteem

Een duidelijk en scherp inzicht in hoe het huidige watersysteem functioneert.

- Inzicht in het risico

Informatie over wat de risico's van klimaatverandering zullen zijn

- Bodemvocht

Wat zal bodemvocht gaan doen onder invloed van klimaatverandering (bijvoorbeeld meer regen of droogte)

Overige opmerkingen:

De risicodialoog is een proces. Dit kan in twee fases gedaan worden. Voor de eerste fase zijn kaarten voldoende om bewustzijn en inzicht te geven over klimaatadaptatie. In de tweede fase komt er dan meer gerichtere informatie per betrokken doelgroep.

Het voeren van de risicodialoog- water afdeling – Groep 2

Missende informatie:

- Welke risico's spelen er binnen de gemeente / regio?

Informatie over wat de risico's van klimaatverandering zullen zijn in de betrokken gemeentelijke gebieden.

- Wat is de omvang en ernst van de risico's / klimaateffecten

Informatie over wat de impact zal zijn van klimaatverandering in de gebieden. Deze informatie kan dan een prioritering geven over welke problemen als eerste aangepakt moeten worden.

- Voor wie is een probleem?

Informatie over voor wie welke klimaat impact een probleem kan gaan vormen.

- Oplosbaarheid op welke termijn?

Informatie over welke problemen op welke termijn opgelost kunnen worden. Dit geeft dan een soort van prioriteit in de problemen aan.

- Meekoppelkansen

Informatie die iets zegt over bij welke projecten, of op welke plaatsen er sprake is van een meekoppelkans.

- Kosten

De kosten die gemaakt moeten worden bij het implementeren van maatregelen
- Openbaar of particulier effect

Informatie over of een bepaalde maatregel effect zal hebben op particulier terrein, openbaar terrein of mogelijk beide

- Zelfredzaamheid (ouderen, gezondheid, veiligheid)

Informatie over de effecten die klimaatverandering heeft op bijvoorbeeld de gezondheid van ouderen gedurende een hittegolf

- Sociale opbouw van de wijk

Informatie over hoe een wijk sociaal is opgebouwd (bevolkingsopbouw, gemiddeld inkomen, etc.)

- Particulier bezit versus bezit sociale woningbouw vereniging

Informatie over welk gedeelte van de woningen in een gebied particulier bezit zijn, welk gedeelte in bezit is van sociale woningbouw verenigingen

- Ambities

Informatie over de ambities die er zijn in beleidsplannen

- Kansenkaart stedelijke ontwikkeling i.c.m. klimaatrobuustheid

Informatie over welke kansen er liggen binnen de stedelijke ontwikkelingen om klimaatrobuustheid binnen deze ontwikkelingen te integreren

-Bestaande situaties / nieuwe situaties

Informatie over de nieuwe (toekomstige) en bestaande klimaatveranderingsimpact knelpunten

- Wanneer praat je over wat wanneer?

Informatie over welke informatie nodig is in welk stadium van klimaatadaptatie en de risicodialoog

- De duur van wateroverlast
Gedurende hoe lang wateroverlast op zal treden na een bui. Dit is nu nog niet duidelijk in kwetsbaarheidskaarten aangezien er alleen een blauwe vlek met overstromingsdiepten wordt getoond

- Dynamiek in de kaart

Kaarten zijn statisch, dit maakt dat je niet de juiste informatie kan tonen aan mensen, tenzij deze informatie er al in zat. → Idee van een GIS-kaart. Je kan lagen 'aan' of 'uit' zetten.

- Ervaringen en beleving in beeld brengen

Het in kaart brengen van de belevingen en ervaringen die burgers bijvoorbeeld hebben als het aankomt op klimaatverandering

Overige opmerkingen:

Informatie helpt, maar dit alleen is niet voldoende. Er is wel een behoefte naar meer en meer gedetailleerde informatie over klimaatveranderingsimpacten.

Er zou een getraptheid moeten zitten in de volgorde hoe je de risicodialoog moet houden met mensen. Allereerst moet deze met collega's en/of externe partijen gevoerd worden. Daarna met het college. en tenslotte met de gemeenteraad.

Het voeren van de risicodialoog- R.O. afdeling – Groep 1

Missende informatie:

- Vertaling van blauwe vlekken naar effecten wateroverlast

Op dit moment is een blauwe vlek gewoon blauw, maar dit zegt niets over de impact die wateroverlast op die locatie heeft (water in een woning, onbereikbare wegen, aantasting vitale infrastructuur)

- Op het straatniveau moet het duidelijk zijn waar mogelijke knelpunten zich bevinden in het stedelijk gebied.

- Bij de begaanbaarheidskaart mist voor welke actoren wegen wel of niet begaanbaar zijn. Betekent een oranje weg dat deze niet meer begaanbaar voor auto's en de brandweerwagen of alleen voor normaal autoverkeer bijvoorbeeld?

Overige opmerkingen:

De risicodialoog met alleen met de belangrijkste stakeholders gehouden worden in plaats van met alle mogelijke stakeholders.

De informatie die verzameld wordt, of al beschikbaar is, moet vertaald worden naar problemen waar specifieke doelgroepen mee te maken hebben.

Het voeren van de risicodialoog- R.O. afdeling – Groep 2

Missende informatie:

- Er mist nog inzicht in hoe erg het probleem is, wat een mogelijke oplossing zou kunnen zijn. Als deze informatie bekend is dan kan je pas echt een gesprek voeren over welke oplossingen haalbaar en wenselijk zijn op die plaats.

- Wat zijn de mogelijkheden die een overheid heeft en wat zijn de mogelijkheden die een inwoner heeft om maatregelen te nemen. Daarbij mist er ook nog informatie over of inwoners bereid zijn om zelf maatregelen te nemen.

- Als reactie op de kaarten wordt gezegd dat je zou moeten kunnen inzoomen op ontwikkelingen die plaats vinden.

Overige opmerkingen:

Denk na over op welke schaal je de risicodialoog wilt gaan houden, Deze kan namelijk voor het gehele gebied, voor kleinere deelgebieden, of voor alleen problemen die kampen met ernstige problemen. Daarnaast kan deze risicodialoog ook gehouden worden met bijvoorbeeld de GGZ, de veiligheidsregio's of woningbouw corporaties. Ook moet het gesprek eerst met experts worden gehouden, en later pas met bewoners

De kwetsbaarheid van een gebied zorgt voor actie en beweging, want er komt urgentie en er moet iets gebeuren.

Ook moeten evaluaties van het gebied (de stresstesten) meerdere keren herhaald worden om zo te zien wat de effecten van klimaatverandering zijn op de omgeving.

Het opstellen van een adaptatiestrategie- Water afdeling – Groep 1

Missende informatie:

Het waterstructuurplan wordt aangedragen als missende informatie in deze fase.

Overige opmerkingen:
-

Het opstellen van een adaptatiestrategie- Water afdeling – Groep 2

Missende informatie:

x

Overige opmerkingen:

x

Het opstellen van een adaptatiestrategie- R.O. afdeling – Groep 1

Missende informatie:

- Een handleiding waarin staat wat geregeld moet worden in een bestemmingsplan.

- Kansenkaart gekoppeld aan het waterstructuurplan.

Overige opmerkingen:

Informatie helpt niet in deze fase, want er zit een afweging tussen de stresstest en het opstellen van de adaptatiestrategie. Daarom zijn tussendoelen en tussenstappen nodig. Dit heeft ook te maken met het feit dat de doelen in 2020 en 2050 liggen. Deze grote tijdsperiode maakt tussendoelen noodzakelijk.

Het opstellen van een adaptatiestrategie- R.O. afdeling – Groep 2

Missende informatie:

x

Overige opmerkingen

x

Gebruik van stresstestinformatie voor de uitvoeringsfase – Water afdeling - Groep 1

Missende informatie:

x

Overige opmerkingen:.

x

Gebruik van stresstestinformatie voor de uitvoeringsfase – Water afdeling – Groep 2

Missende informatie:

x

Overige opmerkingen:

x

Gebruik van stresstestinformatie voor de uitvoeringsfase – R.O afdeling - Groep 1

Missende informatie:

x

Overige opmerkingen:

x

Gebruik van stresstestinformatie voor de uitvoeringsfase – R.O. afdeling – Groep 2

Missende informatie:

x

Overige opmerkingen:
Informatie helpt niet, want de risicodialoog zit er nog tussen.
Algemene observaties over de stresstest flap

De deelnemers van de workshop zitten qua input vooral nog in de risicodialoog, met een kleine doorkijk naar de adaptatiestrategie. Dit is logisch aangezien de risicodialoog op dit moment veruit het belangrijkste is voor de deelnemende gemeenten. Daarbij komt ook nog kijken dat de adaptatiestrategie juist een voortzetting van de risicodialoog. Dit maakt dat er nog weinig over te vertellen valt, aangezien de risicodialoog nog moet worden opgestart na voltooiing van de klimaatstresstest.

Er wordt door de partijen wel aangegeven dat informatie niet het enige belangrijke is als input in de dialoog. Net zo belangrijk zijn ook vragen zoals met wie en waarover ga je de dialoog houden, en wie betrek je juist niet? Daarnaast zit de informatievraag die hier naar voren komt vooral, en dat mag geen verrassing zijn, de risico's, de schade, de impact van klimaatverandering. Dit is logisch omdat aan de hand van deze negatieve effecten, die knelpunten veroorzaken je je volgende stappen gaat zetten.

Wel wordt er aangegeven dat er mogelijk andere data nodig is per doelgroep waarmee je de dialoog voert. Hier zouden 'dynamische' kaarten zoals met GIS lagen die je aan en uit kunt zetten een mogelijke rol spelen omdat je dan per doelgroep andere informatie kan laten zien. Verder helpt die ook in het communiceren naar bijvoorbeeld andere afdelingen omdat je per afdeling zelf de data kan inladen die zij verwachten dat het meest belangrijke zit. Het feit dat je lagen aan en uit kunt zetten zorgt er dan voor dat je sneller botsingen van functies, knelpunten en ruimtelijke keuzes en spanningen kan vaststellen in het gebied.

Daarnaast is er wel zo dat er per gemeente, provincie of waterschap ook andere eisen qua informatie zijn (alhoewel er natuurlijk altijd overlap in zit). Ook hier zouden mogelijk dynamische informatie een rol kunnen spelen tijdens het voeren van de risicodialoog.

Observaties per partij tijdens de werksessies

Gemeente Hoogeveen / Gemeente de Wolden

- Ervaring met buien heeft geleid tot het zetten van het probleem op de bestuurlijke agenda. Dit ging om beelden/foto's van burgers alsmede de onbereikbaarheid van vitale infrastructuur zoals het ziekenhuis gedurende de bui.
- Hierbij gaat het ook om het feit dat het meer moet zijn dan alleen 'kille feiten'. Gevoelens en ervaringen spelen ook een belangrijke rol.
- Intern bij de gemeente is ook eigenaarschap nodig. Maar de informatie die nodig is om mensen te activeren verschilt per persoon. Dit gaat dan voornamelijk om informatie en feiten die betrekking hebben op hun vakgebied, maar ook voorbeelden.
- Dit kan dan leiden tot een interne 'mini-risicodialoog' binnen de gemeente als organisatie.
- Ook wordt aangegeven dat kaarten alleen niet voldoende zijn. Er is ook een doorvertaling nodig. Er zijn ook andere manieren om informatie over te brengen en bewustzijn te creëren. Als voorbeeld wordt een projectie met een laser genoemd die aangeeft wat de waterhoogte zal zijn op een plek bij wateroverlast om bewustwording te creëren bij bewoners en burgers.
- Daarnaast wordt ook aangegeven dat een belangrijke vraag in de risicodialoog is wat de lokale samenstelling is van een gebied voordat je de dialoog aangaat. Dit kan namelijk de dialoog die je moet voeren beïnvloeden.
- Beleving van burgers is anders gedurende wateroverlast dan het is voor andere partijen. Een laagje water op straat kan bedreigend zijn voor een burger, maar gezien worden als geen probleem voor andere partijen zoals de gemeente. Hierbij gaat het ook om de bewustwording van burgers als het aankomt op de risico's van wateroverlast.
- Kaarten zijn vaak duidelijk voor experts die ervaring hebben met een kaart lezen, maar er is een vertaalslag nodig naar andere groepen. Maar het is ook niet duidelijk welke informatie nodig is per doelgroep. Dit kan zelfs per persoon verschillen.

Gemeente Westerveld

- Op dit moment niet veel problemen met klimaatverandering. Maar het is nu wachten op een bui om te zien wat de impact is.
- Reservering / signalering van klimaat-kwetsbaarheid is nodig, alsmede de maatregelen die helpen hierbij.
- Er is een beter inzicht nodig in het functioneren van systemen.
- Ook moet er een stap verder gegaan worden in de vorm van meer gedetailleerde kaarten die gevalideerd en betrouwbaar zijn.
- Verder dient er een doorvertaling te gebeuren van de informatie van de klimaatstresstesten naar de beoogde doelgroepen.
- Risicodialoog moet op een hoger niveau worden gevoerd (overheden ipv het aan de keukentafel te houden).

Gemeente Steenwijkerland

- De vraag is of de risicodialoog Fluvius-breed moet worden gedaan of dat dit dient te gebeuren per gemeente.
- De risicodialoog moet sowieso intern gevoerd worden, maar moet daarnaast ook met externe partijen gevoerd worden.
- Veel benodigde informatie is niet beschikbaar in de KEA zoals leefcomfort etc. Dit komt hopelijk wel terug in de risicodialoog, maar welke informatie is dan nodig om hier over te kunnen praten?
- De bestuurlijk agenda is vooral korte termijn (max. 4 jaar). Er zou daarnaast ook een combinatie plaats moeten vinden met langere termijn visies. Dit zou bijvoorbeeld kunnen in combinatie met de gemeenteraad.
- De overheid is er om de kernkwaliteiten en gebiedsontwikkeling te waarborgen. Klimaatadaptatie kan daarom hiermee botsen als bestuurders met deze velden moeten werken. Hierbij ligt een focus op ambities. Daarnaast is er ook een zeker spanning tussen de verschillende interesses en doelen die er zijn binnen een gemeente. Dit is iets waar informatie over nodig is.
- Het bestuurlijke denken is sober. Focus is op werkgelegenheid en recreatie. Maar er is geen sfeer van experimentele plannen, geen mooi, leuk of extra. Het is sober en functioneel.

- Bij herinrichting wordt klimaatadaptatie meegenomen waar het kan (toevoeging van extra groen zoals bomen, fonteintje, etc.). Hierbij is er sprake van een meekoppelling met de mogelijke klimaateffecten.
- Er is geen goede aansluiting tussen het ambtelijke apparaat, de gemeenteraad en de bestuurders omdat deze op verschillende niveaus werken. Hierbij is wel een rol weggelegd voor het ambtelijke apparaat om bestuurders bewust te maken van klimaatadaptatie.
- Spanningen en kansen als opening gebruiken om klimaatadaptatie op de agenda te krijgen. Het 'framen' van opgaven met klimaatadaptatie.
- Kosten en baten spelen een belangrijke rol binnen de gemeente als organisatie. Verder is er ook niet altijd geld beschikbaar voor klimaatadaptatie.
- De omgevingsvisie moet de ambitie worden voor klimaatadaptatie. Maar welke informatie is daar voor nodig?
- Een mogelijke aanvliegroute zou kunnen zijn dat er een gis-kaart gemaakt wordt met verschillende informatie in lagen die je aan en uit kan zetten. Daarmee zou iedereen dan zijn of haar 'eigen lagen' kunnen gebruiken en zien hoe deze overlappen met bijv. klimaatopgaven of ruimtelijke ontwikkelingen binnen de gemeente.
- Verder worden kaarten vaak als statisch gezien terwijl de werkelijkheid dynamisch is. Er is ook sprake van een onbekende, dus laat dit terugkomen op kaarten. Laat zien op kaarten waar onbekenden zijn (vraagtekens op de kaart) en laat dit een uitnodigingspunt zijn om met collega's te kunnen praten over mogelijke oplossingen, kansen en uiteindelijk een dynamische stad.
- Hoe water en klimaat ingebracht moeten worden in de integraliteit en de omgevingsvisie. Hierbij helpt het om in gesprek te gaan met andere gemeenten.
- Verder is voor de RO-kant de integraliteit nog wat 'raar' om mee te werken.
- Veel meer zou er ingespeeld moeten worden op met elkaar optrekken en kennis te delen. Dit zou bijvoorbeeld kunnen betekenen dat gemeenten in samenwerking gaan werken aan omgevingsvisies zodat zij van elkaar kunnen leren.
- Er zou een koppeling moeten zijn tussen de omgevingswet en de borging van de 7 ambities van de DPRA daarin.

Gemeente Midden-Drenthe
- Bestuurders moeten nog in de actiestand komen. Dit heeft ook nog te maken met het feit dat er net een nieuw college is. Hierbij kan het helpen om een verhaal te vertellen van wat klimaatverandering doet met inwoners en met beelden over de effecten. Als het kan het liefst zo dichtbij of lokaal mogelijk. Hiermee sluit het aan op de belevingswereld van bestuurders.
- Er moet een koppeling gemaakt worden tussen een kaart met kwetsbaarheden, en een verhaal met ervaring van mensen. Hiermee gaan kaarten meer 'leven'.
- Het verhaal rondom klimaatadaptatie is politiek.
- Voor bewustwording werkt een overzichtskaart prima, maar bij ontwikkelingen op het gebied van klimaatadaptatie en het nemen van maatregelen is een meer gedetailleerde kaart nodig.
- Voor de ruimtelijke ordenings-hoek is het thema van klimaatadaptatie nog nieuw. Er is ook een behoefte aan niet alleen feitelijke informatie, maar ook beelden en gevoel.

Provincie Drenthe
- Ervaringen en events helpen op de aandacht te houden op klimaatadaptatie en mogelijke acties te 'triggeren'.
- Beekdalen worden niet gebruikt voor kapitaal intensieve industrie zoals kassen doordat de kans op hoge schade reëel is. Om dit te bepalen wordt er gebruik gemaakt van een hoogtekaart en de mogelijke overstromingsdiepten. Mensen worden 'getriggered' door schadeverhalen en het boerenverstand. Aldus is schade nodig als informatie in de risicodialoog.
- Maar het economisch belang is ook een belangrijke factor.
- Verder zijn beheersplannen en de natura 2000 statisch. De vraag is dan dus hoe dit gecombineerd kan worden met klimaatadaptatie.
- Qua informatie mist er nog schade bij droogte (bijv. bij gewassen), de natuursamenstelling op de kaarten aangezien verschillende typen gewassen en natuur beter/slechter tegen droogte kan, en een kansenkaart voor de landbouw met wat voor gewassen gekweekt kunnen worden.

- Verder vinden ze het ook belangrijk dat er inzicht is over de bereikbaarheid van infrastructuur (snelwegen, landelijke wegen, spoorwegen) bij wateroverlast. Daarnaast is er ook meer informatie nodig over de impact van klimaatverandering op de vitale infrastructuur.
- De juistheid / accuraatheid van de resultaten en de output van de klimaatstresstest wordt als belangrijk gezien.

Provincie Overijssel
- Belangrijk bij de stresstest is een integrale visie.
- De informatie die nodig is voor het (uit)voeren van eigen beleid is mogelijk anders dan de informatie die nodig is om bestuurders te overtuigen.
- Bij de risicodialoog moet er eerst een dialoog komen met experts over de consequenties. Als deze gevoerd is zal daarna pas een dialoog worden gevoerd met bewoners.
- De provincie Overijssel is nog zoekende naar welke informatie nodig voor beleid is. Maar ze geven ook aan dat andere gebieden zelf ook nog zoekende zijn.

Waterschap WDOD
- Er zijn al klimaatworkshops gehouden met gemeenten (zie samenvattingen op de dropbox).
- Er wordt door hen de vraag gesteld of je alleen overheden moet betrekken bij een risicodialoog, of dat je ook andere partijen moet betrekken. Bijvoorbeeld bij hittestress kan de GGD ook een rol spelen in de dialoog die gevoerd moet worden. Daarnaast is het ook de vraag welke departementen je binnen de overheid meeneemt in de dialoog qua input die zij geven.
- Een mogelijke prikkel voor het uitvoeren van klimaatadaptatie zou kunnen zijn via een verandering in belastingen (bijv. als je geen maatregelen neemt, dan belast je de overheid en betaal je dus meer belasting).
- Krantenkoppen kunnen ook tot actie aanzetten omdat het tot de emotie aanspreekt en verhalen bevat van mensen die bijvoorbeeld getroffen zijn door wateroverlast, droogte etc.
- In de risicodialoog moeten burgers ook betrokken worden.
- Qua informatie is het ook belangrijk hoe erg een impact is, en wat acceptabel is als een risico. Dit zou bijvoorbeeld kunnen via een risicodiagram.
- Er moet een eindbeeld zijn van hoe een watersysteem zou moeten werken. Dit kan bijvoorbeeld een ambitie zijn.
- Wie wil je bedienen met een klimaatstresstest en de risicodialoog? Bewoners en de overheid zijn beide vatbaar voor andere informatie. Dit leidt ook tot de vraag over wat de vorm moet zijn van de risicodialoog hiervoor.
- Een kaart als eindproduct van de klimaatstresstest of de informatie met kwetsbare groepen op waarde schatten?
- Er moet niet alleen gebruik gemaakt worden van kaarten, maar het proces zelf is ook belangrijk. De triggers en met elkaar in gesprek te gaan hierover. Dit is niet mogelijk met informatie die je alleen uit kaarten kan halen.
- Voor het Waterschap speelt hittestress geen rol, want ze hebben al genoeg te doen vanuit hun positie. Droogte speelt wel een rol.
- De stresstest kan volgens het Waterschap het beste samen gedaan worden, ook voor het landelijke gebied. Dit tweede gedeelte kan met de hulp van het waterschap.

Appendix VII: Survey questions

Survey questions - Dutch version

Introductietekst:

Geachte wijkbewoner,

Allereerst bedankt dat u de tijd neemt om mij te helpen met het verzamelen van data voor mijn scriptie.

De vragen die u zo dadelijk zult beantwoorden gaan over wateroverlast in stedelijk gebieden die veroorzaakt wordt door (korte) hevige regenval *(in de rest van deze enquête wateroverlast genoemd)*. Deze regenval kan bijvoorbeeld ervoor zogen dat het riool kan overstromen, straten blank komen te staan, dat eventueel water uw perceel op kan stromen, en in extreme gevallen zelfs uw woning in kan komen. Het zal dus niet gaan over bijvoorbeeld grondwateroverlast (bijvoorbeeld natte tuinen, vocht in kruipruimtes, etc.). Ter verduidelijking hiervan zullen hierna een aantal foto's volgen die een voorbeeld geven van wat wateroverlast in het stedelijk gebied kan betekenen.

De enquête zal naar schatting ongeveer 5-10 minuten duren. Verder zal de informatie zelf, die u in deze enquête geeft, alleen gebruikt worden voor academische doeleinden, en zal deze dus niet openbaar gemaakt worden. Mogelijk conclusies (dus niet de data zelf) die getrokken kunnen worden uit deze informatie kunnen mogelijk wel gedeeld worden met uw gemeente. Dit zodat zij een beter beeld kunnen krijgen van uw wijk qua maatregelen die gedaan zijn door burgers tegen wateroverlast.

Met vriendelijke groet,

Gerben Koers
(Master student Environmental & Infrastructure Planning)
Een voorbeeld van een straat die blank staat door hevige regenval

Een voorbeeld van water dat via de straat een perceel op is gestroomd

Een voorbeeld van water dat elk moment een woning binnen kan gaan stromen.

Vraag 1a: Was u voorgaand aan deze enquête al bekend met wateroverlast die veroorzaakt wordt door hevige neerslag?

- Ja
-Nee (indien nee, door naar vraag 2a)

Vraag 1b: Hoe wist u van deze vorm van wateroverlast af? (meerdere antwoorden zijn mogelijk)

- Nieuws (kranten of tv)
- Eigen ervaring
- Van andere mensen gehoord
- Erover gelezen of gezien (boeken/tijdschriften/tv-programma's anders dan het nieuws/internet)
- Via mijn werk
- Anders, namelijk:

Vraag 1c: In welke vorm werd deze informatie overgedragen? (meerdere antwoorden zijn mogelijk)

- Tekst (bijvoorbeeld een rapport)
- Kaarten
- Grafieken
- Eigen ervaring
- Ervaringen van andere mensen (gesproken of geschreven)
- Foto's
- Videobeelden
- Anders, namelijk:

Vraag 2a: Bent u bekend met de voorspellingen en scenario's die aangeven dat het in de toekomst waarschijnlijk vaker en harder zal gaan regenen in Nederland door de invloed van klimaatverandering?

- Ja
- Nee (indien nee, ga door naar vraag 3a)

Vraag 2b: Hoe wist u van deze voorspellingen en scenario's af? (meerdere antwoorden zijn mogelijk)

- Nieuws (kranten of tv)
- Erover gelezen (beleidsdocumenten/(onderzoeks)rapporten
- Erover gelezen of gezien (boeken/tijdschriften/tv-programma's anders dan het nieuws/internet)
- Van andere mensen gehoord
- Via mijn werk
- Anders, namelijk:

Vraag 2c: In welke vorm werd deze informatie overgedragen? (meerdere antwoorden zijn mogelijk)

- Tekst
- Kaarten
- Grafieken
- Mondeling (van andere mensen gehoord)
- Foto's
- Videobeelden
- Anders, namelijk:

Vraag 3a: Bent u bekend met de voorspelde gevolgen in uw eigen wijk, en voor uw eigen perceel, indien er hevige regen zou vallen? (Bijvoorbeeld hoe groot de kans op wateroverlast is, hoe hoog het water zou komen, etc.)

- Ja
- Nee (indien nee, door naar vraag 4a)

Vraag 3b: Hoe wist u van deze gevolgen af? (meerdere antwoorden zijn mogelijk)

- Nieuws (kranten of tv)
- Erover gelezen (beleidsdocumenten/(onderzoeks)rapporten
- Erover gelezen of gezien (boeken/tijdschriften/tv-programma's anders dan het nieuws/internet)
- Van andere mensen gehoord
- Via mijn werk
- Anders, namelijk:

Vraag 3c: In welke vorm werd deze informatie overgedragen? (meerdere antwoorden zijn mogelijk)

- Tekst
- Kaarten
- Grafieken
- Mondeling (van andere mensen gehoord)
- Foto's
- Videobeelden
- Anders, namelijk:

Vraag 4a: Heeft u in het verleden zelf persoonlijk ervaring gehad met wateroverlast?

- Ja
- Nee (indien nee, ga door naar vraag 5a)

Vraag 4b: Op welke manier heeft u dan ervaring gehad met wateroverlast? (meerdere antwoorden zijn mogelijk)

- De straat voor uw woning of in de omgeving stond blank
- Water stroomde van de straat uw perceel op (bijvoorbeeld de tuin in)
- Water stroomde uw woning in
- Anders, namelijk:

Vraag 5a: Kent u mensen die in het verleden zelf persoonlijk ervaring gehad hebben met wateroverlast?

- Ja
- Nee (indien nee, ga door naar vraag 6)

Vraag 5b: Op welke manier hebben zij dan ervaring gehad met wateroverlast? (meerdere antwoorden zijn mogelijk)

- De straat voor hun woning of in de omgeving stond blank
- Water stroomde van de straat hun perceel op (bijvoorbeeld de tuin in)
- Water stroomde hun woning in
- Anders, namelijk:

Vraag 6a: Bent u bekend met de rol die u als burger kunt spelen om wateroverlast te voorkomen?

- Ja
- Nee (indien nee, ga door naar vraag 6c)

Vraag 6b: Hoe zou u dan deze rol omschrijven?

Open antwoord

De wettelijke rol van burgers om wateroverlast te voorkomen:

Volgens de Waterwet zijn burgers in eerste instantie zelf verantwoordelijk voor het bergen, vasthouden en infiltreren van hemelwater (regenwater) op hun eigen perceel. Dit is indien zij de mogelijkheid hebben om dit te kunnen doen, en is ook afhankelijk van de neerslaghoeveelheid. Dit kan bijvoorbeeld zijn omdat zij een tuin of andere omliggende grond bezitten.

Vraag 6c: Bent u het eens met de rol die u als burger heeft? Of bent u van mening dat de gemeente meer verantwoordelijkheid zou moeten dragen?

- Ik ben het eens met de wettelijke rol
- De verantwoordelijkheid zou meer bij de gemeente moeten liggen
- Geen mening
- Anders, namelijk:

Vraag 7a: Heeft u een tuin?

- Ja
- Nee (indien nee, ga door naar vraag 8a)

Vraag 7b: Hoeveel vierkante meter schat u dat het oppervlakte van uw tuin bedraagt?

Open antwoord

Vraag 7c: Hoeveel procent schat u dat dat het oppervlakte van uw tuin bestaat uit verhard oppervlak? (Verhard oppervlak is bijvoorbeeld bestrating die niet water doorlatend is)

Open antwoord

Vraag 8a: Heeft u zelf ingrepen gedaan op uw perceel die mogelijk bijdragen aan het bergen, vasthouden of infiltreren van regenwater op uw perceel? Voorbeelden hiervan zijn bijvoorbeeld: afkoppeling van de regenpijp van het riool, regeninfiltratie in bijvoorbeeld grind, tuinvergroening, aanleg van een vijver, of installatie van een groen dak.

- Ja
- Nee (indien nee, ga door naar vraag 8h
- Staat gepland /Is in uitvoering

Vraag 8b: Wat voor maatregelen heeft u dan genomen?

Open antwoord

Vraag 8c: Wat is de reden / zijn de redenen geweest dat u deze maatregelen heeft genomen?

Open antwoord

Vraag 8d: Heeft uw eigen ervaring of de ervaring van andere mensen met wateroverlast een rol gespeeld in uw beslissing om zelf ook maatregelen te nemen? (wanneer ja is ingevuld bij vraag 4a of 5a)

- Ja
- Nee

Vraag 8e: Heeft het feit dat u kennis had van het probleem dat wateroverlast kan vormen meegespeeld in de beslissing dat u maatregelen heeft genomen? (wanneer ja is ingevuld bij vraag 1a)

- Ja
- Nee

Vraag 8f: Bent u van plan om in de toekomst nog meer maatregelen te nemen voor het vasthouden, bergen of infiltreren van regenwater op uw perceel?

- Ja
- Nee (indien nee, ga door naar vraag 8a)

Vraag 8g: Zo ja, wat voor maatregelen bent u dan van plan om nog te nemen?

Open antwoord (ga door naar vraag 8a)

Vraag 8h: Wat is/zijn de mogelijke reden(en) dat u geen maatregelen hebt genomen op uw perceel? (meerdere antwoorden mogelijk)

- Financiële redenen (bijvoorbeeld gebrek aan geld)
- Tijdgebrek
- Gebrek aan kennis over mogelijke maatregelen die u zou kunnen nemen
- Gebrek aan kennis over de rol die u als burger kunt spelen om wateroverlast te verminderen
- Er waren al (voldoende) maatregelen genomen toen u de woning betrok
- Er is al voldoende onverhard oppervlak op uw perceel om water te kunnen bergen of te kunnen laten infiltreren
- Voelde er geen noodzaak toe
- Anders, namelijk:

Vraag 8i: Wat voor maatregelen waren er al aanwezig toen u de woning betrok (indien 'er waren al voldoende maatregelen aanwezig' is gekozen bij vraag 8h)

Open antwoord

Vraag 8j: Zou u maatregelen hebben willen nemen indien u deze maatregelen niet had gehad? (indien 'financiële redenen; tijdgebrek; gebrek aan kennis over mogelijke maatregelen; gebrek aan kennis over rol burger' is gekozen bij vraag 8h)

- Ja
- Nee

Vraag 8k: Welke specifieke kennis ontbreekt er dan nog volgens u? (indien 'gebrek aan kennis over mogelijke maatregelen; gebrek aan kennis over rol burger' is gekozen bij vraag 8h)

Open antwoord

Vraag 8l: Zou u bereid zijn, indien er subsidiemogelijkheden zijn die een deel van de kosten weg nemen, om te investeren in maatregelen? (indien 'financiële reden' gekozen is bij vraag 8h).

- Ja
- Nee

Vraag 9a: Heeft u zelf maatregelen getroffen die de schade van wateroverlast in uw woning kunnen verminderen of voorkomen? Voorbeelden hiervan zijn bijvoorbeeld: stopcontacten die een stuk boven begane vloer zitten, vloeren van steen of een andere waterbestendige materiaal.

- Ja
- Nee (indien nee, ga door naar vraag 9h)
- Staat gepland /Is in uitvoering

Vraag 9b: Wat voor maatregelen heeft u dan genomen in uw woning?

Open antwoord

Vraag 9c: Wat is de reden / zijn de redenen geweest dat u deze maatregelen heeft genomen?

Open antwoord

Vraag 9d: Heeft uw eigen ervaring of de ervaring van andere mensen met wateroverlast een rol gespeeld in uw beslissing om zelf ook maatregelen te nemen? (wanneer ja is ingevuld bij vraag 4a of 5a)

- Ja
- Nee

Vraag 9e: Heeft het feit dat u kennis had van het probleem dat wateroverlast kan vormen meegespeeld in de beslissing dat u maatregelen heeft genomen? (wanneer ja is ingevuld bij vraag 1a)

- Ja
- Nee

Vraag 9f: Bent u van plan om in de toekomst nog meer maatregelen te nemen die schade door wateroverlast in uw woning voorkomen of beperken?

- Ja
- Nee (indien nee, ga door naar vraag 10a)

Vraag 9g: Zo ja, wat voor maatregelen bent u dan van plan om nog te nemen?

Open antwoord (ga door naar vraag 10a)

Vraag 9h: Wat is/zijn de mogelijke reden(en) dat u geen maatregelen hebt genomen op uw perceel? (meerdere antwoorden mogelijk)

- Financiële redenen (bijvoorbeeld gebrek aan geld)
- Tijdgebrek
- Gebrek aan kennis over mogelijke maatregelen die u zou kunnen nemen
- Gebrek aan kennis dat dit mogelijk nodig zou kunnen zijn
- Er waren al (voldoende) maatregelen genomen toen u de woning betrok
- Voelde er geen noodzaak toe
- Anders, namelijk:

Vraag 9i: Wat voor maatregelen waren er al aanwezig toen u de woning betrok (indien 'er waren al voldoende maatregelen aanwezig' is gekozen bij vraag 9h)

Open antwoord (ga door naar vraag 10a)

Vraag 9j: Zou u maatregelen hebben willen nemen indien u deze maatregelen niet had gehad? (indien 'financiële redenen; tijdgebrek; gebrek aan kennis over mogelijke maatregelen; gebrek aan kennis over noodzaak' is gekozen bij vraag 9h)

- Ja
- Nee

Vraag 9k: Welke specifieke kennis ontbreekt er dan nog volgens u? (indien 'gebrek aan kennis over mogelijke maatregelen; gebrek aan kennis over noodzaak' is gekozen bij vraag 9h)

Open antwoord

Vraag 9l: Zou u bereid zijn, indien er subsidiemogelijkheden zijn die een deel van de kosten weg nemen, om te investeren in maatregelen? (indien 'financiële reden' gekozen is bij vraag 9h).

- Ja
- Nee

Vraag 10a: Bent u bekend met landelijk of regionale initiatieven die proberen burgers bewust te laten worden van wat zij zelf kunnen doen om wateroverlast te voorkomen en/of hen daar in proberen te stimuleren?

- Ja
- Nee

Vraag 10b: Stel dat er een dergelijk initiatief om burgers bewust te laten worden, of hen te stimuleren om actie te ondernemen zou worden gestart in uw wijk. Zou u daar dan aan mee doen?

- Ja
- Misschien
- Nee

Vraag 10c: Zou u, indien u daar de benodigde middelen voor had, zelf een initiatief starten om burgers (bijvoorbeeld in uw wijk of woonplaats) bewust te maken van wateroverlast, of hen te stimuleren om actie te ondernemen tegen wateroverlast?

- Ja
- Misschien
- Nee

U bent nu aan het einde gekomen van de enquete. Er volgen nu nog een aantal vragen over uw persoonlijke omstandigheden (bijvoorbeeld leeftijd en burgerlijke staat) en leefomstandigheden (bijvoorbeeld of u een koop- of huurwoning heeft).

Vraag 11: Wat is uw geslacht?

- Man
- Vrouw
- Anders
- Wil ik niet zeggen

Vraag 12: Wat is uw leeftijd?

- Open antwoord
- Wil ik niet zeggen

Vraag 13: Wat is uw etnische achtergrond?

- Nederlands
- Migratie achtergrond
- Wil ik niet zeggen

Vraag 14: Wat is uw burgerlijke status?

- Alleenstaand
- Samenwonend
- Samenlevingscontract
- Geregistreerd partnerschap
- Gehuwd
- Gescheiden
- Verweduwd
- Wil ik niet zeggen

Vraag 15: Wat is uw hoogst genoten opleiding? Dit moet een afgeronde opleiding betreffen.

- Geen opleiding gehad
- Basisonderwijs
- Lager beroepsonderwijs
- MAVO/LTS/VMBO
- MBO/MTS
- HAVO/VWO
- HBO/HTS
- Universiteit (bachelor)
- Universiteit (master)
- Doctoraal
- Wil ik niet zeggen

Vraag 16: Wat is uw postcode? (4 cijfers + 2 letters)

- Open antwoord
- Wil ik niet zeggen

Vraag 17: In welk jaar heeft u uw woning betrokken?

- Open antwoord
- Wil ik niet zeggen

Vraag 18: Heeft u een inboedel- en of opstalverzekering?

- Inboedelverzekering
- Opstalverzekering
- Beide
- Geen
- Weet ik niet

Vraag 19a: Wie is de eigenaar van uw perceel?

- Perceel is in mijn bezit
- Sociale woningbouwvereniging
- Particuliere huur
- Anders, namelijk:

Vraag 19b: Van welke sociale woningbouwvereniging huurt u uw woning?

Open antwoord

U bent hiermee nu aan het einde gekomen van de enquête.

Hartelijk bedankt voor uw medewerking.

Met vriendelijke groet,
Gerben Koers

Survey questions - English translation

Introduction text:

Dear citizens of neighbourhood <....>

First I want to thank you for taking your time to fill out this survey and with that help me to collect data for my thesis.

The questions that you will answer in a bit are about pluvial flooding in urban areas that are caused by often short lasting, intense heavy precipitation. (in the rest of the survey named pluvial flooding). This precipitation can cause sewers to overflow, streets to flood, or in more severe causes also gardens or even houses to flood. As such, the survey will exclude hinder from groundwater (e.g. wet gardens, or water that creeps up in cellars). To clarify this phenomenon, several pictures will be shown in a bit to help you understand that is meant with pluvial flooding.

Furthermore, the survey will take about 5-10 minutes to be filled in. The data collected with the survey will only be used for academical purposes, and will therefore not be published. Potentially it can happen that conclusions drawn from the data (so not the raw data itself) may be shared with municipalities to help them understand better how and what citizens have been doing in your neighbourhood to take measures against pluvial flooding.

Kind regards,

Gerben Koers
(Master student Environmental & Infrastructure Planning)

An example of a street that is flooded due to sewer overflow

An example of water that has flowed from the street onto a property

An example of pluvial flooding that can flood a house at any moment

Question 1a: Before filling in this survey, were you familiar with flooding that is causesd by extreme precipitation?

- Yes
-No (In case of no, continue to question 2a)

Question 1b: How did you know about this type of flooding (multiple answers are possible)

- The news (newspapers or tv)
- Own experiences
- Heard about it from other people
- Read or saw something about it (books/magazines/journals/tv-programs other than the news/internet)
- In my daily work
- Other:

Question 1c: In which information format was this information transferred? (multiple answers are possible)

- Text (e.g. a report)
- Maps
- Graphs
- Own experience
- Experiences from others (orally or written)
- Photo's / images
- Video
- Other

Question 2a: Are you familiar with the predictions and scenario's that show that in the future it will more likely rain heavier and more frequent in the Netherlands due to climate change?

- Yes
- No (in case of no, continue to question 3a)

Question 2b: How did you learn about these predictions and scenario's? (multiple answers are possible)

- The news (newspapers or tv)
- Read about it (policy documents / scientific journals)
- Read or saw something about it (books/magazines/journals/tv-programs other than the news/internet)
- Heard about it from other people
- In my daily work
- Other:

Question 2c: In which information format was this information transferred? (multiple answers are possible)

- Text
- Maps
- Graphs
- Orally (heard about it from other people)
- Photo's / images
- Video
- Other

Question 3a: Are you familiar with the predicted impacts in your own neighbourhood or property if an extreme precipitation event would take place? (e.g. the risk of experiencing pluvial flooding, flood heights, etc.)

- Yes
- No (In case of no, continue to question 4a)

Question 3b: How did you lean about these impacts? (multiple answers possible)

- The news (newspapers or tv)
- Read about it (policy documents / scientific journals)
- Read or saw something about it (books/magazines/journals/tv-programs other than the news/internet)
- Heard about it from other people
- In my daily work
- Other:

Question 3c: In which information format was this information transferred? (multiple answers are possible)

- Text
- Maps
- Graphs
- Orally (heard about it from other people)
- Photo's / images
- Video
- Other

Question 4a: Did you experienced forms of pluvial flooding yourself in the past?

- Yes
- No (In case of no, continue to question 5a)

Question 4b: In what way did you experienced pluvial flooding? (multiple answers possible)

- The street(s) in front of your house / in your neighbourhood were flooded
- Water flowed from the street onto your property (e.g. into the garden)
- Water flowed into your house
- Other:

Question 5a: Do you know other people who have experienced pluvial flooding in the past?

- Yes
- No (In case of no, continue to question 6a)

Question 5b: In what way did they experienced pluvial flooding? (multiple answers possible)

- The street(s) in front of your house / in your neighbourhood were flooded
- Water flowed from the street onto your property (e.g. into the garden)
- Water flowed into your house
- Other:

Question 6a: Are you familiar with the role you as a citizen can have to prevent pluvial flooding?

- Yes
- No (In case of no, continue to question 6c)

Question 6b: How would you describe this role?

Open answer

The legal responsibility of citizens to prevent pluvial flooding:

According to the Dutch Water Act, citizens are in first instance responsible for retaining, storing, and infiltrating rainwater on their own property. This is of course if they have the possibility to do so, as well as the amount of rain that fell. This can be due to the fact that they have a garden or something similar.

Question 6c: Do you agree with this legal role you have as a citizen? Or do you think the municipality should carry more responsibility?

- I agree with the legal role
- The responsibility should shift more towards the municipality
- No opinion
- Other:

Question 7a: Do you have a garden?

- Yes
- No (In case of no, continue to question 8a)

Question 7b: How many square meters do you estimate you garden to be?

Open answer

Question 7c: How many percent do you estimate your garden to consist of hardened surface? (Hardened surface is surface that is not water permeable)

Open answer

Question 8a: Did you implement measures on your property that may contribute to storing, retaining, or infiltration rainwater on your property? (e.g. decoupling rain-pipes from the sewer system; improving rainwater infiltration into the ground; greening the garden; adding a pond; install a green roof)

- Yes
- No (In case of no, continue to question 8h)
- Is planned / Is being done at the moment

Question 8b: What kind of measures did you then implement?

Open answer

Question 8c: What have been the reason(s) for implementing these measures?

Open answer

Question 8d: Did your own experiences, or the experiences of others with pluvial flooding played a role in the decision to also take measures yourself? (When yes was filled in at questions 4a or 5a)

- Yes
- No

Question 8e: Did the fact that you had knowledge about the problems pluvial flooding can cause played a role in the decision to implement measures (when yes is filled in at question 1a)

- Yes
- No

Question 8f: Are your planning on implementing additional measures that contribute to the ability of storing, retaining or infiltrating rainwater on your property?

- Yes
- No (In case of no, continue to question 9a)

Question 8g: If so, what kind of measures are you planning on taking?

Open answer (continue to question 8a)

Question 8h: What are the reason(s) that you may have not implemented measures on your property? (multiple answers possible)

- Financial reasons (e.g. lack of money)
- Lack of time
- Lack of knowledge about potential measures that you can take
- Lack of knowledge about the role you can have a as a citizen to reduce pluvial flooding
- There were already enough measures taken before you started living on the property
- There is already enough unhardened surface on your property to store, retain or infiltrate rainwater
- Did not feel the necessity
- Other:

Question 8i: What kind of measures were already implemented when you started living on the property? (If 'there were already enough measures taken' was selected in question 8h)

Open answer

Question 8j: Would you have wanted to implement measures if you not had these barriers? (If 'financial reasons; lack of time; lack of knowledge about potential measures; lack of knowledge about role citizens towards pluvial flooding' were selected in question 8h)

- Yes
- No

Question 8k: Which specific knowledge is then still missing according to you? (If 'lack of knowledge about potential measures; lack of knowledge about role citizens towards pluvial flooding' were selected in question 8h)

Open antwoord

Question 8l: Would you be willing to invest in potential measures if there was subsidy available to reduce the cost of these measures? (if 'financial reasons' was picked in question 8h).

- Yes
- No

Question 9a: Have you taken measures that can prevent or limit the damage in your house in the case of pluvial flooding? (e.g. electrical sockets installed above a certain height; use of stone or other waterproof materials for the floor)

- Yes
- No (In case of no, continue to question 9h)
- Is planned / Is being done at the moment

Question 9b: What kind of measures have you implemented in your house?

Open answer

Question 9c: What have been the reason(s) for implementing these measures?

Open answer

Question 9d: Did your own experiences, or the experiences of others with pluvial flooding played a role in the decision to also take measures yourself? (When yes was filled in at questions 4a or 5a)

- Yes
- No

Question 9e: Does the fact that you had knowledge about the problems pluvial flooding can cause played a role in the decision to implement measures (when yes is filled in at question 1a)

- Yes
- No

Question 9f: Are you planning of implementing more measures in your house that can prevent or limit pluvial flooding damage in your house in the future?

- Yes
- No (In case of no, continue to question 10a)

Question 9g: What kind of measures are you then planning to implement?

Open answer (continue to question 10a)

Question 9h: What are the reason(s) that you have not implemented such measures in your house? (multiple answers possible)

- Financial reasons
- Lack of time
- Lack of knowledge about potential measures that you can take
- Lack of knowledge that this may be necessary
- There were already enough measures taken before you started living in this house
- Did not feel the necessity
- Other:

Question 9i: What kind of measures were already there when you started to live in this house? (if 'there were already enough measures taken' was picked in question 9h).

Open answer (continue to question 10a)

Question 9j: Would you have wanted to implement measures if you not had these barriers? (If 'financial reasons; lack of time; lack of knowledge about potential measures; lack of knowledge about potential necessity' were selected in question 9h)

- Yes
- No

Question 9k: Which specific knowledge is then still missing according to you? (If 'lack of knowledge about potential measures; lack of knowledge about potential necessity were selected in question 9h)

Open answer

Question 9l: Would you be willing to invest in potential measures if there was subsidy available to reduce the cost of these measures? (if 'financial reasons' was picked in question 9h).

- Yes
- No

Question 10a: Are you familiar with national or regional initiatives that try to raise the awareness of citizens about what they can do to reduce pluvial flooding vulnerability and occurrence, or that try to help them stimulate into acting?

- Yes
- No

Question 10b: If such an initiative would be started in your neighbourhood, would you then participate in it?

- Yes
- Maybe
- No

Question 10c: If you had the required necessities, would you then start such an initiative yourself in your neighbourhood?

- Yes
- Maybe
- No

You have now reached the end of the survey. Now will follow a questions about personal circumstances (e.g. age and marital status) and living conditions (e.g. whether you have a owned or rented house)

Question 11: What is your sex?

- Man
- Woman
- Other
- Do not want to say

Question 12: What is your age?

- Open answer
- Do not want to say

Question 13: What is your ethnical background?

- Dutch
- Migration background
- Do not want to say

Question 14: What is your marital status?

- Single
- Living together
- Cohabitation contract
- Registrated partnership
- Married
- Divorced
- Widowed
- Do not want to say

Question 15: What is your highest finished education?

- Did not had education
- Primary school
- Lower vocational education
- General secondary education
- Secondary vocational education
- Higher secondary education
- University of applied sciences
- University (bachelor)
- University (master)
- Doctoral
- Do not want to say

Question 16: What is your postal code? (4 numbers + 2 letters)

- Open answer
- Do not want to say

Question 17: In which year did you start living in this house?

- Open answer
- Do not want to say

Question 18: Do you have a home- or contents sinsurance?

- Home insurance
- Contents insurance
- Both
- None
- Do not know

Question 19a: Who is the owner of the propery?

- Own property
- Social housing corporation
- Private rent
- Other:

Question 19b: From which social housing corporation do you rent your house?

Open answer

With this final question you have come to the end of the survey

Thank you for your participation

Kind regards,
Gerben Koers

Appendix VIII: Statistical analysis of the survey results done in the case study areas

Prior adjustments made to the data set used for the statistical analysis

As already explained in the methodology chapter, the data that was used for the statistical analyses was collected with the online survey website 'Qualtrics' and then exported as as a .sav-file that can be opened with SPSS. The next step was to delete not fully filled in surveys, this was done by deleting all surveys that did not filled in question 19a, which was the final mandatory question of the survey (Appendix VII; Any other references to questions made in this appendix will refer to appendix VII). As already mentioned in the methodology chapter this selection led to 166 remaining surveys to work with.

The next two steps were to first change the binary that answers given from (1 = yes / 2 = no) to (0 = yes / 1 = no). to add 'missing' data to the survey that could not be entered due to the way the survey was set up in Qualtrics. This had mostly to do with the fact that with multiple choice questions only the selected questions were noted down as an answer, which means a 0 for yes, and a blank field if the answer was no (see figure 42).

	Q1	Q1a_1	Q1a_2	Q1a_3	Q1a_4	Q1a_5	Q1a_6
1	0	0	0	.	.	.	.
2	0	.	0	.	.	.	.
3	1	.	.	.	.	.	.
4	0	0	.	.	.	.	.
5	0	0	0	.	.	.	.
6	0	0	0	0	.	.	.
7	0	0	0	0	.	.	.
8	0	0	.	.	0	.	.
9	0	0	0	0	0	.	.
10	0	.	0	.	.	0	0

Figure 42: Example of filled-in cells for yes, and blank when a multiple-choice answer was not selected (Q1a_1 till Q1a_6) (Source: SPSS; author)

As such, for all multiple-choice answers that were not selected, a no (1) was filled in the table instead. This resulted in the following table (figure 43):

	Q1	Q1a_1	Q1a_2	Q1a_3	Q1a_4	Q1a_5	Q1a_6
1	0	0	0	1	1	1	1
2	0	1	0	1	1	1	1
3	1	1	1	1	1	1	1
4	0	0	1	1	1	1	1
5	0	0	0	1	1	1	1
6	0	0	0	0	1	1	1
7	0	0	0	0	1	1	1
8	0	0	1	1	0	1	1
9	0	0	0	0	0	1	1
10	0	1	0	1	1	0	0

Figure 43: Example of filled-in cells for no when a multiple-choice answer was not selected (Q1a_1 till Q1a_6) (Source: SPSS; author)

Here the following assumption was made that also affected the final statistical test results: if no was selected for the initial question (in this example case, question 1a) a no was also assumed for the multiple-choice follow-up questions (question 1b and 1c). The reasoning behind this choice was that if a respondent did not had knowledge about (in this case pluvial flooding caused by extreme precipitation), this would also mean that this respondent would also not haveused for example a news article as information source (a potential answer for follow-up question 1b) or that the used information communication channel would have been video in this case (a potential answer for follow-up question 1c). These adjustments were made for every instance in which there were follow-up multiple-choice questions in which respondents could choose multiple answers (question 2b;2c;3b;3c;4b;5b; 8h; 9h).

After this, the different variables were selected out of the survey results that would serve as the independent variables to test against the dependent variables (did respondents take measures that enhance the robustness/absorption capacity of their property?) (see table 19-26). These were selected based on theory discussed in chapter 2, such as the inclusion of experiences of citizens with pluvial flooding which may be influential on their decision-making process (e.g. Werner & Plapp, 2006; Burningham et al., 2008); or whether knowledge about pluvial flooding (impacts) and climate change impacts in the Netherlands (as well as the source from which this knowledge is gained / channel or format in which this is communicated) may have had an influence on the decision to take measures (which is a research question of this thesis). Additionally, also more circumstantial answers surrounding the living environment of respondents were added as well (e.g. age, education, sex, living situation). Additionally, also property value was added as well. This data was gained by using the the postal code (question 16) and using these postal codes to determine WOZ-value of the house for the respondent. This value is an average of the houses that match the postal code that was filled in by the respondent (matching houses were found by filling in the postal code in the following website: https://www.postcode.nl/). As the WOZ-value of the houses was already used for the creation of figure 18, 23, 31, 36, 44 and 49 the average of these houses could be calculated by adding up these values and dividing these by the number of houses. After this, these values were categorized based on the AHV (<50%; >50%-100%<, etc.). For respondents that did filled in a wrong postal code (e.g. only the first four numbers instead of also the 2 letters that are needed to form a Dutch postal coce), or choose to not fill in the postal code (which was an option) an additional 'postal code unknown' category was created.

However, before performing the binary logistic regression analysis, one final test needed to be done. This was to test whether the independent variables that were selected were truly indepent, or whether some of these independent variables had strong correlations with other independent variables. To this end, a quick test was done to test these correlations by running all independent variables through both a Spearman's rank-order test, as well as a Pearson's r correlation test. Based on these tests, several variables were eliminated from the selected variables.

After this test, the binary logistic regression analysis was done for the first time. However, this led to the problem that several variables had to few cases, which distorted the outcomes of the analysis. As such, in these cases one of two choices was made on a case-to-case basis: 1) To delete these variables; or 2) to add several categories in this variable together This led for example to the answer 'other' for questions 1b and 1c to be deleted as variable, and the living situation (question 14) to be simplified to living alone (a combination of the answers 'single; divorced; widowed') and living together (a combination of the answers 'Living together; cohabitation contract; registrated partnership; married). These adjustments led to the results that can be found in table 20 to 27.

Reading guide for the binary logistic analysis results

Nagelkerke R	This value shows the explained variation in the dependent variable based on the model that is used (Laerd Statistics, 2018). As such it can be interpreted that with the above model 65% of all responses can be explained.
B	The influence that the independent variable has on the dependent variable. In this case it, for example, means the influence that the knowledge of respondents about the role that citizens can have to prevent pluvial flooding has on whether they have taken measures that enhance the robustness of their local urban area. This can be positive or negative, which will determine whether the influence is positive (e.g. if knowledge increases so will the amount of measures taken) or negative (if knowledge increases, the amount of measures will decrease).
B (exp)	This is the 'odds-ratio' and explains how the dependent variable is influenced if the independent variable is increased/decreased.
Significance	This value shows whether an outcome can be considered statistically significant, based on the used p-value (in this research, a value of 0,05 has been used). This is used to determine whether trends in the survey can be contributed to a sampling error or to characteristics of the population. As already mentioned, all outcomes mentioned in this chapter are significant.

Table 19: Explanation of the four important values that are the result of the binary logistic regression analysis

Additionally, there are pairs almost similar tables in the tables 20-27. This is since an overview is presented of both the individual parts of the model (all independent variables tested against dependent variables), so only the knowledge of subjects (table 20), only the climate information sources and communication channels (table 22), experiences with pluvial flooding + knowledge about the role of citizens (24), and the demographic factors (26), as well as the whole model (table 21; 23; 25; 27). For the results presented in chapter 5, only the whole model was used.

Outcomes of the binary logistic regression analysis

Table 20: Regression model analysis results – Climate information knowledge

			Robustness			Absorption		
Model factors parts	**Regression variables**	**Responses**	**B**	**Exp(B)**	***p*-value**	**B**	**Exp(B)**	***p*-value**
Climate information	Knowledge about pluvial flooding due to extreme precipitation	0(ref) / 1* *0=yes; 1=no	-0,419	0,658	0,553	1,142	3,134	0,117
	Knowledge about climate change scenarios for the Netherlands	0(ref) / 1	-0,615	0,541	0,368	1,031	2,804	0,150
	Knowledge about local predicted precipitation impacts	0(ref) / 1	-0,744	0,723	0,358	-0,676	0,508	0,101
Constant			0,744	2,104	0,391	-0,499	0,607	0,571
Nagelkerke R					0,022			0,058

Sig. *p<0,01**, p<0,05*; (ref): Reference in the regression analysis*

Table 21: Regression model analysis results – Climate information knowledge – combined model

			Robustness			Absorption		
Model factors parts	**Regression variables**	**Responses**	**B**	**Exp(B)**	***p*-value**	**B**	**Exp(B)**	***p*-value**
Climate information	Knowledge about pluvial flooding due to extreme precipitation	$0^{(ref)}$ / 1*	**-9,318**	**0,000**	**,005****	6,601	736,182	0,094
	Knowledge about climate change scenarios for the Netherlands	$0^{(ref)}$ / 1	-2,137	0,118	,492	6,281	534,353	0,228
	Knowledge about local predicted precipitation impacts	$0^{(ref)}$ / 1	3,004	20,160	,182	2,598	13,440	0,415

Sig. *p<0,01**, p<0,05*; (ref): Reference in the regression analysis*

Table 22: Regression model analysis results – Climate information design

				Robustness			Absorption	
Model factors parts	**Regression variables**	**Responses**	**B**	**Exp(B)**	***p*-value**	**B**	**Exp(B)**	***p*-value**
Information source: knowledge about pluvial flooding	News	0(ref) / 1	-0,199	0,888	0,845	0,968	2,633	0,201
	Own experience	0(ref) / 1	-0,370	0,691	0,418	-0,154	0,857	0,808
	Heard from others	0(ref) / 1	-0,847	0,429	0,202	0,269	1,308	0,725
	Saw or read about it (no news)	0(ref) / 1	-0,288	0,796	0,630	-0,240	0,787	0,716
Information channel: knowledge about pluvial flooding	Text	0(ref) / 1	0,157	1,170	0,735	0,747	2,110	0,232
	Maps	0(ref) / 1	-0,259	0,772	0,757	0,227	1,255	0,846
	Graphs	0(ref) / 1	0,634	1,885	0,431	-0,756	0,469	0,435
	Oral	0(ref) / 1	**-1,115**	**0,328**	**0,048***	-0,907	0,404	0,172
	Images / photo's	0(ref) / 1	0,843	2,323	0,105	-0,459	0,632	0,516
	Video	0(ref) / 1	-0,146	0,864	0,755	0,046	1,047	0,941
Information source: knowledge about climate scenarios	News	0(ref) / 1	-0,875	0,417	0,198	1,308	3,700	0,098
	Scientific journals / policy documents	0(ref) / 1	0,560	1,750	0,332	0,357	1,429	0,629
	Saw or read about it (no news)	0(ref) / 1	0,030	1,030	0,947	0,550	1,734	0,349
	Heard from others	0(ref) / 1	0,160	1,173	0,800	-0,390	0,677	0,597
Information channel: knowledge about climate scenarios	Text	0(ref) / 1	0,222	1,248	0,713	-1,049	0,350	0,198
	Maps	0(ref) / 1	-0,946	0,388	0,087	0,489	1,631	0,521
	Graphs	0(ref) / 1	0,718	2,050	0,143	**-1,370**	**0,254**	**0,030***
	Oral	0(ref) / 1	0,994	2,702	0,088	-0,231	0,793	0,735
	Images / photo's	0(ref) / 1	0,239	1,269	0,627	0,302	1,353	0,656
	Video	0(ref) / 1	-0,375	0,687	0,409	0,689	1.991	0,255
Information source: knowledge about local precipitation impact	News	0(ref) / 1	0,099	1,104	0,911	**-2,545**	**0,078**	**0,024***
	Scientific journals / policy documents	0(ref) / 1	-1,718	0,168	0,066	0,232	1,261	0,828
	Saw or read about it (no news)	0(ref) / 1	-0,479	0,619	0,559	-0,261	0,770	0,788
Information channel: knowledge about local precipitation impact	Text	0(ref) / 1	-0,614	0,541	0,496	0,755	2,127	0,510
	Maps	0(ref) / 1	1,702	5,483	0,149	1,628	5,094	0,278
	Graphs	0(ref) / 1	-1,501	0,223	0,179	0,279	1,321	0,839
	Oral	0(ref) / 1	-0,056	0,945	0,935	1,194	3,301	0,229
	Images / photo's	0(ref) / 1	1,368	3,928	0,102	-0,101	0,904	0,923
	Video	0(ref) / 1	-0,552	0,576	0,549	-0,863	0,422	0,462
Constant			0,477	1,611	0,463	0,830	2,292	0,260
Nagelkerke R					0,227			0,297

Sig. *p<0,01**, p<0,05*; (ref): Reference in the regression analysis*

Table 23: Regression model analysis results – Climate information design – combined model

				Robustness			Absorption	
Model factors parts	**Regression variables**	**Responses**	**B**	**Exp(B)**	***p*-value**	**B**	**Exp(B)**	***p*-value**
Information source: knowledge about pluvial flooding	News	0(ref) / 1	**3,707**	**40,727**	**0,031***	-1,221	0,295	0,666
	Own experience	0(ref) / 1	1,421	4,141	0,296	**-5,874**	**0,003**	**0,047**
	Heard from others	0(ref) / 1	0,523	1,686	0,736	0,330	1,391	0,867
	Saw or read about it (no news)	0(ref) / 1	1,095	2,990	0,262	-1,443	0,236	0,395
Information channel: knowledge about pluvial flooding	Text	0(ref) / 1	0,641	1,899	0,482	1,358	3,888	0,265
	Maps	0(ref) / 1	-0,488	0,614	0,775	-0,541	0,582	0,805
	Graphs	0(ref) / 1	-1,302	0,272	0,406	-1,419	0,242	0,516
	Oral	0(ref) / 1	**-5,691**	**0,003**	**0,001****	-2,338	0,096	0,265
	Images / photo's	0(ref) / 1	-1,899	0,150	0,155	-1,547	0,213	0,500
	Video	0(ref) / 1	1,192	3,293	0,248	2,251	9,502	0,275
Information source: knowledge about climate scenarios	News	0(ref) / 1	0,337	1,400	0,874	1,790	5,991	0,447
	Scientific journals / policy documents	0(ref) / 1	0,785	2,192	0,516	0,921	2,512	0,596
	Saw or read about it (no news)	0(ref) / 1	**3,042**	**20,937**	**0,006****	0,952	2,590	0,558
	Heard from others	0(ref) / 1	-2,183	0,113	0,170	-0,650	0,522	0,694
Information channel: knowledge about climate scenarios	Text	0(ref) / 1	0,563	1,756	0,713	-8,367	0,000	0,074
	Maps	0(ref) / 1	-2,144	0,117	0,105	-1,260	0,284	0,495
	Graphs	0(ref) / 1	1,814	6,133	0,098	-3,177	0,042	0,054
	Oral	0(ref) / 1	**3,435**	**31,021**	**0,017***	-2,605	0,074	0,221
	Images / photo's	0(ref) / 1	1,223	3,396	0,360	4,166	64,460	0,063
	Video	0(ref) / 1	-1,772	0,170	0,144	2,737	15,442	0,233
Information source: knowledge about local precipitation impact	News	0(ref) / 1	-2,231	0,107	0,358	-5,065	0,006	0,112
	Scientific journals / policy documents	0(ref) / 1	**-6,807**	**0,001**	**0,014***	0,529	1,697	0,816
	Saw or read about it (no news)	0(ref) / 1	**-6,385**	**0,002**	**0,010***	3,546	34,684	0,253
Information channel: knowledge about local precipitation impact	Text	0(ref) / 1	-1,213	0,297	0,599	-5,885	0,003	0,182
	Maps	0(ref) / 1	**6,524**	**681,609**	**0,019***	4,091	59,783	0,314
	Graphs	0(ref) / 1	**-7,621**	**0,000**	**0,023***	4,732	113,516	0,089
	Oral	0(ref) / 1	-1,213	0,297	0,505	2,037	7,669	0,477
	Images / photo's	0(ref) / 1	**8,408**	**4482,445**	**0,006****	-7,591	0,001	0,060
	Video	0(ref) / 1	-1,035	0,355	0,616	-4,332	0,013	0,150

Sig. *p<0,01**, p<0,05*; (ref): Reference in the regression analysis*

Table 24: Regression model analysis results – Other factors

			Robustness			Absorption		
Model factors parts	**Regression variables**	**Responses**	**B**	**Exp(B)**	***p*-value**	**B**	**Exp(B)**	***p*-value**
Personal experience pluvial flooding	Overall	$0^{(ref)}$ / 1	0,222	1,248	0,708	0,151	1,163	0,835
	Street flooded	$0^{(ref)}$ / 1	**-1,174**	**0,309**	**0,048***	-0,670	0,512	0,339
	Property flooded	$0^{(ref)}$ / 1	-0,189	0,828	0,828	0,086	1,089	0,881
	House flooded	$0^{(ref)}$ / 1	-0,443	0,642	0,642	-0,675	0,509	0,291
Experience of relatives/friends of respondent with pluvial flooding	Overall	$0^{(ref)}$ / 1	-0,228	0,750	0,750	-0,502	0,605	0,483
	Street flooded	$0^{(ref)}$ / 1	0,542	1,720	1,720	0,687	1,988	0,314
	Property flooded	$0^{(ref)}$ / 1	0,755	2,127	2,127	-0,310	0,733	0,586
	House flooded	$0^{(ref)}$ / 1	0,079	1,082	1,082	-0,336	0,715	0,528
Knowledge about role citizens to reduce pluvial flooding	Knowledge about role citizens to reduce pluvial flooding	$0^{(ref)}$ / 1	**-0,870**	**0,419**	**0,011***	0,663	1,940	0,104
Constant			0,257	1,292	0,257	1,292	0,542	1,475
Nagelkerke R							0,130	

Sig. *p<0,01**, p<0,05*; (ref): Reference in the regression analysis*

Table 25: Regression model analysis results – Other factors – combined model

			Robustness			Absorption		
Model factors parts	**Regression variables**	**Responses**	**B**	**Exp(B)**	***p*-value**	**B**	**Exp(B)**	***p*-value**
Personal experience pluvial flooding	Overall	$0^{(ref)}$ / 1	1,958	7,084	0,235	2,059	7,835	0,301
	Street flooded	$0^{(ref)}$ / 1	-2,045	0,129	0,156	-1,245	0,288	0,469
	Property flooded	$0^{(ref)}$ / 1	-,288	0,750	0,815	-4,951	0,007	0,056
	House flooded	$0^{(ref)}$ / 1	1,211	3,358	0,422	,917	2,501	0,689
Experience of relatives/friends of respondent with pluvial flooding	Overall	$0^{(ref)}$ / 1	-,992	0,371	0,518	-,775	0,461	0,684
	Street flooded	$0^{(ref)}$ / 1	-0,549	0,577	0,733	**6,886**	**978,624**	**0,028***
	Property flooded	$0^{(ref)}$ / 1	2,225	9,252	0,128	-3,069	0,046	0,202
	House flooded	$0^{(ref)}$ / 1	0,543	1,720	0,615	1,198	3,315	0,346
Knowledge about role citizens to reduce pluvial flooding	Knowledge about role citizens to reduce pluvial flooding	$0^{(ref)}$ / 1	**-1,917**	**0,147**	**0,023***	**2,795**	**16,369**	**0,039***

Sig. *p<0,01**, p<0,05*; (ref): Reference in the regression analysis*

Table 26: Regression model analysis results – Demographic factors

			Robustness			Absorption		
Model factors parts	**Regression variables**	**Responses**	**B**	**Exp(B)**	***p*-value**	**B**	**Exp(B)**	***p*-value**
Gender	Gender	0(ref) / 1 0 = Man 1 = Female	0,192	1,212	0,649	0,040	1,041	0,935
Age	Age	Interval scale	-0,012	0,998	0,426	-0,013	0,987	0,437
Living situation	Living situation	0(ref) / 1 0 = Living alone 1 = Living together	0,246	1,278	0,621	0,577	1,780	0,364
Education	Education level	0(ref) / 1 / 2 0 =Low 1 = Average 2 = High	Ref	1,000	-	Ref	1,000	-
			--0,189	0,827	0,815	-0,510	0,600	0,592
			0,489	1,631	0,516	-0,312	0,732	0,729
Property value	Value of the property	0(ref) / 1 0 =<100% of average property value (apv) 1 = >100% of apv	0,049	1,051	0,904	0,578	1,783	0,204
Insurance	Type of insurance	0(ref) / 1 0 = Home insurance or building insurance (one type) 1 = Both types	0,274	1,315	0,722	0,025	1,026	0,978
Property ownership	Property ownership	0(ref) / 1 0 = Respondent owns property 1 = Property is rented	-1,306	0,271	0,245	-0,282	0,755	0,815
Constant			-0,141	0,869	0,913	1,771	5,876	0,242
Nagelkerke R					0,055			0,053

Sig. *p<0,01**, p<0,05*; (ref): Reference in the regression analysis*

Table 27: Regression model analysis results – Demographic factors – combined model

			Robustness			Absorption		
Model factors parts	**Regression variables**	**Responses**	**B**	**Exp(B)**	***p*-value**	**B**	**Exp(B)**	***p*-value**
Gender	Gender	0[(ref)] / 1 0 = Man 1 = Female	-0,024	0,977	0,479	3,565	35,335	0,064
Age	Age	Interval scale	0,156	1,168	0,865	-0,030	0,970	0,413
Living situation	Living situation	0[(ref)] / 1 0 = Living alone 1 = Living together	0,252	1,286	0,847	**5,754**	**315,388**	**0,040***
Education	Education level	0[(ref)] / 1 / 2 0 =Low 1 = Average 2 = High	Ref	1,000	-			0,634
			-2,034	0,131	0,280	-3,645	0,026	0,371
			,091	1,095	0,957	-2,925	0,054	0,453
Property value	Value of the property	0[(ref)] / 1 0 =<100% of average property value (apv) 1 = >100% of apv	1,744	5,719	0,080	**4,762**	**116,968**	**0,018***
Insurance	Type of insurance	0[(ref)] / 1 0 = Home insurance or building insurance (one type) 1 = Both types	-2,432	0,088	0,257	2,462	11,730	0,405
Property ownership	Property ownership	0[(ref)] / 1 0 = Respondent owns property 1 = Property is rented	-1,512	2,562	0,555	-0,793	0,452	0,855
Constant			8,304	4040,438	0,084	-1,232	0,292	0,836
Nagelkerke R					0,650			0,664

Sig. *p<0,01**, p<0,05*; (ref): Reference in the regression analysis*

Survey results

An overview of the survey results. These are done per city, as well as in total. Open answer questions have been omitted from the interview

Table 28: Results of the surveys taken in neighbourhoods in Meppel, Hoogeveen and Drachten (Source: Author)

Question	**Meppel**		**Hoogeveen**		**Drachten**		**Total**	
Question 1a	**Before filling in this survey, were you familiar with flooding that is causesd by extreme precipitation?**							
	Yes	62	Yes	43	Yes	53	Yes	158
	No	4	No	3	No	2	No	9
Question 1b	**How did you know about this type of flooding? (multiple answers are possible)**							
	Information source (IS): news							
	Yes	53	Yes	29	Yes	40	Yes	122
	No	13	No	17	No	15	No	47
	IS: Own experience							
	Yes	28	Yes	37	Yes	43	Yes	108
	No	38	No	9	No	12	No	59
	IS: Heard from other people							
	Yes	11	Yes	9	Yes	16	Yes	36
	No	55	No	37	No	39	No	131
	IS: Read/saw about it on TV/books/internet							
	Yes	31	Yes	13	Yes	20	Yes	64
	No	35	No	33	No	35	No	103
	IS: Work							
	Yes	2	Yes	13	Yes	5	Yes	20
	No	64	No	33	No	50	No	147
	IS: Other							
	Yes	8	Yes	4	Yes	2	Yes	14
	No	58	No	42	No	53	No	153
Question 1c	**In which information format was this information transferred? (multiple answers are possible)**							
	Information Format (IF): Text							
	Yes	43	Yes	12	Yes	19	Yes	74
	No	23	No	34	No	36	No	93
	IF: Maps							
	Yes	16	Yes	3	Yes	6	Yes	25
	No	50	No	43	No	49	No	142
	IF: Graphs							
	Yes	14	Yes	1	Yes	5	Yes	19
	No	52	No	45	No	50	No	148
	IF: Experience							
	Yes	25	Yes	36	Yes	41	Yes	102
	No	41	No	10	No	14	No	65

	IF: Oral							
	Yes	16	Yes	18	Yes	24	Yes	58
	No	50	No	28	No	31	No	109
	IF: Images/photo's							
	Yes	39	Yes	28	Yes	37	Yes	104
	No	27	No	18	No	18	No	63
	IF: Video							
	Yes	37	Yes	20	Yes	25	Yes	82
	No	29	No	26	No	30	No	85
	IF: Other							
	Yes	1	Yes	3	Yes	1	Yes	5
	No	65	No	43	No	54	No	162
Question 2a	**Are you familiar with the predictions and scenario's that show that in the future it will more likely rain heavier and more frequent in the Netherlands due to climate change?**							
	Yes	62	Yes	43	Yes	52	Yes	157
	No	4	No	3	No	3	No	10
Question 2b	**How did you learn about these predictions and scenario's? (multiple answers are possible)**							
	IS: News							
	Yes	58	Yes	38	Yes	50	Yes	146
	No	8	No	8	No	5	No	21
	IS: Scientific journals / policy documents							
	Yes	12	Yes	9	Yes	11	Yes	32
	No	54	No	37	No	44	No	135
	IS: Heard from other people							
	Yes	6	Yes	8	Yes	8	Yes	22
	No	60	No	38	No	475	No	145
	IS: Read/saw about it on TV/books/internet							
	Yes	35	Yes	27	Yes	30	Yes	92
	No	31	No	19	No	25	No	75
	IS: Other							
	Yes	5	Yes	1	Yes	2	Yes	8
	No	61	No	45	No	53	No	159
Question 2c	**In which information format was this information transferred? (multiple answers are possible)**							
	IF: Text							
	Yes	55	Yes	38	Yes	45	Yes	138
	No	11	No	8	No	10	No	29
	IF: Maps							
	Yes	20	Yes	12	Yes	15	Yes	47
	No	46	No	34	No	40	No	120
	IF: Graphs							
	Yes	27	Yes	13	Yes	16	Yes	56
	No	39	No	33	No	39	No	111

	IF: Oral							
	Yes	12	Yes	14	Yes	19	Yes	45
	No	54	No	32	No	36	No	122
	IF: Images/photo's							
	Yes	29	Yes	24	Yes	26	Yes	79
	No	37	No	22	No	29	No	88
	IF: Video							
	Yes	29	Yes	22	Yes	22	Yes	63
	No	37	No	24	No	33	No	104
	IF: Other							
	Yes	2	Yes	1	Yes	0	Yes	3
	No	64	No	45	No	55	No	164
Question 3a	**Are you familiar with the predicted impacts in your own neighbourhood or property if an extreme precipitation event would take place? (e.g. the risk of experiencing pluvial flooding, flood heights, etc.)**							
	Yes	15	Yes	18	Yes	18	Yes	51
	No	51	No	28	No	37	No	116
Question 3b	**How did you lean about these impacts? (multiple answers possible)**							
	IS: News							
	Yes	9	Yes	9	Yes	8	Yes	26
	No	57	No	37	No	47	No	141
	IS: Scientific journals / policy documents							
	Yes	2	Yes	7	Yes	8	Yes	17
	No	64	No	39	No	47	No	150
	IS: Heard from other people							
	Yes	4	Yes	4	Yes	4	Yes	12
	No	62	No	42	No	51	No	155
	IS: Read/saw about it on TV/books/internet							
	Yes	9	Yes	7	Yes	10	Yes	26
	No	57	No	39	No	45	No	141
	IS: Other							
	Yes	3		6	Yes	5	Yes	14
	No	63		40	No	50	No	153
Question 3c	**In which information format was this information transferred? (multiple answers are possible)**							
	IF: Text							
	Yes	13	Yes	14	Yes	13	Yes	40
	No	53	No	32	No	42	No	127
	IF: Maps							
	Yes	8	Yes	3	Yes	4	Yes	15
	No	58	No	43	No	51	No	152
	IF: Graphs							
	Yes	6	Yes	3	Yes	4	Yes	13
	No	60	No	43	No	51	No	154

	IF: Oral							
	Yes	6	Yes	6	Yes	7	Yes	19
	No	60	No	40	No	48	No	148
	IF: Images/photo's							
	Yes	8	Yes	3	Yes	8	Yes	19
	No	58	No	39	No	47	No	148
	IF: Video							
	Yes	5	Yes	3	Yes	6	Yes	14
	No	61	No	43	No	49	No	153
	IF: Other							
	Yes	0	Yes	4	Yes	2		6
	No	66	No	42	No	53		161
Question 4a	**Did you experience a form of pluvial flooding in the past?**							
	Yes	28	Yes	36	Yes	39	Yes	103
	No	38	No	10	No	16	No	64
Question 4b	**In what way did you experience pluvial flooding? (multiple answers possible)**							
	Flooded street(s) in the surroundings							
	Yes	17	Yes	29	Yes	36	Yes	82
	No	49	No	17	No	19	No	85
	Flooded property (e.g. garden)							
	Yes	8	Yes	16	Yes	8	Yes	32
	No	58	No	30	No	47	No	135
	Flooded house							
	Yes	4	Yes	11	Yes	1	Yes	16
	No	62	No	35	No	54	No	151
	Other							
	Yes	13	Yes	11	Yes	14	Yes	38
	No	53	No	35	No	41	No	129
Question 5a	**Do you know other people who have experienced pluvial flooding in the past?**							
	Yes	32	Yes	34	Yes	32	Yes	98
	No	34	No	12	No	23	No	69
Question 5b	**In what way did they experience pluvial flooding? (multiple answers possible)**							
	Flooded street(s) in the surroundings							
	Yes	23	Yes	30	Yes	26	Yes	79
	No	43	No	16	No	29	No	88
	Flooded property (e.g. garden)							
	Yes	14	Yes	24	Yes	14	Yes	52
	No	52	No	22	No	41	No	115
	Flooded house							
	Yes	14	Yes	15	Yes	8	Yes	37
	No	52	No	31	No	47	No	130

	Other							
	Yes	5	Yes	3	Yes	5	Yes	13
	No	61	No	43	No	50	No	154
Question 6a	**Are you familiar with the role you as a citizen can have to prevent pluvial flooding?**							
	Yes	33	Yes	24	Yes	27	Yes	84
	No	33	No	22	No	28	No	83
Question 6c	**Do you agree with this legal role you have as a citizen? Or do you think the municipality should carry more responsibility?**							
	I agree with the role for citizens dicated by legislation							
	Yes	41	Yes	21	Yes	33	Yes	95
	No	25	No	25	No	22	No	72
	Responsibility should move more towards the municipality							
	Yes	10	Yes	16	Yes	12	Yes	38
	No	56	No	30	No	43	No	129
	No opinion							
	Yes	4	Yes	2	Yes	5	Yes	11
	No	62	No	44	No	50	No	156
	Other							
	Yes	11	Yes	7	Yes	5	Yes	23
	No	55	No	39	No	50	No	144
Question 7a	**Do you have a garden?**							
	Yes	66	Yes	46	Yes	55	Yes	167
	No	0	No	0	No	0	No	0
Question 8a	**Did you do implement measures on your property that may contribute to storing, retaining, or infiltration rainwater on your property?**							
	Yes	31	Yes	28	Yes	38	Yes	97
	No	35	No	18	No	17	No	70
Question 8d	**Did your own experiences, or the experiences of others with pluvial flooding played a role in the decision to also take measures yourself? (When yes was filled in at questions 4a or 5a)**							
	Yes	5	Yes	14	Yes	14	Yes	33
	No	11	No	12	No	15	No	38
Question 8e	**Did the fact that you had knowledge about the problems pluvial flooding can cause played a role in the decision to implement measures (when yes is filled in at question 1a)**							
	Yes	20	Yes	21	Yes	22	Yes	63
	No	8	No	6	No	16	No	30
Question 8f	**Are your planning on implementing additional measures that contribute to the ability of storing, retaining or infiltrating rainwater on your property?**							
	Yes	9	Yes	9	Yes	17	Yes	35
	No	7	No	19	No	21	No	47
Question 8h	**What are the reason(s) that you may have not implemented measures on your property? (multiple answers possible)**							
	Financial reasons							
	Yes	3	Yes	4	Yes	2	Yes	9
	No	32	No	14	No	15	No	61
	Lack of time							
	Yes	4	Yes	3	Yes	3	Yes	10
	No	31	No	15	No	14	No	60

	Lack of knowledge about potential measures							
	Yes	11	Yes	5	Yes	3	Yes	19
	No	24	No	13	No	14	No	51
	Lack of knowledge about role citizens to reduce pluvial flooding risk							
	Yes	10	Yes	3	Yes	3	Yes	16
	No	25	No	15	No	14	No	54
	There were already enough measures taken when I started living here							
	Yes	4	Yes	5	Yes	1	Yes	10
	No	31	No	13	No	14	No	60
	There is enough unhardened surface on my property							
	Yes	17	Yes	8	Yes	6	Yes	31
	No	18	No	10	No	11	No	39
	Didn't felt necessary							
	Yes	11	Yes	3	Yes	6	Yes	20
	No	24	No	15	No	11	No	50
	Other							
	Yes	2	Yes	2	Yes	1	Yes	5
	No	33	No	16	No	16	No	65
Question 8j	**Would you have wanted to implement measures if you not had these barriers? (If 'financial reasons; lack of time; lack of knowledge about potential measures; lack of knowledge about role citizens towards pluvial flooding' were selected in question 8h)**							
	Yes	18	Yes	10	Yes	9	Yes	37
	No	8	No	3	No	4	No	15
Question 8l	**Would you be willing to invest in potential measures if there was subsidy available to reduce the cost of these measures? (if 'financial reasons' was picked in question 8h).**							
	Yes	1	Yes	3	Yes	2	Yes	6
	No	2	No	1	No	0	No	3
Question 9a	**Have you taken measures that can prevent or limit the damage in your house in the case of pluvial flooding?**							
	Yes	11	Yes	12	Yes	13	Yes	36
	No	55	No	34	No	42	No	131
Question 9d	**Did your own experiences, or the experiences of others with pluvial flooding played a role in the decision to also take measures yourself? (When yes was filled in at questions 4a or 5a)**							
	Yes	3	Yes	9	Yes	7	Yes	19
	No	5	No	3	No	4	No	10
Question 9e	**Does the fact that you had knowledge about the problems pluvial flooding can cause played a role in the decision to implement measures (when yes is filled in at question 1a)**							
	Yes	7	Yes	7	Yes	11	Yes	25
	No	3	No	4	No	1	No	8
Question 9f	**Are you planning of implementing more measures in your house that can prevent or limit pluvial flooding damage in your house in the future?**							
	Yes	4	Yes	4	Yes	5	Yes	13
	No	7	No	8	No	8	No	23
Question 9h	**What are the reason(s) that you have not implemented such measures in your house? (multiple answers possible)**							
	Financial reasons							
	Yes	5	Yes	8	Yes	5	Yes	18
	No	50	No	26	No	37	No	113

	Lack of time							
	Yes	3	Yes	3	Yes	0	Yes	6
	No	52	No	31	No	42	No	125
	Lack of knowledge about potential measures							
	Yes	11	Yes	7	Yes	8	Yes	25
	No	44	No	27	No	34	No	106
	Lack of knowledge about to potential necessity							
	Yes	12	Yes	6	Yes	8	Yes	26
	No	43	No	28	No	34	No	105
	There were already enough measures taken when I started living here							
	Yes	8	Yes	9	Yes	11	Yes	28
	No	47	No	25	No	31	No	103
	Didn't felt necessary							
	Yes	31	Yes	13	Yes	17	Yes	61
	No	24	No	21	No	25	No	70
	Other							
	Yes	9	Yes	12	Yes	9	Yes	30
	No	46	No	22	No	33	No	101
Question 9j	**Would you have wanted to implement measures if you not had these barriers? (If 'financial reasons; lack of time; lack of knowledge about potential measures; lack of knowledge about potential necessity' were selected in question 9h)**							
	Yes	16	Yes	10	Yes	15	Yes	41
	No	10	No	10	No	9	No	29
Question 9l	**Would you be willing to invest in potential measures if there was subsidy available to reduce the cost of these measures? (if 'financial reasons' was picked in question 9h).**							
	Yes	3	Yes	3	Yes	2	Yes	8
	No	2	No	2	No	3	No	6
Question 10a	**Are you familiar with national or regional initiatives that try to raise the awareness of citizens about what they can do to reduce pluvial flooding vulnerability and occurrence, or that try to help them stimulate into acting?**							
	Yes	15	Yes	11	Yes	16	Yes	42
	No	51	No	35	No	39	No	125
Question 10b	**If such an initiative would be started in your neighbourhood, would you then participate in it?**							
	Yes	23	Yes	11	Yes	20	Yes	54
	Maybe	40	Maybe	31	Maybe	33	Maybe	104
	No	3	No	4	No	2	No	9
Question 10c	**If you had the required necessities, would you then start such an initiative yourself in your neighbourhood?**							
	Yes	3	Yes	4	Yes	5	Yes	12
	Maybe	28	Maybe	17	Maybe	24	Maybe	69
	No	35	No	25	No	26	No	86
Question 11	**What is your sex?**							
	Man	34	Man	30	Man	36	Man	100
	Woman	41	Woman	15	Woman	19	Woman	65
	Other	0	Other	0	Other	0	Other	0
	Don't want to say	1	Don't want to say	1	Don't want to say	0	Don't want to say	2

Question 13	**What is your ethnical background?**							
	Dutch	62	Dutch	45	Dutch	54	Dutch	159
	Migration	0	Migration	0	Migration	0	Migration	0
	Don't want to say	6	Don't want to say	1	Don't want to say	1	Don't want to say	8
Question 14	**What is your marital status?**							
	Single	11	Single	11	Single	4	Single	26
	Living together	6	Living together	5	Living together	6	Living together	17
	Cohabitation	5	Cohabitation	1	Cohabitation	3	Cohabitation	9
	Registrated partnership	1	Registrated partnership	3	Registrated partnership	0	Registrated partnership	4
	Married	39	Married	23	Married	36	Married	88
	Divorced	0	Divorced	2	Divorced	2	Divorced	4
	Widowed	2	Widowed	0	Widowed	1	Widowed	3
	Don't want to say	2	Don't want to say	1	Don't want to say	3	Don't want to say	6
Question 15	**What is your highest finished education?**							
	No education	0	No education	0	No education	0	No education	0
	Primary	0	Primary	0	Primary	0	Primary	0
	Lower vocational	0	Lower vocational	1	Lower vocational	1	Lower vocational	2
	General secondary	5	General secondary	3	General secondary	4	General secondary	12
	Secondary vocational	6	Secondary vocational	8	Secondary vocational	10	Secondary vocational	24
	Higher secondary	8	Higher secondary	5	Higher secondary	5	Higher secondary	18
	University of Applied sciences	28	University of Applied sciences	20	University of Applied sciences	29	University of Applied sciences	77
	University (bachelor)	4	University (bachelor)	1	University (bachelor)	1	University (bachelor)	6
	University (master)	9	University (master)	4	University (master)	2	University (master)	15
	Doctoral	5	Doctoral	3	Doctoral	0	Doctoral	8
	Don't want to say	1	Don't want to say	1	Don't want to say	1	Don't want to say	3
Question 18	**Do you have a home- or contents sinsurance?**							
	Home insurance	6	Home insurance	10	Home insurance	4	Home insurance	20
	Contents insurance	1	Contents insurance	0	Contents insurance	5	Contents insurance	6
	Both	58	Both	36	Both	45	Both	139
	None	0	None	0	None	0	None	0
	Do not know	2	Do not know	0	Do not know	1	Do not know	3
Question 19a	**Who is the owner of the propery?**							
	Own property	66	Own property	37	Own property	52	Own property	155
	Rented	0	Rented	9	Rented	3	Rented	12

Example of a survey flyer

Geachte wijkbewoner

Voor mijn scriptie ter afsluiting van mijn studie aan de Rijksuniversiteit Groningen ben ik op dit moment onderzoek aan het doen in uw wijk. Hierover is ook al overleg geweest met uw gemeente. Het onderzoek gaat, onder andere, over de mogelijke maatregelen die bewoners van deze wijk hebben genomen tegen wateroverlast die veroorzaakt wordt door hevige neerslag. Ik ben hiervoor onder andere geïnteresseerd in:

- uw kennis over dit probleem
- de maatregelen die u mogelijk genomen heeft op uw perceel
- de factoren die mogelijk uw keuze heeft beïnvloed om hier wel of niet mee aan de slag te zijn gegaan.

Graag zou ik uw medewerking willen vragen om mij te helpen bij mijn onderzoek. Mocht u willen meewerken, dan kunt u in de internetbrowser op uw computer, tablet of telefoon de onderstaande link typen, of de QR-code scannen met uw telefoon. Deze zal u dan doorsturen naar de betreffende internet-enquête. Het kost ongeveer 5 tot 10 minuten om deze in te vullen.

Een verder bijkomend voordeel is dat u, door mee te werken aan de enquête, ook informatie kunt krijgen over hoe u zelf bij kunt dragen aan het wateroverlast-bestendig maken van uw wijk. Hierover zal meer uitleg worden gegeven tijdens de enquête.

bit.ly/drachten-swetten	

Alvast bedankt voor uw aandacht en eventuele mogelijke medewerking aan het onderzoek.

Met vriendelijke groet,
Gerben Koers

Vragen? Stuur een mail naar: g.j.koers.1@student.rug.nl

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